Differential cross section measurements of the tW process at CMS

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Introduction

- The CMS' latest measurement of single top differential cross sections has been done on the $t\bar{t}$W process with 2016 data using dilepton final states (CMS-PAS-TOP-19-003).

- Main challenge: **background largely dominates signal**, being the most important $t\bar{t}$.

- **Interference** between signal and $tt$bar processes at NLO. In order to resolve both processes' definitions, and avoid double counting issues, two approaches (JHEP 07 (2008) 029) are used to simulate $t\bar{t}$ events.
  - Diagram Removal (DR): we remove Feynman diagrams that might present two on-shell tops (also called *double resonant*).
  - Diagram Subtraction (DS): we remove locally the pair-production contribution by adding an artificial term in the calculation.

- The differential cross sections are measured as a function of the leading lepton $p_T$, jet $p_T$, $\Delta\phi(e^\pm,\mu^\mp)$, $p_Z(e^\pm,\mu^\mp, j)$, $m(e^\pm,\mu^\mp, j)$ and $m_T(e^\pm,\mu^\mp, j, p_T^{\text{miss}})$. 
Methodology

- The analysis is performed using the **complete 2016 dataset** (35.9 fb⁻¹).
- The **trigger strategy** uses a combination of single and double triggers to maximise efficiency.

**Event selection**
- At least two identified leptons.
- One of them must fulfil $p_T > 25$ GeV, the other $p_T > 20$ GeV.
- The two highest-$p_T$ leptons must have opposite charge, be an electron and a muon (eµ channel), whose invariant mass satisfy $m(e, \mu) > 20$ GeV.
- Exactly one b-tagged jet ($p_T > 30$ GeV).
- Veto on the presence of loose jets (20 GeV < $p_T$ < 30 GeV).

- Signal is extracted by subtracting background from data.
- Unfolding (implemented using **TUnfold**: *JINST 7 (2012) T10003*) is done to an equivalent fiducial region at particle level. The result is normalised to the fiducial cross section.
Results and discussion

- **Agreement** between data and predictions (with the two generators, POWHEG and MADGRAPH5_aMC@NLO) is fairly good.

- **Analysis** largely dominated by uncertainties associated with the ttbar background.
  - Main sources: jet–related uncertainties (e.g. JES, JER) and modeling (e.g. ME/PS matching).
  - Depending on the bin and distribution, the effect of the uncertainties on the measured cross section varies from ~15-40% (bulk of distributions) up to ~25-100% in the tails.

- The result shows **compatible agreement** for the DR and DS schemes of the signal process.