1 Introduction

It is a general consensus among high energy physicists to build an electron-positron linear collider of the energy range up to about 1TeV as the next program after the LHC. It is also a general consensus that there should be only one linear collider of TeV range in the world. Two technologies for linear collider had been competing since more than 15 years ago. ICFA issued a statement in August 2004 during ICHEP at Beijing that the collider, now named ILC (International Linear Collider), was to be based on the superconducting technology. Following this statement, the first ILC workshop was held in November 2004 at KEK, where the remaining technological issues for the superconducting collider were discussed together with the organizational issues of international collaboration.

ILCSC published a report in March 2004 on the organization and timeline of the linear collider development, aiming at the machine completion in mid 2010's. According to the report, the world collaboration is to be coordinated by Central GDI (Global Design Initiative) with three regional GDIs (Asia, North America, Europe) under it. The GDI should complete the CDR (Conceptual Design Report) by the end of 2005 and the TDR (Technical Design Report) by 2007, envisaging the start of construction around 2009.

In the ILCSC meeting right after the workshop at KEK it was decided to have the second ILC workshop in August 2005 at Snowmass in USA in parallel with the already scheduled physics workshop. There the major issues for the CDR should be decided such as the accelerating gradient, the number of tunnels (one or two), damping ring shape (dogbone or smaller ring), positron production scheme (conventional or undulater-based), and so on.

Asia has been recognized since many years as one of the three regions for the study of linear colliders. In its meeting at Kolkata in November 2004 prior to the first ILC workshop, ACFA issued the third statement on ILC, which reconfirms and extends the previous statements. In particular it states 'In such International collaboration ACFA and scientists in ACFA countries should play crucial and leading roles'. In fact we have a significant number of participants in the first ILC workshop not only from Japan but also from many other countries in Asia. This memo was written for expressing our present attitude to the ILC for all Asian colleagues and for inviting participation to the project.

2 Basic Strategy

We would like to contribute to the world collaboration for the ILC putting emphasis on the following three fields.

(A) Establishment of the technology for accelerating gradient 35MV/m

(B) Persuit of possible higher accelerating gradient

(C) Beam technology development using KEK-ATF

It is probable that the Snomass workshop will adopt 35MV/m as the baseline accelerating gradient. The item (A) is to establish the industrial technology for this gradient. TESLA-TTF has proved the feasibility of 35MV/m. What has actually been done, however, was a test of a few individual cavities in vertical and horizontal cryostats and in addition a beam acceleration test of one cavity with other lower-gradient cavities in the same cryostat. It will still take several years to reach the final design which is fit for industrialization. To this end we think we need an all-in-one facility for superconducting technology, albeit many considerations are needed about its scale. TTF2 at DESY and SMTF at FNAL aim at similar purpose. It is desirable that the Central GDI (or something equivalent) coordinates the international collaboration in order to avoid duplication of the R&D expenses. However, it will still take time for such organization to function properly. It must also be taken into consideration that participation of industries of many countries plays an important role in large scale projects like ILC. Nurturing the industrial level of participating countries should also be within the scope of the coordination by the GDI.

The item (B) is to develop cavities for higher gradient and to establish related technologies. The electro-polished cavities of TESLA type can reach the maximum gradient around 40MV/m. If these cavities are to be used at 35MV/m in actual operations, the margin does not seem to be enough. It is more desirable to have a larger margin by using cavities that are durable under higher gradient. Another reason for higher gradient is the site length. The ultimate collision energy of the ILC will be 1TeV. To reach this energy by the gradient 35MV/m, a site longer than 45km is required. There are a few site candidates in Japan that satisfy this requirement but, if one takes into account of other conditions such as access convenience, it is desirable to make the total legth shorter than $\sim$40km by using higher accelerating gradient.

Since the superconductivity breakdown limit due to the surface magnetic field is already reached by the present electro-polished cavities, a development of cavity shapes different from TESLA type is necessary. This is a very urgent subject because the baseline gradient will be decided in the Snowmass workshop. The completion of the whole technology ascociated with the new cavity by August 2005 is obviously impossible. What we aim at is that the possibility of a higher gradient is to be mentioned in the CDR and to establish the technology by the time of TDR.

In the following we adopt 45MV/m as the figure of the target gradient for the consistency of the document. The actually achievable value might be a little different. Also one should note that 45MV/m is the gradient for operation with the margin taken into account rather than the maximum gradient. The latter is somewhat higher.

The main linac is of course the largest and the most cost-driving component in the ILC, but it is not everything. The item (C) aims at the establishment of beam handling technology needed for other components such as the damping rings and the beam delivery system, which also require high technologies. KEK-ATF is the only ring that can realize the beam emittance for the ILC. It was designed as a prototype damping ring for the linear collider with warm technology. As a model damping ring for cold technology, it has a few defects such as non-existence of positron and small space-charge effects. Nevertheless, since it is impossible to build a new prototype ring by the time scale of CDR/TDR, it is our duty to make use of full capabilities of the ATF. An extension of the ATF is desirable within the limited time and budget.

3 Facility Plan

Following the strategy described in the previous section, we consider the following plans. The first three are related to the item (A) and (B) and the rest to (C).

3.1 Test of 45MV/m in Existing Facilities

There are a few cavity shapes that are expected to give higher accelerating gradients. One of them, the reentrant type cavity, has already reached 46MV/m (maximum gradient) at Cornell university in November 2004. This fact proves that a higher gradient is actually possible by choosing a proper cavity shape. However, we anticipate some problem of fabrication for this cavity shape. As a better candidate of the cavity shape for higher gradient we choose the so-called LL (Low Loss) type designed at Jeffereson Laboratory. The first step tests of 45MV/m LL cavities are being planned as

- Single-cell test in December 2004
- Vertical test of four 9-cell cavities in September 2005

All these can be done using existing facilities. The purpose of these tests is to give an impact to the CDR which is to be completed by the end of 2005. In case that we cannot obtain the expected performance in these tests, we will cancel the plan for 45MV/m in the following years and replace it with a slower plan aiming at possible usages in the far future, such as the second phase of ILC and other accelerator applications.

3.2 STF Phase 1

We are planning to build a facility STF (Superconducting RF Test Facility) in an existing building in KEK. The building itself has been used for the development of a proton linac of the JParc project and will be emptied by summer 2005. The basic purpose of the STF is the following.

- Establish the industrial technology for 35MV/m and 45MV/m ready for mass production.
- Promote industrial level of Asian region for the component production.
- Form a base station in Japan for international collaboration.
- Enlist and educate young people in Asian region.

In designing the facility it should be taken into account that the facility also be useful after ILC development for other applications of superconducting technology such as FEL and ERL.

We divide the whole plan of STF into two phases. Phase 1, which is to be build in JFY2005 and 2006 (Japanese fiscal year starting in April), includes the following items:

- Fabricate a cryostat to accomodate the four 45MV/m 9-cell cavities mentioned in the previous subsection.
- Fabricate four TESLA-type 9-cell cavities (nominal 35MV/m) and a cryostat to accomodate them.
- Construct the RF power system and the cryogenic system needed for the simultaneous operation of the above two cryomodules. (These are mostly reuse components and will be prepared in the last quarter of JFY2004.)
- Create an electron beam source and the diagnostics devices for the beam test.
- Test the above system, including both 35MV/m and 45MV/m, by the end of JFY2006.

At the end of this phase, both for 35MV/m and 45MV/m, we will by far exceed the present level of 35MV/m in TESLA-TTF. However, TESLA-TTF2 is being planned so as to test a long cryomodule containing 8 electro-polished cavities in Spring 2006. If both of these plans go well, there will still be about one year difference of development at that time. In particular for the higher gradient technology to compete with that of 35MV/m for the TDR, a test with a longer cryomodule is absolutely needed, which is to be done in Phase 2.

We consider that the electron beam is needed in this facility. By using a beam we can measure the higher modes excited by the beam, can check the alignment accuracy the using these modes, and can develop beam monitors. In addition, if we have an intense beam of ∼10mA (full current of ILC), change of Lorentz detuning by the beam loading can be tested and the control of phase and amplitude variation can be established. Thus, we believe, using a beam we can establish various technologies at a relatively small amount of additional investment compared with that for the linac system itself.

There is another subject for indusrialization, namely the cost reduction, which is a key for the realization of ILC. The technologies of Nb/Cu clad cavity and seamless cavity are expected to bring about considerable cost reduction. The development of these technologies can be done in parallel with the program listed above. If the cavities produced by the conventional technology perform well and if the new technology of fabrication is completed separately, there will be no additional technology needed in combining the two.

3.3 STF Phase 2

Phase 2 of STF is being scheduled in JFY2007 to 2009. What we are now thinking of as Phase 2 is:

- Three cryostats each containing 12 cavities of 35MV/m (or 45MV/m if its development is successful).
- Associated reinforcement of the RF power and refrigeration systems.
- Synthetic test of all the systems with the beam.

As of now we are quite uncertain about this phase, however, since the coordination of international tasks by the GDI will function by the time to design Phase 2 in detail. In any case, nevertheless, tests with a few long cryomodules with a beam will be necessary somewhere in the world for the completion of the TDR.

3.4 Studies Using ATF

- Beam dynamics studies such as the fasi ion instability and the dynamics aperture in the presense of wigglers.
- Continuation of the R&D of diagnostics devices such as the laser wire and the cavity BPM.
- Stabilization and copling correction of ATF extracted beam.
- Development and beam test of fast kickers. (It is also possible to test a kicker developed somewhere else.)

The last item is in particular urgent. There are two different ideas on the damping ring, i.e., the so-called dogbone ring which has been studied for TESLA for many years and a small ring which does not share the tunnel with the main linac. The choice is going to be made in the Snomass workshop in summer 2005. The small ring idea requires especially severe specifications. Obviously it is impossible to develop a kicker that satisfies all the requirements for the small ring by the time of the workshop.

What is necessary by summer 2005 is to show a data that can convince the technology completion within additional few years. The development is fast kickers also has a longer-term purpose. A fast kicker will make it possible to get an ILC-type beam (bunch interval around 300ns) from ATF, which can be used for the development of various diagnostics devices.

3.5 Extension of ATF

The ILC (the first stage) requires a collision of tiny beams with the height as small as 5nm. Fundamental issues are wherether we can produce such small size and maintain it for long time and whether we can stabilize the center-of-mass position of the two beams.

On the first issue, FFTB at SLAC succeeded in obtaining ~60nm beam in 1997. We can extend the extraction beamline from the ATF, which we tentatively call ATF2, to include a prototype of the ILC final focus system. In spite that the beam energy is factor 40 lower in ATF2 than in the FFTB, we expect to get a beam size ~35nm owing to the small emittance of the ATF. The improvement of the size from the FFTB is not quite remarkable compared with the ultimate ILC target 5nm. However, efforts to maintain the size for long period were not made in the FFTB.

For the second issue, i.e. the stabilization, the ILC requires an accuracy down to a few nanometer. The minimum beamsize ~35nm expected in ATF2 is order of magnitude larger. Nonetheless, we can perform a stabilization test to a few nanometer using the 'nanoBPM' which is under development at the ATF.

There are many accelerator and experimental physicists in the world who are interested in this plan. It is quite likely that it is constructed by international collaboration in the sense both of manpower and budget. If this be done, ATF2 will be a miniature of ILC with respect to the world collaboration.

Study items concerning ATF2 are not matters of CDR. In this sense they are not very urgent compared with CDR related issues such as 45MV/m and kickers. It should also be in mind that the design work for the final focus system, except for a few parameters such as the crossing angle and the total length of the beam delivery section, will still continue even after the start of machine construction. Thus, studies after TDR can also have influence on the final beamline design. Training of beam tuning using ATF2 will also be useful for minimizing the actual commissioning period of the real machine.

3.6 Miscellaneous

There are a few individual items that are not included in (A)(B)(C) listed in Section 2, such as

- Target damage test in KEKB for positron production.
- Development of polarized electron gun.

There are two candidates the sheme of positron production, the undulater-based method which has been investigated for TESLA and the conventional method by bombarding electron beam. The latter has an advantage of the absense of interference between electron and positron operations but a problem is the possible destruction of the target material. The abort beam from KEKB can be used for a test of target damage theory albeit the beam pulse length is short compared with the ILC beam (10μs vs. 1ms). This is one of the most urgent issues to be decided in summer 2005.

We have described our plan for the ILC project with the emphasis on the next two years. It will also be useful for understanding our stance to know what we are not thinking of or what we have eliminated or postponed since the initial plan.

The initial plan included a development of super-structure of 45MV/m cavity after the vertical test. Since this process might cause a delay of the technology establishment though it potentially gives higher effective gradient and lower cost, and since it requires a long cryostat for vertical test in the first step, we postponed it to a later stage. We think to get a 4-cavity cryomodule is more urgent than a super-structure. We shall later discuss which should have higher priority, super-structure or a cryomodule with more than 4 cavities.

There are two possible schemes for fast kickers, one is the stripline kicker, the other the so-called Fourier kicker. We decided to develop the former only, since we judged we would not be convinced by summer 2005 with the performance of the Fourier kicker in the real ILC damping ring even if the proposed program is successful.

We will not try to test a positron production nor to develop the related components, although we plan a test of the target damage as mentioned above because we cannot expect a significant contribution in this field within the required time scale.