Responses to TB 2009 questions

The TB posed the following questions:

1. Is it essential to the ILC to run a superconducting quadrupole at the ATF2?
2. Do we need more "complete" prototype than the ATF2 one with simpler structure, i.e. no outgoing beam, large bore, short length, no detector solenoid etc.?
3. Are there the risks for the installation at the ATF2 beam line?
4. What are the resources and the schedule?

The answers are summarized below.

Question 1

Is it essential to the ILC to run a superconducting quadrupole at the ATF2?

Answer

Developments of SC FD address one of the most critical elements of the machine, whose single system performance may affect performance of the whole collider. The design of SC FD has combination of features that create unique challenges: compactness, combination of quadrupole, sextupole, skew and higher order elements in a single cold mass, use of correctors to shift centers of magnetic elements, stringent vibration and magnetic center position requirements, demanding requirements on allowable energy deposition and coil cooling.

Among these challenges, the vibration performance is most uncertain and unknown. All the features of SC FD affect its stability performance. Therefore, a system-wide approach is needed for developments and tests of the Final Doublet that would meet stability requirements of ILC. These challenges are reflected in the ILC R&D plan which lists FD SC as a high priority item.

Developments and studies of SC FD prototype will be done in steps. Design and performance of the cold mass, quench characteristics, field quality and long coil winding procedure will be developed and verified at BNL. After these tests, one would be certain that gradient and field quality can be provided, and that magnet with needed aperture, length and gradient can be built.

These tests, however, would not address the stability requirements of the SC FD. Addressing these requirements require systematic approach to study vibration of the whole system, the FD realistically mounted and connected to service cryostat, as well as stability of the magnetic center.

Such studies are planned to be partly done at BNL and complemented by comprehensive systematic tests at KEK on ATF2.

Tests at BNL will involve measurements of vibration on top of the FD, on its connection systems and will also attempt to measure stability of the cold mass with respect to externals of the FD.

These tests will need to be analyzed and understood, to develop predicting capabilities for the ILC FD.

Studies of FD with beam are essential to ensure system-wide performance of the FD and stability of its magnetic center. The ATF2, after it will complete its planned studies of the goal B (nanometer stability of the beam) will be in unique position, due to quality of the beam and instrumentation that will be available at that time, to perform systematic study of SC FD.

The suggested study of SC FD at ATF2 will involve measurements of the FD stability with respect to its neighboring elements in the final focus beamline, such as IP Beam Size Monitor and upstream parts of FD, followed by measurements of the beam motion. These former tests will allow prediction of performance in terms of beam motion and will be used to disentangle the magnetic field motion from the mechanical motion that will be observed in beam tests.

Question 2

Do we need more "complete" prototype than the ATF2 one with simpler structure, i.e. no outgoing beam, large bore, short length, no detector solenoid etc.?

Answer

The SC FD will have most of essential features of the ILC FD, such as single cold mass housing both the quadrupole and the higher order coils, the winding method, the cooling and quench characteristics, etc. Studies at BNL and KEK ATF2 will allow systematic understanding of the design, development of simulation tools that would help develop prediction capabilities of performance of ILC FD taking into account its possible differences from ATF2 SC FD.

Therefore, differences in terms of the structure, outgoing beam, absence of the antisolenoid, etc., could be mitigated by expected development of predicting capabilities. Meanwhile, the FD prototype would include additional (with respect to ILC) diagnostics possibilities (such as observation ports), that will facilitate its systematic studies.

Question 3

Are there the risks for the installation at the ATF2 beam line?

Answer

The risk of installation of SC FD in the ATF2 beamline that we can think of is potential conflict with possible other experimental programs. This, however, can be mitigated by advance planning, to ensure that other programs (in particular ATF2 goal B has been achieved).

There is also another category of possible risks – those which are related to the prototype itself and its performance. Such risks may include: very large instability of magnetic center, frequent quench, large leakage magnetic field, unexpected large higher multipole components, beam hitting the cryostat (MPS), malfunction of correction coils, etc. These risks, if encountered on the beamline, would consume experimental time. Their mitigation would be to do as much tests as practical before installation of the FD into the beamline.

Question 4

What are the resources and the schedule?

Answer

The resources at BNL for this work have practically been secured, via the ILC BDS funding. There is a need to secure resources at KEK, for cryogenic system. Recently, design efforts on cryogenic system have started by KEK-BNL collaboration, particularly with new participation from the KEK Cryogenics Science Center . The resources required for the cryogenic system are believed to constitute and smaller fraction of the resources needed to build the FD. There are also ongoing discussions with other partners to provide resources for integration and stability studies.

The technically limited schedule would involve building the SC FD in 2010 and 2011, with possible delivery of FD to KEK in early calendar 2012. By that time, the ATF2 goal B is expected to be achieved, opening possibility for SC FD studies, as well as for further studies of squeezed beta, which is expected to greatly benefit from the new SC FD.

These tentative schedule need to be iterated and optimized, as soon as resources capabilities of all partners will be understood.

Since February 2009, the nanobeam scheme has been developed for KEKB upgrade, so-called SuperKEKB , with 80 times luminosity. The beam parameters at the IP are very similar to those at ATF2.

In particular, the vertical beam size is 59nm with β^*_y=0.27/0.42 mm and ε_y =13/8.3 pm at beam energy of 4.0/7.0 GeV. Also, compact superconducting quadrupole magnets will be used. The stability of magnetic center is a common issue. Therefore, we expect a very strong synergy between ATF2 and SuperKEKB.