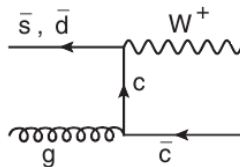
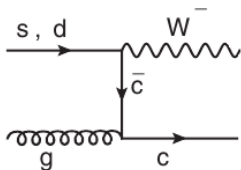


Measurement of associated $W + c$ production



$W \rightarrow e \text{ or } \mu$

$c \rightarrow D^*, \text{ or } D^+, \text{ or } \mu \text{ in jet}$

In total 6 final states

\Rightarrow selecting events with isolated lepton and jet with charm 'signature'

Signal: oppositely signed (OS) W and c

Background: expect equal fraction of OS and same signed (SS) W and c

\Rightarrow : **suppressed background for OS-SS distributions**

Data samples:

- μ : 'SingleMu' dataset
- e : 'SingleEl' dataset

MC:

- $W + \text{jets}$ (MadGraph + Pythia6) [signal]
- Drell-Yan (MadGraph + Pythia6) [background] — not included

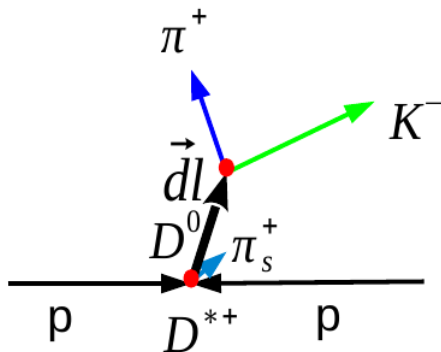
Lepton: leading p_T muon or electron:

- Muons ('muons')
 - $p_T > 25$ GeV
 - $|\eta| < 2.1$
 - isolated with $I_{\text{rel}}^{\Delta R < 0.4} < 0.12$ ($\Delta R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2}$)
 - $M_T > 40$ GeV, $M_T = \sqrt{2p_T E_T^{\text{miss}}(1 - \cos(\phi_l - \phi_{E_T^{\text{miss}}}))}$
 - required to be global muons
 - at least 10 valid tracker hits and 2 pixel hits
 - global track fit $\chi^2/\text{dof} < 10$
 - impact parameter to PV < 0.02 cm in transverse plane and < 0.5 cm in z
 - no opposite sign muon with $p_T > 25$ GeV, $|\eta| < 2.4$
- Electrons ('gsfElectrons')
 - $p_T > 35$ GeV
 - $|\eta| < 2.1$, excluding $1.44 < |\eta| < 1.57$
 - $M_T > 55$ GeV, $M_T = \sqrt{2p_T E_T^{\text{miss}}(1 - \cos(\phi_l - \phi_{E_T^{\text{miss}}}))}$
 - isolated with $I_{\text{rel}}^{\Delta R < 0.3} < 0.05$
 - no missing hits in the silicon tracker
 - no opposite sign electron with $p_T > 20$ GeV, $|\eta| < 2.5$

Jet ('ak5PFJets' + JEC): leading p_T with $p_T > 25$ GeV, $|\eta| < 2.5$ and charm 'tag'

- $D^+ \rightarrow K^- \pi^+ \pi^+$ candidate
- $D^{*+} \rightarrow D^0 \pi_s^+, D^0 \rightarrow K^- \pi^+$ candidate
- muon

- **Crucial to suppress background for D^+ , D^{*+}**
- Differs from the paper:
 - open data: all track combinations fitted using `AdaptiveVertexFitter` [thanks to Nazar Stefaniuk for sharing basic code!]
 - paper: 'exclusive' vertices (no shared tracks)
- Expecting larger selection efficiency, but possibly larger background in open data



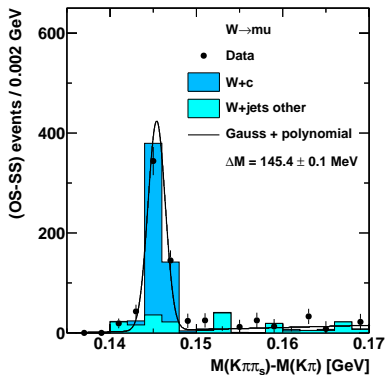
$$l_{proj} = \frac{(\vec{dl} \cdot \vec{p}_D)_{xy}}{|\vec{p}_D|_{xy}}, \quad \vec{p}_D = \vec{p}_{K^-} + \vec{p}_{\pi^+}$$

$$s = \frac{l_{proj}}{\Delta l_{proj}}$$

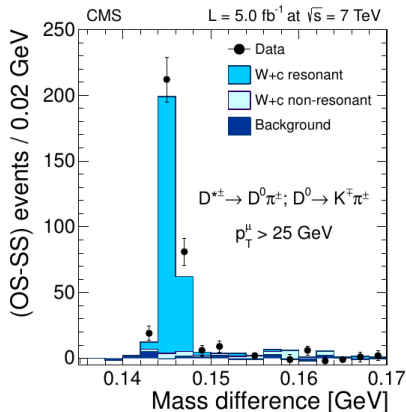
Require:

- $s > 3$
- $(dl)_{xy} < 2 \text{ cm}, (dl)_z < 2 \text{ cm}$

Open Data

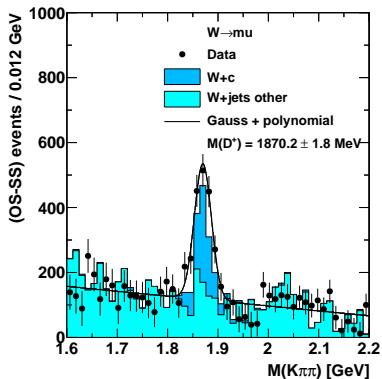


TOP-12-002

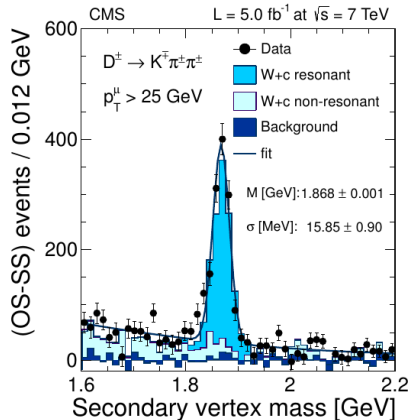


- Fitted to Gaus (signal) + 1st order polynomial (background)
- More signal events in open data
- Similar signal / background ratio

Open Data



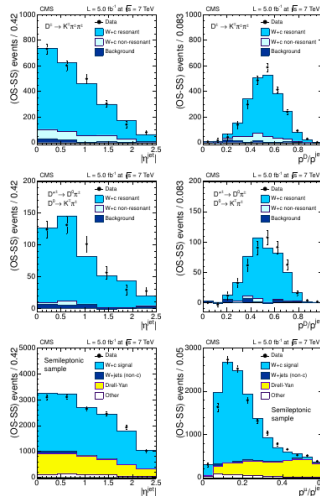
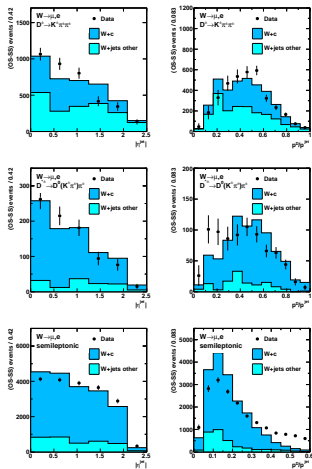
TOP-12-002



- Fitted to Gaus (signal) + 1st order polynomial (background)
- More signal events in open data
- Worse signal / background ratio
- *Drawback in open data vertexing: usage of Adaptive Vertex Fitter with track weighting*

Open Data

TOP-12-002



- Shapes very similar for D mesons
- $MC < data$ for D^+ , μ : missing background samples
- Prevents from measuring cross section in semileptonic channel

Cross section measured at parton level:

$$p_T^c > 25 \text{ GeV}, |\eta^c| < 2.5, p_T^\mu > 25 \text{ GeV}, |\eta^\mu| < 2.1|:$$

$$\sigma = \frac{N_{Sig}}{ALB}, E = \frac{N_{MC reco}}{N_{MC gen}}$$

$$L = 2.5 \text{ fb}^{-1}$$

$$D^*: B = f(c \rightarrow D^* \rightarrow D^0(K\pi)\pi) = 0.622\%$$

$$D^+: B = f(c \rightarrow D^+ \rightarrow K\pi)\pi) = 2.08\%$$

N_{Sig} extracted from fit of invariant mass spectrum (differs from the paper)

Open data

$$W \rightarrow \mu\nu, p_T^\mu > 25 \text{ GeV}$$

$$D^+: 129.7 \pm 12.4 \text{ (stat) pb}$$

$$D^*: 132.9 \pm 13.7 \text{ (stat) pb}$$

$$W \rightarrow e\nu, p_T^e > 35 \text{ GeV}$$

$$D^+: 46.9 \pm 9.8 \text{ (stat) pb}$$

$$D^*: 58.5 \pm 11.8 \text{ (stat) pb}$$

TOP-12-002

$$W \rightarrow \mu\nu, p_T^\mu > 25 \text{ GeV}$$

$$D^+: 103.6 \pm 7.8 \text{ (stat) + 8.1 (syst) pb}$$

$$D^*: 116.9 \pm 8.7 \text{ (stat) + 10.0 (syst) pb}$$

$$W \rightarrow e\nu, p_T^e > 35 \text{ GeV}$$

$$D^+: 83.5 \pm 6.3 \text{ (stat) + 7.1 (syst) pb}$$

$$D^*: 83.3 \pm 10.4 \text{ (stat) + 8.5 (syst) pb}$$

\Rightarrow reasonable consistency with the paper