INFN CVI Report 2009

Conclusions of the CVI Meeting on 7-9 July 2009

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1 Executive Summary

The CVI had its annual meeting in the INFN Headquarters on July 7-9 2009 in order to evaluate the INFN performances during the year 2008. The evaluation addressed the entire spectrum of INFN activities, scientific, technical and educational, including their socio-economical impact.

Following last year's example, one day of the meeting was devoted to a visit of the Gran Sasso National Laboratory, where we had the opportunity to evaluate the large spectrum of the scientific activity of the lab, but also to get a first hand information on the severe sufferings the recent earth quakes had caused to a number of the personnel working there.

Before the meeting we had received a complete report on the *INFN Scientific Productivity and its Socio-Economic and Inter-Disciplinary Impact* which offered a valuable picture of the entire profile of the Institute. The INFN President presented a report on the scientific and technical activities, as well as the questions related to the resources (financial and personnel). We heard comprehensive presentations covering each one of the five sections and a specialised one on the socio-economical impact.

Based on all this material, as well as the personal expertise of the panel members which covers most of INFN activities, we came to the conclusion that as an institution **INFN remains at a very high level of scientific and technological excellency and compares favourably with similar Institutions world wide.** Italian teams play often a leading role in international collaborations and the Italian School of Particle, Nuclear and Astro-Particle Physics is one of the best in Europe. The scientific program is rich and diversified with many important experiments either running or being prepared. A sustained effort for technology transfer and outreach is pursued. All CVI panel members unanimously expressed their appreciation for the scientific and technical achievements of the Institute.

Among the future projects a central position is occupied by the design, construction and operation of a collider dedicated to the study of the $B-\bar{B}$ system. The facility features important technological innovations, studied and developed by INFN scientists, aiming at a record luminosity exceeding 10^{36}, never reached until now. The CVI is convinced on the good discovery potential of such a facility which will address fundamental questions related to CP violation and the detailed study of the quark mass matrix. Its cost far exceeds the possibilities offered by the INFN regular budget and the CVI encourages the President to seek the necessary resources by applying to National or Regional funds. Whichever the outcome of this effort, this question will strongly influence the strategy of the Institute for the years to come.

The President presented the difficult situation of the Institute related to financial and human resources. **The CVI believes that the situation has reached a critical level.** It puts severe strain on existing and future programs and may jeopardise Italy's position in the international competition. Indeed, in some other countries research budgets have been increased. Unless significant new resources become soon available, the INFN Direction may loose the capabilities of launching new initiatives. **The CVI strongly supports the President in his efforts to recover the budget the Institute lost over recent years.** INFN is making efforts to tap European and Regional funds which may provide an alternative source of support and the CVI encourages the President to pursue further these possibilities.

INFN will face soon new challenges, both because of scientific and technical evolutions, but also because it operates in an increasingly complex international environment and has to relay more and more on a diversified profile of financial support. These conditions will make future strategic decisions even more complex. The INFN Direction has introduced some changes in the rules of Management to better prepare the Institute to face these challenges and the CVI supports these initiatives. The President suggested that the CVI could play a more active role in assisting the Direction when the latter is faced with important strategic choices and the CVI is willing to consider this possibility.

The CVI expresses its appreciation to the President and the Members of the Executive Board for their leadership during the recent years which allowed the Institute to maintain its outstanding contribution to science under difficult conditions. They deserve the gratitude of the international scientific community.

2 INFN Achievements and Perspectives

The broad picture of the present status of INFN and its future perspectives were presented to the CVI panel both in the GLV comprehensive report, which was available prior to the meeting, and the presentation by the President. The activities of the five scientific sections as well as the overall socio-economic impact of the Institute were the subjects of specialised talks and will be reviewed below.

The general picture is one of prolific activity combined with scientific excellence. All sections remain at the frontier of modern research. Italy's international position is very strong inside the large collaborations. Italian teams have played a leading role in the preparation of the LHC experiments and they are ready for data taking and analysis which is expected to start soon. The same is true for their contribution in running experiments at Fermilab as well as experiments in neutrino, astroparticle, or nuclear physics. The INFN supported research in theoretical physics is at an equally high level. Future projects are challenging and cover an impressive range of topics, from particle accelerators to underwater neutrino observatories and space based gravitational wave antennas.

A very ambitious project appears to be a high intensity electron-positron collider dedicated to the study of the $B\bar{B}$ system. Italian teams have been very active in the BaBar experiment at Stanford and this project aims at continuing heavy flavour physics with a new generation of very high precision measurements. This Super-B factory is based on a novel concept, the so-called "crab waist", developed at INFN, which will allow to reach a designed luminosity exceeding 10^{36}, a value never obtained before. It combines an increased crossing angle with a reduced vertical beam size, all this achieved without reducing too much the bunch length. A brief presentation of the idea is included in this year's GLV report. A specialised review panel is assessing the technical feasibility of the project. The CVI believes that such a facility, if realised, will be a tool for high precision studies and will address some challenging and fundamental questions in particle physics related to the details of CP violation. It is believed that new physics beyond the Standard Model may manifest itself in the parameters of the quark mass matrix and this facility will allow to reach the required accuracy. On the other hand, the cost of the project puts it far beyond the regular INFN budget and can be built only if outside funds are made available. The CVI encourages the President in his efforts to secure such funds. The decision at a Government level is due to be made soon[1] and the outcome will influence

[1]Note added: We have been informed that the Research Minister in a letter read

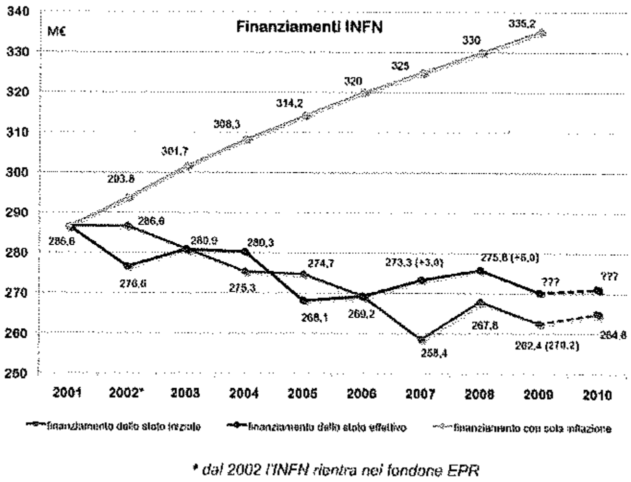

Figure 1: The INFN budget evolution in recent years. The green line shows what it "should" have been taking into account just the inflation rate, the red and blue lines are what INFN actually got, as initial and final budget respectively, every year.

the future strategy of the entire Institute. It will have a direct impact on the evolution of the National Laboratory at Frascati, but also it will largely determine the balance of resources allocated at the various sections. All these questions will require soon important strategic decisions from the Direction of the Institute.

A large project already approved by INFN is SPES at LNL, which will boost considerably the research program on nuclear structure. It is remarkable that the INFN Direction, although under severe financial conditions, was able to launch such an important project. The first allocations have been attributed and the CVI hopes that the project will be completed on schedule.

The CVI is very worried with the situation concerning the financial and human resources. The situation was already critical last year and the CVI takes notice, with regret, that this year's budget brings no improvement.
The situation is best shown in Figure 1. No comments are needed. It is clear that, unless drastic measures are taken to reverse the present tendency, the

during the European Strategy Session of the CERN Council on September the 18th gave her public support to the project.

Institute will soon be unable to launch new initiatives and will be obliged to sacrifice scientifically sound projects. The competitive position of INFN in the international scene will be weaken, especially if one takes into account that, in some countries, the research budgets have been recently increased. The CVI gives its strongest support to the President in all his efforts to recover the lost budget. The situation with regards to human resources is not much better. The restrictions concerning new positions in the entire public sector in Italy affect also research positions. The situation has become dramatic in most major Universities where the part of salaries in the entire budget was traditionally very high. This affects INFN in two ways. First it has a direct effect on the research effort since most projects are done in collaboration with University teams. The second, although an indirect effect, it is nevertheless very important. In the past young scientists often started their careers in INFN positions and later they were taking part in the national competitions for University positions. This created a constant flux of scientific personnel through INFN to the Universities. It was beneficial to both Institutions, to INFN which was able to hire more young researchers and to the University system to whom it offered a reservoir of well qualified senior scientists. This flux is now almost stopped. As a result, INFN has less hiring possibilities and more scientists remain in its payroll creating a pressure for senior positions which increase in turn the personnel budget. The CVI supports all efforts to convince the Government to ease the application of these hiring restrictions to both the research and the University sectors.

Last year we initiated a series of visits to the National Laboratories with the purpose of getting a first hand evidence of the work done there, but also of the specific problems each one is facing. This year we visited the Gran Sasso Underground Laboratory which has an extremely rich research program ranging from accelerator based neutrino physics to dark matter searches and the study of very rare processes, such as neutrinoless double beta decay. The specific evaluation of the scientific achievements will be presented below but we were all impressed by the quality of the infrastructure and the variety of the experimental program which make Gran Sasso one of the leading underground laboratories in the world. The Laboratory was still under the stress caused by the recent earthquakes which devastated the countryside around it. Although the scientific and technical infrastructures themselves had not suffered any serious damage, many members of the personnel had in their homes and families. The Direction of the Institute was able to react promptly by direct participation in the relief effort and the opening of special facilities for the reception of the children whose schools were destroyed. The CVI was impressed by the ability shown by the INFN Direction to face such unforeseen situations.

During the last years the INFN Direction has initiated a series of measures aiming at a more efficient governing structure. Among the measures taken is the creation of a Coordinating Scientific Committee and the transfer of responsibilities for day-to-day decisions from the Consiglio Direttivo, the main governing body, to the Executive Board. This will leave more time to the former to concentrate on strategic issues. The CVI approves these measures and encourages the Direction to pursue these efforts. The President expressed the wish to have the CVI taking a more active role in advising the Direction and the panel gave mandate to its chairman to discuss with the President the practical ways to implement this policy.

The GLV report contains an important section on the socio-economic impact of the Institute as well as its educational role. The CVI strongly approves a new initiative aimed at introducing INFN researchers in some high tech interested industries, with INFN financial support. This will facilitate technology transfer from research to industry and will help these industries to reach higher scientific and technological levels and increase their competitiveness. Concerning the educational role of INFN, the CVI can only repeat the conclusions reached in previous years stating that the record is excellent. The percentage of young scientists which obtain a Doctor's degree in INFN related subjects is, probably, the highest in the world and the scientific level is outstanding. Many young Italian physicists have brilliant careers in European and American Universities and research centres. The CVI was pleased to see that a recommendation we made last year concerning the establishment of an Alumni Association is being implemented. It will contribute to a larger visibility of the educational program and will help in adjusting it to the needs of the society. The CVI worries about the negative impact of the recent freezing of University positions which will force many among the best young Italian physicists to expatriate.

3 CSN-1: Experimental Particle Physics with Accelerators

INFNs participation in the research line of subnuclear physics encompasses a broad range of experiments at major accelerator centres worldwide. The main focus now is on the LHC detector commissioning and first data taking. Clearly, the LHC incident of last September had its natural impact on the activities of CSN1 this year and did not allow to present any results yet.

However, the strongly motivated community in the LHC experiment used the available time to commission eagerly the detectors, in particular using cosmic muons. The expected performances of the detectors and the computing infrastructure (Tier-1 and Tier-2 centres) have been greatly improved to face the first collisions, which are expected during winter 2009/2010. An impressive large harvest was obtained from the experiments at the end of their lifetime: ZEUS, together with H1, and BABAR are presenting their final data analyses, an effort which will still be maintained during the next years, whereas the Tevatron experiments, in particular CDF with a very strong Italian contribution, continue to collect data. First exclusions of the Higgs Boson since the LEP data in 2001 in a mass-range around 160 GeV have been presented, exploring further the energy frontier. In addition, the potential in flavour physics exceeds the expectations. With the run extension until 2011 the experiments have the opportunity for a real competition with LHC, and INFNs continued participation ensures Italy's presence in any possible discovery.

The second strategic line of the CSN1 activities is the preparation of the Super-B factory, a project at the high intensity frontier. Flavour physics has always been a field strongly supported by the Italian physics community, as can be seen from the KLOE/Daphne effort and the participation in Babar, LHCb/CDF and NA62 experiments. The success of the techniques developed in Frascati, allowing to envisage a luminosity 100 times larger than the one achieved by the current generation of B-factories (Babar, Belle), is a strong argument for Italy to host a high intensity e^+e^- facility. The INFN management should be congratulated for all the preparatory work to evaluate the technical feasibility of the project, to establish an international collaboration and to search for the necessary financial resources. The future of the project depends strongly on the outcome of the evaluation by the Italian government. The recent enhancement of the collaboration between Italy and Japan, who has now adopted largely the Italian advances in technology for a similar project, Super-KEKB, can only be welcomed as a very important contribution to establish a worldwide strategy in experimental particle physics.

Concerning flavour physics, the future of the KLOE program will strongly depend on the evolution of the SuperB project and can still be addressed in time. For the NA62 experiment at CERN, which has strong Italian contribution, sufficient funding could be raised. Besides, the involvements in COMPASS and MEG are foreseen to be continued.

Participation in R&D activities for LHC upgrades and the ILC is vital to keep the excellent standing of the INFN in this area. CSN1 has naturally a large-cross participation with CSN5, in particular for detector development (16%). This allows keeping a strong competence in instrumentation among the physicists, besides contributing to eventual technology transfers. As the start-up of the LHC is clearly delayed, the argument of limiting the current efforts for upgrade programs is understandable, yet groups within the collaborations are forming, especially concerning the upgrade of the tracking detectors, a field where the traditional strong contribution from Italy should not be missed.

Overall CSN1 is a very strong group within INFN, accounting for 26% of the INFN staff, 18% of the University staff and 19% of the PhD students. This is certainly justified by the necessity to reach a critical mass within the particle physics experiments. Clearly the main efforts of CSN1 are related to the LHC experiments, where the CMS and Atlas community alone represents more than half of CSN1 and about 60% of the INFN budget.

4 CSN-2: Experimental Astro-Particle and Neutrino Physics

The activities in CSN2 include neutrino physics, astroparticle physics and gravitational wave detection. INFN supports a large community involved in these areas, in some cases in a position of leadership. This is in part due to the existence of the Gran Sasso National Laboratory (LNGS), the largest in the world for non-accelerator particle and nuclear physics. For this same reason, some of the experiments taking place in Italy have a significant international participation.

Several experiments, in preparation or starting during previous years, have now entered the phase of full exploitation and have produced significant results that have attracted great attention. This era of scientific exploitation deserves full support. Planning for the future should take place in the overall European framework.

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

Neutrino Physics: Neutrino physics (21% of the budget) includes the CNGS (CERN to Gran Sasso) experiments OPERA (started) and ICARUS-T600 (goal for installation later this year), and participation in the long baseline experiment T2K in Japan. The CNGS program will continue for a few years, while T2K will start at the end of 2010. The BOREX (formerly

BOREXINO) experiment has also started in May 2007 and has already achieved one of its goals: the real-time detection of Solar Be-7 neutrinos. The limits obtained on departures from the solar neutrino model are already the best in the literature.

Planning for the future of this field has to wait until the completion of OPERA and the first results of T2K or other experiments trying to measure the unknown neutrino mixing parameter θ_{13}. It is recommended that it takes place in the framework of ApPEC, or other European-wide effort.

Search for Rare Processes: Three main areas of research are being pursued in this sector (20% of the budget):

(a) Neutrinoless Double Beta Decay. This area includes the CUORE (cryogenic bolometers) and GERDA (enriched Ge crystals inside a Liquid Argon bath) experiments both being built at the LNGS. These are leading experiments in the field and have a large international participation. Both will be able to probe the region of the claimed signal from the Heidelberg-Moscow collaboration and lower the limit on the Majorana neutrino mass if the above result does not hold.

(b) Direct Dark Matter Searches. These experiments try to observe nuclear recoils induced by the interaction of dark matter particles with the target material.

The DAMA experiment, lead by INFN scientists, did claim a positive observation of an annual modulation of a possible signal, an expected distinctive signature. A second phase of the experiment DAMA/LIBRA, with a larger mass, has confirmed the data. However other experiments do not confirm the signal, but the comparison may not be valid since both the target material and the type of induced signal are different. Ideally the DAMA experiment should be repeated independently, if possible in a different location. Meanwhile the DAMA/LIBRA will install new PMTs and reduce the threshold of the signal.

Another experiment which started taking data in May of 2009 is WARP-100, based in a double phase (liquid and gas) Argon TPC. It uses 100 litres of Ar and was preceded by the successful operation of a 2.3 l prototype. Yet another project is Xenon-100, which uses liquid Xe instead of liquid Ar. This experiment is being commissioned at the LNGS. These experiments are in principle scalable to higher masses.

(c) Search for Supernova Neutrinos. The LVD detector at LNGS has been in stable operation for years integrated into the Supernova alert system.

Cosmic Rays on Earth: This sector (20% of the budget) comprises the study of cosmic neutrinos with underwater telescopes and the study of gamma and charged cosmic rays with ground detectors.

The INFN participates in both the ANTARES and NEMO underwater neutrino projects, aiming at the detection of very high energy neutrinos of cosmic origin. ANTARES covers an area of 0.2 km^2 with 12 strings and is now in operation. NEMO is a demonstrator experiment for a future 1 km^3 neutrino telescope, off the cost of Sicily. The INFN is also participating in the EU funded KM3Net design study. In the future it is expected that there will be one detector in the Mediterranean of a one kilometre-cube scale.

On charged cosmic rays the INFN participates in AUGER, inaugurated in October 2008. The significance of the correlation of high energy cosmic rays with AGNs, indicated by the early data, has not improved with the new data and it is being questioned.

The ARGO experiment, carried out by an INFN-China collaboration, consists of a 10000 m^2 detector array at 4300 m above sea level in Tibet and it is being deployed.

MAGIC (at La Palma in the Canary Islands) consists of an Air Cherenkov Telescope of 17m for cosmic gamma-ray observations and has a strong INFN participation. MAGIC is now producing a large number of interesting results (with three publications in Science during the last year). It has the lowest threshold (about 30 GeV) of the telescopes of this class. A second telescope of the same size, MAGIC-II, has been commissioned this year. The future of this field is the CTA project, which figures prominently in the road-map of European initiatives in astroparticle physics.

Cosmic Rays in Space: In this sector (13% of the budget) the PAMELA satellite has found that the ratio of positrons to electrons increases with energy from about 1.5 GeV to 90 GeV (the maximum energy with significant statistics). This is unexpected and awaits confirmation.

The INFN also participates in the Fermi (formerly GLAST) satellite experiment. Fermi has produced many and very interesting results in just the first year of operation, including the discovery of many new sources. It has also looked for the indirect detection of dark matter. The excess of GeV gamma rays at mid-latitudes seen by the predecessor EGRET satellite has not been confirmed.

AMS-2 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 at CERN and will be ready for a scheduled lunch in the space shuttle in July 2010.

Gravitational Waves: (11% of the CSN2 budget). Italy hosts the VIRGO interferometer located near Pisa, operated by a French-Italian collaboration. The detector is now run in coincidence with the LIGO interferometers in the USA. A new upgrade, Advanced Virgo, has been approved by CSN2. It aims at an improvement over the present VIRGO of a factor of ten. At present the INFN also maintains the operation of three resonant bar detectors which monitor the galaxy: AURIGA, EXPLORER and NAUTILUS.

The long term project in the field is the LISA interferometer in space. The LISA-Pathfinder, testing the feasibility of LISA, is expected to be launched in 2011.

General physics: In this sector (4% of the budget) a number of small experiments, focusing on fundamental physics, such as the test of the equivalent principle, the measurement of G and of Newton's law at short distances, are also financed.

In conclusion, the INFN has maintained a very competitive program in the field of astroparticle physics, gravitational waves and neutrinos. Several major first generation experiments are now producing results, obtaining the scientific return of long term investment in the field. Most of them have a natural continuation in second generation experiments, some of which are now starting. The new generation experiments are larger and more complex, and this imposes that any future evolution should take into account international planning in the field.

5 CSN-3: Experimental Nuclear Physics

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: (1) Structure and dynamics of hadrons; (2) Matter at high-density and temperature; (3) Structure and dynamics of nuclei; and (4) Nuclear astrophysics.

Structure and dynamics of hadrons: This program is carried out both in external laboratories and at national laboratories (LNF). Three themes are being pursued: (a) Parton structure of the nucleon. The experiment HERMES at DESY is now completed and the results have been analysed and published. Ongoing experiments are at JLAB at 6 GeV. It is planned to continue these experiments in 2012-13 once the upgrade of JLAB to 12 GeV is completed (JLAB12 experiment). (b) Baryon and meson spectroscopy. Interesting results have been obtained in this area by the AIACE experiment at JLAB in the photoproduction of f0(980) of importance for understanding whether or not multiquark states occur. Other experiments are MAMBO and PAINUC. (c) Hypernuclei and kaonic atoms. This research is being done at LNF with the experiments FINUDA and SIDDHARTA. An important result here is the first measurement of kaonic deuterium aiming at understanding the kaon-nucleon interaction. INFN is also involved in the upgrade of JLAB to JLAB12, and, most importantly, in the R&D of PANDA and PAX at GSI-FAIR. The aim of these experiments is the spectroscopy of mesons and baryons and the structure of the nucleon through the measurement of its time-like form factor. Because GSI-FAIR will be the leading European facility in this area of physics, and in view of the fact that some experiments, such as the separation of the electric from magnetic form factors can only be done at this facility, the R&D of PANDA and PAX requires particular attention, and should be pursued.

Matter at high-density and high-temperature: This is a major program to be carried out at CERN. An important milestone has been reached with the formal end of the installation of the ALICE detector in July 2008 and the commissioning with cosmic rays. INFN is heavily involved in ALICE in the inner tracking system (ITS), the time of flight detector (TOF), the high momentum particle detector (HMPID) and the muon arm. All of them have been commissioned with the exception, because of its geometry, of the muon arm (70% commissioned). The first interaction in ALICE has been observed on September 11, 2008. The actual experiments with ALICE have been delayed by approximately one year, due to the accident that occurred at LHC in September 2008. However, ALICE is ready for Day 0 physics and the perspectives for the first year (2010) are excellent. INFN is also involved in the ALICE computing grid. Tier 1 is completed and Tier 2 is under way. Finally, the analysis of the pre-LHC experiment N60 has been completed and results published.

Structure and dynamics of nuclei: This research program is carried out mainly at the two national laboratories (LNL and LNS). At LNL the experiment GAMMA has produced interesting results on the structure of medium-mass nuclei with A 70. The combination of the PRISMA spectrometer with the CLARA array has been very instrumental in this research. A major step forward in the study of nuclear spectroscopy will be the development of the AGATA detector. A demonstrator consisting of an array of 5 detectors is being developed at LNL. This is a European project to which INFN is contributing considerably. The AGATA demonstrator was expected to move to GSI in 2010. However, the European collaboration has just extended this period at LNL to the summer 2011 and therefore additional funds may be needed by the laboratory to support its operation. One of the highlights at LNS is the experiment EXOCHIM, designed to study the isospin dependence of the equation of state. The detector array CHIMERA developed at LNS is now fully operational and has been very instrumental in this study as well as in others. Additional planned experiments are FRAG, which aims at the fragmentation of carbon ions, of particular interest for hadron therapy, and at the fragmentation of cyclotron beams to produce radioactive species for nuclear structure studies. The latter is a very interesting idea, worth pursuing as an alternative to EXCYT. The exploitation of EXCYT and MAGNEX has also continued. The major new development in this area is the approval by INFN of the project SPES. This project has evolved into various stages and in its present form consists of a cyclotron as a proton driver which impinges on a UCxISOL target to produce radioactive beams which are then accelerated by the PIAVE-ALPI complex. It is a very good project, if completed within 2012-2013, when SPIRAL2 at GANIL will come into operation. The project will produce neutron-rich radioactive beams, from fission products, of considerable interest for nuclear structure studies. The driver accelerator could also be used for applications in medicine and energy production.

Nuclear astrophysics: This research program is carried out at the two national laboratories (LNS and LNGS). A highlight of the program at LNS is the experiment ASFIN, designed to measure cross sections of interest for models of the interior of stars. A highlight of the program at LNGS is the experiment LUNA, aimed at a direct measurement of astrophysical factors at the energy of the Gamow peak. An important question that needs to be addressed here is the physical location of the new 4 MeV accelerator for nuclear astrophysics (LUNA3) being under design at the present time. It is of importance to keep this experiment at LNGS. Another experiment in this area is ERNA with a separator used previously at Bochum and now installed at Caserta with the aim of measuring nuclear reactions in inverse kinematics.

Interdisciplinary research: In addition to the four preceding areas, CNS3 includes experimental programs having interdisciplinary character. Worth mentioning are the experiments n_TOF, mostly of interest for nuclear technology, and ASACUSA, aimed at the measurement of antiproton-nucleus annihilation cross sections, both at CERN.

In conclusion, the INFN research program in experimental nuclear physics continues to be of very high standard. The ALICE program has been completed and it is ready for the measurement phase from which important clues on matter at high-density and temperature are expected to emerge. Progress has been made in finding a future for the nuclear structure program, with the go-ahead of the SPES project at LNL. INFN has contributed considerably to the development of the European detector AGATA. Establishing a role in FAIR at GSI has proceeded. Excellence in nuclear astrophysics has been maintained. The goal of developing the nuclear physics programs at the national laboratories, line 3 at LNS and line 1 at LNF, has however received a drawback due to budgetary problems and the competing projects NEMO at LNS and B-FACTORY at LNF. Once the situation with these two projects will become clear, INFN will be in a position to address the question of the future of the two laboratories. Their development is necessary to maintain the role that Italy has in experimental nuclear physics in Europe.

6 CSN-4: Theoretical Physics

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 often University Professors. 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 (of course, this is even more true for the experimental groups).

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 recent budget cuts are painfully felt. The CVI members are very worried with the consequences of the freezing of Professor positions in most major Universities. Already last year we expressed our deep concern on this matter. This year the situation starts becoming dramatic. In most Universities the senior Professors are retiring, or are close to it. If nothing is done very soon this excellent School of Italian High Energy and Nuclear Physics will decline.

The Galileo Galilei Institute has been a success. The programmes run so far were of very high scientific level. We should congratulate 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 (Newton Institute, Henri Poincaré Institute, Santa Barbara Institute, ...). The attractiveness of the City of Florence is a very good asset.

The Committee is concerned with the delay in deciding the future of the computing and simulation programme in theoretical physics. In the past years the APE project had allowed Italy to play a leading role 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. The continuation of the programme requires a strategic decision about its direction: designing and building a new "super-APE", or using a commercially available system. The Committee cannot recommend the right course, but strongly believes that a decision should be taken very soon and all efforts should be deployed to guarantee the continuation of the project.

7 CSN-5: Technological and Inter-Disciplinary research

The range of activities of CSN5 reviewed here concern the traditional areas of Detector development, Electronics&Computing, Accelerators as well as Interdisciplinary research.

Both FTE and budget for the Interdisciplinary lines show a constant slight increase over the last four years; they are practically constant for the Detectors, Electronics&Computing lines and are slightly decreasing for the Accelerator lines. The increase of interdisciplinary lines is linked to the strategy aimed at expanding the applications of INFN competences in areas with interesting high potential social and industrial impact.

The CSN5 Personnel is constant since 2006 but FTE/Heads shows a positive upward trend. An increase in the number of CSN5 related talks in the same period is also shown, indicating its growing involvement in the dissemination of the scientific and technological achievements.

The activities related to detectors are characterised by studies concerning a variety of pixel detectors for charged particles including hybrid pixel detectors, monolithic pixel detectors such as MAPS (Monolithic Active Pixel Sensor) which is now reaching maturity but with still room for further substantial improvements. New projects have started such as VIPIX aimed at building thin trackers demonstrators based on pixel sensors using high density microelectronics technologies and the vertical interconnection integration processes to meet the severe requirements of high energy physics experiments at SuperB-Factory, SLHC and ILC, as well as the development of a radiation detector based on Carbon Nanotubes in the frame of GINT collaboration (some prototype of which have already been tested). These activities imply deepening competences in electronics, more specifically microelectronics, in areas such as analog electronics front end, VLSI deep-submicron technology, silicon-on-insulator (SOI), VLSI time-to-digital converter, high speed serial link, low noise and high signal-to-noise ratio read-out, etc. CSN5 is aware that these types of developments are to be carried out not only in-house but also in collaboration with Semiconductor Companies (such as ST-Microelectronics) to create synergies capable to achieve the foreseen goals avoiding useless duplications for CSN5 and, at the same time, focusing on peculiar new developments which might also create opportunities for possible further technology transfer.

The accelerator related activities are following the tradition which has ensured a great success not only in scientific studies (as a result of a strict interactions with the other CSNs, particularly CSN3 and CSN2), but also in the practical impact on applications concerning the medical domain with facilities such as CATANA and CNAO. The CATANA facility continues its successful operation since 2002. The related results observed from the beginning of the operation until April 2009 are reported to show a very encouraging survival of 98% out of 186 patients treated. As to CNAO, the related facilities should now be close to the operation start-up. A 300 Mev/n superconducting cyclotron for ion beam therapy is reported to have recently become ready for realisation at LNS. The TPS project set up by INFN for the development of new treatment planning systems in hadrontherapy with light ion beam (in collaboration with CNAO for testing) is a further contribution of the excellent specific scientific competences of INFN and its capability to operate in an interdisciplinary environment. An interesting objective is to produce a well defined certified and ready-to-use deliverable in collaboration with an industrial partner (Elekta-CMS, associated to IBA). It is relevant to point out the continuation of the collaboration of INFN with industrial partners such as the Belgian company IBA for the application of TIPS results and the extension of the hadrontherapy machine developed by INFN in other European countries. Raising interest by other companies besides IBA is encouraged and actually taking place.

New interesting projects have been activated in recent years and new ones even more recently, related to accelerators to improve or update their performances. Examples are: CANTES experiment aimed at applying a carbon nanotubes based e-source into an ECR ion source to increase performances (with preliminary results showing the CNT emitters characteristics are protected from the effect of the milling action of ions by the alumina template) and a new concept of hybrid ECR source designed during the last year based on recent studies on microwaves to plasma coupling (particularly addressed to CNAO). Moreover, relevant activities are related to laser plasma acceleration and studies of RF cavities versus plasma cavities (particularly based on a 300 TW Ti:Sa laser synchronised with a 150 MeV LINAC at LNF)and especially the development of the FLAME laser system (now close to start experiments). The research activities on laser-generated plasmas and applications continue in the framework of the 2009-2010 PLEIADI project following the 2006-2008 PLATONE project.

Other important studies are receiving special attention among which the free electron laser at LNF (Self Amplified Spontaneous Emission- SASE), with the already observed initial experimental evidence of SASE operation and the first European facility for on line trapping of radioactive atoms (specifically francium isotopes considered the best candidates for APV measurements), built and commissioned at LNL.

Relevant Interdisciplinary activities are carried out also in areas related to cultural heritage and in medical applications different from hadrontherapy. These activities concern for example: Radiotherapy, Imaging (MAGIC-5 project) for lung, mammography and brain, especially for the early diagnosis of the Alzheimers disease, Modeling and Simulation (in the frame of GEANT4 collaboration). Among these activities an interesting area of applications in nuclear medicine is related to boron neutron capture therapy (BNCT) of disseminated tumors at the Pavia reactor and the development of a synthetic single crystal diamond based dosimeter for radiotherapy applications (DIARAD, 2008-2010 project). In the framework of the imaging activities Magic-5 project is particularly interesting. Especially valuable are the lung CAD development which has generated results suggesting now to move in the direction of looking for an industrial partner to turn the prototype into a market product, and the brain MRI for the early diagnosis of the Alzheimers disease.

The facilities and techniques related to the study of cultural heritage and environmental analyses, have kept improving, involving, in particular, LABEC, LANDIS LAB ALPHA with the PIXE system and other dedicated techniques. This is an area of competence which has received a great international recognition with the 2009 IBA Europhysics Prize awarded by the European Physical Society to the director of the Florence INFN section for the development and application of Ion Beam Analysis in the field of cultural heritage.

In summary, The CSN5 activities, also performed in the framework of numerous prestigious collaborations with national and international Institutions and some industrial entities, are plentiful and very diversified needing probably more financial support than that made available with the present constraints. Possibly, further financial support should be raised from Italian regions, especially in the areas of medical, energy and cultural heritage applications. A strict prioritisation policy might otherwise become necessary. All these activities confirm the capability to achieve successful results in various technological areas not only for scientific purposes but also for applications with high social impact.

8 Socio-Economic impact

There are seventeen public Research Institutes in Italy (excluding local or private institutes which obtain some resources from the central budget).

	All Research Institutes		INFN	
	Total resources	Central budget	Total resources	Central budget
2004	2486	2064	298.9	280.3
2009*	2745	2293	285.6	270.2

Table 1: Resources for the research sector. *Estimates at June the 30th

Two are institutes producing statistics and economic research (Istat and Isae), the others are in the field of Science and Technology; among them the most important are INFN, CNR and ENEA (all the others are rather small or very small). From 2004 to 2009, the financial resources for all of them are shown in Tab. I[2]

Resources for the research sector from 2004 to 2009 increased by 10,4% (total resources) and by 11,1% (from central budget), while general transfers in capital account from central budget in the same period increased by 28,5%. Resources for research increased much less than other similar public expenditures; the case of INFN is still worse, because in the same period total resources decreased by 4,4% and that from central budget by 3,6%. So in nominal terms there was a decrease, but in real terms the decrease is much more important; indexing 280,3 millions of 2004 at the inflation rate in 2009 the amount from central budget would have reached 304,8 millions; the decrease then is 12,8% in real terms (actually the percentage is undervalued, since salaries for researchers and high tec. capital equipments have a rate of increase higher than the inflation rate at consumers price). The result is that the INFN share of total resources and resources from central budget went down from 12% (total resources) and 13,6% (central budget) in 2004 to 10,4% (total resources) and 11,8% (central budget) in 2009. If we look (Tab. II) at the percentage of investment expenditures of all the research Institutes is not surprising that we find a decrease of the relative share both for all Institutes and INFN, but the percentage for INFN is much higher than that of the total Institutes, and the cut in research expenditures is greater not only in absolute terms but also in percentage term, that is (6,7-4,9)/6,7 is equal to 26,9%, while (33,4-23,2)/33,4 is equal to 30,5%.

In Tab.III we can look at the strong change in the composition of expenditures as a percentage of resources coming from the central budget of

[2]Data from Infn and Ministero Economia e Finanza, Relazione (EUEF) per il 2009, tabella 3.3.5-5 (p. 104): Enti di Ricerca Amministrazione Centrale. Data from Treasury are on cash basis, while data from Infn are on accrual basis. Anyway the Infn ratios between cash and accrual are fairly constant, so that the ratios in Tab I are not really affected by the conceptual difference.

	All Research Institutes	INFN
2004	6.7%	33.4%
2009	4.9%	23.2%

Table 2: Investment share

the Treasury (resources from the Treasury represent more than 90% of total resources).

	Operation	Personnel	Research
2004	24.9%	41.7%	33.4%
2008	21.3%	53.9%	24.8%
2009	21%	55.8%	23.2%

Table 3: Total budget in share

As we noted in the previous report (2008) from 2006 the cushion of the forced saving, which has been used to finance some large projects producing payment on a multiannual basis, is disappeared, so that the budget assignment is now binding. INFN does mainly basic research; it is also able to attract resources coming from other sources than the central budget of the Treasury, but in a limited amount: last year INFN obtained 25,3 millions from EU, Asi, Miur and Regions (for special projects) which represent a 8,2% of total resources, which is the highest percentage of the last nine years. This year estimates at June 30 are around 15,4 millions, a 5,4% of total budget. . Tab. II shows how the level of investments by INFN is five times that of the mean of all research Institutes; all the big machineries and infrastructures need also necessary operational expenses, so that the percentage decrease of research expenditures imply also some decrease in operational expenditures. The decline in total resources is very strong this year: -7% (total resources) and -4,1% (central budget) in nominal terms. Projects for future researches are decided not on the base of what is better from a scientific point of view, but on the base of what can be done with the budget constraints.

In the 2008 report we wrote: "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 even more true for the near future.

9 General conclusions and Acknowledgements

All CVI panel members unanimously declare that our last visit in Rome was a most instructive and enjoyable experience. We learnt about new and exciting projects and we had the pleasure to see many scientifically interesting new results. INFN is a research institution of the highest quality and we can only wish it is given the means to continue its road of success. We would like to ask the President to transmit to all the personnel our appreciation for the work done. We would also like to thank him together with the members of the Executive Board, the chairpersons of the scientific sections and the Direction of Gran Sasso for organising such a successful meeting as well as for the warm hospitality extended to us.