A Route to a multi-TeV electron-positron collider facility

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A Route to a multi-TeV LC

• Four issues for a multi-TeV LC: cost, beam quality, rf efficiency, and beam acceleration
• Advanced techniques do not have beam quality or efficiency
  ⇒ conventional rf acceleration (plasma ‘afterburner’ later???)
• Must reduce cost of rf sources
  ⇒ optimize at higher gradients
• Gradient limits not understood:
  • Dark current capture ~ f_{RF} (not really a limitation)
  • Breakdown and damage ~ f_{RF}?? (not well understood)
  • Pulsed heating limits (200 ~ 300 MV/m and roughly independent of f_{RF})
• Assume normal conducting rf system at 11 ~ 34 GHz and roughly 200 MV/m — short 11 GHz structures have been to 150 MV/m and single cells have been to 200 MV/m
A Multi-TeV LC Facility

A poorly drawn schematic of a LC facility with an factor of 50 in energy range

Optional low energy IP 92-350 GeV

Low energy (50 - 175 GeV) beamlines

Site roughly 25 km in length with two 10 km linacs

High energy IP 0.25-5.0 TeV upgraded in stages

Return lines: production and possibly drive beam - share main linac tunnel

Centralized injector system possibly for TBA drive beam generation also
NLC Final Focus at High Energy

NLC FF will be ~700 m long and will support 5 TeV collisions

Luminosity $L/L_0$ versus beam energy. Beta functions at IP fixed. Angular dispersion at IP reoptimized at each energy. Final focus still being optimized!

Beam radiation ON

Beam radiation OFF

BEAM PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>$\gamma \varepsilon_x / \gamma \varepsilon_x$ at IP ($10^{-8}$ m)</td>
<td>50 / 1</td>
</tr>
<tr>
<td>$\beta_x^* / \beta_y^*$ (mm)</td>
<td>9.5 / 0.14</td>
</tr>
<tr>
<td>$\sigma_x^* / \sigma_y^*$ at 2500GeV/beam (nm)</td>
<td>31 / 0.54</td>
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<tr>
<td>Energy spread $\sigma_E (10^{-3})$</td>
<td>2</td>
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A Multi-TeV LC Facility

- Multi-TeV LC could be an upgrade to NLC
- Present NLC site concept is roughly 25 km in length with 10 km linacs and 2.5 km beam delivery systems
- Present NLC rf system is less than 20% of total cost
- Don’t know upgrade path to multi-TeV collisions but gradient of 250 MV/m provides 5 TeV collisions on NLC site
- A multi-TeV LC could re-use most NLC components:
  - injection complex (sources, damping rings, bunch compressors)
  - linac tunnels, supports, movers
  - possibly linac accelerator structures
  - beam delivery system
  - conventional facilities: electrical power, cooling
  - control systems