Status & Possible Modifications to the TESLA BDS

Nick Walker
DESY

CollITF Meetings
SLAC
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Overview

- Quick review of TDR system
  Nothing really new in this talk!
  Problems *quantified* by TRC work already ‘guessed at’ at LC02 (and before)

- The collimation problem
  update from Payet and Napoly since Nanobeams

- New FFS

- Ideas for extraction line
  *Very recent ideas* for head-on scheme

- Ideas for collimation system (BDS)
  Towards a better integrated system, given site constraints.
Important constraint: Real estate is now FIXED!! (Assuming DESY site)
Lattice (Beam Envelope)
Lattice (Dispersion)
Magnetic Energy Spoiler (MES)

\[ \Delta x' = \frac{1}{6} K_3 D_x^3 \delta^3 \]

\[ \Delta x_2 = R_{12} \Delta x'_1 = \frac{1}{6} R_{12} K_3 D_x^3 \delta^3 \]

\[ \Delta \varphi_x = (n_x + \frac{1}{2}) \pi \]

\[ \Delta \varphi_y = (n_y + \frac{1}{2}) \pi \]

root of all evil no. 1
TDR Collimation System

ESPOI

\[ D_x = -100 \text{ mm} \]

\[ \Delta \phi_x = 45 \quad \Delta \phi_y = 315 \]

\[ \sigma_x = 130 \mu\text{m} \quad \sigma_y = 7 \mu\text{m} \]

\[ \sigma_{x/y} = 130 / 7 \mu\text{m} \]

\[ \Sigma_{x/y}/\sigma_{x/y} = 13 / 80 \]

\[ a_{x/y} = 1.5 / 0.5 \text{ mm} \]

\[ \pm 45^\circ \text{ lattice shows some strange chromatic properties} \]

\[ \text{root of all evil no. 2} \]
2\textsuperscript{nd}-order Dispersion Correction

-1.5\% < \delta < 0.5\%

Difficulty in balancing (correcting) non-linear terms already sounding alarm bells
Halo Tracking (Dynamic Aperture)

10^5 particles tracked
±16.25σ_x
±100σ_y
−3%<ΔP/P<+0.5%

Energy
Betatron
CCS spoilers
Halo Tracking (Dynamic Aperture)

Results obtained and published in TDR of hard-edge tracking.

‘Scattering’ and secondary production was not included in TDR.
TRC results

Simulation (A. Drozhdin) of collimation with beam halo shows no hard edge for TESLA system → some particles can reach IR

Bad performance of TESLA system *not* due to scattering, but appears to be optics! (confirmed by results of G. Blair)
Merlin Hard Edge Tracking Results

Flat halo: (not 1/r halo of Drozhdin)
- $10^5$ particles
- collimation depth +25%
  - $|x,x'|<1.25 \times 13 = 16.25 \sigma_x$
  - $|y,y'|<1.25 \times 80 = 100 \sigma_y$
- $|\Delta P/P|<5$

Tracking performed using TESLA BDS deck from G. Blair, with apertures supplied by S. Drozhdin
Particles outside rectangle (106/10^5) only in horizontal plane.

Both low and high-energy particles!

\[ \frac{\Delta p}{p} \quad \text{at FD} \]

\[ x/\sigma_x \]

\[ \Delta p/p (\%) \]

\[ x (\mu m) \]

\[ \Delta p/p (\%) \]
Analysis of bad rays

Mapped ‘bad rays’ back to exit of linac, and re-tracked them through BDS
For TDR:

Set final COLY x jaws to
±0.43 mm (±13σx)

Truncated δ above 0.5%

YCCS X spoiler gap = ±0.43 mm
(G.B’s deck: gaps at ±1.31 mm)
these spoilers ($\pm 13 \sigma_x$) not in deck used for ILC-TRC

possible alternative location

TDR Solution
New FFS with $L^*=5$ m

[Napoly, Payet]
Performance (Bandwidth)

\[ \sigma_x \approx 570 \text{ nm} \quad \text{RMS} \]
\[ \sigma_y \approx 5.2 \text{ nm} \]

\[ \sigma_x \approx 553 \text{ nm} \quad \text{TDR} \]
\[ \sigma_y \approx 5 \text{ nm} \]

\( L^*=5\text{m} \)
Halo Collimation

- VTX with \( r = 14 \text{ mm} \) requires mask with \( r = 12 \text{ mm} \)
- Collimation required:
  - \( x: \ 7.8 \sigma \ [\text{cf TDR 13}\sigma] \)
  - \( y: \ 42.4 \sigma \ [\text{cf TDR 81}\sigma] \)

### Table

<table>
<thead>
<tr>
<th></th>
<th>( l^* ) [m]</th>
<th>Mask distance from IP [m]</th>
<th>( N_x )</th>
<th>( N_y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDR design</td>
<td>3</td>
<td>2</td>
<td>13</td>
<td>81</td>
</tr>
<tr>
<td>New design</td>
<td>5</td>
<td>2</td>
<td>10</td>
<td>48</td>
</tr>
<tr>
<td>New design</td>
<td>5</td>
<td>4</td>
<td>7.8</td>
<td>42</td>
</tr>
</tbody>
</table>

Bad news for collimator wakefields
May need to trade on \( L^* \)
New! $L^*=4\text{m}$

Optical Functions

Now just over 600 m!
$L^* = 4\text{m Bandwidth}$

Normalized sizes and luminosity $l^* = 4\text{ m}$

- $\sigma_x \approx 598 \text{ nm}$
- $\sigma_y \approx 5.1 \text{ nm}$

TDR
- $\sigma_x \approx 553 \text{ nm}$
- $\sigma_y \approx 5 \text{ nm}$
Extraction Line Work

• Working Group formed to study all issues of head-on scheme:
  – Optics (stay-clears, tuning etc.)
  – Hardware (electrostatic separators and septum)
• Half day seminar held beginning December to review system and map out work plan
• Action items (head-on):
  – optics solutions (Brinkmann, Napoly, Payet, Walker)
  – tracking (G. Blair, K. Büsser)
  – septum magnet R&D (Eframov Inst.)
  – Electrostatic separator R&D (B. Goddard, CERN)
• Action Items (crossing-angle)
  – Evaluate impact on detector & physics (A. Stahl, DESY-ECFA)
  – Look at collaborating on compact s.c. quadrupoles
  – Impact on cost (DESY site, PFV)
• Final decision unlikely (unnecessary?) before project approval
• ‘Party line’ decision by next ECFA-DESY meeting (April 2003)
300µr vertical x-angle solution

R. Brinkmann

• shines BS away from septum blade and
• away from incoming beam @ BS dump
• needs quadruplet instead of doublet to obtain spent beam bandwidth
• crab-crossing needed but not so bad as that needed for 20mr horizontal crossing angle
• ~1mm difference of in and out beams at feedback BPM
• much optics and tracking work to do!!
Towards a New Integrated BDS

• Need to
  – Design new collimation system
  – Finalise new FFS design
  – Continue study of extraction line possibilities (somewhat orthogonal)
  – Re-evaluate fast extraction system (beyond scope of this talk)

• All this needs to fit into ~1750m

• Ideas:
  – Integrate (either partially or completely) collimation system into \( e^+ \) system bypass arc
  – Save space (~100m+) with new FFS system
  – Use freed-up real estate for dedicated diagnostics and tuning
  – Move fast extraction upstream of BDS (before switchyard)
Double bend achromat system to reduce synch. rad. effects.

(→ light sources)
e+ Source Bypass Arc Optics

Already has large dispersion points for E collimation

Beam sizes smaller than current CDS (spoiler survival)

Possible conflicts between collimation optics and synch. rad. effects

May still need some coll. in downstream section.