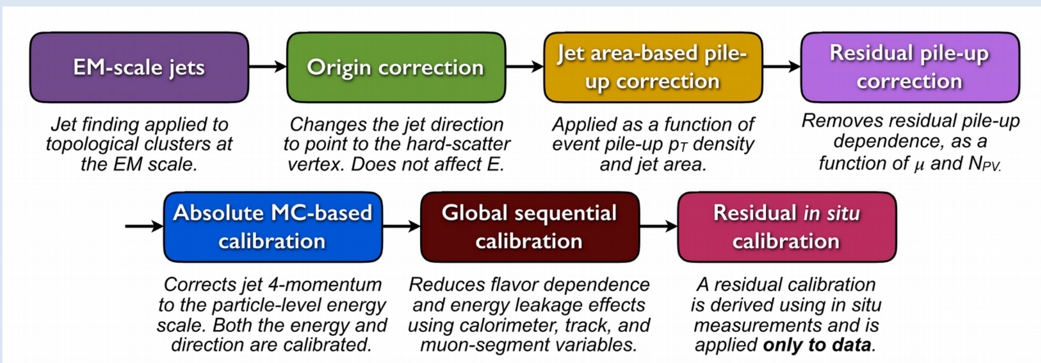
COMBINATION METHODS FOR IN-SITU JET CALIBRATION IN ATLAS

LHCP 2018, Bologna

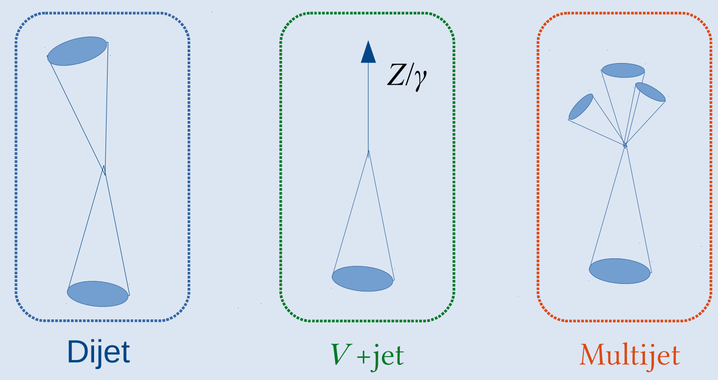
The energy and mass of jets measured with the ATLAS detector are calibrated through a multi-step process. The residual *in-situ* calibration, is obtained from the data-to-simulation ratio of the p_T balance between jets and a reference object. Several in-situ methods are combined to obtain a continuous and smooth calibration scale over a wide range of phase space. A smooth jet energy scale calibration is important for dijet resonance searches with high statistics. The nominal procedure for combining in-situ methods is presented alongside an alternative procedure that ensures smoothness and was used for the ATLAS Dijet Trigger Level Analysis [1]. The calibration chain is similar for all types of jet, but throughout this poster anti-k_t R=0.4 EMTopo jets are used as an example.

In-situ JES calibration



The in-situ calibration accounts for discrepancies in jet response between data and MC

It is measured in events where the jet recoils against a well-calibrated reference object



Dijet balance provides

- An η-intercalibration

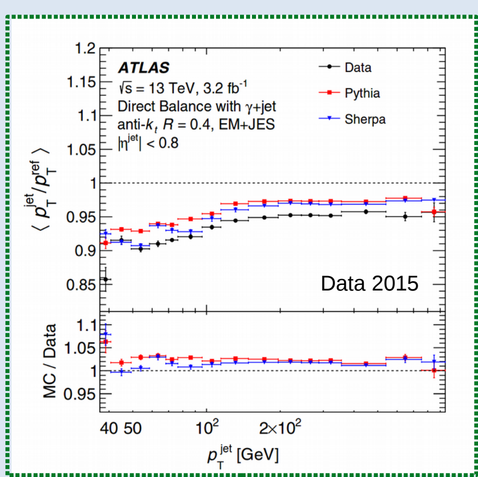
V+jet, and multijet balance provide

- An uncertainty to the JES
- A potential correction factor to the JES

p_T response measurements

The in-situ response measurements are combined to form a smooth and continuous calibration curve

Initially, γ+jet and Z+jet measurements are combined providing a correction factor for low-p_T jets



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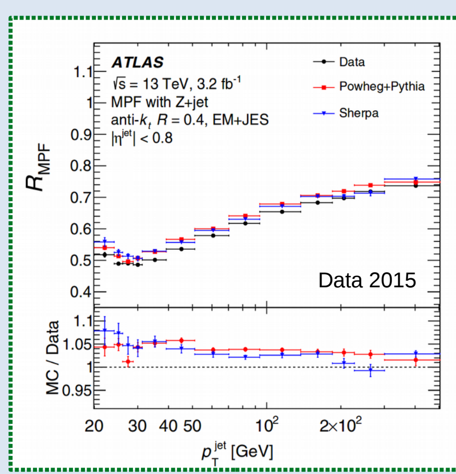

With that correction applied to low-p_T jets, multijet events can then extend the calibration to high jet p_T

At last all three sets of measurements are combined

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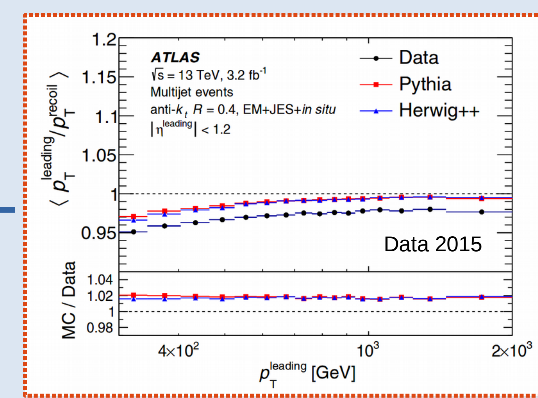


[1]

Nominal Combination

1) Interpolation

- Performed for each set of measurements separately
- Uses cubic splines

2) Averaging

- Weighted average based on a χ^2 minimisation
- Bin by bin

3) Uncertainty propagation

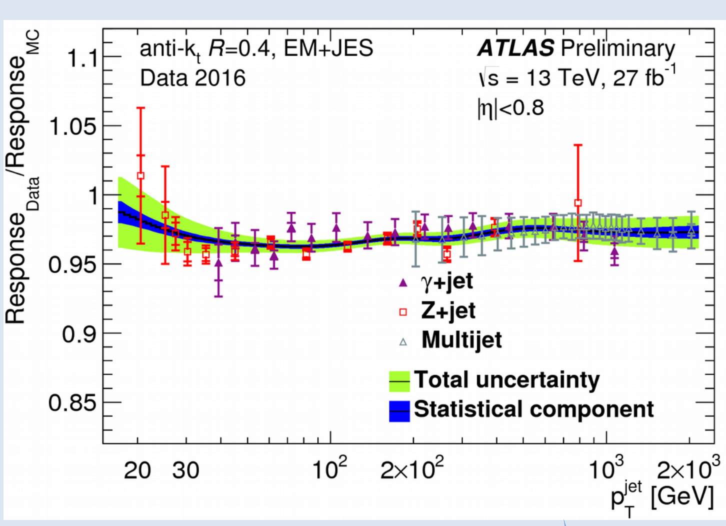
- Done with pseudo-experiments
- Takes into account known correlations

4) Rescaling

- Uncertainties are rescaled by $w=\sqrt{\chi^2/N_{dof}}$ if $w>1$

5) Smoothing

- Variable size sliding window with Gaussian kernel
- Reduces kinks due to statistical fluctuations

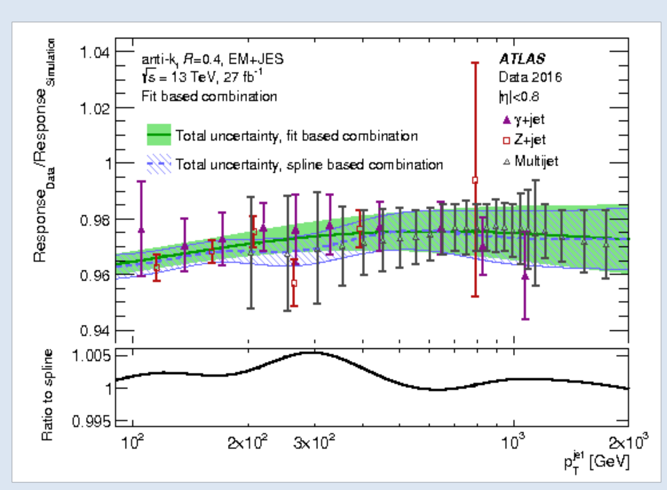


[3]

Fit-based combination

~~1) Interpolation~~
~~2) Averaging~~
~~5) Smoothing~~

} **1) Polynomial Fit**



[2]

- A 4th order polynomial in log(p_T) fitted simultaneously to all three sets of measurements
- Function giving an uncertainty band closest to the nominal
- More robust against local fluctuations
- Removes the dip at ~300 GeV in the 2016 dataset while retaining the overall shape

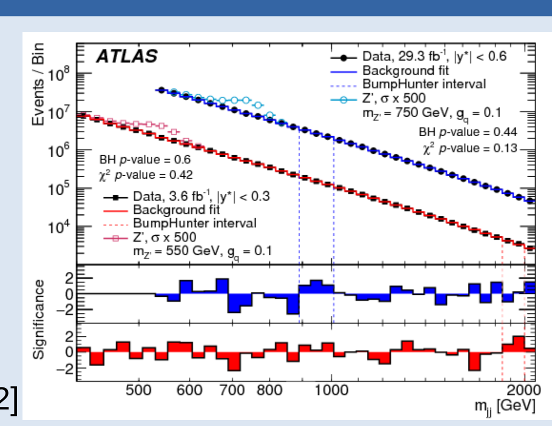
Users: Dijet analyses with smooth backgrounds

Dijet resonance searches look for a bump on a smooth QCD background

- Sensitive to any local fluctuations in p_T calibration → need a smooth calibration curve
- Smooth calibration curve guaranteed by the fit-based combination procedure

Example of such a search: Dijet Trigger Level Analysis (see W. Kalderon's poster)

- Search for low-mass dijet resonances overwhelmed by QCD background → cannot record all data, lose sensitivity
- Solution: Use high-level information from data selection (trigger) system to record more data for a smaller event size
- Consequence: Very high statistics, needs a calibration that is smooth → uses fit-based combination



[2]

References:

[1] ATLAS Collaboration: ATLAS jet energy scale and resolution in early Run 2, Phys. Rev. D 96, 072002

[2] ATLAS Collaboration: Dijet trigger-level analysis, CERN-EP-2018-033

[3] ATLAS Collaboration: https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PLOTS/JETM-2017-003/

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