INFN CVI Report 2008

Conclusions of the CVI Meeting on 9-11 July 2008

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Executive Summary, Recommendations, and overall Conclusion

The CVI met on 9-11 July 2008 to evaluate the INFN activities in 2007, focusing on the scientific and technical activities as well as their socio-economical impact.

A new element of this years review was the visit to Laboratori Nazionali di Frascati (LNF), as the first in a series of visits to the INFN National Laboratories. The goal of these visits is to obtain a better understanding of the capabilities and perspectives of the National Laboratories.

The CVI heard presentations covering the entire range of activities of INFN and the situation with respect to resources. Before the meeting the report 'INFN Scientific Productivity and its socio-economic and inter-disciplinary impact' for the year 2007 was distributed to the committee, providing a broad and valuable overview.

The CVI came to the conclusion that the **impact of the scientific program of INFN continues to be both broad and at a very high level, visible on a world scale.** A new generation of very important experiments is either coming on line or successfully taking data. This is the prerequisite for INFN to remain strong in the European context. In addition, INFN is pursuing successfully a systematic approach to the technology transfer process and outreach.

The President informed the CVI about the financial development: Funding for INFN has been decreasing between 2002 and 2007 by more than 10%. This budget trend differs significantly from that in other European countries where more money is being put into science. **The CVI considers the continuous budget decrease to be a serious threat for the future of the INFN science programme, its outstanding quality, and the training of young people.** The present level of funding is such that big new projects can no longer be funded from the base budget, but need substantial additional resources from the outside. In case the budget cuts should continue, INFN will need a strategy on how to move forward and how to set priorities across the borders of the present research areas. **The CVI encourages the INFN President to take all possible steps to recover the research budget.**

INFN is making all efforts to receive a stronger support by the regions and increasing funds from European programs. **The CVI encourages INFN to pursue this further.**

Last year the CVI was pleased to learn that the government had formally approved the INFN program to provide permanent positions for researchers and technicians as this was easing a critical development endangering the career options for young researchers. In June 2008 the Italian Government

decided to apply a personnel cut of 10% in the entire public sector and to not allow making staff on temporary positions permanently employed. **This decision, if enacted, would seriously endanger the future of science in Italy.**

One of the particular strengths of INFN has always been that it is strongly embedded in the Italian universities. **The CVI recommends that INFN explores possible models to continue a further strengthening of its links to the universities.**

In view of the long time scales and size of future projects the CVI recommends that the INFN Executive Board and the Scientific Committees **prepare a strategy for INFN as a whole,** including the National Laboratories, which is **linked into the European strategies** in the different scientific areas and to **implement an adequate review process** for this strategy.

The CVI expresses its appreciation of the excellent leadership of the President and the Executive Board and **supports the management in the actions taken, especially concerning the overarching strategy and its evaluation, as well as the upgrade of the management rules.**

Status and achievements of INFN

The 2007 INFN Status and Perspectives

In his presentation the President focused on a number of developments during the past year. He presented the scientific highlights and status of the work from the different research areas (CSN's) which are discussed below. He presented in addition the major projects on the INFN road map: Super-B, Nemo, LNGS, and SPES.

Of these SuperB is the most expensive and challenging project. The CVI took note of the R&D work, the possible implementation plan and the funding scenario, but did not make any recommendation as a number of reviews of this project is presently being performed. It supported the management however in the steps taken towards a possible realisation of a SuperB factory.

All major new projects can only be realised with specific financial support from the government, the regions and other partners.

In his presentation the President described the status of the financial and personnel resources. He underlined the continuing decrease in funding and stressed the dramatic consequences this has on the competitiveness of INFN research. He also reported on recent decisions of the Government imposing severe cuts in the personnel.

The INFN Executive Board is working on upgrading the management rules in order to focus the activities of the Consiglio Direttivo more on strategy, budget and personnel and to delegate some responsibility for the day to day business to the Executive Board.

On a final note the President informed the CVI that he intends to give more responsibility to younger staff in order to broaden the age profile for leadership positions.

Experimental sub-nuclear physics with accelerators-CSN 1

In fall of 2008 the LHC will start operation after 15 years of conception, design, production and installation of the accelerator and the detectors. This is a major accomplishment and a huge success for the LHC community and for INFN who has made first quality contributions to Atlas, CMS, LHCb and Alice (see section on CSN 3). Italy also contributes to the smaller experiments, Totem and LHCf. The computing centre in Bologna is operational and, as one of the eleven Tier 1 centre, an important part of the LHC Grid. The Italian involvement in the detector construction and commissioning, the software development and the preparation for physics analysis has been outstanding for

many years. The CVI congratulated the Italian physics community as well as the INFN management for the importance and excellence of the many crucial contributions to the successful completion and start-up of the LHC experiments.

The Italian community, with close to 500 FTE engaged in the LHC experiments, is the largest among the CERN member states (Italy's financial contribution to CERN is the fourth largest among the member states). Italian physicists hold many key positions in the LHC collaborations. However, the strong involvement in the detectors construction and commissioning could render a rapid conversion towards the highly competitive field of physics analysis difficult. A proper recognition of the efforts from physicists with a longstanding dedication to the detector and software development is mandatory. Many initiatives have been taken to build up an Italian community involved in the analysis preparation, including around 60 PhD students and leading to a "Physics Task Force" in collaboration with theorists. It is of prime importance for the INFN management to help maximize the scientific return from the LHC experiments in all aspects, to continuously favour the excellence in its various contributions and coordinate the ongoing efforts as well as to sketch possible participation in LHC upgrades or future experiments.

- The participation in the CDF collaboration at the Tevatron comprises an important and well implemented Italian contribution of about 50 physicists. The data taking at the Tevatron may be extended in 2010, essentially motivated by the search of the Higgs boson. This participation is a great opportunity to remain at the forefront of the newest analysis techniques used in hadron collider environments. The arrival of highly trained CDF physicists (but also those from other experiments) at the LHC will certainly strengthen Italy's contribution to new physics results and possible discoveries. Continuously favouring the contacts and membership in both CDF and a LHC-collaboration may ease the insertion of the CDF physicists.

Currently a number of programs are in their final phase of data analysis producing legacy measurements from their entire data sets taken, which are very valuable, not only as input to the LHC. COMPASS provided a new measurement of $\Delta G/G$. The ZEUS experiment at DESY is finalizing the structure functions measurements and increasing the precision on the parton density functions combining their data with the sister experiments H1. These results are crucial for any precision physics at hadron colliders. The transition of physicists from HERA to the LHC experiments has been successfully achieved without hampering the final HERA analysis.

Heavy flavour physics and CP violation in the quark sector is a strong field among the INFN activities. The results from the BABAR experiment at SLAC, determining the parameters of the CKM matrix, in hadron spectroscopy and

charm physics are outstanding. BABAR ended data taking several months earlier than planned due to budget restrictions imposed by the American congress, despite the strong support from the international community. The NA48 experiment at CERN is also preparing its final results and the follow-up experiment NA62 has been approved by the SPSC, however without being fully founded yet. The latest physics results from KLOE demonstrated impressively the high accuracy of the V_{us} and the K_S, K_L and $K^{+/-}$ measurements.

Besides LHCb, the future participation in projects in the sector of heavy quark physics will depend on the outcome of the review process of the Super-B factory, both on the technical feasibility, the physics case and the national and international acceptance and support. The first report from the International Review Committee has been very positive. INFN has taken the right initiatives to evaluate the project and to probe the possibility for setting up an international collaboration. In this context, the Super-B factory needs also to be evaluated with respect to its place and impact on the worldwide landscape of colliders for particle physics. Within the next year it can be expected that the technical feasibility of the project will be fully appreciated, for which an International Machine Advisory Committee has been put in place. A possible start of a Super-B factory around 2015 would require the INFN management to take a decision in about one year.

With the LHC start-up, the activities of CSN 1 will essentially be centred at CERN. The only new project outside CERN taking data will be MEG at PSI, involving 19 physicists. Therefore the evaluation of the possibilities of a Super-B factory are very important, as well as the participation in the upgrades for sLHC and the R&D efforts for ILC. However, it is difficult to participate in these long-term projects considering the current budget situation. It is essential to pursue the elaboration of strategies for the mid and long-term activities of CSN 1 taking into account all possible scenarios and to be able to continue to prepare the necessary technological developments. The possible discoveries to come in the next years at the LHC may change substantially the physics landscape and clarify the choices for the future. However it is essential to be able to respond and to actively prepare future options.

Experimental Astroparticle and Neutrino Physics-CSN 2

CSN 2 includes astroparticle physics and neutrinos. It is an area where the INFN has maintained a strong presence and where it leads internationally in some sectors, particularly because of the existence of the Gran Sasso National Laboratory (LNGS). For this reason some of the experiments taking place in Italy have a significant international participation.

The experiments in which the INFN is involved are the same as last year, when there was some consolidation. During 2007 and continuing in 2008 a number of experiments are entering a new phase, in that they are starting to take data and are expected to produce significant results. Indeed, this has already happened.

The INFN has a strong presence in the ongoing preparation of the European Roadmap for astroparticle physics promoted by ApPEC. Internationally the field is maturing and it is likely to evolve to a situation in which there would be a smaller number of experiments but considerably larger than at present. In this situation some of the activities would likely need to be discontinued in order to concentrate the resources in some experiments. In the present severe budgetary situation an analysis of the main cost drivers of the programme should be done, in order to see if economies are possible.

The CSN 2 activities are grouped in six sectors: neutrino physics; search for rare processes; cosmic rays on earth; cosmic rays in space; gravitational waves; and general physics.

Neutrino Physics: Neutrino physics (25% of the budget) includes two main lines: the CNGS (CERN to Gran Sasso) neutrino project, aiming at the explicit detection of the oscillation of muon to tau neutrinos, and the BOREX experiment (formerly BOREXINO) intended for the study of the particularly interesting Berylium-7 solar neutrinos.

In the CNGS the OPERA experiment performed correctly in a short run in October 2007 which had to be interrupted because of a problem with the neutrino production target at CERN. The run will resume in the summer of 2008 with OPERA fully installed. The ICARUS T600, pioneering the use of the Liquid Argon TPC technique, is expected to be installed in the fall of 2008.

BOREX started data taking in May of 2007 and is operating correctly, with background levels better than expected. Some results on solar neutrinos have already been published. Also the MARE experiment aims at the direct determination of the neutrino mass with a new method.

Search for Rare Processes: Three main areas of research are being pursued in this sector (23% of the budget):

(a) Neutrinoless Double Beta Decay. The INFN participates in two major experiments at the Gran Sasso, both with large international participation and now proceeding smoothly in the construction phase: CUORE (using cryogenic bolometers) and GERDA (Germanium crystals inside a Liquid Argon bath). Both have a large international participation. A predecessor of CUORE, CUORICINO, has been taking data since 2003.

(b) Direct Dark Matter Searches. An experiment at the LNGS, DAMA, lead by INFN scientists, did claim a positive observation of dark matter particles in its first phase. The experiment detects an annual modulation of the signal,

consisting of flashes of light presumably produced by the dark matter particles colliding with the target nuclei of the NaI crystals of the detector. A second phase of the experiment DAMA/LIBRA, with a larger mass, has released new data in April 2008 in which the signal is confirmed. This is a major result which remains controversial, since other experiments do not see the expected signal with other techniques. But the target material and the signals observed are different from those of DAMA, which makes it impossible to reach a definite conclusion. Ideally the DAMA experiment should be repeated independently, if possible in a different location.

Another experiment is WARP, (Argon TPC), in preparation. A 2.3 liter prototype of WARP has been successfully operated.

(c) Supernovae (SN) neutrinos. The LVD detector has been operating successfully at the Gran Sasso since 1992.

Cosmic Rays on Earth: This sector (16% of the budget) comprises the study of cosmic neutrinos with underwater telescopes and the study of gamma and charged cosmic rays with ground and space detectors.

ANTARES and NEMO are underwater neutrino projects. ANTARES (0.2 km^2, 12 strings) and has recently been completed. Both projects are demonstrator experiments for a future 1 km^3 neutrino telescope being designed in the context of the EU funded KM3Net design study.

AUGER (highest energy charged cosmic rays) is now almost completed in Argentine and has produced a very significant result indicating for the first time a correlation of the very high energy cosmic rays with Active Galactic Nuclei. The ARGO (INFN-China collaboration in Tibet) installation is proceeding smoothly.

The MAGIC telescope (study of cosmic gamma rays with low threshold) is now producing a large number of interesting results, including the discovery of several new sources as well as the detection of the most-distant source emitting at energies above 50 GeV. MAGIC-II, a second telescope, is almost completed and will become operational in 2008.

Cosmic Rays in Space: This sector amounts to 17% of the budget. AGILE, a small satellite for gamma-ray astronomy was launched in April of 2007 and is now taking data. PAMELA, launched in 2006, is also continuing data taking. AMS2, a magnetic spectrometer planned for the Space Station, is being integrated to be ready in 2009 but it is not yet guaranteed that a flight in the Space Shuttle will be available.

GLAST (now named Fermi), a major satellite for gamma-ray astronomy with an area 100 times that of the very successful EGRET predecessor, has been launched in 2008 and is likely to have a large impact in the field.

Gravitational Waves: The field of gravitational waves accounts for 10% of the CSN2 budget. The VIRGO interferometer located near Pisa (French-Italian collaboration) has almost reached the design specifications and it is the best in the world at low frequencies. It now operates in coincidence with the LIGO interferometers in the US. Both groups are working together in VIRGO+, an upgrade of VIRGO, and in an enhanced LIGO.

At present the INFN also maintains the operation of three resonant bar detectors which monitor the galaxy: AURIGA, EXPLORER and NAUTILUS.

General physics: In this sector (3% of the budget) a number of small experiments, focusing on fundamental physics, such as the test of the equivalence principle, the measurement of G and of Newton's law at short distances, the dynamical Casimir effect and others, are also being performed. The anomalous photon magnetic-field effect, claimed by PVLAS, has now been withdrawn by the collaboration.

In conclusion, the INFN has maintained a very competitive program in the field of astroparticle physics and neutrinos, which has entered the phase of producing results. It is also participating actively in several European initiatives promoted by ApPEC, which will result in a road map for the field in Europe. Based on this roadmap, the consolidation process of the program should continue.

Experimental nuclear physics-CSN 3

INFN activities in experimental nuclear physics continue to have four lines of research.

Structure and dynamics of hadrons: The experiment HERMES SIDIS (semi-inclusive deep inelastic scattering) has been concluded and has produced useful information for the future program at CERN-LHC-ALICE. The experiment AIACE (photo-production of two mesons) is of interest in the study of the structure of hadrons in the range up to 1.5 GeV and can produce important information on the existence of multi-quark states. The experiment FINUDA at LNF studies hypernuclear spectroscopy and is of importance in the determination of the hyperon-nucleon interaction. The future of this line of research is, on one side, the INFN participation in the program with antiproton beams at GSI-FAIR and, on the other side, in the development of the Laboratori Nazionali di Frascati (LNF).

Matter at high density and temperature: INFN programs in this area are centred on the development of the detector ALICE at CERN-LHC. The detector is

almost completed. The discovery potential of this detector is very high. INFN participates with 20% to ALICE. Results in this area must wait until LHC is completed and the first experiment with ALICE is run.

Structure and dynamics of nuclei: This is the main part of the research program of INFN in experimental nuclear physics and is centred at the two National Laboratories LNL and LNS. Four experiments were presented. The GAMMA experiment is being performed at LNL in collaboration with GSI and GANIL. Its goal is the study of nuclear structure under extreme conditions (large angular momentum, large excitation energy and large proton-neutron asymmetry). Experiments with the PRISMA magnetic spectrometer in conjunction with the CLARA array at LNL have produced interesting results probing the shell structure of nuclei. Experiments with the MAGNEX magnetic spectrometer in conjunction with EXOTIC at LNS have produced also interesting results, especially in the production of weakly bound states and resonances. Two other experiments were presented: NUCLEX at LNL studying nuclear structure at finite temperature, and ISOSPIN at LNS devoted to the proton-neutron dependence of the liquid-gas phase transition in nuclei. All of these have received considerable international attention.

The future of the two *national laboratories* was also discussed.

The future of LNL is centred on the project SPES (production of radioactive beams of second generation). This project has been changed from earlier formulations. The production of radioactive species is now with proton beams directly on a thin target. Because of budget constraints the project has not been funded yet. INFN will re-evaluate this project in fall 2008. However, timing is essential here, since the larger and competing GANIL-SPIRAL2 project in France is under way and is projected to deliver the first radioactive beams by 2013. The window of opportunity of SPES will shrink considerably after 2013.

The future of LNS was not discussed at this meeting. In a previous meeting, it was indicated that it laid in medical physics without long term commitments in structure and dynamics of nuclei. The CVI feels that medical physics alone cannot sustain the laboratory.

Nuclear Astrophysics: The nuclear astrophysics program of INFN has several aspects and is carried out at LNS and LNGS. At LNS-EXCYT, experiments have been performed related to big-bang nucleosynthesis (ASFIN). At LNGS reactions of astrophysical interest have been performed (LUNA). These activities have also received considerable international recognition.

In addition, the program n-TOF at CERN was presented. This program measures neutron-capture cross sections on the actinide nuclei and is of interest for nuclear energy generation at reactors and for transmutation of nuclear species.

The overall evaluation of the INFN research program in experimental nuclear physics is very good and in many cases excellent. Its program is broad and at the same time of very high quality. The only point of concern of the CVI is the future of the National Laboratories. Because of decreasing budgets, National Laboratories cannot develop new large projects unless additional funds are obtained from outside sources. The loss of the National Laboratories would be a major drawback in the scientific infrastructure of Italy. This is in obvious contrast to the scientific policy of other European countries, most notably Germany and France where major project in this area are under way (FAIR at GSI and SPIRAL2 at GANIL).

The CVI also encourages INFN to establish a National Scientific Committee that can develop a common strategy for all National Laboratories.

Theoretical physics-CSN 4

INFN continues to play a key role for Theoretical Physics in Italy. It covers areas such as Theoretical Particle Physics, Theoretical Nuclear Physics, Mathematical Physics and Statistical Physics. In these areas essentially all groups with a significant scientific activity are financed by INFN.

The large majority of Theoretical Physics groups supported by INFN belong to the Universities and the senior researchers are University Professors. INFN has very few senior theorists on its own payroll. The INFN support covers running expenses, computing facilities, travel money, organisation of Schools, Workshops and Conferences, as well as student and postdoctoral fellowships and some junior positions. Without INFN support Theoretical Physics in Italy would not be possible.

Among the groups supported by INFN several are of world class. In Theoretical Particle Physics Italy has a leading role in Europe and many Italian theorists are holding senior positions at CERN as well as many European and American Universities. In Statistical Physics, and especially the Physics of disordered systems, the Italian School is probably the best worldwide.

The CVI worries about the consequences of the freezing of positions, both in INFN and the Universities. Italy, thanks to INFN, has an outstanding record in training young scientists. If some of them cannot find adequate positions in Italy for several years, the entire scientific program will be in danger. Research and education need continuity in effort and positions. Of course, this remark applies to both Theory and Experiment. However, in Theoretical Physics the situation starts already to be critical in some major Universities if no young faculty members are hired soon.

The Galileo Galilei Institute has been a success. The programmes run so far were of very high scientific level. The CVI congratulates the Scientific Committee of the Institute.

The APE project started many years ago and aimed at the design, construction and configuration of large computers dedicated to particle physics calculations, most prominently, but not uniquely, lattice simulations of QCD. The project has evolved over the years, has been extremely successful and has established Italy in the forefront of scientific research in this field. A rich harvest of results was obtained which includes the standard questions on the spectrum of light hadrons, but also the computation of the hadronic matrix elements appearing in weak decays, as well as problems outside high energy physics, such as the numerical study of various disordered systems, or the application of statistical mechanical methods to problems of complexity. Concerning the future of its high performance computing INFN had set up a committee to study two possible projects. The studies of the possible architectures continue. CVI encourages INFN management to reach a timely decision.

The CVI was pleased to learn that, following last year's recommendation, an effort has started to trace the careers of young scientists trained by INFN grants. The continuation of this effort is encouraged.

Laboratori Nazionali di Frascati (LNF)

At its 2008 meeting the CVI started a series of visits of the national laboratories in order to better assess the role and strategy of these laboratories in the context of INFN.

After a presentation given by the LNF Director, Mario Calvetti, the committee visited the major LNF installations: DAFNE, SPARC and the gravitational antenna NAUTILUS in presence of Eugenio Coccia from LNGS.

With a total of 1000 person working at LNF (350 staff members, 180 associates, 460 visitors), Frascati is recognized among the most important laboratories in Europe. Its central installation is the DAFNE e^+e^- collider with its experiments (KLOE, FINUDA and SIDDHARTA) operating at the Φ production peak at high luminosity (peak value 1.5 10^{32} $cm^{-2}s^{-1}$). Currently work is focused on a luminosity upgrade of the DAFNE collider using low emittance beams and the crab-waist scheme. Impressive results from test runs have shown a 2 times higher ratio of luminosity/current than in the last KLOE run, which allows for higher luminosity, smaller backgrounds and lower running costs. The KLOE experiment proposes to upgrade its detector and to accumulate a luminosity of 20-50 fb^{-1}, a project that cannot be realized at the same time as a possible implementation of a Super-B factory close to Frascati.

SPARC is the realization of an ultra-bright photon injector, the first step for the SASE-FEL photon source SPARX. After the successful Linac commissioning and undulator installation, the commissioning reached its second stage with the aim to generate 500 nm FEL radiation in the SASE regime. An agreement between MUR, the Lazio region, CNR, ENEA, the University Tor Vergata and INFN has been reached in 2007 to proceed with the SPARX project and civil engineering has started. Among the synchrotron facilities, SPARX will respond to soft X-ray FEL demands. The project is well embedded in the European efforts in this area and provides many synergies for developments for an ILC.

NAUTILUS, the gravitational antenna hosted by LNF complements, together with EXPLORER at CERN, the interferometer antennas, such as VIRGO. Recently, interesting results on the detection of high energy cosmic rays by NAUTILUS and EXPLORER has been published, comparing the detection signal while operating in normal conducting and superconducting states.

LNF participates also in experiments and projects hosted outside the laboratory (LHC experiments, CDF, BABAR, OPERA, etc.) and in many areas of R&D for accelerators and detectors to medical applications. One should mention in particular the participation in CNAO, the hadron therapy facility in Pavia, where Frascati is in charge of the technical direction, provided training and tutoring for the accelerator operation besides other technical contributions. The installation and commissioning is ongoing, delivering beam to patients within the next 1-2 years.

Frascati provides a broad spectrum of scientific outreach initiatives and communication with the general public.

With its wide range of activities and its expertise in particular in accelerator physics, in operating facilities and in building detectors, Frascati is among the leading European laboratories. LNF should in particular be congratulated for its impressive results and progress on beam physics and accelerator developments. Similar to other laboratories hosting accelerators, the question on the future physics program with an in-house installation needs to be carefully analyzed. In the current situation, various scenarios need to be elaborated and the consequences and associated risks should be carefully evaluated to maintain the Frascati laboratory at its level of excellence.

Technological and interdisciplinary research-CSN 5

The activities carried out by this committee have continued as in the previous years along the three broad traditional lines: detectors, electronics and computing; accelerators and related technologies; and interdisciplinary physics.

These activities keep showing a fundamental role in science oriented experiments projects but also an important impact on applications such as medicine, cultural heritage and environment.

The CSN 5, as INFN in general, has deployed its special scientific and technological competences in developing devices and technologies often in the frame of collaborations also with Italian industries thus stimulating and allowing them to become more innovative and competitive in the high tech market.

The number of contracts to CERN as a major sophisticated equipment consumer, particularly in the frame of LHC, assigned to Italian companies, can be considered as an indicator of the INFN capability to qualify high tech Italian industries. The data reported during the meeting show that Italy is the second strongest supplier after France.

The tradition and competence of developing detectors particularly for science experiments is well established and recognized worldwide in high energy physics experiments and continues along the usual high quality level for the active detector projects.

As to accelerators and related technologies, SPARC and SPARX are relevant projects. The activities in the frame of SPARC project (housed in the Frascati National Laboratories), intended to develop high brightness photo-injectors to drive SASE-FEL, have shown that the design goal in terms of peak current has been successfully achieved with a UV "flat top" laser pulse illuminating the cathode.

SPARC has become the test facility for the soft X-ray FEL facility. In 2007 a framework agreement has been finalized with MUR and Lazio Region for the development of SPARX soft X-ray FEL facility. It will be built in the Tor Vergata campus by collaborations with other entities such as CNR, ENEA, Tor Vergata University. The domains of investigations and applications span from physics to material science, life science, and environment.

It is interesting to note that some of the photo-injectors operating or under design in Italy and abroad (FERMI in Italy, PAL in Korea, LCLS in USA, BESSY FEL in Germany and European XFEL) base their principle of operation on that originally conceived by the SPARC team.

Relevant strategic new projects are related to the ILC (international linear collider), innovative laser plasma acceleration, high power proton accelerators, fast ramping superconducting dipoles, and the participation in the European XFEL, where INFN is involved in the design and realization stages.

The expertise set up in the area of cancer treatment with accelerators (Catania, Pavia) has reached high levels and general recognition. The related interaction with industry underlines the visibility of INFN in this field. It is desirable that also Italian industries should be further sensitized and engaged in this field with an enhanced support by more Italian regions.

New cyclotrons for hadron therapy are subject of specific project studies together with intense activities related to image processing and to detectors and dosimetry for diagnostics.

MAGIC-V experiment is a particularly relevant project in the frame of activities having a great impact on medical applications. The related activities include the development of models and algorithms for a distributed analysis of biomedical images by making use of the GRID services. The project involves collaborations of 8 INFN sections with Italian universities and hospitals, international partners, and a development agreement with an Italian company. The project implies a strong interdisciplinary activity involving also the contributions of medical doctors and biologists. It creates benefits for mammography, for the early diagnosis of lung cancer, and the early diagnosis of the Alzheimer's disease.

The interdisciplinary activities related to cultural heritage and environmental applications are especially visible. These activities have led to very good results with a strong social and potentially economical impact. They have a great impact in the cultural heritage studies due to the development and application of techniques such as Ion Beam Analysis in combination with other complementary techniques such as Particle Induced X ray Emission, and radiocarbon dating with Accelerator Mass Spectrometry.

The collaboration with some public bodies of the Toscana region has been very fruitful and helped increase the visibility of INFN's activities, e.g. in the area of analysis of very fine particles and their impact on health and environment.

The number of publications and authors (FTE) related to CSN 5 projects has increased during the last years compared to the previous years, indicating an increased appeal to the researchers for this area of INFN activities.

INFN has been developing fruitful collaborations with certain regions. Also in the area of CSN 5 activities INFN should further expand collaborations and contracts with regions to strengthen funding particularly in the field of interdisciplinary physics.

CSN 5 activities and achievements can contribute to further increase the visibility of INFN in the field of Technology Transfer in an attempt to pursue contacts with the general confederation of Italian industries (Confindustria) and particularly its Innovation Committee, in addition to those already active

with the Italian Association for the Industrial Research (AIRI - of which INFN is a member).

Socio-Economic Impact

The report on the INFN scientific productivity and its socio-economic and interdisciplinary impact, prepared by a dedicated INFN Working Group (GLV), provided the CVI with an impressive overview of the scientific highlights, the student and graduate training, the technological highlights, the economic impact and the scientific productivity in an international comparison. The report analyses the impact of INFN research in training, dissemination of scientific culture, the development of frontier technologies and their interdisciplinary implications, including a quantitative analysis of the impact of INFN research on the national economy. In a second part the scientific productivity is analysed in the international context.

The CVI came to the conclusion that INFN is performing very well on an international scale in all the areas mentioned above: INFN plays a key role in Italy in physics education at all levels, is very successful in its programmes to bring science to the public, dedicates significant resources to developing frontier technologies and making them available for interdisciplinary research. The impact of INFN research on the Italian economy was analysed and showed the impressive effect of training of industrial companies by providing them with INFN expertise in high technology products. In short, the data underline very clearly the importance of fundamental science for society.

Concerning the evaluation of scientific productivity the CVI would like to point out again that the monitoring of scientific productivity through bibliometric analysis can only partially reflect the true scientific impact and should mainly be used to complement peer reviews.

Resource and Financial Management

The total budget of Italian research institutes (eighteen institutes, some of them very small) increased from 2004 to 2007 by 8.9 %. In the same period the budget of INFN decreased by 1.9 %. Over the last six years the cut in real terms has been 19 %.

Since 1997 INFN, like all the other institutes of the Public Sector, is constrained by various limits, beginning with cash limits in 1997 and ending with staff limits. The main aspects of legislation which apply to the overall research field are:

- the budget authorisation is constrained by a cash limit so that a forced saving is imposed;
- operation expenses and temporary staff are limited and procurements are centralised by a public corporation;
- an increase in permanent staff is forbidden.

As the CVI noted in its 2006 report past cash-flow limits to budget authorisation led to a forced saving, reaching a peak of 130 M€ in 2002. In the following years the budget allocation has been decreasing. Resources from external funds and special projects represent, at best, a 2-3% of total resources. In 2006 the cushion of the forced saving, which has been used to finance some large projects requiring funding on a multi year basis, has disappeared.

The change in expenditures from 2004 to expected 2007 is described in the following table in terms of operation, personnel and research investments:

Total budget in share

	Operation	Personnel	Research	Budget M€
2004	22%	41%	37%	298.9
2005	26%	40%	34%	283.5
2006	19%	47%	34%	291.6
2007	24%	49%	27%	293.2

There is a clear trend visible: Personnel expenses have increased over three years from 117 M€ to 140 M€ (+20%) due to contractual renewals. Operation expenses have decreased by the same percentage (from 70 M€ to 56 M€). As a consequence research expenses suffered a strong decrease of - 33%, from 94 M€ to 62 M€. In 2006 INFN managed to maintain the share of research but in 2007 was no longer able to do so.

INFN has a peculiar characteristic with respect to other institutes of the research sector. Until a few years ago the personnel expenses where around 40% of total budget, while in general they are higher, reaching in some Institutes up to 90%. When there is a contractual renewal, Institutes with a big share of personnel expenses *must* receive the additional resources in order to pay wages, and at least a minimum amount of operational expenses. INFN did not get any compensation for wage increases but was obliged to absorb them by introducing a strong decrease in funding for new projects and by cutting existing ones.