SuperTRISTAN
A possibility of ring collider for Higgs factory

Higgs Factory Workshop
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## Parameters Example

<table>
<thead>
<tr>
<th></th>
<th>TRISTAN</th>
<th>KEKB</th>
<th>LEP2</th>
<th>LEP3</th>
<th>TLEP-t</th>
<th>SuperTRISTAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beam Energy</strong></td>
<td>32</td>
<td>8 / 3.5</td>
<td>105</td>
<td>120</td>
<td>175</td>
<td>120</td>
</tr>
<tr>
<td><strong>Circumference</strong></td>
<td>3</td>
<td>3</td>
<td>27</td>
<td>27</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td><strong>Beam Current / beam</strong></td>
<td>7</td>
<td>1400</td>
<td>1700</td>
<td>4</td>
<td>7.2</td>
<td>5.4</td>
</tr>
<tr>
<td><strong>Bunches / beam</strong></td>
<td>2</td>
<td>1600</td>
<td>4</td>
<td>4</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td><em><em>β</em> x / y</em>*</td>
<td>2000 / 40</td>
<td>1200 / 6</td>
<td>1500 / 65</td>
<td>200 / 1</td>
<td>200 / 2</td>
<td>200 / 1</td>
</tr>
<tr>
<td><strong>Emittances x / y</strong></td>
<td>18 / 0.1</td>
<td>48 / 0.25</td>
<td>25 / 0.1</td>
<td>20 / 0.1</td>
<td>40 / 0.04</td>
<td>12 / 0.012</td>
</tr>
<tr>
<td><strong>Bunch length</strong></td>
<td>10</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>Beam-beam parameters x,y</strong></td>
<td>0.02</td>
<td>0.05</td>
<td>0.025</td>
<td>0.09</td>
<td>0.05</td>
<td>0.032</td>
</tr>
<tr>
<td><strong>Beamstrahlung loss / spread / equil. spread</strong></td>
<td>0.025</td>
<td>0.09</td>
<td>0.065</td>
<td>0.08</td>
<td>0.05</td>
<td>0.083</td>
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<tr>
<td><strong>synch. tune</strong></td>
<td>0.1</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
<td>0.23</td>
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<tr>
<td><strong>mom. compact.</strong></td>
<td>140</td>
<td>20</td>
<td>18.5</td>
<td>9.0</td>
<td>1.0</td>
<td>2.7</td>
</tr>
<tr>
<td><strong>Radiation loss / turn</strong></td>
<td>300</td>
<td>4 / 2</td>
<td>2750</td>
<td>6900</td>
<td>9300</td>
<td>3450</td>
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<tr>
<td><strong>RF Voltage</strong></td>
<td>400</td>
<td>10 / 5</td>
<td>3640</td>
<td>9000</td>
<td>12000</td>
<td>8300</td>
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<tr>
<td><strong>RF frequency</strong></td>
<td>508</td>
<td>509</td>
<td>352</td>
<td>700</td>
<td>700</td>
<td>1300</td>
</tr>
<tr>
<td><strong>Total SR Power</strong></td>
<td>4.2</td>
<td>5.6 / 3.4</td>
<td>22</td>
<td>100</td>
<td>100</td>
<td>45</td>
</tr>
<tr>
<td><strong>Luminosity / IP</strong></td>
<td>0.04</td>
<td>21</td>
<td>0.13</td>
<td>9.4</td>
<td>6.5</td>
<td>10</td>
</tr>
</tbody>
</table>
Ring Lattice

- 1 IP for the time being.
- 8 arc segments, 16 RF sections.
- 88 cells, $v_{x,y} = (146, 129)$.
- Should not be much more difficult than LEP2, except for smaller IP $\beta$'s (1500/50 vs 200/1 mm) and shorter bunch length (16 vs 1.2 mm).
Unit Cell

- Small momentum compaction is in favor:
  - lower rf voltage
  - shorter bunch length
  - smaller synchrotron tune
  - better dynamic aperture / beam-beam effects

- A good solution is a “2.5π cell”:
  - missing bend to allow negative dispersion region
  - naturally accommodates -1 sextupole pairs
“2.5π” Unit Cell

Sexupole pairs:
188 independent pairs for SuperTRISTAN 40.
IR Optics

“Semi-local” chromaticity correction scheme verified at FFTB / KEKB.
Dynamic Aperture

- Difference is seen in the dynamic aperture between on/off of synchrotron motion.
- Smaller synchrotron tune may reduce the difference.
Effect of Arc Radiation

- Synchrotron radiation somewhat increases the momentum acceptance, but reduces the transverse aperture.

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Sawtooth Orbit

SuperT40_SLC_3_trim_2.sad

- $\Delta p/p_0$
- $\Delta x$
- $\Delta z$

![Graph showing Sawtooth Orbit with axes labeled $\Delta p/p_0$, $\Delta x$, and $\Delta z$ over a range of values.](image-url)
Optics Disturbance by Sawtooth

\[ \Delta \beta_x / \beta_x \sim 70\%, \quad \Delta \beta_y / \beta_y \sim 30\% \]
\[ \Delta \eta_x \sim 10\text{mm} \]
Optics Corrections

- By shifting quads horizontally and trimming quad strengths according to the sawtooth, the optics can be recovered.
Effect of Optics Correction

The dynamic aperture is improved by the optics correction, even achieved a wider momentum acceptance than the no-radiation case.

- Synch. motion + Radiation
- Corrected Sawtooth Optics

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Larger Version:
$E_{CM} = 350 \text{ GeV}, C = 80 \text{ km}$

By dividing the arc into 16 segments, the amplitude of sawtooth becomes comparable to the 40 km version.

A dynamic aperture similar to 40 km is expected (not yet confirmed).
Summary

- A very preliminary evaluation was made for the dynamic aperture of an e+e- ring Higgs factory.
- “Sawtooth orbit” due to the synchrotron radiation in the arc is taken into account.
- The dynamic aperture is more or less acceptable, if simple optics correction to the sawtooth effect is applied.
- Further studies are needed to include
  - IP solenoid
  - Spin rotator
  - Injection scheme
  - High energy version