1.1 Report on the First ILC Workshop, KEK (Japan) November 04

Susanna Guiducci
mail to: Susanna.Guiducci@lnf.infn.it
LNF-INFN, Frascati, Italy

1.1.1 Introduction

The First International Linear Collider (ILC) Workshop was held at KEK (Japan) on 13÷15 November 2004 under the auspices of ICFA and the International Linear Collider Steering Committee (ILCSC). The goal of the Workshop was to facilitate the world-wide formation of an international design team and to initiate the work for the ILC after the choice of the "cold" Super Conducting (SC) RF technology made in August 2004 by the International Technology Recommendation Panel (ITRP).

The workshop charge was the following:

- To review the technical issues with SC-LC, develop lists of design elements and decide whether they are:
  1. non-controversial in concept and may only need some optimization; or
  2. should be considered open to reevaluation, in the conceptual design phase.
- To present the topics the different groups are interested in, and can contribute to the overall design.

At the opening plenary the ITRP recommendations and the status of GDI (Global Design Initiative) formation have been described.

Then a representative of each region: America, Asia, and Europe, has described the activity and plans for the LC.

The work has been divided in 5 Working Groups dedicated to the following items:

WG1. Overall Design
WG2. Main linacs
WG3. Injector
WG4. Beam Delivery
WG5. High gradient cavities.

In the closing plenary, after the summary of the working groups, a discussion has been held on the GDI organization.

1.1.2 Opening Plenary

In the introductory talk the recommendations of the ITRP have been reported [1]. The ITRP Report has stated that: "During the past decade, dedicated and successful work by several research groups has demonstrated that a linear collider can be built and reliably operated." The "wise men" of the ITRP have stressed that they have recommended a technology, not a design :"We expect the final design to be developed by a team drawn from the combined warm and cold linear collider communities, taking full advantage of the experience and expertise of both." This workshop was the first occasion for the two different communities to meet and start to work together for an unique international project.

A road map has been established toward a Global Design Initiative to produce a Conceptual Design Report (CDR) and a Technical Design Report (TDR) within three years.

A search committee to recruit the GDI Central Team Director has been appointed.

Another committee is evaluating the site offerings for Central Team Host, nine offerings have been received: KEK, LBNL, SLAC, TRIUMF, FNAL, BNL, CORNELL, RAL(2), DESY.

A Memorandum of Understanding will be ratified between the big labs to carry on the work of the ILC design. It is hope to have Director and Central team location chosen at the next ICFA meeting in February.

Representatives of each of the three regions have described the ongoing activity and future plans for the ILC.

In America [2] the major labs have expressed their interest in the ILC R&D activity for the Injector, Main Linacs and Beam Delivery systems. In particular Fermilab is planning to build a test facility for SC cavity modules (SMTF). Two groups of Universities has R&D activity already financed going on different arguments. A preparatory Workshop was held at SLAC in October 2004 (http://www-project.slac.stanford.edu/ilc/meetings/workshops/US-ILCWorkshop/workshop.html)

In Asia [3] has been organized a working group structure similar to that of this workshop in order to carry on the work. In a meeting at .Kolkata (India) ACFA has proposed KEK as host of the ILC Regional and Central Team of GDI and has urged the Japanese Governement to fully support the efforts to host the ILC at KEK. KEK is building a test facility for SC cavities with the ambitious goal to build and test high gradient cavities and is planning a final focus test facility at ATF.

Europe [4] has carried out the research on SC cavities within the TESLA collaboration and proved the feasibility of a SC Linac at TTF, the TESLA Test facility.

EU has financed different ILC related activities: within CARE, the project to Coordinate the Accelerator Research for Particle Physics in Europe, the ELAN, Electron Linear Accelerator Network, and the SRF Joint Research Activity. EUROTEV is a design study on linear collider financed by the EU, it has been proposed before the technology choice and it is dedicated to the items independent on the technology.

1.1.3 WG1- Overall Design

Many joint session with other groups have been held to discuss the general parameters and the global design. The following arguments have been discussed [5]:

- Choice of the initial and final stage energies and accelerating gradient.
- Review of the machine parameters and their inter-relationship.
- Conventional facilities for the main linacs and damping rings: tunnel layout
- Beam dynamics issues and tolerances.

After a description of the main physics requirements the discussion has been centered on the parameters choice. The competition between the “warm” and “cold” projects has pushed toward a higher luminosity with a critical parameter set; now these parameters need a critical revision with the contribution of both communities.

A parameter task force has been set up in order to try different sets covering potential operation scenarios and to evaluate the risks in achieving the design luminosity:

- Nominal TESLA parameters with larger vertical emittance and less beamstrahlung at $L = 2\ 10^{34}\ cm^{-2}s^{-1}$.
- Lower bunch charge

- Larger vertical emittance
- Lower beam power
- Different repetition frequency.

Other items discussed were:

- RF summary
- Tunnel configurations.
- Instrumentation
- Beam dynamics
- Wake-fields
- X-FEL synergy
- TTF experience

Four working groups have been created with the following objectives:

1. Define Parameter ranges in the next two months.
2. Study construction schedule, commissioning and availability, positron source, tunnel configurations.
3. Simulate Low Emittance Transport, including failure modes.
4. Define requirements and perform R&D on Instrumentation.

1.1.4 WG2- Main Linacs

The following items have been addressed [6]:

- Synergy with European XFEL (Joint WG1, WG2)
- Beam related topics (Joint WG1, WG2)
- Power sources and Low level RF
- High Gradient impact (Joint WG1, WG2, WG5)
- Cryomodule, Couplers and Test Facilities (joint WG2, WG5)

The joint session on RF (WG1, WG2, WG5) has reached the following conclusions:

There is a flat cost optimum at 35-40 MV/m, therefore there is no significant cost reduction for higher gradient although site choice may impact this. The module at 35 MV/m still needs demonstration. Other optimizations yield small improvements. Regarding the RF frequency it is not clear if an improvement is possible and there is no reason to change.

The conclusion is that the maturity of the cold technology has been demonstrated. It is important to progress with the industrialization and the ILC will profit of the work done for the European XFEL.

Many laboratories have announced their participation to ILC R&D and two of them have plans for large test facilities on superconducting RF: SMTF at FNAL (US) and STF at KEK(Jp).

1.1.5 WG3- Injector

The WG sessions have been dedicated to the following items:

- Polarized electron sources
- Positron source system
- Damping ring
- Bunch compressor

An overview of the different possible solutions for the positron source, the conventional and the gamma based scheme, has been given. The crucial problems both for the conventional and the undulator based schemes are the heat and radiation damage on the target and the focusing device (adiabatic matching lens).

The conventional production system (high intensity e^- beam at ~ 6 GeV energy hitting on a target) would be highly desirable but at present a design with the required intensity and repetition rate is not available.

The undulator source should provide the required intensity and repetion rate but needs a more complex scheme and requires that the high energy, high quality e^- beam be ready before starting the positron production.

For the damping ring the following items have been discussed:

- General layout
- Fast Kickers
- Instabilities and collective effects
- Experience with wigglers

Several possible approaches to the DR design are being considered, circumferences range from 3 km to 17 km. The long linac bunch train (2820 bunches in ~1ms i.e. 300 Km) has to be compressed down to the damping ring length 17÷3 Km with a corresponding bunch distance of 20 ÷ 3.5 ns. The kickers rise/fall time has to be smaller than the bunch distance. Therefore more R&D on fast kickers is needed and many laboratories are studing possible solutions. New ideas have been proposed and are under stuy: use of two crab cavities and a kicker, multifrequency RF deflectors with a CTF3-like injection extraction scheme (see fig.1), Fourier series kicker.

The design vertical emittance (2 pm) is smaller than the minimum emittance ever achieved in a storage ring (KEK-ATF 4.5 pm).

Instabilities and collettive effects are important due to the high bunch density. We have to learn from experience & limitations at past or existing rings with similar features. More detailed simulations studies & experiments are needed for many of the expected collective phenomena as e-cloud and fast ion instability.

Space charge incoherent tune shift is one of the critical items, since it causes a vertical emittance growth. It was the motivation to increase the DR energy up to 5 GeV in the TESLA design. The good news of the workshop is that the emittance growth is mitigated by the strong radiation damping [8].

Other items that need more study are: minimum emittance achievable, e-cloud, fast ion instability and other collective effects, wigglers optimization and dynamic aperture.

The most controversial items are the DR layout (17, 6, 3 Km) and its installation in the linac tunnel (a separate tunnel would be preferable for commissioning and availability). The design choice will be based on: achievable performance from kickers, beam dynamics, operational flexibility and costs. A “To do list” has been prepared with the work to be done in the next 8 months in order to provide the basis for this decision.

1.1.6 WG4- Beam Delivery

The following items have been discussed [9]:

- Collimators & machine protection,
- Final focus, machine detector interface,
- Beam dumps

For the high energy Beam Delivery (BD) system the proposals from the different design groups (TESLA, NLC, JLC), shown in fig.2, will be rethought and integrated into a new beam line. In particular it has to be chosen the crossing angle and the layout for two Interaction Regions (IR) in order to get the maximum luminosity for the e^+e^- option and to allow the feasibility of the $\gamma\gamma$ option. A tentative configuration has been agreed on and will be studied in the next months.

Other points under discussion are the choice of the final focus quadrupole doublet (SC or Permanent Magnet) and the position of the positron source undulator (at full energy or at lower energy).

The optimization of IP collision requires a fast feedback to restore vertical position within the first 100 bunches. More work is needed to ensure that the jitter coming from the linac is manageable for tuning of the machine and to verify the stability specifications of all the components.

Many beam tests crucial for risk mitigation on the CDR and TDR time scale are ongoing or have been proposed, in particular at ATF (KEK) and .ESA (End Station A) at SLAC.

Workshops are planned in order to arrive to the Snowmass meeting (August 2005) with a major progress toward detailed design: Workshop on Machine-Detector Interface (January 6-8, SLAC), and Beam Delivery Interaction Region (BDIR) Workshop (June 20-23, Royal Holloway, UK)

Wg4 made significant progress on the working hypotheses for the BDIR configuration. The urgent work needed in the next 8 months and in many cases the people that will do the work, have been identified.

1.1.7 WG5- High Gradient Cavities

The objective was to discuss the baseline performance of the accelerating cavities and going beyond it [10].

Many issues have been discussed in WG5: basic R&D on surface and materials, fabrication, processing, cost reduction, industrialization, cavity shape, superstructures, gradient, couplers, tuners, cryo-modules, and test facilities.

Electro polished cavities with gradients up to 35 MV/m have been produced and will be tested in the VUV-FEL linac at DESY. A picture of the electro polishing setup at DESY is shown in fig. 3.

The baseline parameters of the TESLA cavities at 25 MV/m have been accepted. A gradient of 35 MV/m is expected to be achieved with electro polished cavities in time for the TDR. New cavity shapes are being developed for the TDR with the ambitious goal to reach 45 MV/m.

It has been stated that industrialization is of critical importance for X-FEL and ILC. Many issues have been addressed by the TESLA collaboration. New activities, financed by XFEL and EC projects (CARE-SRF, EUROFEL), will be of substantial benefit for ILC.

1.1.8 Discussion on GDI Organization

The ILCSC will initiate the Global Design Initiative; its first mission is to quickly produce a globally agreed upon Conceptual Design Report of the machine and to develop the roadmap for future activities[11]. This Initiative will be established using

Memorandum of Understanding among participating institutions and will be supported by their funds.

In the latter phase the organization is expected to metamorphose as governments will begin to provide additional funding and formal international arrangement. The mission in this phase will be to deliver a Technical Design Report including detailed schedule and cost estimates.

The proposed chart of GDI organization in its early phase is shown in fig. 4.

A timeline for the ILC with the objective of obtaining the first collisions around 2015 has been proposed: Organize the GDI and complete the CDR in 2005, complete the TDR with cost and schedule plan in 2007 and begin the process for site proposals, be ready for site selection and approval by the governments in 2008.

1.1.9 Conclusion

The workshop was very successful, a lot of preparatory work has been done and all the big labs and many universities have demonstrated their interest in participating to the ILC project. After the technology choice both the warm and cold communities have joined their efforts toward a common design and planned the R&D activity required in the next months.

The informations on the Workshop and the transparencies of all the talks can be found at: http://lcdev.kek.jp/ILCWS/.

The Working Group structure of the Workshop has been manteined to prepare the Second ILC Workshop (Snowmass ,USA, 14-27 August 2005), with the goal to lead to a Baseline Design Document for the ILC.

1.1.10 References

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