ATF2 project and its status

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T. Sanuki
ILC WG4

Beam Delivery, Interaction Region,....
Everything after Main Linac

Fully international collaboration

Regional/domestic activity

ILC-Asia WG4:

http://lcdev.kek.jp/ILC-AsiaWG/WG4notes/
Goal

A. Small Beam Size
   (A1) Obtain $\sigma_y \sim 37\text{nm}$
   (A2) Maintain for long time

B. Stabilization of beam center
   (B1) Down to ~2nm by nano-BPM (cavity BPM)
   (B2) Bunch-to-bunch feedback of ILC-type beam (~300ns)
## ATF2 & FFTB/SLAC

<table>
<thead>
<tr>
<th>FACILITY</th>
<th>ATF2/KEK</th>
<th>FFTB/SLAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>construction</td>
<td></td>
<td></td>
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<tr>
<td>Optics</td>
<td><strong>ILC-like</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pantaleo's local chromaticity correction scheme</td>
<td>Oide's conventional (separate) scheme</td>
</tr>
<tr>
<td></td>
<td>very short and longer $L^*$</td>
<td>non-local and dedicated CCS at upstream high symmetry; i.e. orthogonal tuning</td>
</tr>
<tr>
<td></td>
<td>($\beta^* y = 100 \mu m$, $L_{tot} = 36.6 m$)</td>
<td>($\beta^* y = 100 \mu m$, $L_{tot} = 185 m$)</td>
</tr>
<tr>
<td>Design beam size</td>
<td>37nm / 3.4$\mu$m, aspect=92 ($\gamma\epsilon_y = 3 \times 10^{-8}$ m)</td>
<td>60nm / 1.92$\mu$m, aspect=32 ($\gamma\epsilon_y = 2 \times 10^{-6}$ m)</td>
</tr>
<tr>
<td>Achieved</td>
<td>?</td>
<td>70nm (beam jitter remains !)</td>
</tr>
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</table>
Optics

Scale down from the ILC-FF
Beam

- Local chromaticity correction
- Similar to ILC-FFS in
  - Chromaticity
  - Energy spread
  - Aspect ratio
- But different in
  - Geometric emittance
  - Bunch length

<table>
<thead>
<tr>
<th></th>
<th>ATF2</th>
<th>ILC</th>
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<tbody>
<tr>
<td>Beam Energy [GeV]</td>
<td>1.3</td>
<td>250</td>
</tr>
<tr>
<td>L* [m]</td>
<td>1</td>
<td>3.5 - 4.2</td>
</tr>
<tr>
<td>$\gamma\varepsilon_x$ [m-rad]</td>
<td>$3 \times 10^{-6}$</td>
<td>$1 \times 10^{-5}$</td>
</tr>
<tr>
<td>$\gamma\varepsilon_y$ [m-rad]</td>
<td>$3 \times 10^{-8}$</td>
<td>$4 \times 10^{-8}$</td>
</tr>
<tr>
<td>$\beta_x^*$ [mm]</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>$\beta_y^*$ [mm]</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>$\eta'(DDX)$ [rad]</td>
<td>0.14</td>
<td>0.094</td>
</tr>
<tr>
<td>$\sigma_E$ [%]</td>
<td>$\sim 0.1$</td>
<td>$\sim 0.1$</td>
</tr>
<tr>
<td>Chromaticity $W_y$</td>
<td>$\sim 10^4$</td>
<td>$\sim 10^4$</td>
</tr>
<tr>
<td>$\sigma_z$ [mm]</td>
<td>8</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Jitter Tolerances of magnets

- Magnet tilt errors are very similar
- Position error are relaxed
- Magnet strength errors are same/tighter for FD/others
ATF2-FF & ILC-FF

- Similar optics
- Similar beam
- Similar jitter tolerance

ATF2 will give valuable experience in providing stable beam at ILC
Beam size at FFTB

Maintenance of small beam size is indispensable.
Beam jitter at FFTB/SLAC

\[ \sigma_{\text{jitter}} \approx 130 \text{ (nm)} \]

With the demagnification of 7, \( \sigma_{\text{jitter}} \) is about 20nm at IP, where, the jitter contributed 30% in the beam spot size.

300 pulses at 30Hz

3 RF BPMs are installed at an image focal point.

\[ \sigma_{\text{RF-BPM}} = 25\text{nm} \]

\[ \sigma_{\text{RF-BPM}} = 80\text{nm at IP, } \sigma_\theta = 460\mu\text{rad} \]
SLAC-LLNL 3 Cavity BPM system for nm resolution study

LLNL Design rigid support and nm mover,
SLAC Improved electronics,
BINP Design BPM

Preliminary result shows 16nm in Nov.29-Dec.17, 2004
KEK 3-Cavity BPM system for nm resolution study
Goal < 2nm
KEK Design nm mover and nm position feedback, KEK design BPM and electronics

Performance of nm Mover

3 BPMs on nm mover, BPM Y positions are locked by laser interference position monitor and piezo actuator feedback.
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(B1) Down to $\sim 2\text{nm}$ by nano-BPM (cavity BPM)

(B2) Bunch-to-bunch feedback of ILC-type beam ($\sim 300\text{ns}$)

Ensure collisions between nanometer beams; i.e. luminosity for ILC experiment
Schedule & Status
ATF2 Proposal

- 75 authors, 17 institute from 3 regions
- 107 pages

http://lcdev.kek.jp/ILC-AsiaWG/WG4notes/atf2
Optics design

- Optics is designed by fully-international team
- We have “optimal” design
- Need some modification to keep enough room at/post FP
Straight shape waveguide(1)
- Result of the Brazing Process “C” -

Seung Hwan Kim
Y. J. Park, J. Y. Huang
July 1. 2005, PAL
Shintake-mon. @ U-Tokyo

- Shipping to U-Tokyo
- Halve the laser wave length
  1064nm → 532nm
Q-magnet @ IHEP

• R. Sugahara (KEK) group visited IHEP
• Will be produced at IHEP
Schedule 2/2

2007  2008  2009
1  2  3  4  5  6  7  8  9  10  11  12

Floor  Installation  
Shield

Magnets

Instrumen-
tation  IP-BPM production  test@ATF  test  test@ATF installation

Support

Vacuum

Alignment system

CDR  Summer shutdown  1st beam mode-I  Summer shutdown mode-I  mode-I  Summer shutdown mode-II

Jitter control: Feedforward from DR to EXT

FONT5 of nm feedback system at KEK and SLAC/LLNL Nano BPMs

FONT6?
Summary

- ATF2 will demonstrate ILC-FF
- ATF2 will give valuable experience in providing stable beams in ILC
- Fully international collaboration
- First beam in 2008