The Linear Collider

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Outline

- Physics case in brief
- Organizational matters
  - Consensus
  - Working towards a global design
  - Building the collaborations
- The Canadian scene

Note: Monday’s Linear Collider talk will discuss the physics, the machine, and the detectors in greater detail
Physics from the Linear Collider

- The physics case is well documented...

- In the last decade, electroweak symmetry was firmly established primarily by LEP/SLC
  - a wide range of independent tests in a well controlled environment of $e^+e^-$ collisions

- In the next decade, electroweak symmetry breaking will only be fully understood by precision measurements at a lepton collider
Physics from the Linear Collider

- Precision electroweak data point to a reasonably light Higgs boson (< 250 GeV)
  - A 500 GeV linear collider can study a light Higgs in detail in a model independent way
    - measure its couplings to fermions and gauge bosons
  - If the LHC does not see a light Higgs, it cannot rule it out. Even a Higgs that decays invisibly cannot avoid detection at the LC, using the recoil mass in Z+Higgs events
  - If a heavy Higgs exists instead, a 1 TeV linear collider can study it. Other lower mass states must also exist, for consistency with precision EW data
Physics from the Linear Collider

To understand how the hierarchy problem of the standard model is avoided in nature, we will need data from a lepton collider

- if weak-scale supersymmetry exists, the lightest spartners should be within reach of a 500 GeV or 1 TeV linear collider
  - special capabilities of the linear collider will add important information about these particles
- other models (e.g. extra space dimensions) produce signatures via real or virtual processes a linear collider
Physics from the Linear Collider

- Further precision measurements can be undertaken:
  - top quark mass to better than 100 MeV
  - $W$ mass to better than 10 MeV
  - $\alpha_s$ to better than 1%
  - $\sin^2\theta_w$ to $10^{-5}$
  - triple gauge couplings to $10^{-4}$

- The physics program of a 500-1000 GeV linear collider is extremely rich, regardless of what LHC finds.
  - good reasons to operate concurrently
Consensus of our leaders

- (2000-2002) ACFA, ECFA, HEPAP:
  - The next large accelerator-based project of particle physics should be a linear collider

- (Late 2003) US DOE Office of Science:
  - Future Facilities Plan: LC is first priority mid-term new facility for all US Office of Science

- (Jan. 2004) ACFA, ECFA, HEPAP:
  - The chairs reaffirmed their community’s priorities for a 500 GeV linear collider operated in parallel with the LHC
Consensus of our leaders

- (Jan. 2004) **OECD** Ministerial Statement:
  - “…noted the world wide consensus of the scientific community, which has chosen an electron-positron linear collider as the next accelerator-based facility to complement and expand on the…LHC…”

- (Feb. 2004) **ICFA**:
  - reaffirms its conviction that the highest priority for a new machine for particle physics is a linear electron-positron collider with an initial energy of 500 GeV, extendible up to about 1 TeV, with a significant period of concurrent running with the LHC
Consensus amongst ourselves

- (Paris announcement): “Over 2600 physicists from around the world have signed a document supporting a high-energy electron-positron linear collider as the next major experimental facility for frontier particle physics research.”

- “Understanding Matter, Energy, Space and Time: the Case for the Linear Collider”
Consensus on the scope

- BASELINE MACHINE
  - $E_{CM}$ of operation 200-500 GeV
  - Luminosity and reliability for 500 fb$^{-1}$ in 4 years
  - Energy scan capability with < 10% downtime
  - Beam energy precision and stability below about 0.1%
  - Electron polarization of > 80%
  - Two IRs with detectors
  - $E_{CM}$ down to 90 GeV for calibration

- UPGRADES
  - $E_{CM}$ about 1 TeV
  - Allow for $\sim$1 ab$^{-1}$ in about 3-4 years

- OPTIONS
  - Extend to 1 ab$^{-1}$ at 500 GeV in $\sim$2 years
  - $e^-e^-, \gamma\gamma, e^-\gamma$, positron polarization
  - Giga-Z, WW threshold
**Scope of physics**

- A roadmap of exploration

![GLC Project report](image_url)
Technical review of LC designs

- In 2003, the ILC-TRC completed its comprehensive review of warm and superconducting accelerator designs
  - Committee chaired by Greg Loew included accelerator physicists from the two competing camps working together
    - a successful test of global cooperation
  - Conclusions:
    - finds no “show-stoppers” in either design
    - ranks a number of R&D steps that remain before a full design can be completed
Moving forward: ILCSC

- ICFA has put in place an organizational structure to move forward:

ILCSC (M. Tigner)

Asia LCSC (W. Namkung)
US LCSC (J. Dorfan)
Europe LCSC (B. Foster)

ILCSC membership:
- Directors of CERN, DESY, FNAL, KEK, SLAC
- Regional LCSC chairs
- Rep.s from China, Russia, Asia, Europe, N. America, outside

Physics and Detector (H. Yamamoto, J. Brau, D. Miller)
ITRP (B. Barish)

Accel. (G. Loew)
Params (R. Heuer)
GDI Taskforce (S. Ozaki)
A global decision: ITRP

- Given that both designs are feasible, but that we can afford to build only one, a technology choice is necessary.
- International Technical Recommendation Panel:
  - Jean-Eudes Augustin (FRANCE)
  - Jonathan Bagger (USA)
  - Barry Barish (USA) - Chair
  - Giorgio Bellettini (ITALY)
  - Paul Grannis (USA)
  - Norbert Holtkamp (USA)
  - George Kalmus (UK)
  - Gyung-Su Lee (KOREA)
  - Akira Masaike (JAPAN)
  - Katsunobu Oide (JAPAN)
  - Volker Soergel (Germany)
  - Hirotaka Sugawara (JAPAN)
  - David Plane - Scientific Secretary

- Six Meetings scheduled
  - RAL (Jan 27,28 2004)
  - DESY (April 5,6 2004)
  - SLAC (April 26,27 2004)
  - KEK (May 25,26 2004)
  - Caltech (June 28,29,30 2004)
  - Korea (August 11,12,13)
  - More meetings as needed
The Linear Collider

ITRP decision process

- The criteria matrix:
  - the scope and parameters specified by the ILCSC;
  - technical issues;
  - cost issues;
  - schedule issues;
  - physics operation issues;
  - and more general considerations that reflect the impact of the LC on science, technology and society

- Will report by the end of 2004 (or earlier)
Global Design Initiative Task Force has recommended a structure to develop the global design, once the technology is chosen:

- **ILCSC**
- **Central Design Team**
  - **Asia Regional Team**
    - Participating Labs and Universities
  - **N. American Regional Team**
    - Participating Labs and Universities
  - **European Regional Team**
    - Participating Labs and Universities
**Time scales**

- **2004** technology recommendation
  - global design MOUs
- **2005** CDR for Collider
  - includes initial cost estimate
- **2007** TDR for Collider
- **2008** site selection
- **2009** construction could start
- **2015** first beams possible
A global funding process

- Ian Halliday (PPARC) is organizing meetings of funding agencies to discuss the status and funding prospects for a linear collider of 0.5 – 1TeV
  - Most recent: 6 April 2004, London, UK
    - Canada (NSERC), CERN (President of Council and DG), France (CNRS), Germany (BMBF), Italy (INFN), Japan (MEXT), UK (PPARC), and the US (DOE, NSF)
  - Next meeting: 26/27 July 2004, London, UK
Building the collaborations

- The Physics and Detector subcommittee are charged to work out a procedure for developing at least 2 detector concepts up to LoI’s and experiment proposals
  - preserving the existing international R&D collaborations
  - open for newcomers and new ideas
  - international as much as possible
  - avoid shoot outs between regional concepts
Building the collaborations

- Set milestones connected to the GDI dates:

<table>
<thead>
<tr>
<th>Year</th>
<th>LC GDI</th>
<th>Detector</th>
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<tbody>
<tr>
<td>2005</td>
<td>CDR</td>
<td>Costings for &gt;1 concept</td>
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<tr>
<td>2007</td>
<td>TDR</td>
<td>Receive Lol's or CDRs from collaborations</td>
</tr>
<tr>
<td>2008</td>
<td>Site selection</td>
<td>Global lab invites 2 TDRs</td>
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- reluctant to form proto-collaborations now
The Canadian scene

- Canadians have been actively involved in LC preparations since 1998.
  - Planning: Travel support through the (now defunct) IOF program
  - Detector: Tracking detector R&D
  - Accelerator: vibration monitor and control
  - Accelerator: fast power switches
Victoria Linear Collider Workshop

Part of a series of N. American regional meetings held twice a year

Sign up! [www.linearcollider.ca/victoria04](http://www.linearcollider.ca/victoria04)

Over 100 registered so far...

Thanks to our sponsors: TRIUMF, IPP, UVic, NSERC
TRI UMF bid to host Central Team

- Canada is neutral territory, Vancouver well situated geographically
  - ILCSC asking labs for EOIs to host 15 – 30 accelerator physicists over the next 4 years
  - would add expertise and recognition to TRI UMF
  - EOI in preparation, due July 1
LCWS 2005 in Canada?

- The next International Linear Collider Workshop is to be held in the Americas
  - Moved earlier, from October to March 2005, to connect with IRTP decision
  - Previous workshop (Paris) had to limit registration at 350

- TRIUMF will bid to act as host for downtown Vancouver site
  - many prefer non-US site due to visa difficulties
  - a kickoff for the GDI Central Team (?)
  - D.K. to organize - two offers of help so far

- LCWS 2005 site will be selected end of July
Summary

- The case for the Linear Collider remains as strong as ever
- Movement towards a single global proposal and experimental collaborations
- Canada may be playing an important role in the accelerator design

To follow the developments, visit:

http://www.linearcollider.ca