Jet Energy Resolution at 13 TeV in CMS

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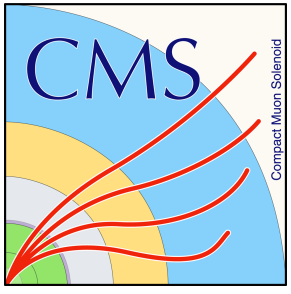

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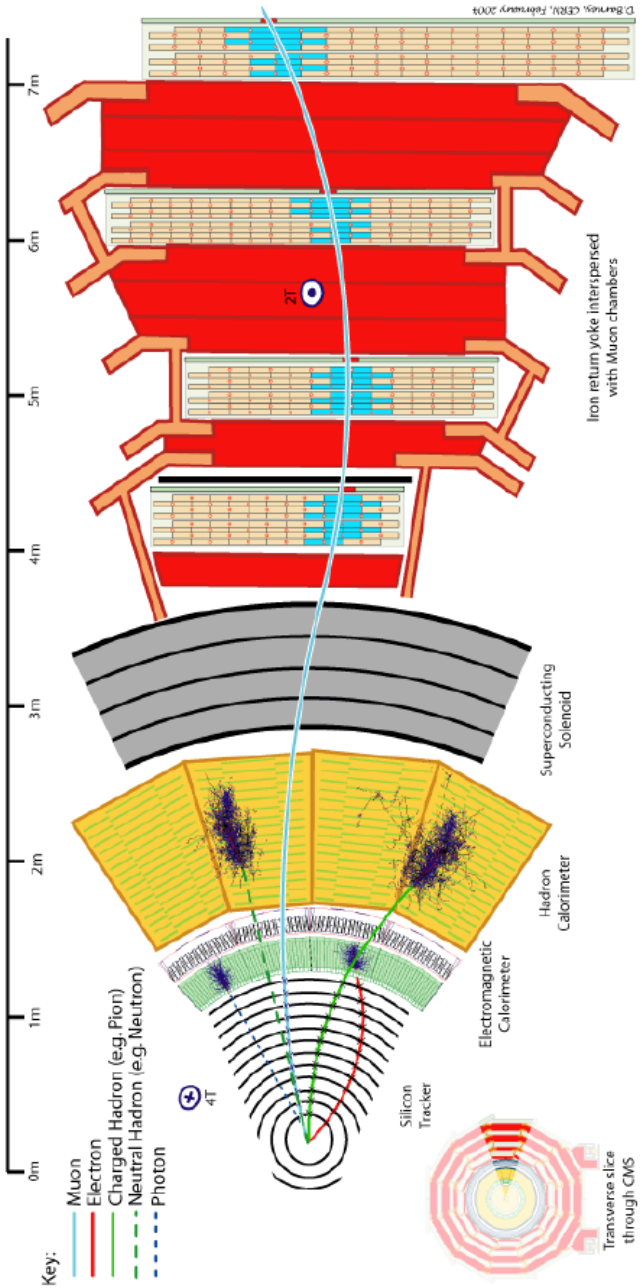
Experimental setup



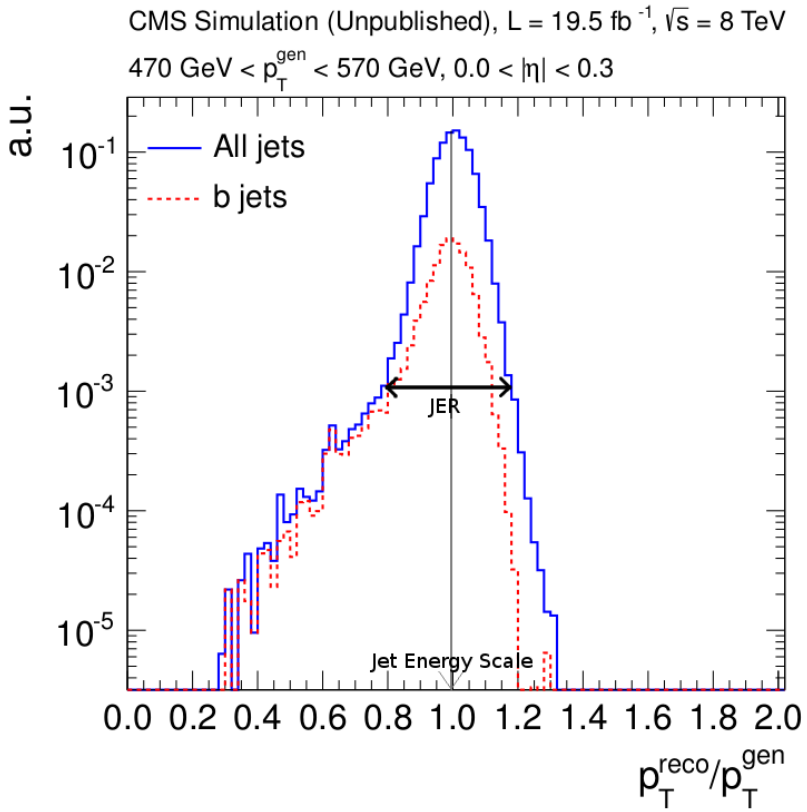
Identification & reconstruction of objects: **Particle-Flow (PF) algorithm**. Detected particles:

- photons,
- electrons,
- muons,
- neutral hadrons,
- charged hadrons.

Jets used in my work:

- reconstructed using PF with **Charged Hadron Subtraction (CHS)**.
- used **anti-k_T algorithm**, $R = 0.4$ (**ak4**)

Motivation



K. Goebel, DESY-THESIS-2015-003

Jet Energy Scale = Mean(p_T^{reco}/p_T^{gen})

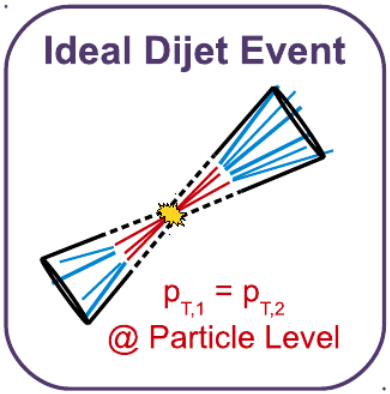
Jet Transverse Momentum Resolution = $\sigma(p_T^{reco}/p_T^{gen})$

Measurement in data:

- γ + jets events
- **dijet events**

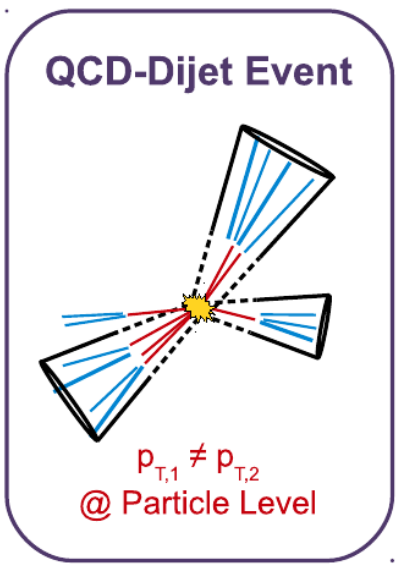
We want to measure the **detector** effect **only**!

Dijet event



Dijet event $\rightarrow \sigma_{JER}$ in simulation and in data.
Asymmetry $\mathcal{A} = \frac{p_{T,1} - p_{T,2}}{2p_T^{ave}}$

$$\sigma_{\mathcal{A}}^2 = \left(\frac{\sigma(p_{T,1})}{2<p_T>}\right)^2 + \left(\frac{\sigma(p_{T,2})}{2<p_T>}\right)^2 \qquad \frac{\sigma(p_T)}{<p_T>} = \sqrt{2}\sigma_{\mathcal{A}}$$



- description possible with some parameter $\alpha \rightarrow$ measure of additional radiation $(\alpha = \frac{p_{T,3}}{p_T^{ave}})$
- $\sigma_{\mathcal{A}}(\eta, p_T) \rightarrow \sigma_{\mathcal{A}}(\eta, p_T, \alpha)$
- we can investigate impact of α on $\sigma_{\mathcal{A}}$

Selection, binnings

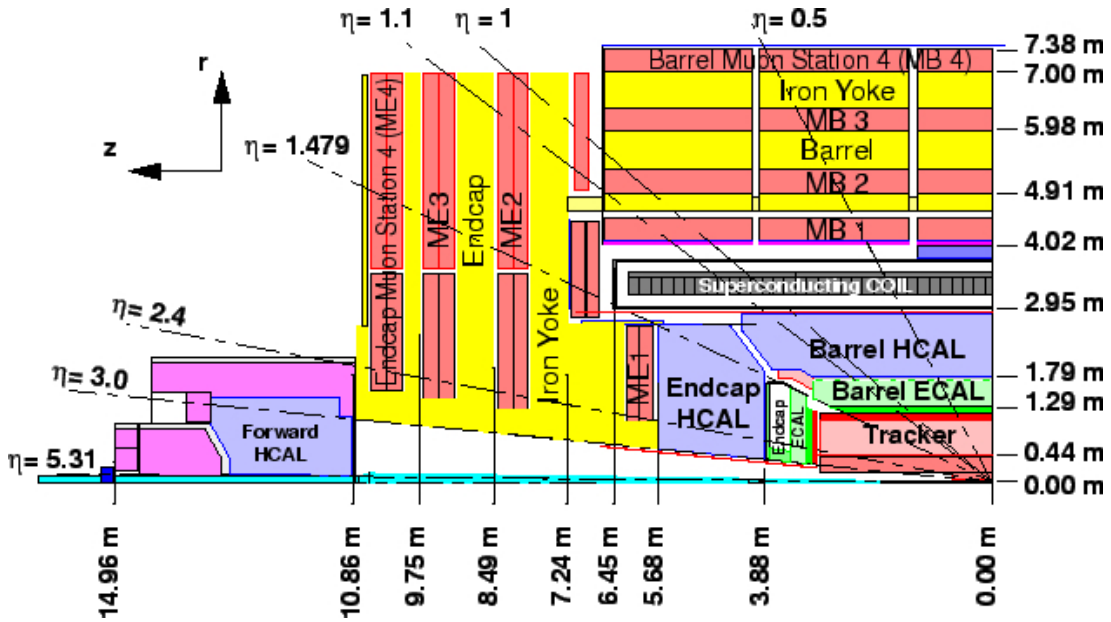
Standard JER calculation:

- $\frac{\sigma(p_T)}{<p_T>} = \sqrt{2}\sigma_{\mathcal{A}}$
- measurements in p_T^{ave}, $|\eta|$ and α_{max} bins,
- p_T^{ave} binning acording to trigger tresholds,
- $|\Delta\phi_{jet1,jet2}| \geq 2.7$,
- both jets in same $|\eta|$ bin.

Forward extension:

- $\frac{\sigma(p_T)}{<p_T>} = \sqrt{2}\sqrt{\left(\sigma_A^{probe}\right)^2 - \left(\frac{\sigma_A^{ref}}{2}\right)^2}$
- Most selection the same,
- one jet in reference $|\eta|$ bin (0.-1.3),
- case when both jets have $|\eta| \leq 1.3$ gives us reference region measurement.

Experimental setup

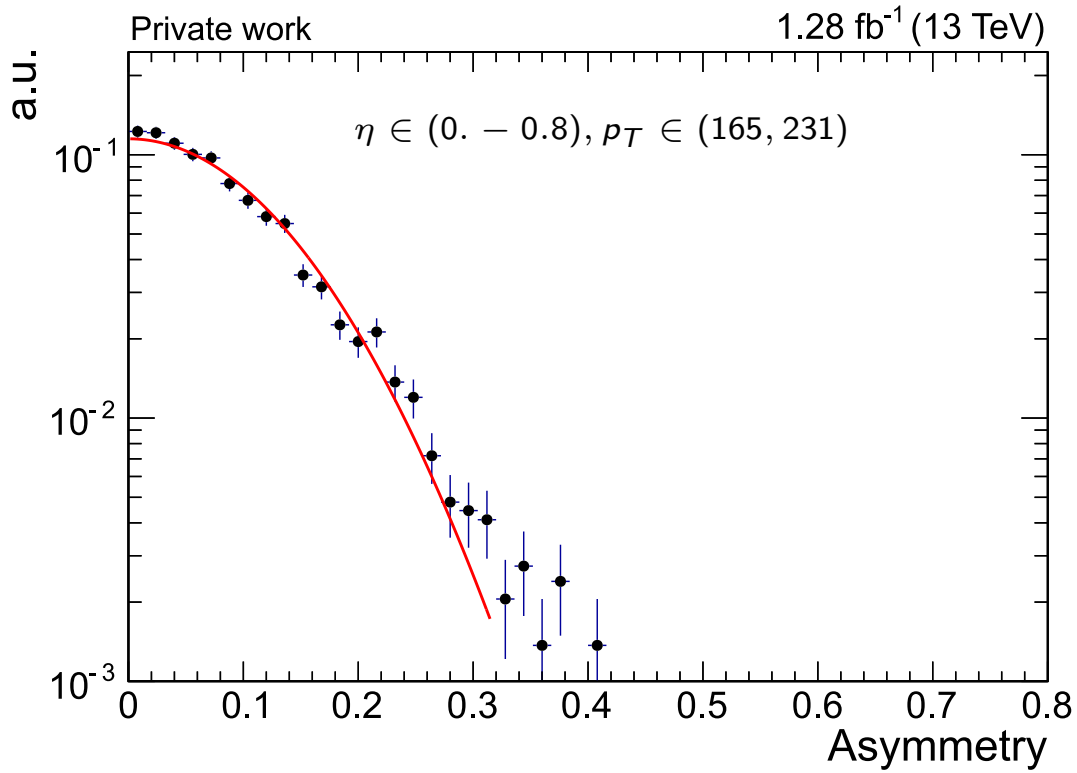


- $\eta \in (0.0 - 3.0)$ standard Dijet triggers,
- $\eta \in (3.0 - 4.7)$ forward calorimeter triggers,

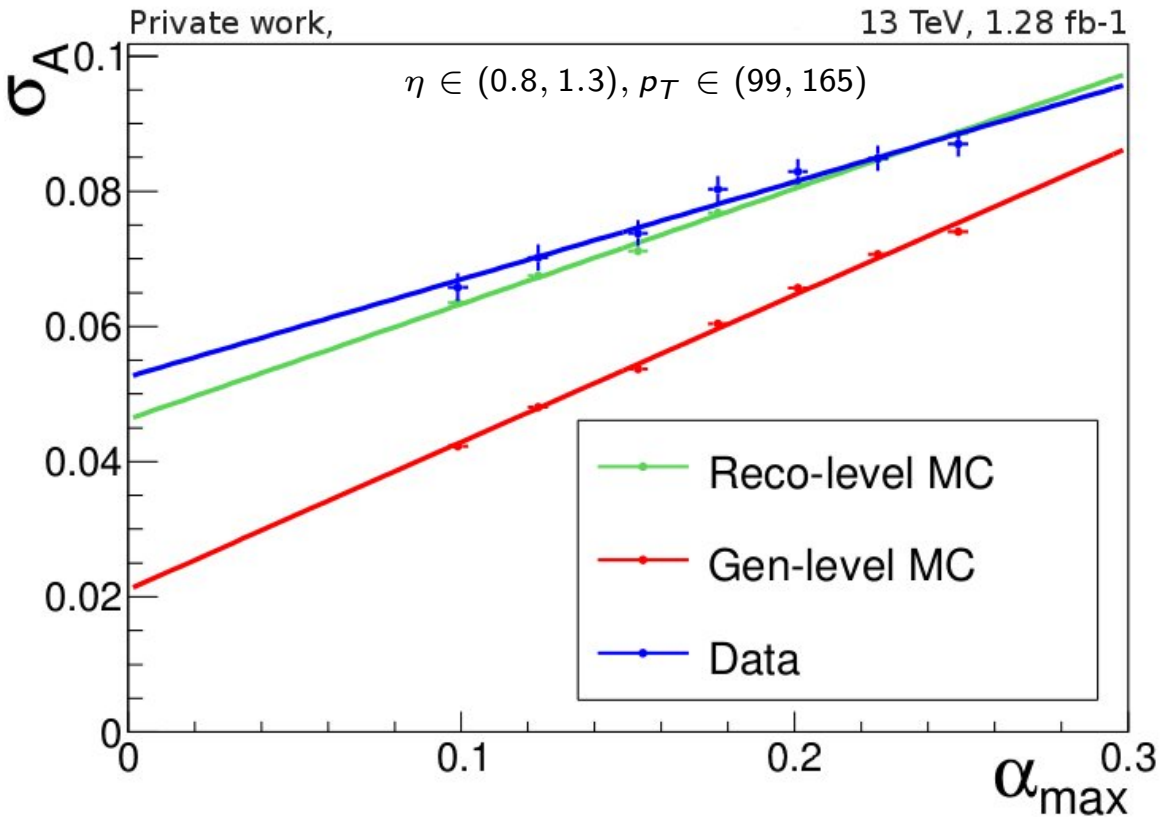
0. - 0.5	Standard
0.5 - 0.8	Standard
0.8 - 1.1	Standard
1.1 - 1.3	Standard
1.3 - 1.7	St + FE
1.7 - 1.9	St + FE
1.9 - 2.1	St + FE
2.1 - 2.3	St + FE
2.3 - 2.5	St + FE
2.5 - 2.8	St + FE
2.8 - 3.0	Fw. ext.
3.0 - 3.2	Fw. ext.
3.2 - 4.7	Fw. ext.

Widths calculation

- Assymetry distribution: gaussian core + non-gaussian tails.
- Truncated RMS $\rightarrow$ 1.5% highest asymmetry points rejected.
- First step it so measure widths in all η, p_T and α_{max} bins.
- Widths calculated using RMS.



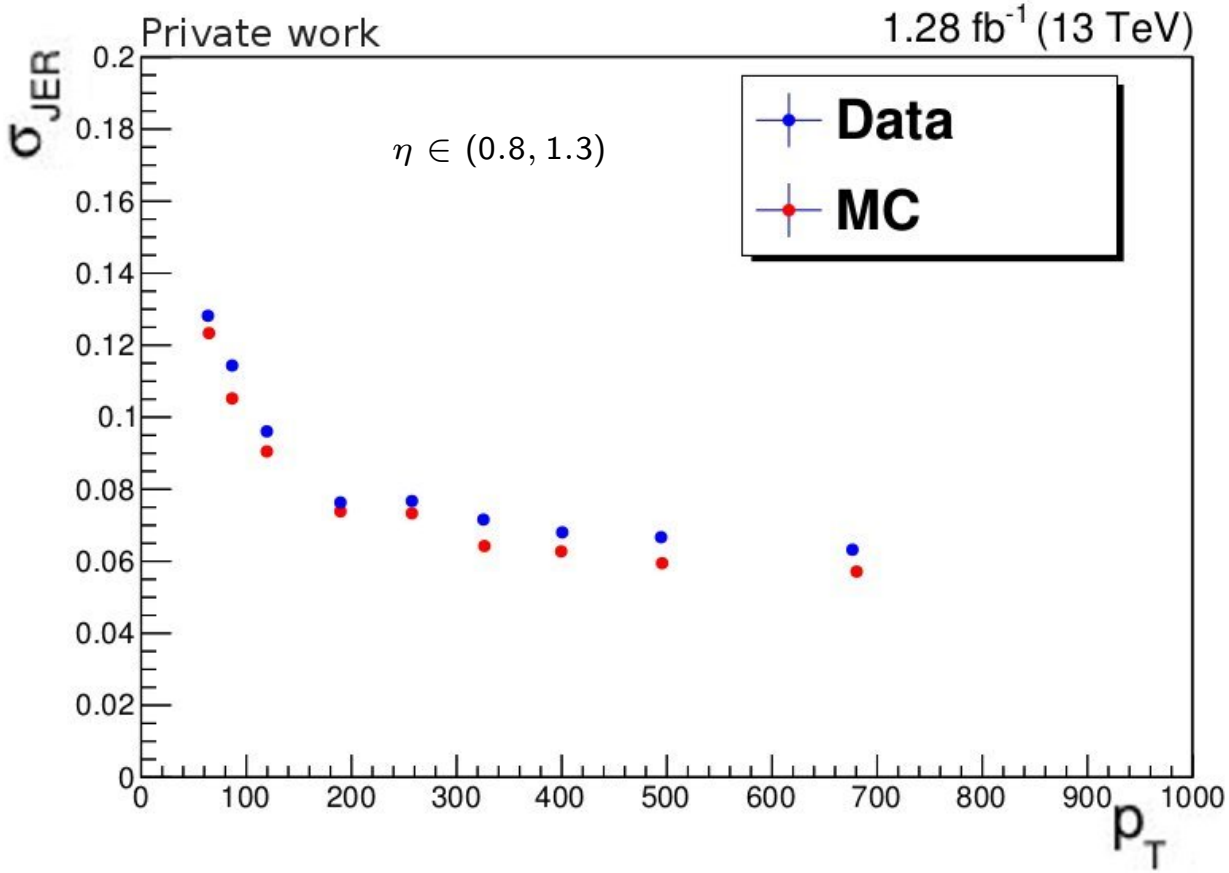
Line fit to $\sigma(p_T)$



$\sigma_{JER}(p_T)$ after **PLI** subtraction

I correct measured widths in data and MC for **Particle Level Imbalance (PLI)**

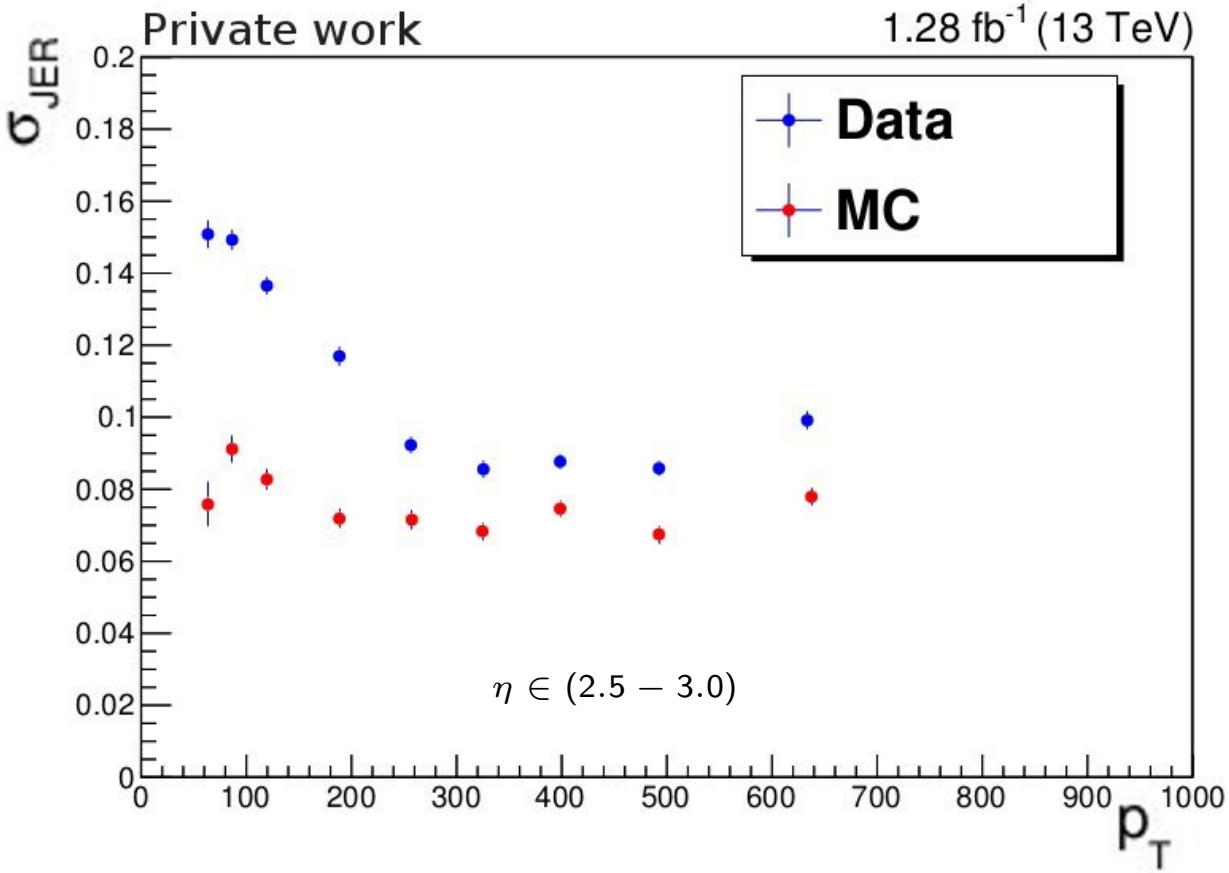
$$\sigma_{JER}(p_T,\eta) = \sqrt{2}\sqrt{\left(\sigma_A^{reco}(p_T,\eta)\right)^2 - \left(\sigma_A^{PLI}(p_T,\eta)\right)^2}$$



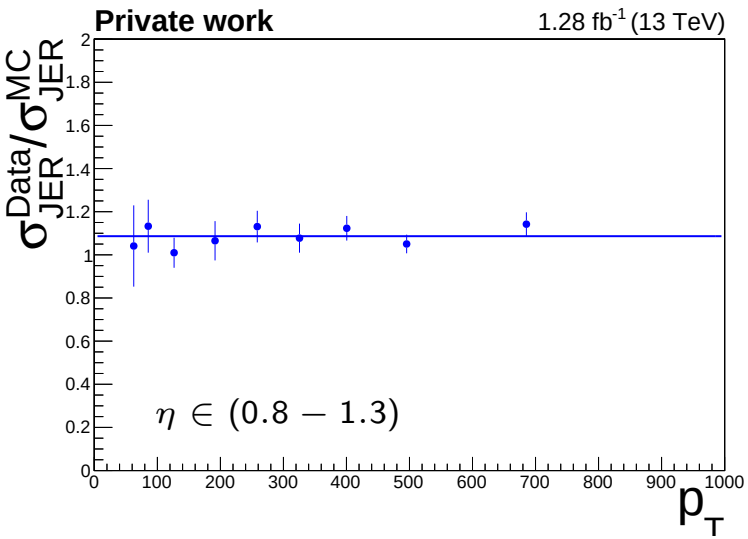
Forward Extension

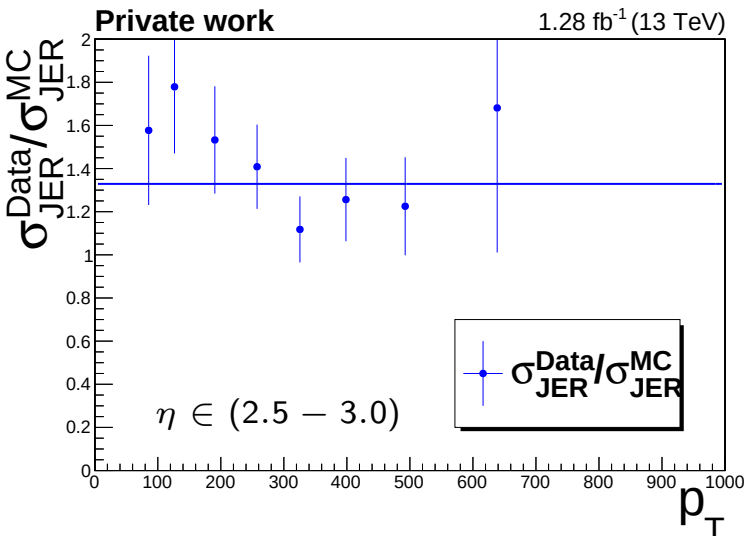
There comes one additional step for Forward extension, subtraction of the reference region JER:

$$\sigma_{JER} = \sqrt{2}\sqrt{\left(\sigma_A^{probe}\right)^2 - \left(\frac{\sigma_A^{ref}}{2}\right)^2}$$



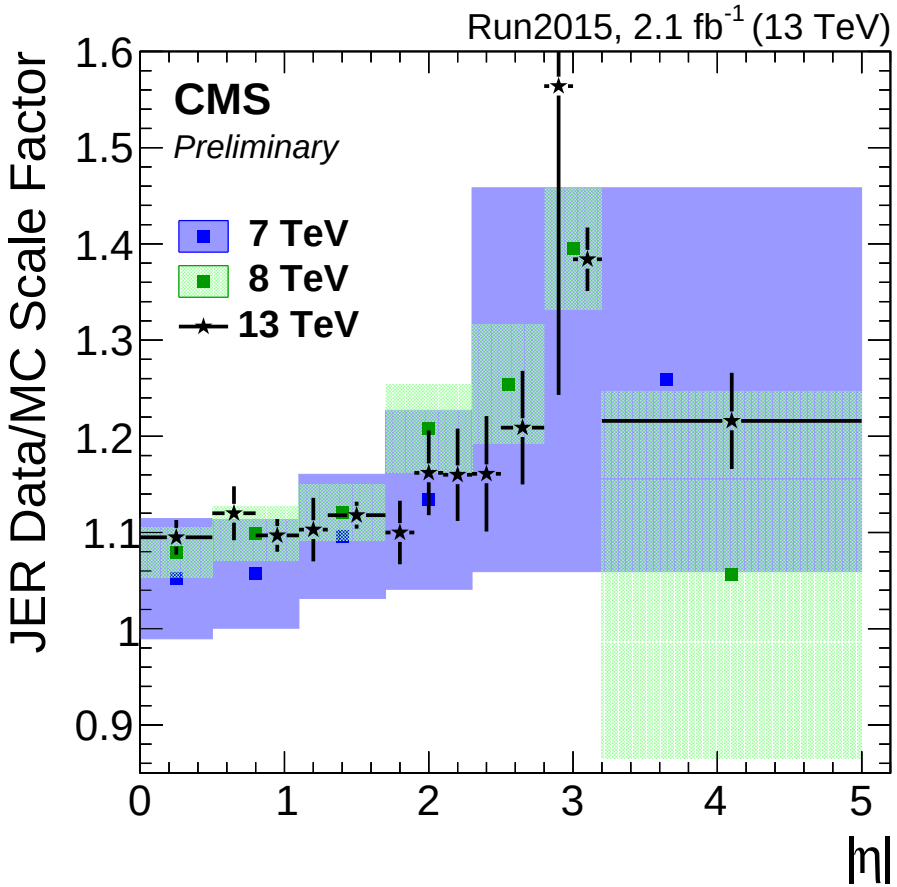
Scale factors





Using calculated σ_{JER} I calculate ratio $\sigma_{JER}^{Data}/\sigma_{JER}^{MC}$ and calculate scale factors from those histograms.

Summary



- Scale factors for 13 TeV calculated.
- Further studies to investigate difference from 8TeV results.