

Report to the President of the INFN

Il Comitato di Valutazione Internazionale (CVI)

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Introduction and General Comments

The 2016 meeting of the CVI took place the 9th through the 11th of October at the University of Torino. In preparation for the meeting, INFN management provided us with the annual report of the Gruppi di Lavoro per la Valutazione (GLV), which summarised the accomplishments of and issues facing the several INFN research programmes, and served as reference for our discussions with the directors of the National Scientific Commissions (CSN's), Technology Transfer group, and the INFN Outreach and Education programme. The GLV report was very well done, and we thank the central management and programme leaders for clearly considering and addressing our recommendations from 2015. We also wish to express our thanks to Angelo Rivetti and the staff of the University for their efforts on our behalf that made the meeting very efficient and productive. The meeting agenda, a list of our recommendations, and a set of requests and suggestions for next year's GLV report are attached as appendices.

President Ferroni opened the meeting with an overview of developments during the past year, and requested we give special attention this year to the INFN National Laboratories, and to the management of large complex projects, especially those involving external funds from the regions and special competitions.

Of great importance, the budget situation has improved, at least for the short term. The base budget remained stable at 230M, and INFN's great successes in international competitions brought in an additional ~ 120M to be spent over the next three years. This validates the high quality of INFN's programmes and personnel. The extra funds are extremely welcome! However, most of the increase is time-limited and directed toward new projects, and to sustain this level will take strong continued effort. It is critical to maintain and work to increase the baseline budget, and integrate the directed funds with the baseline funds.

We were delighted to learn that the hiring freeze has thawed, enabling INFN to bring on board badly needed technical staff (24 engineers, 11 technicians so far). Furthermore the parliament is working on simplification of categories, so that institutes can design staff levels optimally among administrators, technicians, engineers and researchers. It is important to note that INFN management is allowed to optimise these new technical resources around the complex. For example, of the 24 engineers hired so far, 10 are for the National Laboratories.

Under a new mandate INFN is obligated to hire approximately 100 disabled people over the next 5 years; they are doing well, with 15 people on board already and 20 arriving next year. Also on

the staffing front, INFN has done extremely well this past year in a national competition for 215 new staff positions for Gifted Research Institutions, winning 73 positions, more than double the statistical expectation of 30. Searches are in progress for 58 experimentalists and 15 theorists. INFN has instituted policies aimed at recruiting the best people available, without institutional quotas and with freedom for candidates to choose their desired specialties; and most remarkable, the winners can choose their institution! We strongly support the above concept of choosing the large number of new academic positions completely on merit and allowing the winning candidates to choose where they want to go.

We learned from the President that the GSSI in L'Aquila has received approval to become a University, and has already received 1200 applications from all over the world for 40 posts! Only the INFN could have accomplished this, so we were very pleased this great accomplishment has been recognised by giving INFN a permanent seat on the Board of Directors. The strong support from the Prime Minister in creating this and other transformational and lasting successes for INFN was essential, and is gratefully acknowledged.

Recommendation:

General-1. INFN should monitor the reasons for the choices of institutes made by the winners of the competition for academic positions, and anticipate the long-term impact.

Central Management Changes

INFN has been under pressure to conform to the organisation of universities and/or other public research entities, and has responded well by appointing a highly-qualified Director General to deal with administrative affairs, Bruno Quarta, whose background in business, experience in industry, and involvement with universities align well with the goals and plans. The role of the DG is based on the principle that the only objective of the INFN administration is to support research! As funding is tight and is likely to remain so, any plan must consider this by, for example, evaluating and reducing duplication where possible, increasing uniformity by reducing number of systems, etc. We applaud this action, but emphasise that INFN has been extremely successful under its current management structure. We therefore strongly urge the INFN leadership to proceed cautiously as they make necessary changes and improvements –“do no harm.”

We are also delighted that Roberto Saban has joined INFN as Technical Coordinator for the four National Laboratories, as his appointment recognises and addresses the need for stronger organisation and project management at these institutions of vital importance to the future of INFN. Dr. Saban has made excellent progress during his brief time at INFN so far, and promises to accomplish major improvements going forward. We shall comment on this in detail in the section below on the National Laboratories.

INFN's Organisational structure differs from all other Italian research institutions, in that the Giunta (Executive Board) is composed of internal experts instead of independent directors, and that the Giunta carries out most of the duties of a traditional Director General. As a result, the central administration is much smaller, per capita, than its counterparts at Italian Research Universities. The Director General feels that INFN, as a federal system that also supports 2000 people in universities, needs a stronger central management to lead an efficient administration. Aspects of administrative Information Technology are of special concern: whereas the systems for

travel and staff-time management are strong, the accounting system is a major weakness as is the lack of a project management system.

It is of the utmost importance to complete the changes in accounting systems as quickly as possible, and to introduce a proper cost accounting system. This is urgent also to establish a regular and financially sustainable programmes of maintenance and upgrade of infrastructures. Moreover, a full costing accounting of laboratories is a fundamental step for a proper evaluation of the cost of experiments, be it be used for real side payment or simply for imputed costs.

Out-of-ordinary events stress the system as there are few provisions for backup, and there is no reserve capacity to schedule the interventions required to implement improvements. Individual unexpected large tasks require additional management resources to succeed and to mitigate technical and compliance risks. Recent examples include: Rationalising a 66M€ tender for the ELI project in Romania; managing the collaboration between LNL and a private company to operate the LNL cyclotron and SPES. The emerging DarkSide project is very complex and time consuming, and there is yet no legal framework in Europe for ESS-ERIC.

We understand and appreciate that there are areas of the administration that need strengthening. It is important for INFN to have adequate resources to respond to special needs, including the management of new projects of increasing size and complexity. The optimal sizes of the various areas of administration should be based on need and risk. We reemphasise the importance of completing the changes in accounting systems as quickly as possible. This will require finding the staff time for planning, without further compromising performance on the short term.

Federalising the optimal organisation makes sense, to reduce duplication and exploit strengths around the INFN complex. INFN might consider taking the lead in guiding the reform process among other similar institutions, and consulting with similar institutions to configure modern IT systems adapted to a research environment.

Recommendations

Mgmt-1. INFN should consider treating and managing the reconfiguration of its administration as a project.

Mgmt-2. The administrative reorganisation should focus first upon “low hanging fruit,” to realise quick improvements, and remediate urgent problems and weaknesses, and thereby to gain support for future actions. Obvious examples are administrative IP systems; the federalisation of INFN resources, e.g. engineers, to avoid duplication and optimise the breadth of expertise; and project Management.

Mgmt-3. INFN should explore possibilities for collaboration with other institutions in reforming and optimising the administrations.

CSN1 – Accelerator-based Particle Physics

CSN1 coordinates INFN particle physics activities at accelerators and R&D for future projects. It is a large sector with close to 800 FTEs, out of which approximately 80% work on the LHC. In addition to the LHC programmes, there is a good portfolio of experiments at LNF and various international laboratories. The programmes spans hadronic, flavour, and charged lepton physics, proton structure and R&D for future applications. Large sets of good data have been recorded last year. Significant progress in detector construction and R&D towards future experiments was achieved. Some of the highlights are described below:

The LHC machine at 13 TeV surpassed the design instantaneous luminosity reaching $1.5 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ and operated with a high turn-around of 70%. The experiments addressed successfully the challenge and took data with very high efficiency. TOTEM and LHCf have taken some special runs. A wealth of LHC Run 2 results was presented at the ICHEP 2016 conference, together with many analysis of the full Run 1 sample. They feature precision measurements of the Standard Model properties and searches for new physics, but no significant signal of new physics has been observed so far. The LHC experiments are pursuing their upgrade plan, with ATLAS Phase-1 and LHCb upgrades well underway keeping up with the tight schedule. The R&D for High-Luminosity Phase-2 is progressing with various TDRs foreseen for next year. It profits from the support of a special INFN programme RD_FASE2 to help experiments developing new techniques, looking for industrial partners and external funds.

The experiments KLOE2(LNF), BESIII (BEPC) and COMPASS (CERN) have taken data during last year. KLOE2 plans to conclude the experiment collecting 5 fb^{-1} of data by early 2018. BESIII and COMPASS are also preparing their upgrade. NA62 took its first year of data. Some adjustment of the SPS beam structure will be needed to reach nominal intensity.

MEG (PSI) and g-2 (FNAL) are constructing the detector that should be ready for next year data taking. Mu2e (FNAL) passed DOE-CD3 approval last year and is now fully funded with beam foreseen in 2020. PADME (LNF, part of the What Next process) and BELLE2 (KEK) had their first test beam runs.

CSN1 plans to contribute to the update of the EU Strategy by 2019-20 and is launching a programme to support R&D on Future Accelerators (RD_FA). Some highlights include: development of μ -RWELL detectors, high-energy beam steering with crystals or the design study of the SHIP detector.

We congratulate CSN1 for its rich and diverse programme and the important results that are steadily produced. All indicators of scientific productivity and visibility are excellent. INFN plays an important role in all experiments in which they participate. We look forward to hear next year the progress of the various experiments that are still at an early stage.

Finally we note that the average INFN researcher age is growing, and that INFN has put steps in place to mitigate this problem, by increased new hiring and creating a programme to nurture young scientists along the path from undergraduate and graduate student to PhD researchers.

CSN1 functions with a flat budget and receives some additional funding. Concerning the LHC upgrade, so far only the funding for the detector upgrade has been secured. It is in general adequate, although there might be budget pressure in 2017, a construction year. We acknowledge that the

funding for LHC computing needs to be evaluated. Currently, resources are already under pressure as a result of the excellent LHC performance, but HL-LHC computing will represent a much bigger challenge. The CVI sees favourably the plan to build some strong expertise in INFN to contribute to the development of the new computing model to deal with large data samples soon to be collected.

We support the detector and accelerator R&D programmes for the LHC upgrades and the ambition to play a significant role updating the European Strategy for Particle Physics by 2019-20.

Recommendations:

CSNI-1. INFN should make sure now that the infrastructure and other resources required will be available for constructing the Phase-2 upgrades to CMS and ATLAS, since formal TDR commitments will be taken in 2017. This should be done in close contact with other relevant CSNs and laboratories.

CSNI-2. Increase efficiency by pursuing useful synergies with the other INFN CSNs, National Laboratories, in concert with the new Technical Coordination office.

CSN2 – Astroparticle Physics

Astroparticle Physics is a highly diverse field, so a clear strategy is essential for choosing among a plethora of research opportunities. Indeed we observe an increasing strategic approach in CSN2 that includes the definition of clear priorities on the one hand and the reduction of the number of projects on the other. Closing (or not launching) projects is always a difficult decision, in particular if the science is excellent but funding is not available, or if the relative contribution of Italy is comparably small – just to mention two typical reasons. It is highly acknowledged that over the last years CSN2 has defined clear priorities and has taken difficult but reasonable decisions in closing projects. Testifying to the attractiveness of the field, over the last 4 years the Giunta Esecutiva has supported a 35% increase of personnel and a larger budget for CSN2, and the contribution of external funding to CSN2 is higher than in other fields. Even so, financial difficulties remain, requiring the shutdown of scientifically valuable activities.

The CSN2 programme is rich and builds on the historic role and the strengths of astroparticle physics in Italy. We also note the technological innovations to be prepared for the future (like SABRE, CUPID, ARIA, ...). Much scientific progress has been achieved in 2015/16: the following list is impressive but certainly incomplete:

Dark Matter: XENON100 last released record limits, and its follow-up project XENON1T is in its calibration phase, planning to deliver results in 2017. Preparation of the SABRE experiment to scrutinise the DAMA/LIBRA results is moving ahead.

Neutrinoless Double Beta Decay: GERDA-II has delivered first results. CUORE, after a long journey, is to be commissioned in December 2016, after successful operation of a single tower (CUORE-0). This gives LNGS an extremely strong position in the worldwide race to prove a possible Majorana nature of neutrinos. The GERDA collaboration is starting to discuss a 250 kg version, and the CUORE collaboration looks beyond the present CUORE to CUPID, a version with enriched isotopes and particle identification.

Low-energy neutrinos: SOX, the project to search for signs of sterile neutrinos with the help of a radioactive source below Borexino, is well advancing. Borexino continues to deliver top results on solar neutrinos. Italian activities gain speed in JUNO, a future 20kt liquid scintillation detector in China that aims to measure the neutrino mass hierarchy. The neutrino mass hierarchy (NMH) – one of the main targets of JUNO – may well be resolved in 2021 by NOVA and T2K, leaving JUNO’s role as confirmatory. Even so however, JUNO together with ORCA (the low-energy version of KM3NeT) is expected to form the worldwide frontier in precision neutrino oscillometry in the early 2020’s– something like LEP has been for the standard model of particle physics. INFN is well advised to keep the momentum of Italy in JUNO, and buys in with top expertise from Borexino.

Gamma rays: MAGIC has published many new and interesting results. A first small telescope prototype for CTA was built in Italy and successfully tested (with INAF as the main responsible agency).

KM3NeT: The experiment is back on the ESFRI roadmap, now in its incarnation as ARCA (a high energy array off the Sicilian coast) and ORCA (lower energy neutrinos to study neutrino oscillations close to Toulon/France). Three strings were deployed at the Italian site. One of them failed but could be successfully recovered, in a highly non-trivial operation. The reasons for the failure could be identified and a full account of the case has recently been released. Still, some concern remains, amplified by the fact that the first tower (not an official part of the present KM3NeT project) also failed.

Gravitational Waves: The LIGO/VIRGO collaboration made the first detection of gravitational waves – a centennial result! The LISA-Pathfinder was successfully launched and is now in space operation.

However, there are also problems and open questions:

Funding: The impressive recent scientific successes notwithstanding, astroparticle physics needs an increase in its operating budget to maintain Italy’s historically strong role in this important field, and to support the excellence of its larger research community.

KM3NeT: The failure of the 3rd string is a reason of concern (although the string was recovered and the problems identified). However, its strategic importance is very high so INFN should continue to support it, and consider postponing the tower deployment for the moment to continue with strings first. In this way the decision on best use of the towers (e.g. for a dense core) can be made without time pressure.

VIRGO: Delays of about 7 months have been reported (due to problems with the mirror suspension). The first run will therefore have a somewhat lower than the originally planned sensitivity. When data comes in it is important to make sure there is a sufficient team to analyse it in a timely manner.

Auger and AugerPrime: In 2015, we recommended that INFN should support AugerPrime – provided enough other countries also sign in. The mentioned reasons were that AugerPrime will/can be decisive for the future of the field, and that it is relatively cheap. Collecting promises or clear commitments is an iterative process. As a result, in October 2016 70% of AugerPrime

construction funds seem to be secured (Germany, Netherlands, Argentina, Czechia – plus counting Italy with 1.6M€). This is a very positive trend.

However, we note that maintenance costs are becoming a notorious problem worldwide, not only for Auger, which at an annual M&O cost per PhD physicist of 8.5 k€ seems well within the range of other major experiments. We emphasise that delays in realising AugerPrime, as well as constructing a smaller number of upgraded tanks, would lead to longer running and would make the integrated operation cost even higher. INFN should independently seek ways, together with Argentina and the collaboration, to further decrease M&O costs”.

LHHASO: The report to CVI has described the “LHHASO dilemma” very well: the physics case is convincing, in particular the extension of the CTA energy range, and there are acknowledged historical (ARGO/YBJ) and political (broad cooperation with China) aspects. However, the Italian community is rather small, the financial resources are limited and, taking all aspects together, the LHHASO priority is below that of CTA, AugerPrime and KM3NeT. The decision on Italian participation is pending. INFN should decide on LHAASO participation very soon, since joining the collaboration too late may prevent a visible role in the experiment.

Recommendations:

CSN2-1. INFN should follow the presented strategy of LNGS, including the future projects SABRE, DarkSide-20, XENON-nT and CUPID. Keep the high priority for Borexino and LUNA since the portfolio of LNGS must include experiments guaranteeing “positive” results rather than only upper limits.

CSN3 – Nuclear Physics

First, we wish to thank CSN3 and LNS for their helpful and appropriate responses to the recommendations of last year, involving both nuclear-structure and nuclear-reaction theorists in the NUMEN project (measurement of the neutrinoless 2β -decay nuclear matrix element). We applaud the continuous increase in number of publications and visibility through invited talks, and the general impact of CSN3 research. We also note their success with the ERC Starting Grant and ERC Advanced Grant for NUMEN and PAX projects.

We are pleased to report that the different sections have successfully continued their research programmes since our last meeting:

Quarks and Hadron Physics used electromagnetic probes at different energies mainly at MAMI (Mainz), Bonn and JLab (USA), and, in connection with study of strange quark dynamics, at the facilities of LNF (KAONNIS), and KEK (ULYSSES). The group is also involved in development and construction of equipment for the research programme to be pursued at the upgraded JLAB (12 GeV) such as a hadron calorimeter, a RICH detector and detectors for the heavy-photon search. In contrast, all R&D activities for PANDA at FAIR were stopped.

The **Phase Transition in Hadronic Matter** section benefitted from the restart of the LHC at higher energies. Data-taking operations restarted in January 2015 with a cosmic-ray data-taking campaign followed by a run with protons at 13 TeV. This led to many interesting results and hence a large number of publications (43) and more than 500 conference presentations. A highlight was the unexpected observation of signals of collective effects in collisions of the systems pp and p -Pb, which attracted theoretical interest.

The **Nuclear Structure and Reaction Dynamics** section pursued its experimental research programme both at the INFN National Laboratories of LNL and LNS and as users of international laboratories mainly GANIL, GSI, IPN Orsay, Argonne National Lab and RIKEN. The main activities were pursued with AGATA (coupled to the VAMOS spectrometer at GANIL), EURICA (Euroball-Cluster detectors installed at RIKEN) and GALILEO at LNL. Many interesting results were obtained, which consequently resulted in many publications in high-impact journals. At LNS, the CHIMERA detector demonstrated the capability to measure particle- γ -ray correlations and thus the ability to determine the γ -ray multipolarity. Furthermore, important progress was made with the NUMEN project to measure the 2β -decay nuclear matrix element. Single and double charge-exchange test experiments were performed successfully at LNS with the MAGNEX spectrometer set at zero degrees and at incident energies between 270 MeV and 440 MeV. In the framework of the NUMEN project, LNS initiated collaboration with nuclear structure and nuclear reaction groups, which is imperative to understand heavy-ion double charge-exchange experiments. At present, LNS is also investigating the broader experimental programme that could be done complementary to the NUMEN project at the upgraded superconducting cyclotron.

The **Nuclear Astrophysics and Interdisciplinary Research** section performed several experiments at LNGS, n-TOF and other facilities, which can shed light on the CNO cycle, and hydrogen burning in AGB stars, novae and possibly in the stage preceding type Ia supernovae. The Section has been very active in the LUNA-MV project. The contract with the company which will build the new accelerator has been signed. Precautionary measures for neutron shielding will be taken to preserve the low level of neutron background inside LNGS. During the presentation, it was communicated that the level of interest for using the new LUNA-MV facility has decreased, especially by international users.

We conclude with comments on other aspects of the CSN3 programme.

- The FOOT experimental project with focus on nuclear physics application to medicine and radioprotection in space has been launched. The part for measuring nuclear fragmentation for nuclear therapy of ^{16}O and ^{12}C in inverse kinematics is very much needed. It should be emphasised that collaboration with groups in Europe (France, Italy, Austria, etc.) on this topic would be important in order not to duplicate efforts.
- The measurement of the excitation energy of the first-excited state in ^{229}Th with very high precision is indeed of strategic importance for construction of atomic clocks. Advanced efforts by expert groups elsewhere in Europe exist. A combined effort with clear INFN impact would be encouraged.
- PANDORA is the experimental programme that advocates the use of plasmas in study of nuclear astrophysics processes, in advancing observational astronomy and in industrial and medical applications. The programme is very interesting, could lead to ground-breaking results and should certainly be endorsed. It offers also the possibility of measuring nuclear decay rates in stellar conditions. In this particular case, the possibility of using storage rings for studying β -decay rates important for nucleosynthesis should be considered as well.

Recommendation:

CSN3-1. INFN/CSN3 should conduct a critical evaluation of the scientific interest within the community for using LUNA3, considering the delay, and encourage external European (international) groups to use it.

CSN4 – Theory

INFN deserves great credit for the way it has steadily supported theoretical physics over the years. In this field the Italian school has long been one of the best in the world and it is important to foster this excellence. Every indicator this year testifies that this is the case: number of researchers, funding, number of publications and impact factor.

The field covered by CSN4 is large and extends far beyond the phenomenology directly related to INFN activities: string and field theory, particle phenomenology, hadronic and nuclear physics, mathematical methods, astroparticle physics and cosmology, statistical and applied field theory. This allows a healthy balance between more formal aspects that are important for the development of fundamental theories, phenomenology studies providing the theoretical framework to INFN activities, and applications of theory to other fields. This division into sectors is not static and one notes appropriate evolutions: increases in cosmology and astroparticle, decrease in nuclear theory, emergence of the field of gravity. Also the interactions with other CSN and an active participation in the What Next initiative, that we have praised in the past, continue to be promoted.

We welcome a slight increase in the women representation among national coordinators, a trend to be encouraged.

The theorists of CSN4 continue to be very active in training young researchers. The postdoctoral positions that they jointly advertise have a large number of highly qualified applicants that basically cover the whole spectrum, which ensures the excellence of the candidates selected. The information provided on the career path of past postdoctorals shows that, after a few years, a significant fraction of them finds a permanent position, except in Italy. The latter fact was to be expected, given the recent funding situation. One may expect a significant change with the new permanent position openings announced this year.

Similarly, the activity at GGI in Florence remains at the best international level. Some interesting ideas were informally presented at this meeting about giving a higher visibility to the Ph.D. training performed at GGI. We welcome this idea and expect a concrete proposal in this direction next year.

Recommendations: None

CSN5 – Technological and Interdisciplinary Research

CSN5 comprises three technical sections covering the most important fields of research in experimental physics. They are: Detectors, Electronics and Computing; Accelerators and Related Technologies; and Interdisciplinary Physics.

Several interesting projects were presented all of which are top of the state of the art, whether in developing novel detectors such as the ultra-fast silicon detectors (UFSD project, which was honoured by an ERC Advanced Grant), or in development of innovative solutions for charged-particle therapy (the RDH project) or in collaborating with European institutes on advanced technical projects. In particular, we noted the novel ELIMED project, in which CSN5 is

responsible for the design, development and installation of a transport beam line for laser-generated beams.

We observed positively that the mission statement is brief, descriptive and to the point, and that the structure and fields of activity of CSN5 are appropriate. The highlights of the technical research: Cosmic-Ray Calorimeter (CALOCUBE), CHIPIX65, MAGIX (Sextupole magnet) speak to the excellent technical expertise within CSN5. Furthermore, the response of CSN5 to the CVI recommendations has been more than adequate.

We wish to commend CSN5 on the continuous process of defragmentation and concentration, which is setting a good example within INFN, and acknowledge the healthy relationship of CSN5 with CSN1, CSN2 and CSN3. We clearly endorse these collaborations on their successes in calls for and financing/grants of projects, and note with admiration the fact that CSN5 receives external funds equivalent to its annual INFN base budget. Finally we congratulate CSN5 on its productivity in terms of publications and talks at conferences and its visibility nationally and on a European scale.

We look forward to continued and improved results of this successful strategy and its implementation.

Recommendations: None.

The Four National Laboratories and TIFPA.

General.

In recent years the size and complexity of INFN projects have continually increased, especially at LNGS but also at the other National Laboratories. At the same time, budget constraints, retirements, etc. have reduced the technical capability within the INFN complex. In recognition of these issues, in 2014 the President commissioned a comprehensive review and evaluation of the four national laboratories, chaired by Walter Scandale, a retired accelerator physicist, Gabriele Fioni of the CEA, and Roberto Saban, then head of the Engineering Department at CERN. We were very pleased to learn of this sweeping, proactive step on the way to making the INFN laboratories as good as they can be, and of the strong decisive actions of INFN in response to the review panel's recommendations.

The reviewers emphasised that INFN is a superb scientific institution, with outstanding scientists, technical staff and managers who do an excellent job of defining strategy and managing the budget. However, in this context they also concluded that the trends noted above had revealed several weaknesses and opportunities for improvement. They found:

- A proliferation of activities not linked to INFN priorities, and a disconnect between CSN and lab resources.
- No single laboratory has sufficient engineers and technicians to provide all the expertise needed for its programme and expectations. Laboratory resources are insufficient to support experiments over their lifetimes. Renovations and even maintenance are deferred till they become crises; No forum exists for discussing such problems.
- MOU's are not used to define responsibilities and manage projects.

- Project management and modern tools for QA, cost/schedule, etc. are lacking.
- Safety incidents and near misses at LNGS are of concern. They were handled correctly, but revealed the need for consolidations and upgrades of safety infrastructure and procedures.

Following the review, Roberto Saban was appointed to a new senior INFN management position, Technical Coordinator for the National Laboratories, with particular attention to LNGS. (No good deed goes unpunished!) Progress so far has been outstanding and will have a huge positive impact on INFN operations, In addition, each laboratory now has its own technical coordinator to serve as liaison with the experiments. In his few months at INFN Saban has already established a central INFN engineering office, with an access control system staffed by one professional from each lab, to integrate engineering, infrastructure, project management, and relations with experiments across the complex. They have set up a system for monitoring the technical capabilities within the labs, toward a common approach to reducing duplication and filling gaps. Recruiting top engineers has been difficult, but we are hopeful that new rules now in place will allow direct hiring of up to 10% of workforce without competition and at competitive salaries.

Recommendations:

NL-1. INFN should give the technical coordinator as much support as possible so the changes and improvements toward best practices can be implemented promptly, and report on progress at the 2017 CVI meeting.

NL-2. INFN should quickly establish MOU's for all significant experiments and projects, because having them in place will enforce priority decisions in allocating resources.

NL-3. INFN should produce a plan for regular equipment and infrastructure maintenance and renewal.

Laboratori Nazionali di Frascati (LNF)

LNF is the largest INFN National Laboratory with particle accelerators as its main specialty for more than 60 years. Last year's achievements have been numerous and important steps have been taken to establish the future programme of the laboratory. We now take note of some of the many highlights.

In accelerator-based science: DAFNE, an e^+e^- collider unique in Europe running at a centre of mass energy of 1.02 GeV to create phi mesons, has successfully concluded its Run 2 in 2016 with a record instantaneous luminosity of $2.2 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$. The KLOE2 detector acquired 2.4 fb^{-1} of good data. The plan to make the $e^-/e^+/\gamma$ Beam Test Facility (BTF) operational the whole year by doubling the beam lines has been approved. The construction of the PADME experiment reusing L3 BGO crystals to search for dark sector photons has started. A new pulser for the LINAC was tested proving the feasibility of a six-fold increase in the electron beam intensity.

SPARC_LAB, a flagship new initiative for R&D for new particle acceleration techniques, began deployment of a new LINAC configuration, started the characterisation of a plasma cell and other activities, carried out studies with Target Normal Sheath Acceleration (particles emitted by laser impact on targets) and obtained interesting results with the THz line (experiments on topological insulators, the subject of 2016 Nobel in Physics).

LNF is also an important support lab, where the construction of Phase 1 upgrades to the LHC detectors is in full swing at LHF's local facilities. Partially to this end, the research division has reorganised its technical support into three services to better address the full spectrum of the laboratory activities. LNF also offers a broad outreach programme to students, public and teachers.

We were charged to comment on progress and any remaining concerns one year after the new management took over the leadership of LNF.

- We are very pleased there is now a sound plan to conclude the physics programme of the DAFNE collider and concurrently upgrade and exploit the BTF facility. KLOE2 should complete data-taking acquiring 5 fb^{-1} of data during 2017. We support the PADME installation and data-taking in 2018/2019. Siddharta-2 should also be given the opportunity to collect 1 fb^{-1} of data by the end of the collider mode in 2019. Schedules are tight and should be flexible to maximise the use of the machine time. We support LNF management in its efforts to explore a potential future for DAFNE as an accelerator test-bed facility, making use of its specific features: positrons and high currents.
- We note the progress in the development of the SPARC_LAB infrastructure as a significant research and user facility for plasma-based acceleration. Last year featured good advancement in its activities. We support strongly the long-term plan to propose SPARC_LAB as a possible site of EuPraxia, the design study for a European centre for a plasma-based compact FEL. It fits well with SPARC_LAB's expertise and the candidacy can potentially be very strong. The management has submitted a proposal to INFN for a collaboration between various Italian institutions EUSPARC to prepare a bid by 2019. This is challenging in many aspects including the construction of a new bunker, gathering regional financial support, lobbying for international support to the project, all of this within a tight schedule.
- The delays in construction of the ELI-NP facility in Romania, largely due to factors beyond LNF's control, are of concern, because they impact the three-year schedule for commissioning and installation, which in turn affects the planning of the involved LNF expert manpower.
- It is appropriate for LNF to act as a hub for detector construction to best exploit existing facilities. A good case coming up is detector construction for the LHC phase 2 upgrade. Joint planning with CSN1 should take place very soon, and contacts with other CSNs are also encouraged. One should weight overall the pros/cons of local infrastructure in various institutions versus few very high standard installations.
- The management tried fostering more coherence between the CSNs research activities at LNF with limited success so far. The CVI believes that it is important to pursue this goal.

In conclusion, there are many interesting and ambitious ideas for the short and long term future of LNF. However, such a broad programme can only be successful if the laboratory maintains a highly competent staff covering a wide range of competences and maintains facilities with top-level equipment. The required resources in equipment, personnel and financial resources, have to be identified. In that context, we underline the worries related to the overall decrease in personnel, increasing rate of retirements among experts, and large fraction of short-term contracts financed by current projects. We applaud and support the LNF administration in its effort to prioritise activities and reorganise the management to face inadequate and/or imbalanced resources.

Recommendation:

LNF-I. The laboratory should devise a detailed sustainable plan for its new programme, including identified resources from INFN and possibly external funds, and present it to the CVI at our 2017 meeting.

Laboratori Nazionali del Gran Sasso (LNGS)

LNGS continues to shine as a jewel of INFN science. The broad range of experiments is world leading, and the experiments in preparation and discussion should keep LNGS at the forefront of underground science. On a budget of ~13M€ the laboratory and its staff of 100 support well over 1000 users, one quarter of whom are working there on any given day, while many others are off site analysing data or preparing new experiments. By any measure this is a remarkably efficient use of resources and we congratulate the laboratory for this achievement.

The LNGS experiments, emphasising neutrino physics, neutrinoless $\beta\beta$ decay, searches for dark matter, and other activities requiring a low-background environment, have been discussed in detail in the CSN2 section above, so in this section we shall focus on programmatic and strategic issues. An important meeting was held in April 2015 to launch “LNGS – 2020 and Beyond,” a framework for selecting future experiments and performing the necessary R&D. A subsequent call for requests for resources confirmed that the demand for space underground and for other resources exceeds what is available, so setting priorities is a central element. Preliminary priorities include Xenon 1T, CUORE, SOX, LUNA-MV, and DarkSide -20K, and an ultra-low-background facility to test materials for 3rd generation experiments. Longer term, LNGS and SNOLAB are leading a world effort among underground laboratories to define and implement best practices. We strongly support this effort.

LNGS plays a most important role in supporting the Abruzzo region. It is a hub for innovation, internally and in Tech Transfer partnerships with regional enterprises, and serves as a major centre for outreach and education attracting 8000 visitors/year. The symbiosis between LNGS and GSSI brings more intellectual power to the laboratory as students and postdoctoral scientists take advantage of the proximity of GSSI to the laboratory (not unlike the privileged position of the University of Chicago to Fermilab so valuable to both institutions). On a disturbing note, however, visits by students and other classes of the public may have to be discontinued because of concern for underground safety. We hope that the relevant authorities can find a way to sustain this important and popular outreach activity.

With so much and so varied activity, involving large detectors and complex relationships with other INFN institutions and external entities, it is not surprising that improvements in laboratory management are required to implement experiments and projects, and operate them safely and efficiently. Safety in particular remains a significant concern. As described above, the new office of Technical Coordinator for the National Laboratories is now in place, and is making excellent progress in addressing the issues revealed in the recent review. We look forward to receiving a progress report at the 2017 meeting.

Recommendations:

LNGS-1. The laboratory and INFN should give high priority to improving the management of projects and operations, working with the Technical Coordinator office to optimise resources throughout the INFN complex.

LNGS-2. LNGS should establish detailed MOU’s and associated confidential “money matrices” for new projects, to make sure that the financial, technical and human resources are available to complete the projects on schedule.

LNGS-3. Do everything possible to find a protocol by which student visits to LNGS can be conducted safely.

Laboratori Nazionali del Sud (LNS)

The LNS programme continues with a well-defined strategy, with strong leadership from its senior management. As was discussed in the section on CSN2, the realisation of KM3Net is of the highest priority for LNS. The project is making progress and the initial stages of funding are secured, and the problems are being addressed proactively. On the Nuclear Physics and Nuclear and Particle Astrophysics fronts, the directorate expressed optimism on obtaining the funding for the upgrade of the K800 superconducting Cyclotron, which is designed to increase the present beam intensity by a factor 100, essential for the NUMEN project to measure very small cross sections. The increased intensity could also be advantageous to the other nuclear physics programmes using beams of exotic nuclei produced by fragmentation of stable beams at the facility FRIBS@LNS, as well as to nuclear physics applications.

We acknowledge the steps taken following our recommendation of last year to CSN-3: “INFN should make sure there is strong collaboration among nuclear-structure theorists and nuclear-reaction theorists in the NUMEN programme”. In particular, theoretical collaboration with Prof Horst Lenske, an expert in the field, will help setting the theoretical basis for the reaction mechanism of double charge-exchange reactions and clarify the analogy to 2β decay. The available codes written by Lenske could be readily used in DWBA. The development of a coupled-channels approach is desirable and is being addressed now. The CVI is very satisfied with these steps taken to collaborate with Prof Lenske and with the theory groups of the universities of Genoa and Naples who follow different theoretical approaches.

Recommendation:

LNS-1. INFN should help LNS implement its plans to upgrade the K800 cyclotron.

Laboratori Nazionale di Legnaro (LNL)

We learnt of the 2-year delay of SPES during the meeting for the first time. Mitigating this problem and reversing delays if possible are of the utmost urgency considering the observation of the Panel for Evaluation of the Four National Labs: “The panel noted the absence of project management methodologies and of modern tools for the follow-up of progress, manpower, competences, expenditure (e.g., EVM), quality assurance and cost and schedule reviews.” In spite of the delays the scientific programme with radioactive beams would be highly relevant if the laboratory is able to complete the project efficiently.

Recommendation:

LNL-1. Clear organisational steps should be taken under the supervision of the technical coordinator to mitigate management problems, and thereby reverse delays wherever possible.

Trento Institute for Fundamental Physics and Applications (TIFPA)

Last year, we recommended that INFN should continue its strong support for TIFPA, and take steps to remedy the severe shortage of personnel to prevent damage to TIFPA programmes. During the year that followed, the structure of TIFPA was settled with clear management, administrative, technical, research and technological research lines. TIFPA has made a lot of progress since last year by acquiring internal and external resources to build up its infrastructure and pursue different

technical and scientific projects. It was also able to attract fixed-term personnel from different sources of funding to carry on these projects. We were pleased to learn that one staff position of “technologist” is open, that INFN has supported TIFPA with three postdoctoral positions, and that a special call for researchers from foreign countries is pending. Unfortunately, there are still no new permanent staff next to the Director, but nevertheless, our recommendation of last year, that TIFPA should be strongly supported, still stands.

Recommendation:

TIFPA-1. INFN should strongly support TIFPA in its effort to build staff and secure resources.

Technology Transfer

In the last year INFN proved to have taken very seriously CVI’s suggestions. The reorganisation to strengthen the TT group has been completed, and new rules for IP management are in place. Also, great attention was paid to further develop the collaboration with other research centres and infrastructures, at the national and international level. We consider particularly relevant the action taken to start mapping the TT activities and results, an action that has to be reinforced and become structural.

We are impressed by the great effort dedicated to develop collaborations with industrial networks and regional and national technological clusters – an aspect that was clearly recommended in the last report. Considerable steps forward were made, so attention must now focus on exploring opportunities to develop common R&D projects. We strongly encourage INFN to continue and further develop collaborations with enterprises in general, with particular attention to those that can be developed within the experiments and the construction of infrastructures (i.e. through a wider collaboration with enterprises' organisations.)

We request that a more complete description of these collaborations and the actions taken to develop them (direct and within the experiments) be included in next year’s report.

Considering the INFN activity in training of graduate students and young researchers and the new status of GSSI, we suggest that the TT group should explore the possibility to activate an industrial PhD programme in collaboration with enterprises (i.e. within the national technology clusters or within specific collaborations).

Recommendations:

TT 1. INFN should further develop collaborations with enterprises in general, with particular attention to collaborations that can be developed within the experiments and the construction of infrastructures.

TT 2. INFN should explore the possibility to activate an industrial PhD programme in collaboration with enterprises.

Communication, Outreach and “Third mission”

We have been deeply impressed by the amount of outreaching and dissemination activities put in place by INFN in the last year. We applaud the way INFN has managed the mission of disseminating scientific culture by understanding the importance of scientific dissemination, and

how it has put in place a dedicated structure in such a short time. All the premises built in the past and positively commented in the 2015 Report have been fruitfully enacted, enabling INFN to organise an impressive number of outreach events. Moreover, all the suggested recommendations from last year have been duly considered. The Communication Office has actively played the role of central actor of INFN outreach, supporting the initiatives promoted by local Units and National Labs. A fundamental activity has been training INFN researchers on communication in science.

Important progress has also been made in recording, classifying and measuring the impact of outreach activities of this federative organisation, not an easy task. However it is a necessary step, also to answer to the growing requests of accountability of the “Third mission” coming from the National Agency of Research and University Evaluation (ANVUR). Equally important is the promotion of continuous Education, particularly devoted to high school teachers, and directed to familiarising pupils with physical science.

A source of concern comes from the decision, taken after an accident in the Roma-L’Aquila highway, to stop student visits to LNGS. The communication impact of LNGS is fundamental, and we hope that new emergency plans can make possible to re-open the laboratory to student visits.

This event raises a more general issue. All laboratories are effective showcases for the science produced by INFN, and visits of schools to laboratories are an important way to approach young generations. The opening of laboratories to a public wider than researchers and professionals requires the adoption of a systematic approach to emergency plans and dedicated structures for external visitors.

Recommendation:

Outreach – 1. INFN should study how to make laboratories more adequate for hosting a growing number of non-professional visitors.

2016 CVI Meeting

from Monday, 10 October 2016 at **09:00** to Tuesday, 11 October 2016 at **17:30** (Europe/Rome)
at **INFN Structure in Turin (Sala Wataghin)**

Via P. Giuria, 1 Turin

Material [Paper](#)  [agenda](#)  [document](#)  [more information](#) 

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Monday, 10 October 2016

09:00 - 17:30

First day

*All presentations are assumed to be 15', followed by 45' discussion
All CSN talks should begin with response to CVI recommendations*

09:00 **Brief introduction and charge to CVI 30'**

Speakers: Fernando Ferroni, Stewart Smith

Material: [Slides](#) 

09:30 **INFN Response to CVI recommendations and requests for information 30'**

Speaker: Speranza Falciano (ROMA1)

Material: [Slides](#) 

10:00 **INFN administrative infrastructure, present and prospect 1h0'**

Speaker: Bruno Albino Alain Quarta (AC)

Material: [Slides](#) 

11:00 **Coffee Break 30'**

11:30 **An evaluation of the four National Labs 1h0'**

Speaker: Roberto Saban (PRESID)

Material: [Slides](#)  

12:30 **CSN1 1h0'**

Speaker: Nadia Pastrone (TO)

Material: [Slides](#)  

13:30 **Lunch - CVI in Closed Session 1h30'**

15:00 **CSN3 1h0'**

Speaker: Mauro Gino Taiuti (GE)

Material: [Slides](#)    [document](#) 

16:00 **Coffee Break 30'**

16:30 **CSN4 1h0'**

Speaker: Alberto Lerda (TO)

Material: [Slides](#) 

17:30 - 19:00

Closed Session

17:30 **CVI Closed Session 1h30'**

Tuesday, 11 October 2016

09:00 - 17:30

Second day

*All presentations are assumed to be 15', followed by 45' discussion
All CSN talks should begin with response to CVI recommendations*

09:00 **CSN2 1h0'**

Speaker: Marco Pallavicini (GE)

Material: [Slides](#) 

10:00 **CSN5 1h0'**

Speaker: Valter Bonvicini (TS)

Material: [Slides](#)  

11:00 **Coffee Break** 30'

11:30 **LNGS** 1h0'

Speaker: Stefano Ragazzi (LNGS)

Material: [Slides](#)  

12:30 **The INFN Cultural Heritage Network** 1h0'

Speaker: Francesco Taccetti (FI)

Material: [Slides](#) 

13:30 **Lunch - CVI in Closed Session** 1h30'

15:00 **LNF. Present and Future** 1h0'

Speaker: Pierluigi Campana (LNF)

Material: [Slides](#) 

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16:00 **Break - then CVI meets in Closed Session for report/hearing** 1h30'

Appendix II. Recommendations

General-1. INFN should monitor the reasons for the choices of institutes made by the winners of the competition for academic positions, and anticipate the long-term impact.

Mgmt-1. INFN should consider treating and managing the reconfiguration of its administration as a project.

Mgmt-2. The administrative reorganisation should focus first upon “low hanging fruit,” to realise quick improvements, and remediate urgent problems and weaknesses, and thereby to gain support for future actions. Obvious examples are administrative IP systems; the federalisation of INFN resources, e.g. engineers, to avoid duplication and optimise the breadth of expertise; and project Management.

Mgmt-3. INFN should explore possibilities for collaboration with other institutions in reforming and optimising the administrations.

CSN1-1. INFN should make sure now that the infrastructure and other resources required will be available for constructing the Phase-2 upgrades to CMS and ATLAS, since formal TDR commitments will be taken in 2017. This should be done in close contact with other relevant CSNs and laboratories.

CSN1-2. Increase efficiency by pursuing useful synergies with the other INFN CSNs, National Laboratories, in concert with the new Technical Coordination office.

CSN2-1. INFN should follow the presented strategy of LNGS, including the future projects SABRE, Darkside-20 and CUPID. Keep the high priority for Borexino and LUNA since the portfolio of LNGS must include experiment guaranteeing “positive” results rather than only upper limits.

CSN3-1. INFN/CSN3 should conduct a critical evaluation of the scientific interest within the community for using LUNA3, considering the delay, and encourage external European (international) groups to use it.

NL-1. INFN should give the technical coordinator as much support as possible so the changes and improvements toward best practices can be implemented promptly, and report on progress at the 2017 CVI meeting.

NL-2. INFN should quickly establish MOU’s for all significant experiments and projects, because having them in place will enforce priority decisions in allocating resources.

NL-3. INFN should produce a plan for regular equipment and infrastructure maintenance and renewal.

LNF-1. The laboratory should devise a detailed sustainable plan for its new programme, including identified resources from INFN and possibly external funds, and present it to the CVI at our 2017 meeting.

LNGS-1. The laboratory and INFN should give high priority to improving the management of projects and operations, working with the Technical Coordinator office to optimise resources throughout the INFN complex.

LNGS-2. LNGS should establish detailed MOU's and associated confidential "money matrices" for new projects, to make sure that the financial, technical and human resources are available to complete the projects on schedule.

LNGS-3. Do everything possible to find a protocol by which student visits to LNGS can be conducted safely.

LNS-1. INFN should help LNS implement its plans to upgrade the K800 cyclotron.

LNL-1. Clear organisational steps should be taken under the supervision of the technical coordinator to mitigate management problems, and thereby reverse delays wherever possible.

TIFPA-1. INFN should strongly support TIFPA in its effort to build staff and secure resources.

TT 1. INFN should further develop collaborations with enterprises in general, with particular attention to collaborations that can be developed within the experiments and the construction of infrastructures.

TT 2. INFN should explore the possibility to activate an industrial PhD programme in collaboration with enterprises.

Outreach – 1. INFN should study how to make laboratories more adequate for hosting a growing number of non-professional visitors.

Appendix III: Requests and suggestions for next year's report.

At the request of INFN we have put together below a set of suggestions and requests for information to aid the GLV in preparing its 2017 report. These items may also be useful in choosing topics for the 2017 CVI meeting.

1. Please include in the report an expression of INFN's overall strategic view.
2. Please include INFN's response to each of the recommendations in Appendix II; e.g., actions taken, work in progress.
3. We would like to receive a progress report from the Technical Coordinator for the Four National Laboratories.
4. We request that a more complete description of INFN's collaborations on Tech Transfer with industry and the actions taken to develop them (direct and within the experiments) be included in next year's report.
5. We suggest INFN to try an exercise of "competitive assessment" of its more risky or questionable experiments. The exercise should be aimed at ranking these experiments with competitive ones, both to assess the chances of winning the race, given the resources and steps already done by competitors, and to check if and where there is room for complementarities.
6. For the National Laboratories, particularly LNF but also LNS and LNL, we would like status reports on their strategic plans, programme priorities, and their integration with the programmes and priorities of the CSN's. Conversely each CSN section report should indicate, where relevant, how its programmes are integrated with LNF and/or other national laboratories.
7. It would help us in our evaluation of the National Laboratories if their reports could follow a more standard format, as is now the case for the CSNs.
8. We need to free up more time for the committee in camera. Limiting presentations to 15 minutes instead of the current 20 minutes would help a lot. The committee members will have read the report, so the presentations should focus on the main issues. Finally, INFN managers should plan on staying until 1800 on the second day of the meeting.