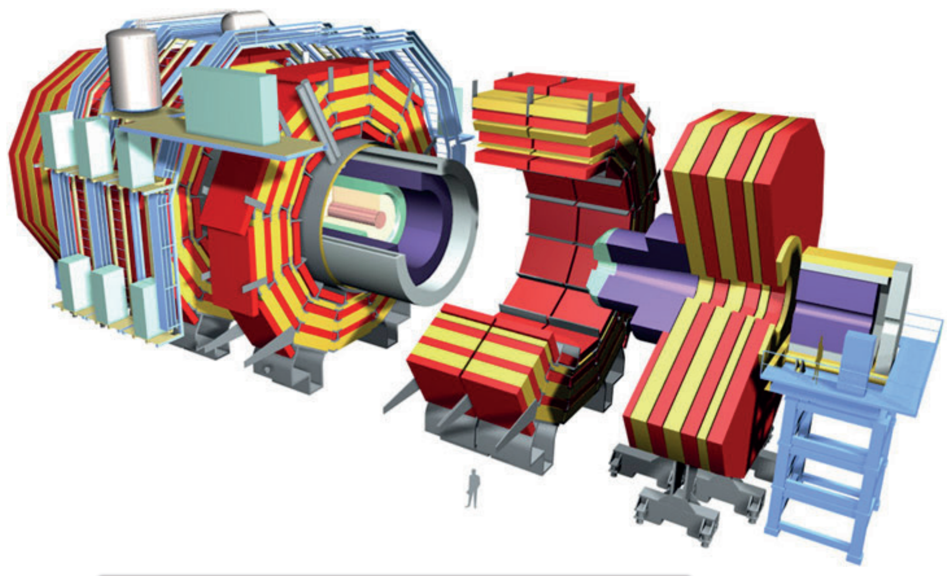
LHCC Poster Session – CERN, 22 February 2017

Jet energy scale and resolution determination in CMS at 13 TeV



Reconstructed jet (uncalibrated)

Correction for pileup and electronic noise

Scale correction vs p_T and η in MC

Residual data/MC scale differences vs η

Residual data/MC scale differences vs p_T

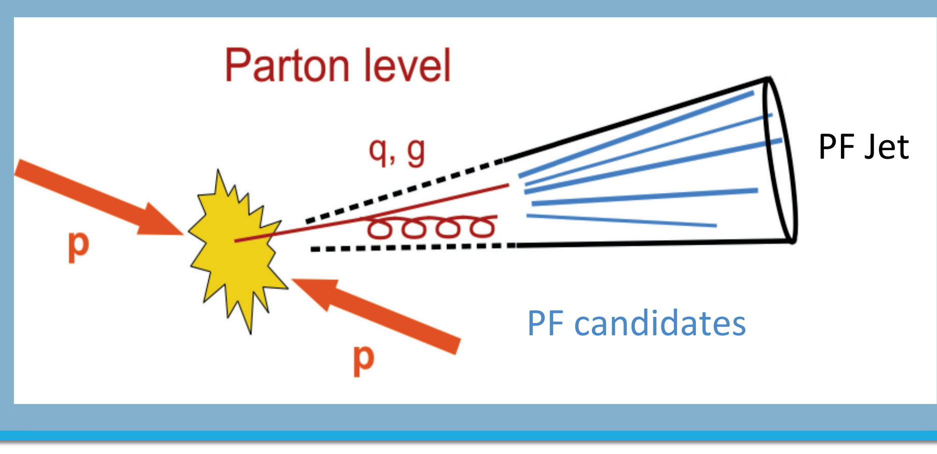
CALIBRATED JET READY FOR PHYSICS

FACTORIZATION OF CORRECTIONS

Collimated hadrons, called jets, are the experimental signature of quarks and gluons produced in the hard-scattering of partons in the collisions.
The detailed understanding of both the **jet energy scale (JES)** and the **jet energy resolution (JER)** has a **strong impact on the CMS physics programme**, as jet measurements critically depend on them.

Jet reconstruction

Particle Flow (PF) candidates: inputs to the clustering algorithm **Anti-kt with R=0.4**



Corrections

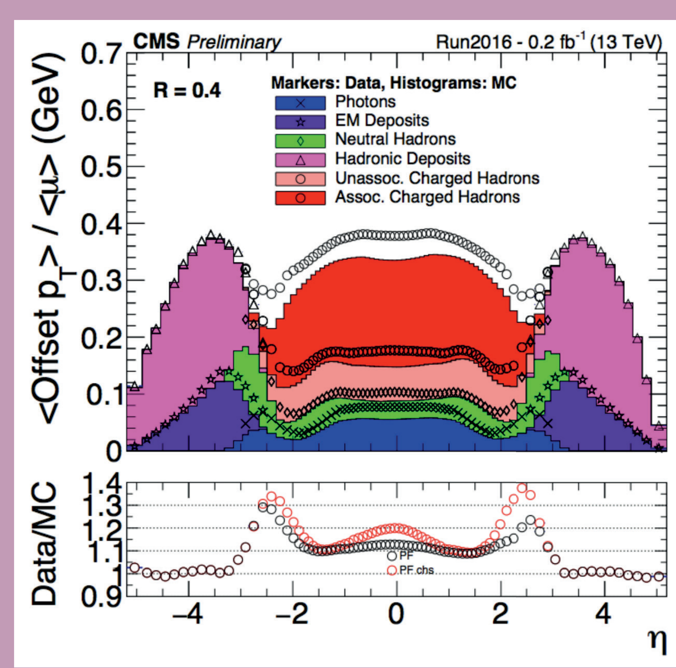
Computed to take into account different effects:

- Jet energy only partly reconstructed
- Non-linear response of calorimeters
- Detector segmentation
- Presence of material in front of calorimeters
- Electronic and physics noise

Pileup and electronic noise removal

Remove the additional energy in the event coming not from the primary hard interaction

- Study based on **Zero Bias events**
- **<Offset p_T>** : average energy due to pileup
  <μ> : average number of pileup interactions
- Data/MC: scale factor to be applied to the data



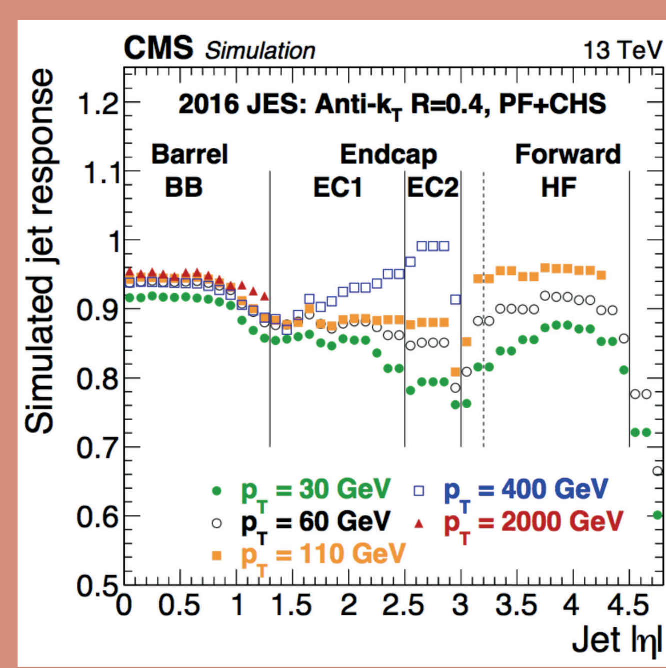
MC JES

Cure differences in jet energy response vs η and p_T

- Study performed on **QCD MC sample**
- Simulated response:

$$Jet\ \ Response = \frac{p_T(Reco)}{p_T(Gen)}$$

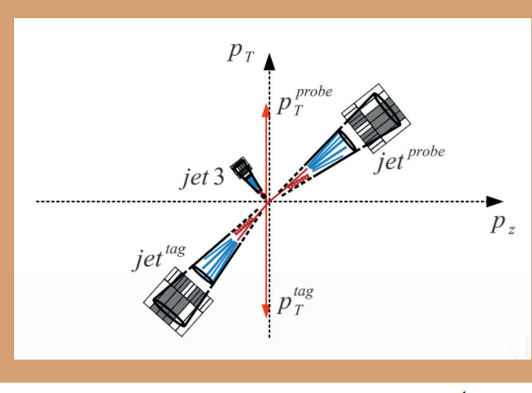
- Response flat and close to 1 after the correction vs η and p_T
- Residual Data/MC differences still to be cured (see next box)



Residual Data/MC jet energy corrections

Relative correction vs η

- **Dijet events**
- Using one jet in the barrel to correct the other one free to scan the whole detector

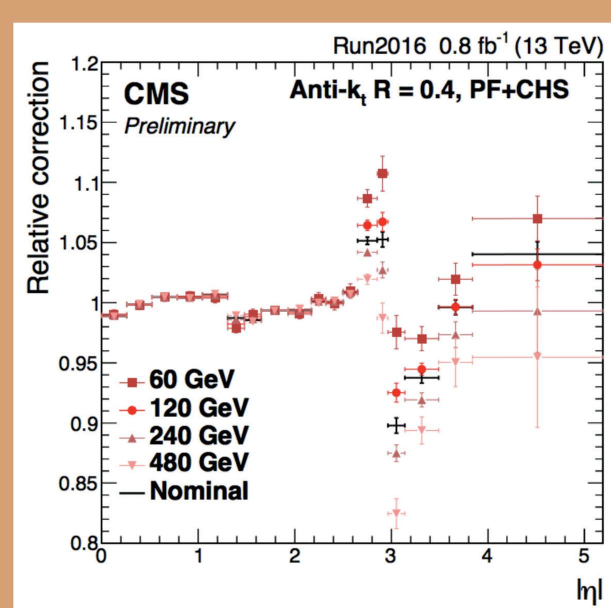


- Asymmetry in p_T between the two jets:

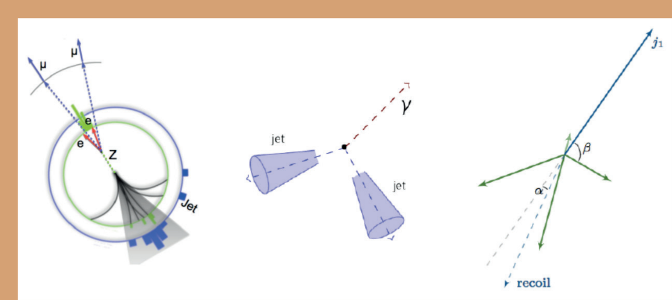
$$A = \frac{p_T^{probe} - p_T^{barrel}}{p_T^{probe} + p_T^{barrel}}$$

- Jet energy response mediated over p_T as a function of jet η:

$$Jet\ \ Response = \frac{1+\langle A\rangle}{1-\langle A\rangle}$$



Absolute corrections vs p_T



Z+jet and **γ+jet events:**

- Calibrate the jet energy scale using a well calibrated object

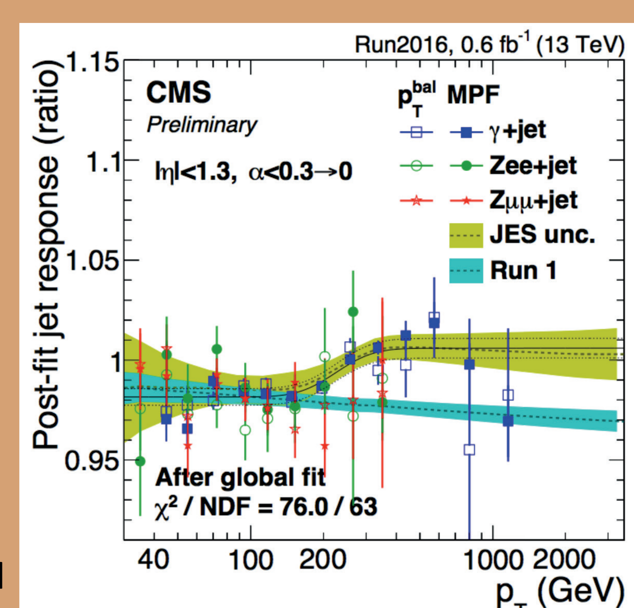
Multijets events:

- High-p_T jet balanced by two or more lower p_T jets ("recoil system")
- Jet energy response for all the methods:

1) $R_{jet}^{p_T} = \frac{p_T^{Leading\ jet}}{p_T^{ref}}$

2) $R_{jet}^{MPF} = 1 + \frac{\vec{E}_T \cdot \vec{p}_T^{\,ref}}{(p_T^{ref})^2}$ where ref = Z, γ, recoil

- Results from all the datasets combined together



Jet Energy Resolution

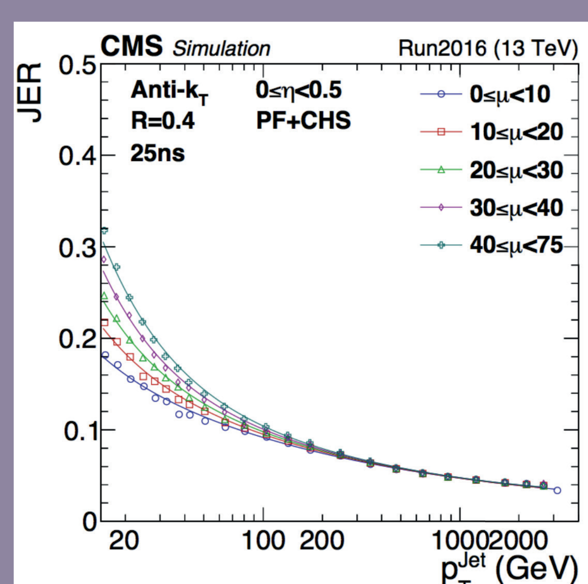
MC needs to be smeared to describe the data/Compute systematics

- Estimated and calibrated using **dijet events**
- Jet energy resolution definitions:

$$\frac{\sigma(p_T)}{p_T}(MC) = \sigma\left(\frac{p_T^{Reco}}{p_T^{Gen}}\right)$$

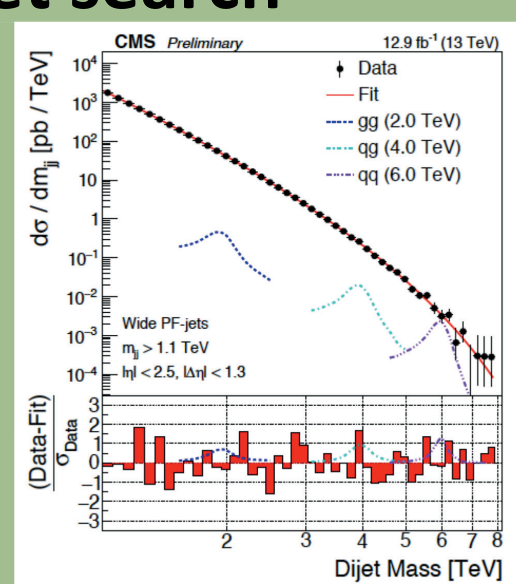
$$\frac{\sigma(p_T)}{p_T}(Data) = \sqrt{2}\sigma_A$$

where $A = \frac{p_T^{probe} - p_T^{barrel}}{p_T^{probe} + p_T^{barrel}}$



Physics example: high-mass dijet search

- LHC is a dijet resonance factory
- The precision in the knowledge of the jets energy → precision in the measurement of the resonance mass:
- Systematics uncertainty due to jet energy scale: 2% shift of m_{jj}
- Resolution @ 3TeV ~10%



Federico Preiato (University of Rome "La Sapienza" and INFN), for the CMS collaboration