LEPIII FFS considerations

R. Tomás and F. Zimmermann

Thanks to R. de Maria and H. Garcia

October 2012
# LEPIII and some machines

<table>
<thead>
<tr>
<th>Machine</th>
<th>L*</th>
<th>$\beta_y^*$</th>
<th>$\beta_x^*$</th>
<th>$L^<em>/\beta_y^</em>$</th>
<th>dp/p accept.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEP III</td>
<td>4</td>
<td>1</td>
<td>200</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>SuperB</td>
<td>0.4</td>
<td>0.2</td>
<td>20</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>SuperKEKB</td>
<td>0.7</td>
<td>3</td>
<td>200</td>
<td>0.23</td>
<td>1.8</td>
</tr>
<tr>
<td>LHC-ATS</td>
<td>23</td>
<td>150</td>
<td>150</td>
<td>0.15</td>
<td>0.5-1</td>
</tr>
<tr>
<td>Light sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-4</td>
</tr>
</tbody>
</table>
LEPIII IR challenges

★ Largest chromaticity than any other circular collider

★ Largest momentum acceptance than any other circular collider (similar to light sources)
Frank’s suggestion

Would the future linear collider FFS suit LEPIII?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>CLIC500</th>
<th>ILC500</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFS length/side [m]</td>
<td></td>
<td>553.1</td>
<td>735.4</td>
</tr>
<tr>
<td>Energy/beam [TeV]</td>
<td></td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>$L^*$ [m]</td>
<td></td>
<td>4.30</td>
<td>3.51/4.50</td>
</tr>
<tr>
<td>Crossing angle at IP [mrad]</td>
<td></td>
<td>18.6</td>
<td>14.0</td>
</tr>
<tr>
<td>Beam size at IP, $\sigma^*, x/y$ [nm]</td>
<td></td>
<td>202/2.3</td>
<td>474/5.9</td>
</tr>
<tr>
<td>$\beta$-function at IP, $\beta^*, x/y$ [mm]</td>
<td></td>
<td>8/0.1</td>
<td>11/0.48</td>
</tr>
<tr>
<td>Bunch length, $\sigma_z$ [$\mu$m]</td>
<td></td>
<td>72</td>
<td>300</td>
</tr>
</tbody>
</table>
MAPCLASS

★ Both ILC and CLIC FFSs are currently optimized with MAPCLASS

★ MAPCLASS minimizes $\sigma^*_x$ and $\sigma^*_y$ by varying all available FFS optics parameters.

$$\sigma^*_x^2 = \sum_{jklmn} X_{jklmn}^2 \Gamma \left( \frac{1 + 2j}{2} \right) \Gamma \left( \frac{1 + 2k}{2} \right) \Gamma \left( \frac{1 + 2l}{2} \right) \Gamma \left( \frac{1 + 2m}{2} \right)$$

$$\times \frac{2^{j+k+l+m-2n}}{(2n + 1)\pi^2} \sigma_x^{2j} \sigma_{px}^{2k} \sigma_y^{2l} \sigma_{py}^{2m} \Delta^2_\delta + \ldots$$

★ where $X_{jklmn}$ are the transfer map coefficients given by PTC

★ Note that currently $\sigma^*_{px}$ and $\sigma^*_{py}$ are not optimized
ILC & CLIC energy bandwidths

\[ \frac{L}{L_0} = 2.4 \times 10^{34} \quad \text{ILC} \]
\[ \frac{L}{L_0} = 1.24 \times 10^{34} \quad \text{CLIC} \]

\( \text{dp/p} (\%) \)
ILC-based LEPIII IR - Optics

Antisymmetric dipoles and sexts on both IP sides
ILC-based LEPIII IR - Chromatic functions

A good fraction is locally corrected as expected.
ILC-based LEPIII IR - dp/p acceptance

... not even the 1%
\[ \beta_x = 20 \text{ m}, \ \text{dp/p}=0.95\%, \ \epsilon_x = 20 \text{ nm}, \ DA=0.15\sigma_x \]

particle is lost in few turns.
Symmetric dipoles and sexts on both IP sides.
ILC-based LEPIII IR - 2\textsuperscript{nd} attempt

No trace of local correction.
ILC-based LEPIII IR - 2\textsuperscript{nd} attempt

slightly worse than first attempt...
Summary

★ Challenging IR design and momentum acceptance
★ First and bold attempts with ILC FFS not satisfactory
★ Reducing L* might help but 4% acceptance still looks difficult
★ Need to try other concepts for the IR design.