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Barrel Electromagnetic Calorimeter Calibration for STAR Run 2017

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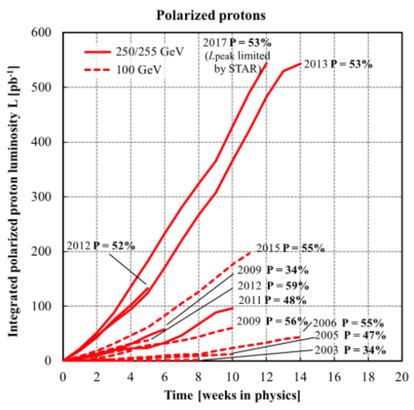
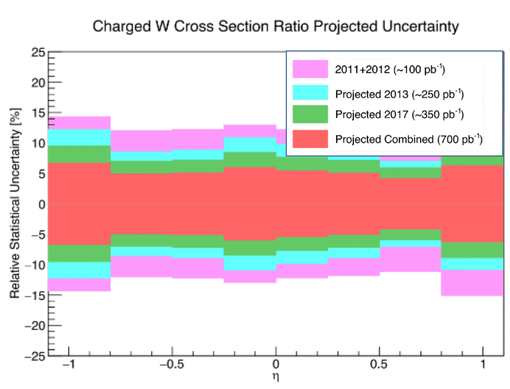
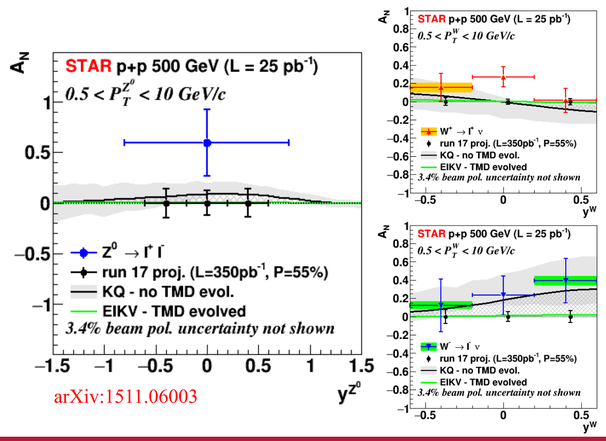
STAR 2017 pp 510 GeV



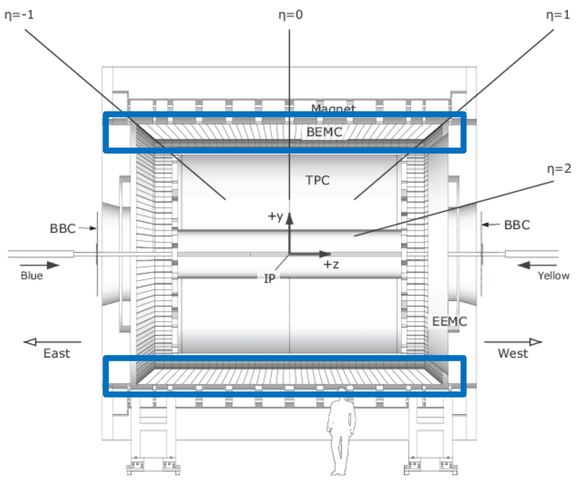
- During STAR Run 2017, **transversely-polarized (53%)** proton beams were collided at a center-of-mass energy, $\sqrt{s} = 510\ GeV$.
- The size of $p^{\uparrow}p$ data sample collected during this period is comparable to the Run 2011, 2012 and 2013 combined ($\sim 350 pb^{-1}$), which will greatly improve the statistics of precision measurements at STAR such as W/Z cross section / cross section ratio, Drell-Yan and W/Z A_N measurements .





arXiv:1511.06003

Barrel Electromagnetic Calorimeter (BEMC)



- The BEMC comprises 4800 towers, each approximately covering an $\eta \times \phi$ region of 0.05×0.05. $(-1 < \eta_{BEMC} < 1\ \&\ 0 < \phi_{BEMC} < 2\pi)$
- The BEMC is used for measurements of non-hadronic particles and to trigger on high p_T processes such as jet/di-jets and W/Z events.

Strategy

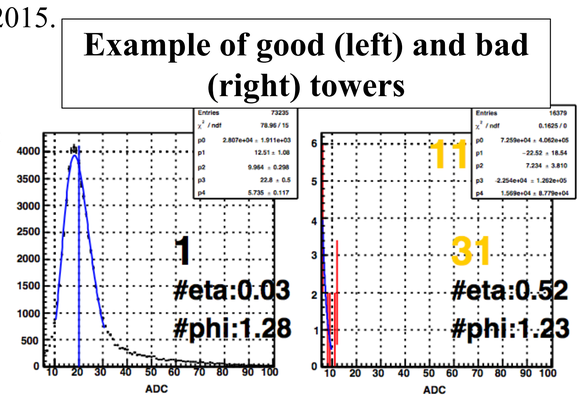
- The principle behind STAR Run 2017 BEMC calibration is identical to the previous calibrations such as Run 2009, 2012, 2013 and 2015.
  - The calibration is performed by comparing the energy deposited in the calorimeter by $e^{\pm}$ tracks with the $e^{\pm}$ tracks measured in the TPC.
  - Since minimum-ionizing particles (MIPs) are abundant and well understood, they are used to find tower-by-tower relative gain.

$$C_{rel} = \frac{0.264(1 + 0.056\eta^2)}{ADC_{MIP}\ \sin(\theta)}$$

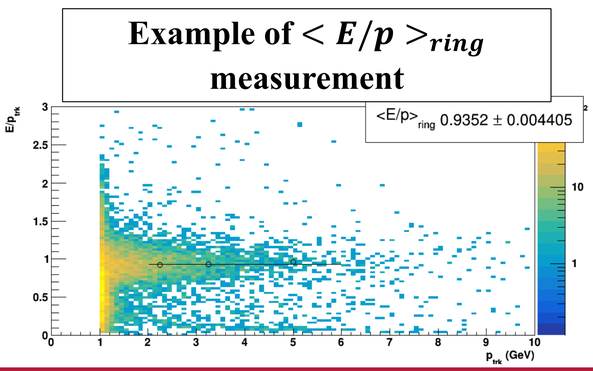
- $e^{\pm}$ tracks are then grouped into 40 η- rings, each covering 0.05 in η. The energy deposited in each ring of the calorimeter is used to compare with the momentum measurement from the TPC.

$$C_{abs} = \frac{C_{rel}}{\langle E/p \rangle_{ring}}$$

Example of good (left) and bad (right) towers



Example of $< E/p >_{ring}$ measurement



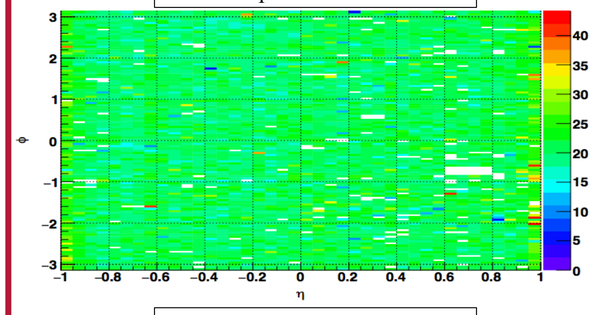
Run Selection

- **STAR Run 2017**
  - 2691 runs out of 3771 have been selected for BEMC calibration based on the following selection criteria.

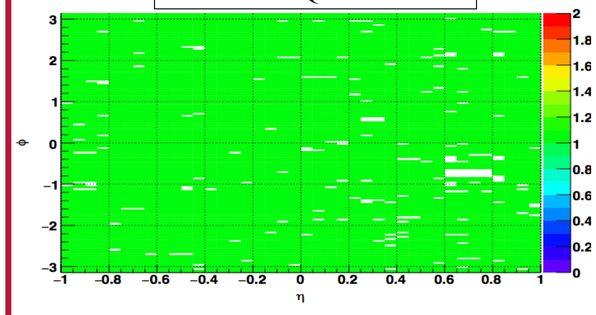
Run selection	$18053092 \leq Run\ ID \leq 18150007$
Trigger	Trigger setup = pp500_production_2017
Status	Shift status = successful
Run time	$\Delta t_{run} \geq 180\ sec$

MIP Analysis

MIP peak distribution



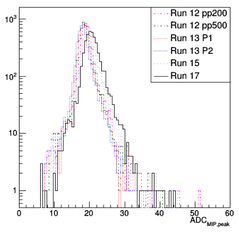
Tower QA status



- **MIP selection criteria**

Vertex based	Vertex rank $> 10^6$
	$\lvert z_{vtx} \rvert < 30\ cm$
Tracking based	Tracks must enter and exit the same tower.
	$p_{trk} > 1\ GeV\ \&\&\ p_{trk}^{neighbor} < 2\ GeV$
Pedestal	$(ADC - ped) > 1.5\ ped\ RMS$

- The MIP peak distribution is somewhat higher than in the previous runs due to an increase in the HV across the calorimeter.
- 181 towers out of 4800 excluded from the calibration after tower QA.

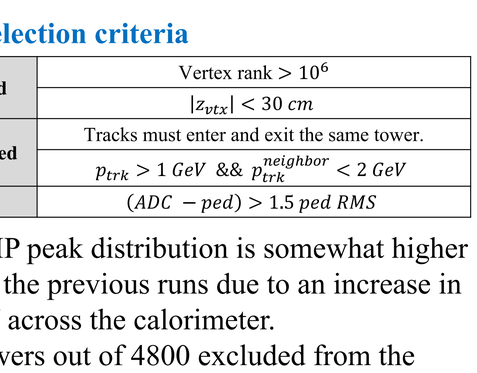


	Mean	RMS
Run 2012 (200 GeV)	19.31	1.493
Run 2012 (500 GeV)	18.82	2.364
Run 2013 (Period 1)	18.62	2.181
Run 2013 (Period 2)	18.26	2.266
Run 2015	20.1	2.626
Run 2017	**20.79**	**2.73**

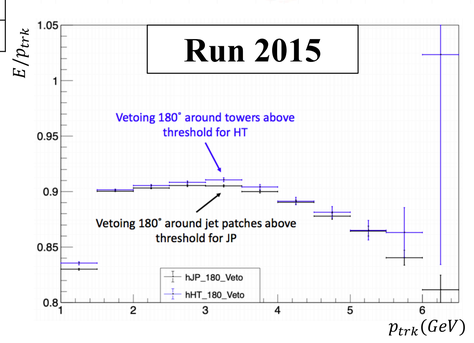
Electron Analysis

- **Electron track selection criteria**

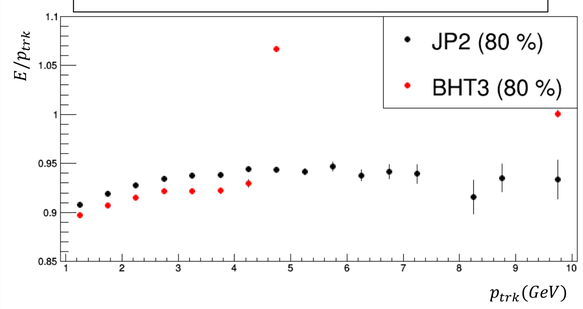
Cluster	Good tower status of the struck tower (center tower)	**Vertex**	Vertex rank $> 10^6$
	Maximum E deposited in the center tower		|z_vtx| < 60 cm
	No tracks in the neighboring (3X3) towers	**Pedestal**	(ADC-ped) > 2.5 ped RMS
	$r_{fiducial} < 0.02$	**Electron PID**	Accept if : $0 < n_{\sigma(e^-)} < 2$ Reject if : $-1 < n_{\sigma(\pi)} < 3$
Tracking	1 track per tower	**Trigger**	BHT1(VPD100), BHT2(BBCMB) **BHT3** JP0(VPDMB30), JP1(VPDMB30) **JP2**
	Track hits > 25		
	Must enter and exit the same tower		
	$3.5 * 10^{-6} < dE/dx < 5.0 * 10^{-6}$		
	$0.5 < p_{trk} < 20\ GeV$ (preselection)		*Tower & JP unmatching



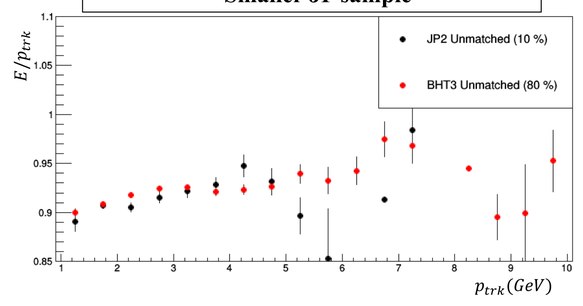
- **Tower & JP unmatching**
  - **Run 2015** (N. Lukow) BEMC calibration departs from the previous calibrations by vetoing towers and jet patches that fired the corresponding trigger.
  - This is also has been tested with a small sample of JP firing electron candidates for Run 2017 calibration.



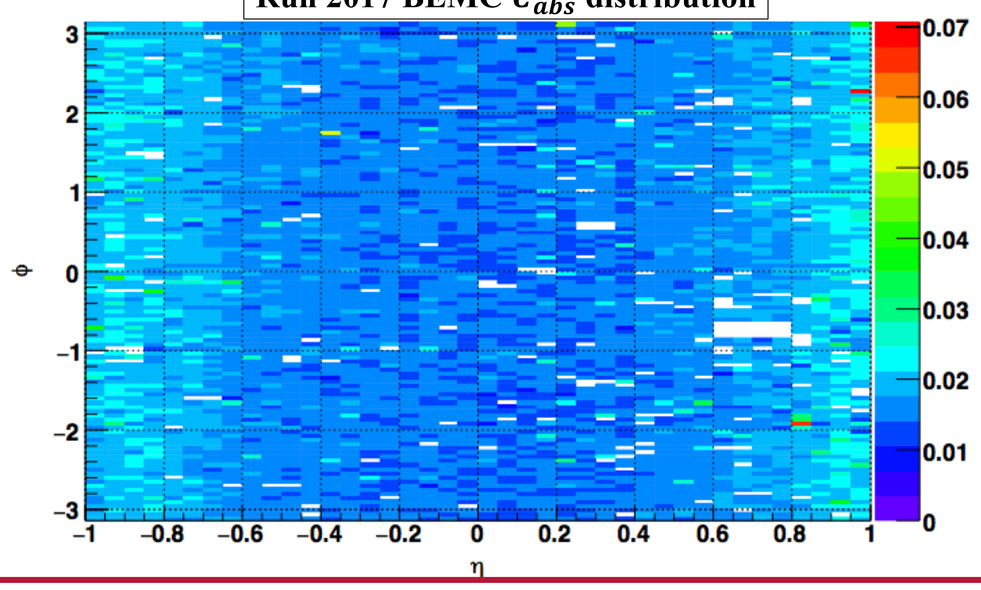
Run 2017 (before vetoing)



Run 2017 (after vetoing)
*Smaller JP sample



Run 2017 BEMC C_{abs} distribution



Results

- **Summary**
  - STAR Run 2017 BEMC calibration has been performed with ~80% of the full statistics.
    → Effort to gain full statistics will be continued.
    → An increase in MIP ADC distribution peak due to a change in HV.
    → ~2 % discrepancy in $< E/p >$ between electron candidates firing JP and BHT triggers.
  - The mismatch between JP and BHT have been improved greatly in Run 2015 calibration with the new trigger bias vetoing scheme. This has been looked into in Run 2017.
    → Good matching between BHT and JP tracks with the currently available statistics.
    → This will be revisited with larger statistics with JP ADC information.
- **Outlook**
  - First look into the systematic uncertainties will be performed with BHT firing electron candidates.
    → Possibly larger systematic uncertainties than in previous calibrations due to longer run period.