Single top quark production

- Top quarks at the LHC are produced predominantly via QCD with a partner,
- Can be produced singly via EW interactions.

Why do we study them?
- Direct probes of $V_{tb}$ and therefore sensitive to new physics,
- Background to many searches,
- Can constrain PDFs,
- Provides measurements of top quark properties.

$tW$ production

The associated production of a single top quark with a $W$ boson:
- $tW$ at NLO interferes with $tt$ and makes simulation difficult,
- DR (default scheme) removes diagrams from signal definition,
- DS (treated as a systematic) subtracts a gauge invariant term.

Event signature
- 2 leptons (muon/electron),
- Associated MET,
- 1 jet from a $b$ quark.

Dilepton channel

Selected events pre- and post-fit

Inclusive cross section

JHEP10(2018)117

<table>
<thead>
<tr>
<th>Region</th>
<th>tW</th>
<th>t̄t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1j1b</td>
<td>1144 ± 44 3300 ± 1962</td>
<td>204 ± 12 286 ± 16</td>
</tr>
<tr>
<td>2j1b</td>
<td>725 ± 85 2560 ± 2411</td>
<td>719 ± 88 2514 ± 281</td>
</tr>
</tbody>
</table>

Measured cross-section:

$63.1 \pm 1.8$ (stat) $\pm 6.4$ (syst) $\pm 2.1$ (lumi) pb

Leading uncertainties:
- JES/JER,
- Object selection and reconstruction efficiencies,
- $t\bar{t}$ simulation

Differential cross sections

CMS PAS TOP-19-003 - CDS record 2712818

Lepton plus jets channel

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Event signature
- 1 lepton (muon or electron),
- Associated MET,
- 3 jets, 1 from a $b$ quark.

Analysis strategy
- 36 fb$^{-1}$ pp collision data collected in 2016 by CMS at $\sqrt{s} = 13$ TeV,
- Data-driven estimation used for QCD background,
- BDT to discriminate between $tW$ and $t\bar{t}$ background,
- Bindependent likelihood fit on BDT output to extract $tW$ production cross-section.

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Result

Measured cross-section: $89 \pm 4$ (stat) $\pm 12$ (syst) pb

First observation of $tW$ in the $l+$jets channel

Leading uncertainties:
- JES, data-driven background estimations, $t\bar{t}$ simulation