

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
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- 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 (eg. extra space dimensions) produce signatures via real or virtual processes a 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
 - α_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”
 - http://sbhep1.physics.sunysb.edu/~grannis/lc_consensus.html

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 90GeV for calibration

■ UPGRADES

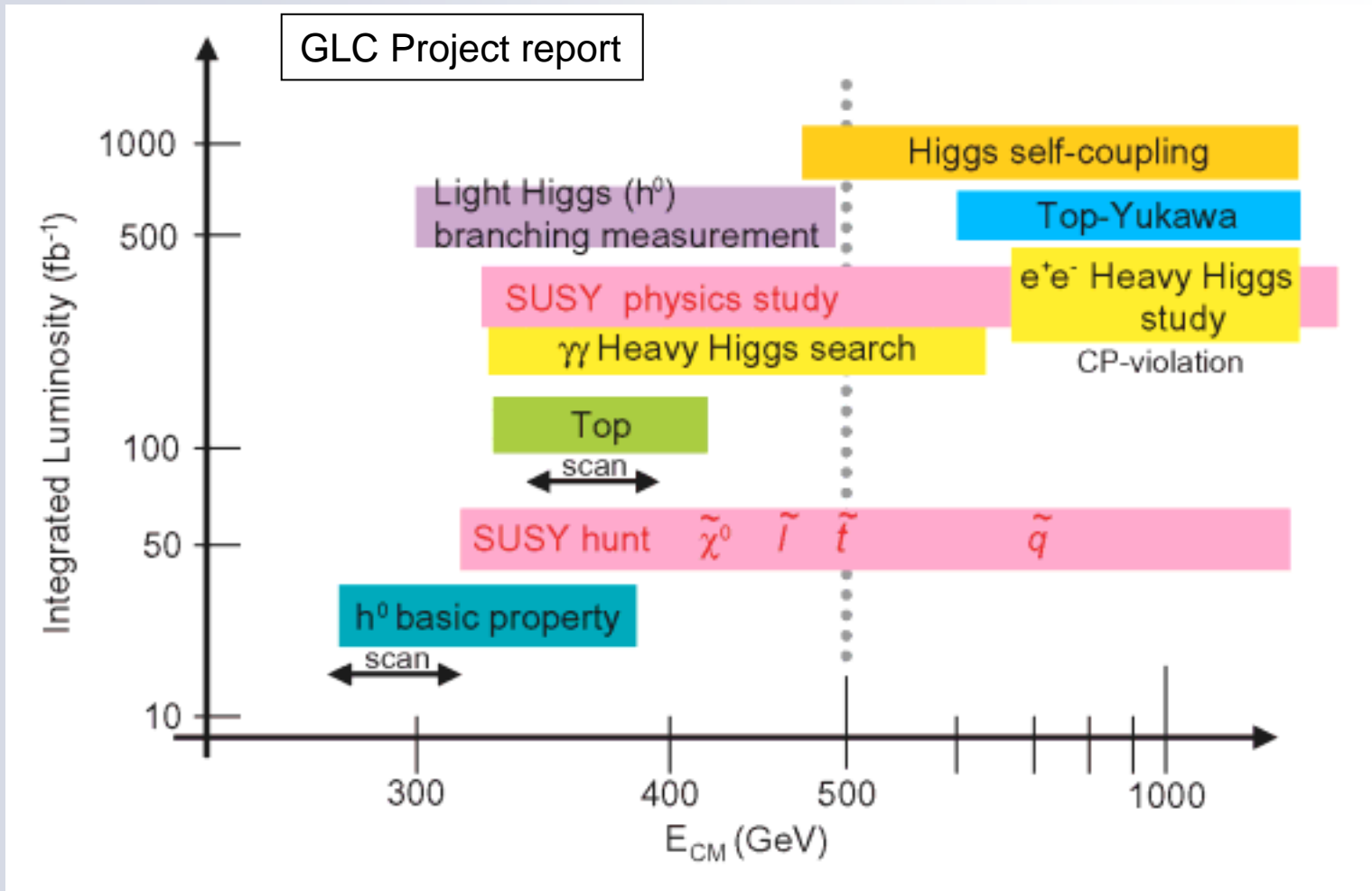
- E_{CM} about 1 TeV
- Allow for $\sim 1 \text{ ab}^{-1}$ in about 3-4 years

■ OPTIONS

- Extend to 1 ab^{-1} at 500 GeV in ~ 2 years
- e^-e^- , $\gamma\gamma$, $e^-\gamma$, positron polarization
- Giga-Z, WW threshold

Scope of physics

- A roadmap of exploration

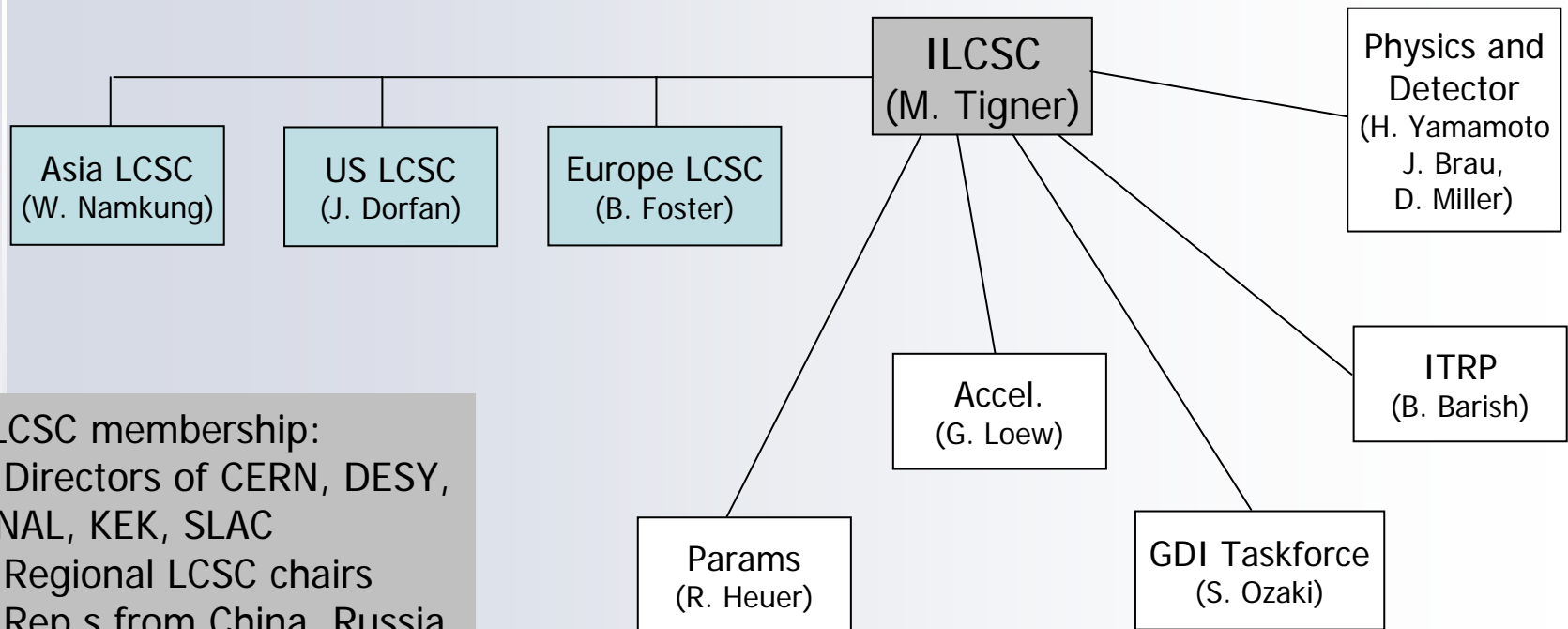


Technical review of LC designs

- 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 membership:

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

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)

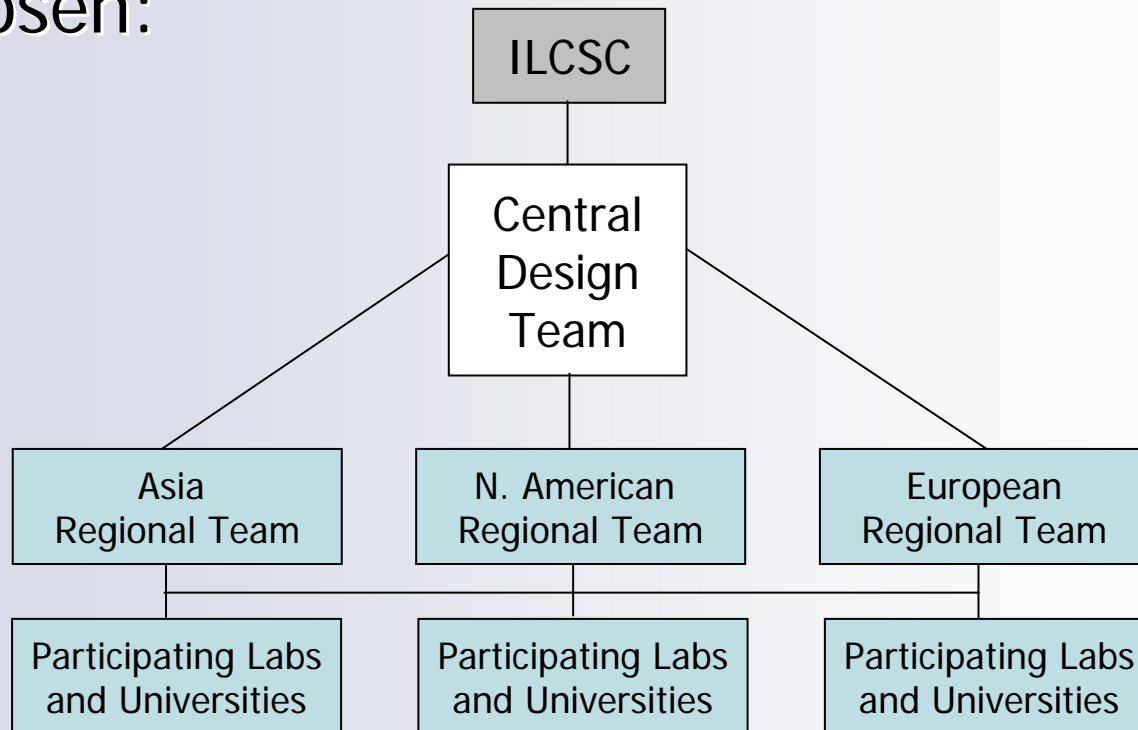
 - David Plane - Scientific Secretary
- Six Meetings scheduled
 - RAL (Jan 27,28 2004)
 - DESY (April 5,6 2004)
 - SLAC (April 26,27 2004)
 - KEK (May 25,26 2004)
 - Caltech (June 28,29,30 2004)
 - Korea (August 11,12,13)
 - More meetings as needed

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)

A global design: GDI

- Global Design Initiative Task Force has recommended a structure to develop the global design, once the technology is chosen:



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 Lols 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:

Year	LC GDI	Detector
2005	CDR	Costings for >1 concept
2007	TDR	Receive LoIs or CDRs from collaborations
2008	Site selection	Global lab invites 2 TDRs

- 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



Victoria Linear Collider Workshop



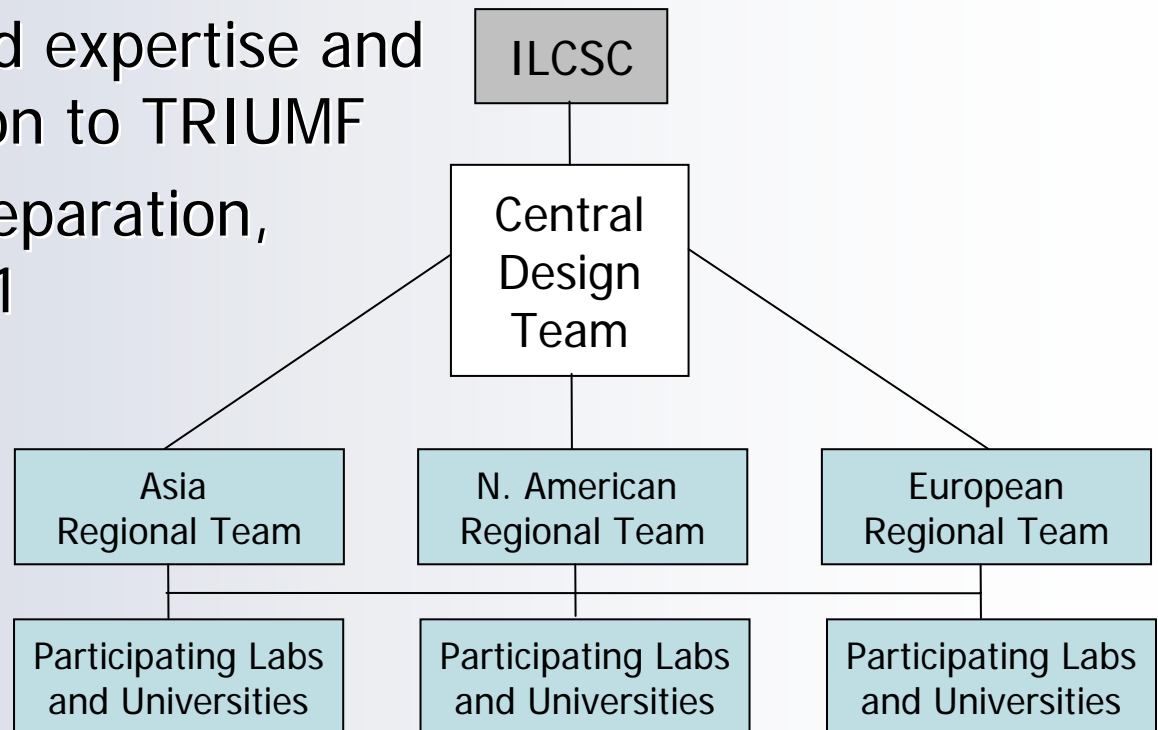
American Linear Collider
Physics Group

July 28-31, 2004

- Part of a series of N. American regional meetings held twice a year
- Sign up! www.linearcollider.ca/victoria04
- Over 100 registered so far...
- Thanks to our sponsors: TRIUMF, IPP, UVic, NSERC

TRIUMF 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 TRIUMF
 - 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>