Summary of the third ATF2 project meeting, KEK, December 18-20, 2006

Conventional Facilities and Construction Schedule

1. There are R&D devices for X-band and KEKB crab cavity at a planned ATF2 beam line in the assembly hall. Most of the devices will be taken out for relocation by end of February 2007.
2. The assembly hall area will be cleaned up for the floor refurbishment by end of April 2007.
3. The ATF will be operated as usual year until June 2008. The operation schedule is updated at the ATF Web page.
4. The floor refurbishment will start in middle of June and will complete by end of September 2007.
5. After the completion, the construction of ATF2 beam line will start, which includes installation of magnets, vacuum pipe, beam dump, power supplies and instrumentations of BPMs and beam size monitor at the focal point.
6. The beam commissioning is re-scheduled from February to October 2008 for a large scale re-configuration of the extraction line during summer shutdown in 2008.
7. The construction schedule of ATF2 beam line will not be changed even with the above re-scheduling. So, major components will be installed by end of January 2008 in order to prepare the official inspection as a radiation controlled facility and to prepare heavy work at the reconfiguration in Summer 2008.
8. The radiation shields have been designed for radiation dose must be less than 0.2uSv/h in public area.
9. Power cables and cooling water pipes will be installed on the floor at north side of the beam line at ATF2 area.

Re-location of existing devices

1. Laser-Wire (LW) : location no.1 and 2 for micron-size test and two dimensional system for R&D.
2. Nano-BPM(SLAC/LLNL) : in the diagnostic section, also to be used as a BPM test stand.
3. IP-BPM : in the matching section for R&D.
4. FONT : in the coupling correction section and reserve a section for IP stabilization in future.
5. Items to be checked before the finalization : (1) The beam optics by each group; (2) Space clearance including girders ; (3) Procedure to move the devices.

Optics and Commissioning

1. Optics has been finalizing as V3.6 with decreasing the U3224 in FF-optics and no octupoles.
2. BH3 can be operated with 110% times present current, which is a sector type magnet.
3. Nine QBPMs are mounted on QD10, QF11, QD12, QD16, QF17, QD18, QD19, QD20 and QF21 without FFTB movers. So, the total numbers of QBPMs and the movers are 33 and 27, respectively.
4. Power supplies of two kickers could be re-located for use of present cables. This possibility should be explored.
5. Necessity of one more sextupole, which is FFTB "1.38S3.00", should be further studied,
6. More detailed geometries should be included in the FF-MAD deck, e.g. QBPMs, movers and etc .
7. More simulation studies are necessary on corrections of magnet misalignments (positions and rolls) with realistic resolutions of wire scanners, magnet strength errors, BPM offsets, BPM rolls and extraction channel coupling errors.
8. There are further investigations on the issue of too strong skew quadrupoles for coupling corrections to use present IDX magnets by T.Okugi, R.Tomas and M.Woodley.

9. The strength of QK1X is proportional to the quadrupole rolls in either vertical dispersion corrections with QS1X/QS2X skew quadrupoles or ZV1X/ZV2X/ZV3X local bumps.
10. In the local bump correction, main coupling source is vertical offsets at sextupoles and bends for strong sextupole fields. Homework is to find a good sextupole setting for smaller chromaticity, 2nd order dispersion and betatron coupling.
11. In the skew quad correction, M.Woodley suggested to use IDX magnets for QS1X, QS2X, QK2X and QK3X, and build (or find) two new skew quads for QK1X and QK4X.
12. Can we align the rolls with 100urad rms (300urad max) instead of 300μrad rms? R. Sugahara said that biggest error source was non-parallelism between alignment reference base plate and the median plane of quadrupole component. This non-parallelism was measured for QEA magnets in the field measurement, and errors will be corrected in the alignment. So 100urad precision for the roll will be accomplished for the QEA magnets, but will not for the existing old magnets.
13. First simulation of ATF2 tuning performance was executed by porting developments for ILC alignment and tuning. The tuning process was converged typically in < 20 iterations.
14. The simulation needs to include ground motion, component jitter, incoming beam orbit and energy jitter, BPM scale and magnet strength drifts etc. .
15. Additional beam size monitors (BSM) are needed around IP for the commissioning; which are a carbon wire scanner and a nano pattern target with resolutions of 1um and 0.3um, respectively.
16. A sweeping magnet is needed for position scans at various BSMs around IP.
17. International collaboration will be strengthened for the commissioning, optics design, beam tuning and studies at the present ATF extraction line among CERN, Valencia university, Orsay lab., Daresbury lab., SLAC, KEK and more .

Magnet, Mover and Alignment

1. The position of the detector of the laser wire signal was considered. The two best locations were compared： (a) Before QD6 and after BH5 and (b) After QD6 and before QF5. The signal would be 16% less in the (b) position. If it is after QD6 then there is some potential interference between the laser beam pipe and QD6 magnet . If the outer diameter of the laser beam pipe is larger than 20mm, the beam pipe will interfere with the side of pole tip of magnet at the entrance of QD6 and with a coil-fixing bolt at the exit. There must be some loss of signals with 20mm outer diameter beam pipe. Modification of the QEA magnet, used as QD6, is unnecessary at present.
2. There are following four types of magnet support base; type-1 for QEA. Qk and ZV, type-2A for QEA and ZH, type-2B for QEA and ZV, type-3 for QEA, Sx and QEA, and type-4 for QEA, whose quantities are 3, 3, 1, 3 and 14, respectively.
3. The FFTB movers are mounted on the bases of type-3 and -4, whose total number is 24 with one spare.
4. The FFTB movers are required to have 16mm diameter holes at the center of the T-plate, whose modification must be approved by SLAC.
5. Magnetic fields of 24 QEA magnets, which have been produced in JFY2005, were measured both at IHEP and KEK. In addition, there is a reference magnet of QEA04 (150A) at IHEP. The total number of QEA magnets is 28 with 4 magnets under production in JFY2006.
6. Two set of measurements are in better agreement in the second batch with improvement in the measuring environment at IHEP.
7. Alignment group must use individual offsets of magnetic centers relative to the alignment targets/bases.
8. Sextupole components were measured to be small, or good magnets can be selected for critical places in the beam line.
9. Request for bids for manufacture of three dipole magnets (B1,B2 and B5) went out from SLAC on 2nd January 2006.
10. Bore aperture of QD0 and QF1 was decided to be 50mm. The old FFTB quads with 35mm bores will be sent to LBNL in January 2007

for EDM processing to increase their bores to 50mm diameter

11. Two new "FD" sextupoles (SF1 and SD0) are being designed at SLAC. They will have 50mm bore and their core length can be somewhat longer than 90mm. They must fit in with FFTB movers, the special support table and also the beam line height of 1.2m .
12. Three new FF sexupoles being designed at SLAC will have 32mm bore and the core length of 90mm. Preferably, the bottom of their core should be flat to sit directly on a "QMAG" mover top plate.
13. 24 FFTB movers have arrived with electronics and cables at KEK.
14. 4 FFTB movers (one wide and 3 less wide ones) will be sent to LAPP in a week of 18 December 2006 for a several month loan.
15. SLAC will design and build adjustable stands for placing under the B1, B2, B5 dipoles. Decision about who pays for these supports to be made.
16. 3 horizontal (ZH8X, ZH9X and ZH10X) and 2 vertical (ZV11X and ZV12X) steering magnets will be produced or prepared by KEK.
17. There may be 2 new skew quads as M.Woodley suggested.
18. New adjustable permanent magnet could be tested in the ATF2.
19. A rough design for an adjustable permanent octupole magnet is being considered , It has a two-piece configuration similar to the adjustable quad. It would be advantageous if such a design could be used for the ILC tail-holding octupole with r=0.7cm.

Scheduling

1. FONT group will demonstrate 1-d FB system(y) in ATF in 2007. Also, the group will decide whether 1um striplines viable mid 2007. If not, multi-bunch cavity BPM will be developed. Beam time will be needed in either case at ATF.
2. MONALIZA : The straightness monitor built from distance meters will be installed in the ATF2 beam line, i.e. between SLAC/LLNL and KEK BPM systems. A compact straightness monitor (CSM) has been proposed in funding process to monitor alignments between Shintake monitor and final doublet. The detailed plans will be worked out by

the next project meeting, May-June 2007.

3. Stable table for FD：In winter 2007, the LAPP group will measure vibrations of dummy weights and QC3 magnets on FFTB movers and the CLIC table honeycomb block without active feet for rigid mount. In Spring 2007, the group will build new table/support system upon the final decision. For summer and fall 2007, the system will be tested at LAPP. In winter 2008, the system will be transported to KEK for full integration and tests. In future, an active control may be added on the table. Also, the group was suggested to investigate an additional control of slow vibrations for the CLIC table.
4. Laser-Wire group will develop a new vacuum vessel and optics for 3-angle scans from March 2007 for about 9 months. Also, the group will develop a light transport system and install the core system together with a new laser hut at beginning of project, i.e. by summer 2008. The group takes a staged approach; (1) 3-angle scans possibly with integrated wire scanner, (2) micron-scale system and (3) BPM integrated system. The group will increase number of 3-direction LW's sequentially, depending on funding.
5. NanoBPM group will continue R&Ds in 2007 through 2008 on the electronics thermal noise limit, multi-bunch operation, a diagnostics of existing slow systematic drifts of extracted beam and preparation for QBPM system at ATF2 (electronics, analysis and full monitoring). The group will disassemble and reassemble the triplet system at start of summer shutdown 2008.
6. IPBPM group will continue R&Ds until December 2007 on nanometer resolution study with installation of alignment mover, stabilization with optical interferometer and bunch length monitor. Also, a new BPM with low-Q will be tested for multi-bunch operation by KNU colleagues, Korea. One IPBPM will be installed in the vacuum pipe of Shintake monitor before the commissioning in October 2008 through March 2009, while an IPBPM quartet system will be developed at the device test section. The quartet system will be installed at IP in April 2009.

7. Shintake monitor group will develop the IPBSM by end of September 2007 at University of Tokyo. The IPBSM will be tested with pulsed high power laser there. Also, gamma detector will be completed by the same time. The IPBSM system will be transported to KEK by end of 2007. The system will be commissioned in February through June 2008 at ATF2 area. The group expects that the first beam size measurement will be performed in 3 months after the first beam delivery to IP if no trouble.

Power supply

1. The Ethernet Power Supply Controller provides an external current feedback loop to the power supply and is capable of 10ppm current regulation. A new local control board which is the half size and more robust will be available for local operation, tuning and programming.
2. Power supplies are under production, which consist of N+1 redundant OCEM modules and provide 50 -200A to the magnets. Each power module is rated at 30V and 50A.
3. They will be installed in Spring 2008. The detailed schedule will be determined with the ATF2 commissioning plan. The critical items needed for installation include: AC service, DC magnet cables, cooling water to the magnets, interlock cables, and control cables.
4. The commissioning may be divided into two parts depending on KEK schedule and preference.
5. The responsibilities were reaffirmed by SLAC and KEK. SLAC will provide all items located in and including the racks. KEK will provide all the services to the racks, such as AC service, DC, interlock and control cables.
6. Upcoming tasks for SLAC include placing orders for the racks, bulk power supplies and a PLC.
7. Magnetic field stability of dipole magnet has been precisely studied at SPICE, NIRS, Japan. The temperature coefficient has been measured to be +14 ppm/degree, which is positive and can not be explained by the standard Bloch theory.

8. Since hysteresis effect is larger than the temperature one, we would like to monitor the magnetic fields by NMR.
9. Local thermal insulation is economical and recommended.

IP configuration

1. Ground motions (GM) were measured in frequency range from 0.008Hz to 50Hz at two points on the ATF-DR floor in the same time by two STS-2 sensors. The distance between two points, L, were varied as L=0, 2, 4, 7, 12, 17, 22 and 27m, where 27m was the longest distance with no expansion joint in the ATF ring. Frequency region of good coherency was shown as a function of L.
2. No significant difference was measured between the GM coherencies with and without an expansion joint.
3. It was suggested at this meeting, ATF/ATF2-GM model should be made for the beam tuning studies with these measurements.
4. LAVISta group studied on the CLIC table for ground stabilization at LAPP, Annecy.
5. For low and medium frequency vibrations, the passive mode is better than the active one, because the active mode has amplification of 1.5 and loss of coherence in $0.1<f<1$Hz and $1<f<20$Hz, respectively.
6. The group will investigate a stiff table for a passive system with no eigen-frequencies up to 50Hz.
7. The CILC table can be adapted for frequencies from 1 Hz to 100Hz with the active mode. It was suggested to add a feedback control in the frequency of less than 1Hz.
8. Slow drift of the CLIC table was observed to be 40μm for temperature variation of $3^{o}$C in vertical direction, where horizontal drift was 3 or 4 times smaller.
9. Three support systems of Shintake monitor and the final doublet were evaluated for stabilization between the interferometer fringes and the electron beam within a few nanometers, which are (1) individual rigid mounts, (2) mount on a stabilized common table and (3) individual mounts with feedback.

10. The systems of (1) and (2) were recommended for mechanical stabilization around IP for good GM coherence of the floor, simple structure, low cost and less R&D.
11. In either system, rigidity of the interferometer body is essential to stabilize the fringes relative to the body. The rigidity will be confirmed by measuring impulse response of the body.
12. A rigid mount system of the interferometer will be designed by taking account of the impulse measurement results.
13. MONALISA group considers a measurement of motion of Shintake monitor with respect to the final doublet by using Compact Straightness Monitor (CSM). Also, the group develops a Straightness Monitor to measure relative motion between the SLAC/LLNL and KEK cavity-BPM systems in close collaboration with LiCAS group.
14. The group will report a detailed plan of CMS at next ATF2 project meeting in June 2007.

Instrumentation

FONT

1. A new amplifier was tested for FONT4 digital feedback system by ATF beam in December 2006, where the ADC clocking was improved from 714/10=71 to 357/4=90 MHz as well as the PCB BPM processor.
2. Kicks were successfully observed at 2nd and 3rd bunches in the three bunch train with 150ns separation.
3. Closed-loop feedback will be extensively tested in 2007 and 2008.
4. The next test plan is FONT5 for long ILC-like train of 20-60 bunches, since the FONT4 amplifier was specified to allow this and waiting for fast extraction kicker in 2008/9.
5. IP FB system will be seriously studied by simulation first, where IPBPM drives an upstream kicker to stabilize the beam position at IP.

Feed-Forward System

1. The system is designed as an ILC turnaround feed-forward prototype at ATF, which can correct fast bunch-by-bunch jitter, a drift across a

train and slow drift. The final goal is the correction of variations from $\pm 6\sigma$ to $0.1\sigma$. Also, this prototype provides a basis for engineering design of the ILC system.

2. The corrections are only in vertical plane for two or three bunches within 0.45 $\mu$s feed-forward time. The hardware consists of one BPM pair and three pairs in the DR and extraction line, respectively, and one pair of stripline kickers in the extraction line.
3. R&Ds have been started on sub-um BPM of compass-like strip line pickup, the electronics and a high voltage kicker amplifier at Daresbury laboratory. The BPM system will be tested in March 2007.

Q-BPM Electronics

1. The performances of 39 electronics boards have been experimentally verified. The noise figures are less than 15dBm which corresponds to 100nm resolution. The cross talk is about -60dB between channels on the same board. Signals start to saturate at 200um off-center position and the gain becomes 10% lower at 1.6mm off-center. Temperature coefficient of gain was measured to be -0.0172dB/$^{o}$C around 30$^{o}$C.
2. First pulse calibration scheme was designed to correct position signs by beam through the first BPM and a reference cavity at well-known z-positions.
3. Electronics and hardware should be developed for installation, which consist of 38 down mix boxes, VME64x crate, RF infrastructure and a BPM magnet mover test bed.
4. Also software should be developed, which includes EPICS IOC for VME control, mover calibration, position calculation, amplifier gain, LO, CAL power and temperature monitoring, and EPICS communication with ATF control system.
5. The test bed setup should be ready for testing first pulse and mover calibration schemes in Spring 2007.

Signal and background simulation for LW and BSM

1. The purpose is background simulation along the ATF/ATF2 beam line with beam halo which has been measured with wire-scanners by Shintake monitor (BSM) group.
2. First thing is a simulation of present ATF extraction line to reproduce LW-signals and background by using BDSIM.
3. Next, the simulation will be applied to signals and background of LW and BSM at ATF2 for the best performances.
4. Simulation technique will be developed, weighting halo particles for efficient statistical calculations.
5. The LW signals have been measured with minimizing background by tuning optics both at upstream and downstream of the LW for spray and back-scattered particles, respectively. It was suggested that "bad" optics data can be used for verification of the simulation.

Shintake monitor (BSM)

1. Present major goal is the fringe pattern (phase) stabilization within 10nm which corresponds to 2nm error in the 35nm beam size measurement with safety factor of 3.
2. This goal was demonstrated by two off-axis interference monitors and a phase scanner controlled by one of the monitors, i.e. 3.2nm of the pattern jitter at the controlled/stabilized monitor while 7.5nm with subtraction of drift at the other one, where the patterns were measured with linear sensors and low power CW laser.
3. Next tasks are (1) test with high power pulsed laser especially for performance of linear sensors, (2) identification of the drift sources, (3) optimization of stabilization algorithm, (4) equalization of two laser beams after splitting by a Pockels cell and (5) correction of laser timing jitter ( about 1ns) by using TDC.
4. While the present (FFTB) laser produces about 1,000 signals/bunch, higher power laser is desired.

Shintake monitor detector

1. Two detector concepts have been studied for robust against backgrounds, which are Cerenkov counter and calorimeter.
2. The multi-material Cherenkov counter was turned out to be impractical for too long space and small number of lights.
3. The two layer (CsI crystal) scintillation calorimeter was proved to be our choice. The geometries were optimized by simulation with S/N of 2000/1000, where the two layers have cross section of 10 x 5cm$^2$ and length of 2 and 30cm.
4. The prototype detector will be fabricated in March 2007. It will be tested by cosmic rays and beam in June 2007.
5. The real detector will be fabricated and tested in September and November, respectively.
6. Space of 40 x 40 x 45 (length) cm$^3$ is needed behind the beam dump.
7. It was noted that background study and suppression are very important for the detector optimization.

IPBPM

1. Two IPBPMs were fabricated, each of which has two cavities.
2. R/Q was measured to be parabolic as expected for dipole signals by small bead scanning in the cavities. Also, the electronics noise was measured to be -95dBm which is less than of -90dBm/nm.
3. They were tested by beam at the ATF extraction line. The position sensitivities were 0.15 and 0.35mV/μm in x and y, respectively, which are 2 and 3 times of QBPM, respectively. The angle sensitivities were 1.8 and 3.8mm/rad in x and y, respectively, which are 1/2 and 1/4 of QBPM, respectively. The position resolution was estimated to be 2.7nm by correlation of split signals.
4. Plan in 2007; Position resolutions will be measured by piezo-movers on the FFTB movers. A bunch length and charge monitor will be designed and fabricated. Also, IPBPM will be designed for installation in the IP vacuum pipe of Shintake monitor.

Bean size monitor using a pattern target

1. The purpose is measure beam sizes from 1μm to 350nm in the "blind" region.
2. Novel monitor can measure the beam sizes by collisions on a thin film with fine strips (target), where small beam makes two peaks of scattered signals while the peaks move loser and finally merge in a single peak in case of large beam. Beam size can be tuned by observing the movement of peaks in real-time. Since this method is statistical, the results are robust for beam jitters.
3. Extendable target can be used for destruction by beam; e.g. a tape of 10mm length/measurement corresponding to 10μm times 1000 pulses or a zigzag pattern.
4. A simple calculation shows that 1.5μm pattern can measure the beam sizes from 1μm to 350nm.
5. Simulation (GEANT4) shows that multiple Coulomb scattering effect is negligibly small and 10% yield of the wire scanner in case of 10μm pattern on 10μm thick Aluminum sheet.
6. Engineering and radiation issues should be investigated.
7. This novel monitor should be seriously considered as a monitor at the beam commissioning.