Crossing Angle Issues
updated on 15 Oct.

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ILC-Asia WG4 meeting, 6 October 2004
Extraction line (head-on) at TESLA-TDR

- Electric separator (20m, 0.8 mrad)
- 0.01% loss
- 0.1% loss
- Photons
- 15 mrad
- 0.2 mrad (1 cm at 50 m)
- Is too small for beamstrahlung photons

Trace Chamber
Amax_offset=0
...Amax_offset=2SIGy
Set-up for TESLA at $E_{\text{cms}} = 500$ GeV

Super-Q with large bore

QD ($r=24\text{mm}$)

QF ($r=7\text{mm}$)

$l^*=4.1\text{m}$

1m

1.5m

2 mrad

$R_{22} = 3$ from IP to QD exit

Total angle of 6 mrad between incoming and outgoing beam lines

Beamstrahlung cone at $2 \text{ mrad} \pm 2\sigma_x$, spent beam ($\leftrightarrow 2 \pm 0.5 \text{ mrad}$)

in "realistic conditions" means 10-16 mm extension at QF
First look at primary beam extraction

Beam energy fraction lost as function of total angle [mrad]
Equivalent clearance after QD as in head-on if \(2 \times \theta \sim 1.6 \text{ mrad}\)

QD : Super-Q with large bore (48mmΦ)

± 2 \(\sigma_x\), for spent beam → “realistic conditions”
Figure 7.6.4: Vertical layout of the final transformer region. The beamstrahlung power levels on the collimators are for the $E_{cm} = 500 \text{ GeV}$ machine.
<table>
<thead>
<tr>
<th>Criteria</th>
<th>head-on</th>
<th>v:0.3mrad</th>
<th>h:2mrad</th>
<th>h:7mrad</th>
<th>h:20mrad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septum at 50m from IP</td>
<td>must</td>
<td>must</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Irradiation at Septum</td>
<td>80W/0.3W</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Electrostatic separator</td>
<td>must</td>
<td>must</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Crab cavity</td>
<td>no</td>
<td>must 200kV,1.3GHz</td>
<td>option: L=85%</td>
<td>option:L=40%</td>
<td>must</td>
</tr>
<tr>
<td>Beamstrahlung dump/beam</td>
<td>2 dumps, 240m free</td>
<td>2 dumps, 240m free</td>
<td>1 dump, 240m? free</td>
<td>1 dump, 90m? free</td>
<td>1 dump</td>
</tr>
<tr>
<td>Final Q (FQ)</td>
<td>SQ:48mmΦ large bore</td>
<td>SQ:48mmΦ large bore</td>
<td>SQ:48mmΦ large bore</td>
<td>SQ:large bore conventional</td>
<td>SQ: compact permanent</td>
</tr>
<tr>
<td>Synchrotron γ/bent in FQ</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes small</td>
<td>no</td>
</tr>
<tr>
<td>Spent electrons over-focused</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes small</td>
<td>no</td>
</tr>
<tr>
<td>E/P measurement after IP</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Physics impact: min. angle</td>
<td>2mrad</td>
<td>2mrad</td>
<td>4mrad</td>
<td>9mrad</td>
<td>22mrad</td>
</tr>
<tr>
<td>Physics impact: background at VTX</td>
<td>no hot spot</td>
<td>no hot spot</td>
<td>no hot spot</td>
<td>no hot spot</td>
<td>hot spot</td>
</tr>
</tbody>
</table>
QC1 (QD)

JLC: $L^* = 2m$
$\theta_c = 8\text{mrad}$
$L/L_0 = 0.6$
$6\sigma_x \ 40\sigma_y$

ILC: $L^* = 5m$
$\theta_c = 3.2\text{mrad}$
$L/L_0 = 0.7$
$7.8\sigma_x \ 42.4\sigma_y$

New design

A. Miyamoto, June 2000
QC1 Coil Size
(unit: cm)

Z: 200cm to 420cm
Field Gradient: 226.03T/m
Current Density: 6.7 MA/m²
SF6 (Fe-Co Alloy)
Halo Collimation

- VTX with $r = 14$ mm requires mask with $r = 12$ mm
- Collimation required:
  - $x$: $7.8\sigma$ [TDR 13$\sigma$]
  - $y$: $42.4\sigma$ [TDR 81$\sigma$]
- Collimation requirements about a factor 2 tighter!
- Collimator wakefields?
- Reconsider choice of L*
- Tail folding octupoles
Figure 7: Diagonal stretch of the synchrotron radiation emitted by the final doublet through the opposite inner mask (black) and doublet apertures (hatched).
Extraction Line: $\theta_c = 7 \text{ mrad} \rightarrow 3.2 \text{ mrad}$

- Opposite beam
- Beamstrahlung $865 \text{ KW} @ E = 500 \text{ GeV}$
- Water Dump $1.6\phi \times 10 \text{ m}$
- Free space: $301.8 \text{ m} \sim 331.7 \text{ m}$