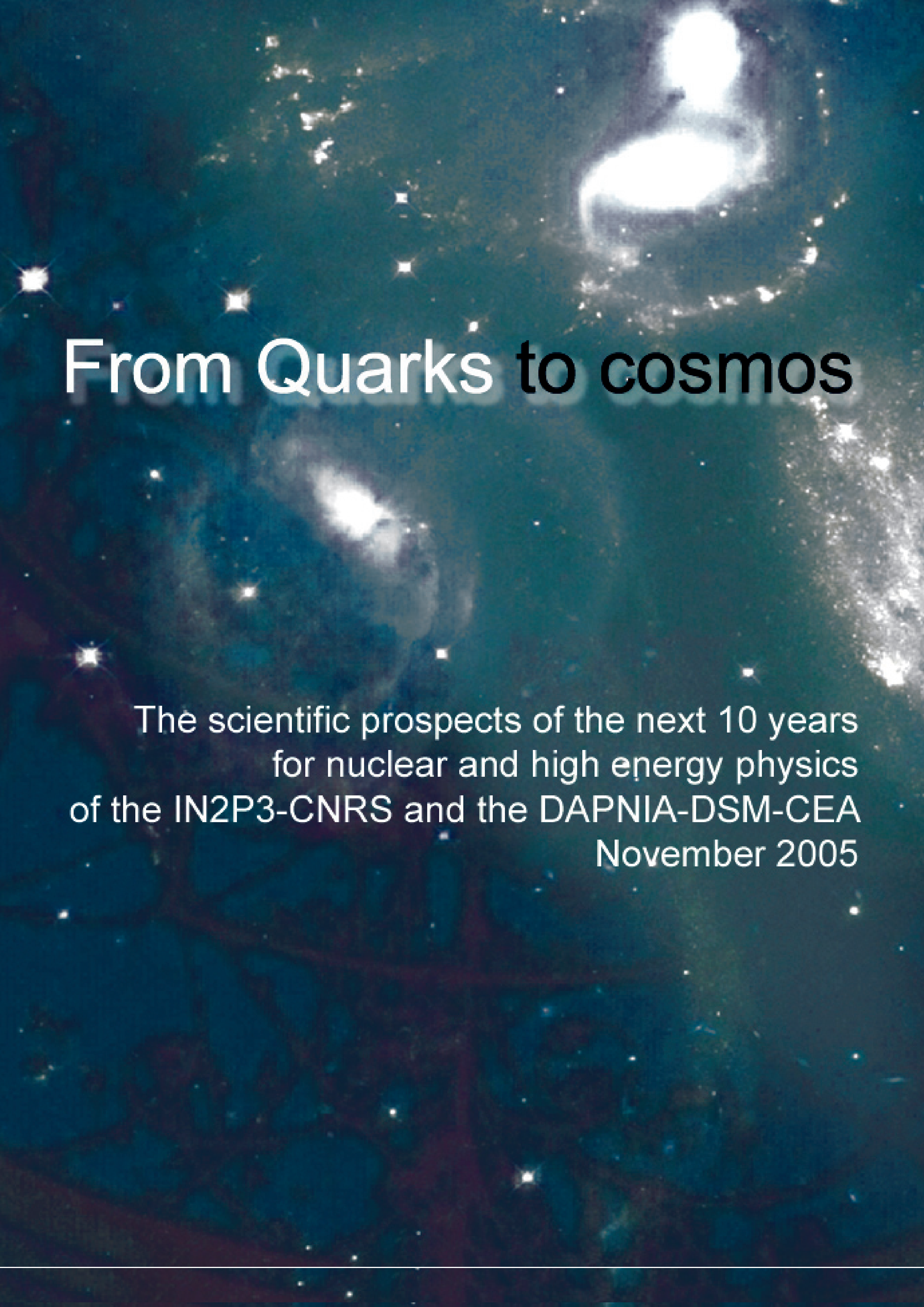

From Quarks to cosmos

The scientific prospects of the next 10 years
for nuclear and high energy physics
of the IN2P3-CNRS and the DAPNIA-DSM-CEA
November 2005

SCIENTIFIC PROSPECTS OF THE NEXT 10 YEARS FOR NUCLEAR AND HIGH ENERGY PHYSICS - FROM QUARKS TO COSMOS –

The scientific prospects for nuclear and high energy physics of the DSM and the IN2P3 presented in this document result from an in-depth study with the participation of the whole French scientific community. Coordinated by a national steering committee composed of members from the scientific committees of the DSM and the IN2P3, thematic groups worked to draft a report from March to September 2004. A workshop on the future of nuclear and high energy physics was held from the 6th to the 10th October 2004 at la Colle-sur-Loup and gathered together more than 400 researchers, teacher-researchers and engineers. The resulting reports and presentations were published together and widely diffused within the community by means of a CD. Based on these results, the management of the DSM and the IN2P3 have distilled, under their responsibility, the summary given below.

THE CONTEXT

The main experimental efforts of the DSM and the IN2P3 has up to now been carried out within the context of large collaborations working at accelerators, in particular at CERN (Geneva), GANIL (France), SLAC (Stanford, USA), FNAL (USA) and DESY (Germany). Their scientific programmes are quite rich. For the first two centres, their programmes will continue over the ten next years. Longer range world-wide projects are also being prepared, and a fraction of the physicists, engineers and technicians actively contributes to it.

The study of cosmic rays and solar neutrinos has brought particle and nuclear physics closer to astrophysics for a long time. Conversely, certain phenomena of stellar physics require measurements of nuclear properties. The evolution of the fundamental questions of particle physics now forces us to complete the information obtained at the present and future accelerators by the measurement of the properties of the Universe. Leading to a natural opening for the theme of “astroparticles”, quite an effervescence is observed in these new fields.

NUCLEAR PHYSICS

Nuclear physics comprises four principal topics today : the exploration of the structure of the exotic nuclei, which is an unstable and transient assembly of neutrons and protons ; hadron physics ; phase transitions of the nuclear matter ; upstream research in physics and chemistry for nuclear power and the environment.

The study of nuclei structure shows an exceptional vitality, thanks to the development of the radioactive beams. Unexpected properties (granular systems, halos, new magicities) are observed for bound but unstable nuclei (far from the “valley of stability” in the nuclear chart). These discoveries impose an important evolution of nuclear theories. The interactions brought into play must be improved (isospin dependence, three-body forces). The models must integrate new concepts : coupling to the continuum and correlations. This theoretical effort must be amplified.

Exotic nuclei have a major impact on our understanding of stellar nucleosynthesis, in particular in the violent phenomena where heavy elements are formed. Measurements of mass, lifetime, cross section, and isomeric states, far from the valley of stability of the nuclei, are necessary today. β-radioactivity of exotic nuclei refines our knowledge of the fundamental interactions.

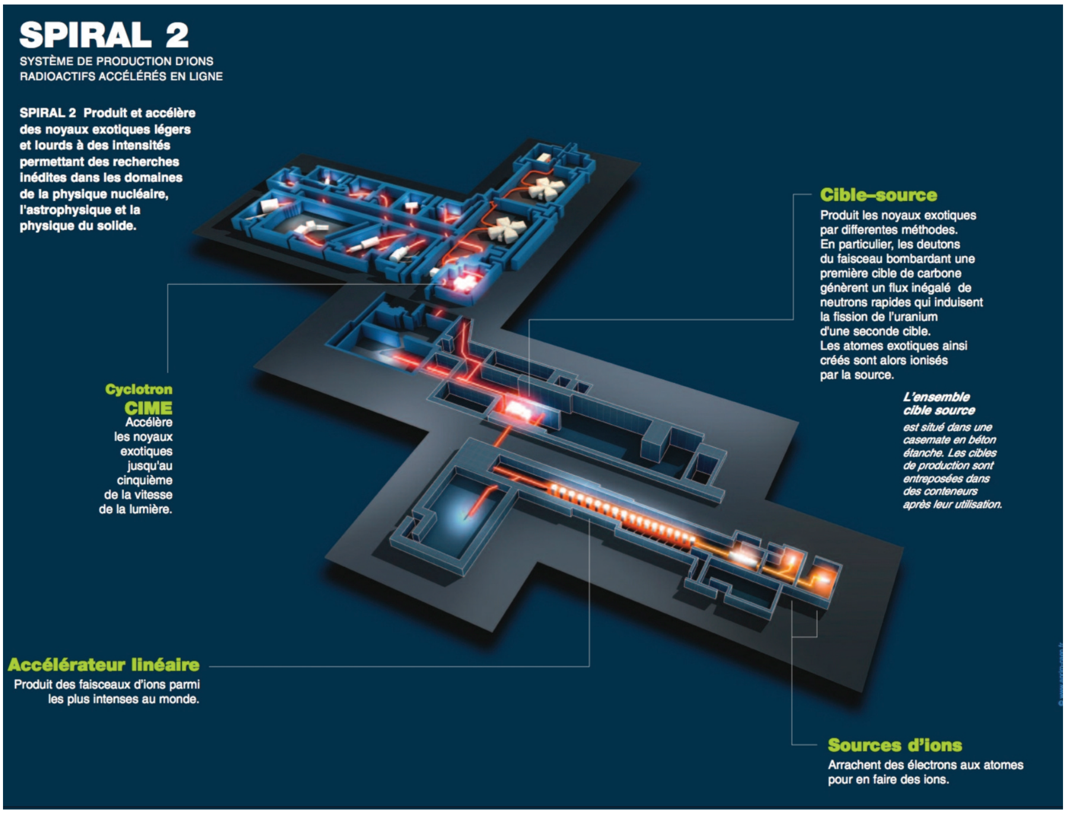

Figure 1 : *Layout of SPIRAL2 : a world leading ISOL Facility for rare isotopes beams*

Further advancement in these fields requires the development of intense beams of nuclei far from stability. This exploration towards the cohesion limits is linked with the research of the limits in mass (superheavy elements) and in deformation (hyperdeformation), which requires stable beams of high intensity, as anticipated for some nuclei with SPIRAL2.

Important investments will be made in the next few years. SPIRAL2 set at GANIL will extend the programme of SPIRAL towards heavy exotic nuclei. It is an essential step before EURISOL, a European project of radioactive beams for the the next generation of facilities. A limited involvement in the FAIR project (Germany) developing the complementary approach of projectile fragmentation is being considered. A new gamma ray spectrometer, AGATA, based on the reconstruction of trajectories, will enable us to take full advantage of the produced beams.

Objective 1 : Exploit as well as possible GANIL SPIRAL1 (exotic beams). Launch and build SPIRAL2 (second generation exotic beams) in a European framework, an essential milestone before EURISOL

Objective 2 : Prepare for EURISOL (third generation exotic beams), an European facility expected for the period 2015-2020 (at GANIL or at CERN coupled with the SPL project). Prepare for the design and construction of a European detector to measure the excitation levels of nuclei (e.g. gamma detector AGATA) for 2012.

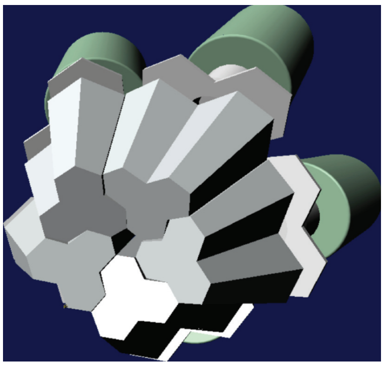

Figure 2 : *AGATA : Gamma-array tracking multi-detector*

Hadron physics aims to study high-energy particles in terms of quarks and of gluons. Their structure and their behaviour, still poorly understood, are the subject of some impor-

Figure 3 : *FAIR : a new facility for antiproton and ion research at the GSI Laboratory in Darmstadt*

tant projects. The generalised parton distributions (GPD) offer a three dimensional picture of quarks and gluons in the nucleon : the first measurements will be taken in Jlab at 6 then 12 GeV.

Polarisation measurements of the gluons and in the longer term of the GPDs are objectives of COMPASS at CERN. The accelerators used are those of particle physics or other more specialised ones (COMPASS at CERN, TJNAF 6 – 12 GeV in the USA, H1 at DESY, GSI in Germany). Antiprotons beams, available after 2014 with FAIR at GSI, will enable to explore the nucleon structure in the pbar-p annihilation channel. Projects of calculators dedicated to QCD (at the European level) could fertilise the activity of the theorists.

Objective 3 : Understand the structure of nucleons (partons distributions, spin) and, more generally, or hadrons (COMPASS at CERN, TJNAF 6-12 GeV, FAIR at GSI), by both experimental and theoretical efforts

Heavy ions collisions probe the phase transitions of nuclear matter. These are liquid-gas transitions of nucleons at GANIL energies. The influence of the proportion of neutrons and protons on this transition will be studied with the use of radioactive beams. A transition from nuclear matter to a quark-gluon plasma is possible with relativistic energies of the CERN-SPS, the RHIC and the future LHC.

The results obtained at the CERN SPS (NA50 and WA98 experiments) brought elements of decisive evidence “of the existence of a new state of the nuclear matter” in collisions between heavy ions”. They confirm the predictions of QCD theory of the strong interactions relative to the conditions of plasma production.

At higher energy, the research programme of the Brookhaven RHIC collider aims to characterise this deconfined state. With the future collisions of LHC heavy ions in the ALICE detector, it will be possible to study the nature of plasma at extreme energy density with the hope to produce a nearly perfect gas of quarks and gluons. The heavy ions experiments generally associate particle and nuclear physicists.

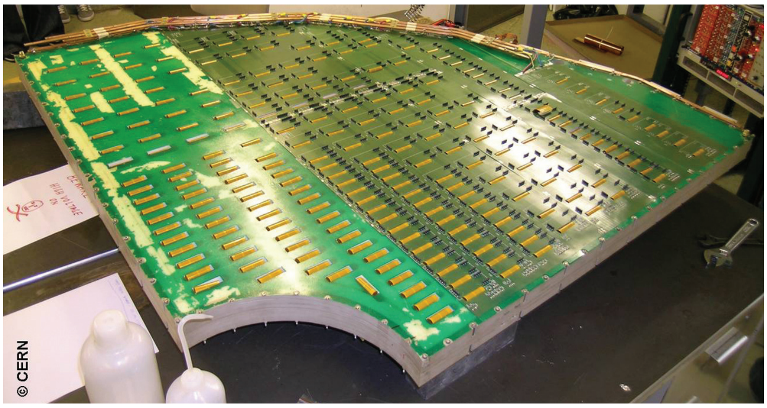

Figure 4 : *Electronic tracking detector for the muon spectrometer of ALICE.*

Objective 4 : Ensure in the next few years a maximum exploitation of the physics potential offered by PHENIX and STAR experiments of RHIC. Carry out ALICE at LHC (collisions of heavy ions leading to the formation of quark-gluon plasma), starting planned for 2007, and exploit its strong scientific potential during ten years.

The objective of the community of physicists and nuclear chemists engaged in the research concerning nuclear fission is the development of innovating concepts. The reduction in the quantity and the radio-toxicity of wastes is a major

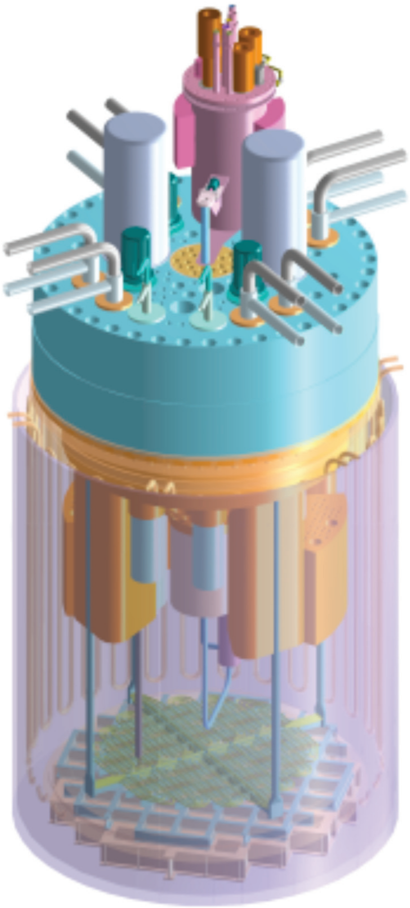

Figure 5 : *Project MYRRHA of an accelerator-driven reactor for the transmutation of the radioactive waste*

challenge for the development of the nuclear energy. One of the tools for this development could be accelerator driven system (ADS, European programme EUROTRANS) for the transmutation of high activity and long life waste (HAVL). With regards to the technological choice for energy production, without neglecting the other possible choices, the IN2P3 community is primarily directing its effort towards Th-U3, in particular in the form of molten salts which permits a more generic research having many other applications.

In this context, radiochemistry pursues new research on actinides chemistry in new mediums and on the behaviour of the radio-nuclides in a condensed phase under irradiation. Finally, concerning the environment, radiochemistry will become more important as nuclear energy is developed in France and rest of the world in the coming years.

Studies will in addition be continued in the field of fusion (support for the ITER project) together with other fields like the dismantling of the nuclear installations and the non-destructive characterisation of materials (photo-fission).

Objective 5 : Carry out upstream research in the electro-nuclear field (fission), in particular by the acquisition of fundamental data (spallation, captures, fission), study hybrid systems for transmutation, and contribute to the study of innovating systems for the future nuclear energy.

Objective 6 : Contribute to the thermodynamic databases and to the physicochemistry of radionuclides for the innovating systems (ionic liquids, molten salts and new combustibles)

PARTICLE PHYSICS

The past decade was marked by the determination, with an unprecedented precision, of the standard model parameters of the electroweak interaction at LEP (CERN), at SLC and PeP-II (SLAC) and at TeVatron (FNAL). At the same time, the description of the strong interaction was consolidated at Hera (DESY) and at LEP.

The next priority is the identification of the components of the sector associated with the spontaneous electroweak symmetry breaking. This identification will be based on discoveries of new particles (like the Higgs boson(s) at the origin of the mass of the particles) and/or on precision measurements. The TeVatron and Hera are the two machines currently exploring the high energy frontier, until the arrival of the LHC at CERN. Many groups of IN2P3 and DSM are involved in this programme ; in the preparation of ATLAS, CMS and LHCb (LHC) experiments, and in the exploitation of the data by the H1 (Hera) and the D0 experiments (Tevatron).

The parameters of CP violation should be well measured in the heavy quark sector by the end of the experiments BaBar (PeP-II) and LHCb (LHC). The BaBar and BELLE (KEK, Japan) experiments, after first observing the violation

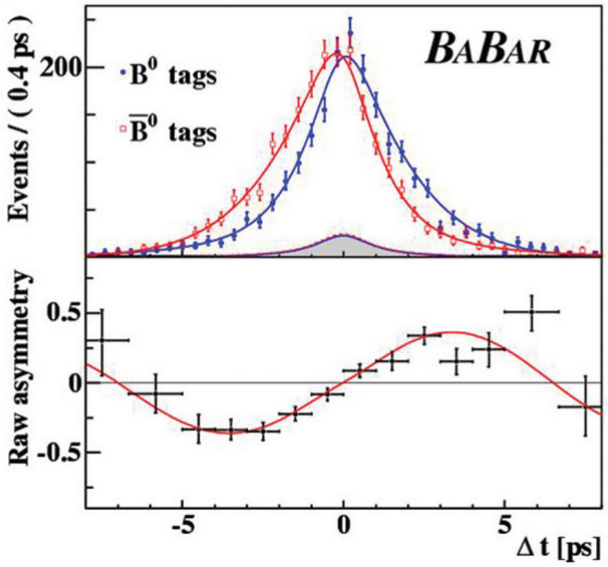

Figure 1 : *Proper time distribution of the ψK^0_S events signed B^0 or $\bar{B}^0$ in the BaBar experiment. A clear difference between the two categories of events, which illustrates in a spectacular way CP Violation in B^0 meson decays. The corresponding asymmetry follows a sine law whose period corresponds to the frequency of B^0 $\bar{B}^0$ oscillations, and whose amplitude is proportional to the sin(2β) parameter.*

of CP in the 'b' quark sector, are actively searching for deviations from Standard Model predictions, which could be induced by the presence of new particles at the TeV scale. This research will be continued in the near future with LHCb, together with measurements of particle electric dipole moments and will be accompanied by a theoretical effort including, among others, lattice QCD calculations.

The LHC, which will begin commissioning in 2007, should enable to identify the mechanism of the electroweak symmetry breaking and to clarify the modifications to be made to the standard model (e.g. supersymmetry, additional dimensions related to new gravitation theories, composite particles.). The existence of non-baryonic dark matter in the Universe has become an unavoidable argument in favour of the existence of exotic, neutral and weakly interacting matter, many properties which suggest supersymmetric 'neutralinos' : the LHC will contribute in the clarification of their possible role.

Objective 1 : Fully exploit the potential of the programmes in progress at FNAL, SLAC and DESY.

Objective 2 : Fulfil our commitments to the LHC experiments : ATLAS and CMS (Higgs research, supersymmetry...), LHCb (matter antimatter asymmetry) ; construction and installation of the detectors, preparation of the analyses, start-up of the detectors in 2007.

Objective 3 : From 2007, ensure an optimal exploitation of the physics potential offered by the LHC and its detectors, including the possible prospect of an accelerator upgrade.

A worldwide agreement took shape on the choice of an electron positron linear collider as the future accelerator of particle physics, with a centre-of-mass energy higher than 500 GeV, of which the Research Ministers Council of OECD took note in January 2004. This machine, the ILC, associated with the LHC, would enable a fully comprehensive study of the electroweak interactions, as well as a thorough characterisation of any new particles produced. Machine

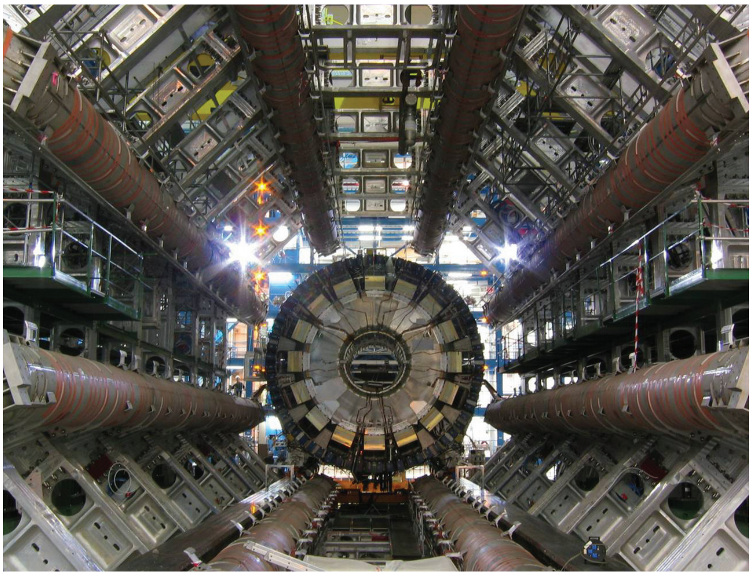

Figure 2 : *ATLAS detector : Insertion of the calorimeter in the toroïd at CERN in Geneva.*

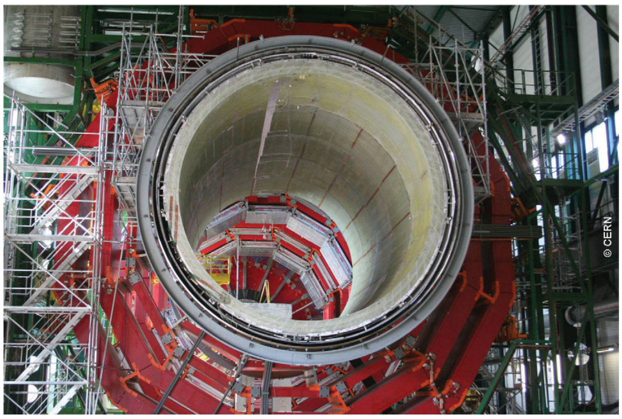

Figure 3 : *CMS Detector : Superconducting coil in place at CERN in Geneva.*

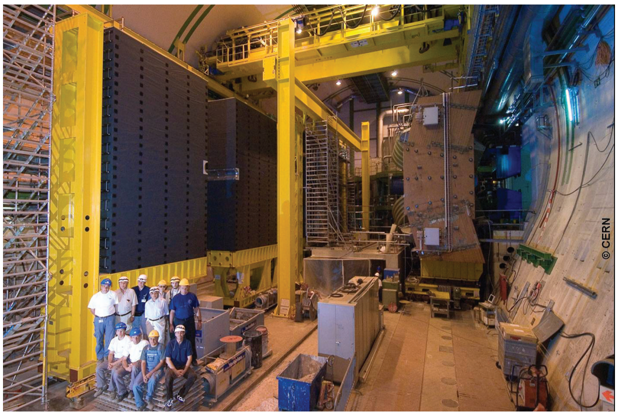

Figure 4 : *The LHCb HCAL detector before its final installation at CERN in Geneva*

studies were largely pioneered in Europe, with a notable contribution of the French laboratories in the development of a superconducting cavity solution (the TESLA project), the technology which was retained by ICFA in August 2004 to be used as a basis for the world-wide global design effort (GDE) underway. The definition of the future detectors at the ILC is also the subject of an intense world-wide effort and France is strongly implicated there. Another less well-advanced accelerator option, CLIC, would enable one to reach an energy of 5 TeV. The development of CLIC should be continued within the context of a collaboration based around CERN including both IN2P3 and DSM/DAPNIA.

Objective 4 : Take an active part in the accelerator R&D and the design of a detector for the ILC. Take part in the accelerator R&D in the CLIC project.

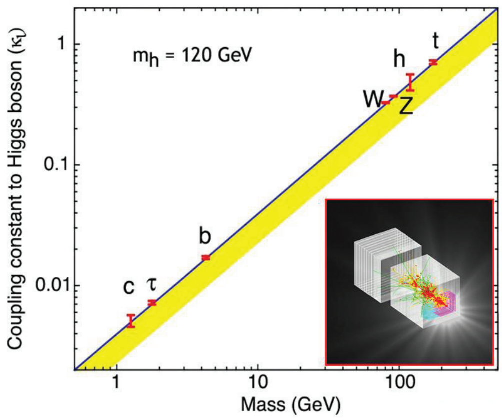

Figure 5 : *Precision measurements expected at the ILC of Higgs boson coupling to the Standard Model (SM) particles, as a function of their mass (in red). The blue line and the yellow strip respectively indicate the predictions in the SM and in a generalization with additional dimensions (ACFA study). In the box, simulation of a prototype of an ultra granular calorimeter developed for the ILC*

ASTROPARTICLES AND NEUTRINOS

The neutrino

The non-zero neutrino mass and the mixing of the various types of neutrinos is now widely accepted. As with the three quark families, this opens the possibility of CP violation in the oscillation of the three-neutrino families. This type of CP-violation could play a role in the matter antimatter asymmetry observed in the Universe. Experiments such as KAMLAND (Japan), MINOS (US) and OPERA (in Gran Sasso) will contribute to specify the parameters of this mixing. The measurement of the last of three mixing angles, not yet measured, and the CP-violation phase measurement will require new equipment (experiments near reactors, accelerators, beams, underground laboratories) under study in the USA, in Europe, and in Japan. Thus one will see the development, construction and exploitation of a set of two detectors

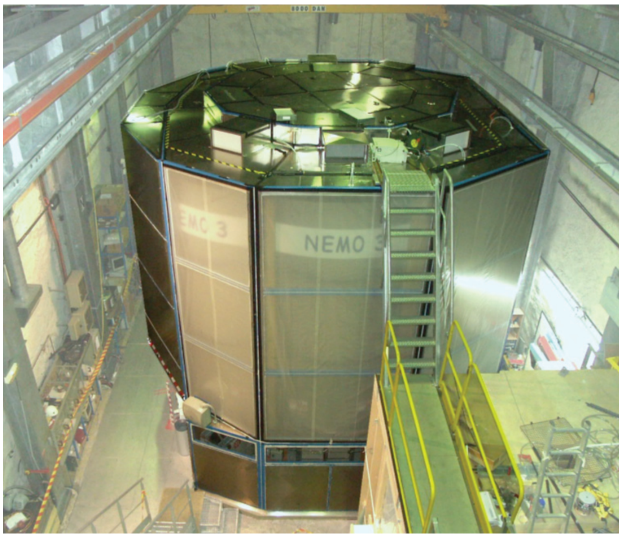

Figure 1 : *NEMO detector in the underground laboratory of Modane.*

installed near the reactor of CHOOZ (DOUBLE CHOOZ), the participation in an experiment of the JPARC complex (T2K experiment in Japan), and finally the preliminary studies of a “megaton” detector of LSM (Underground Laboratory of Modane) which can receive of CERN neutrinos beams (SPL, beta beams). The megaton detector would be used for the detection of astroparticles and the research of proton instability as well.

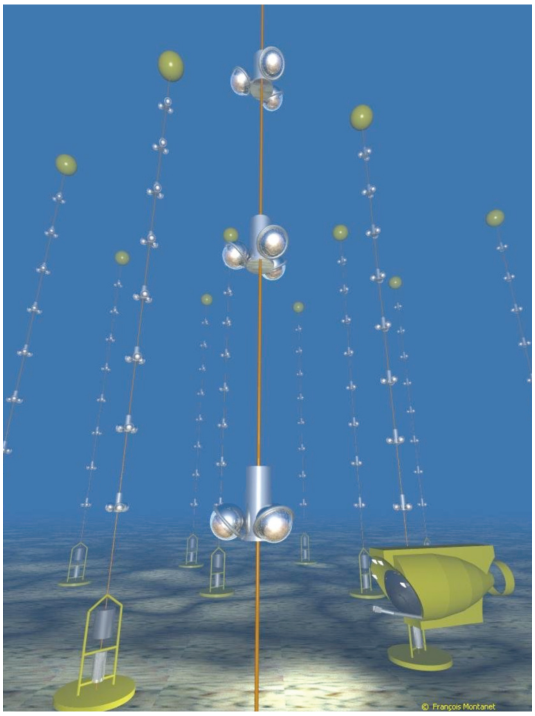

Figure 2 : *Artist view of the ANTARES underwater detector*

Are neutrinos and antineutrinos identical ? If the answer is positive, the neutrinoless double beta decay should be observed. The NEMO3 experiment attempts to observe this phenomenon in Modane, and a future detector will have a 10 times higher sensitivity.

Structure and the Energy content of the Universe

The cosmic ray background measurement and the analyses of supernovae luminosity showed that the Universe is Euclidian, and that its expansion accelerates under the gravitational effect of a dark energy (or cosmological constant). It is the answer to questions which arose at the dawn of cosmology, after the birth of general relativity. The exploitation of several experiments on supernovae : Supernova Legacy Survey (SNLS) with MEGACAM at the CFHT, the great space project of dark energy detection JDEM or DUNE and the study of the cosmic microwave background by the PLANCK satellite, with its excellent resolution, should constrain (with other experiments in the world) the cosmological parameters with a very high degree of accuracy. Experiments on cosmological background polarisation measurements on the ground (the Antarctic) and in space are planned in order to study the structure of the Universe and the inflation hypothesis.

The matter composing the Universe itself is

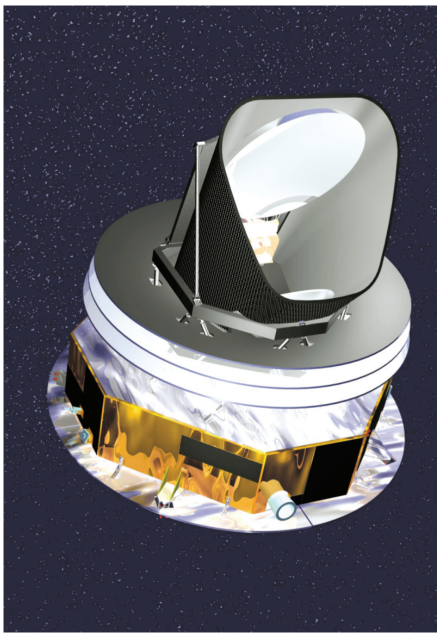

Figure 3 : *The PLANCK satellite.*

dominated by an invisible component, the dark matter. It would be responsible for the greatest part of the mass of galaxy halos, and could consist of particles predicted by the theories beyond the standard model. Great efforts are in progress to detect them and the EDELWEISS experiment in the underground laboratory of Modane prepares a new generation detector with mass of the order of the ton, on a European scale. Space experiments on photons annihilation detection, such as GLAST and AMS and the neutrino telescope ANTARES, will also bring significant potential of discovery.

High energy cosmic phenomena

Subatomic physics techniques open new windows in astrophysics by the detection of charged particles, high energy gamma rays and neutrinos. This radiation is produced in violent phenomena of the Universe, and enables the testing of the physical laws in extreme environments, unattainable on Earth. These 'messengers' can also be a demonstration of unknown particles.

The media used on the ground to detect these rare radiations are the Earth, the atmosphere, the sea, or polar ice. The HESS Telescope in Namibia, will detect high energy γ rays. The AUGER Observatory, under commissioning in Argentina will be able to observe particles of extreme energy, whose origin is not known. ANTARES experiment will detect neutrinos of high energy using in the Mediterranean Sea. Studies have already begun within a European framework to prepare future projects and to increase the sensitivity of the detectors.

Space observations complement the lower energy observations on the ground and the two are indivisible. Satellites constitute the privileged tool for the fine study of the objects of the Universe, revealing in X or in γ, the physical state of the matter, nuclei and magnetic fields. For the γ radiation study, the INTEGRAL satellite is taking data and the GLAST project is in preparation. The AMS experiment, installed on the international space station, will measure the cosmic rays spectrum and will search for antimatter and dark matter.

In general, the mechanisms at the origin of high energy cosmic phenomena (accretion/ejection around compact objects, supernovae explosions, "gamma ray bursts", cosmic radiation...) require the study of the radiation at several wavelengths. This field will profit from an outstanding situation, with the joint use of the set of four instruments : XMM, INTEGRAL, GLAST, and HESS, covering 7 orders of magnitude in energy (0.1 KeV to 10 TeV). For the longest term, the ECLAIRS projects (part of the programme of the CNES micro-satellites, launching after 2008) and SYMBOL X (implementing the techniques of flight in formation, launching ca 2012) are being studied.

Gravitational waves

The first indirect indication of gravitational waves has been provided by binary pulsars. These waves should also be produced in certain violent phenomena (supernovae, AGN). The direct observation of gravitational waves will be a major confirmation of the theory, and will enable one to better understand these violent phenomena. The Franco-Italian VIRGO experiment can detect the space-time deformation which they induce, thanks to exceptional

Figure 4 : *Aerial view of the VIRGO laboratory.*

technical performances in lasers, optics, and engineering. The coincidence of the observations between detectors distributed around Earth will enable the confirmation of the signals obtained. In a more remote future, the space project LISA will complete the range of the covered frequencies, and may permit the study of waves emitted by the primordial Universe.

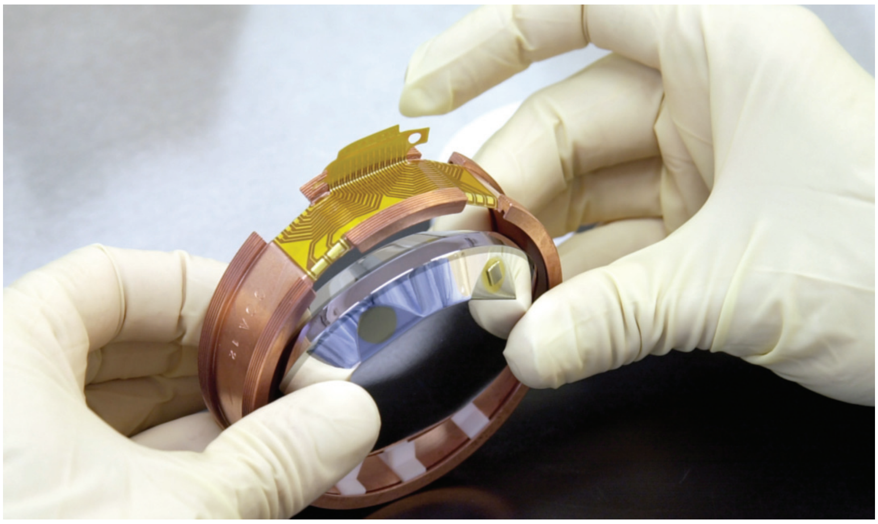

Figure 5 : *A germanium crystal of the EDELWEISS detector.*

Objective 1 : Ensure the success of the current large projects : AUGER, HESS, ANTARES, VIRGO, GLAST, AMS, PLANCK, NEMO, OPERA, T2K.

Objective 2 : Continue neutrino astronomy, with a 1 km3 underwater telescope in the Mediterranean sea (30 times bigger than the ANTARES detector) at the 2010 horizon. As a complementary project to ANTARES and the launching of GLAST, an improvement of HESS is envisaged (HESS II) in the 3-4 years to come.

Objective 3 : VIRGO Detector for the detection of gravitational waves (TGE since 1999), now in commissioning, will reach its maximum of sensitivity in the two coming years. R and D in progress could lead to a follow-up of VIRGO for the detection of the gravitational waves (Around 2010 – 2015)

Objective 4 : Modernisation and expansion of the underground laboratory of Modane within an international framework, in order to house detectors permitting the study of proton stability, to detect supernovae and to study neutrino properties with CERN beams (Around 2015-2020)

Objective 5 : Space is another very important priority axis. The experiments under construction will have to be carried through (for example PLANCK and GLAST horizon 2007, AMS one to two years later), the new generation of experiments in cosmology and gravitation (JDEM/DUNE, LISA, around 2012-2013) and also the study of cosmic phenomena of high energy (SIMBOL-X and ECLAIRS horizon 2008-12) will have to be prepared.

Objective 6 : Follow-up the experiments on cosmic rays of the highest energy (collaboration AUGER in Argentina), dark matter research (EDELWEISS with Modane) and neutrinoless double beta decay researches (SUPERNEMO)

SCIENTIFIC COMPUTATION

Future high-energy physics and astroparticles experiments will lead to considerable data flows. The storage and the processing of these data suppose a large increase in the resources placed at the community's disposal.

In particular, the prospect of the LHC data processing has led to a distributed infrastructure using grid technology. A part of these efforts are coordinated by CERN through the LHC Computing Grid. The computing centre of Lyon will play a central role for the processing in France.

The DSM/DAPNIA and the IN2P3 contribute

actively to animation on the European level of the scientific applications of the computing grid, which combines several tens of thousands of computers from 2005.

Objective 1 : Reinforce the calculation resources of the computing centre IN2P3/ DAPNIA of Lyon within the framework of the LHC Computing Grid project for the data processing of the four LHC experiments.

Objective 2 : Relay this action at the regional or inter-regional level by the creation of computation poles inserted in the grid.

Objective 3 : Diffuse through other scientific communities the experience gained in the grid technologies for massive data processing.

POLICY IN THE FIELD OF THE ACCELERATORS, INSTRUMENTATION

TThe accelerators are essential tools for the scientific development of nuclear and high energy physics. A strong R&D activity (which can be followed by a construction phase) exists within the DSM and the IN2P3. It aims to answer the needs expressed through the evolutions of our scientific fields.

Figure 1 : *Various parts of the XFEL TTF3 couplers which could be used for the ILC linear collider, including warm and cold assemblies, ceramic windows, wave-guide transitions and bellows.*

In addition, several future scientific programmes require the development (as far as possible in partnership with industry) of new detection techniques ensuring state-of-the-art performances in spatial and temporal resolution, increased integration, increasing complexity and controlled cost (CMOS detectors, micropattern detectors, bolometric detectors, developments in micro-electronics...).

Objective 1 : Continue the R & D on the high gradient superconducting accelerating cavities and the power couplers (ILC, EURISOL), together with intense protons sources and intense heavy ions sources (> 1mA).

Objective 2 : Take part with the CERN in the R&D on CLIC in preparation of a 5 TeV e+ e- linear collider at CERN around 2020.

Objective 3 : Build a high intensity proton injector for CERN (IPHI, 3 MeV, 100 mA, around 2007) in order to increase the intensity of the machines at CERN (LINAC4 project, 160 MeV- 10 mA) and be prepared for intense neutrinos beams or radioactive heavy ions beams (SPL project) at CERN,

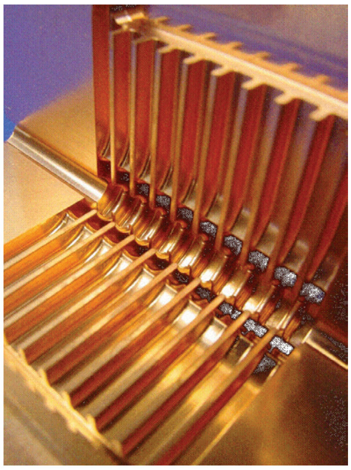

Figure 2 : *CLIC, a new concept of accelerator.*

possibly coupled with EURISOL (beta beams, around 2015-2020). These developments can also be applied to the transmutation of radioactive waste HAVL with hybrid reactors (the "reliability" aspect is essential in this application and will be tested before the sending of the IPHI injector at CERN).

Objective 4 : Continue innovating technical R&D in acceleration technique, in particular laser driven accelerators.

Objective 5 : Research on innovating detection technologies.

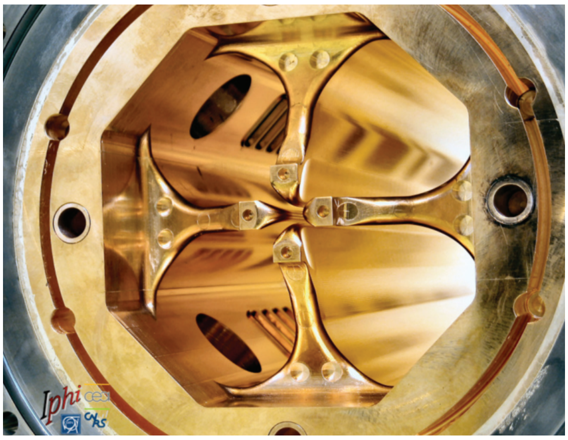

Figure 3: *IPHI injector*

FRENCH SCIENTIFIC PROGRAMMES AND EUROPEAN COOPERATIONS

The research and development activity on the accelerators proceeds on a European scale, and it answers the challenges of precision and gain in energy of the future linear collider, as well as the needs for the accelerators of very high intensity protons studied for the production of intense beams of radioactive nuclei, neutrons or neutrinos. The majority of these instruments use superconducting cavities where very diversified expertises meet. The DSM/Dapnia and the IN2P3 play an important part in these various projects : I3 CARE (cavities, injectors), EUROTEV (generic developments for ILC, CLIC) IP EUROTRANS (waste transmutation), EURISOL Design study of heavy ion and intense proton beams, as well as many bilateral agreements (DESY/TESLA for the FEL, FAIR-GSI, GANIL-Legnaro, for the ions).

CERN is the reference institution for particle physics in Europe, but its role is now worldwide. Coordination of the infrastructure and programmes at the European level has been put in place for nuclear physics (NUPECC : Nuclear Physics European Coordination Committee), and for astroparticles (ApPEC : Astroparticle Physics Coordination). Under the aegis of these committees, three initiatives of integrated infrastructures (13) were approved by the European Commission for the 6th framework programme : EURONS (Nuclear Structure), I3HP (Hadronic Physics) for nuclear physics and ILIAS for astroparticles.

To facilitate the interdisciplinary collaboration, a research grouping on the Cosmic Phenomena of High Energy (PCHE), a research grouping on the neutrinos, a National Programme of Astroparticles, a National Programme of Cosmology and a programme on the electro-nuclear cycle PACE, have been created. A nuclear astrophysics group is also in gestation as well as a research grouping on neutrinos.

OUTREACH

Interdisciplinarity

The core of our technical activity remains the support for projects which aim to understand the Universe at small distances, and also, from now, on at cosmological distances. This implies the realisation of new and complex detectors, which is only possible thanks to the proficiency of the teams which contribute to the design and the construction of the equipment, where their interventions relate to all aspects : accelerators, detectors, mechanics, electronics, computing.

These competences are used in multidisciplinary activities which are based on the implementation of the instrumental techniques of nuclear and particle physics, in order to approach diversified scientific fields: materials, aggregates, chemistry, life sciences, medicine (proton- and hadron-therapy), environment.

Objective 1 : Contribute to the next generation of FEL (most probably in partnership with DESY) and to the R and D on the cold technology of the e+ e- linear collider (TESLA)

Objective 2 : Contribute to the realisation of proton- and hadron-therapy centres.

Objective 3 : Develop innovating imaging techniques in biology and medicine.

Objective 4 : Contribute to emergence in France, of multidisciplinary platforms based on ions beams for the irradiation and the modification of materials coupled with electron microscopes techniques or imaging systems.

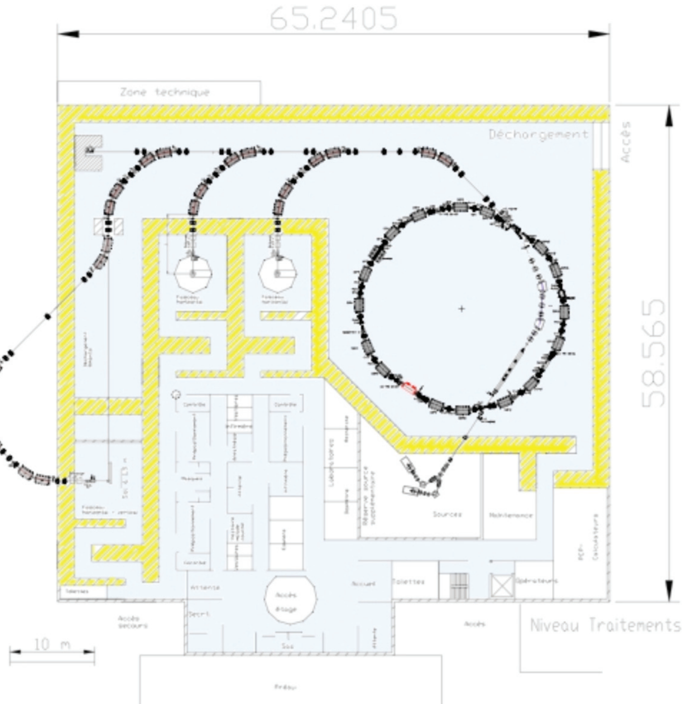

Figure 1 : *Project of implantation of hadron-therapy ETOILE project in Lyon.*

Education

Education must remain a top priority of the IN2P3 and the DAPNIA, and this, as well for the future of our laboratories, so as to ensure the general training of the students in science students.

This training is integrated within the general framework of physics and of modern instrumentation. We have to enable more research for the teacher-researchers on one side and in addition increase the number of students.

Objective 1 : Share the tasks of teaching, on the basis of competences and on voluntary participation, between all the members of our laboratories.

Objective 2 : Vigorously follow a policy of opening and exchange between universities so that the bases of our disciplines are taught in all French universities, along side the bases of the other disciplines.

Objective 3 : Continue to develop training courses (example of Janus) attracting students towards science and in particular towards our disciplines.

Objective 4 : Maintain the institutes' Web sites so that students find there all up to date information allowing them to choose effectively their scientific future.

Communication with the society

Communication with the society of our results, of our contribution to knowledge and culture is a fundamental objective. Sharing with the citizens our questions, our enthusiasm and our amazement with the scientific progress of our fields must be in the foreground of our mission. If we succeed in sharing this passion with youth and implant our thirst of knowledge, we would make a large influence on the society.