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Research at the Bulgarian Academy of Sciences

Panel 1 Report:
Mathematical Sciences,
Physical Sciences, Chemical Sciences,
Engineering Sciences

Volume 2 of 5

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БЪЛГАРСКА АКАДЕМИЯ НА НАУКИТЕ

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Acknowledgements

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The Review Committee wishes to thank all the people who have contributed to the planning and execution of this evaluation exercise including the preparation of the reports. Our special thanks are due to the members of staff of the BAS Institutes who prepared the Self-Evaluation Reports, thus providing the data without which an evaluation such as this would not be possible. We also owe our gratitude and respect to those whom we met during our site visits and interviews for their frank and open attitude that has helped us greatly in understanding the environment and context in which they operate. We applaud the BAS leadership for its consistent support and its encouragement in applying strict international quality standards to this evaluation, even though the conditions for research in Bulgaria are comparatively difficult. Our understanding is that our findings will be used for the purpose for which they are intended: to improve the quality and impact of research in Bulgaria and we are looking forward to the results.

Finally, our work could not have been done without the support of the staff of ESF and ALLEA. Our special thanks go to Dr. Astrid Lunkes, Dr. Bernard Avril, Dr. Farzam Ranjbaran and Dr. Rüdiger Klein as scientific secretaries of the panels. Dr. Klein and Dr. Ranjbaran also acted as secretaries of the Review Monitoring Committee and coordinated its activities including support to the preparation of the final reports.

Contents

Preamble

This report is prepared by the members of the Panel of Experts (PE-1) assembled as part of the ESF-ALLEA evaluation of the Research institutes of the Bulgarian Academy of Sciences (BAS). This panel was responsible for the evaluation of the research units (or institutes) within the four divisions of the BAS outlined below:

Division 1- Mathematical sciences with 3 institutes
Division 2- Physical Sciences with 7 institutes
Division 3- Chemical Sciences with 8 institutes
Division 6- Engineering Sciences with 7 institutes

PE-1 consisted of thirteen members (listed in Table 1) for the evaluation of the 25 institutes within the abovementioned divisions. Professor Juan M. Rojo chaired the panel with secretarial support provided by ESF staff member Dr. Farzam Ranjbaran.

Table 1: Members of PE-1

Professor	Marcel	Arnould	Institut d'Astronomie et d'Astrophysique, Université Libre de Bruxelles, Belgium
Professor	Martin	Berggren	Department of Computing Science, Umeå Universitet, Sweden
Professor	Jean	Cadet (*)	Commissariat à l'Energie Atomique, CEA/Grenoble, France
Dr.	Barbara	Camanzi	Department of Particle Physics, Science and Technology Facilities Council, UK
Professor	Henryk	Chojnacki	Institute of Physical and Theoretical Chemistry, Faculty of Chemistry, Wrocław Technical University, Poland
Professor	João Pedro	Conde	Department of Chemical and Biological Engineering, Instituto Superior Técnico, Portugal
Professor	Manfred	Husty	Arbeitsbereich Geometrie und CAD, Leopold-Franzens-Universität Innsbruck, Austria
Professor	Laurens	Katgerman	Department of Materials Science and Engineering, Delft University of Technology, Netherlands
Mr.	Per Wilhelm	Nieuwejaar	Research Vessel Department, Institute of Marine, Research, Norway
Professor	Jozef	Novak	Institute of Electrical Engineering, Slovak Academy of Sciences, Slovakia
Professor	Antonio	Pascoal	Department of Electrical Engineering, Institute for Systems and Robotics, Portugal
Professor	Juan	Rojo	Dpto Física de Materiales, Universidad Complutense de Madrid, Spain (Chair of Panel 1)
Dr	Jean-Yves	Salpin	CNRS, HDR, Laboratoire Analyse et Modélisation pour la Biologie et l'Environnement, Université d'Evry, France
Professor	Gábor	Speier	Department of Chemistry, University of Pannonia, Hungary

(*)Professor Jean Cadet joined the panel in the beginning but had to discontinue his involvement due to unforeseen events. He started the evaluation process and submitted the first draft of the Institute-level reports for those he had been assigned to but was unable to

attend the site visits and interviews. Dr Jean-Yves Salpin joined the panel and continued the work of Professor Cadet after the meeting of the panel in Amsterdam in June 2009.

The Panel-level report prepared by the Chair of PE-1, with inputs from the other members of the panel, is provided in Part 1 of this document. Part 2 of the report contains the individual Institute-level reports grouped under the four divisions in the panel.

Each institute was assigned one Lead Rapporteur (LR), one Co-Rapporteur (CR) and one Cross-Institute Rapporteur (XR). The panel has prepared the report based on initial assessments of the rapporteurs and following additional information gathering, and detailed discussions at their meetings in Amsterdam (11-12 June) and in Sofia (during 6-11 July). Specifically, the Lead rapporteurs drafted the first version of the Institute-level assessments based on the Self-Evaluation reports submitted by the institutes, their own investigations and analysis, as well as the inputs from the other two rapporteurs. These initial assessments underwent overall panel discussions in the June meeting leading to a set of additional questions and information being requested from the institutes. It was also at this meeting that a preliminary set of scores were given to all the institutes. Finally, the case for which laboratories must be visited in Sofia and which ones should be delegating a representing team that would be interviewed at the BAS Headquarters was also discussed and the conclusions were made. The panel's recommendation was that in order to provide the most effective and fair assessment, it was not necessary to physically appear at the premises of all the institutes. This decision was driven by the expected level of added benefit for a physical tour of the facilities rather than the discussions and interviews of the selected group of staff including early career researchers. Table 2 shows which institutes were physically visited in addition to the on-site interviews and which ones had their delegation interviewed at the BAS Headquarters.

Most of the members arrived in Sofia on 5 July and departed on 11 or 12 July. During 6.5 days of intense activities, the panel met representatives of each of the 25 institutes either at the BAS Headquarters or at the institute's location. At the end of each day, the panel met for extensive debriefing and discussions on the day's activities and findings. The last day and a half in Sofia was dedicated to panel discussions, final scoring, main recommendations, and drafting of the final Institute-level reports. The final reports were mostly completed before departing with some follow-on editing and changes approved by the rapporteurs.

Overall, the panel demonstrated a very strong commitment, engagement and enthusiasm for the task in hand, and provided their best efforts in the most generous and professional manner. In Sofia, the members of PE-1 alone collectively provided more than 1000 person-hours of meetings, deliberations, visits and interviews.

Table 2: Institutes covered by PE-1 evaluation

No.	Institute Name	Interview	Visit + Interview
101	Institute of Mathematics and Informatics	X	
102	Institute of Mechanics		X
103	Institute for Parallel Information Processing	X	
201	Institute for Nuclear Research and Nuclear Energy	X	
202	Institute for Solid State Physics		X
203	Institute for Electronics	X	
204	Institute for Astronomy with National Astronomical Observatory (Rozhen)		X
205	Central Laboratory of Solar Energy Sources	X	
206	Central Laboratory for Applied Physics (Plovdiv)		X
207	Central Laboratory of Optical Storage and Processing of Information	X	
301	Institute of General and Inorganic Chemistry		X
302	Institute of Organic Chemistry with a Center of Phyto-Chemistry		X
303	Institute of Physical Chemistry	X	
304	Institute of Catalysis	X	
305	Institute of Electrochemistry and Energy Systems	X	
306	Institute of Chemical Engineering		X
307	Institute of Polymers		X
308	Central Laboratory of Photoprocesses		X
601	Institute of Metal Science		X
602	Bulgarian Ship Hydrodynamics Center	X	
603	Institute of Computer and Communication Systems	X	
604	Institute of Information Technologies	X	
605	Institute of Control and System Research		X
606	Central Laboratory of Mechatronics and Instrumentation		X
607	Central Laboratory of Physico-Chemical Mechanics	X	

Part A: Panel-level report

1. Overall summary of the institute-level scores

In this section, the scores given to all institutes for the three criteria are summarised.

Table 1.1: Scores for all institutes in PE-1

No.	Institute Name	Quality and Productivity	Relevance: Socio-economic Impact	Prospects
101	Institute of Mathematics and Informatics	A	A	B
102	Institute of Mechanics	B	B	B
103	Institute for Parallel Information Processing	B	A	A
201	Institute for Nuclear Research and Nuclear Energy (Unit 1)	A	A	A
	Institute for Nuclear Research and Nuclear Energy (Unit 2)	B	A	B
	Institute for Nuclear Research and Nuclear Energy (Unit 3)	B	A	B
202	Institute for Solid State Physics	B	A	A
203	Institute for Electronics	B	A	B
204	Institute for Astronomy with National Astronomical Observatory (Rozhen)	C	A	C
205	Central Laboratory of Solar Energy Sources	B	B	C
206	Central Laboratory for Applied Physics (Plovdiv)	C	B	B
207	Central Laboratory of Optical Storage and Processing of Information	B	B	B
301	Institute of General and Inorganic Chemistry	B	A	B
302	Institute of Organic Chemistry with a Center of Phyto-Chemistry	A	A	B
303	Institute of Physical Chemistry	B	B	B
304	Institute of Catalysis	B	B	B
305	Institute of Electrochemistry and Energy Systems	A	A	A
306	Institute of Chemical Engineering	B	B	A
307	Institute of Polymers	A	A	A
308	Central Laboratory of Photoprocesses	A	A	A
601	Institute of Metal Science	C	B	C
602	Bulgarian Ship Hydrodynamics Center (Varna)	C	A	B
603	Institute of Computer and Communication Systems	C	C	C
604	institutes of Information Technologies	C	B	B
605	Institute of Control and System Research	B	B	B
606	Central Laboratory of Mechatronics and Instrumentation	C	A	B
607	Central Laboratory of Physico-Chemical Mechanics	C	B	C

It should be noted that because of the large size of the Institute for Nuclear Research and Nuclear Energy (201), the panel decided to provide three sets of scores to the Institute instead of only one set. The breakdown of the Institute into three constituting units indicated in Table 1.1 is meant to provide more precision to the assessment (see Part 2: Institute report page 36). These are:

Unit 1: Theoretical and experimental nuclear and particle physics and astrophysics, including mathematical theory
Unit 2: Applications
Unit 3: Facilities

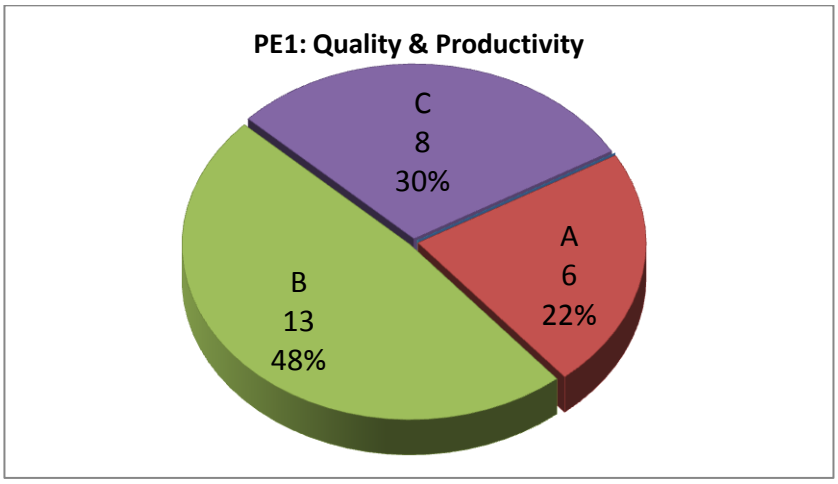


Figure 1.1: Distribution of scores for Quality and Productivity for all PE-1 institutes

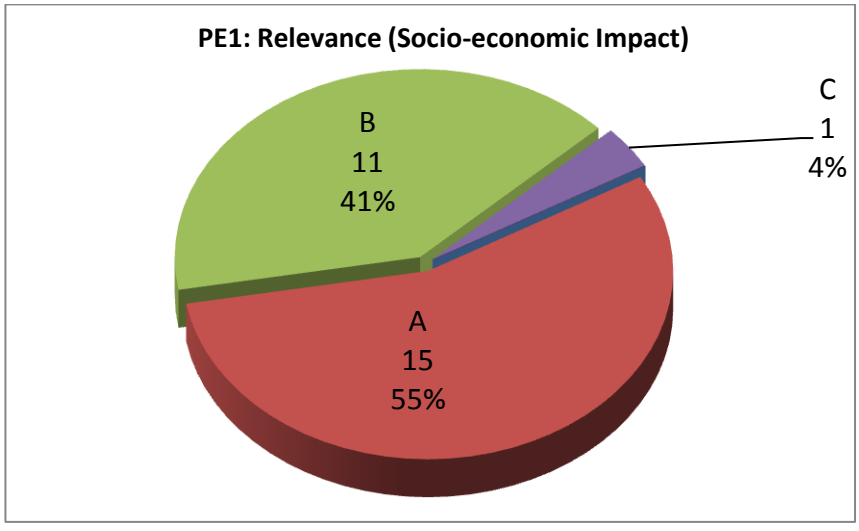


Figure 1.2: Distribution of scores for socio-economic impact for all PE-1 institutes

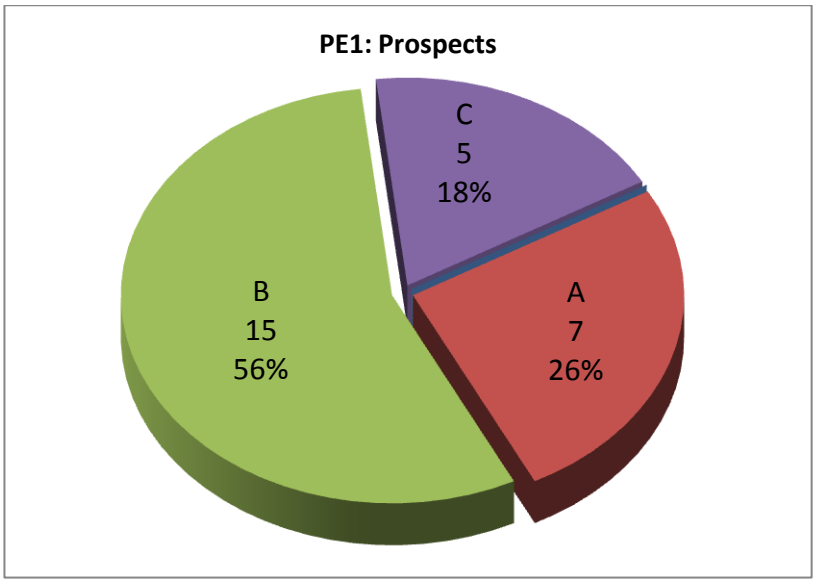


Figure 1.3: Distribution of scores for Prospects for all PE-1 institutes

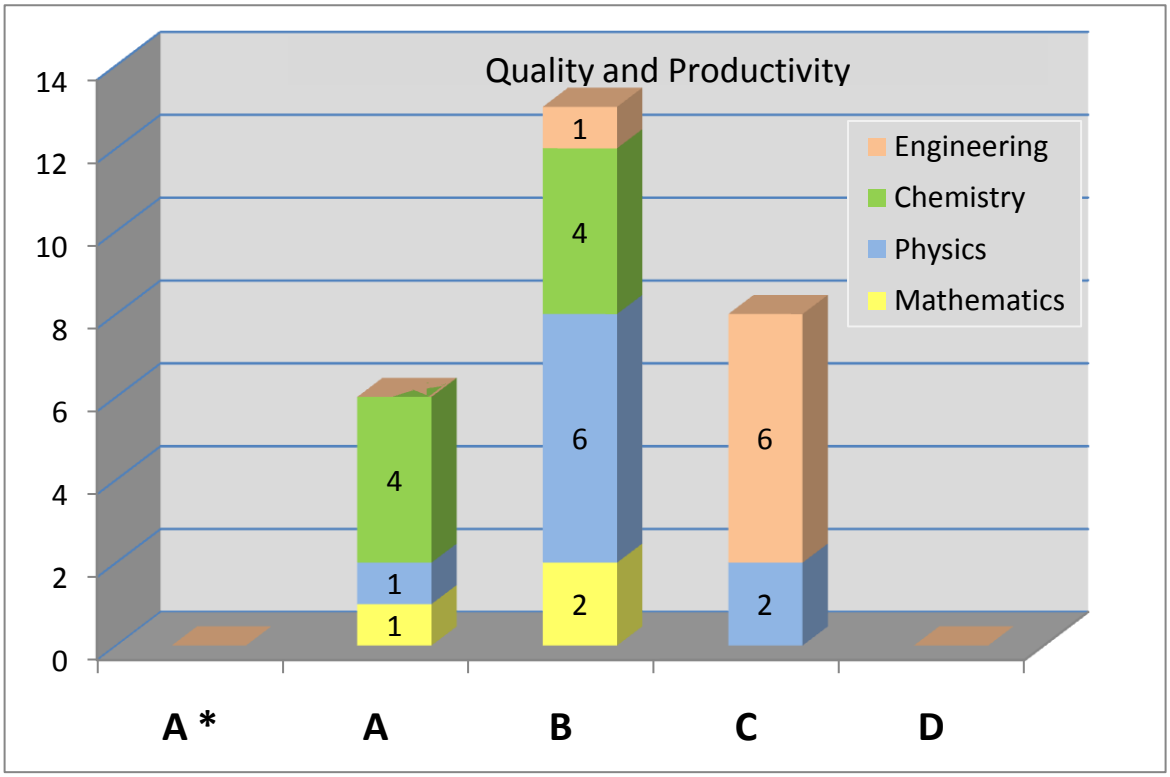


Figure 1.4: Distribution of scores for Quality and Productivity across divisions of PE-1

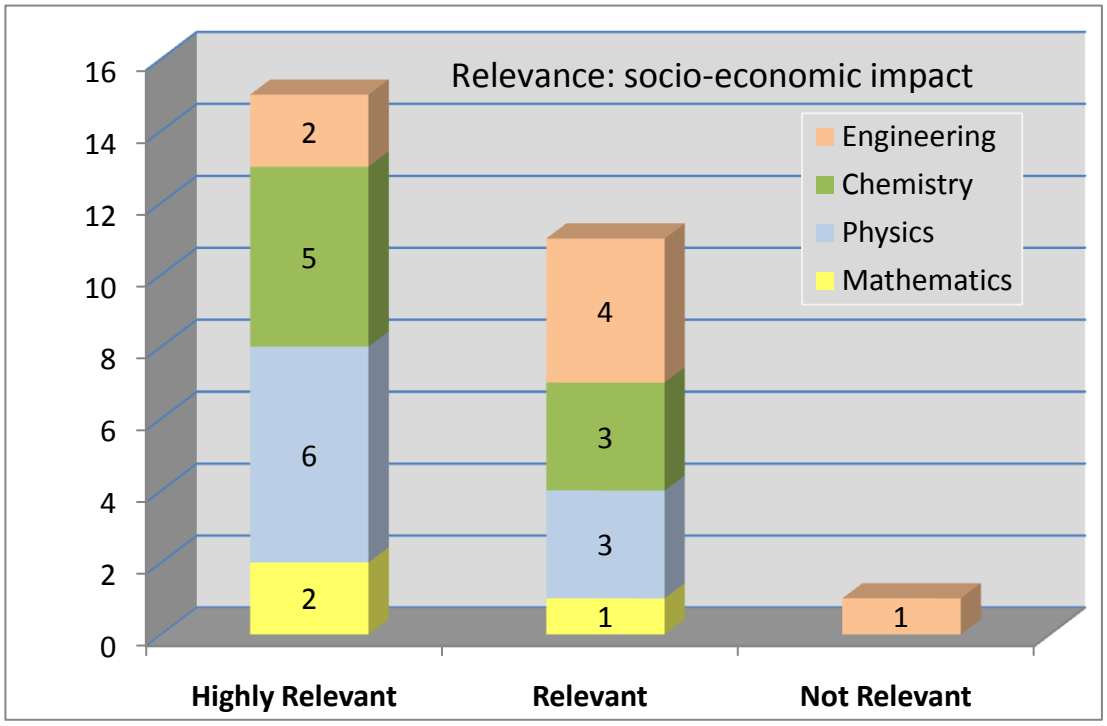


Figure 1.5: Distribution of scores for socio-economic impact across divisions of PE-1

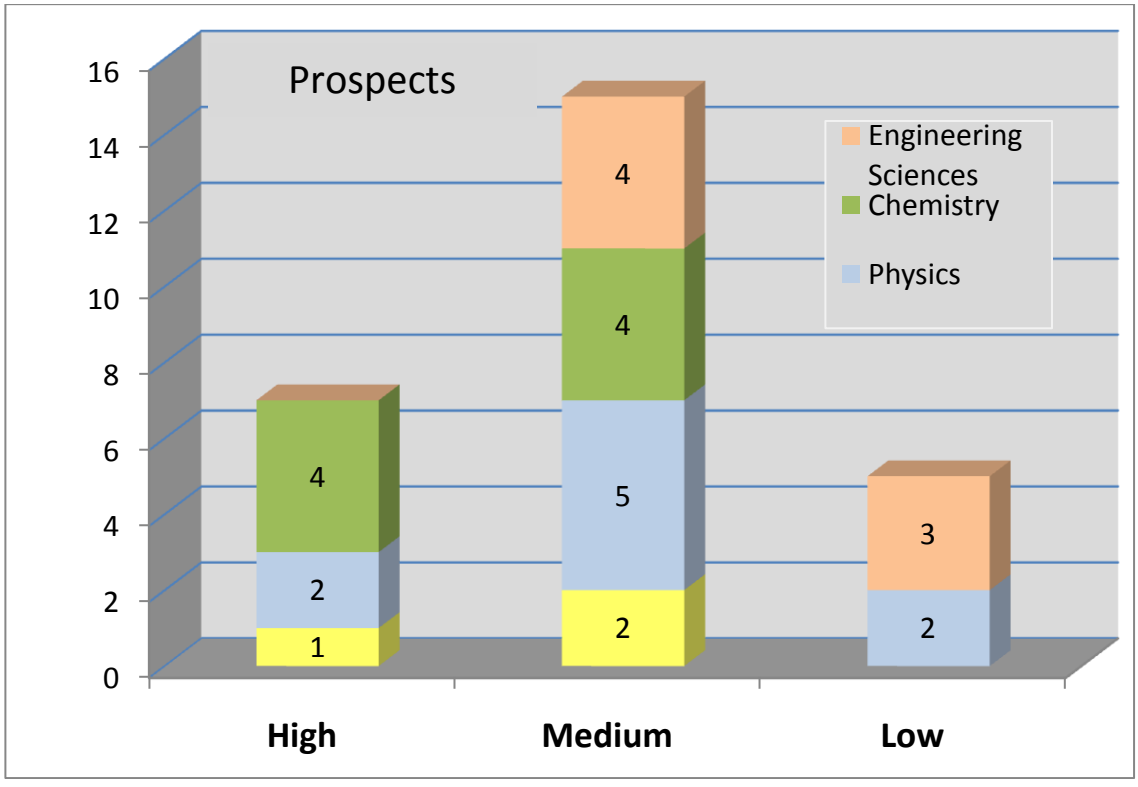


Figure 1.6: Distribution of scores for Prospects across divisions of PE-1

2. Cross-disciplinary considerations (across four divisions)

After analysing the Self-Evaluation Reports (SERs) and discussing the site visits and interviews in Sofia, the panel has little doubt that there is a cluster of BAS institutes (or laboratories; in the following we shall use the term 'institutes' when generically referring to both) which, in spite of the sometimes harsh conditions, produce very good science. It has also become clear that these institutes have made a great effort in networking their research, particularly at the European level. The panel has attempted to explicitly identify such institutes. In a number of cases, especially for the largest institutes, the panel has gone one step further by providing an evaluation at the level of smaller units. This has been motivated to provide enhanced 'resolution' as a result of one of the panel's main concerns not to underevaluate a high-quality group as a consequence of being placed in a scientifically weaker environment.

Analysing the young researchers' careers has been, perhaps, the key subject of the panel's general discussion. Whereas talent and potential were apparent among the young researchers, the panel found too little sense of research competition. The scientific perspective of the institute researchers seemed to be established from the very beginning of their careers–including the fact that most of them held permanent positions, even before their PhD–and there was no clear and explicit driving force towards achieving outstanding performance. Perhaps this is the reason why the panel found so little proclivity in the young scientists holding a PhD to launch independent lines of work or to take advantage of the many opportunities now existing to spend a post-doctoral stage in a foreign laboratory.

A number of specific problems arise in connection with institutes whose centre of gravity is in the Engineering Sciences. The evaluation of these industry-biased or sometimes what were perceived as commercially driven institutes is frequently made very difficult because the application to engineering of scientific scoring criteria, often derived from the Natural Sciences, results in certain inconsistencies. For this reason, care has to be taken when analysing the first criterion of Scientific Quality and Productivity in the scoring of the individual institutes of Division 4 (Engineering Sciences). This criterion refers only to scientific production of international relevance. It might turn out that to assess the output of these institutes the scoring of the second criterion of Socio-economic Impact is of the same–sometimes even of more–significance. The panel's first recommendation, claiming for the need for clearer definitions of the institute's mission, might in the future be helpful to balance out the scores for the first two criteria (columns 1 and 2 of Table 1.1).

3. Panel-level strengths and weaknesses

Comments on overlaps, redundancies, synergies, potential for cooperation and other structural re-arrangements that were found to be important in strengthening the Bulgarian Academy of Science are set out below.

Strengths

Although there are differences, sometimes profound, between the different institutes, a number of common strengths can be identified. They are listed below. It is hoped that BAS can build on these strengths to carry out the necessary changes which will lead to the most efficient and qualified research system in Bulgaria.

- Very good links with universities.
- When relevant (this is not the case for astronomy or mathematical physics), strong commercial exploitation and experience in working with industry. Although up to now, it is often kept at a low level, test-like or *ad hoc*, cooperation. Capable, however, of evolving into R&D projects.
- Manpower: The Panel was impressed by many well-trained and bright researchers. Young people–albeit not in sufficient numbers–of great potential.
- The institutes are progressively getting used to competitive funding via NSF calls.
- The institutes are increasingly opening up to and seeking international collaboration via EC programmes.

Weaknesses

In the course of the visits, some weaknesses previously detected in the SERs became more visible. After much discussion, the Panel has summarised these weaknesses and made some suggestions on how to alleviate them. These are discussed in Section 4 in connection with specific recommendations.

4. Panel-level recommendations

For the sake of clarity, we shall address this section by dividing the Panel's recommendations into four sections: Strategy, Cooperation, Personnel and Funding.

4.1 Strategy

- The BAS encompasses a wide variety of institutes with research objectives that go from the very basic sciences to applications closely connected with industry. These activities entail different objectives, have different funding sources and require evaluation with dissimilar yardsticks. The panel has found that, in a number of institutes, those different objectives are not clearly differentiated.

It is recommended that each institute define its mission accurately and that, in this regard, it analyses its position within the full spectrum of the R&D system. In particular, the institutes should state their perspective and strategy on how to balance their commitment to scientific research versus seeking commercial success and technological development. The institutes centred on the creation of scientific knowledge should be advised to seek international recognition by publishing in better journals and encouraging the presence of their scientists at international events. International leadership in large projects should be an aim of utmost importance. Those with their mission centred on technology should strengthen their links with industry, develop joint R&D programmes and improve their patent records. More explicit and structured transfer of knowledge between institutes and industry should be encouraged as part of the academia-industry relations.

- Several of the institutes were found to be heavily involved in publishing their own journals. In some cases, the bulk of the research output is limited to publishing in these journals or in the proceedings of locally organised conferences and workshops. The panel believes that too much focus on local publishing is problematic for several reasons, among them: international visibility generally suffers; it may be difficult to uphold truly independent peer-review; and the practice carries a risk of scientific isolation.

The panel recommends the institutes to adopt a policy of encouraging researchers to publish primarily in internationally ranked journals (and highly ranked international conferences in areas such as Computer Science where dissemination at conferences dominates the scientific exchange). Moreover, the institutes should also consider a significant reduction of their locally produced publications.

- In the course of the visits, a considerable degree of overlap among the institutes has been recognised, both in relation to scope and objectives and in regard to equipment duplication. It even appeared, in some cases, that a line of research which was presented as a new development in an institute was found to have been previously set up in another one without any mutual recognition. Even if a certain degree of overlapping might be unavoidable or even beneficial, it should always be acknowledged and taken into account within the general strategy and overall policy of the academy and the institutes.

It is recommended that cooperation among the institutes is increased, while giving more attention to synergistic acquisition and use of major equipment and infrastructure. It is also recommended that the BAS should reinforce its present structures in promoting and valuing joint research programming of the institutes and provide central advice on their plans for large equipment acquisition.

- In spite of a noticeably increasing tendency to participate in transnational projects, particularly in those involving EC funding, many of the institutes are still too local in their objectives and methods. The institutes of BAS should be further encouraged and stimulated to open up to the outside world: i.e. universities, industry and foreign institutes. Also, some of the projects that are undertaken by BAS institutes have priority objectives that are no longer at the forefront of science today, or are not as timely as they should be. These criteria should be at the focus of a periodic analysis of the research objectives and strategies. The Scientific Council, as established by the present regulations for each institute, could be considered as the correct body in charge of such an analysis. In practice, however, the observation was that the councils are generally too local in composition and are primarily concerned with everyday managerial issues. Regarding management, the incorporation of younger researchers, elected by their colleagues, to the Scientific Council might help to identify the real problems of the institute and its researchers. On the other hand, for a number of main issues such as strategic thinking and mandates, definition of objectives, long-term evaluation and key appointments, the institutes require another type of instrument.

The panel recommends that, apart from maintaining a Scientific Council – as currently regulated with the possible inclusion of some young researchers – BAS nominates for each institute a Scientific Advisory Committee. This committee would be composed of scientists, mainly from foreign countries, industrialists and some representatives of universities. It would meet about once a year and would be informed about the scientific accomplishment of the institute and would debate fundamental issues such as the strategy of the institute, its long-term investment plan, a general plan to recruit personnel etc. It should be consulted before nominating a new Director of the Institute.

- Information services, including computers, efficient access to the World Wide Web, E-mail, databases, other specialised software and access to scientific literature, are key elements in the current scientific environment. In the past, some of the institutes have grown and managed their own ICT (Information and Communication Technologies) services and some others have borrowed from their neighbours. It is felt that BAS should plan for centrally managing the rapidly growing demands. The suggestion is:

Instead of developing ICT structures as departments of specific institutes, it is recommended that BAS should set up a central ICT structure for all its institutes, which would be considered as a scientific service and evaluated correspondingly. This central unit, in consultation with the institutes, would decide on the best configuration of the whole network and would manage that network once established.

4.2 Cooperation

- The panel has realised that most of the institutes have developed strong links with universities. In particular, many researchers from the institutes give lectures at different Bulgarian universities. However, in some cases, alarmingly high teaching loads have been detected, which could be detrimental to the performance of competitive research by the BAS scientists.

The panel recommends that BAS should introduce clear regulations, and in particular should set limits on the teaching loads of their researchers lecturing in universities, in order not to unduly hamper their research activities. BAS has to ensure that these restrictions will not create financial stress among their researchers.

- The subject of cooperation with industry was frequently evoked and a number of problems recognised in connection with that cooperation. As in many other countries, the evaluation of industry-biased or industry-driven institutes is frequently confused by difficulties stemming from the application to engineering of scientific scoring criteria derived mainly from the Natural Sciences. Apart from the definition of missions referred to above, each institute should consider whether some of its activities related to engineering projects with industries might not be better placed in a structure different from that of a BAS institute. This does not necessarily mean that this structure would have to be completely detached from the institute from which it originated. On the contrary, many intermediate structures can be conceived, for example in the aspect of a Foundation, a mixed laboratory etc. Among its likely benefits, this structure would have a far greater flexibility that could be highly beneficial in terms of transfer of knowledge between academia and industry. It could also be used to discriminate or augment salaries, attract young researchers etc.

The panel recommends that each institute with industry-biased activities explores the possibility of spinning off these activities into novel structures which are intermediate between the institute and an industry. These novel structures would be funded and evaluated mainly on the basis of their technological and industrial objectives.

- It is often found that the efficient exploitation of the technological advances of a scientific institute largely benefits from the help of an office specialised in the broad (national and international) dissemination and advertisement of these achievements. This office would increase the time dedicated to research of the scientific personnel and would free the researchers from an activity for which they are very poorly trained.

Explore the feasibility of setting-up an Office to support and disseminate the institute's technological achievements in order to optimise their transference to industry. In consultation with the institutes, it remains to be determined whether there should be only one Office for the whole BAS or whether some decentralisation by blocks of institutes would be more efficient.

- As stated above, the institutes are increasingly open to international collaboration via EC programmes. Apart from their important contribution to institute funding, EC programmes are excellent platforms to promote young researchers' international contacts. One must not forget also that, frequently, industries are partners of research institutes in EC programmes. This partnership could foster the development of an R&D culture in Bulgarian industries. Therefore, participation in EC programmes should be further encouraged:

The panel reminds the institutes of the many opportunities opened by the EC programmes and recommends that BAS disseminate ample information about the contents, deadlines and all other relevant characteristics of these. Specialised offices – perhaps located in the BAS itself – might be established or enhanced to facilitate contacts and to support the researchers and free them from excessive administrative requirements and bureaucratic intricacies.

4.3 Personnel

The future of BAS institutes is crucially dependent on the existence of well-trained, motivated and efficient personnel. The panel was favourably impressed by many of the researchers who were contacted during the course of the visits and interviews in Sofia. The potential of most of the young researchers is particularly to be remarked upon.

However, concerning personnel, there are a number of issues that require urgent consideration both from the point of view of BAS governance and managerial structures and from the institutes' directorates themselves. We discuss them as follows:

- The panel feels that it would be very important for BAS to clearly define and consistently apply research career programmes within their institutes, making sure that due recognition of scientific or technological performance remains the key factor for promotion or other benefits. Also, although this recommendation probably lies beyond the competences of BAS, the panel feels compelled to say a word about salaries. Of course, the figures themselves are a delicate economic and political issue, but something can be said about their relative values. For example, the panel was amazed to hear that if a PhD student, after successfully defending his/her thesis, obtains a contract from a BAS institute, his/her salary is likely to be reduced.

It is recommended that BAS defines a clear research career programme within its institutes, based on the recognition of scientific or technological performance. It should include a redefinition of PhD graduation in line with the procedures followed in other EU countries. Also, the salary structure has to be consistent with the evolution of the scientist's career.

- The pyramid age of most institutes is a matter of deep concern. In a number of institutes, the number of members of the research staff aged above 50 greatly exceeds the corresponding number below that age. The panel was informed that the existing regulation concerning retirement was being somehow sidestepped, although a number of institutes, mostly in the chemistry area, were enforcing it.

A plan of rejuvenation of the institutes is urgently needed. The panel thinks that the existing retirement regulation has to be strictly enforced. The possibility of developing an early retirement scheme could also be contemplated. The status of Emeritus Professor might be used to select those retiring professors whose permanence might be of special benefit to the institute.

- A particular matter of concern is related to what the panel has labelled as 'the age gap'. This gap in fact exists in the age distribution of most of the institutes' researchers and shows a profound dip in the 35-55 year range. This is especially troublesome taking into account the fact that researchers in that age group are the natural substitutes for managerial and executive positions.

A vigorous programme of repatriation of Bulgarian researchers working now in foreign institutions is necessary. For this programme to have scientific appeal for the brightest researchers, the possibility of dedicating special extra-funding to support the re-launching of the corresponding laboratories and starting of independent research groups should be considered.

- With a few exceptions both the number of PhDs currently working at the institutes and the total number of PhD dissertations defended in the past five years are low, sometimes very low indeed. Although explanations, based mainly on external factors, have been advanced, it is clear that a major effort in this regard can, and must, be made. In this regard, the panel feels that it is necessary to improve the situation of PhD students (as well as that of post-docs and early-career researchers) in terms of equipment support (e.g. personal computers), travel funds, study grants, support for temporary study/research abroad etc.

Increasing the number of PhDs in all the institutes must be given a clear priority. A definition of the standard research career at a BAS institute should be made. At the same time campaigns of information, publicity and recruitment at the universities must be vigorously carried out. Support for PhD students should be improved in terms of equipment aid, travel funds and study grants.

- Post-doctoral students ('postdocs') are universally considered as one of the most important contributors to innovative research at research centres. At the same time, the postdocs themselves generally receive their most efficient training at the end of this period of research. Unfortunately, the figure of the postdoc is practically absent from BAS institutes. Under the present stringent conditions, it is perhaps difficult to attract foreign postdocs to Bulgarian institutes, but there is no reason to impede the training of Bulgarian PhDs as postdocs in foreign institutions. In fact, this could be one of the most effective ways of modernising Bulgarian research systems. It has also to be remembered that the EC programmes largely favour the mobility of postdocs.

Post-doctoral training for PhDs initially trained in BAS institutes should be regarded as a most desirable complement to young-researcher training and a valuable asset for the future of the institute. When defining the research career–as suggested above–the obligation of complementing PhD training with a post-doctoral period should be introduced.

- In order to maintain an effective and continuous communication in the scientific environment, the scientists of the BAS have to have their access to the current world literature increased. Whereas some institutes seem to have resolved this problem, the Panel detected problems in many of the others (especially in remote ones, such as NAO-Rozhen).

The panel strongly recommends that access to the world scientific literature is made possible for each of the institutes. Researchers from BAS institutes must gain access not only to the current publications, but also to those which have appeared in the literature a reasonable number of years earlier.

4.4 Funding

The panel has in mind the difficulties arising from both the present economic crisis and the problems faced by the Bulgarian authorities in the past years after the changes. It also takes into account the terms of reference of the evaluation which laid stress on the fact that recommendations should be executable solely at BAS level. Yet societal issues are pervasive and it is difficult to isolate certain issues. In this section, recommendations that touch upon how to use existing funds are presented; however, some suggestions regarding actions somehow exceeding strict BAS boundaries are also included.

- Infrastructure and scientific equipment still need much upgrading. Although in certain institutes modern equipment is visible, there is much to be improved in order to reach the standards of comparable laboratories in most of the countries from which the panel members originate. Also, some kind of discrimination seems in place: new investments should aim at building up fewer and better equipped laboratories rather than dispersing the funding among a large number of ill-equipped local laboratories

Although this will not solely fall within the remit of the Academy's decision, and power, the panel wishes to point out that the institutes of BAS require an important investment in new equipment and, generally speaking, research infrastructure. For medium- and high-cost equipment, it is essential that the programme of acquisitions takes place under the control of an Academy committee in order to avoid duplications and to encourage cooperation. Also, the movement, which has begun in some institutes, to build up scientific and technological services open to customers from different institutes and from the outside world should be supported explicitly and consciously as complementary endeavours while avoiding departure from the core scientific mandate of the BAS.

- The panel has been pleased to know of the performance of NSF in the last few years, particularly in its recognition of quality as a key element in funding. It has also positively assessed the recent decision of NSF to drastically increase the top funding of a single project, which will result in the progressive elimination of those smaller actions which did not deserve project status. The panel also perceives that the present direct allocation of funds from BAS to each institute rarely exceeds the money needed to pay salaries. It considers that this 'floating-line' subsidy should be increased to provide some freedom for the institute

director to cover additional costs such as travels abroad, invitation for short visits of foreign scientists, some extra salaries etc.

It is recommended that, apart from the competitive funding coming from NSF or other sources, the BAS allocation to each institute be increased to make possible scientific decisions at the directorate level that would result in improving daily working conditions and the quality of research, as well as in stimulating competitiveness.

Part B: Institute-level reports

Division of Mathematical Sciences

101 Institute of Mathematics and Informatics (IMI)

Executive Summary

IMI is the most important research institution in Bulgaria in its field. During the evaluation period it has had to face serious challenges in recruiting young people and in maintaining the traditionally high level of scientific research due to the difficult economic situation. The institute management clearly identified the problems (SER II/4), but there seems to be a lack of consensus on how to overcome the situation.

The institute has, in many departments, an excellent and internationally recognized scientific output, many citations and many members are well known in the world of mathematics.

The overall score in quality and productivity is "A" for "*work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player."* But the panel was almost forced to downgrade it to B because of clearly mentioned deficits in the Informatics division and the poor PhD output. With this score the panel wants to emphasize the scientific achievements in some departments and the commitment of IMI to mathematics education within Bulgaria.

Concerning socio-economic impact there is no doubt that IMI plays a major role in the education and research within mathematics within Bulgaria. The overall score is therefore "*Highly Relevant*".

The prospects are scored as "*Moderate"*. The panel could not see clear strategies to overcome the difficult situation in the age distribution, employing new management strategies and defining the role of Informatics within the institute and within BAS.

Concerning Informatics the panel gives the recommendation to rethink the overall role of Computer Science within BAS and maybe separate the Informatics (with exception of the department of Mathematical Foundations of Informatics) from IMI. It would be advisable to create a new, larger unit comprising all different and at the moment scattered Computer Science activities within BAS.

Evaluation Summary

IMI is organized in three divisions: Mathematics, Mathematical Modeling and Informatics. It covers a wide range of research in pure, applied mathematics and informatics. All classical fields of mathematics are dealt with in the institute. Following a long tradition it is successful in many areas to maintain the high standard of research and its international recognition.

A particular feature of IMI is its devotion to mathematical education in Bulgaria on all different levels. This is highly commended.

The very important Section II/4 in the SER gives an accurate analysis of the situation and is in line with the observations of the panel, but what is missing is a strategy to identify the most important fields of future research and to overcome the difficult

situation in the age distribution and in being attractive for young people. A clear strategy would be most important for the upcoming decisions in hiring new scientific personnel.

From reading the SER and also from the interviews on site one can get the impression that for some members of the institute the general focus is not research. High teaching load is mentioned and additionally there are many people abroad for long periods apparently not for gaining new research perspectives but teaching on an undergraduate level.

(a) Quality and productivity

The quality of the research is generally high and in the Mathematics and Mathematical Modeling divisions on an internationally recognized excellent level. The number of publications in SCI listed journals is in approx. 0.5 papers per year and scientists. The overall average of all publications is approx 2.3 per scientist and year. The leading researchers perform on a level comparable to group leaders of other European universities in publication and have good (some of them excellent) citation records. There are also groups or single researchers which act successfully for example in education, creating databases (for HAC) and digitization, but on a national level because of the content of their research. It cannot be expected that this work is recognized on an international level. But this work is important and within the general goals of BAS and IMI.

The Informatics division seems to be a little bit more problematic when it comes to publication and international recognition. It appears also that some members of this division are permanently employed abroad, whereas their publications are included within the self evaluation report[1]. But also within the Informatics division there is one department acting on an internationally recognized high level (Mathematical Foundations of Informatics).

The low number of young researchers especially PhD students, as well as the economic situation, are a big threat to future realization of the quality standards of the institute. As opposed to other institutes within BAS there seem to be no clear strategies to rejuvenate the different departments of the institute (compare SER II/3). The activities in teaching and organizing the mathematics education in Bulgaria are maybe not enough to attract young talented PhD's and Postdocs to work at IMI.

The international relations seem to be - with the exception of some top researchers - heavily on a teaching level. It is questionable whether this contributes to the overall performance of an institution that defines its strategies on the highest research levels.

The SER lists a large number of publications and a remarkable number of them have appeared in high profile journals with high impact factors. The general productivity is high, but one has also to take into account the large number of scientists working

[1] It is admitted that this might be the case also in other departments of IMI, but it is beyond the capacity of the evaluation team to check this for every single member of the institute.

in IMI and -once more- it is questionable whether papers and projects of IMI members working fulltime abroad for other universities or research institutions should be listed in the report. The above-mentioned imbalance between different divisions concerning the scientific output could also be observed on an individual level. Highly productive members are biased by members of IMI that are not as productive as they should be. On the other hand, taking into account the high teaching load, the number of publications is very remarkable. Many of the researchers are also members of editorial boards, expert commissions on national and international level and make an important contribution to the goals listed in Sec. 3 of SER.

The number of projects listed in Annex 1 is also impressive on a first glance. A close look reveals some inconsistencies which have to be mentioned. First of all, it is not clear if all the projects listed in Annex 1 are really carried out within IMI and not at some other organization, where the project leaders are partly (or fully) employed. Secondly, there are many projects listed that have no funding and no project coordinator. There are also many projects that have very questionable funding (see e.g. Project 19 with 151 BGN). It is conjectured that such projects may be within the normal work of a scientist and should not be listed explicitly. Furthermore there seem to be projects between researchers within different institutes of BAS. One could argue that writing a joint paper within different institutes in BAS should not be classified as a project.

The EC+International funding has monotonically decreased from 727 kBGN (about 363 k) in 2004 to about a half that figure, 400 kBGN (about 200 k) in 2008. At the same time, RTD contracts with firms and universities have also followed an erratic evolution; they have increased rapidly from 26 kBGN in 2004 to 182 kBGN in 2006 and then plummeted to 63 kBGN in 2008. It should be a major concern of the institute management to encourage the members of IMI to increase the number of international and national projects as opposed to all the BAS financed "mini"-projects, especially to create employment possibilities for young mathematicians.

Overall score for Quality and Productivity: "A" for "*work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player.*" It has to be noted that the panel was almost downgraded the overall score to "B" because of clearly mentioned deficits in the Informatics division and the poor PhD output.

(b) Relevance: Socio-economic Impact

The impact of the scientific work of IMI is in general satisfactory and in some results impressive. This can be verified by the number of citations, the invitations to lectures, editorial boards and scientific committees.

IMI has a high input in the qualification of talented young students at all levels of education. This cannot be emphasized enough. It is very important to encourage and to challenge young talented students and to develop further the skills of math and informatics teachers.

Overall score for Socio-economic Impact: "*Highly relevant*"

(c) Prospects

From the research strategy one gets the impression that there is no real consensus on future research plans. It is not enough to state that IMI will continue its research work in all important branches of Mathematics and Informatics. A few interesting projects are listed in Chapter II, Sec. 1, but no overall strategy is visible and furthermore these projects do not really reflect IMI's strengths. If the members of IMI and its governing board agreed on an overall strategy and defined research fields where they want to be in the forefront of international science, then they would have better chances of attracting funding (see the decrease mentioned above!) and to recruit young talented scientists and motivate them to stay in Bulgaria.

Without strategic solutions of the management concerning the age distribution problems, the abundant teaching problem and the brain drain of members of IMI it will be difficult to overcome the problems listed in Sec 4. of the SER.

Overall score for Prospects: "*Moderate*"

Overall Strengths and Weaknesses

Strengths:

- IMI has a large number of highly educated and productive researchers
- A wide range of different fields from pure mathematics to applications are dealt within IMI on an internationally recognized high level.
- IMI is well aware of its role of being the leading research institution in mathematics and (parts of) computer science in Bulgaria.
- IMI makes a strong contribution to the extended education of young talented Bulgarians in mathematics.

Weaknesses:

- The number of 24 researchers below 35 (which is a bit over 10% of the whole institute) is not showing a good age distribution.
- The high ranked research staff is overaged.
- The career perspectives for young, talented scientists seem to be so limited that many prefer to go abroad.
- The number of 10 PhD theses defended within 5 years is unacceptably low.
- The teaching loads of institute members are unacceptably high. This does not match the overall strategies of IMI and BAS.
- Highly qualified members spend too much time abroad to be fully integrated with the institute.

Recommendations

- Define clearly the role of BAS within the education and research landscape of Bulgaria. A decision has to be made whether BAS wants to become another university in Bulgaria having a full Bachelor-Master's and PhD program or if

BAS wants to be a high profile research institution providing education on PhD and Post Doc level.

- Strategies to rejuvenate the institutes should be developed. Such strategies have been developed in other institutes (e.g. some Chemistry departments) within BAS despite the difficult economic situation. Clear career profiles within the institute for young talented scientists should be developed.
- Reduce the teaching loads of all members of the institute. (If teaching is necessary for the members to have a sufficient income to survive then maybe one has to rethink the salaries and the number of scientists at BAS; recommendations concerning this issue are given on the general panel report).
- Furthermore an honest strategy regarding the scientific achievements of the large number of "members" of IMI being abroad has to be found.
- BAS and IMI have to rethink the strategies on how Computer Science within BAS is organized in the future. Research in Computer Science is fragmented between 5 institutes within BAS. BAS should restructure the research in this field. Maybe the separation of the department of Informatics from IMI with exception of the department of Mathematical foundations of informatics should be considered. The department of Informatics could be a main part in a new Institute comprising all BAS activities in CS and IT.

102 Institute of Mechanics (IMech)

Executive Summary

IMech consists of four divisions: Mechanics of Multibody systems, Fluid Mechanics, Solid Mechanics and Bio Mechanics. It covers a wide range of classical and modern fields of mechanics. The organizational structure of the institute is a bit diverse. It consists of departments and Labs of very different size and staffing. From the SER it becomes clear that IMech is trying hard to conduct good, and in some parts excellent research. There are departments that are very successful in this effort. They publish in international, highest ranked journals and attract funding from national and international funding agencies. Within the institute however there are activities which would fit better in an economical environment, like spin offs or SMEs.

The score for quality and productivity is **"B"** for "*Work that is internationally visible. The Institute has made valuable international contributions in the field.*" This score would definitely be better for some parts of the institute like the divisions of Solid Mechanics, Fluid Mechanics and some departments in Bio Mechanics. These three divisions truly act successfully on an international level.

A similar picture is observed when it comes to socio-economic impact. There is a huge diversity in this institute. There exist departments having a strong impact on all different levels mentioned in SER I/7 which again would motivate to rate as "*Highly Relevant*", but there are also departments and labs that seem to work without looking around much in the scientific world. Taking into account all its observations and after some discussion, the panel gave the overall score "*Moderately Relevant*" for this criterion.

The score for prospects is "*Moderate*". The institute has recognized the challenges of the inadequate organizational structure, the need of scientific reorientation according to the ERA and national needs as well as the necessity of inner organizational strategies to rejuvenate the institute. The panel sees good ideas (e.g. SER II/2, answers to questions 3/4) that should be pursued.

A general recommendation is to rethink the organization of mechatronics and robotics within BAS. In these fields there exists a lot of overlap, both within IMech and the faculty of Engineering (Inst. of Systems and Control, Central Lab. of Mechatronics and Instrumentation). The foundation of a Center of Mecha-tronics and Robotics could be a solution to bundle and focus BAS activities in these fields.

Evaluation Summary

The research efforts within IMech are broad, possibly a bit diffuse. The question arises if this apparent dispersion might be excessive. There are really impressive and excellent results, activities in international and national research projects, but there is also work done in fields which are very questionable, which one would not expect to find within a research organization.

But there are also a lot of serious impediments that make it difficult -or even impossible- to achieve the overall goals stated in the mission statement. First of all

the budget situation should be mentioned. In the year 2004-2006 there was a decrease of the budget subsidy. Only in 2007-2008 a slight increase is visible. This situation drives the governing body to accept or support initiatives which are not in the core of research in Mechanics. Second - maybe also caused by the budget problems - the high ranked members of IMech are over average-age. The number of scientists below 35 is very small. There is a big gap in low and middle ranked (younger) scientists. These people are usually the most productive in a research institution. Due to low salaries it seems to be difficult to motivate young, talented scientists for research and development. Looking at the age when some of the institute members got their PhD it seems that career perspectives are not good at IMech and BAS in general.

IMech has undertaken serious efforts to overcome the difficult financial situation by own initiative. It is remarkable that the percentage of own money to the overall budget has increased from 17.7% in 2004 to 42% in 2008. It has to be admitted that most of the increase comes from activities that have been criticized above.

Furthermore it seems that the role of IMech or maybe even more the role of BAS within the Bulgarian education system is not clear any more. With the transition to the Western system of tertiary education it is evident that the classical function of the academy has changed dramatically. It is not clear if its position has been redefined by the government. Efforts to establish Master's programs indicate a direction in which IMech wants to go. If this is the right direction is questionable.

Generally one has to remark that the outcome of research and project work under the circumstances mentioned above deserves praise.

(a) Quality and productivity

The quality of research is high in three of four divisions of IMech. All departments within the divisions Solid Mechanics, Fluid Mechanics, and Biomechanics publish in internationally highly ranked journals, in addition to the local publishing. However, the departments within the division Mechanics of Multibody Systems have hardly any visibility in international journals and a low publication output in general.

The institute is well integrated in national and international scientific initiatives (page 2 -3 SER). Some departments have been successful in attracting funding from European and non-European funding agencies. On the other hand the bulk of the international money comes from five projects having in average 170000 BGN/year. Overall this is not very much for a research organization with close to 100 full time scientists.

It is evident that there is number of highly productive members of the institute whereas some members seem to be not as productive as they should (or could) be. This might also be an outcome of the age distribution of the institute.

The SER provides a long list of publications and claims to have more than 2000 citations. When one breaks down the papers to the number of scientists, then the number of journal papers is ~1 journal paper and one conference paper per scientist per year. Rating these figures one has to take into account the statement in the

paragraph above. Concerning the number of highly qualified scientists and the role IMech wants to play in the creation of an ERA the number of publications in international journals is low (~ 40/ year). Too many of the publications are in Bulgarian, which makes it almost impossible to have international recognition.

Overall score for Quality and Productivity: "B", for "*Work that is internationally visible. The Institute has made valuable international contributions in the field."*

(b) Relevance: Socio-economic Impact

With the exception of some departments and some researchers the socio-economic impact of the work is rather local. This is apparent when one takes into account the papers in Bulgarian and the publications in local journals.

On the other hand there are activities that have important local and monetary aspects like the participation in the "Mechatronics and Automation" cluster, the GIS-Transfer Center Foundation and the building of artistic fountains.

Overall score for Socio-economic Impact: "*Moderately relevant.*"

(c) Prospects

The institute is attempting to reorient its scientific topics towards areas such as (quoting from SER p. 3:) nanotechnology, new materials, biotechnologies, health, and molecular and cell biomechanics. Such a reorientation is in line with current trends and carries the possibility of increased funding on a European level. The challenge is to build up a scientifically sound basis to be able to make significant contributions in fields that must be new for many of the researchers. The list of research subjects in section II is perhaps overly scattered, and it may be wise to concentrate effort toward areas with the greatest prospects for scientific success. It is not so clear that the institute in its current organization and age structure has the capacity to realize these ideas.

Overall score for Prospects: "*Moderate*."

Overall Strengths and Weaknesses

Strengths:

- IMech has a strong group of well trained and productive scientists.
- Some departments and single researchers produce internationally recognized excellent research.
- The governing body seems to be able to identify the most important problems.
- The institute has successfully tried to be integrated in national and international scientific initiatives (page 2 -3 SER).
- Critical assessment of data displays an admirable insight in the problems and possibilities of the institute.

Weaknesses:

- Only 6 researchers below 35 (which is less than 10% of the whole institute) results in a bad age distribution.
- The high ranked research staff is overaged. Additionally an almost overall shift of the age distribution curve to the right can be observed in Fig.1/SER. This makes the above observation even worse.
- The career perspectives for young, talented scientists seem to be so limited that many prefer to go abroad or to industry.
- The number of 15 PhD theses defended within 5 years is very low. It takes much too long to obtain a PhD (or maybe some members get the PhD at a too high age).
- The budget situation forces the institute to act like a company and earn money. Within IMech there exist activities that are no genuine research or development ([maybe fancy] water fountains).
- The existing cluster of computers is highly outdated. It does not make sense to invest the time of a PhD student into maintenance of this system.

Recommendations

- BAS in general and IMech especially have to define their role within the Bulgarian education system. BAS has to make a decision if it wants to become just another university within Bulgaria or if it wants to become (again) a high level research institution like Max Plank institutes or INRIA in France. This has consequences to the teaching levels at IMech, or at least at the teaching of its members. In the second case one would have only PhD or postdoc level teaching.
- A clear career model for young scientists has to be developed (Following the SER/Sec.7: It seems that the institute has made efforts to establish a model for career development although this model is not formally applied up to now).
- Young scientists have to have clear rules and time frames for obtaining the PhD.
- Reorganize the IMech in more consistent units.
- IMech should focus on a few areas where it has real expertise. There is no doubt that whenever possible well defined European research topics should be incorporated into the IMech strategy. Maybe some focus on particular areas and specific problems, so as to complement rather than duplicate work being done elsewhere might be better suited to the modest, possibly deficient financial and human resources.
- Create spinoffs for those products that are ready to commercialize (Micro-Nono robot, fountains…).
- Rethink the organization of Mechatronics within IMech and BAS.

103 Institute for Parallel Information Processing (IPP)

Executive Summary

Among the institutes that pursue activities connected to Information Technology/Computer Science, the IPP has the most impressive track record during the evaluation period. The institute has successfully attracted large amounts of competitive external funding. Also, the IPP has a favorable age distribution in comparison with many other institutes: 18 out of 66 research staff are below 35, the institute seems to have been able to recruit some outstanding young staff, and there are no serious age gaps.

The panel rates the overall score for quality and productivity as "B" for "*Work that is internationally visible. The Institute has made valuable international contributions in the field*." The score could have been even higher if only the top departments had been considered. The crucial national importance of the infrastructures and services provided by the institute as well as the high socio-economic impact of much of the scientific output motivates the overall score of "*Highly Relevant*" for socio-economic impact. Moreover, the panel scores the prospects as "*High*" due to a timely research profile, a good and progressive management, the favorable age distribution, the ability to attract external funding, and the institute's good international network.

The panel recommends a growth of the institute by a careful expansion into more research areas within Computer Science/Information Technology. The panel also recommends an oversight of the organizational structure so that pure service providers (such as the administration of NERIN) do not need to be organized as research departments. The institute could consider a closer cooperation between the Parallel Algorithms and Scientific Computing departments, since these are scientifically closely related. The departments of High Performance Computing Architecture and Mathematical Methods for Sensor Information Processing should attempt to improve their visibility in internationally ranked journals and the high-tiered conferences.

Evaluation Summary

The institute encompasses *very* different kinds of activities: basic and applied research; services provisions to companies and government; and infrastructure development and management. The activities are more disparate in character than many other institutes.

The Bulgarian Education and Research Information Network (NERIN), which provides high-speed Internet access to Bulgarian research and education establishments, is administered through the Distributed Computing Systems and Networks Department (DCSND). The department also manages the national link to the pan-European research computer network. Such infrastructure activities -of crucial national importance- are at center stage in the DCSND, the largest department of the institute. The output of traditional academic research is meager.

The High Performance Computer Architectures (HPCA) department seems to operate in a manner different from the other departments. The highlight output mentioned in the SER is information systems for SMEs, a kind of work that to the panel sounds more like IT consulting than a research activity. The output of traditional academic research is very small.

A group also involved in infrastructure activities is the newly formed Grid Technologies and Applications (GTA) department, which seems to be a spin-off from the Parallel Algorithms (PA) department. The GTA department is the main Bulgarian node in EU grid infrastructure projects, which are crucially important activities in modern e-science. The researchers still manage to produce a fair amount of academic research at an international level.

Both the PA and Scientific Computing (SC) departments perform work that can be characterized as modern Scientific Computing (which by necessity involves parallel algorithms these days) at a high international level. The difference between the groups is not in the emphasis on Parallel vs. Scientific Computing per se. The difference is rather in the application areas: researches in the PA department mainly concentrate on physics problem, whereas the SC researchers seem more inclined to applications in the engineering sciences. Both groups perform solid, modern work of high socio-economic impact and maintain a good international publication record and visibility.

The Linguistics Modeling (LM) department has a long a distinguished history, arranges the well-regarded RANLP conferences, is a leading unit in its field, maintains an extensive infrastructure for language technology, and maintains a good publication record. To be noted is that this broad range of activities is done by a department that employs only a handful of senior scientists!

The activities in the Command Control Communications Computers and Intelligence (C4I) department are centered around issues of civil as well as military security, and the end users are typically government agencies (rather than the international research community, as for most of the other departments). The C4I activities are of a kind that in other countries often are performed by defense research establishments.

The work of the Mathematical Methods for Sensor Information Processing (MMSIP) department concerns areas such as signal processing and data fusion. The activities are mainly internally funded. The output seems to be traditional publications in the open literature, mostly in Bulgarian journals and in national or international conferences. The impact on the international level seems limited.

(a) Quality and productivity

There are three groups that stand out regarding quality, in terms of international recognition, namely (in alphabetic order) the LM, PA, and SC departments. The infrastructure work of the new GTA department is also internationally recognized, and the group is also visible in international academic research.

Some of the output of the MMSIP department appears in internationally ranked journals, but the focus seems to be local, and the quality is hard to assess.

A scientific panel is not the right forum to evaluate the main activities of the DCSND, namely the management of national computer networks, which is a service rather than research. Also, most of the services provided by the C4I department would be better off being evaluated by the involved agencies, or perhaps by international actors with competence in security issues.

The quality of the work performed by the HPCA department is unclear. Much of the work seems to be practical development, rather than research, with an impact that is hard to assess, and very little is published.

Overall score for Quality and Productivity: "B" for **"***Work that is internationally visible. The Institute has made valuable international contributions in the field.***"** This score could have been higher if only the top departments had been considered.

(b) Relevance: Socio-economic Impact

Infrastructure, services: The DCSND (computer networks) and GTA (grid computing), are service providers of crucial national importance. The LM department provides infrastructure (linguistic resources, language technology tools) of preeminent regional importance (for Bulgarian and other Slavic languages). A service provider to governmental agencies of national importance is also the C4I department's activities in Operations Analysis, simulation, training, et cetera.

Research:

The LM, PA, and SC departments conduct internationally visible academic research that mostly covers highly relevant research topics.

The institute also displays ability to renewal, as witnessed by the recently created GTA department, a subject currently of extreme socio-economic impact.

Overall score for Socio-economic Impact: "*Highly relevant*"

(c) Prospects

The prospects for most of the departments seem very good. The top quality departments are likely to continue positioning themselves as international players. The management is progressive, encouraging young people to grow and take responsibility, and the institute has a favorable age distribution, particularly in comparison with other institutes within the academy. Moreover, several of the departments maintain good international networks.

Overall score for Prospects: "*High*"

Overall Strengths and Weaknesses

Strengths:

- Much of the work, particularly in the GTA, LM, PA, and SC departments, is of excellent or good quality.
- An impressive ability to attract external competitive funding
- The deep involvement with both infrastructure and research in the highly timely subject of Grid Computing
- A good and progressive management
- A favorable age distribution
- A good international network

Weaknesses:

- The HPCA and MMSIP have low international visibility in highly ranked journals or high-tiered conferences
- Some senior staff and department leaders maintain a quite heavy teaching load, which probably impacts their ability to be effective leaders

Recommendations

- The field of Computer Science/Information Technology (CS/IT) is currently scattered within several of the institutes in the Academy. Several of the CS/IT departments within the other institutes have substantial problems with quality, international recognition, age distribution, and recruitment. The panel recommends rethinking the organization and concentrating on the resources in the institutes with the highest prospects. Because of its proven track record, the panel recommends a growth of the IPP institute by a careful expansion into more areas of CS/IT research.
- The HPCA and MMSIP should attempt to improve their international visibility in highly ranked journals or high-tiered conferences. The mission and the nature of the output of the HPCA department should be evaluated.
- Departments that mainly operate as service providers would probably benefit from being organized in a different manner that as research departments. For instance, a pressure to publish makes little sense for the maintainers of NERIN.
- Because of the close scientific relations, closer cooperation between the PA and SC departments could be considered. Internationally, there is an increased focus on involvement in advanced applications (often labeled “Computational Science and Engineering”) among scientists working in such fields. Encouraging signs of the awareness of this issue can be already found in the SER in terms of projects A.5 and B.2. The panel encourages even more involvement of this kind.

Division of Physical Sciences

201 Institute of Nuclear Research and Nuclear Energy (INRNE)

Executive Summary

The Institute for Nuclear Research and Nuclear Energy (INRNE) was formed in 1972 by the split into two of the former BAS Institute of Physics. INRNE is one of the largest institutes within BAS and one of the leading research centres in Bulgaria. INRNE is divided into seven divisions, and subdivided into 27 laboratories and two experimental facilities. The staff totals 329 people, including 17 professors, 71 associate professors and 82 junior research fellows and more than 100 supporting technical staff. The scientific management of INRNE is carried out by the Scientific Council, a body of 24 members with a four year mandate.

INRNE research activities are in the fields of study and applications of nuclear and sub-nuclear science and technologies and of study of their interactions with the environment. INRNE therefore covers a large spectrum of disciplines, ranging from theoretical and experimental nuclear physics, to theoretical and experimental particle physics, to fission, fusion and reactor physics, dosimetry and radiation safety, radioactive waste management, radiochemistry and radioecology and the environment monitoring and management. INRNE priorities were defined in accordance with national interests and needs and to EU statements and directives. Links and collaborations with industry are not mentioned in the self evaluation report. This, added to the fact that the number of products ready to be implemented in industry is not large, compared to the size of INRNE, and that INRNE holds only one patent, suggests a low level of cooperation with industry.

As expected, INRNE is part of a very large number of national and international collaborations in all its areas of activity. Most of these collaborations are with leading European and international institutes and laboratories like IAEA, JINR, CERN, DESY, CNRS, INFN and Grenoble, The reconstruction and modernisation of the storage facility at Novi Han was chosen by IAEA as a model for the reconstruction of all similar facilities in South-East Europe. The Basic Environmental Observatory is a Centre of Excellence and is an infrastructure of pan-European importance. INRNE was awarded 1st prize within EU FP6 for the most active scientific team. Three INRNE staff received one Russian award, one national and one BAS award. INRNE staffs are members of many national and international councils, commissions and organisations and of national and international editorial boards. The number of visits abroad carried out by INRNE scientists and the number of foreign scientists who paid visit to INRNE is, as expected, very large.

INRNE has obtained many important achievements in all its areas of investigation, both in pure and applied science. The following are those highlighted in the self evaluation report in the field of pure science:

1) Study of soliton interactions
2) QCD studies of nucleon spin structure
3) Precision spectroscopy of molecular hydrogen ions
4) Study of lepton and proton scattering from atomic nuclei
5) Study of models of complex deformed nuclei.

In the field of applied science, the following were highlighted in the self evaluation report:

1) Design and construction of detector elements and electronics for the CMS experiment at LHC
2) Development of Boron Neutron Capture Therapy
3) Monitoring of aerosol activity and of all components of secondary cosmic rays
4) Development of modern nuclear spectroscopic systems for radioecology
5) Construction and analysis of performance of new magneto-resistive oxides.

INRNE has been accredited by the National Evaluation and Accreditation Agency for educating PhD students in the five different areas of theoretical and mathematical physics, nuclear physics, elementary particle and high energy physics, neutron physics and nuclear reactor physics and radiochemistry. 35 PhDs have been awarded to date and 25 new students are currently working on their PhD. This is certainly a good number, considering that INRNE is not a university. INRNE staff is also very active in educational activities, having delivered a large number of hours in courses, specialized classes, practices and seminars. INRNE has also organized many national and international schools and conferences.

For the purposes of this evaluation, and given the very wide breadth and heterogeneity of activities carried out at INRNE and the complexity of the institute, it was decided to divide INRNE into the following three units:

1. **Unit 1**: Theoretical and experimental nuclear and particle physics and astrophysics, including mathematical theory
2. **Unit 2**: Applications
3. **Unit 3**: Facilities

The evaluation summary, scoring, overall strengths and weaknesses, and the recommendations are therefore given separately for the three units.

Some general recommendations for the Institute as a whole are given at the end.

Evaluation Summary Unit 1: Theoretical and experimental nuclear and particle physics and astrophysics, including mathematical theory

(a) Quality and productivity

Quality

The Research activities of Unit 1 are in the fields of theoretical and experimental physics. In the theoretical area Unit 1 is involved in theoretical and mathematical physics and nuclear physics. In the experimental area Unit 1 is involved in high energy and particle physics, astrophysics, nuclear and positron spectroscopy and nuclear reactions.

Productivity
During the period 2004–2008, Unit 1 has been involved in around 205 projects**.** This corresponds to a total number of projects per year of around 41. This large number may be partly justified by the large involvement of Unit 1 in theoretical projects, many of which can be developed in parallel by the same staff. Unit 1 has been involved in only 12 European projects, of which only one is an EU FP6 project. A strategy based on a lower number of projects might be more efficient in terms of human resources and might help to achieve a bigger impact and increase the involvement in major European programmes.

Unit 1 has published a total of 464 papers in peer-reviewed journals, of which 447 are in international journals including Physical Review Letters, Nuclear Physics, Physical Review C, Physics Letters and Nuclear Instruments and Methods. The average is therefore 1.2 publications per professor per year. The number of citations is also impressively large, 8897 for the period 2004-2008.

Scientists working in all areas have strong national links. At international level, Unit 1 scientists are participating in international collaborations and projects, in partnership with different organizations, universities and research centres and international leading institutes like CERN, JINR, SISSA, INFN and GSI.

Overall score for Quality and Productivity: "A" for **"***work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player***."** The high quality of research carried out by Unit 1 is proven by the national and international recognition of the Unit. The Unit is participating in collaborations with international leading institutes like CERN and GSI. The total number of papers published in peer-reviewed journals and of citations shows the high productivity of Unit 1.

(b) Relevance: Socio-economic Impact

The research carried out by Unit 1 is pure scientific research. This type of pure scientific research not only helps mankind in deepening the basic understanding of the Universe we live in; it also creates the basis of a strong programme in applied research that can address major challenges facing the world, like alternative energy sources, climate change, etc. Pure research is also instrumental in attracting new students to science.

Overall score for Socio-economic Impact: "*Highly Relevant*". The fundamental research carried out by Unit 1 is advancing our knowledge of the Universe we live in. It also forms the strong basis for applied research programmes that address today major challenges like renewable energy sources and climate change. It is the type of research carried out by Unit 1 that attracts new students to science. For all these reasons the socio-economic impact of Unit 1 research activities is high.

(c) Prospects

The scientific importance of the research carried out by Unit 1 is certainly high. The bases of Unit 1 activities in theoretical and mathematical physics come from a very

strong and long national tradition. In the experimental field, the Unit is quickly developing the mandatory skills and expertise also thanks to international links with European institutions like CERN and the Italian INFN. A better prioritisation and a reduction in the number of projects might, however, help Unit 1 to concentrate on the most relevant ones, thereby increasing its impact. This strategy would also allow Unit 1 to increase its participation in European programmes.

The division of personnel into two age groups (below and above 50) shows an acceptable balance between the two groups: 40% are below 50 and 60% above 50.

Overall score for Prospects: "*High*". The foundations of the research activities in theoretical and mathematical physics of Unit 1 are very sound, being based on a long very strong tradition. In the experimental area, Unit 1 has also developed very good links with European groups, primarily high energy physics groups: it is clear that these links are helping Unit 1 to fast develop the skills and expertise needed. Unit 1 has also already identified the need to reduce the number of projects it is involved in, in order to increase its impact and move toward international leadership. The balance between staff aged below and above 50 is also OK: 40% below 50 and 60% above 50.

Overall Strengths and Weaknesses Unit 1

Strengths

- High national and international recognition
- Large national and international network of collaborators
- Participation in many highly relevant national and international projects
- Large volume of scientific output

Weaknesses

- No demonstrated international leadership
- Research programme fragmented in a large number of projects
- Limited participation in European programmes

Recommendations for Unit 1

Unit 1 should continue to build on the fertile ground of international collaborations and projects already developed in order to consolidate its position and to move toward international leadership.

Unit 1 has already identified the need of a strategy that focuses on a small number of relevant projects. The implementation of this strategy is strongly encouraged as it would guarantee research teams the critical mass needed to increase their participation in EU FPs and to achieve leadership in collaborative projects worldwide.

The experimental teams on nuclear and positron spectroscopy are directly connected with Materials Science and might be better located in Unit 2 together with techniques of structure analysis, Moessbauer etc.

Evaluation Summary for Unit 2: Applications

(a) Quality and productivity

Quality

Unit 2 is involved in four main areas of research: 1) reactor physics and associated research like decommissioning of existing facilities, safety system analysis, nuclear fuel modelling, nuclear physics, etc; 2) material science, including Moessbauer spectroscopy, structure analysis and development of new materials; 3) radio-isotope analysis and development; 4) detector development.

National and international links are presents in all the four areas, although these links are stronger in some areas than in others. International collaborations for Unit 2 include among others international leading institutes like IAEA and EUROATOM. Unit 2 has participated in the EU FP5 and FP6 and is currently a partner in FP7.

Productivity
In the 2004-2008 period, Unit 2 has published 240 articles in total, of which 139 are in international journals including Journal of Material Science, Nuclear Instruments and Methods, Journal of Applied Physics and Nuclear Physics. This total corresponds to an average of 0.6 publications per researcher per year. The total number of citations for the five-year period is 830.

In the period 2004-2008 Unit 2 has worked on 216 projects, which corresponds to an average of 43 projects per year, spread across the four research areas.

It is not clear how many products developed by Unit 2 are now ready for implementation in industry.

Overall score for Quality and Productivity: "B" for **"***Work that is internationally visible. The Institute has made valuable international contributions in the field***."** The number of publications is low, while the number of citations is quite large. The activity of the Unit, divided into four different areas and fragmented among a large number of projects, prevents the Unit from achieving high levels of quality and productivity.

(b) Relevance: Socio-economic Impact

Given the Bulgarian Government's strategic decision of relying on nuclear power, the research activities in reactor physics and associated areas are highly relevant for Bulgarian society. The detector development activities of Unit 2 are supporting large international research programmes, like those at CERN (LHC), and are therefore highly relevant too. The importance of research in the fields of new materials and radio-isotopes is recognised worldwide.

Overall score for Socio-economic Impact: "*Highly Relevant*". All four areas of research in which Unit 2 is involved are highly relevant for Bulgaria. Reactor physics and associated research form a solid basis for the utilisation of nuclear power that is supported by the government. Research in the area of new materials and in particular

nano-materials is gaining importance worldwide. The detectors developed by Unit 2 are for use in major international research programmes like those at CERN. Radio-isotope analysis and development are vital for areas like security and medicine.

(c) Prospects

The scientific and socio-economic importance of the research carried out by Unit 2 is certainly high for all four areas. Each of these areas is also very complex. The only way to have a big impact in these areas is by having reached a critical mass in the research teams. This is currently not the case for Unit 2, which divides itself among too many areas and projects within each area. Unit 2 should concentrate on the one or two most relevant areas and prioritise the projects in these areas, thereby increasing its impact. A better prioritisation might be also more efficient in terms of human resources and operational costs.

Only one third of the staff in Unit 2 is aged below 50, while the other two thirds are older than 50. It is important for Unit 2 to develop a programme of hiring younger staff members.

Overall score for Prospects: "*Moderate*". The research activities of Unit 2 are currently fragmented over too many different areas and too many projects within each area. It will be extremely difficult for Unit 2 to make a big impact in any of these areas, unless they select one or two priority areas and concentrate on a smaller number of projects. The lower number of staff aged below 50 in respect of the staff aged above 50 is another source of concern, as it may prevent the transfer of know-how to a new generation and the development of new innovative ideas.

Overall Strengths and Weaknesses for Unit 2

Strengths:

- High national and international recognition
- Participation in national and international projects and in European programmes
- Involvement in research areas with high socio-economic impact
- Involvement in educational activities for graduate students

Weaknesses:

- Research programme fragmented in four research areas and many small projects
- No demonstrated international leadership
- No evident high potential for innovation
- Imbalance between number of staff aged below (1/3) and above (2/3) 50

Recommendations for Unit 2

Unit 2 would benefit from the selection of one or two priority research areas among the current four. Greater prioritisation on one-two areas and on fewer projects might achieve a higher critical mass. It might also provide for the development of

international leadership in the chosen priority areas, as well as greater innovation in those areas. It is also worth considering if the detector development activities of Unit 2 would be better placed within Unit 1 instead: this approach might prevent duplication and entail a more efficient use of man-power. Unit 2 may also want to investigate the possibility of creating a strong coordinated research programme in the area of new materials and nano-technologies along with other BAS institutes working in the same area. This approach would once again avoid duplication, allow a more efficient use of resources and help in reaching positions of international leadership.

A better balance between the two age groups below and above 50 should be established. Unit 2 needs to develop a programme for attracting students and young researchers. Personal development (management/leadership) training programmes shall also be developed and young researchers should be encouraged to attend. This would allow the next generation of leaders and managers to be formed.

Evaluation Summary for Unit 3: Facilities

(a) Quality and productivity

Quality

Unit 3 is well recognized internationally, as well as nationally. One notes in particular that the Basic Environmental Observatory Moussala (BEO) is the first BAS interdisciplinary oriented complex research infrastructure in the field of observing, monitoring and study of the environment. It offers interesting perspectives of complementary, multidisciplinary and synergetic research.

At international level, BEO is part of a Pan-European network, along with other similar observatories across Europe and has been given the status of EC Centre of Excellence. The main activities linked to the refurbishment of the IRT Research Reactor and other related activities are carried out in close collaboration with the US DOE, IAEA and Russia.

Productivity
Scientists in Unit 3 have published a total of 55 papers, 26 of which in international journals include four papers in the Journal of American Institute of Physics, one in Nuclear Instrument and Methods and one in Journal of Modern Physics. Given that the total number of professors in the Unit is 10, the publication productivity is somewhat low. The number of citations is also not high: 128 for the five year period. This low scientific output may be explained by the fact that the work carried out at the IRT Research Reactor is not that suitable for publication in regular peer-reviewed journals.

During the period 2004–2008, Unit 3 has been involved in 41 projects, some of which with a low level of financial support.

Overall score for Quality and Productivity: "B" for "*Work that is internationally visible. The Institute has made valuable international contributions in the field.*" The activities of Unit 3 are recognized nationally as well as internationally. There is

however no evidence of international leadership. The productivity, in terms of number of publications and citations, is also not that high.

(b) Relevance: Socio-economic Impact

The applied research carried out by Unit 3 addresses some of the major challenges facing the world, like alternative energy sources, climate change, etc. The creation of the Nuclear Technological and Educational Center plays also a very important role in the education of nuclear experts needed for Bulgarian industry and required by a special governmental decision to keep using nuclear power.

Overall score for Socio-economic Impact: "*Highly Relevant*". Unit 3 is deeply involved in the education of a new generation of nuclear experts, vital for Bulgaria given the government decisions in relation to nuclear power. For the same reason, the work carried out at the IRT Research Reactor is also of high socio-economic impact.
Work carried out at BEO tries to address one of the major challenges currently facing the world. It is therefore of high socio-economic impact as well.

(c) Prospects

The scientific and socio-economic importance of the researches carried out by Unit 3 will certainly remain high in the future. A better prioritisation and a reduction in the number of projects, especially those carried out at BEO, may, however, help Unit 3 to concentrate on the most relevant ones, thereby increasing its impact.

The breakdown of the personnel in the two age groups shows a certain ageing: the total number of people younger than 50 is 70 and the total number of people older than 50 is 92. The development of a programme for hiring younger staff members should be considered. This will allow the preserving of the extremely important know-how acquired by Unit 3, by transferring it to the younger generation.

Overall score for Prospects: "*Moderate*". The importance and the need of the research carried out by Unit 3 will certainly remain high in the future. Unit 3 has the potential to build on the acquired know-how and on the international links already developed. However, the present imbalance between number of staff younger and older than 50 and a fragmentation of the activities in a high number of projects may prevent Unit 3 from reaching positions of international leadership if not addressed in the very near future.

Overall Strengths and Weaknesses for Unit 3

Strengths:

- High national and international recognition
- Participation in international networks
- Work in areas of applied research with high socio-economic impact
- Training of students in Nuclear Technological and Educational Center

Weaknesses:

- No demonstrated international leadership
- No evident high potential for innovation
- Larger number of personnel aged above 50 in respect of people aged below 50
- Lack of links with industry

Recommendations for Unit 3

Activities carried out by Unit 3 at BEO would benefit from a greater prioritisation on fewer projects. Such an approach might achieve a higher critical mass. It might also provide for the development of international leadership in the chosen priority areas, as well as greater innovation in those areas.

A programme for attracting young researchers and students should be developed, along with personal development (management/leadership) training programmes. This would allow establishing a better balance between the two age groups (below and above 50) and the preservation of the Unit 3 know-how.

Recommendations for the whole Institute

- All three INRNE's Units are currently well placed in the national and international context, having gained considerable experience in international collaborations. INRNE is, however, a big institute fragmented in many departments working in very different disciplines. The current micromanagement of such large Institute may not be the best approach. And it is indeed felt that the various parts of INRNE are not well integrated. A more flexible leadership structure should be considered, where each of the three Units has its own Director and the Institute activities are managed by a Board that includes the three Directors. Synergies among the Units would be more easily identified, as well as duplications in the research programme. A better and more efficient use of resources would also be achieved along with a possible decrease in operational costs.
- Links with industry need developing and strengthening. Given the number of products already developed by INRNE for practical applications, this should be quite achievable.

202 Institute of Solid State Physics (ISSP)

Executive Summary

The Institute of Solid State Physics (ISSP) was founded in 1972 with the aim of developing basic and applied research in the fields of microelectronics, acoustoelectronics, low temperature physics, superconductivity, optics and spectroscopy. Throughout the years ISSP activities have expanded to cover modern areas like liquid crystal physics, soft and living matter physics, biomaterials and nanophysics. ISSP success at transfer of technology is clearly documented in the report.

Currently ISSP has 136 researchers. It is a large institute, with divisions in Theory, Low Temperature Physics, Physical Optics and Optical Methods, Laser, Atomic, Molecular and Plasma Physics, Material Physics, Nanophysics, Soft Matter Physics, Micro- and Acousto Electronics. This is a large Institute and the SER, although comprehensive, is not structured to let the reader understand the activity of each division and laboratory. This results in long lists of achievements from which meaningful information is sometimes hard to extract.

In the last 5 years as a whole, ISSP has produced a comprehensive set of papers (80-100 ISI Web of Science papers/year) in international journals of high-quality. Not only is the citation record increasing every year, which is a sign of increasing impact of the ISSP research, but there is an extensive set of highly cited papers from ISSP authors.

Funding has been at a much reduced level during the years covered in the report. Nevertheless, success in FP5 and FP6 grant applications, and the recent increase in the size of the individual NSF grants, has allowed some improvement of the funding conditions. Besides funding, issues such as the attraction and retention of PhD students, and the renovation of an aging group of researchers, require immediate attention.

The Institute has divisions in more “classical” areas (Theory, Low Temperature Physics, Physical Optics and Optical Methods, Laser, Atomic, Molecular and Plasma Physics), and also divisions in more “contemporary” areas of higher current interest (Material Physics, Nanophysics, Soft Matter Physics, Micro- and Acousto Electronics). The new areas are by nature more interdisciplinary and often applied. These new areas have more potential in the longrun to attract students and financing and should be specifically supported. The visit was very useful to highlight a strategy of focusing on the interfaces of condensed matter (in the widest sense of the word, including with biologics). The visit also highlighted the on-going renovation of the physical plant and equipment of the laboratories.

Contrary to our understanding of many other institutes views on their future research, the Direction of the ISSP showed a strategic insight into the need to approach the Institute to contemporary trends in solid matter research. Their stake at developing the frontier between Solid State Physics and Biological Systems, based on current research in some units of the Institute (not on mere imitation of current priorities defined in many European and National Strategies)

is remarkable. For this strategy, the current construction of a clean room facility is a key element, and it will allow the institute to pursue research in micro and nanofabrication of high contemporary socio-economic impact.

Evaluation Summary

(a) Quality and productivity

Quality
Strengths:

- The ISSP has divisions in Theory, Low Temperature Physics, Physical Optics and Optical Methods, Laser, Atomic, Molecular and Plasma Physics, Material Physics, Nanophysics, Soft Matter Physics, Micro- and Acousto Electronics.
- The report asserts that 780 publications have been achieved by ISSP in 04-08 in prestigious international journals with high impact factor like Physical Review Letters, Monthly Notices of the RAS, Optics Express, Applied Physics Letters, Physical Review, Langmuir, New Journal of Physics, Optics Letters, Journal of Chemical Physics, Plasma Processes and Polymer, Journal of Applied Physics, IEEE Journal of Quantum Electronics, Journal of Physics, European Physical Journal, European Biophysical Journal, Surface Science, Thin Solid Films, Physics Letters, Journal of Optoelectronics, and Advanced Materials, etc..
- There is a large set of papers with a high citation record (2 with more than 100 citations, 9 with more than 50 citations, 27 with more 27 citations – resulting in an institute h-index of 27 (see search parameters below). This clearly shows a pattern of publication of work with international impact in high-visibility journals.

Weaknesses:

- The information that allowed assessing the track record of individual divisions and laboratories is missing: this is a big institute and most likely not all the research areas have the same track-record.
- It is thought that the relevant scientific production is concentrated in a subgroup of the individual laboratories. The large number of researchers and the presence of less productive units decrease the overall score.

Productivity
Strengths:

- A search in the ISI Web of Knowledge using the keywords OG=Bulgarian Acad Sci AND SG=Inst Solid State Phys (citations to source items indexed within Web of Science) reveals that since 1998 the ISSP has published approximately 80-100 ISI papers per year, which gives an average of 0.6-0.75 ISI papers/researcher/year. This is a respectable number, although on the low-side of international standards. Notice that with 136 researchers vast differences between researchers, laboratories and divisions are hidden in the averages.

- Using the same keywords, the citation report shows that the number of citations in each year has been steadily growing, from ~400 in 2004 to above 900 in 2008. The h-index for the ISSP is 27. This number shows that a significant set of high-impact international papers have been produced by the ISSP.
- These metrics need to be considered taking into account also the funding available for research – which was at a very low level during the period under evaluation - and the equipment available (which is not detailed in the report). And additional consideration, to be discussed later, is that the ISSP graduated only approximately 20 PhD students over 5 years.

Weaknesses:

- Again, it would have been relevant to assess the track record of individual divisions and laboratories: this is a big institute and most likely not all the research areas have the same track-record.

Overall score for Quality and Productivity: "B" for **"***Work that is internationally visible. The Institute has made valuable international contributions in the field***."** but it should be emphasized that several laboratories are internationally competitive and players in that field (for example, the laboratories of metal vapour lasers and soft matter). The institute should ask itself the following question: should some of the divisions/laboratories that are not doing top-level research be incrementally deactivated?

This grade is due to the significant set of publications in high quality, high impact journals. This output has been regular over the last few years, taking into consideration the number of researchers in the institute.

This classification is given in an absolute scale, and does not take into account the very low funding levels that ISSP has received in the last years, the inability of the Bulgarian research system to attract PhD students and to achieve renovation of the researchers, and the departure of many key researchers. The ability of ISSP to produce good quality scientific research and technical innovations in the last decade in very difficult conditions is to be highly praised.

(b) Relevance: Socio-economic Impact

Strengths:

- The Institute has divisions in more "classical" areas (Theory, Low Temperature Physics, Physical Optics and Optical Methods, Laser, Atomic, Molecular and Plasma Physics), and also divisions in more "contemporary" areas of higher current interest (Material Physics, Nanophysics, Soft Matter Physics, Micro- and Acousto Electronics). The new areas are by nature more interdisciplinary.
- The main scientific and applied achievements of the Institute are very comprehensive and in the field of condensed matter theory, critical phenomena and phase transitions, crystal growth of new materials, superconductivity and superconducting materials, low temperature physics,

microelectronics and acoustoelectronics, nanophysics, liquid crystal physics, living matter physics, structure and properties of crystals and amorphous materials, atom and plasma physics, nonlinear, integrated and fiber optics, metal vapor lasers. This is a very wide range of achievements which shows a very large know-how basis from which to build future research.

- Interactions with other BAS institutes, Bulgarian Universities, and companies are documented. In particular, the consortium of ISSP-BAS with the Institute of Electronics-BAS and the Central Laboratory for Applied Physics, Plovdiv-BAS (since 2007) is a complementary approach for strengthening often expensive scientific infrastructure. Recently, a physical properties laboratory has been launched which includes integrated equipment capable of controlling many physical parameters with a minimum of manipulation. It is, therefore, optimal to have a general characterisation of any new material developed in-house in a short time. It is intended to give service to a wider community of scientists and could contribute to a much needed real cooperation between institutes.
- In average the ongoing projects in the Institute per year are 100, 35 of them are funded by contracts with the National Science Fund and other internal organizations and about 55 are funded under the Academy's bilateral agreements and other international organizations. The participation in the ISSP in FP5, FP6, FP7, and other programs of EU (EURECA, ECONET, ANNA, etc.) are characterized by important level of financing and are a good demonstration for the involvement of ISSP in the process of internationalization of research. Ability to attract financing is clearly demonstrated.

Weaknesses:

- Solid state physics was a central part of science and technology from the 50's to the end of the 20th century, since it was a main contributor to the development of electronic devices. A global shift of interest towards problems related to biological and nanosystems systems (and away from classical solid state) will force the redirection of the ISSP research efforts if it wants to stay relevant. ISSP is aware of this, and taking the first steps to stay relevant.

Overall score for Socio-economic Impact: "*Highly relevant.*" ISSP has a formidable knowledge-basis on a series of topics that were hot in the past 50 years. A set up groups are world class. The focus of applied sciences in general and solid state physics in particular is shifting rapidly. ISSP is making an effort of modernization by creating new laboratories and new divisions (namely in biointerfaces and soft matter) and investing in new researchers. Renovation of laboratories and research equipment is on-going and is highly praised.

(c) Prospects

Strengths:

- ISSP has identified a clear strategic focus on interfaces in condensed matter, taken in the broadest possible sense, including biologics. This is to be highly praised. Steps have been taken to create new laboratories and to promote young scientists that can lead these initiatives.
- The background scientific and technical knowledge of ISSP is staggering. There are world-class groups working in the institute. A combination of innovation within the tradition and the exploration of new topics will ensure the vitality of the Institute in the future.

Weaknesses:

- The report emphasizes that there has been no process for the renovation of researchers to occur. Of the 136 researchers, less than 20 are less than 40 years old, and less than 40 are less than 50 years old. This is considered a major problem. New topics are emerging, which require new researchers and new infrastructures. Considering the extent of the degradation of the physical plant and the outdated equipment, this is formidable task.
- No mechanism seems to be in place to exist to recruit post-doc fellows, which could be a factor of rejuvenation and a source of scientists to recruit, in particular in a non-academic environment. A mechanism to make possible the attraction of PhD students is crucial for the future of ISSP.

Overall score for Prospects: "*High*".
Solid state research has moved to aspects such as soft matter, polymer electronics, flexible electronics, biointerfaces, and nanotechnologies. These are very competitive fields, and the difficulties of the past 20 years have impeded a smooth adaptation of ISSP to the new challenges.

Overall Strengths and Weaknesses

Strengths:

- The ISSP has a very broad base of know-how, both in mature and emerging areas of solid-state physics. It has a publication record of high-impact papers in top-journal. It has demonstrated capacity to attract national, international, academic and industrial funding. Transfer of technology to industry is important and demonstrated. A strategy to update the research topics and to renovate existing laboratories and create new laboratories (biomaterials, physical characterization of materials, clean-room) is considered to be very positive.
- Research with significant impact has been achieved with extremely limited funding.

Weaknesses:

- There are major difficulties in the attraction of PhD students and post-doctoral fellows. There has been no renovation of the researchers.
- An overall institute strategy is not sufficiently articulated. Should new areas be created at ISSP (perhaps with new researchers) in areas like biophysics and nanotechnologies, for example? Should some of the divisions/laboratories that are not doing top-level research be incrementally closed down?

Recommendations

Develop an overall strategy for ISSP which is more than the sum of its parts (divisions and laboratories). Probably a long-term (5-year) contract with clear metrics which would support the renovation of human resources, equipment, and allow active groups in new topics to be established is required for a qualitative improvement.

This strategy will involve:

- Identify limited number of focus areas in which the institute wants to be a world player
- Identify key equipment necessary for the strategy to be implemented
- Identify key research personnel needs for strategy to be implemented
- De-activate underperforming units
- Develop a strategy of intense cooperation with other institutes/universities (to attack new directions related to chemistry, biology, nanotechnologies, etc.)

With the appropriate framework, it is believed that ISSP can be a world player in its focus areas within 3-5 years, due to the strength of its traditional background in condensed matter physics, materials physics, and laser technology, and its investment in emerging areas such as MEMS and NEMS, soft-matter, and biomaterials.

203 Institute of Electronics (IE)

Executive Summary

Institute of Electronics has a broad research area from plasma up to HTc superconductors (14 research laboratories). Scientific staff involves 76 scientists (10 DrSc, 2 Corr. Member, 64 PhD individuals) with a great potential for education and PhD study. On the other hand, Only 31 students have awarded PhD degrees in past seven years. Although this is a low number in absolute terms, it is quite high when compared to the other institutes reviewed. The Institute needs to put more emphasis on graduate education.

Average age of staff seems to be on the high side. Only 25 scientists are under 35 of them 11 hold a PhD degree. Although this is a low number in absolute terms, it is quite high when compared to the other institutes reviewed.

Level of participation in international programmes is low and decreasing. No participation in FP7 Programme. International cooperation is oriented on bilateral exchange programmes covered by BAS, other academies and governmental agreements (mainly with former socialist countries) that allow personal mobility.

Priorities for 2009-2013:

- Photonics
- Nanoelectronics and new materials
- Optical and radio-wave technologies

The Institute has comprehensive and deep knowledge of techniques involving particle, electron beams, plasmas and plasma processing, lasers and microwave electronics. Although the background knowledge is solid, most are not considered as real "hot topics". The Institute needs the right personnel and equipment to enter new promising avenues of research. From this evaluation it did not become clear if the research priorities are supported by the appropriate experimental basis.

A number of high-budget projects recently funded by NSF can be listed as follows:

- "National Center on Biomedical Photonics" (2009-2010) – 850 000 EUR Collaboration with National Oncology Center, University Hospital "Tsaritsa Ioanna", Institute of Organic Chemistry-BAS
- "Coherent Spectroscopy of Alkali Nano-layers for Miniaturization of Photonics Sensors" ,(2009-2011) – 100 000 EUR
- "New Magnetic and Magneto-Electric Materials for the New Generation of Electronic Elements" (2009-2011) – 250 000 EUR
- "Research on and development of new materials based on recycling of reactive and refractory metal scrap using electron beam method" (2009-2011) – 160 000 EUR
- "Plasmon and Optical Properties of Metal Nanoparticles and their Application in High Sensitive Raman Spectroscopy and Biophotonics" (2009-2011) – 240 000 EUR

Evaluation Summary

(a) Quality and productivity

In terms of scientific quality, the level of research outputs, the common scientific indicators of scientific recognition (number of published papers in CC journals, number of SCI citations, invited talks at high level conferences), is considered to be low. On the other hand, some high quality scientific papers show the existence of potential for success when the level of cooperation increases. New prospects are connected with new projects well funded by NSF.

Average productivity measured in papers published in international scientific journals is lower than 1 paper per scientist per year.

The research scientists of the Institute have produced a total of 850 papers in International Journals with 279 in Conference Proceedings; 443 Scientific books (abroad and in Bulgaria); 9 Text-books; and with 6454 papers cited 1548 times

Overall score for Quality and Productivity: "B" for **"***Work that is internationally visible. The Institute has made valuable international contributions in the field***."**

(b) Relevance: Socio-economic Impact

Overall score for Socio-economic Impact: "*Highly Relevant*." Research and development conducted by the Institute is competitive on national level. The Institute has acquired some useful contacts with industry at the national level. Through these activities common research projects with appropriate levels of funding have been organized. Nevertheless it appears that the IE has lost its nationwide leading and dominant position in the recent decades.

Two international summer schools for young scientists and PhD students are organized biennially.

(c) Prospects

Overall score for Prospects: "*Moderate*." Recent high budget projects funded by NSF would lead to an improvement of the research conditions and would enhance the prospects of the Institute. These projects will also enable participation of new PhD students. It seems that the very important and difficult decision has been made to close down at least 3 departments by the end of this year. However, it appears that these kinds of changes should have been considered and made much earlier.

Goals for the near future (reinstallation as national leader, improvement of PhD students recruit, etc.) presented by the Institute management are very important but hard to achieve in the proposed time frame.

Overall Strengths and Weaknesses

Strengths:

- Relatively good personal contacts at the universities and research institutes abroad
- Existing contacts with industry

Weaknesses:

- Very broad research area organized into 14 laboratories
- Low number of young scientists (only 11 PhD under age of 35)
- Low number of PhD students
- Some staff members are abroad for long term stays without real contribution to the institute in terms of research and outputs
- There seems to be excessive reliance on historically driven focus and orientation for many of the departments.

Recommendations

- To improve systematic engagement and utilisation of young scientists
- Modernization of the organizational structure
- The financing of the IE BAS activities has to be substantially increased. This would allow improving the infrastructure, and most importantly the IE BAS staff capacity and quality. In this respect, all efforts should be made to hire top and young scientists/project leaders including if appropriate from abroad. At the same time, all possible measures should be taken in order to avoid a brain drain to foreign, institutions or industries
- If possible, retirement plans should be considered in an attempt to correct the age distribution of the staff members
- Systematic effort with the aim to increase the quality and quantity of publications in relevant and recognised international scientific journals.

204 Institute of Astronomy with National Astronomical Observatory-Rozhen (IA)

Executive Summary

The Department of Astronomy was created in 1953 within the BAS Physical Institute. It was amalgamated with the National Astronomical Observatory in 1995 to become the current Institute of Astronomy (IA). IA is divided into seven departments and two national astronomical observatories. The staff totals 79 people. One of the two observatories, the "Rozhen" National Astronomical Observatory (NAO-Rozhen), is the largest astronomical research centre in South-East Europe.

The main activities of the two observatories are in the field of optical astronomical observations. This research is aligned with the strategic directions and priorities of BAS, as well as with a national strategy developed in 2006-2007.

IA has developed links with Bulgarian institutes and international partners, while appearing somehow isolated within BAS. IA is involved in many projects that are funded internally by BAS, in many bilateral agreements, and in some projects funded by EU, NATO and UNESCO. A limited number of visits have been carried out abroad by IA scientists, and there has been a limited number of foreign scientists who paid a visit to IA.

The scientific achievements obtained by IA concern pure and applied research. In the field of pure research, the most relevant achievements identified in the IA SER are 1) study of the relation between stellar atmospheric abundance anomalies and orbits of binary systems, 2) examination of the last active phase of the Z And interacting binary system, 3) study of rotational velocities of giants in symbiotic stars, 4) discovery of 61 new variable stars, 5) study of active galactic nuclei and quasars, 6) study of small bodies in the solar system, which led to the discovery of many new asteroids. In the area of applied research, the reported major achievements are: 1) construction of two auto-guiding systems and of one photo-guiding system to be mounted on NAO-Rozhen telescopes, 2) design and construction of new instruments for detecting circumsolar sublimating dust particles during solar eclipses.

Some IA staff scientists are members of national councils and of national and international editorial boards.

IA offers some graduate education and training and has also organised national and international schools. In addition, IA promotes and carries out outreach activities.

Evaluation Summary

(a) Quality and productivity

Quality

Strengths:

- Some efforts have been made to improve the performances of the 2 m telescope of NAO-Rozhen
- New instruments have been designed and manufactured for the detection of circumsolar sublimating dust particles
- IA and its staff are well known in Bulgaria

Weaknesses:

- IA has some international visibility, but it remains at a somewhat low level. In spite of the IA involvement in international programmes, it lacks strong and efficient collaborations with major astronomical/astrophysical foreign institutes
- IA does not demonstrate any leadership in international research programmes
- The number of IA astronomers who have participated and actively contributed to international conferences in the 2004-2008 period is relatively small. No keynote talk, and only two invited talks are reported
- The number and the length of visits of IA scientists abroad (and especially in major astronomical institutions) are limited. The reverse is also true: the number of top astronomers who have paid visits to IA is small
- Most of the research is conducted on rather standard astronomical questions which are interesting, but not especially timely and at the forefront of astronomical research. There is no clear demonstration of a strong innovative potential, and the set-up of interdisciplinary research programmes is rather limited, and not of top quality by international standards
- The use of top astronomical facilities is lacking, both on the ground and in space
- A reasonably strong theoretical research component, or strong collaborations on theoretical issues, is lacking. This results in a major danger of limiting the quality and innovation of the observation programmes.

Productivity
Weaknesses:

- A total number of about 75 papers including one or more IA co-authors have been published in major astronomy journals with peer-review systems and impact factors larger than unity. About 43% of these papers have been published during 2007 and 2008, which is somewhat reassuring. However, for a present total number of 21 senior research associates and 15 research associates, and for a total number of 60 projects during the 2004-2008 period, this publication record is on average rather low by international

standards. In addition, a few departments have an unacceptably low record of publications in top international journals.

Overall score for Quality and Productivity: "C", for "*Work that is solid and has added to our understanding and is in principle worthy of continuation. The institute is nationally visible. "*

(b) Relevance: Socio-economic Impact

The IA has a good societal socio-economic impact as a "Regional center for scientific investigations and education". It also plays an international role as a centre for education in astronomy for south-east European students. This prominent status relates directly to the fact that NAO-Rozhen is the largest observatory in South-East Europe. At the national level, IA scientists have collaborations with the Sofia and Shumen Universities, where they deliver courses and lectures.

IA emphasizes its active support to high-school amateur astronomy developed in Bulgarian Peoples Astronomical Observatories and Planetariums. Every summer, NAO-Rozhen welcomes astro-schools and meetings.

Plans are reported to join the Central-European Space Weather Initiative (no details are given regarding the organization and deliverables of the project). This participation would certainly add even more to the socio-economic impact of IA.

Overall score for Socio-economic Impact: "*Highly relevant*".

(c) Prospects

The age pyramid of the IA personnel by the end of 2008 leads to a serious worry. There is only 1 staff scientist with age less than 36. The peak number of staff scientists (17) is located in the 56-65 age group. It is satisfying to note that there are attempts to bring some solution to this problem, in particular through a project of IA integration into a consortium referred to as RATIO. However, it is not possible at this time to ascertain the future and scope of this project

Only 3 PhDs have been awarded during the 2004-2008 period. The prospects of increasing this number do not appear bright. The difficulty of attracting students is acknowledged in the SER.

As stressed in the SER, the funding of science in Bulgaria is largely insufficient. This has limited the development of astronomy in Bulgaria, as well as the development of strong collaborations within the European Research Area. The vitality and the ability of IA to tackle new scientific challenges are to be considered as low if there is no drastic change in the financing of astronomical research. This would help stopping the brain drain to industry or to foreign universities or research institutions. This could also make possible the hiring of top scientists and project leaders from abroad. The future trends in the financing of astronomical research are unknown.

The IA staff is well aware of the key importance for Bulgaria to become a member of top European astronomical institutions (e.g. ESO). As the IA staff is well aware of, this membership is highly unlikely to be effective in the five coming years

Overall score for Prospects: "*Low*".

Overall Strengths and Weaknesses

Strengths:

- The facilities of the NAO-Rozhen have been upgraded. Some new observational facilities have been designed and implemented. Further improvements are planned, and the dynamism of some staff members in this respect is appreciated
- A programme to make NAO-Rozhen an international centre for education in astronomy of South-East European students has been developed
- The outreach activities of IA are of major importance and are most welcome. Their intensification would be of great societal importance.

Weaknesses:

- The SER refers to some collaboration with various institutes (BAS Space Research Institute, Physics Faculty of two Bulgarian Universities). In practice, however, the visibility of these collaborations is very weak or even absent
- The overall productivity of IA is rather low, and the productivity of a few departments is clearly insufficient
- The overall international visibility of IA is quite weak
- IA has no experience in leading collaborations and projects
- The potential for innovation is not demonstrably high. This relates to various reasons, among which: (i) the age pyramid of the staff researchers is not favourable (not enough researchers with age below 40), (ii) several fields of astronomy in which IA wants to pursue the research are not at the forefront of astronomical research, (iii) strong effective collaborations with top astronomy institutes are lacking, (iv) observations at ground-based or space-borne top-level facilities are lacking, and (v) a strong link to theory is lacking
- The research activities are too fragmented, and do not allow to federate research efforts at a sufficient level. Such a federation would be expected to improve the visibility of IA at the international level
- The mobility of students and staff is limited
- Not enough effort is put into education and training of young students, but also of junior, and even more senior, staff

Recommendations

Based on the above comments, some recommendations can be proposed:

- All possible efforts have to be made to hire top astronomers or astrophysicists from abroad, attract young staff researchers, and also provide them with good working conditions. This includes mobility and training programmes in order to develop management and leadership skills
- A stronger collaboration with Bulgarian and foreign (especially EU) universities in the field of training/education would be most welcome. All efforts should be made to attract gifted students to IA. This includes more

financial support and a further improvement of the infrastructures. A high level of mobility of the students should be among the priorities

- An institutionalization of training in universities by staff IA members should be preferred to the present system based on individual initiatives to organize lectures
- A better financing would also allow the establishment of tighter collaborations with top astronomical institutions, would develop the participation in international (especially EU) programmes, especially as leader partners.
- These collaborations would also help to define more timely and attractive research programmes, and improve the theoretical activities of IA. The definition of research programmes requiring the use of prime ground-based and space observatories should be a priority. In the latter respect, the establishment of strong contacts with ESA is recommended.
- The research programmes would profitably be restructured, with an attempt to limit a too large scatter, to create better synergies among the different IA departments/researchers, and to redirect the activities of the least dynamical departments. This would certainly provide better conditions (in terms of manpower and of budgets) to improve the productivity and the international visibility of IA
- The scientific council should include foreign members.

205 Central Laboratory for Solar Energy and New Energy Sources (CL SENES)

Executive Summary

The Central Laboratory of Solar Energy and New Energy Sources (CL SENES) was established as a scientific institution in 1977 and as a permanent unit of BAS in 1994. CL SENES is divided into four departments and a mechanical workshop. The staff of the laboratory totals 43 members. In the period 2004-2008, seven researchers were promoted and two new young scientists were appointed. Four Senior Research positions will be opened this year.

CL SENES research activities are in the field of Renewable Energy Sources, with focus on conversion and utilisation of solar energy. This research is in perfect alignment with the BAS Research Development Programme, the national Strategy of Research Development and EU policies.

CL SENES is very well established in BAS, being part, with other BAS institutes, of various consortia, two of which are lead by CL SENES. At the national level, CL SENES collaborates with various universities and SMEs. This diversity in partnerships points to the multi-disciplinary character of the research carried out at CL SENES. CL SENES scientists are members of national, state and governmental Institutions and of country infrastructures such as national centres, societies and associations. Various links and collaborations with European and worldwide partners have been established. One example of the CL SENES involvement at the European level is its participation in bilateral agreements and projects within the EU Framework Programmes 5 and 6. CL SENES has also organised one advanced institute, with funding from NATO. Another good example of the CL SENES strong international links is the large number of visits abroad, some of long-term nature, carried out by CL SENES scientists and the fairly large number of foreign scientists who have visited CL SENES. The work carried out at CL SENES is internationally known, having been presented at various conferences.

The scientific achievements obtained by CL SENES are in pure and applied research. In the field of pure research, the most relevant achievements reported in the SER are: 1) study of the influence of surface potentials on surface recombination rates for Si isolator-crystal, 2) study of the influence of deposition temperature and H concentration on the properties of poly-Si films, 3) optimisation of the electro-chromic effects in transition metal oxides, 4) study of the influence of substrate temperature on ZnO thin films, 5) development of a prototype solar cell based on a new technology. In the area of applied research, major achievements reported in the SER are: 1) proposal for a new technology for producing highly efficient solar cells, 2) construction of new solid state electro-chromic solar cells, 3) construction of the first Bulgarian grid-connected photovoltaic system, 4) construction of a modern test-stand for water solar collectors, 5) realisation of a new type of solar cell using low temperature epitaxy and metallization.

CL SENES offers graduate education and training. All students are given the possibility of attending conferences, workshops and other meetings in Bulgaria and

abroad. CL SENES has also just started a technical training programme for young researchers. Their staffs deliver lectures and courses in universities, companies, and at national and international schools worldwide.

Evaluation Summary

(a) Quality and productivity

Quality

Strengths:

- The CL SENES research programmes are based on some guidelines of interest. They include the request for feasibility, for a mutual support of theory and experimentation, and for practical applications as a goal.
- CL SENES appears to be well recognized nationally, as well as internationally. This is demonstrated in particular by much collaboration inside Bulgaria, including other BAS laboratories, as well as with foreign laboratories from all over the world. One notes in particular that CL SENES has been a partner in two (FP5 and FP6) programmes of the European Commission, and its activities fall within the priorities of the European Regional Development Fund.
- Through its many, especially international, collaborations, CL SENES remains at the forefront in a strategic area of research, and exploits potential for innovation, particularly through Operational Programmes. Innovation and versatility can also be favoured by the policy of the laboratory to set up temporary research teams to work on specific projects that are limited in time. This policy is encouraged.

Weaknesses:

- CL SENES has developed a national leadership, but does not demonstrably have a comparable status in any international collaboration
- CL SENES totals 79 projects during the 2004-2008 period, sometimes with rather modest financing. This splitting of the activities is not recommended. An effective reduction in the number of projects with a larger manpower and more important financing would be advisable. This strategy is favoured by the new funding policy of the National Science Fund which privileges larger projects with increased funding.

Productivity
Strengths:

- CL SENES can boast many scientific achievements, as well as a large number of products ready to be implemented in industry.

Weaknesses:

- There is no clear account of the CL SENES theoretical activities, and no clear description of possible synergies between experiments and theory
- A total number of about 85 papers including one or more CL SENES co-authors have been published in journals with peer-review systems. About half of them only are found in journals with impact factors in excess of unity. About 40% of the total number of papers has been published during the 2007-2008 period, with about half of this fraction in journals with impact factors in excess of unity. For a present total number of 12 senior research associates and 16 junior researchers, and for a total number of 79 projects during the 2004-2008 period, this publication record (1.5/scientist/year in journals with impact factors in excess of unity) might have been expected to be somewhat higher
- Many papers involving one or more CL SENES co-authors have been published in international conference proceedings. Nine invited talks have been delivered by CL SENES scientists, with just one in 2007, and none in 2008. No keynote talks are reported.

Overall score for Quality and Productivity: "B", for "*Work that is internationally visible. The Institute has made valuable international contributions in the field*."

(b) Relevance: Socio-economic Impact

Strengths:

- The CL SENES research is most timely both in a national and international context. The development of renewable energy sources is indeed one of the major challenges that society faces. Of course, addressing this challenge requires strong underlying scientific investigation. Within this field, CL SENES has identified a specific key area, that of solar energy, on which to concentrate
- The many collaborations in which CL SENES is involved secure a transfer of knowledge at the national level (with universities, agencies and scientific organizations), and reasonably contribute to the strengthening of the European Research Area through the CL SENES participation in Framework programmes of the European Commission
- CL SENES has valuable activities in the education and training through agreements with universities (especially Sofia)
- CL SENES is also involved in a limited outreach activity

Weaknesses:

- The relations with Bulgarian industrial partners may lack efficiency in view of the very limited financial support they provide to CL SENES. In addition, these relations regrettably do not involve any transfer of knowledge
- The number of PhD students during the 2004 – 2008 period amounts to only 5. This is dramatically low. The number of PhD theses awarded during the same period 2004-2008 is only 4.

Overall score for Socio-economic Impact: "*Moderately relevant*".

(c) Prospects

Strengths:

- CL-SENES is clearly engaged in research activities with a high innovation potential, a wide range of collaborations with national and international academia, or with industrial partners
- CL SENES shows good flexibility in creating research teams. Their number and their composition are in well agreement with the research needs
- The process of reviewing ongoing projects and approving new ones goes beyond the normal BAS policies
- CL SENES expresses the hope of increasing the number of staff members up to 70, has several plans for developing its infrastructure, and wants to turn into a national center for the utilization of solar energy.

Weaknesses:

- Future lines of investigation are too vaguely defined, and some proposed projects are most likely unfeasible and unmanageable in the years to come considering the CL-SENES expertise
- The age pyramid of the CL-SENES personnel by the end of 2008 leads to a very serious worry. There is no staff scientist with age less than 36. The peak number of staff scientists (9) is located in the 61-65 age group
- The difficulty of attracting students is acknowledged even if the CL SENES field of research certainly offers a bright future
- The funding of science in Bulgaria is by and large insufficient. The vitality and the ability of CL SENES to tackle new scientific challenges are in great danger if there is no drastic change in the financing of the laboratory. The budgetary situation should allow a vigorous effort to attract highly qualified scientists from abroad, as well as gifted students. This appears to be crucial
- In relation with the above, career plans have to be made attractive to young researchers, and an enhanced mobility should be a cornerstone in their research activities

- In view of the importance of the role played by the Scientific Council, it is regrettable that it does not include foreign researchers to evaluate the scientific achievements of the laboratory, and to identify new routes of investigation.

Overall score for Prospects: "*Low*".

Overall Strengths and Weaknesses

Overall strengths:

- The CL SENES appears to be reasonably well recognized nationally and internationally. Within Bulgaria, it has developed leadership

- It has set up a strategy of research that is sound and efficient in several respects
- The research is very timely, involves scientific as well as technological aspects
- CL SENES has developed national and international partnerships, and is involved in particular in broad European research programmes
- The laboratory is also engaged in higher education.

Overall weaknesses:

- CL SENES shows a deficit of leadership at the international level
- CL SENES should seek for a new format of collaboration with national industries, especially in terms of transfer of knowledge
- The prospects for future lines of research lack clear definition and substantiation for example, assessing reasonable levels of feasibility
- The structure of the age groups of the staff researchers is most worrying, with a dramatic lack of young (age below 40) scientists
- The publication record of CL SENES is not as good as might be expected compared to international standards
- CL SENES suffers dramatically from a lack of PhD students. All efforts should be made to improve this situation
- The splitting of the activities into a large number of projects that are sometimes not financed to any reasonable level is detrimental to the efficiency and visibility of the research.

Recommendations

Based on the above comments, some recommendations can be proposed:

- All efforts have to be made to hire top scientists from other Bulgarian institutions or from abroad, and attract young staff researchers
- This would help CL SENES to move on to become an international leader. In this respect, the funding opportunities offered by the FP7 programme of EC should be best exploited. In parallel CL SENES should focus on a limited number of projects, and avoid excessive diversification
- The prospects to develop international leadership should benefit from explicit training programmes for example on management and leadership
- It should be a priority for CL SENES to rejuvenate. The lack of young scientists is most worrying
- A more conscious and timely effort of CL SENES is advisable towards attracting good students for emerging research fields. An institutionalization of the educational activities of the BAS researchers in universities should help avoiding disparate individual initiatives which may not lead to the optimal results (e.g., insufficient added value or excessive teaching loads)
- The connection between CL SENES and Bulgarian or foreign industrial partners should be strengthened. These relations should be redefined, especially in terms of transfer of knowledge. Explicit means and processes for the creation of spin-offs when relevant should be encouraged.

206 Central Laboratory for Applied Physics–Plovdiv (CLAP)

Executive Summary

CLAP is a relatively small laboratory oriented towards the application of scientific results and small series production of microelectronic devices. In addition, design and development of model equipments (prototypes) for SME and various customers are conducted in CLAP. These devices and equipments are based on own results or on high tech products from the market.

Scientific staff involves 35 individuals including 11 researchers with a PhD degree, 3 PhD students and 10 other personnel. The number of young researchers is very low although there is a close relationship between Clap and University of Plovdiv and the Technical University of Plovdiv (in the period 2004-2008: 1335 hours of lectures given, 270 hours for practices and seminars, 4 master theses,1 Post-graduate students). Such activity has a substantial impact on the quality of education at the regional universities (students have access to modern technologies as MBE, PLD, etc.).

CLAP is divided into four departments:

1. Microelectronics, optoelectronics, sensor devices and technologies
2. Technology and characterization of thin film
3. Thermoelectric cooling-heating systems and energy efficiency
4. Design Engineering

Scientific projects: In addition to previous projects funded by national resources and BAS support more international projects (EC, INTAS and bilateral BAS cooperation agreements) three new important and well funded projects were presented. These projects are under coordination of CLAP:

“Center for high technologies in the field of nanosized and nanostructured films and superhard coatings” (2008 - 2011), NSF, 1 200 000 BGN – together with University of Plovdiv;

“Equipment and methods for characterizing micro- and nano-hardness of superhard materials and coatings” (2008 - 2011), NSF, 330 000 BGN, together with Institute of Metals Research – BAS, University of Chemical Technology and Metallurgy - Sofia -

International: New European project ENIAC– 2009 – 1(NERFA) “Nano-electromechanical RF Switch Arrays”, 8 European scientific organizations and one company. Total funding: 6 050 197 Euro, 480 000 Euro for CLAP.

Evaluation Summary

(a) Quality and productivity

Quality

International recognition inside the EC is relativey low with very small indications for improvement (see ENIAC project, cooperation with Greece on hardcoating nanomaterials). It has not been made clear if produced small series devices are standard in performance or if they are designed for special applications (extreme working conditions, exceptional parameters especially designed for space or other applications, etc.). It was realized during the visits that the production has been decreasing and probably would be stopped soon. On the other hand, some new devices and device application were developed in the frame of collaborative projects with Finland, Belarus, and Greece. New development areas are reported such as application of white LEDs for illumination and hard and superhard covering were opened. Clear re-orientation towards nanotechnology may be considered.

Productivity

Scientific output (papers and citations) is low (46 papers and 104 conference contributions), although this may be partially the result of CLAP's focus on their choice of research. Institute's budget is a combination of own income and BAS support. While BAS support is increasing (although not sufficiently), the Institute's own income is rapidly decreasing. This indicates that the CLAP management should change the marketing policy and reorient the target group of possible research and development partners. Orientation on small and medium enterprises (SME) may be very helpful.

Overall score for Quality and Productivity: "C", for "*work that is solid and has added to our understanding and is in principle worthy of continuation. The institute is nationally visible.*"

(b) Relevance: Socio-economic Impact

Research and development work is competitive on national level with CLAP being an important regional centre of research and development. The presence and activities of CLAP can play an important role for attracting and engaging young people from the region to scientific work or development since the scientific research at universities in Plovdiv are not as competitive as expected. This may also be a reason for extremely high overloading of CLAP's staff by teaching activities.

CLAP has identified and established some interesting and useful contacts with industry on the national level. At least two collaborative research projects with appropriate funding and under CLAP's coordination have been approved.

Overall score for Socio-economic Impact: "*Moderately Relevant*."

(c) Prospects

Recent changes during 2008-2009 in the CLAP structure and application of the most recent scientific approaches in the design and development may open a new chapter in the CLAP history. It is encouraging that the policies have been modified with the aim of making PhD study more attractive (e.g., salary increases from CLAP incomes, etc.).

Long term educational activities have been transferred to common projects with University of Plovdiv (Centre of excellence, well funded by NSF). It is very prospective with strong potential impact on the enhancement of the quality of education.

Some of the experimental techniques seem to be very old (MBE and LPE epitaxial equipment) and need to be fully renewed.

The vitality of the current leadership is enormous but the age gap after this generation is quite wide. The presence of new scientist in age 30-40 is necessary. The probability or chances of covering this gap by own young scientists are extremely low or non-realistic.

A clear strategy exists for short term research priority: high temperature electronics, white LEDs and solid state lightning, and superhard coatings.

The long-term strategy of the Institute should be re-defined taking into account the new challenges in the area, including nanotechnology and related areas.

Overall score for Prospects: "*Moderate*."

Overall Strengths and Weaknesses

Strengths:

- Relatively good personal contacts at the universities and research institutes abroad
- Existing contacts with industry
- The CLAP structure was changed after detailed analysis in September 2008 with the aim of making it more up-to-date and flexible. The number of laboratories decreased from 7 to 4 according to the actual request and possibilities.
- The notion of interdisciplinary research has been applied as a main tool for new research areas and projects.

Weaknesses:

- Low number of young scientists
- Low number of PhD students, although the education activity is very high. On the other hand, this number is relatively high in comparison to other BAS institutes on average.

- Weaker than necessary cooperation with SMEs. CLAP may be very useful for the SMEs due to developed infrastructure for epitaxy, metallization, testing, small scale production and flexibility.
- Age pyramid strongly biased towards the 50 year old or more.
- Excessive teaching load for the staff
- the small series production of old devices seems to be almost obstacle in the realm of modern applied physics
- Slow re-orientation from former Soviet research area to ERA

Recommendations

- Modify the marketing policy and reorient the target group of possible research partners more towards the EU.
- Orientation towards small and medium enterprises (SME) inside Bulgaria or other EU countries may be very helpful. The very important role of CLAP is not only to transfer knowledge to industry but also to help generating knowledge within the industry.
- Develop a mechanism for cooperation with other BAS institutes with the aim of using their scientific results and knowledge for design and development of special sophisticated devices.
- Refocusing and orientation on some of the modern disciplines such as nano-science and nanotechnology may be very beneficial.
- Define and develop a resolute policy of rejuvenation (and perhaps retirement) of the staff.
- Evaluate the efficiency of the teaching activities: Teaching load is extremely high but the number of PhD students is very low.

207 Central Laboratory for Optical Storage and Processing of Information (CLOSPI)

Executive Summary

The Central Laboratory of Optical Storage and Processing of Information (CLOSPI) has been founded in 1975. CLOSPI is divided into four departments and its staff totals 57 members. One senior researcher and two junior researchers were appointed during the period 2004-2008. During the same period, nine PhD theses were successfully defended.

The research activities of CLOSPI are in the area of optical and digital recording and processing of information, with a focus on the development of light-sensitive materials, of holography and on the development of sensors and equipment for metrology. This research is aligned with five priority areas of BAS and with four EC priority topics. CLOSPI has recently been equipped with modern laboratories that have been refurbished with new equipment.

CLOSPI is well established within BAS, being part of various joint projects with other of its institutes/laboratories. At the national level, CLOSPI has collaborations with various Bulgarian universities and SMEs. The diversity in collaborating institutes shows the multi-disciplinary character of the research carried out at CLOSPI. CLOSPI has members in two Specialised Scientific Councils to the Higher Accreditation Commission and experts in the National Science Fund and in the Innovation Fund. Many links and collaborations are established with European countries and partners worldwide. CLOSPI is participating in many bilateral contracts. Good international relationships are also demonstrated by the large number of visits abroad of CLOSPI scientists and the large number of foreign scientists who have visited CLOSPI. A large number of CLOSPI scientists have also been invited abroad to participate in conferences and workshops. CLOSPI has organised an international conference on holography in Bulgaria.

CLOSPI's scientific achievements are in pure and applied research. Its most relevant achievements in the field of pure research as identified in the SER are:

1) Calculation of diffraction pattern for a multi-wavelength phase-stepping system for real-time measurements of profiles of micro/macro objects,
2) Development of a new holographic bifocal polarised lens based on theoretical studies carried out at CLOSPI,
3) Development of a model for the refractive index of liquids on metallic structure,
4) Measurement of electro-optical characteristics of nano-composite liquid crystals,
5) Investigation of the influence of different doping materials on the optical properties of BiGeO crystals.

CLOPSI's most relevant achievements in the field of applied research are:

1) Development of new panchromatic light-sensitive materials,
2) Design and construction of a new diffractive laser refractometer,

3) Creation of a new type of polarization grating for Stokes-meters,
4) Construction of a highly accurate interferometer for micro/macro measurements.

CLOSPI has a strong programme for PhD education and training, with a high success rate for the awarding of PhDs. Various CLOSPI staff members are delivering courses and lectures at universities and companies on a regular basis, as well as many lectures at national and international schools. CLOSPI also provides support set-ups for educational purposes, some of which are included in museum collections.

Evaluation Summary

(a) Quality and productivity

The SER is nicely written and goes to the points in a clear and concise way.

Quality
Strengths:

- The CLOSPI R&D programmes are multi/interdisciplinary. They involve technological activities and research of a more basic nature in physics, chemistry and electronics
- CLOSPI appears to be well recognized nationally, as well as internationally. This is demonstrated in particular by many collaborations inside Bulgaria, including other BAS laboratories and universities, as well as with foreign laboratories
- The CLOSPI research is timely. It is in line with the ever-growing world-wide demand for fast and reliable information techniques. It falls within several BAS priority areas, as well as within EU priority topics (Information Society Technologies, Nano-technologies and nano-science, Genomics and Biotechnologies in Human Healthcare, Sustainable Energy Europe Campaign). As a result, CLOSPI has been a partner in several FP6 programmes and COST actions of the European Commission
- The collaboration with national or international industrial partners has been fruitful. CLOSPI has been involved in the development of products ready for implementation in industry. Some patents have been taken out or applied for
- CLOSPI shows a potential for innovation, and appears as a very dynamical laboratory. The organization of research in the form of `close research circles' is welcome, and if efficiently applied, presents the promise for future interesting developments. The availability of an efficient computer cluster may open the way to future developments
- The level of the active contribution of CLOSPI to international conferences is rather good, and may be considered as a sign of the international recognition of the laboratory. In particular, CLOSPI scientists have been members of programme committees (9), chairmen (8), and invited speakers (5).

Weaknesses:

- CLOSPI is lacking leadership in major international projects.

Productivity
Strengths:

- A monograph has been published at Cambridge University Press by two CLOSPI staff members. Three contributions to collective books have also been produced
- CLOSPI scientists have contributed actively to international conferences. The level of related publications in conference proceedings is good.

Weaknesses:

- A total number of about 85 papers including one or more CLOSPI co-authors have been published in journals with peer-review systems. Among these, only 65 are published in journals with impact factors in excess of unity, with a mere 28% for the period 2007-2008. For a present total number of 23 senior research associates and 14 junior researchers, and for a total number of 6 EC projects during the 2004-2008 period, the publication record (1.8/scientist/year in journals with impact factors in excess of unity) should have been expected to be somewhat higher. The most worrying point is that CLOSPI has no publication for 2007 in journals with impact factors in excess of unity, and just one for 2008
- Five CLOSPI scientists have delivered invited talks during the 2004-2008 period. This is good, but this number remains on the somewhat low side with no information on any CLOSPI scientist having been keynote speakers at international conferences.

Overall score for Quality and Productivity: "B", for "*Work that is internationally visible. The Institute has made valuable international contributions in the field*."

(b) Relevance: Socio-economic Impact

Strengths:

- The CLOSPI research topics are timely both in a national and international context
- There are close connections to high-technology industrial activities, with a concomitant socio-economic impact. CLOSPI has developed products that are ready to be implemented in industry. Patents have been registered (see below, however)
- CLOSPI is involved in the education and training in Bulgarian high-education institutions/universities, as well as in several foreign countries inside and outside EU
- CLOSPI has demonstrated its ability to train PhD students all the way to graduation. More specifically, 12 students have been trained during the 2004-2008 period, 9 of them having been awarded a PhD degree. This is a high number compared to other BAS laboratories
- The management of the research activities is adequate

Weaknesses:

- After a dramatic decrease in the number of patents in the nineties, the situation has improved somewhat in the last years, but remains at a low level compared to the situation at the beginning of the nineties.
- The financing of projects by industrial partners is limited to the 2007-2008 period and is very low.

Overall score for Socio-economic Impact: "*Moderately Relevant*."

(c) Prospects

Strengths:

- CLOSPI has already identified a very good and strong programme of research to be carried out in the years to come within a wide range of collaborations with national and international academia, or with high-technology industrial partners
- CLOSPI is planning to develop small spin-off companies in the future. This would certainly allow to increase its innovative potential, and to create the necessary conditions for a transfer of knowledge of high societal importance
- In addition, CLOSPI wants to federate science, education and industry-type activities. The added value of this project is high
- There is a clear policy from the laboratory management to develop new initiatives in a competitive environment. CLOSPI should especially be praised for its continuous encouragement of personal initiatives and its policy for young researchers to take responsibilities in the projects they are involved in. The development of a specific training programme for young scientists might improve the situation further. The policy for personnel promotions and new appointments is adequate
- The process for reviewing ongoing projects and approving new ones goes beyond the requirements of the BAS policy (see below, however).

Weaknesses:

- The age pyramid of the CLOSPI personnel by the end of 2008 leads to some worry. There are only 3.5 staff scientists with age less than 36. The peak number of staff scientists (7) is in the 61-65 age group, followed by the 66 to 70 age group with 4 staff members.
- The CLOSPI Scientific Council is composed exclusively of Bulgarian members. The appointment of some foreign scientists would be most welcome to evaluate the research achievements and to define the future lines of research
- The difficulty of attracting students as a result of the educational structure is emphasized. All efforts should be made to improve the situation.

Overall score for Prospects: "Moderate."

Overall Strengths and Weaknesses

Overall strengths:

- CLOSPI appears to be well recognized nationally and internationally
- It has developed a strategy of research that is sound and efficient in several respects
- The research is very timely, involves scientific as well as more technological aspects. It is highly inter/multidisciplinary and is well suited for future developments and innovation. Especially noticeable are the many close connections to industrial partners
- CLOSPI has developed national and international partnerships, and is involved in particular in broad European research projects, especially within EC programmes
- The laboratory is involved in high education both in Bulgaria and in several other countries. CLOSPI has trained a good number of PhD students

Overall weaknesses:

- The structure of the age groups of the staff researchers is most worrying, with a dramatic lack of young (age below 40) scientists
- CLOSPI lacks experience in leading large national and international collaborations
- In spite of some positive trend since the beginning of the years 2000, there has been still a substantial deficit in the number of obtained patents compared to the situation up to 1990
- Industry, in spite of its many collaborations with CLOSPI, provides only a small financial support. BAS-industry transfer of knowledge is at an unsatisfactory level.

Recommendations

Based on the above comments, some recommendations can be proposed:

- All efforts should be made to hire top scientists from abroad, attract young staff researchers and students
- CLOSPI's plans to develop small spin-off companies are strongly encouraged. A higher level in the transfer of knowledge between CLOSPI and industry should also be achieved
- CLOSPI should develop leadership experience, especially in projects funded from outside Bulgaria, such as EU FP programmes. Specific training programmes for young researchers would be of great help in this respect
- The CLOSPI Scientific Council should include foreign members
- All efforts should be made to basically modify the age group structure of CLOSPI by appointing a larger number of young researchers
- The infrastructure has to be improved and updated. The installation of an efficient cluster of modern computers is highly recommended
- An integration of CLOSPI and of the IPI should perhaps be envisaged.

Division of Chemical Sciences

301 Institute of General and Inorganic Chemistry (IGIC)

Executive Summary

The Institute is one of the earlier units within the BAS and research focuses on three main subjects, namely 1) Inorganic Material Science, Adsorption and Catalysis, and Chemical Analysis. The scientific staff consists of 129 members including 4 professors, 24 associated professors, 32 research fellows, 49 graduate researcher and 10 technicians. About 35 % of the staff can be regarded as young. The scientific level and standing of the researchers is not made clearly evident. There may be room for further enhancement including increasing the number of PhD holders. The number of awarded PhD degrees in the last years from the Institute was 19 with slight decrease due to lack of financial support.

The Institute has taken part in important projects such as Mission, Transmission, and Union and has been awarded the status of "Centers of Excellence" as lead contractor together with 3 other institutions (PHARE). Participation in 7 EC Framework Program together with several international cooperation are found to be significant and indicative of high-level science.

Evaluation Summary

(a) Quality and productivity

Quality:

International recognition is relatively high; some papers from the Institute were listed among the ISI top papers for Bulgaria in chemistry and engineering. Impact factors of the papers are high by EU standard. Institute researchers have monographs, appearance at international meetings, visiting EU universities and having speakers from EU and other countries. Good leadership and fairly good age distribution.

Productivity:

The average number of publication is at about 0.8 papers per person per year. Moreover; citation of the research papers also seems to be in good standing (i.e., about 1000/year). There are clear indication of good productivity in terms of publications and regular patenting.

Overall score for Quality and Productivity: "B", for "*Work that is internationally visible. The Institute has made valuable international contributions in the field.*"

(b) Relevance: Socio-economic Impact

The research of the Institute is competitive and even very good at national level. IGIC has some good contacts with other institutions and universities, and the industry.

Some efforts have been made to secure funding for collaborative research. The Institute organized colloquia at all levels for the exchange of ideas and to promote young researchers.

IGIC has started a UNION program and is a Center of Excellence with University of Sofia, PI and Medical University in Materials for clean energy and biologically active compounds.

Overall score for Socio-economic Impact:"*Highly relevant*."

(c) Prospects

Due to financial problems (funding and salaries) difficulties have appeared in attracting young people into research careers at the Institute. Due to a new retirement scheme, the ground work has been prepared for changing this and therefore attracting enthusiastic, talented and ambitious young researchers. The management is dedicated and dynamic and provides good leadership.

European standards are approached. A more intense cooperation with leading European laboratories and involvement in joint projects together with enhanced funds will lead to better science in each term.

Overall score for Prospects: "*Moderate*."

Overall appreciation: The work conducted at the institute is competitive at national level and already shows signs of a valuable contribution in the international arena. The Institute is a national stronghold in inorganic chemistry and internationally visible and a modest player with good prospects.

Overall Strengths and Weaknesses

Strengths:

- Good and competitive infrastructure
- Relatively good personal contacts with institutions in Europe
- Good management
- Good age distribution, new retirement scheme

Weaknesses:

- Low financial support for research and researcher
- Relatively low number of PhD students
- Low international cooperation e.g. in COST
- Not high-enough level in scientific publications
- Low scientific output

Recommendations

- Urge BAS management for access to online literature
- Intensify efforts for European grants
- Improve cooperation between BAS institutes
- Joint efforts with BAS institutes for projects to improve
- Infrastructure
- Join COST Actions

302 Institute of Organic Chemistry with a Center of Phyto-Chemistry (IOCCP)

Executive Summary

IOCCP is the main research unit of Bulgarian Academy of Sciences devoted to research activities in organic chemistry and biochemistry. It consists of 11 laboratories mostly located in Sofia (one unit is based in Plovdiv), with a total research staff of 117 including 13 professors, 37 Associated professors and 67 research fellows at the end of 2008. The main research activities that include synthesis of various compounds (functional molecules, chiral ligands and catalyst for asymmetric synthesis), identification of naturals compounds, studies on biomolecules (lipids, proteins polysaccharides), molecular modeling and analytical methods (NMR, mass spectrometry) fit with research priorities of Bulgarian Academy of Sciences (BAS) together with those of Bulgaria and EU, including technological development, nanosciences and quality of life.

It may be added that IOCCP has developed efficient research cooperation in Bulgaria and also abroad (NATO, Swiss National Science Foundation), including collaborative projects with several European pharmaceutical companies. In addition, the Institute is involved within the FP7 program in an action aimed at enhancing access and services to East European users in the domain of NMR analysis ("EAST-NMR" within Research-Infrastructures FP7-INFRASTRUCTURES-2008-1), and as a member of the management committee of two COST actions MP0702 "Towards Functional Sub-wavelength photonic structures" and CM0802 "European Phosphorous Sciences". On the whole the research activities of IOCCP have shown (despite a few weaknesses and limitations that will be discussed below) a satisfactory level from both national and international points of view as inferred in particular from relevant scientific achievements, and good productivity in terms of number and quality of publications. It may also be emphasized that they have a suitable platform of performant equipment that has benefited from recent acquisitions

The scientific policy and the internal evaluation of the activities are fair. The permanent research staff are totally free to apply for grants and have control of their funds. As other positive aspects one may note an efficient training program for PhD students and a good organization of the Institute in particular with the definition of the scientific policy and the evaluation of the activities by a Scientific Council which however should be more open to external experts.

The situation is a little more difficult with the scientific staff since promising young researchers have resigned and there is a great difficulty in recruiting PhD students (only 5 PhD students in 2008 against 13 in 2004). One may also question the relatively high number of projects (a total of 124 according to a presentation given during the interviews, without considering those funded by the budget subsidy of BAS), that lead to some dispersion in the activities and therefore may weaken the impact of research findings thus generated. This situation is notably a consequence of the former policy of NSF which, until 2007, only provided several thousands of

Euros per project for a period of three years. In 2008, the NSF support increased substantially to reach 300-600 k€ for the same period. This should reduce project fragmentation and therefore dispersion.

Evaluation Summary

(a) Quality and productivity

Quality

The scientific activities of IOCCP as inferred from both basic and applied achievements and the publication of a reasonable number of original publications (about 85 a year) in well established international scientific periodicals are likely to be one of the best in Bulgaria in the fields of organic, bioorganic and theoretical chemistry. The number of citations (5930) over the 2004-2008 period is also satisfactory, attesting to an excellent impact of the research activities of IOCCP within the scientific community, that compare quite well with those of established institutions in the country and abroad. Note however that the scientific output is not equally distributed among the various laboratories. The number of scientific papers in international journals ranges from 6 to 75 according to the group. The same comment can be made concerning the repartition of the research staff. One may therefore question the relatively high number of laboratories (11) and may wonder if a reorganization of the IOCCP by (slightly) reducing the number of groups would result in better scientific impact.

The active participation of IOCCP in several collaborative programs abroad and particularly with EU is another positive parameter of the international recognition of the Institute. It is clear that this should be reinforced in the coming years with higher participation in EU programs and other scientific activities (review articles, more invited lectures in congresses, editorial board membership).

Productivity
Based upon the additional bibliographic information provided by IOCCP, the number of published manuscripts in peer-reviewed international journals is 424 over the 2004-2008 period is fair (434 if one also includes non Bulgarian national journals), representing on the average about 0.7 contribution per researcher per year. One may also stress that in many cases the articles have been published in excellent journals of chemistry and biochemistry including top level periodicals such as The Journal of the American Chemical Society, Angewandte Chemie, Journal Organic Chemistry, Journal of Physical Chemistry, Theoretical Accounts, Journal of Molecular Biology, Biochemistry,… to mention a few of them. Members of IOCCP also wrote some general reviews, six chapter books, and gave 17 invited lecture and about 20 keynotes in both national and international meetings. This underlines the excellent quality of the research work and also the interdisciplinary character of the activities conducted in the Institute. One may note a slight decrease in the number of publications in 2008 which may be however difficult to interpret at this stage.

The number of citations is also good at about 1200 a year and should be increased in the near future in particular by promoting more focused research activities and

publishing more articles in leading journals. Efforts should also be made to increase the participation of staff as invited speakers in international conferences and to organize of international congresses and workshops (one may note that IOCCP has organized and hosted the XVII EuCheMS on Organometallic Chemistry in 2007).

Overall score for Quality and Productivity: "A", for **"***work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player.*"

(b) Relevance: Socio-economic Impact

The overall scientific contribution of IOCCP to several domains of chemistry and biochemistry with a strong interdisciplinary emphasis is of excellent level and most of the research activities fit well with national and EU priorities. In that respect one may point out the strong involvement of the Institute in 3 FP7 EU Program (research on influenza and food quality characterization, pool of Pan-European, NMR capacities), 1 FP6 EU program (HPC-Europa Pan-European Research Infrastructure on High Performance Computing) and its active participation in two COST actions. One may also mention a brand new mass spectrometry facility easily accessible for external users.

Many applied investigations are directly connected to the socio-economic environment, and more particularly IOCCP is nicely involved in the promotion of the Bulgarian natural resources that may receive applications in industry particularly in Bulgaria (food products, oil plants, materials for nanotechnology). However, contacts with industry remain rather scarce. The institute is aware of this problem and has recently organized workshops with invited industrial companies in order to increase collaboration and partnership with industry.

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

The scientific activity particularly from a fundamental point of view is of excellent quality as illustrated by a fair number of publications in well respected journals of chemistry and biochemistry as well as in the participation of IOCCP in several EU networks and cooperative projects in Bulgaria and abroad.

The institute recently installed very competitive NMR and mass spectrometry facilities. The NMR facility (600MHz) is unique in Bulgaria and should favour in a close future new contacts and partnership with both industries and institutions from Bulgaria and abroad. In addition, this new platform of efficient equipments will ensure the development of the new projects (and notably the study of biological systems) in excellent conditions.

Despite attempts to attract new scientists, the Institute suffers from a deficit of PhDs and to a lesser extent, of researchers in the middle generation. Attracting new PhDs is mandatory to maintain the dynamism of the IOCCP institute, as there are currently only 2 PhD students at the institute.

Another issue is the number of projects currently developed. It is clear that more focused research activities along major projects are needed, and those major projects should be defined more clearly.

The scientific management benefits of the presence of a Scientific Council for the orientation of the scientific policy, and the internal evaluation of the activities is fair. However more external expertise should be introduced in the evaluation system. This could be done for example by inviting international experts during an annual meeting involving the whole institute.

Overall score for Prospects: "*Moderate*".

Overall Strengths and Weaknesses

Strengths:

- High potential of qualified scientists showing excellent expertise in several key fields of organic chemistry (synthesis, spectroscopic analyses, analytical chemistry, theoretical chemistry …) and biochemistry
- Participation in relevant cooperation networks in Bulgaria and abroad
- Suitable training system for PhD students and also scientists in general
- Modern package of equipment recently renewed or acquired.
- Strong interdisciplinary character of most of the research projects at the interface between chemistry and biology.
- Partnerships with Bulgarian and foreign industries that however should be further developed.
- Good scientific management

Weaknesses:

- Low numbers of PhD students and almost complete lack of postdoctoral fellows.
- Need of more international contacts for in particular young researchers
- Dispersion in the activities as reflected by a large number of research projects, some of them having weak impact and low financial support
- Low number of patents.

Recommendations

- Need of recruitment of young talented scientists (new PhDs, repatriation of young researchers from abroad), both in chemistry and biochemistry, as well as postdoctoral fellows (European programs?).
- Increase the visibility of the scientists by increasing the quality and quantity of publications, organizing international congresses and workshops and being members of editorial board of journals and international scientific committees.
- Development of collaborative programs and scientific exchanges with foreign institutes and universities through in particular EU research programs.

- Strengthen cooperative actions with industrial companies in Bulgaria and abroad. Increase the number of patent applications with abroad extension.
- Establish efficient collaborations with respect to the studies of biological molecules
- Prepare the institute for the analysis of biological samples (dedicated laboratory, know-how of the staff).
- Strengthen the "Biocatalysts" group
- Promote fundamental aspects of the research in the field of the chemistry of natural compounds, in order to better support applications and to provide a better visibility of the Institute.
- Attempts need to be made to have more focused research activities along major projects. In this respect, a reflection could be engaged about a possible reduction of the number of departments.
- Organization of an annual meeting involving the whole institute, and to which international experts could be invited.

303 Institute Physical Chemistry (IPC)

Executive Summary

The Institute consists of 5 departments and a total of 106 staff members. IPC focuses on nucleation, crystal growth, surface phenomena, disperse systems and electrocrystallization.

The IPC has realized 92 projects in the period 2004-2008 and has organized 13 conferences including 10 at international level during the last decade. The large number (about 2900) publications in international journals, monographs, the number of citations (around 11300) by foreign scientists, international cooperation, 8 written monographs, demonstrate the recognition of the scientific achievements of the Institute.

The Institute also has at its disposal unique scientific equipment. The practical importance of the Institute research is worthy of note in the developing industry in Bulgaria.

Evaluation Summary

(a) Quality and productivity

Quality

Strengths:

- The Institute has 106 employees, including 13 professors, 23 associated Professors, 5 PhD students, 27 Research Associates, 22 Administration and Technicians across 5 departments.
- The Institute scientists collaborate with many European countries e.g., Sweden, Switzerland, and Germany. Several projects in FP6, including a major one in which IPC was considered a Centre of Excellence, denote international recognition. There seems to be a current strong project within the ESF COST actions. Institute appears to be connected to the main networks in Europe.
- The research concerning above mentioned problems can be qualified to the best within the Academy. The IPC adheres well to European standards.

Weaknesses:

- Major difficulties in attracting PhD students and post-doctoral fellows.
- Problems with very low salaries.
- The number of PhD students (5) seems to be too low as the number of professors (13) and ass. professors (23) is significant.

Overall score for Quality: "B" (leaning to B+) for "*Work that is internationally visible. The Institute has made valuable international contributions in the field*."

Productivity
According to the Self Evaluation Report, 106 scientific members of staff have published over 2900 papers in 1958-2008. This means ca. 0.53 papers per year per researcher. This is a respectable number although on the low side by international standards. Possibly, some differences can be hidden in the average as the number of employees was growing with years. However, in the period 2004-2008 the number of citations ranges from 1160 (2004) to 1404 (2008). Except for a rather large number of conference proceedings, in the last 5 years 312 papers were published abroad and 46 in Bulgaria. It gives ca. 0.68 papers per year per person. Cooperation with many countries in Europe, 8 written monographs, 13 conferences (10 international), 10 patents and 20 written books or book chapters, during the last decade, demonstrate the recognition of the scientific achievements of the Institute.

Overall Score for Productivity: "B" for "*Work that is internationally visible. The Institute has made valuable international contributions in the field*."

(b) Relevance: Socio-economic Impact

The research in the Institute is closely related to practical applications. The problem of water and air purification is one of the most important goals today. Another important aim is production of new types of glass and ceramics. They focus on metals and materials science and classical but important research in metallurgy and electrochemistry. There is a strong drive by the Institute to move on to more contemporary topics.

Overall score for Socio-economic Impact: "*Moderately relevant.*"

(c) Prospects

Good, modern and unique scientific equipment and advanced scientific personnel should enable the Institute to tackle new scientific challenges. IPC aims to become a national and regional center in Nanosciences and Nanotechnologies.

Applied scientific research seems to be important for modern industry development and from the socio-economic point of view. The NATO project "Nanomaterials for Photochemical and Photoelectrochemical Purification Processes" seems to be most important in the Bulgarian situation. This is because of the fact that the country has a developed chemical industry and, as a result, water and air pollutions are particularly relevant and important problems. The pollution would require decontamination of water and air which can be carried out by phototocatalytic processes. The aim of this main program at the Institute is to develop visible-light-active photocatalysts and advanced photooxidation processes like photoelectrocatalysis to be used in water and air treatment. Within the "Catalytic Coatings" project, the establishment of template methods for the production of electrocatalysts as well as the development of electrocatalytic and photocatalytic modules as original aims of the programme are noticeable.

The Linkoping-Sofia "LINSOFRAC" project introduces new modern theoretical contributions, i.e. original fractal treatment of the crystal growth processes.

Overall score for Prospects: "*Moderate.*"

Overall Strengths and Weaknesses

Strengths:

- The Institute has realized 92 projects, and has organized 13 international conferences during the last decade, The large number (total about 2900) of publications in international journals, monographs, the number of citations (around 11300) by foreign scientists, international cooperation, 8 written monographs (edited in Bulgaria), demonstrate the recognition of the scientific achievements of the Institute.
- The Institute has well trained staff and seems to be well prepared to undertake modern ambitious tasks.
- Organising regular annual schools on nanotechnology and nanosciences for young researchers is considered to be a very positive aspect of the activities of Institute.
- The research concerning above mentioned problems can be qualified to the best within the Academy. The IPC represents good European standard.

Weaknesses:

- The Institute seems to have some difficulties in attracting high-quality PhD students and post-doctoral fellows.
- The number of PhD students (5) seems to be too low considering that there are 13 professors and 23 assistant professors (relatively significant numbers).
- It seems that the Institute is engaged in too many projects leading to dispersion in their activities and achievements.

Recommendations

- Some quantum chemical methods in the interpretation fields are recommended to be introduced in the future as new research programmes. These approaches, as well as other theoretical methods seem to play an increasing role in the modern chemical research work and may be useful in the further modernization of the research priorities and plans. The "LINSOFRAC" project is in line with this approach; however, it does not cover sufficient grounds in this field. Much stronger theoretical group is recommended to be formed.
- The teaching of PhD students is important; however, their number should be increased.
- The salaries should be increased to a reasonable level.

304 Institute Catalysis (IC)

Executive Summary

The Institute was founded in 1983 on the basis of the staff of the Kinetics and Catalysis laboratory which began its activity in 1963. Nowadays, it consists of 3 departments divided into 15 laboratories. The IC research is oriented towards catalytic materials, catalytic processes and molecular catalysts in EPR spectroscopy and quantum chemistry. In 2000-2008 the total staff of 77 researchers published over 400 papers, mostly in international journals (ca. 0.58 per year/person), and 5 monographs have been written. The Institute also has at its disposal unique scientific equipment. Very effective collaboration is continued with France, Italy, Germany, Belgium, Poland, Turkey, Russia, Latvia and beyond Europe with Canada, Mexico, Brazil, Egypt and Libia. 61 projects are realized with national support as well as within COST, ESF, NATO, UNESCO, and UNIDO projects. Within some projects a modern nano-sized catalytic systems are being studied for ecological catalysis.

The Institute is a leading center for catalytic science not only in Bulgaria but also in South-Eastern Europe.

The practical importance of the Institute's research lies in its close relationship with the developing industry in Bulgaria.

Evaluation Summary

(a) Quality and productivity

Quality

Strengths:

- IC staff numbers include a total of 77 employees, with one corresponding Member of the BAS, 7 professors, 23 Associate Professors, 23 research Associates and 15 research groups . The Scientific Council of IC consists of 25 scientists and 5 specialists and it is authorized to elect associated professors for its own needs in 5 specialties: chemical kinetics and catalysis; chemistry of the solid state; petroleum chemistry and petrochemical synthesis; technologies for purification of waste waters; technologies for purification of air.
- The high prestige of the Institute has been reconfirmed by EFCATS upon assigning the task to organize the VII European Congress on Catalysis in 2005. The IC is known world-wide as an organizer of the traditional International Symposia on Catalysis, annual conferences and methodological workshops on catalysis. The position of the IC has been enhanced by establishing research contacts with institutions within the European Union and beyond. Also, training of scientists from Bulgaria and abroad continues strongly.

Weaknesses:

- There seems to be relatively low number of researchers in laboratories. The number of PhD students (6) seems to be too low and is decreasing with years as the number of professors (23) and assistant professors (23) seem to be maintained strong.

Productivity:

There is a large number of publications in international journals, 5 monographs, the number of citations by foreign scientists, international cooperation, 18 projects sponsored only by the BAS budget, 17 sponsored by the National Science Fund, 6 additionally sponsored by contracts with Bulgarian ministries, organizations and companies, 6 projects additionally sponsored by contracts and programs of EU, NATO, UNESCO and other international organizations. Also there have been 20 projects for equivalent non-currency exchange visits within the framework of inter-academy and inter-institute collaboration. These facts, as well as organized conferences, demonstrate the recognition of the scientific achievements of the Institute. The Institute coordinates the research activities in the field of catalysis in Bulgaria. Three of the 13 submitted FP proposals have been successful.

The Self-Evaluation Report reveals that 77 scientific personnel published over 400 papers between 2000-2008 amounting to about 0.58 papers per year and per person.

Overall score for Quality and Productivity: "B" for "*Work that is internationally visible. The Institute has made valuable international contributions in the field*."

(b) Relevance: Socio-economic Impact

The research in the Institute is closely related to the practical applications e.g. petroleum industry and with other branches of the Bulgarian chemical industry.

Overall score for Socio-economic Impact: "*Moderately relevant*."

(c) Prospects

Strengths:

- The activities of the Institute are considered to be in good correspondence with the European trends and they present good prospects. These points may include investigations on catalytic nanomaterials, photocatalysis, quantum chemical methods in catalysis, mechanisms of catalytic reactions in catalysis, chemistry of ozone reactions, and deactivation of catalysts among others.

- Good, modern and unique scientific equipment and advanced scientific personnel should enable to tackle new scientific challenges.
- The applied scientific research carried out at the Institute seems to be important for modern industrial development and from the socio-economic point of view.

Weaknesses:

- A global shift of interest towards problems related to biological systems (and away from solid state) will force the redirection of some research efforts e.g. towards catalysis in biological systems (enzyme catalysis) as well as towards nano-sized catalysts for ecological catalyzing processes.

Overall score for Prospects: "*Moderate*."

Overall Strengths and Weaknesses

Strengths:

- At the end of 2008, the Institute took an important decision to group 11 laboratories into three units at improving the efficiency of the research work. This is found to be a positive step in the reorganization process.
- The research concerning the above-mentioned problems can be qualified to the best within the Academy. The IC represents good European standard. The Institute is a leading center for catalytic science not only in Bulgaria but also in South-Eastern Europe. Within some projects modern nano-sized catalytic systems are being studied for ecological catalysis.
- The IC is authorized to train PhD students in the following specialties: chemical kinetics and catalysis; chemistry of the solid state; petroleum chemistry and petrochemical synthesis.
- The applied scientific research seems to be important for modern industrial applications and from the socio-economic point of view. One example could be the NATO project entitled "Nanomaterials for Photochemical and Photoelectrochemical Purification.

Weaknesses:

- It appears that there is insufficient number of researchers in laboratories. The number of PhD students (6) seems to be too low and is decreasing by years as the number of professors (23) and the number of assistant professors (23) is significant.
- The levels of salary are found to be too low.

Recommendations

- Some quantum chemical methods in the interpretation fields are recommended to be introduced in the future research programs. These approaches, as well as other theoretical methods seem to play an increasing role in the modern chemical research work and may be useful in the further modernization of the research plans.
- The teaching of PhD students is important; and, their number at the institute should be increased.
- The salaries should be increased to competitive levels.

305 Institute of Electrochemistry and Energy Systems (IEES)

Executive Summary

IEES consists of 8 laboratories with a scientific staff comprising 20 senior scientists (7 professors and 13 associate professors) and 28 research associates at the end of 2008. The scientific activities of IEES, which are in the tradition and continuity of the Bulgarian "Stranski-Kaischev" electrochemical school, are devoted to the design and optimization of renewable electrochemical energy sources, with emphasis on applied end-points that have led to the successful development of lead-acid and Li-ion batteries. Major efforts now focus on investigations directed to generation and storage of hydrogen and development of bio-electrochemical fuel cells. The overall scientific activities integrate the priorities of BAS and National Scientific Strategy well,
as well as those of EU research programs. This applies also to industrial requirements in particular for hybrid electric vehicles and solar energy.

It may be added that the "know-how" of IEES is well established worldwide as illustrated by its designation in 2002 as a Centre of Excellence devoted to Electrochemical Power Sources and Hydrogen Energy (supported by the FP5 project "POEMES"), and its strong involvement in 6 other EU projects. In addition, there are cooperative projects within Bulgaria and abroad involving scientific partners and more than 200 scientific and business partnership with Bulgarian and international industries.

The implementation of a relevant educational program for PhD students and the participation of IEES in special courses dedicated to the training of postdoctoral fellows should be pointed out. Therefore, one may consider that despite a few weaknesses, IEES displays on the whole a very satisfying research activity that positions it as the leading institute in Bulgaria and a well-recognized research unit worldwide.

Evaluation Summary

(a) Quality and productivity

Quality

The research action of IEES is mostly recognized by various applied-research orientated studies on renewable sustained energy including the development of the worldwide disseminated "Differential Impedance Analysis" method which, through UNESCO support is established as European Internet Centre for Impedance Spectroscopy", and the design of valuable technologies in the field of sustainable energy systems such as lead-acid batteries. Other illustrations of the international position of IEES are provided by the involvement of the Institute in several European projects within the FP5 (3), FP6 (2) and FP7 (2) programs. On may also point out active and fruitful cooperative projects with national agencies (French CNRS, Italian CNR), numerous countries worldwide and industrial companies in UK, Norway and USA. One may add that IEES has been very active in the organization of several

schools and conferences with the participation of foreign lecturers (however accurate information on the format and content of these events is lacking in order to be able to assess their impact).

The participation of IEES scientists as associate editor and editor board members in one US journal and three international periodical respectively are recognised. Also, IEES is clearly recognized as a world-leader in the Lead-batteries field of research, its expertise being appreciated worldwide.

Productivity
The number of published articles in international peer-review journals is about 100 during the 2004-2008 period. This is relatively modest but it must be emphasized that most of the research studies performed have a strong applied focus. However the scientific output is not equally distributed among the various laboratories. An important point is that two of the eight laboratories have a very low number of publications (one of these two groups actually did not publish for three years). The managing board of IEES is aware of this problem, and one may wonder if a slight restructuration could be envisaged.

It may be added that most of the published works appear in journals that do not have a major scientific impact. This is partly corroborated with the total number of citations (1521) which is low for a 5 year period and the involvement of about 50 research scientists. On the other hand, members of IEES have given numerous lectures and talks in international conferences, and young researchers and PhD are highly encouraged to participate to such events. Another positive point is the active participation of scientists from IEES in organizing national and international conferences and workshops.

The number of deposited patents that is 7, with only one having an international extension; this is low when considering the high value of applications in the domain of renewal energy sources. Efforts should be made to protect these applied developments by dedicated patents.

Overall score for Quality and Productivity: "A" for "*work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player.*"

(b) Relevance: Socio-economic Impact

The impact of the scientific achievements with the availability of the differential impedance analysis method worldwide and the determination of several mechanisms (mode of action of carbon in Pb-batteries and cathode reaction in solid oxide fuel cells) during the last 5 years is satisfactory.

IEES is particularly relevant in terms of partnership with international industries (more than 200 contacts in 32 countries) thanks to its solid expertise in Lead-acid batteries, and also highly relevant in terms of potential applications, as illustrated by the development of new technology for the manufacture of Modified Absorptive Glass Mat (MAGM) separators and the creation of an automated pilot installation for this system, the realization of Mg-air cells and a highly active Ir-composite catalyst.

The addressed topic on sustainable energy sources with emphasis on production and storage of hydrogen is of major economical importance which should increase in the coming years. Finally, one may also mention that IEES hosts and participates with other chemical institutes in the "National Centre for Nanoscience and Nanotechnology".

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

Management of the institute is particularly clever. The permanent research staff is totally free to apply for grants and have the control of their funds. Thanks to numerous contacts with international institutions, young researchers and PhDs have the possibility of visiting foreign laboratories, and in turn many researchers abroad come to visit the institute. It is clear that IEES plays a major national and international role in the research activities dealing with sustainable energy due to a long tradition and the acquired expertise by several key researchers. IEES should be congragulated for its efforts in financially supporting PhDs and young researchers. However, the number of PhDs has significantly decreased over the last years and more efforts should be done to attract new and talented scientists. Note that two new PhDs should join the institute in the next months.

The panel experts also really appreciated the efforts of IEES to avoid scientific dispersion, by dividing the number of scientific projects (40 in 2009) with two groups.
This effort should be further continued in a close future, as the scientific priorities (listed below) are clearly defined for the next five years:

- Lead-acid batteries: development of new technologies for batteries meeting the requirements of hybrid electric vehicles,
- Electrochemical Impedance spectroscopy,
- Hydrogen energy and fuel cells.

The existence of a scientific council is likely to be a valuable system for the discussions of the projects and the evaluation of the scientific activities. However more external expertise should be introduced into the evaluation system. This could be done for example during an annual meeting involving the whole institute, to which international external experts should be invited.

Overall score for Prospects: "*High*."

Overall Strengths and Weaknesses

Strengths:

- High potential of qualified scientists
- Excellent and long time established expertise in several domains of electrochemical energy sources.
- Centre of Excellence devoted to Electrochemical Power Sources and Hydrogen Energy

- Centre of excellence for nanosciences and nanotechnology
- Good financial balance due to strong involvements in EU projects and active cooperation with industrial companies.
- Involvement in efficient cooperation programs in Bulgaria and abroad.
- Relevant and suitable equipment.

Weaknesses:

- Low numbers of PhD students, and to a lesser extent, of scientists aged 35-45.
- Absence of postdoctoral fellows.
- Low number of patents.
- Organization that is not completely suitable in terms of scientific evaluation (lack of external experts).
- Due to extensive applied research, relative weakness in basic research as reflected by a modest scientific productivity and low score for citations.

Recommendations

- Need of recruitment of young talented scientists (new PhDs, repatriation of young scientists from abroad) for the replacement of the scientific staff who are expected to retire within the next fifteen years.
- Increase of the number of publications in highly-ranked Impact factor international journals
- In relation to the previous point, a reflection could be carried out about a better balance between applied and basic research in order to provide better support to the applications, to improve the scientific outcome and the productivity.
- Partial restructuration of the IEES organization which should lead to more integrated research activities along targeted major projects
- Increase the number of patent applications with abroad extension.
- Increase the number of applications to NSF funding as NSF funds represented only 1.4 % of the total budget in 2008.
- Call for external expertise, notably by inviting international experts during an annual meeting involving the whole institute.

306 Institute of Chemical Engineering (IChE)

Executive Summary

IChE of the Bulgarian Academy of Sciences was founded in 1986 and currently has 36 research scientists in its staff. IChE is composed of the following laboratories:

(i) transfer processes in liquid media;

(ii) heat and mass transfer in gas-liquid systems;

(iii) chemical reactors;

(iv) biochemical reactors;

(v) system engineering; and

(iv) data acquisition and simulation.

In addition, there is a Construction and Design Bureau that makes a bridge to potential users of the IChE R&D. The laboratories have between 6-8 research staff members each. There is regular publication of results in the international literature demonstrating the competitiveness of the research, despite severe funding limitations and structural difficulties attracting PhD students and hiring promising new talents. Despite this hindrance, the academic level of the existing PhD researchers is quite advanced. There is also clear evidence of very relevant commercialisation and cooperation activities with both Bulgarian companies as well as international entities.

The Self Evaluation Report provided a very well written and informative basis for conducting the assessment of the current situation at IChE, and, most importantly, it offered a clear strategic plan for the future development of the IChE. The overall picture is that IChE is an active and well-organized institute with strong expertise in the fields of mass transfer processes in two-phase systems, chemical and biochemical reactor engineering, and mathematical modeling of industrial processes. The strategy proposed for the future involves focusing on the emerging topics of green chemical processes, chemical process waste reduction, and renewable energies. The expertise available in IChE provides a solid foundation for these clearly spelled and focused ambitions. Increased baseline funding to renovate the buildings and laboratories, and to attract and retain motivated researchers is required. With the appropriate support to renovate its infrastructure and enable it to pursue the strategic goals outlined, this well-managed and well-dimensioned institute should be able to become an international player in a 3-5 year horizon.

Evaluation Summary

(a) Quality and productivity

Quality

Strengths:

- There is a good publication record in leading journals in the field (the report refers publications in journals such as Applied Biochemistry & Biotechnology, Biochemical Engineering Journal, Biodegradation, Bioprocess & Biosystems Engineering, Chemical Engineering Journal, Chemical Engineering Progress, Chemical Engineering Science, Chemical Engineering & Technology, Computers & Chemical Engineering, Enzyme & Microbial Technology, Industrial & Engineering Chemistry Research, International Journal of Heat & Mass Transfer, Journal of Chemical & Engineering Data, Journal of Membrane Science, Separation Science & Technology, etc.).

Weaknesses:

- From the information available, it It was not clear if the members of IChE participate regularly in the international activities of the scientific community they belong to, namely in the main conferences (with contributed and invited talks), in the different committees of the main conferences, and in editorial boards of journals. This participation is important to divulge the research performed and increase its impact, and to establish networking activities that may lead to new collaborations and common projects.

Productivity
Strengths:

- IChE currently has 36 full time scientists of full-time appointment with scientific degrees or scientific positions from research fellow and above. This makes it a small institute in the context of BAS.
- For the given period, IChE researchers have published approximately 140 scientific papers in international journals, and 62 in full text in proceedings of international conferences. This yields a 140/36/50.8 papers per year per researcher in 05-08. 25-30 papers were published every year in good quality international journals. Taking into account the dimension of the institute and the budget available in previous years, these are respectable numbers. An ISI web of knowledge search using the keywords OG=Bulgarian Acad Sci AND SG=Inst Chem Engn in the Web of Science revealed a steadily growing number of citations per year since 2002, reaching more than 200 in 2008. The same search yielded an h-index for IChE of 14.
- IChE has established an international network of collaborations. It refers that in the period of analysis a significant fraction of the international papers involved joint work with international partners.

Weaknesses:

- In absolute terms, if one abstracts the local and historical constraints that have conditioned IChE's activities, there is clearly room for growth both in the number of international papers and citations, as a measure of the scientific output and international standing. Again in absolute terms, these metrics are respectable, but not world-class.

Overall score for Quality and Productivity: "**B**" for "*Work that is internationally visible. The Institute has made valuable international contributions in the field.*"

This classification is given in an absolute scale, and does not take into account the very low funding levels that IChE has received in the last years, the inability of the Bulgarian research system to attract PhD students and to achieve renovation of the researchers, and the departure of many key researchers. The ability of IChE to produce good quality scientific research and technical innovations in the last decade in very difficult conditions is to be highly praised. With the appropriate support to renovate its infrastructure and enable it to pursue the strategic goals outlined, this well-managed and well-dimensioned institute should be able to become an international player in a 3-5 year horizon.

(b) Relevance: Socio-economic Impact

Strengths:

- Topics of research range from the classical subjects of chemical engineering to some more recent interests such as computer simulation of reactors and process and bioengineering. Accumulated know-how in the Institute is important and relevant to both scientific development and technological innovation.
- It is important to emphasize that the interaction with local companies is well-established, with many research contracts – the amount involved in each project is in general small due to the small dimension and economical situation of the companies - but IChE has positively considered the importance of keeping the contacts active and the projects going. This collaboration appears to be very relevant to the companies involved.
- Interaction with other BAS laboratories is clearly documented with common projects and publications. Interaction with the university system in different Bulgarian cities has been the focus of several agreements. 13 PhDs have completed their thesis in 04-08, which shows a considerable and regular activity in advanced formation. It is important to mention that a significant number of the PhD students completed their thesis before reaching 30 years of age, which is an important benchmark.
- Regular patenting activity is documented, although with difficulties due to the time delays processing the patents, and the lack of funding to support the patents.

Weaknesses:

- Many important topics that are often taken by modern chemical engineering institutes such as Environment Engineering; Polymers and Soft Materials; Microelectronics Processing & MEMS; Materials, Materials Processing and Interfacial Phenomena; Electrochemical Engineering; Heterogeneous Catalysis; Bioengineering and Biotechnology are either missing at IChE or have a secondary role. These topics are partially addressed in other BAS institutes.

Overall score for Socio-economic Impact: "*Moderately relevant*"

Ths IChE has well established activities in advanced training; international-level research; and well-established industrial collaborations in their field of core competences.

(c) Prospects

Strengths:

- The strategy proposed for the future of the IChe focuses on the environment, biofuels, and green technologies:
  - Green processes
  - Biocatalysis for environment protection and value-added products
  - Raw materials and energy saving processes;
  - Energy production from renewable resources
  - Natural products extraction and manufacturing
  - Nano-materials and processes for hydrogen storage in practical aspect

- These are important developments both in the Bulgarian and international context and have a high promise of innovation. The current activities at IChE constitute a promising basis from which these novel topics can be addressed and developed.
- IChE is a solid, well managed, and reasonably-sized active institute with well-established core competences in the classical areas of chemical engineering. Regular publication in good journals and an extended network of international contacts are assets for the future. A clear and well designed strategy for the future is an important plus. Flexibility of the structure and team formation is highlighted. Aspects related to people management are clearly indicated and seem quite reasonable.

Weaknesses:

In this institute, as in others of BAS, there is a strong concern about the ability to attract and retain young researchers. Essentially all the professors and associate professors are over 55 years old. The report emphatically highlights the urgent need for:

- Higher fellowships and salaries for young scientists;
- Updating the scientific equipment for research and training.

Besides the above points, the IChE building and laboratories need to be urgently renovated and updated.

Overall score for Prospects: "*High*"

The prospects of the IChE are excellent: a well-managed, reasonably sized, scientifically and technically active institute with a clearly designed strategy to focus on topics of great scientific and technological interest. The ability to attract external funding is demonstrated and the motivation of the researchers is high. Working connections with the other institutes of BAS whose collaboration is necessary for the outlined strategy are established.

The main question is if IChE will manage to attract and nurture PhD students and young researchers which can be active and creative. This requires funding and a positive prospects for the Institute.

Overall Strengths and Weaknesses

As mention above, IChE is a solid, well managed, reasonably sized, and active institute with well-established core competences in the classical areas of chemical engineering.

The strategy to develop research on green processes and energy-related issues seems appropriate and well-considered. There are two main concerns:

- Does the institute have the human and material resources to be competitive in these areas – which are clearly multidisciplinary?
- Should the institute aim at comprehensiveness reaching out to novel areas such as bioengineering, new materials, nanotechnology, etc.?

Recommendations

- As a system, BAS needs to address issues such as increased funding, increased attractiveness for PhD students and post-docs, remove the non-performing researchers and staff members, and the renovation/rejuvenation of the institutes.
- For IChE, the strategy outlined requires new equipment and new researchers, since the focus topics go beyond the classical topics of chemical engineering which are the main current focus of the research. It also requires close cooperation with institutes in the areas of environment, materials, and energy.
- Novel multidisciplinary topics may require either a consolidation of several institutes, the creation of trans-Institute structures, or the creation of a mechanism of mobility between laboratories.
- If funding is available, a 5-year contract with clear metrics should be established with IChE so that the research equipment and the physical plant can be renovated, and so that a few key researchers can be hired, to give it the chance of achieving its goal of becoming an international leader in the strategic topics chosen.

307 Institute of Polymers (PI)

Executive Summary

The research in the Institute focuses on two main areas, namely a) synthesis and modification of polymers and b) tailoring the properties of polymer materials. Within these areas there is a huge number of sub-areas as well.

The scientific staff includes 58 members, which was reduced recently due to financial problems. The age distribution seems to be almost optimal; the number of qualified young people could be higher. There are currently 11 PhD students and in the last 4 years 13 have defended their PhD theses. International fellowships in European countries and the USA are numerous.

Scientific projects include considerable participation in international programs. About 30 bilateral projects, involved in 2 FP-7 projects, 4 within FP-6, Leonardo and NATO projects. The co-operations are not restricted to former socialist countries.

Priorities for coming years:

- advanced materials for medicine
- nano-structured materials
- nano-composites for various properties
- advanced materials for fuel cells

Evaluation Summary

(a) Quality and productivity

Quality:

International recognition due to publications, impact factors, and citation is high and in recent years has been increasing. Correlation between the levels of financial support and output is difficult to draw. Joint publications with researcher of foreign countries seem to have led to higher quality. This line is to be considered for improving the overall quality of research.

Productivity:

The scientific output in the evaluation period was reported to be 439 papers and 2476 citations. Impact factors are at medium levels. The overall publishing productivity is at about 1.5.

Overall Score for Quality and Productivity: "A" for "*work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player.*"

(b) Relevance: Socio-economic Impact

Research at the Institute is nationally competitive. Contacts with industry are good but could be further improved. Foreign contacts for researchers are usually too short. Longer time scale for working in foreign laboratories (PhD or post doc positions) would bring more benefits to PI.

The researchers of the Institute are involved in European and joint projects and the Institute is a center of excellence.

Overall score for Socio-economic Impact: "Highly relevant."

(c) Prospects

More financial support and more European cooperation would lead to a better science in the field and at the Institute. In order to make science more attractive to young people (education, moral and financial appreciation) some changes are needed. The Institute organizes a good number of seminars with foreign scientists and the Institute researchers are invited speakers at numerous conferences and seminars.

Young people should have better chances to take part in international meetings. The leadership is competent and of good quality. Laboratory leaders are very young and with a promising scientific future.

Overall score for Prospects: "High."

Overall Strengths and Weaknesses

Strengths:

- Relatively good personal contacts with institutions in Europe
- Involvement in European projects
- Good management and leadership
- Enthusiastic young scientists
- Attractive personal management approaches and styles

Weaknesses:

- Low financial support for research and researcher
- Relatively low number of PhD students
- Low international cooperation (COST, long term visits)
- Not high-enough levels of achievements in scientific publications
- Medium-level of scientific output
- No online access to primary literature

Recommendations

- Upgrade of instrumentation
- Intensive application for new grants especially for young researcher
- Participation in bigger possibly European projects
- Fight for online access to literature

308 Central Laboratory of Photoprocesses (CLP)

Executive Summary

The CLP is a highly regarded research unit oriented towards research in the field of photoprocesses. The interaction of solid materials with different kinds of radiation like microwave, X-ray, electron, ion & laserbeams and UV-VIS light presents the main object of the research. A part of the research activity of CLP is concentrated on R&D of innovative advanced products, which are oriented towards industrial applications in the fields of sensor techniques, organic based optoelectronics, renewable energy sources, biomedical engineering as well as detection, control and detoxification of environmental pollutants. The development of innovative applied products for realization in the reviving Bulgarian economy is the main goal of the actualization of overall CLP research topics.

The scientific staff involves 29 individuals including 19 scientists with PhD or DrSc degree.

The average age of the staff is quite high. Only young researchers have been employed in CLP instead of technicians in order to decrease the average age. Traditionally, after receiving their PhD degrees the young researchers have the possibility of entering a competition for research associate positions.

During the last years, the CLP activity in the field of education of the PhD students has substantially increased. During the period 2004-2007, 15 PhD students have started their studies, 10 PhD-Theses were defended for awarding of PhD degrees In addition, 5 PhD-students finished successfully their research work and now they are preparing their PhD thesis. Although this is a low number in absolute terms, it is quite high when compared to the other institutes reviewed. The Institute needs to put more emphasis on graduate education.

Scientific projects:

The complexity of the innovative products needs interdisciplinary R&D approaches towards industrial realization. This is the reason why recent CLP research projects have to be realized in collaboration with other Academic institutes, Universities and research groups abroad. To achieve this CLP carefully follows the R&D activities of all Bulgarian and many international scientific units. Relying on forty years of experience and existing equipment the Institute looks out for new perspectives to extend their field of interests. If an idea with potential for significant contribution comes into sight and there are basic knowledge and research experiences available, new joint project is formed. CLP research plan in the last five years covers 36 funded projects - 20 national with scientific units, 2 national with SME, and 14 international. CLP participated also as a coordinator in one and as subcontractor in five FP7 project proposals which were not funded.

Priorities for 2009-2013:

CLP-staff intends to concentrate the research activity on these topics:

- **Multilayered organic/inorganic systems for application in organic electronics**
  1. Organic Light Emitting Diodes (OLED) for R&D of flat panel displays and new generation low energy consuming light sources

  2. Organic photovoltaic cells as a low-cost solar panels solution

- **Micro and nanosized films and non-woven mats**
  1. Synthesis of novel functional materials of DLC, inorganic oxides, hybrids and composites for biomedical engineering (bone and teeth regeneration) and coatings for biomedical purposes (lubricated, wear-resistant and bactericidal materials)

- **Novel catalytic materials for environmental control and protection**
  1. Smart sensors for control of hazardous pollutants in the environment

  2. Novel photocatalysts for detoxification and purification of waste waters and air based on laser modified TiO_2 thin films and non-woven mats

  3. Bi-functional electrocatalysts as oxygen electrodes for application in secondary batteries and regenerative fuel cells

  4. Novel laser assisted method for design of heterogeneous catalysts

Evaluation Summary

(a) Quality and productivity

Quality: The Institute provides an extremely nice example of the transferring of fundamental knowledge into very useful applications. For example, the researchers at the Institute have developed inorganic photoresist and very simple technology for its application. Claim for this application is apparently still intact although many customers seem to have been lost.

Decreasing number of research requests from industry led the Institute management to the decision to focus on basic research in the field of photosensitive materials. Two new departments OLED and nanocomposites were thus created. Close cooperation with Universities was developed. Recent results in field of organic light emitting diodes proved that this decision was appropriate and timely.

Quality of management is very high with broad perspectives and ability to make proper decisions with long term impact. Management indicated that main goals of short and long term future were to change the generation gap. Bold and clever decisions regarding the young researchers have been made at the Institute. In the current Bulgarian conditions under sever shortage of tentative PhD students, CLP management decided to start work with promising students before they finish their master degrees. These students are working at the Institute at half position and this may increase the chances of continuation towards PhD.

Productivity: Scientific output (papers and citations) is good in comparison to other thematically similar institutes. Average staff of 19 scientists produced more than 100 papers in scientific journals (total number is 133, but it includes some conference proceedings) during the evaluated period. Some papers were published in highly ranked journals (Thin Solid Films, Applied Surface Science, Surface Science, Phys. Rev. B, etc...).
Multidisciplinary education of the junior scientists and PhD students is very important for their incorporation in the CLP-staff. For that reason CLP organizes annual spring seminars "Interdisciplinary chemistry" related to other research fields of the natural sciences. Besides, two semesters lecture courses **"Introduction to Surface Science"** and **"Physical Methods for Surface Analysis of Materials Microstructure and Chemical Composition"** are offered, which are acknowledged by the Academic Centre of Education. Thus, the PhD students and junior scientists being successful in both courses are awarded with certificate.

Overall Score for Quality and Productivity: "A" for "*Work that is internationally competitive and is expected to make a significant contribution. Institute is considered an international player, national leader. „*

(b) Relevance: Socio-economic Impact

Research and development work is competitive at the national level, at which some interesting contacts with industry have been established. Collaborative research projects with appropriate funding have been developed.

Institute is an **international leader** in the field of radiation assisted synthesis of materials in vacuum. It has a large potential in nanotechnology and ecology (tissue engineering, spinning ...) together with application of non convential materials.

CLP has broad cooperation with universities in Bulgaria. Traditional CLP partners are research teams from many Bulgarian Universities - especially Sofia University (SU), University of Chemical Technology and Metallurgy - Sofia (UCTM), Technical University - Sofia (TU), Technical University - Rousse and Technical University - Gabrovo. In the period 2004-2008, 3 projects were developed in close cooperation with UCTM, 2 with SU and 2 with TU - Sofia.

Overall score for Socio-economic Impact: "*Highly relevant.*"

(c) Prospects

The site-visit demonstrated that management has a prospective vision with perfect overview and the ability to make important and timely decisions.

2008 Bulgarian NSF projects have significantly enhanced funding (but even the enhanced funding remains at a rather low level!) which would lead to an improvement of the research conditions.

Systematic efforts seem to have been made with the aim of catching young people to science and to the Institute.

Basic equipment is mainly old with some exceptions. For instance AFM is missed.

Overall score for Prospects: "*High*."

Overall Strengths and Weaknesses

Strengths:

- Flexibility in terms of modernization
- Relatively very good personal contacts with national universities and research institutes abroad
- Existing contacts with national industry and SMEs
- Interdisciplinarity has been valued as a main tool for new research areas and projects.
- Very good and competitive management with broad vision

Weaknesses:

- Low financial support for research and researcher
- Low number of young scientists
- Low number of PhD students
- Infrastructure insufficient in several respect
- Lack of international collaborations with academia or industry, except with some Eastern countries

Recommendations

- The financing of the CLP activities has to be substantially increased. This would allow improving the infrastructure, and most importantly improving the required staff and their employment condition. In this respect, all efforts should be made to hire top and young scientists/project leaders. At the same time, all possible measures should be taken in order to avoid a brain drain to other, especially foreign, institutions or industries.
- If possible, retirement plans should be considered in an attempt to correct the age distribution of the staff.
- The plans to improve the educational activities of CLP have to be supported. In this respect, it is suggested to put the educational activities of the BAS laboratories on an institutional basis with the universities, instead of just relying on individual initiatives.
- CLP should make all efforts to further improve its international visibility.

Division of Engineering Sciences

601 Institute of Metal Science (IMS)

Executive Summary

IMS is one of the largest institutes at BAS (total staff is 400, research staff 148). The institute carries out fundamental and applied research in the field of metal science and technology. In addition to that, a substantial amount of time, effort and additional income is devoted to the development and production of high-tech defence systems at national security and NATO level. As these activities are only partly indicated in SER and in many cases are classified, they have not been included in the scientific evaluation of the institute.

This evaluation comprises the activities as given in the SER for the following 5 departments:

1. Nonferrous metals and alloys,
2. Ferrous metals and alloys,
3. Physical chemistry and structural transformations in metals and alloys,
4. Welding of metals and alloys,
5. Deformability and analysis of metals and alloys.

It is recommended that the high-tech defence systems activities are located in a separate department or institute and are evaluated by the relevant military and defence experts. The institute has an unbalanced age distribution for the staff, with approximately 60% in the 56+ age group. As the number of PhD levels has fallen to a dramatic low level of 2 in 2008, given the overall size of the institute this requires immediate attention of the management of the institute.

The institute has a large international network in the defence area and is very productive in terms of education activities, technical services and products, patents etc. However it scores very low when it comes to scientific publications in SCI listed publications with good impact factors. The IMS needs to increase its academic reputation and productivity by focusing more on journal publications and graduating PhD candidates. Due to the substantial income from external resources (only 40% of the budget is provided by BAS) the financial situation of the institute should make it possible to use these additional resources to improve the scientific quality of the institute.

Evaluation Summary

(a) Quality and productivity

Quality:

Due to the overall financial situation in Bulgaria a substantial part of the projects is contract research for national and international parties. These project activities in general do not result in internationally recognized publications or exposure at international conferences. The institute participates in European networks and the

international exposure of the Institute can be determined by e.g. the substantial number of NATO contracts.

To improve the scientific quality of the institute more attention should be paid to acquire projects with a clear publication potential.

Productivity

In the SER the IMS has listed a large production of papers, but predominantly in Bulgarian journals and conference proceedings. However the publication record in international SCI listed journals and SCI listed proceedings is limited (see Table 2) given the number of scientists and in addition the scientific work of the institute is cited at a very low level.

Table 2: 2004-2008 SCI publication data as provided by IMS

SCI publications	Int. Journals	Nat.nB	Nat.B	Conf.
IMS Totals	**17**	**5**	**4**	**78**
Nonferrous	0	0	1	4
Ferrous	2	1	3	22
Phys. Chem.	6	4	0	24
Welding	0	0	0	14
Deformation	9	0	0	14

It is reasonable, given the nature of the field that a substantial number of articles will be written in conference proceedings. Similarly, the applied nature of the field leads to an underestimate of the usefulness of the papers, since the end-users of the result are those who apply them to practice and are unlikely to write papers. However a sustainable effort has to be made to increase the number of journal and conference papers.

Overall Score for Quality and Productivity: "C" for "*Work that is solid and has added to our understanding and is in principle worthy of continuation. The institute is nationally visible.*"

(b) Relevance: Socio-economic Impact

Because the institute activities are limited in terms of PhD dissertations and scientific publications, it is fair to say that the scientific impact of the institute and the socio-economic impact on the education of the Bulgarian population are on the low side. On the other hand, the IMS plays an important role as testing facility at national and international level. It has required the necessary accreditations and certifications at ISO 9000 and NATO level so in that respect the socio-economic impact for Bulgaria is reasonably high.

IMS is a leading national scientific body in Bulgaria, developing high-tech systems in the defence and security area. On international level, IMS is closely engaged with

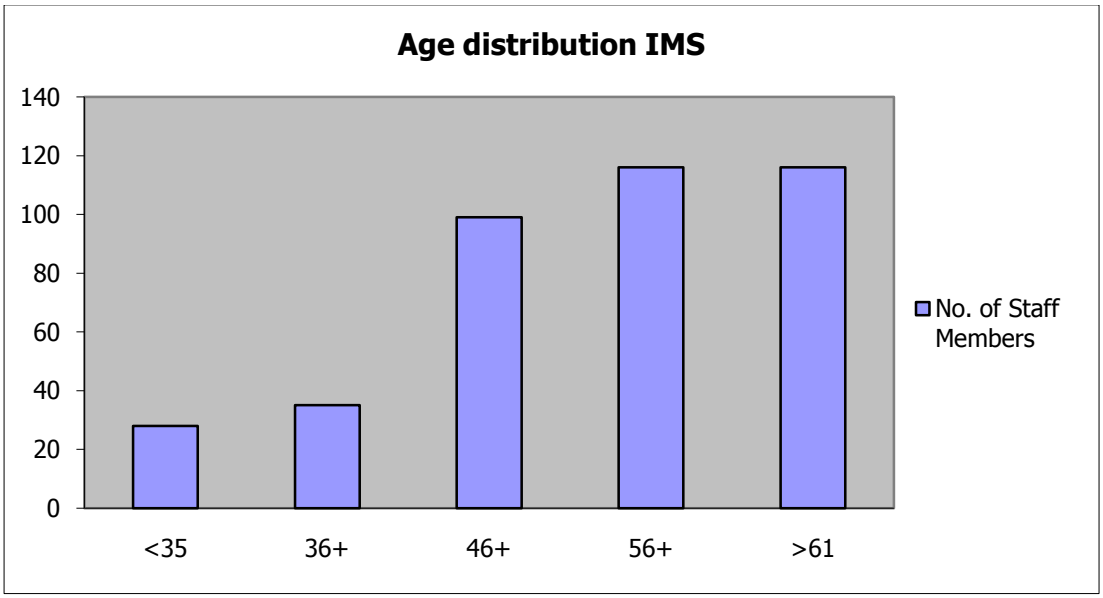
NATO and EU activities in the anti-terrorist area. The international reputation of the Institute in the high-tech defence and security area can be determined by the substantial number of products (37 systems), certified by special NATO boards. However, as indicated before, these activities are beyond the scope and expertise of the panel and were not taken into account for the purposes of the scientific evaluation and ratings of the institute.

Overall score for Socio-economic Impact: "*Moderately relevant.*"

(c) Prospects

The IMS is a well organized and structured research institute. An critical problem is the unbalanced age distribution that endangers the continuity in expertise in this important competence area with approximately 60% in the 56+ age group. As the number of PhD levels has fallen to a dramatic low level of 2 in 2008, given the overall size of the institute this requires immediate attention of the management of the institute. Lack of research funds and non-competitive salaries at BAS level make it very difficult to see how the institute can revitalize itself by recruiting and retaining new, young staff members and make the necessary improvements to the scientific output and research infrastructure.

To keep its leading position in the area of metal science and metal technology and to keep being the leading organization that serves the national industry in that area requires a clear vision what new directions to exploit and what areas of metals research to stop. To become and to remain a reliable international partner is also highly dependent on the quality and productivity of the conducted research in the chosen areas of metals research. A clear strategy to move into new areas of metals research is essential to increase the international cooperation for scientific projects and also to attract young PhD students.



Overall score for Prospects: "*Low.*"

Overall Strengths and Weaknesses

Strengths:

- Institute is highly visible in the high-tech defence & security area through NATO projects & contracts
- Very successful in acquisition of external funding (NATO, NSF etc.)
- Certified (ISO & NATO) testing facilities

Weaknesses:

- Low number of scientific publications and citations
- Low number of young researchers, including PhD students
- Low visibility outside the high-tech defence & security area
- No participation in EU framework programmes

Recommendations

- Recruit more PhD students
- Publish in SCI listed journal & proceedings
- Balance contract research & basic research
- Invest benefits from contract research in staff, infrastructure & exploratory projects
- Explore 'new' areas like:
    - Friction stir welding
    - Nano-composites & magnesium alloys
    - High performance wrought alloys
- Defense & security related activities in a separate department/institute

602 Bulgarian Ship Hydrodynamic Center (BSHC)

Executive Summary

BSHC is a relatively small institute in terms of number of staff, and it has a very large and complex infrastructure consisting of a number of model towing tanks and other test facilities for hydrodynamics, propeller cavitation, in addition to a small wind tunnel.

The institute, like similar towing tank centers around the world, are very "engineering oriented" and BSHC became a member of BAS as late as 2004 and therefore has a very short "career" within this "academic framework".

The average age of the scientific staff is high, the academic ranks are relatively low and in addition the recruiting and retaining of young scientists is very limited.

The management team members of the institute are all close to retirement, and there are actually very few, if any, "mid-age" level personnel (40-55 years of age) which could be expected to take over the head positions in the near future. The institute therefore needs to either recruit qualified Bulgarians who works abroad and/or foreign experts, but in any case they will have to be able to offer competitive salaries, pension schemes etc. in order to attract the right people. Since the Bulgarian scientific community within hydrodynamics, CFD-analysis etc is limited, the ability to educate and train the sufficient numbers of PhDs in-country is probably too low to meet the future personnel and competence needs if BSHC shall be able to continue to operate.

After some difficult years for the nation, which influenced heavily on the BSHC business opportunities, the market improved considerably and the number of projects increased accordingly. But currently the global ship building market is in great difficulties due to the global financial crisis, and that has a direct impact on the income opportunities for this institute. Since BSHC has a very large and expensive infrastructure, which is partly more than 30 years old, the institute needs to generate considerable external income to pay for the maintenance and upgrade of the facilities, instruments and software packages to be competitive on the global market for model test centers.

The future for the BSHC looks relatively bright, given that the institute is able to recruit and retain young people, to get in place a new management when the current one retires in the coming years, and win enough industry contracts to generate the necessary income to pay for more staff, and to expand, update and maintain the infrastructure as necessary to stay competitive.

The BSHC is evaluated to be a non-typical academic science institution, but more of an engineering and consulting institute in support of the maritime industry inside and outside of Bulgaria. Their prime motivation for being a BAS institute could be seen to be the direct funding for salaries and coverage of expenses for heating, electricity etc from BAS. On the other hand, the institute is totally dependent on a large external income in order to pay for extra staff and the up-keep of the infrastructure. It is therefore recommended that alternative ways for BSHC's

affiliation to BAS is considered, for example to turn BSHC in to a BAS owned foundation of some kind, with a large degree of freedom regarding hiring staff, negotiate salaries etc, in order to be able to recruit and retain the necessary number of qualified people from both Bulgaria and abroad, with a basic funding from BAS and its main income from external projects.

The BSHC also needs to develop a business strategy that clearly identifies those areas where they have a comparative advantage to their competitors, both globally and in Europe, in order to strengthen those areas where the business opportunities are the best, which seems to be within inland waterways, coastal engineering, based on Bulgaria's geographical position and national priorities, in addition to renewable energy installations which is a novel and to a large extent unexplored market today.

BSHC depends on a very large, complex and expensive infrastructure which requires a large amount of resources to maintain and improve, and that should be fully utilized at all times. In order to reduce the financial risk and running costs, in addition to better utilize the facilities, BHSC should search for national and international partners to share the use of the facilities and the financial costs and risks.

Evaluation Summary

(a) Quality and productivity

Quality:

The BSHC is to a large extent oriented towards commercial contracts for model testing, engineering analysis etc, so their academic production is low. The scientists in the BHSC are rather few and their academic ranks are generally very low compared to other BAS institutes, an indication on that the academic production among the staff is low. In order to improve on their scientific quality, the recruiting of young and middle aged scientists is of vital importance.

Given the existing infrastructure and accumulated knowledge and experience in the institute, the innovative potential is probably reasonably good, but again depends on even higher external income than today, in addition to recruitment of a large number of highly qualified scientists. If the BSHC is evaluated from a commercial engineering point of view, their success in winning competitive commercial contracts shows that they are on an acceptable level concerning quality.

Productivity:

The BSHC has a modest productivity in terms of educational activities, PhD candidates and scientific publications. The project activity is to a large extent oriented towards industry projects and the scientific results are therefore limited. It is therefore reasonable, given the nature of the activities at this institute that most of their results will be presented and documented in conference proceedings rather than in academical journals. Similarly, the applied nature of the field leads to an underestimate of the usefulness of the papers, since the end-users of the result are

those who apply them to practice and are unlikely to write papers. However a sustainable effort has to be made to increase the number of journal and conference papers if the BHSC should be regarded as a scientific and academical institute.

Overall Score for Quality and Productivity: "C" for **"***Work that is solid and has added to our understanding and is in principle worthy of continuation. The institute is nationally visible***."**

This score on Quality & Productivity, is seen in a scientific context using international benchmarks, however, in an engineering context the institute would have scored at least a "B", for "*Work that is internationally visible. The Institute has made valuable international contributions in the field.*"

(b) Relevance: Socio-economic Impact

The BSHC activities is more or less the single research and development institution in Bulgaria within their field so the socio-economic impact of their activities is very high regarding the socio-economic impact on the education of the Bulgarian population and Bulgarian industry.

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

The BSHC is describing itself as a well organized and structured research institute which has a good infrastructure and a well qualified staff. The problem is the lack of funds and non-competitive salaries which make it very difficult for the institute to "regenerate" itself through recruiting and retaining new, young staff members and at the same time make the necessary improvements to the infrastructure. If this situation is not changed in a few years time, the cost of "turning BSHC around" may be too large given the current economical situation in Bulgaria.

Measures to recruit new leaders of the institute and to fill the "age gap" between the "below 35" and the "above 55" age groups are therefore of vital importance.

Overall score for Prospects: "*Moderate*."

Overall Strengths and Weaknesses

- BSHC is working in a somewhat different field from most of the other BAS institutes, and therefore their cooperation with others is limited.

- On the other hand, BSHC has formed a cluster in Varna with the Institute of Oceanology, and educational institutions such as the Varna University and the Bulgarian Naval Academy. This shows promise for the future growth within the marine and maritime sector in Bulgaria. Their new educational program in Ocean Engineering which will start this fall is also a very positive initiative in order to produce the necessary future experts in this field for the country.

- There are no other institutes within BAS that are obvious candidates for a merger BSHC.

Recommendations

***Affiliation**:*

BSHC is totally dependent on considerable external income to be able to maintain and upgrade its infrastructure and to pay for the necessary number of staff if they shall be able to compete for the commercial contracts that forms the basis for their existence. Being a "semi-academic" institution, their affiliation with BAS should be discussed, and maybe a "looser" connection to BAS should be considered in order to give BSHC a higher degree of freedom to recruit and pay personnel as necessary. At the same time BSHC needs the financial support from BAS that it receives today, so the current basic funding from BAS must be secured, and preferably increased, also in the future.

***Recruiting**:*

BSHC needs to start a recruitment program as soon as possible, focusing both on the "age gap" between 35 and 55 years of age where there are virtually no staff members today. This can best be done by recruiting Bulgarians living and working in related institutes/companies abroad, or foreigners who sees a future for themselves and their families in Bulgaria.

But this strategy requires a dramatic shift in the policies for salaries, pension schemes etc since Bulgarian salaries are not competitive on an international level.

Recruiting and retaining PhD students is also necessary, and again a strategy for this has to be developed fast, and the necessary incentives for these young people has to come in place, such as competitive salaries compared to the maritime industry in Bulgaria and the region.

A program to increase the number of PhDs by sending students abroad, in addition to increase their economical and social status is highly recommended. A "mentor" program where senior scientists at BSHC brings young scientists to conferences and meetings abroad so the young can "inherit" the mentors networks, in addition to creating their own, is also a possible measure. A plan for the coming transition of leadership of BSHC is highly recommended.

***Infrastructure**:*

BSHC is an "infrastructure driven" institute and it is vitally important to have the necessary plans and means to continuously upgrade and improve the infrastructure in order to be competitive on the world market. If not, the institute will soon be obsolete, both industrially and academically since the ability to compete and deliver in accordance with the world market standards and expectations is absolutely necessary. BSHC must therefore continue to compete for commercial contracts, and be given a "fair share" of the infrastructure funds available through

NSF, NATO and the EU. BSHC must be highly skilled in how to compete for infrastructure money from international organizations such as NATO and EU, a competence they either have to build up on their own or get access to from BAS, and in addition they must increase the profits made from commercial projects in order to generate sufficient funds for infrastructure up-keep and improvements.

Strategic business plan:

BSHC needs to develop a strategic business plan based on their comparative advantages in for example inland waterway navigation and coastal engineering etc, in addition to emerging markets such as renewable energy installations, in order to select those parts of the market where the competition is the lowest and their own capabilities the best, and leave other parts of the market to their competitors where they are the strongest and the competition is the hardest.

At the same time the need for one or more academic institutions within research in hydrodynamics, ship stability, ship maneuvering, ocean engineering, coastal engineering etc in Bulgaria should be reevaluated in order to decide if BSHC should continue to be within academia, or be turned in to a completely engineering and industry oriented institute/company/foundation.

Partnership*:*

Because BSHC is operating within a relatively volatile industrial market, the prospects and opportunities for external projects can change very rapidly. The infrastructure of BSHC is its most important asset, but also its "Achilles heel" in difficult financial times. It also requires a lot of investment and maintenance money, and the infrastructure should be used as effectively and as much as possible due to the high cost of the infrastructure whether it is in use or standing idle.

BHSC should therefore search for national and international partners to share the facilities with and also share the financial costs and risks.

603 Institute of Computer and Communication Systems (ICCS)

Executive Summary

ICCS was created in 1994. It consists of eight departments. During the period 2004-2008 the total number of staff has decreased by 25%, from an initial 133 to the current 99 people. As pointed out in the self evaluation report, this is primarily due to better pay outside academia. The most dramatic decreases have been in the number of associate professors I and III and engineers.

ICCS works in the area of scientific research and applied investigations in computer and communication science. This area is aligned with BAS Policies 1 and 2, with one of the priorities, "Information and Communication –Technologies", of the National Strategy and with the EU plan to set a European Research area.

ICCS appears to have developed partnership with other BAS institutes, Bulgarian universities and SMEs. ICCS has provided national support structures, like two laboratories for E-learning, and is part of a know-how transfer network and of Special Regional Networks. Many ICCS staff participate in Bulgarian editorial boards. The participation of ICCS in international collaborations is instead limited. The number of ICCS staff who are members of R&D national and international organisations, international conference committees and peer reviewing is large. The number of visits abroad by ICCS scientists is also large, while only four foreign scientists have visited ICCS. The scientific achievements obtained by ICCS are in pure and applied research.

In the field of pure research, the most relevant achievements are:

1) Integration of web services for remote applications of internet providers;
2) Development of a new flexible technique for internet browsing that uses soft computing agents;
3) Development of a new approach to digital signal processing based on group theory;
4) Proposal for an innovative method for developing programmable controllers.

In the area of applied research, major achievements are:

1) Construction of new USB based specialised microprocessors;
2) Creation of a software package for modelling signal processing systems;
3) Development of a prototype platform for interactive communication that uses standard satellite TV multiplex.

ICCS offers PhD education and training in three different areas. The total number of hours spent by ICCS staff in delivering lectures and courses to Bulgarian universities is very large. ICCS has also organised and hosted international schools.

Evaluation Summary

(a) Quality and productivity

Quality
Although ICCS scientists are part of international collaborations, the majority of projects in which they are involved are of local character and are only funded internally. A large number of ICCS scientists have been on visits abroad, while only four foreign scientists have visited ICCS during the period 2004-2008. ICCS has provided some national support infrastructure and networks.

Productivity
In the period 2004-2008 ICCS has been involved in 93 projects in total, corresponding to an average of 18-19 projects per year. Of this total, a majority, 51 projects, were internally funded (budget subsidiary). Some of the projects in the list have very little allocated funding and in some case no funding at all. A strategy based on a lower number of better financed projects might be more efficient in terms of human resources and operational costs. A distinction should have been made between real projects and simple statements of intent.

The number of publications in national and international journals is also very limited, 114, of which only 32 are in international journals. The number of papers published in proceedings of international conferences and symposia is also quite small, 53.

Although ICCS lists 23 products ready to be implemented in industry, quite a few are on-line courses and distance learning packages and they seem to be more products for education than for implementation in industry. These on-line courses and distance learning packages show the involvement of ICCS in educational activities. This involvement is also demonstrated by the very high (maybe too high) number of hours spent by ICCS staff in teaching activities, a total of 6399 hours in the period 2004-2008 between courses, lectures, seminars and practice. The number of PhD awarded is however very low: two out of 23 PhD students successfully defended their theses.

Overall Score for Quality and Productivity: "C" for **"***Work that is solid and has added to our understanding and is in principle worthy of continuation. The institute is nationally visible."*

At national level ICCS is certainly visible, having created support infrastructures and being also very much involved in educational activities. ICCS's participation in international collaborative actions has however been quite limited. A moderate-to-low level of productivity is also demonstrated by the low number of publications in international journals, participations in major international conferences and products ready to be implemented in industry.

(b) Relevance: Socio-economic Impact

A strong national research institute working in the field of computing and communications is essential for a modern country. ICCS appears however to act more as a service institute to BAS, and to local industry, rather than a research institute. ICCS does not appear to have strong links with modern international projects like the Grid.

Overall score for Socio-economic Impact: "*Not Relevant*". The work carried out by ICCS to provide services to BAS and to local industry has very limited scientific socio-economic impact. It is also questioned whether this work would be better carried out outside BAS. The portfolio of research projects does also not have any link to modern, relevant scientific programmes.

(c) Prospects

ICCS management is aware of the very difficult position ICCS is in and of the problems facing the institute. This is demonstrated by the self evaluation report that not only reads well, but is also admirable in its honesty. ICCS management has however yet to identify a clear strategy to solve this situation. In the fast-moving, fast-changing field of IT, the direction ICCS seems inclined to take and the programme of future projects ICCS has developed are too vague to really help ICCS to improve its position. The senior members of the ICCS appear also to have a very heavy teaching load, which further inhibits the development of a strong research base. At the moment there are not many collaborating activities across the different departments either and projects are confined usually within a single one.

The breakdown of the personnel by age groups by the end of 2008 leads to serious concern. All senior staff are aged 46 or older. The peak in each personnel category is at ages above 51, with the only exception of research associates of II degree where the peak is in the age range 31-35. The seriousness of the situation is reinforced by the low rate of success in awarding PhD: two out of 23 PhD students have defended their theses in the period 2004-2008. This is certainly due to the very low level of pay in academia, which makes this type of career highly unattractive to students. A programme for hiring younger staff members should be developed. Clearly, this would only be possible if government science funding becomes adequate. Higher funding would also help to stop the brain drain to industry or to foreign research institutions. And it would make careers in research more attractive for talented students. Furthermore, the senior management does not appear to be open to new ideas from young researchers, an attitude that must be addressed.

Overall score for Prospects: "*Low*." Although ICCS leadership understands that the institute is in a difficult position; it is not strong enough to fundamentally change the strategies of research, the management of the institute and its organization. It has not yet developed a vision for the future and a solid strategy to improve the situation. The roadmap presented is too vague to be really useful. Senior staff do not appear to be receptive to new ideas put forward by young researchers. Without a change in their attitude, it will be extremely difficult for them to attract and retain

young bright students, especially when competing with the much more attractive perspectives for young people in the industry and abroad.

Overall Strengths and Weaknesses

Strengths:

- Participation in national support networks and involvement in setting up national support infrastructure
- Involvement in teaching activities in universities
- Understanding of the limits and of the difficulties ICCS is faced with

Weaknesses:

- Majority of projects so far carried out at local level only
- No leadership experience at national and international level
- Extremely small number of publications
- Major difficulties in attracting and retaining PhD students
- Weak links with industry

Recommendations

Although the scientific area in which the ICCS works is nationally important, the lack of recruitment of a new generation of young researchers will, if not addressed, make it very difficult for the Institute to become competitive internationally. It may be advisable to consider a restructuring of ICCS. This could be achieved either via major investment in the Institute that would allow ICCS to rejuvenate its staff and hire new bright young associate professors and young researchers and attract more talented students, or developing a coordinated research programme with other stronger institutes working in the same field.

604 Institute of Information Technologies (IIT)

Executive Summary

The institute has suffered serious challenges during the evaluation period: 15 individuals from the research staff have left the institute, and recruitment is very difficult due to low salaries and a gruelling competition for staff from the information technology industry. The institute management is seriously attempting to address these problems: the management style has been modernized, and young people have been given the possibility of promotion. Still the age distribution is unfavorable, with only 13 % young scientist and with an age dip of people in their 40s.

The institute shows a good activity level in terms of the total publication output, with a yearly average of 2 publications per researcher. Substantial new grants from the NSF have been approved for the years 2009-2010, which indicates a definite recognition at the national level. However, the publications mainly appear in local or low-impact journals and conferences.

The overall scores are as follows:

Overall Score for Quality and Productivity: mainly due to the low international visibility and impact, a score of "**C**" is given for "*Work that is solid and has added to our understanding and is in principle worthy of continuation. The institute is nationally visible*"

Overall score for Socio-economic Impact: "***Moderately Relevant***"

Overall score for Prospects: "**Moderate**"

The main recommendation of the panel is to gradually shift focus towards internationally recognized journals and high-tiered conferences; to identify the researchers, particularly young scientists, with the highest potential; and to provide resources for them to succeed at the international stage. The panel recommends the Institute to reconsider the rationale of publishing two journals, in addition to a pre-publication series. Moreover, a general strategy for organization of IT (CS) research within the academy needs to be formulated and implemented. Currently there seems to be excessive fragmentation in the way this basic service is provided among different institutes.

Evaluation Summary

The IIT is devoted to engineering aspects of Computer Science and Systems Science and currently employs 66 researchers. The institute is organized in eight quite small departments, which consist of about 7 researchers on average. It is very difficult for the institute to recruit and maintain staff, because of competition in terms of much higher salaries and career prospects from the IT industry.

The SER is informative and discusses in an admirably open and frank manner the challenges that the Institute faces.

The Institute has been quite successful in attracting external funding, particularly from the Bulgarian National Science Fund (NSF). The SER also points out that substantial increase in funding from NSF and from EU projects will be available in 2009-2010.

A particular feature of the IIT is the high activity level in publishing. The Institute publishes the journals *Cybernetics and Information Technologies* and *Problems of Engineering Cybernetics and Robotics* in addition to the pre-publication series *IIT Working Papers*. The researchers of IIT are also active in a number of other local publications, as specified in Annex 12 of the SER. None of these journals enjoy international recognition as a leading research journal. It is difficult to assess the quality in publications appearing in the IIT journals since they do not appear in standard databases like *ISI Web of Knowledge* or even Google Scholar.

The publication profile reflects this devotion to local publication. A large fraction of the journal publications appears in these in-house journals. Moreover, some of the journal publications that are labelled as "abroad" appear in journals that are in fact Bulgarian. A large portion of the scientific output is in the form of conference proceedings. The emphasis on conference proceedings is common and uncontroversial in many areas of Computer Science. In fact, some of the most influential, good-quality research is communicated through the highest rated conferences, which have a very rigorous peer review process and a quite low acceptance rate. Unfortunately, conference participations from IIT researchers are rarely within the top tier conferences.

(a) Quality and productivity

The productivity, in terms of the total number of journal publications and papers in conference proceedings, is good. However, most of these publications are in in-house journals and in conferences of low international recognition. Thus, the international visibility is low. This weakness is particularly alarming in such a fast-moving and timely subject as Information Technology.

Overall Score for Quality and Productivity: "C" for "*Work that is solid and has added to our understanding and is in principle worthy of continuation. The institute is nationally visible*."

(b) Relevance: Socio-economic Impact

The level of external funding is substantial and has improved recently. The high level of funding from the NSF suggests that the IIT enjoys a good national standing and socio-economic impact. However, the low international visibility and the lack of participation in the major international computer science conferences carry the risk of isolation and scientific inbreeding.

Overall score for Socio-economic Impact: "*Moderately relevant*"

(c) Prospects

The general high activity level and the ability to attract external funding are promising signs. The discussion of management reforms outlined in section II.11 of the SER as well as the impressions gathered in the interviews indicate a progressive leadership. The institute management is doing as good as they can to maintain staff, for instance by quick promotions of young people in higher scientific ranks. However, the senior management does not seem to appreciate the problem with focusing too much on local publication and provided many excuses to continue with this practice during the interview session. This attitude might seriously hurt the Institute prospects to build up an international recognition.

Overall score for Prospects: "*Moderate*."

Overall Strengths and Weaknesses

***Strengths**:* The IIT operates in a timely and important research area. The activity level is generally high and distributed throughout the departments. The challenges of pursuing computer science research in Bulgaria are immense, but the Institute leadership appears to be aware of problems and is acting to improve the situation.

***Weaknesses**:* The low level of visibility in international high-quality journals and high-tiered international conferences is a clear weakness. The SER does not really seem to appreciate this issue as a serious problem, although it shows a remarkable awareness of many of the other challenges of the institute. Also, in the answer to the additional question 6 ("prove a formulation of where you want the Institute to stand in 5 years"), a higher international standing and visibility of the research results is surprisingly not mentioned. The interviews also confirmed these impressions from the SER.

Recommendations

The panel recommends the institute gradually to shift publication focus towards internationally recognized journals and higher-tiered conferences and to provide resources and support for the most promising -particularly young- scientist to succeed with such publications.

The suggestion in II.4 of the SER, regarding a more flexible and dynamic departmental as well as interdisciplinary organization is commendable.

A strategy for Information Technology research within the Academy needs to be formulated and implemented. Currently, research in the area is scattered around institutes, which prevents critical mass to be build up in the central areas.

605 Institute of Control and Systems Research (ICSR)

Executive Summary

ICSR is a relatively small research institute in terms of staff (total 72, with 37 research staff, 31 research support staff, and 5 other staff including administrative). The institute promotes research in a number of areas that include both theoretical and practical implementation issues. Especially relevant, with considerable visibility and noteworthy results, are the areas of: i) Sensors (e.g., study and development magnetogradient sensors, micromagnetic diodes, magnetoresistor sensors, linear displacement sensors, and 3D-Hall magnetometers), ii) Biotechnological Process Control, iii) Control Theory (e.g. advances on Multiple Predictive Control and the theory of Positive Systems), iv) Intelligent Systems and Applications of Neural Networks. Some of the work done is visible in publications in international journals and conferences. At the Institute, research is also carried on a number of other topics for which substantial more work would be required to yield results. In particular, research on robotics and ecosystem modeling does not seem to be in line with current trends worldwide yet.

The Institute has a reasonably good international network and is quite productive in terms of educational activities, scientific services and products, and patents (11 awarded and 21 pending). Out of 103 projects, 7 are funded through programs of the EU, NATO, UNESCO and other international organizations. The sources of funding are diverse. There is still a strong dependency on BAS funding (app. 79.9%), but the overall picture shows that the Institute is resourceful in attracting financing from other sources. In order to promote internationalization, however, it seems necessary to try and increase the number of projects funded through EU, NATO, UNESCO and other international organizations (the amount of financing channelled through these projects is only 2.9% of the total budget).

From a purely scientific point of view, the number of publications in peer reviewed international journals (app. 67, of which 37 in journals with Impact Factor) brings the number of publications per year per researcher to app. 0.2 in international journals with impact factor, and .36 in international journals without impact factor. These are average figures, for there are areas where the figures are higher. Nevertheless, it is advisable to substantially increase the number of scientific publications in international journals.

The involvement of young students and researchers is key towards achieving the above goal. In 2004-2008, only 3 PhD degrees were awarded, the average age of the candidates being 34 years old. Furthermore, 5 scientists (average age 39) were promoted to the level of senior researcher II. Clearly, there is a need to attract younger researchers. A possible solution to the above problems is to further promote the internationalization of the Institute by strengthening its participation in EU funded projects, thus affording young students the financial support that is required to travel, attend conferences, and spend time abroad.

Concerning plans for future R&D, there is a need to better define the scope of the R&D development work that must be undertaken and, especially, to clearly identify

challenging theoretical problems associated with it. In this respect, the Institute is strongly encouraged to seek the participation with other institutes with a better record of R&D in areas that are key to the implementation of advanced computer/robotic systems. Further work is also required to tackle issues that stand at the forefront of research, namely large scale, networked, decentralized control systems under communication constraints.

Evaluation Summary

(a) Quality and productivity

Quality: The Institute promotes research in a number of areas that include both theoretical and practical implementation issues. Especially relevant, with considerable visibility and noteworthy results, are the areas of: i) Sensors (e.g., study and development magnetogradient sensors, micromagnetic diodes, magnetoresistor sensors, linear displacement sensors, and 3D-Hall magnetometers), ii) Biotechnological Process Control, iii) Control Theory (e.g. advances on Multiple Predictive Control and the theory of Positive Systems), iv) Intelligent Systems and Applications of Neural Networks. Some of the work done is visible in publications in international journals and conferences. In other areas, substantial more work is required to yield results. In particular, research on robotics and ecosystem modeling does not seem to be in line with current trends worldwide yet.

The areas of Sensors, Biotechnological Process Control, and Control Theory hold considerable potential for innovation and relevant industrial applications.

Productivity: The Institute has a reasonably good international network and is quite productive in terms of educational activities, scientific services and products, and patents (11 awarded and 21 pending). Out of 103 projects, 7 are funded through programs of the EU, NATO, UNESCO and other international organizations. The sources of funding are diverse. There is still a strong dependency on BAS funding (app. 79.9%), but the overall picture shows that the Institute is resourceful in attracting financing from other sources. In order to promote internationalization, however, it seems adequate to try and increase the number of projects funded through EU, NATO, UNESCO and other international organizations (the amount of financing channelled through these projects is only 2.9% of the total budget).
From a purely scientific point of view, the number of publications in peer reviewed international journals (app. 67, of which 37 in journals with Impact Factor) brings the number of publications per year per researcher to app. 0.2 and .36 in international journals with and without impact factor, respectively. These are average figures, for there are areas where the figures are higher. Nevertheless, it is advisable to substantially increase the number of scientific publications in international journals.

Overall Score for Quality and Productivity: "B" for "*Work that is internationally visible. The Institute has made valuable international contributions in the field.*"

At a national level the activity of ICRS is certainly visible. The Institute has a reasonably good international network and is quite productive in terms of

educational activities, scientific services and products, and patents (11 awarded and 21 pending). Furthermore, the ICRS is very much involved in educational activities. Some of the work done is visible in publications in international journals and conferences. In other areas, substantial more work is required to yield results. In particular, research on robotics and ecosystem modeling does not seem to be in line with current trends worldwide, yet. From a purely scientific view point, the number of publications in peer reviewed international journals with impact factor is low.

(b) Relevance: Socio-economic Impact

The products and services described in the SER convey the image that the ICSR is contributing to society, both scientifically and socio-economically through their research, educational programs and technology transfer. However, the ICSR seems to lack some of the expertise required to bring integrated solutions to the industry, namely concerning those that revolve around robotics applications.

Overall score for Socio-economic Impact: "*Moderately Relevant.*"

(c) Prospects

The ICSR has produced a number of patent applications, products and scientific papers, and has participated in a reasonable number of national and international projects, both science and industry oriented ones. For example, the joint projects with the Laboratory of Magnetic Sensors of Lviv Technical University microsensors with linear output have been devised. They are characterized by high sensitivity, low internal noise and enhanced spatial resolution. They are ready for technological transfer to industrial institutions.

This indicates a large potential for new innovations and growth. The main challenge is again recruiting and retaining young scientists. It must however be remarked that there is a need to better define the scope of the R&D development work that must be undertaken and, especially, to clearly identify challenging theoretical problems associated with it. In this respect, the Institute is strongly encouraged to seek the participation with other institutes with a better record of R&D in areas that are of key socio-economic impact and importance to the implementation of advanced computer/robotic systems. Further work is also required to tackle issues that stand at the forefront of research, namely large scale, networked, decentralized control systems under communication constraints.

Acknowledging the key challenge of recruiting and retaining young scientists, and given adequate funding to educate, recruit and retain young researchers, this Institute seems to have every opportunity to grow and strengthen its position as an international (European) player and national leader.

Overall score for Prospects: "*Moderate*."

Overall Strengths and Weaknesses

Strengths:

- The research on Sensors, Biotechnological Process Control, and Control Theory can be qualified to the best within the Institute.
- The research on Sensors has led to the development of advanced, innovative sensor units.
- The research on Biotechnological Process Control has potential for far reaching practical applications.
- Good participation in national support networks and involvement in setting up national support infrastructure
- Good involvement in teaching activities at universities
- Reasonably good involvement in international projects.

Weaknesses:

- Small number of scientific publications in international journals with impact factor
- Small number of projects funded through EU, NATO, UNESCO and other international organizations
- Concerning plans for future R&D, no clear definition of R&D development work that must be undertaken. There is a need to clearly identify challenging theoretical problems associated with them.
- Low level of cooperation with other institutes, namely those with a better record of R&D in areas that are key to the implementation of advanced computer/robotic systems.
- No clear vision of research/development issues that stand at the forefront of research, namely large scale, networked, decentralized control systems under communication constraints.

Recommendations

- Seek cooperation links with other institutes to establish proper balance between theoretical and practical issues. Suggested symbiotic links are those with the Physical Chemistry Institute and the Central Laboratory of Mechatronics and Instrumentation
- Intensify internationalization via the participation in international projects.
- Solidify the areas of Sensors, Biotechnological Process Control, and Control Theory
- Address issues that stand at the forefront of research, namely large scale, networked, decentralized control systems under communication constraints
- Address the problem of recruitment of young researchers to increase international competitiveness. A partial solution to this issue is to strengthen participation in EU funded projects, thus affording young students the financial support that is required to travel, attend conferences, and spend time abroad.

606 Central Laboratory for Mechatronics and Instrumentation (CLMI)

Executive Summary

CLMI is a relatively small laboratory in terms of staff (total 61, with 34 academic research staff). Together, the staff members hold valuable experience on the development of robotic manipulators and software/hardware for data acquisition, processing, and transmission. Noteworthy recent achievements are: i) development of a robotic manipulator to handle aluminium profiles (under a contract with the Bulgarian-Greek company STILMET AD), ii) construction of equipment and devices for the CMS project at CERN - European Organization for Nuclear Research, iii) development of specialized scientific equipment intended for measurement of wave and plasma parameters (near surface zone) in the International Space Station (ISS), as part of the international project "OBSTANOVKA, iv) development of a telemetry system for single cell recording at the avian hippocampus, and v) development of small robots with potential impact on educational-related activities. Also relevant, with very good potential for future exploitation but in some cases needing further R&D effort, is the activity on: a) Energy-saving mechanisms with mechanical energy storage, b) Devices for sea wave energy conversion, c) Mechatronics bioreactor systems for three-dimensional cell-cultures cultivation, d) New electrical energy storage devices and systems based on supercapacitors, and e) Software tools for intelligent instrumentation (e.g. with applications to the Langmuir probe of the International Space Station). The connections with the industry are strong, and there is a good vision of what actions to undertake to strengthen them.

The laboratory is strong in what concerns systems design and implementation. However, theoretical research is often not well focused, a fact that impacts on the reduced number of publications in international peer reviewed journals, with many of them focusing on CERN-related activities. For example, the number of publications in international journals is 51, app. 31 of which revolve around work done integrated in a CERN team. It is not clear which of the journals cited have an IF. Nevertheless, given the number of researchers involved, the above figure yields an average number of publication per person per year of 51/34/5=0.3. The laboratory shows a very good track record in terms of publications in proceeding of conferences in Bulgaria (app. 60% of all publications). This must be contrasted with the very reduced number of publications in international conferences (app. 5% of all publications). Clearly, there is a need to substantially increase the number of scientific publications in international journals and the participation in international conferences. Given the lack of funds available to this purpose, an immediate solution is to actively seek involvement in European funded projects.

CLMI has a good international network and is quite productive in terms of educational activities, scientific services, and teaching activities at universities. In fact, CLMI has intensive interconnections with academic, industrial and research partners from BAS, in Bulgaria and abroad, working on joint prospective projects. Especially noteworthy are cooperation links with the Institute of Electrochemical Energy Systems and IGIC at BAS (development of new electrical energy storage

devices and systems, based on supercapacitors, designed for energy management and intermittent renewable power sources), the BAS Institute of Water Problems (development of a system for analysis of the soil filtration properties), and the Institute of Oceanology, together with the Institute of Water Problems (Adaptive technology for sea wave energy conversion). It is however intriguing why, given the complementatiry of expertises, no tight cooperation links have been established with the Institute of Control and System Research (ICSR). This would probably be extremely beneficial to both institutions. In terms of projects and funding, CLMI has a steady and "steep" growth in funding from research grants in the report period, with a distinct shift from mainly industry grants to National Science Fund (NSF) and National Innovation Fund (NIF) grants in 2008. This indicates that the institute's services and products are of such a quality that their customers are satisfied with what they deliver, and that they are highly competitive within their area of expertise on a national level. However, the total amount of research grants per year is still on a relatively modest level in terms of monetary values, so they need to increase the actual level of external grants if they shall be able to recruit and retain young scientists. CLMI states clearly that they have not been successful in landing EC-funded projects up to now, but they are currently working towards EC-funded projects under FP 7, and they currently have two project applications in the EC review process. This indicates that the Institute has started the necessary shift towards EC projects, which is necessary if it shall succeed in its efforts to become an internationally recognized research institute and have the necessary future growth.

There is definitely a need to strengthen cooperation links with institutions abroad, in the scope of common projects, and to also pose and solve a number of challenging theoretical problems that stand at the root of many of the practical issues that are currently being studied at the Institute. The involvement of young students and researchers is key towards achieving this goal. In this respect, the Institute is in a weak situation: in the 2004-2008 period, out of 14 students enrolled in a PhD program, only one graduated. Once again, a possible partial solution to the above problems is to further promote the internationalization of the Institute by strengthening its participation in international conferences and EU funded projects. This will allow young researchers to become familiar with new practices, while affording the Institute the means to complement their salaries and sponsor their trips and stays abroad if at all possible, thus making their activity more attractive overall.

Concerning plans for future R&D, there is a need to better focus on the scope of the R&D development work that must be undertaken and, especially, to clearly identify challenging theoretical problems associated with them. The future plans described show an ambitious program with a number of relevant activities in close cooperation with international partners. If the plans are realized, CLMI will deliver a large amount of relevant science within the institute's area of interest. The laboratory is therefore strongly encouraged to strengthen its participation in joint projects in areas that: i) stand at the crossroads of control and robotics, computers, communications, and embedded systems, and ii) exploit novel techniques for renewable energy sources and energy distribution, storage, and management as well as bio-related applications.

Evaluation Summary

(a) Quality and productivity

Quality: The laboratory holds valuable experience on the development of robotic manipulators and software/hardware for data acquisition, processing, and transmission. Very important work is also visible in industry-related projects as well as projects with highly reputed European organizations. In fact, the connections with the industry are strong and there is a good vision of what actions to undertake to strengthen them. Also relevant is the activity on energy-saving mechanisms with mechanical energy storage, devices for sea wave energy conversion, mechatronics bioreactor systems for three-dimensional cell-cultures cultivation, new electrical energy storage devices and systems based on supercapacitors, and software tools for intelligent instrumentation.

Productivity: The laboratory is strong in what concerns systems design and implementation and its connections with the industry. The practical achievements listed are quite impressive given the small number of scientific staff. However, theoretical research is often not well focused, a fact that impacts on the reduced number of publications in international peer reviewed journals, with many of them focusing on CERN-related activities. For example, the number of publications in international journals is 51, app. 31 of which revolve around work done integrated in a CERN team. The laboratory shows a very good track record in terms of publications in proceedings of conferences in Bulgaria (app. 60% of all publications). This must be contrasted with the very reduced number of publications in international conferences (app. 5% of all publications). Clearly, there is a need to substantially increase the number of scientific publications in international journals and the participation in international conferences.

CLMI has an active collaboration with four universities and one technical college in Bulgaria.

14 PhD students have received their training at CLMI in the reporting period, but only one PhD degree was awarded.

Overall Score for Quality and Productivity: "C" for "*Work that is solid and has added to our understanding and is in principle worthy of continuation. The institute is nationally visible*."

The laboratory is strong in what concerns systems design and implementation and its connections with the industry. The practical achievements listed are quite impressive given the small number of scientific staff. However, theoretical research is often not well focused, a fact that impacts on the reduced number of publications in international peer reviewed journals, with many of them focusing on CERN-related activities. CLMI has an active collaboration with four universities and one technical college in Bulgaria. From an educational point of view, 14 PhD students have received their training at CLMI in the reporting period, but only one PhD degree was awarded. There is a need to substantially increase the number of scientific publications in international journals and the participation in international conferences, as well as to seek ways of attracting young scientists.

(b) Relevance: Socio-economic Impact

The envisioned scientific impact of the CLMI is clear in its mission statement, where it is stated that the mission of CLMI is to contribute to society by "conducting research at international level within mechatronics, robotics and specialized instrumentation". The products and services described in the SER strengthen the impression that CLMI is contributing very positively to society through their research and educational programs. Furthermore, the SER describes strong correlation with the policies and programs promoted by BAS. There are good working relations and cooperation with relevant national research institutions, and a reasonably large European network, both for academic collaboration and projects. The cooperation with CERN – European Organization for Nuclear Research is quite strong and remarkable. CLMI has an active collaboration with four universities and one technical college in Bulgaria. It must also be pointed out that the CLMI staff has participated and contributed to a number of national initiatives, and given the small number of scientific staff versus the services and products produced in the report period, CLMI seems to have substantial scientific and socio-economic impact in their areas of expertise.

Overall score for Socio-economic Impact: "*Highly Relevant*." CLMI is contributing very positively to society through their research and educational programs. Furthermore, the SER describes strong correlation with the policies and programs promoted by BAS. There are good working relations and cooperation with relevant national research institutions, and a reasonably large European network, both for academic collaboration and projects. The cooperation with CERN – European Organization for Nuclear Research is quite strong and remarkable. CLMI has an active collaboration with four universities and one technical college in Bulgaria. It must also be pointed out that the CLMI staff has participated and contributed to a number of national initiatives, and given the small number of scientific staff versus the services and products produced in the report period, CLMI seems to have substantial scientific and socio-economic impact in their areas of expertise.

(c) Prospects

The mission of CLMI is to contribute to society by "conducting research at international level within mechatronics, robotics and specialized instrumentation". Based on their reported production over the last five years, CLMI comes across as a vital and strong organization with enormous possibilities to maintain and further develop their position both nationally and internationally, if a higher degree of externally funded projects are won and the laboratory manages to attract young scientists and technicians.

Overall score for Prospects: "*Moderate*." As a vital and strong organization with enormous possibilities to grow if more funds are allocated to educate, recruit and retain young researchers, this institute seems to have every opportunity to grow and strengthen its position as an international (European) player and national leader.

Overall Strengths and Weaknesses

Strengths:

- Laboratory is strong in what concerns system design and implementation and its connections with the industry
- Practical achievements listed are quite impressive given the small number of scientific staff.
- Good working relations and cooperation with relevant national research institutions, and a reasonably large European network, both for academic collaboration and projects.
- The cooperation with CERN – European Organization for Nuclear Research is quite strong and remarkable.
- CLMI has a good international network and is quite productive in educational activities, scientific services, and teaching activities at universities
- Good participation in national support networks
- Intensive cooperation links with other institutes within the BAS.

Weaknesses:

- Small number of scientific publications in international journals with impact factor.
- Small number of projects funded through EU and other international organizations
- In what regards plans for future R&D, no clear definition of R&D development work that must be undertaken. There is a need to clearly identify challenging theoretical problems associated with them.
- Small number of PhDs awarded
- No clear vision of research/development issues that stand at the forefront of research, namely large scale, networked, decentralized control systems under communication constraints.

Recommendations

- Seek cooperation links with other institutes to establish proper balance between theoretical and practical issues. A suggested symbiotic link is that with the Institute of Control and System Research (ICSR).
- Intensify internationalization via participation in international projects and conferences and increase the number of publications in international journals
- Address challenging problems that stand at the crossroads of control and robotics, computers, communications, and embedded systems and exploit novel techniques for renewable energy sources and energy distribution, storage, and management as well as bio-related applications.
- Address the problem of recruitment of young researchers to increase international competitiveness. A partial solution to this issue is to strengthen participation in EU funded projects, thus affording young students the financial support that is required to travel, attend conferences, and spend time abroad.

607 Central Laboratory of Physico-Chemical Mechanics (CLPhChM)

Executive Summary

According to its SER, CLPhChM is a national centre for research in the field of mechanics and technology of non-metallic composite materials for engineering and construction applications. The mission of CLPhChM is to carry out scientific research, publishing, consulting and expert activities, which are focused on solving special problems in theoretical considerations and practical applications of composite materials. Its total permanent staff is of 37, 23 of them being full-time researchers.

In a period of 5 years (2004-2008), with a permanent scientific staff of 23, the Laboratory has published only 20 papers (international) none of them in high-level journals. The number of PhD's awarded in the same 5-year period is only 2. The stagnation of the Institute is also reflected in the age pyramid. Out of a staff of 23 researchers, 14 exceed 50 years of age (7 are above 60 years old). Furthermore, according to the information received from the Directorate of the Laboratory during the Sofia interviews, the scientific equipment of the Laboratory is in need of urgent upgrading.

In terms of scientific output this Laboratory is below the average standards of European contemporary research. The contribution of the Laboratory to the European Research Area is very limited indeed as it is its contribution to the training of young Bulgarian scientists in R+D subjects. On the other hand, the Laboratory might provide some kind of technical support to Bulgarian industries, although most of this support does not see to take place beyond the level of Laboratory testing.

A vigorous policy of rejuvenating the staff seems mandatory and urgent. For this purpose, a policy of retirement, when feasible, should be stimulated. Action aiming at incorporating researchers from other centres into the vacant places should be undertaken. At the same time, the general strategy of the Laboratory should be re-examined. In this regard, and in order to make the necessary adaptation of the Laboratory to the competitive environment of contemporary research, the Panel considers that a strategy involving the integration of the Laboratory research with that of neighbouring areas is mandatory. In particular, the Panel suggests the Laboratory and the Academy to give serious thought to a reorganisation involving the integration of this Laboratory into IP, a much larger structure with well defined objectives. The particular interests of CLPhChM, particularly in the field of composites, would be preserved whereas the researchers from CLPhChM would benefit from the added value of cooperation with a stronger structure and the recognition of IP in the outside world.

Evaluation Summary

(a) Quality and productivity

Quality: In terms of scientific quality, the level of research from the Institute laboratories is low. All the common indicators of international scientific recognition (published papers, citations, invited talks etc) are unsatisfactory. Consequently, the innovative potential of the research carried out at the Institute does not look very promising. In the course of the Sofia interviews, the Directorate of the Laboratory has excused the low productivity of the latter in terms of inadequate infrastructure.
Even at a moderate level, the Department of Formation of Composites seems in a better shape than the other one, Mechanics of Composites, the latter carrying research on the mechanical behaviour of solids. In the SER, the latter is said to be more closely related to industry but this commitment, as discussed below, is not so patent in the results.

Productivity: The scientific productivity of the Institute is rather disappointing. Although the manpower of the Institute is not large, with only 23 researchers, a publication record of 20 papers (international, but not of high recognition) in a five-year period, is a figure which is difficult to accept. The number of citations reported stands at a total of 318. Furthermore, during that five-year period, only two people have obtained their PhD at the Institute which is an extremely low number.
Overall score for Quality and Productivity: "C", for "*Work that is solid and has added to our understanding and is in principle worthy of continuation. The institute is nationally visible.*"

Concerning quality and productivity, as commented above in more details, the Laboratory lacks international projection. The level of research from the Institute laboratories is low and, with some exceptions, not up to European standards in similar institutes. Therefore, one cannot go beyond the C level. At the same time, the Panel recognises that the work is worth pursuing provided that the recommendations below are taken into account; therefore C seems the right mark.

(b) Relevance: Socio-economic Impact

Scientific impact, for example in terms of its contribution to the European Research Area, is little significant. As indicated elsewhere, the figures of publications, citations, PhD trainees etc., fall below reasonable standards.

In the SER, it is stated that the Institute carries out significant amount of work for the Bulgarian industry, particularly through the work of one of its three units, the Laboratory for Testing Materials (LTM). Whereas recognising the value of the initiative of starting up testing laboratories (a second one is beginning operation), it is hard to tell whether the impact in the industry is at an adequate scientific/technical level. For example, the Institute claims to have "developed 8 scientific products ready to be implemented in industry" but it is not clear that the latter has yield any benefits from those products (except, perhaps, that related to the special material employed at Sofia Airport).

On the whole, it seems that the cooperation of the Laboratory with industries takes place at a rather low technological level. The SER makes abundant reference to the role of the contracts associated to external projects and to the benefit they represent. However, when the figures related to funding from projects are examined, one is worried by the low level of industrial budgetary involvement. The so-called projects "from outsourcers, including state or private companies from the country or abroad" apparently include all funding from Bulgarian industry. For these 18 projects (nr 47 to 64) the *total* budget falls short of 100 kBGN, i.e. 50 k€. Moreover, most of these projects are funded at very low rates; they look rather like testing tasks: taking the funding as a figure of merit, there are 8 of them whose budget is less than 500 €. It is even doubtful that these activities deserve the name of "project".

Overall score for Socio-economic Impact: "*Moderately Relevant*."

The subjects undertaken by the Institute, particularly in the field of composites, are certainly of socio-economic impact to the Bulgarian society. Albeit, unless a number of changes referred to below are undertaken, the work of the Laboratory is unlikely to make a significant impact in this regard. On the other hand, the laboratory testing work is of value to the emerging new Bulgarian industry and this should be recognised.

(c) Prospects

In view of the previous diagnose it is hard to make a positive judgment on the vitality of the Institute. Rather, it would seem appropriate to suggest the Institute an immediate injection of scientific freshness and an intensification of cooperation with industry (not necessarily limited to Bulgaria) in R+D projects, not merely in testing materials. This, of course, implies changes in the management and leadership that are discussed in other sections of this Report.

In this regard, and in order to make the necessary adaptation of the Laboratory to the competitive environment of contemporary research, the Panel considers that a strategy involving the integration of the research of the Laboratory with that of neighbouring areas is mandatory. The Panel suggests the Laboratory and the Academy to give serious thought to a restructuration involving the integration of this Laboratory into IP, a much larger structure with well defined objectives. The particular interests of CLPhChM, particularly in the field of composites, would be preserved whereas the researchers from CLPhChM would benefit from the added value of cooperation with a stronger structure and the recognition of IP in the outside world.

Overall score for Prospects: "*Low*"

For the reasons explained above, unless substantial reforms are undertaken, the prospects of the Laboratory are gloomy. It should be said that some of the Laboratory scientists have a good training and a few young researchers look enthusiastic and motivated. If the alluded reforms are met, the prospects of the (integrated?) laboratory would certainly be more brilliant.

Overall Strengths and Weaknesses

The main weakness of the Institute lies in the lack of young researchers. This starts at the PhD level but continues in all the research position strata. Urgent action is required in this matter.

Another important weakness is related to the need of a well-defined strategy. This could be helped by the suggestion of integration in a larger unit suggested elsewhere.

Excessive localism, including a limited extent of opening to international scientific endeavour is also a major matter of concern.

Funding seems to need a major thrust as it is, at present, a major weakness. However, it should be increased only in connection with other structural reforms. The Institute claims that much external funding is being accreted in recent years but much of that external funding is too dispersed and some of the so-called 'projects' are much too small .

A group of Laboratory scientists with a good training and a few young researchers which are enthusiastic and motivated are the main strength of the Laboratory.

Another strong point of the Laboratory has to do with its incipient penetration in the Bulgarian systems of production (connection with industries) and training (good connections with a number of universities) although, as stated before, the scientific/technical level of the cooperation with industry should be increased.

Recommendations

- Rejuvenate the Institute. Encourage, if possible, the retirement of the staff with more advanced age. Make sure that the vacant places (including promotions) are open to researchers from outside the Laboratory.
- Give serious thought to a reorganisation involving the integration of this Laboratory into IP, a much larger structure with well defined objectives. Note that the particular interests of CLPhChM, particularly in the field of composites, would be preserved whereas enlarged in scope. Special benefit would arise from extension of the Laboratory work into emerging fields like nanotechnologies.
- Increase substantially the number of PhD students working for their Thesis in the Institute. Make sure that the openings are well published at the Universities.
- Internationalise the cooperation programs of the Institute, including young researchers' mobility, with special emphasis in the UE, making full use of the Framework Program, the ERC etc.
- Increase the connection with industry (both Bulgarian and non-Bulgarian) trying to develop joint projects of a minimum size and projection. Small-scale services to industry might be also considered but should not be confused with joint R+D projects.

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