FORCE -
10 Years of Funding Research at CERN

1997 - 2007

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Swiss National Science Foundation

Contents

Editorial

In the early fall of this year, the world's most powerful particle accelerator is due to start up at the European Organization for Nuclear Research (CERN) in Geneva. Scientists hope to provide answers to some fundamental questions concerning the structure of matter through experiments that will be made possible for the first time by this piece of equipment. In order to gain access to this world of minute detail, it is necessary to use enormous instruments – and these come at a price. Although the Large Hadron Collider (LHC), the accelerator facility itself, was paid for by the CERN Member States' contributions, it is the scientists themselves who have to foot the bill for the detectors.

The two particle beams inside the LHC, travelling in opposite directions, are made to collide with each other in four places around the accelerator ring. Researchers are trying to prove the existence of the yet-to-be-observed Higgs boson by extremely precise measurements of the daughter products. Swiss researchers are participating in the work on two large detectors (ATLAS and CMS) and on one of the smaller facilities (LHCb). The question of who was to bear the enormous cost of this infrastructure was raised early on. Various initiatives to try to obtain additional funding for the project from the Swiss Federal Council or the Swiss Parliament were unsuccessful. The Swiss National Science Foundation (SNSF) was cautious about putting monies entrusted to the Foundation for supporting basic research into the costly construction of these experimental facilities. The starting point from which these problems were resolved came about purely by chance: under pressure from Germany, the Member States' annual contributions to CERN were reduced. At the request of the Swiss community, the Federal Council authorized the use of the unexpectedly available funds for the construction of detectors for CERN research projects. The article by P.E. Zinsli (section 2.5) explains in greater detail the creation of the Fund for Research at CERN or FORCE *(**FO**nds pour la **R**echerche au **CE**RN)* budget line. In the years that followed, the SNSF – on behalf of the State Secretariat for Education and Research – evaluated research applications and made recommendations on allocation of the FORCE funds. This was something new for the SNSF – reviewing research proposals that the SNSF would not be funding itself. Although the total amount of CHF 3 million per year seems relatively small as compared to the cost of the LHC detectors at CHF 500 million, the support was decisive in enabling researchers in Switzerland to take part in the CMS, ATLAS, and LHCb experiments. Other, smaller experiments at CERN were also made possible by the support of the FORCE funds (DIRAC, Athena, Opera), to which the contributions by F. Pauss (section 2.3) and M. Bourquin (section 2.2) bear witness. H.R. Ott describes how the National Research Council of the SNSF adapted to the new situation, where its role was not to evaluate entire research projects but to make decisions on investments in equipment (section 2.1).

Looking back today, it can be said that the FORCE contributions were decisive in enabling Swiss groups to participate in the experiments. The initiative for this type of funding came from the researchers, and with persons at the different institutions putting their heart and soul into supporting it, the result was success.

Readers who would like to learn more about what stands behind the abbreviations CMS, LHC, and LHCb will find brief descriptions (section 1) of these particle detectors that were co-financed by FORCE.

This brochure is by way of a thank-you to everyone who contributed to the success of what was initially a unique form of financial support for particle physics research. Thanks to the success of this initiative, it was possible to convince Parliament to institutionalize this infrastructure support for major experiments for the federal funding period 2008-2011.

Paul Burkhard
Head Mathematics, Natural and Engineering Sciences
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1. The Experiments Funded

This section presents short descriptions of the various experiments funded by FORCE in the last ten years. Most of them are closely related to the construction of the Large Hadron Collider (LHC) at CERN, for which CERN has announced a start-up date of September 10, 2008. The LHC, 100 m underground and 27 km in circumference, will be the world's most powerful particle accelerator. The colliding of particles at TeV energies will enable precise measurements of the properties of known objects as well as the exploration of physics at energies ten times higher than previously achieved. Physicists look forward to confirming the existence of the Higgs Boson and studying new physics beyond the Standard Model. The huge amount of data to be collected in the coming years is expected to provide an immense gain in knowledge.

Many experiments are under construction along the LHC tunnel, including the detectors ATLAS, CMS, and LHCb. ATLAS and CMS are general-purpose detectors, while LHCb is dedicated to precise measurements of b-quark physics, in particular CP violation and rare decays.

1.1 ATLAS

ATLAS (**A T**oroidal **L**HC **A**pparatu**S**) is a general purpose particle detector designed to measure the broadest possible range of signals. It has impressive dimensions (46 m long, 25 m wide, 25 m high, and 7,000 tonnes) and is one of six experiments planned to explore particle physics along the LHC. The unprecedented energy and extremely high rate of collisions generated by the LHC require ATLAS and CMS (see section 1.2) to be larger and more complex than any detector ever built.

The project involves roughly 1,700 scientists and engineers at 159 institutions in 37 countries. In Switzerland, groups at the universities of Berne and Geneva are involved. The R&D for the detector components was conducted at the participating institutions, which also supervised the construction, carried out in collaboration with industries. The detector components were shipped to CERN and assembled in the ATLAS experimental pit beginning in 2003.

One of the most important goals of ATLAS is to search for the only missing piece of the Standard Model, the Higgs boson, which would be identified by the particles into which it decays. In addition, ATLAS may allow much more accurate measurement of the properties of known particles, such as the top quark or the W boson. The possibility to make precise measurements of the mass and interactions of particles could provide indirect information on the details of the Standard Model, perhaps revealing inconsistencies that point to new physics. Moreover, ATLAS, like OPERA, will provide clues on exciting physics beyond the Standard Model, namely, supersymmetry or extra dimensions.

The ATLAS detector consists of series of concentric cylinders around the interaction point where the proton beams from the LHC collide. It consists of four major components: the inner detector, the calorimeters, the muon spectrometer, and the supraconducting magnet systems with a field intensity of 2 T. Each of these is in turn made of multiple layers. The detectors are complementary: the inner detector tracks particles precisely, the calorimeters measure the energy of easily stopped particles, and the muon system makes additional measurements of highly penetrating muons. The two magnet systems bend charged particles in the inner detector and the muon spectrometer, allowing the momentum of the particles to be measured.

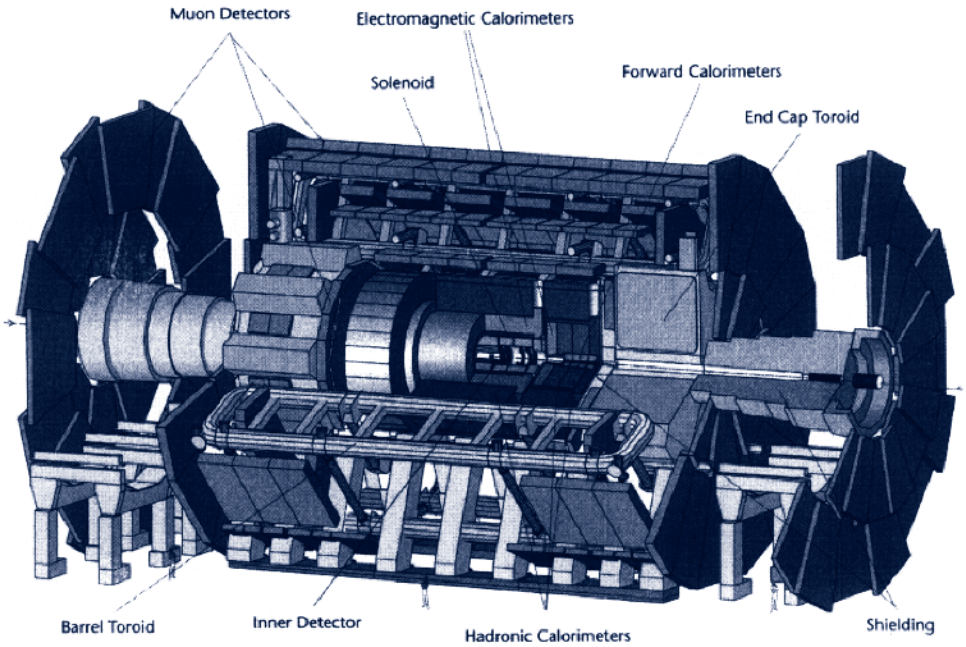

Figure 1: Three-dimensional view of the ATLAS detector

1.2 CMS

CMS (**C**ompact **M**uon **S**olenoid) is designed as a general-purpose detector to run at the highest luminosity at the LHC. It will be capable of studying many aspects of proton collisions at 14 TeV and is optimized for the search for the Higgs boson over a mass range from 80 GeV to 1 TeV, but it also allows detection of a wide range of possible signatures from alternative electroweak symmetry breaking mechanisms. In addition, CMS is well adapted for the study of top, beauty, and tau physics at lower luminosities and will cover several important aspects of the heavy ion physics program.

The experimental concepts of ATLAS and CMS are different, which will allow a cross-check of the scientific results, which means confirmation or refutation of the discoveries.

At the core of the CMS detector there is a large superconducting solenoid generating a powerful and homogeneous magnetic field of 4 T, leading to a compact design. The CMS contains subsystems that are designed to measure the energy and momentum of photons, electrons, muons, and other products of the collisions. The innermost layer is a silicon-based tracker. Surrounding that is a scintillating crystal electromagnetic calorimeter, which is itself surrounded by a sampling calorimeter for hadrons. The tracker and the calorimeters are compact enough to fit inside the CMS solenoid. Outside the magnet are the large muon detectors, which are inside the return yoke of the magnet. Muons are strongly penetrating particles that are able to go through the internal detectors.

Like ATLAS, CMS is the result of a large and worldwide collaboration. Swiss participants belong to groups from the Swiss Federal Institute of Technology Zurich (ETH Zurich), the Universities of Zurich and Basel, and the Paul Scherrer Institute (PSI).

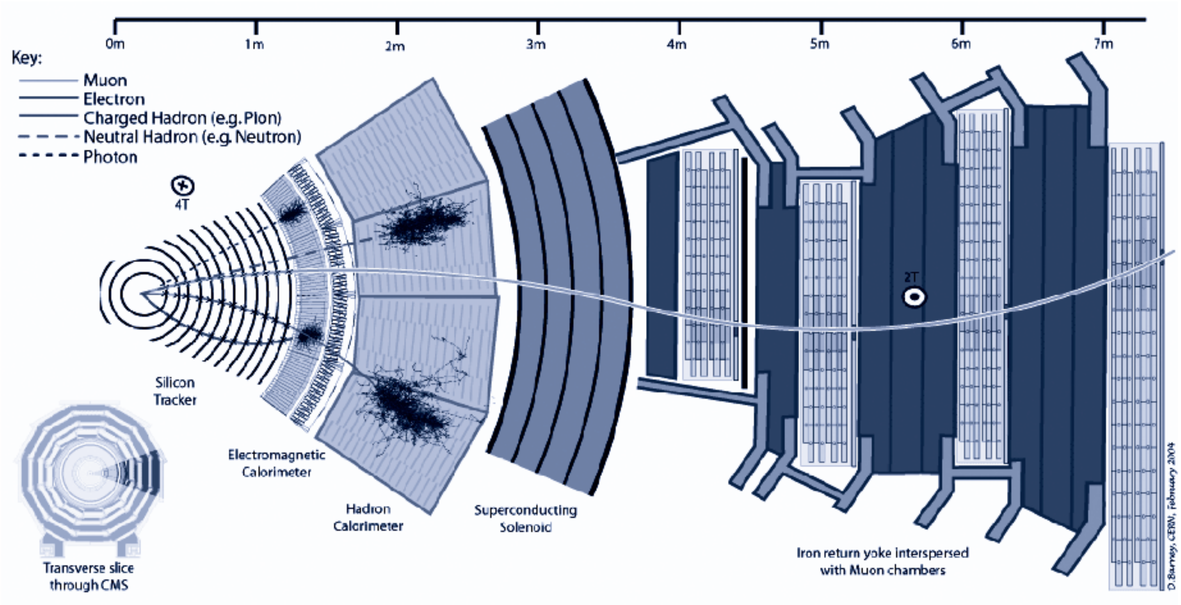

Figure 2: Transverse view of the CMS detector

1.3 Other Experiments (LHCb, L3, ATHENA, OPERA, DIRAC)

1.3.1 LHCb

The "b" of LHCb refers to b-hadrons that are heavy particles containing a bottom quark. The LHCb detector will be the most sensitive instrument ever created to detect tiny differences between matter and antimatter. Its objective is to record the decay of b mesons, which are particles containing b or anti-b quarks. The asymmetry between the behavior of matter and antimatter is known as CP violation. Current experiments have not yet detected sufficient CP violation in the Standard Model to explain the lack of detectable antimatter in the universe. It is possible that new models of physics will introduce additional CP violation, shedding light on this problem; these models might either be detected directly by the production of new particles, or indirectly by measurements made of the properties of b mesons.

The LHCb experiment is designed to record specifically b mesons and the products of their decay. Rather than flying out in all directions, b mesons formed by the colliding proton beams (and the particles that they decay into) stay close to the line of the beam pipe, and this is reflected in the design of the detector. Other LHC experiments surround the entire collision point with layers of sub-detectors, like an onion, but the LHCb detector stretches for 20 meters along the beam pipe, with its sub-detectors stacked behind each other like books on a shelf.

The total number of participants in the LHCb experiment collaboration is 680, of which 39 are affiliated to Swiss research institutions (Ecole Polytechnique Fédérale de Lausanne EPFL and University of Zurich).

1.3.2 L3

L3 is a particle detector that was running on the LEP (**L**arge **E**lectron **P**ositron Collider) which is the accelerator precursor to LHC. It was designed to detect particles produced in the collision of electrons and positrons circulating in the LEP ring. This detector started taking measurements in 1989 and was already operational at the time when the FORCE program started. Therefore, only maintenance costs have been financed. L3 has produced many valuable contributions to particle physics together with the other experiments at LEP. Groups from many Swiss universities have been working on the L3 experiment.

1.3.3 Athena

The ATHENA experiment, also called “antimatter factory,” deals with the production and spectroscopy of antihydrogen. Antiprotons and positrons are decelerated by cooling them to temperatures within a few degrees of absolute zero. The antihydrogen atoms must be created cold, since they annihilate if they interact with normal matter such as liquid helium. The ultimate goal is to make a spectroscopic comparison between hydrogen and antihydrogen, more specifically to compare the frequencies of the 1S-2S electronic transition (ground state to first excited state) in this atom/anti-atom pair. These investigations aim at obtaining fundamental results on the symmetry between matter and anti-matter and test CPT invariance.

Among the many scientists involved in ATHENA, Switzerland is represented by researchers at the University of Zurich.

1.3.4 Opera

OPERA (**O**scillation **P**roject with **E**mulsion-t**R**acking **A**pparatus) is a detector located at the Gran Sasso Laboratory in central Italy and is designed to record the interactions of neutrinos sent from CERN, 732 km away. The main goal is to observe oscillation from muon neutrinos into tau neutrinos and identify which neutrino flavors take part in the oscillation relative to the atmospheric neutrino signal. These experiments are of fundamental interest in particle physics and neutrino physics. The CERN Neutrino to Gran Sasso (CNGS) beam is now operational, and OPERA has started taking data.

The OPERA collaboration involves more than 150 researchers from 35 research institutes and universities worldwide. The Universities of Berne and Neuchâtel have been participating in OPERA for several years, and the ETH Zurich group joined the collaboration in 2006.

The beam line incorporates a target to produce hadrons and a magnetic horn and reflector to focus them before they decay to muons and neutrinos in a 1 km vacuum pipe. At the end of the decay pipe, a barrier of graphite and iron absorbs the remaining hadrons, leaving only muons, which are quickly absorbed downstream in the rock and a beam of muon neutrinos travelling towards Gran Sasso. Due to the very low interaction with matter within the weak force, the neutrino beam is subject to almost no attenuation on its way to the detector. The OPERA detector at Gran Sasso is made of two identical supermodules with a total target mass of about 1.35 kton and with a total of more than 100,000 single detectors (called bricks). Each single detector consists of series of lead and photoemulsion sheets for the detection of charged particles that are produced by neutrino reactions. The target is complemented by scintillator trackers used for the real-time localization of interaction vertices. In addition, muon spectrometers stand behind the supermodules, consisting of a precision drift tube tracker, a 1.55 T magnet, and resistive plate chambers. As the OPERA detector contains both passive elements (photoemulsions) and active elements (electronic detectors), it is designated a hybrid detector.

1.3.5 Dirac

The DIRAC experiment aims to investigate the lifetime of K-pi atoms, that is, a negatively charged pi-Meson and a positively charged kaon, which are bound through the Coulomb interaction and can disintegrate into neutral pi-Meson and kaon. This disintegration can be precisely calculated using the chiral perturbation theory. The experimental test of these theoretical predictions is of central importance for an understanding of the strong force in the energy domain, which cannot be handled using perturbation theory.

The experimental setup consists of a high precision magnetic double arm spectrometer, installed in the high intensity proton beam of the CERN Proton Synchrotron.

Like the other experiments, DIRAC is a collaboration of researchers from many countries. In Switzerland, groups from the Universities of Basel and Zurich have been supported by FORCE.

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2. The Various Viewpoints

2.1 Evaluation of Proposals

Hans Rudolf Ott, Former President, Mathematics, Natural and Engineering Sciences Division of the National Research Council of SNSF

In 1997, the Swiss National Science Foundation (SNSF) was mandated the task of allocating financial resources for the funding program *Fonds pour la Recherche au CERN* (Fund for Research at CERN), or FORCE for short. Within SNSF, this task was delegated to Division II, *Mathematics, Natural and Engineering Sciences*, of the National Research Council (NRC Div. II). The first meeting of the steering committee (LA) of the FORCE program, known as LA FORCE, took place at the close of 1997, with the committee comprising representatives of the Federal Office for Education and Science (FOES) (which is today the State Secretariat for Education and Research (SER)), the Board of the Swiss Federal Institutes of Technology (ETH Board), SNSF, and the Swiss CERN delegation, and Swiss physicists actively engaged in research at CERN. This meeting defined the major guidelines and recommendations by which existing financial resources were to be allocated annually. The subsequent annual meetings of the LA FORCE held over the course of the past 10 years have, with only a few general changes, proven effective with respect to the selecting of meeting participants and agenda items.

From the point of view of the NRC Div. II, it was clear from the outset that, as a general rule, proposals submitted for FORCE funds could neither be evaluated nor funds allocated to them on the same premises as the SNSF funding procedure treats common individual projects. It was particularly important to consider the recommendations of LA FORCE, which in the beginning were focused primarily on compensating somewhat for the existing, unequal financial support given by the Swiss Federal Government to LHC projects involving Swiss researchers. However, the NRC Div. II was prepared to find a tenable way and to achieve operational implementation without any major problems. Among other measures, this included efforts to provide a high degree of transparency, mainly to counter any impression arising among representatives of other areas of science that the SNSF was giving preferential treatment to particle physics. As a result, applications for FORCE funds were always assessed in conjunction with regular requests to the SNSF for CERN project funding. In this way, the efforts endeavored to satisfy the demand that high scientific quality be granted appropriate promotional priority, while at the same time taking due account of the guidelines of the FORCE steering committee, on which direct stakeholders – that is, applicants – were represented. Scientific quality and *significance* were given due consideration, in particular for those requests for FORCE funds that were not directly related to the LHC project. Time and time again, budget guidelines forced substantial cuts to be implemented when approving FORCE applications.

The NRC Div. II assumed from the outset that the allocation of financial support within the scope of the FORCE program should in no way influence the scope of the direct funding provided by the NRC Div. II for projects at CERN. This also corresponded well to the approach taken by the SER (and former FOES). This issue subsequently took on considerable importance, because for a period of several years to 2005, the general lack of funding led to a situation in which from year to year even the budgets of excellent, high-quality funding requests submitted to the NRC Div. II had to be cut on average by 5%. Project proposals from the field of particle physics, which were usually submitted annually, were hit by these cutbacks more often than proposals normally covering two- or three-year periods from other disciplines. However, the NRC Div. II was able to demonstrate that – contrary to suppositions sometimes voiced – applications for high-energy and particle physics projects were not put at any disadvantage compared to other scientific fields. Nevertheless, without the additional financing from FORCE, scientific contributions to the longer term development and construction of the LHC detectors planned by Swiss research groups would have most certainly run into serious financial difficulties. The expenses incurred in these efforts, for the most part well founded, could not have been adequately financed with the annual resources normally budgeted to the NRC Div. II. Once the initially somewhat one-sided distribution of federal funding for LHC-based projects undertaken by the various individual research groups across Switzerland had been balanced out to a certain extent, it was possible, after 2001, to give the LHC detector projects equal treatment. It should be noted, however, that LA FORCE clearly demanded that top priority be given to funding the ATLAS and CMS projects. Despite this, it was possible to adequately support also other CERN projects, mentioned above, both within and outside the LHC complex. Towards the end of the 10-year FORCE program, it also proved possible to make up for and balance out the lag in financing for the Compact Muon Solenoid (CMS) detector.

A positive development in Swiss particle physics, from the standpoint of the SNSF and the NRC Div. II, was the establishment in 2003 of CHIPP, the Swiss Institute for Particle Physics, which from its founding assumed the representational role spelled out in its charter for researchers based in Switzerland and active in the field of particle physics. Accordingly, a representative of CHIPP joined LA FORCE. Shortly after its founding, CHIPP approved a paper on the status of particle physics research in Switzerland and a national strategy envisaged for this discipline over the next 15 years. This document was and is valuable in several ways. The rapidly developing dialogue between the NRC Div. II and CHIPP soon proved to be very useful for research promotion, and the contacts were marked by mutual respect and a simultaneous preservation of independence as regards the assessment of the prevailing situation, in particular on the part of the NRC Div. II.

Once the lion's share of Swiss-funded financing of the LHC detectors was felt to have been secured and construction was at an advanced stage, attention shifted in 2004 to the expansion of the high-performance computer infrastructure that is so absolutely essential for such systems and that is also intended to be used for the analysis of the future experimental data. The NRC Div. II became convinced that this planned network should be financed at least in part by funds from the FORCE program. Furthermore, the NRC Div. II was of the opinion that after 2007, the costs of operating and maintaining the LHC facility should no longer be included in the normal annual budget of the NRC Div. II for reasons of principle. Requests for support of that kind can be scientifically assessed only to a very limited degree and as such do not form part of the SNSF's core business. Furthermore, the investments in question are an inevitable result of the decision made long ago by all members of CHIPP to take part in this major project. Any inadequate funding or total lack of financial support in this respect would severely hinder or even prevent a Swiss contribution to the scientific utilization of a facility developed over a long period of time. LA FORCE agreed to a large extent with these arguments and approved the possibility of using funds from the FORCE program also for purposes of operations management and maintenance. Increasing use was made of this possibility from 2005 onward.

At the end of the 10-year period of the FORCE program, it is apparent that the financial resources provided have helped to maintain visible participation of Swiss particle physicists in the LHC project. As noted above, the NRC Div. II would not have been in a position to provide the funding actually necessary to ensure Swiss participation in the LHC project from its own resources without seriously jeopardizing its mandate of financially promoting individual research projects in the engineering and natural sciences. The collaboration between government authorities, promotion organizations, and representatives of active researchers has certainly been very good, if not exemplary for such actions. Utilization and maintenance of the facility, soon to go into operation, and its foreseeable expansion will demand further considerable financial support that cannot be provided within the scope of standard project funding by the SNSF. It is therefore recommended that a similar, additional financing program be maintained specifically for the use of the CERN facilities – this especially, if for operating its facilities and the LHC in particular, the CERN organization remains dependent on, or demands, funding from individual user groups.

It is very possible or even to be expected that similar situations will arise in the future in other fields of research. In national or international research projects conceived and executed over the long term, a considerable cost history can usually be projected at the time of project launch, and corresponding declarations of intent (memoranda of understanding) are expected with respect to the extent and security of financial participation. Current research promotion practice in Switzerland is poorly equipped for these scenarios. It is recommended that pertinent guidelines be developed to accommodate such cases. Such guidelines should be prepared within the framework of collaboration between government agencies, promotion organizations, and representatives of active research bodies. Regulation should also be provided for the inclusion of such programs in the federal government's four-year research funding budgets. The prioritization necessary for this purpose should be developed in hearings that include representatives of the various stakeholders. This would help promote the transparency of the processes, which is a frequently heard requirement. However, in the framework of such procedures not only the financial backers must signal a certain longer-term commitment but a similar commitment is also needed from the research institutions concerned (that is, as a rule the universities and other higher education or research institutions).

2.2 Historical Perspective of the Creation of the FORCE Budget Line

Maurice Bourquin, CERN Delegate

Swiss researchers are encouraged to participate in international scientific projects. But a major problem stands in the way when working in large centers devoted to particle physics, astronomy, space research, oceanographic research, polar research, etc., where considerable equipment is necessary. The equipment can no longer be constructed in the framework of these centers, and its cost is beyond the possibilities of ordinary grants from Swiss universities and the Swiss National Science Foundation. This problem is not new, having been recognized, for example, by the former Swiss Science Council in 1992 and the Swiss National Science Foundation in 1993.

So when the Federal Office for Education and Science and the Federal Department of Foreign Affairs requested in 1994 the opinion of the Forum of the Swiss Particle Physicists about the LHC Project at CERN, it was not only concluded that "the LHC is the project of highest scientific potential world wide in high energy physics," but it was also strongly recommended "to establish specific ways, which allow for LHC detector funding."

The LHC project was originally approved by the CERN Council in December 1994 as a two-stage project to be completed in 2008. However, the Council stated that if sufficient interest and financial commitment was forthcoming from Non-Member States, the project could be completed in one stage.

In August 1996, a CERN Member State (Germany), in a unilateral move, proposed a reduction in its contribution to the CERN annual budget. The other Member States decided that any reduction should be general, and, taking into consideration heated discussions at meetings in September and November, Council agreed that funding for the LHC project would be preserved as foreseen when the project was approved, albeit with a reduction in the Member States' annual contributions to the Organization of 7.5% in 1997, 8.5% in 1998-2000, and 9.3% in 2001 and thereafter, compared to the level foreseen in December 1994. As great enthusiasm had been shown by some Non-Member States with considerable commitment of financial resources, the Council decided that the LHC Project should be completed in a single stage and planning should proceed on the basis that it would be commissioned in 2005.

The Swiss delegation to the CERN Council (J. Vernet, M. Bourquin) was not in favor of any budget reduction for obvious reasons: Switzerland benefits greatly from CERN on scientific, political, economic, and education levels. But it had to accept that Germany decrease its contribution even beyond the special circumstances from which it already benefited (-10 %), and it joined a consensus to reduce all Member State contributions. Having settled the budget, it became clear that one of the consequences would be further pressure on the general scientific program of CERN. Council, being responsible for the organization, became worried about the impact on scientific productivity in the years 2000 to 2005. It therefore included in the 1997 "Resolution concerning the Construction of the LHC and the Funding of the Organization" an encouragement for "additional contributions to enhance the vitality of the general scientific program during the LHC construction period."

The Swiss delegation believed that Switzerland should respond positively, and it readily found a favorable echo with the Swiss authorities. In particular, during her visit to CERN on February 24, 1997, Ruth Dreifuss, who headed the Federal Department of Home Affairs, told the CERN Director-General that she shared his worries about CERN and high energy physics. She expressed her wish that part of the spared contribution could be reserved for science, with first priority at CERN. Several possibilities existed for Switzerland to make special contributions to help CERN. In the past there had already been special gifts for the SPS accelerator, the antiproton-proton project, loans for buildings, the LHC transfer tunnel, and a guarantee for indexation.

In March 1997, I asked the Forum of Swiss High Energy Physicists if there were ideas for Swiss participation in projects that, in spite of the absence of necessary resources in the CERN budget, could enhance the vitality of the scientific program during the LHC construction period. Strong interest was expressed in running LEP for another year in 2000 with an upgrade of the LEP cryo-plants, enabling the LEP cavities to run at higher accelerating gradients, and also in funding detectors for a new antimatter project, the Antiproton Decelerator.

Both these problems found an elegant, although partial, solution, with the decision of the Swiss Federal Council on August 20, 1997, to set up FORCE.

Apart from the strictly financial aspect of FORCE, one should also recognize the positive impact of such a unilateral initiative of the Swiss government with respect to its influence in CERN affairs. For example, in the discussion to allow LEP to be exploited at the maximum level in the year 2000, I was able to announce the special FORCE contribution to the CERN Council in 1998 and 1999 in these terms: “It illustrates Switzerland’s political will to support the future of the Laboratory.” This was seen as a highly visible gesture of stronger Swiss participation in this European institution.

During these last ten years, this budget line has been invaluable for supporting scientific experiments carried out by Swiss researchers at CERN. It is noteworthy to add that the full integration of Switzerland in the European Research Area does not mean the end to direct contributions of Switzerland in international collaborations. On the contrary, financing tools such as FORCE will be necessary in the future to secure the international position of Swiss research and science. The Federal Council's Dispatch on the Promotion of Education, Research and Innovation for the period 2008-2011 has the merit of leaving the door open for such support to new research installations arising from international cooperation. I believe, for example, that the new infrastructures needed by astroparticle physics, the new discipline emerging from particle physics, astrophysics, and cosmology, are such a possibility.

2.3 Challenges of Large-Scale Projects and the Impact of FORCE

Felicitas Pauss, Grant Beneficiary

Particle physics has a long tradition of operating very large international facilities. Over the past years, the number of big projects has decreased, while the size of the worldwide collaborations and the costs have increased substantially. At the LHC, the present flagship project of particle physics, more than 2,000 scientists are working together in each of the two general-purpose experiments ATLAS and CMS. The challenges to construct and operate these experiments are numerous, ranging from the development of cutting-edge technologies and the search for new physics to the process of decision-making within the community to obtain and manage the necessary funds over a long period of time, in line with the construction and operation schedule.

The international visibility of the Swiss groups working in the LHC experimental program and their impact within the collaborations is also linked to the available funding. The possibility for Swiss groups to apply for funds via FORCE was the only way to overcome the remaining funding difficulties and thus to allow Swiss groups to fulfill their respective responsibilities. In the case of CMS, FORCE funds were decisive for the completion of the electromagnetic calorimeter, and we are very grateful for this financial support.

FORCE will also be crucial in the future – for the optimal exploitation of LHC physics as well as for any new international project in particle physics.

2.4 Steering of FORCE in the Past and in the Future

André Rubbia, CHIPP Representative

Particle physics will soon be at a turning point with the start-up of the CERN LHC. Switzerland has played a key role in the definition and construction of the LHC program, and not only in its position of host country. The physics exploitation of this unique facility will be the reward of many years of scientific and financial investments and will remain the top priority of the high-energy community for the years to come. At the same time, Swiss physicists have contributed substantially to other high-quality projects, such as for example the CERN-Gran Sasso long-baseline neutrino program, or low energy experiments at the CERN PS (Proton Synchrotron). Funding for all these CERN-based activities would not have been possible without FORCE.

The CHIPP Roadmap,[1] which included a thorough survey of the field in Switzerland, defined a strategy and a list of recommendations for the near and long-term future, outlining a balanced and diversified program along three main complementary priorities: (1) the high-energy frontier, (2) neutrino masses and mixing, and (3) astroparticle physics.

The findings at the LHC will define the next step in the high-energy frontier, the realization of a linear collider machine. On the other hand, neutrino experiments (which have led in the last decade to a breakthrough in the Standard Model of particle physics) and astroparticle physics experiments at the interface of particle and astrophysics (such as dark matter searches) will bring more fundamental discoveries and diversity in domains not accessible to and complementary to colliders.

The Swiss community cannot proceed alone towards the realization of this program. It must follow the directions defined by large international consortia. As CERN's interests expand towards a more global European and worldwide coordination, Swiss particle physicists will be asked to contribute to other international projects, encompassing the present "CERN-approved" activities (which use its accelerators) and "CERN-recognized" activities (which use its infrastructure).

CHIPP warmly welcomes the continuation of the FORCE funding beyond 2007. The CERN European Strategy[2] underlined various experimental options beyond the LHC and recommended investigations into wider domains of particle physics. With an adequate and flexible source of funding, Swiss physicists will continue to play their role by having the resources to participate in these long-term international projects that will determine the future of CERN. This will contribute to CERN's strategic reinforcement as a worldwide particle physics center of excellence located in Switzerland.

[1] The CHIPP Roadmap is available at http://www.chipp.ch/chipp-meet-roadmap.html

[2] Available at http://council-strategygroup.web.cern.ch/council-strategygroup

2.5 The Creation of the FORCE Budget Line

Paul-Erich Zinsli, Deputy Director, State Secretariat for Education and Research (SER)

In 1997, the Forum of Swiss High Energy Physicists – the umbrella organization for these research scientists – took in hand the ongoing issue of funding by the Swiss Federal Government for experimental work at CERN by submitting a formal proposal to the Federal Office for Education and Science (FOES) on 19 March 1997. This proposal projected a budget of CHF 23 million for the period 1997 to 2005. In light of the fact that owing to cuts in CERN's budget there was an annual surplus of CHF 3 million in Swiss funding plans for CERN as of 1998, FOES was able to take up this idea and, in close consultation with the Swiss Federal Finance Administration (FFA), propose the creation of a fund enabling the federal government to participate in the financing of experiments on the Large Hadron Collider (LHC).

At the request of the Federal Department of Home Affairs (FDHA), the Swiss Federal Council consequently opted in August 2007 to provide “Swiss support for the scientific work of CERN and the construction of the LHC detectors,” amounting to annual funding of CHF 3 million for the period 1998 to 2001. Operational administration of the subsidies awarded from this Fund for Research at CERN, or FORCE, was entrusted to the Swiss National Science Foundation (SNSF), while a steering committee chaired by FOES compiled the guidelines governing the use of these monies.

Over the course of the first four years that FORCE was in place, the SNSF's NRC Div. II was thus able to allocate an additional CHF 12 million; this bolstered the funding normally provided by the SNSF and thereby strengthened work in the field of high energy and particle physics. Following a comprehensive review by FOES of the status of high energy physics in Switzerland and its future needs, in August 2001 the Federal Council approved funding to continue maintaining FORCE, earmarking CHF 6.4 million for 2002 and 2003.

After six years of favorable experience with FORCE, FOES incorporated this important element for promotion of Swiss participation at CERN into the “Message on the Promotion of Education, Research and Technology (ERT) for the 2004-2007 period.” With its approval of this message in the 2003 winter legislative session, Parliament paved the way for continued funding of FORCE to the tune of CHF 13.6 million over the next four years.

At the recommendation of the SNSF, the State Secretariat for Education and Research (SER) – the successor organization to FOES – exhausted the remaining FORCE funds for the ERT period at the end of September this year. Just a few days later, Parliament approved its “Dispatch on the Promotion of Education, Research and Innovation (ERI) for the period 2008-2011,” which ensures the continued existence of FORCE with some CHF 14 million. In addition to this support, first-time funding totaling some CHF 5 million over the four-year period is provided to Swiss research groups for operations and computing activities associated with their LHC experiments. This ensures not only a consolidation of FORCE but also its expansion to include operational areas.

The SER regards the first 10 years of FORCE as a success. Thanks to coordinated planning by Switzerland’s high energy physicists, the Swiss government was able to use this financial instrument to reinforce and expand the scope of Swiss experimental research and thereby enhance Switzerland’s position and status at CERN. Over the 10-year period, support totaling CHF 32 million has been provided for the scientific activities of the organization as well as for participation in experiment funding for the LHC – a figure that exactly matches Switzerland's regular annual contribution to CERN. The SER is convinced that the ERI period launched in 2008 will witness the continuing success story of the expanded FORCE instrument and wishes all those involved in Switzerland's particle physics research a successful and productive future.

3. Funding Statistics

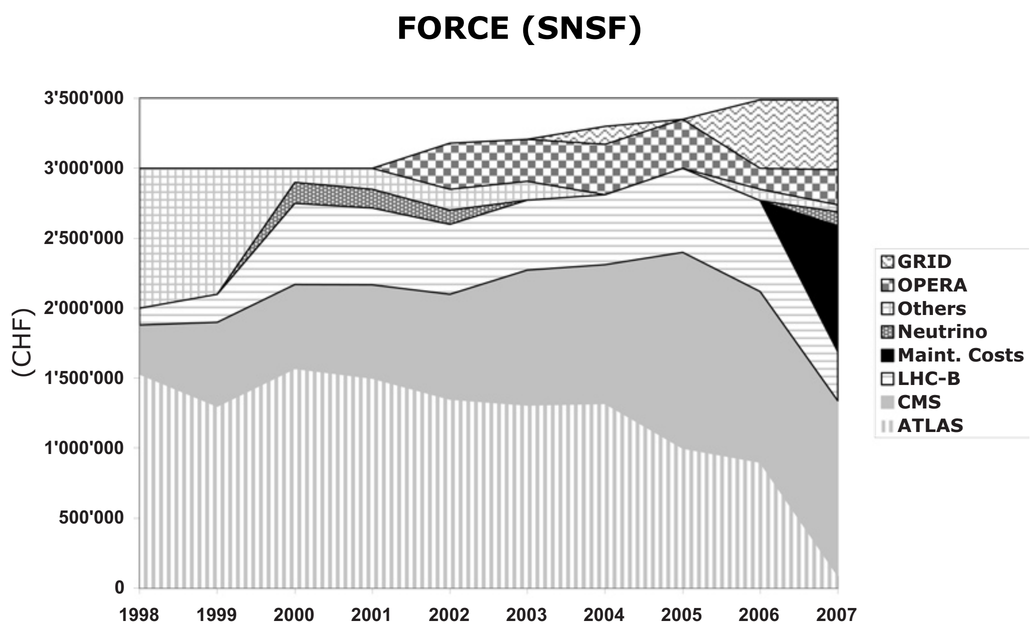

Figure 3: Evolution of FORCE funding of the various experiments in the last 10 years

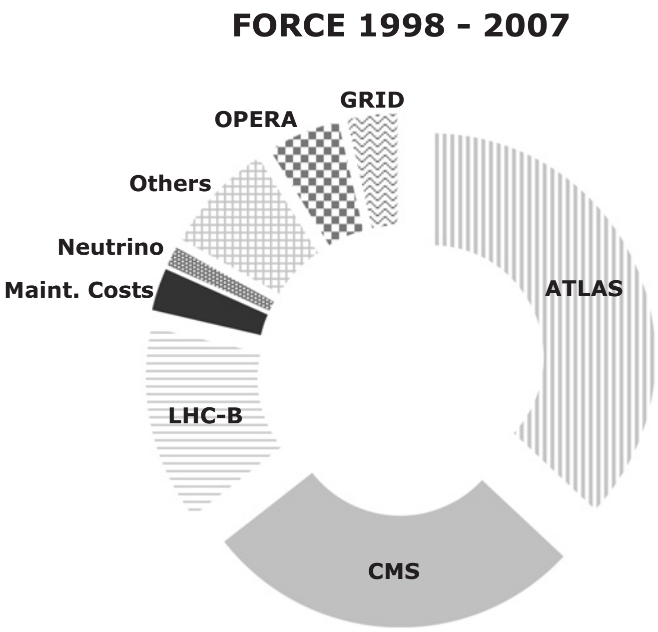

Figure 4: Breakdown of FORCE funding in 2007

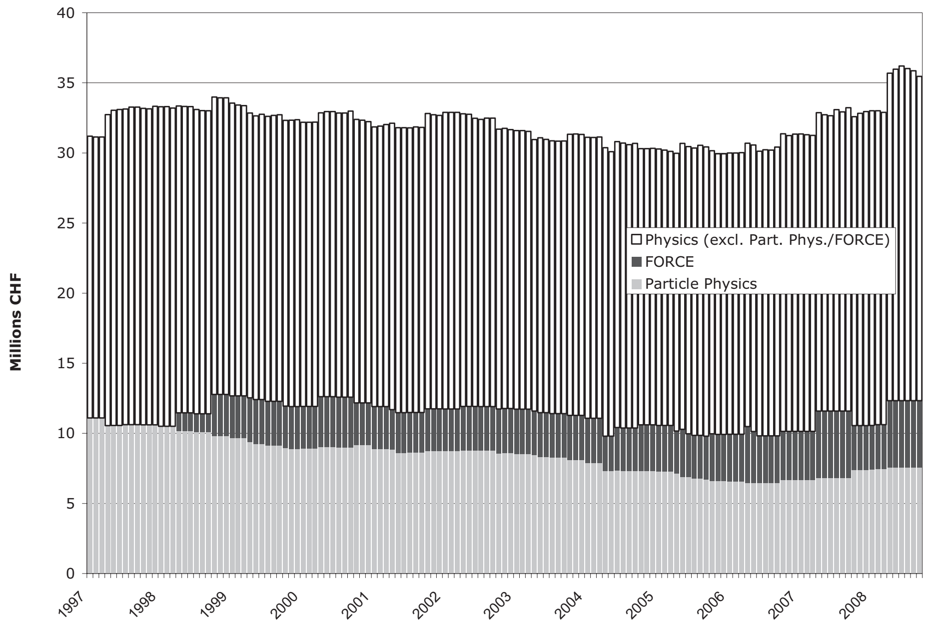

Figure 5: Evolution of funding of FORCE, particle physics, and other physics domains from 1997 to today

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