FALC FUNDING AGENCIES FOR LARGE COLLIDERS

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REPORT

on

ILC Global Design Effort

December 2013

1. Introduction

1.1. GDE

In response to the interest of the worldwide elementary particle physics community in TeV scale physics, the International Linear Collider Steering Committee (ILCSC), a subcommittee of the International Committee for Future Accelerators (ICFA) has been exploring research and development (R&D) efforts towards a 500 GeV to 1 TeV electron-positron linear collider. The ILCSC intends to globalize the International Linear Collider (ILC) technical design effort and broaden collaborative efforts internationally and inter-regionally as well as with national laboratories and universities.

Major laboratories around the world have invested substantial R&D efforts in linear collider technology for more than ten years and a number of test facilities have been developed. Significant resources have been devoted to the technical preparation of the Linear Collider and numerous design reports and cost estimates have been generated in Americas, Asia and Europe. Based on the R&D developments, the ILCSC created an International Technology Recommendation Panel (ITRP) that has recommended the linac technology on which the ILC design is to be based, and this recommendation has been accepted by ICFA.

To provide a framework to internationalize the technical design of the ILC, the ILCSC has drafted a Memorandum of Understanding (MoU), which was signed in 2005, initially by ILCSC members representing their laboratories and subsequently by other participants, as an instrument to jointly initiate the Global Design Effort (GDE).

The GDE had successfully completed the Baseline Configuration Document (BCD) by the end of 2005 and completed the development of the Reference Design Report (RDR) by the beginning of 2007. The RDR document and accompanying cost estimate were delivered to the ILCSC and ICFA in 2007. With the International Cost Review that was jointly organized by the ILCSC and FALC in 2007, the first phase of the GDE mission was completed.

Towards the second phase of this R&D effort, the ILCSC has drafted the second MoU in 2008 as an instrument to embark on the Technical Design Phase (TDP) of the GDE activities, including more focused R&D as required to reduce the technical risk and cost and for a more refined cost estimate

and value engineering;

By the end of 2012 the GDE had successfully completed the Technical Design Report (TDR) and submitted to the ILCSC. After technical and cost reviews, the final version of the TDR was delivered to the ILCSC in June 2013. The preparatory activity towards the construction of the ILC has been taken over by a new organization, the Linear Collider Collaboration (LCC) that is led by the Directorate of the Central Team (the successor of the GDE) and overseen by the Linear Collider Board (the successor of the ILCSC) established by the ICFA.

1.2. FALC

FALC was established in 2003 as an informal body composed of funding agency representatives. The rationale for creating such a body was that the particle physics programme was increasingly confronted with the need for facilities on a global scale. This potential expansion from a national or regional level created a new need for the funding agencies to interact on similar basis. As a first step, it was decided that an informal forum to share views and opinions on prospects and issues in each of the states would be valuable. By 2004, funding agencies from all three regions were represented (Canada, CERN, France, Germany, India, Italy, Japan, Korea, UK and US).

FALC recognized the need for the funding agencies and the physics community to move forward in a coherent manner following the choice of superconducting technology for the sub-TeV linear collider in 2004. The Chairs of ICFA and the ILCSC, and the Director of the GDE have been invited to attend the meetings of FALC.

At its inception the prime focus of FALC was the status of the current funding for R&D towards a sub-TeV linear collider and the perceptions of the prospects for its future. By the middle of 2006, it was apparent from discussions at FALC that to make progress towards a construction decision for a linear collider it would be necessary to consider the wider picture of particle physics research, understanding the priorities and constraints in each region. FALC agreed that the remit of the Group would be expanded to include promotion of global coordination of, and information exchange on, the global accelerator programmes.

FALC established a Linear Collider Resources Group (RG) to provide a clear view of the funding arrangements for the linear collider, and to provide a forum to prepare for, and report, decisions on

funding arrangements. Membership of the RG is open more widely than that of FALC. The FALC RG established a Memorandum of Understanding between funding agencies to fund the administrative support required for the ILC GDE.

1.3. Purpose of this Report

Following the completion of the GDE, the FALC considered it instrumental to summarize the achievements of the GDE and compile lessons learned from the 8 years of GDE activities in entering into a new phase, in which detailed design and preparatory work towards construction will be completed.

2. GDE Achievements

2.1. Technical Design Report

The completion of the technical design of the ILC accelerator is above all the most significant achievement of the GDE. The TDR contains the design of the ILC accelerator and reports on related R&Ds coordinated by the GDE central team, together with a report on physics study and the Detailed Baseline Design (DBD) of the detectors. After producing the RDR in 2007, the machine parameters and the accelerator layout have been revisited, in particular for the injector complex, in order to refine the design and to reduce the cost. In addition to the design of the accelerator complex, the GDE has also developed design of the conventional facilities and cost-optimization for three different sample sites taking into account of the regional differences in their topography, geology and local legislation. The Technical Design Report (TDR) was published in June 2013 after a review by the ILCSC Programme Advisory Committee (PAC) in December 2012. The TDR will be a solid basis for an engineering design for a specific candidate site in the next step.

2.2. R&D

The GDE has coordinated global R&Ds to accomplish performance goal and for risk mitigation and cost reduction, in collaboration with accelerator laboratories worldwide. Among many technological achievements of the GDE, it should be highlighted that a production yield of 94% has been achieved for superconducting RF cavities, one of the most critical R&D item, satisfying 35 MV/m with 20% gradient spread. The collaborative activities between the GDE and the laboratories have been essential for the ILC because of the resources/facilities and expertise accumulated in those

collaborating laboratories. It should be noted that those R&Ds are also beneficial to industrial and/or medical applications.

2.3. Cost Estimate

The cost estimate has also been an important deliverable of the GDE. Because of an international nature of the project, the GDE had to overcome many complications arising from different accounting systems, floating exchange rate and uncertain cost sharing scheme. The value estimate by the GDE was reviewed by the International Cost Review Committee and was concluded to be satisfactory as an estimate at this stage.

2.4. Project Implementation Planning

The GDE has studied various governance/funding models of the ILC project and published a report “ILC Project Implementation Planning (PIP)” as a separate document. The GDE has investigated recent major science projects and lessons learned from those projects are summarized in the PIP. The PIP report will be a starting point for the further consideration by the LCC.

2.5. Outreach

The GDE considers the outreach as an important part of the ILC project and established a team of communicators from around the world. Since 2005, the team has been issuing ILC Newsline, a weekly electronic newsletter (bi-weekly from December 2012). The articles are targeted not only on particle/accelerator physicists but also on non-experts by delivering up-to-date news in plain language. The outreach group has also produced various materials including a brochure “Gateway to the Quantum Universe” published in eight languages, and collected many ILC-related photos/movies.

2.6. Accelerator School

Equally important as the outreach activities is the annual “International Accelerator School for Linear Collider”, to which the GDE has made a major contribution. The school offered an opportunity for young talents to learn a variety of accelerator technologies that are all necessary ingredients of the ILC and the basis of various accelerator applications. The sponsoring laboratories support many participants from developing and emerging countries.

2.7. Conference

The GDE has co-organized bi-annually the Linear Collider Conferences, including both international and regional, with physics and detector communities. The continuous dialog between the accelerator community and the physics/detector community that has been maintained from the inception of the GDE was facilitated by the regular conferences. The consolidation of these communities resulted in the creation of the LCC.

3. Lessons Learned

3.1. GDE Specific Issues/Lessons Learned

The GDE was the first-ever attempt by the high energy physics communities in the three regions to collaborate on a major global project from its R&D stage. The GDE's multi-laboratory teams have concertedly moved forward to a specific goal, the completion of the Technical Design report (TDR), while carrying out their own missions. Their concerted efforts demonstrated how a multinational team can be coordinated and organized for operating a future global collaboration or project.

In their continuous efforts, the GDE has undergone and overcome a number of challenges in promoting good governance and coordinating the teams distributed in the three regions. Their struggles can also be regarded as part of the GDE legacies, as well as many of their great achievements. FALC believes that those episodes will be invaluable for people within and beyond the high energy physics communities.

The major issues /lessons identified in the GDE activities include:

- ICFA/ILCSC, an international high energy physics organization, determined the physics goals of the ILC and created a mandate for the R&D and design effort to be carried out by the GDE. That guidance has been crucial to focusing the effort and keeping it on track to a final deliverable, the Technical Design Report (TDR).

- At the beginning, oversight by the two independent committees, the FALC and the ILCSC/ICFA, did not function well in terms of providing clear goals and guidance. The situation was improved by better connections and clearer definition of responsibilities between the two groups.

- The Common Fund, which supported administration, communications and electronic data management, etc., although small (~1.5M$/year vs. ~75M$/year global support), was absolutely crucial to making the global organization function.

- Interactions/communications between the machine group and the detector group were not seamless, despite a machine-detector interface working group. The problem was that the two groups were essentially organized autonomously, but their projects and goals were deeply connected. The new organization will solve that problem by having a common Director above both programs.

- Agreements among laboratories to carry out the R&D program were mostly informal and thus required good relations and good will. This situation brought some challenges in its resource control. Although it can be solved by close coordination among the major participating laboratories, more formal arrangements would be needed for a construction stage.

- Whether a regional organization is necessary or not will be an issue for future consideration. Research programs are basically carried out by countries, not regions; therefore, even a streamlined organization by regions would not be able to fill and fit into the roles and the priorities of local laboratories/institutes that are supported by a country.

- Lack of defined CERN role in development of SCRF technology and the initially undefined relationship with CLIC were issues that will be mitigated by the new organization.

- Lack of a home institution was a handicap in terms of building good governance, but can work with strong global oversight, common funds, transparency in decision-making, and program priorities.

Essential success factors for a global project/collaboration composed of globally distributed project teams.

From the activities of the GDE teams, the FALC recognized that the following factors may be the keys to success, which are applicable to any future global collaborations/projects.

1. To Ensure Good Communication:

- It is necessary to form a central management team dedicated 100% to the project, providing clear definition of team interfaces and responsibilities.

- It is preferable to have face-to-face meetings on a frequent basis, alongside frequent use of remote conferencing.

2. To Provide Transparency in Decision-Making Process

- It is desirable to hold general collaboration workshops, not least to build team spirit but also to enable consensus building, communication with stakeholders and change control.

3. To Build Good Governance

- It is necessary to establish an integration team responsible for pulling it all together and maintaining documentation.

- It is necessary to establish a formal framework upfront, taking into account the bureaucratic overhead required for administrating distributed teams.

- It is highly desirable for geographically localised teams to provide local critical mass and to allow the central team to better delegate to a “local team”.

- In the absence of a physical laboratory, a strong communications/public affairs team should be placed for tying project together and providing a visible identity to the outside world.

4. To Build and Maintain Team Spirit

- Strong commitment from participating institutes should be maintained throughout all phases of a project.

4. Conclusions

The eight years of GDE activity covered a pre-engineering design phase of the ILC. Although the GDE has faced various difficulties during this period, as pointed out in the previous sections, the GDE has never lost momentum and the central team has led the high-energy physics community worldwide as the control tower. The completion of the TDR has demonstrated the technical feasibility of the ILC. Likewise, the success of the GDE itself has demonstrated the organizational feasibility of a GDE-type activity for a global project with a long lead time. The FALC appreciates the effort made by the central team of the GDE and all the other collaborators around the world.

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