Activities in the ATLAS experiment

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ATLAS EXPERIMENT

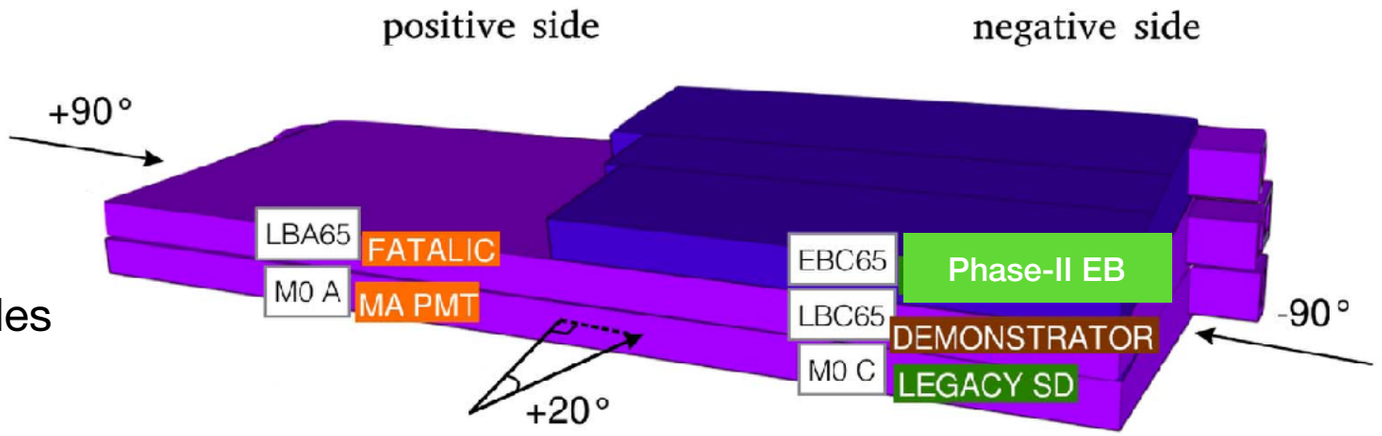
Outline

- ATLAS is preparing for the HL-LHC:

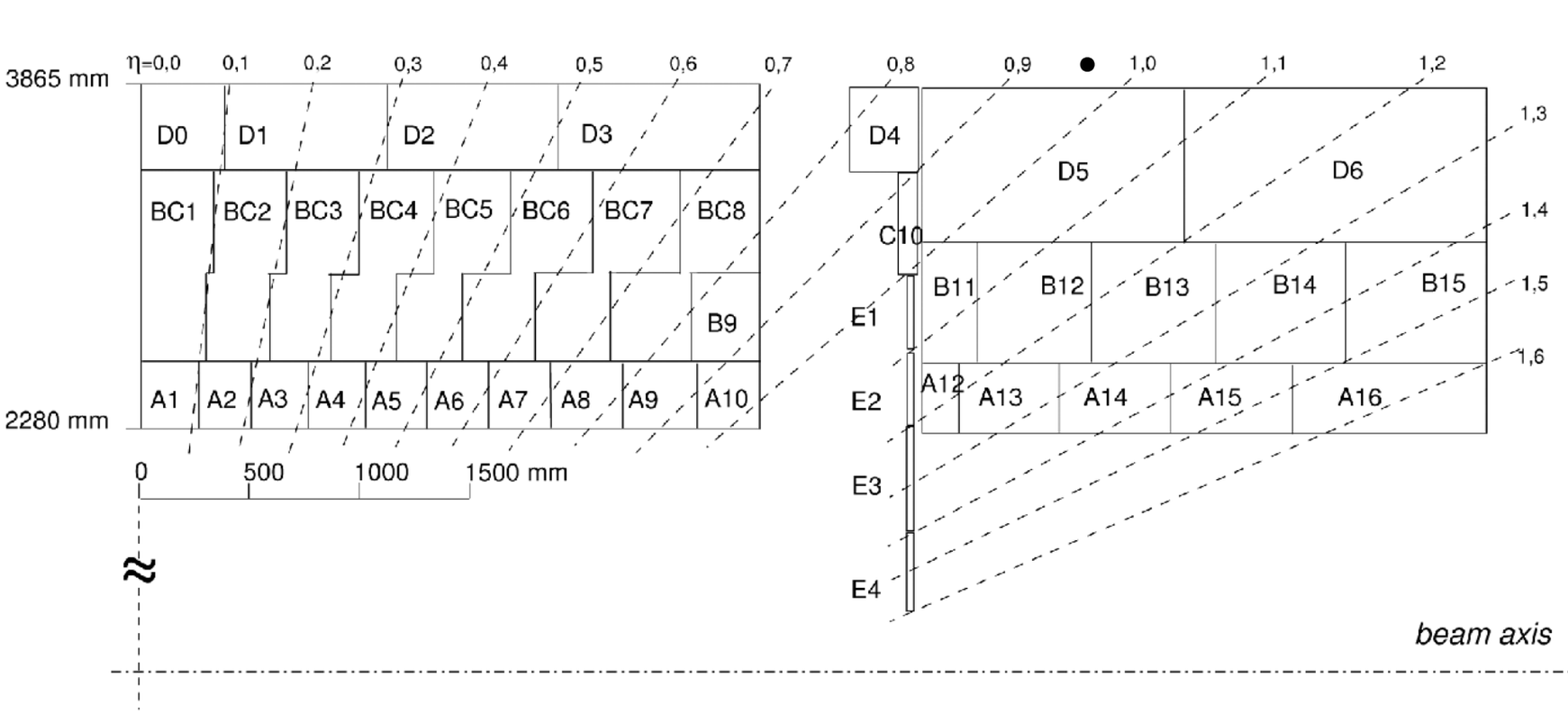
2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028+
← Run 2 →				← LS2 →		← Run 3 →			← LS3 →		← Run 4 + →		
← Phase-0 →				← Phase-I upgrade →					← Phase-II upgrade →				

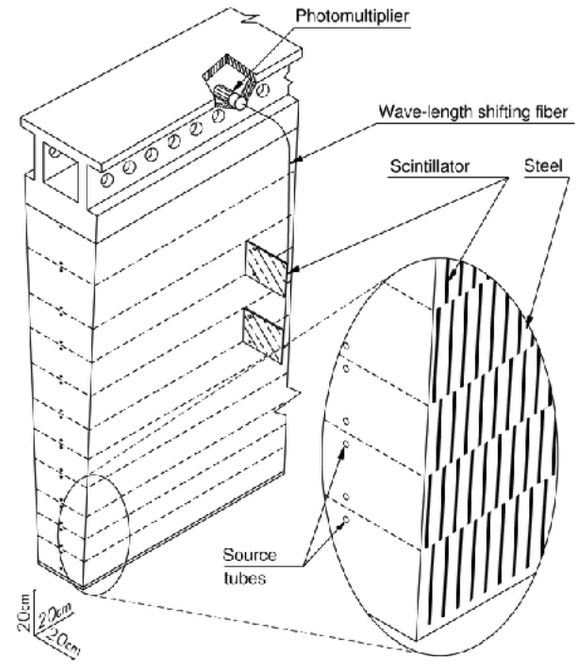
- Tile Calorimeter Testbeams for the Phase-II upgrade
  - Using physics data to test and validate the upgrade electronics and mechanics
- ATLAS software (Athena) is now open source! (https://gitlab.cern.ch/atlas/athena)
- Migration to multi-threading (AthenaMT)
- RUN-2 has finished:
  - Collected a large data-set of about 150 fb^{-1} of integrated luminosity
  - More precise measurements and searches to be done
  - Jet production cross-section measurements with the whole Run2 dataset
  - Various physics performance studies

TileCal TestBeam

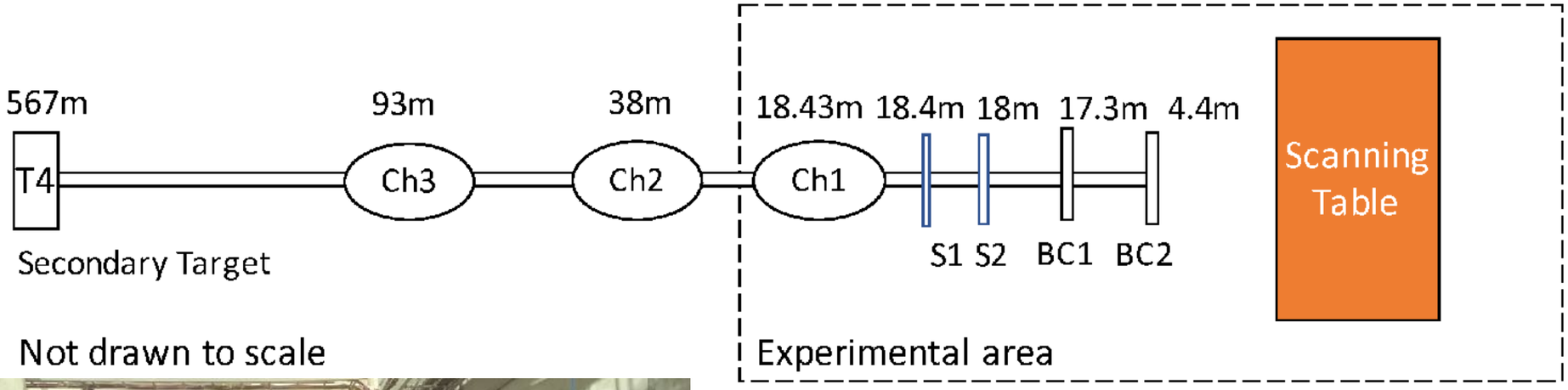


- 3 Stacks of Long Barrel and Extended Barrel modules
- SPS 400 GeV proton beams
- Targets used to create secondary and tertiary particles:
  - Muons
  - Electrons
  - Hadrons
- 3 longitudinal layers (1.5, 4.1 and 1.8λ thick at η=0)
- Table with 3 degrees of freedom
- Physics data taken in projective eta, 20deg and 90deg

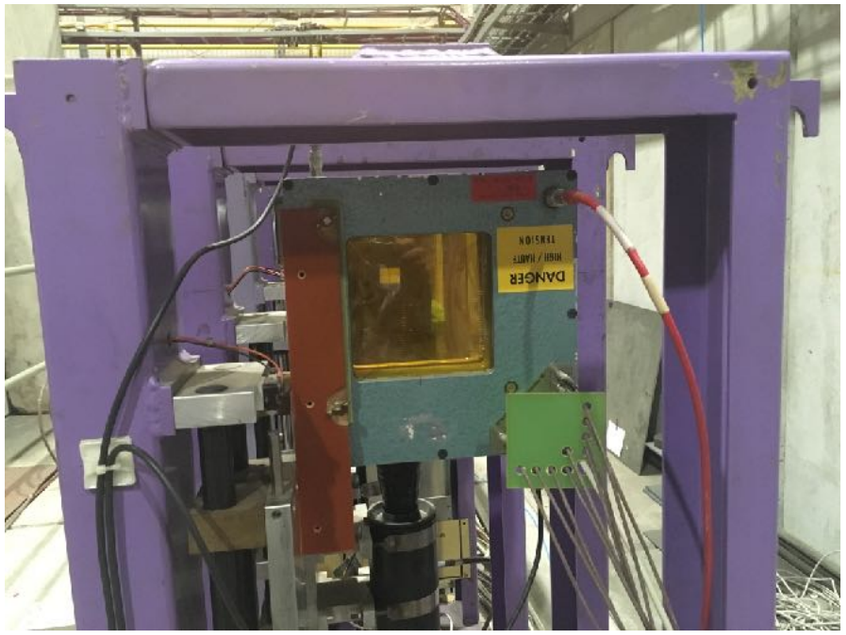




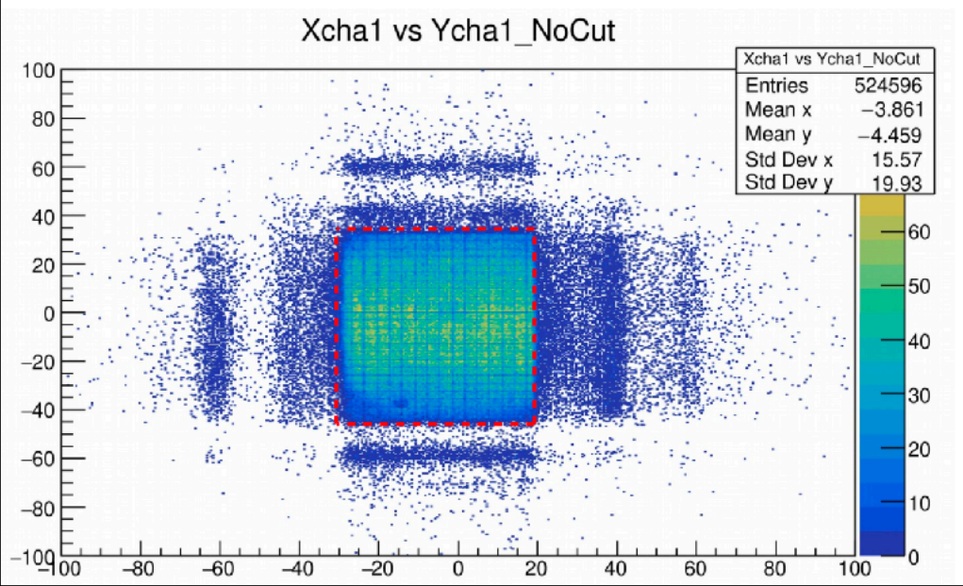
Beam Line Elements



Not drawn to scale



- 2 Trigger Scintillators
- 3 Cherenkov detectors along the beamline
- 2 Wire Chambers



- Triple coincidence(Logical AND) of 2 trigger scintillator signals and LTP partition busy signal
- Separate for Physics and Calibration data

Hadron separation

- Beams always have electron and muon contamination
- In order to acquire a pure sample of hadrons, Cherenkov detectors (ML algorithms) and topological analysis is used
- Shower profile parameter Clong:

$$C_{long} = \sum_{i=A,BC} \sum_{j=1}^{3} (E_c^{raw})_{i,j}/E_{beam} + \sum_{i=A,B} \sum_{j=1}^{3} (E_c^{raw})_{i,j}/E_{beam}$$

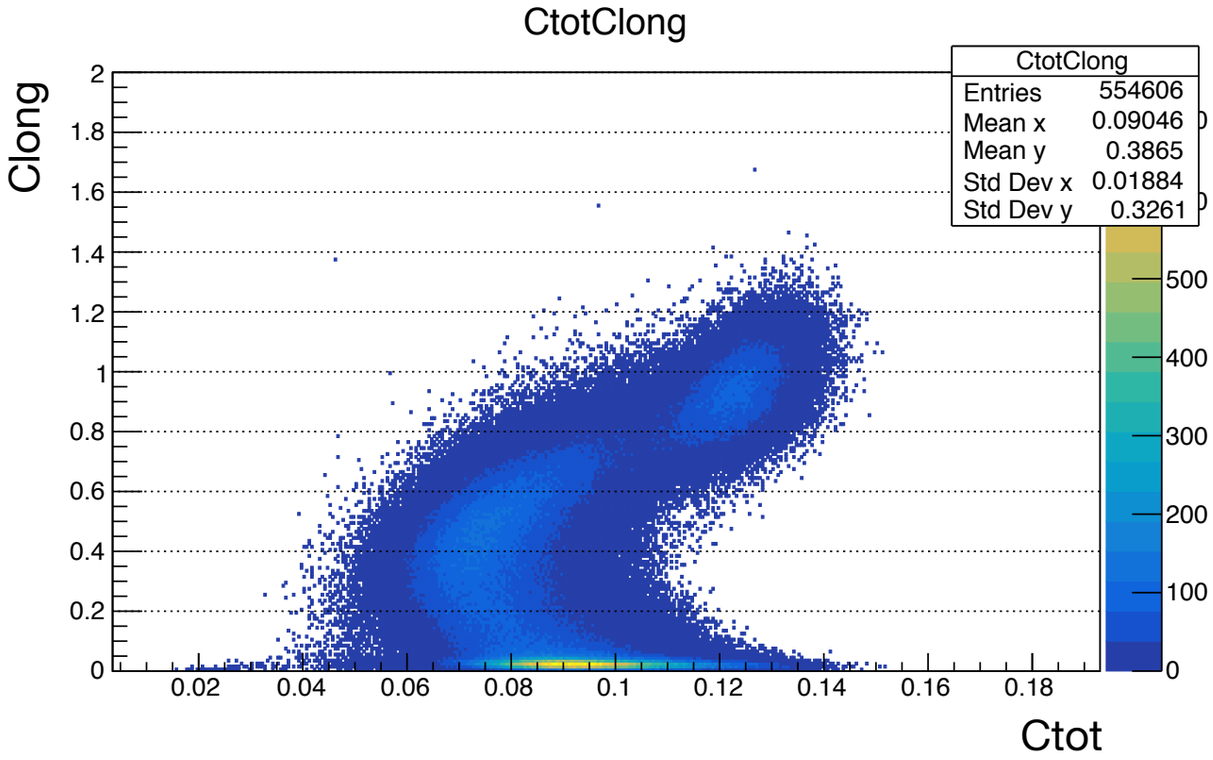
  - represents the fraction of energy deposited in the first two layers A and BC

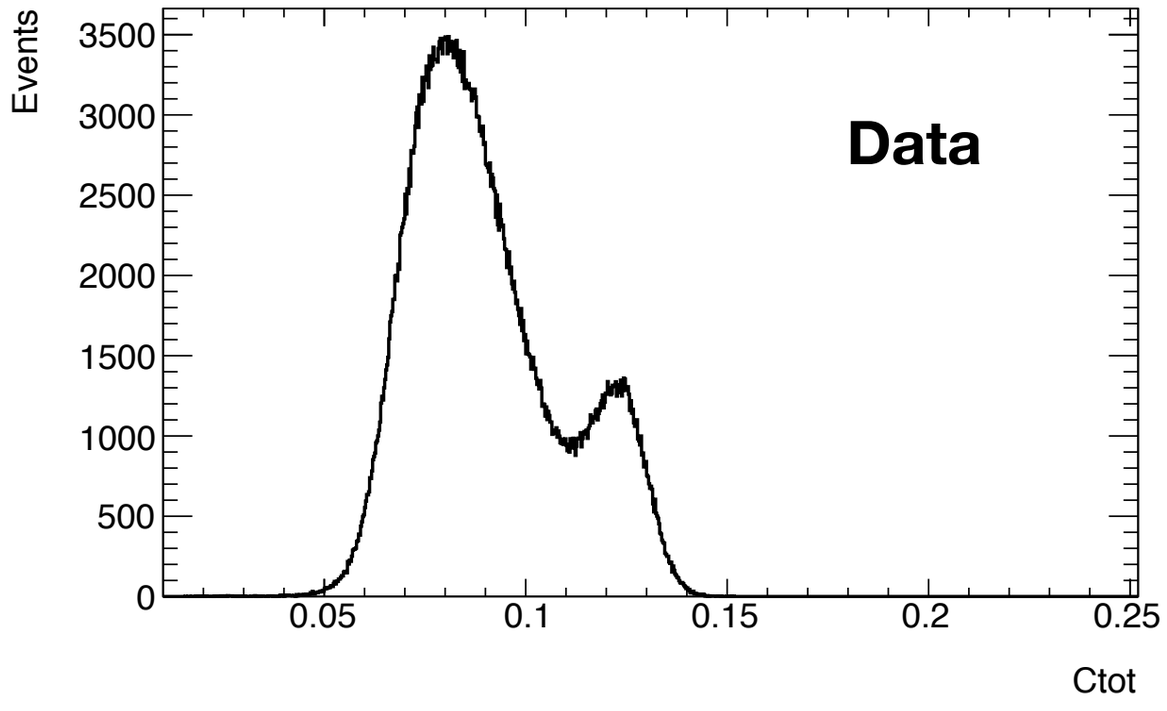
- The Ctot quantity:

$$C_{tot} = \frac{1}{\sum_c (E_c^{raw})^\alpha} \sqrt{\frac{1}{N_{cell}} \sum_c ((E_c^{raw})^\alpha - \frac{1}{N_{cell}} \sum_c (E_c^{raw})^\alpha)^2}$$

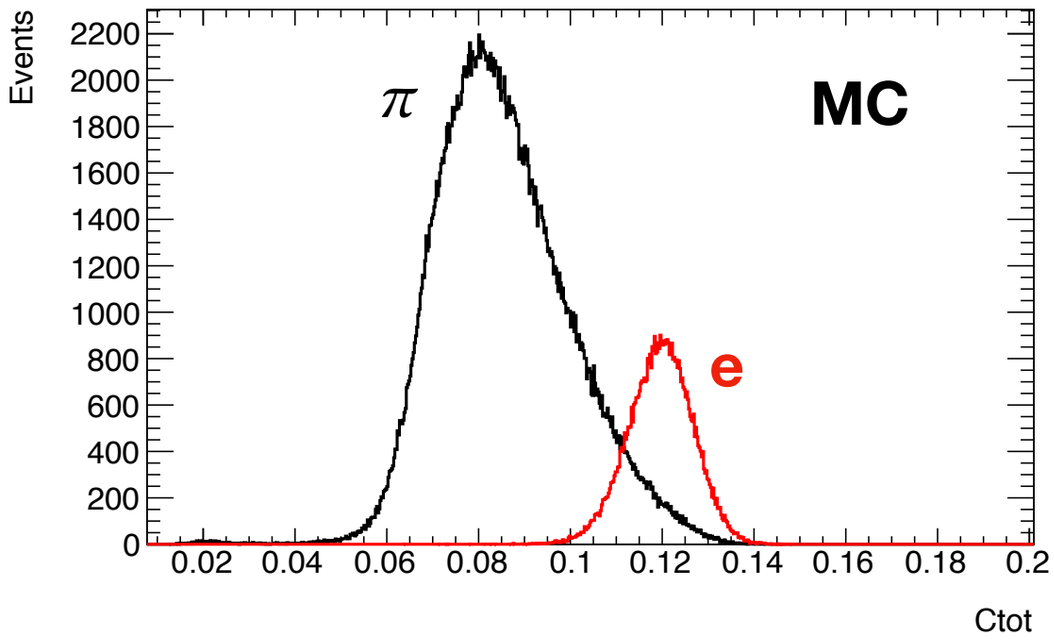
- Measures the spread of the energy deposited in the cells of the calorimeter

Topological analysis (MC driven)

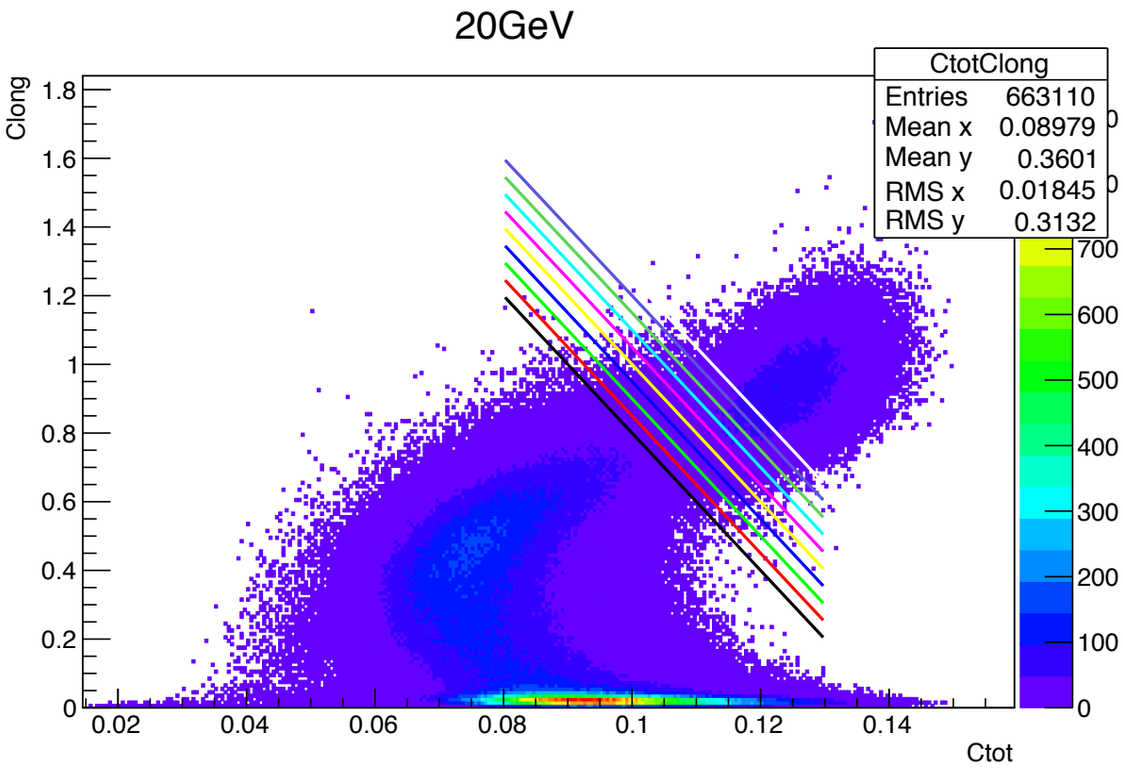


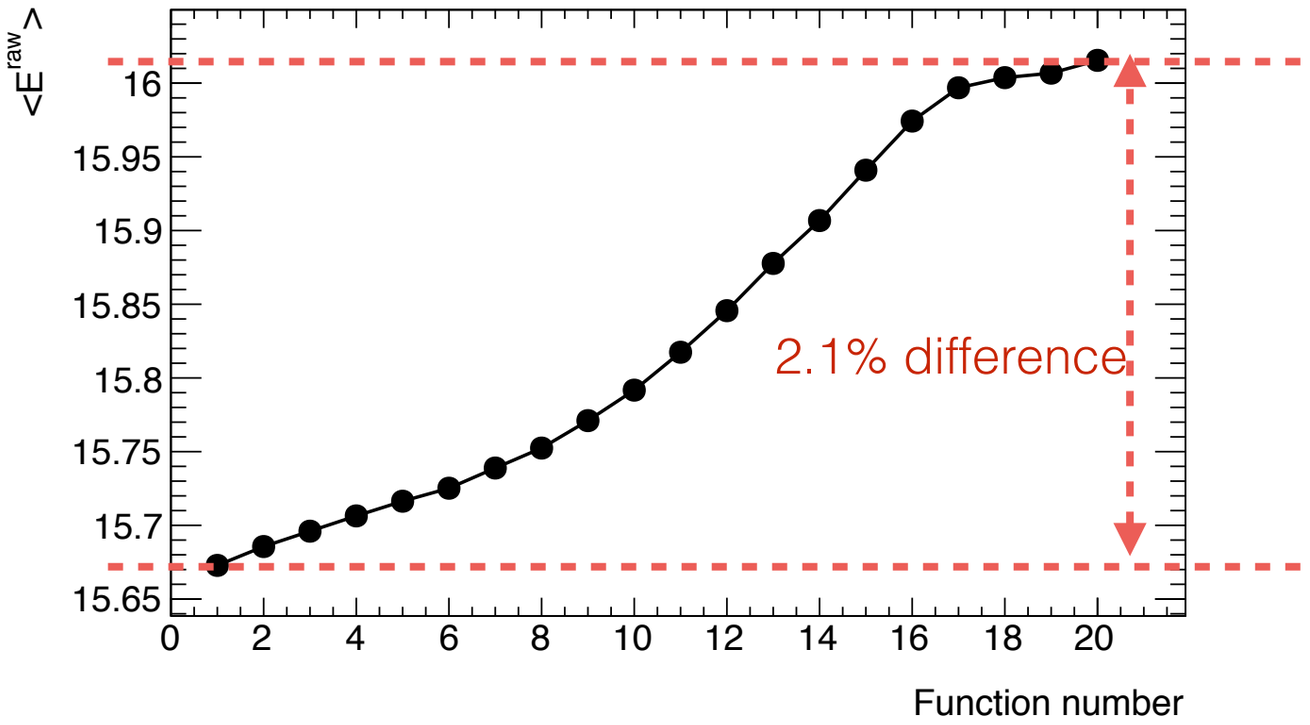


- Both parameters provide good separation power
- Estimation of the number of electrons and shape subtraction using MC

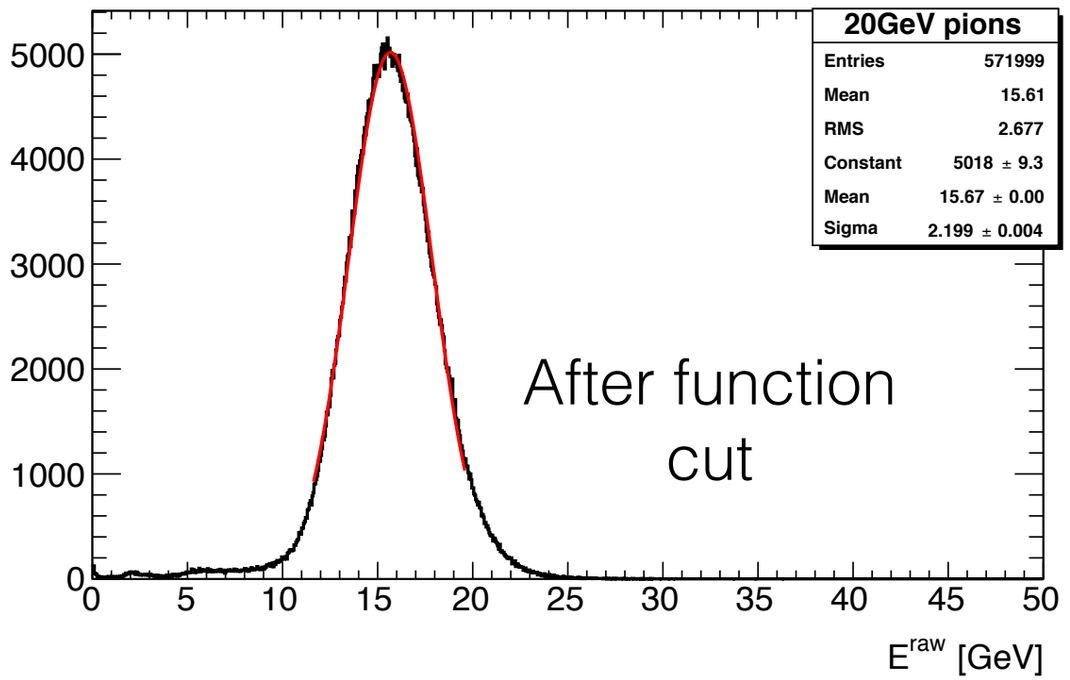


Topological analysis (selection function)



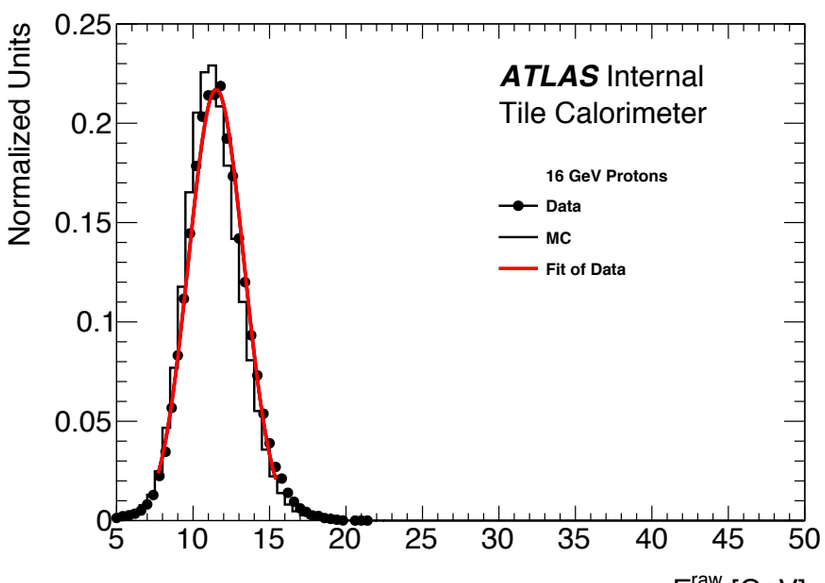


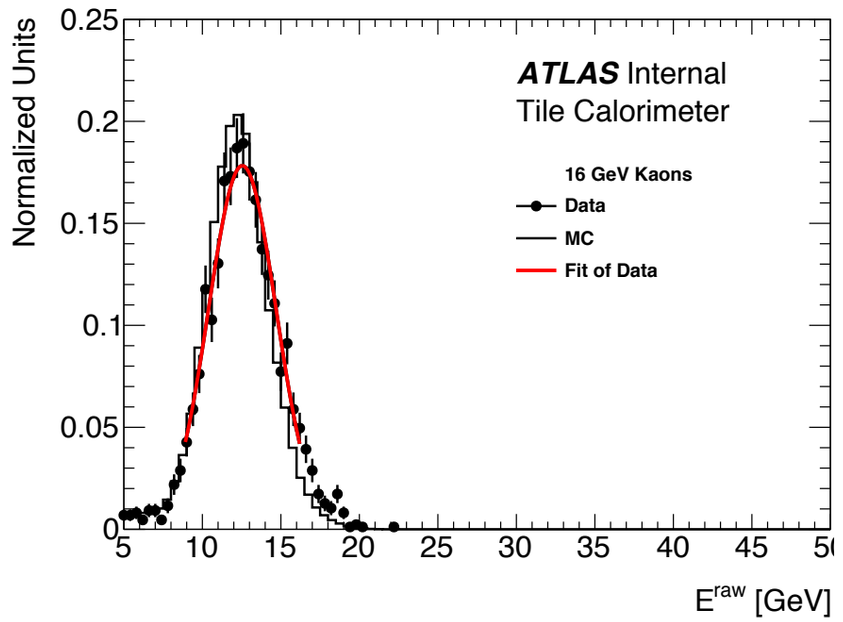
- Selection functions in the shower shape parameter plane
- Determination of the systematic error based on the selection functions
- Removal of the electrons due to low layer penetration

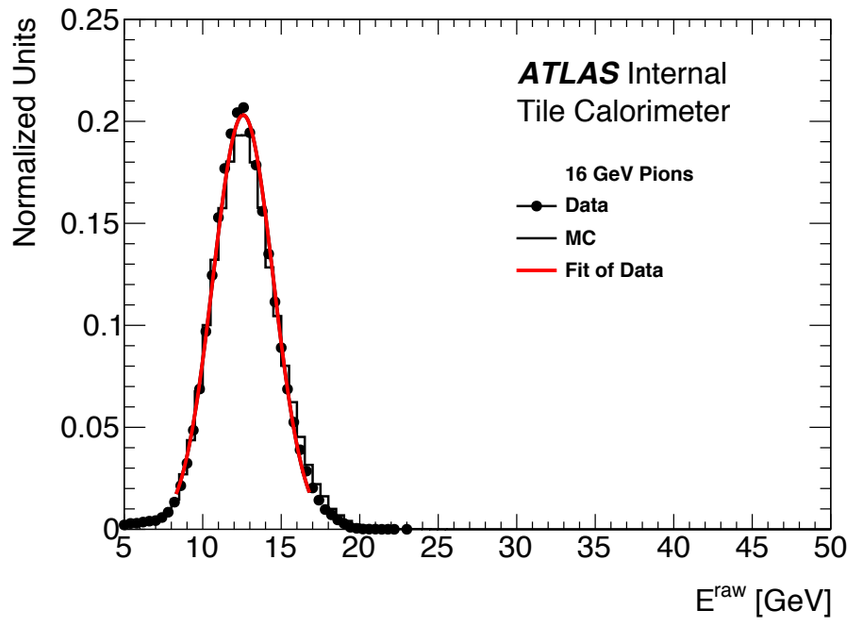


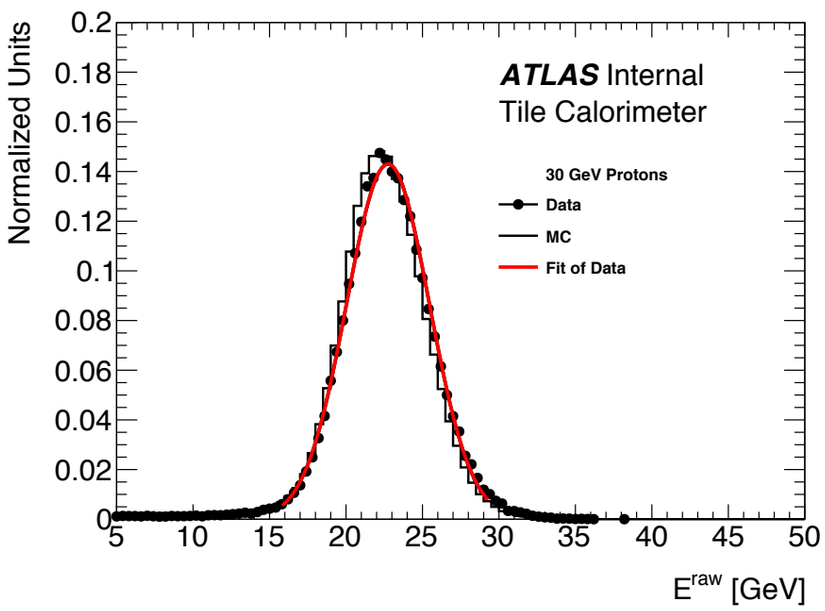
Hadron response

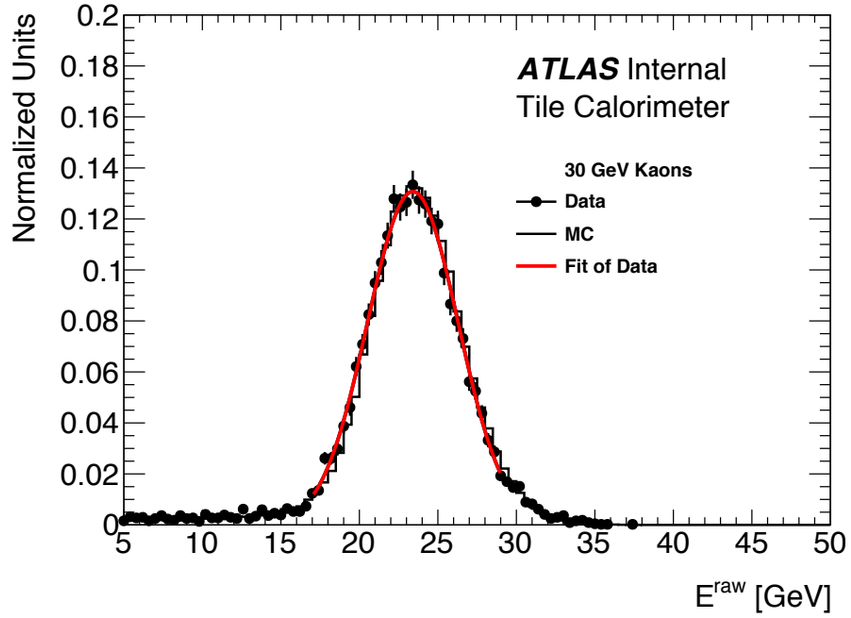
- Calorimeter response for Protons, Kaons and Pions
- Various cleaning cuts applied on the beam line elements
- Kaons and protons can be separated using Cherenkov detectors, Pions need addition topological cuts to remove electrons

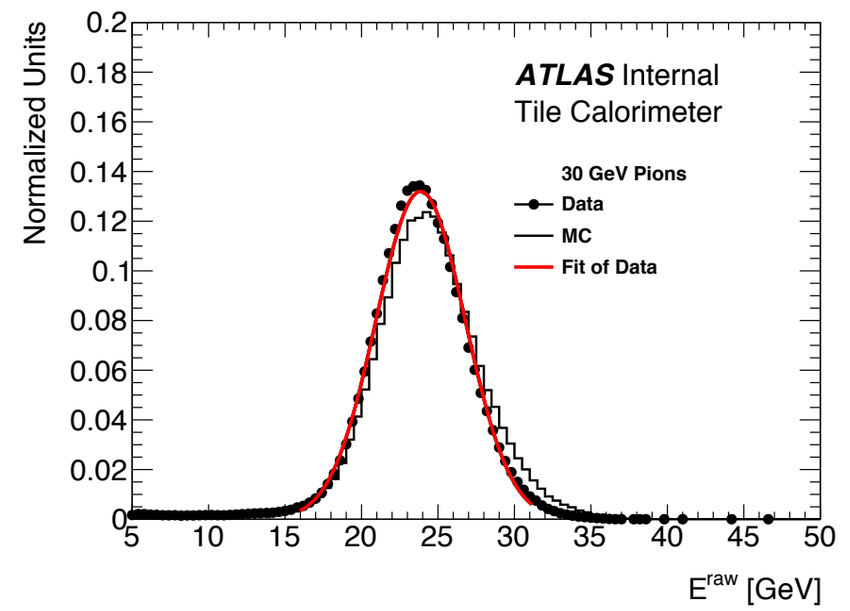








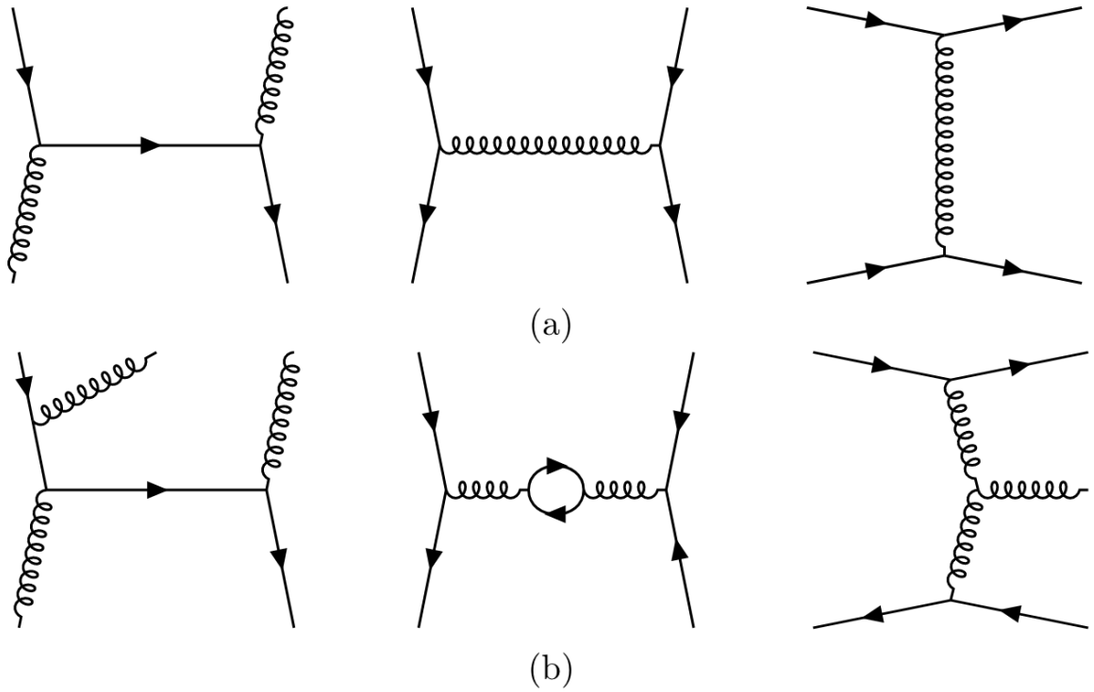


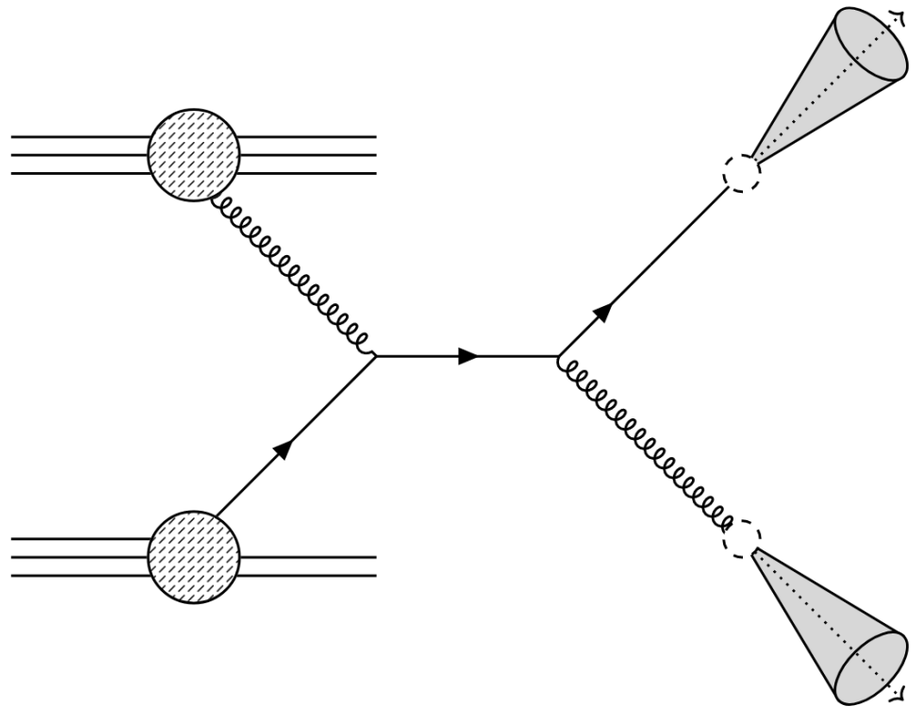


Low pileup Dijet datasets

- In 2017 and 2018 special datasets have been collected in a low pile-up environment
- Average interactions per bunch-crossing = 2
- Aim is to perform the cross-section measurement going lower in pT

- LO(a) and NLO(b) QCD hard scatter





Single Jet trigger efficiencies

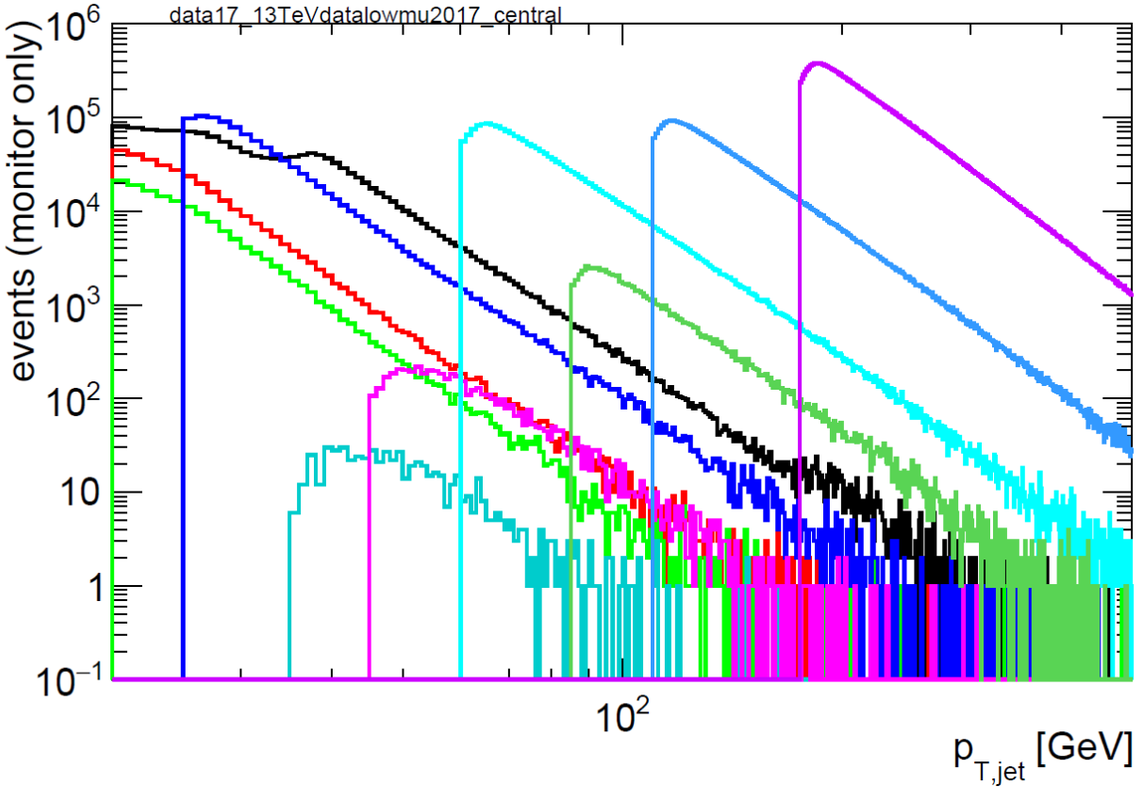
- Single jet trigger search for individual jets in the detector
- Multiple triggers defined by a threshold requirement on the transverse energy E_T

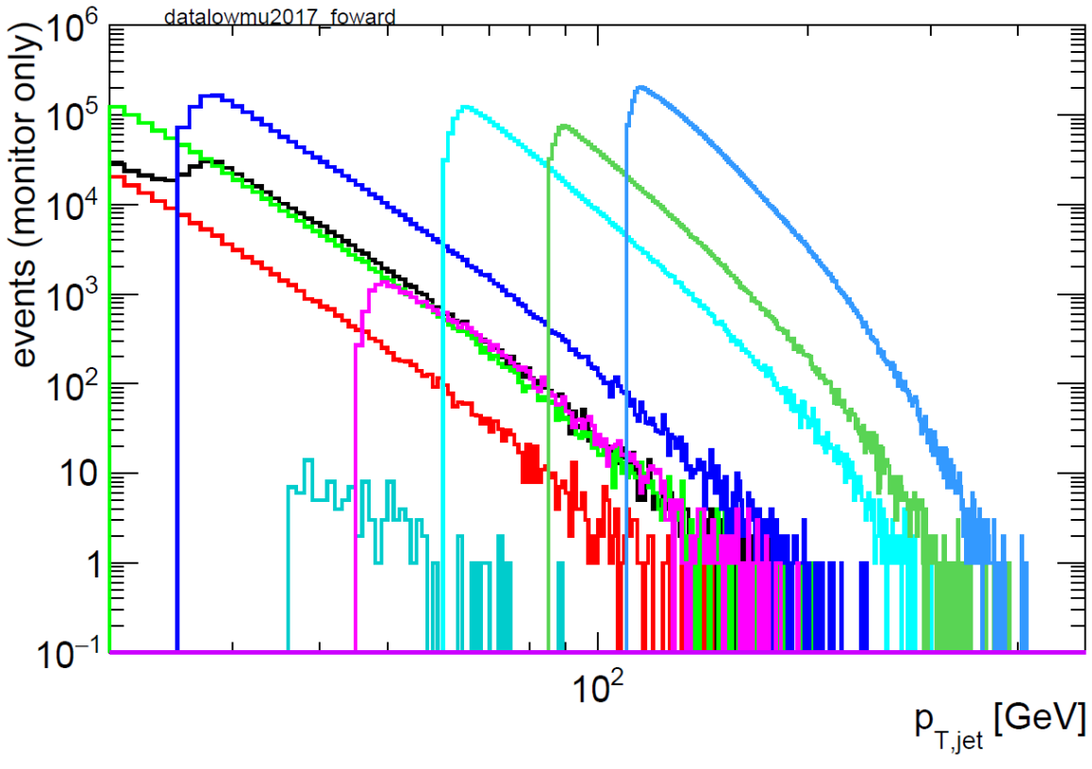
$$E_T = \frac{E}{cosh(\eta)}$$

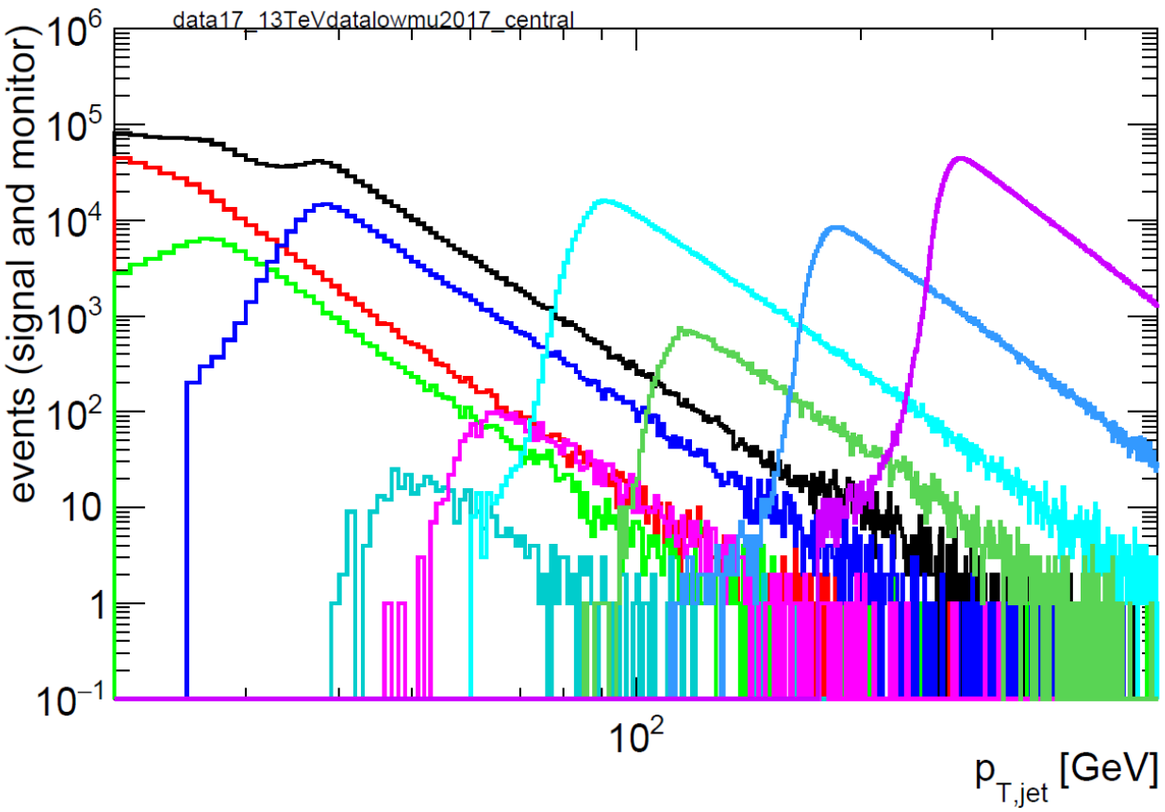
- The efficiency is defined by : $\varepsilon = \frac{N : \mathrm{passATD(ref)\ \&\ passRTD(probe)}}{N : \mathrm{passATD(ref)}}$
- Determination of the 99% efficiency point (turn on)
- Fitted by a standard error function:

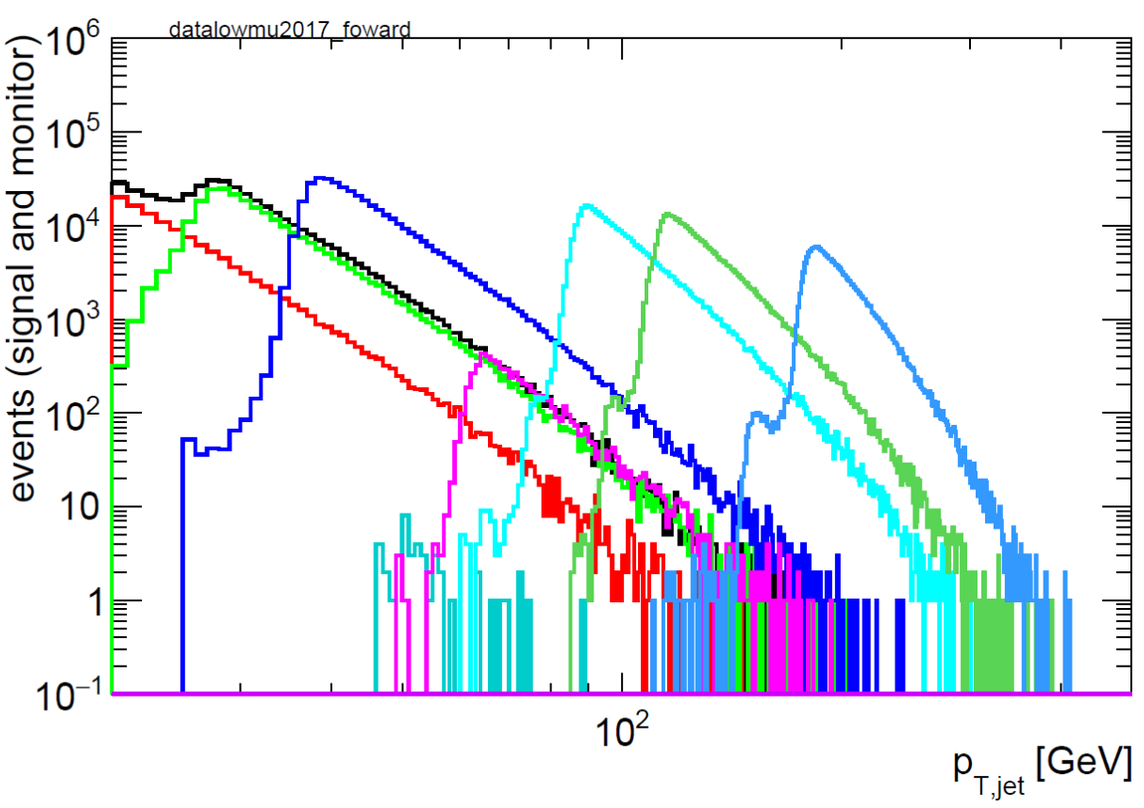
$$\varepsilon(p_T) = \frac{1}{2}\left[1 + \mathrm{erf}\left(\frac{p_T - \mu}{\sqrt{2}\sigma}\right)\right]$$

Single Jet trigger efficiencies





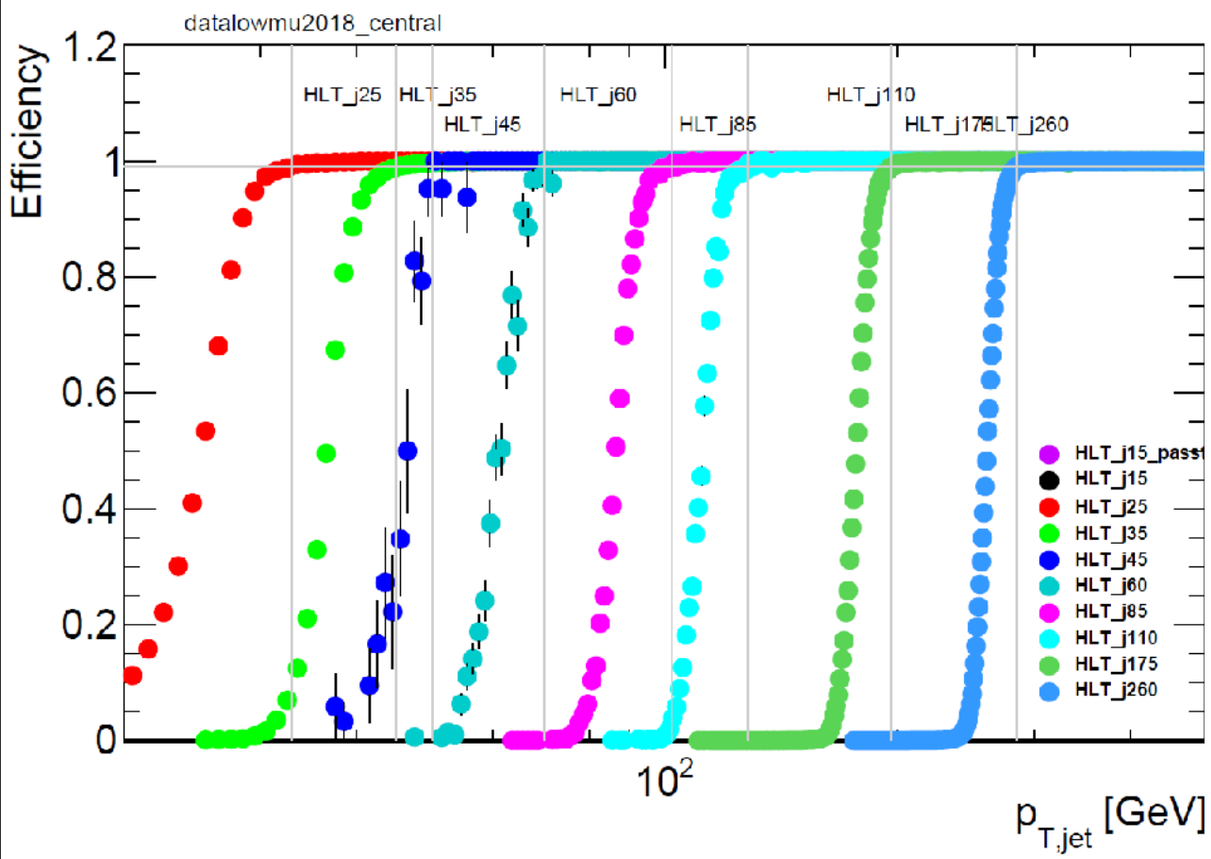


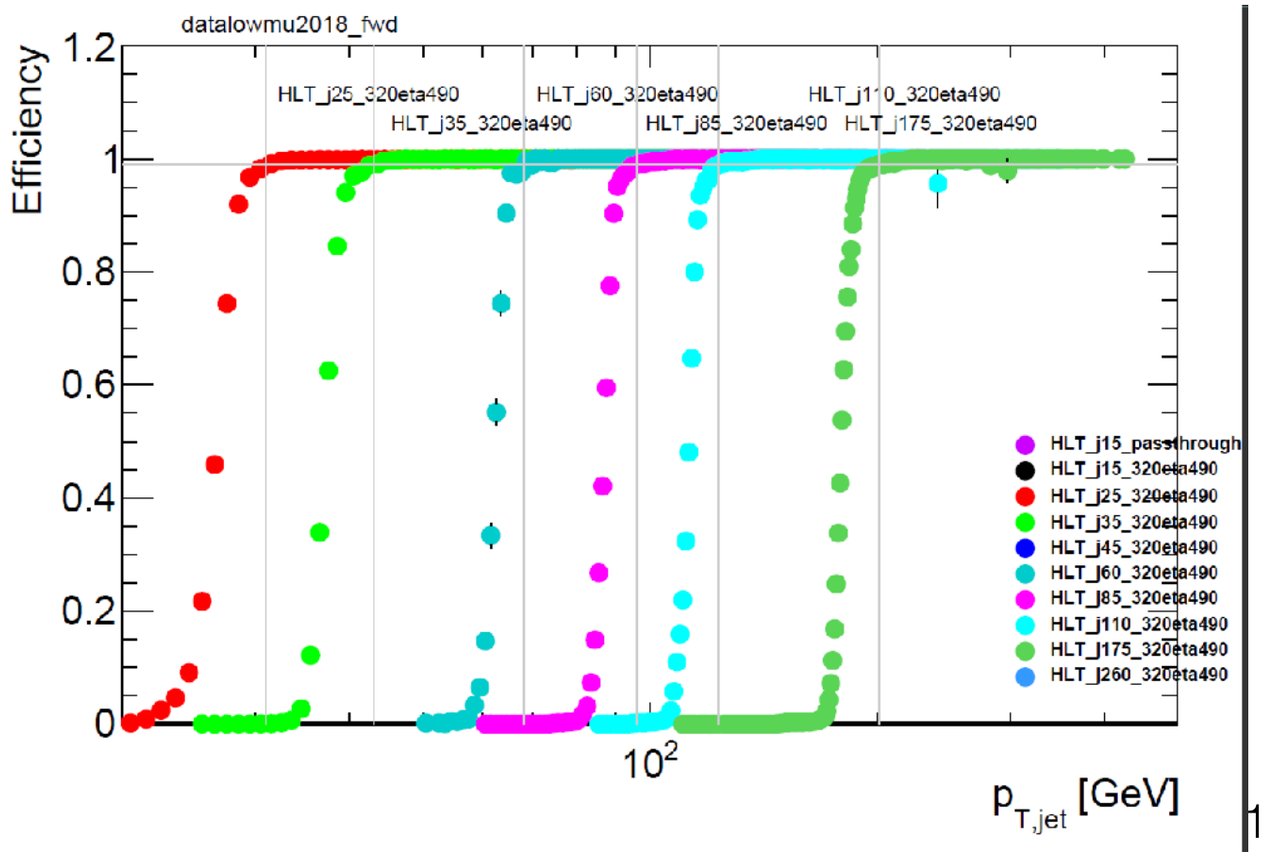


Trigger efficiencies

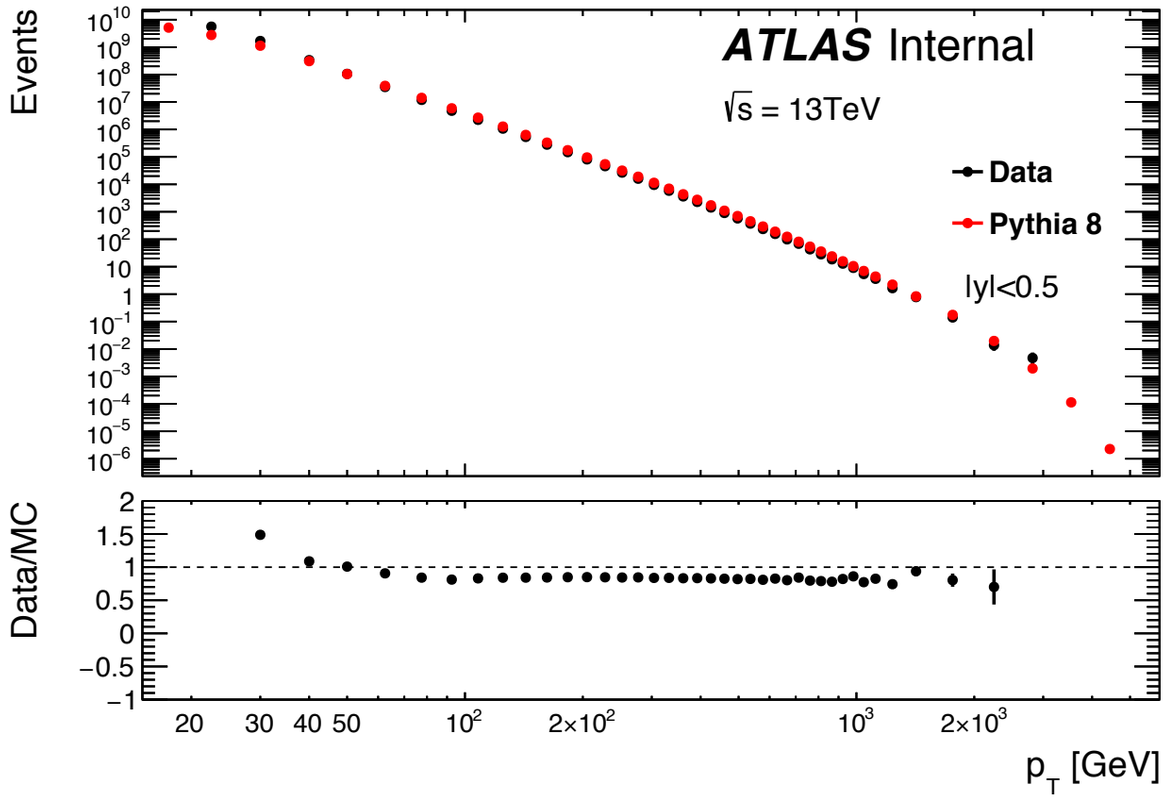
Name	Lumi [fb^{-1}]	p_T[GeV]
HLT_j15	9.75544E-07	20
HLT_j25	2.46018E-06	32
HLT_j35	1.62975E-05	46
HLT_j45	8.328E-05	50
HLT_j60	0.000259824	74
HLT_j85	0.00110252	103
HLT_j110	0.0031845	128
HLT_j175	0.146581	199
HLT_j260	0.146581	287

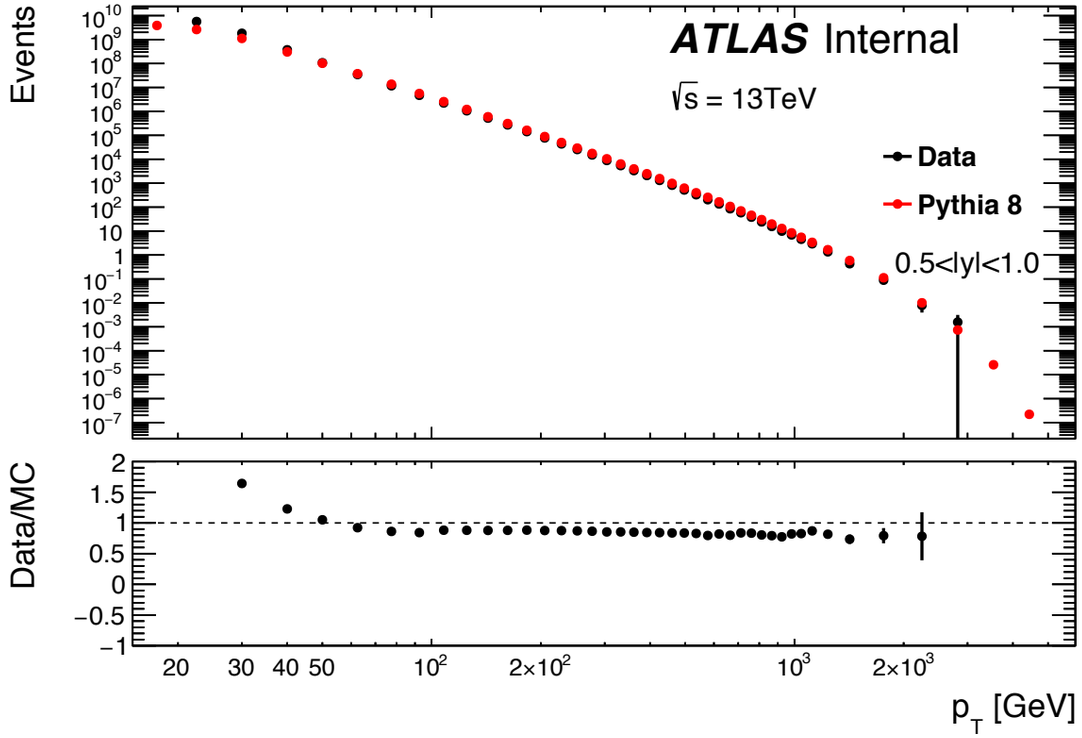
Name	Lumi [fb^{-1}]	p_T[GeV
HLT_j15_320_eta_490	9.75544E-07	20
HLT_j25_320_eta_490	2.46018E-06	31
HLT_j35_320_eta_490	1.62975E-05	43
HLT_j45_320_eta_490	8.328E-05	48
HLT_j60_320_eta_490	0.000259824	67
HLT_j85_320_eta_490	0.00110252	96
HLT_j110_320_eta_490	0.0031845	123
HLT_j175_320_eta_490	0.146581	200
HLT_j260_320_eta_490	0.146581	



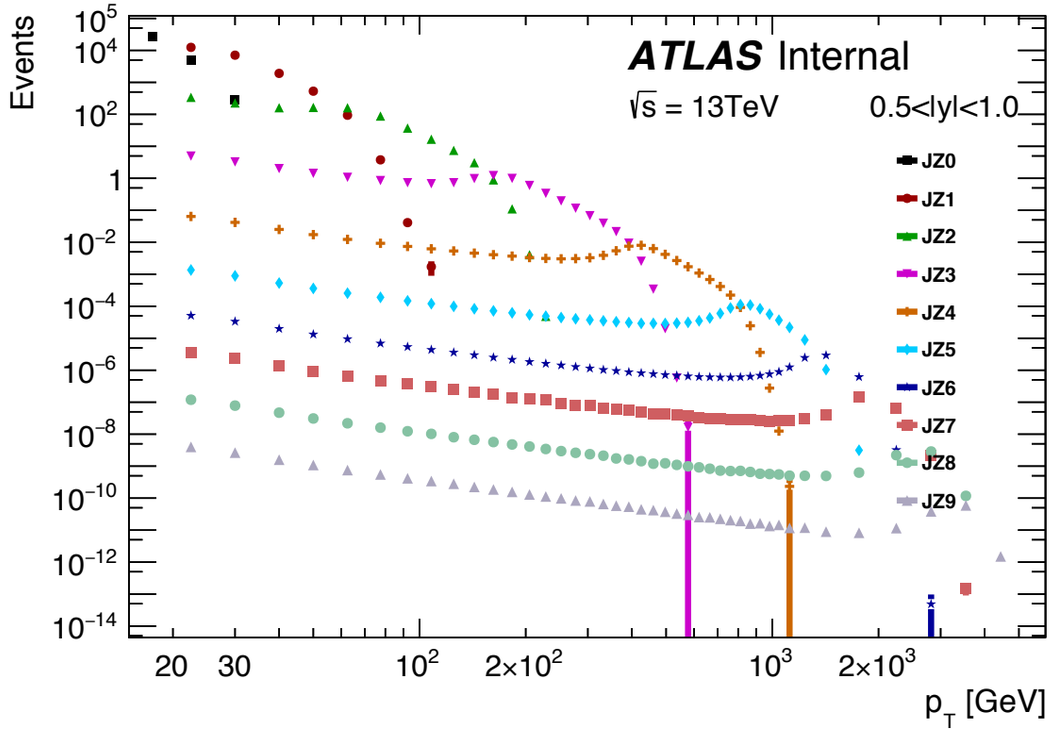


pT spectra





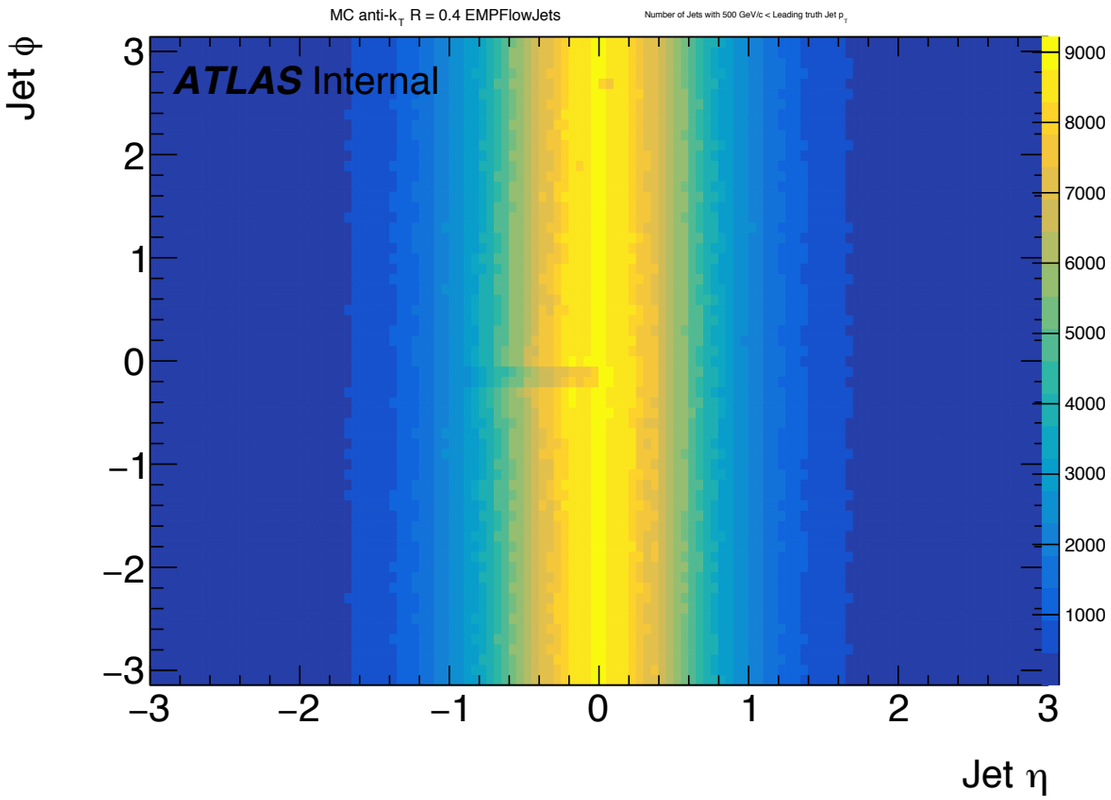
- Data is compared to the MC for the pT range from 20 GeV to 3 TeV
- MC is comprised of 9 pT slices



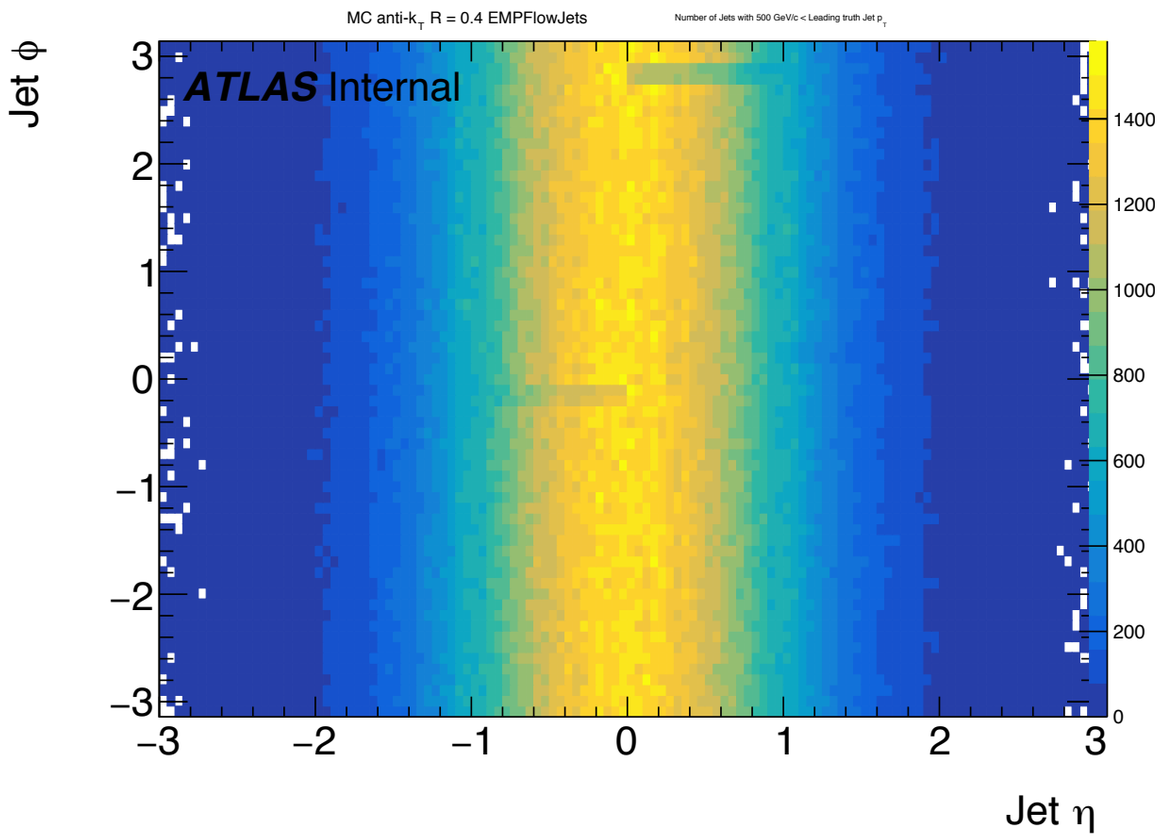
Missing Tile modules

- In the spring of 2018
- 2 consecutive Tile Calorimeter modules were disabled
- Due to cooling problems
- Special MC datasets have been produced to study the effect on the jet response
- The special MC is compared to Data and standard MC

Standard MC



Special MC with 2 modules off

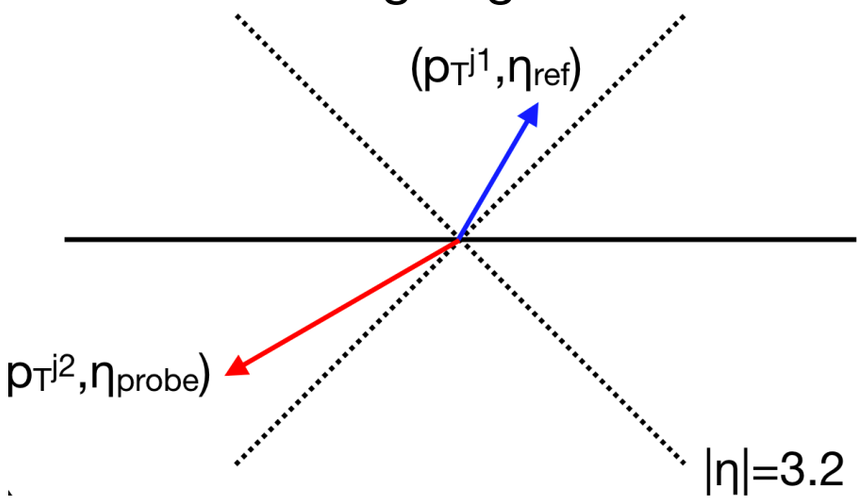


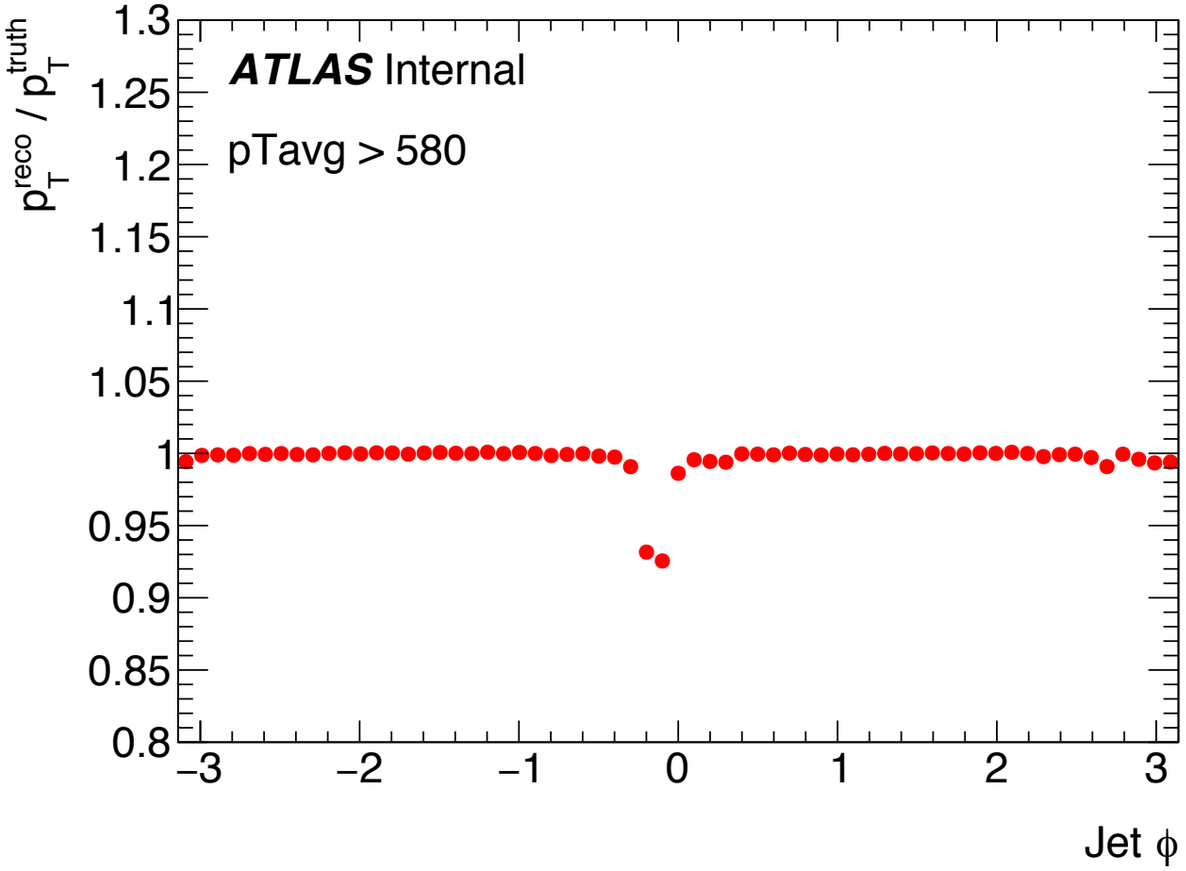
pT balance method

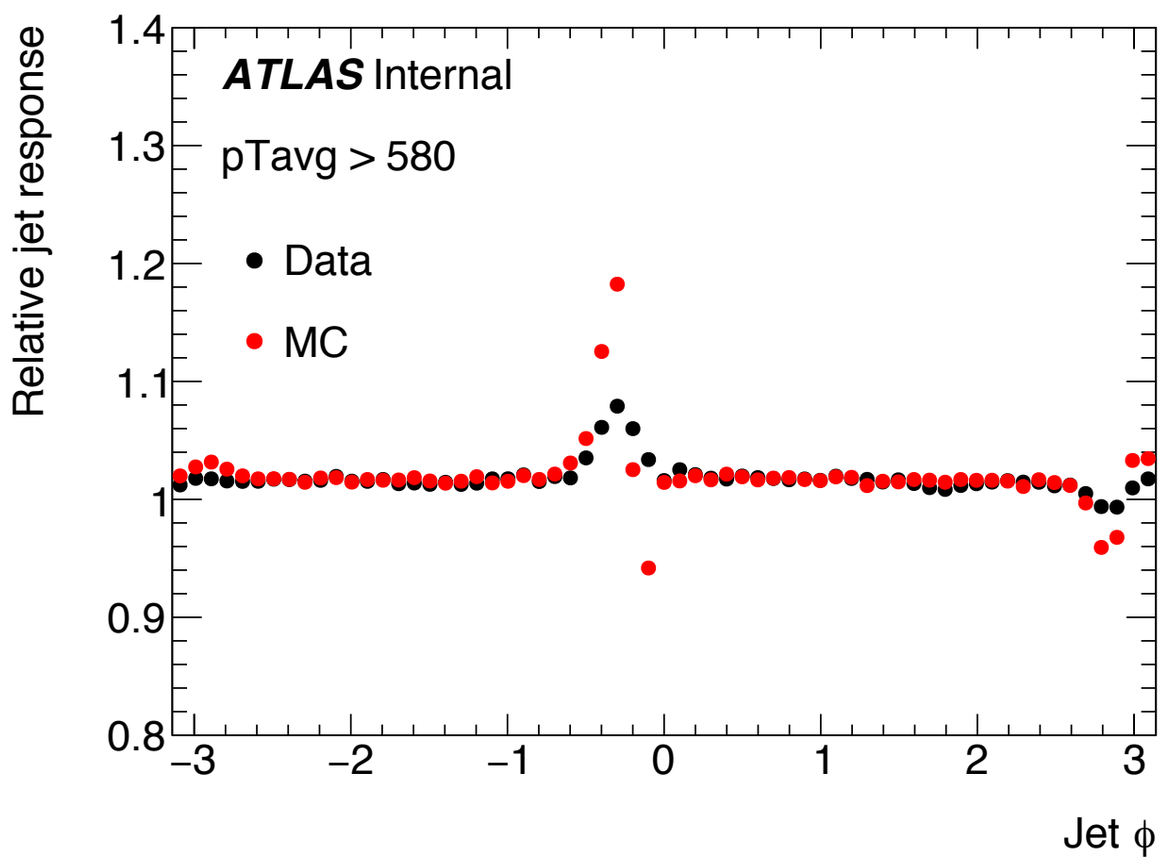
- Balance a probe jet with a reference jet
- Momentum balance due to the conservation of the transverse momentum
- The relative jet response:

$$R = \frac{p_T^{probe}}{p_T^{ref}} = 1/c$$

- Derivation of a correction for the effect is ongoing







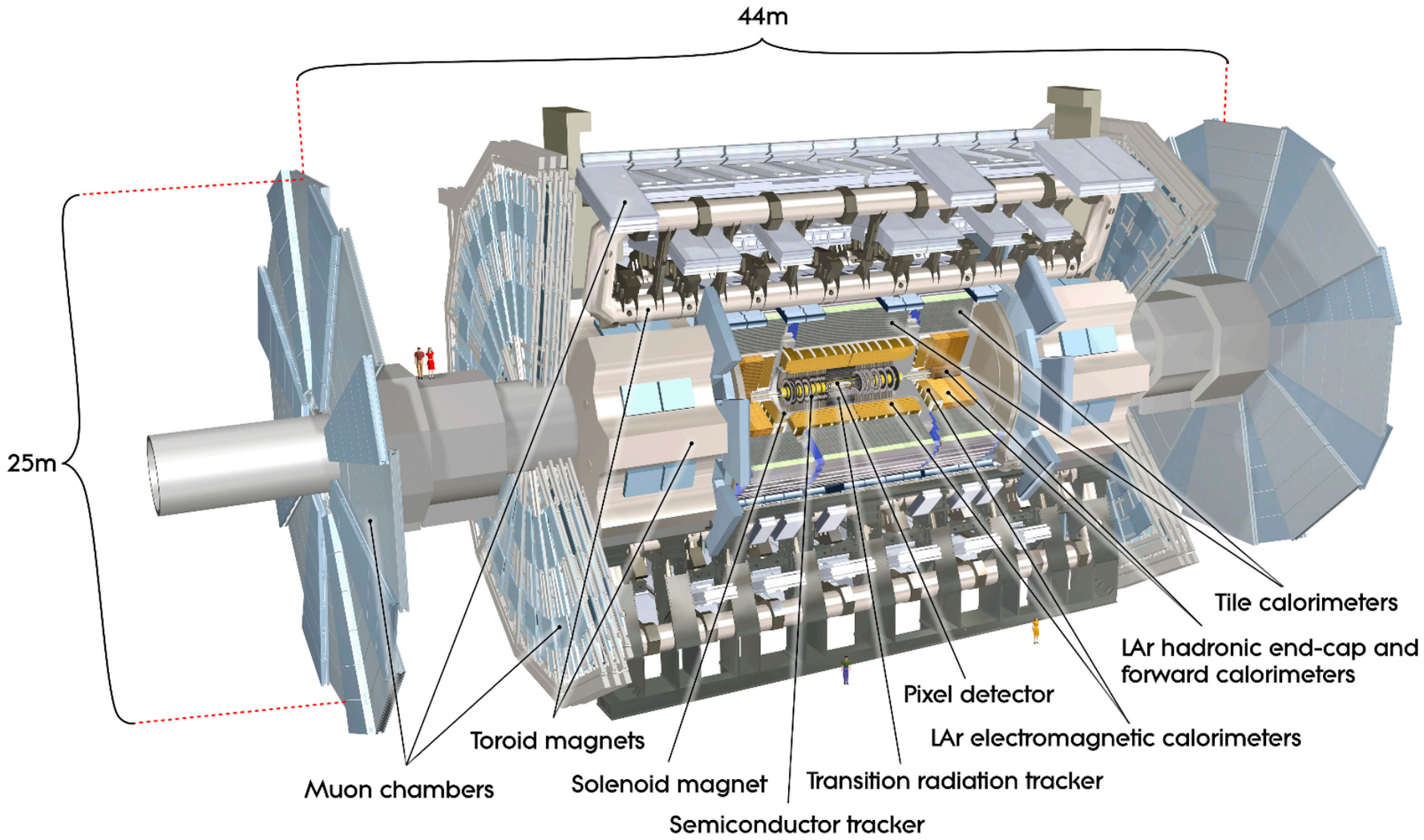
Conclusion

- Last Testbeam until 2021
- Good Demonstrator physics performance
- Planned insertion (for 1 module) in May 2019
- Preparation for Run3
- Software preparation for multi-threading in the next release (22.0)
- Run2 analysis under way with final recommendations in 2019

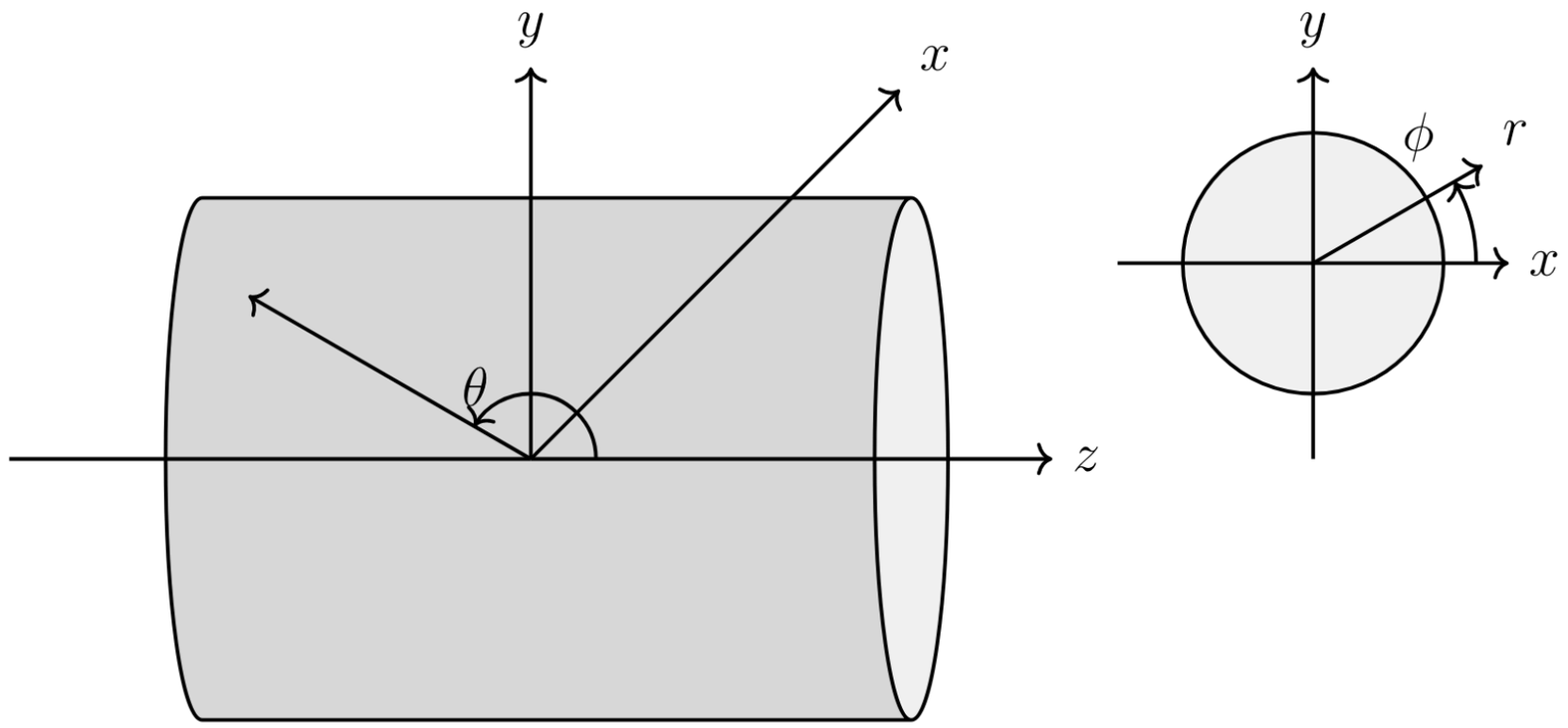
Thank you

Backup

The ATLAS detector



Pseudo-rapidity



$$\eta \equiv -\ln\left(\tan\left(\frac{\theta}{2}\right)\right)$$