INFN INTERNAL REVIEW COMMITTEE (CVI) REPORT, 2005

Executive Summary

The CIV met on July 11, 12, 2005 and heard presentations covering a broad range of topics including the triennial plan of INFN, the situation with respect to resources, the five scientific lines and the evaluation process. In addition, copies of presentations on other occasions by the Directors of the four national laboratories were provided in advance of the meeting.

Overall, the program of research in INFN is world class. The institute is a major player in all the fields in which it participates. This excellence is reflected in the extent to which INFN researchers are chosen for leadership roles, for important conference presentations, and in the extent to which the publications are uniformly high profile. Finally the facilities which INFN brings to the world table are superb and, in some instances, unique.

In response to the need for research institutes to demonstrate their relative quality, INFN is using the guidelines put in place during the past several years by the CIVR. In addition, a small group in INFN is investigating a further possible step in this process. This is an attempt to formulate a global numerical characterisation of the research based on a quasi-complete set of existing measures. These studies are at an early stage. Caution and care should be applied until the extent to which the results are robust and applicable can be established. It may be important to share the work with comparable institutes across Europe since the acceptability of conclusions depends on how acceptable are the methods.

The situation for CSN I, particle physics with accelerators, is interesting. The productivity and the science from the INFN participation in the BaBar program at Stanford, and in CDF at the FermilabTevatron, continue at the highest level. Those programs are mature and there are discussions, which INFN must follow closely, concerning their eventual longevity. The big challenge for all of particle physics, including INFN, is the mounting and commissioning of the Large Hadron Collider accelerator and experiments over the next two to three years. Furthermore decisions have been taken over the course of the past year, which lay out a program of research and development leading to construction of an International Linear Collider. INFN will need to energetically establish its roles in this area and is already well placed based on its past participation in the Tesla Collaboration.

For astroparticle physics and neutrinos, CSN II, there is a premium on re-establishing the program of work at the Gran Sasso Laboratory, which was restricted as a result of environmental concerns. It is hoped that the Borexino detector can be filled with liquid during the course of the next year and that the Cern to Gran Sasso beam can start to deliver beam to a complete Opera experiment during 2006. There are several developments with the global neutrino program in the US and Japan and INFN will need to carefully consider the future opportunities. One interesting possibility advanced was the evolution of Liquid Argon detector technology in the direction of proton decay searches. For the present, the committee was struck by the breadth of the

astrophysics program and while fully supporting an appropriate level of diversity, it felt that future developments might benefit from some higher degree of coherence.

The nuclear physics program (CSN III) continues to be vital with prominent activities in all of hadronic structure studies, nuclear structure and dynamics, matter in extreme conditions of density and temperature, and nuclear astrophysics. The primary issue concerning the committee is that of the positioning of the national laboratories within Europe; this is discussed more below.

For theory, CSN IV, the existing suite of research is extremely healthy with a high degree of success. The committee is also pleased to see that within the scientific committee, initiatives are being encouraged, and carefully managed, which are generating activity in areas in which INFN was previously not sufficiently well represented. Several specific initiatives now address quark gluon plasma on the one hand and astroparticle physics on the other. Several directed fellowships have been created and awarded and a new school, the Galileo Galilei Institute (GGI) will provide opportunities to encourage activity in a succession of new areas.

In the area of technology (CSN V), progress appears to be excellent and impressed the committee.

The activities in the area of technological innovation and other areas, contribute clearly to science advancement, and also have important socio-economical impacts in terms of public utility applications and stimulation of advanced technology in industry. Most prominent from this viewpoint are the activities in the field of hadron therapy accelerators, imaging, and computing impacting on medical applications and other fields. The committee feels that even more could be achieved as far as introducing the work of INFN to the public and to industry. It is also important to emphasise the roles of the INFN national laboratories as platforms for much of this work.

The President of INFN introduced the CIV to the concept that the time has come for INFN to develop a plan for the evolution, a roadmap of its activities over the next several years. There are several motivations:

- The projections of budget possibilities do not suggest significant growth in funding over the next few years; this implies that in order to introduce new initiatives, there will need to be a redirection of resources.
- If INFN is to retain its pre-eminent role in the world of physics, it cannot be simply a contributor, however important, to initiatives in the rest of Europe and the World. It will be necessary to generate initiatives within Italy which can attract world attention and support.
- It is clear that the major components of the programs of all the four national laboratories are at a point when their existing programs need re-examination, reenergisation or redefinition. These facilities are important components of the world physics resource network and their planning cannot sensibly be considered independently of facilities in the rest of the world.
- The external constraints and parameters are changing. There are major programs in the United States, in which INFN participates strongly, whose futures beyond the next couple of years are under discussion. Conversely there are discussions of new and future programs, for example the FAIR project at

GSI, Darmstadt in Germany and the International Linear Collider initiative. The recent decision to site the ITER fusion program in Cadarache, France will result in reverberations throughout the technology based institutes of the whole of Europe.

The committee is concerned that all the important factors be considered in this process. These factors include the evident stringencies and inflexibilities in the available resources and their apportionment among materials and personnel. In particular the difficulties of maintenance of opportunities for the youngest and brightest future Italian scientists remains a major concern for the committee. It will be important for INFN to increase the visibility and the leverage of their significant developments in the area of application of the fruits of the research to socio-economic issues.

The committee was very pleased to find that the INFN Directorate is well aware of all of these issues and more. The committee was impressed that the President and the Directorate appear to be determined to involve the existing scientific management structures in the discussions of the future. The intent is that a broad consensus about the major initiatives can be forged. The President expressed the view that, should the discussions and the physics goals suggest that changes to the organisation be desirable, he is ready to consider such a possibility. The committee feels that all aspects of this approach are very healthy and looks forward to hearing about the plan itself in the future.

Status and achievements of the INFN
The 2006-2008 INFN Plan

In his presentation of the key elements of the INFN Triennial Plan for 2006-2008, the President concentrated on the resource planning giving a picture of the present and the future. The discussion of the scientific issues was deferred to the presentations from the individual scientific committees.

Of considerable importance is the situation concerning personnel. Overall the fraction of the INFN budget devoted to personnel is less than 50%. By most measures this is a very healthy situation. In physics research, the unhealthy situation arises when the budget available for investment in materials or in services is less than about 30%. However, since the personnel component of the budget is controlled directly in terms of numbers of employees permitted in the different sectors, there are considerable difficulties. Of the total personnel, a considerable fraction of persons are in fixed term positions. It is especially clear that many fixed term positions for researchers are occupied for a longer period than is healthy. There is a trend for persons to take longer to reach the point at which they join INFN (doctorate) or are awarded permanent positions for which they have already competed successfully. It is anticipated that there will be a considerable number of retirements of researchers in the upcoming years, which should allow INFN to manage the situation. Nevertheless, it has been decided that the situation be managed by introducing central selection and distribution of fixed term positions. The committee does not see any other better solution to this situation, given the present laws. One area which is receiving attention is that of affirmative action. Measures, such as the provision of crèches, are being promoted to improve the relative situation with respect to female/male employment in INFN.

Attention has been paid to the conventional infrastructure, the four national laboratories and the sections, along with the projects, including the grid, which are vital to the science. Often-forgotten components are the information and business systems and a new business system is being deployed.

The plan for the research is conditioned by the basic budget expectations. It is expected that the budgets will be constant and hence reducing in terms of purchasing power. This implies a steady reduction of most components. It will become increasingly important that the institute compete well for EU resources and share in EU wide programs and specific grants, as well as regional resources within Italy. This is already happening with INFN participating in, for example, a number of EU-funded accelerator R&D projects.

It is the intent of INFN that the efforts to transfer technological understanding, techniques, and processes to Italian industry and other sectors of the economy be reinforced. This will become increasingly important; as stated elsewhere in this report, the committee considers the opportunities in this area to be rather attractive.

The presentation by the President emphasised the need for an in-depth study of future directions for INFN. This will involve all the scientific lines. Considerable emphasis was placed on the desire to promulgate the discussions down and up through the scientific committees so that any plan, which emerges, has broad support

within the whole institute. Indeed the President emphasised that the human resources of the institute have the highest priority along with the need for a plan. Overall, it is expected that the plan will be such as to position INFN within the worldwide physics, the European resource management system, and ensure excellent integration in the national society.

The Committee is impressed by the considerate but proactive approach being taken by the INFN management. The Directorate has been in place with all its current membership for less than a year. There is every indication that it is approaching the task imaginatively and energetically. We look forward to seeing a complete plan next year.

Experimental subnuclear physics with accelerators-CSN I

A major thrust during the past several years has come from attempts to understand the quark flavour system which seems to be characterised by the so-called CKM (Cabbibo-Kobayashi-Maskawa) matrix. In the Kaon system, advances by several experiments across the world including the KLOE experiment at the Frascati-DAFNE accelerator, have ironed out a longstanding discrepancy. The program at KLOE is now mature with only modest further increases in luminosity anticipated. In the B system at BaBar, the precision of the measurement of the β angle of the CKM triangle has continued to improve. New advances have come in measurements of the α and γ angles. For example, the BaBar experiment, in which there is strong INFN participation, appears to have observed direct CP violation in the B-> $\pi\pi$ system and interesting measurements are coming in the B -> $\rho\rho$ system. However, in contrast to the β measurements the situation for α and γ does not enjoy good agreement between the two different experiments. The B system, however, is also proving to be a good laboratory in which to observe new light meson states.

In the Tevatron Collider CDF experiment, the primary target is the search for new phenomena and the understanding of the top quark. Nevertheless the physics of the B_s system is currently only accessible at the Tevatron. Limits on the rare decay, B_s -> $\mu\mu$ have been set at 1.5 10^{-7} (90% CL) and are starting to restrict possible SUSY contributions to this channel. Measurements have been made separately of the two lifetimes, which correspond to the short and long-lived B_s eigenstates. The searches for new physics are currently all negative but CDF has recently presented a measurement of the mass of the top quark which matches the previous world average and promises significant improvements to come soon.

The INFN groups have enjoyed good physics success and have recently filled the key Spokesman roles for both BaBar and CDF and the physics productivity is excellent. The PEPII accelerator was hampered by reduced running during the year as a result of a serious accident which affected the SLAC laboratory operations. Along with that of the Tevatron, the duration and strategy for the future program will be the subject of a study within the USA over the next several months.

Enormous efforts are being made by INFN groups which are participants in many of the critical subsystems of the LHC experiments, Atlas, CMS and LHC-B.

These initiatives also have been a showcase for Italian industry where, as only one example, the magnet manufacturer, Ansaldo, has been very prominent. Italian groups play big roles in the electromagnetic calorimeters and the muon detector systems of both Atlas and CMS. For CMS they are also major players in the silicon tracking and for Atlas in the silicon pixel vertex system. Progress with the LHC machine components has also been marked and the first fifty dipoles are in the tunnel.

Major efforts have been made to deploy computing across the world, in order to enable researchers to analyse the data anticipated from the LHC. This has already enabled considerable planning and preparation for physics. Emphasis is on the early discovery potential of the experiments.

Pressure is high on all aspects of the LHC schedule both for experiments and for the machine. Many have emphasised that this project cannot be allowed to fail, the credibility of big science would drop immeasurably. This pressure will put a heavy premium on strong and sensible management of the end games. Discoveries may await us, but the detectors will need to operate for approximately 20 years; they are delicate and careful and thorough testing should be demanded.

With the collider program complemented by well chosen programs in fixed target flavour experiments and in deep inelastic experiments, Compass and Zeus, INFN should be very pleased with the excellent productivity and prominence of its particle physics program.

Experimental astroparticle and neutrino physics-CSN II

Two years ago, a considerable fraction of the operations at the LNGS, Gran Sasso laboratory were suspended as a result of environmental problems. At this stage considerable progress has been made in restoring normality and improving the drainage systems. It is expected that the major experiment, Borexino, affected by the strictures, will be able to be filled with liquid inside the next year. The Opera experiment designed to detect the appearance of ν_τ in long baseline oscillations of the neutrino beam from CERN will be ready for the anticipated beam in 2006. The T600 module of the ICARUS experiment has also been installed in the Laboratory and will be commissioned over the course of the year with a view to operations in 2006. This will be the end result of this phase of the ICARUS program. In conjunction with the collaboration, INFN is examining the prospects of a new approach to construction and purification which could be possible based on large scale industrial Liquid Natural Gas tanks.

Other thrusts in the program of work at the Gran Sasso laboratory include searches for Dark Matter where follow-ups to the DAMA experiment are being prepared. Also prominent is a program to search for neutrinoless double β decay which, with sufficient sensitivity, could provide an indication as to whether the neutrino is a Majorana particle and if so, what is its mass. The Gran Sasso continues to occupy a unique position; it is the most extensive underground laboratory in the world.

Cosmic Ray experiments supported by INFN run the full gamut from large scale land based arrays such as the Auger detector in Argentina and the Argo array in Tibet, to the Pamela and AMS experiments to look for antiparticles in space; from the Magic gamma ray telescope in the Canary Islands to the GLAST detector to be deployed in space.

The spectrum of experiments is very broad. This committee has argued in the past that, in a young field such as astroparticle physics, the fruitful direction is not obvious and a consensus is hard to achieve. Nevertheless, the committee at this stage feels that it is appropriate to make sure that the development of the plan, the roadmap, over the course of the next year, should pay some attention to the coherence of the program in particle astrophysics and neutrinos. One area, that of large underwater detectors, has acquired particular importance. INFN is participating in a joint venture with French, and other, physicists in the Antares project which is sited off Toulon, France. The idea is that eventually a choice would be made between the Antares site and a site being investigated off Sicily, for which the project name is NEMO. Since there is yet a third initiative led by some Greek groups, with the project name NESTOR, it is important that a rationalisation take place and European resources not be dissipated in the pursuit of three fully fledged competitors.

A clear example of INFN excellence is the VIRGO gravitational wave experiment which is a joint IN2P3-INFN initiative. The very large laser interferometer is now installed in Cascina, Italy and has made enormous strides towards operation. A physics run in 2005 is fully anticipated. Along with operation of several cryogenic bar detectors, INFN physicists are exploring the space based initiative LISA on a much longer timeframe.

Over the course of the past 15 years particle astrophysics and our view of cosmology have changed significantly. Perhaps because of the youth of the field, we tend to expect that a new discovery will be just around each corner. A prerequisite for discovery is a full suite of operating experiments. With the recovery of the Gran Sasso laboratory, Virgo commissioned, Opera ready to go the next year, INFN should feel it has put in place the necessary components for a successful program.

Experimental nuclear physics-CSN III

The experimental nuclear physics program covers a wide spectrum of research that can be classified into four main areas: (i) Structure and dynamics of hadrons; (ii) Structure and dynamics of nuclei; (iii) Matter at high density and temperature; (iv) Nuclear astrophysics.

Structure and dynamics of hadrons: This program includes experiments both at external facilities and at LNF. The program is of very good quality and has achieved important results. Two of the most notable results are the experimental verification (AIACE at TJNAF) of the non-existence of pentaquarks, particles thought to be formed of four quarks and an antiquark, which has major implications for the future of the entire field of hadronic physics, and the observation of kaonic hydrogen (DEAR+SIDDHARTA at LNF), a form of hydrogen in which the electron is replaced

by a strange particle, which provides information on the interaction between strange and non-strange particles. Other parts of the program (HERMES at HERA, FINUDA at LNF) have also good visibility. The combination of outside and local (LNF) activities appears to be good. Maintaining a strong program in this area would require a development of LNF (DAPHNE-2) and a re-organization of the outside activities in view of the changing world scenario, in particular, integration into the European framework (FAIR at GSI).

Structure and dynamics of nuclei: This program is primarily concentrated at the National Laboratories LNL and LNS. It is also of very good quality and has achieved important results. Two of the most notable results are the study of dynamic symmetries in nuclei, especially of the novel type of symmetries occurring at the critical point of quantum shape phase transitions (LNL/PRISMA+CLARA), and the determination of the equation of state of nuclear matter in the region of the liquid-gas phase transition (LNS/MEDEA+CHIMERA), displaying the unusual behavior of nuclear matter with a possibly negative heat capacity. Both of these results are at the forefront of research in their respective fields of nuclear structure and nuclear dynamics. Maintaining strength in this area would require development of additional facilities, SPES at LNL and EXCYT-2 at LNS. Integration into the European framework is already partly in place (GANIL-LNL collaboration), and could be further enhanced by other collaborative programs (GSI-GANIL-LNL/LNS).

Matter at high density and temperature: This program addresses one of the issues of major current interest, namely the question of whether or not phase transitions to different forms of matter occur at high density and/or temperature, in particular a transition to a de-confined phase composed of quarks and gluons. Experiments will be carried out exclusively at external facilities (CERN). The program is devoted to the construction of a detector (ALICE) within the framework of an international collaboration. The discovery potential of this program is very high. However, its scientific achievements cannot be evaluated yet, as the detector is under construction and first results are expected only in 2008. Future developments in this area need wait for the completion of the project and first data taking.

Nuclear astrophysics: This program is relatively small and is carried out at the National Laboratories LNGS and LNS. It is of excellent quality. Despite its small size, this program has already obtained interesting results, most notably the measurement of reactions of importance in the CNO cycle that determines the age of stars (LUNA at LNGS). This measurement has been possible because of the unique opportunities offered by LNGS. The development of a second generation radioactive beam facility at LNS (EXCYT-2) would be crucial for maintaining strength in this area.

The overall assessment of this program ranges from very good to excellent. The program compares well with similar programs in other European countries (most notably, France and Germany), in the USA and Japan. Its future appears to be well delineated. The only aspect requiring attention is the balance between funding of outside activities and of activities at the national laboratories.

Theoretical physics-CSN IV

Activities of this group can be classified according to six "Iniziative Specifiche (IS)".

Quantum Field Theory and Strings remains a strong area of research, attracting a growing number of young researchers. String theory provides a challenging framework for combining the standard model of particle physics with a quantum theory of gravity. Its scope has lately evolved by adding to the study of its mathematical structure that of its implications for accelerator and astro/cosmo-particle experiments. It has also brought new tools for studying non-perturbatively a large class of supersymmetric gauge theories, complementing those of the lattice approach, so far the most successful way to study non-perturbative properties of QCD, (confinement, chiral symmetry breaking, phase transitions at high temperature/density).

Particle Phenomenology is the other traditionally strong area of Italian theoretical physics, and has also continued to produce a stable research output at the highest international level. Work in this area ranges from neutrino physics, to supersymmetric extensions of the standard model, to alternative symmetry-breaking scenarios, to perturbative QCD, to extracting basic parameters of the standard model from lattice calculations (weak matrix elements, heavy-flavour parameters, signatures for the quark-gluon plasma). This group works in close contact with CSN I and plays an important role in the planning of future experiments.

The *Nuclei and Nuclear matter* group, while continuing successfully its traditional lines of research in Nuclear structure, Nuclear reactions, and Nuclear Astrophysics, has experienced further development of its component addressing the physics of relativistic heavy-ion collisions and the search for the quark-gluon plasma. In particular, a new IS, strongly correlated with the ALICE experimental program, has been recently created.

The share occupied by *Mathematical Methods* has been slowly shrinking, probably as a result of competition from String Theory with which it has important points of overlap (e.g. in non-commutative geometry). Other interesting topics belonging to this area of research are: non-linear dynamics and integrable models, classical and quantum chaotic systems, quantum information, and interpretations of Quantum Mechanics.

Activity in *Astro-particle and Cosmology* has grown at a considerable pace over the last few years, probably as a result of the quantity and quality of challenging data recently harvested in the field. It covers a large spectrum of subjects, from more traditional astrophysical ones, like neutron stars and radiation sources, to conventional and unconventional models of inflation, dark matter and dark energy. It also covers neutrino astrophysics, as well as gravitational-wave sources. The good quality of INFN research in this field is reflected in the high level of ISI-citations.

Statistical physics and field theory, though a small component of CSN IV's activities, provides an important bridge to other fields of theoretical physics, like

those of complex systems, turbulence, and biological systems, as well as non-equilibrium statistical mechanics and stochastic processes.

Besides the six specific initiatives, two more items are worth mentioning:

CSN IV has one special project, *ApeNEXT***,** that will soon make computing resources of the order of 20 Tflops available at various locations within INFN but also in France and Germany. Such an order of magnitude increase in computing power will allow important progress on the particle physics questions mentioned before, as well as in other areas, such as turbulence, the physics of complex systems, and computational biophysics. It will make *ApeNEXT* the most powerful European-made dedicated Supercomputer as well as an excellent example of technological transfer.

INFN, together with the University of Florence, has recently approved the establishment of the *Galileo Galilei Institute for Theoretical Physics* (GGI) to be located in Arcetri (Florence). In its initial planning GGI will host each year two 3-months long workshops in basically all the areas covered by CNS IV. An inaugural conference will be held in September 2005 and the first workshop will take place in the spring of 2006. While the main aim of the workshops remains that of making progress on hot theoretical issues, the encouraged participation of doctoral students and post-docs will help their insertion in active research. GGI will also play an important role in identifying the most promising directions of theoretical research in the years to come.

In conclusion, CSN IV appears to be still following a very promising course. The main cloud on the horizon is the scarcity of openings for young Ph. D's and post-docs (both in the University and within INFN). Together with the poor financial conditions offered by Italy to its youngest generation, this could lead to a dangerous brain drain that would negatively affect the evolution of this component of INFN's activity and, by consequence, of Italian theoretical physics in general.

Technological and interdisciplinary research-CSN V

The development of technologies for experimental particle, astroparticle and nuclear physics and of their application in other disciplines or in industry has been a continuous effort within INFN. These efforts resulted in impressive scientific and technological capabilities, positioning INFN high in the worldwide ranking and with well developed interdisciplinary activities.

About 100 different projects are on going each year. In general these projects are rather small (3-5 FTE/project) and short-term (2-3 years/project) activities with a constantly high level of scientific productivity in terms of publications, presentations at international conferences and achieved milestones. The overall budget of CSN V is rather low, about 4M€/year, but CSN V is using infrastructure and facilities, which are also financed by other sections or the national laboratories.

By linking projects and by allowing the necessary follow-ups, the good level of application in other scientific domains or in industry is reached. This maturation is especially visible in the bio-medical domain. Two outstanding examples are the

CNAO collaboration, where INFN is in charged of the technical realization of the future hadrontherapy facility in Pavia and the operation of the CATANA hadrontherapy facility at LNS, leading to the development of the SCENT super conducting cyclotron technology. A recent agreement was reached to work in collaboration with ACCEL, one of the leading companies in the sector of commercial accelerator units and ANSALDO SUPERCONDUTTORI, producer of super conducting magnets.

A high social impact is especially visible for the activities related to the medical/biological applications or to the sector of cultural heritage. It is important to keep a high priority in these fields where INFN has achieved excellence. An important economical impact of applications is occurring in other domains. A prominent example is the contributions to the new synchrotron radiation sources with the advent of SPARC and its associated free electron laser SASE-FEL. Further domains to enhance development could be civil security or material science.

Concerning innovative instruments and technologies produced in 2004 by CSN V, some increase is seen related to particle sources for accelerators compared to the previous triennium. This may be considered positively in view of the worldwide high interest in the activities related to accelerators. This interest is generate by the development necessary for the future programs of accelerator based particle physics (ILC, neutrino factories), new sources of synchrotron light as well as medical and biological applications.

The excellence achieved by INFN merits a further increase in visibility and outreach with the general public, industries and all potential beneficiaries of INFN's technological and scientific capabilities. To facilitate the contacts and interactions particularly with industries and to speed up the finalization of the technology transfer policy, a generally accessible database of available competences could be a subsequent development of the booklet currently in preparation by INFN. Progress has been made to settle questions of intellectual properties and patents. In collaborations with industry it could be worthwhile to strengthen the consciousness of the importance of the time factor in developing and finalizing the existing and potential collaborations. This will allow INFN to maintain the present high rank position in strongly competing worldwide scientific and technological arenas.

Activity of the GLV

The INFN working group on evaluation, GLV, presented an evaluation report on the scientific activities in 2004. The evaluation is based on criteria requested by the triennial report 2001-2003 to CIVR, to which the new results have been compared. The indicators used are the number of publications and their impact, conference presentations, the degree of internationalization and leadership in international collaborations.

In the field of accelerator based particle physics (CSN I) it is striking to notice the relatively high fraction of leadership roles taken by INFN scientists in international collaborations, which exceeds the average participation of INFN in those collaborations (27% vs. 15-20%)

In astroparticle physics, the LNGS gives INFN the opportunity to play a particular role and have a major impact in the field. A general trend towards an increased internationalization can be seen for all INFN section, but is driven by nuclear physics (CSN II) reflecting major changes in the field towards bigger, international collaborations. In theoretical physics (CSN IV) the scientific impact is difficult to evaluate considering only citations during a given year, as major theoretical progress is often only recognized after longer periods of time. However selecting 19 papers on similar criteria than for the previous triennial review, places all of them among the top 10 cited papers in their field and is a valuable indicator of the liveliness of theoretical physics within INFN. It is also interesting to notice the increased effort of the technological and interdisciplinary research groups in diffusing their results to the international scientific community and the increasing activities, compared to the previous triennium, in terms of number of International Conferences, Workshops and Schools organized by INFN in Italy.

In general, INFN results show no major differences with those from the previous report and compare very well with the best international, and particularly European benchmarks along all the research lines. The high standards established during the previous evaluation remain or are slightly exceeded by the new estimators presented. Yet numbers can only partially reflect true scientific impact and should mainly be used to complete peer reviews and give an overall indication of the healthiness of research within INFN and its different sections. Establishing standards on the European and the International level within a given field would allow to refine the definitions of the indicators used and would render comparisons with other countries or institutions more meaningful. This idea was well received and some investigations may be pursued by INFN to see if initiatives in this sense may already be ongoing in other Institutions.

The committee heard a presentation about an idea to develop a single metric of the quality of the work performed by INFN. The method involves defining a list of general indicators. To the committee, the list appeared to be appropriate, however there were concerns about some of the indicators constructed as products of the individual measures, In particular, for one of the products, what constitutes an innovative component of an experiment and what not is unclear, and how to count different components of an experimental setup when it is segmented into various pieces.The use of a weighting system when combining different products has merit. However, some study is necessary in order to assess the robustness of the conclusions with respect to changes in the weights.

The classification of papers according to impact-factor ranges, as well as the set of proposed indicators for the specific CIVR evaluation, is interesting. However, for purposes of international comparison, it is not clear to the Committee whether or not the GDP/person is the appropriate quantity against which the number of papers should be plotted, rather than the share of it that goes into supporting research. This attempt to make an international comparison is interesting, but the Committee feels that more work is needed to define the indicators that are appropriate to the particular comparison one is interested in. It would also be important to check whether similar attempts at evaluation and/or comparison have been made or are planned in other Countries in order to arrive at some common criteria. Again, it would seem more

appropriate to plot productivity as a function of the country's investment in research rather than its GDP.

Resource management: budget and personnel

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 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 derogations);
- operational expenses and temporary staff are limited and procurements are centralised by a public corporation;
- increases in permanent staff are forbidden.

As we noted in previous reports (2003,2004), past cash-flow limits to budget authorisation led to an increasing forced saving, which reached a peak of 130 millions of euro in 2002; since from this year the budget assignment is almost flat; a Ministry decree of October 2004 established a 2% reduction for this year (2005) and the next one (2006); INFN estimates a possible 2% reduction, compared to the budget of the previous year, for 2007 and 2008 (the Ministry decree is waited for next autumn). Financial resources will remain fixed or decrease slightly for the next three years a part from resources available from special projects, which anyway are a percentage around 5% of total resources; in 2006 the cushion of the forced saving, which has been used to finance some large projects producing payment on a multiannual basis, will disappear, so that the budget assignment will be binding.

The change in total expenditures from 2003 to 2004 is described in the following table:

	Operation	Personnel	Research
2003	28%	31%	41%
2004	22%	41%	37%

The 41% of personnel in 2004 includes a 4% of retirement bonus. In the next three years personnel will increase slightly, operation will remain constant, but research will decrease. INFN is conscious, and the committee is concerned, that in the long run, the scientific activity will be harmed, if the financial laws continue to impose these restrictions.

This situation creates a real danger of a worsening of the human capital (mainly young researchers). In the previous report we had the opportunity to note that in the research field physical and human capital are not substitutes one for the other but are mainly complementary. Staff recruitment and term contracts are the main items of budget expenses in many Institutes of the public sector in general, and also in

research institutes. Institutes of statistical or economic, or research in the humanities, typically have 80% or more of their total expenses in human capital. The case of INFN is very different, since less than 50% is devoted to personnel. For this reason the use of the same limits (on human capital) as for Institutes that have so different cost structures, may lead to difficulties and inefficiencies; perhaps those limits should be diversified according to the different percentages of the budget of the various Institutes.

In this report we may add a second point: the flat (or even decreasing) trend of total financial resources in nominal terms leads to serious restrictions for new projects, since they imply new and more expensive machinery; this throws a shadow on the ability of INFN of maintaining the high standard which rightly INFN has obtained so far.

Membership of the committee

- U. Bassler, LPNHE - U. Paris VI/VII, France
- B. Ferrario, SAES Getters S.p.A., Italy
- F. Iachello, Yale U., U.S.A.
- H.E. Montgomery (Chair), Fermi National Accelerator Laboratory, U.S.A.
- R. Paladini, University “La Sapienza”, Roma, Italy
- G. Veneziano, CERN, Switzerland
- A. Wagner, DESY, Germany

Agenda of the INFN CVI Meeting

Rome, 11-12 July 2005

Monday, July 11

09:00	Welcome and Introduction from the President of INFN Discussion and approval of the Agenda *Closed session*	R. Petronzio
09:30	Report on the status and achievements of the INFN The 2005-2007 INFN Plan	R. Petronzio
	Discussion	
	Break	
11:10	Report on the experimental subnuclear physics with accelerators - CSN1 *Discussion*	M. Diemoz
12:20	Report on the experimental astroparticle and neutrino physics - CSN2 *Discussion*	C. Montanari
13:30	*Lunch*	
14:30	Report on the experimental nuclear physics - CSN3 *Discussion*	M. Taiuti
15:40	Report on the theoretical physics - CSN4 *Discussion*	P. Nason
	Break	
17:10	Report on the technological and interdisciplinary research - CSN5 *Discussion*	L. Catani
18:20	Closed Session	
19:15	Queries and questions to the INFN Executive Board and to the Scientific Committee Chairpersons	
20:30	*Social Dinner*	

Tuesday, July 12

09.00	Report on the activity of the GLV *Discussion*	A. Bertin
10:00	Attempts towards a quantitative evaluation of basic research *Discussion*	G. Viesti
10:45	Report on resource management: budget and personnel	B. D'Ettorre Piazzoli G. Ricco
11:30	*Discussion/Closed Session (Report drafting)*	
13:30	*Lunch*	
14:30	Responses to queries and questions posed to the INFN Executive Board and to the Scientific Committee Chairpersons	
15:00	Closed session (report drafting)	
16:00	Closeout: Comments and remarks by the CVI members *Discussion* Closure of the official part of the meeting	

Final remarks

- INFN Executive Members will be present to the presentations and discussions. All other invited participants will be present at the presentations and at the pertinent discussions.
- The time reserved for the presentations of the scientific programs are expected to be equally shared between presentation and discussion.