Discussion on MC Production and Physics Benchmarks for ILD Optimisation

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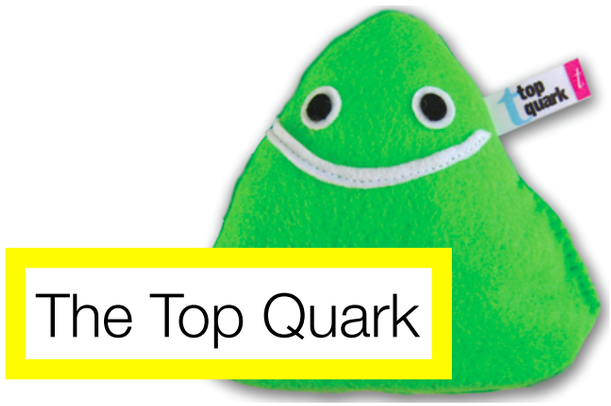
ILD Physics Conveners Meeting,
July 26 2017



Our priorities

Priority No.1 = to realize ILC

What we need =

- **clear physics case**

Priority No. 2 = to realize ILD

What we need =

- **detector design, which is cost effective and technically feasible, to realize the physics**

What do we want to achieve?

1. **validate/establish/debug/commission the new software chain and the new detector models**
   - ready start now with single particles / uds
   - proceed to some physics signals which can be compared to existing active analyses

} **(hopefully) quick 1st item today: assign person power**

2. **detector optimisation “proper”**
   - compare ILD-S vs ILD-L
   - make the case for important choices (eg TPC)

} **main topic today: agree on a strategy - opinions seem to differ a lot ?!**

3. **help make the physics case for ILC with realistic and plausible studies**
   - can be fast simulation in some cases - not in others
   - strengthen 250 GeV
   - while not neglecting 350 GeV & 500 GeV

} **not today - needs new beam parameters, Whizard2, the best detector**

Proposal for item 1) (email JL July 19)

A. reconstruction of single particle & uds samples
   => assign person power from relevant analyses for checks
   eg Moritz: photons, Shin-ichi: muons and so on
   => iterate by email to clarify before next Wednesday?

B. a suggestion first physics samples:
- qqev
- tau tau
- mumuH
- bbar

But of course there are alternatives and we should factor in existing person power. Thus I suggest that all WG conveners check with the active people in their groups, so that we can finalize the list, best with names, in the meeting next Wednesday.

1.A single particles & uds

- μ^+ : [-> Shin-ichi Kawada (H->mumu), Hirokazu Yamashiro ? (ee->mumu)]
  - tracking efficiency vs p, theta
  - track parameter resolution vs p, theta
  - ID efficiency vs p, theta
- γ : [-> Moritz Habermehl, NN]
  - ECal resolution, energy scale vs E, theta, phi
- K^0_L : [-> NN1, NN2]
  - HCal resolution, energy scale vs E, theta, phi
- uds: [-> NN1, NN2]
  - PFA resolution & scale vs E, theta
  - tracking efficiency vs p, theta
  - particle ID vs p, theta

1.B first physics samples

- general considerations:
  - active analysis on DBD samples?
  - needs for tuning of higher-level reconstruction?
    => do we need samples for training flavour tag to prepare full analyses
- a suggestion first physics samples:
  - qqev: Robert Karl? (very limited availability since in last half year of thesis!)
  - tau tau: nobody active?
  - mumuH: Yan Wang?
  - bbar: Sviatoslav still available?
  - Higgsinos: Swathi Sasikumar (has actually already simulated events already)

2. Detector Optimisation “proper” - What do we want to achieve?

- **suggestion A: repeat what we did in the past - do full fledged physics analysis for both ILD-L and ILD-S**
  - what does this cost in terms of resources (computing and persons)?
  - keeping in mind that we also need to continue “priority No 1”?
  - what would we learn from this?
- **suggestion B:**

1. **prepare for defending why this detector is better than others on the market - and if not make it so:**
   - develop reconstruction tools that allow to show the real performance of the ILD detector
   - highlight areas where we expect the detector/accelerator will outperform CLIC / SiD
2. **establish the basic performance characterization of ILD-L and ILD-S beyond a momentum resolution plot or a jet energy resolution plot:**
   - catalogue all performance plots one would like to see in a TDR **-> see next slide**
   - most of them “object-level” plots, involving single particles
3. **use the results of the above to produce a better detector design** **-> see talk in Lyon**

From Oshu meeting, Sept 2014

Optimisation benchmarks – Detector Level

- Hermeticity:
  - for high E (>90%E_{beam}?) e^{+-}/ γ
  - for "normal" e, μ, γ, π, n
- Calorimeters:
  - Jet energy resolution, including $5 < E_{jet} < 50$ GeV
  - Photon energy & angle resolution
  - Bhabha reconstruction
- Tracking system:
  - Efficiency, fake rate
  - $\sigma(1/p_t)$, σ_{IP}
  - Vertex efficiency, resolution
  - Jet charge
  - Flavour tag
- Low momentum particles (p_t = 0.1….2 GeV):
  - Tracking efficiency, $\sigma(1/p_t)$, σ_{IP}
  - Calorimeter detection efficiency
- Particle ID (dE/dx & calo)
  - e / μ / π^{+-} / p / K / n / π^0/ γ
  - Low p_t and "normal"
  - Particle ID in jets
- Exclusive decay mode reconstruction:
  - τ leptons
  - B, D hadrons

+ "control benchmarks":
  - LEP, dL/dE
  - gluon splitting g->bb ?
  - …..

General considerations

- small ILD parameters have been picked from SGV scan such that tracking performance for medium/high momentum particles is equivalent to DBD ILD
- full analyses need tuned flavour tag, BeamCal reco, PID, …
- many DBD analyses limited by background MC statistics
- LoI & DBD benchmarking experience:
  - differences SiD <-> ILD often small
  - it is not easy to pin differences in full analyses to a single detector performance aspect
  - the strength of ILD does not lie in the “easy” cases
  - physics performance often limited not by detector hardware but by reconstruction / analysis software => improve reconstruction!
- should employ spares resources (person power!) carefully
  (need to continue to deal also with “Priority No 1” ?!

List of active people (except conveners)

- KEK / Japan
  - Yumi Aoki
  - Daniel Jeans
  - Hirokazu Yamashiro
  - Masakazu Kurata
  - Hiroaki Ono
  - Yu Kato
  - Yo Sato
  - Takaaki Yasui
  - Yuto Eda
- Europe
  - Swathi Sasikumar
  - (Robert Karl)
  - Yan Wang
  - Shin-ichi Kawada
  - Paul Malek
  - Mila Pandurovic
  - Naomi van der Kolk?
  - Sviatoslav or successor ?
- US/Americas
  - Justin Anguiano ?

Benchmarks for detector optimisation

J.Tian @ LCWS2015

benchmark processes for detector optimisation

process	physics	detector	Ecm	
H—>cc	BR	c-tag JER	any	H.Ono
H—>μμ	BR	high P tracking	500 GeV	S.Kawada
H—>ττ	BR, CP	τ reconstruction, PID track separation	250 GeV	D.Jeans
H—>bb	M_H, BR	JES, JER b-tag	500 GeV	A.Ebrahimi J.Tian
H—>invisible Z—>qq	Higgs Portal	JER	250 GeV	Y.Kato
eνW—>eνqq	M_W, TGC	JES, JER	500 GeV	K.Cotera G.Willson
tt-bar—>qqbℓν	top coupling A_{FB}	b-tag, JER jet charge	500 GeV	S.Bilokin Y.Sato
$\chi_1^+\chi_1^-$, $\chi_2^0\chi_1^0$ near degenerated	natural SUSY	low P tracking PID	500 GeV	J.Yan
γXX	WIMPs	Photon ER & ES Hermiticity	500 GeV	M. Habermehl

in total 9 = 5 (Higgs) + 2 (EW) + 2 (BSM) 5

Barely covered, more manpower highly welcome!

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J.Tian @ LCWS2015

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Discussion

- Your turn!

Backup

Priority No.1: Physics Case

- staging is upon us
- new 250 GeV beam parameters coming up
- full SM MC samples for physics
  - typically have a life time of > 5 years
  - should assume an improved detector (not degraded)
  - need to be able to generate additional signal samples on request
- *not* the topic of today

Conclusions

- productive meeting
- physics group has several ideas where to optimize (= improve!) ILD
- evaluation of ILD performance in some places still limited by lack of well-tested reconstruction (eg PID)
- full-fledged physics studies require large, but also long-term stable MC samples / software
- any new full SM production will be the basis for physics studies for a long time => use our “best” detector

Physics & MC Productions

- physics studies still have to rely on DBD simulation and reconstruction samples => they do *not* yet reflect the progress since:
  - mini-vector tracking
  - dE/dx & particle ID
  - LCFI++ improvements
  - software compensation
  - photon reconstruction
  - BeamCal reconstruction
  - .....

  => full exploitation essential for meaningful detector optimization!

- any new full SM production will be the *basis for physics studies for many years* => best possible detector!