Triboson studies for HL/HE-LHC

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VVV: WWW, WWZ, WZZ

- WWW → ℓν ℓν ℓν, WWZ → ℓν ℓν ℓℓ, WZZ → ℓν ℓℓ ℓℓ
- WWW → ℓν ℓν qq, WWZ → ℓν ℓν qq, WZZ → ℓν ℓℓ qq
- ZZZ would be hard to observe
- These processes could be important to show the impact of the ITk rapidity coverage in eta.

What do we want to study

- Optimise selection requirements in order to maximise sensitivity (significance)
- Simple cut-and-count approach.

Lower priority

- Estimate of expected sensitivity to aQGC
- Time constrains for the yellow report

<table>
<thead>
<tr>
<th>Process</th>
<th>scale µ</th>
<th>Born cross section [fb]</th>
<th>NLO cross section [fb]</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZZZ</td>
<td>3M_Z</td>
<td>9.7(1)</td>
<td>15.3(1)</td>
</tr>
<tr>
<td>WZZ</td>
<td>2M_Z + M_W</td>
<td>20.2(1)</td>
<td>40.4(2)</td>
</tr>
<tr>
<td>WWZ</td>
<td>M_Z + 2M_W</td>
<td>96.8(6)</td>
<td>181.7(8)</td>
</tr>
<tr>
<td>WWW</td>
<td>3M_W</td>
<td>82.5(5)</td>
<td>146.2(6)</td>
</tr>
</tbody>
</table>

Include HE-LHC study: still to be discussed (depending on the time constrains)
**METHODOLOGY**

**MC studies**
- Parametrised detector response

**Signal**
- $\text{WWW} \rightarrow ℓν ℓν ℓν$, $\text{WWZ} \rightarrow ℓν ℓν ℓℓ$, $\text{WZZ} \rightarrow ℓν ℓℓ ℓℓ$
- $\text{WWW} \rightarrow ℓν ℓν jj$, $\text{WWZ} \rightarrow ℓν jj ℓℓ$, $\text{WZZ} \rightarrow ℓν jj ℓℓ$
  - Sherpa, normalised to (N)NLO QCD
  - VBFNLO as cross-check

**Backgrounds**
- Main backgrounds are diboson (WZ, Sherpa) and instrumental backgrounds (fakes)
- Top pairs in association with W and Z (aMC@NLO)
- Also consider Higgs in association with top, W and Z (aMC@NLO)
- Common cross sections across yellow report (ATLAS + CMS)?

**Expected output results**
- Demonstrate VVV can be observed with high significance at HL-LHC

**Needed theoretical inputs**
- Cross sections and MC predictions for the signals
PEOPLE, TIME CONSTRAINTS

- **The group:**
  - 2 seniors, but working only part-time on this project
  - 1 master student
    - *Starting to learn analysis in HEP*

- **Timeline**
  - Plan to finish the project till summer

- **Current status of the analysis**
  - Code fully setup, first result obtained.