

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:

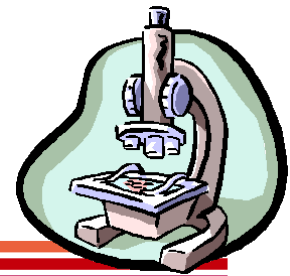
Which detector properties will allow to overcome the current reconstruction / analysis limitations?

ILD Optimisation

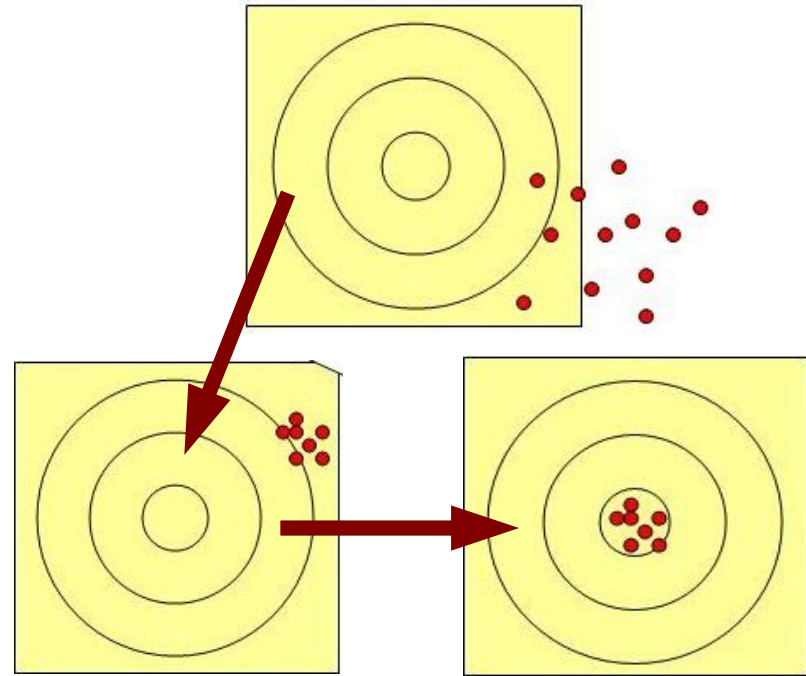
- Consider physics goals to
 - make up our minds how ILD should look like
 - at various ILC energy stages?!
 - gauge impact of performance vs cost re-balancing
 - finally: justify our decisions towards review bodies / funding agencies
- Concentrated a lot on *resolution* (jet energy, tracking)
 - but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

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

What is needed - Systematics

- Simulation of misalignments.....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, simplified 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, ...)