SPEC - Service de physique de l'état condensé

Rapport Hcéres

agence d'évaluation de la recherche
et de l'enseignement supérieur

Department for the evaluation of research units

AERES report on unit:

Service de Physique de l'État Condensé

SPEC

Under the supervision of the following research bodies:

Commissariat à l'Énergie Atomique et aux Énergies Alternatives

Centre National de la Recherche Scientifique - CNRS

January 2014

agence d'évaluation de la recherche
et de l'enseignement supérieur

Department for the evaluation of research units

On behalf of AERES, pursuant to the Decree of 3 november 2006[1]*,*

– Mr. Didier HOUSSIN, president
– Mr. Pierre GLAUDES, head of the evaluation of research units department

On behalf of the expert committee,

– Mr. Alain SCHUHL, chair of the committee

[1] The AERES President "signs [...], the evaluation reports, [...] countersigned for each department by the director concerned" (Article 9, paragraph 3 of the Decree n ° 2006-1334 of 3 November 2006, as amended).

Evaluation report

Unit name:	Service de Physique de l'État Condensé
Unit acronym:	SPEC
Label requested:	UMR
Present no.:	URA 2464
Name of Director (2013-2014):	Mr François DAVIAUD
Name of Project Leader (2015-2019):	Mr François DAVIAUD

Expert committee members

Chair:	Mr Alain SCHUHL, Université Joseph Fourier
Experts:	Mr Sergio CILIBERTO, ENS Lyon
	Mr Matthias FUCHS, Universitaet Konstanz, Allemagne
	Mr Mathias GIREL, Département de philosophie, ENS Paris
	Mr Klaus HASSELBACH, Université Joseph Fourier (représentant du CoNRS)
	Ms Claudine LACROIX, Université Joseph Fourier
	Mr Christian SCHÖNENBERGER, Université de Bâle, Suisse
	Mr Cyrille TRAIN, LNCMI Grenoble

Scientific delegate representing the AERES:

Mr Marc DRILLON

Representatives of the unit's supervising institutions and bodies:

Mr Giancarlo FAINI, INP, CNRS

Ms Maria FAURY, DSM, CEA

1 • Introduction

The SPEC is a basic research laboratory of the Atomic and Alternative Energies Commission (CEA) located on the Saclay plateau. The SPEC is a part of the Radiation and Matter Institute (IRAMIS), which is itself a part of the Department of Materials Science (DSM) of the CEA. The SPEC is also a Unité de Recherche Associée / Associated Research Unit (URA) of the National Center for Scientific Research (CNRS).

The activities of SPEC concern the physics of condensed matter and are directly linked to the basic research missions of the CEA in the fields of information and health technologies (TIS) as well as in alternative energies.

The present director of SPEC is Mr François DAVIAUD. He did replace Mr Eric VINCENT since October 2012. Mr François DAVIAUD was deputy director from 2003 to 2011 along with Mr Jean-Louis PICHARD from 2008 to 2011 who was replaced as deputy director by Mr Patrice ROCHE in 2011.

Unit workforce

Unit workforce	**FTE 30/06/2013**	**FTE 01/01/2015**
N1: Permanent professors and similar positions		3
N2: Permanent researcher, engineer, managerial personnel (A1) from Institutions and similar positions	51	67
N3: Other permanent staff technical and administrative personnel	20	27
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)	1	1
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	18	21
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**90**	**119**

Unit workforce	**FTE 30/06/2013**	**FTE 01/01/2015**
Doctoral students	23	
Theses defended (January 2008- dec 2013)	45	
Postdoctoral students having spent at least 12 months in the unit	65	
Number of Research Supervisor Qualifications (HDR) taken	5	
Qualified research supervisors (with an HDR) or similar positions	34	46

2 • Overall assessment of the unit

The scientific production and quality of SPEC are based on world leading scientific achievements based on profound understanding of the physical problems combined with excellency in instrumentation, which result of long term research at the forefront of progress. The SPEC has an excellent international visibility and attractivity because of the high quality of the research produced by its teams. As far as the attractivity and visibility of the SPEC are concerned, the committee did not observe any real weakness. Indeed the committee is convinced that this high visibility will not weaken, taking into account the high quality of the research performed in this laboratory. It is thus clear that the overall interaction of the research unit with the economical, social, and cultural worlds is globally very good, but it should be noted that the implications of the different groups of the research unit in these directions exhibit important disparities. Despite SPEC does not have full-time professors in his staff, the laboratory takes special care with the reception and support of Master's and PhD students. Finally, the SWOT analysis was done very seriously, indicating that SPEC management is aware of the challenges SPEC will have to solve in the next years. Since the reorganization of IRAMIS has been decided very recently, it is clear that the main issues related to the reorganization are still in discussion, and solutions have still to be found.

Strengths and opportunities related to the context

The scientific production is very good, both in terms of quality and number of publications. The international visibility is excellent: large number of invitations to international conferences, involvement in many cooperative projects, several high level scientific prizes. We consider very positively the large spectrum from fundamental to applications with several interactions with industrial world (spin-off, patents, licensing…). Shared open platforms, facilities and mutualized services (mechanical workshop, nanofabrication platform, stockroom and calculation cluster) are very efficient, with an easy access. Integration of post-docs and students is well appreciated. The ability to develop new experimental setups is an important strength of the SPEC. The high visibility of the LARSIM attests the importance of human science activity in such a fundamental physics research lab. The scientific prospective is well done with a good identification of the challenges which have to be solved.

Weaknesses and threats related to the context

The number of young scientists hired in the last few years is very small and several departures are expected shortly, retirements as well as the departure of LEM from SPEC. It will induce important limitations to the efficiency of the SPEC if the hiring rate does not increase rapidly.

Looking to the scientific production, we have noticed a low level of collaboration between the different teams of the lab with the exception of the collaboration between Quantronics and Nanoelectronics.

Despite the participation to ED107 scientific board, the connection with university remains still limited. In the new organization, the SPEC will be cut in two parts. The large distance between the two localizations will introduce rigidity and slow down the overall synergy.

Recommendations

The committee believes that a substantial increase of the interactions between the different teams could have a very positive effect on future researches. We are also convinced that it is very important to find a solution to the separation of the teams on two sites 3 km away. Finally, the link with universities and with the different teaching components of the Paris-Saclay campus should be strengthened.

3 • Detailed assessments

Assessment of scientific quality and outputs

The scientific production and quality of SPEC are founded on world leading scientific achievements based on profound understanding of the physical issues combined with excellency in instrumentation, which result from long term research at the forefront of progress. The number of publications (450), many in high impact journals and being already widely cited, and the high number of invitations to conferences (270) are good indicators of the reputation and the outstanding research of this laboratory. Other indicators are the strong collaboration of SPEC with national and international groups, as emphasized by the numerous ANR and European contracts. The laboratory has also gained a lot in public visibility in hosting science philosophers, playing an important role for transmitting the scientific approach to the general public.

Assessment of the unit's academic reputation and appeal

The SPEC has an excellent international visibility, resulting from the high quality of its research. This can be illustrated through many different aspects: the laboratory hosted 65 post-docs coming from different countries, 45 PhD thesis have been performed in the laboratory, many researchers have been invited at international conferences, many researchers participate to international and national boards. Moreover, several researchers have been awarded prestigious national and international prizes, for a total of twelve distinctions. Most of the teams of SPEC have a very good number of national and international research contracts. All these indicators demonstrate the very good reputation of the SPEC activities within the international community. Note that all the teams of the SPEC contribute to the international attractivity of the SPEC. As far as the attractivity and visibility of the SPEC are concerned, the committee did not observe any real weakness. Indeed, the committee is convinced that this high visibility will not weaken, taking into account the high quality of the research performed in this laboratory.

Assessment of the unit's interaction with the social, economic and cultural environment

It is clear that the overall interaction of the unit with the economical, social, and cultural worlds is globally very good but it should be noted that the implications of the different groups in these directions exhibit important disparities.

The laboratory manages several strong connections with the economic world. In the last period, the Lab has filed 13 patents. At least one of them is now transferred to a private company that started an industrial production. The corresponding royalties will start to contribute to the research unit budget from 2014.

Though its opening is very recent, the new ultra-low noise building appears to be already attractive for industrial companies willing to characterize their sensors and determine their performances in absence of any magnetic perturbation. The research unit has created a series of very low temperature cryostats based on an original DRY technique that does not rely on the use of liquid helium. One company (Cryo Conception) benefits from the development work of the lab and hired some former members of the research unit to build up and sell this new type of cryostats.

Some groups of the research unit are involved in subjects with strong social implications, like metrology, life science, geomagnetism, and, to a less extent for the moment, climate change. Thanks to the presence of LARSIM within SPEC, the link of the research unit to the social and cultural world was particularly strong over the last period. LARSIM indeed played an important role on the outside visibility of the SPEC. This group has organized a series of working groups that allowed to shine a philosophical light on some topics developed in the unit (quantum information, nanotechnology, energy transition …). Its presence at SPEC shows the pertinence of a human science activity in such a fundamental physics research unit. Unfortunately, the interaction with the other groups of the lab implied in the scientific aspects of these topics remained rather elusive. Science activity spreading was luckily not restricted to this group. Several groups actively participated to « Fête de la Science ». Some groups organized presentations in elementary and secondary schools and/or took part to several radio or TV programs.

Assessment of the unit's organisation and life

The SPEC organization fits very well with the scientific objectives of the lab. Each research group is focused on coherent research topics without overlap between the thematic groups. Several facilities, managed at the SPEC direction level are shared by all the teams of SPEC: a mechanical workshop, a nanofabrication platform, a stockroom and a calculation cluster for intermediate-scale numerical simulations. These platforms are very efficient with an easy and fast access. Group leader meetings are organized to favor point-of-view exchanges on all subjects (budget, promotions, hiring…) between the group leaders and the direction of the SPEC, who takes the final decisions. Members of the SPEC can express their concerns and demands through a "Conseil d'Unité" in which delegates represent SPEC members. Regular meetings of this council are organized to directly address concerns and demands to the SPEC and IRAMIS management.

Assessment of the unit's involvement in training through research

Despite SPEC does not have full-time professors in his staff, the laboratory takes special care with the reception and support of Master's and PhD students. During the evaluation period, 134 Internships have been received, 69 students have prepared or are still preparing their PhDs, and 45 PhD theses have been defended. Moreover, the SPEC staff is involved in many different pedagogical actions and participate to training modulus and courses in Masters (Paris 7, Paris 11, INSTN) and Grandes Écoles (École Polytechnique, ESPCI, École Centrale Paris, ESE, ENSTA …), and in foreign countries (NTNU Norway). During the same period many post-doctoral fellows have been hired in the laboratory.

The number of PhD student is quite high as regards French standard. The Doctoral Schools are mainly ED 107 (Physics in Ile de France) but also ED 447 (École Polytechnique), ED 422 (Electronics). An important effort is done by the SPEC direction to welcome the new members, with each year a welcome day organized for PhD and post-doctoral students. A PhD day is also organized each year during which the PhD students present their work.

Assessment of the five-year plan and strategy

The SPEC project presented by the Director emphasized the strong reorganization of IRAMIS. SPEC includes since January 1st several teams coming from SPCSI (Service de Physique et de Chimie des Surfaces et des Interfaces), while two teams from SPEC (LEM and LARSIM) have joined other laboratories. Except for LARSIM, this reorganization appears to be completely justified, bringing together teams from both laboratories working on close topics. This reorganization is in good adequacy with the strategic plan of CEA (PMLT). Concerning LARSIM, no argument was given for the departure of this team from SPEC. The committee regrets that the opportunity to have close links between physics and social sciences will disappear.

The new organization implies to solve several challenges, which have been clearly identified by SPEC and that have to be solved:

Concerning science, teams working on close topics will be divided among 4 well-defined scientific poles, but it is yet not clear what will be the organization within each pole. It also appeared that in SPEC, the scientific policy is made at the level of the teams.

SPEC is now delocalized on two different places, which are 3 km far away from one another. In the future, it is planned by CEA to have a new building at l'Orme des Merisiers but, in the meanwhile, it is not clear how the integration of part of SPCSI in SPEC will be achieved in a concrete way in order to form a unique laboratory.

SPCSI has many instruments and platforms: these instruments can be very useful for SPEC but this implies large running costs for SPEC. No detail was given about the future of all these instruments. Maybe some will be stopped, with some consequences on scientific activities.

Concerning the PhD students and post-docs, no indication on the strategy and objectives was given.

Finally, the SWOT analysis was done very seriously, indicating that Director of SPEC is aware of the challenges SPEC will have to solve in the next years. Since the reorganization of IRAMIS has been decided very recently, it is clear the problems pointed above concerning the reorganization are still in discussion, and solutions have still to be found.

4 • Team-by-team analysis

Team 1: Physique Mésoscopique

Manager's name: Mr Daniel ESTEVE and Mr Denis Christian GLATTLI

Workforce

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
N1: Permanent professors and similar positions		
N2: Permanent researcher, engineer, managerial personnel (A1) from Institutions and similar positions	12	12
N3: Other permanent staff technical and administrative personnel	4	4
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	7	7
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**23**	**23**

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
Doctoral students	6	
Theses defended (January 2008- dec 2013)	17	
Postdoctoral students having spent at least 12 months in the unit	19	
Number of Research Supervisor Qualifications (HDR) taken	1	
Qualified research supervisors (with an HDR) or similar positions	9	9

Assessment of scientific quality and outputs

The quantronics group (GQ) and the nanoelectronics group (GNE) are both acting in the field of solid-state quantum electronics. Their emphasis is however different: while the focus of the GQ is on superconducting devices, GNE targets mainly devices based on low-carrier density two-dimensional systems. Although the staring material for the micro and nano-devices may be different in the two groups, one has to stress that there is quite some overlap on the connectional side, i.e. quantum transport at low temperature combining DC charge transport with microwave radiation techniques, and consequently also on the experimental side. Hence, a lot of synergies exists between the two groups.

Both groups are renowned worldwide. They are leading in their specific area and often enough determine the state-of-the-art with novel experiments and breakthroughs. Another highly appreciated feature of the two groups is the extraordinary quality of their work. This quality is apparent in their publications, which often appear in highly cited journals. The "Saclay style" has always been to do novel experiments with engineered quantum systems that can be tuned in such a way that (almost) all parameters can be controlled, making the experiment directly accessible to theory. This mode of operation has led to a profound insight into the physics and generated real progress. The groups publish in major journals, with many contributions in the best physics journal (Phys.Rev.Lett.) and contributions in Nature journals and numerous (110) invited conferences, mostly in USA and Europe.

The GQ undertakes highly original work in the fields of mesoscopic superconductivity and has been a world leader over many years when it comes to the physics of cooper-pair transport in superconducting circuits. The group has been combining superconducting quantum bits with microwave resonators. They have extended this "cavity QED" approach to hybrids including spins in NV centers, demonstrating a quantum memory. The group has also pioneered measurements with few transmission channels, which can be fully characterized and used for quantitative studies of Josephson junctions, acting as source of photons or in reverse as detectors. A deep insight in Cooper-pair transport has been reached implementing a new approach in Andreev state spectroscopy. The QG has furthermore demonstrated a quantum speed up in a Grover algorithm with two qubits (four states).

The GNE is a world leader when it comes to quantum-statistical properties of colliding electron wave packets in electron-optic like experiments using edge state modes as guiding channels. The group undertakes optics-like experiments with electron beams using 2DEG in the quantum Hall regime, where they have realized different versions of Mach Zehnder interferometers. They have pioneered insightful shot-noise experiments in nanostructures and went on to generate single electron wave packets (Levitons) using well-defined pulse shapes. The group has applied this technique in a recent demonstration of the Hong-Ou-Mandel correlation experiment for electrons. The group has also looked into the question of supersolidity in solid helium. Moreover, the GNE has done novel experiments in graphene, by studying the dynamics of magneto-edge plasmons in graphene.

Both group have been open to new developments in recent years. While the GQ has taken up the hybrid concept in order to store and transport quantum information, the GNE has taken up graphene as a new playground for physics. Both groups discuss new experiments using the concept of topological insulators to generate Majorana states. The impact of both groups is exceptional. The two teams are leaders in France, in Europe and belong to the top groups in their field worldwide. They are a reference to the community in terms of depths of science and quality of output. As mentioned before, both the GQ and the GNE are recognized internationally as leader in their field. In particular, one has to stress that their output has been impacting the research community to a great extend, often enough defining the state-of-the-art due to an often unmatched depth in understanding which the groups reached through a careful design and theoretical modeling of their devices. This has led to numerous invitations at international conferences and research institutions, amounting to more than one hundred (110) for both groups, mostly in Europe and USA.

Assessment of the unit's academic reputation and appeal

The external funding level is very good, including many regional ones at the Ile de France level (9), national ANR ones (7), as well as EU ones (4). In particular, for the latter, one has to stress one ERC advanced research grant and one starting grant, as well as the strong involvement in highly competitive STREPs through e.g. the FET open calls. The two groups account for 1/3 of the third party funding of SPEC, which is quite considerable. Further appreciations include four scientific prices and the coordination of several projects.

Both groups are attractive for postdocs, PhD students and also visiting researchers. Albeit the two groups are lighthouses that shine far beyond France, one must stress that a major concern for the future is the diminishing of grants for basic science, both within CEA (for PhD students), the ANR and also EC, and even more importantly the currently difficulty to promote the very best students at CEA on permanent research position. This trend in current funding is a threat to the continuity of this highly competitive endeavor in science, which has reached so incredibly wide.

Assessment of the unit's interaction with the social, economic and cultural environment

The research in this team is exceptional by its originality and profoundness of the approaches. The focus of the two groups is clearly in basic science and not on the application side. However, this does not mean that the research is not relevant for the society. On the contrary, through engineering, exactly the way it is done in the GQ and GNE, quantum science has been turned from a curiosity into an engineering discipline with far reaching implications in data communication and computation. The two groups have helped by teaching the subject to classes and at open days so that this information is penetrating into the society.

The principal investigators are heavily involved in various committees and University boards (such as LABEX-PALM, Triangle de la Physique, LNE, CNRS, CNRS-C2N), including in defining the new campus of Paris-Saclay University. Moreover, the members of the group are called to participate in many French and European panels of research evaluation AERES, ANR, ERC, RTRA, Labex, ETH Zurich, CoNRS, GDR.

Assessment of the unit's organisation and life

The structuring of the communication with the different meetings / bodies seems adequate and the work is always undertaken by sizeable parts of each group. Common publications witness the collaboration between the two components. The increasing interaction between the two groups will further strengthen the team and SPEC. This is even more important as the recurrent funding from CEA and the national agencies becomes less and less. The participation of SPEC in the Saclay Campus is highly desirable.

One should stress that the GQ and the GNE are by large in charge of the nanofabrication technology infrastructure. They provide an invaluable service to the whole SPEC and beyond by training researchers in this technology and insuring an operative functional environment. The mode of operation with a steering board, as suggested by the last review, seems to work well. In a similar manner the low temperature laboratory is key for support of the very demanding low temperature experiments undertaken by the mesoscopic physics group.

Assessment of the unit's involvement in training through research

Almost all permanent staff members (7) teach either at Universities or Engineering Schools at the Bachelor/Master or Doctoral level or participate with high-level contributions at dedicated PhD summer/winter schools (Les Houches, Cargese….) and other international schools. It is expected that this involvement might even increase when the new Paris-Saclay University will start.

The number of postdoc recruitment has steadily decreased. This holds maybe less for the GQ and GNE, but is a general trend within SPEC and needs the attention of the upper management. Furthermore, recruitment to permanent positions has become very difficult at CEA (see comment before). The training of PhD students and postdocs in the reporting period is quite impressive. There were around 20 postdocs and 22 PhD students involved in training activities at the two groups.

The ratio of permanent staff to contract-based temporary employees is around 1:1. As compared to Universities the ratio may still be seen high, meaning that the fraction of permanent staff is relatively large. However, this is the difference between a University and a research institution like CEA. This mode of operation makes possible research on a much higher level of quality since continuity is insured. The exceptional reputation of the Saclay teams GQ and GNE is also to great extend due to this unique constellation which should be maintained.

Assessment of the five-year plan and strategy

The outlook of the future research is very bright. Both the GQ and GNE have identified important new topics where impact can be expected. These are hybrid quantum systems for the storage and communication of quantum information between more distant quantum systems, an important question both for quantum communication and scaling of quantum processor. In addition, the use of new state of matter to generate exotic excitations, such as Majoranas will be in the focus. In further detail, topics include:

• exploration of the Andreev two-level system as a qubit, opening towards proximity superconductivity in collaboration with CNRNano and detection of Majorana Fermions in 2 DES wires in presence of strong spin-orbit coupling ;

• quantum information processing will be extended to 4 and 8 qubits, new readout techniques will be implemented. The hybrid structures aiming at maintaining long coherence times in spin systems will be implemented in new spins systems (collaboration University College London);

• detection and control of a single spin in collaboration with LPN;

• research on the interconnection of quantum transport and quantum radiation, in order to develop the field of quantum microwaves;

• extension of the Leviton to fractional charges and integration of leviton electron emitters into other circuits.

The research strategy is aimed at deepening the understanding of basic physics processes in quantum science making use of nanoscaled solid-state based devices. The research avenue of the group relies on existing and newly established national and international collaborations. This strategy is supported by a coordinated drive to acquire high-level scientific equipment in the frame of the Saclay Physics collaboration. The committee looks favorably the enhancement of the links between GQ and GNE and expects that it will lead rapidly to a unique scientific team.

Conclusions

Both groups are renowned worldwide for the extraordinary quality of their work, its originality and profoundness of the approaches. They are leading in their specific area and often enough determine the state-of-the-art with novel experiments and breakthroughs. The outlook of the future research is very bright. The only small advice we could give is to increase the interaction between the two groups. It will further strengthen the team and SPEC.

Team 2: Laboratoire Nanomagnétisme et Oxydes

Manager's name: Mr Claude FERMON

Workforce

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
N1: Permanent professors and similar positions		
N2: Permanent researcher, engineer, managerial personnel (A1) from Institutions and similar positions	9	9
N3: Other permanent staff technical and administrative personnel	6	6
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	4	4
N6: Other contractual staff (without research duties)	1	1
TOTAL N1 to N6	**20**	**20**

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
Doctoral students	6	
Theses defended (January 2008- dec 2013)	8	
Postdoctoral students having spent at least 12 months in the unit	11	
Number of Research Supervisor Qualifications (HDR) taken	1	
Qualified research supervisors (with an HDR) or similar positions	7	7

Assessment of scientific quality and outputs

The LNO team covers a large range of topics in the field of magnetism and oxides with a good balance between fundamental research instrumentation and applications. In most of the addressed topics, the LNO team members have performed excellent research. The high numbers of published papers, more than 163 in the period, and the overall quality of the publications, attest this high level research. Beside number, the international scientific community views several results as very important. The first observation of photostriction in multiferroic materials, the elaboration of a model for the magnetic ground state of rare earth frustrated pyrochlores, based on crystal field determination, the development of magnetometers which sensitivity is in the femtotesla range are representative examples of the international status of the research. Moreover, one of the big strengths of this team is its capacity to transfer the results towards applications in partnership with industries. Dedicated to conception and characterization of ultra low noise magnetic sensors, the UBM platform is unique in Europe. It will allow the LNO team characterize and measure the "noise level" of ultrasensitive sensors down to level lower than the femtotesla.

Assessment of the unit's academic reputation and appeal

National and international visibility of the team is very important. Most of the researchers of LNO team have developed national collaborations with other leading laboratories in the field in Orsay/Saclay, Paris, Nancy and Grenoble. The activity is supported by a large number of contracts (about two per permanent investigator during the period), mainly ANR, or European funded. The academic excellence of the attractivity can also be measured by the high number of invited conferences or by the capability to attract international top-level senior visitors. Two members of the team have received the Ayme Poirson prize of the French Academy of Science for the development of ultrasensitive magnetic sensor. Moreover, the high number of non-permanent (PhD students and postdoc) researchers is also a proof of the high attractiveness of the team.

Assessment of the unit's interaction with the social, economic and cultural environment

It's certainly one of the strengths of the team. Some members of the team are strongly involved in applications of the research results in many aspects. Team's expertise in the field of magnetic sensors is well recognized, and consequently leaded to important industrial contracts, which insure the industrialization of their concepts. This is clearly demonstrated by a large portfolio of 15 patents with 4 new items in the last five years. During these years several magnetometer concepts have been transferred to SME and large industries. Today, a major industrial partners is strongly interested for the development of GMR based sensors for automotive and consumer applications. The devices production started already in 2013. Moreover, the development of ultra-sensitive sensors for medical applications and security and in particular low field MRI will possibly have an important societal impact in the future. A new building, funded mainly on contracts of the team, for this purpose with very low noise will give access to the development for and high sensitivity magnetic detection.

Assesment of the unit's organisation and life

The team activity is covering many subjects that may appear not connected one to each other. When looking at the publication list, one may have the feeling that the team is a collection of small groups of one or two peoples each of them dedicated to one of the topics without joint publication between the different topics. However, this diversity is used positively due to the organization of regular meetings with all the members and to the large scientific culture of most of the permanent members. Moreover, it is already programed to stop some topics, and consequently to concentrate the manpower on a reduced number on subjects. Consequently, we have a very positive statement on the team life and organization.

Assessment of the unit's involvement in training through research

The team is involved in teaching activity: courses on statistical Physics, Magnetism and Superconductivity in various Master 2; teaching in various summer and winter schools; courses and student training at the École Polytechnique. The team is well involved in the formation of PhD with a ration of 2 PhD students for 3 permanent researchers. If we include the postdoc this ratio rises to 1.

Assessment of the five-year plan and strategy

The five-year strategy is in the continuity of the current research of the team. For each subject, there is a real ambition: the increase of the activity on oxide thin films with the acquisition of a PLD system based on a femtosecond Laser (funding obtained in 2013); the continuity of the activity in superconductivity with the elaboration of single crystals in combination with physical measurements for an improved understanding of these unconventional superconducting compounds; the development of optical techniques for the investigation of magnetism at the local scale; the development of medical applications of sensors and in particular full scale systems for MRI and probes for NMR and magnetic mapping at local scale in vivo and in vitro. However, we would expect a strategy to enhance the transversal scientific activities and consequently to increase the number of common publications.

Conclusions

The LNO team covers a large range of topics in the field of magnetism and oxides with a good balance between fundamental research instrumentation and applications with a very high level national and international visibility. We see some possible difficulties that may occur from the merging with a group which will be at an important distance (several kilometers) from the core of the team. Moreover, we note that a larger collaboration between the different members of the team should enhance furthermore their already high quality research.

Team 3 : Laboratoire d'Electronique Moléculaire

Manager's name: Mr Vincent DERYCKE

Workforce

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
N1: Permanent professors and similar positions		
N2: Permanent researcher, engineer, managerial personnel (A1) from Institutions and similar positions	3	3
N3: Other permanent staff technical and administrative personnel	0.5	0.5
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	2	3
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**5.5**	**6.5**

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
Doctoral students	2	
Theses defended (January 2008- dec 2013)	6	
Postdoctoral students having spent at least 12 months in the unit	13	
Number of Research Supervisor Qualifications (HDR) taken	2	
Qualified research supervisors (with an HDR) or similar positions	3	3

Assessment of scientific quality and outputs

The activity of the group in the past five years has been productive and of good level. In addition to publications in general journals of very good level (J. Am. Soc., Adv. Mater. ...), the specialized journals where the group publishes goes from Current Organic Chemistry to Applied Physics Letters, reflecting the pluridisciplinary research of the team and the control of their systems from synthesis to precise physical measurements. The editorial activity is relatively balanced between the different themes. In the field of synthesis and functionalization of carbon nanotubes (CNT) and graphene, the team has developed an expertise in the functionalization based on click chemistry. In particular, they have highlighted a selective functionalization directly related to the electronic properties of the CNT, opening the possibility of post-functionalization sorting of the CNT. Depending of the interacting partners and on the targeted applications, other types of functionalization are also performed relying in particular on supra-molecular chemistry. The types of molecules grafted onto carbon-based materials are numerous. The grafting of single molecules-magnets has allowed detecting the magnetic bistability at the molecule scale. This opens the perspectives towards applications in spintronics, all the more that the team is actively involved in the high frequency electronics. The team is also interested in using its compounds for energy conversion. This is an extremely promising and competitive subject, with important development worldwide but particularly in Asia. The expertise of the team in terms of functionalization of carbon materials is a real asset in this area to overcome some technological barriers. The development of these themes are based not only on the skills directly present in the group, but also on a well-developed network of local (ICMMO, IEF ...), national (IEMN, IN ...), European (Trieste ...) and international (Seoul ...) collaborations.

Assessment of the unit's academic reputation and appeal

Involvement in national programs is very good with the participation in ten ANR projects, five being led by the lab, and four projects funded through the C'Nano program. This positive judgment also holds at the European level with three STREP projects and two Marie Curie postdoctoral fellowships. This obviously is/will be supported by the recognized importance of graphene at European level. The undergraduate, doctoral and post-doctoral recruitment is also very good. Industrial companies hired most young doctors trained in the laboratory. The team members are active in many selection committees at regional, national and international levels. One is member of the organizing committee of two conferences bringing together more than two hundreds people.

Assessment of the unit's interaction with the social, economic and cultural environment

Although the systems studied in the lab have an obvious potential for applications, the team essentially claims for a fundamental approach of these systems. Nonetheless, it should be noted that nine patents have been filed. This reflects the attention that the group carries to synthetic methodology and to the potential applications of its compounds. In addition, the fate of young doctors formed by the team indicates that the experience gained during their PhD (and/or the contacts of the team members) is well recognized in the industrial world. Finally, the group is active in spreading of science not only during "Fête de la Science" but also through talks in elementary and secondary schools and has participated to two radio programs.

Assesment of the unit's organisation and life

The group is organized around a central expertise (functionalization of carbon-based materials), with variations in terms of systems and applications that allow each of the three members of this small group to develop its own subjects. The complementary and some kind of complicity between them are obvious.

The group is well equipped for synthesis and has plenty of room for that. It benefits from the Nanofabrication facilities of the research unit. Moreover, they have their own characterization equipment that is complementary to those present in the vicinity of their synthesis laboratories like NMR.

It is difficult to judge about the regular update of the website. It has definitely been updated just prior to the evaluation of the research unit. Anyhow, it is not very rich and one of the members does not have a webpage.

Assessment of the unit's involvement in training through research

The undergraduate enrollment is large and varied. This attractiveness indirectly reflects a good direction of the students' work and a good atmosphere within the team. Six PhD have been defended during the period and it should be stressed once again that most of the PhD trained in this group have already been recruited in the industry. Moreover the group has welcome 13 postdoctoral fellows.

Finally, members of the LEM have taught in the Master 2 Nanosciences at the University Paris-Sud throughout the period. They also gave lectures in the European School On Nanosciences & Nanotechnologies (ESONN).

Assessment of the five-year plan and strategy

The project is based on the expertise of the group in carbon-based materials. It will be undertaken within NIMBE, a new research unit devoted to nanochemistry. The research activity of the group is indeed focused on synthesis and processing of materials towards applications. It will find a more adapted environment within this new research unit. It should be noted that this is essentially an administrative change but not a geographical one since the synthesis laboratories of the group were not located on the Orme des Merisiers site but on the Saclay site. Moreover, given the drastic reduction of the group size during the last five years, the group has wisely decided to stop some of their previous activities.

They will actually develop the following research directions:

- supra-molecular assembly of high dimensionality carbon-based materials of using DNA linkers and functionalized fullerene tectons;

- development of high frequency flexible electronics using graphene instead of carbon nanotubes;

- connection of CNT to standard electronic devices in order to develop neuronal network in collaboration with IEF Orsay;

- synthesis of functionalized CNT for energy conversion.

The three last topics underline that the synthesis and processes developed in the group are definitely orientated towards physics and applications. Following their pluridisciplinary culture, the members of the group are strongly implied in this second aspect of their project. Interestingly, the team wants to get closer to LETI for some relatively mature technologies. On the same footing, a common work with a research of NIMBE, who is involved in water reduction with V. CEA/DSV/iRTSV in Grenoble could lead to a complete molecular system for water conversion to di-oxygen and di-hydrogen under sunlight that would be of interest to INES. Such a project would facilitate the integration of the team in NIMBE.

Conclusions

The LEM team activity is productive and of good level, with a real pluridisciplinary research published in journals of very good level. However, given the drastic reduction of the group size during the last five years, the group has wisely decided to stop some of their previous activities. The project is based on the expertise of the group in carbon-based materials. It will be undertaken within NIMBE, a new research unit devoted to nano-chemistry. We recommend a rapid integration of the team with NIMBE.

Team 4: Groupe Physique Mésoscopique et Thermoélectricité

Manager's name: Mr Jean-Louis PICHARD

Workforce

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
N1: Permanent professors and similar positions		
N2: Permanent researcher, engineer, managerial personnel (A1) from Institutions and similar positions	3	7
N3: Other permanent staff technical and administrative personnel		
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	2	3
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**5**	**10**

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
Doctoral students	1	
Theses defended (January 2008- dec 2013)	2	
Postdoctoral students having spent at least 12 months in the unit	4	
Number of Research Supervisor Qualifications (HDR) taken		
Qualified research supervisors (with an HDR) or similar positions	2	6

Assessment of scientific quality and outputs

The GMT group is a new group, created in December 2010, gathering 3 theoreticians. The topics they are working on are various, going from electronic properties of bulk cobaltates, to transport in mesoscopic systems. The main topics are:

Localization in 2D systems: this activity is now stopped, but it has led to several important results, in particular concerning the question of the 2D metallic systems.

Scanning gate microscopy in quantum point contacts and quantum dots: the effect of electron-electron interactions, and temperature was studied. A Kondo dots model was studied to interpret some experiments. This activity was partially supported by two ANR projects.

Quantum charge and heat transport in various models. In particular, the role of the mesoscopic fluctuations in thermo-power of nanostructures has been explored. Some important results concern the optimization of nanostructures for thermoelectric conversion.

Seebeck coefficient in organic electrolytes. This topics is studied in collaboration with SPHYNX for the experiments

Thermoelectricity in sodium cobaltates: it has been proposed that the large thermopower of this compound is related to its charge ordering.

Thus, it is clear that besides the research on thermoelectricity, the researchers of this team have studied many other topics. The publication list indicates 19 published papers in excellent journals (Phys.Rev.Lett., Phys.Rev.B, Nature materials, Eur. Phys J. B…). Researchers of GMT are also regularly invited to international conferences. Thus, research performed by the GMT group concerns various interesting topics, mainly in mesoscopic physics. The team collaborates with several theoretical and experimental teams, not only in SPEC, but also in other labs in France or in various countries.

Assessment of the unit's academic reputation and appeal

In the last five years, the GMT group was involved in several national and European contracts. One of the members has been co-chair of a CEA-CNRS commission for thermoelectricity. Researchers of the GMT group have organized several workshops and schools, in particular one international conference on thermoelectricity in Cargese (2012) and one on quantum coherence in Saclay (2012). Three post-docs and several visitors have been working in the group. The report mentions eleven invitations to international conferences and several in national conferences or workshops (GDR…). These numbers indicate a good impact, taking into account the small number of researchers in the team. It appears that the team has acquired some expertise in the field of thermoelectricity, which is rapidly developing in the last years.

The researchers of the group have been involved in several contracts, both at national and international level: two ANR projects (2008-2011 and 2012- 2015), one European project (2008-2012), several short RTRA contracts and two DSM-energy contracts from CEA. Part of these contracts involves also researchers from SPHYNX.

Assessment of the unit's interaction with the social, economic and cultural environment

GMT is not much concerned with this aspect, but one of the members is taking part in a CEA-commission on thermoelectricity and "gestion de la chaleur".

Assessment of the unit's organisation and life

As often in theory groups, the activities are very diverse, but most of the papers involve several researchers of the group, which indicates a lot of collaborations.

Assessment of the unit's involvement in training through research

Three PhD theses have been defended during the last five years, and one student is presently preparing his thesis. This is a good number for a small theory group.

One researcher of the group is giving lectures (80 h. /year) in several Engineer-schools: ECP, Supelec and at INSTN.

Assessment of the five-year plan and strategy

The GMT group will continue to work in the field of thermoelectricity which becomes an important topics related to sustainable energy sources. They will continue to develop theoretical approaches in relation with experiments at the national and European levels.

However the group will certainly be reorganized, since, in the new organization of SPEC, a team of four theoreticians from SPCSI, performing mainly ab-initio calculations for interfaces and nanostructures, will join GMT. This could be a good opportunity for GMT to enlarge his theoretical approaches of thermo-electricity, but the committee regrets that no real common project was presented.

Conclusions

Research performed by the GMT group concerns various interesting topics, mainly in mesoscopic physics. The team publishes in excellent journals and researchers of GMT are also regularly invited to international conferences. The size of the team is certainly a limitation, however the group will certainly be reorganized due to the arrival of four theoreticians. A rapid elaboration of a scientific synergy between the two groups which merge in the new team have to be a priority of the team management.

Team 5: Laboratoire SPHYNX

Manager's name: Mr François LADIEU

Workforce

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
N1: Permanent professors and similar positions		
N2: Permanent researcher, engineer, managerial personnel (A1) from Institutions and similar positions	15	18
N3: Other permanent staff technical and administrative personnel	3	3
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	2	4
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**20**	**25**

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
Doctoral students	6	
Theses defended (January 2008- dec 2013)	10	
Postdoctoral students having spent at least 12 months in the unit	16	
Number of Research Supervisor Qualifications (HDR) taken	1	
Qualified research supervisors (with an HDR) or similar positions	12	13

Assessment of scientific quality and outputs

The main research activities developed by the members of SPHYNX are focused on the statistical properties of out-of-equilibrium systems. The systems under study are hydrodynamic turbulence, magneto-hydrodynamics, glasses, granular matter, magnetic systems, self-propelled particles and thermoelectricity. Although the number of these research directions might look too large, it is important to stress that they are strongly related by the kind of statistical tools used to analyze them and by the relevant scientific questions, such as self-organization, to which one wants to give new insight. This is the very original aspect of this team, which although rather small in comparison to the large number of topics, has been able to get in all of them interesting results, which are highly appreciated by the scientific community. Among the most relevant, we can mention the first observation of dynamo effect in an unconstrained fluid, the first reliable measurement of the non-linear susceptibility of glasses and its connection with dynamical heterogeneities predicted at the glass transition, the identification of the mechanisms for self-organization of filaments moved by molecular motors, the characterization of building blocks for dynamical heterogeneities in granular media and the measure of huge Seebeck coefficients in organic electrolytes. The group is internationally renowned and among the leading ones in experiments on dynamical heterogeneities in complex systems close to jamming. Microscopy with particle resolution in granular systems and demanding (non-linear) dielectric spectroscopy in supercooled liquids and spin glasses correlated particle motions and their spatial-temporal evolution. The group is among the worldwide leading experimental groups in this active field, which is largely dominated by theory and computer simulation. This is just a limited selection of the most important results. Indeed the production of the team is very good in quantity and quality. In the last five years, they published about 30 articles per year, all of them in excellent international journals with a high impact factor. The articles have a good number of citations taking into account the small size of the statistical mechanics community. Finally the team has a large number of national and international collaborations.

Assessment of the unit's academic reputation and appeal

In the last five years the team benefited of about 32 research contracts from European Community, ANR, RTRA. The corresponding budget has been 2.43M€ which is rather adequate for the researches performed in the team. Because of these contracts, the team benefited of 16 post-docs and 17 PhD students, showing that it plays an important role in national and international projects and in the training of students and post-docs. Its members participate as experts in the directions and committees of various funding agencies, research institutions and societies. Several of them have editorial responsibility of important scientific journals, such as Phys.Rev.E and Phys.Rev.Letters. It is also worth-mentioning that four members of the group have received prestigious prices. Furthermore, two PhD students and young post-docs have been awarded prices for young scientists. These awards testify the good impact that the group researches have on the scientific community. The group has undergone major changes in the staff, in part successfully replacing established members by young researchers, adding novel topics and moving the scientific focus of the group forward.

Assessment of the unit's interaction with the social, economic and cultural environment

The research area of the group lies in fundamental science. However, complex and soft matter systems and materials science have a clear technological and ecological relevance. All the researches performed by the team have strong connection with important social and economical issues such as climate, energy, robotics, biology and materials aging. The research on thermoelectricity seems to be very promising from the viewpoint of industrial follow up. Some collaboration with industries exists but no patent has been produced. The "Prix Jeune Chercheur" de la SFP has awarded however a thesis on viscous mixing that has been performed in collaboration with Saint-Gobain. The team has a strong activity in science popularization at the level of schools, TV documentary and radio/TV broadcasting. One of its members has actively participated to the installation of an efficient chilling system for the entire SPEC. Two members have also actively participated in the project for the bicycle network in the Saclay area. Thus the team has an excellent impact in the diffusion of scientific knowledge and in the development of useful network infrastructure.

Assesment of the unit's organisation and life

The group has been established in 2012 and since then has undergone major changes in personnel, adding some young researchers and new research directions. The fusion of four research teams forming SPEC has been in our opinion a very good reorganization. It has gathered several teams, which, although they are studying different physical systems, have in common the main scientific focus, i.e. self-organization of complex out-of-equilibrium systems. Thus, the team has a clear and coherent scientific goal.

Unfortunately, it has been weakened by the departures of several members. We think that a reinforcement of several high level activities is becoming urgent. In the future SPEC, the team SPHYNX will be joined by another group coming from the CEA, institute IRAMIS. This group will bring a strong expertise in the field of the statistical physics of fracture, which is another aspect of out-of-equilibrium physics, and is along the main scientific stream of SPHYNX.

Assessment of the unit's involvement in training through research

The group has contributed to teaching in French and international institutions. 17 PhD students and 16 Postdocs have been trained and educated in trendsetting scientific techniques and areas. Members of the group have engaged in scientific outreach activities, which have partially attracted mass media interest. The follow up of the PhD students is very well done and they have either a post-doc or a permanent position in prestigious institutions.

Furthermore, the group members are involved in teaching in Paris 7, ESPCI, EC Paris and abroad. They are members of committees related to teaching duties.

Assessment of the five-year plan and strategy

The scientific strategy points along three axes, which convincingly evolve from the previous activities but also move forward towards novel and promising topics. The research on phase transitions and new kinds of order builds on the expertise of the group on slow dynamics in complex systems and proceeds to test novel theoretical concepts. Experiments on transport through quenched amorphous matrices, on relaxation processes in ferromagnetic fluids, and on elasticity in solid helium will reveal important fundamental insights into cooperative processes and structure formation. Investigation of fracture would complement this area nicely as it concerns the breakdown of solidity in strong fields. The well-established hydrodynamic research will concentrate on the important dissipative processes in turbulence, turbulence modeling including of climatic processes, and thermoelectric experiments in electrolytes and ferrofluids. This research promises to be of especial technological relevance. The third direction concerns active matter and biological systems, where theories will be developed and extended aimed at describing well-controlled model experiments. The strength of statistical physics to establish universality classes in complex phenomena appears especially promising here. Overall, the scientific projects of the team evolve coherently and are direct consequences of the research performed by the team in the last five years. They want to analyze more deeply the original results that they have obtained. The scenario is very rich and interesting. The coherence is insured by the kind of techniques and analysis performed on the different systems, which always remain within the framework of self-organization in out-off-equilibrium systems.

Many subjects of this team are potentially very interesting and useful for applications. The projects point out these aspects that hopefully will be more developed in the next five years. All team members are excellent researchers and they certainly will be able to continue to have interesting and original results. The collaboration with the laboratory FAST could allow the team to continue the research on granular material. It seems to us that although this subject has given very beautiful and interesting results, it will be probably reasonable to cut such a research subject, which seems to be under-critical in the number of researchers. Furthermore, a new research subject on fracture will arrive with the new team.

Conclusions

The SPHYNX team is among the worldwide leading experimental groups in this active field, which is largely dominated by theory and computer simulation. This is just a limited selection of the most important results. Indeed the production of the team is very good in quantity and quality.

Despite the large number of research directions, it is important to stress that they are strongly related with the kind of statistical tools used to analyze them and by the relevant scientific questions, such as self-organization, to which one wants to give new insight. All the researches performed by the team have strong connections with important social and economical issues such as climate, energy, robotics, biology and materials aging.

Team 6: LARSIM

Manager's name: Mr Etienne KLEIN

Workforce

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
N1: Permanent professors and similar positions		
N2: Permanent researcher, engineer, managerial personnel (A1) from Institutions and similar positions	3	3
N3: Other permanent staff technical and administrative personnel		
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	2	2
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**5**	**5**

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
Doctoral students	2	
Theses defended (January 2008- dec 2013)		
Postdoctoral students having spent at least 12 months in the unit	1	
Number of Research Supervisor Qualifications (HDR) taken		
Qualified research supervisors (with an HDR) or similar positions	1	1

Assessment of scientific quality and outputs

The team is working on several subjects, ranging from foundations of physics, ethics (in particular on nanoethics), on philosophy of technology (in particular on very big instruments), and also on the didactics of science. Its two main objectives during the period were (1) the coordination of the European Project "Observatory-nanos", on ethical questions raised by nanotechnologies (publication of thematic "toolkits"), (2) Coordination of an ANR project Foundphys, on the foundations of physics, which lead the group to reach a strong visibility (8 conferences, 50 seminars), with publications in distinguished journals.

Its specificity (being renowned in science and society issues) is visible in the distribution of activities: 25 % for academic research, 40 % for development and society, 10 % for education, 20 % for research support, but it does not prevent the group, relying on limited forces (3 full time researchers) to have an excellent scientific output, with publications in the best reviews in philosophy of science (Foundations of Science, Foundations of Physics, British Journal for the Philosophy of Science). The bibliography lists 151 publications for the period (16 articles on the theme foundations of physics, 40 articles on the theme ethics and the philosophy of science, about a hundred popular articles), and the lab has given 252 invited talks (on the 525 given by the unit). In addition to a rich series of publications on time and on several fundamental aspects of physics and cosmology, one of the highlights is the exploration of the connections between quantum physics and the theory of information, which led to a series of conferences, including an international conference in 2013 with LCTI (CNRS/France Telecom), entitled Physics and Information. The lab activities are not confined to this field: major figures of history and philosophy of science are investigated, in particular Mr Gaston BACHELARD (International Surrationalism Conference, 2012, and a monograph) and Mr Gilbert SIMONDON.

Assessment of the unit's academic reputation and appeal

On nanos, LARSIM is featured in many workshops in French and International Workshops, on ELSI (Ethical, Legal, and Social Issues) aspects; it brings expertise during debates, government consultations. LARSIM is a partner of the French National Forum and Synthetic Biology. It is often invited in conferences on societal aspects of emerging technologies (recently: drones, robots), at EEC, SNET society, OMS, Stanford, UC Davis, TU Darmstadt.

LARSIM is producing an expertise for all the CEA centers (including CEA-DRT Grenoble and the CEA Nanosciences program). Its international visibility appears in exchanges with Institute Veneto, on workshops on major figures of Physics (Majorana, Enriques, Ricci…) and on its involvement in collaborations with Vienna University, the Austrian Academy of Science, the University of Maryland, University of Sidney, Imperial College London.

Assessment of the unit's interaction with the social, economic and cultural environment

This interaction is very strong and reaches a wide audience, through formations, lectures ("Conférences grand public"), books meeting a wide readership (eg Galilée et les indiens), participation of the group leader to the permanent exhibition "Le Grand Récit de l'Univers" at "la Cité des Sciences et de l'Industrie" (2009-2024), radio programs (France-Culture, France-Inter). The work on nano aims at contributing to a dialogue between science, industry, and society through the analysis of the main arguments used in debates and controversies around technologies.

Assessment of the unit's involvement in training through research

LARSIM had a very good involvement: members teach in several programs, including Master courses (LOPHISS, Paris 7/ENS), and several Grandes Ecoles (ENSTA, École Centrale, Polytechnique). The group leader has initiated a permanent education program at INSTN, titled "Questions de Sciences", that has to date trained 320 CEA staff.

Assessment of the five-year plan and strategy

The Lab will move into another Institute, IRFU, the Institute of Research into the Fundamental Laws of Universe. The committee regrets that the opportunity to have close links between physics and social sciences will disappear. However, the LARSIM will reinforce its collaborations with École Normale Supérieure (Ulm) and Lausanne on philosophy of science and science in society projects. The lab will also foster interactions, on the Saclay Campus,

between natural and human sciences, on philosophy of technology topics, with engineering schools already on campus (Polytechnique, Supelec, ENSTA, …) and, soon, with École Centrale and ENS-Cachan. These two objectives seem promising, since a good integration of human sciences in interdisciplinary projects is now a priority in many research agendas, and LARSIM is an excellent asset from that perspective. The collaborations would also rely on existing relationships (with ENS, through the Cirphles Lab and the Revue de Synthèse), and the second objective would benefit from the lab's expertise on contemporary approaches to philosophy of technology.

Conclusions

The national visibility of LARSIM is excellent. International appears in exchanges with Institute Veneto, on workshops on major figures of Physics (Majorana, Enriques, Ricci…) and on its involvement in collaborations with Vienna University, the Austrian Academy of Science, the University of Maryland, University of Sidney, Imperial College London. The team counts a rich series of publications on time and on several fundamental aspects of physics and cosmology, one of the highlights is the exploration of the connections between quantum physics and the theory of information. Although no real argument was given, LARSIM will leave from SPEC. The committee regrets that the opportunity to have close links between physics and social sciences will disappear.

Support activities: Cryogenics, Nanofabrication, Mechanical workshop

Manager's name: Mr Patrick PARI, Mr Christian URBINA, Mr Pierre-Francois ORFILA, Mr Marco BONETTI

Workforce

Unit workforce	FTE 30/06/2013	FTE 01/01/2015
N1: Permanent professors and similar positions		
N2: Permanent researcher, engineer, managerial personnel (A1) from Institutions and similar positions	1	1
N3: Other permanent staff technical and administrative personnel	5.5	7
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)		
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	**6.5**	**8**

The Cryogenics Laboratory is a well-recognized support group at the SPEC. It plays an important role in development and delivering of the cryogenic environment, which is essential for most of the low temperature experiments. The research unit has created a series of very low temperature cryostats based on an original DRY technique that does not rely on the use of liquid helium. One company (Cryo Conception) benefits from the development work of the lab and hired some former members of the research unit to build up and sell this new type of cryostats. Another spin-off company will begin soon a topic related to advanced magnetic sensors and one member of the research unit will devote 20 % of his working time to this company.

Cryogen free dilution refrigerators are developed with the financial support of the RTRA Triangle de la Physique, reducing the operation cost and increasing the ease of operation. One prototype was delivered to the Quantronics laboratory. The technology has been licensed to the Cryoconcept company. Cryoconcept is a spin-off of the Cryogenics laboratory and is located in close proximity to SPEC. Several dry cryostats bases on the SPEC design are run at SPEC.

Other ongoing projects include:

Retrofitting of existing dilution refrigerators with re-liquefaction units funded by the ASTRE call of the Ile de France Region.

Participation in the international Edelweiss collaboration for detection of Wimps, based on the use of heat and ionization.

Immunization of the dilution refrigerator from the vibrating pulse tube precooled, passively by gas or actively by a piezoelectric vibration cancellation.

The Laboratory has trained visitors from ENS and UPS during many months in the design and operation of dilution refrigerators. Members of the team are involved in teaching in CNAM and Paris Sud, participates in international conferences LT 25.

The perspectives of the Cryogenics laboratory rely on the operation of a low temperature platform, hosting experiments for other departments of the CEA and external CNRS laboratories, forming the center of the regional pole of low temperatures comprising CEA and CNRS laboratories.

Conclusions

The expertise of the cryogenic group is well recognized worldwide. Cryogen free dilution refrigerators developed are very competitive in terms of performance, ergonomics of the experiments and operation cost and increasing the ease of operation. One prototype was delivered to the Quantronics laboratory. Connection with Cryoconcept company is also a very positive point of the group. We recommend this group to have a proactive action on the formation of the regional pole of low temperatures in the Paris-Saclay campus.

5 • Conduct of the visit

Visit dates

Start: Tuesday, January 14th

End: Wednesday, January 15th

Visit site

Institution: CEA

Adress: SPEC, Orme des Merisiers CEA Saclay, 91191 Gif sur Yvette cedex

Specific premises visited

The visit has been very well organized. We have obtained all the information we asked for. The oral presentations were efficiently chosen to give an overview of the research developed in the SPEC. The only drawback was the lack of presentation of the perspectives of the teams that will join the lab to form SPEC.

Programme of visit

Tuesday 14/01

8h30 - 9h00	Closed meeting of the committee
9h00 - 10h00	SPEC Direction: presentation of the SPEC
10h00 - 10h15	Coffee Break
10h15 - 10h45	D. ESTEVE: MP1 / Quantronics
	P. BERTET: Hybrid spin ensemble–qubit structures for quantum information
10h45-11h15	C. GLATTLI: MP2 / Nanoelectronics
	F. PORTIER: Mach Zehnder interferometry
11h15-11h45	J.L. PICHARD: Mesoscopic Physics and Thermoelectricity
	G. FLEURY: Thermopower of gated nanowires
11h45 - 12h15	Visits of cryogenics laboratory and nanofabrication platform
12h15 - 13h30	Buffet Lunch
13h30 - 15h00	Visits of Laboratories
15h00 - 15h30	C. FERMON: Nanomagnetism and Oxydes
	G. DE LOUBENS: Memory magnetic vortices
15h30-16h00	V. DERYCKE: Molecular electronics
	S. CAMPIDELLI: Functionalized carbon nanotubes for energy conversion
16h00 - 16h15	Tea Break

16h15-16h45	F. LADIEU: SPHYNX
	S. NAKAMAE: Thermoelectric effect in complex liquids
16h45-17h00	E. KLEIN: Laboratory for Research on Physical Sciences
17h00 - 17h30	Meeting with Conseil d'Unité
17h30 - 18h00	Meeting with graduate students and postdocs
18h00 - 19h00	Closed meeting of the committee

Wednesday 15/01

8h30 - 10h30	Posters
10h30- 10h45	Coffee Break
10h45 - 11h45	SPEC Direction: strategy and perspectives
11h45 - 12h45	Meeting with heads of CEA/DSM and CNRS/INP
12h45 - 14h00	Lunch committee-SPEC Direction
14h00 - 17h00	Closed meeting of the committee

6 • Supervising bodies' general comments

Direction des Sciences de la Matière
Institut Rayonnement Matière de Saclay

Le Chef d'Institut

M. Pierre GLAUDES
Directeur de la Section des Unités
de Recherche
AERES
20, rue Vivienne
75002 PARIS

Saclay, le 7 mai 2014

Objet : Rapport d'évaluation – S2PUR150007580 - SPEC - Service de Physique de l'Etat Condensé - 0912281K - URA 2464

Réf. : IRAMIS-DIR/MS-CB/2014-022

Monsieur le Directeur,

Nous nous associons à la Direction du SPEC pour remercier le Président du comité d'experts, le Délégué scientifique et les membres du comité de leur analyse approfondie et constructive du SPEC. Ce rapport est en particulier très élogieux pour les résultats obtenus par les différents groupes du laboratoire et pour leurs perspectives scientifiques.

Le comité a bien noté la faiblesse de nos recrutements, tant CEA que CNRS, et le nombre important de départs (à la retraite) prévus dans les prochaines années. L'embauche de jeunes scientifiques et techniciens représente effectivement un point très important pour l'avenir du laboratoire. La direction du SPEC est d'accord avec le fait que les interactions entre les différents groupes du SPEC pourraient être améliorées et va promouvoir des actions en ce sens.

Malgré la présence d'un grand nombre d'étudiants au SPEC et l'implication de plusieurs chercheurs dans des activités d'enseignement, l'interaction avec l'université est également un point à améliorer et nous pensons que l'implication du SPEC dans la future Université Paris Saclay représentera un élément stratégique. Concernant les thésards et post-docs, le SPEC a mis en place un système de suivi de l'avancement de leur travail et de leur devenir professionnel.

Le comité a également bien noté que le processus de réorganisation de l'Institut IRAMIS était en cours, processus qui a des conséquences importantes pour le SPEC avec l'arrivée des équipes de physique du SPCSI. En particulier, le fait d'avoir dès 2014 des équipes sur 2 sites (Saclay et l'Orme) distants de 3 km représente un handicap important. Les directions du SPEC et de l'IRAMIS sont parti-

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culièrement attentives à ce que la réorganisation se déroule pour le mieux, et travaillent sur un projet de regroupement des équipes du SPEC à l'Orme à l'horizon 2020. Dès les mois à venir, les théoriciens du nanomagnétisme et l'équipe de fracture et systèmes complexes de l'ex-SPCSI vont rejoindre le site de l'Orme.

Ce rapport appelle de notre part quelques remarques et précisions. Pour chaque point, les parties du rapport concernées sont rappelées en bleu.

1) Départ du LARSIM pour l'IRFU:

Page 6, Assessment of the five-year plan and strategy

"Concerning LARSIM, no argument was given for the departure of this team from SPEC. The committee regrets that the opportunity to have close links between physics and social sciences will disappear."

Page 24, *"The lab will move into another institute, IRFU, the Institute of Research into the fundamental laws of universe. The committee regrets that the opportunity to have close links between physics and social sciences will disappear."*

L'avenir du LARSIM ne s'inscrivant pas à l'intérieur du SPEC, nous reconnaissons que nous n'avons pas fourni au comité d'éléments détaillés pour expliquer son positionnement futur au sein de l'IRFU. L'IRFU est un institut de recherche en physique particulièrement impliqué dans la physique des deux infinis (cosmologie, physique nucléaire et physique des particules). Comme le mentionne le comité, le LARSIM développe une activité importante sur les aspects fondamentaux de la physique et de la cosmologie. Aussi les chercheurs du LARSIM trouveront-ils un écho favorable avec les dernières avancées expérimentales de ces domaines de physique. D'autre part, l'activité du LARSIM a toujours dépassé le strict cadre du SPEC, et l'ensemble des chercheurs du SPEC et de l'IRAMIS pourront toujours bénéficier de l'ouverture d'esprit apportée par les échanges avec le LARSIM.

2) Physique Mésoscopique:

Page 10

« The committee looks favorably the enhancement of the links between GQ and GNE and expects that it will lead rapidly to a unique scientific team. »

Nous sommes d'accord avec le comité sur ce point et nous pensons que les collaborations entre les groupes Quantronique et Nanoélectronique peuvent être encore renforcées. Cependant, nous souhaitons que cette réunification se fasse dans la durée, en prenant en compte les approches différentes des deux groupes et en respectant les différents aspects de la physique mésoscopique qu'ils développent.

3) SPHYNX:

Pages 21-22

Nous notons que le comité a salué très positivement aussi bien la qualité des résultats scientifiques obtenus au SPHYNX que sa stratégie de regroupement pour fédérer les travaux de physique statistique du SPEC. Nous prenons bonne note du jugement très encourageant du comité sur la stratégie

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scientifique que nous avons élaborée pour les prochaines années. Nous attirons l'attention du comité sur les travaux effectués actuellement dans les domaines de la turbulence et de la matière active, travaux qui seront développés dans l'avenir.

4) Cryogenics, Nanofabrication, Mechanical workshop

Pages 26-27

Nous attirons l'attention du comité sur le fait que l'atelier de Nanofabrication, dont il est surtout question dans la section consacrée à la physique mésoscopique, est une plateforme utilisée par de nombreux groupes du laboratoire, qui est aussi une centrale de proximité du réseau national des grandes centrales de micro-et nanofabrication.

Nous vous prions d'agréer, Monsieur le Directeur, l'expression de nos salutations distinguées.

Hervé Desvaux
Chef d'institut

Maria Faury
Directrice adjointe des Sciences de la Matière

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