Software Tools for Physics

ILD Workshop, Krakow
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J.List, DESY

Why still more Physics Studies now?

- We have to continue to make the Physics Case and to keep it up-to-date
  – *at least* until the ILC will have been approved!
- In view of new LHC results
- to convince our colleagues, need to
  - include experimental systematics
  - use state-of-the-art theory predictions
  - and corresponding uncertainties
- Which observables are needed to which precision?

Can't just the theorists do it?

- Not without us:
  - experimental systematics
  - Many key channels currently limited by reconstruction/analysis issues
    eg: Higgs self-coupling by jet clustering
  - Very close connection to detector optimisation
    beyond the *direct* detector performance:

Which detector properties will allow to overcome the current reconstruction / analysis limitations?

ILD Optimisation

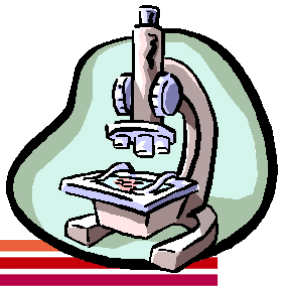
- Consider physics goals to
  - make up our minds how ILD should look like
    – at various ILC energy stages?!
  - gauge impact of performance vs cost re-balancing
  - finally: justify our decisions towards review bodies / funding agencies
- Concentrated a lot on *resolution* (jet energy, tracking)

→ but physics might ultimately be limited by *accuracy*

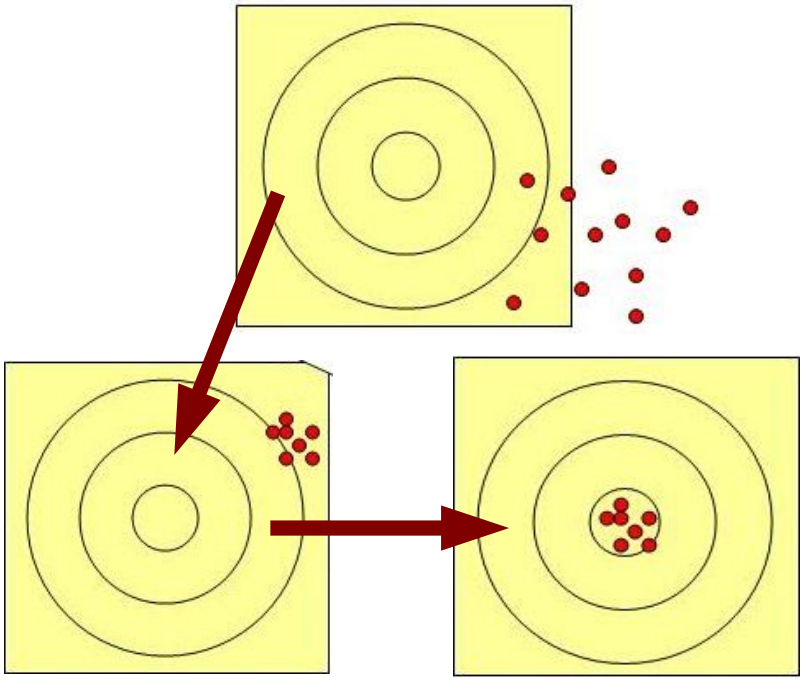
→ systematics, scale calibration, alignment, …

c.f. Slide from parallel session:

Precision Measurements



- **Precision** (detector resolution):
  - separate close-by states
  - separate decay modes
- **Accuracy** (detector calibration):
  - momentum / energy scale
  - beam energy spectrum etc



- **Modelling** ("Standard model" calibration):
  - fragmentation / hadronisation corrections
  - γγ background: photon structure functions, modelling of γ-hadron interactions

=> needs SM precision measurements!

“ILC Optimisation”

- How much integrated luminosity is required at which beam energy in which helicity configuration in order to have the best final precision – eg on Higgs couplings?
- This coud have implications on machine design / choice of physical energy stages!
- Could we live with asymmetric beams:
  - In energy, eg to reach WW threshold with positron polarisation and without 10 Hz running?
  - In beam intensity: compensate for lower positron yield by putting more electrons?

Do we have all software tools to do such studies?

What is needed – MC Generators

- sofar: ILCWhizard based on whizard 1.95
- Need to switch to state-of-the-art Whizard 2.x series before the “Next Big Report” (cf talk by JRR)
- Current bottle-neck in generation chain: hand-made transfer of beam spectrum from GuineaPig to Whizard → automatic interface?
- Will need additional generators for special purposes:
  - Bhabha's, γγ, ...
  - Study impact of hadronisation model, ..

=> We need to endorse and support the continuation of the Generator Group

What is needed - Systematics

- Simulation of misaligments.....and doing the alignment
  - Eg: answer usefulness of SET
- Study impact of time dependent effects?
  - Eg: if no difference in JER between choices – maybe in terms of stability of calibration?
- Impact of TPC distortions?
- Stability of AntiDID?
- …?

Enable to have differences between simulated properties and those assumed in reconstruction

What's need - Simulation

- DBD: focussed on putting more realism, more details into the simulation
- Now: revisit optimisation of overall concept

Do we need an additional, simplifed simulation model of ILD allowing more easy change of parameters?

- Note:
  - studies on tracking system alone can be done to a large extend with SGV – even flavour tag
  - but impact on calorimeters, Pflow etc needs fullsim

Justifying our Choices

- Eg: Probably nobody in this room would question that we'd like to have a TPC
- But eventually we have to be able to make a strong physics driven case for this choice and its consequences
  (remember IDAG question from Arlington:
  Why can SiD deliver the same performance at much lower costs?)
- Make sure we have the tools to study all benefits!
- Eg one missing feature in simulation: **dE/dx !**
  (more details? Ask...)
- Are there others?

Conclusions

- **Generator Group did a great job – but we need to continue!**
  - Whizard2, additional generators
- **Simplified detector model for studying parameter changes?**
- **Tools for studying alignment, calibration**
  - Might be important for detector design / technologies?
- **Missing detector features in software:**
  - dE/dx
  - Others?

dE/dx

- parametrise HEAT results and implement into TPC digitizer – and SGV
- use mass information in tracking and vertexing (multiple scattering especially important for low momentum particles!)
- use particle ID (and vertexing) for analysis
  - branching ratio of exclusive decays
  - does it help the flavour tag?
  - definitively interesting for exotics
  - but also buys into systematics (fragmentation, photon structure functions, ...)