Detector qualification with Higgs bosons in the jets and missing energy final state

Janik von Ahnen, Krisztian Peters (DESY)
FCC week, 9-13 April 2018, Amsterdam

Motivation

- Higgs couplings can be precisely measured at FCC-ee
- Need a measurement of the Higgs cross-section \( \times \) branching ratio in as many channels as possible
- The effect of different detector components on the precision of these measurements are important for the development of efficient detectors
- In this work, detector effects are studied for a final state with jets and missing energy.

![Higgsstrahlung](image1)

Vector Boson Fusion (VBF)

\[ ZH \rightarrow \nu \bar{\nu} b\bar{b} \] at 240 GeV

Event selection

- Exclusive 2-jet reconstruction (ee \( k_t \)-algorithm)
- At least 1 jet is b-tagged
- \( 85 < \text{missing mass [GeV]} < 125 \)
- Di-jet transverse momentum > 15 GeV
- Di-jet longitudinal momentum < 50 GeV
- Angle between the jets > 100°
- cross > 10

![Invariant mass](image2)

Impact of scaling on Higgsstrahlung (ZH).

![Scaling](image3)

Detector performance has a strong effect on the Higgs boson precision measurements for the channels studied. It was shown that this improvement is mainly due to both, a better jet energy resolution and an improved tracking/b-tagging performance.

Conclusion

**Detectors**

- Two detectors implemented in the papas simulation, CMS and CLD.
- The papas simulation is able to reproduce the results of the LEP3 note (arXiv:1208.1662v2) in many different channels.

<table>
<thead>
<tr>
<th></th>
<th>CMS</th>
<th>CLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic field [T]</td>
<td>3.8</td>
<td>2</td>
</tr>
<tr>
<td>Tracker radius [m]</td>
<td>1.3</td>
<td>2.15</td>
</tr>
<tr>
<td>b-tag efficiency</td>
<td>60%</td>
<td>80%</td>
</tr>
<tr>
<td>HCAL resolution @100 GeV</td>
<td>14.2%</td>
<td>5.5%</td>
</tr>
<tr>
<td>ECAL resolution @100 GeV</td>
<td>0.8%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Uncertainty of signal (ZH) yield for the different detector variations. For the 3 red bars the CMS detector with a magnetic field of 2T is changed by replacing the corresponding component with the one from CLD, and changing the outer parts to prevent overlapping.

Uncertainty of signal (VBF) yield for the different detector variations. For the 3 red bars the CMS detector with a magnetic field of 2T is changed by replacing the corresponding component with the one from CLD, and changing the outer parts to prevent overlapping.