



FUNDING AGENCIES FOR LARGE COLLIDERS

ANNUAL REPORT 2011-2012

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Funding Agencies for Large Colliders Annual Report 2011-2012

1. Introduction

This third annual report summarizes the discussions at the meetings of the Funding Agencies for Large Colliders (FALC) in the years 2011-2012.

FALC consists of representatives from funding agencies in three regions: Europe, Americas and Asia. The current membership includes representatives from eleven countries and three major laboratories: Canada, China, France, Germany, India, Italy, Japan, Korea, Spain, the United Kingdom, the United States, CERN and CERN Council, Fermilab and KEK. The Chairs of the International Committee for Future Accelerators (ICFA) and the International Linear Collider Steering Committee (ILCSC), together with the Director of the ILC Global Design Effort (GDE), are invited to the meetings so that FALC stays abreast of the status of efforts for future particle physics facilities, especially the research and development (R&D) for a future linear collider.

FALC has been holding biannual meetings since its inception in 2003. As described in its Terms of Reference (TOR), FALC is a group to consider the wider picture of particle physics research, to understand the priorities and constraints in each region and to provide information and guidance to governments for planning and coordinating large particle physics facilities. The representatives exchange information on the status of their respective particle physics/high energy physics programs, and discuss the prospects for global cooperation in future large global projects.

Over the past years, FALC has been tracking the status of international R&D efforts for the International Linear Collider (ILC) in its conceptual design and technical design phases. Efforts at the LHC at CERN, and at high luminosity and high current machines have been the topics to discuss and monitor for FALC as well.

2. Executive Summary for 2011-2012

FALC met four times during the period between January 2011 and December 2012. The first two meetings, held at SLAC and CERN, were chaired by the Canadian delegation, and the latter two meetings, held in Hayama, Japan and at Fermilab, were chaired by the Japanese delegation. While some members were replaced in some regions/nations/laboratories, the composition of the member countries/organizations remained fundamentally unchanged during this period.

The highlighted topics from each delegation are summarized in the following subsections.

2.1 2011-2012 Highlights at Major Laboratories and Countries

At each meeting, FALC heard the status and future plans of the major laboratories in the three regions, CERN, Fermilab, INFN (SuperB) and KEK. At the 20th meeting, FALC had an opportunity to hear the particle physics researches and related R&D activities in the Asian countries deeply engaged in particle physics (India, China, and Korea). FALC learned that the particle physics/high energy physics communities in Asia are active in their own accelerator R&D and particle physics researches supported by the respective governments; they are promoting their individual programs while participating in the international collaborations.

2.1.1 CERN

- The ATLAS and CMS teams at the Large Hadron Collider (LHC) discovered a new particle that's consistent with being the Higgs boson.
- The Conceptual Design Report (CDR) for a future Large Hadron electron Collider (LHeC) was completed in September 2011.
- The three-volume set of CDR for Compact Linear Collider (CLIC) was completed in October 2012.
- R&D for the High Field Magnet (HFM) has been in progress toward High Luminosity LHC (HL-LHC) and High Energy LHC (HE-LHC).
- Study for neutrino experiments, both long-baseline and short-baseline, using proton beams from the existing Super Proton Synchrotron (SPS) accelerator was initiated.
- Plans for several phases of long shutdowns were developed for maintenance, improvement and consolidation of the LHC accelerator complex.
- Currently CERN holds twenty member states. Romania is a candidate for a new member state. Israel and Serbia are associate members in the pre-stage of membership. The current observer states/organizations include: the European Commission, India, Japan, the Russian Federation, Turkey, UNESCO and the USA.

2.1.2 Fermilab and U.S. program

- After making significant contributions to the progress in particle physics over the past 26 years, Tevatron, the world's second highest energy particle collider after LHC, concluded its operation in September 2011. Analysis of DØ and CDF data continues.
- Fermilab and U.S. high energy physics (HEP) program maintain their positive approaches in cosmic frontier, energy frontier, and intensity frontier. At the cosmic frontier, dark energy projects include DES (in operation), DESI (pre-approval) and LSST (design phase). Ongoing direct-detection dark matter experiments include SuperCDMS, COUPP, DarkSide, ADMX and LUX; also, DOE is planning the fabrication of a number of "next-generation" dark matter experiments. At the intensity frontier, MINERvA is in operation, and MINOS has completed its operation for upgrade to the NOvA, which is currently under construction¹; the construction of MicroBooNE is in progress toward operation in mid-2014. The Daya Bay

¹ NOvA has started preliminary experiment in March 2013 through data collections from cosmic rays using its completed section

Reactor Neutrino Experiment, an IHEP/DOE collaborative project, continues operation.

Preparations for the LBNE, the physics goal of which is to determine the mass-hierarchy and the CP violating parameter of the neutrino sector, are in progress. Fermilab is also carrying forward muon programs, namely the Mu2e that will search for the muon to electron conversion process, and the Muon g-2 for improved determination of the muon anomalous magnetic moment. At the energy frontier, Fermilab works on the Superconducting RF (SCRF) technology R&D for Project X and ILC, and the technology R&D for LHC upgrade.

- Project X at intensity frontier, a proposal for a high-power proton facility, in conjunction with LBNE, has been promoted as the laboratory's future core program.

2.1.3 KEK

- The earthquake occurred on March 11, 2011 caused severe damages to the facilities in Tsukuba and Tokai campuses of KEK; more than a few months were required for recovery before resuming regular research activities at KEK.
- For the ILC R&D, Accelerator Test Facility (ATF) and Superconducting RF Test Facility (STF) made a full recovery about 9 months after the earthquake; beam tests and other R&D activities were then resumed toward the GDE milestones. At Tsukuba campus, the Cavity Fabrication Facility (CFF) was inaugurated in July 2011 for development of Superconducting Radio Frequency (SCRF) cavity production technology.
- For the T2K experiment, the first neutrino event after the earthquake was captured in Super-Kamiokande on January 26 2012.
- KEKB completed its operation in June 2010, and construction of the SuperKEKB has been in progress toward the commissioning scheduled in Japanese fiscal year (JFY) 2014.
- Construction of the compact Energy Recovery Linac (cERL), a demonstrative prototype for the next-generation synchrotron light source, has started and is in progress. (Commissioning of the cERL's injector has begun in April 2013)
- Since 2009, the R&D programs and research activities at KEK have been carried out in accordance with the KEK's 5-year roadmap which was issued in 2008. In 2012, KEK started drawing up the KEK roadmap for the next five years (2014-2018)².
- The power upgrades of the J-PARC accelerators are scheduled to begin in the summer of 2013.

2.1.4 INFN (SuperB)

The Technical Design Report (TDR) for SuperB was completed in September 2012. The proposal was submitted to the Italian ministry for cost reviews in November 2012.

2.1.5 China

- IHEP in China has been operating an electron-positron collider, Beijing Electron-Positron Collider (BEPC/BEPC II). The upgraded BEPC has been in operation since 2009 for

² The KEK roadmap for 2014-2018 was published in May 2013

precision measurement in the tau charm energy region.

- Daya Bay Reactor Neutrino Experiment (Daya Bay), a neutrino experiment facility that measures the mixing angle θ_{13} using anti-neutrinos, has started data taking in August 2011. The first result, observation of an electron-antineutrino disappearance event reported in March 2012 provided a non-zero value of θ_{13} . Data taking using the near-far configuration began at the end of 2012.

2.1.6 India

- India has been planning on a large-scale neutrino experiment, India-based Neutrino Observatory (INO), and Dark Matter at INO (DINO) which will search for WIMP candidates for dark matter. INO was approved by the Indian government, and R&D required for DINO is under way.
- India has also been planning on space missions, ASTROSAT and Chandrayaan-II, to investigate astrophysical phenomena and moon surface.
- One of the sites for Laser Interferometer Gravitational-Wave Observatory (LIGO), an international collaborative experiment that directly observes gravitational waves of cosmic origin using interferometric GW detectors underground, is planned to be in India.

2.1.7 Korea

- Korea has been operating YangYang Underground Laboratory, a deep underground facility to investigate dark matter and double beta decay.
- Reactor Experiment for Neutrino Oscillation (RENO), Korea's reactor neutrino experiment facility that measures θ_{13} , has started operation in August 2011. A clear disappearance of reactor electron antineutrinos was reported in April 2012 as the first result at RENO. The data taking is ongoing.

2.2 ICFA

The 10th ICFA Seminar was held at CERN in October 2011. Its summary report was a useful input for FALC on the efforts of physicists worldwide and their research progress.

In 2011, ICFA published a booklet called, "Beacons of Discovery," which delineates the recent scientific endeavor in particle physics. FALC appreciated the work since this kind of outreach effort is highly effective in disseminating information about the current worldwide efforts in particle physics to the public, politicians as well as the scientists in the field. An online edition of the Beacons of Discovery is available at the following website.

<http://www.interactions.org/beacons/>

ICFA announced that the ICFA guideline No. 5 was revised in 2011 reflecting the needs for setting a new provision for financial arrangement appropriate for a large global facility. The ICFA guidelines

were established by ICFA in 1980 to define the inter-regional use of the major regional experimental facilities for particle physics/high energy physics. The guidelines, which consist of six recommendations, are regarded as a common policy for the experimental physicists from other regions seeking to use the facilities they operate.

http://www.fnal.gov/directorate/icfa/icfa_guidelines.html

In 2012, ICFA announced that the neutrino panel was established under ICFA to facilitate international cooperation in R&D for super beams and a neutrino factory through regional/international dialogues.

2.3 GDE (ILC R&D)

At each meeting, FALC was briefed on the status of the technology R&D for ILC and the related activities led by the GDE teams. The proposed ILC requires 16,000 units of superconducting radio-frequency (SCRF) cavities, and thus acquisition of mass production technology, along with quality control and cost-efficient techniques, will determine the success and realization of the ILC. The ILC Technical Design Report (TDR) discusses those challenges and GDE's achievements, together with a technical design, construction timescale, cost estimates and physics/detector baseline design. The draft version of the TDR was submitted to the ILCSC in December 2012, and was presented to a technical design review and an international cost review³.

The GDE has made a major progress in developing and demonstrating the technologies for a linear collider. GDE's R&D activities have been supported by in-kind contributions. The administrative support at Fermilab and elsewhere has been funded through a common fund which has been contributed from funding organizations under a Memorandum of Understanding. FALC formed a subgroup to monitor the GDE's funding status through reports from the GDE⁴.

2.4 ILCSC

In early 2012, as the expiration of the GDE mandate approaches, the ILCSC Chair prepared a proposal for creating a new organization to continue and promote the R&D efforts for a future linear collider. The proposal, which integrates ILC, CLIC and physics/detector teams, was approved by ICFA in July 2012. At the 21st meeting, FALC heard a general idea of this new organization, Linear Collider Collaboration (LCC), whose mandate will last for three years after its launch in February 2013. FALC discussed a range of issues concerning funding arrangement for the LCC.

³ After deliberation on the results of the design/cost reviews, the TDR was officially approved by ILCSC and ICFA in February 2013.

⁴ The GDE accomplished its mandate by successfully completing and publishing the TDR in June 2013.

2.5 Updates of Research Strategies in Three Regions

Europe, the U.S. and Japan have been undertaking studies and work towards updates of their regional research strategies in high energy particle physics.

2.5.1 European Strategy Group

The updated European Strategy was drafted by incorporating the scientific/political inputs from specialists and the particle physics communities within and beyond Europe⁵.

2.5.2 The U.S. High Energy Physics

In 2012, numerous preparatory sessions were held toward the Community Summer Study 2013 (also known as “Snowmass Process 2013”), which was held in Minneapolis in the summer of 2013. The community will hold discussions to decide on the future direction of the U.S. high energy physics, which involves eight areas (energy, intensity, cosmic, instrumentation, facilities, computation, education, communication and outreach, and theory).

2.5.3 JAHEP Recommendations and KEK Roadmap

In March 2012, the Japan Association of High Energy Physics (JAHEP) adopted the recommendations for future large projects drafted by a special subcommittee, in light of the worldwide circumstance in particle physics/high energy physics. The KEK Roadmap for the next five years (2014-2018) was prepared incorporating the recommendations and the inputs from the research communities in nuclear, material and life sciences.

2.6 Report on GDE Activity

FALC elected to create a report on GDE’s activities and achievements from the FALC’s point of view. The GDE was the world’s first attempt by the high energy physics communities in the three regions to collaborate on equal footing for a major global project from its R&D stage. Multi-laboratory teams at the GDE have been striving to accomplish their own missions toward a specific goal, the completion of the TDR. Their endeavors demonstrated how a multinational team can be coordinated, organized and made to work. The report is expected to include the lessons learned from the GDE’s efforts and achievements, especially in terms of global coordination and governance. The report will be beneficial for members within and beyond the high energy physics communities, as an example for future large-scale global collaborations and projects.

FALC formed a team to write a draft report. In order to obtain information necessary for drafting the report, a special FALC-GDE joint session was held at the 21st meeting.

⁵ The draft was finalized and agreed by consensus at the CERN Council Session in March 2013. The updated European Strategy was then formally adopted at the special European Strategy Session of the CERN Council held in Brussels on 30 May 2013. It was also presented to the EU ministries. The relevant documents can be found at <http://council.web.cern.ch/council/en/EuropeanStrategy/ESParticlePhysics.html>

2.7 FALC Public Website

FALC discussed the possibility of creating its public website, considering its usefulness for explaining FALC's activities to the related communities, to politicians, and to the public. At the 20th meeting, FALC agreed to open the public website.

<http://www.falchep.org/Pages/default.aspx>

3. Conclusions

The year 2013 marks the 10th anniversary of FALC. Over the past decade, FALC has been serving as a forum for funding agencies in the three regions to share the recognition and the information relevant to particle physics activities worldwide.

Although FALC was originally established as a group to discuss the funding status for R&D towards a sub-TeV linear collider, the remit of the group has been expanded later to the extent that FALC deemed it appropriate and necessary to discuss in the global context.

As seen in the current trends in high energy particle physics, programs are confronting the growing needs for large facilities and large-scale upgrades, which will cost more than a nation or one region can afford. FALC is in a good position to take initiatives in international dialogues to coordinate preparation for necessary financial arrangements for new demands.

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