Use of WHIZARD for the mass production of CLIC CDR volume 2

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CERN

November 22nd, 2011

Outline

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Introduction

CLIC detector studies use ILC concepts as baseline: use common tools.
For generation, linear collider common generator tools group: use WHIZARD 1.95 as proved to be good for ILC LOIs.

CLIC detector studies as presented in the Conceptual Design Report (CDR): study 6 physics channels to assess detector performance.

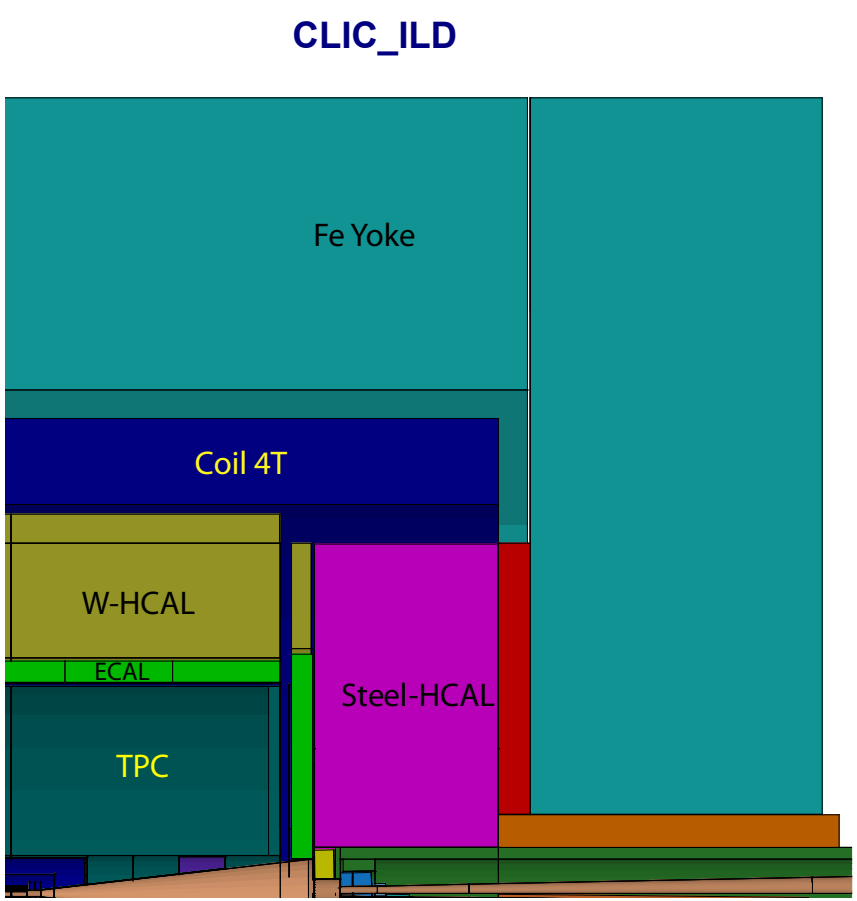
This presentation:

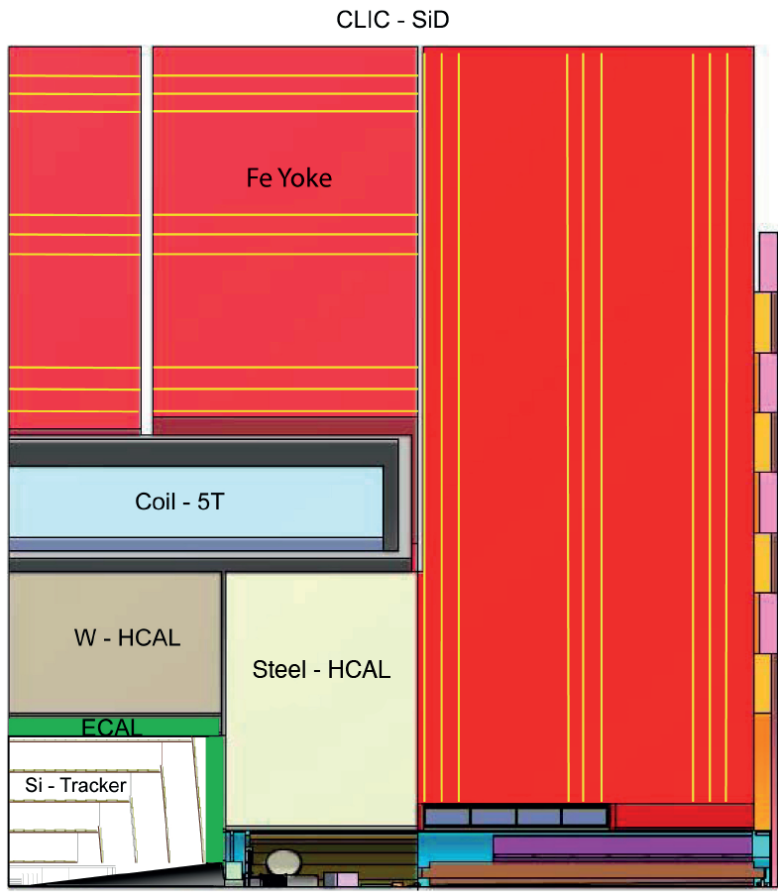
- Channels studied
- Tools developed for mass production
- Limitations

A short word on CLIC

CLIC is

- an e^+e^- linear collider
- operating nominally at 3TeV cme
- 2 detector concepts (ILD and SiD) based on ILC concepts





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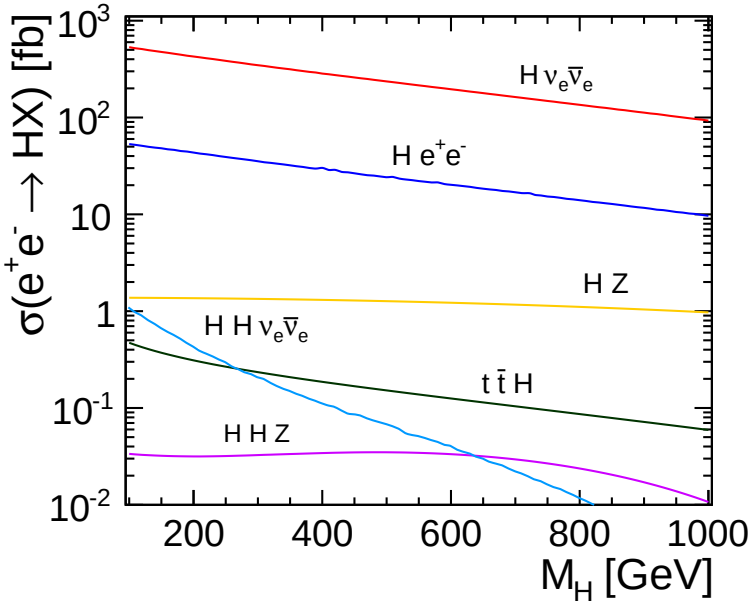
Physics channels studied

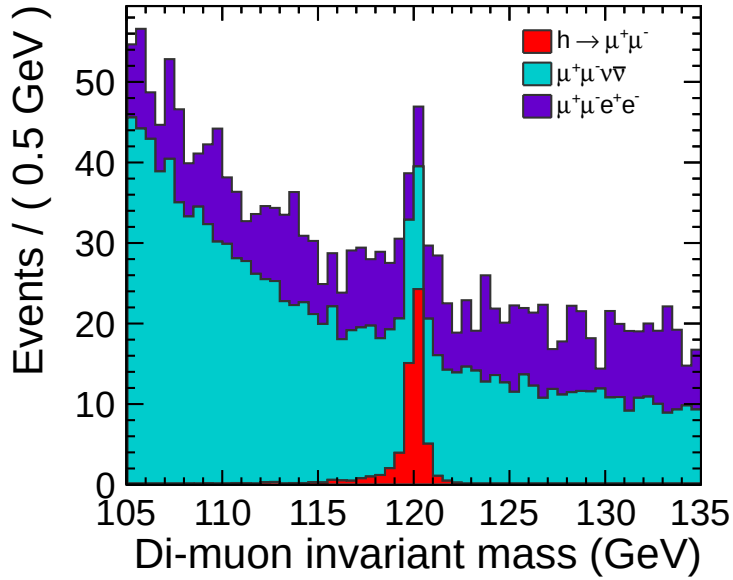
6 benchmark channels to assess detector performance:

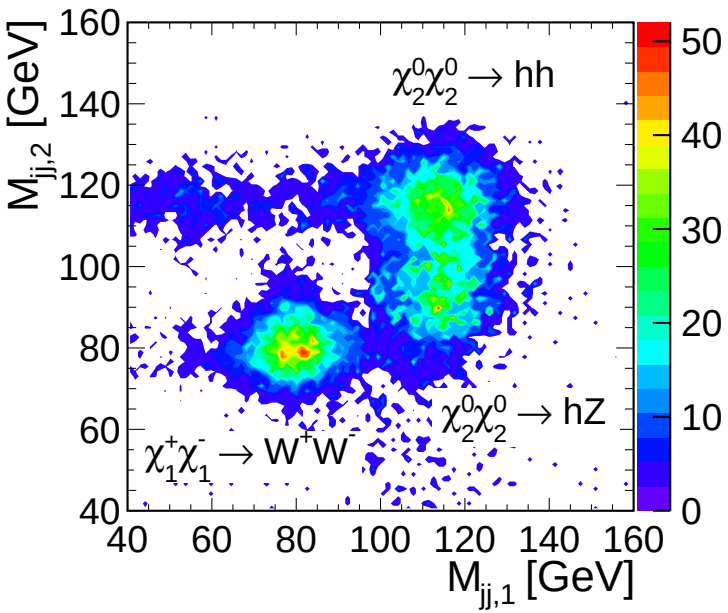
- $e^+e^- \to h\nu_e\overline{\nu}_e, h \to \mu^+\mu^-, h \to b\overline{b}$,
- $e^+e^- \to H^+H^-$, $e^+e^- \to H^0A$,
- $e^+e^- \to \widetilde{q}_R\overline{\widetilde{q}}_R$,
- $e^+e^- \to \widetilde{\ell}\overline{\widetilde{\ell}}\,(\ell = e, \mu, \nu_e)$,
- $e^+e^- \to \widetilde{\chi}^{\pm}_i\widetilde{\chi}^{\mp}_j$, $e^+e^- \to \widetilde{\chi}^0_i\widetilde{\chi}^0_j$,
- $e^+e^- \to t\bar{t}$ (500 GeV).

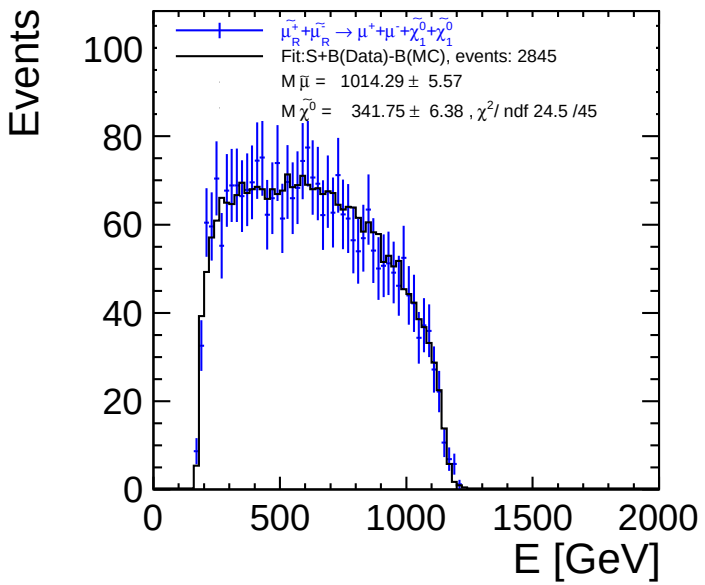
2 different SUSY models, 2 different energies (luminosity spectra), many background samples (SUSY and SM), millions of events needed

Examples of results









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Modifications needed

ILC LOIs used WHIZARD.

Several tweaks implemented (T. Barklow, M. Berggren, A. Miyamoto):

- Installation tools
- Specific support for luminosity spectra: chose between ILC, CLIC, etc.
- TAUOLA support
- Stdhep output
- 6 fermions final state handling (for ILC LOIs): $t\bar{t}$ reconstruction
- Color flow (for DBD studies)

Production framework

CLIC detector studies use the GRID for mass production.
Need to run many applications in heterogeneous context:
ILCDIRAC

- Based on DIRAC: grid solution developed initially for the LHCb experiment. PYTHON based.
- Comes with production system: define task and let the system create and monitor the jobs.

Needed to interface WHIZARD in ILCDIRAC:

- Run configuration: ILCDIRAC configuration is in PYTHON $\rightarrow$ convert to whizard.in
- Process selection: Make sure all relevant files (e.g. LesHouches files) are available

Example of job definition

```
from ILCDIRAC.Interfaces.API.NewInterface.Applications import *
from ILCDIRAC.Interfaces.API.NewInterface.UserJob import *
from ILCDIRAC.Interfaces.API.DiracILC import *
d = DiracILC()
j = UserJob()
wh = Whizard(processlist=d.givePro cessList())
pdict = {'process_input':{'process_id':"h_n1n1","sqrts":3000.,
                          "polarized_beams":"F"},
         "simulation_input":{"n_events":10000}}
wh.setFullParameterDict(pdict)
res = j.append(wh)
if not res['OK']:
    print res['Message']
d.submit(j)
```

Defines the WHIZARD executable to install.

What happens on the grid node

1. Install software if not available
2. Get files: user whizard.in, LesHouches file
3. Set whizard.in as needed
4. Set the environment: read the lumi spectra, set the library path
5. Run WHIZARD
6. Treat output: rename according to user convention and upload to Storage Element

Running WHIZARD in ILCDIRAC

Problem: How to prevent users from trying non-existent channels?

- Store the content of the whizard.prc in a file that can be used at submission time by DIRAC
- Keep relation between WHIZARD version and channels (SM vs SUSY)

Problem: How to reduce configuration issues?

- Catch all errors before the job is submitted
- New functionality: all WHIZARD options are wrapped in a XML file, also holds default values and types

Running WHIZARD in the production for the CLIC CDR

- Framework is global: generation, simulation and reconstruction of events done using same tool (ILCDIRAC)
- Account for simulation/reconstruction CPU time constraints on the GRID (24 hours max on average)
- Account for optimal file sizes: Storage Element access is the most problematic

$\Rightarrow$ need to generate $10 - 1000$ events per job depending on the channel.

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Limitations met

- Impossible to generate specific final states with width: $t\bar{t}$, WW, ZZ, HH, HA. Used PYTHIA standalone for those. For SM Higgs processes assume width to be 0.
- Would have been useful to be able to disable diagrams explicitly to have pure signal samples
- Generator level cut interface not easily generalized: had to add extra filtering programs to run after WHIZARD.
- Process selection for people not compiling WHIZARD: Adding a new process requires compiling a WHIZARD executable, not easy from scratch

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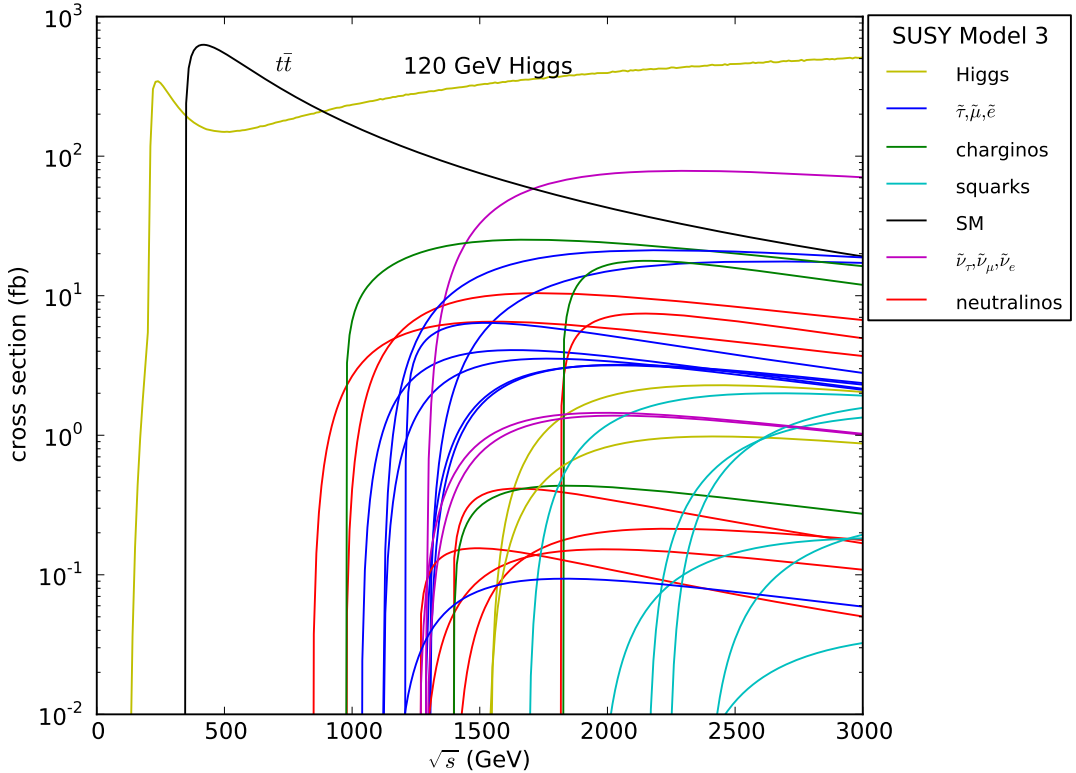
Using WHIZARD 2.0

Using analysis framework of WHIZARD 2:



Includes CLIC 3TeV luminosity spectrum.

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Conclusion

For the CDR:

- Very complete software
- Accurate cross sections
- Efficient event generation
- Lightweight to run on the GRID once compiled
- Compilation is tricky
- Some channels could not be done ($t\bar{t}$, WW, ZZ, HH, HA)

For WHIZARD 2.0:

- Easier process selection
- Work on run configuration
- 8 fermions final states (ILC DBD studies)

Conclusion

CDR has been internally reviewed, visible here:
`https://edms.cern.ch/document/1160419`

Join the signatories here:
`https://indico.cern.ch/conferenceDisplay.py?confId=136364`

Backup slides

Requests for the future

- Mechanism to suppress explicit contributions in processes
- Do not depend on compiler at run time (More or less OK if I understand)
- Interface to other languages (e.g. XML, PYTHON)

Making WHIZARD 2.0 and ILCDIRAC play well with each other

- Install WHIZARD 2.0 on an ILCDIRAC server
- Interface properly in ILCDIRAC (.sin content)
- Make the central installation compile the process on the fly (Request mechanism)
- Register that WHIZARD version as a new application and install it on the sites
- Run the user job against this version when compilation is done

Needs to hold on some database the processes (can use some checksum mechanism) and the versions.