ILC energy phasing

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1st meeting of the ILC parameters group

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Introduction

- Recent report presented to LCB & LCC Directorate
- Scope of report
  - 1st phase 250 GeV CM machine
  - as part of the full 500 GeV construction project
- Focus
  - Layout of first phase (technical implications)
  - Years of operation at 250 GeV CM
  - Scenarios for mass production (cryomodules)
- Questions for the physics & detector community

Phasing Report

Implications of an Energy-Phased approach to the realization of the ILC

Prepared for: LCC Directorate
Prepared by: G. Dugan, M. Harrison, B. List, N. Walker

FINAL VERSION 26.02.2014

Concept

In the ILC requirements document "Parameters for the Linear Collider[1]", the ILC design as given in the Technical Design Report (TDR), describes a 500 GeV machine with the possibility of extending the energy up to 1 TeV. Following the discovery of the Higgs boson at the LHC, the Japan Association of High Energy Physicists (JAHEP) recommended that the ILC physics studies "shall start with a precision study of the Higgs boson and then evolve into studies of the top quark, dark matter particles, and the Higgs self-couplings, by upgrading the accelerator. A more specific scenario is as follows:

- A Higgs factory with a centre of mass energy of approximately 250 GeV shall be constructed as the first phase.
- The machine shall be upgraded in stages up to a centre of mass energy of ~500 GeV which is the baseline energy of the overall project.
- Technical extendibility to a 1 TeV region shall be preserved."

A multiple staged energy implementation, while technically feasible, will require several stop-start cycles with associated complications: thus the LCC Directorate has interpreted the JAHEP statement to mean a project with a first stage of 250 GeV. A pause in installation would then ensue to allow for a period of commissioning (~1 year) and physics operation of approximately 4 years after which time a single shutdown of ~1 year would be used to complete the project to 500 GeV.

This is consistent with the TDR physics goal of 250 fb^{-1} of integrated luminosity at 250 GeV using the nominal TDR peak luminosity of 7.5×10^{33} $cm^{-2}s^{-1}$ and assuming a yearly luminosity progression of 10%, 30%, and 60% of peak as proposed in the requirements document (see Figure 1).

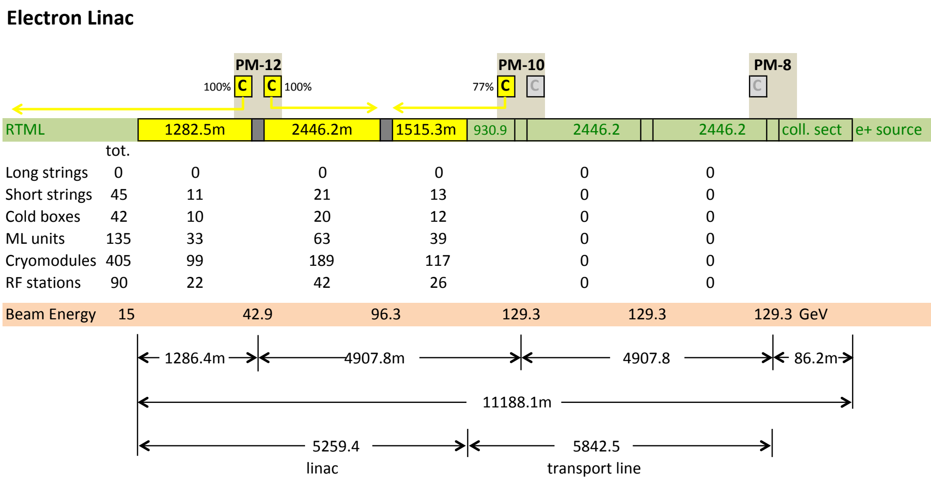
ILC-EDMS ID D*01046475

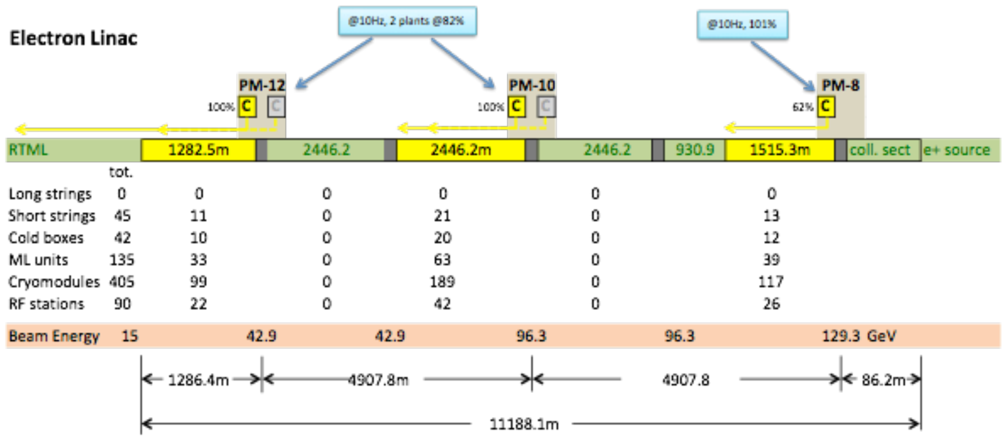
- Dugan, Harrison, B. List, Walker
- Presented to LCC Directorate and then to LCB
  - 18-19 Feb. @ DESY
- An "awareness raising" document
  - a response to JAHEP statement
  - for discussion
  - no formal decisions

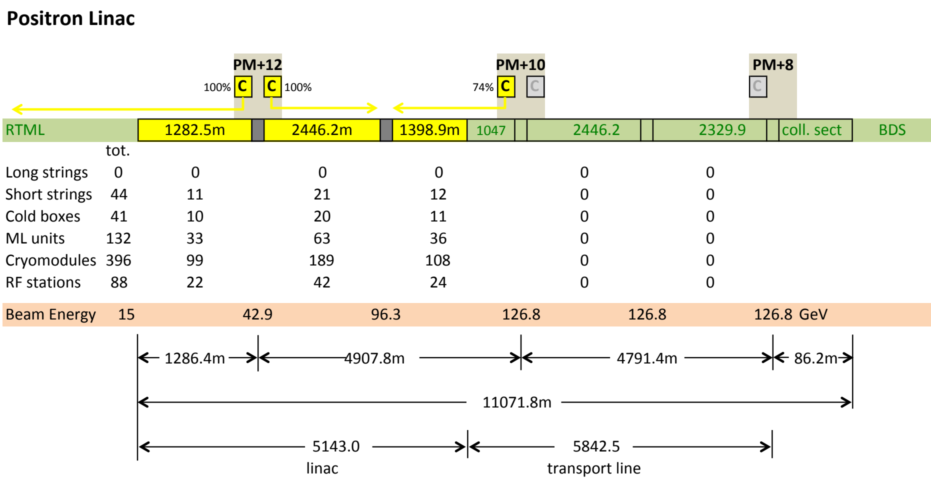
Assumptions

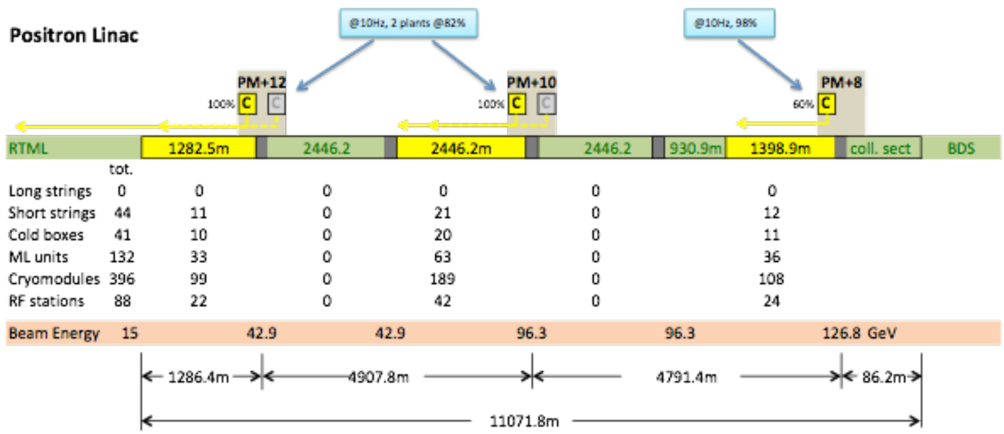
- Project scope is the full 500 GeV cm machine
  - as described in the TDR
  - full construction of tunnels, caverns, access ways etc.
  - full installation of injector complex (remains unchanged)
    - except e+ source (see later)
  - full installation of BDS
  - full installation of bunch compressor systems
- A possible first-phase 250 GeV machine
  - installation of ~50% of main linac
  - additional ~2×6km of beam transport line (to fill the tunnel)
- Beam / physics parameters as given in baseline TDR
  - 250 GeV cm: $\mathscr{L} = 0.75\times10^{34}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$

Machine layout: 2 options considered









considerations: installation, beam dynamics, (cost)…

Integrated luminosity

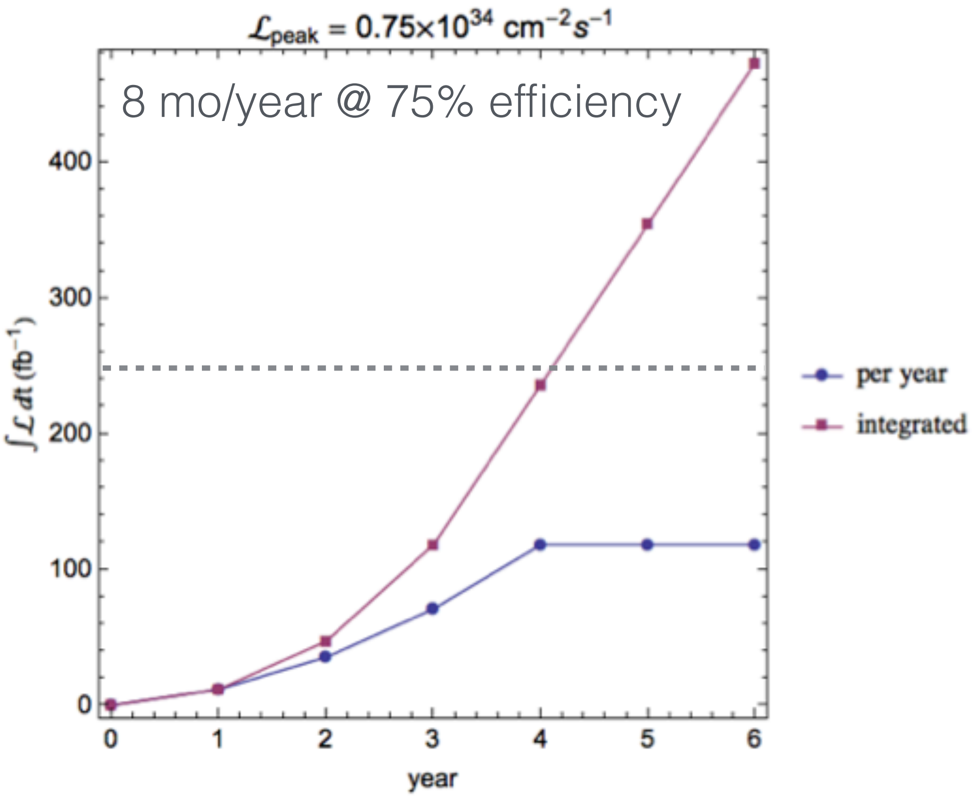
Parameters for the Linear Collider
Update November 20, 2006

1. Introduction

Over the past decade, studies in Asia, Europe and North America have described the scientific case for a future electron-positron linear collider [1,2,3,4]. A world-wide consensus has formed for a baseline LC project with centre-of-mass energies up to 500 GeV and with luminosity above 10^{34} $cm^{-2}s^{-1}$ [5]. Beyond this firm baseline machine, several upgrades and options are envisaged whose weight, priority and realisation will depend upon the results obtained at the LHC and the baseline LC. This document, prepared by the Parameters Subcommittee of the International Linear Collider Steering Committee, provides a set of parameters for the future Linear Collider and the corresponding values needed to achieve the anticipated physics program. The membership and the charge in 2003 and in 2006 to the subcommittee are appended.

It is assumed here that the ***design luminosity*** *and the* ***efficiency/reliability*** *of the machine will only be* ***reached gradually*** *within the first years of operation* ***(10, 30 and 60% in years 1,2 and 3, resp.)*** *and that the design luminosity and reliability will be reached in year four (i.e.* ***100% in year 4****) of physics running,* ***not counting year 0****.*

- Heuer parameters documents from Snowmass 2005
  - published 20.11.2006



Positron production

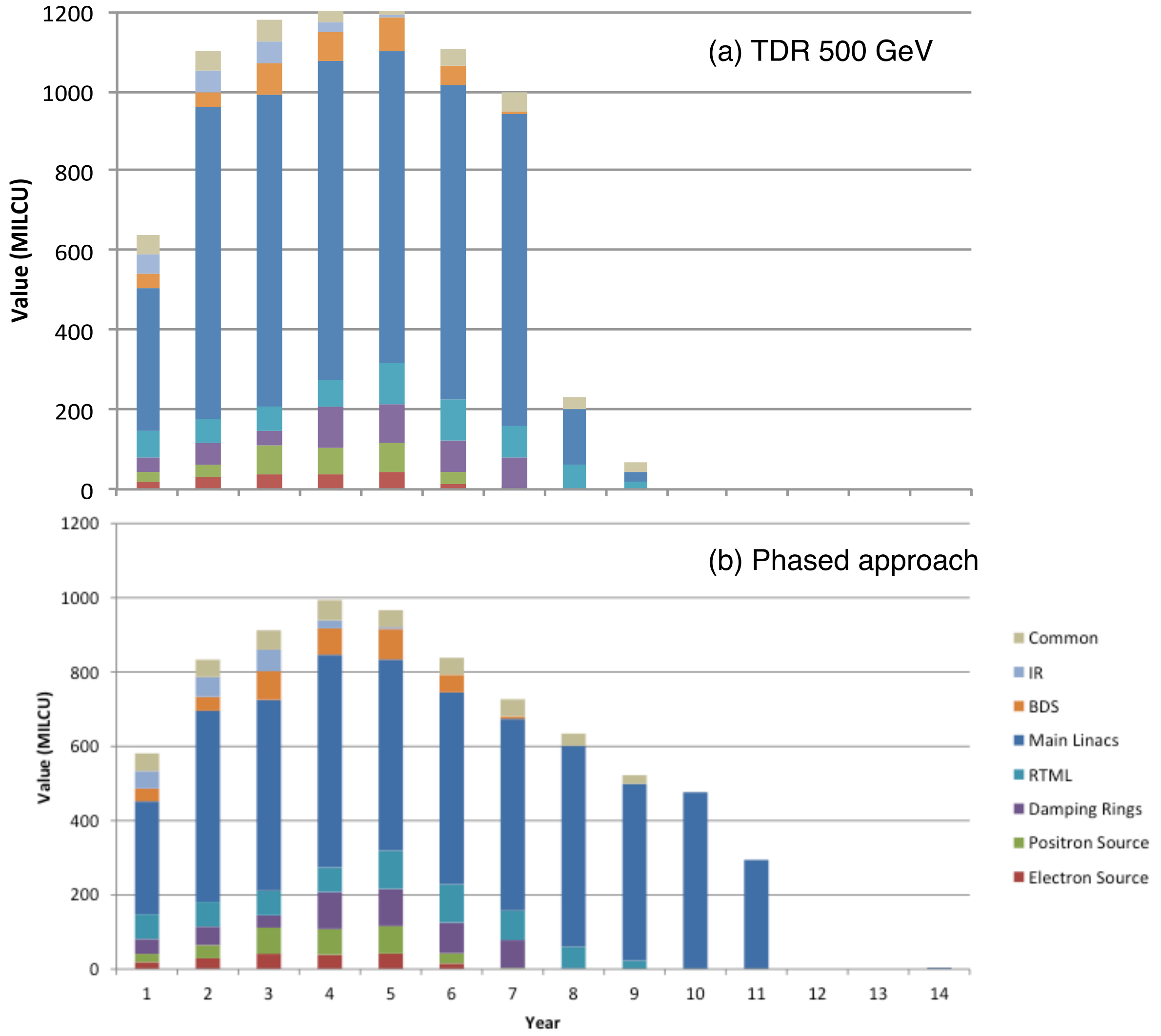
- TDR assumed so-called 10-Hz mode production at $E_{cm} \leq 250$ GeV
  - "Worked" for TDR since AC and cooling power were available when running Main Linacs at half gradient.
  - First-phase scenario requires full 31.5 MV/m operation ⇒ install more cooling and AC power
- Report assumes use of longer undulator (~230m) which avoids
  - need for 10-Hz mode
  - additional 25 GeV of e- linac (to drive source)
- Sufficient for 250 GeV
  - But **not** lower centre-of-mass energy running
  - Question for physics & detector community

fine design tuning

Cost, schedule and CM production

- First phase @ 250 GeV cm offers no major gain in schedule compared to full 500 GeV
  - 12-18 months (max)
- No major change in total project cost
  - additional ~1-2% for transport lines
  - Shifts ~20% of costs to later date for CM production
    - reduces peak spending by ~200 MILCU per year
- CM production
  - Shutting down and re-starting CM production not attractive
  - Assume CM production continues through first-phase physics run (possibly at reduced rate)
  - Installation of CM after initial physics running (4 years?)
    - roughly one year shutdown

Estimated cost profile



Questions for Physics & Detector community

- Assuming we start running at 250 GeV cm, *how much integrated lumi is needed before a move to higher energies is required*?
  - Report assumed 250 inv. fb.

- [General] what would be a likely staging at energies from 250 GeV up to "about 500 GeV"
  - integrated luminosity at each identified E_{cm}.

- What is the demand for $E_{cm} < 250$ GeV
  - Implications for e+ source