CERN Physics Department international projects in particle detectors technology: adapting the strategy

Mar CAPEANS

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As always, my work is dedicated to my daughter Lara.

Geneva, 1st December of 2006

OUTLINE

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Glossary of Acronyms

CC	Consulting Company
CERN	Centre Européen pour la Recherche Nucléaire, European Laboratory for Particle Physics
CERN-PH	CERN Physics Department
CERN-TT	CERN Technology Transfer Group
CIP	Competitiveness and Innovation Programme
CLIC	Compact Linear Collider
FP5, 6, 7	Framework Programme 5, 6, 7
ERA	European Research Area
ERC	European Research Council
ESFRI	European Strategy Forum on Research Infrastructures
ESGARD	European Steering Group on Accelerator R&D
ESGID	European Steering Group for Detector Instrumentation
EST	Marie Curie Early Stage Training Actions
EC	European Commission
ECFA	European Committee for Future Accelerators
EU	European Union
GDP	Gross Domestic Product
ICT	Information & Communications Technologies
ILC	International Linear Collider
LHC	Large Hadron Collider
NoE	Network of Excellence
PH	Physics
R&D	Research and Development
SG	Steering Group
SME	Small and Medium-sized Enterprise
TT	Technology Transfer
WP	Work Package

1 Executive Summary

This study addresses how the CERN Physics Department (CERN-PH) can most effectively initiate and develop research projects within the European Union (EU) Seventh Framework Programme (FP7). It considers how the CERN-PH human resources, technological knowledge and specific experience can be used and developed in such projects and how such projects can be exploited as part of CERN's future plans. While CERN and the particle physics community in Europe have important activities in FP6, CERN-PH has only succeeded using these programs in certain areas, training being the most prominent, and furthermore quite often not as part of the main research lines of the Department. **This study will address how CERN-PH can improve the situation.**

To address this problem the study starts by identifying scientific or structural overlaps between the activities of CERN-PH and the FP7 funding programmes. These overlaps are related to certain technical areas, to training, or to projects involving a large European Research Community for new experimental facilities and also to projects with industrial partners. Constraints, benefits and risks of involvement in such projects are reviewed and the experiences from applications to and participation in the previous Framework Programmes are summarized. On the basis of the above analysis the report highlights those FP7 programmes that could be a possible future focus through several case studies, and finally identifies the key aspects that could help in implementing a strategy for successful submissions. The approach suggested for CERN-PH's involvement in FP7 can be generalized to other research European institutions, but CERN has some specific features that need to be taken into account.

As a result of these studies, the project report is concluded by summarizing a set of concrete recommendations for how CERN-PH should approach the FP7 programs and which FP7 programs are most suited.

Overlap (technology, CERN's European user community, training, facilities, industrial partners): CERN's main missions are research in basic physics involving development of the instrumentation needed for its research programme, training of students, physicists and technical personnel, and finally outreach and dissemination to the public. Some of the key technologies are superconductive systems, materials and surfaces science, imaging systems for radiation detector and information technologies covering from hardware to software. CERN-PH is the largest Department at CERN with about 750 staff members, associates and students and around 7000 external users (physicists, students, technical personnel) from all over the world but in particular the 20 European member states, that carry out research in their home institutions for experiments at CERN and visit CERN regularly. Both CERN-PH and CERN's user community work actively with a very large network of industrial partners for the development of the technologies needed for the CERN projects, and in particular of large detector systems. Relevant for this discussion is that the CERN Council has recently prepared a Strategy for European Particle Physics where new infrastructure/facilities were identified: upgrades of the Large Hadron Collider (LHC) machine and detectors at CERN, R&D for a novel linear e^-e^+ collider (CLIC), participation in the International Linear Collider (ILC), and a global neutrino programme. All these projects require very substantial accelerator and detector R&D, and the CERN organisation is central for implementing this strategy. A model of how this type of R&D can be coordinated and implemented at European level and using FP7 is the European Steering Group for Accelerator Development (ESGARD) that has organized several successful FP6 bids within accelerator R&D, involving CERN in central roles. For CERN-PH specifically is it crucial that also R&D for detector systems for these facilities is included in FP7 calls.

The four FP7 programmes cover COOPERATION (projects related to certain technological areas), IDEAS (new researcher-based projects), PEOPLE (training) and CAPACITIES (new Research Infrastructures being the most interesting funding instrument). Specific thematic areas are identified, with Medicine, Security, Materials and Information Technology as the most relevant for CERN. Industry participation is considered a priority in FP7. Concerning future European facilities (infrastructures) in the field of Particle Physics the European Strategy for Particle Physics is currently accepted as a guideline for such priorities. In all four programmes there are therefore potentially important overlaps between future CERN-PH activities and research foreseen to be supported by FP7.

<u>Constraints, benefits and risks:</u> Even though there are several potential common areas, certain constrains have to be respected. First, particle physics is not a direct priority in the EU research plans. Second, it is CERN's policy to only participate in EU co-funded projects when they involve activities that are well aligned with the future plans of the organization. Therefore the EU projects have to be carefully designed to focus on specific areas related to future plans for the organization, on training, or strategic areas related to technology transfer and industrial collaboration in areas central for the future development of particle physics detector systems. While adjusting an organization's scientific profile to EU programs might be a possibility for many research organizations, CERN has to maintain its scientific focus as defined by its steering and primary funding bodies, and look for FP7 areas where its expertise can be used, strengthened and additional public funding is justified.

The benefits can nevertheless be very significant; in addition to the obvious advantage of being able to carry out research and training activities, certain programs can greatly improve the contact and exchange between CERN researchers, the user community and industrial partners. The latter can in the long-term enhance technology transfer and spin offs significantly through industries, researchers and students (2/3 of the students in particle physics end up outside particle physics), possible making room for new projects with scopes also outside pure particle physics. The projects can also help to implement a common strategy for the future as described in the European Strategy for Particle Physics. Overall it is therefore important to measure the benefits across all three CERN's missions (research, training, outreach) and include the network of users and industries in the equations.

There are also other risks; the EU funding periods are short and are generally not extended. The EU strictly defines the organizational rules of co-funded projects and this may condition how the research activities have to be carried out and their deliverables. This translates into an important lack of flexibility for the research objectives and number of partners involved in the projects. The management and administrative overhead is also rigorously implemented and significant, beyond what is normal in standard CERN R&D projects.

<u>Experiences and case studies:</u> The current FP6 programmes involving CERN overall are related to IT (GRID), accelerator R&D and training, the latter being the most relevant for CERN-PH. In addition CERN participates in a number of projects where the overall goals are partly outside CERN's core activities, but where CERN delivers key competences within specific work packages. Typical examples would be within medical projects where CERN focuses on medical instrumentation or imaging. Several large initiatives for FP6 were not successful in their bids. Failures of proposed projects on basic science tend to be

lack of focus, too large number of partners, not clearly identified deliverables or project management weaknesses. It seems that most projects proposed by CERN have a fairly high technical standard and tend to pass the initial thresholds set by EU, but some fail in the final rounds when other more subtle parameters are judged such as ethical and gender issues, the Competition Law, the capacity to promote results beyond the consortium and to engage with the public (awareness of science) and involving industrial partners in the projects. Concerning involving industrial partners the study finds out that despite the existing 'basic science culture' at CERN, industrial partners have demonstrated to be beneficial for CERN R&D projects, and obviously also in construction projects when leaving the R&D phase. While CERN-PH resources in the FP6 phases were tied up in preparing the LHC project, R&D for LHC upgrades can now become part of EU new facility programmes provided coherent bids are made involving the user community. In the field of accelerator R&D, ESGARD has proven this is possible already in FP6.

Understanding the past experience can be used to better define and propose new projects. Two clear directions must be fully exploited to be able to successfully bid in FP7: CERN has the ability to involve a large part of its European user community in bids related to new European infrastructures, avoiding to compete with its own user community and second, the projects (of all types) must consider involving industrial partners, even more a priority in FP7 than in FP6. Furthermore, projects related to training or co-operation for specific technology development must be continued.

Case studies of training programs, cooperative projects with industry and R&D projects highlight the benefits and difficulties of working within FP6 or 7 (as described above), the EU programmes that can be considered and their limitations (see summary in recommendations), and organization and implementation issues.

Implementation: CERN has a CERN-EU office to coordinate the relations between CERN and the institutions of the European Union. The resources in this office are limited and given the above considerations consulting companies seems highly advisable, as they help not only to define and tune the project at the proposal phase, but they also take the administrative management for the projects when they are approved, usually acting as partners (EU funds for administrative tasks is for them, no significant cost for the host organization). These companies usually also have very good contacts to the FP7 and EU officials, and can actively help to identify industrial or institutional partners for projects. On the other hand, it seems however difficult to find companies that can assist identifying CERN technologies and technical research areas that are suitable for a specific EU programme. CERN also has a Technology Transfer (TT) activity, which is significant, and it seems advisable that CERN-TT group is formally more involved in the EU application process. As a means to increase the contacts between industries, researchers and CERN a CERN School of Technology can be an efficient measure, not only for CERN-PH but also other Departments. A more general approach to external funding is also needed since in collaborative efforts with industry EU funding is one out of several possibilities.

Generalize (to any research institute): This study and report can be generalized to any research institute with a similar basic science profile to CERN. The issues related to focus on basis science, a user community and industrial partners, and the approach of identifying common areas and involving external expertise are generally applicable to such organizations. Some of CERN's obvious strengths and particularities, as a large user community and a wide network of industrial partners at a European scale, have not been exploited fully in EU bids and it in particular for CERN-PH it is important to focus on these two aspects for FP7, beyond an already successful training activity.

Summary of Recommendations:

Organizational:

1) Restructuring the role of the EU office (from advisor to active role), helped when needed by external, private institutions specialized in EU funding for initiation, planning, reporting and administration of projects.
2) Get the CERN Technology Transfer (TT) group actively involved in the selection of technologies, giving TT a pro-active role in specific work packages of CERN-EU co-funded projects.
3) R&D at CERN can be boosted by collaboration with industry in general. Establish a central office that would get all proposals and direct projects to the best funding opportunity (industry, private investors, EU, etc.). This must be done building on the existing CERN-TT and CERN-EU offices to ensure coherence.

Interactions with user community and industries:

4) It is advisable to reorganize the interactions of CERN-PH with its user community to be able to launch successful FP7 projects related to **Research Infrastructures** in particular, focusing on detector development for new facilities. The model established by ESGARD can be used, but the best representatives of European Particle Physics concerning detector construction are the main experiments planned for these facilities, as opposed to the laboratory representatives in ESGARD.
5) A key factor in FP7, seen across all its work programmes, is the effort of the Commission to involve European industry in the definition of the research themes, and the rather explicit requests to involve industrial partners in project proposals. A CERN School of Technology is proposed as a specific measure to do this, in addition to involving CERN-TT and external consultants more as mentioned in recommendations 1, 2 and 3.

Practical recommendations

6) The timeline of EU projects is very strict. When the funding is terminated after 2-5 years, the project is over and deliverables have to materialize. Therefore it is advisable to apply for funds for mature projects, and/or to be used to enlarge scope of projects.
7) Experts in the different research fields of CERN-PH should be encouraged to sign up as referees (expert evaluator) for the EU. The expertise that is gained in the evaluation procedures become key for writing good proposals.

Recommendations per FP7 programme:

8) For CERN-PH the continuation and development of the Marie Curie Actions (**PEOPLE**) is important and have a high likelihood for success.
9) Projects within **COOPERATION** are interesting when looking at the wider scope of CERN's missions including training, spin offs and outreach. These projects have a tendency to stay outside CERN's main research lines as they are linked to main thematic lines of FP7, out of which Health, Security, Materials and Information Technology might offer possibilities for CERN-PH. The industrial links must be fully exploited.
10) The programme **IDEAS** awards grants on the basis on scientific excellence no matter the proposed research. CERN must attempt to identify young researchers (2 to 8 years of post-doctoral experience) who can apply for this type of support, with adequate backing, and innovative projects.
11) **CAPACITIES** have so far allowed the most directly useful funding instrument for European Particle Physics, either with accelerator physics, GRID developments or detector R&D. However CERN-PH has not been central in any of them. Given the development with respect to a European Strategy for Particle Physics where R&D for certain facilities are identified, one of the main priorities for CERN-PH is to work with its user community and industrial partners to plan good projects related to these facilities, focusing on detector R&D for them.

2 Introduction

2.1 Objectives

The European Organization for Nuclear Research (CERN) is the world's largest particle physics centre. It sits astride the Franco-Swiss border near Geneva. CERN employs about 2000 people of a wide range of skills - physicists, engineers, technicians, craftsmen, administrators, etc. Some 7000 visiting scientists, half of the world's particle physicists, come to CERN for their research. They represent 500 universities and over 85 nationalities.

CERN is now completing the construction of the Large Hadron Collider (LHC) [1]. This new particle accelerator, due to switch on at the end of 2007, will be the world's largest and most complex scientific instrument, probing deeper into matter than ever before. Research at CERN pushes technology to its limits, bringing also important benefits at other levels: education, spin-offs (the World Wide Web for example), knowledge transfer, investment (a substantial fraction of CERN's budget is spent on hardware produced by European industry) and international relations (particle experiments are only possible with a truly remarkable international collaborative effort).

CERN has participated successfully in about a hundred EU co-funded projects under the 5th and the 6th Framework Programmes for Research and Technological Development (FP5 and FP6). Most projects are not aligned with CERN's core business, basic research in Particle Physics, but rather on projects where CERN and EC interest's coincide, such as Outreach, Information & Communications Technologies (ICT) and other scientific disciplines relevant to European industry, such as accelerator technology. The Physics Department (CERN-PH) is the biggest unit at CERN, and plays a leading role in the construction and running of experiments, with strong groups developing detector technologies including mechanics, electronics, and technical computing. The number of EU-CERN co-funded projects hosted by CERN-PH is negligible. In view of the upcoming Framework programme FP7 for the 2007-2013 period, the Physics Department aims at finding ways to promote its key activities within general instrumentation, sensor and IT-technology for future submissions to the EU.

This report aims at assessing the capacity of the organization to get involved in EU projects, in terms of human resources and knowledge and experience, as well as reviewing the risks and benefits of such involvement. The project will also highlight those EU programmes which could be a possible focus for the Physics Department, as well as identifying key aspects that could help in the development of the strategy. This will be done reaching the following objectives:

a) An overview of the upcoming EU programmes for Research and Technological Development (FP7) and for Competitiveness and Innovation (CIP), with emphasis on key elements that could be related to the core activities in the CERN-PH department.

b) The analysis of CERN's position as an international research organization specialized in particle physics and accelerators with respect to the EU framework programmes and defined research domains.
c) A summary of the PH involvement in EU-projects so far, analyzing successes and failures.
d) A comparative case study between R&D projects carried out at CERN with and without EU funds, in order to extract the advantages and disadvantages of both funding schemes.
e) A list of recommendations for future submissions referring to the context, partners, technology areas and effectiveness of such proposals with respect to the main aims of the CERN-PH department, so that to ensure that the PH Department is well-placed to make successful proposals under the new competitive environment. A longer strategy is also presented for further discussion.

2.2 Methodology

The work in this report has been carried out at CERN, the European Laboratory for Particle Physics, located in Geneva, Switzerland, during the period 4/9 to 4/12 of 2006, in the framework of the Internship Project for the **Executive MBA in Management of Technology** (EPFL & UNIL, Lausanne).

The key question is the understanding of the upcoming funding opportunities for research supported by the European Union (Seventh Framework Programme, FP7) in order to position properly projects within the expertise of CERN Physics Department in future bids. Given the extensive experience already accumulated at CERN in previous Framework Programmes, it has been possible to use qualitative and quantitative methods, including desk and field research, case studies and the analysis of existing data, in order to be able to formulate a set of recommendations.

In order to collect the maximum amount information and to get an accurate view of the EU programmes, desk research has been carried out exploring the EU information sources[1] (mostly available in Internet), reading the existing documentation prepared by the CERN - EU relations office and specific documentation on the vast amount of CERN - EU co-funded projects. The author has actively participated in the meetings of the CERN - Marie Curie Steering Group, the 3-day visit of EU officials of the Marie Curie programme to CERN, and attended specialized Seminars and Workshops:

- Information Seminar on *ICT and Mobility in FP7*, by Euresearch, CERN, Geneva, 5/10/2006.
- Seminar *Premiers appels Marie Curie et ERC du 7e PCRD*, Euresearch Genève, UniMail, Geneva, 18/10/2006.
- Workshop "Getting Ready for FP7 & How to Write an Excellent FP7 Proposal" by Dr. Sean McCarthy, Managing Director of HYPERION, Bern 17/10/2006.

The fieldwork consisted of face-to-face interviews, informal and/or structured conversations with an important amount of people that have been involved in setting up and running EU co-funded projects at CERN. This group consists of a adequate representation of CERN population: CERN-PH Management, technical, scientific and administrative staff running EU projects, researchers from different fields of expertise, staff from the Human Resources Department, Audit Department representatives and Marie Curie Fellows. Such meetings permitted to make a comparison between the information

[1] At the time when this project has been carried out, the FP7 Work Programmes exist only in draft versions. The final documents are expected to be published by the end of December 2006.

that is provided by the EU and the reality behind it, as well as a correct view of how EU projects are run at CERN and potential improvements as recommended by the real players.

We have carried out structured face-to-face and repeated phone interviews with private organizations specialized in management of European projects, in order to asses their capacity to help CERN-PH in future submissions.

To gain understanding of the different type of research projects, with or without EU funding, several case studies have been carried out involving an in-depth examination of single and multiple events, i.e., particular types of research projects. The cases collect existing data through interviews and desk research, analyze the information, and report the results, which are used thereafter to formulate strategies and recommendations.

This report is supported by the CERN-EU Office, whose mission is to provide policy advice, as well as administrative and technical support on EU matters to the Directorate of CERN.

3 CERN & EU funding

3.1 Research at CERN

CERN was founded in 1954 as one of Europe's first joint ventures with the mission of serving science in conceiving, building and operating new research instruments. These are large particle accelerators, which provide particle beams to teams of physicists from all over the world that group in experiments to study the inner workings of the basic constituents of matter and the origin of our Universe. Since its foundation, CERN's membership has grown from 12 to 20 European states, each contributing to the CERN's budget in proportion to its national income. CERN's annual budget expenditure (~1'350 MCHF in 2005) pays for the provision and maintenance of the accelerators and facilities used by the research community and the salaries of the CERN staff required to operate these. Today, additional nations from around the globe also contribute to and participate in CERN's research programme.

The instruments used at CERN are particle accelerators and detectors [2]. Accelerators boost beams of particles to high energies before they are made to collide with each other or with stationary targets. Detectors observe and record the results of these collisions. While CERN builds the accelerators, detectors are built and operated by CERN and above all by physicists from universities and research institutes in the Member States and other countries. The largest of those experiments in preparation for the LHC are ATLAS [3] and CMS [4]; they stand as high as a six-storey office block and are being built by teams of around 2000 scientists. Altogether, CERN's research programme involves some 7000 researchers from over 500 institutes in 85 countries.

As a novelty of 6th Framework Programme, the rules of participation defined that "International European Interest Organizations" could participate in FP6 actions on the same basis as any national body, and CERN is one such organization. On that basis CERN participates in a wide range of EU financed projects; there are about 30 active projects at any instant [5]. Most are not aligned with CERN's core business but rather on projects where CERN and EC interest's coincide, such as Outreach and projects on Information & Communications Technologies (ICT) relevant to other scientific disciplines and to European industry. The type of EU projects (also called funding instruments) are diverse, covering Networks, Training actions, Integrated Infrastructure Projects, etc. The overall success rate of proposals from CERN is about 40-45%, significantly higher than the figures published by the EU (numbers would depend on the type of project, but typical success rates are below 20%). Most of those projects are very well aligned with the research priorities defined by the EU, and vice versa, i.e., CERN only participates in EU co-funded projects when they involve activities that are well aligned with the future plans and scientific goals of the organization. An important reason for this is that normally the EU works on the basis of co-funding; therefore it is generally assumed that the project partners will be making considerable contributions to the activities from their own resources. A second factor is that the administration of EU projects is quite complex and the administrative procedures differ considerably from CERN's own procedures. Most important, the scientific priorities of the programme at CERN should not be controlled by the availability of possible additional resources from the European Commission.

A new development is that the CERN Council has recently prepared a Strategy for European Particle Physics [6]. The strategy addresses the main lines of Particle Physics in Europe, accelerator-based and non-accelerator based, including R&D for novel accelerator and detector technologies. Among the most important recommendations are:

- CERN Council should take a leading role in defining and updating a European Strategy for Particle Physics, and take a leading in role in defining the European responsibilities in future global projects.
- The EU relations are to be strengthened and the relations to European Industry likewise.
- Among the scientific cases given priority are: upgrades of the LHC machine and detectors at CERN [7], R&D for novel linear e-e+ colliders (CLIC) [8] and developments towards the International Linear Collider (ILC) [9], and a global neutrino programme [10]. All these projects require very substantial accelerator and detector R&D.

There is therefore a clear wish, and an opportunity for CERN, to have CERN taking an even more leading role in future accelerator and detector R&D, also beyond its current programme, and to work actively to create a European coordination of such developments, including national laboratories, universities and industrial partners. Some of these activities can be carried out as parts of the 7th Framework Programme.

A model for how European Particle Physics can make progress in developing their main instruments as detailed in their Strategy Document, is already implemented for European accelerator R&D, with a specific steering group called ESGARD, European Steering Group on Accelerator R&D [11]. The mandate of ESGARD is to develop a proposal to optimize and enhance the outcome of the Research and Technical Development in the field of accelerator physics in Europe by promoting coordination and coherence, efficient uses of resources and infrastructures, and promoting inter-disciplinary collaborations involving industry. ESGARD prepared and conducted a coherent set of bids to apply for EU funding in the 6th Framework Programme. ESGARD is composed of one representative from each laboratory promoting the initiative (CCLRC, CERN, DAPNIA/CEA, DESY, LNF, Orsay/IN2P3, and PSI).

Two Contact Groups issued from ESGARD have been set up to bidding preparation, one of electron-positron linear colliders and one on super proton accelerators and neutrino beams. These Contact Groups have created Working Groups with the people of the community involved in the relevant activities. They also maintain close contact with existing committees, boards and teams. The mandate of the Contact Groups is to act as liaison between community and ESGARD, develop proposals for FP6 and identify the programs and funding instruments that are suitable, and finally organise the community and propose names for coordinators.

The result of the ESGARD initiative is that several FR6 projects co-funded by the European Union have been launched, with all the European laboratories and universities involved in accelerator physics as participants. The work, which started in 2004 and will last three to five years, includes integrated projects and design studies. CERN's participation is a clear strategic need, even if the available resources that can be contributed are very limited. This programme of cooperation includes contributions to CARE (Coordinated Accelerator Research in Europe) and to design studies, mainly EUROTEV (generic issues for the design of a lepton linear collider), DIRAC (Darmstadt Ion Research and Antiproton Centre) and EURISOL (acceleration and storage of radioactive nuclei, and neutrino source from the decay of some of the latter).

To address the main priorities in the Strategy Document [6] CERN has recently proposed the introduction of some targeted R&D activities, whose funding requires additional resources for the period 2008-2010. Some of those activities can possibly attract collaboration from other laboratories and CERN and also financial support for some proposed actions from the European Commission through FP7. CERN management estimates that external contributions over the period 2008-2010 could amount for 10% of the total resources needs (material and personnel), i.e. 190 MCHF and 570 FTE [12]. The realism of this will depend on the detailed implementation of FP7 and that accelerator and detector R&D can be included in successful bids for future EU projects.

The CERN General Director has set up a CERN-EU office to coordinate the relations between CERN and the institutions of the European Union, in particular the European Commission. Its mission involves the understanding of all programmes of the EU, insofar as they are directly relevant for the activities of CERN. Within this framework the CERN-EU office has been involved setting up collaborative projects, making that understanding available to CERN staff, and better integrating the handling of EU projects and contracts into standard CERN administrative procedures. This coordinated approach and permanent representation towards the EC is effective in the two directions: it provides lobbying in Brussels, a key factor for increasing the success of proposals, and it supports CERN staff in the application process. A comprehensive summary of the CERN-EU office's mission and aspects of participation of CERN in EU programmes can be found elsewhere [13].

A mixture of strategic decisions and the will of some individuals have driven the involvement of CERN groups in EU projects. In all cases, as soon as any project involving EC co-funding starts to be considered, both the CERN-EU office and the normal departmental hierarchy should be informed. This is because any decision about whether to participate in an EU proposal is a management decision, since it implies a commitment of CERN resources to work on a project which had not, until then, been foreseen in the laboratory's agreed programme. Such decisions are taken by the Directorate, following a proposal from the head(s) of department(s) concerned, and taking into account advice from the CERN-EU office which is responsible for the relationship between CERN and the EU institutions. Thus it is essential that both the normal CERN management hierarchy (section leader, group leader and head of department) and the CERN-EU office are informed about the proposal at the earliest possible moment, and, if approved, are then kept informed of future developments.

3.2 CERN Physics Department

CERN organization is designed for the very specific needs of a scientific community. The Director General, appointed by the Council, manages CERN and is authorized to act in its name. He is assisted by a Directorate Unit and runs the Laboratory through a structure of Departments. The Physics Department (CERN-PH) carries out basic research in the field of experimental and theoretical particle physics. It plays a leading role in the construction and running of experiments and in the physics analysis, at the same time ensuring the support of the collaborations in the domains of detector technologies. Fields of expertise include microelectronics and electronics, acquisition and control developments for Physics Experiments, technical computing (simulation and analysis toolkits), detector development, and last but not least, theoretical physics.

The Physics Department accounts for a quarter of all CERN staff members and for about 7300 visiting scientists. Table 3-1 shows the figures as of August 2006.

CATEGORY	Number
Staff Members	536
Fellows (PhD level)	133
Paid Scientific Associates	35
Technical and Doctoral Students	51
Users	7299

Table 3-1 Scientific personnel in the CERN-PH Department.

The involvement of CERN-PH in EU projects has been minor for large collaborative projects (presently CERN-PH acts as partner in *EUDET: Detector R&D towards the International Linear Collider,* a project supported by the European Union in the Sixth Framework Programme structuring the European Research Area), but very successful in Training actions. CERN's large international collaborations provide a valuable environment for educating and training young people, in particle physics, applied technologies, IT and also in engineering of many kinds. The effort to present high quality training projects in FP6, in particular for the Marie Curie Early Stage Research Training scheme, was coordinated CERN-wide. The Laboratory was selected Marie Curie Host and a CERN - Marie Curie Steering Group was set up in December 2002 with members from all sectors of CERN. The group prepared a total of 24 proposals (for 3 calls) of which 6 were accepted (3 in the Physics Department). Section 5.1 analyzes the lessons extracted from that effort.

To be able to see the full potential of CERN's future involvement in FP7 EU programs one has to look wider than the CERN staff. The large majority of Particle Physics Researchers in Europe, including industries developing components for CERN experiments, are linked to the CERN user community, and EU programs with the involvement of CERN will have higher chance to succeed and have a larger positive impact if it includes a significant fraction of the CERN user community, such that local activities are supported across Europe.

CERN has a unique and large user community. More than 7000 researchers are registered as CERN users, meaning that they participate in the scientific programme of the organization and/or use the facilities one way or another. This user community consists of physicists and students from all over the world, contributing to the CERN programmes from technical subjects related to detector development and operation, to physics simulation, analysis and theoretical modeling. Users participate in the projects at CERN in a number of ways; typically outside research groups build parts of the instrumentation needed for the CERN experiments, they participate in integrating, installation and commissioning of the equipment, they operate the equipment staying at CERN in shorter periods, and participate in data analysis and simulations work, using local resources at their home institutes. Around 30% of the CERN users are students, playing important roles in the scientific activities of a scientific collaboration during their thesis work. The user community therefore spreads through external researchers to their local industries and collaborating researchers at their home institutes, typical examples would information technology groups, electronics or engineering groups.

Roughly 2000 of the CERN users are typically at CERN, either for short visits or for longer stays linked to their research activities. Many of the CERN users have at some point in their career spend some time at CERN, usually linked to recruitment programs as the 2-year Fellowship programme, as Associates at CERN, or following the Student programmes. Typically 2/3 of the students in particle physics leave the field and move into related research and careers, using the acquired skills within instrumentation, modeling, computing, statistic analysis, etc in a completely different setting.

The users from the CERN member states are actively using the EU programs to built networks allowing them to carry out research related to CERN activities, but usually linked to collaborating with other CERN user groups for specific developments. CERN might or might not be associated these EU programs, and will in some cases compete with these applications formed by the CERN user community.

On that basis, there are some good reasons to try to attract EU funding for detector R&D projects hosted by the CERN-PH Department. This could be done in similar way and using similar programs and funding instruments as done by ESGARD for accelerator R&D. One major difference is that the European Detector Development community is wide spread and distributed; quite different compared the accelerator community, such that any steering body must have a quite composition and be based on the major future detector communities. The LHC project is due to switch on at the end of 2007, when a long period of data taking and physics analysis will start. While the contribution of CERN-PH to the maintenance, operation and physics analysis in LHC remains a central activity and will use most available resources; the Department needs to prepare for future detector and experiments at the new accelerator facilities. Strategically it is also important to maintain and develop the department's expertise within instrumentation and technology development in a wide sense. Upcoming research & development at CERN will be focused on the LHC upgrade programme, but as the European Particle Physics Strategy Document outlines also CLIC, ILC and Neutrino facilities are interesting and priorities. Therefore the main challenge of the CERN-PH is, together with its user communities and industries, to formulate strong proposals for Detector R&D for future facilities, and make every effort to ensure that these activities are included in FP7 funding instruments.

Concerning LHC a major luminosity upgrade of the accelerator and its detectors by around 2015, motivated by physics results and operation experience, will be enabled by focused accelerator and detector R&D. As a counterpart of this, fields of expertise that are not foreseen for future LHC upgrades are likely to be under-funded. There is an important risk of loosing valuable technical knowledge where CERN-PH is world leading. An obvious example is gas detection technology for high-rate tracking, a technology not foreseen at this moment for future LHC upgrades, but of extreme potential for the future linear colliders, and industrial and medical applications [14]. As a consequence CERN should aim to participate also in these R&D developments, in the areas where there is key competences.

In addition, in the field of training, there is the opportunity of profiting from CERN-PH ongoing core activities to train young researches and support human mobility taking advantage of the inherent international dimension of the research carried out at CERN. This has been successful in FP6 and the goal must be to be to extend this in FP7. A new programme called IDEAS, could also provide new opportunities for young CERN researchers within selected fields. This is discussed in chapters 4-6.

EU funds would also represent additional funding for projects that can benefit society and European industry, supporting the transfer of knowledge and technology, an integral part of CERN's principal mission of fundamental research. As will be discussed later such projects can be very interesting but they tend to stray outside CERN's core programme and have less direct impact than the research infrastructure and training projects mentioned above, but they can have very important impact and spin offs indirectly.

4 EU Funding Programmes

Since 1984, Framework Programmes (FP) are the EU main instruments for R&D funding, and are the world's largest publicly-funded research and technological development programmes. In short, they are multi-year plans outlining those areas of research in which the EU intends to invest. Framework Programmes are implemented through specific funding streams and mechanisms proposed by the European Commission in agreement with the European Council (where the national governments are represented by their ministers of research and industry) and Parliament. A number of non-framework Programmes also exist, with most offering grants, networking opportunities or both.

This chapter makes a fast run over recent Framework Programmes, highlighting their major differences and giving an overview of existing possibilities in FP7 and how they work. The information has been collected from a multitude of sources and then analyzed and compiled. It is intended to facilitate the reader the understanding of the following chapters and not a reference guide to the framework programmes. Detailed information is to be found elsewhere [15]. FP7, and in particular the FP7 schemes that may be more relevant to potential CERN-PH projects, are further explained in the case studies presented in Chapter 5.

4.1 Framework Programmes

For clarity, the following naming conventions will be used when discussing EU funding:

- Programme refers to EU funding possibilities with well-defined objectives (such as to fund projects on specific research topics, or actions for researchers, or to fund research infrastructures, etc.)
- Instrument refers to the structure that specifies how the work is to be organized, i.e., a type of project or action set up following EU rules. They are Networks of Excellence, Collaborative Projects, Coordination & Support Actions, etc.

FP5 covered the period 1998-2002, with a total budget of €13.7 billion and €1.26 billion to fund and promote nuclear energy research within the European Atomic Energy Community (Euratom). This represents an increase, in absolute terms, of 4.61% compared to the Fourth Framework Programme. FP5 was conceived to respond to major socio-economic challenges faced by the European Union, reflecting the major concerns of increasing industrial competitiveness and the quality of life for European citizens.

FP6 covered the five-year period from 2002 to 2006. The main part of FP6 was funded at the level of some 19 B€. The main additions compared to FP5 were the introduction of the European Research Area (ERA) and the introduction of new, important funding instruments, the Integrated Projects and the Networks of Excellence. The other available instruments in FP6 already existed in FP5 in similar forms.

FP7 builds on the achievements of its predecessor. It is intended to not only be yet another Framework Programme, but something that contributes to delivering the Lisbon goals set in 2000, "making the European Union the most competitive and dynamic knowledge-based economy in the world by 2010". While providing continuity with FP6, FP7 demonstrates significant extension in scale and ambition, with a budget of €53.2 billion over 2006-2013 to match the period of the next financial perspective. Even with the proposed increase in funds, the budget will represent less than 10% of public spending on research and development within the European Union unless Member States follow the EU's lead and fulfill their commitment to devote more national resources to research and development. Furthermore, the proposed research budget for FP7 is a small proportion of the total needed of the overall amount, about 0.1% of EU GDP, when the objective is to invest 3% of EU GDP.

We have noted that the instruments enabled by the EC along the different Framework Programmes are constructed following a strategic, evolving approach. For instance, instruments supporting specific research topics with **studies and workshops** are supposed to evolve naturally to **Networks.** These should deliver some global research strategy and R&D roadmap of the topic in question. The natural continuation would be the EC funding Collaborative Projects in that field, with well-defined deliverables, or a project funded by National Agencies or for instance establishing a collaboration with industry. Fig. 4.1 visualizes the discussed strategy. This approach has also a restricting effect; in order to apply for funds in subsequent Framework Programmes projects with clear deliverables (Such as **Collaborative Projects**) have to, either evolve to a different type of project, or to be significantly reformulated with a new, distinct set of deliverables.

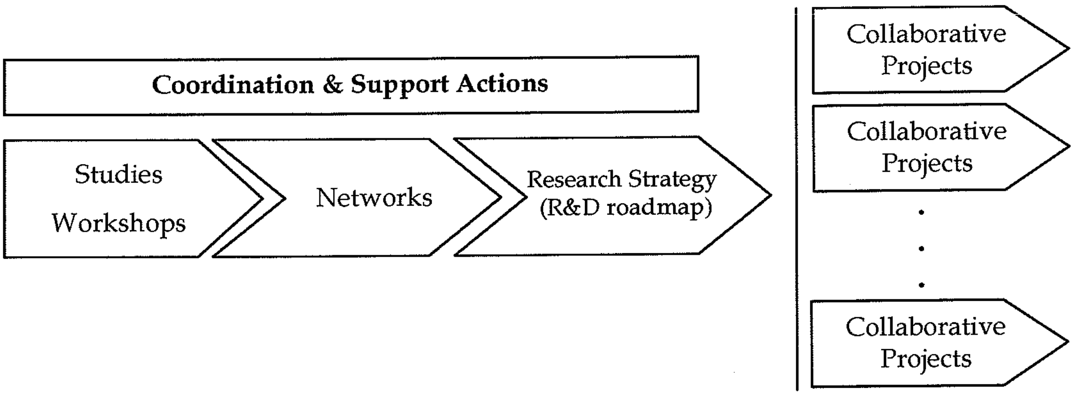

Figure 4-1 Long-term strategy behind some EU funding schemes.

4.2 FP7 Structure

The basic structure of FP7 looks simpler than that of its predecessors. The broad objectives have been grouped into four categories: **COOPERATION, IDEAS, PEOPLE** and **CAPACITIES** (Table 4.1). The first part, **COOPERATION,** is planned as more industry-driven and based on defined research themes. The second part of FP7, **IDEAS, PEOPLE** and **CAPACITIES,** should be more research-driven.

Programme		Budget (M€)
[redacted]		
Ideas	European Research Council	7460
People	Marie Curie Actions	4728
Capacities	Research Infrastructures	4217
	Research for the benefit of SMEs	
	Regions of Knowledge	
	Research Potential	
	Science in Society	
	Coherent development of Research Policies	
	Activities of International Co-operation	

Table 4-1 The four programmes in FP7 and allocated budgets: COOPERATION with 9 thematic priorities and main funding instruments of IDEAS, PEOPLE and CAPACITIES.

- **COOPERATION** supports all types of research activities, on well-defined topics, carried out by different research bodies in trans-national cooperation and aims to gain or consolidate leadership in key scientific and technology areas.
- **IDEAS** is one of the most important innovations of FP7. Through the newly created European Research Council (ERC), the EU will support 'researcher led' basic research in all scientific and technological areas.
- **PEOPLE** hosts Marie Curie actions to support individual researchers. It will operate horizontally across all research themes.
- **CAPACITIES** supports activities across all research areas to support research infrastructures, Small and Medium Enterprises (SME), international cooperation and 'science in society' issues.

The next sections will give some details about each of four programmes, highlighting the instruments that would apply better to projects in the CERN Physics Department.

4.2.1 FP7 - COOPERATION

The EC divides its Framework Programmes into vertical programmes that focus on specific research topics, and horizontal programmes that cut across research areas. **COOPERATION** supports projects with very well defined topics (top-bottom approach).

FP5 had four thematic priorities; FP6 had seven and FP7 adds two new areas, space and security. Fig. 4.2 shows the percentage of budget allocated to each of the thematic priorities in FP7. The total is €32,365 million, for the period 2007-2013. None of the Framework Programmes funds explicitly research on Particle Physics, though some of the available funding opportunities relate properly to some activities carried out at CERN. In particular, for research and development of particle detectors and its applications (including detector performance, electronics readout, data acquisition and imaging) some opportunities may be possible within the **HEALTH** and **SECURITY** themes. **INFORMATION & COMMUNICATIONS TECHNOLOGIES** naturally suits projects to be carried out in the CERN/IT Department, and maybe some within the IT expertise of CERN-PH. Some specific projects of detector development and production may also match with the area of **MATERIALS**.

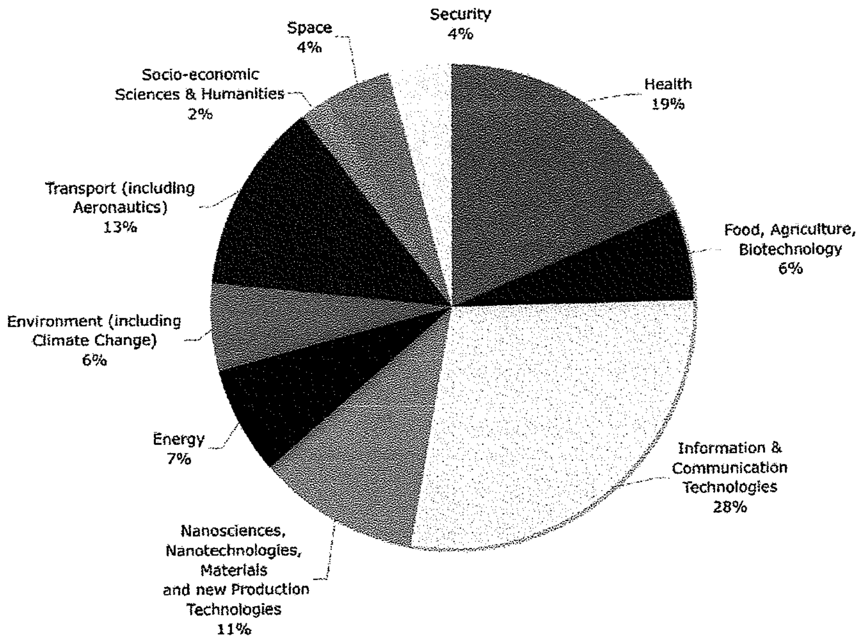

Figure 4-2 Distribution of the €32,365 million allocated to the FP7 COOPERATION thematic priorities.

The **COOPERATION** programme will be implemented through four distinct instruments (Fig. 4.3): **Collaborative research, Joint Technology Initiatives**[2], **Co-ordination of research programmes**[3] **and International Co-operation**[4]. Of the four available instruments, **Collaborative Research** seems to be the most interesting to allocate CERN-PH Research & Development projects, provided the project matches well with one or more of defined thematic priorities.

Collaborative Research constitutes the bulk of EU funding through a range of funding instruments: **Collaborative projects, Networks of Excellence** and **Co-ordination/support actions.** They all aim at establishing, in the major fields of advancement of knowledge, excellent research projects and networks able to attract researchers and investments from Europe and the entire world. The latter, **Support Actions,** should be attempted by CERN-PH as these actions support activities aimed at coordinating or supporting research (networking, exchanges, studies, conferences, etc) and they may also be implemented by means other than calls for proposals. They are suited to one event, can be submitted by one partner and they are 100% funded.

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[2] **Joint Technology Initiatives** will be implemented when the scope of a RTD objective and the scale of the resources involved could justify setting up long-term public private partnerships. They will combine private sector investment and national and European public funding.

[3] The **Co-ordination of research programmes** action will make use of two main tools: the ERA-NET scheme (coordination of national and regional research activities) and the participation of the Community in jointly implemented national research programmes.

[4] **International Co-operation** will serve to open all activities carried out in the thematic areas to researchers and research institutions from all third countries.

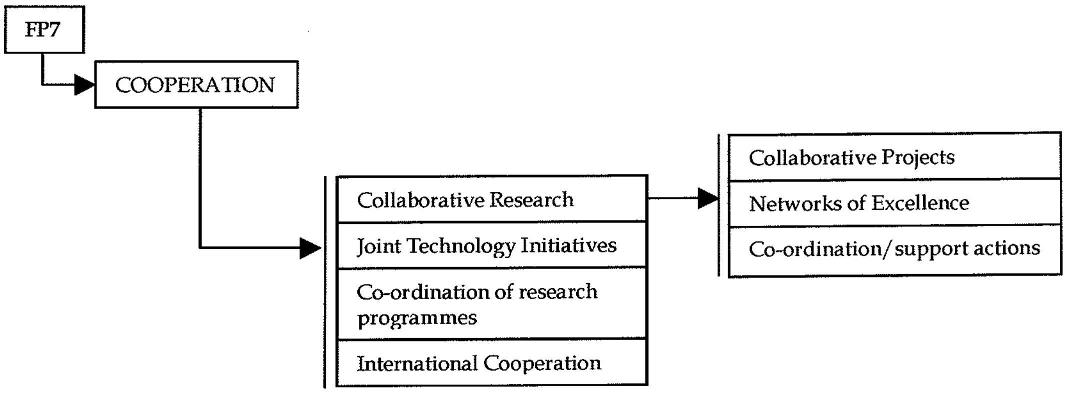

Figure 4-3 Scheme of the four funding instruments available in the Cooperation programme.

Collaborative Projects support research projects carried out by consortia with participants from different countries, aiming at developing new knowledge, new technology, products or common resources for research. The specific characteristic of Collaborative Projects is the radical innovation through innovation. A **Network of Excellence (NoE)** aims at developing a progressive and lasting integration of multidisciplinary research teams in selected areas of the Work Programme. The implementation of any of these joint programmes will require a formal commitment from the organizations, at strategic level, integrating part of their resources and their activities.

One of the decisive criteria for choosing one or another instrument is that while a **Collaborative Project** can be formed and funded almost entirely by the EU (up to 75% of research activities and 100% of management expenses), a **Network of Excellence (NoE)** is supposed to fund networking and common activities for Institutions (up to 20-25% of total costs) that have a defined work programme possibly already approved by National funding Agencies. Table 4-2 makes a comparison of some considerations for both schemes.

	Collaborative Research	Networks of Excellence
Nb of partners	3 to 8-20	3 to 15-20
Outputs	Clear deliverables	"More structured EU research"
Most suitable for	Applied Research	Future Projects
Duration	Up to 5 years (to complete deliverables)	5 years (designed for continuity)
Promoters	The Researchers	The Institution
Result	Knowledge	Integration
Future Impact	EU competitiveness Solving Societal problems	Position EU as leader in the scientific field
Work plan	Implementation Plan	Joint Programme Activities
Typical Funding	200,000 € per partner/year	23,500 € per researcher/year, to a max of 25% of partners capacities
EU coverage	75% of research activities and 100% of management expenses	Up to 20-25% of total costs

Table 4-2 Comparison between projects organized as Collaborative Research or Networks of Excellence.

As an indication, FP6 funded 147 **Networks of Excellence** and about 2000 collaborative projects (**Integrated Projects** and **STREPS**). For the collaborative projects, the figures below have been taken from FP6 2004 data, and indicate that the probability to succeed obtaining EU-funding for such projects was about 12% [16]:

- Number of proposal submitted: 16,000

- Number of participants: 84,400
- Number of contracts awarded: 2000
- Average of 6.8 partners per project
- Success Rate of 1:8

An interesting example of how CERN could act as partner in **Collaborative Projects** is the CLOUD experiment [17] that has begun taking its first data in October 2006 with a prototype detector in a particle beam at CERN. The goal of the experiment is to investigate the possible influence of galactic cosmic rays on Earth's clouds and climate. This represents the first time a high-energy physics accelerator has been used for atmospheric and climate science. The collaboration comprises an interdisciplinary team from 18 institutes and 9 countries in Europe, the United States and Russia. It brings together atmospheric physicists, solar physicists, and cosmic ray and particle physicists. The type of project fits perfectly into FP7 Framework goals and thematic priorities (**CLIMATE**).

4.2.2 FP7 - IDEAS

Funding of basic research (also known as Frontier Research) is one of the main novelties in FP7 and represents a unique funding opportunity for leading researchers and research teams in Europe. The European Research Council (ERC) will implement the Programme **IDEAS**. In analogy to the American National Science Foundation, the ERC will be the first pan-European funding agency for frontier research in all fields of science, distributing about 7.5 B€ for the period 2007-2013. Based on excellence, its aim is to create competition between researchers in Europe. ERC will be a totally independent, research-driven institution deciding itself on which direction to go in the future and on how to create an environment for the development of new ideas.

IDEAS reflects the EU belief on Investigator-driven "frontier" research, within the framework of activities commonly understood as basic research, as a key driver of wealth and social progress, as it opens new opportunities for scientific and technological advance, and is instrumental in producing new knowledge leading to future applications and markets.

Researchers from any nationality will be able to compete for ERC grants with scientific excellence as the sole criterion for funding. Two main funding streams are envisaged (Fig. 4-4). The first one for researchers with 2 to 8 years of post-doctoral experience (**Starting Independent Researcher Grant**); from 2008 onwards, a second stream will be started targeted to established researchers at different stages of their careers (**Advanced Investigator Grant**). It is expected that the "**Starting Independent Research Grant Scheme**" will award about €300-350 million per year to 200 grants (€1.5 million per grant).

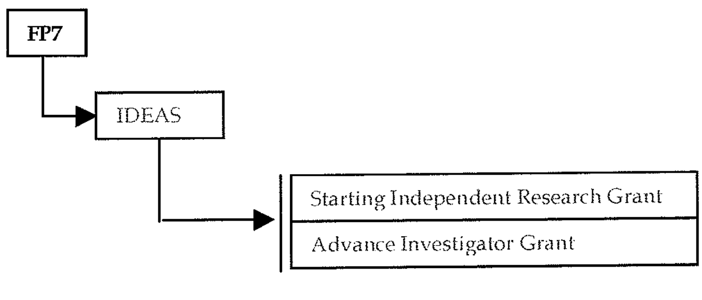

Figure 4-4 Funding streams for the IDEAS programme.

CERN will be eligible to host ERC grant recipients and both CERN staff and CERN users will be eligible to apply for both ERC grants streams. However, all CERN research staff has well-defined missions, agreed with the management, and this will not facilitate making one-off "personal research" proposals to the ERC. This means that participation in ERC projects on particle physics (or other research fields of interest to the Organization) will depend strongly on applications from CERN users. The participation of CERN in ERC projects needs, therefore, to be coordinated with the senior management.

The CERN-PH Department, having identified the need of a coordinated action to support research in defined activities, could appoint one leading staff physicist as formal coordinator of a CERN R&D Collaboration. That candidate would then apply for ERC funds on the basis of excellence, both of the scientific programme and the main Investigator and his/her project partners. The proposed project should also reflect the capacity of the Collaboration to generate knowledge and translate such knowledge into economic and social value and growth. This is because even if **IDEAS** funds basic research, there is a concept of applicability behind it, thus CERN-PH must take this into account for the selection of research topics.

Having said that, the only evaluation criteria for ERC grants is scientific excellence of the scientist and of the research field, therefore minor recommendations can be given:

- It should be noted that an important element of EU frontier research, as opposed to typically nationally funded frontier research, is the multi-, inter-, trans-disciplinary character of the projects. This implies that research themes should be at the interface of established scientific disciplines, from two or more disciplines combining their efforts and to be done by scientists moved from one discipline to another. At the same time, if at all possible, the research topic should fall within the FP7 strategic themes.
- It seems too that the ERC wants to address other competitive aspects of EU vs. USA, such as figures revealing the weaker position of Europe in number of patents and references or Nobel Prize winners, for instance. The proposal should explain that funding the project in question would help to position the EU in the world-leading position.
- While keeping in mind that **IDEAS** is not a collaborative project but it has a competitive nature to fund only the best researchers, one should keep the international collaborative approach with US, Russia, etc.
- In line with the FP7 main goal, to make Europe the most competitive region, the proposed scientific research should easily relate to the development of patents, emphasizing that the project not only can produce knowledge but also apply it where is created, Europe.

4.2.3 FP7 - PEOPLE

PEOPLE builds on the positive experiences with the "Marie Curie" (MC) actions under previous Framework Programmes. The revised Commission proposal (28 June 2006) reinforces substantially the MC actions from €1,8 billion for 4 years in FP6 to €4,7 billion for 7 years in FP7, and increase that constitutes a 50% rise on averaged yearly basis. The goal of all MC actions is training and they address researchers at all stages of their careers, in the public and private sectors, from initial research training, specifically intended for young people, to life long learning and career development. All FP7 MC actions are listed in Fig. 4-5.

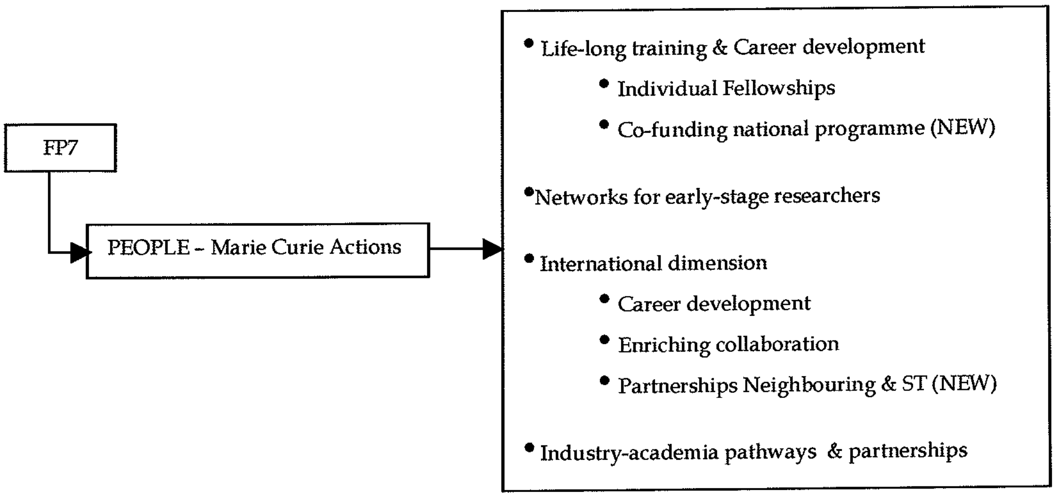

Figure 4-5 Marie Curie actions in FP7.

In general, MC actions address either individuals or Networks. The first action delivers a contract between the individuals and the EC, while the second action results in a contract for a number of fellows between a research center or enterprise and the EC. In either case, the key evaluation criteria comprise the quality of training activities and knowledge transfer and the quality and capacity of the Host and management. For the PH Department, the second type of global actions is of more interest and appears in FP7 in three forms: **Life-long training & Career development (Co-funding scheme)**, **Networks for early-stage researchers** and **Industry-Academia pathways.**

Co-funding National Programmes is a novelty of FP7. The EC will, for the first time, co-fund regional, national or international programmes which are corresponding to the Framework Programme objectives. This scheme seems to match well with the existing CERN Fellows and Associate Programme. The implications of accepting EU funds for the existing programme have to be well assessed. This effort should be driven by the CERN Marie Curie Steering Group (See Section 5.1) due to the expertise accumulated in the FP6 MC actions. An important issue will be to decide whether CERN should present a single application or several applications targeted to different research areas. It is also important to know that the co-funding scheme seems to target quality-enhancement, not quantity, of the existing programmes. Therefore EU funds will probably have to be used to extend the length of the stay of fellows, passing from the standard 2 years of a CERN contract, to 3 years in the CERN-EU co-funded scheme.

The **Initial Training Networks** (ITN), that can be considered extended FP6 Research Training Networks (RTN)- contains the EST programme as known in FP6, but stays rather well suited to the existing CERN Technical and Doctoral Students Programme. The new EU instrument presents major novelties that affect CERN and will have to be properly tackled:

a) Host-driven actions do not exist any longer.

b) Instead, MC actions are addressed to International networks. Networks shall be composed of at least three participants but typically of about 8-10 partners (e.g. universities, research centres, companies, SMEs). Single research organisations or "twinning of research institutions" may be considered under this action, where participants clearly demonstrate that the necessary elements of the research training programme are effectively addressed through well-established, international collaborations with other research institutions without the latter formally being part of the network. CERN falls naturally in this category. However, the EU probably encourages the networks, so CERN should use that approach whenever possible. In this framework, the only funding possibility for the successful CERN schools is to include them in the network.

c) A second novelty is the requested involvement, direct or indirect, of private enterprises. Their participation will be foreseen at three levels: i) full network "partner", if appropriate to the network and taking into consideration the research discipline; ii) "Provider" of research training and complementary training, including secondment opportunities and iii) Member of the "*supervisory board*" of the network, which will co-ordinate the network-wide training and will define the complementary skills requirements applicable to each early-stage researchers. At CERN, research activities in some topics are already carried out with industry. This is the case for instance of information technology and microelectronics projects. Others will have to find industrial partners probably acting as explained in points ii) and iii) within existing suppliers or large industrial corporations that would benefit of collaborative training activities with CERN.

CERN has presented high quality projects in FP6, an effort that was coordinated CERN-wide by the CERN/Marie Curie Steering Group set up in December 2002 with members from all sectors of CERN. The Group prepared a total of 24 proposals FP6 HOST-DRIVEN actions, of which 6 were accepted. A detailed study is presented in Section 5.1. The success accounts for the recognized value of CERN as a major asset for the scientific and technological community worldwide. Participants benefit from advanced training in a high-tech, multi-cultural and multi-lingual environment. At the same time, the organization benefits amply from their stay as they provide very valuable help with the commissioning of the LHC and the experiments and, more generally, with the fulfillment of CERN's mission.

The so-called **Industry-Academia partnerships** appears also adequate for CERN-PH projects. This scheme encourages industrial participation by supporting long-term cooperation programmes between academia and industrial entities, in particular SMEs, through staff secondments and workshops for exchanging information and experience, a practice that is common in this type of development projects. CERN-PH projects on microelectronics, system controls do have natural links with industry and should be exploited. Last, the **International Dimension** of the programme aims to attract research talent from outside Europe by reinforcing cooperation with researchers from third countries and introduce new dimensions for collaboration with the EU's neighboring countries. It should be used whenever CERN would like to encourage partnerships with research institutions in countries covered by the European Neighborhood Policy [18] or who have a Science and Technology Agreement with the EU [19].

4.2.4 FP7 - CAPACITIES

This part of the Framework Programme will enhance research and innovation capacities throughout Europe and ensure their optimal use. In FP6, most EU-CERN co-funded projects use the **Research Infrastructures** instruments, and specifically **Integrated Activities, Design Studies** or **Communication Network Development** within that instrument. In short, this scheme aims at optimizing existing European infrastructures and to give European researchers optimal access to those, and to contribute to the creation of new pan European infrastructures, real or virtual, in all fields of science and technology. In FP6, GRID technologies (EGEE, ETICS projects) and research for future accelerators (CARE project for example) fit perfectly with the goals of the funding scheme and continuation is guaranteed in FP7.

The funding instruments available in FP7 are listed in Fig. 4-6. Of all of them, part of **Research Infrastructures** follows a Bottom-Up approach and can therefore allocate projects from all fields of science and technology without any preference for one field over another.

Access to Research Infrastructures supports the use and exploitation of world-class infrastructures by a community of scientific and customer industries as large as possible on a European scale. This access may be made available to external users, either in person ("hands-on") or by suitable electronic communication. It may also take the form of the provision of remote scientific services. In this scheme, CERN could act as a host to external collaborators coming to the Laboratory to use its infrastructure (lab space, workshops, production facilities, beam lines, etc) with a common, defined goal that would benefit the development for particle physics and future applications in the experiments carried out at CERN. However the use of CERN infrastructures by the users community is already a part of CERN's scientific programme and it is difficult to argue that this specific EU funding scheme would be applicable or add relevant value to current CERN activities.

Integrated Activities, Communication Network Development and Design Studies support networking of research infrastructures in a given field related to access and performance improvement, interconnection and improvement of communication networks, and design studies for creation of new infrastructures. These instruments have been successfully used by the European Particle Physics community and CERN for a number of important projects, ranging from GRID development, to accelerator R&D to detector R&D. CERN-PH however has only had very limited participation in these projects as none of them are related to the core activities of the department. Based on the discussion in chapter 3.1 the potential for CERN and CERN-PH to take leading roles in defining FP7 projects related to the main priorities of the European Strategy (LHC upgrade, CLIC, ILC and Neutrino facilities) is very evident, and provided these funding instruments will be implemented in a similar way as in FP6, and detector R&D for these infrastructures are included, CERN-PH could be much more successful in FP7. A coordinated approach with its user community and with industrial partners will be crucial for success.

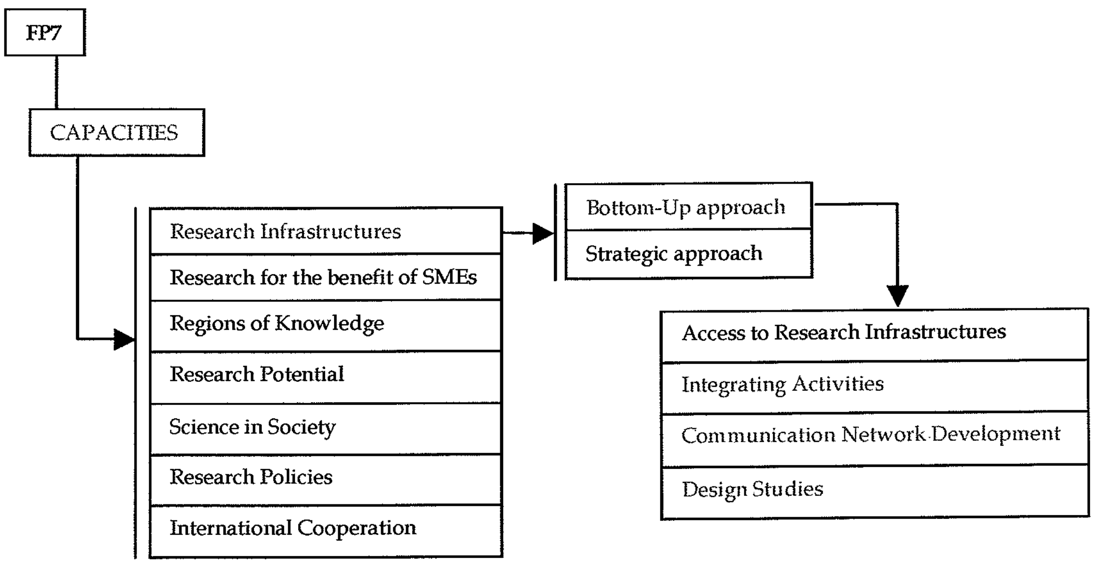

Figure 4-6 Funding instruments available in the FP7 Capacities programme.

The second main funding instrument under **Research Infrastructures** is **Strategic Approach**, and represents a significant increased support for certain priority projects, as defined by the Roadmap of the European Strategy Forum on Research Infrastructure (ESFRI) [20]. A first version of this roadmap has recently been published and it cites the priorities as defined by the before mentioned European Strategy Group for Particle Physics [21]. If this approach is finally implemented in call for proposals to this funding instrument it opens for important bids for major particle physics projects as LHC upgrade, CLIC, ILC and Neutrino facilities, both accelerators and detector R&D as they combined defined facilities. The same comment can be applied as a recommendation as above: a coordinated approach of CERN and CERN-PH with its user community and with industrial partners will be crucial for success.

4.2.5 Summary of Opportunities in FP7

Concerning funding instruments, FP7 adds some simplification but overall stays rather similar to FP6. Appendix II shows FP6 vs. FP7 funding schemes, a type of information that can only be useful for people already familiar with the previous Framework Programme. Despite the fact that the type of instruments has been reduced/simplified and that Particle Physics has once more not being included as a thematic priority, more opportunities could be attempted in FP7. Fig. 4.7 shows the correlation between the type of basic projects that could be set up and the optimal FP7 instrument within the four EU broad Programmes.

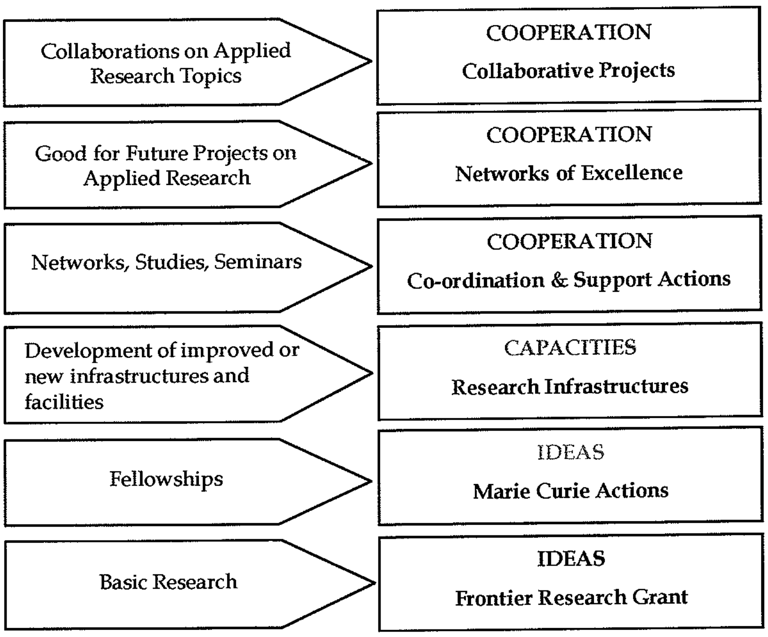

Figure 4-7 Summary of the Funding Schemes in FP7.

Some projects on applied research could be organized as **Collaborative Research** projects that would fit appropriately within the defined EU thematic priorities of the **COOPERATION** programme, such as **HEALTH**, **SECURITY**, **MATERIALS**, and **INFORMATION & COMMUNICATION TECHNOLOGIES**. Within that programme, **Networks of Excellence** are suitable for supporting research activities that are less mature and that could evolve into **Collaborative Projects** in few years. The training actions within the **PEOPLE** programme (Marie Curie actions) should be enhanced, in turn adapting the strategy of the existing training programmes at CERN. The **IDEAS** programme, through the award of Grants of the European Research Council, support for the first time researcher-led basic research in all scientific and technological areas, therefore it emerges as reasonable opportunity too. CERN, as the world leading and largest laboratory for Particle Physics research, is well positioned to success in that Programme, in order to exploit the world-class research topics and scientific community, both user and staff members. The specific programme **CAPACITIES**, that supports activities across all research areas to support research infrastructures and facilities, SMEs, international cooperation and 'science in society' issues applies adequately to some specific informatics and accelerator/detector development projects and also GRID development, with very significant potential for CERN in general and CERN-PH specifically. It is important for CERN-PH and European Particle Physics groups in general that detector R&D for future facilities are treated on an equal level to the accelerator part.

4.3 Basics of the EU Programmes

EU Programmes generally last for a number of years and are managed by the various Directorate Generals of the European Commission through public tenders. The call for tenders is the first official step to initiate a programme. Submission of proposals is only possible in response to **calls for proposals**, which are published in the Official Journal of the European Communities and on the Internet. Special information packages are issued for each call comprising documents, explanations and forms, which are needed for the preparation of a proposal. Generally, the deadline by which a proposal should be presented is within three months upon publication of the call. In exceptions though, this deadline can vary between six weeks and four months.

Proposals are evaluated and selected for funding by the European Commission with the help of independent external experts (peer review). **Evaluation criteria** and a detailed description of the process of evaluation, including the ethical review, are published in advance. For successful proposals, the European Commission enters into (financial and scientific-technical) contract negotiations. A successful negotiation will lead to a contract between the European Commission and participants. The typical time scale for the whole process is summarized in Fig. 4-8.

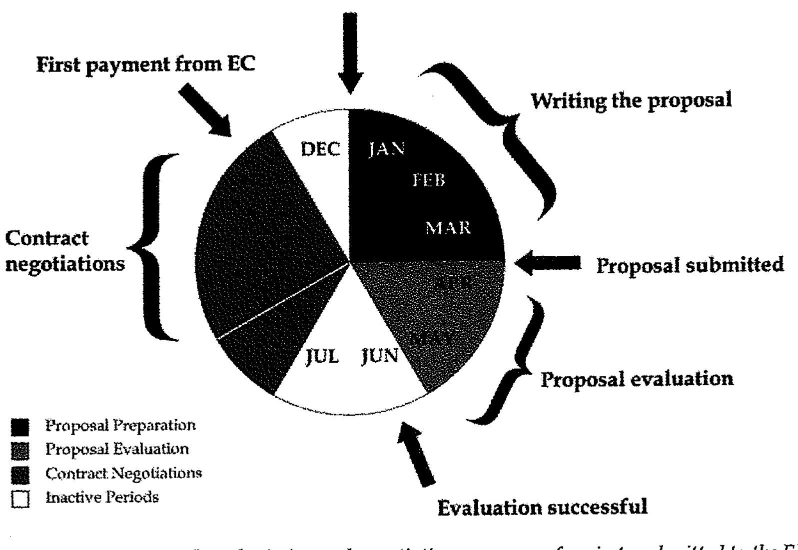

Figure 4-8 Typical time scale in the submission and negotiation processes of projects submitted to the EU.

Project proposals can be submitted by all natural or legal persons originating from the EU Member States (e.g. enterprises, universities, research institutes, public bodies, private bodies, NGOs, etc.) or others originating from countries participating in that particular programme.

One of the major prerequisites for the participation in European programmes is the transnational character a proposal should have. Normally, a project has to involve at least two organizations of two different Member States or at least an organization from one Member State and another from an associated State to the European Union to guarantee the realization of the requirement.

In every project, one of the participants has to take on the role of the **Coordinator**. He/She acts as single point of contact for communications with the EU. This participant has to have substantial experience in project management, and a non-written rue seems to be that a track record of EU-programmes increases significantly his/her credibility. In particular, the coordinator is in charge of all the financial operations (receiving the contribution from the Commission and distributing it to the partners within the project), and reporting on the advancement of the project and collecting data from the partners of the project. The Coordinator concludes the necessary contracts with his partners to realize the project. Every contract has to clearly describe the role, the rights, the financial requirements and the responsibilities of participants.

A **Partner** contributes to the project in one or more ways and in consequence carries parts of the costs. A Partner benefits from the financial contribution of the Commission according to the contract signed by the coordinator and the Partner. He is obliged to provide all the required (technical) information to the Commission.

A third possibility is acting as **subcontractor** for a Consortium via one or more of its partners. The European Commission does not regard subcontractors as project participants. Subcontractors have a contract with the partners, and are paid 100% commercial costs. They perform non-core elements of the work programme. Its selection is made through a tendering process on the basis of best-price:quality-ratio. While the conditions of the EC contract are applicable to the subcontractor (confidentiality, communication of data, payments, audits, etc) the Intellectual Property belongs to the Consortium/Commission and subcontractors have no rights to the results generated.

4.4 Outsourcing the preparation/management of EU co-funded projects to Specialized Consulting Companies

One of the key problems that this report tries to address is how to position the expertise in CERN-PH, such that a number of projects can be submitted to the adequate EU funding programmes taking into account that first, particle physics is not a priority in the EU research plans and, second, it is CERN policy to only participate in EU co-funded projects when they involve activities that are well aligned with the future plans of the organization. One approach has being tried, that is to understand well the expertise and needs in the Department and the funding programmes in FP7. A second strategy would be to encourage a in-depth technology scan within the Department, ideally by an independent, specialized institution that would spot technology areas that are suitable for EU funds and attractive as regard to the requirements of FP7. There are a number of consulting companies that have being working in European projects since more than a decade and have accumulated important expertise, both in the EU programmes and the research needs of European industry. These institutions are well positioned to detect potential projects in CERN-PH and exposed them to projects that are being set up in

Europe by other research institution or industries, and/or help CERN-PH setting up the appropriate type of project structure following EU rules.

In addition, outsourcing the managerial tasks associated to planning and running an European research project may be particularly attractive in two cases: when the Coordinator role falls at CERN, due to the heavy duties associated to this task, and second, when the project needs to be slightly reshaped to appear more attractive for SME and/or industry players. Fig. 4.9 shows a typical skills profile of Research Groups and highlights the areas where support on R&D services (legal, contractual, financial) and professional managerial skills would be complementary and beneficial.

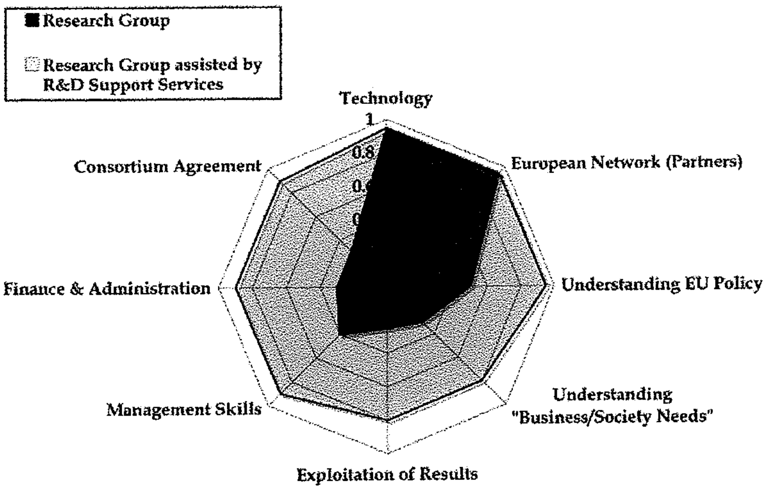

Figure 4-9 Typical Skill profile of Research Groups and added value when working with firms specialized in R&D management.

We have studied the role of 12 European companies specialized in project management of EU-funded projects; they are listed in Appendix I. They were selected after some research in Internet and some coarse filtering process that selected companies with an important track record of successful involvement in FP6 international projects (success rate above 50%, more than twice the overall success rate quoted for FP6) and trans-national scope. We have found that about 60% of those private firms base their offer in project management tools used for the administrative and financial management activities, and the development and maintenance of web-based applications used as communication platform during project's lifetime. While this would already be of great help and relief for the scientists in charge of the project, is worth mentioning that the CERN IT-AIS-PM group has developed equivalent applications[5] for two CERN-EU projects, EGEE and ETICS.

There is a second type of consulting companies specialized in EU projects. They follow projects from the very early conception to the end. Five of them are worth to be mentioned: CHALEX in Devon (UK), SCIPROM in Lausanne (Switzerland), IDETRA in Madrid (Spain) and ALMA and ACIES in Lyon (France)[6]. With all of them we have carried

[5] Presently, CERN IT-AIS-PM has customized a Project Management tool (PPT) for the management of the EGEE and ETICS.
The application consists of a Members and Partners Database, Activities Management (Activities, Tasks, EU deliverables), Data Collection (Timesheets and Cost Claims) and Data Repositories for Effort Reports and Requested EU Contribution Reports.
More information is available at: http://ais.web.cern.ch/ais/apps/ppt/eu_projects/online_help.html
Contact person: jurgen.de.jonghe@cern.ch

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out face-to-face or phone interviews in order to assess a potential collaboration with CERN-PH for future submissions to FP7. The aim was to understand the background of the companies, their experience attracting EU funds for Academia and other research institutions (active and completed projects), and its methodology. A special focus was given to value their role in the whole process, from identifying opportunities within the PH department activities to project management.

These companies usually start playing once CERN identifies the technologies that could be the based for EU co-funded projects. It should be noted that the investigated Consulting Companies (CC) would not commit a priori to perform technology scans of all available technologies in CERN-PH in order to pick up those that, on the basis of technology innovation, excellence and maturity, would be more attractive for EU co-funded projects. They all recognize that the innovative research topics are to be defined by CERN-PH. However they are capable of assessing the fit of the topic within EU priorities, helping to organize the optimal project type and its structure and identifying potential project partners.

The success rate of these five firms is very high, from 50 to 75%, and can reach higher values for projects targeted to specific thematic areas. For instance, ACIES records 92% success rate for 12 projects proposed in the HEALTH topic. This is mostly due to their very early involvement in the project proposal, identifying the consortium, and very important, discussing the project in Brussels before it is proposed. These type of actions permit to tailor the project and optimize the Consortium as suggested by the EU. SCIPROM claims the following factors as drivers of successful proposals:

- If the project coordinator is well involved in the preparation of the call for proposals, the proposal preparation is straightforward, well adapted to the call and, accepted.
- The earlier a project preparation starts, the better adapted the proposal to the call and the better the project evaluation.
- A project has to clearly focus on one possible project type (Collaborative, Network of Excellence, etc).
- The project has to be well known to decision makers in Brussels. Even if a project fails upon a first trial, it can succeed upon a second trial, after intensive discussion of threats and concrete answers of the project with the administrators before the submission.

In general, at the early stage of project preparation, a CC will typically focus on three aspects: i) dialoguing with programme officers in Brussels to increase the chance that the technology of the project in question is aligned to one of the calls, ii) identifying the optimal EC funding programme and specific calls where the project fits best, and ii) understanding the impact of the project (socio-political, industrial, technological) such that a proposal with the highest chances to succeed can be written. The CC delivers a list of recommendations and together with CERN co-writes the project proposal. Yet the technical part of the proposal would be the responsibility of the CERN team. At this stage, normally the CC works for an hourly-fee or flat rate, and may enter into a collaborating agreement

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http://www.chalex.com/
http://www.sciprom.ch/
http://www.idetra.com/
http://www.almacg.com
http://www.acies.fr/

for the proposal writing. This task may last for about 3 months and includes building the consortium, helping to assign partners to work package tasks, preparing the budget for the proposal, etc. It is to be remarked that ACIES do not charge any fee during the preparation phase of the project. ALMA Consulting works on the basis of risk-sharing cost model. There is an upfront payment calculated on the basis of number of partners involved in the project, and if the project is approved for funding a second invoice called 'success-fee' is delivered and calculated as a percentage of the budget allocated to the project in the EU grant.

If a proposal has been short listed for funding, the project enters in contract negotiations with the EC. This phase of the project will usually involve one, or more, face-to-face meetings with the EC in Brussels to establish the details of the contract. This is a complex phase of the project, which will lead to an agreement on the work to be carried out in the project and on the budget and associated administrative, legal and financial information. Contract negotiation requires a strong understanding of Framework procedures, and especially of the new financial aspects of FP7, therefore the help of an experienced CC is fundamental.

During the project lifetime the role of the private firm depends on the type of instrument. However it is acknowledged that in well-focused Collaborative Projects, CERN should play the role of Coordinator due to its reputation on scientific excellence and international collaboration expertise. Some of the interviewed consultants would prefer to be included as Project Partner in the project. As such they are explicitly in charge of the Project Management work package. The EC favors this configuration, where professionals carry out the project management. Others prefer to work on a real cost basis and complement it with private agreements with the project partners. Typically the CC will assign one of its professional project managers that supports project management activities, as understood by the EC:

- Managing the project on a day-to-day basis.
- Updating partners on the progress of the project.
- Ensuring that all work is being completed on time and is being done to the highest standard.
- Encouraging the development of relationships between partners.
- Compiling all necessary reports (including audit certificates and financial statements).
- Representing the consortium at review meetings.
- Acting as the liaison point between the EC project officer and the consortium.
- Managing the project's finances and making EC payments to partners.
- Some CCs, and in particular all companies studied except ALMA Consulting, are also specialized in Technology Transfer and Dissemination activities, helping to design and development of effective web sites, organization of workshops, seminars and conferences, design and distribution of publications (project newsletters, brochures, flyers, posters etc.). A technology transfer/training programme, to spread best practice and the targeted dissemination of the project's results to stimulate commercialization and further developments is part of their role.

Establishing a collaboration with consulting companies seems advisable, as they help not only to define and tune the project at the proposal phase, but they also take the administrative management for the projects when they are approved, usually acting as partners (EU money for administrative tasks is for them, no cost for the host organization). These companies usually also have very good contacts to the FP7 and EU officials, and can actively help to identify industrial or institutional partners to projects.

4.5 EU Competitiveness and Innovation Programme

In parallel with FP7 the Commission approved on 6 April 2005, a proposal for a Competitiveness and Innovation Framework Programme (CIP) with a budget of €4213 million that will be an instrument to support Competitiveness and Innovation in the single market between 2007-2013 [22]. The new programme pulls together a number of the Commission's existing programmes relating to innovation, competitiveness, information and communication technologies (ICTs) and energy. The Competitiveness and Innovation Framework Programme will run alongside the FP7, being complementary and mutually reinforcing. Whereas FP7 focuses on the invention and demonstration of new knowledge and products, CIP would target the next stage, the commercialization and full-scale application of such outputs.

The programme will comprise three sub-programmes:

- The Entrepreneurship and Innovation Programme with between 66 and 75 % of the budget is essentially an SME programme. This Programme will support horizontal activities to improve, encourage and promote innovation (including eco-innovation) in enterprises.

- The ICT Policy Support Programme, with a budget of €802 million, will promote the adoption of ICT in businesses, administrations and public sector services. These actions have previously been funded under the eTEN, eContent and MODINIS programmes.

- The Intelligent Energy - Europe Programme with a budget of €780 million will be continued and enlarged under CIP. The programme's objective is to support sustainable development as it relates to energy, and to contribute to the achievement of the general goals of environmental protection, security of supply and competitiveness.

CIP seemed an attractive route to be explored for future collaborations between CERN and the EU. However it has become more apparent that CIP is about applications, getting closer to industry and market, and about the commercialization and full-scale application of research outputs. While CIP maybe interesting for some field of activities at CERN, it looks difficult to apply to projects in CERN-PH, which are more oriented to basic research.

5 Case studies: advantages and disadvantages of CERN-EU co-financed projects and other funding schemes

Chapter 5 has being organized in several case studies carried out to help understanding the implication of using co-funding schemes for research and development projects of CERN, a laboratory with clear scientific objectives to accomplish basic research on Particle Physics.

The first case explores the successful experience of CERN with the Marie Curie Training actions in FP6, in order to extract key lessons that may help to boost the collaboration of EU and CERN in training. The second case has a look at two R&D projects carried out at CERN with industrial partners in order to asses their influence in the basic research carried out, highlighting the benefits of constraints of such an approach. The third case studies how a collaborative project set up by CERN and other European research institutions could be adapted to the rules of the selected FP7 funding scheme. The comparison between the organization of traditional R&D collaborations and EU co-funded collaborative projects has been carried out in order to clarify the value of including EU in research activities.

5.1 Lessons from Submissions to FP6 Marie Curie Fellowships for Early Stage Training Programme

CERN has been very successful with FP6 Marie Curie actions. A significant amount of CERN-EU co-funded Students, Fellows, Schools and Networks have been integrated in the Organization activities. It is amply recognized that the MC training actions are beneficial for CERN and should be continued and encouraged all across the fields of activity in the Laboratory.

The Marie Curie Fellowships for Early Stage Training programme (**EST** hereafter) deserves special attention. Overall, in FP6 the European Commission has funded 145 trainees per year at CERN through the **EST** programme, with a total contribution to the CERN student programme exceeding €9 million. This corresponds to about CHF14.4 million for the 3 years, at the level of 15% of the existing CERN Fellowship programme.

In average, CERN-PH hosts 140 Fellows per year in the theory and the physics groups through the CHF30 million/year CERN's Fellows and Associate Programme [23]. Simply taking into account the present demands from the LHC experiments, an increase of 25-30% in the number of students could be absorbed and properly supervised (40 fellows ~ €2.8 million) [12]. As seen in Fig. 5-1 the number of good applicants CERN-wide exceeds the amount of available positions, the number of appointments simply being limited by budget constraints. Preparing high quality proposals for MC actions in FP7 could boost significantly the training capacity of the Organization.

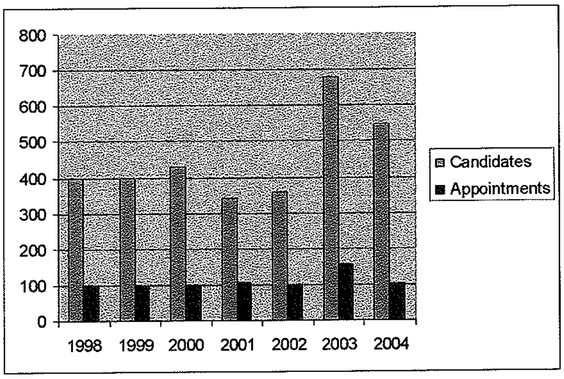

Figure 5-1 Candidates and appointments for CERN Fellowships.

Table 5-1 lists all proposals submitted by the CERN/MC Steering Group to the FP6 calls in 2003, 2004 an 2005 (projects appearing in BOLD in the Table were successfully funded). The table takes into account that some projects are submitted in subsequent calls with minor or major changes, depending on the evaluators suggestions; in the latter case, the new submission could carry a change of the project name. They are a total of 24 submissions for 11 projects in different topics, which purposely grouped requests of several groups working in research topics alike. It is worth noting that out of the 24 submitted proposals, 10 were launched by the Physics Department, of which three (MITELCO, ELACCO, EUROTHEPHY) were finally funded.

Research Topic	CALL 1	CALL 2	CALL 3
Developments in Informatics	**DEVINFO**		FURDEVINFO
High Intensity Particle Accelerators		**HIGHINT**	SHIPB
Digital Library Developments			DIGLIB
Science Communication and Education	COMEDU	COMEDU	COMEDU/SCICOM
Microelectronics,Telecommunications and Controls	**MITELCO**	**MITELCO**	**ELACCO**
Theoretical Physics	THEOPHYS	THEOPHYS	**EUROTHEPHY**
Future Accelerator Developments	FUTACC		
Mechanical Engineering and Materials Science	MECANEERING		
Particle Detector R&D	PARDET	PARDET	PARDET
Radiation Protection	RADPRO	RADPRO	**RADENV**
Scientific Computing		WORLDSCICOMP	WORLDSCICOMP

Table 5-1 MC EST host-driven proposals submitted in the three FP6 calls (2003 to 2005). Research areas are varied, representing well the expertise at CERN. Funded projects appear in bold.

The statistics and success rate for the total amount of proposals to the MC **EST** action in FP6 reveals that the success rate does not exceed 8%, as seen from the figures below [24]:

- Number of proposal received: 741
- Number of eligible proposals: 706 (95.3%)
- Proposals above threshold: 67.4%
- Proposals funded: 7-8%

Such intrinsic, low success rate, which is due a number of submitted projects exceeding largely the amount of available funds, implies that the evaluation process and further classification of high quality projects are perceived as rather unpredictable. The people involved in the preparation of CERN's **EST** projects have corroborated this frustrating observation. Nonetheless, CERN seems to do better than the average. Table 5-2 shows the proposals submitted by CERN in each FP6 call. The EC filters proposals in a first-stage evaluation, and succeeding proposals are invited for a second-stage evaluation and catalogued for funding (A), on reserve (B), above threshold but not for funding (C), and proposals failing one or more thresholds (D). 83% of the CERN proposals are above the set thresholds and only 2 out of 24 had one section below threshold. The success rate (funded/total) of CERN proposals overall is ~25%, exceeding the average success rate, thus recognizing the very high quality of proposals prepared by the CERN MC Steering Group. The increased rate in subsequent calls probably reflects the Steering Group's learning curve. The group profited from the referees' suggestions and evaluation comments from each proposal to optimize common aspects over all projects. This is a key success factor, as the technical field description accounts only for 15% of the overall qualification, therefore special emphasis should be given to the common training aspects in all the proposals.

	CALL 1	CALL 2	CALL 3	Grand Total
Total nb of proposals	8	7	9	24
Proposals failing 1 or more thresholds	1	1	0	2
Funded	1	2	3	6
Success Rate	13%	29%	33%	25%

Table 5-2 Number of proposal presented by the CERN-MC Steering Group and the success rate of those in the different FP6 calls.

Table 5-3 shows the time evolution of MITELCO (Engineering Panel), one of the projects in CERN-PH. The original proposal in Call 1 was graded 12th out of 117 eligible proposals, but due to insufficient funding it was only encouraged for resubmission in the following Call. The proposal was updated taking into account the referees' suggestions, and accepted for partial funding in Call 2, presumably again due to a mismatch between available funds and number of good proposals. The average mark was better, most likely reflecting the fact that some of the weaknesses identified in Call 1 (lack of information on supervisors and specific work programmes) were properly addressed in Call 2. Finally, MITELCO was resubmitted in Call 3 under the name ELACCO and adapted to the new rules of the call, where it was finally fully funded.

Proposed Project:	MITELCO 2003	MITELCO 2004	ELACCO 2005
Scientific Content	4	4.2	4.1
Quality of Training	4.6	4.4	4.3
Quality of Host	4.2	4.6	4.5
Management & feasibility	4.3	4.4	4
Relevance to Action	4.4	4.5	4.4
Value to Community	4.2	4.6	
Overall	85.9	89.6	86.4
Average	4.3	4.5	4.3
Classification	B	A	A
Max. EC Contribution (Meuro	0	1556	2318

Table 5-3 Evaluation of MITELCO in the 3 FP6 calls.

A detailed analysis of proposals submitted in Call 1, the less successful of all, does not enlighten much more the situation. Table 5-4 shows the grades in each section for the eight proposals. It simply reflects that CERN does generally very well, that all tasks should be considered equally important (for instance, COMEDU gets the highest mark but the lowest classification -D-, as one section is below threshold), and that competition with other proposals within the same panel is the key factor to get funded or not. More generally, the criteria for getting a high quality, well above threshold project funded or not, seems to be, as for other type of projects co-funded by the EU, a set of unwritten subtle rules (written at the end of this section) and maybe also referee-dependent. For instance, the description of the *Quality of Training* for MITELCO (Engineering Panel) and COMEDU

(Social Sciences Panel) are identical, with the exception of a short sentence in MITELCO that describes the equipment existing in the laboratory. MITELCO gets the highest mark (4.6) and COMEDU the lowest (3.8). The same for instance occurs in the Section *Value to the Community* for FUTACC and COMEDU. The description in the two proposals is 100% identical; the first project is rated with 3 points and the second one gets the highest grade 5.

MC FP6 CALL 1 / Panel:	PHYSICS			ENGINEERING				SOCIETY
Proposed Project:	**RADPRO**	**THEOPHYS**	**PARDET**	**MECANEERING**	**FUTACC**	**MITELCO**	**DEVINFO**	**COMEDU**
Scientific Content	4	4.3	3.8	3.4	3.5	4	4.4	4
Quality of Training	4	4.3	4	4.1	4	4.6	4.6	3.8
Quality of Host	4.5	4.8	4.1	4.9	4	4.2	4.6	5
Management & feasibility	4.1	3.9	3.7	3.5	3.7	4.3	4.3	5
Relevance to Action	4.3	4.4	4.2	3.7	3.7	4.4	4.3	5
Value to Community	4.2	4.4	4.1	3.5	3	4.2	4.6	5
Overall	84.6	88	80.3	79.4	73.9	85.9	89.5	94.4
Average	4.2	4.4	4.0	3.9	3.7	**4.3**	4.5	**4.6**
Classification	C	C	C	C	C	**B**	A	**D**

Table 5-4 Grades obtained in the different sections of the proposals in FP6 Call 1.

Despite the apparent randomness of the classification procedure, a study of several evaluation forms of the funded and non-funded proposals suggests that the following issues should be taken into and emphasized in the corresponding sections of the proposals to increase the chance to succeed.

Scientific Content:

- The specificities of the research topic seem to be less important than how the research work is going to be carried out and the benefit of the training action for the two involved parties (researcher and host). Therefore as first and most important recommendation, in addition to the eleven topics attempted in FP6, Experimental Particle Physics should be included in FP7. In the next few years, the physics and technology challenges relating to the analysis of LHC data as well as R&D programmes for future accelerators call for an increase in the number of Fellows and Associated contracts. Co-funding existing CERN Fellowship programme with the EU would be beneficial for all stakeholders.
- Whenever appropriate specify the link between the scientific content of the proposed research and the thematic priorities in FP7.
- Propose training on a wide topic, but explained very much in detail, with an accurate description of the training methodology, work programme and timetables. The two last factors seem key, as they provide EU the tools to monitor the progress of fellow and project.
- Accentuate the multidisciplinary character of the technical training activities and acquired multi-sector skills.

Training activities:

- Stress that the project will prepare fellows for leading independent positions.
- If possible, demonstrate how the stay at CERN has fostered the career development of researchers.
- Emphasize the knowledge transfer during the training period, especially for skills adapted to industrial needs.
- Add structured training on other subjects than the research line, but correlated to the core subject.
- Detail themes and number of hours that Fellows will dedicate to courses and schools.
- Include monitoring and training objectives.
- Guarantee a true commitment towards generating a PhD during the fellowship and the links between CERN and the home institutions that will deliver the PhD degree.

Quality of the Host:

- Include specific information about the mentors for the programme in question, rather than the vast potential existing in the Organization.

- Include past training expertise of the proposed supervisors and host group.
- If possible, repeat supervisors. Known people are liked.
- Reference to the use of the European Charter for Researchers [25].

Management and Feasibility:
- Justify budget/fellow.
- Specify milestones.
- Include recruitment procedure.

Relevance of the activities to the Action
- Explain the structuring effects of the action.
- Focus on the benefits to students (that is the aim of MC Actions), avoiding the impression that the Fellows work for the needs of the Laboratory.

Added value to the community:
- The project must increase the attractiveness of Europe towards high quality researchers.
- The project should enhance competitiveness of EU.
- Mention that both fellow and host benefit of the action.
- There must be a strong need for additional public funding and for such intervention to be at a European level.

Probable rules underlying in FP7:
- Inclusion of new EU member states and candidate countries in the projects.
- Serious consideration of ethical issues.
- Encourage promotion of women (EC seeks > 40% female participation in Marie Curie actions), including the role of female supervisors.
- The Competition Law.
- Competition EU - US.
- Link to industry or industrial needs.
- The capacity to promote results beyond the consortium/project/action and to engage with the public (awareness of science).

5.2 R&D Projects at CERN with Industrial Partners

A key factor in FP7, seen across all its work programmes, is the effort of the Commission to involve European industry in the definition of the research themes, and the explicit requests to involve industrial partners in projects and actions. Fig. 5-2 shows the income received by industries as a percentage of total EU budget from FP2 (1987) to FP6. The involvement of industry seems to decrease steadily, implying that Framework Programmes have become less and less relevant to European industry. FP7 attempts to reduce this increasing gap.

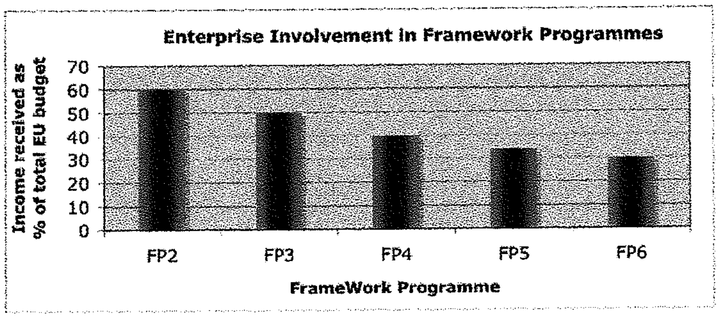

Figure 5-2 Income received by industries as a percentage of total EU budget from FP2 (1987) to FP6. Data Source: FP7 Ex-ante Evaluation (April 2005).

For projects in CERN-PH, two approaches to find industrial partners would appear feasible:

a) To find industrial suppliers that have already worked in projects with the PH Department for the LHC, trying to get an insight on their interest and capacity to participate in partnership in EU projects. CERN-PH has already fruitful relationships with industry, especially in the development phase of projects. In order to advance a step further in an effective way, CERN-PH should encourage collaboration with the Technology Transfer (TT) group at CERN. As an indication, more than 30% of the active technologies (available for licensing, partnership and/or projects) at CERN-TT come from the Physics Department.

b) Some effort should be put to understand the interest and potential return of using CERN infrastructures (magnets, beam lines, specialized laboratories in the Physics Department) for testing technical developments driven by SME and/or for carrying out experiments not related to Particle Physics, but where CERN-PH would benefit at long-term. The emphasis would be trying to identify projects in areas other than Particle Physics where the involvement of CERN-PH would be beneficial acting as partner or sub-contractor in EU projects.

Having identified the importance of including industrial partners in EU co-funded projects, we have carried out a comparative study between two projects where CERN groups play a key role and SME and industry have been being involved as development partners. The goal is to extract the advantages and inconveniences of such alliance. We have selected two projects that are similar in terms of the role played by CERN, the inclusion of industrial partners in the project, the number of partners involved and budget. ETICS is a successful CERN-EU co-financed project related to GRID technologies, and MediPix, is a successful project on microelectronics development with no EU funding.

MediPix can be consider a spin-off of the CERN RD-19 project, a collaborative effort between particle physics institutes and the microelectronics industry for the development of Hybrid and Monolithic Silicon Micro-pattern Detectors for Particle Physics [26]. RD-19 was approved by CERN in the middle of 1991 and was successfully completed at the end of 2000. MediPix1 was supported by the Technology Transfer group of CERN, that helped setting up an R&D project with external institutes, each tackling a specific domain of the application, and took care of IP issues. It was formed by five of the twenty-eight original universities and institutes in RD-19 that had expressed interest to continue the development of the RD-19 chips for domains other than particle physics, in particular for medical imaging. The project today, MediPix2, has 15 collaborators and an enlarged scope.

ETICS is also a spin off of an existing, larger project, EGEE [27]. The EGEE project was funded in 2004 with over €30 million Euro from the European Commission. It gangs 70 contractors and over 30 non-contacting participants and aims to build on recent advances in grid technology and develop a service grid infrastructure that is available to scientists 24 hours a day. ETICS identifies and isolates a topic from EGEE. It was formed at the beginning of 2006 by five partners aiming at improving the quality of Grid and distributed software. ETICS received €1.4 million funding from the EC's Information Society and Media Directorate, under the 6th Framework Programme.

Table 5-5 shows some of the main differences detected in the two types of collaborations.

	ETICS	MediPix
Budget/year	~ €0.7 million	~ € 0.3 – 0.5 million
EU contribution	€1.4 million	0
Nb of Partners	5	5 in MediPix1 17 in MediPix2
Industrial Partners	2	1, not official member of the Collaboration.
Type of Agreement	Consortium Agreement between the 5 partners Contract between Consortium and EU	Collaboration Agreement between Research Institutions & Memorandum of Understanding Separate contract between MediPix and one industrial partner (for transfer of technology)
Role of CERN	Coordinator (IT Dept/GD group) & technical activities	Coordinator (PH Dept/MIC group) & technical activities
Role of CERN Technology Transfer Group	None	Legal and administrative support in negotiations, contribution to manpower
Project Management & Organization	Project Management Board (PMB) composed of Project Manager and Partner Managers, each with one vote Project Manager coordinates the work of the Work package leaders Expert Board from outside institutions advising PM and WP leaders Project reviews up to 3 times/year	Project management Committee with 1-2 representatives per Institute, each Institute with one vote. The industrial partner has no vote.
IP	The Consortium	CERN (for the chip) and specific Collaborators for some other developments (HW & SW)
Deliverables	Technical Reports Dissemination of activities Prototypes Test Execution System	Dissemination of Activities A number of chips to the industrial partner
Deliverables exploitation	*Information not disclosed during the interviews.*	Research findings are free of use The industrial partner has an Exclusive License to exploit the MediPix chip in its domain of expertise Royalty scheme for other industries

Table 5-5 Main differences between two CERN research projects where an industrial partner forms part of the collaboration.

Several important differences appear between the two projects, many related to the fact that ETICS is a European project, therefore the administrative and managerial overhead is important. MediPix follows a more unstructured approach, in line with the standard collaborative research projects carried out at CERN. This adds some flexibility that is especially comfortable if important aspects of the research topic and group structure would need to be adjusted during the project's lifetime. An important aspect is the different role played by the industrial partner. In the EU project the partner is involved in several work packages and it is directly responsible of at least one of them and its deliverables. They are also involved in the managerial aspects of the project, with equal voting rights to the research institutions. MediPix introduces one industrial partner only for the transfer of knowledge in a given, specified field. While the industrial partner brings a very significant financial contribution, it is explicitly not included in the management board to avoid potential conflicts in the research goals (basic research vs. market needs). MediPix has also profited of a tight collaboration with the CERN Technology Transfer group, in particular for resolving Intellectual Property issues.

From discussions with the coordinators of the two projects, the advantages of having an industrial partner in the collaboration seem to be:

- Industry forces to go to the end of developments.
- Through the industrial partners, there are natural links with other industries, opening up new opportunities.
- In a EU-project, industrial partners increase the probability to access EU funds.
- Industrial partners can take over specific technical requests that arrive to the project.

The major disadvantages are:

- The potential conflict between the scientific objectives and the market needs. For MediPix the agreement works well because there is perfect match between the MediPix research line and deliverables and the needs of the partner.
- Difficulties to integrate the role of the industrial partner at CERN.

Concerning involving industrial partners the study finds out that despite the existing R&D culture at CERN, so based on basic science, industrial partners have demonstrated to be very beneficial for CERN R&D projects, and obviously also in construction projects when leaving the R&D phase. Whether MediPix or ETICS have found the right and most efficient approach is a more difficult question.

5.3 Advantages and Inconveniences of EU co-funding

In the previous section we have already seen that strict rules dictated by the EU have to be applied when a project accepts EU funds. Those rules define quite closely the structure and organization of the project, and some activities related to the management of the project and outreach. This section highlights the advantages and inconveniences of tailoring projects for successful submission to the EU funding programmes. RD-51, a made-up project for the development of gas particle detectors, is used to carry out a case study that compares the organization and objectives of traditional R&D projects carried out at CERN, and the same aspects for a **Collaborative Project** co-funded by the EU within the 7th Framework Programme.

5.3.1 Introducing RD-51

In October 2006, the PH Department has proposed CERN Directorate to help initiating R&D collaboration in micro-pattern gas detector technologies, in analogy to the existing CERN RD-50 [28]. While RD-50 is focused on the development of radiation hard semiconductor devices for very high luminosity colliders, RD-51 goal will be to bundle and coordinate micro-pattern gaseous detector development and simulation work, which is currently being performed in numerous groups at universities and research institutes worldwide.

CERN-PH would coordinate the project and would bring expertise from other CERN Departments as well, bringing together specialists in particle detectors, electronics, simulation, production technology, technology transfer, and where applicable, the collaboration would be complemented with members from the experimental collaborations. The number of non-CERN Research Institutions and potential industry partners are to be defined. Their number, affiliation and type will largely depend on the scope of the project and the source of funds.

The collaboration will allow to:

- Structure, coordinate and focus ongoing R&D efforts.

- Share knowledge, experience and infrastructure, to agree on common test and quality standards.
- Transfer of knowledge to European institutions and Industry.
- Coordinate widespread simulation efforts towards setting-up a common maintainable software package for gas detector simulations.
- Share investment of common projects.

This is expected to lead to:
- An improved understanding of operational parameters (gas, fields, readout structures, MC simulations).
- Optimized detector performance.
- Optimized readout electronics and readout integration with detectors,
- New detector concepts.
- Progress in manufacturability aspects (base materials, fabrication methods, industrialization and cost effectiveness).

While the basis of the project would be Particle Physics technologies, detector development, readout, simulation, etc., the stated aim of an EU co-funded project should be redefined and very targeted to specific FP7 objectives. For instance, such **Collaborative Project** into the **HEALTH**[7] priority theme should develop innovative approaches to in-vivo Bio-Medical Imaging in view of building detector prototypes suitable for clinical trials in selected centres across Europe, for instance. Wining arguments would be the beneficial synergies between High Energy Physics technologies and medical imaging technologies, the collaboration with the best Institutions (academia, industrial, medical), performing R&D that can be easily transferred to industry, and probably including a good selection of industrial partners. Such project would require additional efforts beyond the institutional mandate of the Organization; thus including EU funds would be justified. In any case, this approach can only be validated whenever the final work programme and calls are published and RD-51 objectives' match well with those.

CERN has already attempted to do an **Integrated Project** in FP6 (2002), the so-called EUROMEDIM for the development of medical Imaging Devices. EUROMEDIM was promoted by the CERN Technology transfer Group, with a funding target of €90 million and partnering about 77 participants (research institutions, industry and hospitals). EUROMEDIM was presented as a way to convey to the EC the generic technological transfer in detector, electronics and informatics in the PH Department, given the substantial overlap between HEP and Medical Developments. Unfortunately, the project was not approved.

Another possible, more modest approach would be to position the RD-51 project towards the EC as a **Network of Excellence (NoE).** A **NoE** is an institutional commitment at strategic level from the very start and for the whole duration between a dozen of partners. A **NoE** seems to naturally apply to collaborations organized in the typical Particle Physics way, and even more for a RD-51, where if the activity is not co-funded by the EU there is high probability that the expertise on that field at CERN, therefore in Europe, will disappear. However if potential RD-51 Institutes would start a process towards their national funding agencies, the progression could be slow and the collaboration would

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[7] The **HEALTH** research theme objective *is improving the health of European citizens and, increasing the competitiveness and boosting the innovative capacity of European health-related industries and businesses, while addressing global health issues including emerging epidemics. Emphasis will be put on translational research (translation of basic discoveries in clinical applications including scientific validation of experimental results), the development and validation of new therapies, methods for health promotion and prevention including promotion of healthy ageing, diagnostic tools and medical technologies, as well as sustainable and efficient healthcare systems.*

possibly not be mature enough to launch a EU application on time. It should be taken into account that a **NoE** does not fund R&D activities, but networking actions.

5.3.2 EU co-funded Collaborative Projects VS CERN R&D Projects

Table 5.6 outlines the main differences that can be found in the scope and organization of RD-51 as CERN-EU co-funded **Collaborative Project** or as more traditional CERN Research and Development Project. EU applies a strict set of rules on the number of partners, the management and financial procedures and about some of the type of activities to carry out. The project will probably loose focus as applications and links with SME and industry should be enhanced to increase the chances to succeed in the bid. It should also be taken into account that due to the strict rules set by the EU (managerial, administrative, deliverables) the researchers may sense an important lack of flexibility if the research line or project members need to be changed during the lifetime of the co-funded project. Both for small and larger projects the management and administrative overhead is rigorously ruled and significant, as opposed to standard CERN R&D projects; therefore allocating enough resources and commitment by project's partners are basic to succeed. Dissemination activities are compulsory. Entering into a co-funding scheme should attempted whenever there is a strong and justified need for additional public funding and for such intervention to be at a European level. As for the first point, the additional funding should be justified by the externalities and wider benefits from the research and by the need to attract increased investments. The European level intervention through a collaborative project should be justified by the need to create the necessary multi-disciplinarity and critical mass of scale and scope; to overcome fragmentation and unnecessary duplication, lack of connections and of interoperability; to complement other intergovernmental, national and private actions; to address shared or European level problems; or to enhance visibility of European research excellence.

Due to the existing high interest at European level and excellent research proposed for RD-51, the Collaboration might be able to exist without EU funds, even more, without a significant financial contribution from CERN. CERN would play a strategic, coordinating role and would naturally include organisational, administrative and managerial support for access to facilities at CERN (test laboratories, clean rooms, workshops, beam test facilities, software development, etc.) and some personnel within strategic research areas.

	CERN-EU co-funded Collaborative Project in FP7	R&D collaboration "a la Particle Physics"
Goal	Making the European Union the most competitive and dynamic knowledge-based economy in the world by 2010.	Scientific.
Objectives	To deliver a product to the next-user (cover the range from Research to Take-up). Scientific excellence (beyond state of the art, defined objectives). To merge European leadership. To pose Europe in the leading position in this field of research.	Structured R&D *on gas detectors.* Coherent development *of novel gas detectors* for particle physics experiments. Develop CERN and international expertise in view of *new detectors* in the future.
Deliverables	Clear, quantifiable.	Scientific report and publications. Specific research milestones and workshops.
Potential Impact	Reinforcing competitiveness, solving societal problems.	New detector types useable also in areas beyond particle physics.
Project Duration	2 y, renewable in subsequent EU calls	Not defined, usually 2-3 years initially, renewable – typically 5-7 years overall.
Participants	Consortium with a minimum of 3 partners, fixed for the duration of the project. One single Institute acts as Coordinator. <u>Non-written rules for successful projects:</u>	"Unlimited" number of Universities and institutes across Europe and in CERN observer or non-member states.

Participants	Consortium with a minimum of 3 partners, fixed for the duration of the project. One single Institute acts as Coordinator. <u>Non-written rules for successful projects:</u> • Max of 15 partners • Multidisciplinary • Industry should be in, acting as an equal partner • Gender balance • Favor new member states and third countries, acceding and candidate countries • EU-USA cooperation Possible to have non-contracting partners (do not receive EU funding).	"Unlimited" number of Universities and institutes across Europe and in CERN observer or non-member states. Possible to have "Observer" members in the Collaboration.
Typical Contribution	Up to 75% of the R&D activities, typically ~ 200,000 Euro/partner/y	1-4 FTEs per partner, typically 20-40 partners, 5,000-100,000 Euro material contributions per partner.
Legal Documents	Contract between EU and the Consortium: • Duration of the project • Community financial contribution • Reporting periods • Reports • Payment modalities • Special clauses Consortium Agreement: • Obligations of the coordinator and parties • Organization of the project and boards • Costs and Payments • Liability • Access Rights • Default and termination rules	Technical Proposal, approved by CERN scientific committees. Possibly a Memorandum of Understanding defining: • Objectives • Rules for collaboration • Task/resource allocations • The role of CERN related to use of facilities
Organization of the collaboration	1 Coordinator (that acts as unique link to EU and is responsible for the budget) and multiple Partners. The coordinator typically sets up a Project Office that: • Supports the management activity of the project • Oversees the administration of the project, relations between partners, related projects • Supports events • Maintains website technical pages • Hosts admin staff • Submits deliverables, project reports to the EU	Organized by Scientific Areas. 1-2 Spoke-person and Coordinators or Topic Conveners per scientific areas. A Collaboration Board acts as decision body, with one representative per Institute. Each institute applies for National Funds. The spoke-person manages a low volume Common Fund where each Institute contributes per year. Working groups, Steering groups: • Working meeting 3-4 times per year and topical workshops, specific working meetings as needed for sub-activities • Reports to CERN scientific committees • WEB site • Co-ordinate common efforts pooling resources and distributing work • Discuss, evaluate and publish results
Organization of the work	Work packages well defined before project (for at least the first 18 months), including technical, managerial, and administrative and dissemination tasks.	Work packages reflecting the scientific needs of the project. They are usually organized in sub-projects or working groups. Dynamic structure that can be changed as the project develops.
Reporting	Clear reporting guidelines, dictated by EC FP7 rules. Heavy monthly, quarterly and yearly reporting. Audits.	To CERN scientific committees, to National Funding Agencies for partners, to scientific committee in partner countries, to conferences and other projects.
Management	Need a strong 'Project Management" Plan form the start	Steering Groups and overall project management, developed as needed. Collaboration Board with one representative per institute for approval of major decisions,

Table 5-6 Main differences of RD-51's organization when it is set up as a CERN-EU Collaborative Project or a traditional CERN R&D project.

5.3.3 Proposed Organization of RD-51 as FP7 Collaborative Project

For a CERN-EU co-funded project, the work is to be organized in work packages (WP), with tasks associated to them. Partners are allocated to one or more tasks. RD-51 has two types of partners: contracting and non-contracting. The first type sign the RD-51 contract and will receive contributions from the EU, whereas non-contracting partners do not receive any EU contributions but are interested in the programme of work and may participate in some RD-51 activities

Based on FP6 experience, there are some unwritten rules for the Work Plan Organization. It would be advisable to follow them, when possible, for RD-51:

- Establish a WP for Exploitation/Dissemination
- Identify and name partner in order of priority
- Avoid everyone in every WP
- Avoid one partner per WP
- Avoid partners doing work in every WP
- For a project of about 6 WPs, every partner should lead one WP and be involved in 2 others

The chart in Fig. 5-3 shows a simplistic WP organization for RD-51. WP3, Joint Research Activities, for simplicity comprises all research activities but probably it will need to be fragmented, especially if the project has to be tailored to fit into the HEALTH topic. CERN-PH would appear as WP responsible for Detection Technology Development, and other institutions from other disciplines would be responsible of the Clinical Validation, Implementation, Treatment Simulation, and so on.

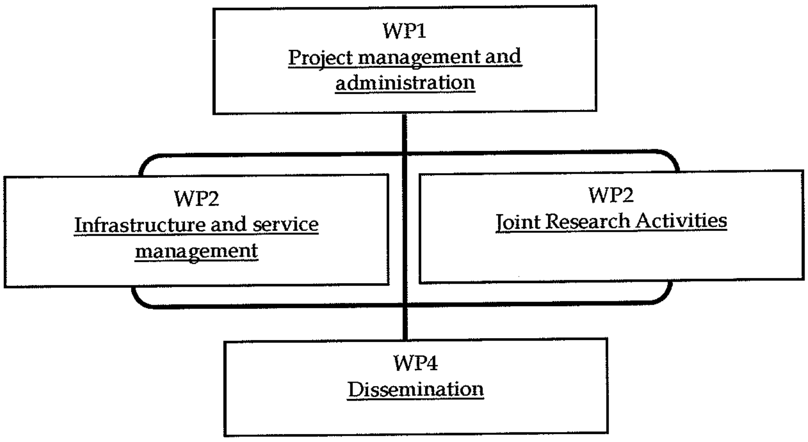

Figure 5-3 A possible organization of RD-51 in four different work packages.

WP1: Project management and administration

WP1 is explicitly responsible for Consortium Management and Quality Assurance and Progress Monitoring Plan.

The tasks that fall in this WP are:

- To manage the project work programme and coordinate the all project activities. Consortium management refers to activities such as establishing Governing bodies, Project Members registration, WP Activity Plan, Documentation Management Policy, Risk Management.

- Establish reporting procedures
- Establish and train administrative staff
- Defining a Quality Assurance Plan for reviewing and assessing project results and progress towards its objectives, for all work packages. This includes producing quarterly reports for further analysis and actions as required.

Deliverables: Structure of the Consortium, Work Breakdown Structure, Work Breakdown per partner, Time Schedule, Work package description, Deliverables Table, Quality Assurance and Progress Monitoring Plan

WP2: Infrastructure and service management

WP2 is responsible for identifying, setting up, maintaining and expanding as required, the resources and facilities needed to run the project: beam lines, laboratories, clean rooms, workshops, hardware, databases and repositories of software activities, etc.

WP3: Joint Research Activities

Most of funding should go towards the Joint Research Activities, which are divided into five different areas:

- Joint Research Activity 1 (JRA1) is progress in manufacturability aspects (base materials, fabrication methods, industrialization and cost effectiveness) and the development and Quality Assurance for production.
- Joint Research Activity 2 (JRA2) is Optimization of Detector Performance.
- Joint Research Activity 3 (JRA3) is optimized readout electronics and readout integration with detectors.
- Joint Research Activity 4 (JRA4) is Simulation Work and includes the coordination and widespread simulation efforts towards setting-up a common maintainable software package for gas detector simulations aimed at an improved understanding of operational parameters (gas, fields, readout structures, MC simulations).
- Joint Research Activity 5 (JRA5) is Development of Medical imaging Systems and Industrial applications (Security, QC, etc).

WP4: Dissemination

WP4 includes the organization of dissemination events, workshops, training, outreach and any other networking activity required to promote the work of the project. WP4 also maintains internal WEB pages and ensure that project members are kept accurately informed of all activities.
Special emphasis will be done to raise awareness of the project among industry and to encourage businesses to participate in the project. Innovation-related activities, such as socio-economic studies to measure the impact of results and exploitation plans, would fall into this WP, and are developed to ensure the optimal use of the project results.

Deliverables:

- Yearly Workshops on RD-51 results
- Scientific Publications and Notes
- Publishing a newsletter twice a year for Industry
- Organizing and managing a working group on industry-related issues
- Fostering contact between industry and RD-51 members.

The success of a proposal in FP7 would strongly depend on the assessment by the EC's evaluators of the potential impact of proposed projects. This is to be measured as potential routes for exploitation, economic and social impacts and the project impact on EU policy. Therefore explaining accurately and extensively all those aspect is of key importance. Table 5.7 shows an approach to find out the potential impacts of RD-51 if set up as a **EU Collaborative Project** in Basic Science. It starts identifying the results to be obtained and who is the next user of those results. Then it translates those results into the language of that next user and finalizes proposing ways to disseminate and exploit them.

	Potential Impact of RD-51		
Results	**Next User**	**What User Calls RESULT**	**Dissemination and Exploitation**
Improved knowledge of Gaseous Detectors	Basic/Applied researchers	Scientific Publications	Scientific Journals, Books
Scientific Data	Basic/Applied researchers	Validation and Reference Data	Websites, Databases
Reports on Results	Basic/Applied researchers, Lecturers	Post-Graduate Course Material	Master and PhD programmes
Report on optimized Medical Imaging Systems	Engineering Department Medical Imaging Systems' Companies	Design Specifications of Medical Imaging Systems	Further Development by a Partner Joint Ventures

Table 5-7 Potential impact of the RD-51 collaboration.

6 Recommendations for future submissions of co-funded projects in the Physics Department

This chapter gives a list of recommendations for future submissions to EU funds, referring to the context, partners, technology areas and effectiveness of such proposals with respect to the main aims of the CERN Physics Department, so that to ensure that the Department is well-placed to make successful proposals. We also present, for further discussion, two other strategic proposals for the coordination of actions at longer term. These cannot be followed up by CERN-PH alone but requires coherent action for CERN as a whole including its CERN-EU office and Technology Transfer Group. However, if successful, they can enhance significantly the CERN-PH EU related activities. These two proposals are related to Accelerator and Detector R&D at European scale for new infrastructures (LHC upgrade, CLIC, ILC or Neutrino facilities) and CERN School of Technology, as a mean to disseminate knowledge and promote potential applications of CERN technologies within industry, as well as to bring up to date industry with the technological needs of CERN.

6.1 Proposed Strategy to Succeed Co-Funding CERN-PH Projects

The underlying studies leading to these conclusions are related to CERN's future role within the field of Particle Physics and experiences from FP6 (Chapter 3), the structure of FP7 and investigations of the role of external consultants (Chapter 4), and the case studies of various projects (Chapter 5).

<u>Organizational:</u>

1) Restructuring the role of the EU office (from advisor to active role), helped when needed by external, private institutions specialized in EU funding. Track record of EU-programmes increases significantly the credibility of Project Coordinators and Host institutions. The EU office should be made responsible of collecting procedures and practices from projects CERN-wide, from the proposal to the running phases, in order to disseminate experiences and optimize procedures. An accurate database of submissions should be created. The office could be helped by the creation of a formal Advisory Group including experienced FP participants, evaluators, Department administrators, etc. This strategy may foster interdisciplinary approaches and ensure presence in Brussels. In addition, the extra-load intrinsic to EU projects (heavy reporting and difficulties to manage EU funds within the CERN rules) can be minimized if external consulting firms are

included as project partners, taking the full responsibility of the project and administration management work package.

2) It is CERN's experience and consulting firms' view that the vast majority of proposals that are successfully submitted to the EC for funding have been discussed in some way in Brussels prior to their formal submission. The project has to be well known to decision makers in Brussels. Even if a project fails upon a first trial, it can succeed upon a second trial, after intensive discussion of threats and concrete answers of the project with the administrators before the submission. Note that messages from EU high officials about preference and guidelines of particular funding schemes may not match the evaluation criteria followed after by independent evaluators. Consulting firms have also been proven to be efficient in identifying partners (industrial) for projects, while in general they do not have the necessary expertise, or willingness, to go into a research organization as CERN to identify the most suited technologies for EU projects.

3) Get the CERN Technology Transfer (TT) group actively involved in the selection of technologies, giving TT a pro-active role in specific work packages. A EU project is not only about doing the work and getting paid, but also protecting, publishing, and utilizing the knowledge generated. Management of intellectual property and exploitation of results, both the anticipated direct results and any unexpected spin-offs, is fundamental to achieving a highly rated project. It should be noted that already now about 30% of the CERN-TT projects are linked to CERN-PH, such that strong links already exist for many specific projects.

4) R&D projects on applied science can be significantly boosted by collaboration with industry in general. If this could be considered a serious opportunity for CERN, EU co-funding should be seen as one of the many existing possibilities, and not the only mean to increase to some extent R&D at CERN. A possible help would be establishing a dedicated Office that would receive all proposals and direct projects to the best funding opportunity (industry, private investors, EU funding programmes, etc). This must be done building on the existing CERN-TT and CERN-EU offices to ensure coherence.

<u>Interactions with CERN users and industry:</u>

5) It is advisable to reorganize the interactions of CERN-PH with its user community to be able to launch successful FP7 projects related to **Research Infrastructures** in particular. This is to some extent foreseen in the European Strategy for Particle Physics. CERN is supposed to take a wider role than today but the driving forces for detector R&D for such facilities are large collaborations where CERN-PH is typically a 10-20% partner. CERN-PH must therefore define carefully its role in such proposals to make sure their contribution is coherent with the overall goals of these projects. The risk is otherwise that CERN-PH appears as competitor to EU proposals made by its own user community.

6) A key factor in FP7, seen across all its work programmes, is the effort of the Commission to involve European Industry in the definition of the research themes, and the rather explicit request to involve industrial partners in project proposals. To start partnerships between CERN-PH and Industry two approaches, jointly coordinated by CERN-PH and CERN-TT, would appear feasible: i) to find industrial suppliers that have already worked in projects with the PH Department for the LHC, trying to get an insight on their interest and capacity to participate in partnerships for industrial development in EU-projects, and ii) to understand the interest of using CERN infrastructures (magnets, beam lines, specialized labs in the Physics Department) for testing technical developments driven by SME and/or for carrying out experiments not related to Particle Physics, but where PH would benefit at long-term acting as partner or sub-contractor in EU-funded projects.

Practical recommendations:

7) The timeline of EU projects is very strict. When the funding is terminated after 2-5 years, the project is over and deliverables have to materialize. Therefore it is advisable to apply for funds for mature projects, and for funds to be used to enlarge the scope of projects.

8) Experts in the different research fields of the Physics Department, and CERN in general, should be encouraged to sign up as referees (expert evaluators) for the EU Framework Programmes. Training courses are available [29]. The expertise that is gained in the evaluation procedures becomes key for writing good proposals.

6.2 Correlation Between Specific CERN-PH Fields of Research and FP7 Funding Opportunities

Table 6.1 shows the main fields of expertise in CERN-PH, the FP7 funding opportunities identified as most suitable, and the type of instruments and suggested actions to target.

TOPIC (PH Department)	FP7 Programme	Actions to target
Microelectronics & Electronics	PEOPLE	EST Network (CERN & SMEs) Fellows in the co-funding scheme Industry-Academia partnership International Dimension
	COOPERATION	Partner in Collaborative Projects Network of Excellence
Acquisition and Control Developments for Physics Experiments	PEOPLE	EST Network (CERN as single point network) Fellows in the co-funding scheme Industry-Academia partnership International Dimension
Technical computing: simulation and analysis toolkits	PEOPLE	EST Network (CERN & SMEs) Fellows in the co-funding scheme Industry-Academia partnership International Dimension
	COOPERATION	Partner in Collaborative Projects Network of Excellence
	CAPACITIES	Research Infrastructures
Detector development	PEOPLE	EST Network (CERN & SMEs) Fellows in the co-funding scheme Industry-Academia partnership International Dimension
	COOPERATION	Coordinator in Collaborative Projects Partner in Collaborative Projects Network of Excellence Support Actions
	IDEAS	ERC Grant
	CAPACITIES	Research Infrastructures
Engineering	PEOPLE	EST Network (CERN & SMEs) Fellows in the co-funding scheme Industry-Academia partnership International Dimension
Experimental Particle Physics (for the LHC running experiments)	PEOPLE	EST Network (CERN as single point network) Fellows in the co-funding scheme International Dimension
	IDEAS	ERC Grant
Theoretical Physics	PEOPLE	EST Network (CERN as single point network) International Dimension

Table 6-1 Expertise in CERN-PH and potential funding opportunities in FP7.

Table 6.1 shows the following when turned into recommendations for each of four FP7 programs:

1) For CERN-PH the continuation and development of the Marie Curie Schemes (**PEOPLE**) is important and have a high likelihood for success.

2) Projects within **COOPERATION** are interesting when looking at the wider scope of CERN's missions including training, spin offs and outreach. These projects have a tendency to stay outside CERN's main research lines as they are linked to main thematic lines of FP7, out of which Health, Security, Materials and IT might offer possibilities for CERN-PH. In many cases CERN-PH should act as partner for certain areas and take the leading role in others. As the funding instruments are not yet detailed this possibility should be evaluated carefully over the next months. The industrial links must be fully exploited to increase the likely hood for success in this programme (see also section 6.4).

3) **IDEAS** is a new type of project (grants) based on scientific excellence. CERN must attempt to identify young researchers who can apply for this type of support, with adequate backing, and innovative projects.

4) **CAPACITIES** have so far allowed the most directly useful funding instrument for European Particle Physics, either with accelerator physics, GRID developments or detector R&D. However CERN-PH has not been central in any of them. Given the development with respect to a European Strategy for Particle Physics where R&D areas with CERN as a central part are identified, and the status of LHC project allowing some resources to be directed towards R&D over the next years, one of the main priorities for CERN-PH is to work with its user community and industrial partners to plan good projects within this programme. This suggestion is expanded in the next sections (6.3 and 6.4).

6.3 European Particle Detectors Development

The possibilities for CERN-PH within the FP7 programme **CAPACITIES** can be very significant but some strategic groundwork is needed to position CERN-PH correctly within European networks that can successfully make bids in this area. Four points should be recalled to motivate these strategic moves:

a) The CERN Council has recently prepared a Strategy for European Particle Physics [6] increasing CERN's role in new projects in Particle Physics (its organization needs to be adapted to do this), also outside CERN's own programme. Four new facilities were identified: upgrades of the LHC machine and detectors, R&D for novel linear e-e+ colliders (CLIC), participation in the International Linear Collider (ILC), and a global neutrino programme. All these projects require very substantial accelerator and detector R&D. This has been discussed in section 3.1.

b) A very similar and successful steering body exists for European accelerator R&D, ESGARD [11], discussed in section 3.2.

c) Other institutions in Europe have examples of successful EU proposals and projects of this type, running as part of FR6: EUDET [30] for ILC detectors and GSI for Nuclear Physics detector developments [31]. Both these will stop in 2008.

d) As discussed in Section 4.2.4, a first version of the Large-scale Research Infrastructures Roadmap has recently been published by ESFRI and it adapts the priorities as defined by the before mentioned European Strategy Group for Particle Physics as the main priorities for European Particle Physics facilities.

The clear strategic recommendation is therefore for CERN-PH, as part of a much wider network of groups and industries, to make sure that detector R&D for the above mentioned facilities can be pursued as part of FP7.

Going beyond such a recommendation it is worth thinking about ways to do it. There are at least two possible implementations of an European Steering body for such developments, one would be to extend the composition and mandate of ESGARD (European Steering Group on Accelerator R&D) to cover also detector R&D, or to set up a parallel body called **European Steering Group for Detector Instrumentation (ESGID)** with a similar role in the area of Detector development for future facilities.

In either case the composition of such a group of experts would have to be different since the R&D activities would be widespread across a large number of universities, institutions and laboratories in Europe, much larger than in the case of accelerator R&D. To encompass all these institutions it would therefore be most efficient to make sure the large experiments planned for the future are represented in the Steering Group, and throughout their contacts to their institutional members cover the entire field. The members would certainly include the LHC experiments, CLIC and ILC detector representatives, and representative(s) from the European Neutrino Physics community. It would be natural for CERN to take an initiative to set up such a Steering Group and possibly the European Committee for Future Accelerators (ECFA) could play a similar role as they do for ESGARD. Through the CERN Council and ECFA the European Funding Agencies and the major laboratories are well informed and can influence ESGID.

A composition based on the large experiments, as opposed to laboratories and research institutions, would have several additional benefits:

- The R&D work would be directed and focused towards experiments being planned in the relatively near future such that well-defined objectives can be defined.
- Co-ordination across the experiments will be taken care of, currently there is very little contact between R&D groups that have different projects in mind.
- An overall European framework for this work would maximize, maintain and develop the use of a distributed resources (personnel and funding) and facilities across Europe. These R&D projects are also great for student training and would allow students on most of the CERN user community to participate in technical development and instrumentation R&D.
- Since these large collaborations are truly global such a composition would also ensure contact and co-ordination beyond Europe.
- ESGID would be the right partner to developing a stronger dialogue with European institutions (the Commission, the European Parliament), contributing its expertise to the development of discussion and decision-making at EC level.

In a similar way as done for ESGARD several Contact Groups can be set up, preparing FR7 bids for specific programs, for example for LHC upgrades, linear e+e- collider experiments, and possible more. The timescale for setting up such a Steering Group would be first half of 2007, aiming to prepare proposals for start-up in 2008.

CERN's responsibility, as defined in the European Strategy for Particle Physics, for setting up such a Steering Group is clear and the model successfully adapted for ESGARD suggests a way to do it. CERN's role in the actual R&D projects would, as for ESGARD, be strategic and limited by resources, but would naturally include organisational, administrative and managerial support for projects, access to facilities at CERN, some personnel within strategic research areas, and a limited materials budget.

6.4 CERN School of Technology

The last strategic recommendation also requires actions beyond CERN-PH itself but has clear potential for improved research and technologies, technology transfers, industry collaboration and outreach for CERN-PH.

The importance of industry involvement has been repeatedly pointed out in the context of FP7. In that direction, we have tried to understand how industry could play a key role in projects at CERN. Two directions appear possible: on one hand, basic science projects, as traditionally run at CERN, could be slightly aligned to match EC requirements, involving industrial partners in the Consortiums. The study of two CERN projects with industrial partners (Section 5.2) has shown the beneficial effects of such partnerships. The bi-directional transfer of know-how and know-who pays back. On the other hand, CERN can position itself as high-tech center demanding technology, so CERN groups could play key roles as partners (as opposed to Coordinator of projects) or sub-contractors for projects submitted and lead by technology industry.

We have tried to find consulting companies that would commit to scan all available technologies in CERN-PH and pick up those that, on the basis of technology excellence, innovation and maturity, would be more attractive for EU co-funded projects, therefore to industrial companies that would play a key role in Consortiums with CERN. Many consulted companies claim to lack the scientific expertise needed to study and evaluate all the available possibilities. The potential benefit of getting to know all possibilities for technology development seems too time consuming and would need a major effort.

A measure to overcome the lack of knowledge about CERN technologies by European industry and vice versa is widening the Technology Transfer (TT) activities. In year 2000 CERN introduced a proactive TT policy to identify, protect, promote, transfer and disseminate its innovative technologies in the European scientific and industrial environment. There are key elements suggesting extending CERN's technology transfer activity to include a CERN School of Technology as a complementary tool for successful and efficient technology and knowledge transfer from a world-class research environment to technology industry. Those key elements are CERN's technical expertise, the existing research network, and CERN's extended collaboration with industry.

The school should have a bi-directional technology transfer process. This should be achieved by highlighting CERN research, industry frontline for some selected technological areas to enable researchers to learn about the state of the art of these selected research fields and market trends, and in the opposite direction, to allow some industries to develop their technical findings at CERN. Such an event has the potential of placing CERN and CERN's technology transfer activity at a highly visible centre of an increasing network of researchers, industries and technology transfer experts in Europe, creating new opportunities for collaboration and projects in the future. Among such projects EU funding is a clear possibility for support in the first phases.

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Appendix I

List of consulting companies investigated for the study carried in Section 4.4.

A list of some other available consulting firms, ranging from global full-service networks with an EU affairs subsidiary to individual experts, can be found at: http://www.euractiv.com/en/Fixed/consultancies/index.htm

Company Name	WEB Page	City, Country
CHALEX Research	http://www.chalex.com/	Devon, UK
IAGO European Consultants Ltd	http://www.iago.eu.com/	Leeds, UK
ACIES	http://www.acies.fr/index.php	Lyon, France
ALMA Consulting Group	http://www.almacg.com	Lyon, France
VITAMIB SARL	http://www.vitamib.com	Meylan Cedex, France
WelcomeEurope	http://www.welcomeurope.com/	Paris, France
IDETRA	http://www.idetra.com/english/index.html	Madrid, Spain
European Toolbox	http://www.europeantoolbox.com/	Barcelona, Spain
Berkley Associates	http://www.berkleyassociates.be	Brussels, Belgium
European Research and Project Office GmbH	http://www.eurice.de/	Saarbrücken, DE
SCIPROM	http://www.sciprom.ch/	Lausanne, CH
EURELATIONS	http://www.eurelations.com/en/	Zurich, CH

Appendix II

Correlation between the existing funding schemes in FP6 and FP7, for the latter showing also the minimum and optimal number of partners for each type of Instrument.

Framework 6	Framework 7	Minimum	Typical Size
Integrated projects	Collaborative Projects	3	8-20
STREPS			
Networks of Excellence	Networks of Excellence	3	15-20
Article 169	Article 169 + 171		
Specific Support Actions	Co-ordination and Support Actions	1	1-20
Co-ordination Actions			
Research Infrastructures	Research Infrastructures	1	1
Marie Curie Fellowships	Marie Curie Fellowships	1	1
CRAFT/Collective	Research for SMEs/Associations	5	10
	Frontier Research Grant	1	1