LPNHE - Laboratoire physique nucléaire et hautes énergies

Rapport Hcéres

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

Department for the evaluation of research units

AERES report on unit:

Laboratoire de Physique Nucléaire et des Hautes Énergies

LPNHE

Under the supervision of the following institutions and research bodies:

Université Paris 6 – Pierre et Marie Curie

Centre National de la Recherche Scientifique

January 2013

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

Research Units Department

President of AERES

Didier Houssin

Research Units Department

Department Head

Pierre Glaudes

The president of AERES "signs[...], the evaluation reports, [...]countersigned for each evaluation department by the relevant head of department (Article 9, paragraph 3, of french decree n°2006-1334 dated 3 november 2006, revised).

Grading

Once the visits for the 2012-2013 evaluation campaign had been completed, the chairpersons of the expert committees, who met per disciplinary group, proceeded to attribute a score to the research units in their group (and, when necessary, for these units' in-house teams).
This score (A+, A, B, C) concerned each of the six criteria defined by the AERES.
NN (not-scored) attached to a criteria indicate that this one was not applicable to the particular case of this research unit or this team.

Criterion 1 - C1 : Scientific outputs and quality ;
Criterion 2 - C2 : Academic reputation and appeal ;
Criterion 3 - C3 : Interactions with the social, economic and cultural environment ;
Criterion 4 - C4 : Organisation and life of the institution (or of the team) ;
Criterion 5 - C5 : Involvement in training through research ;
Criterion 6 - C6 : Strategy and five-year plan.

With respect to this score, the research unit concerned by this report and its in-house teams received the following grades:

- Grading table of the unit: LABORATOIRE PHYSIQUE NUCLEAIRE ET DE HAUTES ENERGIES

C1	C2	C3	C4	C5	C6
A+	A+	A	A+	A+	A+

- Grading table of the team: Masse et Interactions Fondamentales (MIF)

C1	C2	C3	C4	C5	C6
A+	A+	A	A+	A+	A+

- Grading table of the team: Asymétrie Matière-Antimatière (AMA)

C1	C2	C3	C4	C5	C6
A+	A+	A	A+	A+	A

- Grading table of the team: Nature et Origine du Rayonnement Cosmique de Hautes Energies (RCHE)

C1	C2	C3	C4	C5	C6
A+	A+	A	A+	A+	A+

- Grading table of the team: Matière Noire et Energie Noire (MNEN)

C1	C2	C3	C4	C5	C6
A+	A+	A	A+	A+	A+

Evaluation report

Unit name:	Laboratoire de Physique Nucléaire et des Hautes Énergies
Unit acronym:	LPNHE
Label requested:	UMR
Present no.:	UMR7585
Name of Director (2012-2013):	Mr Reynald PAIN
Name of Project Leader (2014-2018):	Mr Reynald PAIN

Expert committee members

Chair:

Mr Matteo CAVALLI-SFORZA, Inst.Física Altes Energies, Barcelona, Spain

Experts:

Mr Alain BLANCHARD, Université Paul Sabatier, Toulouse

Mr Paschal COYLE, CPPM, Marseille

Mr Daniel DENEGRI, IRFU/CEA, Saclay

Mr Bernard ILLE, IPNL, Lyon, (Representative of CNU)

Mr Jean-Pierre LEES, LAPP, Annecy, (Representative of CoNRS)

Mrs Clara MATTEUZZI, INFN et Université Milano-Bicocca, Italy

Scientific delegate representing the AERES:

Mr Cristinel DIACONU

Representative(s) of the unit's supervising institutions and bodies:

Mr Paul INDELICATO, Université Paris 6

Mr Laurent SERIN, CNRS, IN2P3

1 • Introduction

History and geographical location of the unit

LPNHE is a CNRS, UPMC and University Paris-Diderot laboratory located on the campus of the Université Pierre et Marie Curie, at 4 Place Jussieu. 75005 Paris.

It has a staff of about 145 persons, of which about 95 are permanent.

Management team

Director: M. Reynald PAIN; Adjunct Director: Mme Sophie TRINCAZ-DUVOID.

AERES nomenclature

ST2

Unit workforce

Unit workforce	Number as at 30/06/2012	Number as at 01/01/2014	2014-2018 Number of project producers
N1: Permanent professors and similar positions	25	25	25
N2: Permanent researchers from Institutions and similar positions	24	26	26
N3: Other permanent staff (without research duties)	47	48	3
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)	2	2	2
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	12	12	12
N6: Other contractual staff (without research duties)	1	0	0
TOTAL N1 to N6	111	113	68

Percentage of producers	***100 %***

Unit workforce	Number as at 30/06/2012	Number as at 01/01/2014
Doctoral students	28	
Theses defended	26	
Postdoctoral students having spent at least 12 months in the unit*	9	
Number of Research Supervisor Qualifications (HDR) taken	3	
Qualified research supervisors (with an HDR) or similar positions	23	30

2 • Assessment of the unit

Strengths and opportunities

The scientific program is of the highest level, diverse but well-focused within each theme and balanced among them, covering all the main issues of experimental particle and astroparticle physics and much of those of observational cosmology.

All research takes place at large international facilities. This goes hand-in-hand with numerous scientific partnerships, which helps in recruiting an internationally diversified body of postdocs and PhD students.

There is a strong base of highly qualified permanent researcher and technical support staff.

The new laboratory premises, with large and well-equipped clean rooms and specialized technical rooms, and rooms for experimental tests, puts this lab in a very good position for experiments of the next several years.

The rich, diversified, forward-looking research program should allow this lab to remain at the forefront of research on all of its themes.

Weaknesses and threats

On the permanent personnel side, the age distribution of the University faculty may create difficulties in hiring new people, or promoting the junior researchers.

On the temporary personnel side, there has recently been a decrease in the number of temporary positions from the supervising Institutions (University and CNRS) as well as increase difficulties in funding for hiring PhD students. Due to the latter, the lab when recruiting cannot take full advantage of its high international visibility.

The theoretical and experimental activities are not strongly in contact with each other. A higher level of integration would be beneficial particularly to the former, considering that the theoretical staff consists of very few people.

The ambitious, large-scale future research programs necessarily imply uncertainties in what will be built or funded.

Recommendations

The research efforts on high-energy physics experiments that are in their final phase (CDF, D0, BaBar) should be brought to an end in an orderly but expeditious manner in order to maximize the output on experiments that are likely to produce important, novel results.

Efforts on the current very successful experiments should be continued along the current lines in order to maintain the high impact and the visibility so far achieved.

The R&D for future experiments and/or upgrades (ATLAS, ILD, T2K, LHCb, CTA, LSST …) should be pursued most vigorously, but keeping an eye on the emerging trends, positive or negative as they may be, for they may suggest changes in directions.

As already perceived by the involved resserchers, the activities in cosmology should acquire more diversification, while ensuring, if possible, a continuing inflow of data to be analyzed.

Generally, in order to take advantage of the very attractive research and training opportunities offered by LPNHE it would be highly desirable that the supervising and funding organizations counteract the negative trend in supporting student and postdoc grants.

3 • Detailed assessments

Assessment of scientific quality and outputs

The recent discoveries in all the experimental activities pursued by the Units's researchers represent crucial breakthroughs in each field. Specifically, the discovery of the Higgs-like boson, of a new type of neutrino oscillations, the break in cosmic ray spectra at the highest energies and the accelerating Universe expansion have had enormous impact.

The discoveries in which the LPNHE has been directly involved, often in a crucial manner, determine the directions of future research worldwide. This is a statement that can be made only rarely.

All these results have been communicated at international conferences, often by LPNHE personnel. They have been published in the most prestigious journals of the field. Altogether, in the last 5 years the Unit produced 1061 refereed publications.

Overall, the scientific excellence of the research output of this unit is outstanding.

More details are given under each research theme.

Assessment of the unit's academic reputation and appeal

The Unit's staff have important responsibilities in large international collaborations (D0 spokesperson, IN2P3 coordinators in Auger and LSST, the HESS camera, etc) and obtained several prizes (CNRS bronze and silver medals). These facts attest to the high quality of the staff.

Postdocs and PhD students are recruited internationally. About half of the students, from 2007 to 2012, are not French.

The collaborations themselves attained worldwide recognition such as the Gruber prize to the Supernova Cosmology Project and the Rossi prize to HESS.

Over the last 5 years, there have been 74 participations in the organizing committees of international conferences or workshops, including the primary organizer of the Moriond conference series.

Over the same period, 217 talks have been given by the Unit's personnel at international conferences.

These numbers clearly indicate an excellent research unit, of highest international reputation.

Again, more detailed data about these issues are given in the sections on individual research themes.

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

While a basic research lab as this one cannot be expected to intensely interact with commercial entities, the cultural fallout from the recent fundamental discoveries is significant and has an important role enhancing and maintaining the general public's interest in science.

The Unit's staff has numerous collaborations with the news media, it hosts and maintains a public web site (www.laradioactivité.com), it organizes the conference cycle "Physique et Interactions Fondamentales" and the yearly "Fête de la Science" with other physics labs of the Jussieu campus. In addition, there are frequent interventions in high schools, as well as master classes.

Several books have been published.

The high-level electronics engineering work done at LPNHE might lead to applications in other fields. Circuitry based on associative memories, developed for upgrades of LHC tracking triggers, may find application in genomics research.

Assessment of the unit's organisation and life

The laboratory's activities are organized by means of the statutorily required representative bodies but also by ad-hoc committees. The Scientific Council, comprised of 4 elected and 5 appointed members, including two foreign ones, meets about twice a year.

The management work is effectively divided between the Director and the Adjunct and the Technical Directors. The organigram is well-structured and transparent, with clearly defined responsibilities at various levels in the scientific and technical sectors.

The regularly held meetings comprise two weekly meetings: one involving the top management only, the other meant for everyone. The latter is well attended. Two monthly meetings are held, one with the persons holding administrative and technical responsibilities, the other with the scientific leaders. Technical staff is assigned to projects twice a year. This structure is clearly effective in maintaining the lab's scientific priorities and an overall balance among the different sectors.

In addition, a three-day retreat of the whole lab in a remote site is held at two year intervals, to keep everyone informed in detail about the activities of the lab.

Positive information was gathered from a meeting with the administrative and technical staff. The only reservations expressed had to do with the time it takes to treat increasingly diversified budgets, and to receive the minutes of the meetings.

Assessment of the unit's involvement in training through research

One-half of the permanent staff of this Unit is teaching as well as doing research – a fact that naturally leads to important involvement in training of junior personnel through research.

A particularly important facet of these activities is the large number of stages – about 50/year on average.

The great majority of PhD students continue in research, with a few finding positions in industry.

The Committee had a very positive impression about the intellectual level of interactions among junior and senior personnel, about the training provided to postdocs and students, and about the seminar program, which informs everyone about progress in the field in a timely manner.

The PhD students belongs mainly to 'Ecole Doctorales » ED 517 "Particules Noyaux Cosmologie" (UPMC, UPD, UP11, CEA) and ED 389 "La physique de la particule au solide" (UPMC), but also to ED 127 "Astronomy et Astrophysics d'ile de France (UPMC, UPD, UP11) and ED 107 "Physique de la région parisienne" (ENS, UPMC, UPD, UP11)

Assessment of the five-year plan and strategy

The excellence of the research program of LPNHE will naturally be maintained by continuing the current activities in the highly successful projects it is engaged in: ATLAS, T2K, LHCb, Auger, HESS, and LSST. All of these activities include significant or very major upgrades programs, which will further enhance their discovery potential and lead to more accurate and powerful measurements of the phenomena already partially explored. In the detailed assessments, each of these programs is examined in some detail.

Overall, the 5-year research plan should maintain the currently achieved level of excellence in each of the four broad themes because in each of them at least one project will be realized, leading to significant or major instrumentation development activities and more data and new analyses and publications. Specifically, the ATLAS and LHCb upgrades, CTA and the LSST can be counted on despite other uncertainties in the international programs for future large research facilities.

Concerning instrumentation developments, while it is important that LPNHE maintain its present capabilities, the plan is robust even if not all future international projects will prosper, because there are (intended) synergies in the R&D work being carried out: for instance, in the MIF (Matter and Fundamental Interactions) sector, these activities have a common semiconductor detector development emphasis; while the activities in the other sectors share important strengths in electronic engineering developments and in photon detection.

The SWOT analysis is well-developed, and has helped in formulating both the general analysis contained in the overall assessment of the Unit and in the assessments of the theme-by-theme analysis.

4 • Theme-by-theme analysis

Theme 1: Masses et Interactions Fondamentales (MIF)
[Expériences CDF D0 ATLAS et projet ILC/Calice]

Manager's names: Ms. G. BERNARDI, G. CALDERINI, S. DE CECCO, D. LACOUR, Ph SCHWEMLING

Workforce

Theme workforce in Full Time Equivalents	As at 30/06/2012	As at 01/01/2014
FTE for permanent professors	9	9
FTE for permanent EPST or EPIC researchers	9	10
FTE of other permanent staff without research duties (IR, IE, PRAG, etc.)	3.4	3.4
FTE for other professors (PREM, ECC, etc.)	0	1
FTE for postdoctoral students having spent at least 12 months in the unit	2	
FTE for other EPST or EPIC researchers (DREM, etc.) excluding postdoctoral students	0	0
FTE for other contractual staff without research duties	0	0
FTE for doctoral students	11	
TOTAL	34.4	23.4

• Detailed assessments

Assessment of scientific quality and outputs

CDF/D0: From the year 2000 until the onset of the LHC in 2010 the CDF and D0 experiments at the Tevatron were the leading research instruments in the world at the high energy frontier of particle physics. The LPNHE had teams participating in both experiments and a strong one in D0 with significant instrumental commitments on the electromagnetic calorimeter. With the closure of the Tevatron in 2011 the activities are now exclusively on physics analysis. The physicists from the LPNHE participate in the two key studies at the Tevatron, the precise determination of the mass of the top quark – where the Tevatron is still in a leading position, with the LHC approaching the same level of precision only at the end of 2012, and the search for a Standard Model Higgs boson where the LHC has rapidly taken over the leadership during 2011. Nonetheless, in a final effort, combining results of D0 and CDF on the Higgs, circumstantial evidence has been found for a signal at ~125 GeV through a very sophisticated statistical analysis. The LHC now has a large competitive edge in hadron collider physics and the activities on D0 analysis should be brought to an orderly end within a few years, as the ongoing PhD theses are completed.

ATLAS: With CMS, ATLAS is the leading experiment in high energy particle physics and will remain so for the next ten years and probably much more. The LPNHE team is strong and extremely well placed both on the instrumental and analysis sides and it is important that it remains so. The LPNHE team had important instrumental commitments during the construction phase of ATLAS, specifically on the electromagnetic calorimeter which is the key and most successful component of ATLAS, and responsibilities in the calibration and monitoring of this device. In direct relation with this commitment the LPNHE team has developed expertise in the reconstruction of electrons and photons and in the study of the gamma-gamma background production, which put them in pole position in the search for the Higgs boson through its gamma-gamma decay mode. This shows the excellent positioning of this team. The study of this decay mode for precise mass determination and spin will be a topic of central importance for the 3 to 5 years to come.

The discovery by ATLAS and CMS of a particle which is very likely to be the Higgs boson is the most important advance in particle physics since the W and Z bosons were found thirty years ago. The ongoing studies of the top quark, its production and more precise mass determination through the two-leptons final state in ttbar production is another field of activity of the LPNHE group. This is a topic of high importance and visibility and will remain so for a number of years, the mass of the top in particular.

ILC/ILD: involvement in the International Linear Collider project goes many years back and participation in the development of a tungsten-silicon electromagnetic digital calorimeter is a very good technical option, in line with the laboratory expertise with construction/operation of electromagnetic calorimeters (in D0 and ATLAS), and coherent with the desire to master silicon detector techniques at the LPNHE. In view of present uncertainties, even if the ILC does not materialize, the knowledge and techniques acquired will very likely be reusable elsewhere.

Assessment of the unit's academic reputation and appeal

The evidence for a Higgs-like particle at about 125 GeV was obtained under the leadership of physicists from the LPNHE, among them the spokesperson of D0 for years 2011-2014.

In ATLAS, it is the analysis of the decay mode H to gamma-gamma by the LPNHE team which was used as the official analysis for the world-wide presentation of the discovery for a Higgs-like boson on July 4th at CERN.

This gives a measure of how the work of these teams is valued within these large collaborations which are chacterized by an extremely competitive environment.

Team members have been editors – on behalf of their collaborations - of about 10 papers per year, have given about 12 talks per year, and given several lectures at thematic physics schools.

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

The discovery of a Higgs-like boson by experiments at CERN in summer 2012 was a world-wide scientific event and attracted much attention even from the general public. It was followed in France in particular with a number of presentations and articles in the media (TV, radios) and science popularisation journals, lectures at international and national level conferences and seminars, lectures in schools, with members of the LPNHE taking a very active part.

Assesment of the unit's organisation and life

In large collaborations like ATLAS there is quasi-continuous activity through working group presentations at the level of the experiment and weekly at the laboratory team level. There are also meetings with other French labs on the calorimeter calibration, operation and upgrade, and overall ATLAS /France yearly meetings.

It is worth pointing out that recent decisions about the laboratory's ATLAS upgrade commitments were not easy, but were taken based on a broad discussion within the group that converged on a strategy involving a focus on silicon tracking detectors. This decision makes optimal use of the technical strengths of the lab and shows that this community when faced by potentially divisive issues is capable of making good choices.

There is a satisfactory mix of senior scientists and young doctoral students and postdoctoral researchers within this group.

Assessment of the unit's involvement in training through research

The large fraction of permanent researchers also engaged in teaching allows the laboratory and this team to attract many doctoral students.

The quality of the team together with the laboratory and the subjects of research makes it very attractive to foreigners. In this team there are at present more than ten thesis students; this ensures a very sound and dynamic base for present studies. The postdocs and permanent researchers constitute a solid base for instrumental involvement in the upgrade of ATLAS, centered on the silicon tracker project.

Assessment of the five-year plan and strategy

Undoubtedly the LHC will dominate the particle physics scene for the next ten years, and more. Thus the involvement, on the one hand, in the needed tracker upgrade of ATLAS to face the still higher luminosities envisaged, and on the other hand the continuing effort on the determination of Higgs boson properties (mass, spin, branching ratios, production cross sections) to understand the exact nature of the particle seen in 2012, is an excellent medium-term strategy and will ensure high visibilty of the team and laboratory.

The competent technical and physics personnel and the newly commissioned clean rooms provide the base for the work on development of more radiation-hard silicon sensors and electronics needed for the tracker upgrade.

The effort on the top physics should also be rewarding, especially with the determination of cross sections at 13-14 TeV in single-top and ttbar production in the coming 3 to 5 years and further work on reducing the uncertainties on the top mass.

This last activity will gradually become a metrology task, not necessarily interesting, in spite of its importance, to all present members of the team. In this respect it could be of interest for the laboratory and team to open new fields of investigation at the LHC, oriented more towards Beyond Standard Model physics; with the acquired competence in electron/photon reconstruction and in handling b-jets a promising field could be, for example, supersymmetry.

Conclusion

- Overall opinion of the theme:

Excellent positioning in ATLAS, both on the present liquid argon calorimeter and on Higgs and top physics analyses topics assures longer term prospects with the LHC. The laboratory clearly perceives the need to maintain strong involvement in the upgrade of ATLAS to insure the relevance and visibility of team.

- Strengths and opportunities:

The team is taking advantage of its long term involvement in electromagnetic calorimetry (D0, ATLAS) to master aspects of electron and photon reconstruction and to apply it in key physics analyses (H to gamma-gamma for example). Both physics analysis topics the team is engaged with, Higgs and top properties, will remain key issues at the LHC for years to come.

Involvement in the (unavoidable) tracker upgrade of ATLAS, on silicon pixel/macropixel detectors is an excellent choice, will put the team in a strong position in ATLAS, while opening possibilities with closer contacts with industries too.

● Weaknesses and threats:

A possible weakness might be a lack of involvement of this team in "new physics" searches at the LHC. The presently available manpower may not allow to effectively open a new line of studies now, but if and when saturation with present themes occurs, competence with electrons, photons and b-jets should allow a reorientation of studies. For ILC/ILD activities, the threat is uncertainty with ILC approval, probably more pronounced now that the Higgs could be within the reach of an "LEP3"-type collider and that SUSY is receeding beyond ~400 GeV mass even for stops and sbottoms. Nonetheless the investment in the CALICE calorimeter would not be in vain, a high granularity digital calorimeter will probably/likely find applications in future experiments.

● Recommendations:

Bring to successful end without much delay analysis activities on CDF and D0 data so as to partipate in full strength on ATLAS.

LHC and ATLAS have a clear future for next ~10 years, the ATLAS tracker upgrade is well justified in view of the expected rise in luminosity of the machine, thus involvement on the silicon tracker is of strategic importance for the LPNHE team and should be supported with adequate human, technical and financial resources in the coming years.

The physics analysis topics chosen, Higgs and top studies, are central issues for particle physics in the coming years, but it is advisable to devote new personnel to searchs for Beyond-Standard-Model physics.

Theme 2: Asymétrie Matière-Antimatière (AMA)
[Expériences NA61, T2K, Babar et LHCb]

Managers' names: MS E. BEN-HAIM, J. DUMARCHEZ

Workforce

Theme workforce in Full Time Equivalents	As at 30/06/2012	As at 01/01/2014
FTE for permanent professors	5	5
FTE for permanent EPST or EPIC researchers	6	7
FTE of other permanent staff without research duties (IR, IE, PRAG, etc.)	0	0
FTE for other professors (PREM, ECC, etc.)	1	1
FTE for postdoctoral students having spent at least 12 months in the unit	2	
FTE for other EPST or EPIC researchers (DREM, etc.) excluding postdoctoral students	2	2
FTE for other contractual staff without research duties	0	0
FTE for doctoral students	2	
TOTAL	18	15

Detailed assessments

Assessment of scientific quality and outputs

LPNHE conducts experimental research on Matter-Antimatter Asymmetry in the lepton and quark sectors. In both sectors, the quality of the scientific production is outstanding.

The first measurement of the neutrino mixing angle theta13, given by the T2K experiment, was made with a very significant and essential contribution from the LPNHE group. For this measurement a necessary ingredient is the evaluation of the expected number of neutrino events in the absence of oscillations and of the shapes of certain kinematical variables, which were determined by LPNHE.

In particular, the group provided the best estimate of the neutrino flux available, making it more precise through collateral activities of which they are responsible: namely a dedicated CERN experiment, NA61, that measured pion and kaon production and spectra, a basic ingredient for the neutrino flux calculations. The group is also responsible for the normalization of the flux calculation with the use of the near detector of the T2K experiment.

In addition, the group was the main actor in selecting the electron-type neutrino events.

In summary, the LPNHE group can be considered one of the main international actors for the first measurement of the angle theta13, a major breakthrough on the mixing of flavours in the lepton sector. Its measured magnitude is an important step towards the CP violation measurement. Other experiments have since improved the measurement and the worldwide competition for further progress is high.

The neutrino oscillation paper produced by T2K has received more than 600 citations in the last two years.

On the quark sector side, LPNHE is involved in two of the most important experiments in this domain, i.e. BaBar (ended in 2011) at a B-factory machine, and LHCb, at the LHC.

LPNHE contributed to all phases of the BaBar experiment, from the construction and the commissioning of the detector to the publication of many physics results. The group had and still has the responsibility of the analysis of the 3-body charmless decays of B hadrons. These are sophisticated analyses, based on Dalitz plots techniques, which produced measurements that were published in excellent physics journals. Very high quality theses have been written as a result.

The analysis techniques used in BaBar constitute an important know-how to be transferred to the LHCb experiment, which will allow much more precise measurements of the observables already measured at BaBar.

Assessment of the unit's academic reputation and appeal

The choice of major international collaborations, the best worldwide in the specific field of matter/antimatter asymmetry, attests to the high level of these groups.

LPNHE had several analysis coordination roles in T2K and NA61.

The group had a very visible role in the BaBar executive board and speakers' bureau, and contributed the IN2P3 project leader. LPNHE members gave several invited talks at conferences and workshops..

The small but active phenomenology group has been quite visible, regularly giving invited talks at conferences.

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

A large effort in scientific communication is made by several members, with participation to public events, in conferences, radio and television, to publicize and explain to the general public the significance of understanding how the matter and antimatter behave differently. Due to the well-known cosmological implications, this is a theme of great public appeal.

Assessment of the unit's organisation and life

The communication between members of each group is open and the information circulates at all level of researchers (from students to senior physicists) to everyone's satisfaction.

Assessment of the unit's involvement in training through research

Several members of groups are involved/invited to different level of physics schools in the domain of flavour violation. They teach courses for students (including high-schools students), PhD schools, but also courses at international schools for researchers: École de Gif (2010), SLAC (2010, 2011), Master Classes, CERN-Asia School (2012)

In the lepton flavor sector, a weak point of the group is the fact that it has attracted very few PhD students. As a result very few theses were produced, despite the important and high quality involvement of the group members in international activities.

The group working on the quark-flavour sector, with the participation to BaBar and now to LHCb, attracts young people who make high quality PhD theses, up to PhD level. The preparation acquired by these students is excellent, as shown by the fact that many of them find positions in other labs and other experiments.

Assessment of the five-year plan and strategy

The theme of lepton and quark flavour transitions and CP violation continues being of enormous scientific importance, therefore it is only natural that the two groups should plan to continue with their current international commitments.

The possible evolution of the neutrino measurements planned with the Hyper-Kamiokande project would be a good research direction for the long-term future. However the group's immediate future task is to complete data taking in order to conclude the current physics program, that requires 8x1021 protons on target: the current data are from only about 3x1020 protons, due to the unexpected stop caused by the disastrous earthquake in Japan last year. There is some uncertainty on how long it will take to complete this program, which might last until about 2020.

The challenging goal of measuring CP violation in the lepton sector is of paramount importance, for this is amongst the most important still open issues in particle physics.

The group working on heavy flavor has already started the transition from BaBar, now closed, to LHCb, which started in 2010 at the LHC.

LHCb will produce in the years to come the most precise measurements of very rare processes involving heavy quarks decays. Transitions with rates of the order of 10-9, 10-10 can be measured and compared to the Standard Model expectations. Deviations from the SM will reveal the existence of new particles, up to mass scale higher than can be reached by actual production of particles predicted in beyond-the-SM models. The LHCb experiment has proved to be able to do such measurements, and the LPNHE group is transferring its expertise on this physics field from BaBar directly to the new commitment. The disadvantage of joining the project well after its construction and installation will be overcome with a very active participation (already ongoing) to the operation and running of the present detector.

In the years to come LHCb is planning a major upgrade, to work at higher data acquisition speed from about 2018 onwards. The LPNHE group is planning to take the opportunity of participating in this upgrade. The upcoming instrumentation work will offer to students a broader, more complete spectrum of opportunities in experimental physics research.

Conclusion

● Strengths and opportunities:

Heavy quark physics:

- The group has acquired solid expert knowledge with the BaBar detector at PEP-II, where the members of the group had (and to some extent they still have) analysis coordination responsabilities.
- The group can transfer the expertise to the new commitments in the LHCb experiment.
- LHCb offers the best opportunity for the next decade to further explore the rarest decay processes of b-hadrons, which may indirectly reveal new physics.
- Analysis techniques learned and successfully applied to BaBar data can be transferred to pp data analysis at LHC.
- This young group has potential to assume in the near future significant responsabilities within LHCb
- High quality thesis subjects can attract good PhD students.

Lepton flavour physics:

- Neutrino physics has always been and still is a line of research rich in measurements that goes to the essence of the standard model and explores anomalies or inconsistencies of its predictions.
- The group actively participated and carried out the first measurement of theta13, later confirmed and improved by other experiments.
- The group has strongly contributed to the first measurements of theta23 and Delta (m223) in T2K.
- The group has an important involvement in the ancillary NA61 experiment, very useful for improving neutrino flux calculations.
- The members of the group have analysis coordination responsabilities.

● Weaknesses and threats:

Heavy quark physics:

- At the moment the activity is shifting from BaBar (B-factory) to LHCb (at a proton machine). This implies differences and adjustments which must be addressed. However the transition could be fast considering the expertise of the people involved.
- Joining the LHCb experiment well after its construction is a handicap which must be overcome with a strong involvement in running and operating the detector.

Lepton flavour physics:

- the goal of T2K to collect $8x10^{21}$ protons-on-target may depend on the availability in Japan of electrical power following the Fukushima earthquake, and may be linked to the issue of the HyperKamiokande project.
- Commitment in hardware aspects is small.
- Few PhD students are attracted to do a thesis in the group.

● Recommendations

Heavy quark physics:

- The group must define as soon as possible its involvement in the LHCb analyses where their skills are best put to good use (like 3-body charmless decays of B's and K*e+e- decays). This will allow them to contribute to the publication of new and more precise measurements, to take responsibilities before the end of first phase of LHC (around 2016), and to acquire in a short time the visibility and leadership that this group is capable of reaching.

- The participation in LHCb should be complemented by commitments in the upgrade phase of the detector, planned for the years 2013-2016. The choice of activities should be made keeping in mind of the technical strengths at LPNHE (calorimeters, silicon technologies). Activities in software High Level Triggers can be a very valuable choice.

- It would be desirable to strengthen the group, for the field of matter/antimatter asymmetry is one of the most promising ones in terms of testing the standard model and discovering new physics at high mass scales

Lepton flavour physics:

- Clarifying the neutrino mass hierarchy and measuring CP violation in the lepton sector is one of the most important, most exciting open problems in today's particle physics. The physics program of LPNHE is enriched by this important activity. It is recommended that the LPNHE remains active in this field, by participating to new projects beyond the T2K.

- It is desirable for the group to get more involved in the instrumentation aspects of present and future projects, exploiting the well-equipped workshops and the technical expertise of the unit.

Theme 3: Nature et Origine du Rayonnement Cosmique de Hautes Energies (RCHE) [Expériences Auger, HESS et projet CTA]

Manager's names: Ms. A. LETESSIER-SELVON, J-P. TAVERNET, P. VINCENT

Workforce

Theme workforce in Full Time Equivalents	As at 30/06/2012	As at 01/01/2014
FTE for permanent professors	5	5
FTE for permanent EPST or EPIC researchers	3	4
FTE of other permanent staff without research duties (IR, IE, PRAG, etc.)	3.3	4.3
FTE for other professors (PREM, ECC, etc.)	1	1
FTE for postdoctoral students having spent at least 12 months in the unit	3	
FTE for other EPST or EPIC researchers (DREM, etc.) excluding postdoctoral students	0	0
FTE for other contractual staff without research duties	0	0
FTE for doctoral students	7	
TOTAL	22.3	14.3

• Detailed assessments

Assessment of scientific quality and outputs

Cosmic Ray research at LPNHE is performed by two groups, working on Gamma-Ray Astronomy (GRA) and on Ultra High-Energy Cosmic Rays (UHECR)

GRA: Since its completion in 2003, the HESS experiment has revolutionized the field of high-energy gamma astronomy. It has increased the number of identified astrophysical sources from a few to more than one hundred and established the existence of high-energy gamma ray emission from a variety of sources (AGNs, SNRs, binaries, PWN, etc.) many of which were previously unknown.

The international community has recognized the success of the HESS achievements by a number of awards (Descartes-2007, Rossi-2010). The HESS experiment has published 57 articles during the period 2007-2012. Based on the citations of its publications HESS is ranked 10th in the list of high impact observatories.

UHECR: The Pierre Auger Observatory is the world's largest and most sensitive cosmic ray detector. It has made important contributions to the understanding of ultra high-energy cosmic rays (UHECR). For example it has confirmed the presence of a cut-off in the energy spectra, consistent with expectations from the GZK process, but which could also be explained by photodisintegration of heavy nuclei or alternatively a limitation in the maximal energies of particles emitted by the source. The experiment also indicates that the CR composition changes from proton to Iron at the highest energies. Nevertheless, it should be noted that other UHECR experiments do not necessarily confirm all of these observations. Auger has published a total of 33 papers in reviewed journals, with over 2500 citations.

Assessment of the unit's academic reputation and appeal

GRA: The HESS group has made important technical contributions to the design and construction of the telescopes, in particular to the construction, calibration and maintenance of the cameras for both HESS I and HESS II. The group is generally recognized by the Atmospheric Cherenkov Telescope community as having leading expertise in the construction and calibration of Cherenkov telescope cameras.

On the analysis front, members of the group have important physics coordination responsibilities within the HESS experiment. The group is particularly active in the search for dark matter and tests of Lorentz invariance. Group members were the leading authors of the corresponding papers and the limits on these quantities are the best currently available.

The group has suffered from the departure of a number of researchers holding permanent posts. Nevertheless, recently two new researchers have strengthened the group.

UHECR: The Auger group at LPHNE has played a leading role at the national and international level for the operation of the experiment and analysis of the data. Members of the group have major responsibilities in the management of the experiment (Publication Committee chairperson, Analysis Coordinator). Some of the analyses conducted by members of the group have resulted in papers with a high number of citations.

Members of both groups regularly present their results at major national and international workshops and conferences as well as invited seminars at national universities and are invited to give lectures at summer schools.

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

The study of high-energy cosmic phenomena in the Universe has great appeal for the general public. Consequently both groups are frequently invited to give presentations to the general public, national TV, schools and to write articles in popular science magazines. The groups participate every year to the annual 'Fête des Sciences'. The year 2012 has been particular rich of outreach activities based around the HESS 100th anniversary and the year of Astronomy. The Auger group has also been involved in 'mini-Auger', a project for high schools based on operating a small charged particle detector.

Assessment of the unit's organisation and life

The groups are a well-balanced mix of junior and senior researchers and engineers.

Both groups are well structured and organize regular weekly groups meetings to discuss progress and plan the next steps. Regular meetings are also made with other local labs collaborating on technical contributions for the future experiments. Annual national meetings with other French labs contributing to the experiments are also held.

Assessment of the unit's involvement in training through research

Both groups are very active in training PhD students ; six PhD students have graduated or are in progress within the HESS group and also six from the Auger group during the period of evaluation. A total of five members are professors or lecturers at the University. The CNRS researchers also contribute to the lectures courses for the master's program.

Assessment of the five-year plan and strategy

Data taking and data analysis with HESS and Auger should be continued until the end of the decade and will be a major activity of the groups.

The lower energy threshold of the HESS-II camera offers excellent opportunities to study low mass dark matter and extend the distance horizon; aspects of considerable importance for the analyses currently being pursued by the group. The successful construction and operation of CTA will be the next important step forward for the field; it is expected to detect an order of magnitude more sources offering unprecedented statistics for population studies of the various source types. The leading role of the group in the NecTar/GATE proposal for the front-end electronics of CTA is a natural continuation of the group's efforts for HESS.

Significant progress in the understanding of high-energy cosmic rays will rely on improved techniques for measuring the mass composition and at least an order of magnitude increase of statistics; this will not be forthcoming from five more years of standard Auger operation. An evaluation of the potential of the radio detection technique to augment the duty cycle of the fluorescence detectors and facilitate the instrumentation of a larger surface - O(30,000 km2) - is of high priority. The EASIER and GIGAS radio wave detection projects proposed and led by the LPNHE group should provide the answer as to whether this approach is really feasible. If the results are positive the community would then be in a good position to propose a cost-effective next generation surface-array. The proposal for vertical segmentation of the water Cherenkov arrays, to enhance composition studies, looks promising.

Conclusion

● Overall opinion of the theme:

Both the Gamma-Ray Astrophysics and the Ultra-High Energy Cosmic Rays work are at the forefront of research, and must continue.

● Strengths and opportunities:

GRA: The HESS/CTA group has a clear path forward towards an exciting program of exploration of the high-energy gamma Universe. Once the difficulties in commissioning of HESS-II are resolved this will allow the technical efforts of the group to focus more on the CTA project and offer a novel and very promising physics program while preparing CTA.

The NecTar/GATE proposal for the CTA front-end electronics has been well received by the collaboration and the project is proceeding well. Consequently, the NecTar approach has reasonable prospects to be chosen as the baseline solution from amongst the other competing technologies within the collaboration.

UHECR: The main strength of the group is its expertise and its prestige within the collaboration, based the scientific and technical leadership positions it held over the duration of the experiment. The group will remain in this position because of its role in exploring the novel radio detection techniques and in segmenting the water Cherenkov detectors.

Increasing the density of the surface detectors with an infill array, will lower the energy threshold and provide new information on the energy region around the knee. The group's efforts to improve the trigger efficiency and reconstructions algorithms will also contribute to enhancing the detector sensitivity.

● Weaknesses and threats:

GRA: The apparent lack of funding for the HESS-I maintenance is a worry and threatens to impact the live time of the telescope and consequently the physics output from the experiment. Any further delays in the HESS-II commissioning may have a negative impact on the start of CTA funding.

The main threat for CTA, apart from delays in funding from the stakeholders, is a lack of coordination at the national level and delays in agreement of strategy amongst the large number of partners. Significant delays in the project risk inducing evaporation of key expertise and manpower.

UHECR: The future for the field of UHECR study is not entirely clear. Given the statistics already accumulated by Auger, further data taking with the current configuration will only yield marginal progress on some of the issues opened up by this experiment, such as the origin of the highest-energy events. This fact may call into question the extension of the Auger MoU beyond 2015.

● Recommendations:

GRA: In order to reduce the load on the technical team it is recommended to transfer the responsibility of the HESS-I camera maintenance to another group in the collaboration.

On CTA, efforts should be made by the collaboration to adopt, where possible, common technology amongst the different sized telescopes of the various countries. This would clearly reduce costs and can only help the final integration of the telescopes into a coherent infrastructure.

UHECR: The addition of a denser "infill" array is also a promising approach to the open questions in the "ankle" energy region. This line of inquiry should be energetically pursued by the LPNHE team.

Addressing the highest energies requires new approaches and certainly, given its promise, the radio technique should be fully explored as rapidly as possible. A demonstration of the feasibility of the radio technique will then allow the group to propose a next generation ground-based array, or if proven unfeasible, to seriously consider alternative approaches (e.g. JEM-EUSO, large volume neutrino telescopes, etc.).

Theme 4: Matière Noire et Energie Noire (MNEN)
[Expériences SCP, SNF, SNLS et projets LSST et EUCLID]

Manager's names: MS. P. ANTILOGUS, P. ASTIER, J. GUY, M. JOYCE, R. PAIN

Workforce

Theme workforce in Full Time Equivalents	As at 30/06/2012	As at 01/01/2014
FTE for permanent professors	6	6
FTE for permanent EPST or EPIC researchers	6	6
FTE of other permanent staff without research duties (IR, IE, PRAG, etc.)	6.5	7.5
FTE for other professors (PREM, ECC, etc.)	0	0
FTE for postdoctoral students having spent at least 12 months in the unit	2	
FTE for other EPST or EPIC researchers (DREM, etc.) excluding postdoctoral students	1	1
FTE for other contractual staff without research duties	1	0
FTE for doctoral students	8	
TOTAL	30.5	26.5

• Detailed assessments

Assessment of scientific quality and outputs

The MNEN team is strongly involved in dark energy studies through type Ia supernovae since the beginning of the Supernovae Cosmology Project (SCP). One LPNHE member co-authored the pioneering papers which led the Nobel prize in physics in 2011. Since this beginning, the LPNHE became one of the top teams in the world, and now has a worldwide leading position with the publication of the first data set of SNLS and its scientific interpretation, completed by having obtained a local SNIa sample with the SNFactory project. The quality and richness of the scientific production of the group is evidenced by the numerous publications in top astrophysics (Ap.J., A&A, MNRAS) and physics (Phys. Rev.) journals, as well as awards received (Nobel Prize to the leader of the SCP, the Gruber Prize, the Silver and Bronze CNRS medals). The qualitative aspect must be emphasized: the excellence of this work is due to the rigour of the additional analyses and to the new methods introduced: the new algorithm to monitor the light curve of supernovae and the development on a telescope calibration device (DICE) are emblematic examples. The theoretical activity, within its boundaries, is worthhile, as can be seen by its publications.

Assessment of the unit's academic reputation and appeal

The contribution of the LPNHE cosmology team is central to the world position of the SNLS project. The reward has been its international recognition and has been instrumental for its significant involvement in the LSST project. In additions its expertise in telescope calibration puts it in a strong position to get involved in other international projects. This position benefits the entire French community. Having been recognized by the award of two medals of the CNRS, and having produced several highly cited, major publications in recent years, the LPNHE researchers are present as invited speakers in many international events. The team obviously attracts many PhD students and postdocs. However the difficulties in funding such positions does not allow to fully exploit the training potential of this group.

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

The problem of dark energy has emerged as one of the major problems of cosmology and modern theoretical physics. This naturally led to its successful dissemination in society. The LPNHE cosmology team has significant activity in the diffusion towards popular media. Its diffusion activities in schools and colleges is positively recognized.

Assessment of the unit's organisation and life

The team is mainly organized around the projects to measure distant supernovae. The size of the team does not call for elaborate organization. The complications associated with the physical move of the laboratory did not affect its scientific production.

The synergy between the theory and experiment could be further developed.

A significant involvement in various national bodies (CNU, PNCG, Labex...) should be noted.

Assessment of the unit's involvement in training through research

With a significant proportion of teachers from university, members of the team are heavily involved in university through courses both academic and training at different levels, including the master level, as well as in summer schools.

Assessment of the five-year plan and strategy

The team is certainly at a turning point in its strategic choices: involvement in LSST at an early stage of the project offers an opportunity that must obviously be developed. The proposed strategy for the coming years capitalizes on the acquired know-how while broadening the scope of its scientific involvement in large programs (such as new astrophysical studies from samples of supernovae) and addresses other cosmological probes that provide additional information. The early commitment on the LSST project allows a highly visible role at the international level and a leadership role at the national level. This approach is very relevant, positioning the LPNHE as a national leader in a broad international program that is likely to be the flagship on dark energy research for this coming decade. The strategy of investigating more cosmological probes and problems distinct from dark energy is very relevant, but the necessary changes are important and may need to be conducted in a narrow time window: in a very competitive topic in which the Anglo-Saxon prevalence is often the rule, the positioning of the laboratory will be critical to ensure optimal visibility, rewarding the level of investment and quality of its production.

Participation in a new project like Dark Energy Survey (DES) is a very sensible direction for the short/medium term. The LPNHE commitment in the EUCLID project is at a relatively low level because this involvement is restricted to the supernovae subject that is not a major part of EUCLID. Although EUCLID is a long-term project, it should occupy the front of the scene after the LSST on the dark energy issue and on some legacy aspects. It would therefore be beneficial to LPNHE to increase its foothold in this project without having to change its strategy elsewhere.

The theoretical component is specific and original in this laboratory and could produce interesting synergies if an appropriate strategy is implemented, allowing further added value to the observational work on dark energy.

The SWOT analysis of the team broadly matches the various elements listed above. The analysis shows a very good understandind on the current position of the team, as well as of its strengths, of what can be improved and of the identifiable risks.

Conclusion

- Strengths and opportunities:

This is a world-leading team on the study of dark energy by means of type Ia Supernovae. Its achievements on SNIa observations are the world reference and are not yet superseded. The team has developed a coherent strategy to capitalize on its expertise in accurate photometry both by software and instrumental tools. This has allowed the team to be involved early on as a major partner of LSST, the only one not from US, leading the French participation in this project.

It will be also a key point in view of their possible involvement in other international projects like DES.

Its scientific production consists of numerous papers in the best astrophysical journals, with many citations. Their strength is attested to by numerous invited talks at international conferences and two national prizes (CNRS medals) and the Gruber international prize (through the SCP collaboration). Broadening the probes of dark energy and the spectrum of scientific questions addressed from their analyses is strategically appropriate. The presence of a (small) theory component is potentially a catalyst for it.

- Weaknesses and threats:

It is challenging to maintain the very high standard the team has reached unless one can lead one of the next generation experiments devoted to dark energy! Broadening the team's expertise beyond SNIa may well be necessary on a short time scale, in a context where recruiting PhD students and post-docs might be difficult. The domain targeted by the theory component is focussed and somehow far away from the field of the observational activity. A better synergy would be highly beneficial, but difficult to achieve.

The future activities in DES and to a lower level in LSST are not yet fully secured.

- Recommendations:

The team has gained international visibility in just a few years, and can be regarded as being a world leader on the topic of photometry of SNIa for cosmological applications. Its involvement in LSST is to be supported. The strategy to broaden the astrophysical questions being addressed, the probes of dark energy to be studied, and the projects in which team can be involved is very relevant and might need to be acted upon in a short time period.

The LPNHE cosmology team would benefit from consolidating its implication in EUCLID on the basis of its technical expertise (photometry) and through topics beyond SNIa that will be part of their plans to expand their research subjects. This is very relevant as the leader of EUCLID is a member of another laboratory (IAP) in the same university. The university could and should encourage this synergy by favouring a better integration and should accordingly provide substantial support. As a matter of fact, the "tutelles" should provide above-average support to this team to ensure that it can pursue its high-level scientific activities in a very competitive area and in which large dedicated international facilities will be the drivers.

5 • Conduct of the visit

Visit dates:

Start:	Wednesday, January 9th, 2013
End:	Friday, January 11th, 2013

Visit site:	Venue of the LPNHE
Institution:	LPNHE
Address:	4 Place Jussieu, 75005 Paris.

Specific premises visited:	Laboratories, clean rooms, experimental facilities, shops.

Conduct or programme of visit :

1st day:

12h30 - 14h00:	Closed session of Committee (preparation, cold lunch)
14h00 - 17h00:	Plenary session
14h00-15h00	Director of LPNHE: Summary and plans
15h00-17h00	4 talks, 30 min. each: Highlights of the 4 teams
17h00-18h00	Visits of the facilities
18h00-18h30	Meeting with postdoctoral fellows
18:30- 19:00	Meeting with PhD students

2nd day: Closed session

9h00-10:30	Meeting with IMF team
10h30-12:00	Meeting with AMA team
12h00-12h45	Meeting with technical groups (engineers, technicians, administrative staff)
12h45-13h30	Lunch
13h30-15:00	Meeting with CRHE team
15:00-16:30	Meeting with MNEN team
16h30-17h15	Meeting with the "tutelles": IN2P3, P6/7
17h15-18h00	Meeting with the Council of the Laboratory

3rd day: Closed session

8h30-12h30:	Discussion, "fiches notation", report, recommendations.

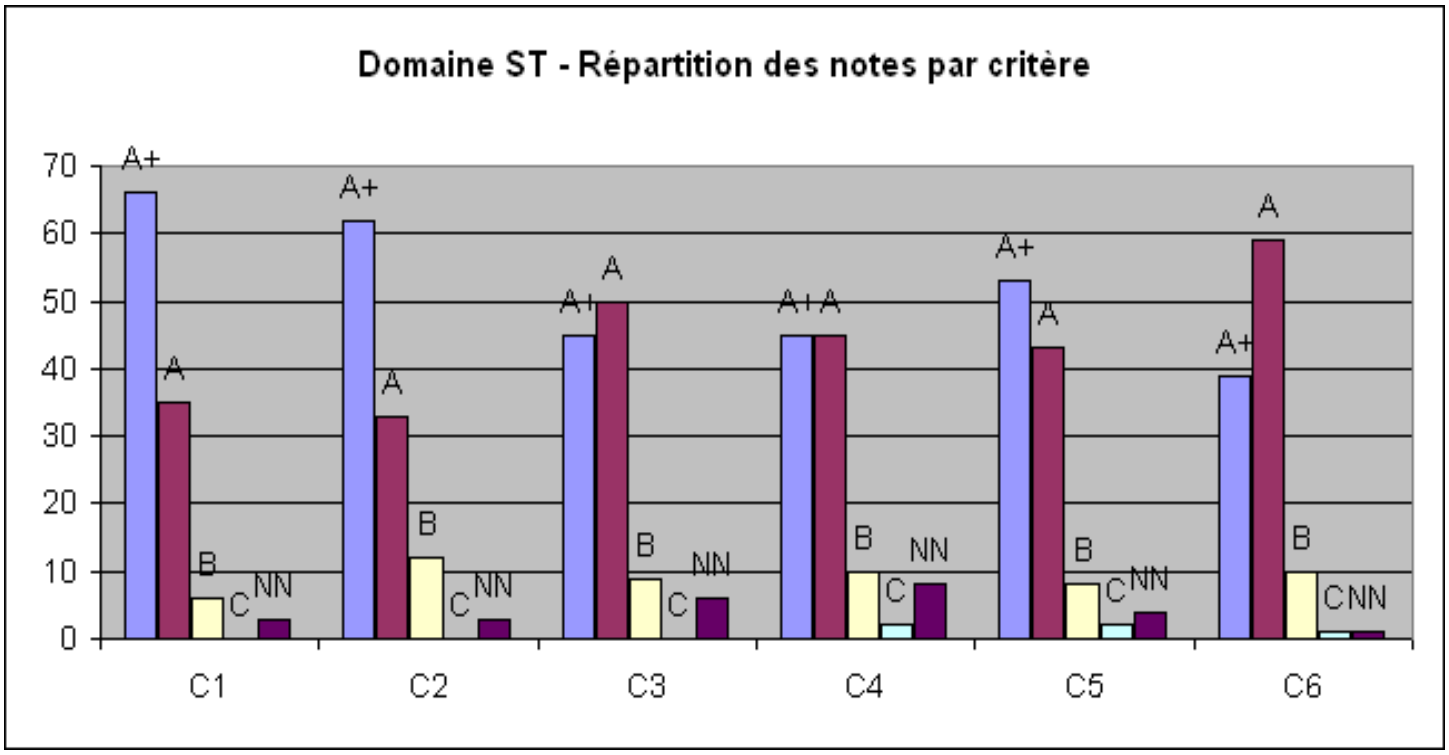
6 • Statistics

Grading tables and percentage per field

Critères	C1 Qualité scientifique et production	C2 Rayonnement et attractivité académiques	C3 Relations avec l'environnement social, économique et culturel	C4 Organisation et vie de l'entité	C5 Implication dans la formation par la recherche	C6 Stratégie et projet à cinq ans
A+	66	62	45	45	53	39
A	35	33	50	45	43	59
B	6	12	9	10	8	10
C	0	0	0	2	2	1
Non Noté	3	3	6	8	4	1

Critères	C1 Qualité scientifique et production	C2 Rayonnement et attractivité académiques	C3 Relations avec l'environnement social, économique et culturel	C4 Organisation et vie de l'entité	C5 Implication dans la formation par la recherche	C6 Stratégie et projet à cinq ans
A+	60%	56%	41%	41%	48%	35%
A	32%	30%	45%	41%	39%	54%
B	5%	11%	8%	9%	7%	9%
C	0%	0%	0%	2%	2%	1%
Non Noté	3%	3%	5%	7%	4%	1%

Histogram



7 • Supervising bodies' general comments

Paris le 11 04 2013

Le Président
Didier Houssin
Agence d'évaluation de la recherche
et de l'enseignement supérieur
20 rue Vivienne - 75002 PARIS

M. le Président,

Nous avons pris connaissance avec le plus grand intérêt de votre rapport concernant le projet du Laboratoire de Physique Nucléaire et des Hautes Energies, porté par M. Pain. Nous tenons à remercier l'AERES et le comité pour l'efficacité et la qualité du travail d'analyse qui a été conduit.

Ce rapport a été transmis au directeur du laboratoire. Nous prenons acte des recommandations qui ont été formulées et qui n'appellent aucun commentaire particulier de notre part.

Restant à votre disposition pour de plus amples informations, je vous prie de croire, M. le Président, à l'expression de mes salutations respectueuses.

Le Vice -Président Recherche et Innovation

Paul Indelicato

Vice-présidence Recherche et Innovation
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