Heavy resonances at 100TeV

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Outline

• Almost final results for the resonances
  • $Z' \rightarrow ll$
    • Small bug identified in the limits for the theory cross section, limits a bit degraded. Was using the cross section of $Z' \rightarrow$ all lepton flavor instead of 1
Z' -> ll limits

**Limit versus mass**

- **FCC simulation**
  - $\sqrt{s} = 100\,\text{TeV}$
  - $\sqrt{L} = 30\,\text{ab}^{-1}$

- **Theory (LO prediction)**

  - $95\%$ CL exp. limit FCC nom.
  - $95\%$ CL exp. limit z+\text{z}
  - $95\%$ CL exp. limit z\text{z}

**Z -> ee FCC**

**Z -> \mu\mu FCC**

**Z -> ll FCC**
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    • Discovery plot unchanged (only the style has improved)
Z'→ll Significance

luminosity verus mass for a 5 σ discovery

30 ab^{-1} Study lumi

2.5 ab^{-1} First 10y baseline lumi

FCC simulation
\( \sqrt{s} = 100 \text{ TeV} \)

\[ Z'_{SSM} \rightarrow l^+l^- \]

Integrated luminosity versus mass for a 5 σ discovery
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    - Discovery plot unchanged (only the style has improved)
    - Thinking of trying an other benchmark model like $\psi/\chi$
  - tau tau
    - Produced more di-jet events $\mathrm{pT}>2.5\mathrm{TeV}$ of 50M events and 20M $<2.5\mathrm{TeV}$
    - Added Tagging Rate Function instead of direct cuts
Instead of directly cutting on the tagging variable, estimate a tagging weight per event.

To calculate this weight we need to know the truth flavour of each jet and the tagging probability.

- The truth flavour is found by associating a parton to a jet.
- The association is done given the priority to a given flavour wrt another.

For example, in an event with light 2 jets, the TRF weight for 2 tag is:

\[ W_{2\text{tag}} = \text{eff1} \times (1 - \text{eff2}) + \text{eff2} \times (1 - \text{eff1}) \]

\[ \text{eff1}/2 = \text{mistag rate for light jets at given pT and eta} \]
TRF

Di-jet

m8_pp_jj_lo_sel0_mzp

Drell-Yann Di-tau

m8_pp_tautau_lo_sel0_mzp

QCD_sel0_mzp
Entries 1.46095e+07
Mean 3.856
Std Dev 1.066

QCD_sel0_mzp
Entries 27235
Mean 4.183
Std Dev 2.155

p8_pp_Zprime_10TeV_ll_sel0_mzp

m8 = 10 TeV, sel0_mzp
Entries 302659
Mean 6.387
Std Dev 1.653

10TeV signal
Di-jet events with 2 taus partons

- \( \eta < 2.5 \)
  - \( pt > 10 \) pt \( < 5000 \rightarrow 0.01 \)
  - \( pt > 5000 \) pt \( < 34000 \rightarrow 0.01 \times \left( \frac{8}{9} - \frac{pt}{30000} \right) \)
  - \( pt > 34000 \rightarrow 0 \)

- \( \eta > 2.5 \) \( \eta < 4.0 \)
  - \( pt > 10 \) pt \( < 5000 \rightarrow 0.0075 \)
  - \( pt > 5000 \) pt \( < 34000 \rightarrow 0.0075 \times \left( \frac{8}{9} - \frac{pt}{30000} \right) \)
  - \( pt > 34000 \rightarrow 0 \)

- \( \eta > 4.0 \rightarrow 0 \)
Z’->tau tau

Few things to understand, but seems a promising approach to avoid large statistical fluctuations after tagging.

CUT ALL EVENTS

```
selection: Jet1_pf04_pt > 1000. && Jet2_pf04_pt > 1000. && ntau>1
```

<table>
<thead>
<tr>
<th>process</th>
<th>yield (30.0 ab-1)</th>
<th>stat. error</th>
<th>raw</th>
</tr>
</thead>
<tbody>
<tr>
<td>m_{Z} = 10 TeV</td>
<td>6545.0</td>
<td>34.2</td>
<td>36521</td>
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<tr>
<td>Drell-Yann</td>
<td>11355.0</td>
<td>29.3</td>
<td>1285971</td>
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<tr>
<td>QCD</td>
<td>13823882.5</td>
<td>292898.6</td>
<td>27235</td>
</tr>
</tbody>
</table>

TRF 10M events

```
selection: weight_2tagex**Jet1_pf04_pt > 1000. && Jet2_pf04_pt > 1000.
```

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<tr>
<th>process</th>
<th>yield (30.0 ab-1)</th>
<th>stat. error</th>
<th>raw</th>
</tr>
</thead>
<tbody>
<tr>
<td>m_{Z} = 10 TeV</td>
<td>8020.8</td>
<td>22.6</td>
<td>802859</td>
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<tr>
<td>Drell-Yann</td>
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<td>6249411</td>
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<tr>
<td>QCD</td>
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<td>14609504</td>
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<tr>
<td>signal</td>
<td>8020.809</td>
<td>4.749</td>
<td></td>
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<tr>
<td>background</td>
<td>8632621.209</td>
<td>10802.257</td>
<td></td>
</tr>
</tbody>
</table>
$Z' \rightarrow \tau \tau$
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    • Ran over large di-jet samples $p_T>2.5$TeV of 50M events
    • Included the TRF
    • Discovery reach also made for $Z'$ SSM model (coupling universality)
Z’→ttbar

- Discovery reach (and limits soon) for two models
- Same generator used Pythia8
Z'->ttbar

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• Di-boson, Di-jet
  • Thinking about new benchmarks