Recent top quark results from ATLAS

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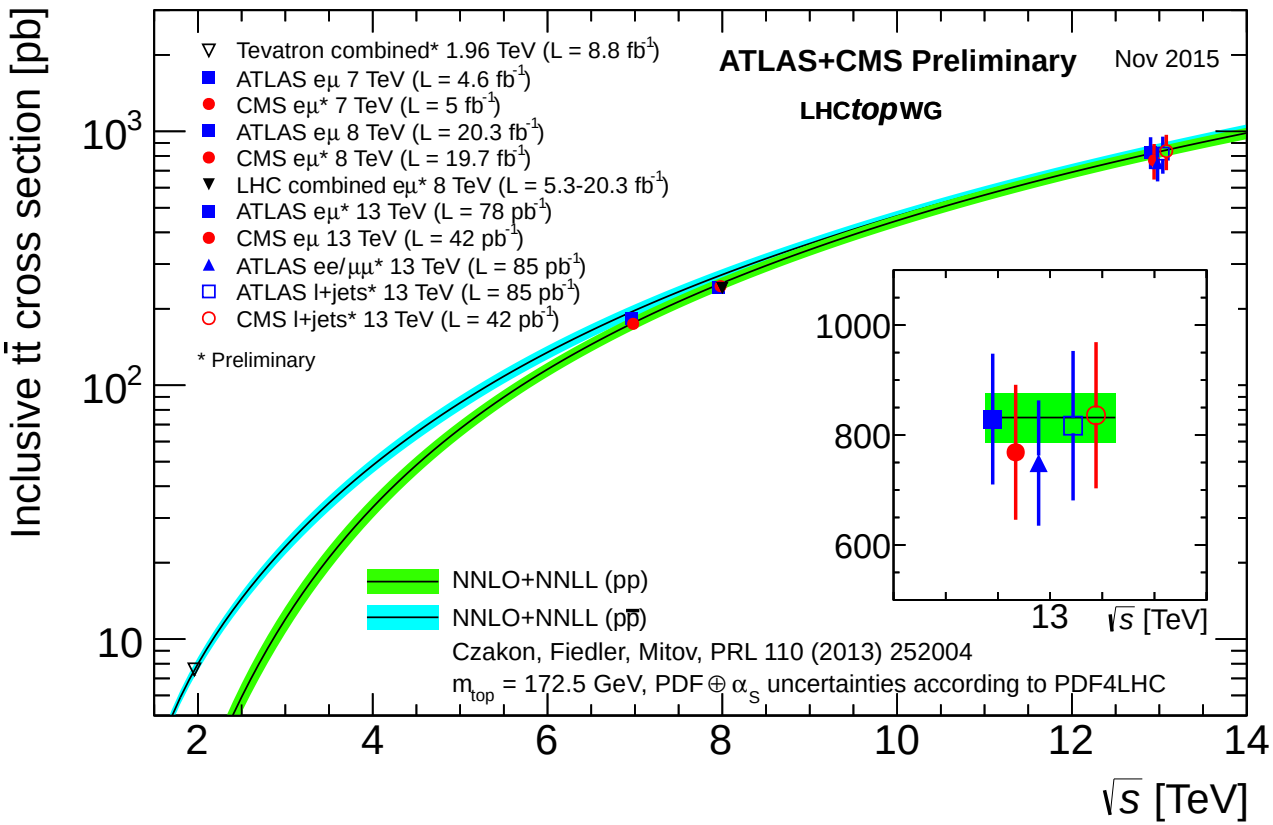
The top quark

Top Properties
$m_t = 173.3 \pm 0.7$ GeV
$\Gamma = 2.0^{+0.7}_{-0.6}$ GeV
$\tau \approx 3.3 \times 10^{-25}$ s

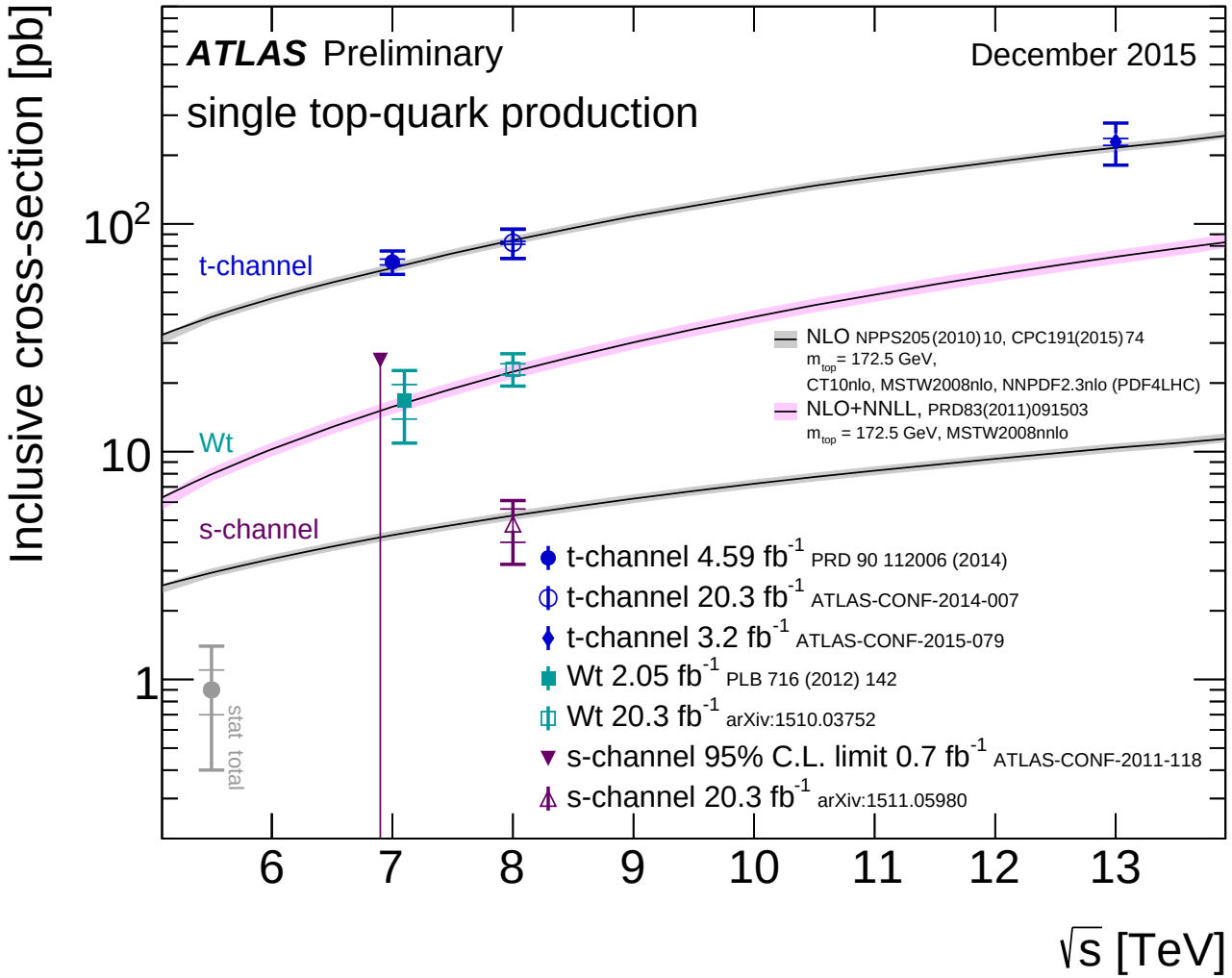
- The top quark decays before hadronization can significantly modify its quantum state.
- The top's production vertex can be probed by looking at its decays.

Top quark production at the LHC

[pb]	7 TeV	8 TeV	13 TeV
$t\bar{t}$ (all channels)	177 ± 9	253 ± 11	832^{+40}_{-46}
single top (t-chanel)	65 ± 2	88 ± 3	217 ± 6

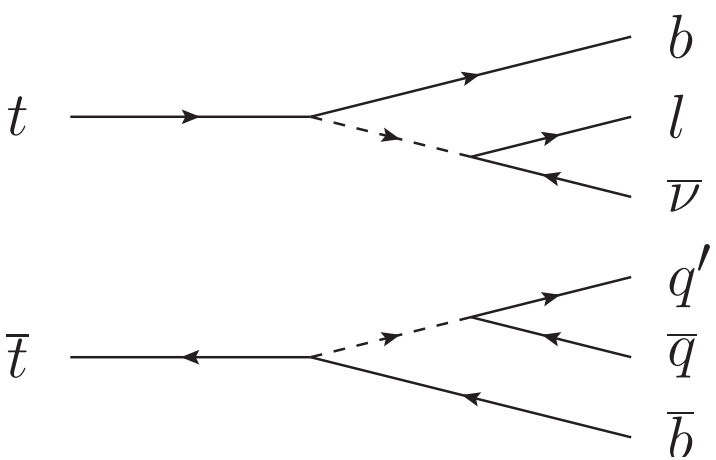


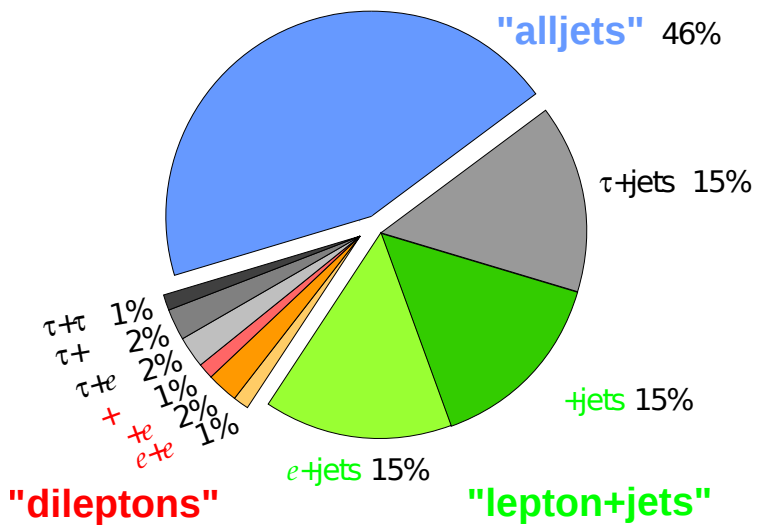
Single top production cross section



Top quark decay channels

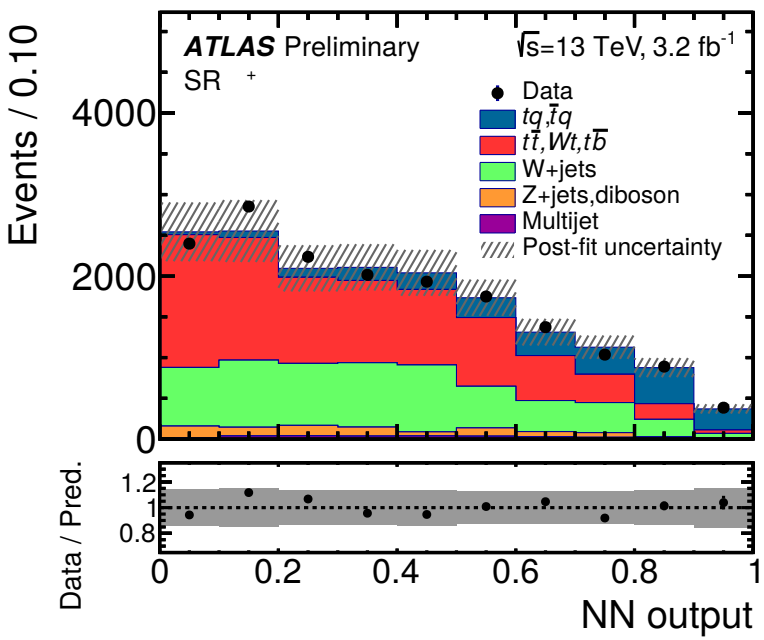
- Leptonic decay: $t \to b + W \to b + l + \nu$
- Hadronic decay: $t \to b + W \to b + q + q'$





Single top cross section at 13 TeV

- Measuring $p\bar{p} \to t + \text{jets} \to b + \mu + \nu_\mu + \text{jets}$.
- Process is proportional to $|f_{LV} \cdot V_{tb}|^2$.
- Background yields estimated from theory and from a fit to orthogonal data.
- Neural network discriminant used to separate background from signal.



Results:

$$\sigma(tq) = 133 \pm 25\,\text{pb}$$
$$\sigma(\bar{t}q) = 96 \pm 45\,\text{pb}$$
$$|f_{LV} \cdot V_{tb}| = 1.03 \pm 0.11$$

Theory (NLO):

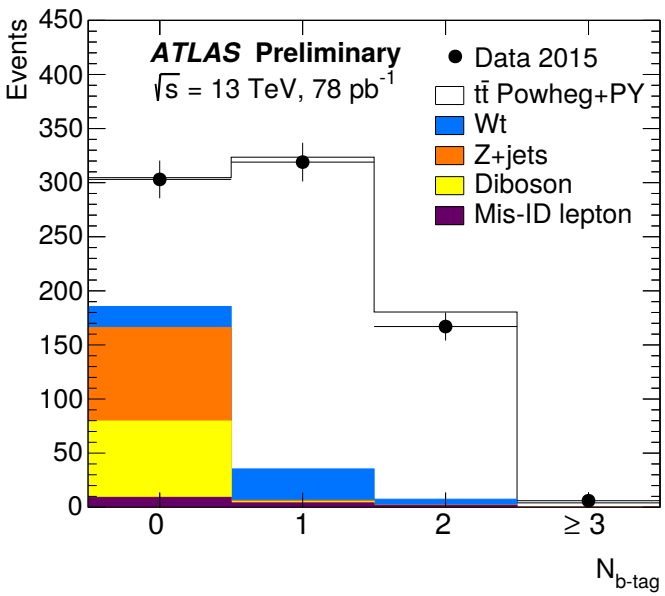
$$\sigma(tq) = 136^{+5.4}_{-4.6}\,\text{pb}$$
$$\sigma(\bar{t}q) = 81^{+4.1}_{-3.6}\,\text{pb}$$

ATLAS-CONF-2015-079

$t\bar{t}$ cross section from $e\mu$ events at 13 TeV

- Measuring $p\bar{p} \to t\bar{t} + \text{jets} \to e^{\pm}\mu^{\mp}\nu_e\nu_\mu + \text{jets}$.
- Backgrounds are very small.
- Simultaneously measure the $\sigma_{t\bar{t}}$ and the efficiency to reconstruct and b-tag a jet (ϵ_b).
  - Events in 1 and 2 b-tag multiplicity bins (N_1 and N_2) are correlated.
  - Exploit this correlation to constrain b-tagging efficiency.

$$\sigma_{t\bar{t}} = 825 \pm 49\ (\text{stat}) \pm 60\ (\text{syst}) \pm 83\ (\text{lumi})\ \text{pb}$$



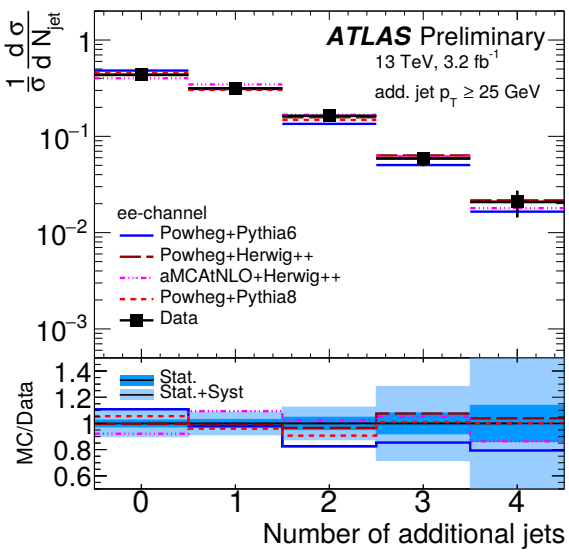
$$N_1 = L\sigma_{t\bar{t}}\epsilon_{e\mu}2\epsilon_b\left(1 - C_b\epsilon_b\right) + N_1^{\text{bkg}}$$

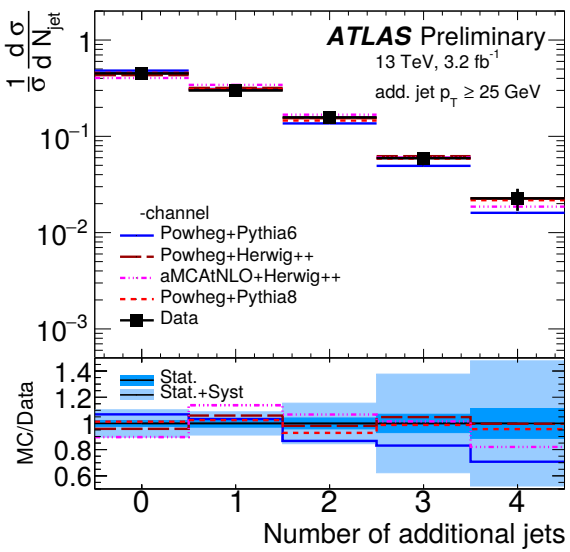
$$N_2 = L\sigma_{t\bar{t}}\epsilon_{e\mu}C_b\epsilon_b^2 + N_2^{\text{bkg}}$$

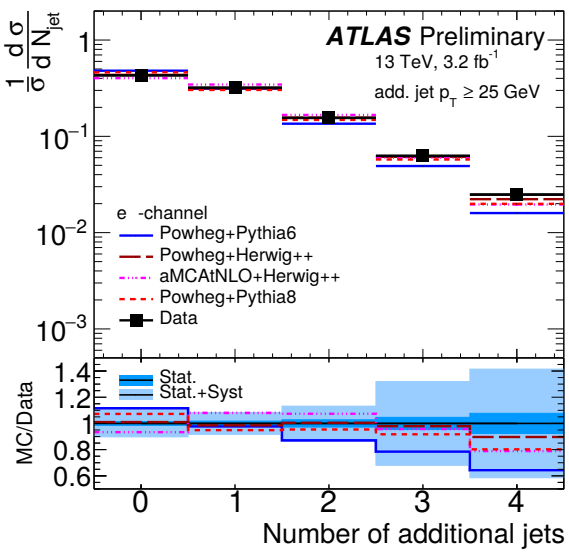
ATLAS-CONF-2015-033

Jets produced with $t\bar{t}$ at 13 TeV

- Measuring $t\bar{t}$ pairs decaying in the dileptonic channel as a function of additional jets (not including the b-jets).
- Rates depend on higher order QCD modelling.
- Distributions are an important background to Higgs and new physics measurements.
- Distributions are unfolded to the fiducial detector acceptance.



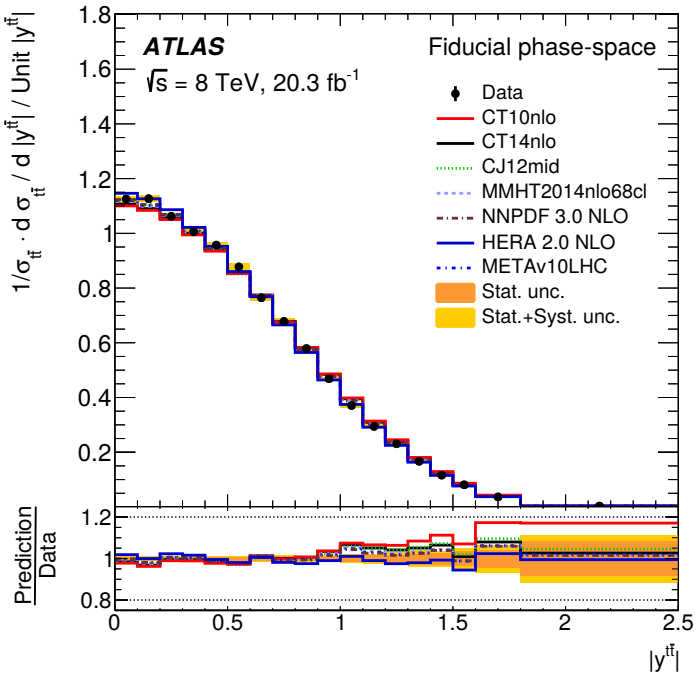


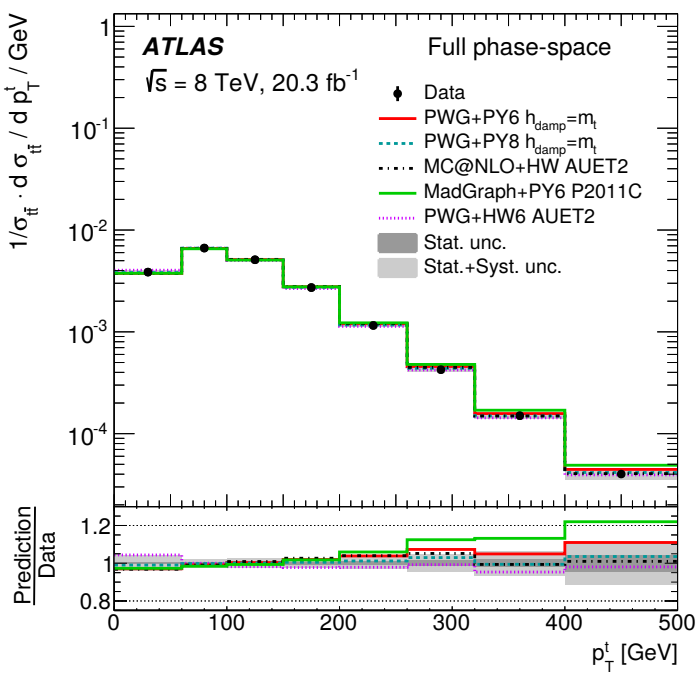


ATLAS-CONF-2015-065

$t\bar{t}$ differential cross section

- $t\bar{t}$ is an important background for many searches.
- Important to correctly describe $t\bar{t}$ kinematic distributions.
- Measurements extrapolated to the fiducial and partonic levels.
- High p_T distributions constrains NNLO predictions, angular distributions constrain PDFs.





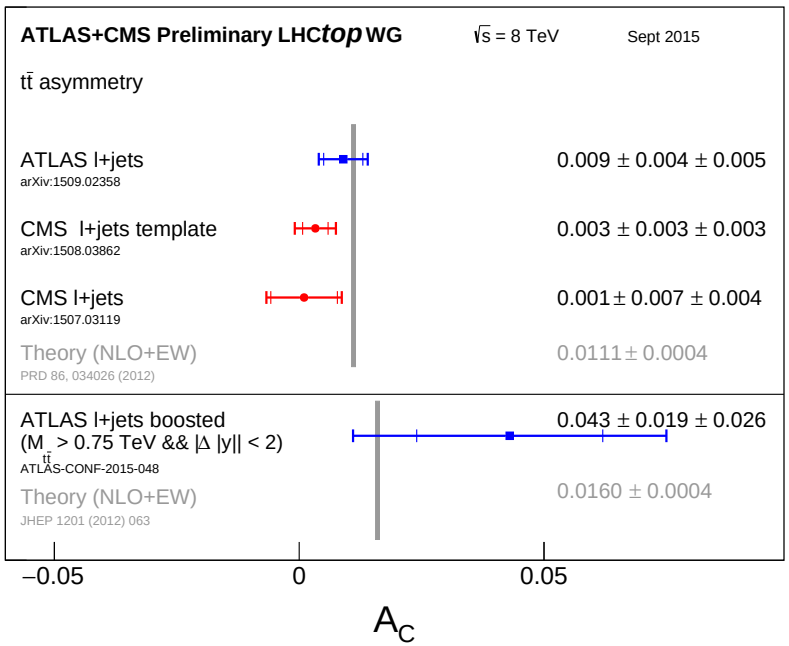
arXiv 1511.04716

Charge asymmetry in highly boosted $t\bar{t}$ pairs

$$A_C = \frac{N(\Delta|y| > 0) - N(\Delta|y| < 0)}{N(\Delta|y| > 0) + N(\Delta|y| < 0)}$$

$$\Delta|y| = |y_t| - |y_{\bar{t}}|$$

- Related to the forward-backward asymmetry observed at the Tevatron.
- High $m_{t\bar{t}}$ events have boosted hadronic decays merging into fat jets.
- High $m_{t\bar{t}}$ not included in standard analysis selection.

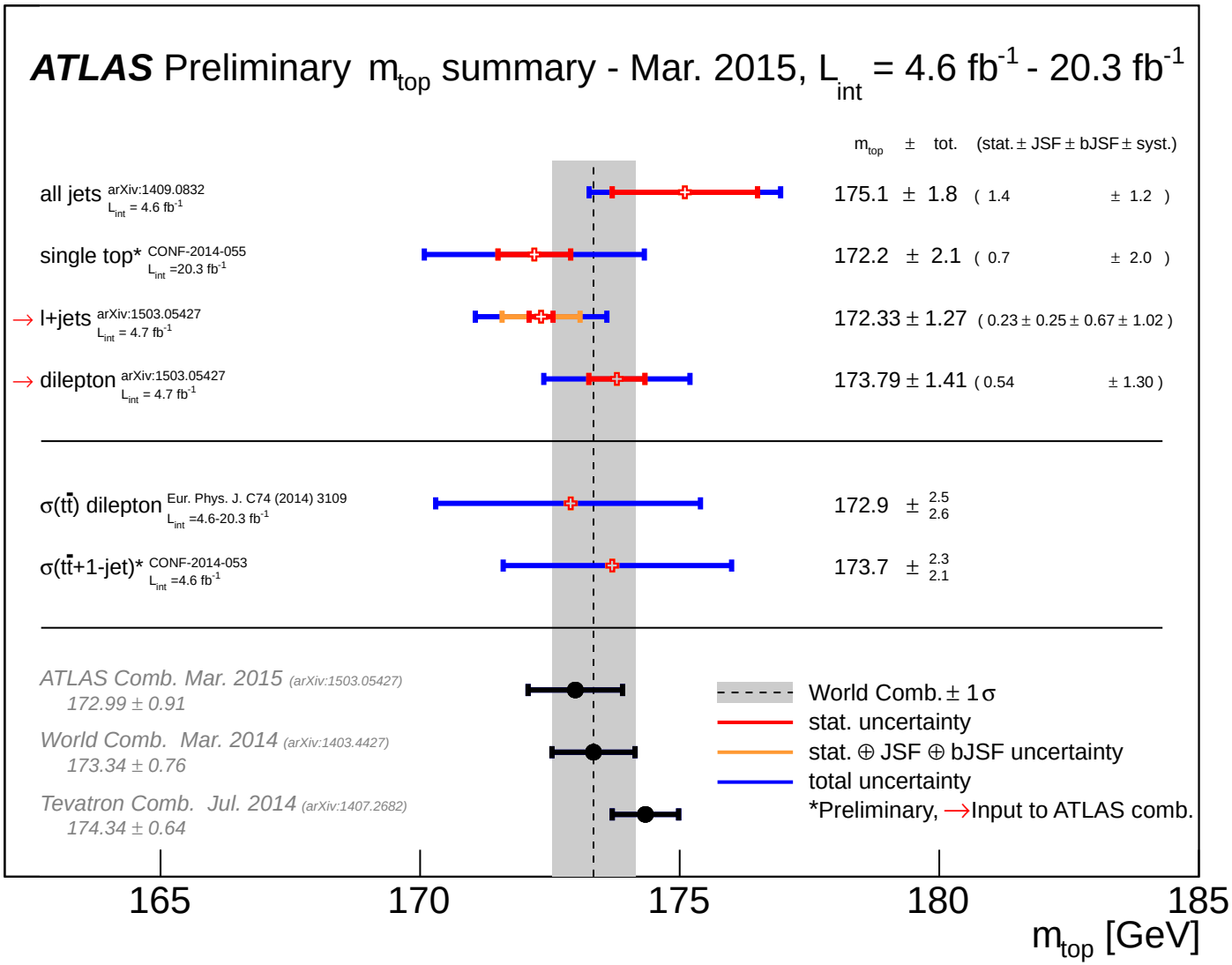


arXiv 1512.06092

Summary

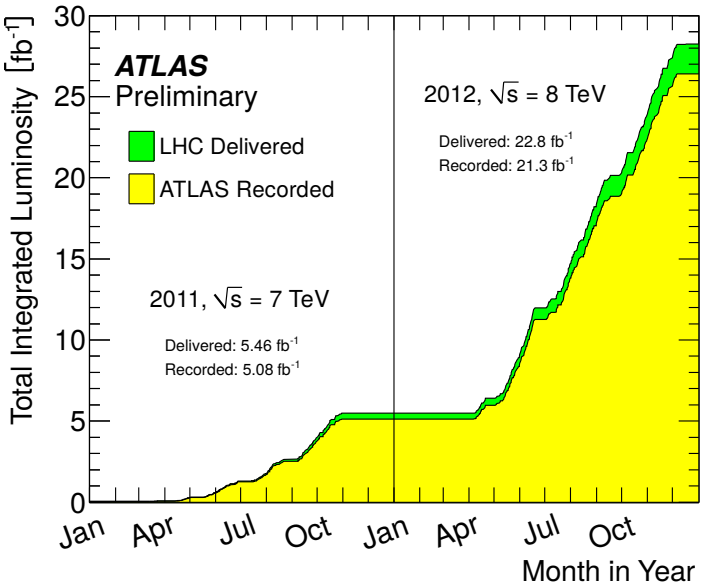
- First results at $\sqrt{s} = 13\,\mathrm{TeV}$ in good agreement with predictions.
- Jet multiplicity studies are testing our ability to describe higher order QCD processes.
- Measurements of top quark properties are constraining new physics contributions.
- Using fat jets in boosted topologies to explore higher energy events.
- Ongoing studies to be released soon to further increase our knowledge of the top sector.
- `https://twiki.cern.ch/twiki/bin/view/AtlasPublic/TopPublicResults`

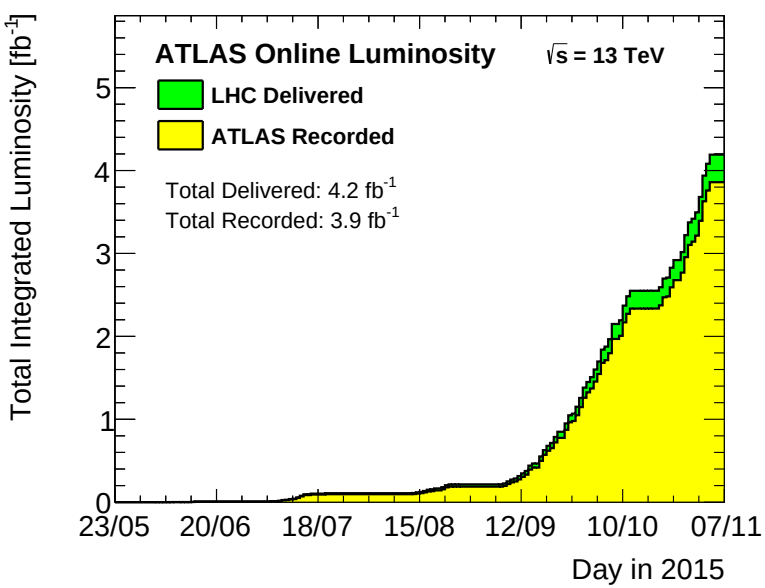
Top mass


ATLAS Preliminary m_top summary - Mar. 2015, L_int = 4.6 fb-1 - 20.3 fb-1
m_top ± tot. (stat. ± JSF ± bJSF ± syst.)
all jets arXiv:1409.0832 L_int = 4.6 fb-1
175.1 ± 1.8 (1.4 ± 1.2)
single top* CONF-2014-055 L_int =20.3 fb-1
172.2 ± 2.1 (0.7 ± 2.0)
→ l+jets arXiv:1503.05427 L_int = 4.7 fb-1
172.33 ± 1.27 (0.23 ± 0.25 ± 0.67 ± 1.02)
→ dilepton arXiv:1503.05427 L_int = 4.7 fb-1
173.79 ± 1.41 (0.54 ± 1.30)
σ(tt̄) dilepton Eur. Phys. J. C74 (2014) 3109 L_int =4.6-20.3 fb-1
172.9 ± 2.5 2.6
σ(tt̄+1-jet)* CONF-2014-053 L_int =4.6 fb-1
173.7 ± 2.3 2.1
ATLAS Comb. Mar. 2015 (arXiv:1503.05427)
172.99 ± 0.91
World Comb. Mar. 2014 (arXiv:1403.4427)
173.34 ± 0.76
Tevatron Comb. Jul. 2014 (arXiv:1407.2682)
174.34 ± 0.64
World Comb. ± 1σ
stat. uncertainty
stat. ⊕ JSF ⊕ bJSF uncertainty
total uncertainty
*Preliminary, →Input to ATLAS comb.
165
170
175
180
185
m_top [GeV]

LHC luminosity

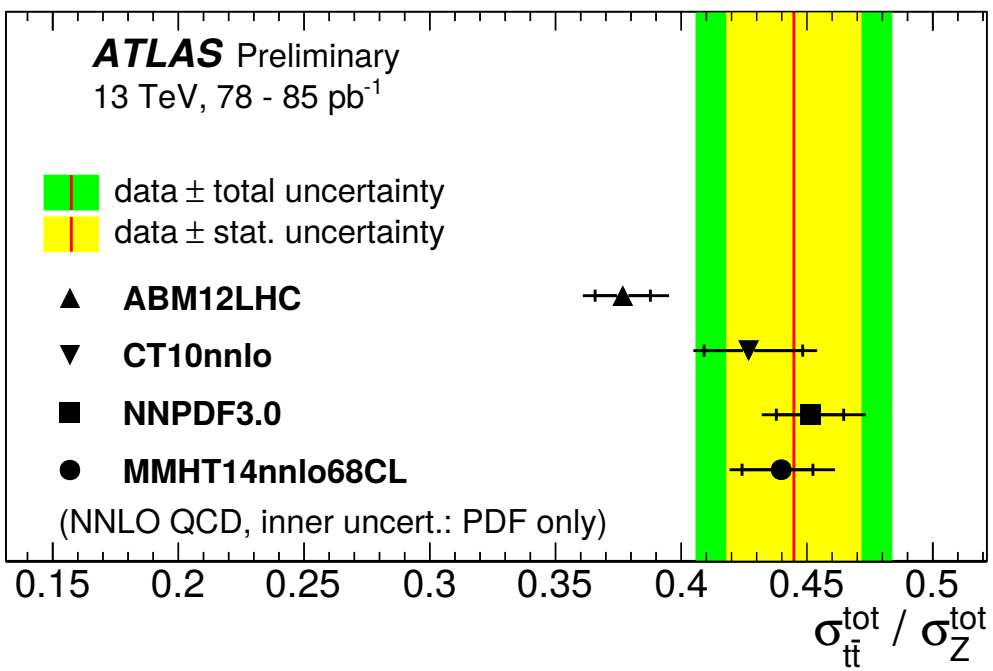
- Presenting results at $\sqrt{s} = 8\,\mathrm{TeV}$ from 2012 and at $\sqrt{s} = 13\,\mathrm{TeV}$ from 2015.
- 2015 was a commissioning year: collected $3.9\,\mathrm{fb}^{-1}$.
- Still produced around 60% as many $t\bar{t}$ pairs at $\sqrt{s} = 13\,\mathrm{TeV}$ than at $\sqrt{s} = 8\,\mathrm{TeV}$.





$t\bar{t}$ inclusive cross section at 13 TeV

- Measured in lepton+jets, and opposite-sign same-flavour dileptonic channels (e^+e^- or $\mu^+\mu^-$).
- Calculated the ratio between $t\bar{t}$ and Z-boson production.
  - Expect cancellation in common sources of systematic uncertainty.
  - Probes the PDF composition of sea quarks and gluons.



Results (dileptonic, lepton+jets):

$$\sigma_{t\bar{t}} = 750 \pm 120\,\mathrm{pb}$$

$$\sigma_{t\bar{t}} = 820 \pm 140\,\mathrm{pb}$$

$$R_{t\bar{t}/Z} = 0.445 \pm 0.039$$

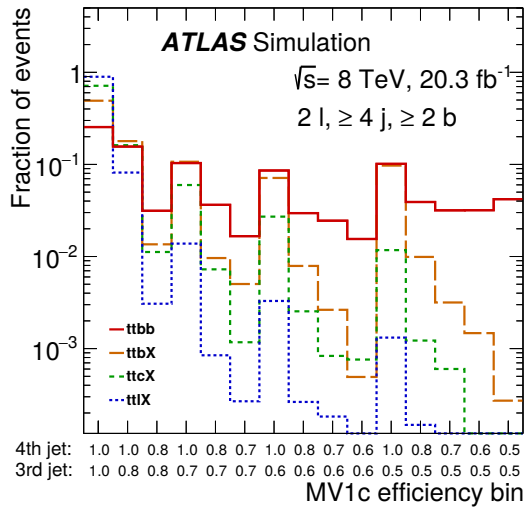
Theory (NNLO+NNLL):

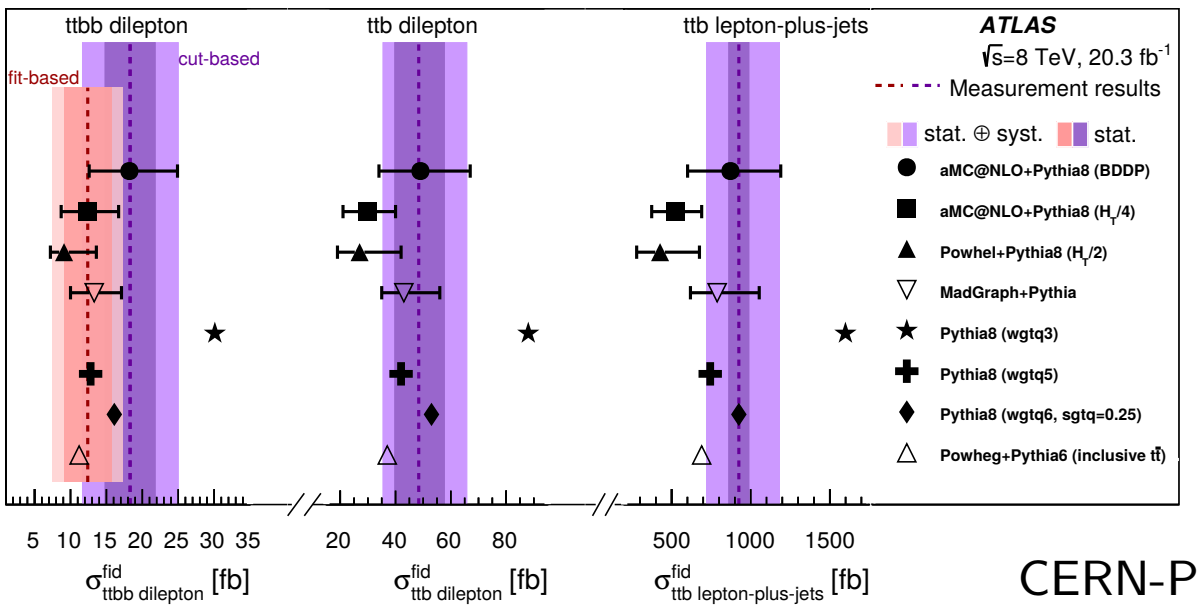
$$\sigma_{t\bar{t}} = 832^{+40}_{-46}\,\mathrm{pb}$$

ATLAS-CONF-2015-049

Fiducial $t\bar{t}$ cross section with additional b-jets

- Measuring events with additional b-jets.
- Background to Higgs production.
- Results given for stable particles passing the detector acceptance.
- Events originating from different processes are b-tagged differently.

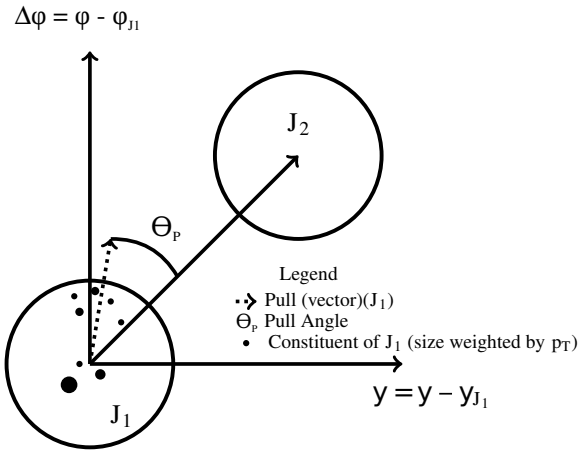


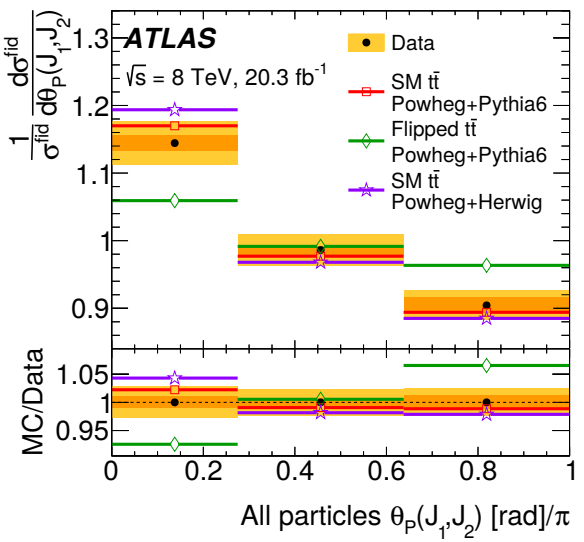


CERN-PH-EP-2015-200

Measurement of colour flow with jet pulls

- Coloured objects share gluons, which can be modelled by *colour-flow*.
- The exchange of gluons between two objects is correlated to the *jet pull* vector.
- Look at hadronically decaying W bosons originating from a top decays.





CERN-PH-EP-2015-128