Residual Jet Energy Correction with 2017 Dijet Data at CMS

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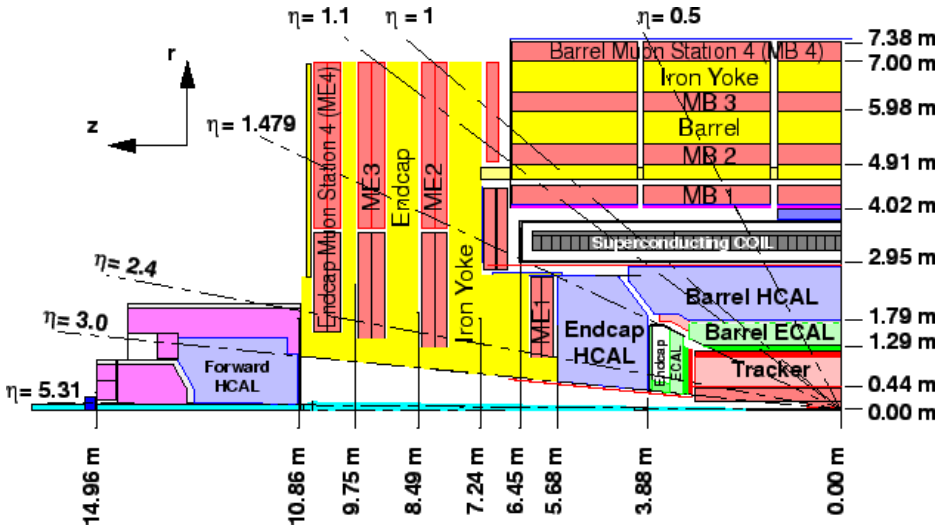
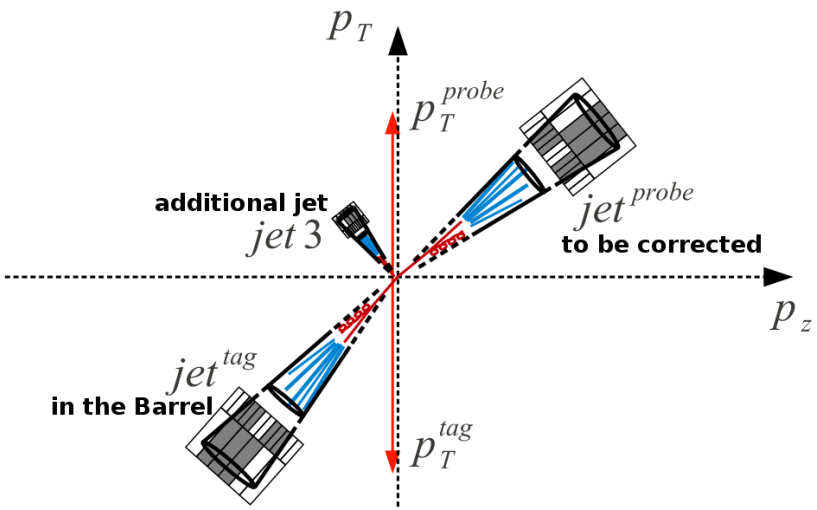
Relative Residual Correction

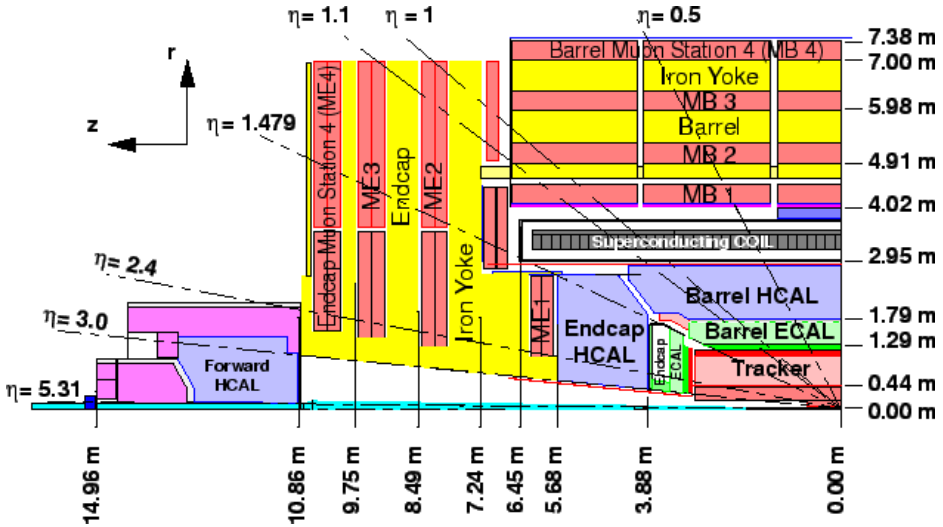
Correct the jet energy response differences in simulation and data after the main response and pile-up correction.



Relative Residual Correction

- Ideal dijet jets are balanced
- Barrel ($|\eta| < 1.3$) jet as reference
- Calibrate probe jet ($|\eta| < 5.2$)
- Dijet events are rare, $n_{jet} > 2$ events are considered to improve statistic





Input and Selection

Data

RunII 2017 41 fb^{-1}

with HLT single and di particle flow jet triggers

Simulation

QCD MC `pythia8`

Selection:

- Lepton veto
- At least two particle flow jets with charged hadron substruction, clustered with anti-kt with R=0.4 (AK4CHS)
- $|\eta_{tag}| < 1.3$

Response Definition

p_T-balance response

- $A = \frac{p_T^{probe} - p_T^{tag}}{p_T^{probe} + p_T^{tag}}$
- Relative response $R_{rel}^{p_T} = \frac{1+<A>}{1-<A>}$
- In bins of $|\eta_{probe}|$ and p_T^{ave}

less effected by detector resolution

MET projection fraction (MPF) response

- $B = \frac{\not{\vec{E}}_T \cdot \vec{p}_T^{tag} / p_T^{tag}}{p_T^{probe} + p_T^{tag}}$
- Relative response $R_{rel}^{MPF} = \frac{1+<B>}{1-<B>}$
- In bins of $|\eta_{probe}|$ and p_T^{ave}

less effected by energy loss from parton balance and showering

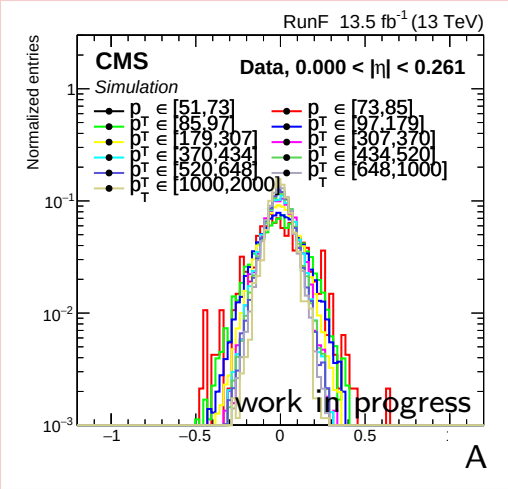
$$p_T^{ave} = \frac{p_T^{jet1} + p_T^{jet2}}{2}$$

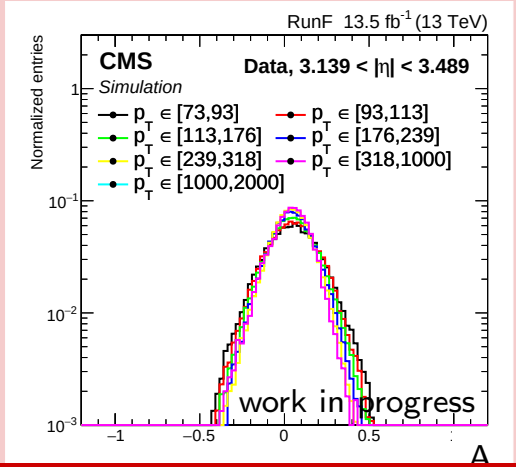
Asymmetry and MPF

Example part of the data in the barrel (upper row) and end cap (lower row)

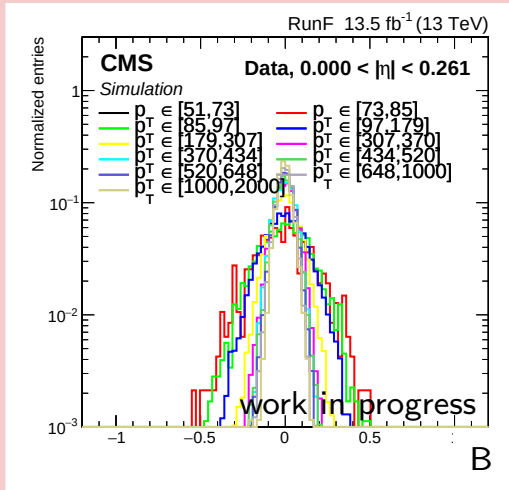
p_T-balance response

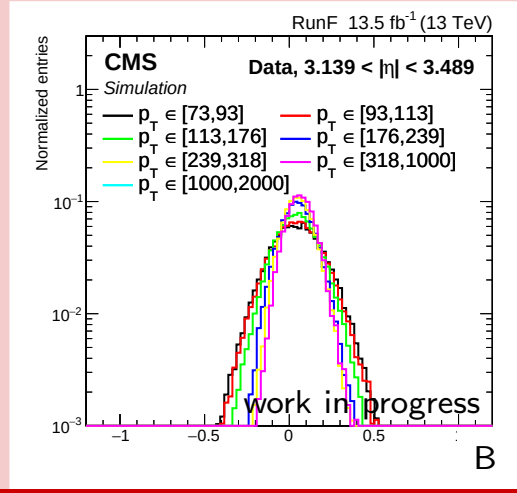
$$A = \frac{p_T^{probe} - p_T^{tag}}{p_T^{probe} + p_T^{tag}}$$





MPF response $B = \frac{\vec{E}_T \cdot \vec{p}_T^{\,tag} / p_T^{tag}}{p_T^{probe} + p_T^{tag}}$



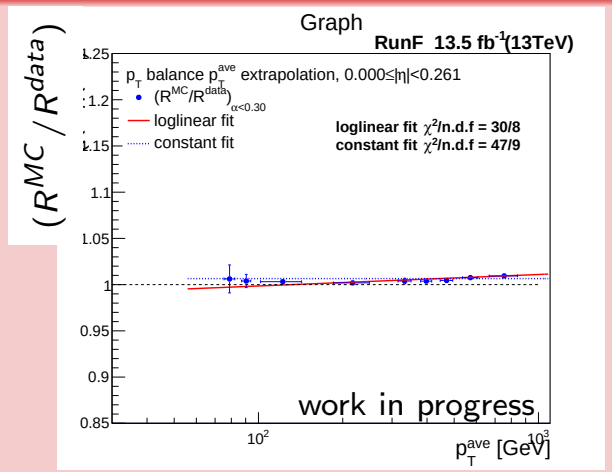


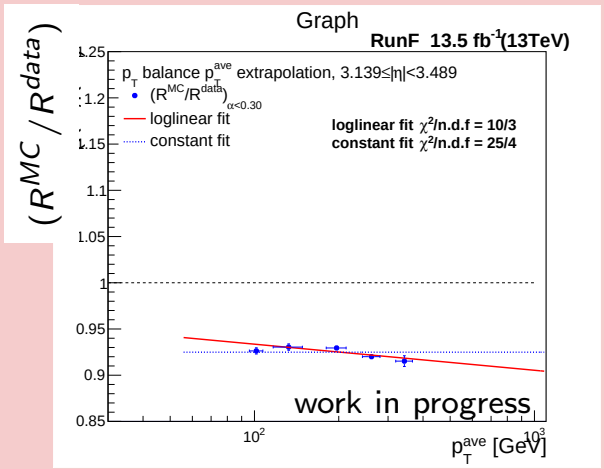
Relative Response at $\alpha < 0.3$

Example part of the data in the barrel (upper row) and end cap (lower row)

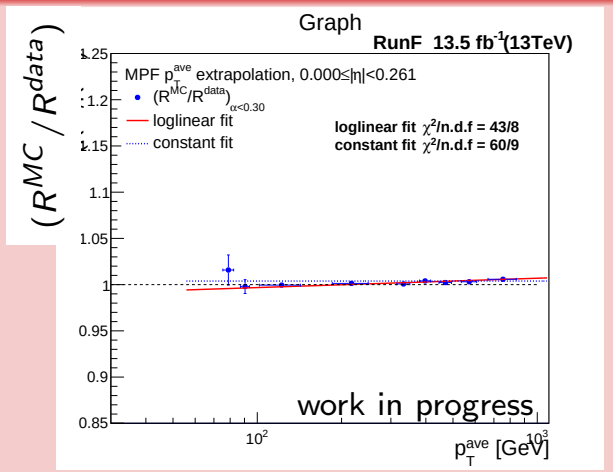
$$R = \frac{1+<A>}{1-<A>} \qquad \alpha = p_T^{jet3} / p_T^{ave}$$

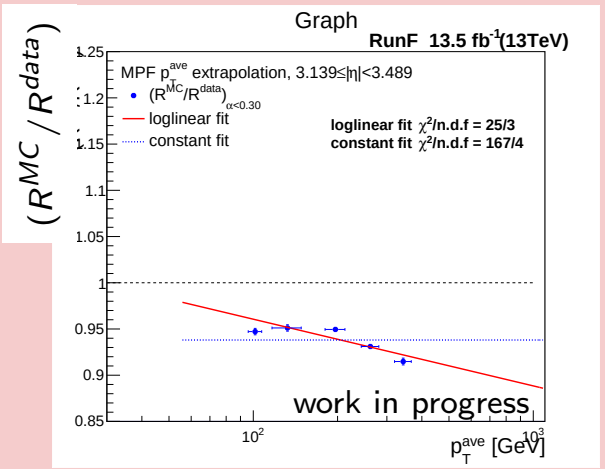
p_T-balance response





MPF response

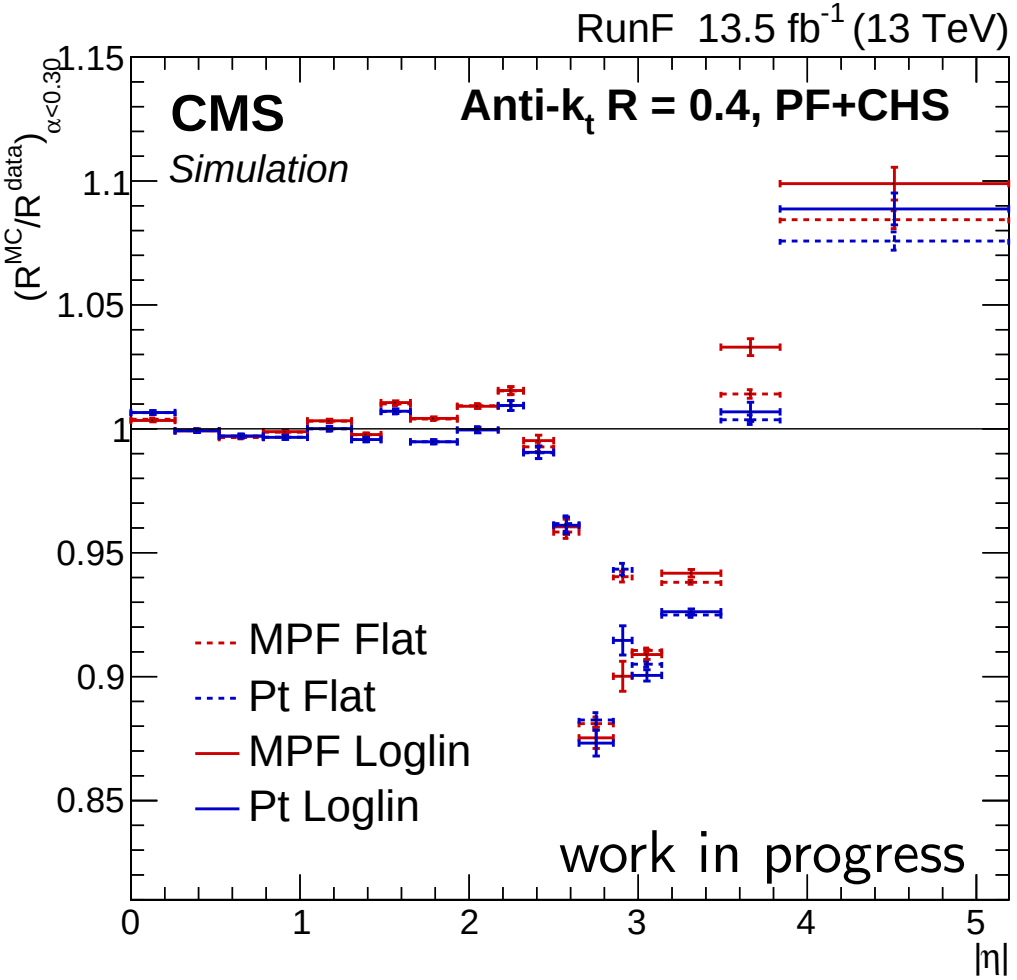




$(R^{MC}/R^{data})_{\alpha<0.3}$ per p_T^{ave} is fitted constant and loglinear

Ratio of Responses at $\alpha < 0.3$

Take loglinear function at $< p_T^{ave} >$



Difference between p_T-balance and MPF method is expected due to additional radiation

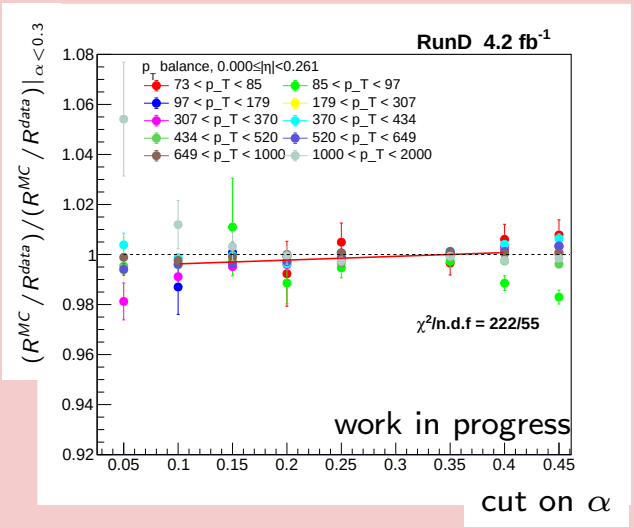
$$\mathcal{C}(|\eta_{probe}|) = \left\langle R^{MC}/R^{data} \right\rangle_{\alpha<0.3} \cdot k_{FSR}, \text{ with } k_{FSR} = \frac{\left\langle R^{MC}/R^{data} \right\rangle}{\left\langle R^{MC}/R^{data} \right\rangle_{\alpha<0.3}}|_{\alpha\to 0}$$

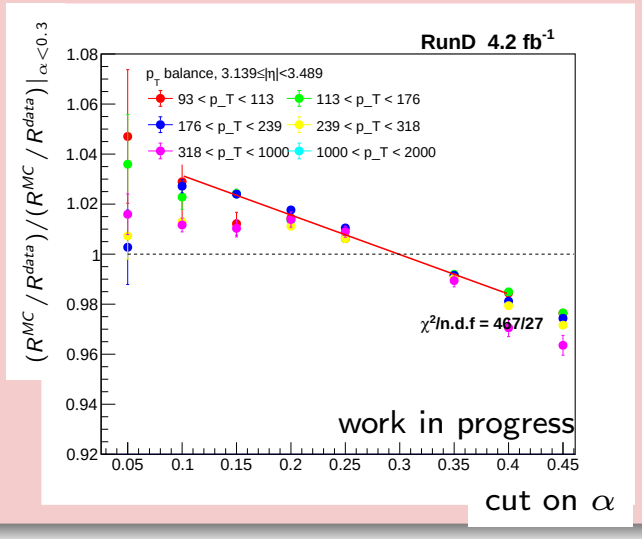
$\alpha \to 0$ extrapolation

Example part of the data in the barrel (upper row) and end cap (lower row)

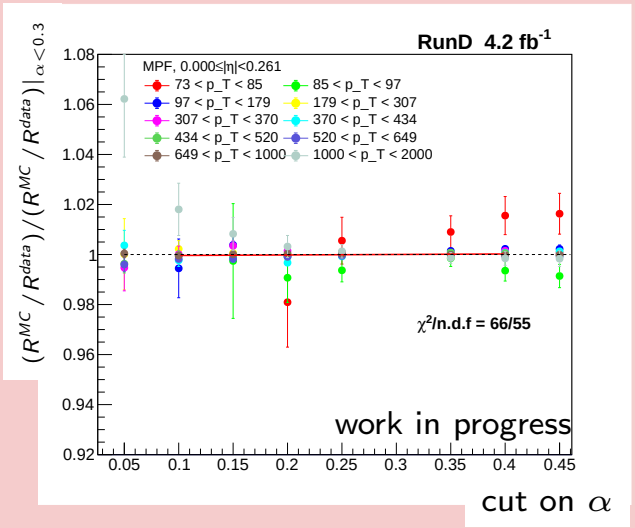
Fit $(R^{MC}/R^{data})/(R^{MC}/R^{data})|_{\alpha<0.3}$(cut on α)

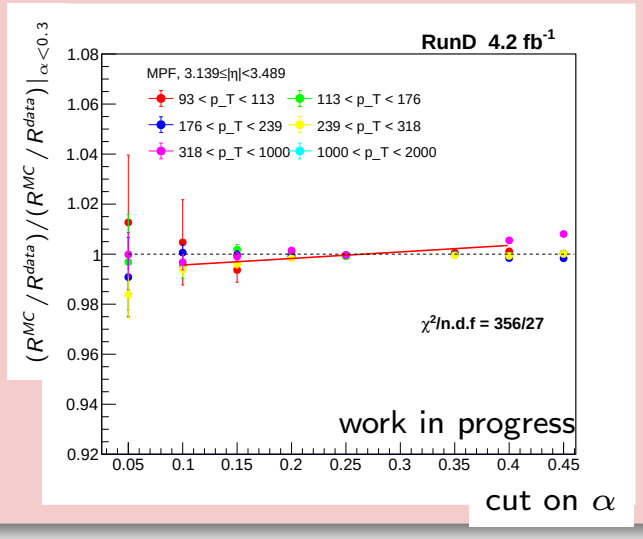
p_T-balance response



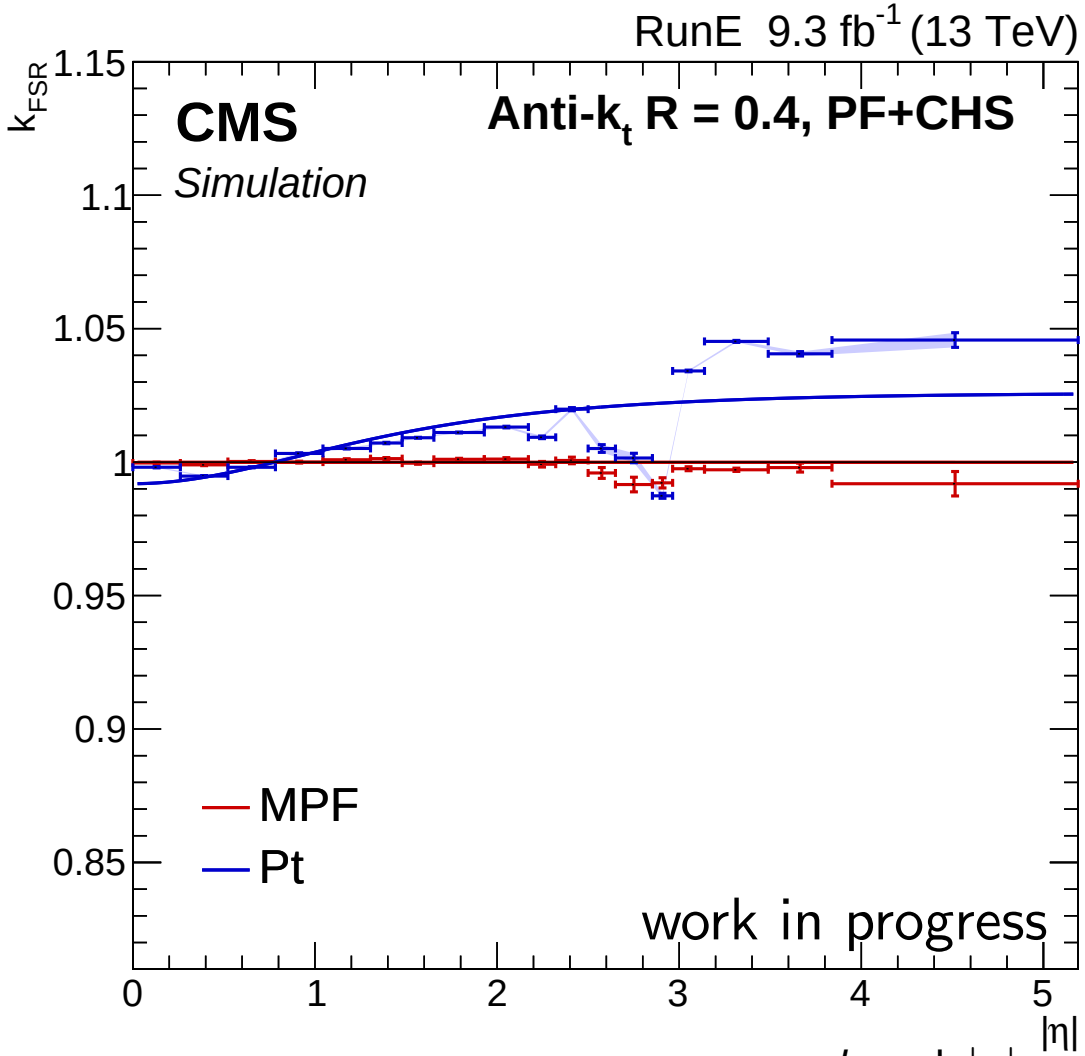


MPF response





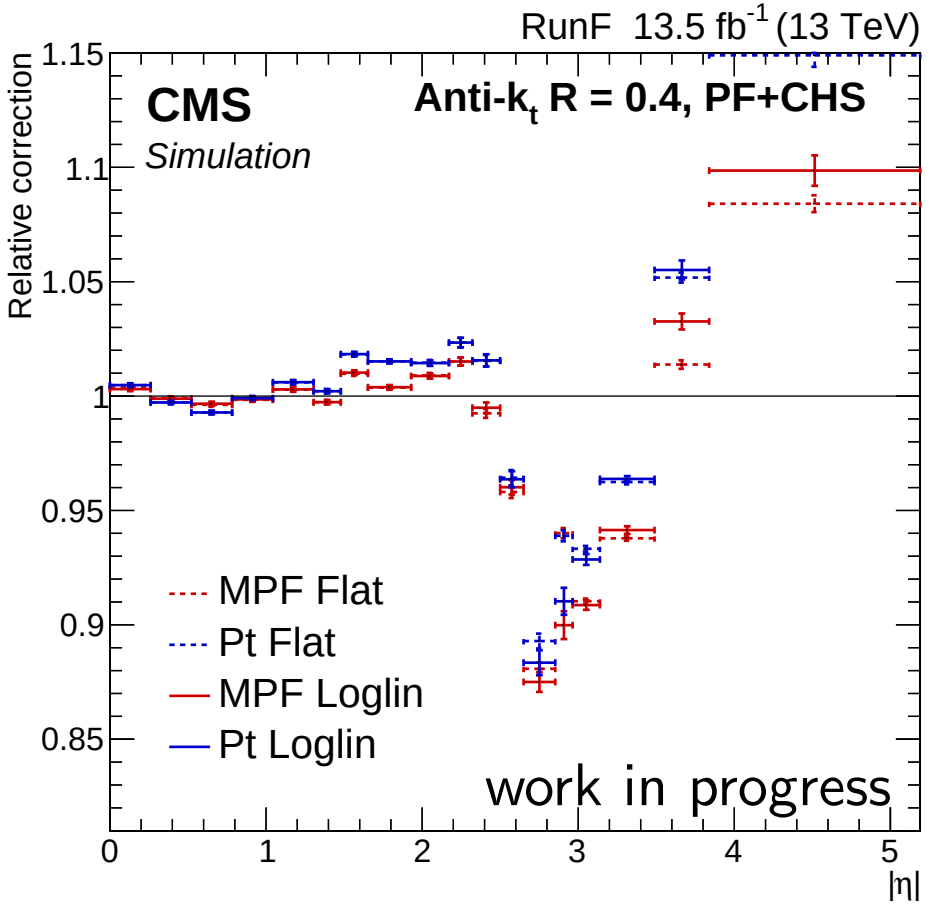
Residual Correction for Additional Radiation



Fitted with $k_{FSR}^{fit}(|\eta|) = a + \frac{b \cdot \cosh|\eta|}{1 + c \cdot \cosh|\eta|}$

Relative Residual Corrections

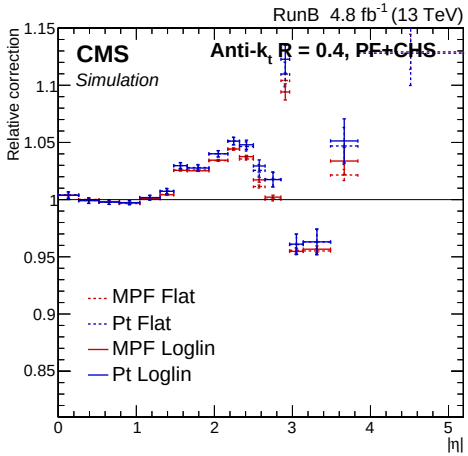
$$\mathcal{C}(|\eta_{probe}|) = \left\langle R^{MC}/R^{data} \right\rangle_{\alpha<0.3} \cdot k_{FSR}$$



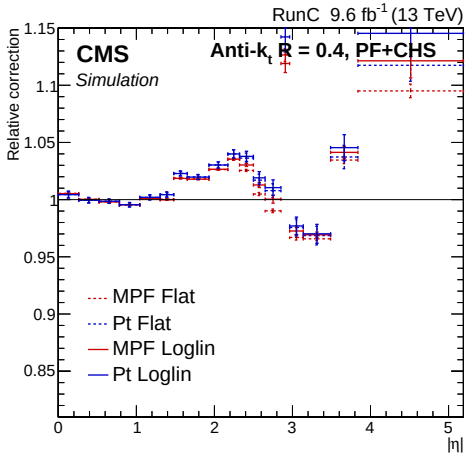
Final Pt and MPF response corr. are expected to be compatible

L2Res 2017 with V23 JEC, with JER SF 2017 V1

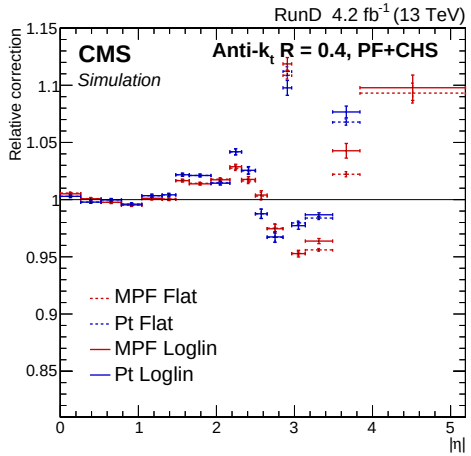
Run B



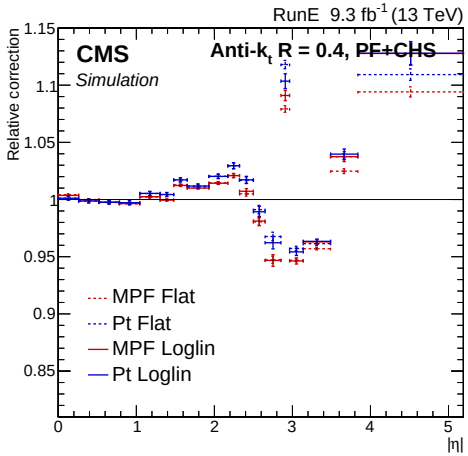
Run C



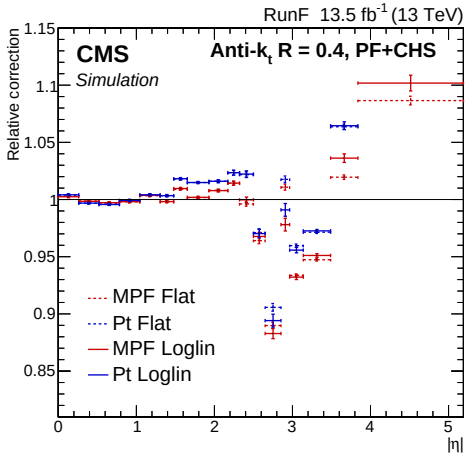
Run D



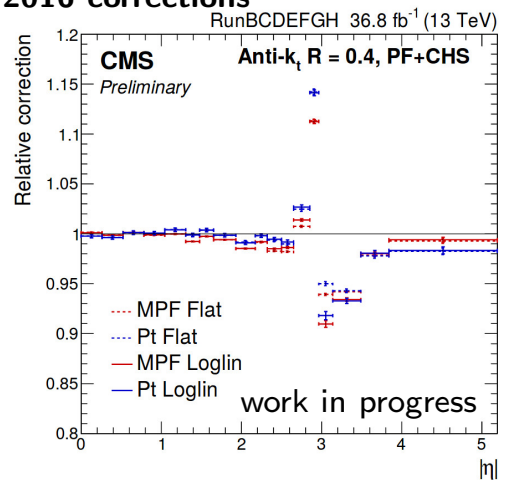
Run E



Run F

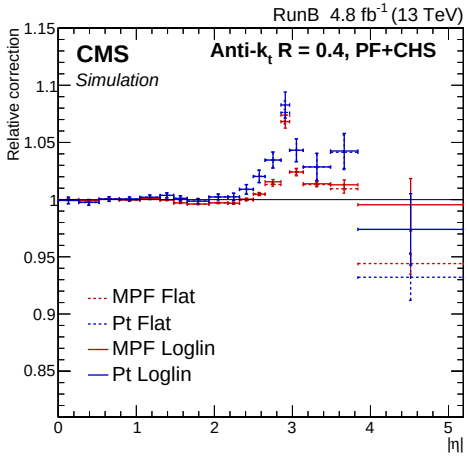


2016 corrections

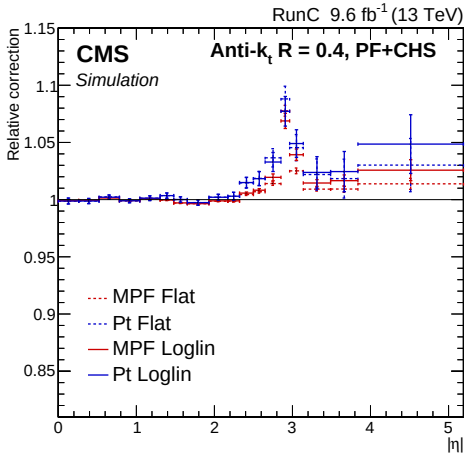


Effect of JER SF on L2Res

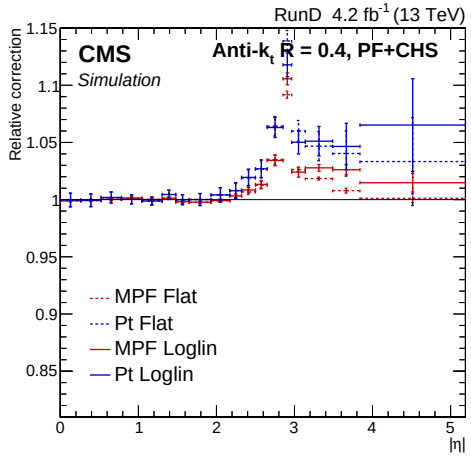
Run B



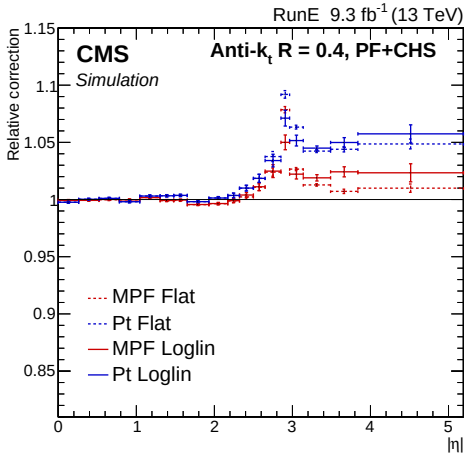
Run C



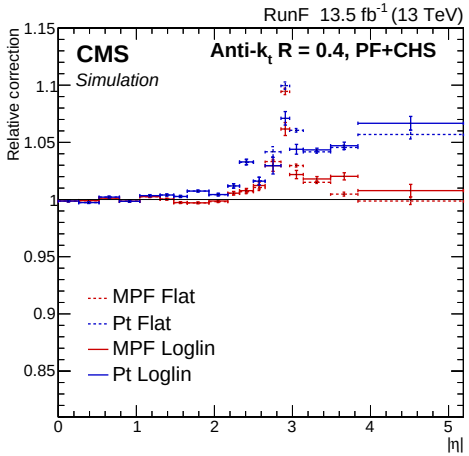
Run D



Run E



Run F



JER SF has a big influence in the ECAL region

Basics of ECAL Pre-Firing

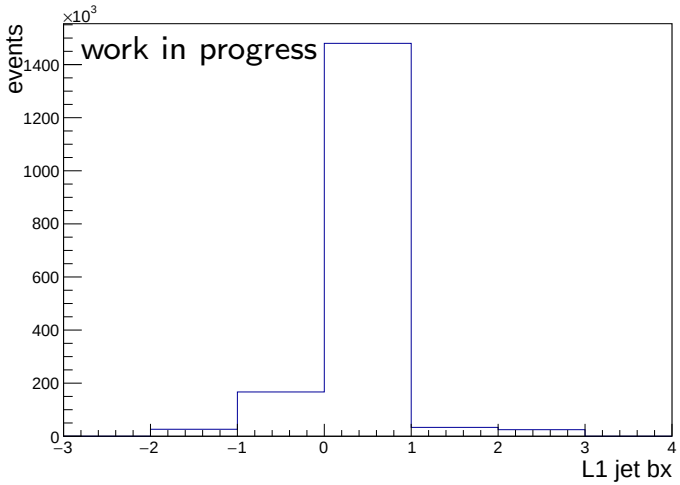
as reported at PPD General Meeting 05/24/18 by Andrew Brinkerhoff

- Mis-timing of L1 objects due to ECAL transparency loss
- If a mis-timed (early) L1 object is above the E_T threshold for an unprescaled L1 path, the previous event will be sent to HLT, and the event actually containing the offline object will be discarded
- Potentially leads to trigger inefficiency
- ECAL selective readout at PF can be affected (based on L1 decisions) $\rightarrow$jet energy bias

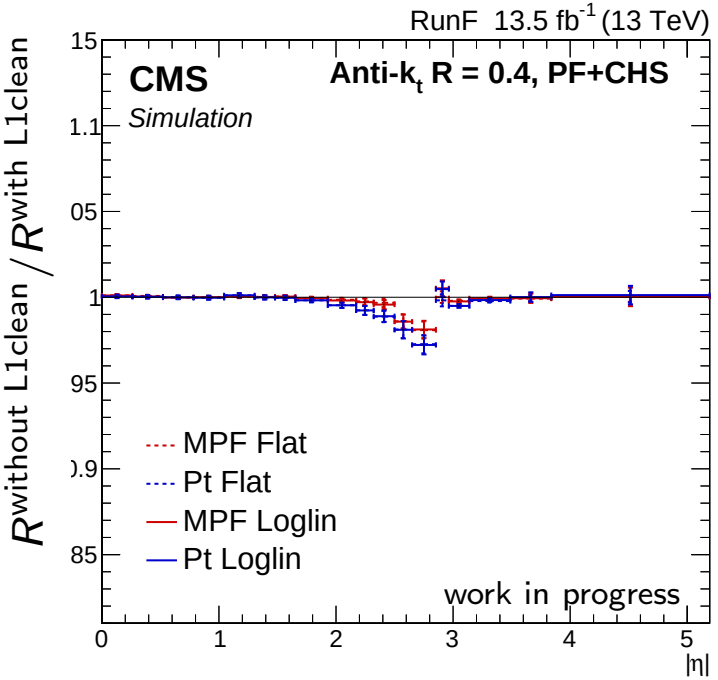
more information:
https://indico.cern.ch/event/729127/contributions/3014895/attachments/1655476/2649972/2018_05_24_PPD_ECAL_prefiring.pdf
https://indico.cern.ch/event/732212/contributions/3026917/attachments/1663881/2666673/Level1_DPG_UpdatePreFire_PPD_7June2018.pdf
in depth from ECAL report: https://indico.cern.ch/event/724266/contributions/2978986/attachments/1638851/2615873/ecaltp_prefire.pdf
with a proposal on how to check the effect on your analysis https://indico.cern.ch/event/751713/contributions/3113327/attachments/1704193/2745495/ecalprefiringupdate.pdf

Filter Pre-Fired Events

L1Jet seed bunch crossings matched
to the three leading jets for $2.2 < \eta < 3.2$



Response ratio without and with pre-firing cleaning



L1Jet Seed Based Cleaning:

- $\Delta R\left(\text{jet}_i, \text{L1Jet}_{\text{bx}=-1}\right) < 0.4$ for $i \in [1, 2, 3]$
- $\text{L1Jet}_{\text{bx}=-1} p_t > 20\%$ of matched jet p_t

Keep that in mind but handle ECAL noise and FSR problem first.

Summary

- L2 residual corrections without JER SF available (V27)
- L2 residual corrections with first 2017 JER SF available (V28)
- Pre-firing effect on relative residual correction up to 3%

Outlook:

- cross-check with MadGraph QCD MC
- check if the single jet HF trigger in Run C can be used
- closure test with unprefirable events
- check time-dependence to combine L2Res in less IOVs