Measurement of inclusive jets and dijets with ATLAS

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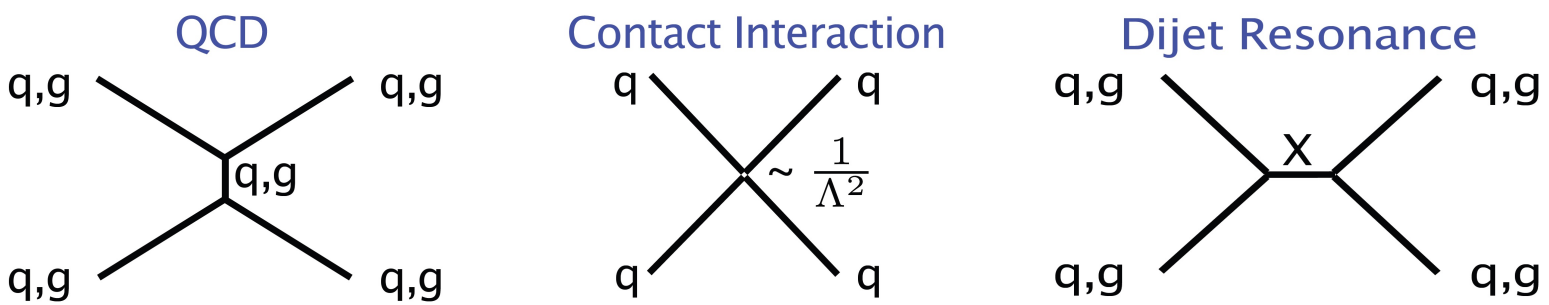
Motivation

- dominant high p_T processes at hadron colliders
- testing of QCD
- events with the highest transfer momentum $\Delta x \Delta q \sim \hbar$ (1TeV$\approx 10^{-19}\,\mathrm{m}$)
- searching for quark compositeness, extra dimensions, ...
- resonances



Event and jet selection

Event selection:

- GRL
- Event Cleaning (data only):
  - Corrupted data or incomplete data are rejected by LarError, TileError, CoreFlag and SCTFlag.
- 1 PV with at least 2 tracks.

Jet collection:

- anti-k_T , EMTopo, R = 0.4 jets

Jet calibration:

- appropriate JetEtMiss recommendations

Jet cleaning:

- Cleaning cut: TightBad for leading jets, LooseBad for the rest.
- TightBad was especially designed to remove non-collision background:
  - https://cds.cern.ch/record/2016323

Event and jet selection

Inclusive jets selection:

- $p_T > 100$ GeV
- $|y| < 3.0$

Dijets selection:

- Second leading jet $p_{T2} > 75$ GeV
- $H_T = p_{T1} + p_{T2} > 200$ GeV
- $|y| < 3.0$

Definition of measured variables

The **inclusive-jet** cross-section is measured as a function of the jet p_T and absolute jet rapidity $|y|$.
The full rapidity range is divided in six equidistant jet rapidity bins:

$$|y| < 0.5, \quad 0.5 \leq |y| < 1.0, \quad 1.0 \leq |y| < 1.5,$$
$$1.5 \leq |y| < 2.0, \quad 2.0 \leq |y| < 2.5, \quad 2.5 \leq |y| < 3.0.$$

The **dijet** cross-section is measured as a function of the dijet invariant mass

$$m_{12} = \sqrt{(P_1 + P_2)^2}$$

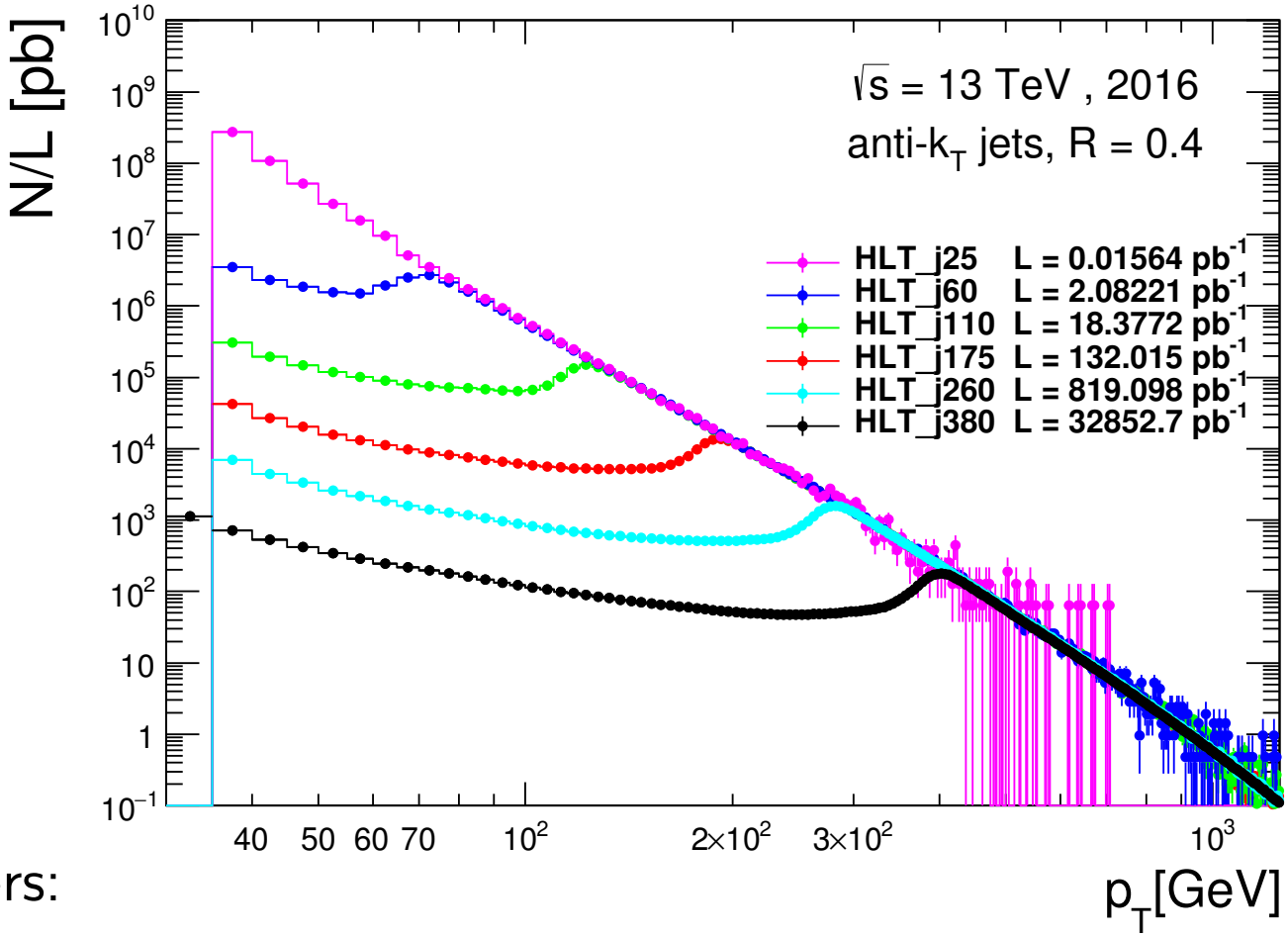
and the half absolute jet rapidity separation

$$y^* = \tfrac{1}{2} |y_1 - y_2| ,$$

The full y^* range is split into 6 equidistant bins:

$$y^* < 0.5, \quad 0.5 \leq y^* < 1.0, \quad 1.0 \leq y^* < 1.5,$$
$$1.5 \leq y^* < 2.0, \quad 2.0 \leq y^* < 2.5, \quad 2.5 \leq y^* < 3.0.$$

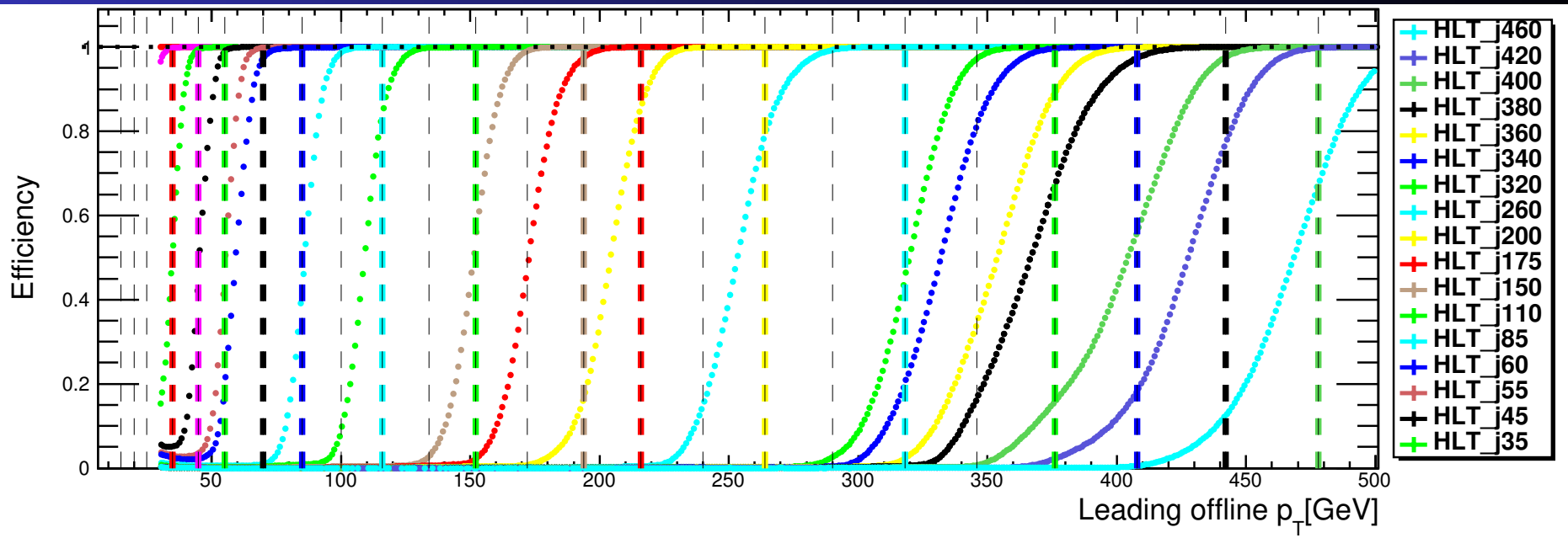
pT spectra of triggers with luminosity info



Triggers:

- L1 - hardware-based, E_T cut on tiles 8×8
- HLT - software-based, standard anti-k_T jet algorithm

Trigger Emulation



Trigger	p_T range [GeV]
HLT_j15	35-45
HLT_j25	45-55
HLT_j35	55-70
HLT_j45	70-85
HLT_j60	85-116
HLT_j85	116-152
HLT_j110	152-194
HLT_j150	194-216
HLT_j175	216-318
HLT_j260	318-376
HLT_j320	376-408
HLT_j340	408-442
HLT_j380	442-478
HLT_j400	478-10000

$$\varepsilon(pT) = \frac{\text{events passing the emulation}}{\text{events having at least one HLT jet reconstructed}}$$

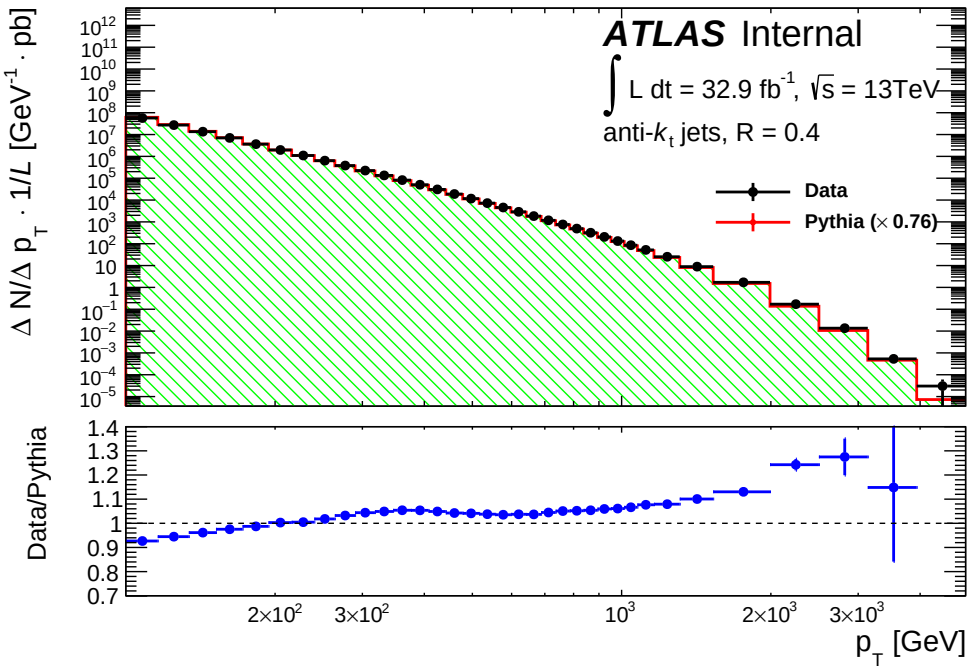
Trigger strategy

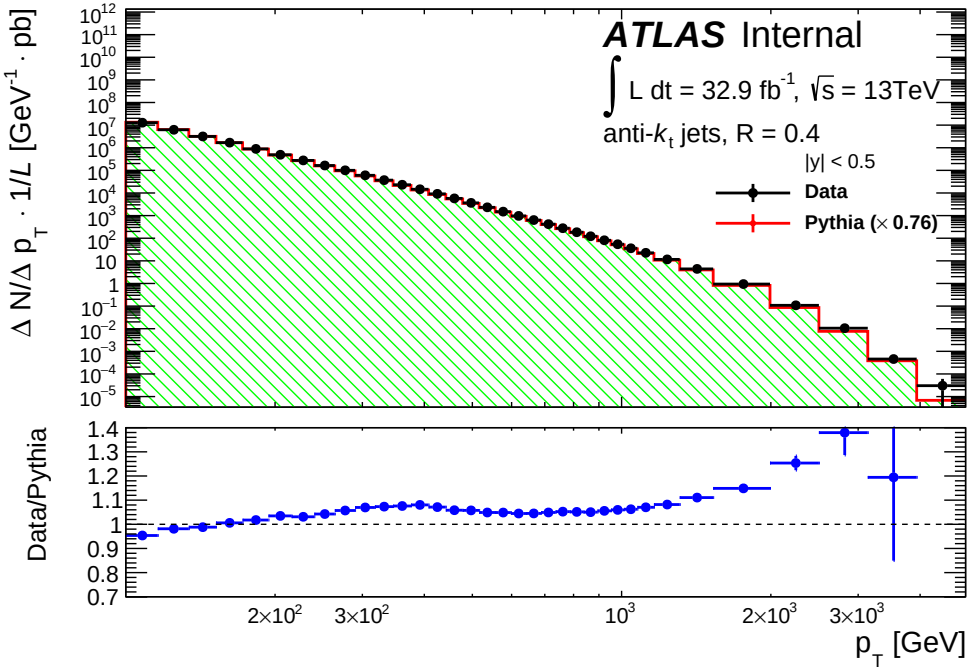
- using the trigger depending on the jet p_T where the jet falls
- each jet contributes to the inclusive-jet cross-section with different weight
- for example, jet falling in 442-478:

$$weight = \frac{\text{TotalLuminosity}}{\text{Luminosity}_{\text{HLT\_j380}}}$$

Inclusive jets

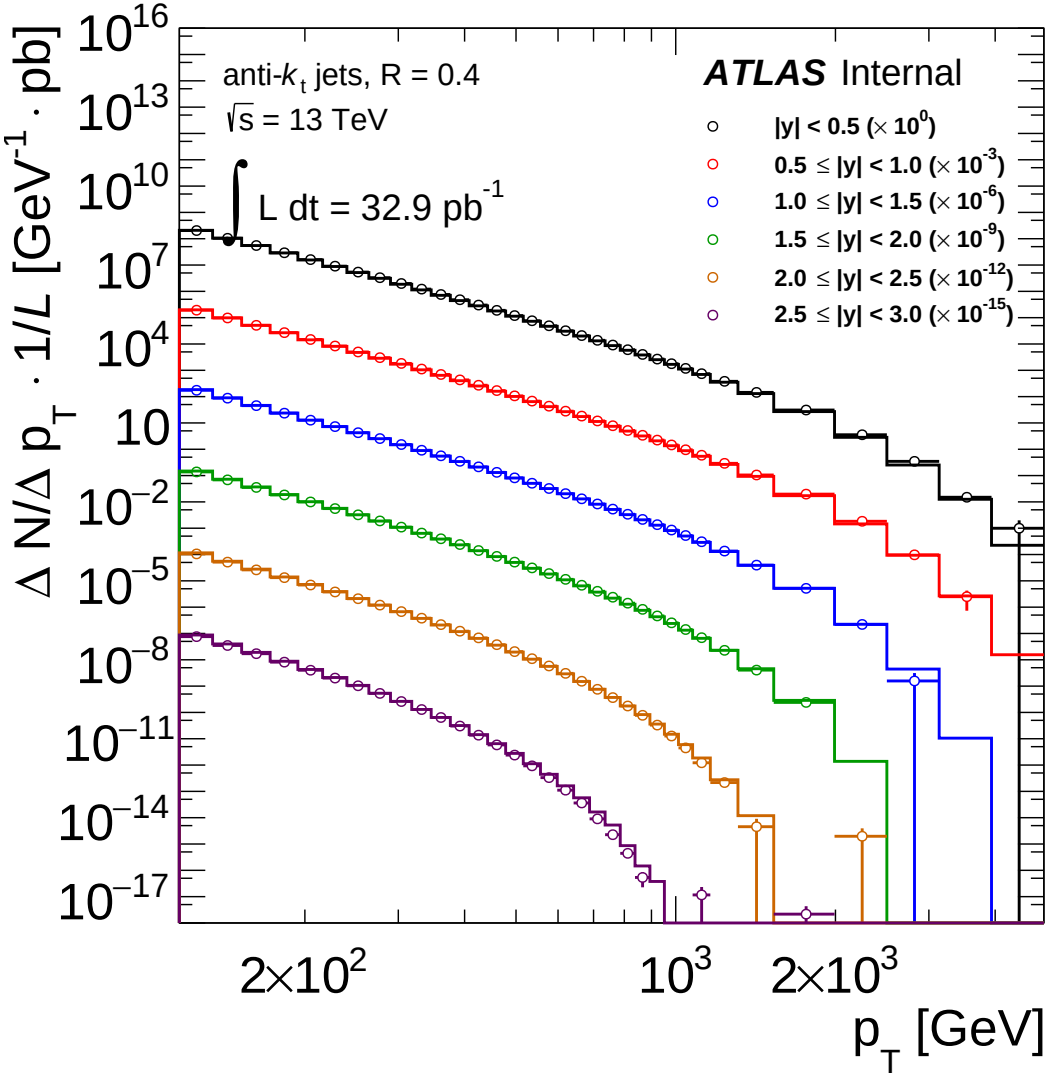
inclusive jet p_T





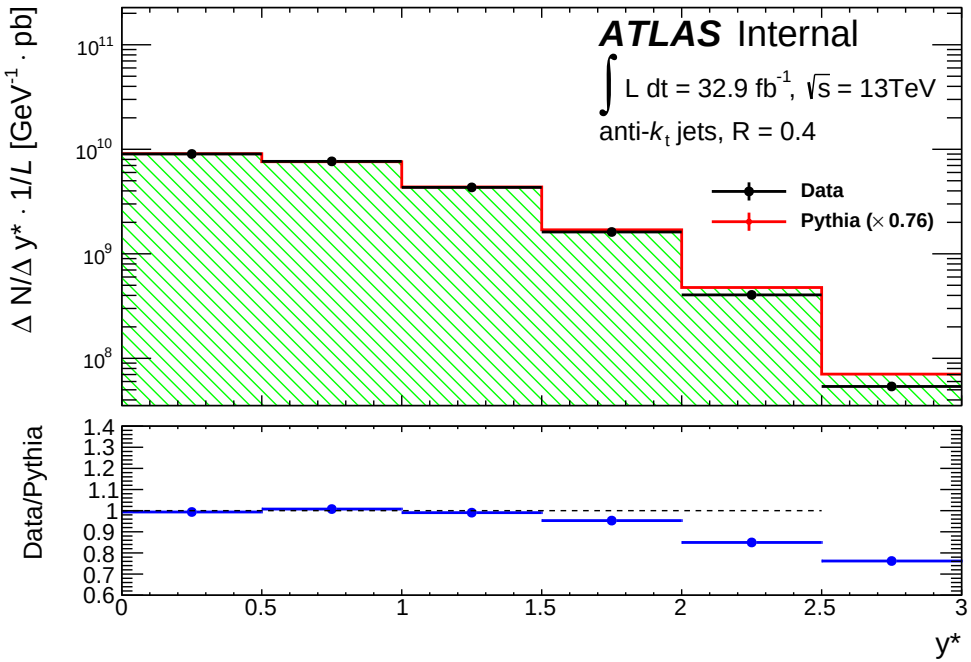
- uncorrected jet p_T spectra

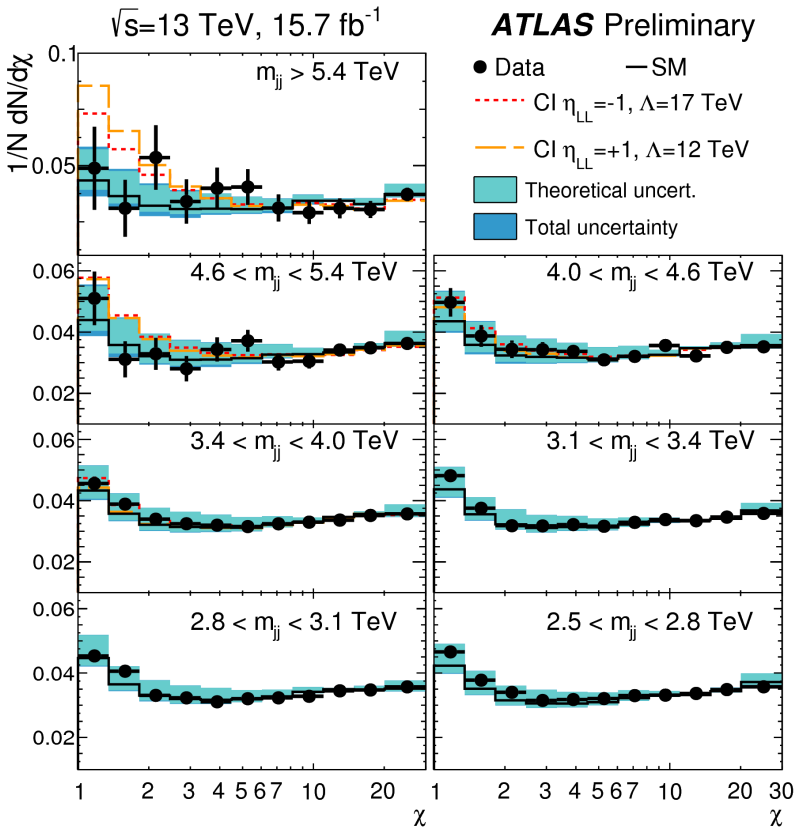
inclusive jet p_T distribution for different y bins



Dijets

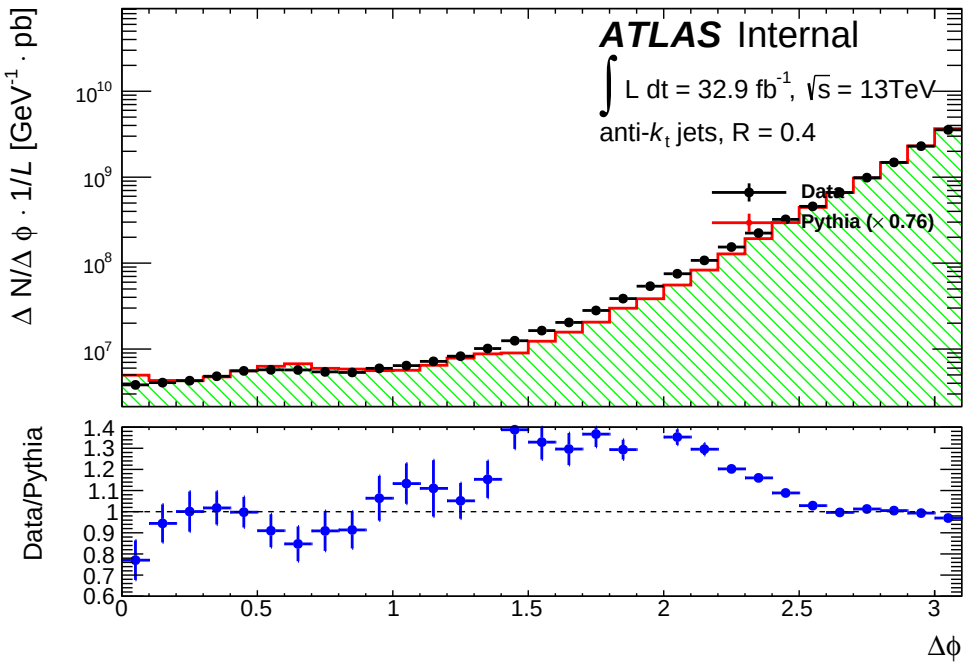
distributions of $y^* = \frac{|y_1 - y_2|}{2}$

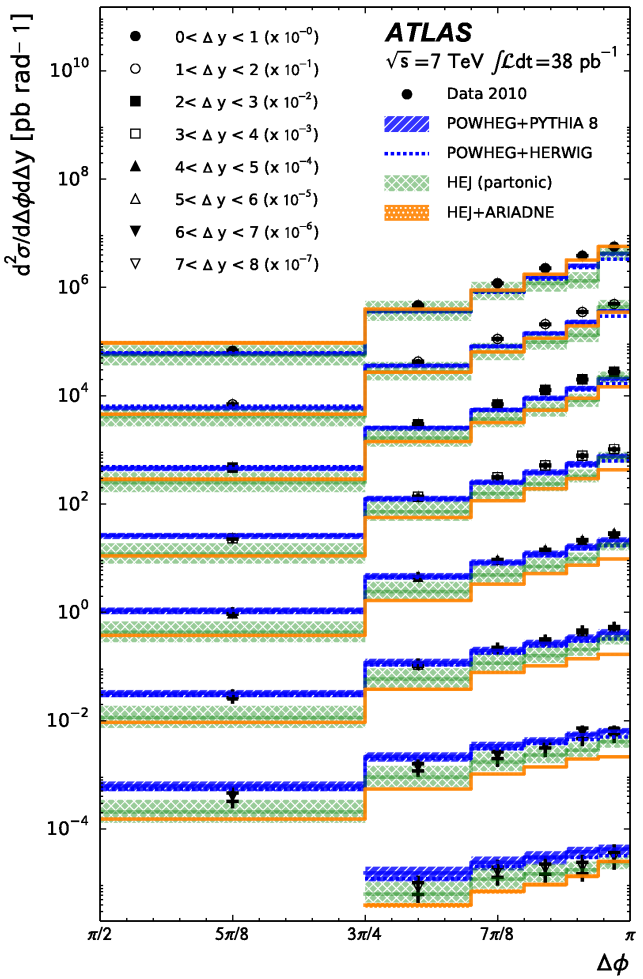




- y^* is basically angular distribution in parton-parton CMS and is sensitive to new physics $\Longrightarrow$ searching for quark compositeness
- $\chi = e^{2y*} = e^{|y_1 - y_2|}$

distributions of $\Delta\phi = \phi_1 - \phi_2$

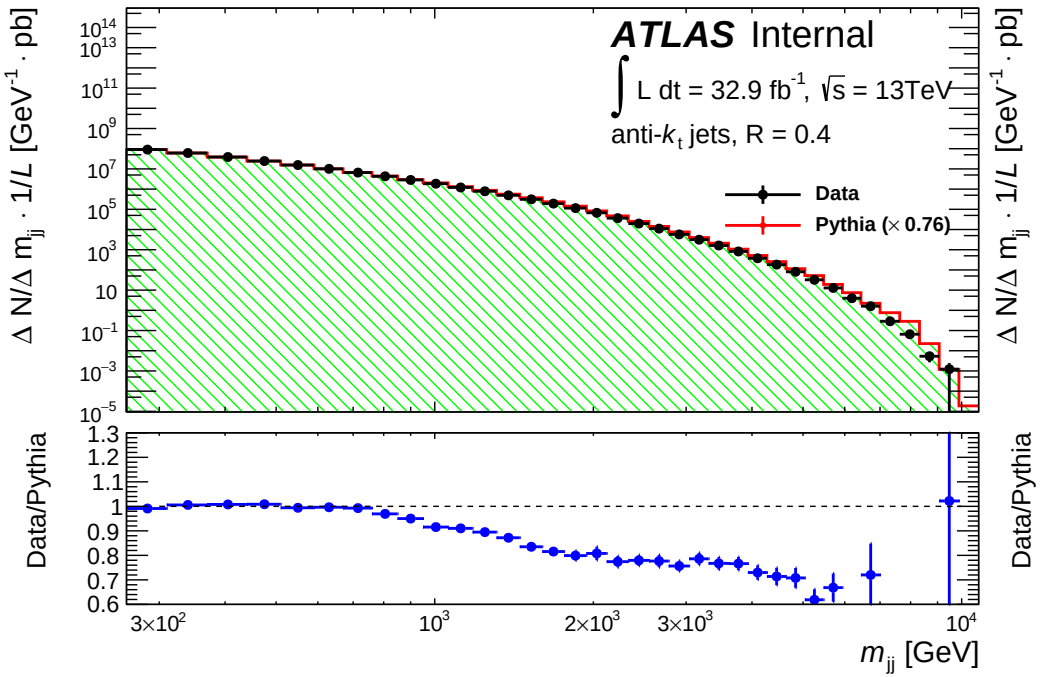


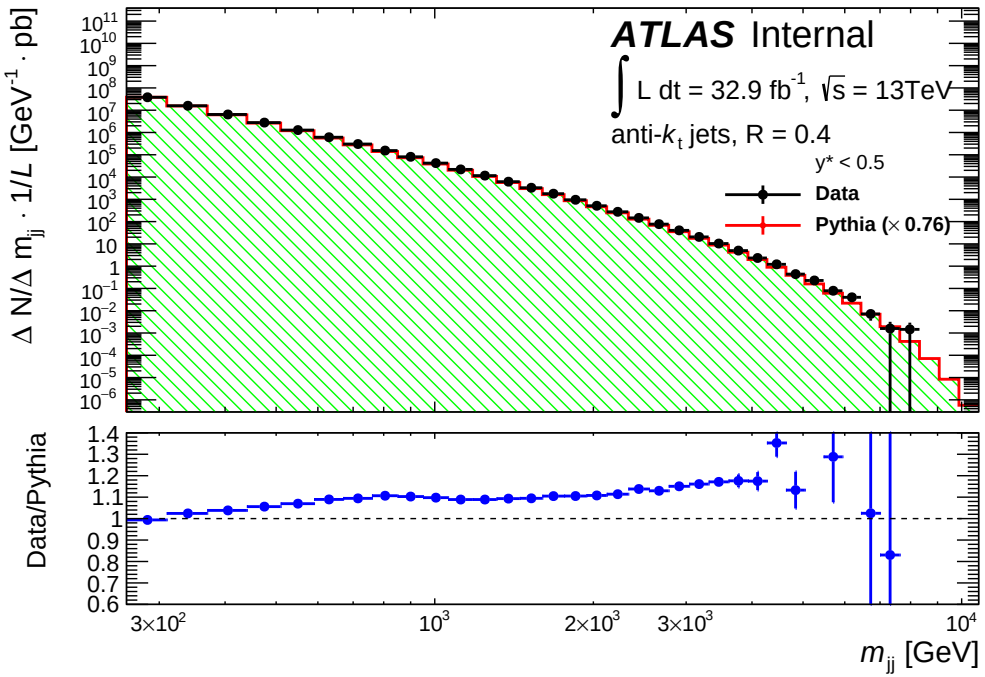


- jets in LO are precisely back-to-back $\Longrightarrow$ $\Delta\phi$ depends e.g. on initial state radiation

Dijets

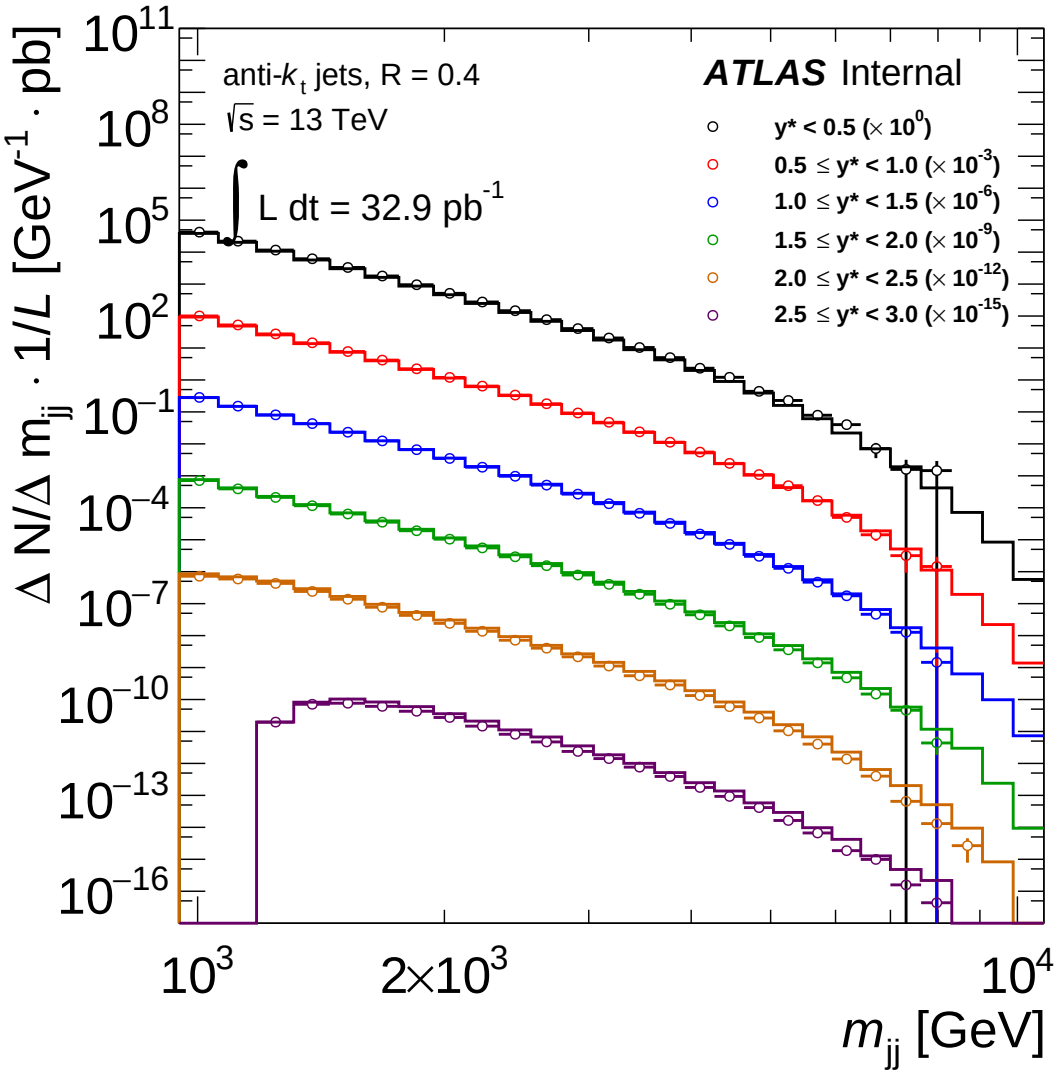
dijet invariant mass m_{jj}



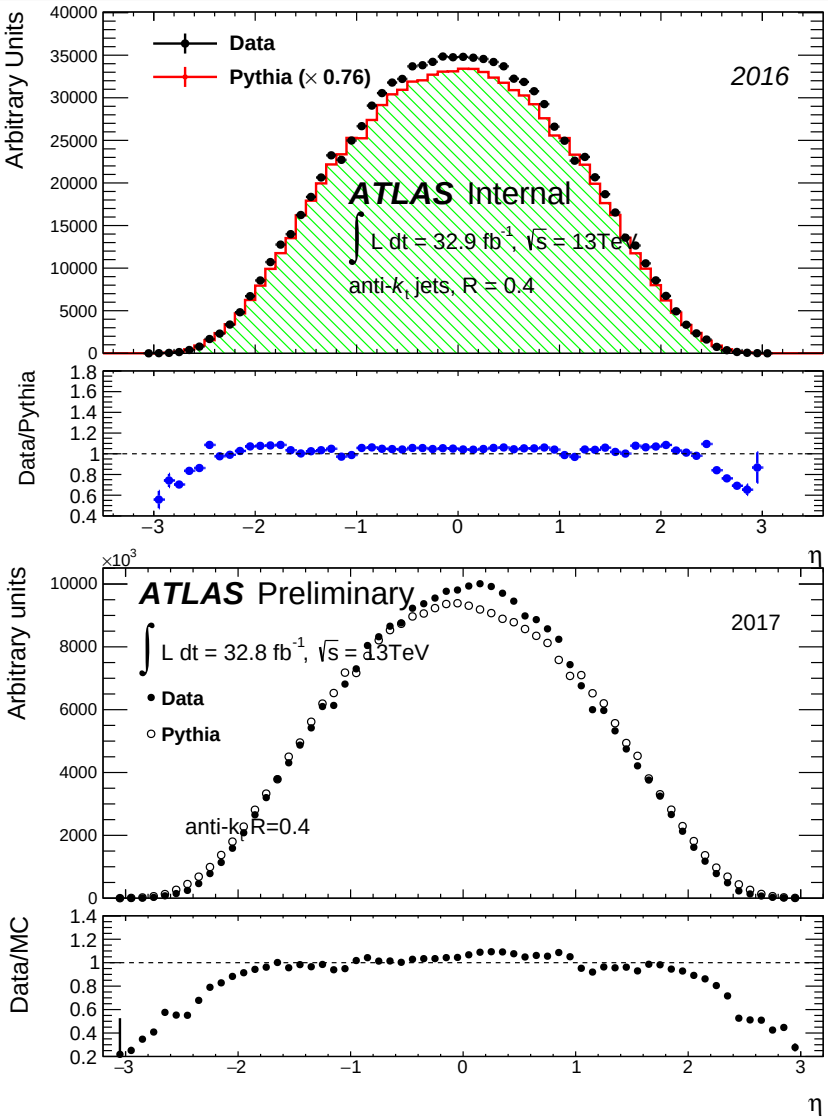


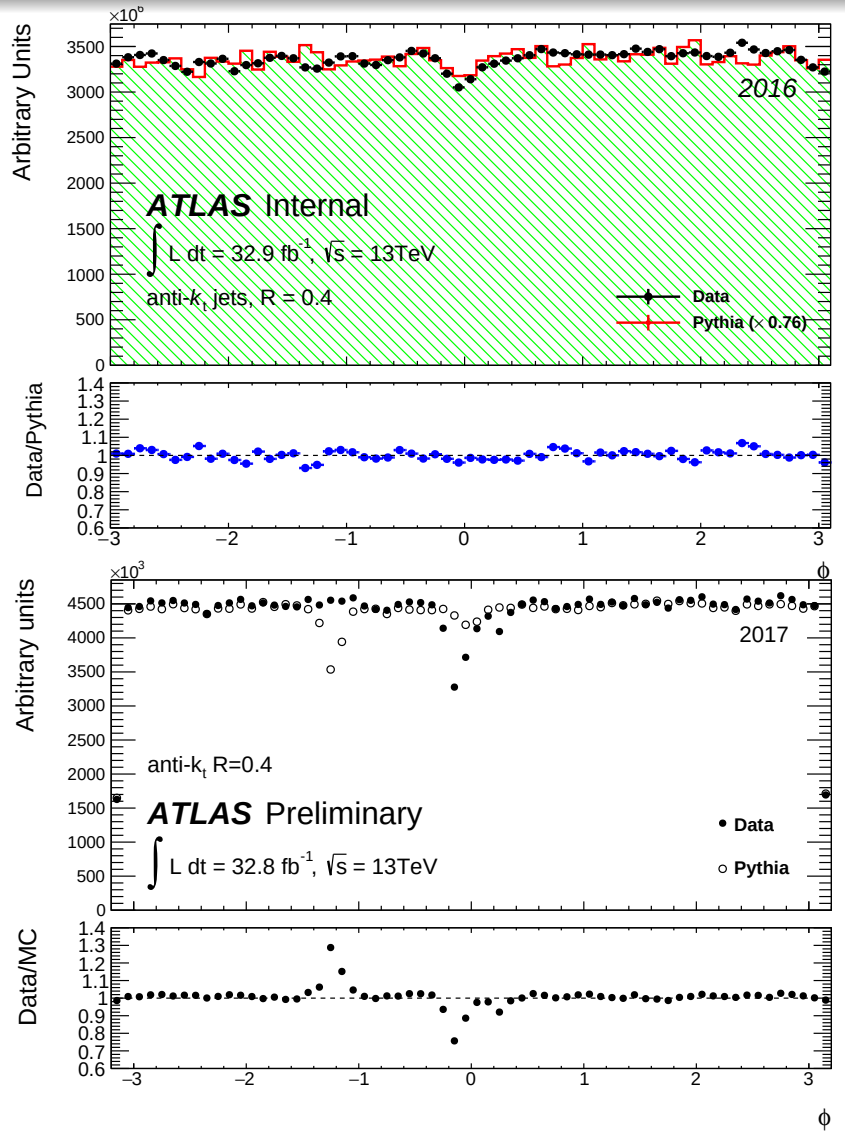
- $m_{12}^2 = (P_1 + P_2)^2 = 2p_{T1}p_{T2}(\cosh(\Delta\eta) - \cos(\Delta\phi))$

m_{jj} distribution for different y^* bins



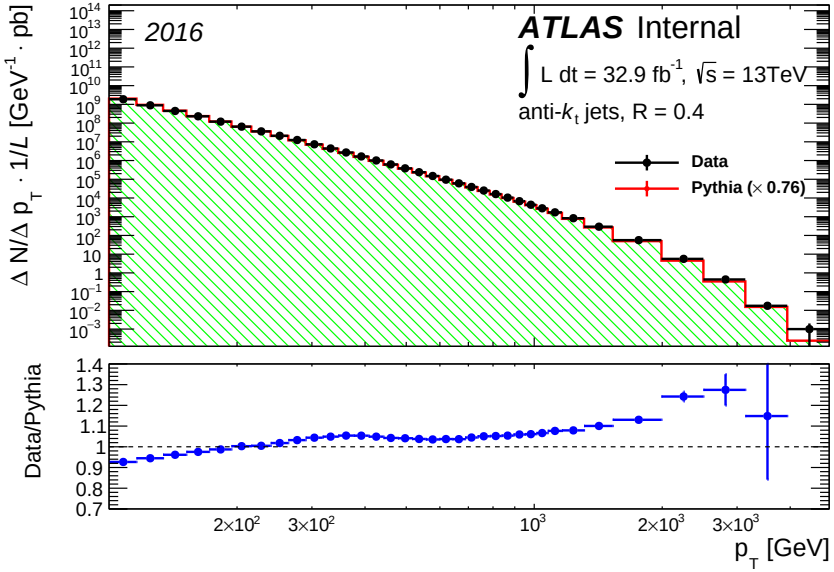
Control plots: distributions of η and ϕ

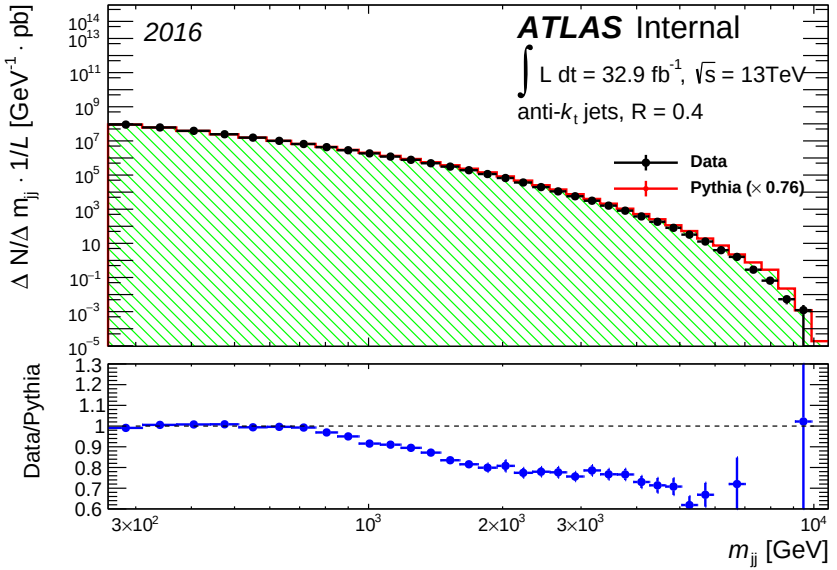


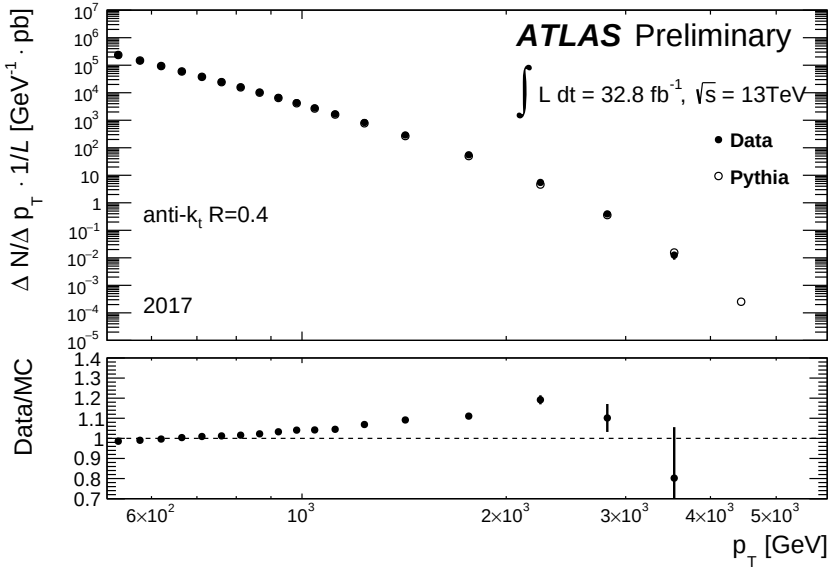


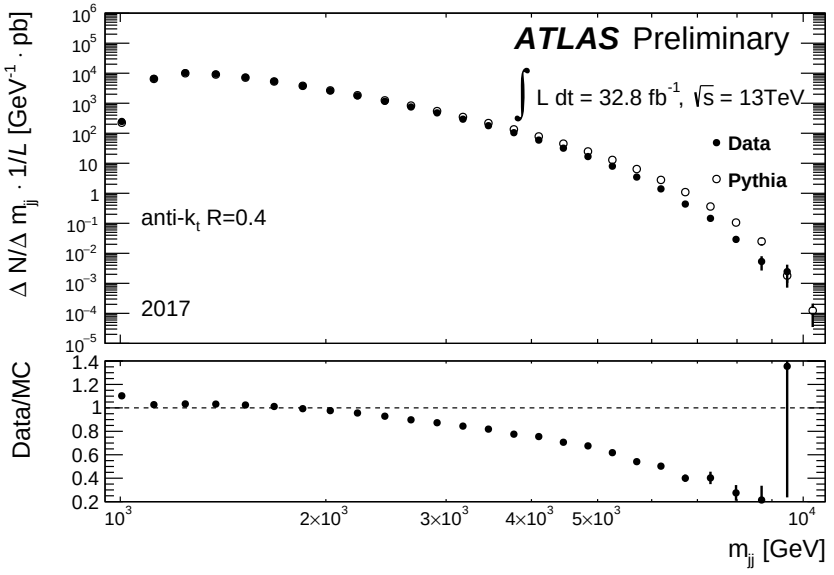
Observed the two known dead modules ($\phi \in [-0.1, -0.2]$ and $\phi \in [0.2, 0.3]$). Masked cells modelled but not present in data ($\sim \phi = -1.2$).

Inclusive jets and dijets









Future plans

- finalizing the next steps of analysis (unfolding, systematics, ...)
- checking the new 2018 data
- preparing for final measurement of inclusive jets and dijets in full Run2 dataset
- studying the potential new variables to measure e.g. triple-differential dijet cross section $\frac{d^3\sigma}{dp_{T,avg}\,dy^*\,dy_b}$