Designing the TESLA Interaction Region with $l^*=5$ m

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1. Final Focus **Optics**
2. Extraction of **Beam** after the interaction
3. Extraction of **Synchrotron Radiation** from Final Doublet
TDR: TESLA Final Focus

\[ l^* = 3 \text{ m}, \quad L = 690 \text{ m} \]

Beamstrahlung Dump at \(~250 \text{ m}\) from the IP
Chromatic Acceptance

(a) Horizontal
(b) Vertical

about \( \pm 0.4\% \Delta P/P \)
New Final Focus 'à la NLC'

Advantages from the machine point-of-view:

- Better chromaticity correction → larger $l^*$

chromaticity: $\xi = l^* / \beta^*$

- $l^* = 5m$ ↔ final doublet moved out of the detector solenoid
New Final Focus with $l^* = 5\text{m}$

Advantages from the detector point-of-view

– Larger forward acceptance at low angles

– Final doublet moved out of the calorimeter
  $\Rightarrow$ less background

– Lighter Tungsten-mask and simpler support
Main issues of the Design

1. Extraction of Beam after the interaction

2. Extraction of Synchrotron Radiation from Final Doublet (i.e. check collimation requirements)

3. Final Focus Optics

N.B. : First two issues, independent of the FF optics, depend only on $l^*$ and on the final doublet apertures $\Phi$. 
Beam Extraction

Final doublet acceptance $\Theta_{\text{max}}^* (E, \phi^*)$

with

- $l^* = 5\, \text{m}$
- $\Phi = 48\, \text{mm}$
- Solenoid $B_S = 4\, \text{T}$
Comparison of horizontal acceptances ($\phi^* = 0$) for $l^* = 3,4,5$ m

Differences are small. Tracking simulations are needed

$l^*=5$m acceptance:
- better for lower energies
- worse for high energies
Synchrotron Radiation Extraction

**Collimation requirements**

- $l^* = 5\, m$
- $\Phi = 48\, mm$
- inner mask
  - $s = 4\, m$
  - $\Phi = 24\, mm$
Collimation Requirements

<table>
<thead>
<tr>
<th></th>
<th>$l^*$ [m]</th>
<th>$s_{\text{mask}}$ [m]</th>
<th>$N_x$</th>
<th>$N_y$</th>
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<tbody>
<tr>
<td>TDR</td>
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<td>13</td>
<td>81</td>
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<tr>
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<td>New FF</td>
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<td>4</td>
<td>7.8</td>
<td>42</td>
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⇒ new collimation section required with tail folding by octupoles
Clear path to the beamstrahlung dump, with $l^* = 5 \ m$
Angular dispersion at the IP

\[ \text{Dx’} = 3 \text{ mrad} \]

Nominal \[ \Theta_x^* = 37 \mu \text{rad} \]

\[ \sigma_{E/E} = 0.5 - 1.5 \times 10^{-3} \]
Emittance Growth induced by Synchrotron Radiation

Tesla FFS Emittance growth @ 400 GeV

Nominal $\varepsilon_x = 2 \cdot 10^{-11}$ m
Chromatic Acceptance

\[ \sigma_{E/E} \]

Graph with data points indicating chromatic acceptance.
Clear path to the beamstrahlung dump, with $l^* = 5\ m$
Angular dispersion at the IP

\[ \text{Dx'} = 11.7 \text{ mrad} \]

FFS Optics

Nominal \( \Theta_x = 37 \text{ \mu rad} \)

\[ \sigma_{E/E} = 0.5 - 1.5 \times 10^{-3} \]
Emittance Growth induced by Synchrotron Radiation

**FFS Emittance growth @ 400 GeV**

\[ \varepsilon_x @ 250 \text{ GeV} \approx 2 \times 10^{-11} \text{ m.rad} \]
\[ \varepsilon_x @ 400 \text{ GeV} \approx 1 \times 10^{-11} \text{ m.rad} \]
Conclusions

- Design for $l^* = 5$ m new optics is in progress
- Several optimisations are still needed
  (w.r.t. to T166 aberrations, sextupole fields, …)
- Beam extraction through final doublet : OK
- Collimation requirements about a factor 2 tighter