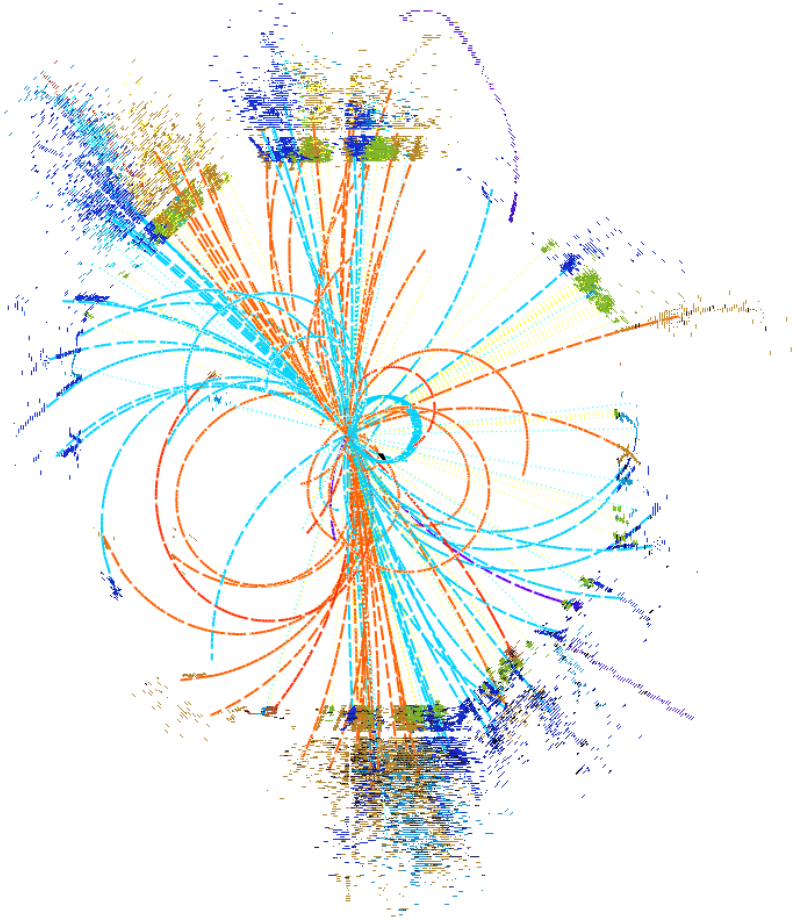
Physics benchmark plans

Philipp Roloff (CERN)



CLICdp meeting at LCWS13
University of Tokyo, 14/11/2013

Status of the Higgs paper

Editing team:
Christian Grefe (CERN)
Strahinja Lukic (Belgrade)
Ph. R. (CERN)
Frank Simon (MPI Munich)
Mark Thomson (Cambridge)

First meeting:
November 6
Next meeting:
December 5

- Target journal: The European Physics Journal (EPJ) **C**

- The analysers will be contacted soon and asked to provide a one page description of their analysis and one or two important plots

- For the plots the same style files as used for the CLIC CDR should to be used, common colour scheme still needs to be defined

- Every analysis for the paper needs to be described in an LCD note

Refined outline of the paper

1.) Introduction including accelerator and detectors
2.) MC generators, simulation
and reconstruction tools
3.) Overview of Higgs production at CLIC
4.) Higgsstrahlung at 350 GeV
5.) WW fusion
6.) ZZ fusion
7.) top Yukawa coupling
8.) Higgs self-coupling
9.) Higgs mass
10.) Combined fits
11.) Summary

Section 4 ("Higgsstrahlung") in detail

4.1 Inclusive cross section from recoil mass

4.1.1 $Z \rightarrow l^+l^-$

4.1.2 $Z \rightarrow q\bar{q}$

4.1.3 Invisible Higgs decays

4.2 Higgs branching ratios

4.2.1 $H \rightarrow bb/cc/gg$

4.2.2 $H \rightarrow \tau^+\tau^-$

4.2.3 $H \rightarrow WW^*$

4.2.4 $H \rightarrow ZZ^*$

Section 5 ("WW fusion") in detail

5.1 Higgs coupling to fermions

5.1.1 $H \to b\bar{b}/c\bar{c}/gg$

5.1.2 $H \to \tau^+\tau^-$

5.2 $H \to WW^*$ and $H \to ZZ^*$

5.2.1 $H \to WW^*$

5.2.2 $H \to ZZ^*$

5.3 Rare decays

5.3.1 $H \to \gamma\gamma$

5.3.2 $H \to Z\gamma$

5.3.3 $H \to \mu^+\mu^-$

Ideas / plans for future studies

Precision EW measurements

- Triple and quartic gauge boson vertex corrections to $e^+e^- \rightarrow W^+W^- (\nu\bar{\nu}/e^+e^-)$

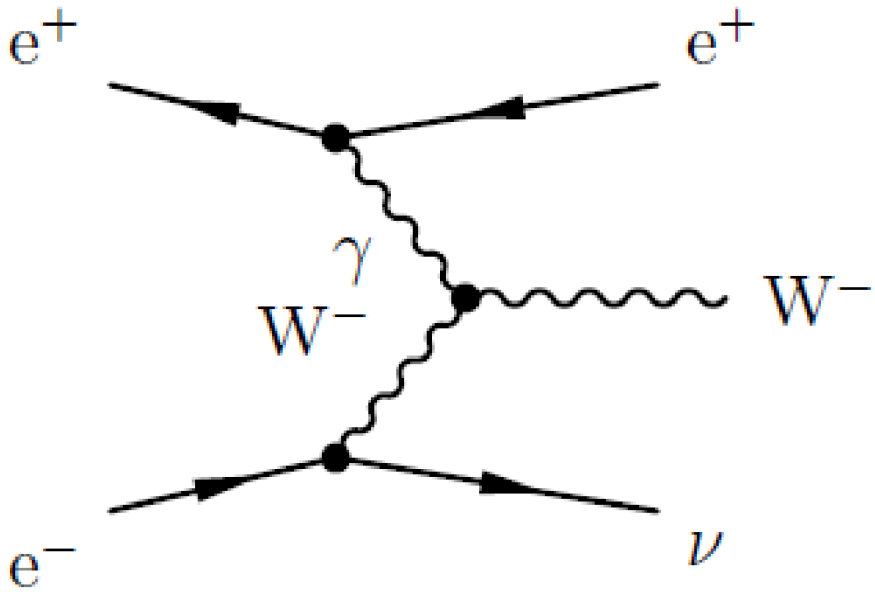
- Forward-backward and left-right asymmetries of fermion production to achieve precision measurements of $\sin^2\theta_f^{eff}$ at various energies

- W boson mass determination at high energy and high luminosity

- Total $e^+e^- \rightarrow f\bar{f}$ cross sections at high energy with various electron-positron polarisations in search of form-factor suppressions or enhancements

M_W from single W events

- Large samples of single W events produced at high-energy CLIC
- Potential for competitive measurement of M_W using $W^{\pm} \rightarrow q\bar{q}$
- Need full simulation study to understand the impact of systematic effects, i.e. the jet energy scale



$e^+e^- \rightarrow e^+W^-\nu$

	1.4 TeV	3 TeV
L_{int}	1500 fb^{-1}	2000 fb^{-1}
# eWν events	22.3 x 10^6	44.9 x 10^6
# eWν events, $W \rightarrow q\bar{q}$	15.0 x 10^6	30.3 x 10^6
# eWν events, $W \rightarrow q\bar{q}$, $20° < \theta(q,\bar{q}) < 160°$	8.9 x 10^6	15.4 x 10^6

Top physics

Study potential to use top quarks as probe for New Physics:

- Production asymmetries
- Couplings to γ, W and Z
- CP violation in top sector
- Flavour changing top decays

BSM physics

Mayor focus of CLIC physics at high energy!

- Model-independent searches for Dark Matter
- Composite Higgs bosons
- Generalisation of higher-dimensional effective operator searches at the various CLIC energy stages
- Searches for weakly interacting exotic particles
- Searches for vectorlike particles charged under electroweak group
- Responding to theory guidance for New Physics that is compatible and explains LHC data in the future

How to get involved

Regular analysis meetings at CERN (every 2-3 weeks):

http://indico.cern.ch/categoryDisplay.py?categId=3222

Remote participation by webex is always possible!

If interested, please contact us:

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Summary

- CLIC physics benchmark studies are a very active area

- Contributions from many groups / individuals

- In the last few months we have focussed on Higgs physics

- Plan to finish the comprehensive paper on Higgs physics from 350 GeV to 3 TeV by the end of the year

Backup slides

List of Higgs studies I

1.) Simultaneous extraction of $H \to b\bar{b}$, $H \to c\bar{c}$ and $H \to gg$ at 350 GeV
(Jan Strube, Victoria Martin, Jonatan Rosen, Marco Szalay) and 1.4 TeV (Tomas Lastovicka)

2.) Measurement of $H \to WW^*$ at 350 GeV and 1.4 TeV (and 3 TeV?)
(Mark Thomson: fully hadronic final state at 1.4 TeV and 3 TeV; Nigel Watson: qqlv final state, Mila Pandurovic: fully hadronic in HZ events at 350 GeV):
- At 1.4 TeV potential for absolute Higgs to W coupling

3.) ZZ-fusion at 1.4 TeV (and 3 TeV?)
(Aidan Robson, Dan Protopopescu, Tom Doherty, project student):
- Ratio of the ZZH to WWH couplings
- Potential for other coupling measurements

4.) Higgs to gamma+gamma (Christian Grefe) and Z+gamma (Eva Sicking) at 1.4 TeV

5.) Measurement of $H \to \tau^+\tau^-$ at 350 GeV, 1.4 TeV and 3 TeV (Astrid Münnich)

6.) Measurement of $H \to \mu^+\mu^-$ at 1.4 TeV
(Ivanka Bozovic-Jelisavcic, Gordana Milutinovic-Dumbelovic, Strahinja Lukic, Mila Pandurovic)

7.) Measurement of the top Yukawa coupling at 1.4 TeV
(Sophie Redford, Marcelo Vogel, Philipp Roloff)

List of Higgs studies II

8.) Measurement of the Higgs self-coupling at 1.4 and 3 TeV
(Tomas Lastovicka, Jan Strube (CLIC_SiD & CLIC_ILD)
+ MPI Munich (investigating potential of different analysis techniques in CLIC_ILD))

9.) Measurement of $H \rightarrow ZZ^*$ at 350 GeV and 1.4 TeV
(Gordana Milutinovic-Dumbelovic, with Z-decays qqqq and qqll)

10.) Model independent measurement of σ(HZ) using the recoil method with $Z \rightarrow q\bar{q}$ at 350 GeV (Mark Thomson)

Uncovered topics (volunteers welcome):

- 350 GeV, WW fusion, Higgs decay to WW*
- 3 TeV, WW fusion, Higgs decay to gammagamma
- 3 TeV, WW fusion, Higgs decay to Zgamma