Preparation for next ILD Optimisation Meeting

ILD Software&Analysis Meeting
January 29, 2014
J.List, DESY

Next Optimisation Meeting

- Forseen date: 26th February
  → in 4 weeks from today (one sw/ana meeting in between)
- Forseen main topic: **Tracking**
- Task for sw/analysis group: Prepare discussion from
  - Physics side:
    - What are the physics arguments to justify a certain performance arspect?
    - Which benchmarks can illustrate this?
  - Software side:
    - Which detector configurations?
    - Do we have all the tools?

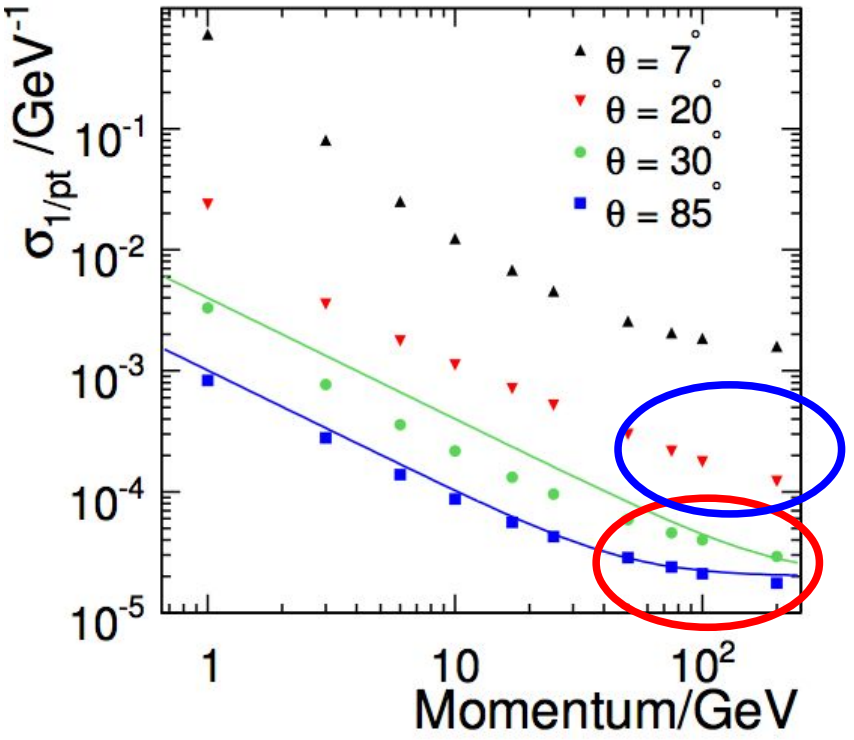
Tracking issues

- “geometry driven” (R, B, ...):
  - **Momentum resolution → today!**
  - Track separation at calo (Pflow)
- “technology driven” (Si point resolution vs timing, ...):
  - Impact parameter resolution
  - Pattern recognition with pair bkg
  - In particular at low pt: charm tagging, taus, exclusive decays, exotics

=> balance of point vs time resolution in Si trackers

Momentum Resolution

- Resolution in barrel:
  → could we shrink TPC?
  → with or without
  increasing the B-field?
- Degradation at small θ:
  starts when tracks hit endplate
  → TPC length / aspect ratio



=> Physics arguments?

Physics Case for Momentum Resolution

- Classic: $ZH \rightarrow \mu\mu X$
  - Model-independent mass, cross-section
- In the long run: $H \rightarrow \mu\mu$
  - Branching ratio
- Basis for precision physics: $Z^* \rightarrow \mu\mu (\gamma)$
  - $\sqrt{s}$ determination

Classic case: ZH → μμ X

Rock solid physics case:

- model-independent measurement of ZZH coupling!
- Final precision depends on
  - Luminosity
  - Signal-to-Background ratio → narrow peak!
    - Beam energy spectrum
    - **Momentum resolution**

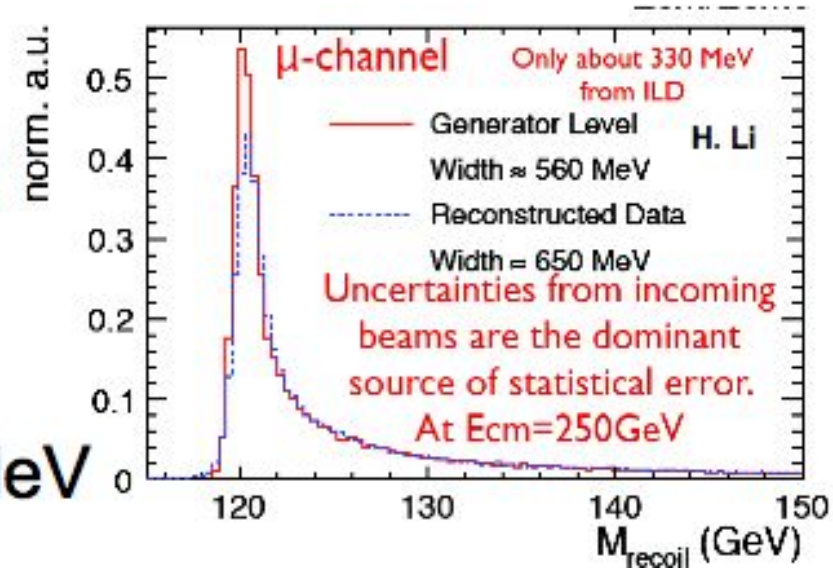
Classic case: ZH → μμ X

- Hengne Li et al: LoI & LC-PHSM-2009-006:

=> for M_H = 120 GeV, E_{CM} = 250 GeV:

- width of recoil peak dominated by beam energy spread:

$$\Gamma_{rec} \approx 650 \text{ MeV}$$
$$\approx \sqrt{560^2|_{beam} + 330^2|_{det}} \text{ MeV}$$



… but detector resolution non-negligible!

- Higher energies:
  cross-section drops, larger muon momenta, more forward → but still contributes to combination

Classic case: ZH → μμ X

Update for m_H=125 GeV:

- ongoing work by Shun Watanuki (Tohoku)

Proposal: study model-independent δσ/σ(ZH → μμ X)

- At 250 GeV, 350 GeV, 500 GeV
- for different TPC radii (eg 1.8m, 1.6m, 1.4m)
- and B-fields (3.5 T, 4 T, 5T)

=> Can be done reliably in SGV

Probably sufficient to treat ZH and μμff background..

…. any volunteers?

In the long run: $H \rightarrow \mu\mu$

- Higgs WP: 100% on branching ratio at 500 GeV (SiD)
- Most relevant at 1 TeV: 31% (1 ab^{-1} , Tino Calancha)
- But: even for TeV upgrade, we won't rebuild the coil / the calorimeters.....
- HighLumi-LHC projections: ~20% - however more model-dependency.

  => again, the previous options could be studied rather easily in SGV

Basis for Precision Physics

- Interpretation of any cross-section measurement will depend on an accurate knowledge of sqrt(s) !
- In particular: Threshold scans
- In-situ determination of sqrt(s) from Z* → μμ (γ), c.f. Graham Wilson at ECFA LC2013:

$$\sqrt{s_{\mathrm{p}}} = p_{\mathrm{T}} \left(\frac{1+\cos\theta_1}{\sin\theta_1} + \frac{1+\cos\theta_2}{\sin\theta_2} \right)$$

(Statistical errors only …)

ECM (GeV)	L (inv fb)	Δ(√s)/√s Angles (ppm)	Δ(√s)/√s Momenta (ppm)	Ratio
250	250	64	4.0	16
350	350	65	5.7	11.3
500	500	70	10.2	6.9
1000	1000	93	26	3.6

< 10 ppm for 200 – 500 GeV CoM energy

Propose this as an additional benchmark

Discussion

- Comments?
- Other proposals?
- Volunteers?
- …..