CSIC PLAN OF ACTION

Strategic Plans for

IFIC

Instituto de Física Corpuscular

Centro Mixto CSIC-Universitat de València

1. GENERAL INFORMATION AND SITUATION IN JANUARY 2005

1.1. PRESENTATION

The *Instituto de Física Corpuscular, IFIC,* from Valencia is a *Joint Institute* belonging to two Institutions: *the Spanish Research Council*, CSIC (Consejo Superior de Investigaciones Científicas) and *the University of Valencia,* UVEG (Universitat de València).

In the autumn of 1950 Profesor Joaquin Catalá formed a group at Valencia to study atomic nuclei and elementary particles using the nuclear emulsion technique. He first had been working with Professor C. F. Powell at Bristol. This technique had been successfully employed to detect particles in cosmic rays and fixed target experiments leading to the discovery of the pion in 1947 by Professor C.F. Powell who received the Nobel Prize in 1950. Professor Catalá's group first operated as a Local Division of the Instituto de Óptica Daza de Valdés belonging to CSIC and specialized in photo-nuclear studies. One of Catalá's students, Fernando Senent, later becoming Professor and director of the Institute, produced what was the first Spanish thesis in Experimental Particle and Nuclear Physics. This was in 1954 and the title was: "*Distribuciones angulares de los protones producidos en el bombardeo del carbono 12 por deuterones"*. Another of his students, Professor Eugenio Villar, defended his PhD in 1957 on: "*Análisis de los procesos nucleares producidos al bombardear gas acetileno con deuterones de 19 MeV*", and was later the person leading the Particle Physics group in Santander, now known as Instituto de Física de Cantabria, IFCA.

It was at the beginning of 1960 when the Institute got its present name, IFIC, Instituto de Física Corpuscular.

IFIC, hence, is one of the oldest Spanish Institutes in Experimental Physics and the oldest studying particle and nuclear physics. During many years, the Institute shared the building, offices and facilities, with the University department of Física Atómica, Molecular y Nuclear, FAMN, (called Física Fundamental before 1990) which has been the traditional link with the University.

The first observation of the exotic nuclei, ^{8}He, through the reaction: $^{8}He \longrightarrow {}^{4}He + {}^{4}He + 2e^{-}$ was performed by IFIC in 1971.

The international impact of the Institute research activities have been very much related to the political Spanish situation. In the period 1950-1984, IFIC survived having modest, but heroic, contributions to the physics performed at the international scale. However since 1984, when Spain re-entered CERN (the European Organization to study the properties of elementary particles) a strong boost to the scientific activity of IFIC took part in both quantity and quality aspects and at both the national and the international level.

Around the year 1985 most of the researchers of the Theoretical Department of the University of Valencia joined the Institute and configured its final structure which benefits from the knowledge of both fields: theory and experiment. The present situation contributes to add a clear advantage with respect to the previous one having a direct impact to the research work of the Institute as it provides an excellent atmosphere for scientific cooperation especially in the phenomenological and experimental areas.

During the last years, it is worth mentioning the participation of the Institute in experiments at CERN (Geneva-Switzerland), GSI, (Darmstad-Germany), Stanford (California-USA), FERMILAB (Chicago-USA), etc.. Results obtained in collaboration with other groups in these laboratories have lead to establish the Standard Model of elementary particles and the number of light neutrino species to be three.

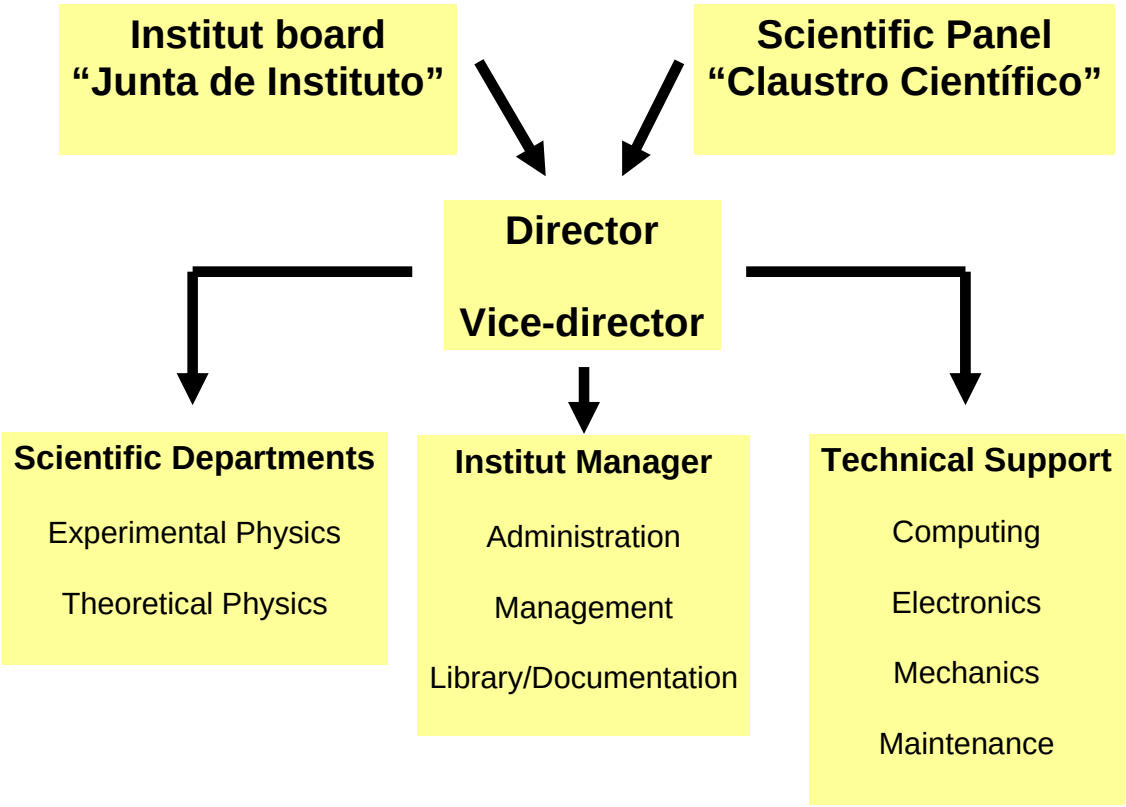
In 2005 IFIC has been officially classified by the Spanish Ministry of Education and Science (MEC) as Class A in the list of CSIC Institutes.

The Institute is situated in the University Campus of Burjassot-Paterna and the personnel are distributed at the University departments (Física Teórica and FAMN), at the University building containing the Research Institutes and at the CSIC building where all the laboratories and infrastructures are located.

1.2. STRUCTURAL DATA AND RESOURCES

1.2.1. Organizational structures

IFIC Organization Structure and Mangament



IFIC location

IFIC: Instituto de Fisica Corpuscular

Joined Institute belonging to two Institutions

Administration and offices

UVEG
Universitat de València
- **FAMN**
- **Física Teórica**

Laboratories

CSIC
Consejo Superior
De Investigaciones Científicas

General Structure:

- **Research departments: Theory and Experimental Physics**
- **General Services: Administration, Computing, Electronics, Mechanics, Maintenance**

1.2.2. General infrastructure

- Space at the two University departments at Burjassot (offices and labs) : Física teórica and FAMN, around 1000 m²
- Space at the Institutes Building of the University at Paterna (offices): around 1000 m²
- Space for labs at the Laboratory building of CSIC: around 3000 m²

IFIC: Laboratory building

- Total surface of 3000 m^2.
- Only 3/4 are built.
- Contains:
  - Offices for physicists, engineers and technical staff.
  - Computer Center: 100 m^2
  - Electronic laboratory: 120 m^2
  - Mechanics workshop and storage: 300 m^2
  - Clean Room: 80 m^2
  - Labs for present projects: LHC, Antares, N-Tof, Isolde, Medical Physics, Detector R&D, etc..

IFIC: Computer Center

Total numbers:

- +450 Nodes registered in the cell: ific.uv.es
- +150 PC's in Linux/Windows
- 11 General printers

Services:

- Web and mail
- Software Instalation
- Printing services
- Software and Hardware maintenace
- Security and data storage

Center:

- 30 KVA UPS (30 min)
- Cooling system 40 KW

Net:

- Gigabit Ethernet backbone
- 100 Mbps for computers

AFS:

- Cell: ific.uv.es
- 200 GBytes RAID

FARMS:

- GOG-GRID: 134 PC's Athlon 1.2GHz
- NPQCD: 5 PC's Dual Xeon 2GHz
- BEE: 5 PC's Athlon 1.2 Ghz
- GCHIRAL: 5 PC's Athlon 1.5 Ghz
- Lattice: 13 PC's Xeon dual 2,7 GHz

Storage:

- Hierarchic system
  - Tape: 180 TBytes
  - Disc: 3 TBytes

IFIC: Mechanical Workshop and Electronic Lab

Mechanics:

- Design
- Crane 10 Tn
- High precision center

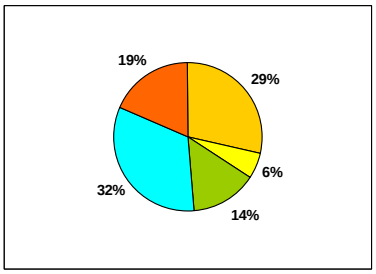
Electronics:

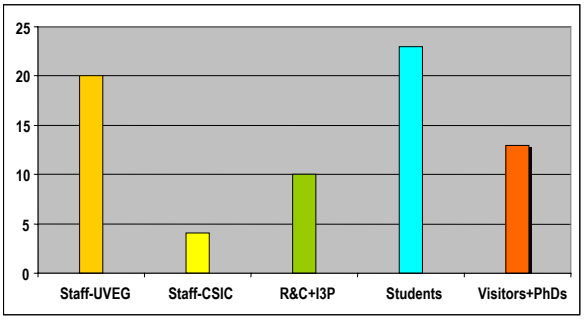
- Card design and fabrication
- Multilayer production (8) PCB
- Assembling of components
- PLDs programation

IFIC: Clean Room for SemiConductor Detector Development

- **Clean Room 20 m^2 class 1000 and 55 m^2 class 10.000.Temperature and humidity controled within 0.5 ^{0}C and 5%, respectively**
- **Automatic detector assembling and gluing system with 1-2 μm precision**
- **Metrology system for detector alignement with precision <0.5 μm**
- **Detector characterization system**
- **Automatic and semi-automatic wedge bonding: 8090 K&S y 1470 K&S**
- **Pull tester**
- **Enviromental chamber**
- **Infra-red camera**
- **Readout system for Si detectors**
- **Laser and radioactive source systems for detector calibration**

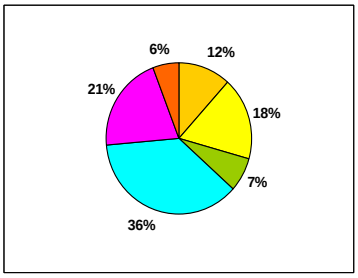
1.2.3. Human resources
IFIC: Composition of the Departments, General Services and Technical Support

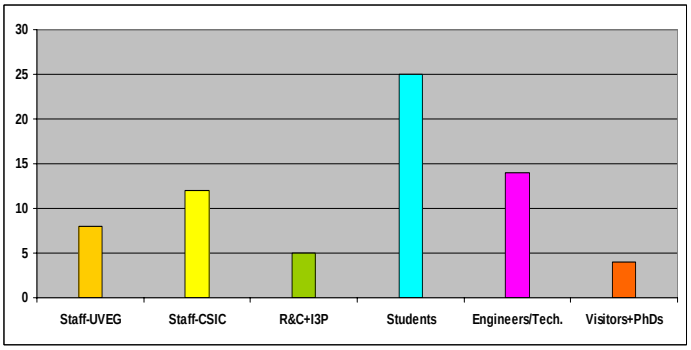




Theory Department
70 members

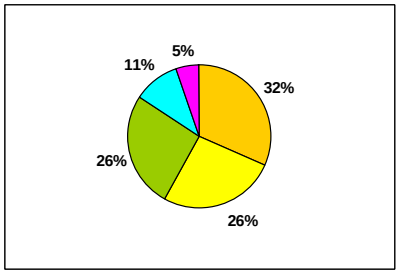
70 researchers

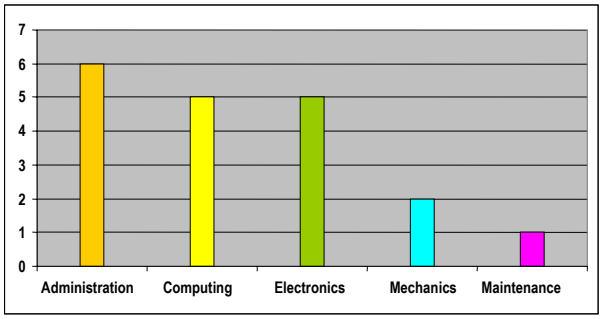




Experimental Department
68 members

54 researchers

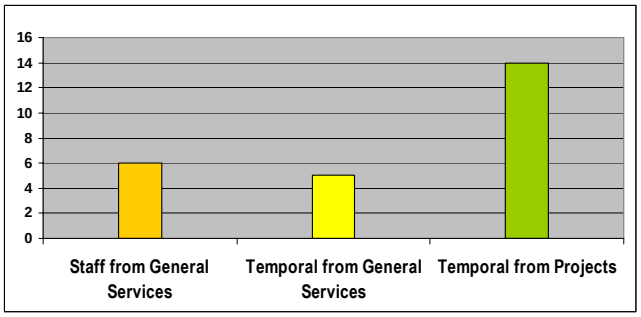




General Services
19 members

Technical Support
(Computing, Electronics, Mechanics)
Total: 25

Only 24% of the Technical Support have a fixed contract. The rest being funded by local projects



1.3. DEPARTMENTS

IFIC consists of two research departments, one theoretical and the other experimental whose activities are described following.

Department of Theoretical Physics

AHEP: Astroparticle and High Energy Physics Group

The group consists of one *profesor de Inv*. CSIC, one lecturer, *titular* from UVEG, three Ramón & Cajal, CSIC, one Juan de la Cierva Contract, 1 Sabbatical visitor (Victor Semikoz), 1 Postdoctoral Researcher, 6 PHD students and 6 external members.

The group has a long and solid tradition as host of senior and postdoctoral researchers (Premio Profesores Visitantes de Iberdrola), with a very intense research atmosphere and its own seminar programme, fully cosmopolitan. It is funded by Spanish (BFM-2002-00345 from MEC, GRUPOS03/216 from Generalitat Valenciana) as well as a variety international collaboration grants (at present, the European RTN network MRTN-CT-2004-503369) and bilateral agreements such as *acciones integradas*. In the last 5 years, the group has coordinated the network Neutrino Astrophysics of the ESF and the training site HPMT-2000-00124 of the European Commission and is part of the ILIAS I3 initiative as well as the ISAPP collaboration. It has developed an intense research effort that include different theoretical, phenomenological and observational aspects of Astroparticle and High Energy Physics, that can be divided into two main research lines, as follows

- AHEP-1 Astroparticle physics and Cosmology: analysis and phenomenology of neutrino properties, neutrinos in supernova physics and cosmology, neutrinos as astrophysical and cosmological probes. The group has a leader position in this area, playing an active role in the analysis and interpretation of the experimental results on flavor neutrino oscillations.

- **AHEP-2 Theory and phenomenology of high energy physics:** includes the study of the origin of neutrino masses, their mixing and CP violation. The contribution of the group in this line is based on the study of particle physics beyond the Standard Model and its experimental consequences. The main emphasis is on the neutrino sector and the study of supersymmetric models including simulation of signals at future accelerators like the LHC.

More detailed information can be found in the attached report of the group and at its web-page **http://ahep.uv.es/**

COMPSYS: Dynamics of Complex Systems Group

Formed by two IFIC staff researchers, one *Inv. Científico*, CSIC, and one *Catedrático*, UVEG. Funded by the ministry (FIS2004-00912) and the Generalitat Valenciana (GRUPOS03/002). The research activity is centered in two broad lines: 1) Study of systems of particles in interaction (atomic nuclei, nanodrops of helium, nuclear matter, liquid helium), treated from different perspectives (phenomenological or microscopic descriptions with suitable calculational techniques). These aproximations require specific calculational techniques, some of which represent a considerable computational effort . 2) Evolution equations of classic and quantum systems by means of tecnicas that incorporate the qualitative properties (symmetries, unitarity..) of their solutions derived from first principles, inherited also in their numerical integration. We also consider systems whose complexity does not even allow one to know the laws of evolution.

FMEE GROUP: Phenomenology of the Standard Model and its Extensions

The group consists of thirteen researchers, ten of them permanent, one *Catedrático de Universidad* and nine *Titulares de* Universidad and three with contracts within the *Ramón y Cajal* program, as well as various PhD fellows and collaborators from other national and foreign institutions. We participate in 2 research projects from the Plan Nacional: FPA2002-00612 and BFM2002-00568 and several others. The group has been developing research projects during the last 25 years in the field of elementary particle physics. Its research lines are diverse and cover from the study of the newest theories on high energy phyics (extra dimensions, supersymmetry, superstrings) to phenomenological studies of the Standard Model closely related to the experiments (B quark physics, CP violation, jets, neutrino physics), including also some applications of particle physics to cosmology and astrophysics (baryon asymmetry, dark energy and dark matter, supernovae, etc) and hadronic physics at low energies (lattice QCD, effective theories, sum rules applications, etc). We have even initiated a new line on quantum computation.

MATHEPTH: Mathematical and Theoretical High Energy Physics Group

The group consistis of one full professor, *Catedrático* UVEG, one lecturer, *titular* UVEG, one lecturer contract, one I3P post-doctoral contract and two RyC. There various external members and seven PhDs.

Research lines (see 1.4 for details)
-String Theory, Supergravity and M-Theory
-Quantum Fields and Gravity
-Geometrical Aspects of Fundamental Physical Theories
The group has a tradition of over 25 years with two monographs edited by Cambridge Univ. Press. and Imperial College Press. Research supported by:
"Geometría, grupos, teoría de campos y supersimetría" (MEC) BFM2002-03681
"Aspectos cuánticos de agujeros negros" (MEC) BFM2002-04031-C02-01
"Física Matemática y Teórica de Alta Energía" (Generalitat Valenciana, Grupos-03-124)
"Gravedad cuántica y teoría no conmutativa de campos, cuerdas y branas" (Generalitat Valenciana, GV04B226)
"Constituents, fundamental forces and symmetries of the Universe"
(Proyecto Europeo MRTN-CT-2004-005104).

The group has international agreements and/or collaboration with INFN (Bologna, Padova, Torino, Frascati) and U. of Cambridge, Imperial College, U. Wisconsin-Milwaukee, Kharkov, Wroclaw, CERN, UCLA, Universidad de Concepción (Chile), as well Spanish Universities and CSIC.

More details at the groups's web-.page, http://ific.uv.es/~mathepth

HADMOD GROUP: **Hadronic Models and Fundamental Interactions Group**

Members of the group: The group consists of three permanent researchers, one *catedrático* UVEG, and two *titulaesr* UVEG) and an average number of 2 post-docs and 1 PhD fellow.

The research activity of the group is focused in the relation between hadrons and the underlying quarks and gluons. The project deals with problems related with models for hadrons in terms of quarks and with models based on the effective degrees of freedom. Our aim in the study of all these subjects is to make theoretical predictions or explanations of the experimental data.

Our group is funded by the project of the Plan Nacional FPA2004-05616-C02-01 (coordinated with the University of Salamanca), the grant GRUPOS03/094 from Generalitat Valenciana and various European grants such as networks (HaPHEEP and ESOP) and Infrastructure Initiatives (I3 Hadron Physics) continuously since 1996, in which the group was always responsible of one node.

NUCTHEO: Hadronic and Nuclear Theory at Intermediate Energies Group

The group has two permanent staff members, one *catedrátcio* UVEG and one *titular* UVEG, four postdocs, a sabbatical and three predoctoral fellows. There are two external members of the group with part time dedication to the project. The nuclear theory group has as main objectives the following:

1) Description of hadron interactions (mesons , nucleons, hyperons) at energies of the order of the GeV. This is the region where QCD is well described in terms of effective Lagrangians and chiral perturbation theory, requiring in most of the cases a nonperturbative extension based upon unitarity in coupled channels.

2) Application to the study of properties of elementary particles in nuclei using quantum theory of many body systems. Here we include the interaction of neutrinos in nuclei which will be used to analyze future experiments at Kamiokande.

3) Study of the nature and properties of meson and baryon resonances and the proposal of reactions to determine these properties. This includes possible exotic mesons and baryons which cannot be constructed with three constituent quarks or quark antiquark respectively. We also study the properties of these resonances in a nuclear medium. The group collaborates regularly with other groups in Spain, Germany and Japan mostly. The group works very close to experiments being performed at the different hadronic Laboratories like Mainz, GSI (Darmstadt), COSY (Juelich), ELSA (Bonn), CELSIUS (Uppsala), Spring8/Osaka, Jefferson Lab (USA), BES (Beijing), and has made many proposals of experiment which have been performed or are under analysis at these different Labs.

PARSIFAL GROUP: Particles and Interactions: Flavour and Colour Dynamics

The members of the group are one full professor, catedrático UVEG, one investigador cientifico CSIC), two titular UVEG, one cientifico titular, CSIC, shared dedication), two Ramón & Cajal, four postdoctoral researchers, one I3P postdoctoral contract, five predoctoral fellows and two external doctors.

The research activity covers all aspects of Particle Physics Phenomenology, using the most recent experimental data and the most advanced theoretical tools available. The modern field theory techniques make possible a rigorous control of the observables allowing us to make precise tests of the underlying dynamical theory. Our main objective is the determination of the parameters of the Standard Theory with the highest possible precision, and the identification of possible signals of new physics beyond the present theoretical framework. The specific subjects of our research are closely related with the present experimental situation in High Energy Physics and its expected evolution in the near future. We can group our different activities in three general lines of research:

— Line 1: Quantum Chromodynamics (QCD)

- Perturbative QCD: Inclusive Processes, Jets, Collider Physics
- Non-Perturbative QCD and Field Theory
- Interplay of Strong Interactions in Electroweak Transitions
- High Temperature and/or Density: Critical Phenomena
- Monte Carlo Generators
- Low Energy Effective Field Theories: ChPT, RChT, HQET, NRQCD, …
- Quantum Field Theory on the Lattice and Numerical Simulations

— Line 2: Electroweak Theory and Phenomenology

- Flavour Changing Phenomena: Quark and Lepton Mixing, CP Violation, τ Physics, Weak Decays
- Precision Tests of the Standard Model: LEP, NLC, …
- Spontaneous Symmetry Breaking: Higgs Phenomenology, LHC, …
- Physics Beyond the Standard Model

— Line 3: Astroparticle and Cosmology

- Neutrino Physics: Oscillations, Astrophysics and Cosmology
- Baryogenesis, Leptogenesis.

IFIC: Theoretical Department, summary of research topics

Effective Field Theory

- EQFT grounds
- Chiral perturbation theory
- Heavy quark effective theory
- Dynamical symmetry breaking
- Effective theories and new physics
- QFT at finite temperatures

QCD

- QCD jets
- Tau decays and QCD
- Heavy quark masses
- Lattice QCD
- Quark masses in the lattice
- QCD sum rules

Weak interactions

- Flavour Dynamics
- B-quark physics
- CP violation
- Electroweak Radiative Corrections
- Neutrino physics
  - Analysis of neutrino properties
  - Theories of neutrino mass

Beyond the SM

- Supersymmetry and the origin of mass
- Supersymmetry Phenomenology
- New physics signatures at colliders
- Lepton flavor and lepton number violation
- Dual Models
- Extra dimensions (b-physics, neutrino masses, GUT in extra dimensions, effects in colliders)

Astroparticle Physics

- Neutrino astrophysics and cosmology
- High energy cosmic ray physics
- CMB and structure formation
- Compact objects in astrophysics
  - Supernovae
  - Neutron Stars
- Baryogenesis
- Dark matter and dark energy

Hadronic Physics Many Body Theory

- Hypernuclei
- Nuclear Drell Yan
- Interactions of photons, electrons and neutrinos in nuclei
- Static properties and variation density
- Spectrum of exotics
- Parton distributions
- Bosonization
- Effective theories for nucleons
- Nucleon dynamics
- Nuclear matter
- Quantum liquids

Mathematical HEP-TH

- Strings and M-theory
- Supergravity
- Quantum gravity and black holes
- Symmetries and quantization
  - Gauge theories and anomalies
  - Deformation of symmetries
- Dynamical systems
  - Sympletic integrators
  - Non linear systems
  - Evolution of quantum and classical systems

Department of Experimental Physics

The research in Experimental Nuclear and High Energy Physics is in the origin of IFIC. Since its foundation in 1950, the researchers of IFIC have performed a lot of experiments oriented to Fundamental Physics but also a variable amount of effort has been devoted to more applied fields on Physics (Radioactivity measurements and controls, collaboration with hospitals, progress in electronic advances for detectors, Computing Science, etc).

To properly understand the activity of this department two different periods can be identified at IFIC: one which goes from 1950 up to 1984 and another one from 1984 until now. They correspond to Spain being outside CERN (frist period) and being finally member of such organization (second period). In the first period there were some years during which Spain was also member of CERN which helped the groups to survive. For the last period, however there has been an extraordinary progress to meet the experimental standards of research achieved in most of the developed countries. To reach this it has been necessary to increase the presence and participation in the scientific programme of CERN, of GSI, of GANIL, of SLAC, of Fermilab, etc. The Experimental Physics Department consists of about 60 people and in addition to pure research, other activities like the formation of young researches /scientists in Experimental HEP/NP and the spin-offs which derive from the knowledge achieved in instrumentation are very important.

Another fundamental aspect of the last years is the fact that IFIC has got and deployed important infrastructures and high level scientific equipments to accomplish the research in the different projects. The first steps were given in the eighties even though the most important boost has been given in the last 10 years linked with the participation in the ATLAS experiment (in the LHC collider at CERN). It is the first time IFIC (Spain) participates in such a high level experiment since its early infancy. Another important aspect has been to get a proper IFIC building as before people were using space belonging to the University departments. The impact of such change to the experimental section of IFIC has been crucial.

However this positive events have also implied new problems. For instance, the need of specialized technical personnel has increased, from around 10 people in 1995 till around 25 in 2005. The progress has not been accompanied by a satisfactory policy of consolidation of positions by the CSIC and the UVEG in this area and makes very difficult to maintain what has been achieved.

In the case of IFIC, as most of the Research Centres, it is not easy to establish the limits of a 'Research Group' (RG). The present RGs at IFIC are identified by the objectives established by the existence of one or several related projects. In this way three groups have been defined: the Experimental High Energy Physics (EHEP) Group, the Experimental Nuclear Physics (ENP) Group and the Medical Physics (MP) Group.

EHEP, Experimental High Energy Physics group:

The EHEP group is presently formed by thirty five researchers plus fifteen technical members. The staff researchers are thirteen (eight CSIC + five UVEG), four people have contracts in the *Ramon & Cajal* program and four are post-docs (funded by national or European projects). There is a total of fifteen PhD students and thirteen PhD theses were presented in the period 2000-2004. The number of engineers and technicians is fifteen. The participation of CSIC and UVEG is well balanced in the group in all aspects, personnel and infrastructures. The group has obtained a benefit in the period 2000-2004 with the incorporation of three permanent CSIC and four *Ramon & Cajal* researchers.

The Experimental HEP Group is presently a consolidated group with an important scientific record (background) and is one of the most important experimental groups in Spain. The Experimental HEP activities were already present at the start-up of IFIC (more than 50 years ago) and the present group has its fundaments in the group formed around the DELPHI experiment (CERN), just after the Spain re-entering CERN in 1984.

The Spanish quota to CERN is about 47 Meuros (2004) corresponding to the relative Gross National Product with respect to the other countries members of the Organization. This represents about 7% of the total CERN budget. The percentage of Spanish experimental physicists is however much lower than what it would correspond in comparison to the rest of European countries and seems mandatory to increase it in order to have a fair balance for all these numbers.

The funding support of the EHEP group has been possible mainly thanks to the different National Programs on High Energy Physics (the Mobilizing Plan-1983, the HEP Program since 1986 and the National Plan of Particle Physics and Accelerators since 2000). The DELPHI data taking ran from 1989 up to 2001 and , at present, the activities in this experiment are almost finished and restrict to data analyses. The scientific production of DELPHI has been huge: more than 300 publications and more than 20 PhD theses presented at *Universitat de Valencia*. The results obtained by the DELPHI collaboration are some of the most important contributions in EHEP in the last years as they have been used to established the present parameters of the Standard Model of the elementary particles and the number of light neutrino families to be three.

Within the group the following subgroups can be identified:

1. **ATLAS**: the participation with the major CERN projects has been and is a fundamental part of the strategy of the EHEP group of IFIC, and in this orientation it is necessary to emphasize the participation in the ATLAS experiment started in 1995. This experiment is one of the biggest projects in HEP world program and data taking is foreseen to start in 2007 in the LHC accelerator at CERN. The results will be decisive for the future of HEP. Three projects are being developed :
    - the construction of the SCT detector, the Silicon Tracker,
    - the TILECAL detector, the Hadronic Calorimeter, and
    - the GRID Computing in order to be ready to analyse the data coming from the experiment.

The participation in ATLAS has been important to develop several infrastructures at IFIC. In the period 2000-2004, the ATLAS group has got a generous budget (4.9 Meuros from the National Program). This has allowed for an important and visible participation in the ATLAS experiment: the construction of 220 SCT forward modules that later was extended by 80 more, an important part of the extended TiCal calorimeter modules and a farm for the GRID computing project. There has been a fruitful collaboration with several local industries for precision mechanics which lead to the construction and developments of the jigs to assemble the SCT modules and very close collaboration with the Institute of Microelectronics in Barcelona IMB-CNM in the field of silicon radiation detectors. This collaboration has enabled the fabrication of the pitch adaptors of all forward SCT modules by IMB-CNM. The group has been chosen as the coordinator for the Spanish ATLAS tier-2 centre.

Two important infrastructures can be highlighted :

- the Clean Room for developing Silicon radiation detectors with a surface of 80 m^2 and has had a fundamental role for the successful completion of prototyping, testing and finally producing detector modules for the SCT;

- the GoG (PC farm for GRID): A PC farm of about 140 nodes (GoG: Grupo de Ordenadores para el GRID) which at present is used by all the IFIC scientific groups and, in particular, for the GRID deployment.

Both infrastructures and part of the existing equipment have been acquired thanks to FEDER funds and the help of the Institutions: UVEG, CSIC, MEC and Generalitat de Valencia.

The knowledge in detector and instrumentation techniques has originated, together with the Experimental Nuclear group, several initiatives in the field of Medical Applications especially in the area of medical imaging. In a similar way, more general activities for software applications, i.e., GRID and e-Science, have been started as this can be a possible solution to process and distribute huge amounts of data all over the world.

2. **ANTARES and Neutrino K2K**: These experiments aim at different physics issues, but both rely on neutrino detection as their basic principle. ANTARES -a non-accelerator project- is an example of experiment in the discipline of Astroparticle Physics, a relative new field that has stirred up both Astrophysics and Particle Physic during the last decades. K2K aims to further clarify the fundamental question of neutrino masses and mixings, a subject of paramount importance in the progress of our understanding of Particle Physics. Both types of experiments stem from the pioneering work in the US and Japan in non-accelerator neutrino detection, work that has been recently recognized by the awarding of the Nobel Prize to Profs. R. Davis and M. Koshiba.

The ANTARES Collaboration has started the installation of a neutrino telescope in the Mediterranean Sea to detect high energy cosmic neutrinos. Measuring neutrinos originating from different sources in the Universe will open an entirely new field of Astrophysics. The observation of neutrinos coming from compact astrophysical objects such as active galactic nuclei, gamma-ray bursts and micro-quasars will contribute to a better understanding of the mechanisms that power these high energetic cosmic objects.

Moreover, due to its location, this telescope will observe the centre of the Galaxy and may shed light on the origin and nature of the dark matter.

The K2K experiment has confirmed at four sigma level the evidence of the atmospheric neutrino oscillations observed by the Super-Kamiokande experiment. The discovery of neutrino oscillations, both in the solar and the atmospheric sector has been a major step forward in our understanding of the nature of the fundamental interactions.

Both IFIC groups, ANTARES and K2K have made important contributions to the design, construction, simulation and preparation of their respective experiments. The groups have been consistently working on these experiments or in activities related therewith since nearly a decade and have been funded accordingly through competitive processes. Indeed, funds at the level of 2 Meuros from the Spanish National Research Programme in the period 2000-2004 have been obtained by these two projects. Furthermore, their fields of application have been explicitly listed as of high priority in the Programme of Astronomy, Astrophysics and Particle Physics within the *Plan Nacional de I+D+i 2004--2007*.

The K2K experiment has materialized in 2003. ANTARES has recently deployed one of the lines of the final detector.

3. **BABAR**: the BABAR experiment (SLAC in USA) studies CP violation at SLAC. The participation in this experiment is recent: BABAR has got funds since 2004. In BABAR important contributions in data analysis have been achieved.

4. **Accelerator Physics and R&D in new detector technologies:** the group has contributed to some aspects of the design of LEP and LHC accelerators and are now involved in the development of the future Linear Colliders. In parallel, studies on high radiation tolerant silicon detectors (ROSE and R&D50) and on new detector techniques for tracking and vertexing (MAPs and DEPFETs) for the Linear Collider detectors are being performed.

5. **Particle Data Group:** JJ. Hernández is also member of the Particle Data Group being part of the Meson Team and takes care of the unstable mesons.

The diversification of the group in the above projects allows for a participation in the experiments at different exploitation phases, construction and data taking, thus keeping the level of activity of the technical and scientific parts of the group constant in time.

ENP, Experimental Nuclear Physics group:

The ENP group is formed by 5 staff people (2 CSIC + 3 UVEG) and 1 contracted person (post-doc). There also exists a good equilibrium between CSIC and UVEG. One technician is supporting their research. The group consists of 10 people (cf final table). One of the most important activities is the formation of young researches /scientists in ENP and has presently four Doctoral Students. A total of 6 PhD theses were presented in the period 2000-2004 and (and 16 in the last 15 years). The global budget of the group is around 0'7 M Euros.

The experimental nuclear physics research in Spain has its origins at IFIC in the 70ths. The activity itself has of course evolved in different directions along the years, it started mainly focussed in the study of the nuclear reactions. In the year 1987 two new CSIC members started an activity in nuclear structure research, they dedicate most of their effort nowadays to the study of exotic nuclei and to neutron captures studies of astrophysical interest. On the other hand the members of the group working originally in the nuclear reactions studies at low energy perform now experiments with heavy ions at relativistic energies.

At present, the fields covered by the group are recognised as priority activities internationally by the committee of experts NuPECC **(Nuclear Physics European Collaboration Committee) in its repport:** Long Range Plan 2004: Perspectives for Nuclear Physics Research in Europe in the Coming Decade and Beyond (http://www.nupecc.org/pub/lrp03/long_range_plan_2004.pdf), namelly structure and dynamics of exotic nuclei, hadron physics, phases of nuclear matter, and nuclear astrophysics. At the same time some members of the group joint more applied activities as nuclear medicine and nuclear technology.

The group have active experiments going on at CERN (Isolde and nTOF) and GSI (Rising and Hades). These experiments will extend until 2010 approximately when the activities at FAIR (Facility for antiproton and ion research) will start. The scientific program during these five years is essential to maintain a high level of productivity in terms of publications and PhD Thesis works. The number of IFIC participants in any of these experiments is in average 4 scientists.

At the same time the group will start an activity in Research and Development for the new FAIR facility. In the next they will put an effort in simulating and prototyping new detectors with the idea of constructing part of the equipment for FAIR which will be then considered as in-kind contribution of Spain to the facility. In order to take these new responsibilities the group must be able to increment the human resources.

The group participates in three main experiments proposed at FAIR which have been approved by the scientific advisory committee, namely:

1. **DESPEC**: decay spectroscopy of exotic nuclei, with an estimated building cost 8 M€
2. **NCAP**: neutron capture on instable nuclei with an estimated cost 4.7 M€
3. **PANDA**: hadron spectroscopy with antiprotons with estimated cost 50 M€)

It is worth emphasising that the Spanish Ministry for Education and Science and CSIC consider the Spanish participation in the FAIR project as one of their priorities in their future programs.

The ENP group has two laboratories in the new experimental building of IFIC. They count on a complete gamma spectroscopy experimental set-up which includes Ge and large volume scintillator detectors, the associated electronics, and a data acquisition system. This equipment allows the group to mount a complete experiment at a facility like Isolde.

MA, Medical Applications group:

The MA group is formed by 8 staff people (4 CSIC + 4 UVEG) with some of them also belonging to previous groups. There is one person with the *Ramón & Cajal* contract, 5 PhD students and 3 persons provide technical support. The group started its activities as the result of the know-how

achieved by the EHEP and ENP groups in developing instrumentation techniques for particle detection, specially in the area known in the field as imaging.

The new group has already built a portable mini-camera with applications to the diagnostic by images in Nuclear Medicine. The resolution reached is around 1 mm (the large commercial cameras have a resolution of about 10 mm). Now is mainly working an innovative prototype of the Camera of Positron Emission Tomography (PET). Two patents have been registered: European Patent PCT ES03 00497 and European Patent P2004070020. The OTRI of CSIC in Valencia has promoted the creation in 2002 of a spin-off company (www.gem-imaging.com) for the production and marketing of the equipments of medical diagnose. Furthermore, this group has manifested as a way to provide qualified scientists to industry. As matter of fact 5 researchers formed in the group have been recruited by the above company

On top of that it has been developed a probe for the detection of prostate cancer by using an advanced technology based on silicon detectors and benefiting from the Compton effect. This probe increases significantly the sensitivity of the image by means of the elimination of the collimators.

Another sub-team of the group is dedicated to research in radiotherapy in collaboration with hospitals and commercial companies. The main activities are: dosimetric studies of radioactive sources used in brachytherapy, design an study of inserts for quality assurance, design an study of applicators for treatment, and radioprotection studies.

IFIC: Experimental Department Summary, existing projects

High Energy Physics

- LEP-Delphi
- LHC-ATLAS:
  - TiCal
  - SCT
  - GRID
- Neutrino Oscillations
- Antares
- BaBar
- Accelerator Physics
- Detector R&D

Nuclear Physics

- γ–Spectroscopy
- nTOF
- Hades, TAPS
- Integral

Medical Applications

- Nuclear Medicine
- Compton Imaging
- Brachyterapy

1.4. LINES OF RESEARCH

Table 1.4. Most representative lines of research at IFIC

Lines of research
Line 1: High Energy Physics Phenomenology (theory)
Line 2: Strong interactions and Quantum Chromodynamics (theory)
Line 3: Astroparticle physics and Cosmology (theory)
Line 4: Theoretical Nuclear Physics (theory)
Line 5: Mathematical and theoretical High Energy Physics (theory)
Line 6: Dynamics of Complex Systems (theory)
Line 7: Experimental High Energy Physics (EHEP - experimental)
Line 8 : Experimental Nuclear Physics (ENP - experimental)
Line 9: Medical Physics Applications (MP - experimental)
Line 10: GRID and e-Science in Physics (GEP - experimental)

Line 1 High Energy Physics Phenomenology: the main objective is the determination of the parameters of the Standard Model with the highest precision, as well as identifying possible signals of physics beyond the current theoretical framework as it happened with neutrino masses. A fundamental ingredient is the study of new theoretical models and their experimental implications, not only at the High Energy frontier, but also at high precision experiments in other ranges. The main topics are completely related with the current situation in High Enegry experiments and their future evolution (LEP, SLC, TEVATRON, LHC, ILC, Babar, Belle, K2K, etc). Specific subjects of relevant importance are: the mechanism of spontaneous symmetry breaking, flavour and CP violation physics, baryon asymmetry, neutrino physics, etc.

Line 2 Strong interactions and Quantum Chromodynamics (QCD): Electroweak hadronic processes are tampered by the strong interaction driven by non-perturbative QCD. Hence the extraction of valuable information from the observables can be spoiled by a poor treatment of strong interaction effects. This is a key problem if we remember that the possible outcome of electroweak hadronic observables is not only the precise determination of Standard Model parameters but to disentangle effects of New Physics beyond the Standard Model too. A very successful treatment has been achieved with the use of Effective Field Theories of the Standard Model, and by the new developments in Lattice QCD. On the other side, perturbative QCD is the

toolkit for the discovery of New Physics both at LHC and RunII of the Tevatron. For that purpose, it is necessary to improve the accuracy of theoretical predictions for a large number of processes by including either more external particles or higher order loop corrections This is a formidable challenge requiring a major theoretical effort that will require the development of new analytical and numerical methods, and a better insight into the structure of Quantum Field Theories. Recently developed techniques in String Theory may also provide some hints to face this problem.

Line 3 Astroparticles and Cosmology: This area of research deals with the connections between the science of the very large and that of the very small, which has not ceased to grow ever since it was realized. It forms a fast-moving corner of multidisciplinary science which is now a mature field recognized with the 2002 physics Nobel prize. The increased precision and diversity of the new generation of experiments in this field of science will make data analyses far more complex in the future. Experiments as diverse as the upcoming satellite missions and neutrino telescopes on the one hand, and particle physics experiments like the Large Hadron Collider (LHC) on the other, demonstrate that Europe is strongly committed to experimentation in this field. Such involvement clearly requires strong theoretical support. Research involves neutrino astrophysics and cosmology, including high energy cosmic rays, modeling neutrino masses, mixings, and CP-violation, analysis of neutrino properties as well as supersymmetry and the origin of mass. Research connects with experimental acitivities at various Spanish laboratories such as IFIC, IFAE and Canfranc and involves the interplay between accelerator and non-accelerator methods.

Line 4 Theoretical Nuclear Physics: The main objective is to describe the interaction of mesons and baryons at intermediate energies, and then study how these interactions manifest them selfs in nuclear phenomena. We use effective Lagrangians accounting for meson and baryon degrees of freedom and use resummation techniques based upon exact unitarity in coupled channels. From there one obtains dynamically generated resonances which correspond to many of the resonances of the particle data table. By using many body techniques we can study the interaction of mesons and baryons in a nuclear medium and see how, for instance, these dynamically generated resonances are modified in this medium. These studies are basic for many of the experiments being carried out in different hadronic labs around the world.

Line 5 Mathematical and theoretical high energy physics:

1. superbranes and dynamical supergravity
2. possible constituents of M-theory and tensorial superspaces
3. BPS preons and further aspects of enlarged superspaces
4. superstrings, M-theory and higher spin fields
5. holonomy in M-theory
6. two-time physics
7. supergravity theories, deformations and non-commutative geometry
8. black holes and 2d string theory
9. ADS/CFT duality. braneworlds
10. twistors, spacetime geometry, dynamical models and preons
11. quantum field theory in curved spacetime: theoretical and cosmological aspects
12. black hole evaporation and the information loss problem
13. hawking effect and transplanckian energies
14. other aspects of branes and m-theory

-Non-perturbative structure of the standard model

-K-theoretic and non-commutative aspects of M-theory
-Multibrackets, higher order algebras and *p*-branes
-Complex and generalized complex manifolds in QFT and strings
-Duality in quantum mechanics

Line 6 Dynamics of Complex systems. The research activity is centered in two broad lines: 1) Study of systems of particles in interaction (atomic nuclei, nanodrops of helium, nuclear matter, liquid helium), treated from different perspectives (phenomenological or microscopic descriptions with suitable calculational techniques). 2) Evolution equations of classic and quantum systems by means of tecnicas that incorporate the qualitative properties (symmetries, unitarity..) of their solutions derived from first principles, inherited also in their numerical integration

Line 7 + Line 8 + Line 9 Experimental High Energy Physics, Experimental Nuclear Physics and Medical Physics Applications: These three lines represent the continuation work of the groups already introduced in previous section with a full identification to the activities defined there.

Line 10 GRID and e-Science: this line has its origin in the challenge of the huge data set that will come from the ATLAS experiment (activity developed in the EHEP group) and the use of the GRID technologies to solve this problem. The involvement in European projects with a scientific and technological aim beyond ATLAS objectives has generated a high level of expertise in GRID and e-Science and adequate computing infrastructure to face other problems beyond the original ATLAS Data Challenge aim as the research fields covered by the Institute, i.e. Experimental Nuclear Physics, High Energy Physics, Medical Physics and Theoretical Physics .

1.5. SERVICES

IFIC: Present Structure of General Services and Technical Support

Computing

Tit. Superior[1]

(Service Responsible)

Tit. Superior[0]

(General Support)

Tit. Medio[1]

(General Support)

FP[0] – FP[0] – FP[2]

Tit. Superior[0]

(Specific Scientific Support)

(i.e.,GRID)

Mechanics

Tit. Superior[0]

(Service Responsible)

Tit. Medio[0]

(General Support)

FP[0]

Tit. Superior[0]

(Specific Scientific Support)

Electronics

Tit. Superior[1]

(Service Responsable)

Tit. Medio[0]

(General Support)

FP[0] – FP[2] – FP[2]

Tit. Superior[0]

(Specific Scientific Support)

Administration and Library

Manager[0,1]

(Service Responsable)

Habilitado Pagador[1]

Adminstrativo[1] Adminstrativo[1] Adminstrativo[1] Adminstrativo[1] Adminstrativo[0] Adminstrativo[0]

Maintenance

Tit. Medio[0,2]

(Service Responsible)

Legend: [0] : Temporal Contract, [1] : Permanent-CSIC, [2] : Permanent-UVEG

The numbers reflect the status of the contracts as indicated in the legend. In some cases when the contracts are “interinos” or in consolidation phase two numbers appear.

1.6. EXTERNAL RELATIONS

U. Salamanca, U. Complutense Madrid, Mainz, GSI (Darmstadt), COSY (Juelich), ELSA (Bonn), CELSIUS (Uppsala), Spring8/Osaka, Jefferson Lab (USA), BES (Beijing), Universities of Barcelona, INFN Univ. de Bologna, Padova, Cambridge (Centre for Mathematical Sciences, DAMTP), CSIC (Madrid), Durham, Granada, Imperial College, Madrid (UAM), Salamanca, SLAC, NSC-KIPT (Kharkov, Ukraine), Steklov Mathematical Institute (St. Petersburg), Valladolid, Wisconsin (Milwaukee), Wroclaw, UNESP & USP São Paulo, U. C. Chile. MPI Munich, LAPTH Annecy, Univ. Napoli, Liverpool (UK), RAL (UK), Univ. Charles V (Prague), Univ. Geneva, IFAE, IFCA, UAM, UB, Univ. Pisa, LAL-Orsay, Univ. Pierre et Marie Curie (Paris VI), Nikhef (Amsterdam), Univ. La Sapienza (Rome), Univ. Santa Cruz (California), LBL-Berkeley (San Francisco), Univ. Michigan, etc…

Participation in International Experimental with groups and labs from almost all parts of the world.

List of International laboratories in which IFIC groups participate:

- CERN (Geneva, Switzerland)
- FERMILAB (Chicago, USA)
- SLAC (California, USA)
- KEK (Japan)
- GSI (Darmstad, Germany)
- DESY (Hamburg, Germany)

List of participation in networks funded by the European Commission:

- The Quest For Unification: Theory Confronts Experiment (MRTN-CT-2004-503369)
- Physics Across the Present Energy Frontier: Probing the Origin of Mass (HPRN-CT-2000-00148)
- Study of strongly interacting matter (RII3-CT-2004-506078)
- Training Site on Particle Physics Beyond the Standard Model (HPMT-2000-00124)
- High Precision Elementary Particle Physics at the Phi Factory DAPHNE (TMR-ERB FMRX-CT98-0169)
- European Investigation in DAPHNE and other International Collider Experiments using Effective Theories of Colour and Flavour, EURIDICE (HPRN-CT2002-00311)
- Electron Scattering Off Confined Partons, ESOP (HPRN-CT2000-00130)
- The Third Generation as a Probe for New Physics (HPRN-CT2002-00292)

European Science Foundation networks:

- Neutrino Astrophysics Network

Bilateral agreements CICYT-INFN:

- IFIC / Trieste (Peñarrocha/Bertolini)
- IFIC / Turin (Valle/Bottino)
- IFIC / Povo (Vento/Orlandini)
- IFIC / Bolonia (Navarro/Venturi)
- IFIC / Naples (Pastor/Miele)
- IFIC/Pisa (Martinez/Forte)

Bilateral agreements CICYT-IN2p3:

- IFIC / Grenoble (Noguera/Desplanques)
- IFIC / Annecy (Pastor/Lesgourgues)
- IFIC/Orsay (Faus/Bambade)
- IFIC/ParisVI (Marti/Navarro)
- IFIC/Marseille (Zuniga/Coyle)

Acciones Integradas:

- IFIC / IST Lisbon (Botella/Branco) HP1999-0063
- IFIC / Univ. Vienna (Valle/Grimus) HU2002-0019
- IFIC / Univ. Vienna (Potolés/Neufeld) HU2002-0044
- IFIC / IST Lisbon (Hirsch/Romão) HP2003-0148
- IFIC / Univ. Dresden (Rodrigo/Krauss) HA2003-0164
- IFIC / IST Lisbon (Botella/Rebelo) HP2003-0079
- IFIC / INFN-Univ. Naples (Pastor/Miele) HI2003-0320
- IFIC / Univ. Vienna (Porod/Majerotto) HU2004-0022

2. CENTRE/INSTITUTE RESOURCES FOR 2000-2004

Table 2.1. Human resources

Centre or Institute	Code of centre
INSTITUTO DE FISICA CORPUSCULAR	10166

Years	2000	2001	2002	2003	2004
Total scientific staff personnel	38	41	43	44	44
Nº Research Professors	1	1	2	3	3
Nº Scientific Investigators	3	4	4	3	5
Nº Staff Research Scientists	8	8	9	10	8
Nº University Professors, “catedrático” (joint C/I only)	7	8	8	8	8
Nº Associate Professors, “titular” (joint C/I only)	19	20	20	20	20
Nº Other Univ. Professors in other categories (joint C/I only)	9	5	1	3	4
Nº "Investigadores Titulares"					
Nº "Doctores vinculados"	3	3	5	5	6
Total contracted postdoctoral personnel	17	17	21	31	32
Nº Ramón y Cajal contracts	0	5	9	12	14
Nº I3P doctors	0	0	1	1	1
Other contracted doctors/postdoctoral fellowship	17	12	11	18	17
Total predoctoral personnel	29	37	36	50	52
Nº predoctoral FPI and FPU fellowships	17	24	23	33	32
Nº predoctoral I3P fellowships		1	1	2	4
Other contracted predoctorals/predoctoral fellows	12	12	12	16	16
Total civil service research support personnel	4	4	5	5	6
"Titulados Superiores" (University graduates)	1	1	1	1	2
"Titulados de grado medio"	0	0	0	0	0
Laboratory assistants	3	3	4	4	4
Research auxiliaries	0	0	0	0	0
Total research support personnel (permanent)	4	4	5	5	6
Total contracted research support personnel	5	8	12	16	17
Total general services personnel	7	8	10	11	11
Total support unit personnel	2	2	3	4	4

Centre or Institute	Code of centre
Theoretical Department	10166

Years	2000	2001	2002	2003	2004
Total scientific staff personnel	21	23	24	24	24
Nº Research Professors	1	1	1	1	1
Nº Scientific Investigators	1	1	2	2	2
Nº Staff Research Scientists	1	1	1	1	1
Nº University Professors, “catedrático” (joint C/I only)	5	6	6	6	6
Nº Associate Professors, “titular” (joint C/I only)	13	14	14	14	14
Nº Other Univ. Professors in other categories (joint C/I only)					
Nº "Investigadores Titulares"					
Nº "Doctores vinculados"	1	1	4	4	4
Total contracted postdoctoral personnel	10	14	15	24	23
Nº Ramón y Cajal contracts		3	7	8	9
Nº I3P doctors		1	1	1	1
Other contracted doctors/postdoctoral fellowship	10	10	7	15	13
Total predoctoral personnel	16	19	17	26	26
Nº predoctoral FPI and FPU fellowships	11	14	12	15	14
Nº predoctoral I3P fellowships				1	2
Other contracted predoctorals/predoctoral fellows	5	5	5	10	10
Total civil service research support personnel					
"Titulados Superiores" (University graduates)					
"Titulados de grado medio"					
Laboratory assistants					
Research auxiliaries					
Total research support personnel (permanent)					
Total contracted research support personnel					
Total general services personnel					
Total support unit personnel					

Centre or Institute	Code of centre
Experimental Department	10166

Years	2000	2001	2002	2003	2004
Total scientific staff personnel	18	18	19	20	20
Nº Research Professors			1	2	2
Nº Scientific Investigators	2	2	2	2	2
Nº Staff Research Scientists	7	8	8	8	8
Nº University Professors, “catedrático” (joint C/I only)	2	2	2	2	2
Nº Associate Professors, “titular” (joint C/I only)	6	6	6	6	6
Nº Other Univ. Professors in other categories (joint C/I only)					
Nº "Investigadores Titulares"					
Nº "Doctores vinculados"	2	2	1	1	2
Total contracted postdoctoral personnel	2	4	6	7	9
Nº Ramón y Cajal contracts		2	2	4	5
Nº I3P doctors					
Other contracted doctors/postdoctoral fellowship	5	2	4	3	4
Total predoctoral personnel	13	18	18	25	26
Nº predoctoral FPI and FPU fellowships	6	10	11	18	18
Nº predoctoral I3P fellowships		1	1	1	2
Other contracted predoctorals/predoctoral fellows	7	7	7	6	6
Total civil service research support personnel	4	4	5	5	6
"Titulados Superiores" (University graduates)	1	1	1	1	2
"Titulados de grado medio"					
Laboratory assistants	3	3	4	4	4
Research auxiliaries	0				
Total research support personnel (permanent)					
Total contracted research support personnel	5	8	10	14	13
Total general services personnel					
Total support unit personnel					

2.2. SCIENTIFIC AND TECHNICAL INFRASTRUCTURE

Table 2.2. Acquisition of equipment (more than 60,000 euros) in the last 5 years (Centre / Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR	010166

Equipment	Year of purchase	Purchase cost (euros)	Annual maintenance cost	Date end of useful life	Observations
Server	2000	108.182,18 €	12.000,00 €	2005	
Bonder K&S	2001	219.369,40 €	9.000,00 €	2011	
Multilayer Printed Circuit system	2002	73.449,00 €	5.100,00 €	2012	
Infrared Camera	2002	70.576,85 €	2.000,00 €	2012	
Photomultiplier	2002	228.752,09 €	0,00 €	2012	
Storage system	2003	126.440,00 €	12.000,00 €	2008	
Calibration system for radioactive sources	2003	160.000,00 €	16.000,00 €	2013	
High Precision Mechanical Centre	2004	106.714,20 €	3.000,00 €	2014	

2.3. BUDGET

Table 2.3. Evolution of budgets (in euros)* (Centre / Institute)	
Centre or Institute	Code of centre
INSTITUTO DE FISICA CORPUSCULAR	10166

Years	2000	2001	2002	2003	2004
Total budget	**5.812.150,27**	**3.013.227,21**	**4.058.524,13**	**7.347.698,08**	**3.746.146,14**
Total external resources	**2.832.111,83**	**631.516,38**	**1.534.420,56**	**4.614.569,05**	**1.281.563,22**
Total internal resources	**2.980.038,44**	**2.381.710,83**	**2.524.103,57**	**2.733.129,03**	**2.464.582,92**
Personnel budget	1.619.704,39	1.725.222,12	1.950.086,12	2.014.934,33	2.084.665,20
Ordinary budget	130.673,99	199.583,50	247.567,86	250.153,41	257.556,27
Investments	1.229.660,06	456.905,21	326.449,59	468.041,29	122.361,45

* This information will be provided for the Centre/Institute

In this table the salaries for personnel included in the projects are considered in the “personnel budget” row.

3. CENTRE OR INSTITUTE ACTIVITY BETWEEN 2000 AND 2004

3.1. DIMENSION 1. FINANCIAL RESOURCES OF A COMPETITIVE NATURE (PUBLIC CALLS FOR GRANTS) FOR RESEARCH

Table 3.1. Competitive financing obtained (Centre/Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR	10166

Year	2000	2001	2002	2003	2004	Total 2000/4
Nº National Plan projects	14	7	13	16	11	61
Nº PROFIT projects	0	1	0	0	0	1
Nº. FIS projects	0	0	0	1	1	2
Nº INIA projects	0	0	0	0	0	0
Nº projects/networks Framework R&D Programme	6	4	6	4	4	24
Nº regional government projects	4	6	7	0	16	33
Nº private foundation projects	0	0	0	0	0	0
Other competitive projects	18	20	19	26	36	119
Total Nº competitive projects	42	38	45	47	68	240
Nº of FTE involved in the approved projects	52	55	57	58	58	280
Financing (euros) National Plan projects	2.886.863,04	245.946,02	1.179.482,55	5.058.800,00	580.030,00	9.951.121,61
Financing (euros) PROFIT projects	-	30.050,61	-	-	-	30.050,61
Financing (euros) FIS projects	-	-	-	31.770,07	18.515,00	50.285,07
Financing (euros) INIA projects	-	-	-	-	-	-
Financing (euros) projects/networks Framework R&D Programme	487.318,17	544.431,78	635.533,76	473.960,00	484.500,24	2.625.743,95
Financing (euros) regional government projects	97.364,88	40.688,52	108.600,46	-	236.686,25	483.340,11
Financing (euros) private foundation projects	-	-	-	-	-	-
Financing (euros) other competitive projects	92.753,67	278.148,76	235.546,26	222.764,08	136.671,23	965.884,00
Total Financing (euros) competitive projects	3.564.299,76	1.139.265,69	2.159.163,03	5.787.294,15	1.456.402,72	14.106.425,35

The above amounts also consider the salaries of personnel included in the projects contrary to the previous table in which the salaries were added to the personnel budget.

Table 3.1. Competitive financing obtained (Centre/Institute)	
Department	Code of Centre
Theoretical Department	10166

Year	2000	2001	2002	2003	2004	Total 2000/4
Nº National Plan projects	3	2	6	2	2	15
Nº PROFIT projects						
Nº. FIS projects						
Nº INIA projects						
Nº projects/networks Framework R&D Programme	3	5	5	3	6	22
Nº regional government projects	4	3	3	9	9	28
Nº private foundation projects	1					1
Other competitive projects	5	6	5	12	12	40
Total Nº competitive projects	16	16	19	26	29	106
Nº of FTE involved in the approved projects						
Financing (euros) National Plan projects	243068	52738	452502	318402	37342	1.104.052
Financing (euros) PROFIT projects						
Financing (euros) FIS projects						
Financing (euros) INIA projects						
Financing (euros) projects/networks Framework R&D Programme	198.570	267.074	120.217	115.754	246.636	948.251
Financing (euros) regional government projects	52.402	88.234	33.425	147.688	143.710	465.459
Financing (euros) private foundation projects	4207					4207
Financing (euros) other competitive projects	14.320	35.346	23.858	96.530	66.482	236.536
Total Financing (euros) competitive projects	512.567	443.392	630.002	678.374	494.170	2.758.505

Table 3.1. Competitive financing obtained (Centre/Institute)	
Department	Code of Centre
Experimental Department	10166

Year	2000	2001	2002	2003	2004	Total 2000/4
Nº National Plan projects	9	4	5	15	7	40
Nº PROFIT projects	0	1	0	0	0	1
Nº. FIS projects	0	0	0	1	1	2
Nº INIA projects	0	0	0	0	0	0
Nº projects/networks Framework R&D Programme	2	0	2	1	2	7
Nº regional government projects	2	3	4	0	8	17
Nº private foundation projects	0	0	0	0	0	0
Other competitive projects	12	13	8	15	16	64
Total Nº competitive projects	25	21	19	32	34	131
Nº of FTE involved in the approved projects						
Financing (euros) National Plan projects	2.630.105	132.365	697.428	4.759.740	244.690	8.464.327
Financing (euros) PROFIT projects	0	30.051	0	0	0	30.051
Financing (euros) FIS projects	0	0	0	31.770	18.515	50.285
Financing (euros) INIA projects	0	0	0	0	0	0
Financing (euros) projects/networks Framework R&D Programme	179.046	0	307.000	160.000	216.115	862.161
Financing (euros) regional government projects	51.086	28.668	47.181	0	91.222	218.158
Financing (euros) private foundation projects	0	0	0	0	0	0
Financing (euros) other competitive projects	34.683	103.536	37.958	163.860	44.416	384.452
Total Financing (euros) competitive projects	2.894.920	294.619	1.089.566	5.115.370	614.958	10.009.433

* The theoretical and experimental tables do not add up to the table of the Institute due to the fact that some projects have been initiated directly by the IFIC management.

3.2. DIMENSION 2. SCIENTIFIC AND TECHNICAL PRODUCTION

3.2.1. Scientific production in ISI-indexed journals

Table 3.2.1. ISI-indexed scientific production (Centre/Institute)						
Centre or Institute					Code of Centre	
Instituto de Física Corpuscular						10166
Years	2000	2001	2002	2003	2004	Total 2000/4
Total Nº articles in SCI/SSCI/A&HIS-indexed journals	196	188	156	233	261	1034

List of up to 20 ISI-indexed journals most relevant to the Centre/Institute's activity and articles in them (indicate the nº of articles published in each)	2000	2001	2002	2003	2004	Total 2000/4
Physical Review Letters	5	6	7	32	54	104
Astrophysical Journal	0	0	0	1	1	2
Journal of High Energy Physics	7	7	11	20	22	67
Nuclear Physics A y B	49	45	32	32	14	172
Progress on Particle and Nuclear Physics	2	0	0	1	0	3
Physical Review A, B, C y D	35	34	24	49	66	208
Physics Letters A y B	42	23	27	21	14	127
Astroparticle Physics	1	0	2	1	0	4
European Physical Journal A y C	16	25	25	33	33	132
Classical and Quantum Gravity	1	2	1	0	3	7
New Journal of Physics	0	0	1	0	3	4
Journal of Physics A, C y G	0	2	2	5	2	11
Nuclear Physics B Proceedings Supplements	12	10	3	12	9	46
Physics of Atomic Nuclei	0	1	2	0	1	4
Annual Review of Nuclear and Particle Science	1	0	1	0	0	2
Acta Physica Polonica	3	2	0	0	0	5
International Journal of Modern Physics	0	5	0	4	1	10
Modern Physics Letters A	1	3	1	5	4	14
Nuclear Instrumentation Methods A/B	9	6	7	7	16	45
Physics Reports	0	0	1	0	0	1
Medical Physics	4	4	1	1	6	16
Physica Medica	1	0	0	0	1	2
IEEE Transactions on Nuclear Science	0	0	3	0	3	6
Physics in Medicine and Biology	1	4	0	2	2	9
Springer Lectures in Computer Science	0	0	0	2	1	3
Czechoslovak Journal of Physics	0	0	0	0	1	1
Revista de Oncologia	1	0	0	0	0	1

Table 3.2.1. ISI-indexed scientific production (Centre/Institute)						
Centre or Institute					Code of Centre	
Theoretical Department						10166
Years	2000	2001	2002	2003	2004	Total 2000/4
Total Nº articles in SCI/SSCI/A&HIS-indexed journals	140	132	116	144	129	661

List of up to 20 ISI-indexed journals most relevant to the Centre/Institute's activity and articles in them (indicate the nº of articles published in each)	2000	2001	2002	2003	2004	Total 2000/4
Physical Review Letters	4	3	6	3	6	22
Astrophysical Journal				1	1	2
Journal of High Energy Physics	7	7	11	20	22	67
Nuclear Physics A y B	45	35	29	28	11	148
Progress on Particle and Nuclear Physics	2			1		3
Physical Review A, B, C y D	32	34	24	34	33	157
Physics Letters A y B	19	11	16	12	12	70
Astroparticle Physics			2			2
European Physical Journal A y C	2	6	11	14	15	48
Classical and Quantum Gravity	1	2	1		3	7
New Journal of Physics			1		3	4
Journal of Physics A, C y G		2	2	5	2	11
Nuclear Physics B Proceedings Supplements	12	10	3	12	9	46
Physics of Atomic Nuclei		1	2		1	4
Annual Review of Nuclear and Particle Science	1					1
Acta Physica Polonica	3	2				5
International Journal of Modern Physics		5		4	1	10
Modern Physics Letters A	1	3	1	5	4	14
Nuclear Instrumentation Methods A	6	2	1		2	11
Physics Reports			1			1

Table 3.2.1. ISI-indexed scientific production (Centre/Institute)						
Centre or Institute					Code of Centre	
Experimental Department						10166
Years	2000	2001	2002	2003	2004	Total 2000/4
Total Nº articles in SCI/SSCI/A&HIS-indexed journals	56	56	40	89	132	373

List of up to 20 ISI-indexed journals most relevant to the Centre/Institute's activity and articles in them (indicate the nº of articles published in each)	2000	2001	2002	2003	2004	Total 2000/4
Physical Review Letters	1	3	1	29	48	82
Physical Review A, B, C y D	3			15	33	51
European Physical Journal A y C	14	19	14	19	18	84
Nuclear Instrumentation Methods A y B	3	4	6	7	14	34
Medical Physics	4	4	1	1	6	16
Nuclear Physics A y B	4	10	3	4	3	24
Physics Letters A y B	23	12	11	9	2	57
Astroparticle Physics	1			1		2
Physica Medica	1				1	2
IEEE Transactions on Nuclear Science			3		3	6
Physics in Medicine and Biology	1	4		2	2	9
Springer Lectures in Computer Science				2	1	3
Annual Review of Nuclear and Particle Science			1			1
Czechoslovak Journal of Physics					1	1
Revista de Oncología	1					1

- The IFIC production is the sum of the above tables
- For the period of years 2000-2002 some information is missing and probably some numbers are wrong, being the real production higher.
- The above pattern of publications indicates that:
  - ✓ the production of the theoretical department is high and stays constant in time,
  - ✓ the experimental production on the other hand reflects the operation level of the experiment. When the experiment is being built the production of results is low when data taking starts the number of publications increases considerably.
  - ✓ a good strategy to optimize this behavior is to participate in different experiments at different execution phases. This relies however on the amount of resources mainly manpower.

3.2.2. Scientific production in journals not indexed by ISI and in other publications

Table 3.2.2. Non-ISI scientific production (Centre / Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
Nº articles in international NON-ISI journals*	29	16	81	109	111	346
Nº articles in national NON-ISI journals	3	1	2	4	5	15
Nº chapters in books/Collective works**	1	1	6	2	1	11
Nº collective works edited/directed**			1		1	2
Nº books	1	1		2		4

* Here preprints are considered in these numbers since 2002
** Collective works do not include meeting proceedings

3.2.3. Reports and invited conferences presented at congresses and participation as editors or advisors to scientific publications

Table 3.2.3. Congresses and editorial activity (Centre / Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
Total presentations at national congresses	5	11	2	10	8	36
Invited presentations at national congresses	5	11	2	10	8	36
Organizers/Members of scientific committees for national congresses						
Total presentations at international congresses	68	66	79	82	73	368
Invited presentations at international congresses	68	66	79	82	73	368
Organizers/Members of scientific committees for international congresses	14	18	17	24	22	95
Editors/Directors of ISI journals	1	1	1	1	1	5
Editors/Directors of international non-ISI journals						
Editors/Directors of national non-ISI journals						
Board members of ISI journals						
Board members of international non-ISI journals						
Board members of national non-ISI journals						

3.2.4. Application for and granting of patents and utility models

Table 3.2.4. Patents (Centre/ Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR (Experimental Department)	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
NATIONAL patents applied for			1	1		2
NATIONAL patents obtained				1	1	2
EPO patents applied for						
EPO patents obtained						
PCT patents applied for				1	1	2
PCT patents obtained						
USPTO patents applied for						
USPTO patents obtained				1	1	2
Portfolio active national patents						

3.2.5. Technology transfer and participation of Centre or Institute personnel in the generation of or in activities of companies, especially of basic technology

Table 3.2.5. Technology transfer (Centre / Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR (Experimental Department)	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
Patents licensed to companies				1	1	2
Patentes in exploitation						
Revenues of licensed/exploited patents						
				1		1
Start-ups initiated by Centre/Institute personnel				1	1	2

3.3. DIMENSION 3. INTERACTION WITH THE PRODUCTIVE AND SOCIAL ENVIRONMENT AND INTERNATIONALIZATION

3.3.1. Contracts with companies for joint implementation of research projects, advisory services, technical reports, etc.

Table 3.3.1. Contracts and services to companies (Centre / Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR (Experimental Department)	010166

Años	2000	2001	2002	2003	2004	Total 2000-4
Nº R&D contracts/agreements				1	1	2
Revenues from R&D contracts (euros)				63000	51000	114000
Nº de technological or advisory services						

Data included should refer to the year of concession although it is a multi-year activity

3.3.2. Contracts and agreements with the public sector (ministries or their organizations, regional governments, etc.) and not-for-profit institutions

Table 3.3.2. Contracts and agreements with the public sector (Centre / Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR (Experimental Department)	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
Nº R&D contracts/agreements				1		1
Revenues from R&D contracts (euros)				30000		30000
Nº advisory services						
Revenues from advisory contracts/agreements						
Associated R&D units						

3.3.3. Implication of the Centre or Institute's researchers in external scientific and technological consultancies

Table 3.3.3 Assessment (Centre / Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
Nº ANEP coordinators/assistant		1	1	1		3
Nº managers/assistant PN			1	1	1	3
Nº National Plan selection commission members				1	1	2
Nº regional government selection commission members			1			1
Nº evaluations as HLG en EU	1	1	1	4	5	12
Other expert advisory committees	5	6	4	4	4	22

3.3.4. Internationalization of research activities

Table 3.3.4. Internationalization(Centre / Institute)	
Centre or Institute	Code of Centre
INSTITUTO DE FISICA CORPUSCULAR	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
Nº projects/networks Framework R&D Programme	6	4	6	4	4	24
Nº projects in other European or international programs		1	1	1		
Non-Spanish staff research personnel						
Postdoctoral personnel contracted with non-Spanish funds	7	6	3	4	2	22
Foreign researchers on sabbatical and visiting professors (minimum 6 months)	4	4	4	8	4	24
Integrated actions and other bi(multi)lateral collaborations	5	9	9	15	16	54
Integrated actions and other bi(multi)lateral collaborations (euros)	30.672,47	44.218,67	40.232,40	49.561,54	69.725,84	234.410,92

3.4. DIMENSION 4. TRAINING OF RESEARCHERS AND POSTDOCTORAL ACTIVITY

Table 3.4. Formative activity (Centre / Institute)	
Centre or Institute	Code of Centre
Instituto de Fisica Corpuscular	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
Total predoctoral fellowships/contracts granted	10	7	8	9	5	39
Predoctoral FPI fellowships granted	2	1	3	1	0	7
Predoctoral FPU fellowships granted	3	4	1	6	1	15
Predoctoral Regional Government fellowships/contracts granted *	3	1	2	0	0	6
Predoctoral I3P fellowships	0	1	0	0	2	3
Postgraduate I3P fellowships	0	1	0	1		2
Other predoctoral fellowships/contracts granted*	2	0	1	2	1	6
Total stock predoctoral fellowships/contracts	2	0	0	0	0	2
Total predoctoral project fellowships/contracts granted (in equivalent/year)	5	0	0	3	0	8
Total postdoctoral fellowships/contracts	4	7	9	10	5	35
Total Ramon y Cajal contracts granted	0	4	3	1	1	9
Total Juan de la Cierva contracts	0	0	0	0	1	1
AC post-doctoral contracts granted*	0	1	0	1	0	2
Total Postdoctoral I3P doctor granted	0	0	1	0	0	1
Other postdoctoral fellowships/contracts granted*	4	2	5	8	3	22
Total stock postdoctoral contracts	2	0	0	0	0	2
Total postdoctoral project fellowships/contracts granted (in equivalent/year)	2	0	0	0	0	2
Total technical I3P contracts granted						0
Total MEC contracts for technical personnel	0	0	0	0	0	0
Other contracts for technical personnel	0	1	0	0	0	1
						0
Total doctoral theses directed by C/I personnel	7	6	9	7	6	35
Total theses under way directed by C/I personnel	21	22	23	26	19	111
Total doctoral courses directed by C/I personnel	9	10	11	10	10	50
Total credits for doctoral courses	24	27	30	25	27	133
Total credits for postgraduate courses	0	1	1	1	1	4
Nº university associate professors	4	5	4	3	5	21

Table 3.4. Formative activity (Centre / Institute)	
Centre or Institute	Code of Centre
Department of Theoretical Phsycis	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
Total predoctoral fellowships/contracts granted	9	5	6	5	3	28
Predoctoral FPI fellowships granted	1	1	2	1		5
Predoctoral FPU fellowships granted	3	3	1	4	1	12
Predoctoral Regional Government fellowships/contracts granted *	3	1	2			6
Predoctoral I3P fellowships					1	1
Postgraduate I3P fellowships						0
Other predoctoral fellowships/contracts granted*	2		1		1	4
Total stock predoctoral fellowships/contracts						
Total predoctoral project fellowships/contracts granted (in equivalent/year)						
Total postdoctoral fellowships/contracts	4	6	8	8	4	30
Total Ramon y Cajal contracts granted		4	3	1	1	9
Total Juan de la Cierva contracts					1	1
AC post-doctoral contracts granted*		1		1		2
Total Postdoctoral I3P doctor granted			1			1
Other postdoctoral fellowships/contracts granted*	4	1	4	6	2	17
Total stock postdoctoral contracts						
Total postdoctoral project fellowships/contracts granted (in equivalent/year)						
Total technical I3P contracts granted						
Total MEC contracts for technical personnel						
Other contracts for technical personnel						
Total doctoral theses directed by C/I personnel	4	3	5	4	3	19
Total theses under way directed by C/I personnel	13	13	14	13	11	64
Total doctoral courses directed by C/I personnel	6	7	8	5	7	33
Total credits for doctoral courses	18	21	24	15	21	99
Total credits for postgraduate courses						
Nº university associate professors	2	3	2	2	3	12

* In competitive calls for grants

Table 3.4. Formative activity (Centre / Institute)	
Centre or Institute	Code of Centre
Department of Experimental Phsycis	010166

Years	2000	2001	2002	2003	2004	Total 2000-4
Total predoctoral fellowships/contracts granted	1	2	2	4	2	11
Predoctoral FPI fellowships granted	1		1			1
Predoctoral FPU fellowships granted		1		2		3
Predoctoral Regional Government fellowships/contracts granted *						
Predoctoral I3P fellowships		1			1	2
Postgraduate I3P fellowships			1		1	2
Other predoctoral fellowships/contracts granted*				2		2
Total stock predoctoral fellowships/contracts	2					
Total predoctoral project fellowships/contracts granted (in equivalent/year)	5			3		8
Total postdoctoral fellowships/contracts		1	1	2	1	5
Total Ramon y Cajal contracts granted						
Total Juan de la Cierva contracts						
AC post-doctoral contracts granted*						
Total Postdoctoral I3P doctor granted						
Other postdoctoral fellowships/contracts granted*		1	1	2	1	5
Total stock postdoctoral contracts	2					
Total postdoctoral project fellowships/contracts granted (in equivalent/year)	2					2
Total technical I3P contracts granted						
Total MEC contracts for technical personnel						
Other contracts for technical personnel		1				1
Total doctoral theses directed by C/I personnel	3	3	4	3	3	16
Total theses under way directed by C/I personnel	8	9	9	13	8	47
Total doctoral courses directed by C/I personnel	3	3	3	5	3	17
Total credits for doctoral courses	6	6	6	10	6	34
Total credits for postgraduate courses		1	1	1	1	4
Nº university associate professors	2	2	2	1	2	9

* In competitive calls for grants

3.5. DIMENSION 5. ACTIVITIES FOR DEVELOPMENT OF SCIENTIFIC CULTURE OR DISSEMINATION

3.5.1 Participation in the Week for Science, science fairs, or other activities to develop scientific culture

List the most important

Participation in the Week for Science, science fairs, or other activities to foster scientific culture

IFIC has recently participated in the following activities of scientific dissemination

2004 Public conferences in the Museum *Príncipe Felipe* of Valencia with the presence of 300 *bachillerato* students from 10 high schools.

2000-2004 *Semana de la Ciencia*, J. Navarro, co-organizer.

2004-2005 Exhibition of panels in the Museum *Príncipe Felipe* of Valencia on the 50th anniversary of CERN and the work developed at IFIC along its historical collaboration with CERN.

2004 Participation at "*Física en Acción*" in Granada through the presentation of the work "Electronic journal of IFIC" selected as finalist. At every edition of *Física en Acción* since it began in 2000 there were works presented by IFIC members.

3.5.2. Dissemination activities in the media (press articles, etc.)

List the most important

2004-2005 Edition of the Electronic journal of IFIC (twice a year, only in electronic format) available at http://ific.uv.es/rei

2004 Participation in the TV programme REDES of RTVE, broadcast on Feb 3rd, 2004

2000-2004 J. Navarro, was member of editorial committee of *Metode*

2005 Press articles and journals:
Albert Einstein and his science, *Revista de la Unión Iberoamericana de Sociedades de Física*, January 2005, by J.A. de Azcárraga.

III Foro de la Valldigna para el Mediterráneo, 10-12 de Noviembre, public lecture *Astroparticulas, del Microcosmos al Macrocosmos*, by J. W. F. Valle, plus round table with Rafael Rebolo and others, Univ. Politecnica de Valencia (televisada)

Some press articles also in internet (El Pais, El Levante, and others), by J. W. F. Valle, in particular those related to the award of the Humbolt prize in 2002

Around 12 popular science articles by J. Navarro in various media, and also two chapters of Collective books.

Many of IFIC' s conferences and workshops, such as the Valencia series of Meetings on *Astroparticle physics* find echo in the local press.

3.5.3. Training of primary and secondary school teachers

Working Group with teachers in secondary education: some IFIC members belong to this group whose aim is to favour a closer contact bewteen the teachers in secondary education and the IFIC researchers. They organize workshops and presentations at the high schools, as well as visits to IFIC.

3.5.5. Open-house days at the Centre/Institute

2005 European Masterclass with the participation of 40 high schools (IES) and schools from all over Spain in different Universities, in collaboration with more than 60 European research institutions involving a total of more than 3000 students at the secondary education level. IFIC was the organizer at the national level and one of the main supporters of the idea through its representative at EPOG (European Particle Physics Outreach Group) Miguel Angel Sanchis Lozano. We foresee the organization of more editions of the Masterclass in the coming years.

3.5.6. Vocational days in secondary schools

List the most important

2004-2005 Many talks at IES and schools in the Valencian region, as preparation for the European Masterclass

3.5.7. Others

2005 EPOG meeting at IFIC (April 8-9, 2005) EPOG is a European commission involved with the dissemination of information in the field of Particle Physics

2004-2005 Colloquia IFIC: series of conferences-colloquia organized at IFIC with the participation of prestigious speakers (examples are U. Amaldi, C. Quigg, etc)

2003-2005 Public Lectures of prestigious international researchers (Museum *Príncipe Felipe*, *Aula cultural la Llotgeta de la CAM*) within a series of meetings on Astroparticle Physics held in Valencia.

4. STRATEGIC PLAN FOR THE CENTRE/INSTITUTE

4.1. ANALYSIS OF THE STATE OF THE ART OR POSITION OF THE CENTRE/INSTITUTE IN ITS COMPETITIVE ENVIRONMENT

4.1.1. Strengths

General:

As it has been already mentioned, the present IFIC structure with two strong departments one in theory and the other in experiment has a direct impact to the research work of the Institute as it provides an excellent atmosphere for scientific cooperation between the two fields, mainly in the phenomenological and experimental areas. This is certainly an advantage of this Institute with respect to others in both the national and the international scene. There are very few Institutes with such composition.

The fact that IFIC is a *Joint Institute* between the CSIC and the University of Valencia is also very positive. This feature gives a close contact of CSIC personnel with University students, allowing them to recruit among the best PhD students, participate in lecturing (though this should be improved) at the post-graduate level, share the scientific administration and complement funding for equipment and infrastructures from the contributions of both Institutions.

Theory Department:

1. The activities of the Theory Department have an absolutely international character from any point of view: publications, presentations, collaborations, visitors, organization of conferences and schools, participation in working groups, European research networks and other EU initiatives. The Department has been pioneer in the recruitment of foreign research personnel.

2. In every line we have groups in the front line of research, either considering the number of publications (research papers, conferences, monographs), the number of citations, participations in working groups, networks of international committees, collaborations or the positions that our students obtain at the postdoctoral level.

3. Although the main activity of the Theory Department is High Energy physics in a broad sense, it is formed by complementary groups. The Department has specialists of recognized prestige to develop high competitive tasks: Nuclear Theory, Hadronic Physics, perturbative and non perturbative QCD, Electroweak Interactions, Neutrinos, Astroparticle Physics, Black Holes and Cosmology, Physics beyond the Standard Model, Supersymmetry, String Theory and Quantum Gravity. This complementarity provides the theory group with great versality towards possible changes of direction in the research lines and ensures a steady high profile publication record to IFIC as a whole.

4. The Department is mainly integrated by the most important set of phenomenology groups at the national level, that can be also considered as one of the European leaders in this field (the chairman of the corresponding section of the EPS is member of our Department, in addition to two Humboldt prize awardees). In order to keep this leadership, we have developed many contacts with experimental groups on Nuclear and Particle Physics at the most relevant laboratories in the world. In this sense, the

coexistence at IFIC of both theoretical and experimental groups of international relevance in Particle Physics generates synergies that enhance in an extraordinary way the activities of both Departments. The Theory Department has also a group devoted to Mathematical and Theoretical High Energy Physics that presents a high scientific productivity and active collaborations with prestigious international groups.

Experimental Department:

Main Aspects of Strength shared by all the experimental lines:

1) *High Expertise.* the senior members of the research lines are in the frontier of the knowledge in their respective research fields,

2) *Capacity of leadership in the international context:* spokesperson of international collaborations with approved experiments: conveners, project leaders, member of scientific research panels, etc..

3) To have access to high level experimental facilities: all the groups are developing their research works using experimental infrastructures based at IFIC (Clean Room, GoG, etc) and large international facilities installed abroad .

4) *Industrial interest :* Interest shown by companies in several developments and exploitation performed at IFIC and establishment of agreements, projects , etc with them.

5) *High number of doctors formed in the last years.* These doctors are a patrimony of the department. A substancial percentage of these doctors are presently employed in key research positions in other national and international centres or industry.

Specific aspects of strength for individual lines

1. *Experimental High Energy Physics: Targets of a consolidated group with long –term perspectives:* several parameters of this group permit to ensure the mainstream of the Research Line in HEP and to have a long term perspective projected beyond the LHC experiments, i.e., Linear Collider. Several member of the group participate in national and international committees.

2. *Experimental High Energy Physics:* International participation in the most relevant experiments of the field for accelerator and non accelerator High Energy Physics.

3. *Experimental High Energy Physics:* Existence of groups and existence of knowledge in the areas of detector instrumentation and accelerator physics (quite rare in Spain).

4. *Experimental Nuclear Physics: Capacity of leadership in the international context:* spokesperson of international collaborations with approved experiments in different European and American facilities, as well as the participation in International Management and Selection Committees. Leading role in the Spanish participation of the new facility FAIR.

5. *Medical Physics:* This constitutes an innovative initiative in Spain which has a challenging future and IFIC is extremely well placed due to the experience and know-how of the group in detector instrumentation.

6. *EHEP & GEP:* IFIC will be the coordinator centre for the ATLAS TIER-2 and this will allow the group to establish a more long term strategy of actions obtaining a 'catalytic' effect in an increasing participation of the rest of research lines of IFIC.

7. *GEP:* the GRID Computing Group has a large experience and a leadership capability in computing projects related to GRID technologies which can be useful to establish new initiatives during the next five years period, in particular, gathering to the Medical Physics Application groups in the area of image reconstruction and simulation.

4.1.2. Weaknesses

General:

1. As a general comment and despite the effort of the last 20 years, the Spanish researchers still need to considerably increase their human resources in order to reach the same level of participation as other European countries of our environment (France, UK, Italy,…). In particular for IFIC this means to incorporate more Scientific and Technical staff.

2. The technical support is mainly based on non stable positions (see table in section 1.5) and furthermore the salaries are not competitive with industry for equivalent jobs. There is a clear lack of a technical career path in CSIC such that engineers/technicians can perform their work to their best and be motivated. In particular at IFIC, this makes the normal operation of the Institute extremely vulnerable as the technical expertise achieved can be lost at any moment. If this would happen it will have a very negative impact to the normal work of the Institute and future projects would suffer drastically. This applies mainly to the experimental department but not only.

3. The researchers suffer from an excessive bureaucratic charge, with summaries, reports, discussions and helping foreign visitors with visa and stay permits, PhD titles co validation, housing, etc. Some of the tasks could be carried out by the IFIC administration, but the inertia of the institutions makes difficult to modify the traditional tasks that they develop in order to cope with the fast social changes. On the other hand, the time devoted to lecturing by the UVEG staff is significantly larger than the European average.

Theory department:

1. The *Theory Department* of IFIC has highly qualified scientific personnel in non permanent positions (9 researchers with a Ramón y Cajal contract, 2 with an I3P contract and 1 with a Juan de la Cierva contract). If this situation continues in the next years, the future development of various research lines would be at risk.

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Experimental department:

1. In the experimental department the distribution of the research staff of the two Institutions, CSIC and UVEG, is relatively well balanced but too low in both cases, especially considering that IFIC is one of the few Spanish Institutes with experimental groups. The ratio CSIC/UVEG is in this case **12/8**. Thanks to the CSIC effort during the last years the situation is slowly improving.

2. In relation to the above comment, the University Department, FAMN, is in real danger of losing its status as an independent department due the small number of staff members. This specially dangerous as this Department is the contact of our Institute to the University in contacting and being known to students.

3. *Experimental High Energy Physics:* Again and common to the rest of national Institutes, the participation of the Spanish groups in human resources and contributions to the experiments is still far a way from the real Spanish weight as a country. For instance, Spain contributes as 7% to the total CERN budget (according to its GNP) while the contribution to the ATLAS experiment is of the order of 2% (personnel + funding). There is a clear lack of manpower and technical resources.

4. *Experimental High Energy Physics*: In the Spanish Research administration, the EHEP is included usually within a common field with Theoretical Physics, which has achieved a remarkable strength in our country. This creates a unavoidable and unnecessary competition in some aspects like: grants, fellowships, contracts, permanent positions and the number of students. This competition becomes manifest at the University and at the CSIC levels.

5. *Experimental Nuclear Physics*: Similarly to the previous line, the lack of human resources specially of senior scientists (the group has not been incremented in the last 16 years) represents a problem. This imposes a limit in the number of actions that can be taken and specially when trying to develop new and more ambitious activities such as those related to FAIR. At present there are projects and activities initiated by scientists at IFIC that are finally carried out by other groups, usually outside Spain, which have more human resources. At the same time and because of the lack of positions the group shows generation gap between the permanent staff and the Ph. D students.

6. *Experimental Nuclear Physics*: The tenured contracts as the *Ramon & Cajal* and *Juan de la Cierva* could partially help. In fact, the participation of experimental nuclear physicists in the selection committees of these contracts should be increased as presently it is clearly under-represented.

7. *Medical Physics:* In the last 5 years groups have devoted a substantial part of their time and resources to the research and developments in detector applications for Medicine. This activity certainly looks very promising but needs to be consolidated.

8. *GRID & e-Science for Physics:* difficulty to have participation of senior researchers of research groups other than ATLAS to lead and to have active part in other initiatives and projects;

4.1.3. Opportunities

Theory department:

The start of the Large Hadron Collider (LHC) in 2007 will originate the need of a renovated activity in High Energy Physics. The LHC will provide a unique opportunity to complete the framework of the Standard Model and scrutinize new theoretical ideas such as supersymmetry. Versatile theoretical groups covering many diverse areas will be needed to interpret the results at the TeV scale. The multi-disciplinary field of Astroparticle Physics offers new opportunities for experimentation, with a rush for new projects, using both accelerator and non-accelerator methods. New stimulating theory ideas are needed, in addition to theoretical support in the interpretation of data, in the simulation of future experiments, and in development of new tools of data analysis. Possible spin-offs may arise, for example, in the study of neutrino geotomography. Similarly, the search of new targets for neutrino detection may open fruitful synergies with material and molecular science research.

The availability of results from B factories has been (and will continue with their upgrades) a unique opportunity in the search of New Physics, in particular in the flavour and CP violation sectors, and a challenge for QCD and its effective developments.

The new FAIR laboratory at GSI in Darmstad, that will be operative in 2013, with proton, nuclei and antiproton beams, will offer new perspectives in Hadronic and Nuclear physics. In addition, the start of JPARC operations in Japan in 2008, with intense beams of kaons and other hadronic sources, opens new research possibilities in Hadronic Physics, complementing the information that is now obtained mainly from electron laboratories.

One of the main and recent discoveries in Physics was the empirical evidence for an accelerated expansion of the Universe. This implies the existence of vacuum energy (“dark energy”), whose understanding requires simultaneously quantum mechanics and gravity. This is a great challenge for string theory, M theory and quantum gravity.

There exist observational evidences for the existence of non ordinary matter in the Universe, known as dark matter. One of the main objectives of extended models of Particle Physics, in particular those supersymmetric, is to provide dark matter candidates and predict their properties.

Nowadays a large number of experiments are being developed with the aim of determining neutrino masses and mixings (SNO, SuperKamiokande, K2K, T2K, to name a few). This is a unique opportunity to compare the theoretical models of neutrino masses with the experimental results. At the same time, the determined parameters have an impact on the early Universe and astrophysical scenarios such as supernovae and neutron stars.

The International Linear Collider (ILC) is a worldwide collaboration (Europe, USA and Japan) to study the construction of a linear electron-positron collider (in contrast to the last built, LEP, that was circular) with the aim of reaching centre of mass energies of the order 1 TeV to perform studies at higher precision of the discoveries at the LHC. The study of the diverse phenomenology to analyze will condition the final design of the ILC. The theory group takes part in various working groups and the physics related to the ILC will certainly fix the future of Particle Physics on the long term.

The TJNAF new experiments and the upgrades of MAMI will allow us to study the hadron properties via the scattering of high intensity electron beams, leading to the discovery of new hadronic states and a better study of the electromagnetic and weak properties of those already known.

The amazing advances being achieved with systems such as ion traps, quantum points, teletransportation, quantum cryptography, etc... need a parallel theoretical development in the field of Quantum Information. This is an interdisciplinary research field with applications on condensed matter, simulations of physical systems, black holes, etc...

Experimental department:

A) *Experimental High Energy Physics:*

As said above, data taking of ATLAS in the LHC collider will start in 2007 and will last for at least 10 years more. It is desirable that this fact will have a similar boost for the EHEP as it was the launching of the DELPHI Data Taking in the 90's. ATLAS is a collaboration with more than 1500 physicist and includes most of the top groups in the world. The results that will be produced by this experiment will be crucial for the understanding of the physics of elementary particles and will certainly define the future of the field. Therefore to have a relevant contribution to the experiment is not an easy task for a group like ours but is possible as has been shown for the time being. To keep and hopefully improve this visibility an important investment in terms of human resources and technology will be however needed during the whole period of data taking.

The IFIC activity in ATLAS will consist in: operation, preparation for possible hardware upgrades and data exploitation - processing and analysis -. In all these activities our group is prepared and should perform an important role in:

- maintenance of the subdetector parts built at IFIC: the hadron Calorimeter (TiCaL) and the Silicon Tracker (SCT),
- service task as TIER-2, being the Spanish coordinating centre in the ATLAS-GRID computing system,
- data analysis: Higgs searches and other process signatures which may indicate physics beyond the Standard Model: supersymetry, composite models, Extra-dimensions and the most challenging, the unexpected,
- prepare new upgrades for the ATLAS tracker with high radiation hard tolerant detectors for the phase of high luminosity or Super-LHC (SLHC),

Furthermore, IFIC has at present good infrastructures (labs, mechanical workshop, electronic lab, computer centre, clean room, specialized equipment, etc..) which allow for good opportunities in the field of High Technology Detector Development. The experience achieved in the construction and operation of the Time of Flight (TOF) detector for DELPHI and their participations in the Hadron Calorimeter (TiCaL) and the Silicon Tracker (SCT) of ATLAS and the monitoring system of ANTARES make the group very attractive to be part of new initiatives in the field. This has happened already for the ROSE collaboration and the present RD50 which try to understand and develop radiation hard semiconductor detectors. Applications to nuclear medicine are also a natural choice which derives from this capability as for instance the participation in the CIMA collaboration for developing Compton Imaging techniques for detecting early cancer. This has derived to the design of a 'Compton Camera' for prostate cancer.

After or during LHC operation it is hoped to also have an e+e- Linear Collider producing data at around 2015. A worldwide collaboration (Europe, USA, Japan), called International Linear Collider, ILC, has been started to study the viability of its construction, the machine technical requirements, the detector design and the physics involved. Since some our present commitments for the ATLAS-LHC construction are finished we have joined this international effort. The present work is mainly concentrated in the accelerator machine itself, the machine-physics interface aspects and the development of new technologies for vertex and tracking detectors (MAPs and DEPFETs).

Neutrino Physics is nowadays one of the most exciting and challenging topics of the EHEP field. We participate in ANTARES and K2K and will be part of the new projects KM3 and T2K (natural sequels of ANTARES and of K2K, respectively). KM3 will be the only deep-sea neutrino telescope of one cubic-kilometre size in the world. It will be complemented by the American IceCube project under construction in the Antarctica, but with several advantages over the latter such as a better angular resolution, a better sensitivity and the possibility of observing neutrinos originating from the Galactic Centre. The KM3NeT initiative has been recommended for a *Design Study* within the Infrastructure Programme of Framework Programme VI and the KM3 project has been recently included in the preliminary "List of Opportunities" for the development of a European Roadmap for new, large-scale Research Infrastructures elaborated by the European Strategy Forum on R.I. as requested by the EU Commission.

The T2K experiment will search for the not-yet-observed sub-leading oscillation, $\nu_\mu \rightarrow \nu_e$. The discovery of these transitions would imply the measurement of one of the two unknowns parameters of the neutrino mixing matrix --the small angle θ_{13}--- and would open the way to the search for CP violation in the leptonic sector. T2K will send a beam of unprecedented intensity (0.4 MW in the first phase, up to 4 MW in the second phase) to the Super-Kamiokande detector. The beam will be measured in a complex near detector system, that will be built by an international collaboration, in which the European presence is very substantial. In particular, the IFIC group will play a leading role both in detector construction and data analysis.

Concerning our participation in the experiments like BABAR is mainly related to the extraction of physics results and data analysis in the very important areas of CP-violation.

B) Experimental Nuclear Physics

The MEC (Ministerio de Educación y Ciencia) has identified the participation in the future international facility FAIR as highly interesting and it has signed the corresponding MoU (Memorandum of Understanding). This facility, which will be deployed at GSI in Darmstadt, implies a qualitative change in terms of experimental nuclear physics facilities in Europe, which until now were national based laboratories. At FAIR the effort of many countries will concentrate in a single facility covering a large range of nuclear physics aspects. The IFIC group has played a leading role in this initiative at national level, and the IFIC scientists are heavily involved in the proposed experiments. The construction of this large scale facility arises in the right moment from the scientific point of view and Spain can benefit from its participation right at the beginning, when the decisions are taken. One of the members of this group is a representative of the Ministry of Education in the FAIR committee for Scientific and Technical Issues (STI). At the same time IFIC is coordinating through a grant application to the MEC the participation of the Spanish Industries in the design of the magnets for the FAIR facility.

The heavy involvement of IFIC in FAIR represents a unique opportunity for the institute, but it needs a determined and specific support to carry out the needed new activities. CSIC has in fact agreed to include this activity as one of its priorities.

C) Medical Physics

The cooperation between particle or nuclear physics and medicine has a very long tradition even though only now is consolidating as a field by itself. Medical physics has a bright future with a relevant social impact. In our case our knowledge in accelerators and detector techniques makes our natural choice to be the therapy and detection of cancer. Our lab, IFIC, is in an extraordinary position to co-lead such an activity in Spain in case new initiatives to create specialized centres are decided. The participation of hospitals is mandatory for such an activity and contacts are being established at present. The effort however needs to be balanced in a way that the fundamental research always preserves its priority.

The new techniques in the therapy of cancer such as hadron-therapy are being followed and several projects to develop devices to detect early tumours have already shown successful results.

There is already an initiative to cooperate with hospitals to built a future Center for hadrtherapy and cancer detection/monitoring using imaging techniques. The role of IFIC in such project, if successful, will be crucial.

D) GRID & e-Science for Physics:

The opportunities can be grouped in the following levels:

At the level of the Comunitat Valenciana: during 2004 we put the basis of creating the Meta-centre of the CV established between IFIC , the UPV and UVEG. In particular the IFIC contributes with its expertise setting up a Resource Centre and developing the Thematic Field of Physics inside e-Science.

At the national level: IFIC will coordinate the ATLAS TIER2 which will permit to have access to a infrastructure of Excellence (see the explanation in 'Strength'). On top of that, the possible opportunities in e-Science would be considered: it has been delivered the 'White Book on e-Science in Spain' where IFIC has contributed very actively. This white Book will be the basic document to define the Strategic Actions of e-Science in Spain.

At the international level: the VI and the VII Framework Program will provide us the participation instruments to collaborate in projects oriented to GRID technologies and e-Science

4.1.4. Threats

In general we do not detect particular threats in the research fields of the different lines. All of them are currently very lively and the variety of experimental projects guarantees a full activity during the next years. At the national level, the Experimental Nuclear and HE Physics have got a solid funding support since the Mobilization Program of 1983 after the re-entry of Spain into CERN. It is expected that this support will continue for the next decades.

The young generation of scientists with research contracts, such as the holders of a *Ramón y Cajal (RyC)* and others, is increasingly assuming more responsibilities within the diverse research lines, as well as on the training of new PhD students. The lack of professional stability of such a valuable personnel could be a serious threat for the consolidation of some groups.

The advantage of the IFIC composition with two departments, one theoretical and the other experimental, is an advantage but if this participation is not fairly recognized or if there are not enough/balanced opportunities for all the groups involved, this feature can transform into a cause of local competition. This should be avoided by all means.

In fact the Spanish Institutions (Ministry of Education and Science, Generalitat, etc..) that decide on the funds for projects and research activities and the Others (CSIC, UVEG, etc..) deciding on research positions should work together. This would probably bring a better correspondence between the manpower and the funding of our projects.

It is extremely important that the basic pillars of the technical support of the Institute consolidate so that the know-how is not lost. Otherwise the level of technical expertise achieved by the Institute will not be guaranteed with a very negative impact on its research. Here it should also be noted that the present Spanish way of recruiting technical staff in the Institutes is far from being optimal. It follows very general rules in the Spanish Administration which do not usually meet the particular needs of the research Institutes making this positions completely useless in some cases. This system needs to be changed.

Specific to EHEP, one threat concerns the fact that the collaborations are large and the life of an experiment is very long. This is needed due to difficulty of the experiments and the price they cost. This makes the work more or less attractive for students depending on the level of execution of the experiment (design, develop, construction, data-taking, etc..). Furthermore there are time periods which produce a good amount of results (design, data taking) but there are others in which this production is low (construction). Therefore it is wise for the Institute to participate in several projects at the same time and at different phase. The negative side of this strategy is the amount of resources, human and technical, needed to accomplish this objective.

Because the EHEP collaborations are very ambitious in their technical and scientific goals they need to be formed by many scientists and the results obtained are usually signed by all the people as it should be. This fact however is not well understood by most of the rest of the scientific disciplines and when in competition for contracts, positions or promotions our researchers are unfairly considered and their real merits ignored by applying too naive and sometimes malicious rules.

The Nuclear Physics activity at IFIC has contributed to the development of this field at national level. However the null growing of the staff in the last 16 years has as consequence that the members of the group, although leading a series of projects, cannot profit from the results of the work. This is presently happening with some experiments originally proposed by members of this group and being done now by other more numerous groups. On the other hand the leading role of IFIC at the new FAIR facility will critically depend on an increment in the human resources of the group including permanent positions.

The sources of funding for the Medical Physics activities are very low since there is not a National Program where these studies can be included in a direct way. For the time being, the funding is

fundamentally based in the collaboration with companies of the medical sector, in small grants coming from the Generalitat Valenciana and the existent IFIC projects for which this activity is a clear "spin-off".

4.1.5. Integrated analysis

Table 4.1. Competitive position of the Centre or Institute in the lines of research

Line of Research	Overall evaluation	Capacity	Quality	Competitive tendency	Relevant observations	Proposed action
High Energy Physics Phenomenology	5	5	5	5	5	To be promoted
Strong interactions and Quantum Chromodynamics	5	5	5	5	5	To be promoted
Astroparticle physics and Cosmology	5	5	5	5	5	To be promoted
Theoretical Nuclear Physics	5	5	5	5	5	To be promoted
Mathematical and Theoretical High Energy Physics	5	5	5	5	5	To be promoted
Experimental High Energy Physics	5	4	5	5	4	To be promoted
Experimental Nuclear Physics	4	2	5	5	4	To be promoted
Medical Physics Applications	3	3	5	5	4	To be promoted
GRID & e Science	4	2	5	5	4	To be promoted

Relevance of the CSIC.

The relevance of the CSIC participation to fulfill these lines is very high. In fact without CSIC most of them will not be performed specially in the experimental side.

There is a clear competition with other centers, in particular in Spain, in several actions and initiatives but this is natural and logic considering that the objectives are scientifically interesting and ambitious. Usually, most of the Spanish centers of the field, which are collaborators in many projects, are also competitors at the same time. For instance: IFAE (Barcelona) , CIEMAT (Madrid), IFCA (CSIC) in Santander, IEM (CSIC) in Madrid, IMAFF (CSIC) in Madrid, IFT (CISC-UAM) in Madrid, CIEMAT (Madrid), UAM (Madrid), etc.

Performance proposal.

All lines need to be promoted

4.2. MISSION AND VISION OF THE CENTRE/INSTITUTE

4.2.1. Mission

The mission of our Institute covers a wide range of subjects. In a broad sense, we study the fundamental interactions (gravitational, electroweak and strong) and the building blocks of matter in the Universe in both the theoretical and experimental aspects. Our aim is to understand the nature of these interactions and their phenomenological consequences in the laboratories, to predict the behaviour in future experiments and, as final goal, to search for a unified theory of all of them. In parallel, we wish to know which physical processes occur in the Universe, and how it has evolved from its initial conditions. The variety of the existing groups at IFIC and the different research subjects provides the Institute with a unique character, where our studies cover from the smallest to the largest objects. As can be seen from the published results, in all energy ranges and evolution phases there exist concrete achievements by IFIC researchers.

Most of the research activities are included in the framework of the national programmes of Particle Phyiscs and Physics within the *Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica* of the Spanish government. In what follows, we list concrete results to be considered,

- to scrutinize the basic structure of matter up to the energy scale of TeV (the energy range measurable in the future LHC at CERN),
- to advance in our knowledge of the flavour structure and CP violation, both in the quark and the lepton sectors,
- to confront new theoretical ideas such as supersymmetry, extra dimensions, etc...
- to develop effective theories for QCD and nuclear physics,
- to study particle interactions in the early Universe and astrophysical scenarios, such as supernovae and neutron stars,
- to study neutrino astrophysics and cosmology
- to study the dynamics of complex systems,
- to improve our knowledge on the quantum aspects of the gravitational interaction,

- to understand better the structure of hadrons through the analysis of data from the TJNAF, DESY or GSI experiments.
- to develop ideas in the field of Quantum Information, with applications to spin systems or quark networks,
- to participate in the most relevant experiments of the fields covered by the research activities of the groups at CERN, SLAC, GSI, Fermilab, DESY, KEK, GANIL, etc..
- to follow a long-term activity in particle and nuclear instrumentation, in particular in semiconductor radiation detectors, calorimetry, electronic design, data acquisition, software, etc..
- to develop tools for GRID and e-Science mostly motivated by our physics needs but keeping opened to go to further applications,
- to support initiatives in connection with Medical Applications related to our know-how achieved by working in our fundamental research.

4.2.2. Vision

It is our aim to keep and improve our level as an international reference Centre for Theoretical and Experimental Physics in the High Energy and Nuclear fileds.

It is also very important for us to be open and support applications which may derive from our research on fundamental physics.

4.3. RESEARCH STRATEGY

4.3.1. General objectives

The general objective is the ultimate understanding of the constituents and the interactions that rule in the Universe. Of course, such an ambitious plan must be based on the achivement of partial objectives. One needs collaborations among the research groups, as well as a continuous training of new researchers that could be later integrated into the institute staff. Here the collaboration of CSIC is crucial, providing the opening of new positions.

4.3.2. Specific objectives

Table 4.3.2. Specific objectives

Objective	Action	Responsible	What to do	Conditions	Period	Observations
Characterization of the Effective Theory of QCD at low energies	enhance this research goal	J. Portolés (R&C)	Analysis of Green functions		2005-2006	
Research Methods in Collider Physics	enhance this research goal	G. Rodrigo (R&C)	Study of Jets, Monte Carlo simulations		2005-2007	

Research in Mathematical and Theoretical High Energy Physics	enhance this research goal	M.A. Lledó (R&C)	Superstring theories and gravitation		2005-2007	
Research in supersymmetry phenomenology	enhance this research goal	Martin Hirsch (R&C)	Theories of neutrino mass and supersymmetry		2005-2006	
Study of new physics at LHC and future colliders	enhance this research goal	Werner Porod (R&C)	Study of supersymmetric models		2006-2008	
Research in Astroparticle Physics	enhance this research goal	Sergio Pastor (R&C)	Study particle properties with data from astrophysics and cosmology		2005-2007	
Enhance the study of hadronic structure	enhance this research goal	V. Vento	Hadronic matter at high density and temperature. Spectroscopy, exotic hadronic state. Proton GPD and spin		2005-2009	
Understanding masses and mixings of quarks and leptons	enhance this research goal	Oscar Vives (R&C)	Study of non abelian flavour SUSY models with spontaneous CP breaking		2005-2009	
Study of the dark energy of the Universe	enhance this research goal	Gabriela Barenboim (R&C)	Analyze its possible dynamical origin (scalar fields)		2005-2009	
Study of heavy resonances in gauge theories	enhance this research goal	Joannis Papavassiliou (R&C)	Gauge invariant analysis in the resonant region of top quark production		2005-2007	

Enhance the research line on Theoretical Nuclear Physics with a new permanent member	enhance this research goal	Eulogio Oset	Non perturbative chiral theory of hadrons. Hadrons in a nuclear medium Dynamical generation of baryonic resonances. Interaction of particles with nuclei.		2005-2009	
Enhance the research in Lattice Physics	enhance this research goal	P. Hernández	Unify lattice techniques and effective theories		2005-2009	
ATLAS: TiCal	Operation and Maintenance	E. Higón	Integration, monitoring, data quality control		2005-2015	S-O strategy
ATLAS: SCT	Operation and Maintenance	C. García	Integration, monitoring, data quality control		2005-2015	S-O strategy
ATLAS: General	Organization and data analysis	A . Ferrer	Physics exploitation		2005-2015	S-O strategy
ATLAS: GRID-Computing	Coordinating Centre: TIER-2	J. Salt	Keep GoG and get more/new resources		2005-2008	S-O strategy
ATLAS Upgrade for Super-LHC	Radiation Hard Silicon Detectors	C. García	Continue the studies of radiation hard silicon detectors and develop of a new ID tracker		2007-2015	S-O strategy
Linear Collider: Accelerator	Machine Phtysics Interface	A Faus (R&C)	Define machine parameters in connection to physics processes		2006-2020	W-O strategy

Linear Collider: Detector R&D	New technologies: MAPs, DEPFETs	C. Lacasta J. Fuster	Define layout, study in mechanics and viability of the new technologies		2006-2020	S-O strategy
ANTARES	Data analysis and design of KM3	J. J. Hernández	Continue ANTARES & launch KM3		2005-2010	S-O strategy
K2K	Data analysis and design of T2K	J. J. Gómez	Continue the k2K project & launch T2K		2005-2010	S-O strategy
BaBar	Data analysis CP-violation	F. Martínez (R&C)	Continue Babar participation		2005-2010	S-O strategy
PDG	Meson Properties	J.J. Hernández	Continue participation		2005-2015	S-O strategy
FAIR	Design of experiment	B. Rubio / J. Diaz	Development of dedicated instrumentation		2006-2010	W-O strategy
NTOF	Research on applications in Nuclear Technology and Astrophysics	J. L. Tain	Experiments using neutrons reactions		2006-2010	W-O strategy
Medical Applications	New developments	J.M. Benlloch F. Ballester C. Lacasta M. Rafecas (R&C)	Research: Scintillator and semiconductors Simnulation Reconstruction		2005-2010	W-O strategy
To extend the e-science in other fields of Physics	To participate in national and European projects	J. Salt	Launch new projects	Computing support / Strategical Action in e-Science	2005-2009	W-O strategy

4.4. CONDITIONS AND EXTERNAL TENDENCIES AND PROPOSED EVALUATION CRITERIA

4.4.1. Quality of research

The indicators of quality suggested in order to evaluate the research in our field are:

- Participation in the programmes of the *Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica.*
- Publication in scientific journals with the highest impact factor.
- Participation in editorial committees of quality international scientific journals.
- Training of PhD's, characterized by the number of theses and their quality.
- Invitation to present talks in international and national conferences.
- Hosting of national and international researchers, both as visitors and postdocs.
- Collaboration with prestigious institutions and laboratories at the international level.
- Participation in European networks and other international initiatives.
- Relevance of the experiments we cooperate and our participation in their activities.
- Member-ship in national or international research panels.

4.4.2. Research impact

The main impact of the IFIC research is the knowledge of the laws that rule the interactions among elementary particles, their symmetries and implications on Cosmology and Astrophysics. This is a very active field, at the frontier of basic research, where we have enormous expectative of performing crucial discoveries in the understanding of the ultimate theory that describes the physical laws of the Universe. These aspects are a must for any research institution like CSIC.

Since we deal with basic research, it is difficult to also look for immediate technological applications, but history shows that discoveries that initially where purely theoretical have often lead to technological applications that none had previously dreamt of. As it is often said, "*in order to develop applied physics we first need physics to apply*". The development of Quantum Mechanics is a clear example, but there are many others. For what concerns our institute, IFIC has played an important role, through the University and the outreach activities, in the development of a scientific culture and the diffusion of Science.

4.4.3. Generation of revenues

In the framework of a long historical trajectory, we have traditionally obtained funding through the different national and European agencies in an open competition basis. We certainly expect that this support will continue in the next years.

The fields of Medical Applications and GRID e-Science are certainly a good investment for a possible new generation of resources in future. Furthermore it is an activity which comes along in parallel and in a natural way from our basic research.

4.4.4. Added value

The leadership of our institute in particle physics in their interactions, indeed a unique centre in this field of research, its scientific contribution at the highest level, the collaboration with many of the most ambitious experiments of Physics, the close relation with the University due to its joint centre character, its training capabilities as shown by the PhD theses, its contribution to public outreach activities on science and the close contact with the most prestigious international research institutions by far justify the continuous effort of support from CSIC, that must lead to the contribution to the IFIC funding and in particular to offer the new permanent positions to secure the research personnel.

5. ACTIONS TO ACHIEVE OBJECTIVES

5.1. ORGANIZATION

We should consolidate the organization and structure presented before.

5.2. SPACE AND LOCALIZATION

At present, the work to finish the laboratory building has started and in it is expected to be finished in the next 18-24 months. The total cost will be around 0.5 Meuros and the area to be build will be about 800 m². Offices for personnel and labs for the new activities (linear accelerator, medical applications, etc..) are foreseen.

5.3. SCIENTIFIC INFRASTRUCTURE

Radioactive Installation:
The use of radioactive sources for nuclear physics and system test devices will require to have a proper and authorized installation.

Update of GOG:
The computing infrastructure will need to be updated along this period (2005-2009) in order to satisfy the requirements of the projects. For instance, the setup of the ATLAS TIER2 at IFIC will imply an important amount of resources: to multiply by 6 the present CPU power and by 20 the present disk capacity in the next 2 years. This fact could need some basic infrastructure changes.

Clean Room:
The operation of the clean room needs for an automatic control of its operative parameters, cleanness, temperature and humidity. This will need to solved in the coming years.

New equipments will also be needed to keep the performance of all the lab services. An annual investment of 100-150 Keuros will be necessary.

5.4. HUMAN RESOURCES

5.4.1. Retirements/vacancies

No retirements are expected for the coming 5 years.

5.4.2. New positions

To achieve the above objectives and taking into account our constraints, the main need we have now is to stabilize the young and good researchers and to consolidate the technical know-how by at least keeping the present manpower resources. As an indication, it is worth mentioning the number of present post-doc contracts at IFIC which is 19, 14 from the *Ramón y Cajal* program, 1 from the CSIC I3P program and 4 from national and European projects and networks. Therefore we believe we should be provided with the following new positions during the next five years

New technical and administrative positions:

- Computing:
  - Titulado Superior (2 positions 2007+2007)
  - FP2 (2 positions-2006 + 2009)
- Electronics:
  - Titulado Superior (1 position -2008)
  - Técnico Medio (1 position -2007)
  - FP2 (1 position -2006)
- Mechanics:
  - Titulado Superior (2 position 2006+2009)
  - FP2 (1 position -2008)
- Administration:
  - Consolidate the Institute Manager (urgent !)
  - Administrativo (2 position 2007+2008)
- Maintenance:
  - FP2 (1 position 2006)
- Library:
  - FP2 or administrativo (1 position 2009)

It is also essential to have 3-4 new contracts every year from the I3P program to train and maintain the present technical services.

From the I3P program of CSIC for PhD fellows and post-doctoral contracts a minimum of 2-3 new grants per year would be needed in each program. This will be mandatory to keep our scientific visibility, especially considering the fact that LHC will start taking data 2007-2008 and that the new FAIR facility will be constructed.

New positions in theoretical physics and experimental physics of *Científico Titular*. A minimum of 10 to 13 in the following areas:

Theory:

- Phenomenology of Effective Theories in non-perturbative QCD,
- Perturbative QCD in colliders,
- High Energy Physics: phenomenology,
- Astroparticle Physics,
- Mathematical and Theoretical High Energy Physics,
- Theoretical Nuclear Physics.

Experiment:

- Experimental High Energy Physics:
  - ✓ Accelerator physics: ATLAS, BABAR, Linear Collider,
  - ✓ Non accelerator and Neutrino physics: ANTARES-KM3, K2K-T2K,
- Experimental Nuclear Physics for FAIR,
- Medical Physics necessary to consolidate this line,
- GRID and e-Science,
- Detector development and instrumentation,
- Accelerator physics.

In addition to the positions above, we also request two position at the "Investigador Cientifico" level, one in the area "Física Nuclear Teórica para FAIR", and the other in the area of "Física Nuclear Experimental para FAIR", "por concurso libre".

5.5. ECONOMIC RESOURCES

Table 5.5. Evolution of the prospective budget (in euros) Centre / Institute)	
Centre or Institute	Code of centre
INSTITUTO DE FISICA CORPUSCULAR	10166

Years	2005	2006	2007	2008	2009	Total 2005-9
Total budget	**5.550.000**	**7.025.000**	**4.350.000**	**6.500.000**	**7.650.000**	**31.075.000**
Total external resources	**3.000.000**	**4.000.000**	**1.500.000**	**3.500.000**	**4.500.000**	**16.500.000**
Total internal resources	**2.550.000**	**3.025.000**	**2.850.000**	**3.000.000**	**3.150.000**	**14.575.000**
Personnel budget	2.100.000	2.200.000	2.300.000	2.400.000	2.500.000	**11.500.000**
Normal budget	300.000	325.000	350.000	400.000	450.000	**1.825.000**
Investments	150.000	500.000	200.000	200.000	200.000	**1.250.000**

5.6. SCIENTIFIC-TECHNOLOGICAL PROJECTS

5.6.1. Departments

We will keep our present structure

5.6.2. Services

The existing structure of services should be supported with more permanent positions.

5.6.3. External relations

We will probably continue our present international relations and collaborations. Extending our cooperation to Asian groups and labs, mainly in Japan, consists a natural action to do, specially under the label of the Neutrino and Linear Collider initiatives.

5.7. ACTIVITIES FOR DEVELOPMENT OF SCIENTIFIC CULTURE OR DISSEMINATION

We plan to continue and reinforce our participation and involvement in the present activities and support for new initiatives.

5.8. RESULTS INDICATORS FOR RESEARCH ACTIVITIES

In accordance with the strategic dimensions of the activity of the Centre/Institute, quantitative objectives should be defined in global terms for each of the following:

Table 5.8. Prospective values for general indicators

Year	2005	2006	2007	2008	2009	Total 2005/9
Total financing (euros) in competitive projects	3.000.000	4.000.000	1.500.000	3.500.000	4.500.000	16.500.000
Total nº articles in SCI/SSCI/A&HIS-indexed journals	240	245	250	255	260	1.250
Nº articles in international non- ISI journals	110	110	110	110	110	550
Nº articles in national non- ISI journals						
Nº books	1	1	1	1	1	5
Portfolio of active national patents			1			1
Portfolio of active EPO, USPTO, etc. patents		1			1	2
Patents licensed to companies						
Start-ups initiated by Center/Institute personnel						
Income from R&D contracts (private sector)						
Income from contracts/consulting (public sector)						
Total stock predoctoral fellowships/contracts	10	10	10	12	12	54
Total stock postdoctoral fellowships/contracts	4	4	4	5	5	22
Total PhD theses defended by C/I personnel	9	9	9	9	9	45
Total doctoral/postgraduate course credits	30	30	30	30	30	150

ANNEX. INDEX TO THE PROPOSED STRATEGIC PLAN

3.5. DIMENSION 5. ACTIVITIES FOR DEVELOPMENT OF SCIENTIFIC CULTURE OR DISSEMINATION

- **3.5.1. Participation in the Week for Science, science fairs, or other activities to develop scientific culture**
- **3.5.2. Dissemination activities in the media (press articles, etc.)**
- **3.5.3. Training of primary and secondary school teachers**
- **3.5.4. Preparation of manuals and textbooks**
- **3.5.5. Open-house days at the Centre/Institute**
- **3.5.6. Vocational days in secondary schools**
- **3.5.7. Others**

4. STRATEGIC PLAN FOR THE CENTRE/INSTITUTE

4.1. ANALYSIS OF THE STATE OF THE ART OR POSITION OF THE CENTRE/INSTITUTE IN ITS COMPETITIVE ENVIRONMENT

- **4.1.1. Strengths**
- **4.1.2. Weaknesses**
- **4.1.3. Opportunities**
- **4.2.4. Threats**
- **4.1.5. Integrated analysis**

4.2. MISSION AND VISION OF THE CENTRE/INSTITUTE

- **4.2.1. Mission**
- **4.2.2. Vision**

4.3. RESEARCH STRATEGY

- **4.3.1. General objectives**
- **4.3.2. Specific objectives**

4.4. CONDITIONS AND EXTERNAL TENDENCIES AND PROPOSED EVALUATION CRITERIA

- **4.4.1. Quality of research**
- **4.4.2. Research impact**
- **4.4.3. Generation of revenues**
- **4.4.4. Added value**

5. ACTIONS TO ACHIEVE OBJETIVES

5.1. ORGANIZATION
5.2. SPACE AND LOCALIZATION
5.3 SCIENTIFIC INFRASTRUCTURE
5.4. HUMAN RESOURCES

- **5.4.1. Retirements/vacancies**
- **5.4.2. New positions**

5.5. ECONOMIC RESOURCES
5.6. SCIENTIFIC-TECHNOLOGICAL PROJECTS

- **5.6.1. Departments**
- **5.6.2. Services**
- **5.6.3. External relations**

5.7. ACTIVITIES FOR DEVELOPMENT OF SCIENTIFIC CULTURE OR DISSEMINATION
5.8. RESULTS INDICATORS FOR RESEARCH ACTIVITIES