INFN CVI Report 2007

Conclusions of the CVI Meeting on 9-10 July 2007

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26 September 2007

Executive Summary

The CVI met on 9-10 July 2007 to evaluate the INFN activities in 2006, focusing on the scientific and technical activities as well as their socio-economical impact. It 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 2006 was distributed to the committee, providing a broad and valuable overview.

The CVI came to the conclusion that in terms of international visibility and impact the scientific program of INFN continues to be outstanding on a world scale. A new generation of very important experiments is coming on line while the role of INFN in the European context remains strong. Furthermore, INFN is pursuing successfully a more systematic approach to the technology transfer process.

Compared to 2005 the CVI was pleased to learn that the government has formally approved the INFN plan and that a program is being put in place to provide permanent positions for researchers and technicians. This will ease a critical development which has endangered the career options for young researchers. In spite of a stronger support by the regions and increasing funds from European programs, the CVI remains concerned about the budget development which could endanger the outstanding position of INFN.

Concerning the different research areas the CVI concluded:

Sub-nuclear Physics with Accelerators (CSN 1): The present program continues to be extremely strong and very productive. The activities are well balanced, the contributions to the flagship project of the field, the LHC, are highly visible and successful. The important role of INFN is internationally fully recognized. Before the LHC startup, important results are still expected from the ongoing experiments in which INFN actively participates, BaBar at the PEP-II B-Factory at SLAC, CDF at the Tevatron at Fermilab and ZEUS at HERA, DESY. By contributing actively to the planning and R&D for future projects in accelerator based high-energy physics, INFN preserves and further develops successfully a variety of competences and activities.

Astroparticle and Neutrino Physics (CSN 2): The program of CSN2 is very broadly positioned and of high scientific value, with some experiments which are at the forefront of the field in the world. In particular the existence of the Gran Sasso National Laboratory (LNGS) is a major asset for this field of research. Quite a few new results are expected soon. The INFN has maintained a very competitive program despite a significant budget reduction. INFN is also participating actively in several European initiatives promoted by ApPEC, which will result in a road map for the field. Based on this roadmap, the consolidation process of the CSN 2 program should continue.

Nuclear Physics (CSN 3): The INFN research program in experimental nuclear physics continues to be of very high standard and comparable to that of other European countries (notably France and Germany). Progress has been made at the National Laboratories LNL and LNS to increase the intensities of the beams and to make more beams available. The ALICE program is on the verge of being completed and will soon enter the measurement phase. Establishing an Italian role in FAIR at GSI has proceeded. Excellence in nuclear astrophysics has been maintained. The goal of developing the National Laboratories LNL, LNS and LNF has however received a drawback due to budgetary problems. The CVI feels that the development of the National Laboratories is of utmost importance to maintain the role that Italy has in experimental nuclear physics in Europe.

Theoretical Physics (CSN 4): INFN plays a particular role for Theoretical Physics in Italy. It covers areas such as Theoretical Particle Physics, Theoretical Nuclear Physics, Mathematical Physics and Statistical Physics. 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 major institutions around the world. In Statistical Physics, and especially the Physics of disordered systems, the Italian School is probably the best worldwide. The Galileo Galilei Institute has been a success and the programmes run so far were of very high scientific level. The Institute seems to stand very well the competition of similar institutions in Europe and the United States.

Technological and Interdisciplinary Research (CSN 5): The excellent INFN contributions keep proving their great impact on basic science progress and on training of high level researchers. These contributions are also beneficial in promoting the enhancement of the technological level of the Italian companies involved in collaborations with INFN and capable of creating concrete technology transfer to industry. The CVI recommends developing a more systematic policy to strengthen the links of CSN 5 projects to industry further. It is recommended to make INFN activities even more visible in terms of their impact on social and industrial domains.

The CVI received a report on the socio-economic and interdisciplinary impact of the 2006 INFN activities and was impressed by the strong position of INFN in all these areas. The CVI commends the strong role of INFN in education. INFN 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 shows the impressive effect of training of industrial companies by providing them with INFN expertise in high technology products.

Concerning the financial resources, INFN did not receive any increase in budget to cover the wage increase and therefore had to continue to strongly decrease its project funds, therefore being unable to start new projects and forced to even cut existing ones. As in its report of last year the CVI wants to point out that the flat (or even decreasing) trend of total financial resources, in nominal terms, leads to an almost general cut for new projects. This weakens the ability of INFN of maintaining the high standard which it has obtained so far.

The CVI therefore encourages the INFN President to take all possible steps to recover its research budget.

The CVI recommends that the INFN Executive Board and the Scientific Committees take steps:

- To further develop the road maps for INFN as a whole, the National Laboratories and the Scientific programmes,
- To continue developing the long-term role of national labs and the relative balance between national and international projects,

The CVI expresses its appreciation of the excellent leadership of the President and the Executive Board.

Status and achievements of the INFN

The 2006 INFN Status and Perspectives

In his presentation the President focused on a number of developments during the past year which have led to an increased optimism concerning the future programs and developments. A new generation of key experiments are forthcoming, the results of which, notably from the Large Hadron Collider, will be of key importance for the development of the field. Also in the area of astroparticle physics an impressive number of programs will soon provide data. In short, INFN has an exciting scientific future ahead.

The CVI learned with great interest that the critical situation in the personnel sector (no promotion, lack of permanent positions) will soon be eased by new measures. The funding situation remains critical, but has been improved slightly by bidding successfully for funds from the European Union and the regions.

INFN has strengthened its transfer in technology in a number of areas, notably in computing (Grid) and hadron therapy.

INFN is in the process of aligning its programs with input from the road maps for astroparticle physics (ApPEC), nuclear physics (NUPECC), particle physics (European Strategy group).

Experimental sub-nuclear physics with accelerators-CSN 1

More than half of the CSN 1 manpower and budget is currently focused on the preparation of the Large Hadron Collider (LHC) at CERN, where major new discoveries are expected in the coming years. INFN is contributing to the Atlas, CMS and LHCb experiments with outstanding technical contributions, and in the commissioning of the detectors. Recently major milestones in the installation of the LHC detectors have been achieved. The CNAF Computing Center in Bologna is among the 11 Tier 1 processing sites for the LHC data and contributes successfully to the GRID development. The CVI underlines that it is now important to find the right balance of physicists and means necessary to get the experiments running and to be involved at a corresponding level in the preparation of the data analysis.

Even though first collisions at the LHC are expected in 2008, INFN is already engaged in the preparation of possible future upgrades of the LHC towards higher luminosity, such as a Crystal Collimator study and a replacement of the Atlas and CMS pixel and tracking detectors which may become necessary after 5 to 10 years of operations.

In parallel, the experiments from the previous generation at HERA (DESY), PEP-II (SLAC) and the TeVatron (FNAL) are heading towards their final results, producing a steady flow of publications with increasing precision. The observation of D^0 mixing and the measurement of sin2β by the BaBar experiment illustrate the accuracy reached by running experiments. CSN 1 is one of the major contributors in both areas and should be congratulated for its contributions to these achievements. BaBar at PEP-II is ending its operation in 2008.

At the end of June 2007, the HERA accelerator concluded its operation after 15 years. INFN participated predominantly in the ZEUS collaboration, representing about 17% of the 320 ZEUS physicists. The final data analysis during the next years will yield further constraints of the parton density functions through measurement of the longitudinal structure function F_L and the heavy flavor contributions to the proton structure function. INFN is contributing in both areas to the final HERA publications, while ensuring at the same time the transition towards future experiments.

The expected results from the TeVatron collaborations constraining the standard model Higgs boson by high precision mass measurement of the W boson and the top quark, or by its direct search, fully justify a further strong contribution from INFN in the CDF experiment. Besides the fundamental physics results at the high energy frontier, achieved with the high luminosity running of the TeVatron, the participation of Italian physicists in the CDF data analysis allows to maintain and acquire valuable competences for the LHC data analysis and the training of young physicists on running experiments. The CDF experiment at the TeVatron is foreseen to come to an end in 2009, depending on the start-up of the LHC.

CSN1 contributes also to a few small to medium size experiments: COMPASS measuring the spin structure of nucleons at CERN, MEG at PSI searching for the μ to eγ decay, and P326 in preparation to follow up NA48 in the charged kaon program of CERN. The final results from KLOE at DAPHNE (LNF), which ended data taking in 2005, allow for tests of standard model unitarity at the 0.1% level, of lepton universality at the 1% level and of quantum mechanics in the kaon system. These are among the highlights presented by CSN 1 and complete the knowledge on the CKM matrix from the B-factories.

The development of accelerators for e^+e^- physics is traditionally a domain where INFN contributes with outstanding and innovative ideas. A new proposal for a SuperB Factory has been initiated by INFN, which, if successful, would be producing e^+e^- interactions with an instantaneous luminosity of 10^{36} $cm^{-2}s^{-1}$, about 2 orders of magnitude above the PEP-II luminosity achieved for the BaBar experiment. This increase is based on a new concept initiated by an INFN physicist and has received worldwide attention. The roadmap towards such a facility proposed by INFN includes a feasibility study of the new beam crossing technique with the Daphne Collider at LNF during the next 2 years. Detailed studies to evaluate the physics potential will be pursued at the same time. This is crucial in order to fully evaluate the impact of such a facility and to form an international collaboration for this project. The possibility of using parts of PEP-II and of the current BaBar detector has been investigated and would allow reducing the cost. The INFN management has initiated an international review process of the proposal in order to reach a decision within the next two years.

INFN participates in the R&D program for ILC. Within CSN 1 contributions are part of the EUDET program, funded by the 6th framework program. The developments are focusing on pixel detectors, where INFN is one of the world leaders. The importance to continue with R&D in this area cannot be enough underlined.

In summary, the activities of CSN 1 are well balanced, the contributions to the flagship project of the field, the LHC, are highly visible and successful. The important role of INFN is internationally fully recognized. The technical realization for the LHC and its experiments were helped by a close collaboration with the Italian industry. Before the LHC startup, important results are still expected from the ongoing experiments in which INFN continues to participate. By contributing actively to the planning and R&D for future projects in accelerator based high-energy physics, INFN preserves and further develops successfully a variety of competences and activities.

Experimental Astroparticle and Neutrino Physics-CSN 2

The area of Neutrino and Astroparticle Physics is one in which INFN has traditionally maintained a strong presence, in particular with the existence of the Gran Sasso National Laboratory (LNGS), the largest in the world devoted to this field. In terms of personnel it is also one of the largest inside the INFN, with over 650 FTE. This figure has not changed significantly with respect to last year; however the budget for CSN 2 has been reduced considerably. The scientific productivity, as measured by the number of publications and their impact, has slightly increased and is highly visible in the international context, with INFN leading some significant experiments.

The INFN has taken steps towards implementing the recommendations of the CVI of last year to consolidate the activities in this area. Some experiments have come to an end in 2006 and there has been some consolidation of smaller experiments. INFN has a strong presence in a number of European activities promoted by ApPEC (Astroparticle Physics European Coordination

Committee), in particular in the ongoing preparation of the European Roadmap in Astroparticle Physics.

The activities of CSN 2 are grouped in 6 areas: Neutrino physics; search for rare processes; cosmic rays on earth; cosmic rays in space; gravitational waves; and general physics.

Neutrino Physics: Neutrino physics, with 26% of the budget, is the largest area of CSN2. A major effort is in the CNGS (CERN to Gran Sasso) neutrino project, aiming at the explicit detection of the oscillation of muon to tau neutrinos in a neutrino beam produced at CERN and studied by the OPERA and ICARUS detectors located at the Gran Sasso.

The first beam was sent to Gran Sasso in the summer of 2006 and neutrino interactions were seen in several detectors. ICARUS is pioneering the use of the Liquid Argon TPC technique which could be the basis of future large experiments. Data taking is expected to start next year. OPERA is being installed and will be completed by the spring of 2008.

Also at the Gran Sasso the BOREXINO experiment has started data taking in May of 2007. This is a solar neutrino experiment intended for the study of the particularly interesting Beryllium-7 neutrinos, but that can also detect other solar neutrinos and neutrinos of geophysical origin.

The MARE experiment, which has resulted from the merger of MINIBETA and MANU2, has as its objective the direct measurement of the electron neutrino mass with sensitivity below 1 eV. The first of the two phases of the experiment is ready to start.

Outside the Gran Sasso Laboratory INFN has participated in the K2K experiment in Japan, which has effectively finished in 2006 and confirmed the atmospheric neutrino oscillations with accelerator produced neutrinos. A decision to participate in some of the major neutrino experiments being planned or constructed elsewhere, such as T2K in Japan and NOVA in the US, has not been taken for the moment.

Search for Rare Processes: Three main areas of research are being pursued:

(a) Neutrinoless Double Beta Decay. One of the major future experiments in neutrinoless double-beta decay is CUORE at the LNGS. It is a collaboration between the INFN (50%), the US and China. Its predecessor, COURICINO, has been taking data since 2003 and has already given a strong limit in the half life of the process.

Another major future experiment, GERDA, is also prepared for the LNGS. It consists of enriched Germanium crystals inside a Liquid Argon bath. The phase-I of the experiment will start in 2008. In a second phase it is proposed to double the mass of Germanium, thus being able to check the claimed positive detection in the Heidelberg-Moscow experiment. The INFN share of the experiment is 10%.

(b) Direct Dark Matter Searches. These experiments try to observe nuclear recoils induced by the interaction of dark matter particles with the target material. An experiment at the LNGS, DAMA, lead by INFN scientists, has claimed a positive observation. The experiment detects an annual modulation of the signal, which is a distinctive feature of interactions with dark matter particles present in the galactic halo as the Earth rotates around the Sun. The evidence was obtained in the first phase of the experiment. DAMA is now running with a six-fold increase in the same material and the first data will be released in 2008.

An innovative technique for searching for dark matter, based in a double phase (liquid and gas) Argon TPC, is that of the WARP experiment, a collaboration between the INFN (80% share) and the US. A 2.3 liter prototype of WARP has been successfully operated and has already produced competitive results. The 100 liter detector will be completed in 2007.

(c) Supernovae (SN) neutrinos. Searching for SN neutrinos is the objective of the LVD detector, also at the Gran Sasso, which has been in operation since 1992. LVD can also monitor the CNGS beam and it is a member of the SNEWS (Supernova alert system) network.

Cosmic Rays on Earth: This is the second largest line in CSN 2, with 21% of the budget. The ANTARES and NEMO underwater experiments aim at the detection of very high energy neutrinos of cosmic origin. ANTARES, when completed, will cover an area of 0.2 km^2 with 12 strings. At present 5 strings are already taking data and two more have been deployed. Some candidate neutrino events have already been seen. The INFN share of the experiment is 10%. NEMO is a demonstrator experiment for a future 1 km^3 neutrino telescope. A 4-storey tower has been deployed and is now taking data. The INFN is also participating in the EU funded KM3Net design study.

The ARGO experiment is a INFN-China collaboration. It consists of a 10000 m^2 detector array at high altitude in Tibet. It aims at the study of gamma-rays (300 GeV to 10 TEV), CR (1 to 10^4 TeV) and other physics. More than half of the array has been deployed.

Another ground based experiment with an INFN participation of 10% is AUGER, which studies the highest energy cosmic rays. All the 24 fluorescence telescopes and 75% of the surface detectors (water tanks) are operational. Many results are being obtained and they seem to confirm the GZK cut-off.

MAGIC is an experiment for the study of gamma rays at the lower end of the spectrum measurable from the ground. It consists of a single Air Cherenkov telescope of 17m diameter. A second telescope of the same size is under construction. MAGIC has already produced many results, including the discovery of some sources. Its threshold energy is about 50 GeV.

Cosmic Rays in Space: CREAM is a balloon experiment in collaboration with NASA, to study the chemical composition and spectrum of CR in the 1 to 1000 TeV region. Analysis of the data from 2 flights is in progress and INFN will end its participation.

AMS2 is a magnetic spectrometer planned for the Space Station, to search for antimatter and dark matter and for CR studies. The satellite is being integrated to be ready in 2009, although there is not yet a guaranteed available flight in the Space Shuttle.

WIZARD is also a small magnetic spectrometer satellite to look for antimatter and dark matter, and to study CR. It was launched in 2006 and the first data will be presented soon.

AGILE is a small satellite for gamma-ray astronomy. It was launched in April of 2007 and the commissioning phase is now ending, with all the detectors working.

GLAST is a major satellite for gamma-ray astronomy with an area 100 times that of the very successful EGRET satellite. The launch by NASA is expected early next year.

Gravitational Waves: Italy hosts one of the major experiments in the world in this area, the VIRGO interferometer located near Pisa. It is now working in coincidence with the LIGO interferometers in the US. An upgrade of VIRGO (VIRGO+) is foreseen, which will bring the sensitivity at the level of LIGO.

There are also several resonant antennas, namely AURIGA and ROG, taking data, and DUAL, in R&D phase. AURIGA and ROG will continue monitoring our galaxy until VIRGO+ starts. DUAL is a new concept and aims for a demonstrator in 2009.

INFN is also involved in the LISA Pathfinder mission of ESA, a demonstrator for LISA, a giant interferometer in space, and R&D on the thermo-acoustic detection of cosmic rays in a superconducting bar (RAP), motivated by some anomalous signals seen in the Nautilus detector.

General physics: A number of experiments focus on fundamental physics such as the test of the equivalent principle (GGG, running), the measurement of G and of Newton's law at short distances (MAGIA, running), the dynamical Casimir effect (MIR, in R&D phase) and the study of QED vacuum polarization (PVLAS). PVLAS aims at measuring the change in polarization when linearly polarized light from a laser passes through a magnetic field. A rotation had been reported but with an upgraded hardware no signal is detected for fields below 5.5T, excluding the physical origin of the previous result.

In conclusion, the program of CSN 2 is clearly very broadly positioned and of high scientific value, with some experiments which are at the forefront of the field in the world. Quite a few new results are expected soon. The INFN has maintained a very competitive program despite a significant budget reduction. It is also participating actively in several European initiatives promoted by ApPEC, which will result in a road map for the field. Based on this roadmap, the consolidation process of the program should continue.

Experimental nuclear physics-CSN 3

INFN has a broad research program in experimental nuclear physics covering all four areas considered by NuPECC as the main areas of nuclear physics research: Structure and dynamics of hadrons; Matter at high-density and temperature; Structure and dynamics of nuclei; and Nuclear astrophysics.

Structure and dynamics of hadrons: INFN research in this area combines participation in international collaborations (HERMES at DESY, AIACE at JLAB, CTT at MAINZ, LEDA at JLAB) with experimental programs at LNF (FINUDA at LNF, SIDDHARTA at LNF). The experimental programs at LNF are devoted to the study of strangeness nuclear physics (hypernuclei and kaonic atoms) with the purpose of extracting properties of the interaction of strange particles, Λ's and K's, with the nucleon. The external program is in part also devoted to hypernuclei (LEDA), but includes the study of baryon resonances in the nuclear medium (CTT), the study of the contribution of orbital angular momentum to the nucleon spin (HERMES) and of the structure functions of the nucleon (AIACE). An interesting proposal was presented to the Committee for the short range plans of LNF, namely the exploitation of the Raimondi-Shatilov-Zobov idea to increase luminosity at DAΦNE. If successful, it will allow continuation of the research programs at LNF for the upcoming years (FINUDA and AMADEUS). The long term plans in this area, namely the participation in PANDA and PAX, both at FAIR, are well developed, focusing on the new opportunities which will be provided in Europe by the construction of the FAIR facility at GSI.

Matter at high-density and temperature: The INFN effort in this area is almost exclusively devoted to the development of ALICE at CERN-LHC. There is a participation in IPER at CERN which has produced the interesting result that the mass of vector mesons, in particular the ϱ meson, is not changed in high-density matter, while its width is. The detector development at LHC-ALICE appears to proceed well. Data taking for ALICE is expected to start in the spring 2008 for pp collision and presumably in 2009 for heavy ion collisions. In view of the major contribution of INFN in ALICE (ITS, HMPID, TOF, Muon Arm and ZDC), the CVI found it rewarding to see that some of these projects are becoming a reality. Since calculation power is of utmost importance for LHC, the CVI noted with interest the development of ALICE-GRID, with the construction of two Tier2 centers and two more in planning. An evaluation of research for this area must await 2009-2010 when the first results will become available. The intention is to measure heavy flavor production, jet production and quarkonia production, all of which may be indicators of the transition to a de-confined phase of quarks and gluons.

Structure and dynamics of nuclei: This part of the research program is almost exclusively carried out at the two National Laboratories, LNL and LNS, except for GAMMA running also at GANIL and GSI. The cryogenic problems at LNL have been solved and the PIAVE-ALPI complex delivers beams with good intensity. Experiments are GAMMA at LNL, PRISMACLARA at LNL and EXOTIC at LNL. Results on the spectroscopy of light and medium mass nuclei are interesting, especially the study of the proton halo structure in ^{17}F, and the study of the shell structure of the neutron rich nuclei ^{36}Si, ^{40}S. GAMMA at GSI has also produced very interesting results on the dipolar vibrations of the neutron skin in ^{68}Ni.

The future of LNL relies on the development of the project SPES. A new idea was presented to the CVI for an ISOL-NEW target with a lamellar structure. If successful, this target will allow production of radioactive beams in a single step, rather than the two-step process of GANIL-SPIRAL2. It is of utmost importance however to complete the SPES project before 2012-2013, which is the projected completion date of GANIL-SPIRAL2. LNL will also have the opportunity of doing very interesting physics in the short-range by exploiting the AGATA detector that will be stationed there in 2008-2009.

The research program at LNS is oriented to the study of the equation of state of nuclear matter, especially its isospin dependence (ISOSPIN at LNS). The CHIMERA detector has been extremely useful in this study. Another interesting result presented to the CVI related to the di-proton decay from $^{18}Ne^*$. This result needs to be confirmed but could potentially be of great importance. The future of this area at LNS is linked to the development of the project EXCYT. In 2006 a beam of ^{8}Li was extracted with intensity of ~10^3 particles per second. This intensity has been improved (~10^4) and experiments for 2007 are planned (BIGBANG, RCS, RSM, MAGNEX-RIB). The plans for the future of EXCYT, beyond 2007, need to be developed.

Nuclear Astrophysics. The INFN research program in this area is carried out at the two National Laboratories LNGS and LNS. LUNA at LNGS has produced some interesting results on reactions of astrophysical interest, primarily $^{3}He(\alpha,\gamma)^{7}Be$. The future for this research line at LNGS is the R&D for a 4MV tandem. At LNS the experiment ASFIN is studying light elements nucleosynthesis. However, this part of the INFN research program could be further expanded at LNS with the improvement of EXCYT. A future plan for astrophysics at LNS can be developed only after the running of the experiment BIGBANG.

In conclusion, the INFN research program in experimental nuclear physics continues to be of very high standard and comparable to that of other European countries (France and Germany). Progress has been made at the National Laboratories LNL and LNS to increase the intensities of the beams and to make more beams available. The ALICE program is on the verge of being completed and it will soon enter the measurement phase. Establishing an Italian role in FAIR at GSI has proceeded. Excellence in nuclear astrophysics has been maintained. The goal of developing the National Laboratories LNL, LNS and LNF has however received a drawback due to budgetary problems. The CVI feels that the development of a long term program for the National Laboratories is of utmost importance to maintain the role that Italy has in experimental nuclear physics in Europe.

Theoretical physics-CSN 4

INFN plays a particular 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. 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 will simply stop functioning. Due to recent budget cuts many projects for medium scale computing facilities had to be abandoned or postponed.

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 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. For the moment the Institute seems to stand very well the competition of similar institutions in Europe and the United States such as the Newton Institute, the Henri Poincaré Institute, and the Santa Barbara Institute. The attractiveness of the City of Florence is a very good asset.

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. These calculations are particularly demanding in both speed and memory, both of which were, and are still to a certain extent, putting severe limits to practical calculations. The project has evolved over the years, has been extremely successful and has established Italy in the forefront of scientific research in this field. The physicists involved have developed novel techniques in every aspect of it, starting from the hardware of the computer itself and going to new fast algorithms as well as more theoretical problems, such as that of chiral fermions on the lattice, or the reformulation of the renormalisation programme. In all these problems the Italian physicists took often the leading role in international collaborations. 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. All efforts should be deployed to guarantee the continuation of the project.

Technological and interdisciplinary research-CSN 5

The activities in this area are well in line with the mission and tasks assigned to this Committee. They cover three areas: accelerators; detectors; and applications of cutting-edge technologies in interdisciplinary and life science fields.

The projects are carried out in typical timeframes of 2-3 years and are based on several collaborations. These collaborations are not only confined to INFN and academic frame, but are also open to industrial entities.

The collaborations with certain industrial sectors have been aiming both at jointly developing the most appropriate technologies and equipments to meet the specific needs of the INFN activities and also at transferring to industries some technologies originally developed and mastered by the CSN 5,with a clearly positive social and economical impact.

The proposals for the projects are submitted to an evaluation process for their selection which appears to be appropriate. Out of 127 projects which were evaluated, 106 have been approved, 5 experiments being funded 100% and 8 funded over 80%. The evaluation process has taken into account a variety of elements such as: acquisition of leadership in cutting-edge technologies, interdisciplinary context, technical and scientific collaborations with industries in view also of a potential technology transfer and training.

The total allocated budget of 3.4 ME, however, has been only 47% of the original request: this is a somewhat penalizing budget in view of the broad technological targets foreseen for this Committee and the relevance also in term of potential social and economic impact of some of them.

The available budget has been split into the three areas of activities in the following way: 31.5% for interdisciplinary projects, 29.3% for detector projects, and 21.7% for accelerator projects.

The number of projects for the year 2007 compared to 2006 increased about 10% in the fields of detectors (44) and interdisciplinary research (41) and decreased some 20% for accelerator related activities (21).

To keep managing projects effectively and efficiently it will be important to actually maintain a constant monitoring of the project evolution, as foreseen by the evaluation process. As to the R&D interdisciplinary and application driven experiments it is also important that the end-users be possibly involved already at the proposal stage.

Detectors: The main projects are GINT, MATRIX and SLIM-5. The GINT radiation detector has required and led to the successful development of carbon nanotubes patterned structures based on nanolitography and the achievement of their good growth control. This outcome might be prone to spin off in other application areas.

MATRIX is an integrated project for the development of a large area silicon sensor array with a large dynamic range and low noise front-end electronics for the charge identification of relativistic cosmic rays. A 64 pads,6", prototype has been developed as a building block for the array.

SLIM-5 is a silicon detector having low interactions with material, based on the development of thin silicon tracker systems which is crucial to reduce multiple scattering effects for future collider experiments; 6 APSEL chips based on deep Nwell CMOS MAPS design have been produced.

Accelerators: The main projects are HCCC, ARCO, and SPARC:

HCCC (Halo Collimation through Crystal Channelling) which has allowed studies concerning channelling and volume reflections in strip silicon crystals;

ARCO, an international collaboration project, where CSN5 has the task of developing the internal coating of RF cavities with the best performing superconducting Nb or Nb-Cu films deposited by the UHV arc technique; for this purpose a new version of the cavity coating device has been studied and some specific plasma parameters have been analysed.

SPARC, in whose frame a special movable emittance-meter for the FEL project has been developed and SALAF, a project aimed at producing accelerating sections at 11 GHz, wherein a copper prototype has allowed showing a good agreement between numerical and experimental results of relevant RF parameters.

Interdisciplinary Research: The main projects are MAMBO and MAGIC-V, related to life science and NUTELLA, PESA, DANTE related to environmental or material sciences.

The MAMBO project is aimed at investigating possible advantages in using Thomson Backscattering based X-ray source in mammography. The practical implication should be the possibility to observe a phase contrast when absorption contrast is undetectable and distinguish between different kinds of soft tissues.

MAGIC-V (Medical (Imaging) Application on a GRID Infrastructure Connection)) is finding application in mammography (it is now in use at several Italian hospitals and in a hospital in Alexandria-Egypt), lung CT analysis, neuro-images to facilitate Alzheimer's disease diagnosis (started in 2007).The application to mammography related technology appears to be ready to technology transfer.

NUTELLA (Nuclear Techniques for Environmental Pollution Analysis) can have practical applications as, for example, to atmospheric particulate analysis (underway, in collaboration with the Tuscany region).It might be interesting to investigate its potential application in the analysis of PM pollution particularly from diesel cars.

PESA (Proton Elastic Scattering Analysis) is aimed at a non destructive detection of H, C, N, O in matter with fast response and very high sensitivity in a multielemental analysis;

DANTE (Development of Analytical Nuclear Techniques) is addressed at innovative set-ups and methodologies for material analysis with ion beams, applicable to fields such as cultural heritage, geology, material science.

The scientific and social/economical impact of the above mentioned projects is clearly visible and fully justifies the allocation of adequate resources for these projects.

Some of the achievements of the CSN5 activities have led to a concrete technology transfer. The most recent examples, mentioned during the meeting, are:

- "Cubo Magico", a dosimeter based on strip and pixel ionization chambers ,originally proposed for hadron therapy, now a conventional radiotherapy dosimeter manufactured by a company,

- SC(EN)T a new superconducting cyclotron for exotic nuclei therapy. The project has been approved in 2003 with the support of the Sicily region to be set it up in Catania; in July 2006 a cooperation agreement has been finalized between the Belgian company IBA and INFN for the construction and marketing of this cyclotron which is now being implemented.

The excellent world class INFN contributions keep proving their great impact on basic science progress and on training of high level researchers. These contributions prove also to be beneficial in promoting the enhancement of the technological level of the Italian companies involved in collaborations with INFN and capable to create concrete technology transfer to industry.

CVI recommends developing a more systematic policy to further favour linking CSN5 projects to industry, capitalizing on CSN 5 and more generally INFN knowledge stock. This implies the setting up an appropriate IP policy, desirably based on few basic patents rather than on an excessive and redundant patent portfolio which may turn out to be a barrier to industrial interests.

CVI also recommends making INFN activities and particularly CSN 5 activities even more visible and appreciated not only for science but also for their impact on social and industrial domains. Further efforts should be made to disseminate information about INFN activities on a regional basis. This could also help increasing funding from regional governments, particularly for the projects related to health care and prevention and cultural heritage to which regions are usually more sensible.

Socio-Economic Impact

The 2007 report on the INFN scientific productivity and its socio-economic and interdisciplinary impact, prepared by 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 analyses in the international context.

Based on the report 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, however, 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

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 applies to the over all research field are:

- the budget authorisation of the Institute is constrained by a cash limit so that a forced saving is imposed; the cash limits apply bimonthly (with possible exceptions);
- operational 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 an increasing forced saving, which reached a peak in 2002. Since then the budget assignment is decreasing. Resources from external funds and special projects represent, at best, 2-3% of the total resources. Moreover in 2006 the cushion of the forced saving, which has been used to finance some large projects producing payment on a multi-annual basis, has disappeared, so that the budget assignment will be binding.

The change in total expenditures from 2004 to expected 2007 is described in the following table

	Operation %	Personnel %	Research %	Budget M€
2004	24.9	41.7	33.4	280.3
2005	24.8	44.8	30.4	274.7
2006	24.0	46.7	29.3	269.2
2007	21.7	54.2	24.1	258.4

There is a clear trend: Personnel expenses have increased, in three years, from 117 M€ to 140 M€ (+20%), due to contractual renewals; operation expenses have decreased by the same percentage (from 69.9 M€ to 56.1 M€), but research expenses suffered a strong decrease, - 33%, from 93.6 M€ to 62.3 M€.

INFN has a special characteristic with respect to other Institutes of the research sector; until few years ago the personnel expenses where around 40% of total budget, while in general they are the greater share, and in some Institutes they represent the largest fraction of the budget (up to 90%). When there is a contractual renewal, Institutes with a big share of personnel expenses *must* receive an increase in budget in order to be able to pay wages, and at least a minimum amount of operational expenses. INFN, on the contrary, did not receive any increase in budget in order to cover the wage increase, and therefore had to strongly decrease its project funds. As a consequence INFN was unable to start new projects and forced to even cut existing ones.

The CVI would like to point out that in the research field (in part even in the case of the theoretical research), physical and human capital is mainly complementary and can not substitute each other.

The CVI was informed that there is hope for an increase of resources in 2007 and following years which may help in avoiding the cut of further research projects; the Ministry decree would be probably issued in November.

In its report of last year the CVI wrote that "we have to point out that the flat (or even decreasing) trend of total financial resources in nominal terms, leads to an almost general cut for new projects, since they imply new and more expensive machinery; this throw a shade on the ability of INFN of maintaining the high standard which rightly INFN has obtained so far". The statement remains unfortunately true since the three year plan, which was formally approved by MUR, depends on the availability of funds which are uncertain.

Acknowledgment

The CVI would like to thank the President of INFN, the Executive Board, the chairs of the scientific sections and the speakers for the information and material provided for the review.