Report from Common Task Group for Generators

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Outline

Paris and Beijing

At the ILD meetings in Paris and Beijing, plans for future mass-production for bench-marking, detector optimisation and physics analyses were discussed.
Three areas needing development before we would start were identified:

- Developments on detector simulation (all options equally advanced, more realism, integration with engineering designs)
- Amelioration in reconstruction, mainly tracking.
- Updating event-generation.

The first two is the main topic of this work-shop - The third is the charge of Common Task Group for Generators.

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Common Task Group for Generators

A cross-region and cross-concept working group was created to look into the generator side

Members

- Tim Barklow, SiD/Americas
- Akiya Miyamoto.ILD/Asia
- M.B., ILD/Europe

Since, CLIC has also joined

- Stephane Poss
- Marco Battaglia

Generators for LOI

How was it done for the LOI ?

- Basically, all done
  - At one place (SLAC)
  - By one person (Tim)
  - With one generator (Whizard 1.40)
- In addition, some signal samples were done elsewhere by other people (N. Wattimena, P. Schade, Nicola d'Ascenzo, M.B. ...) and with different whizard versions
- In ILD, the generated files were ftp:ed from SLAC, stored on the grid, entered into the database, and used as input to Mokka+Marlin. Once again, by one person (I. Marchesini).

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What is needed for the DBD

Why not do the same ?

- Tim will not do it alone, due to his work-load
- There are a number of short-comings with the version of Whizard used:
  - Diagonal CKM
  - No tau polarisation in decays
  - Hadronisation tune in PYTHIA
  - Colour-flow and helicity information
- Whizard is not ideal for some specific channels which might need other generators:
  - SUSY
  - $\gamma\gamma$
  - $>$ 6 fermions
  - bhabha
  - tth, ttz, ttbb
  - ...

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- For the DBD, there are new bench-marks
- at other E_{CMS}
- The Baseline Assesment issue has been added to the list of tasks. Time-line
  - 1st BAW in Sep (KEK) and 2nd BAW in mid. Jan (SLAC).
  - Physics/Detector groups are expected to provide a report by 2nd BAW.
- Machine backgrounds should be treated more in detail.
- The LHC runs.

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Shoping List

This leads to a number of items to decide on/develop:

- Work sharing:
  - Be able to run production-scale Whizard at KEK's local computer, the NAF, or the ILC-VO GRID.
  - Tools for mass production.
  - Manage generated samples: Storing generated files, documentation, knowing they will be used by both SiD and ILD, ie. by different production systems.
- Develop a plan for MC sample generation for DBD and ILC baseline assessment work
- Signal samples: What and How?
- SM background samples: What and How?
- Beam backgrounds: What and How?

Initial working meeting at SLAC (Tim, Akiya, MB) in May.

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Some words on Whizard

Whizard combines

- Matrix-element calculation (O'Mega, MadGraph or CompHEP; we use O'Mega),
- Phase-space calculation.
- Multi-channel integration

into an efficient generator of un-weighted events.

Features:

- Treats up to 6 fermions in the final state
- Does not separate "signal" and "background" sources of the final state → interference correctly treated.
- Keeps track of polarisation.
- Knows about beam-strahlung and ISR, hence varying initial-state properties.
- NB. hadronisation and eg. τ-decays are *not* treated by Whizard, but by external programs, supplied by the user.

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Some words on Whizard

- We use PYTHIA for fragmentation and decays.
- Note that PYTHIA doesn't know about polarisation (τ:s, charginos, ... !). Use TAUOLA instead.
- Many models (SM and beyond) known. NP parameters read from LesHouches file.

Problems with Whizard:

- Many channels: SM alone is made of 2348 distinct Whizard channels...
- Non-perturbative processes, eg. $\gamma\gamma$ beyond multi-peripheral.
- Highly singular phase-space, eg. Bhabha:s
- Eg. low-mass SUSY gets very complicated. SPS1a': 13 open production channels open, 49 decay-channels (40 of which are SUSY cascades), 100's of final states, many with $>$ 6 fermions.
- CLIC: $>$ 6 fermions, beyond top-pairs ?

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Generator choice

SM will be done with Whizard

- Whizard version by choice : 1.95. Has
  - CKM correct
  - Colour flow
  - Spin
- Latest version is 2.0.2, but “Note that some of the features of WHIZARD 1 (esp. ILC) have not yet been re-enabled.” (Whizard home-page).
- Fragmentation: Latest PYTHIA6 (6.422). PYTHIA8 is out but “To some extent this switch is nominal, since 8.1 does not yet offer a complete replacement of 6.4, and is not yet tested and tuned enough to be recommended for major production runs.” (PYTHIA home-page).

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Generator choice

Technical issues needed to be solved to be site-independent:

- Whizard used to need to be compiled with Intel's commercial Fortran compiler ifort, but bleeding edge GNU gfortran (gcc 4.3) works. Does not link with code compiled with gcc 4.1 (default in SLC5) $\Rightarrow$ need to recompile other packages as well.
- Previously, all was done on 32-bit systems, but as 64-bit ones are getting increasingly wide-spread, it would be preferable that all is checked to run on 64-bit as well $\Rightarrow$ also CERNLIB needs to be compiled in 64-bit.

Other generators

Non-Whizard generation

- physim for tth, ttz, and ttbb events. physim uses CAIN for luminosity spectrum, Whizard uses GuineaPig. Check consitency.
- SUSY generators.
  - Need full event, knowing about ILC conditions, having polarised decays
    - SUSYGEN, but no maintenance, polarisation for bosinos, not staus $\Rightarrow$ NO
    - ISAJET, but is "doubtful" dixit Gudi $\Rightarrow$ NO
    - SHERPA, but works the same way as Whizard $\Rightarrow$ probably NO
  - $\Rightarrow$ stick with Whizard
- Bhabha generator: investigate GRACE, contacted authors.
- $\gamma\gamma$: PYTHIA. Tim has a consistent way to use PYTHIA insteadof Whizard.
- Investigate whizard-2.02

Whizard improvement

- PYTHIA 6.422 is used for hadronisation in order to use the LEP latest parameters. Got input from DELPHI, ALEPH and Sjöstrand.
- Propose to use ALEPH, as it is easy, and has been adopted to PYTHYI6.4.
- Tau-polarisation in decay: TAUOLA interface standardised, for polarisation-dependent τ-decays. Also for τ's in fragmentation $W \to \tau\nu$. Verified to work correctly - Thanks for advice Gudi!
- Extension of information in the event record:
  - Colour singlet system information and particle spin.
  - Beam-particles before and after beamstruhlung.
  - Process ID in each event record.
- Coding of FSR, which confuses Mokka (but not Slic, so a safer, more portable solution, is to modify Mokka)

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Tools for productions of generator samples

- Tim's scripts to run Whizard jobs at the SLAC batch server migrated to the KEK environment, and will be migrated to DESY.
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- SiD: Fermi Pipeline system fits well, but not migratable (Needs Oracle, needs special job management server existing at SLAC and CCPN). Tim is prepareing the interface.
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Plan for beam background samples

- By GuineaPig++, T. Hartin will do them/has done them.
  - Disrupted beams
  - Beam-strahlung photons
  - Pairs.

  The first two are used as input beam-spectra for Whizard, the third comes for “free”.
- Other backgrounds with BDSIM. Help assured from experts (P.Bambade and T. Murayama), but definite beam design before it is useful to initiate work.
  - Synchrotron radiation.
  - Beam-halo muons.
  - Neutrons.
- Two-photon mini-jets: Unclear. PYTHIA ?

Samples for ILD's 350 GeV study

Aim: What can be done for a light Higgs if the ILC luminosity will be as low as the original SB2009 proposal ?

At 350 GeV, SB2009 is quite similar to RDR. So:

- Check performance of Higgs branching ratio measurement.
- Compare with LOI study (at 250 GeV).

Signals needed:

- H$\rightarrow$ cc, H$\rightarrow$ bb, and vector bosons in hadronic mode.

Backgrounds needed:

- 4q final states, ($\mu\mu$qq exists already, eeqq and $\tau\tau$qq not needed.)
- Suggestion to produce 6 quarks (top pairs)

Beam parameters:

- sb2009-with TF as this is the widest. Rescale to RDR-350 or sb2009-without TF.

To be done with LOI generator and detector model.

Sample for ILD's 350 GeV study

Status:

- $\approx$ all samples generated by Akiya at KEK (4f, 6f, Hff).
- Some files were put through the Mokka/Marlin-chain. They run fine.
- Tentative information record produced, that should serve as input to SiD:s or ILD:s production database.
- See: http://wiki.kek.jp/display/ miyamoto/ILC+Common+Generator+Samples

Conclusions and outlook

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- Whizard, the main work-horse of the SM simulation, has been updated to the most current, ILC-usable version.
- Most issues on list of needed amelioration has been solved, both technical and physics ones.
- A full production of samples for the 350 GeV study has been done at KEK, with tools migrated from SLAC. However, this was done with the old generator.
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