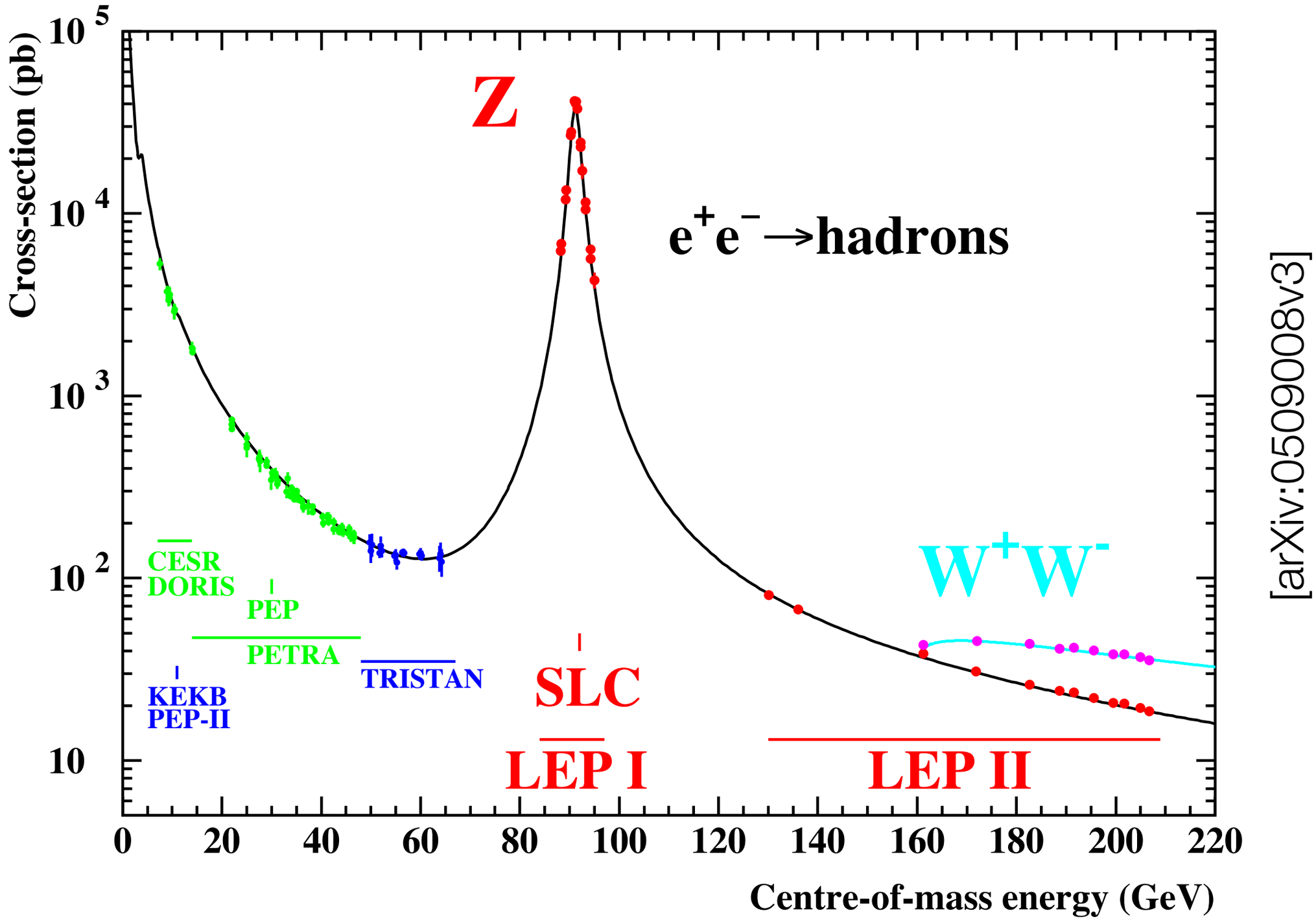

Update from the Parameter Group: Z pole calibration

J. List (DESY),
ILC@DESY General Project Meeting
May 13, 2016

Since last Parameter Group report in this meeting…

- new running scenario approved (c.f. arXiv:
- physics case updated (with LCC Physics WG, c.f. arXiv:)
- main activities afterwards:
  - studied complementarity of linear and circular e^+e^- colliders
- provided preliminary parameters for physics running at the Z pole and at the WW threshold
  (c.f. talk by N.Walker here on December 18, 2015)
- **revisit the case for operating the ILC on the Z pole for *detector calibration***

Submitted note to Hitoshi in March

Request to ILD & SiD to specify their needs for Z pole calibration

ILC Parameters Joint Working Group

T. Barklow, J. Brau, K. Fujii, J. Gao, J. List, N. Walker, K. Yokoya

Abstract

The ILC Technical Design Report documents the design for the construction of a 500 GeV linear collider, including beam parameters for its operation at centre-of-mass energies from 200 to 500 GeV, as well as for the energy upgrade to 1 TeV. The ILD detector concept proposed in the TDR, however, assumes that operation at lower energies, in particular at the Z pole, will be possible for calibration purposes. However, the accelerator as proposed in the TDR is not easily operated at energies that low and would probaby need some modifications depending on the amount of Z pole data required and on the frequency of such calibrations runs. We therefore request that each ILC detector concepts quantifies and justifies more precisely their need for Z pole calibration runs.

Introduction

- TDR detector volume refers to calibrating detectors with Z pole data in several places, in particular for ILD

- This feature is *not* included in the TDR design

- switching optics between high and low energy running might take substantial time

- Need to specify amount of data needed and frequency of these runs

Detector Calibration

- ILC precision physics programme requires detectors with unprecedented resolutions
- Technologies matching resolution requirements have been developed successfully over last decades
- **But: can only exploit resolution if matched by calibration and alignment over whole time of ILC operation**

- Multi-layered approach:
  - pre-installation calibrations
  - in-situ: laser systems, LEDs, …
  - **ultimately: calibration against physics quantities, e.g.:**
    - **against known masses: Z, J/Psi,…**
    - **kinematically over constrained events (rad. Bhabha's, muon pairs,..)**

Tracking

- Re-establish alignment after each push-pull move
- need sufficient number of tracks everywhere, with appropriate angles

SiD:

- O(10^4) tracks/months in outer tracking layers from normal lump operation sufficient

ILD:

- Z-pole running with L ~ 10^{32} /cm^2 / s or 1 pb^{-1} in a few hours
- TPC:
  - 10 pb^{-1} on Z during commissioning
  - 1 pb -1 on Z during the year “depending on operating conditions”VTX: several 10^3 muon pairs / day
- VTX: several 10^3 muon pairs / day

Calorimetry

- MIP scale calibration => need sufficient number of hits in each cell
- absolute scale from physics reference

SciECAL:

- MIP scale: muon pairs from Z-pole running
  - => 50 hits/cell/day
  - => need couple of days
- Endcaps: use halo muons in addition
- Absolute scale: e, γ from rad. Bhabha's & rad. returns => no Z-pole run required

AHCAL, gaseous options similar:

- MIP scale 3% => 1000 MIP-like tracks
- most efficiently from Z-pole:
  - 1 pb^{-1} up to layer 20 ~ few hours
  - outermost layers: 10-20 pb^{-1}
- at 500 GeV:
  - 2 fb^{-1} up to layer 20 ~ 1 month in year1
  - outer layers: 20-40 fb^{-1} ~ whole year1

Jet Energy Scale

- PFlow: interplay of all sub-detectors …
- and the reconstruction algorithms!

SiD:

- di-jet and WW events from normal running
- di-jets: 2800 / fb^{-1}
- WW: 1900 / fb^{-1}

ILD:

no statement in DBD / LoI

Comments:

- WW: give up on W mass measurement?
- 1% stat. uncertainty on scale
  => 10000 events
  (for 100% efficiency and purity)
- **need this for all angles!**

Operating the ILC at 90 GeV

- Z-pole physics: L ~ 10^{33} / cm^2 /s could be possible with **major machine reconfiguration** (positron source!)
- Z-pole calibration has similar issues plus in addition: **frequent switch** between low and high energy!
- Key questions: How often? How many pb^{-1}?
- positron source:
  - undulator source does not work below E_{beam} ~ 100 GeV
  - low-power auxiliary source: few % of current => 10^{30} /cm^2 /s
  - electron-driven source (unpolarised, not baseline!) under development at KEK would in principle provide full e^+ current - but beam dynamics issues unknown…
- switching between energies:
  - not “turn-key”
  - **retuning of luminosity could take days….**

Conclusion

Clear discrepancy between assumptions of some sub-detector systems and the actual TDR machine design

ILC Parameters Joint Working Group asks detector concepts to revisit their needs for calibration data:

- For which sub-detectors is Z-pole calibration essential and why? Which precision could be achieved without Z-pole running?

- If Z-pole running is required, specify how often (once for commissioning, every year, every push-pull?) they are needed and with which integrated luminosity.

Outlook: What is going on now?

- ILD Executive Team started to discuss this
- Task Force is preparing a draft for a preliminary answer
- full answer needs
  - dedicated studies on statistics available for “standard candles” Z, J/Psi etc in high-energy data sets
  - considering as well angular distributions etc
  - input from sub-detectors
- stay tuned - or even better: contribute! ;-)