Memoria Técnica de la segunda fase del Programa de Actividad Investigadora

CONSOLIDER-INGENIO 2010
CONVOCATORIA 2007
Segunda fase

1. RESUMEN DE LA PROPUESTA

INVESTIGADOR COORDINADOR: Antonio Pich Zardoya

TITULO DEL PROYECTO:
CENTRO NACIONAL DE FÍSICA DE PARTÍCULAS, ASTROPARTÍCULAS Y NUCLEAR

RESUMEN:

Este proyecto CONSOLIDER pretende promover activamente la participación coordinada de los grupos científicos españoles en las investigaciones punteras en Física de Partículas, Astropartículas y Nuclear. Esta propuesta quiere potenciar la visibilidad de nuestros grupos, reforzar su competitividad internacional y garantizar una masa crítica, optimizando al mismo tiempo los recursos disponibles. Los objetivos que se detallan en esta propuesta han sido elegidos siguiendo una estrategia científica clara y bien definida.

El principal objetivo de esta propuesta es la creación de una nueva institución con carácter permanente, el Centro Nacional de Física de Partículas, Astropartículas y Nuclear, que consolidaría y garantizaría, principalmente mediante la contratación de personal técnico y científico, las actuaciones descritas en la memoria.

El Centro Nacional concentrará de manera prioritaria sus recursos en un conjunto de líneas de investigación perfectamente alineadas con las hojas de ruta establecidas por el CERN, ApPEC y NuPECC, que se detallan en esta memoria, y con el Espacio Europeo de Investigación.

La investigación en esos ámbitos se desarrolla en un entorno de estrecha colaboración internacional, normalmente en grandes instalaciones y laboratorios de primer nivel mundial y con participación de un gran número de personas e instituciones. La coordinación nacional a través del Centro Nacional de Física de Partículas, Astropartículas y Nuclear permitirá un mayor peso específico de los grupos españoles, y se traducirá en mayores retornos científicos y tecnológicos para nuestro país.

El Centro Nacional coordinará las actividades de los grupos participantes y podrá representarlos en los grandes proyectos e iniciativas internacionales. Promoverá y facilitará la participación en proyectos del Séptimo Programa Marco y otras iniciativas europeas. Contribuirá a proveer el personal técnico y el 'know-how' necesarios para abordar de manera competitiva en el entorno científico internacional los desarrollos tecnológicos necesarios para los futuros experimentos, tanto los ya aprobados (como el LHC, FAIR, MAGIC, ANTARES, Auger South, etc.), los que están en fase de I+D (como ILC, KM3, CTA, Auger North o EURISOL, por ejemplo), o los proyectos futuros que así lo requieran.

Finalmente el Centro Nacional permitirá promocionar actividades de I+D no accesibles a grupos individuales, apoyar la excelencia de los grupos con la incorporación de jóvenes científicos y personal técnico, asegurar la correspondiente transferencia de conocimiento tecnológico a empresas y potenciar las actividades de formación y difusión científica.

PROJECT TITLE:

NATIONAL CENTRE FOR PARTICLE, ASTROPARTICLE AND NUCLEAR PHYSICS

SUMMARY:

This CONSOLIDER project intends to promote a coordinated participation of the Spanish scientific groups in forefront research in Particle, Astroparticle and Nuclear Physics. The proposal is targeted to optimize the visibility of our groups, reinforce their international competitiveness and guarantee their critical mass while optimizing the resources made available to them. The objectives outlined in this project have been chosen with a well defined scientific strategy and timely and clear objectives.

The main aim of this proposal is the creation of a permanent new institute, the National Centre for Particle, Astroparticle and Nuclear Physics. This Centre will support the participating groups mainly by providing adequate technical and scientific personnel staff to them.

The National Centre will prioritize the use of its resources to support a number of lines of research that are listed in this proposal. They are perfectly aligned with the road maps established by CERN, ApPEC and NuPECC, and with the European Research Area.

Research in these fields is carried out in an international environment, usually the experiments taking place in large scientific infrastructures and world class laboratories, within international collaborations involving a large number of persons and institutions. The coordination through the National Centre for Particle, Astroparticle and Nuclear Physics will increase the specific weight of the Spanish groups in this competitive environment and will bring to our country larger scientific and technological returns.

The National Centre will coordinate the activities of the participating groups and may represent them in the large international projects and initiatives. It will promote and facilitate the participation in projects of the Seventh Framework Programme and other European programs. It will help provide adequate technical staff and expertise to face the challenging technological developments required by future experiments, both for the ones already approved (such as LHC, FAIR, MAGIC, ANTARES, Auger South, etc.), those in phase of R&D (such as the ILC, KM3, CTA, Auger North or EURISOL, for instance) or all those future projects that might require it.

Finally, the National Centre will promote those activities of R&D not accessible to individual groups, support the excellence of the groups with the incorporation of young scientists and technical personnel, ensure the corresponding technological transference of "know-how" to Spanish firms and reinforce the training and outreach activities.

2. DESCRIPTION OF THE RESEARCH ACTIVITY PROGRAMME

The main goal of the National Centre for Particle, Astroparticle and Nuclear Physics is to propitiate a significant participation of Spanish science in the important challenges of the XXI Century in these fields. We want to reinforce our competitiveness at the international level, increase our visibility significantly, and allow our research to take a leading position in some areas. At the same time, we want to guarantee an optimal use of the resources made available to us and ensure optimal technology transfer to society. In order to reach these goals, we need to have a planned scientific strategy, an efficient coordination of the activities in our groups, and adequate human resources, in particular those related to the more technological aspects. At present, on all three counts the Spanish scientific community is lacking appropriate instruments.

The groups participating in this proposal work on different subjects, most of them in the frontier of our knowledge in Particle, Astroparticle and Nuclear Physics, such as the origin of elementary particle masses, the nature of dark matter, and dark energy, in our Universe, the matter-antimatter asymmetry in the Universe, the unification of all fundamental interactions, including gravitation, the origin and nature of cosmic radiation, the properties of neutrinos, quark and lepton flavour dynamics, the dynamics of quark confinement, the mass and the structure of hadrons, the structure and limits of existence of atomic nuclei, the origin of chemical elements in stellar nucleo-synthesis, and the equation of state of nuclear matter and its phase transitions. The research activity in these fields takes place almost exclusively in the framework of international collaborations with the participation of a large number of scientists and institutes of the highest scientific reputation.

On the other hand, the experimental techniques and the technological developments in Particle, Astroparticle and Nuclear Physics have traditionally been of great impact to society at large. Information technologies (such as the web) or many developments in medicine (e.g. cancer therapy) owe their origin to research in particle and nuclear science. Thus progress in these fields has potentially great impact in society. We would like to make sure that Spanish scientists play a role in the technical advances in accelerator physics and detector instrumentation and that these advances are properly transferred.

The instruments and tools that are available today in the Spanish science system are somehow not sufficient if we want to give a leap forward and become part of the countries leading world science. It is a fact that in the fields of Particle, Astroparticle and Nuclear Physics our scientific community is very well positioned in the European research area and that it should be possible to give this big step forward, provided that the needed support and resources are available and, perhaps even more importantly, provided that proper coordination and organization mechanisms are put in place. Since the creation of the “Programa Movilizador en Física de Altas Energías” in 1983, there has been a steady but significant growth of the Spanish community in these fields, which has gone hand by hand with a profound insertion of our scientific community in many of the best international scientific programs. In addition there is an ever increasing industrial and technological component in our area. The history of Particle, Astroparticle and Nuclear Physics in Spain in the last twenty years is, in a sense, a success history, but at the same time the current instruments are showing their limitations. If we want to continue the progression in this field, a new instrument is needed now.

This is why we are proposing the creation of the National Centre for Particle, Astroparticle and Nuclear Physics (CPAN). National coordination through the CPAN will boost the visibility and influence of the Spanish groups in a competitive global environment and provide a better participation in mainstream research lines. The existence of the CPAN will also boost research in fundamental aspects of science in our country and greater scientific and technological returns. It will also optimize our participation in international Organizations or Laboratories.

A) EXECUTIVE SUMMARY

The main objective of the Project is to undertake strategic initiatives in Particle, Astroparticle and Nuclear Physics with the aim to have a substantial leap forward in Spanish research in this field. This is clearly a medium and long-term enterprise and therefore it is only achievable if a permanent entity such as the National Centre is firmly established. The creation of the CPAN is therefore the pivotal object of this Project. The special characteristics of the Consolider program make it particularly adequate to constitute a National Centre to coordinate the activities of the participating research groups. This will provide to our national community an organizational structure of a nature similar to the existing ones in other countries of the European Research Area with whom we collaborate and compete.

The project is articulated in two phases. In the first phase, covering the first three years, the process of creation of the National Centre for Particle, Astroparticle and Nuclear Physics will be launched. The new centre, which should be a legal entity of its own, will have to be provided with appropriate Statutes, a Director chosen in an open and competitive process, and a General Manager. In parallel, the "Consolider Team" will start the first strategic initiatives, with the aim of providing coordination and support to well-defined present projects, and with very ambitious targets, being the main ones:

- Optimization of the scientific exploitation of LHC. It is essential to be able to finance contracts (scientists and technicians) and stays at CERN, to give technical support to the maintenance, operation and upgrades of the detectors, as well as the data taking and analysis in close collaboration between experimental and theoretical physicists, in order to play a key role in the search of the Higgs boson and of new phenomena such as supersymmetric particles.

- Boost for the initiation of experiments in the Canfranc Underground Laboratory, the development of MAGIC and of other international initiatives in Astroparticle Physics.

- Implementation of the participation of Spanish groups in FAIR, coordinating their activity around well defined key experiments, and financing the contracts of technical personnel necessary for the design and construction of scientific instrumentation by the Spanish groups.

In addition to these strategic initiatives, several horizontal actions will be contemplated:

- Training of personnel in R&D activities and in particle acceleration techniques.
- Data processing and numerical simulations.
- Transference of advanced technology.
- Training of young scientists.
- Outreach.

In the second phase the National Centre should be already in place. Among the strategic lines foreseen for this second phase, are projects presently in preparation, in neutrino physics, such as KM3 or T2K, as well as new experiments in astroparticle physics and cosmology, or the future facilities such as the International Linear Collider, flavour factories, both hadronic (B-factories) and leptonic (neutrino factories or beta beams), and EURISOL.

Who is signing this proposal?

The researchers signing this CONSOLIDER proposal are in one of the following situations: either he/she is presently a Principal Investigator (IPs) of a project approved and funded by the National Program (2004-2007), or of a project in the Sixth European Framework Program, or he/she is acting as an IP of a new Project request in the present call for requests in the National Program (2004-2007), or he/she is in a Management position in one of the affiliated institutes. This ensures that this initiative is well vertebrated within the Spanish communities of particle, astroparticle and nuclear physics.

B) CURRENT STATUS OF THE FIELD IN SPAIN

Experimental Particle Physics

Since Spain re-joined CERN, in 1983, a very significant growth of the Spanish community in High Energy Physics has taken place, both in quality and size. The participation in the LEP programme resulted in important contributions of several Spanish groups to three large experiments: the IFAE group to ALEPH, IFCA and IFIC to DELPHI, and CIEMAT to L3. The contribution to the design, construction and operation of the three detectors, and later to the physics analysis, led to a substantial increase in the available resources and the consolidation of existing groups (CIEMAT, IFIC, IFCA) and the creation of a new one (IFAE). These groups, and others which were also created (UAM, USC, UB), have made since that time visible contributions to other relevant international projects: the UAM group in ZEUS, in the HERA accelerator at DESY, the UB group in HERA-B, the CIEMAT, IFAE and IFCA groups at CDF in the Tevatron, at Fermilab, and the USC group in the SMC and DIRAC experiments at CERN.

After all these activities in large international projects, the Spanish groups have reached a reasonable level of maturity, technical expertise and scientific know-how that has allowed them to become more competitive and visible. They are now in a fairly good position at the start of the operation of the next CERN accelerator, the Large Hadron Collider (LHC). Spain is making a relevant contribution to the experiments being prepared for the LHC: ATLAS (with participation of the IFAE, IFIC and UAM groups), CMS (CIEMAT, IFCA, UO, UAM), LHCb (UB and USC), and ALICE (USC, CIEMAT). Spain is also contributing to the LCG (LHC Computing Grid) project, and hosts one of the 11 Tier1 centres of the GRID worldwide structure for the LHC. This Tier1 is located at PIC (Puerto de Información Científica), a centre for massive storage and data processing created through a consortium of DURSI and CIEMAT at the UAB campus. In addition there are also Tier2 centres, one for each LHC experiment. If, as expected, the institutional support is maintained, the Spanish community will likely have appropriate visibility in the scientific exploitation of the huge amount of data to be delivered by the LHC experiments.

Spanish groups also take part, in the neutrino physics program, in the experiments NOMAD, HARP (IFIC), ICARUS (UGr), K2K (IFAE, IFIC), T2K (IFAE, IFIC) and DoubleCHOOZ (CIEMAT). There is also a small, but significant, presence in the BABAR experiment (UB, IFIC) at SLAC. However, the community has not yet reached the critical size needed, according to European standards. Thus, it is necessary to keep a continued effort of training and, at the same time, to promote and ensure long term positions to the new generation of young researchers who are playing now an important role in the ongoing experiments. And it is rather urgent to establish a program to define and sustain an adequate technical personnel work force.

Astroparticle Physics

Astroparticle Physics is an emerging field of fundamental research at the crossroad between particle physics, astrophysics, space science and cosmology. It addresses some of the hottest open questions in fundamental physics and high energy astrophysics by studying in a new domain the different particles coming from the sky, such as cosmic rays, gamma-rays, neutrinos, gravitational waves and dark matter particles. Its goal is twofold: on the one hand using particles to study cosmic accelerators, the most violent and energetic phenomena in the universe, and on the other hand, using the particles produced in these cosmic accelerators to perform fundamental physics studies beyond the reach of man-made accelerators. This allows a very rich program of theoretical activities in which a handful of groups of theoretical physicists and astrophysicists work in Spain since the late eighties.

In Spain the experimental activity in this field started more than a decade ago with pioneering experiments at the “Roque de los Muchachos Observatory” in the Canary island of La Palma and in the Canfranc tunnel under the Pyrenees, and has flourished during the last decade with the creation of several small groups which are participating in many of the most important experiments in the field, such as: AUGER, ANTARES, MAGIC, AMS, LIGO, LISA, CAST, etc. An important milestone in this field in

Spain is the recent creation of the Laboratorio Subterráneo de Canfranc (LSC), a Consortium between the Spanish Ministry of Science, the Regional Government of Aragón and the University of Zaragoza, which with its 1.000 m^2 surface and its 2.500 meters water equivalent depth is presently one of the few European installations for underground physics experiments.

Most of these experiments, in spite of their success, are just precursors of even larger scientific installations which are already in the phase of design study, in some cases with support from the European Union. Our present participation in most of the important initiatives and even a position of leadership in some of them should not jeopardize the fact that the participation in these large initiatives will require a decisive boost in the Spanish Astroparticle physics community to allow a scientific and technological return at least similar to the one in other neighbouring fields of research.

Experimental and Theoretical Nuclear Physics

Recent technological developments providing intense beams of exotic nuclei, anti-protons or relativistic heavy ions offer exciting possibilities for new physics during this new century in the field of Nuclear Physics. Spain has well established activities in both, theoretical and experimental Nuclear Physics, with a reputed international recognition and increasing competitiveness. The research teams are spread all over the country, involving universities and public research agencies. Experimental research groups are present at CIEMAT, CSIC (IEM, IFIC), and at the universities of Huelva, Madrid (UAM, UCM), Politécnica de Cataluña, Salamanca, Santiago, Sevilla and Valencia. Research in Nuclear Theory is conducted at the universities of Barcelona (UB, UAB, IEEC), Cantabria, Granada, Huelva, Madrid (UAM, UC), Salamanca, Sevilla, Valencia and CSIC (IEM, IFIC).

The experimental research is focused mainly on the study of the structure and dynamics of the atomic nucleus. Other important activities are related with nuclear astrophysics, nucleus-nucleus collisions or hadronic physics. The experiments are carried out mostly at European facilities, such as ISOLDE and n_TOF at CERN, GSI (Germany), GANIL (France), LNL (Italy), CRC (Belgium) and JYFL (Finland). These laboratories support the Spanish activities due to the scientific excellence of the Spanish projects and researchers although Spain is not contributing to the installation maintenance, except for the facilities at CERN, ISOLDE (contribution since 2003) and n_TOF, and RISING (GSI) since this year. During the last years the Spanish groups have made a coordinated effort to contribute effectively to the experiments ELISe, HISPEC/DESPEC, PANDA and R3B at FAIR. Synergies with the Spiral2 project are considered in order to prepare for the future EURISOL project. The theoretical activities cover most of the fields of Nuclear Physics, from nuclear structure and reactions of stable and exotic nuclei to hadronic physics and astrophysical applications. The researchers are well integrated in the international context, being remarkable the participation of our country in the ECT* (Italy) that coordinates the European Nuclear Theory activities. Moreover the theoretical nuclear physics community has an increasing degree of integration with the experimental and applied nuclear physics communities. Some international projects act as catalyzers for theoretical and experimental groups, as it is the case of FAIR.

The Spanish participation in the new Facility for Antiprotons and Ions Research, FAIR, represents a unique opportunity to boost the Spanish activities in experimental nuclear physics. The financial support from the National Agencies and from the European Union Framework Programs has allowed the experimental groups to acquire basic scientific equipments and train young scientists. However, a larger investment in scientific and technical personnel as well as infrastructures is required to have a leading role in the international context and to benefit from the technological spin off of the scientific activity. Both for the theoretical and experimental groups, it is important to increase the budget devoted to pre-doctoral and post-doctoral contracts, in order to maintain and increase the high quality level of research, and to ensure the generational takeover.

Theoretical Physics

The Spanish community of theoretical particle physics has a well established international prestige. Spanish theoreticians have had an important impact on the development of this area during the last two decades. Relevant work in many fields, including QCD phenomenology, flavour physics, neutrino physics, physics beyond the Standard Model, field theory, supersymmetry, cosmology, string theory, etc., has been carried out in the Spanish institutions participating in this proposal. There are at present very competitive groups in most of the big Universities and research centres of our country: IFAE, IFIC, IFT, IGFAE/USC, IMAFF, UB, UCM, UGR, US, UZ ...

With the new experimental challenges the role of the theoretical community will be particularly important. The main purpose of the LHC project is to understand the origin of the mass of the elementary particles. The first objective will be the search for the Higgs particle, but there are good theoretical reasons to believe that LHC should discover additional new physics beyond the Standard Model: supersymmetry and/or a new strongly-interacting sector and/or extra dimensions and/or string theory, etc. The Spanish theoreticians will work together with their experimental colleagues in the analysis and physical interpretation of the data. The same applies to other objectives of this proposal, such as astroparticle, neutrino or flavour physics. The CPAN will play an important role providing the means for the coordination of efforts between theoreticians and experimentalists. In addition, it is an important mission of theoretical physics to improve our understanding of the fundamental laws of matter. In this respect the field theory basis of particle physics as well as the search for a unified theory of all interactions including gravity will also be an important objective. There is in Spain a very active community working on String Theory, the leading candidate for such a unified theory.

In spite of the scientific good health of the theoretical particle physics community, there is a big problem of aging and generational takeover. The Spanish theoretical particle physics has now an excellent generation of young researchers with the highest international level, whose incorporation and stabilization in the R&D system turns out to be problematic. The resultant “brain escape” to other countries is worrisome, especially considering the foreseen retirement of a significant number of researchers in the following years. The strong Spanish implication in the LHC and the foreseeable participation in projects at world level indicate that the effort in particle physics phenomenology should be promoted, and the collaboration with the experimental groups encouraged. The non-existence of theoretical physicists in institutes with very important experimental activity is anomalous.

R&D in Accelerators and Detectors

Accelerator physics has been traditionally underdeveloped in our country. Universities in Spain have been lacking the technological infrastructure, and have been unable of providing the technical support, required by this kind of research. There has been, for a long time, only one research centre, CIEMAT, with the capability to promote a modest activity in this field. In spite of this, during the last decade, some important progress has been achieved and the Superconductivity group at CIEMAT was able to design, make prototypes and test some quadrupole magnets, which were accepted to be used in the LHC. The final series fabrication of these magnets was made in a Spanish industry. This group has also developed superconducting magnets for TESLA 500, with the potential to be used in XFEL. At present, they are involved in an ambitious project in collaboration with groups at IFIC and UPC for the construction of the CLIC Test Facility 3 at CERN, which includes developments in radio frequency that represent a new line of R&D in Spain. The CIEMAT group also coordinates the Spanish contribution to the accelerators of the FAIR project, in particular the design and construction of the ring NESR. The last decade has seen the installation in Spain of some accelerator facilities. The Centro Nacional de Aceleradores (CNA) in Sevilla has 3 accelerators: A 3 MV tandem, a 1 MV tandem and a cyclotron which produces 18 MeV protons. The CMAM in Madrid has a 5 MV tandem. Another project which will have an important impact on the development of accelerator physics in Spain is the construction of the ALBA Synchrotron in Barcelona.

In the field of Particle and Astroparticle Physics, R&D in detectors has also experienced a very important progress since Spain rejoined CERN, although as in the case of accelerators, we are not still at the level of other advanced European countries. However, it should be said that the participation, first in LEP, and now in the LHC, of all the experimental groups has been excellent at the detector construction level, in spite of the high technological complexity of the projects. Good examples are the contribution from CIEMAT to the muon detectors of L3 and CMS, the hadronic calorimeters made at IFAE and IFIC for ATLAS, the electronic calorimeter made at the UAM for ATLAS, the contribution to the ATLAS silicon tracker from IFIC, the global alignment system of CMS by IFCA, UO and CIEMAT and the contribution to the LHCb silicon tracker and calorimeter systems from IGFAE/USC and UB. This has had very positive effects in the hardware contribution of the groups to other activities, and experiments, in which they have progressively become involved. For example, we could mention the ANTARES photomultiplier systems which have to operate deep in the sea, the cameras of the MAGIC telescope, the leading participation of IGFAE/USC in the TOF and GEM detectors for the DIRAC spectrometer, the contribution of IFCA to the TOF detector at CDF, the design and construction of the RICH detector for AMS at CIEMAT, the developments in the field of silicon detectors and associated electronics at IFIC and IMB-CNM, the progress in the field of optical sensors, the improvement of the precision in metrology and in the machining of mechanical structures, and the development of sophisticated digital readout electronics. They are also involved in R&D European projects for the next linear colliders.

Nuclear Physics groups have also been active in making projects of R&D in detectors. As an example, the developments made in the detection of gamma rays with scintillating detectors and of hyper-pure Germanium, in the detection of neutrons and in the design of silicon detectors and their associated electronics for low threshold charged particle detection. The Spanish participation in FAIR will help to push further these developments during the next few years. Spanish groups contribute to the development of gamma ray calorimeters for the R3B (IGFAE/USC, IEM, UCM), DESPEC (IFIC, UAM) and PANDA (IFIC) experiments, to the beam tracking and charged particle detectors based on silicon and Diamond (UH, US, IEM) and RPC´s (USC) for HISPEC and R3B, the neutron detector of DESPEC (CIEMAT) and the magnetic spectrometer and simulations for ELISe (UCM, IEM, UGR, US).

The entity of all these R&D activities, some of them being actually developed in collaboration with industry, is still small compared to other advanced European countries, as already mentioned, but it offers a large potential to grow, and the creation of the National Centre we are proposing in this Consolider Project, should play a fundamental role to achieve this objective.

Technological Applications

Particle, Astroparticle and Nuclear physics applications to different fields, from energy production to medical therapy passing through semiconductor technology and dating techniques are widely used in our society. Therefore, there is a remarkable spin-off potential related to scientific discoveries and new techniques, and these activities are growing in our country. Some examples are given next:

MEDICAL PHYSICS.- As half of the European population suffers, at least once, a cancer, all countries have active groups in this field. Advanced imaging techniques have been highly developed, and some groups in Spain (CIEMAT, IFAE, IFIC, IGFAE/USC and UCM) are developing new strategies to improve the image quality and the sensitivity and resolution with new sensor devices. The development of a portable positron-electron tomography (PET) Camera for diagnosis, with units sold in Spain, Switzerland and Germany, is a good example of these efforts. On the other hand, PET nuclides are produced with the 18 MeV cyclotron at the CNA and preparation of radiopharmaceuticals is also possible in this facility. But physics is not only used for diagnosis, but also for therapy. The radiotherapy (using gamma rays) is a standard procedure to treat cancer at hospitals, but the most recent advances in Medical Physics point to the use of hadronic therapy because of higher effectiveness in the tumor leaving the surrounding tissue almost undamaged. A hadronic therapy facility (IFIMED) has recently been approved in Spain under the IFIC leadership.

TRANSMUTATION OF RADIOACTIVE WASTE.- The separation and transmutation of actinides offers a potential solution to the problem posed by the management of radioactive waste, by reducing the proportion of long-lived isotopes. The goal is to reduce the radio-toxicity of the waste inventory below the uranium ore level after a few thousand years of decay. The transmutation of actinides can take place at low rate in fast critical reactors and in accelerator driven subcritical systems (ADS) with a much higher efficiency. Research groups from CIEMAT, IFIC, IGFAE/USC, UPC and USE are leading basic nuclear physics experiments at n_TOF (CERN) and GSI with a great impact in the field.

DATING TECHNIQUES.- The Carbon-14 technique has allowed measuring samples aged up to 60.000 years causing a big impact on Archeology. At the CNA there is an AMS facility providing ^{14}C dating. Application of ^{14}C to marine and atmospheric studies will also be offered at CNA.

ION BEAM TECHNOLOGIES.- The RBS (Rutherford Back-Scattering) technique used in the ceramic industry allows to do surface lithography and to analyze the composition of materials in surfaces. The PIXE techniques are used in precision microscopy reaching the level of the atomic composition. Also the use of proton accelerators for nanolithography is in development. Some of these applications are now developed at the tandem accelerators of CNA in Seville and CMAM of the UAM.

ENVIRONMENTAL SCIENCE TECHNOLOGIES.- High Energy Astroparticle physics experiments use extremely large atmospheric, deep sea and polar ice volumes as sensitive particle detectors and are developing rather complex instrumentation for the detailed characterization, study and monitoring of their physical properties. These new instruments are triggering the interest of several environmental science communities such as the ones working in atmospheric science studies, deep see science and polar science.

C) THE NEED OF A NATIONAL CENTRE

The “Programa Movilizador en Física de Altas Energías”, was a pioneer program in Spain that introduced modern evaluation methods and new instruments to our R&D system. Due to the remarkable qualitative and quantitative growth in recent years, these instruments are becoming insufficient in some areas. This is particularly the case in Particle, Astroparticle and Nuclear Physics, where there has been a steady significant growth of the Spanish community over this period. This growth has come hand by hand with a relevant involvement of our scientific community in many of the best international scientific programs, a rigorous management and a level of scientific excellence that is recognized by any objective evaluation.

This is why we are proposing the creation of the National Centre for Particle, Astroparticle and Nuclear Physics. Its aim is, basically, to ensure that the role played by our country in these fields of research is in accordance with our socio-economical situation in Europe. It should be clearly stated that the idea behind this proposal is not just to dedicate more resources to a specific research field, but rather to make use of all the coordination mechanisms that such a National Centre would put in place, in order to support several lines of research with well-defined scientific and technological objectives and the definite will to transfer the benefits of such research to society at large.

The CPAN will constitute a powerful instrument of scientific policy that could support the innovative proposals, boost the underdeveloped lines of research and reward the research teams with higher scientific excellence. It will be a coordinating body that could encompass horizontal programs envisaged to: a) contribute to the formation of new researchers and technicians in these fields, b) maintain and promote scientific meetings and other activities designed to enable the flow of scientific information between the different groups and areas, and c) administrate common infrastructures to be used by all the groups in these fields.

The National Centre is a key step forward

In 1997 and 2003, when the Restricted European Committee on Future Accelerators (RECFA) examined the situation of the field in Spain, it considered pertinent to recommend to the Government to create a National Centre with the aim to promote and coordinate the research in experimental particle, astroparticle and nuclear physics and its applications.[1] These recommendations were included in the current Spanish National Plan of R+D+i (2004-2007), where it reads:

> *"There are several reasons for the creation of a National Centre for Particle Physics. They are mainly related to the increase of scientific and technological returns due to the membership to CERN.*
>
> *a) The first one is the optimum use of the important scientific, academic technological and industrial opportunities that derive from the membership of Spain to CERN: to increase the number of experimental physicists and technicians at CERN, helping to obtain greater returns, to exploit the training capacity of CERN and, eventually, to reach a greater presence at CERN.*
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> *b) The second reason comes from the special characteristics of the research projects in these fields. In particular, its long time period and highly technological complexity and its development in a totally international framework require a very good coordination at the national and international levels.*
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> *c) The third one is also consequence of the technological complexity of the experiments in particle physics that requires to involve in the same working team personnel of different competences: scientists, technicians and engineers. In the environment in which the research develops at present in Spain, this task turns out to be extremely difficult, particularly due to the deficit of technicians in the university groups."*

In the same direction, the Nuclear Physics Board of the European Physical Society also recommended to the Spanish scientific authorities, after the last meeting held in Spain in 2004, an increment of the human and economical resources dedicated to these areas in our Country, as well as to establish the mechanism that allow a coordinated participation of the Spanish research teams in FAIR.[2]

RECFA recommended the establishment of a national institute, to some extent similar to INFN in Italy or IN2P3 in France:[1]

> *"Such an institute would have outstations at each university and the senior staff would have joint appointments involving the normal range of teaching and other duties. Such an institute would also result in better inter-group collaboration, and improve the strategic planning of experimental physics in Spain. It would also be able to provide the infrastructure and technical posts necessary to carry out the experiments, which cannot be provided by the universities. Care must be taken that such a structure be loose enough not to jeopardize the excellent collaboration between the experimental groups and the Spanish regional governments, which is one of the strengths of the current system."*

RECFA therefore recommends the creation of a National Centre devoted to Particle, Astroparticle and Nuclear Physics and that this centre should have a 'distributed nature', that is to say, without premises or buildings of its own, but rather that it should be associated to existing or future research institutes and centres. It is also implicit that this National Centre should not add a further layer of bureaucracy. Its most crucial activity, as indicated by the National Plan itself, is the support of scientific and, specially, technical personnel to be posted in our institutes and centres. This support is absolutely necessary in order to allow our scientific community to continue its strong drive towards scientific excellence, and eventually to take a visible place in the international arena in these areas.

The investment in R&D of new techniques of acceleration and detection is another key point. The advanced nations invest in the study of future projects and techniques a reasonable part of their resources. With the present structures in Spain this is unthinkable. Similarly, technology transfer to

[1] Letter of the Chairman of RECFA to the Minister of Science and Technology of 22 April 2003.

[2] Letter sent by the "chairman" of the "Nuclear one Physics Board" of the EPS to the Minister of Education and Science in June of 2004.

industry should be ensured, and the mechanisms reverting to the companies the developments and innovations that are produced in this competitive field, should be identified.

Last but not least, the field should be well coordinated in order to profit from the scientifically incipient structures that are getting commissioned in our country. Among them we should mention the Underground Laboratory of Canfranc, the telescope MAGIC at the Roque de los Muchachos, PIC, the synchrotron ALBA, the CNA, and the large installation for medical physics (IFIMED) and the ESS, still under consideration. It is obvious that in order to profit from all these investments it is necessary to create adequate structures of coordination, planning and the necessary human and material support.

The CONSOLIDER Project as a means to launch the National Centre and its activities

There have been in the past several attempts to create a National Centre with the characteristics proposed here; all of them were unsuccessful. The main reason for it was the lack of a sufficiently clear roadmap. The last attempt led to the creation of the so-called CEFAE, a proto-institute that legally came to life in 1995 as a semi-autonomous institute within CSIC. Unfortunately, this Centre (although existing on paper) never had any real activities, budget or personnel.

The Spanish science needs now in several fields with a strong international component, and where frontier science and high level technology go together, to create a coordinating Centre. With the Call for Proposals for "Consolider Projects/Centres" the situation has changed. It is now the Ministry itself who has established an official pathway leading to the creation of National Scientific Centres like the one we propose here. Following the terms of the Call, a complete functional structure has been designed and the protocols for decision taking, and renovation of Committee members, established. A well-defined structure of departments/committees to cover all the different areas of interest (scientific, technological and outreach) has been put in place. Steps to constitute the National Centre, as well as a possible chronogram for them have been considered. Last but not least, a minimal administrative team has also been defined. We thus believe that this proposal is both consistent and realistic. If the Consolider committee chooses to finance this initiative, and the political support to the National Centre is present, we believe that its positive effects in Spanish basic research and technology will be visible at medium term. We also believe that this success may show the way for analogous initiatives in other fields that may need them.

D) DETAILED DESCRIPTION OF THE GOALS OF THE NATIONAL CENTRE

We can divide the five years period spanned by the Consolider Project in two subperiods: a first one where the Consolider Group will pursue both the scientific goals and the creation of the National Centre, and a final one where the National Centre will be fully operational and will have taken over from the structure developed by the Consolider Group to accomplish its objectives. The objectives, which are described below, are goals of both the Consolider Group (for the first part of the 5 years spanned by the Consolider Project) and the National Centre (second part and, eventually, long term).

Scientific goals

LHC Particle Physics

The Spanish participation in the LHC Program at CERN should be optimized taking into account not only the scientific aspects, but also the technology and training ones. It is essential to support the Spanish participation in the scientific exploitation of this instrument to take adequate profit of the large investment made in its realization (in accordance with its exceptional scientific interest). It is clear that LHC will dominate the scientific scene in particle physics for several years, and we would like LHC to become a turning point in Spanish Physics, exactly as LEP was in its time.

- To provide support to the coordination of the physics analysis by the Spanish groups. Identify

topics where the Spanish participation could be more visible and decisive.

- To facilitate and promote the collaboration between theoretical and experimental groups in the analysis and the interpretation of the LHC data, with proposals of new analysis techniques and the identification of new signals.
- To establish a network concerning phenomenology of the LHC results.
- To provide a forum for the discussion and coordination of the Spanish position in the relevant decisions to be taken by CMS, ATLAS, LHCb and ALICE collaborations, in connection to CERN and LHC scientific policy aspects.
- To facilitate a smooth operation of the Spanish centres participating in the WLCG computing GRID project, and the cooperation between these centres and the experimental groups.
- To guarantee a significant Spanish participation in the working groups of LHC upgrading, and the corresponding efforts in R&D, in particular for the high luminosity option.

Astroparticle

The field of Astroparticle physics, which covers particle physics research without man-made accelerators (cosmic rays, dak matter, non-accelerator neutrinos, ...) is, at this moment, a most glamorous scientific field. Europe is a leading region in this international effort and Spain is making important investments in infrastructures in this area. Therefore, Spain should take advantage of the existence of relevant domestic installations and from a very active community of astrophysicists.

- To facilitate the Spanish participation in the experiments at Canfranc, thus contributing to the success of this important installation. It is essential for our groups a significant participation in experiments that may lead to concluding results in the case of double beta decay (SuperNEMO) and dark matter searches.
- To reinforce the Spanish contribution to the large and relevant experiments in this field using particle messengers to explore astrophysical and cosmological sources, such as MAGIC, AUGER, ANTARES or LIGO-GEO.
- To prepare Spain for the new challenges in Astroparticle Physics such as CTA, Auger North, KM3 and large volume underground detectors, as well as others that surely will turn up, supporting developments in the field that will allow sensible choices following ApPEC recommendations and adjusting to our national preferences.
- To favour the collaboration between Astroparticle, Astrophysics and Space Science Spanish groups by organizing common meetings and helping setting out specific joint projects transversal to the existing National Programs.
- To stimulate the participation of Spanish groups in the observational facilities at Roque de los Muchachos, Calar Alto, and others, so that Astroparticle and Astrophysics groups work together.
- To stimulate the collaboration between theoretical and experimental groups in astroparticle and neutrino physics.
- To increase our participation in relevant neutrino experiments without accelerators (e.g. DoubleCHOOZ), decisive to improve our knowledge of the leptonic mixing matrix.

Nuclear Physics

The aim is to coordinate and promote the Spanish participation at international laboratories and, in particular, in the new Facility for Anti-proton and Ion Research (FAIR), to be built in Germany. FAIR represents the most ambitious scientific project of the international community of Nuclear Physics offering excellent conditions for new physics in this discipline. An adequate Spanish contribution to this project will provide a unique opportunity for giving the required boost to experimental Nuclear Physics in our country.

- To facilitate that Spanish groups can efficiently join the different experiments which will take place in FAIR.
- To encourage the coordination among the nuclear physics groups in Spain, so that the Spanish scientific participation acquires the visibility at international level in accordance with the

participation in the construction of this large installation.

- To coordinate and optimize the synergies between the scientific and technological activities in FAIR with the ones taking place in other Nuclear Physics experimental installations, both European (ISOLDE, n_TOF, SPIRAL II, etc.), and Spanish (CNA, CMAM, Canfranc).
- To stimulate the collaboration between the experimental and theoretical nuclear physics communities in our country, with the purpose of obtaining the maximum scientific benefit from the participation in FAIR.

Theoretical Physics

Research in these fields lays at the frontier of human knowledge, and revolutionary results are possible as a consequence of the new experiments. This could lead to a fundamental revision of our current ideas, where supersymmetry, superstring theory, etc. may be especially relevant. The present (and new) ideas should be tested to explain experimental data and guide the design of future facilities and experiments. The Spanish scientific community should play a major role in the development of new theoretical ideas. The CPAN can help to achieve this objective through:

- The coordination of the efforts of the different teams in the formation of new generations of scientists in these fields.
- The provision of a framework enabling the exchange of ideas all over the country, via the generation or support of initiatives for specific networks, workshops, schools, etc.
- The setting up of policies aiming to attain an appropriate balance of the different lines of theoretical research, based on timeliness, international impact and other well accepted criteria.
- The support of those initiatives having a major impact on the visibility of the Spanish scientific community of the field, such as international conferences, long-term workshop programs, etc.
- The encouragement of the transfer of ideas and knowledge between the theoretical and experimental physics communities, aiming at the generation of novel proposals of experiments.

Accelerator and detector R&D

The CPAN will promote the participation of Spanish groups in the preparation, at all levels (detection and acceleration techniques, data taking, analysis and scientific results), of the future "International Linear Collider" (ILC) and European ISOL Radioactive Ion Beam Facility (EURISOL). We are actually participating in the CTF3 CLIC facility (mostly through CIEMAT), a project with a strong technological component, and it would be very convenient to have a strong presence in the ILC initiative too, not only from the scientific point of view, but also strategically and even industrially. Therefore, only a coordinated effort will give good chances for success. There exists already a national network devoted to this purpose, but it should be further developed and extended.

New and Future International Accelerator Initiatives

The goal is to coordinate also the Spanish participation in future international accelerator initiatives, in addition to the previously mentioned ILC and EURISOL, within the scope of fields covered by the CPAN. Possible examples are flavour factories (Super-B), or the proposals for neutrino beams produced at CERN by means of a Neutrino Factory, or a Beta-Beam, directed to the Canary Islands or Canfranc. CERN has recently defined the European Strategy in particle physics, with important implications in the field for the next decades. The National Centre should participate in the decision taking process at the international level and push for the scientific, technological and industrial interests of Spain. It should also participate in the implementation of these decisions at the national level. It should also promote an adequate participation of Spanish groups in the new generation of neutrino experiments using accelerators, like for instance T2K or NOvA.

Information Technologies

Information technologies are crucial to particle physics with all its complicated experiments generating petabytes of data and complicated calculations. Conversely, IT have greatly benefited

from the ingenuity and the work of particle physics. We should guarantee that this fruitful exchange takes also place in our country.

- The National Centre should support the implementation of the WLCG Project for GRID computation in the LHC experiments: in particular, it should support the coordination of distributed Tier1 and Tier2 activities and the optimization of the scientific exploitation, the procurement of additional manpower and hardware resources and the strengthening of international links.
- Support should be given to fulfil the intensive numerical computation needs of the theoretical groups in Particle and Nuclear Physics.

Scientific Policy objectives

The National Centre should be pivotal in:

- Defining the strategies and priority lines of research at medium and long term.
- Coordinating the research activities of the different groups participating in this Project.
- Giving technical and administrative support to the activity of the Particle Physics National Program.
- Providing advice, in the topics covered by the groups participating in this Project, to the Particle Physics National Program, and to the Administration, if required to do so.
- Representing the researchers of the field at the national and international level and defending their scientific interests.
- Coordinating the Spanish participation in large European and international projects.
- Promoting and stimulating the participation in the Seventh European Framework Program and in future European Programs.

In addition to these, other objectives are:

- To incorporate technicians and engineers to the participating groups in order to work in activities considered as strategic, coordinated by the Consolider Project and, in due time, by the CPAN.
- To incorporate temporary high-level technicians and engineers from other institutions, in order to facilitate the transfer of the relevant “know how”, mainly in aspects associated to accelerator or detector hardware.
- To facilitate the establishment of a competitive program of postdoctoral contracts. It will complement, and extend, the existing programs. These contracts will be allocated to the different groups working on strategic and priority projects.
- To contribute to the incorporation of young scientists, giving priority to the experimental and technology transfer areas.
- Foster the development of R&D activities not accessible to separate independent groups by helping to set common projects, endowed with personnel from the CPAN.

Technology transfer

Spanish industry has taken advantage, at the level of advanced technology transfer, of being connected to the activities in some of our groups, in the fields of Particle, Astroparticle or Nuclear Physics. In this sense, we could mention a few particular examples, like the vacuum technology transferred to some industries (INGOVI, TELSTAR, Duro–Felguera), the construction of complex equipment (Equipos Nucleares, Duro–Felguera, SENER, Norte Mecánica), and several contracts to relatively small industries associated to special electronics. However we believe that this is well under the real possibilities and an Institute like CPAN is necessary to push this aspect of the field. It should be mentioned that CERN, and other Institutions like IN2P3 in France, INFN in Italy, or PPARC in the UK, have established long ago a Department to take care of technology transfer. At the end, it has been shown that relevant technological

achievements produce important beneficial effects for the progress of our society. We consider important goals of the CPAN, in this line, the following ones:

- To facilitate the transfer to the Spanish industry of knowledge related to experimental particle and nuclear physics technologies like for example Electronics (systems, micro-electronics and opto-electronics), Light and Particle Detectors, Radiofrequency, High performance magnets (normal and superconducting), Power supplies, Very high precision mechanical engineering, Cryogenics, Ultra vacuum technologies, Information technologies (data bases, GRID) and Special materials.
- To provide support to new initiatives in technological applications from the Particle, Astroparticle and Nuclear Physics fields, which can be applied in, for example, Medical Physics, E-science and Space sciences
- To promote the development of new technologies, whenever possible, when produced as a consequence of R&D activities of any group participating in the National Centre.
- To create, and make available to the Spanish industry, a database with the different possibilities of technology transfer, the name of a contact person in each case, and a description of possible ways to collaborate.
- To encourage the training of specialists in the new technologies, both in the case of personnel associated to the Centre and of the participating groups. Follow up of the technology fellowship program in international organizations.
- To incorporate, according to available resources, high-level technical experts, to help in the technology transfer activity, in collaboration with CDTI, OTRI's, and other similar organizations.

Scientific training and outreach objectives

- To support the "Taller de Altas Energías" (High Energy Workshop) and the "Programa de Doctorado Interuniversitario de Física Nuclear" (Nuclear Physics Inter-university Doctorate Program), as well as other postgraduate programs, within the aim of combining the national resources to optimize the training in Particle, Astroparticle and Nuclear Physics.
- To support and coordinate the organization of special workshops like the "Internacional Winter Meeting", "Encuentros de Física Nuclear", "Centro de Ciencias de Benasque", "Jornadas de Altas Energías de la RSEF" and other scientific conferences of the field.
- To support the implementation of outreach activities inside our society (seminars and talks, articles in newspapers, special exhibitions, like for instance during the "Science Week", etc.), and to improve the knowledge of students, in secondary schools and universities, about particle, astroparticle and nuclear physics. Coordinated actions with the RSEF will be established.
- To support the organization of thematic networks.
- To promote the setting up of a special group inside CPAN responsible of outreach activities.
- To create a brochure that condensates the main objectives and capabilities of the CPAN, and a dynamical web page addressed both to the general public and the CPAN researchers.

E) LINES OF ACTION TO REACH OUR OBJECTIVES

We have defined three action lines: a line of strategic scientific actions, another one of horizontal actions that complement the previous one seeking to reinforce their efficacy, and a third line oriented to the management and implementation of the National Centre, which will be detailed in subsections H and I. The definition of these action lines keeps in mind the scientific objectives defined, and they are implemented in a working plan that considers a first step of three years, in which well-defined goals should be reached to be evaluated at the end of the step as indicated in the Consolider Ingenio-2010 programme, including the launch of the National Centre. In the second step the action lines will be executed already by the National Centre.

STRATEGIC ACTIONS (SA)

- SA1: Coordinated analysis of all the physics associated with the LHC

As previously mentioned, Spain has carried out a big investment in the development and construction of detectors for this large CERN collider, which will begin operating in December 2007, from which important discoveries are expected that could change our vision of matter at the more basic level. Our community should play a prominent role in the scientific analysis of the results. To make this possible, it is necessary to optimize the exploitation of our data processing resources and to reinforce the currently insufficient human capital, with the purpose to be competitive with the rest of the international community. The fundamental directions of this SA are:

i. To ensure our data process capacity by contracting specialized technicians and coordinating the existing infrastructures.
ii. Creation of a Spanish thematic network to coordinate the scientific analysis of the results of the LHC.
iii. Contracting young scientists (post-doctoral) to investigate the phenomenology of the LHC experiments, both in proton and heavy ion collisions.
iv. Hiring of technicians for the maintenance and improvement of the detectors.
v. To ease the stage of the scientific and technical personnel at CERN during long time periods.

- SA2: Experiments in the Underground Laboratory of Canfranc and other experiments in Astroparticle physics

The exploitation of this national laboratory, recently inaugurated, is a priority for our community. The CPAN should promote its scientific exploitation, as well as the best use of the resources invested in other installations as MAGIC or Auger, dedicated to the Astroparticle field. At long term, during the second phase of the project, the Spanish participation in future international projects such as CTA, KM3Net, Auger North, a large volume underground detector for dark matter and neutrino physics or a new-generation interferometer for gravitational waves, should be ensured.

i. Promote the utilization of Canfranc as Underground Laboratory for first class experiments.
ii. Hiring of technicians for the development of experiments in Astroparticle Physics.
iii. Contracting young scientists (post-doctoral) to do research in Astroparticle Physics.
iv. Support a Spanish thematic network to coordinate the activity on Astroparticles and networks on specific subjects such as, for instance, Neutrino Physics.

- SA3: Developments of R&D for the international project FAIR

The MEC has officially declared the Spanish interest to participate in this international project and our community has already assumed economic and scientific commitments. The first phase of FAIR will begin to operate in 2011, so the next five years will be critical to ensure our capability to face these responsibilities. At the same time, we should take advantage of the present activities in the CERN installations (Isolde, n_TOF) and plan the future developments in this field (Eurisol, β-Beams). The priority objectives of this SA are:

i. Support the development and construction of detectors, by contracting qualified technicians and coordinating the existing infrastructures, ensuring its optimal use.
ii. Contracting young scientists (post-doctoral) to do research in this field.

iii. To ease the stay of the scientific and technical personnel at International Laboratories during long time periods.
iv. Support the thematic network which coordinates the efforts of the Spanish community of nuclear physicists.

- SA4: New and Future Facilities

Neutrino oscillations have already provided the first experimental signs of the existence of new physics beyond the Standard Model. Once LHC will have clarified the mechanisms of electroweak symmetry breaking, the physics of flavour will be a priority objective of the international research in particle physics: to determine the origin of the scales of masses and mixtures of the known fermions, as well as of the new particles that LHC could discover, and study the possibility to detect violations of the CP symmetry in the lepton sector. A series of international projects centred in new neutrino accelerator facilities and future flavour factories under discussion are presently the mainstream line to try to answer these questions. Moreover, the future International Linear Collider should perform a high-precision investigation of the highest attainable energy scales. The CPAN should ensure the Spanish presence in all forums of discussion and promote the participation of our community with a sufficient specific weight to assume prominent responsibilities. The priority objectives of this SA are:

i. Creation of thematic networks on the physics associated with new and future facilities.
ii. Contracting young scientists (post-doctoral) to do research in these fields.
iii. Hiring of technicians to support the developments of detector R&D for these new and future facilities.

These Strategic Actions on priority scientific objectives will be complemented with a series of Horizontal Actions, seeking to reinforce their effectiveness:

HORIZONTAL ACTIONS (HA)

- HA1: Training of personnel and activities of R&D in particle acceleration techniques

The physics of accelerators is an important field of work with a very scarce presence in our country. Given its technological and scientific interest, the CPAN should promote the training of specialized personnel and the development of R&D activities with the goal to participate in future international accelerator projects, such as the ILC, CLIC, EURISOL, or the several flavour factories presently under discussion. The fundamental directions of this HA are:

i. Contracting of international experts in accelerator physics to initiate the training of specialized personnel in this field.
ii. Contracting and training of technical personnel in this field.
iii. Support the activities of R&D in particle acceleration techniques.
iv. To ensure a prominent Spanish contribution to the acceleration rings of FAIR.
v. To study the viability to direct a beam of β nuclei (β-Beam) to the Underground Laboratory of Canfranc from the nuclear installations at CERN. This possibility would involve in a coordinated manner the strategic actions SA2, SA3 and SA4.

- HA2: Data processing and numerical simulations

The CPAN should promote the coordination of the existing data processing infrastructures to optimize its exploitation, and to ensure the availability of enough computing capacity to cope the needs of the community. The huge quantity of data that LHC will supply poses an immense computational challenge. The priority objectives of this HA are:

i. Supporting the coordination of the GRID infrastructures that are being developed in our country to process the LHC data and to facilitate mechanisms to correct the possible structural deficits (Tier-1, Tier-2) that can arise.
ii. Help financially (co-finance) the GRID groups in the start of the "Tier 3".
iii. Co-finance the Spanish groups involved in numerical lattice simulations to acquire powerful data processing infrastructures, so that they can compete adequately with the groups of the other countries.
iv. Assuring our data processing capacity and supporting the development of numerical simulations, by means of the contract of specialized technicians.

- HA3: Advanced Technology Transfer

The promotion of the development of new technologies as a consequence of the R&D activities of the groups should be a priority of the CPAN. The necessary mechanisms should be structured to support efficiently initiatives in technological applications related to the areas of action of the CPAN and to facilitate the transfer of technology to the industrial sector. The main goals of this HA are:

i. Launching a technology transfer Service in the CPAN Office, by contracting an expert in technology transfer and providing him with the necessary support of technical staff.
ii. Coordination of the technology transfer activities of the CPAN groups.
iii. To promote the collaboration with the CDTI, OTRI's and similar agencies in technology transfer activities.
iv. Supporting new initiatives in technological applications related to the areas of action of the CPAN, such as medical physics, e-science or space sciences.

- HA4: Scientific Training

The CPAN should promote all aspects related to the training of new researchers, and the diffusion inside the international scientific community of the results obtained by the members of the project. The fundamental directions of this HA are:

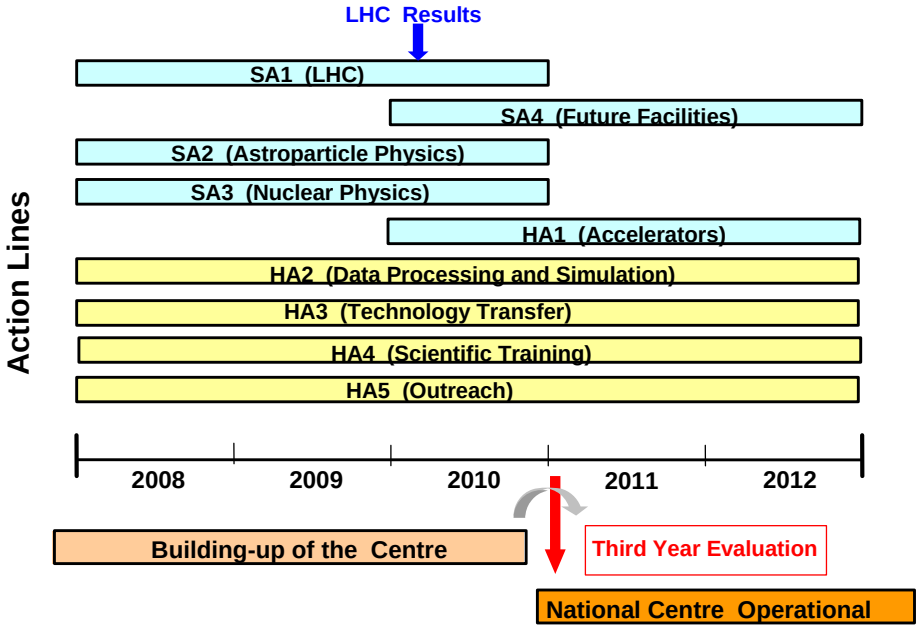
i. Support and coordinate graduate national schools related to the CPAN activities. Promote the coordination of the Doctorate and Master Programmes, which exist at present in some groups.
ii. Support and coordinate specialized workshops and promote the organization of international scientific conferences in our country.
iii. Launch a competitive programme of postdoctoral contracts, based on the excellence of the candidates and open to all the scientific areas covered by the CPAN, with the aim of training young researchers within the CPAN groups.
iv. Create and support thematic networks on those fields not covered by the previous strategic actions.

- HA5: Outreach

The CPAN should promote all aspects related to the diffusion of scientific culture to the society. The priority objectives of this HA are:

i. Launch a CPAN outreach group, through the contract of an outreach expert and support him/her with the necessary technical staff with experience in web technologies.
ii. Support the diffusion of scientific culture in our society and promote the knowledge on particle, astroparticle and nuclear physics at secondary schools and universities.

F) WORKING PLAN, METHODOLOGY, OPPORTUNITY AND VIABILITY



The tentative working plan, shown schematically in the figure, is organized around the action lines, keeping in mind the two steps of the project, marked by the creation of the National Centre and the calendar of the scientific projects. Each one of the strategic action lines will be developed according to a common methodology:

- Initial phase of confirmation of the objectives, milestones and necessary resources: this phase will have a maximum duration of three months, will be coordinated by a member of the Executive Committee and approved by the Scientific Strategy Council; in the second step, this phase will have an approximate duration of one year.

- Execution phase of the foreseen activity: with a typical duration of three years, in which will be contracted most of the personnel, with milestones yearly defined in the initial step and a report to be given to the Scientific Strategy Council.

- Summary phase and definition of the continuity and sustainability of the activity: to be carried out in the last three months of the proposed activity, to provide arguments of evaluation and consideration of new related actions.

This methodology will be revised during the process of definition and implementation of the National Centre. Section 5 specifies the detailed budget of execution and includes a detailed description of the needed resources for each activity. The opportunity and viability of the National Centre has been already partly discussed before, in what concerns the effect of structuring the area. Its structure and a detailed implementation plan will be discussed later (subsections H and I).

All planned actions carry a considerable challenge, and the confidence level of the success is partly based in previous achievements, in general at a smaller scale, of the teams involved. Thus, for example, the experimental particle physics groups achieved an impressive success in the analysis of LEP and Tevatron accelerator data. They contributed to very prominent results as well as in precision measurements and new particle searches. In LHC a similar visibility is expected, given the scale of the contributions. This is one of the challenges and the reason to propose this action. On the other way a higher risk is involved with the new Canfranc laboratory, due to the more limited previous experience.

Among the foreseeable generic risks, the following can be emphasized:

- Difficulty of coordination to achieve a specific objective, and risk of financial atomization. We have tried to reduce this risk by undertaking a limited number of initiatives, and guaranteeing a critical mass, not only of researchers of the interested team but also of contracts and support in each case. The structure of the coordination establishes a dedicated link with the Executive Committee for each initiative, and foresees the execution of periodic reports that will allow correcting problems along the execution. Likewise, the actions contain scientific discussion forums to achieve a reasonable diffusion and exchange of ideas inside the own project, key for the success in several actions.

- Problems of execution of the scientific associated projects. This risk should be assumed at the same level that is usually adopted in other projects. The Executive Committee and Scientific Strategy Council should play an important role selecting and revising carefully the corresponding initiatives, particularly those belonging to the second phase.

- The adequate coordination between horizontal and strategic actions. The plan of coordination foresees also the existence of an "integration" team under the Executive Committee to ensure that the horizontal actions complement and reinforce the effectiveness of the strategic actions.

Among the more specific risks, one can mention:

- SA1 LHC: possible delays in the setting of the accelerator and/or detectors; problems of access to by-products data of the models of each detector; difficulties to establish the forum of coordination among theoretical and experimental physicists.

- SA2 Canfranc-Astroparticle: problems associated with the administrative structure of the new laboratory and its management; problems originated in the estimated resolution threshold of astroparticle experiments; difficulties of coordination among the different programmes.

- SA3 FAIR: possible delay in the setting up of the detectors; scientific return to the community proportional to the effort done. Both risks should be mitigated by the fact of the smooth transition from the present GSI situation to the final FAIR setup.

- SA4 New and Future Facilities: delays in the election of new initiatives on a worldwide basis and in the operation of the present detectors.

G) COMPLEMENTARITIES WITH THE NATIONAL AND EU R&D PROGRAMMES

Since this proposal gathers the majority of the researchers of our country in the domain of particle, astroparticle and nuclear physics, there is a high degree of overlap among the scientific objectives here exposed and the general objectives of the National Program of Particle Physics. Nevertheless we have been extremely careful in proposing Strategic and Horizontal Actions that are not expected to be financed through the National and European Programmes of R&D.

First of all, the creation of the National Centre itself is beyond the scope of the projects of the National Programs. The National Centre is not contemplated so much like an objective in itself, but rather as an instrument to allow our community to be endowed with the technical means and the required coordination to reach a greater scientific excellence as well as an appropriate presence in the international scene. In fact the experience accumulated after 23 years of operation of the Mobilizing Plan of High Energy Physics and the sequel Programs show that only through an Institute or National Centre it is possible to reach the level of the most advanced countries in these scientific domains.

The incorporation of an adequate number of engineers and technicians to the different groups and institutes, in order to contribute to reach successfully the priority lines here described, is not possible in the context of the existing National and European Programmes. The specificity and scope of the research in Particle, Astroparticle and Nuclear Physics makes absolutely necessary the presence of technical staff. Up to now, the technical support has been rather reduced, limiting often the participation of Spanish groups in the development of equipments. The National Programs allow short-term contracts for technicians or engineers to develop a specific task. However in order to have an adequate participation in large international projects it is crucial to have the possibility of coordinating the effort of a larger group of technicians and engineers. Similarly, the existing mechanisms do not permit to incorporate to the different groups a sufficient number of postdocs, in order to analyze and exploit scientifically the huge amount of data that will be generated at the LHC. It is clear that we should profit from our investment in detectors with an adequate investment in the physics analysis part.

The National and EU Programmes cannot assume the additional costs of long stay periods of some scientists and technicians "in situ" at CERN. Without this presence the Spanish groups would be condemned to a subsidiary participation in the big analysis programmes of the LHC. These reflections are especially relevant in connection with the complex structure that represents the LHC Computing Grid project. An additional effort is required, mainly in personnel, but also in equipment that is not available through the National and EU Programmes, without hurting in other areas. Similarly, the design and construction phases of the different experiments of FAIR will require some personnel spending long periods abroad, which makes also necessary to implement a specific funding procedure.

The EU Programmes require usually the involvement in large collaborative efforts. The Spanish groups, through their participation in international projects, have received substantial funding through the EU Programmes. However, other European countries, which have larger scientific infrastructures, have benefited much more than Spain. The creation of the National Centre can be seen as an opportunity of correcting this imbalance, so that small groups can find the required platform to participate in international projects which may apply to the EU Programmes.

Our country has a small, but excellent community of physicists, experts in numerical simulation methods in particle physics and field theory. Up to now the very specialized computing requirements of this community have not been covered by the different calls of the National Program. This project would permit to fulfil the needs of these groups and to ease their contribution.

Our groups have accumulated a great potential in aspects associated with technological transfer, which are clearly very important. As an example, the unique expertise in our country in the development of radiation resistant electronics, as well as in development of detectors for medical applications and detectors of high sensitivity to low energy particles and radiation. There are many more examples. The National Program has neither a specific mechanism to attend these needs nor a way to ease the training of scientist and, above all, technicians in these specialities.

The articulation of institutional representation aspects, although perhaps less glamorous, is also extremely important. Our experimental activities are almost completely inserted in large international collaborations. The National Centre would coordinate these activities and the thematic networks in the area, and could assume the institutional contribution to the large scientific projects in the domain. To this purpose a long-term program with specific financing should be established with the scientific policy authorities. Obviously none of these activities enter easily in the scope of the National R&D Program and traditionally its inclusion has caused tensions and, occasionally, international breaches. Finally, as it has been indicated, when applicable, all the proposed initiatives are in accordance to the respective "road maps" and European initiatives inside the VII Program Framework of the EU.

H) PROPOSED STRUCTURE AND ORGANIZATION OF THE NATIONAL CONSOLIDER CENTRE

From a practical point of view, it is essential that this centre has a legal entity of its own, or a very large degree of autonomy. This requires either adopting the legal structure of a Consortium, or its integration within an existing Public Research Organization with an appropriate financial autonomy. This Centre should be an institute without "bricks" (with the exception of central administrative services) whose members are posted as researchers or technicians in the different affiliated groups. That is, it would be a distributed Centre, reproducing in good measure the examples of INFN or IN2P3. A legally viable possibility would be to adopt the legal structure of a consortium with participation of MEC, CDTI, CSIC, CIEMAT and the different Universities and Institutes (or the Autonomous Communities in representation thereof).

The centre should be formally headed by a Governing Board of Trustees or High Patronage formed by representatives of the participating institutions (Secretario de Estado, President of CSIC, Director General of CIEMAT, etc.). The Centre will have a Scientific Director, an Executive Committee, a Scientific Strategy Council and an external Scientific Advisory Committee.

- The Governing Board of Trustees holds the final responsibilities for the functioning and organization of the CPAN. It will represent the CPAN in any relation with the Spanish Government or in formal agreements with international institutions and other governments. In addition:
    - It will appoint the Scientific Director upon proposal from the Scientific Strategy Council.
    - It will study and discuss the report of activities presented regularly by the Scientific Director and approve the general lines of activity.
    - It will appoint the Scientific Advisory Committee and its Chairperson after consultation with the Scientific Director.
    - It will approve the modification of its composition and Statutes, should this action be considered necessary.
    - It will approve the yearly budget.
    - It will establish the general directives concerning personnel.

  The Governing Board of Trustees will be chaired by the officer of highest rank.

- The Scientific Director will be the responsible of the implementation of the different policies of the CPAN. He will be elected in an open, competitive and public process for a fixed period of time. He will chair the Executive Committee. In addition he will:
    - Chair the meetings of the Scientific Strategy Council.
    - Participate in the meetings of the Scientific Advisory Committee.
    - Appoint the members of the Executive Committee and, in particular, the General Manager (see below) and other positions in the Centre, following the general directives of the Governing Board after ratification by the Scientific Strategy Council.
    - Prepare a “Report of Activities” which should include the recommendations of the Scientific Advisory Committee, to be presented to the Governing Board of Trustees.

  The Scientific Director shall seek the maximum consensus and adequate representation of all the interested parties (individuals, research groups, institutes, sub-field communities, etc.), particularly when appointing the members of the Executive Committee.

- The Executive Committee will take care of the running of the centre. It will be formed by the Scientific Director, four representatives of the four main scientific lines (theoretical physics, experimental particle physics, astroparticle and nuclear physics), one or two coordinators in charge of the supervision of specific tasks (like relations with national facilities, relations with international labs, etc.) and the General Manager. It will:

- Administer the resources necessary for the successful completion of the strategic initiatives approved by the Scientific Strategy Council.
- Deliberate and propose new strategic initiatives to the Scientific Strategy Council.
- Generally speaking, will take any initiatives deemed necessary to make of the CPAN the successful National Centre that we all foresee in this Project.

- The Scientific Strategy Council will be formed by the local representatives of the different research groups that compose the CPAN. Its decisions will be taken with the majority of the votes of its members, weighted in each case with the number of senior doctors represented by these members. Its main missions will be:
  - Propose to the Governing Board the Scientific Director.
  - Ratify the composition of the Executive Committee appointed by the Scientific Director.
  - Ratify the General Manager appointed by the Scientific Director.
  - Approve the new strategic initiatives proposed by the Executive Committee.
  - Propose new strategic initiatives to the Executive Committee.
  - Generally speaking, the SSC will be competent to decide on the relations between the CPAN with its current research group members and with other research groups applying for incorporation to the CPAN.

- The Scientific Advisory Committee will be an external committee integrated by relevant scientists of each speciality at the international level. Its mandate will be to evaluate and provide advice and recommendations about the activities of the CPAN.

The non-purely scientific activities of the Centre will be around:

- A Support Unit structured in several departments:
  - Computing Support.
  - Technology Transfer.
  - Organisation of Events (Conferences, Workshops, etc.), Diffusion and Out-reach.
  - Relations with National Facilities and International Laboratories and Organizations.

Pivotal to the success of the CPAN is the incorporation of new scientists, engineers and technicians to the field. It is foreseen the creation of two different but complementary structures:

- The "Staff and Contracted Personnel Unit" (scientists, engineers and technicians). Its members will be distributed among the different research groups according to the strategic priorities of the CPAN. These personnel, although ascribed to the corresponding research group, will be linked contractually to the CPAN. The selection process for permanent positions will be based on a public open procedure with international diffusion. The salaries will include incentives according to the fulfilment of objectives.

- The "Short-Term Contracts Unit" for scientists, engineers and technicians to be assigned and used by the different research groups according to the strategic priorities of the CPAN. The existence of this unit will bring to the research groups the possibility of flexible employing of qualified personnel who may be needed during only short-term periods (of the order of one year).

Concerning the share of infrastructures by the members of the CPAN, it is foreseen the creation of:

- The "Common Infrastructures Unit", including mechanical and electrical workshops, computing facilities, etc. Initially it will be formed by already existing infrastructures belonging to the different groups of the CPAN. It is foreseen that the CPAN will boost the creation of newer

facilities, more modern and capable, which will help substantially in the achievement of the goals of the CPAN.

All the administrative work will be carried out by

- A Secretariat with a staff of three members (tentative).

For non scientific, technological, academic, etc. matters, the maximum responsible of the CPAN will be

- The General Manager. This person will have the responsibility for the correct functioning of the various Units, the Secretariat, the Central Management Service complex (see below) and any other common infrastructure, virtual or physical, of the CPAN. The General Manager should be highly efficient and will be evaluated according to objectives.

The General Manager, Secretariat and appropriate parts of the Support Unit will be housed in the Central Management Services complex, which will be located in a place yet to be decided.

The general function scheme in annual cycles will include:

- Fortnight meetings of the Executive Committee; at least one of them in person each three months.
- At least two annual meetings of the Scientific Strategy Council, where the status in the different areas and globally will be revised and new strategic initiatives will be discussed.
- One annual meeting of the Scientific Advisory Committee.
- One annual meeting of the Board of Trustees, where the Scientific Director will report on the current status and present new initiatives.

The duration of the mandate of the different bodies composing the CPAN will be established in the Statutes of the CPAN. If those Statutes are not ready within the first three years of the Consolider Project, all of them will be renovated or confirmed after that period by the Scientific Strategy Council.

I) PLAN OF IMPLEMENTATION OF THE NATIONAL CONSOLIDER CENTRE

The starting point will be the precedent CEFAE Centre. Assuming that this initiative is approved, the first step would possibly be a renegotiation of the creation agreement, including the change of the name, and the composition of the Board of Trustees according to the new situation and needs. This process could be handled in a reasonable way in a maximum period of two or three months. After this centre is reactivated (or created anew), it could manage directly the first contracting actions, using the administrative infrastructure provided by the management institution for the administration and management of the CONSOLIDER project.

In parallel, the procedure to transform this into a CONSOLIDER centre as a separate legal entity could be initiated. According to previous experience, the constitution of a centre of this type that includes at least two OPIs, CDTI and the MEC director council in the Board of Trustees requires at least one year for the completion of all the steps. The affiliation of the different Institutes and Universities through specific agreements would require most likely several months more, but the centre could be already operative once the Board of Trustees is constituted and a Director appointed. The estimated time for the centre to be operative is two and a half years. A tentative schedule is given below, including the list of steps and/or milestones required for a correct implementation.

First Semester (January → June, 2008)

- (S0) Setup of the Board of Trustees for the National Consolider Centre through a meeting of the CEFAE Board of Trustees with the following agenda:
  - Re-activation, changes in its composition and change of its name to Board of Trustees of the National Consolider Centre (NCC) for research in Particle, Astroparticle and Nuclear Physics. Notice that the NCC is the formal name that we give here to the CPAN, before the formal approval of the later foreseen in S14.
  - Approval of the "Process for Launch and Formation of the National Consolider Centre" (PLF- NCC).
  - Confirmation of the executive structure of the CONSOLIDER project for the execution of the PLF-NCC.

- (S1) Proposal of the composition of the Committee in charge of the PLF-NCC and of the redaction of the statutes of the NCC (CC-PLF-NCC). Proposal of the composition of an International Advisory Panel for the PLF-NCC (IAP-PLF-NCC). By the Coordinator.

- (S2) Approval of the composition of the CC-PLF-NCC and IAP-PLF-NCC. By the Scientific Strategy Council.

- (S3) Draft of NCC Statutes: Management Structure of the NCC and the terms of mandate of each of their members/bodies. By the CC-PLF-NCC. The starting point will be the one drafted in this Consolider proposal:
  - Scientific Director.
  - Executive Committee (Scientific Director, Scientific Representatives, General Manager).
  - Scientific Strategy Council.
  - Scientific Representatives of the different research lines: Theoretical Physics, Experimental Particle Physics, Astroparticle and Nuclear Physics.
  - Scientific Advisory Committee.
  - Support Unit (Informatics Support, Technology Transfer, Out-reach, Relations with External Institutes, etc.).
  - General Manager.

- (S4) Draft of NCC Statutes: Governing Rules and Decision Procedures in the different statements. By the CC-PLF-NCC. The starting point will be the one drafted in this Consolider proposal:
  - Scientific Strategy Council: by majority of member votes, these being weighted by the number of senior doctors in the corresponding groups.
  - Scientific Advisory Committee: by majority of its members, allowing particular votes for those in disagreement.
  - Executive Committee: to be discussed.

- (S5) Decision on the structure of the Administrative Support Unit and Central Management Services. By the CC-PLF-NCC.

- (S6) Decision on the placement of the Central Management Services. By the CC-PLF-NCC.

- (S7) Meeting of the IAP-PLF-NCC. Its recommendations must arrive before S8.

Second Semester (July → December, 2008)

- (S8) Meeting of the Scientific Strategy Council for formal approval of the proposals and drafts submitted by the CC-PLF-NCC (steps S3-S6).

- (S9) Launch of the process for hiring the personnel of the Secretariat, including an interim Manager that would be eventually replaced by the Manager of the NCC. By the CC-PLF-NCC with the help of some of the participating Groups.

- (S10) Start of the conditioning work of the Central Management Services in its final placement. By the CC-PLF-NCC with the help of the, eventually, host Group (or the participating Group most related to the physical place where those Services will be housed).

- (S11) Draft of NCC Statutes: Rules for the process for incorporating the Groups to the NCC (initially, those groups participating in the Consolider Team). Regulation of the relations between the groups and the NCC. By the CC-PLF-NCC.

- (S12) Draft of NCC Statutes: About infrastructure belonging to the participating groups to be incorporated partially to the NCC. On the normative on its use and the procedures of incorporation. By the CC-PLF-NCC.

- (S13) Submission of the drafts for S11-S12 to the Legal Services of the different institutions for revision. By the CC-PLF-NCC with the help of some of the participating Groups.

- (S14) Draft of NCC Statutes: Final name of the National Consolider Centre. By the CC-PLF-NCC. The basis proposal will be CPAN.

- (S15) Draft of NCC Statutes: analysis of the reports received from the legal services of the institutions; care taken of the eventual corrections or requests. By the CC-PLF-NCC.

Third Semester (January → June, 2009)

- (S16) Draft of NCC Statutes: Procedure for election and renovation of the Scientific Director, General Manager, the Executive and Scientific Advisory Committees, and the Scientific Strategy Council. By the CC-PLF-NCC.

- (S17) Meeting of the IAP-PLF-NCC. Its recommendations must arrive before S18.

- (S18) Meeting of the Scientific Strategy Council for formal approval of the proposals and drafts submitted by the CC-PLF-NCC (steps S11, S12, S14, S16).

- (S19) Conclusion of conditioning work of the Central Management Services.

- (S20) Incorporation of the personnel in the Secretariat, including the interim Manager.

- (S21) Final draft of the NCC Statutes, including all relevant points described in the previous milestones. Distribution to all the groups in the Consolider team for final comments and corrections.

- (S22) Meeting of the Scientific Strategy Council for formal approval of the NCC statues.

- (S23) Meeting of the Board of Trustees of the NCC with the following agenda:
  - Report of the Coordinator of the Consolider project on the PLF-NCC.
  - Presentation of the Statutes of the NCC by the Coordinator of the Consolider project.
  - Approval of the report.
  - Approval of the Statutes of the NCC.
  - Approval of the creation of the NCC.

- (S24) Formal creation of the NCC according to its Statutes.

- (S25) Launch of the process for search + election of the Scientific Director. By the CC-PLF-NCC.

Fourth Semester (July → December, 2009)

- (S26) Launching of the hiring process for a General Manager. By the CC-PLF-NCC.

- (S27) Election of the Scientific Director according to the NCC Statutes.

- (S28) Election of the General Manager according to the NCC Statutes.

- (S29) Incorporation of the General Manager.

Fifth Semester (January → June, 2010)

- (S30) Incorporation of the Scientific Director.

- (S31) Constitution of the Executive Committee and first meeting.

- (S32) Constitution of the Scientific Advisory Committee and first meeting.

At this point the NCC is fully created and the PLF-NCC is concluded. An early incorporation of the Scientific Director could reduce substantially the time required to reach the final milestones.

- (S33) Meeting of the Board of Trustees of the NCC. Agenda:

  - Report of the Scientific Director on the created NCC and plans for 2011-2012.
  - Approval of the report.

3. RESEARCH GROUP FUNCTIONAL STRUCTURE

Before the National Consolider Centre (the CPAN) has been formed, the Consolider Project is based on the 26 groups from the Research Institutes and Universities that have signed it. We name them globally the CPAN-Consolider Collaboration. They are: IFIC, CIEMAT, CNA, ICE, IEM, IFAE, IFCA, IFT, IGFAE/USC, IMAFF, IMB, UAH, UAM, UB, UCM, UGR, UH, UIB, UM, UO, UPC, UPV, URL, US, USAL y UZ. Eight of those (IFIC, CNA, ICE, IEM, IFCA, IFT, IMAFF, IMB) belong to CSIC, the Institution managing the present application.

The CPAN-Consolider Collaboration will adopt the following functional structure which tries to be as close as possible to the one foreseen for the CPAN:

- The Coordinating Investigator, Antonio Pich Zardoya, will assume the scientific coordination of the team and the functions assigned to him in the official Call of the Consolider Program, the Research Activity Programme and the Management Agreement. He will be assisted by Marcos Cerrada Canales, who will assume the functions of the co-coordinator.

- The Principal Investigators of the groups integrating the team will form the Scientific Strategy Council. This Council is the maximum body of Government of the project, and has the mission to provide advice and support to the Coordinating Investigator, acting in addition as a consultative board. The decisions will be taken with the majority of the votes of the members, weighted in each case with the number of senior[3] doctors represented by these members.

- The Executive Committee will be formed by the Coordinator, the Co-Coordinator and four investigators. The Executive Committee will have, among other attributions, the responsibility of proposing the distribution of the budgetary allocations to the different groups of the Consolider project. It is also a fundamental mission of this Executive Committee to promote, supervise and coordinate the accomplishment of the different aims of the Consolider project, and in particular the discussion in the scientific community at large of the design of the future National Centre, and to ensure all the steps necessary for its implementation. The constituent Executive Committee will be composed initially by the coordinator, co-coordinator, and the investigators Dr. María José García Borge, Dr. Teresa Rodrigo, Dr. Manel Martínez and Dr. Luis Ibáñez. Their deputies will be, respectively, Dr. Joaquín Gómez Camacho, Dr. Lluis Garrido, Dr. Enrique Zas, and Dr. Francisco del Águila. The composition of the Executive Committee should be ratified by the Scientific Strategy Council, once the Consolider Project is approved, and will be reconsidered annually.

- The Executive Committee will be provided with a Secretariat, dedicated to administrative tasks, and, eventually, with a Support Office for computer support, transference of technology, outreach and administrative relations with the national facilities and with the international laboratories and organizations. Before the final decision is taken within the formation of the CPAN, the Secretariat will be housed in the Managing Institution.

The Executive Committee will meet every two weeks; physical attendance to the meeting should be mandatory at least once every three months. The Council of Scientific Strategy will meet at least two times a year.

[3] This number includes staff doctors and those with contracts from the MEC “Ramón y Cajal” or equivalent senior programmes

4. EVALUATION SCHEMA, SPECIFIC FOR THE RESEARCH ACTIVITY PROGRAMME AND THE PROJECT.

As described in the Report, the CPAN-Consolider team has several objectives of scientific and technological character, as well as of scientific policy and of education and outreach, which translate in specific Lines of Action. The participants already carry out actions that touch all these targets, but the existence of the CPAN would on the one hand give them a larger cohesion and on the other improve them both quantitatively and qualitatively; thus the emphasis on the words promotion and coordination all throughout the Report.

In the following Table we propose an evaluation scheme that could be objective and quantitative. For each of the Objectives of the proposal the principal Lines of Action are identified. For each of these Lines concrete Actions are specified (that do not appear in the Table for lack of space but that are described in the Report) and for each of them the possible Indicators that would allow their evaluation. For each of the Actions there would be a Target for the period under evaluation. Each Target has a Degree of Accomplishment which will translate into a numerical figure (e.g. from 0 to 10) such that the output of the evaluation could be a number. The evaluations would take place every 6 months. Clearly the Degree of Accomplishment will depend on the time. In the end it is the "integral" over the whole period of the project that matters, but the periodic evaluation will allow the identification of where a larger or smaller effort is needed along the project. It should also be understood that the evaluation method will itself evolve, in particular the validity of specific indicators.

Action Lines	Indicators	Target	Accomplishment
SA1: Coordinated analysis of LHC Physics.	1. Creation of thematic network 2. Postdoctoral contracts		
SA2: Experiments in the Canfranc underground laboratory and other Astroparticle experiments.	1. Postdoctoral contracts 2. Contracts of technicians 3. Creation of thematic network		
SA3: R&D developments for the FAIR project.	1. Postdoctoral contracts 2. Contracts of technicians 3. Creation of thematic network		
SA4: New and Future Internacional Initiatives.	1. Creation of thematic networks 2. Postdoctoral contracts 3. Contracts of technicians		
HA1: Training of personnel in R&D activities in acceleration techniques.	1. Postdoctoral contracts 2. Contracts of technicians		
HA2: Data processing and numerical simulations.	1. Creation of infrastructure 2. Contracts of technicians		
HA3: Technology Transfer	1. Creation of office 2. Technological transfers		
HA4: Scientific Training	1. Creation of thematic networks 2. Organization of schools 3. Coordination of workshops 4. Postdoctoral contracts		
HA5: Outreach	1. Creation of office 2. Outreach activities		
General to all scientific CPAN activities	1. Publications 2. Talks in Conferences		

5. DETAILED BUDGET FOR THE PROPOSED RESEARCH PROGRAMME

5.1 NEEDED RESOURCES AND BUDGET SUMMARY

The following table gives the estimated budget needed for each of the actions proposed in the research programme (FTE = Full time Equivalent):

	Infrastructure	Personnel	Running Costs	Travel Expenses	Total
SA1: LHC Physics		1.579.097 € 16,29%		150.000 € 1,55%	1.729.097 € 17,84%
SA2: Astroparticle		1.330.298 € 13,73%		130.000 € 1,34%	1.460.298 € 15,07%
SA3: FAIR		1.237.597 € 12,77%		120.000 € 1,24%	1.357.597 € 14,01%
SA4: New and Future Facilities		700.398 € 7,23%		50.000 € 0,52%	750.398 € 7,74%
HA1: Accelerator Techniques		619.598 € 6,39%		50.000 € 0,52%	669.598 € 6,91%
HA2: Data Processing & Numerical Simulations	400.000 € 4,13%	442.898 € 4,57%			842.898 € 8,70%
HA3: Advanced Technology Transfer		578.271 € 5,97%	60.000 € 0,62%	30.000 € 0,31%	668.271 € 6,89%
HA4 : Scientific Training		556.202 € 5,74%	400.000 € 4,13%	30.000 € 0,31%	986.202 € 10,18%
HA5: Outreach		217.771 € 2,25%	240.000 € 2,48%	50.000 € 0,52%	507.771 € 5,24%
Management & International Relations	20.000 € 0,21%	240.000 € 2,48%	90.000 € 0,93%	370.000 € 3,82%	720.000 € 7,43%
TOTAL	**420.000 €** 4,33%	**7.502.129 €** 77,40%	**790.000 €** 8,15%	**980.000 €** 10,11%	**9.692.129 €** 100,00%

Budget Summary:

Personnel			7.502.129 €
Direct Costs	Infrastructure Building Infrastructures Travel expenses Running costs Other expenses Total Direct Costs	420.000 € 0 € 980.000 € 790.000 € 0 €	 2.190.000 €
Indirect Costs (3,18%)			307.870 €
TOTAL			9.999.999 €

Committed Funding:

- CIEMAT: 10%
- CSIC: 20% ($\leq$ 1.000.000 €)

Budget Time Schedule:

We must anticipate a reasonable margin of time to open a public call for the positions, to select suitable candidates and to carry out the first contracts. It seems also advisable to leave a safety margin for the execution of the budget in the last year. A reasonable temporary distribution of the budget could be:

Year	1	2	3	4	5
Percentage	12%	24%	24%	24%	16%

5.2 TENTATIVE DETAILED BUDGET

We present a tentative detailed scheme of the needed budget to carry out the different actions proposed in the project. This allocation of resources may be modified by the project governing bodies in view of the national and international evolution of the field. In particular, since one of the main goals of this project is the creation of a Consolider Centre, once this Centre will be legally constituted and in view of the evaluation of the results obtained until that moment, the Executive Committee, advised by the Scientific Strategy Council, might consider a new definition of strategic actions and reassign the necessary resources for it.

Personnel Costs:

3 contracts of 4 years for the personnel of the Administrative Office: 593.144 €

- 1 Manager 1 x 4 x 60.000 = 240.000 €
- 1 expert in technology transfer [HA3] 1 x 4 x 44.143 = 176.572 €
- 1 expert in outreach [HA4] 1 x 4 x 44.143 = 176.572 €

28 Engineer contracts of 3 years (30% co-financed): 28 x 3 x 44.143 = 3.708.012 €

- 8 for LHC (data analysis, detector maintenance and development) [SA1, HA2]
- 5 for development of experiments in astroparticle physics [SA2]
- 6 for detector development for FAIR [SA3]
- 2 for detector R&D for new and future facilities [SA4]
- 4 for development of accelerator technologies [HA1]
- 2 for new technological initiatives [HA3]
- 1 for the technology transfer section of the CPAN Administrative Office [HA3]

39 Technician contracts of 2 years (30% co-financed): 39 x 2 x 29.428 = 2.295.384 €

- 10 for LHC (data analysis, detector maintenance and development) [SA1,HA2]
- 7 for of experiments in astroparticle physics [SA2]
- 7 for detector development for FAIR [SA3]
- 5 for detector R&D for new and future facilities [SA4]
- 4 for development of accelerator technologies [HA1]
- 2 for numerical simulations [HA2]
- 3 for new technological initiatives [HA3]
- 1 to maintain and develop Web applications in the CPAN Administrative Office [HA5]

37 post-doctoral contracts of 2 years (30% co-financed): 37 x 2 x 44.143 = 3.266.582 €

- 10 for LHC physics [SA1]
- 8 for astroparticle physics [SA2]
- 5 for nuclear physics [SA3]
- 5 for physics at new and future facilities [SA4]
- 9 open to all CPAN fields [HA4]

10 contracts of 1 year of High Level Experts (30% co-financed): 10 x 1 x 60.000 = 600.000 €

- 4 for LHC physics [SA1]
- 2 for astroparticle physics [SA2]
- 2 for detector development for FAIR [SA3]
- 2 for development of accelerator technologies [HA1]

TOTAL PERSONNEL = 10.283.122 €
REQUESTED FUNDING = 7.502.129 €

Infrastructure:

1) Small computing infrastructure for the CPAN Administrative Office: 5 years x 4.000 = 20.000 €

2) Co-financing to cover possible deficiencies in the Spanish GRID infrastructures for the LHC data analysis [SA1, HA2]: 200.000 €

3) Co-financing of computing mainframes for lattice and numerical simulations [HA2]: 200.000 €

TOTAL INFRASTRUCTURE = 420.000 €

Travel Expenses:

This section includes expenses associated with the national CPAN coordination (meetings and visits to the local sites of the participant groups) and with the different international committees in which the CPAN will have to be present. Since a significant proportion of the personnel contracted by the project must work at international laboratories (CERN, Darmstadt ...) we have allocated some funds to face the corresponding travel expenses.

1) CPAN Coordination: 60 trips/year x 5 years x 500 = 150.000 €

2) Travel expenses of the contracted personnel working in international laboratories: 500.000 €

3) Responsibilities at different International Committees: 330.000 €
   - CERN Committees (SPC, ACCU, Outreach, LGB-RRB, ATLAS, CMS, LHCb ...): 20 trips/year x 5 years x 1.000 = 100.000 €
   - RECFA & ECFA Committees 7 trips/year x 5 years x 1.000 = 35.000 €
   - DESY Financial & CDF Committees 2 trips/year x 5 years x 1.000 = 10.000 €
   - ApPEC, FRB Auger & ILIAS Committees 6 trips/year x 5 years x 1.000 = 30.000 €
   - NuPECC & EPS Nuclear Physics 6 trips/year x 5 years x 1.000 = 30.000 €
   - Committees FAIR, Isolde and other nuclear physics laboratories 7 trips/year x 5 years x 1.000 = 35.000 €

- ILC Committee 5 trips/year x 5 years x 1.000 = 25.000 €
- Organization of major International Conferences
  3 trips/year x 5 years x 1.000 = 15.000 €
- Coordination of big national and international initiatives
  6 trips/year x 5 years x 1.000 = 30.000 €
- Other laboratories and international organizations
  4 trips/year x 5 years x 1.000 = 20.000 €

TOTAL TRAVEL EXPENSES = 980.000 €

Running Costs:

The CPAN will maintain an active policy of technical and scientific training of young people, scientific diffusion and technological transfer. The budget of operation estimated for the next five years is the following one:

1) Organization of Masters and Advanced Schools [HA4]: 5 years x 30.000 = 150.000 €

2) Organization of specialized workshops [HA4]: 5 years x 30.000 = 150.000 €

3) Co-financing for the Organization of International Conferences [HA4]:
   5 years x 20.000 = 100.000 €

4) Management of patents and activities of technology transfer [HA3]: 5 years x 12.000 = 60.000 €

5) Promotion and diffusion consumables [HA5]: 5 years x 30.000 = 150.000 €

6) Other consumables: 5 years x 12.000 = 60.000 €

7) Software Licenses: 5 years x 6.000 = 30.000 €

8) Maintenance and development of the CPAN Web and electronic journal [HA5]:
   5 years x 18.000 = 90.000 €

TOTAL RUNNING COSTS = 790.000 €

6. RESUMEN EJECUTIVO EN CASTELLANO

Este proyecto pretende abordar iniciativas estratégicas en Física de Partículas y Astropartículas y Física Nuclear, propiciando un salto cualitativo en la investigación en estos campos. Claramente, este es un objetivo a medio y largo plazo, que requiere para su consecución la implementación de una entidad permanente como el Centro Nacional. La creación del CPAN es por lo tanto la motivación fundamental del Proyecto. Las especiales características de la convocatoria Consolider, la hacen particularmente adecuada para constituir un Centro Nacional que coordine las actividades de los grupos investigadores del área y posibilite un salto cualitativo en su actividad científica, poniendo a disposición de la Comunidad Nacional de Física de Partículas, Astropartículas y Nuclear estructuras organizativas equiparables a las existentes en otros países del Espacio Europeo de Investigación, con quienes colaboramos y competimos.

El proyecto se articula en dos fases. En los primeros tres años se pondrá en marcha el proceso de creación del Centro Nacional de Física de Partículas, Astropartículas y Nuclear. El nuevo centro, que tendrá entidad jurídica propia, deberá contar con Estatutos propios, un Director elegido en proceso abierto y competitivo, y un Gerente contratado. En paralelo, el "Equipo Consolider" iniciará las primeras iniciativas estratégicas correspondientes a proyectos muy bien definidos en el momento actual, de una cierta urgencia, y con objetivos muy ambiciosos:

- Optimización de la explotación científica del LHC. Es esencial que seamos capaces de financiar contratos (científicos y técnicos), y estancias en el CERN, para garantizar el mantenimiento, la operación y las mejoras de los detectores, así como la toma de datos y su posterior análisis mediante una estrecha colaboración entre físicos experimentales y teóricos, para jugar un papel clave en la búsqueda del bosón de Higgs y de partículas supersimétricas.
- Apoyo a la puesta en marcha de experimentos en el Laboratorio Subterráneo de Canfranc, a la explotación de MAGIC y a otras iniciativas internacionales en Física de Astropartículas.
- Apoyo a la participación de grupos de investigación españoles en FAIR, coordinando su actividad alrededor de experimentos relevantes, y financiando la contratación del personal técnico necesario para el diseño y construcción de la instrumentación científica de esos experimentos.

Además de estas iniciativas estratégicas, se contemplarán iniciativas horizontales en:

- Formación de personal en actividades de I+D y en técnicas de aceleración de partículas y núcleos.
- Procesado de datos y simulaciones numéricas.
- Transferencia de tecnología avanzada.
- Formación de jóvenes investigadores.
- Divulgación y difusión científica ("outreach").

Entre las nuevas líneas estratégicas previsibles para la segunda fase, definidas ya en el marco del nuevo centro creado, hay que señalar proyectos actualmente en preparación en física de neutrinos, como KM3 o T2K, así como nuevos experimentos de astropartículas y cosmología, o futuras instalaciones como el International Linear Collider, las factorías de sabor, tanto hadrónico (B-factories) como leptónico (neutrino factories o beta beams), y EURISOL.

¿Quien firma este proyecto?

Cada uno de los investigadores firmantes de esta propuesta CONSOLIDER es a su vez Investigador Principal de un proyecto vigente del Plan Nacional I+D+i 2004-2007, del 6º Programa Marco, o bien se encuentra solicitando un proyecto en la última convocatoria del Plan Nacional I+D+i 2004-2007, o bien ostenta cargos de dirección en algún centro participante. Ello asegura la adecuada vertebración de esta iniciativa dentro de la comunidad española de física de partículas, astropartículas y nuclear.