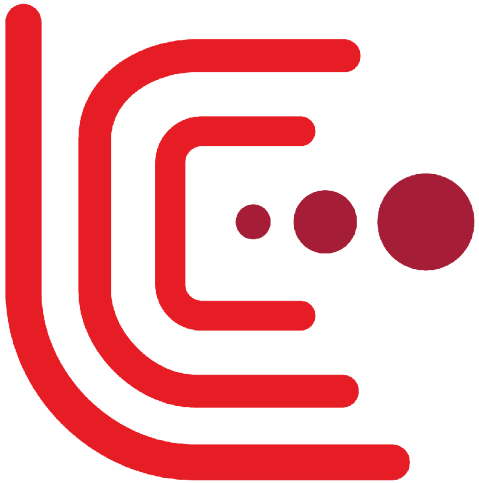
Report from the ILC Parameter Joint Working Group



LCForum

Bonn, April 30, 2014

J.List (DESY)

on behalf of the parameters group

A New Parameters Group for the ILC

The ILC parameter working group *reports to the LCC Directorate*. It consists of *members from both the ILC accelerator and the physics & detector groups* where each team selects a co-convener for this working group.

=> Acc: Nick Walker (co-chair), Kaoru Yokoya, Jie Gao
P&D: Jim Brau (co-chair), Tim Barklow, Keisuke Fujii, JL

This working group *prepares information on ILC machine parameters and staging scenarios* as well as potential upgrade paths in a form readily usable by the LCC. In doing so, the WG will take into account *technical machine constraints and physics and detector needs regarding the fundamental ILC machine parameters such as energy, luminosity, crossing angles, etc.*

The first task for the working group is to *prepare multiple scenarios for staging up to about 500 GeV.* The report should contain the pros and cons of each scenario as well as luminosities needed at each energy to produce corresponding physics results.

Proposed Timeline

- March: charge formulated
- May: plenary discussion (2h) at AWLC, Fermilab

  => community input!

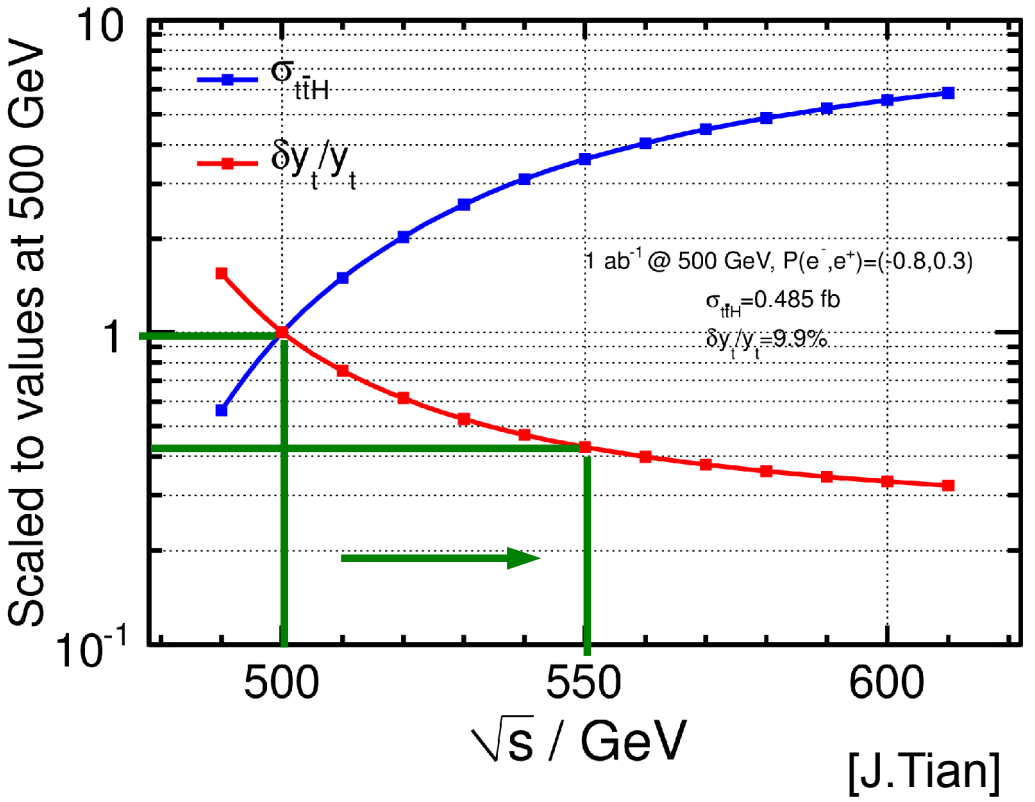
- June – September: prepare first draft report
- October: presentation of draft with discussion at LCWS in Belgrade

  => community input!

- November/December: finalize draft

Key Question 1: Top baseline energy (TBE)

- Tunnel length to be fixed to ±300m by end of year
  => top priority question!
- large impact on ttH, eg 500 GeV → 550 GeV:
- σ_{ttH} increases by 3.7
- Bkg decreases
- Coupling precision better by factor ~2.4
- Delicate political issue: *should* point out the strong physics case, but be prepared for compromises!



Key Question 2: Staging from 250 GeV to TBE

"real life" issues to be considered (cf Benno's talk):

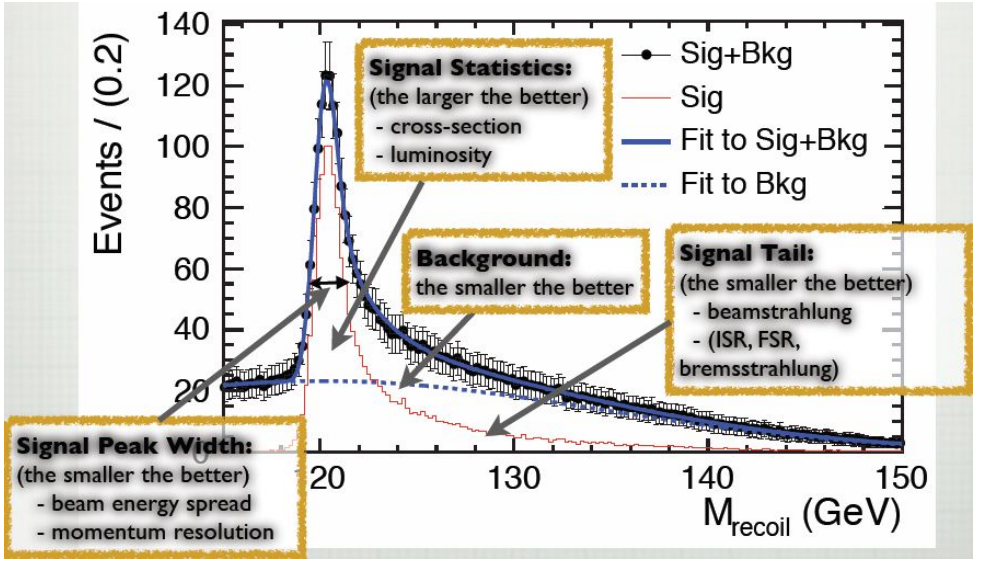
- Start at ~250 GeV given by JAHEP statement
- Cryomodule production: stop or continue?
- Lumi at 250 GeV:
  for TBE machine higher by factor 2-4 than for 250GeV-machine
- Positron source: polarised / unpolarised / both?!

In view of this, consider physics needs energy by energy:

Key Question 2: Staging from 250 GeV to TBE

250 GeV: Higgs recoil mass and ZH cross-section

- precision needed for m_H, g_{HZZ}
  → lumi required?
  - ***Initially***: before TBE ILC data
    eg: δM = 100 MeV ok
  - ***Ultimately***: after a full ILC program (1 TeV, lumi-upgrade)



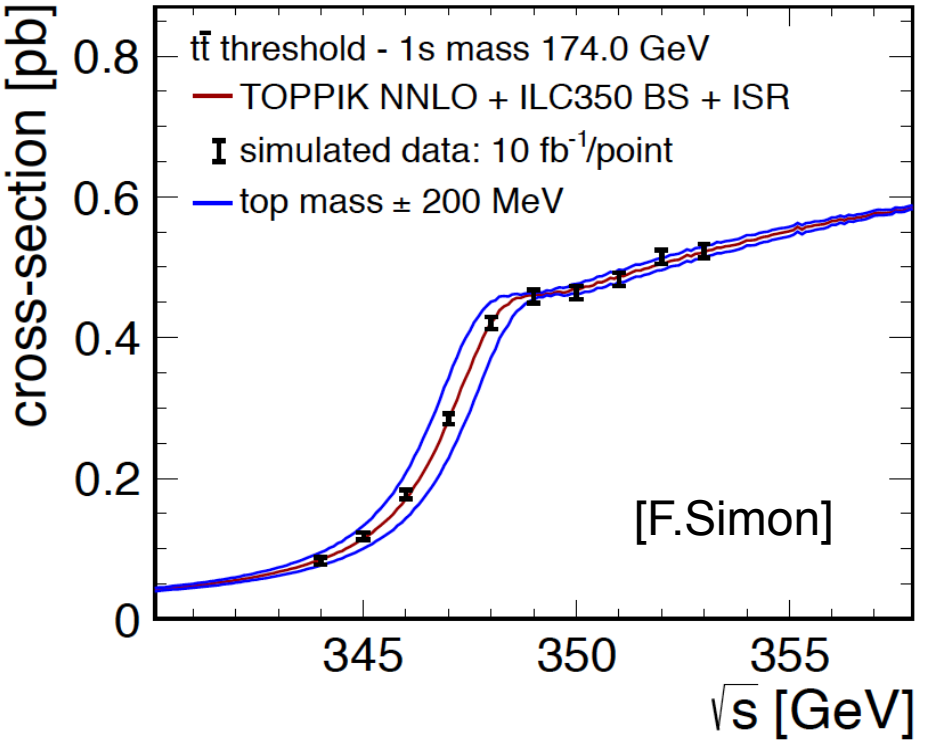
eg: δM = 100 MeV => 0.5% on κ_b/κ_W → **need 30 MeV?**
(extraction of couplings from σxBR)

- **Impact of positron polarisation for Higgs recoil physics**
  - Gain in cross-section → shorter running time
  - anything else?

Key Question 2: Staging from 250 GeV to TBE

350 GeV: top-threshold scan, plus parasiticly: Higgs, TGCs,...

- How much lumi for top threshold scan? → **100-200 fb^{-1}**
  ~ 1 year at design lumi:
  - **before or after TBE?**
  - LowP or lowQ beams?
  - Experimental uncertainties?
  - Ultimate theory precision?
- What about Higgs physics?
  - first useful access to WW-fusion, total width
  - **But:** will be "history" once TBE is reached, thus *not* considered a driving argument



Example Running Scenarios

a) 250 fb^{-1} @ 250 GeV, 500 fb^{-1} @ 500 GeV

b) 250 fb^{-1} @ 250 GeV, 500 fb^{-1} @ 550 GeV

c) 250 fb^{-1} @ 250 GeV, 1000 fb^{-1} @ 500 GeV

d) 100 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 500 GeV

e) 100 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 550 GeV

f) 25 fb^{-1} @ 250 GeV, 350 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 500 GeV

g) 500 fb^{-1} @ 250 GeV, 500 fb^{-1} @ 500 GeV

h) 50 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 500 GeV, *then* 1000 fb^{-1} @ 250 GeV

i) 50 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV, 500 fb^{-1} @ 550GeV, *then* 1000 fb^{-1} @ 250 GeV

Key Question 3: Running below 250 GeV

- **Calibration** at the Z pole:
  - **How much luminosity? How often?**
  - LoI estimate: ~ 1pb^{-1} after each push-pull (in ~ 1 day)
- **Physics** at the Z pole:
  - What is ***minimum*** **luminosity / polarisation** required for relevant precision gain?
  - **When** is the optimal time? After full TBE program?
- **W threshold** scan:
  - Which **luminosity** required? 100fb^{-1}? 1 ab^{-1}?
  - Impact of **positron polarisation**?
  - **When?** After TBE, before Z pole?

A few general remarks

- A further discovery at LHC or ILC might change our planning → important to stay “flexible”
- Even before 1 TeV upgrade, there will be a rich physics program for much more than a decade
- Utra-precision physics will require a well-understood machine –
  - eg don't want threshold scans during comissioning
- Distinguish “installed” from “operation” beam energy:

  operating at a lower energy than the installed one can be more efficient
- We should be prepared to defend positron polarisation, once again, and in particular at < 300 GeV ECM.

My **personal** conclusions sofar

- start-up at 250 GeV unavoidable, *but in TBE length tunnel*
- *stretching* (not interruption) of cryomodule production
- Install up to TBE as soon as cryomodules ready ~3-4 years
- TBE slightly above 500 GeV, eg 550 GeV, offers significant improvement of physics opportunities (ttH)
- Exploring run at TBE ~3-4 years
- Further time order depends on what we learned til then:
  - More lumi at TBE (ttH, ZHH, surprises, …)
  - ttbar threshold scan, lowQ pars ~1 year
  - Go back to 250 GeV with 2-4 x luminosity
  - Eventually: WW threshold, Z pole physics – polarised!
- Nailing this needs studies – if **you**'d like to contribute, contact us!