L1T Jets and MET: 2017 Status and 2018 Plans

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Science & Technology Facilities Council
Rutherford Appleton Laboratory

Introduction

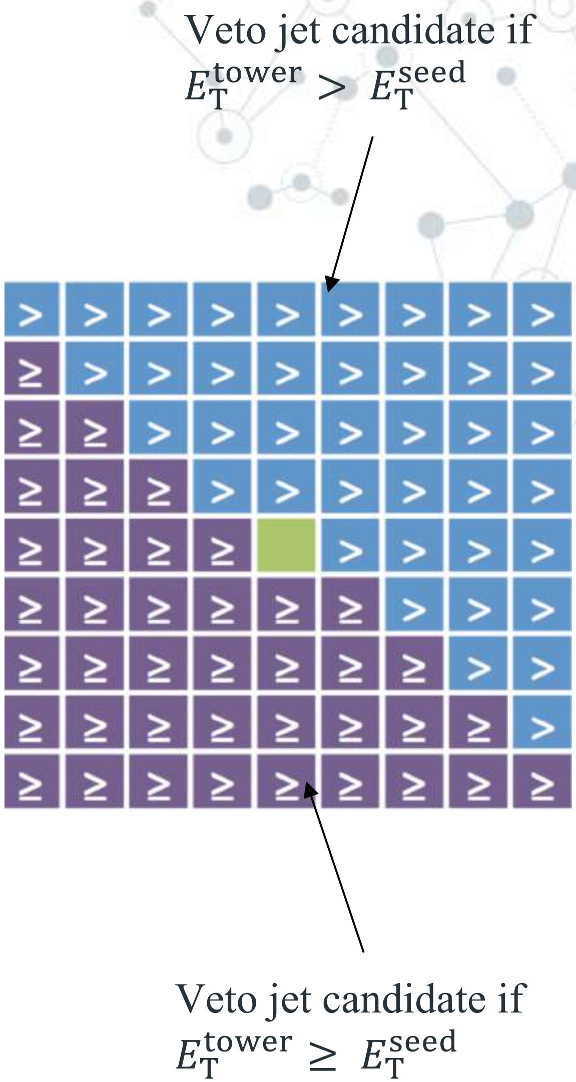
- Presentation overview:
  - Jet and MET algorithms
  - 2017 performance and data
  - New 92X calibrations
  - Trigger Tower 28
  - 2018 plans

- Noteworthy issue from 2017 (Trigger Tower 28):
  - See large rate and pileup dependence
  - Pursuing better treatment with ECAL and HCAL groups
  - Further discussion at trigger workshop

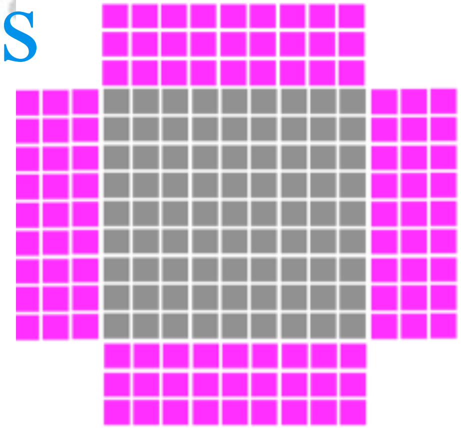
Algorithms

Algorithms – Jet seed

- 9x9 trigger tower (TT) "sliding window" centered on tower with local maximum E_{T} (jet seed)
- Jet E_{T} = sum of TT E_{T} in the sliding window
- Use the seed to determine η and ϕ of jet
- Use an inequality mask to avoid self-vetoes and double counting of energy deposits in TTs
- Apply a seed threshold $\mathcal{O}$(GeV) to avoid pileup jets. η-dependent thresholds being investigated
- Algorithm compared to anti-k_t jet finding for validation



Algorithms – Chunky doughnuts



- Used for pileup subtraction in jets
- Strips of size 3x9 TT placed on each side of the jet
- Energy deposits are recorded in each strip to determine pileup energy density
- Can be summed in different ways to subtract contributions from PU – currently take the sum of the 3 lowest-energy strips
- Investigations to determine which is most suitable (detailed in 2018 plans)

Algorithms – Jet Energy Corrections

- Compensates for various losses (p_{T}, η) when recording jet properties, and ensure performance is uniform across the detector
- Match reference jets (GenJets) to L1 jets
- Bin in $|\eta^{\mathrm{L1}}|$, then plot 1/response against $< p_T^{L1} >$ (with response = $p_{\mathrm{T}}^{\mathrm{L1}}/p_{\mathrm{T}}^{\mathrm{ref.}}$)
- Fit a function to each curve which becomes a "correction curve"
- Use correction curves to calibrate jets
- Export as LUTs and perform closure test to check them

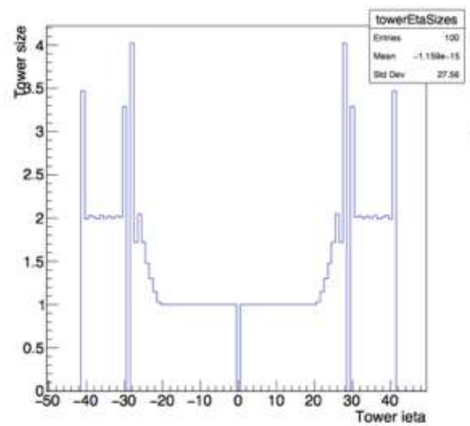
Algorithms – MET pileup mitigation

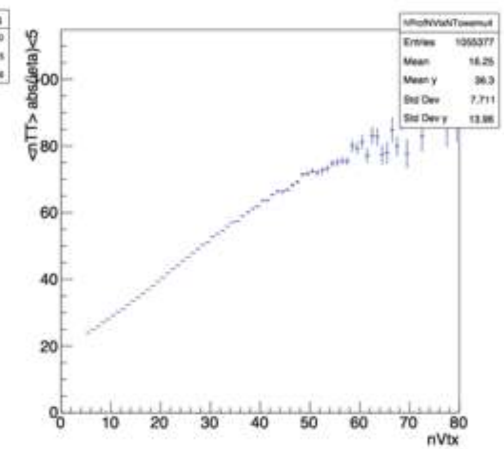
- MET pileup "subtraction" running throughout 2017 data taking

- For towers to be included in the MET calculation, they must be above a dynamic tower E_T threshold retrieved from a LUT, with two inputs:
  - Tower $i\eta$: threshold increases with η since more pileup in forward direction and is larger for wider towers
  - Compressed pileup estimate: count #TT within $|i\eta| < 5$ to estimate pileup

- Maximum tower E_T set to 6 GeV

- No threshold applied in the barrel

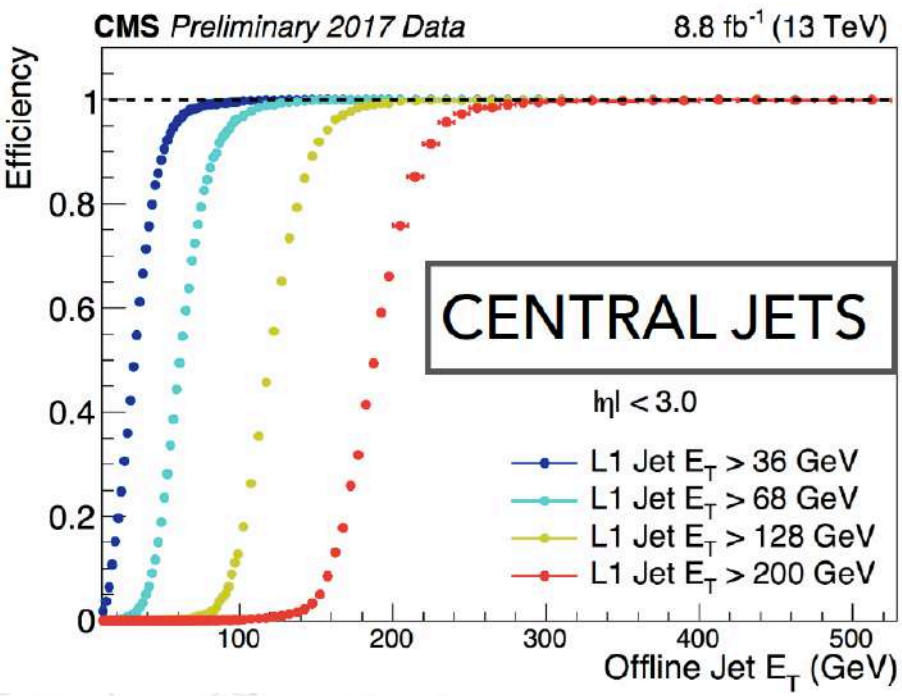


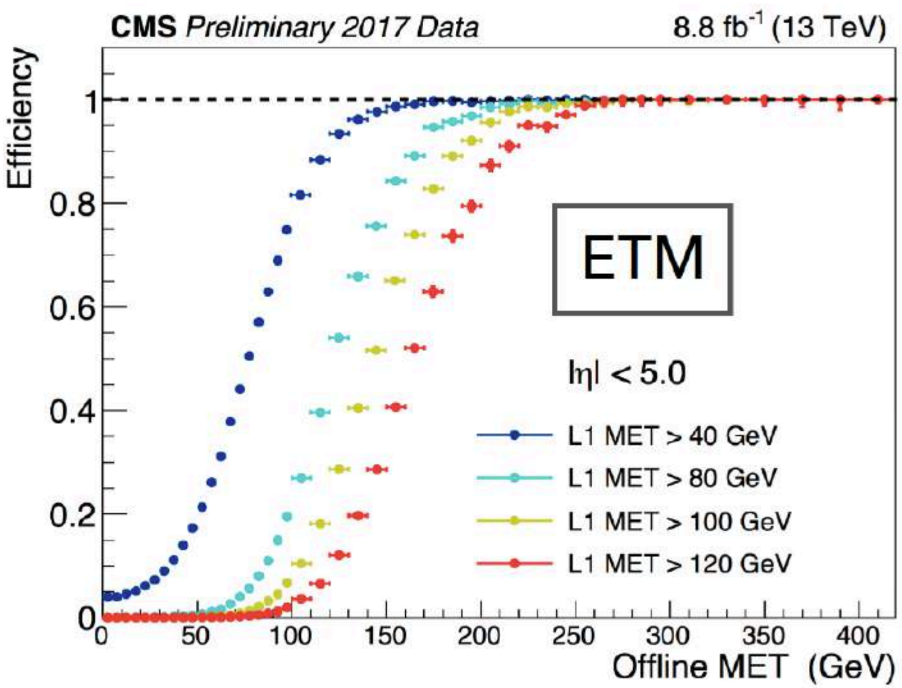


2017 Performance and Data

2017 Performance and Data

- Problems running ntuples for full 2017 dataset
- Should be ready for trigger workshop. In the meantime, here are some 8 fb^{-1} plots:

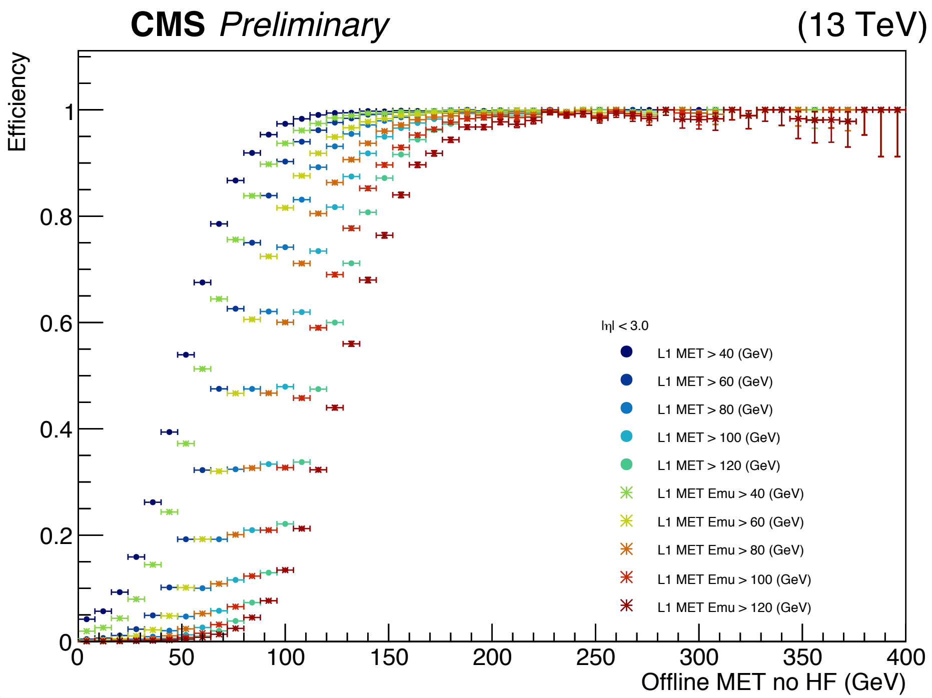




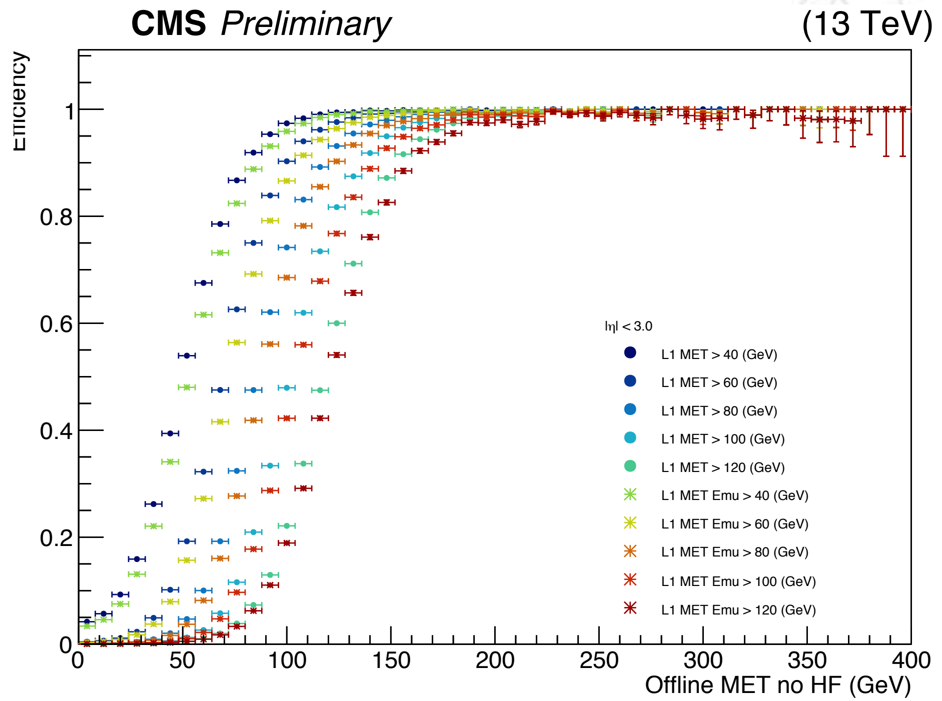
MET with 92X calibrations

- Turn-on curves in BE for old corrections (80X) vs. "mode" and vs. "mean" parameters from Layer-1 (92X):

80X vs. 92X Mode



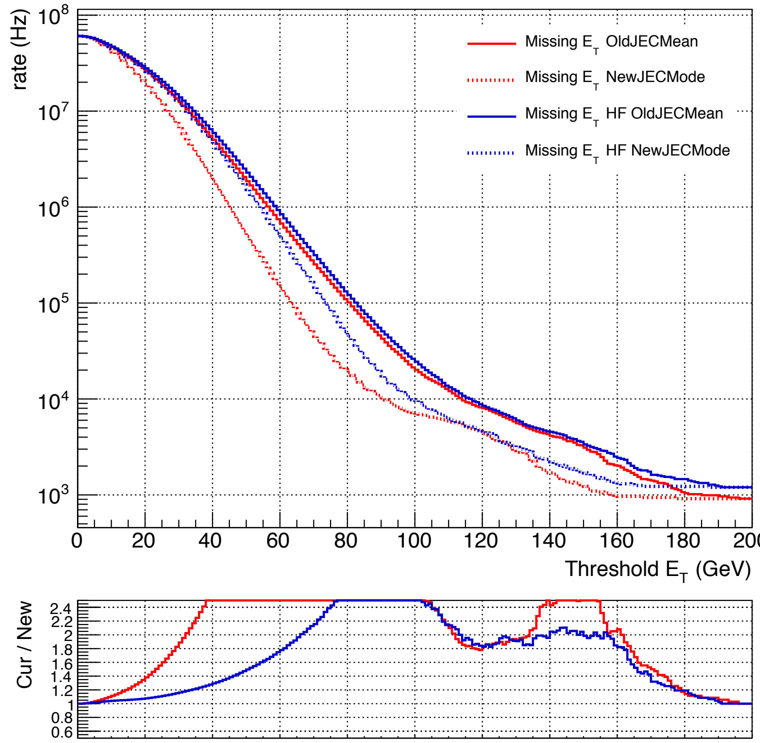
80X Old vs. 92X Mean



MET with 92X calibrations

- Rates in BE for old corrections vs. mode and vs. mean:

80X Old vs. 92X Mode



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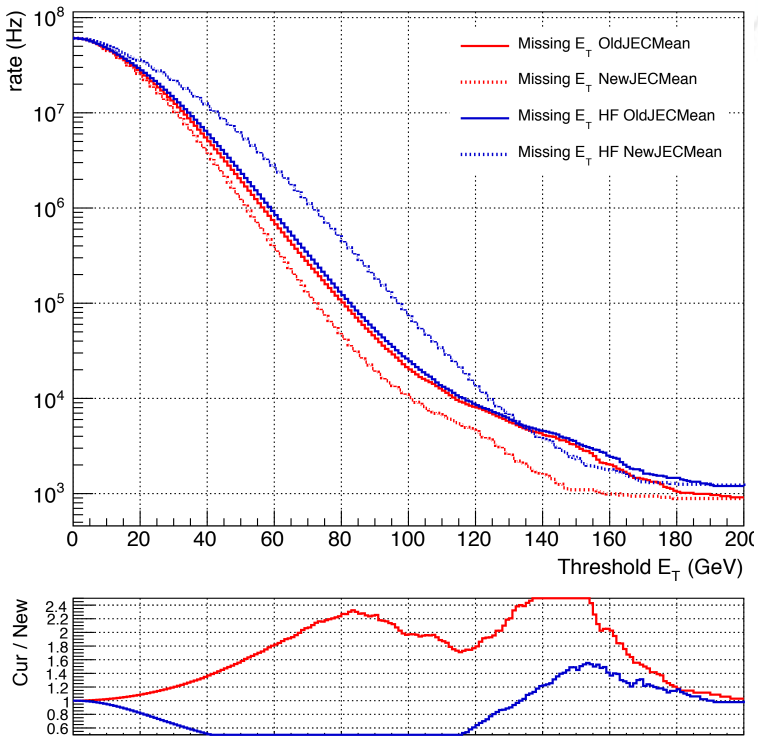

- Mode preferred because of rate reduction with similar performance

Jet Energy Corrections with 92X

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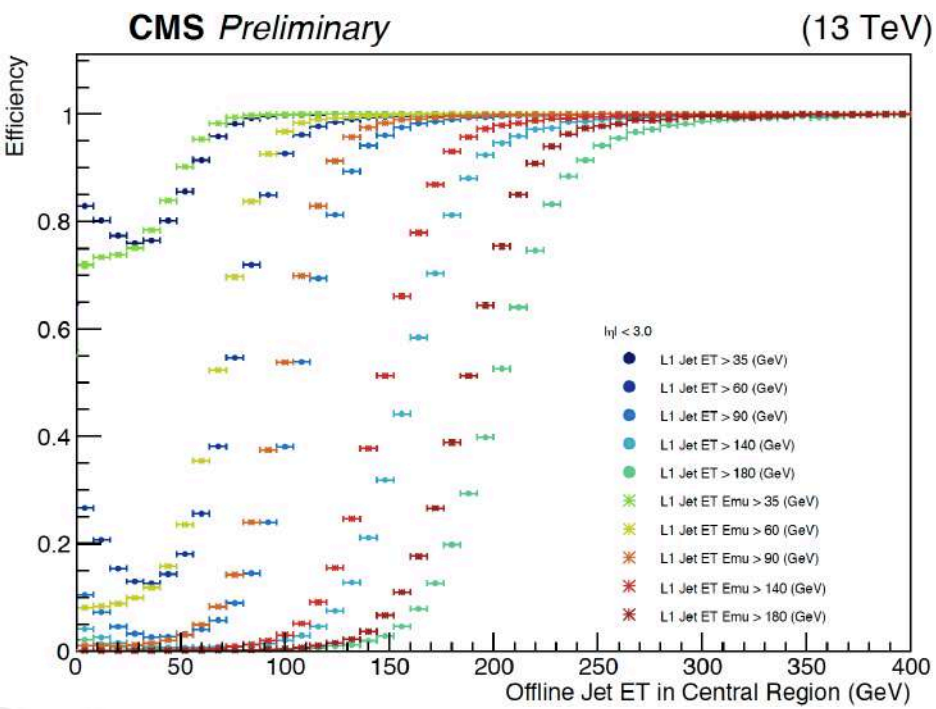

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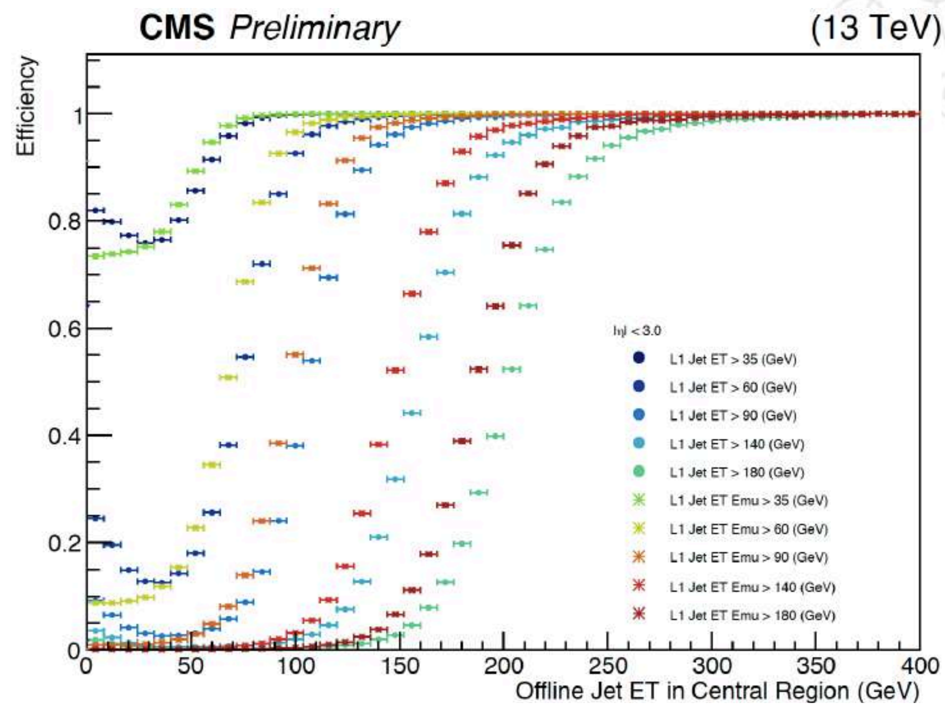

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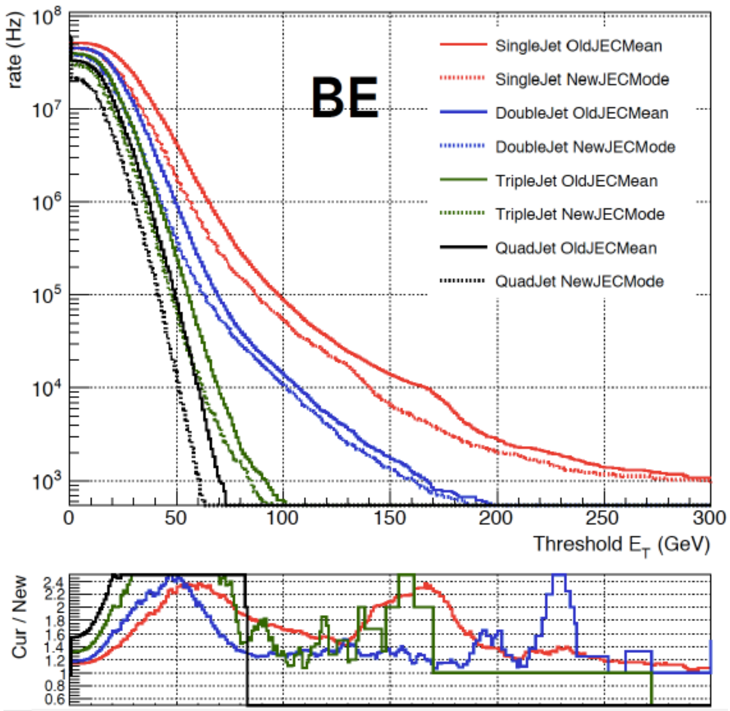

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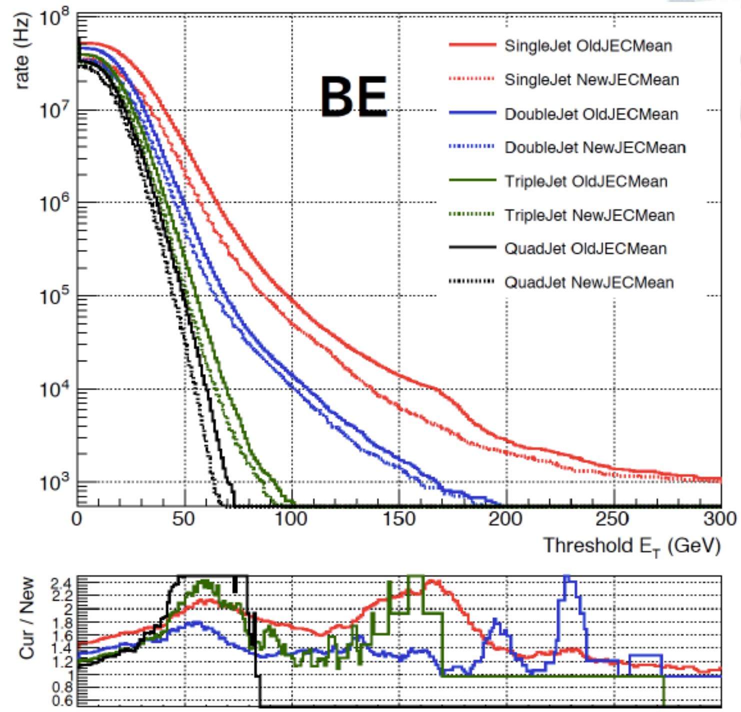

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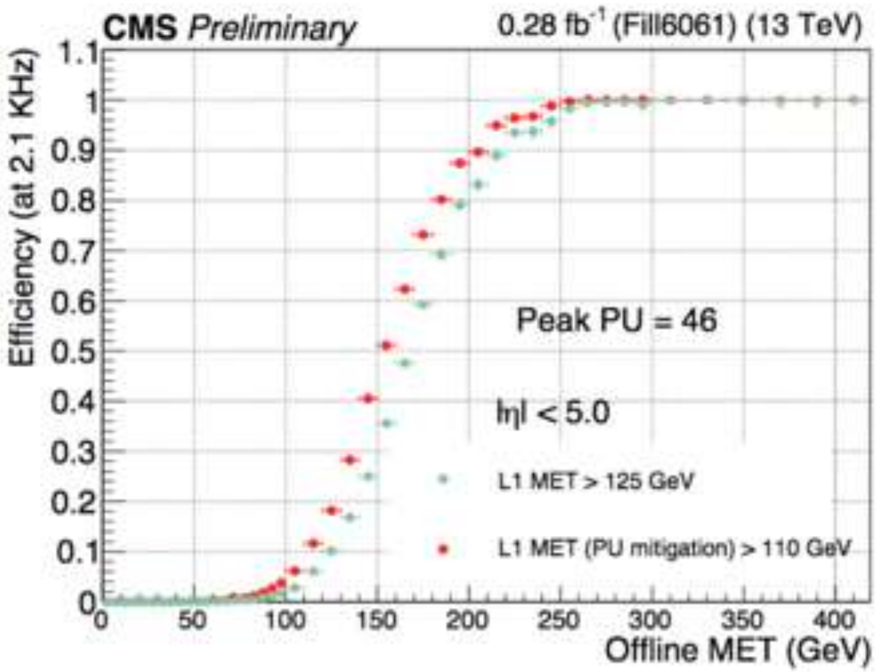
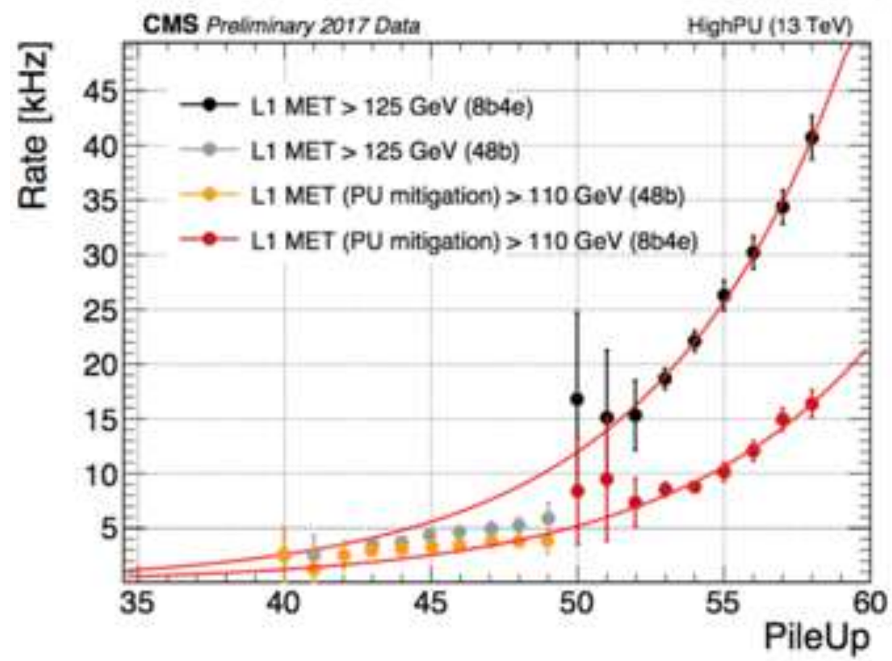
Performance of MET pileup mitigation

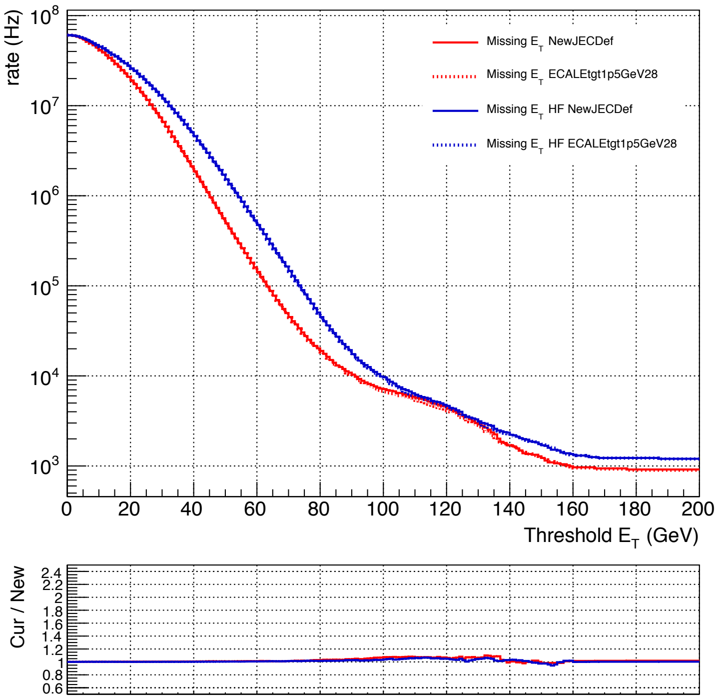
- Significantly reduces pileup dependence of MET rates whilst maintaining performance

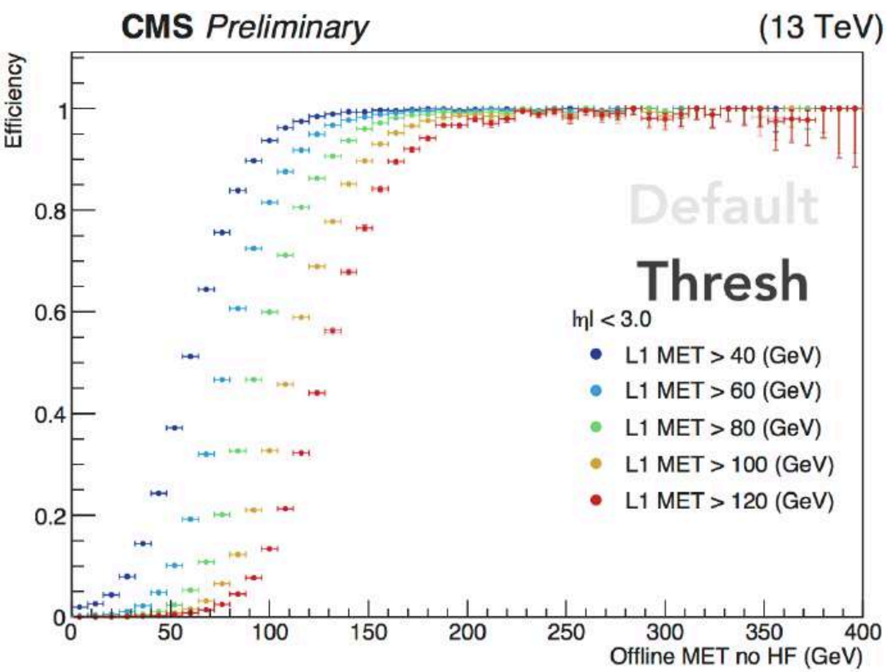




ECAL TP E_T > 1.5 GeV for TT28

- Due to transparency loss, large gain corrections for TT28 in ECAL
- Check if raising TP threshold from 0.5 GeV to 1.5 GeV affects MET
- ~ 5 % rate reduction for almost identical performance





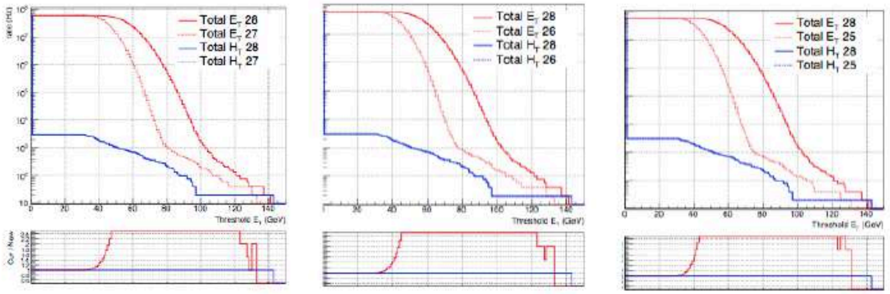
ETT rates for pp ref. run ~ 0 PU

- Look at ETT rates with different η restrictions to check if TT28 problem is due to calibration issue or because it is more sensitive to pileup than neighbouring towers

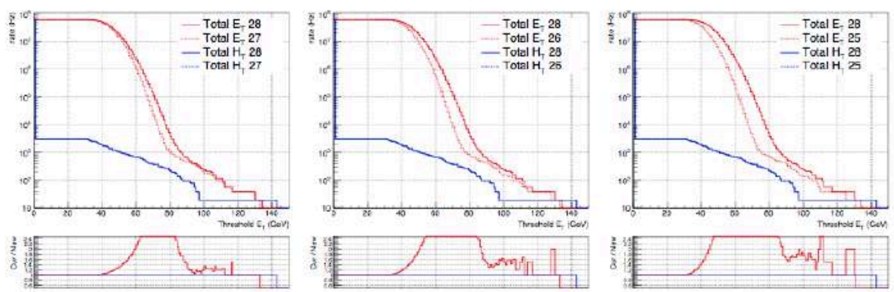
- Even at ~ 0PU, would appear that most of the rate comes from TT28!

- Apply ECAL TP $E_{\mathrm{T}} > 2$ GeV: significantly reduces the ETT from TT28 (mostly noise?)

ECAL TP Et > 0.5 GeV



ECAL TP Et > 2.0 GeV



2018 Plans

2018 Plans

- MET pileup mitigation introduced this year with η and PU estimation-dependent p_T thresholds for towers. Plan to further optimise

- Implement MET energy scale calibrations – so when calibrations change upstream, MET energy scale can be fixed for minimal menu re-tuning

- Tune jet seed thresholds to counter large quad jet rates

- Optimise the chunky doughnuts for jet pileup subtraction

- Investigate deriving JECs using data to see if we can improve performance

2018 Plans – Jet seed tuning

Shane Breeze

- Large rates in quad jet paths so change jet seed threshold (possibly as function of η) to determine effects on efficiencies and rates

- Current procedure (seed threshold = 60 GeV):
  - Ensure that the leading 4 L1 jets are matched to offline jets with $\Delta R = 0.3$
  - Require the matched offline jets to the leading 3 jets have $E_T > 60$ GeV
  - In numerator of efficiency, require leading 4 L1 jets have $E_T > 60$ GeV
  - Plot as a function of the offline jet p_T matched to the 4^{th} leading jet

- Variations on this have been proposed. Still early stages of investigation

2018 Plans – Chunky doughnuts

Matthias Komm

- Potentially underestimating pileup energy for jets, especially in forward region due to larger tower sizes and PU sensitivity of region

- Different ways to subtract pileup energy (so optimisation needed):
  - take the sum of the lowest 3 strips
  - take the sum of the highest 3 strips
  - take the average of all 4 strips
  - take the sum of the middle 2 strips

- Consider correcting pileup energy estimation by a factor retrieved from LUT that takes into account tower sizes

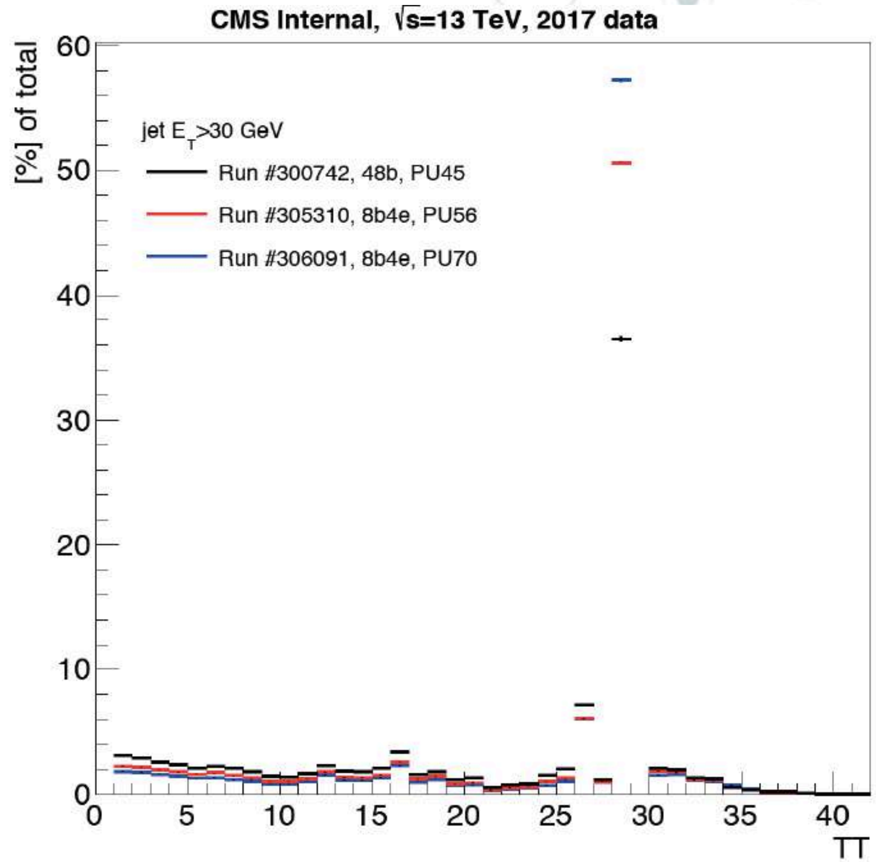
Backup

Trigger Tower 28

- Most of the rate comes from the TT

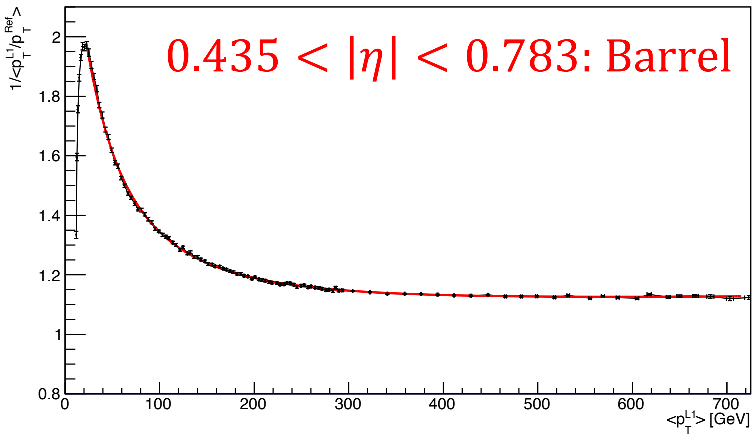
- Several sources could contribute to the effect

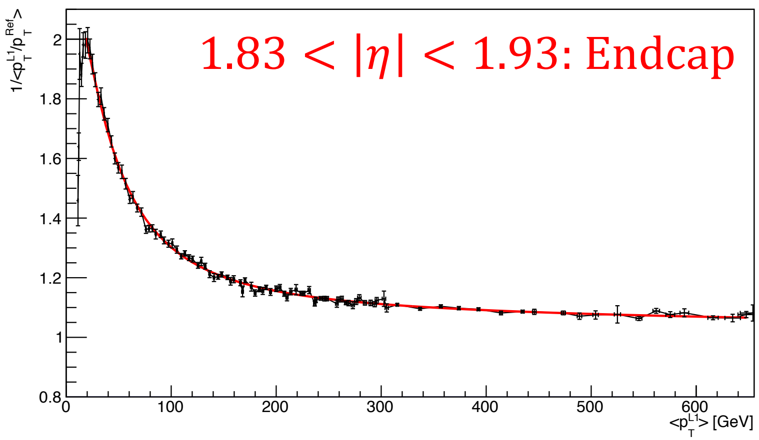
- Possible to reduce the rate while the issue is being dealt with:
  - calibrate TT28 down at Layer-1
  - remove jets in TT28 depending on E_{T}

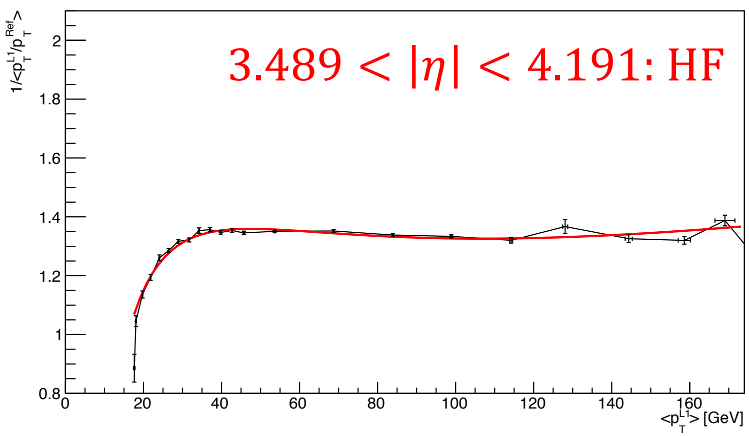


Performance of Jet Energy Corrections

- Correction curves for a $|\eta|$ bin in each detector section (mode params):







Performance of Jet Energy Corrections

- Scatter plots before and after corrections:

Barrel Endcap HF