BCID Efficiency in Heavy Ion Data

L1Calo Joint Meeting

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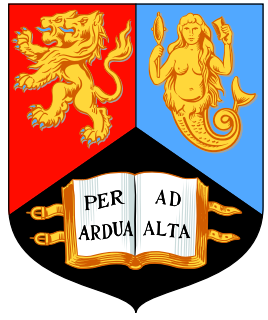
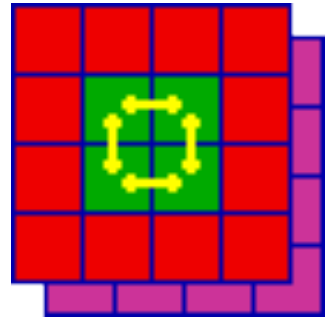
University of Birmingham

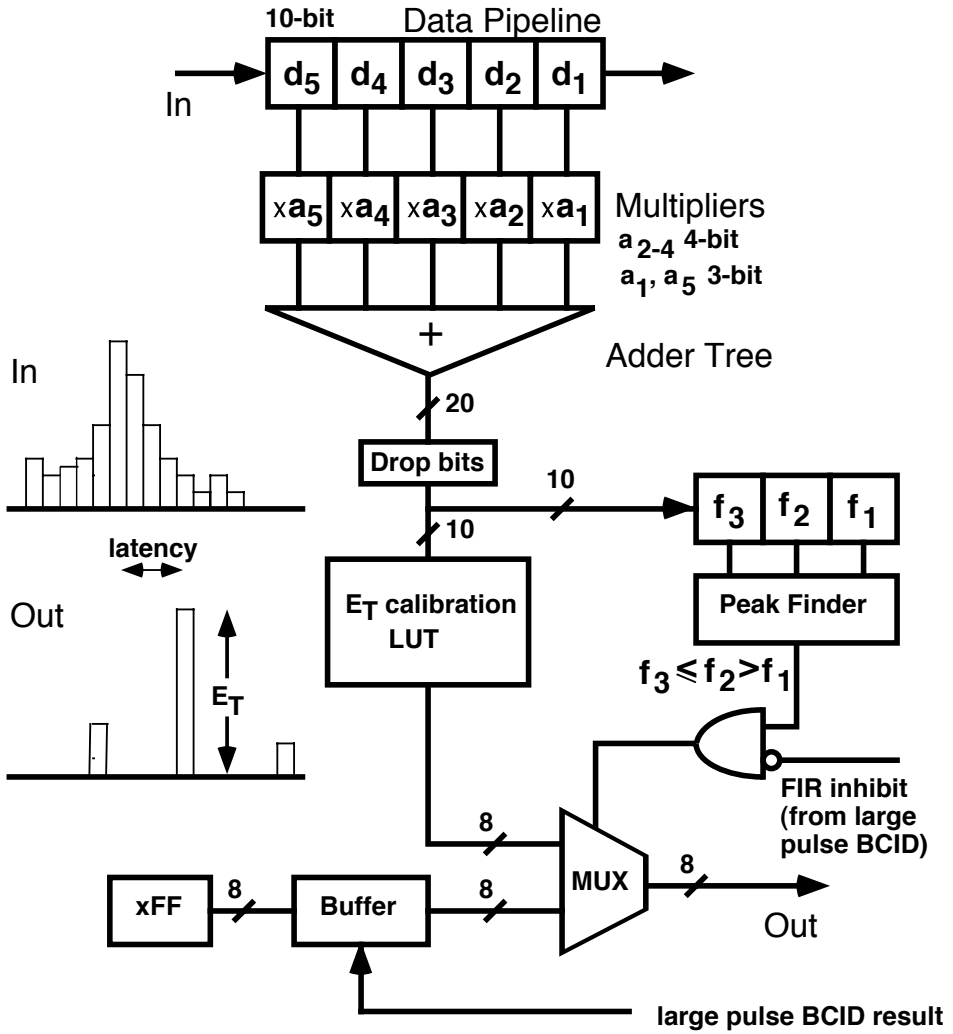
24th March 2011





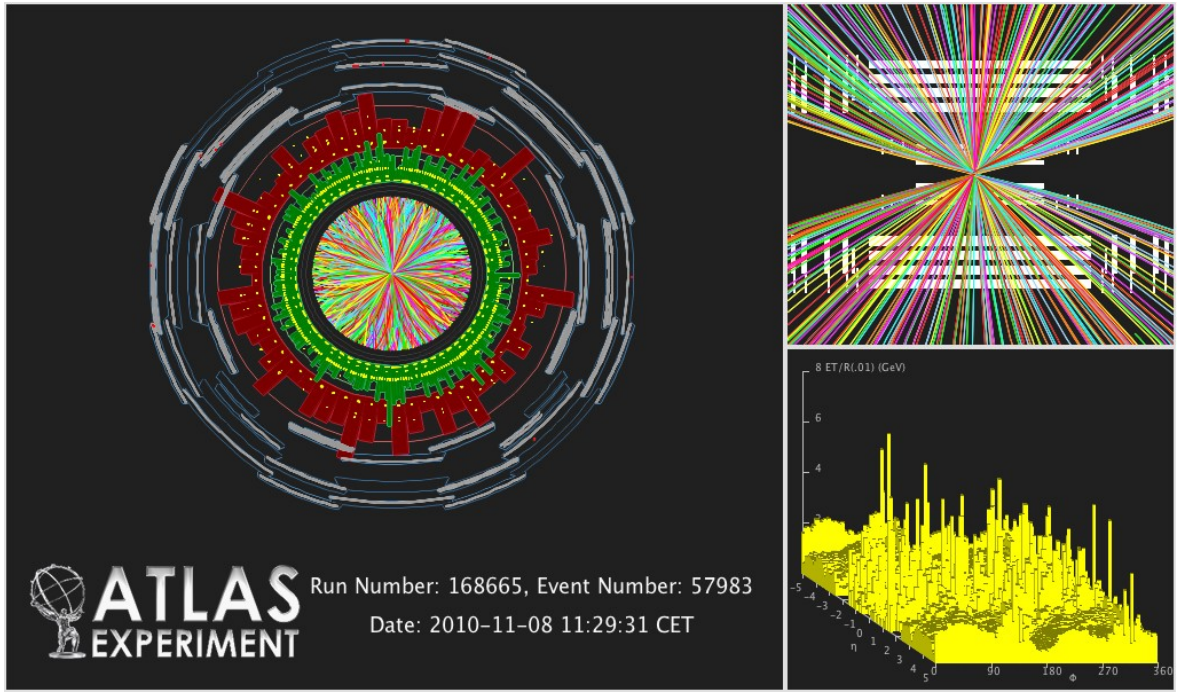
Bunch Crossing Identification in L1Calo

- Trigger Tower pulses are several bunch crossings wide
- BCID system associates calo pules with a single bunch crossing
- Saturated pulses ($\sim$250GeV): Shape of leading edge of pulse
- Non Saturated($\lesssim$250GeV): Finite Impulse Response (FIR) Filter
- Currently useing a "Common" filter: coefficients fitted to general shape of pulses in regions
- Alternative is "Matched" filter: coefficients set for each tower
- Peak finder selects bunch crossing where $f_2 > f_1$ & $f_2 \geq f_3$



$$f_{output} = \sum_{i=1}^{5} a_i d_i$$

Motivation For Using Heavy Ion



- HI provides Huge numbers of low E_T towers & Collisions well separated in time
- Trigger Tower doesn't care what's in the beam pipe: only what's hitting it

HI angular multiplicities are different to pp which can skew summed efficiencies

Methodology

- L1Calo Ntuple Analysis framework
- Heavy Ion L1Calo Ntuples: `NTUP_TRIG` with p329 tag: Contain both layers of Towers where either has $\geq$ 0.5GeV or ADC $\geq$ 36 counts
- Runs Used: 168759, 168865, 168875, 169045, 169884
- Most plots use $\approx$ 1% of Run 169884 $\approx$ 6 minutes of running Large enough for negligible errors, Small enough to feasibly run
- For all plots require `L1_MBTS` Trigger & Primary Vertex
- All plots in terms of E_T from Calo systems not L1Calo E_T

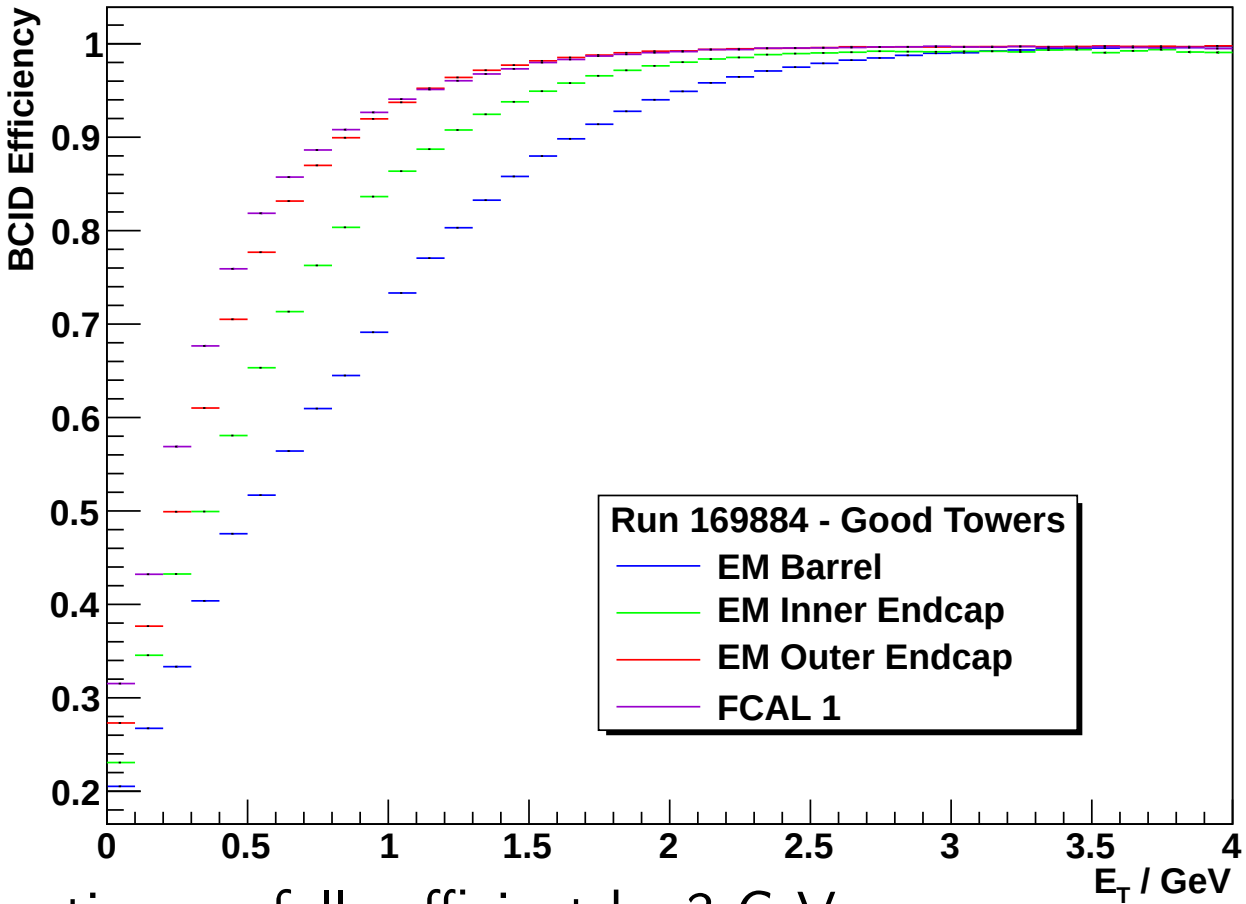
$$\text{Efficiency} = \frac{\text{Calo Cell } E_T \& \text{ BCID} > 0}{\text{Calo Cell } E_T}$$

WARNING

Method is inherently bias below 0.5GeV so results presented below this are for interest only

Run 169884 - EM Regions for Good Towers

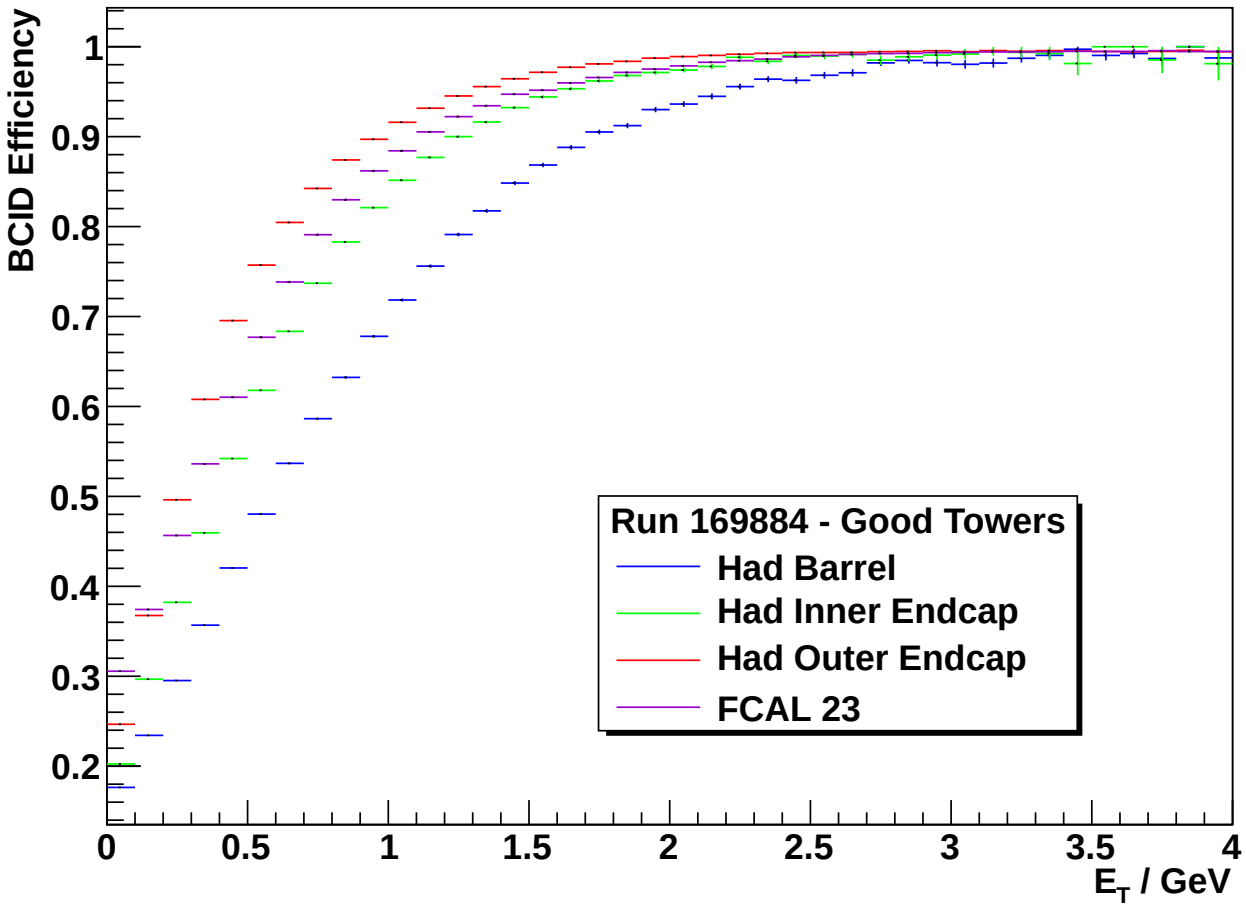
- Crack excluded - See later



- All sections $\approx$ fully efficient by 3 GeV
- Turn on curves certainly not equal
- Barrel requires largest E_T as $|E_T| \approx |E|$ so small pulse

Run 169884 - Had Regions for Good Towers

- Wobble at higher E_T due to lowish statistics: most energy absorbed in ECAL



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- Barrel requires largest E_T as $|E_T| \approx |E|$ so small pulse

Efficiency Tables for Run 169884

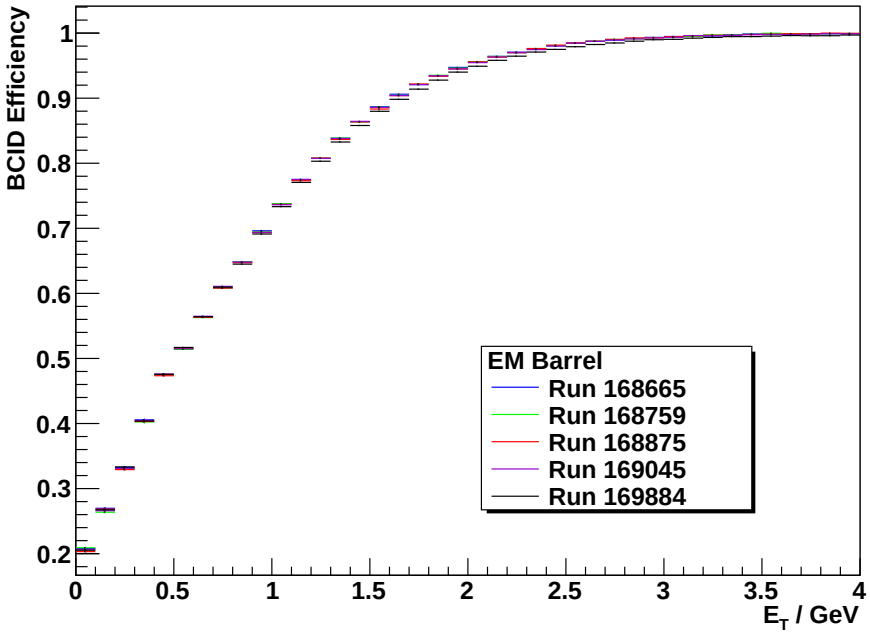
- EM Efficiencies:

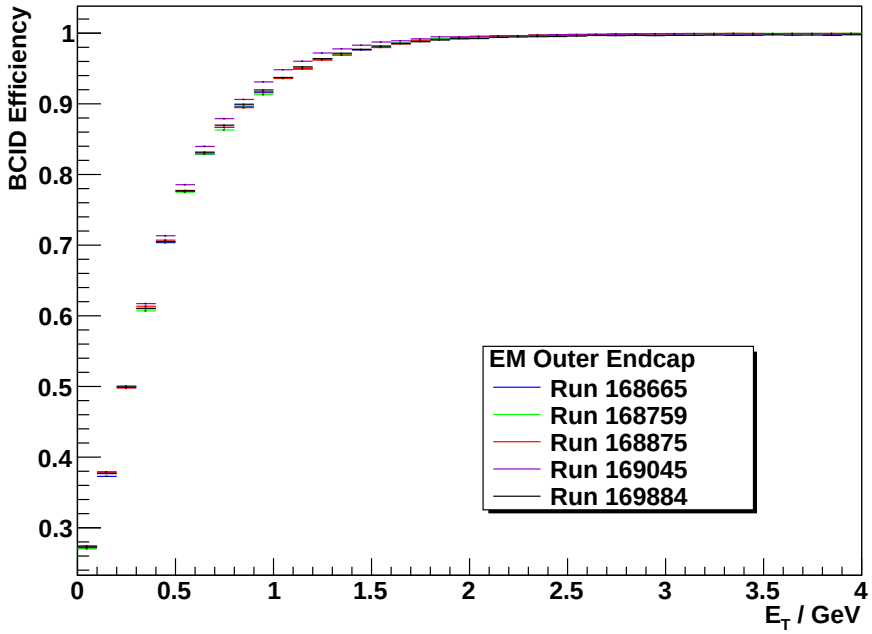
	E_T Values / GeV					
Region	0.5	1.0	1.5	2.0	2.5	3.0
Barrel	0.50	0.71	0.87	0.94	0.98	0.99
Inner EC	0.62	0.85	0.94	0.98	0.99	0.99
Outer EC	0.74	0.93	0.98	0.99	1.00	1.00
FCAL1	0.79	0.93	0.98	0.99	1.00	1.00

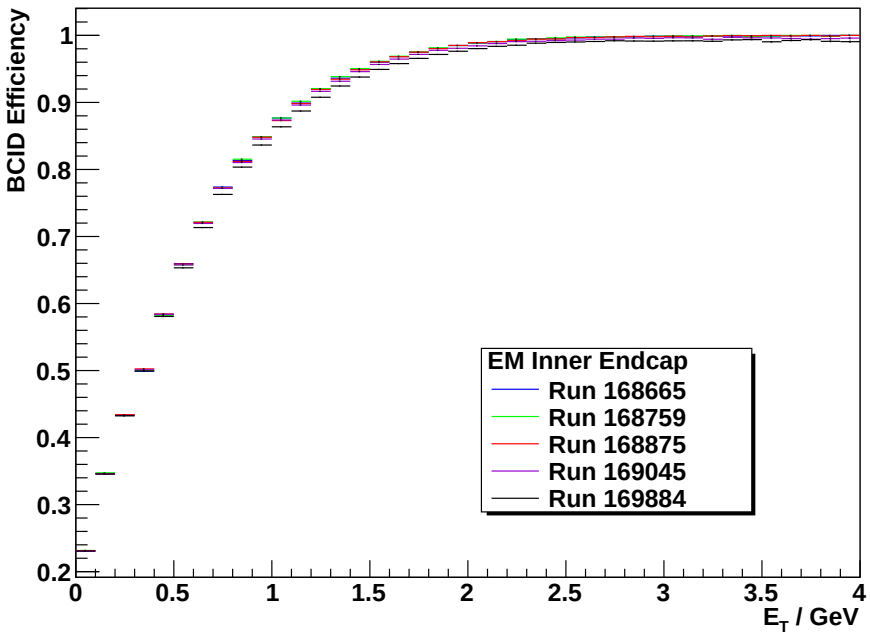
- Had Efficiencies:

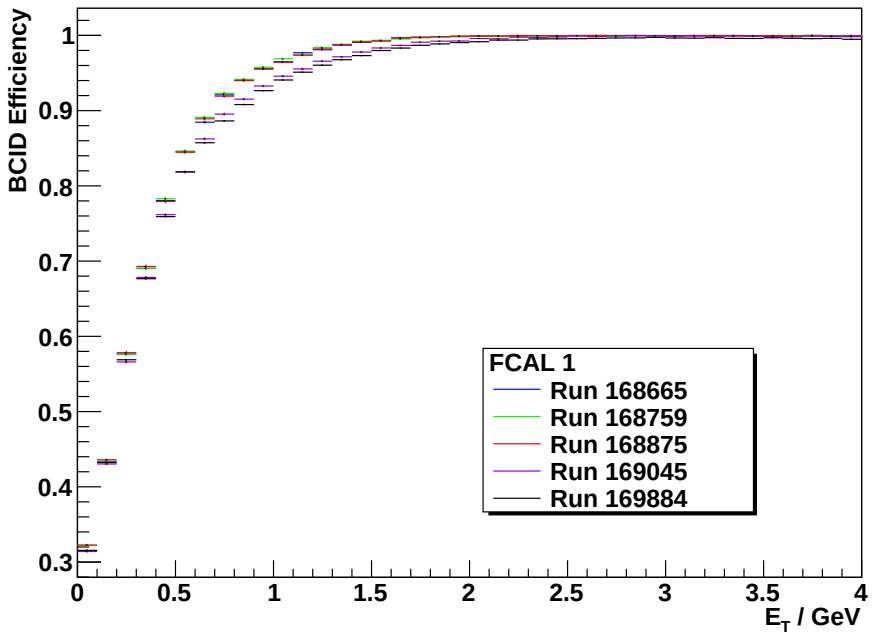
	E_T Values / GeV					
Region	0.5	1.0	1.5	2.0	2.5	3.0
Barrel	0.45	0.70	0.86	0.93	0.97	0.98
Inner EC	0.58	0.84	0.94	0.97	0.99	0.99
Outer EC	0.73	0.91	0.97	0.99	0.99	1.00
FCAL23	0.64	0.87	0.95	0.98	0.99	0.99

EM Regions - Run Comparison for Good Towers

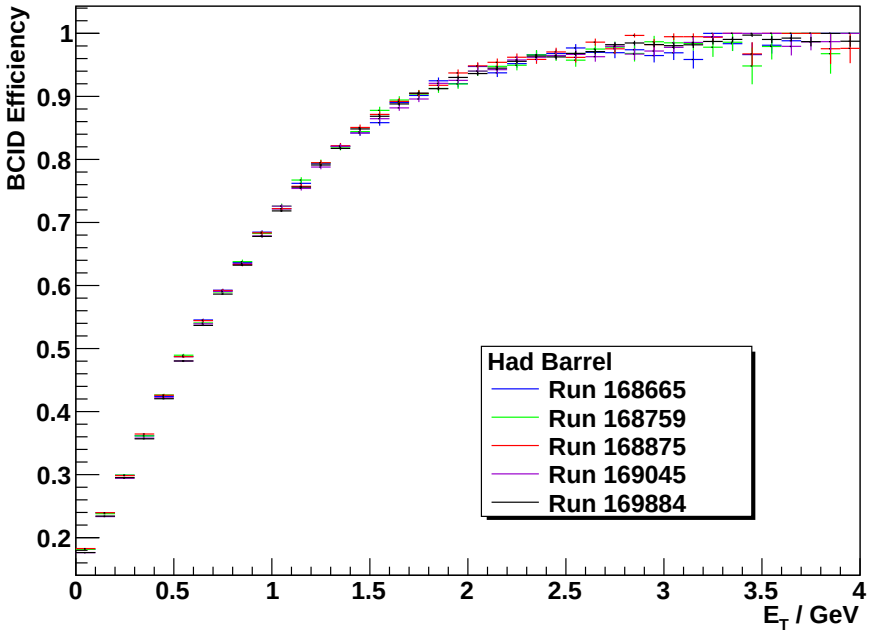


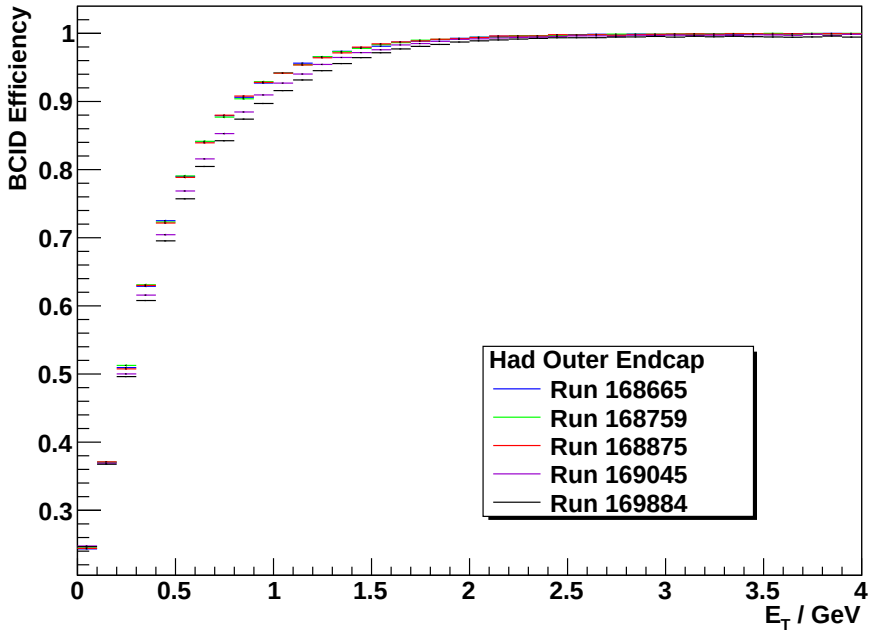


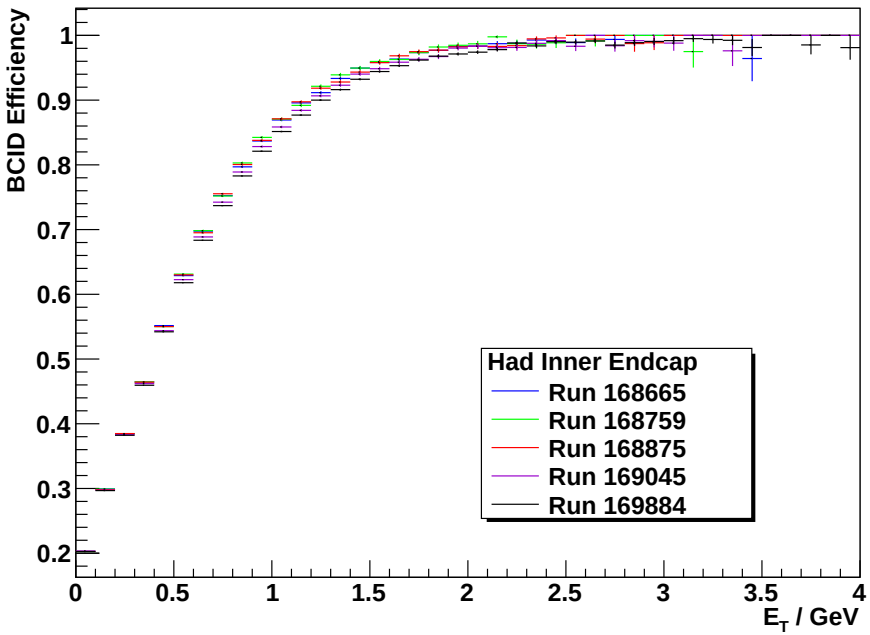


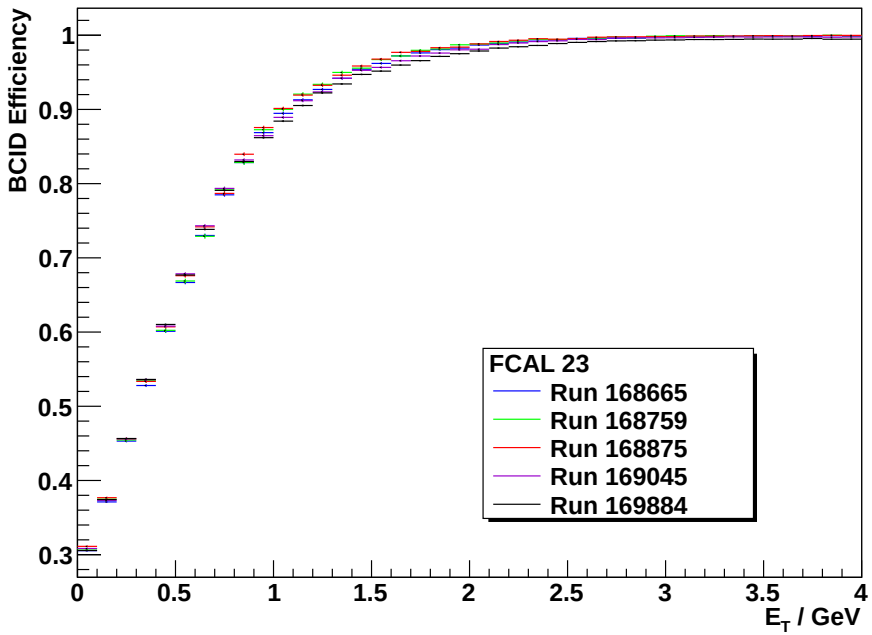


Had Regions - Run Comparison for Good Towers



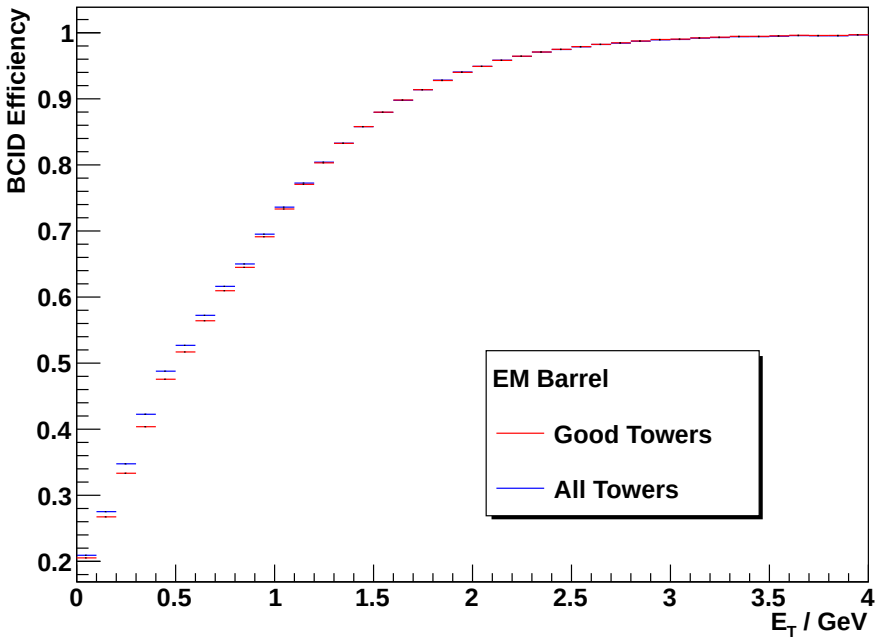


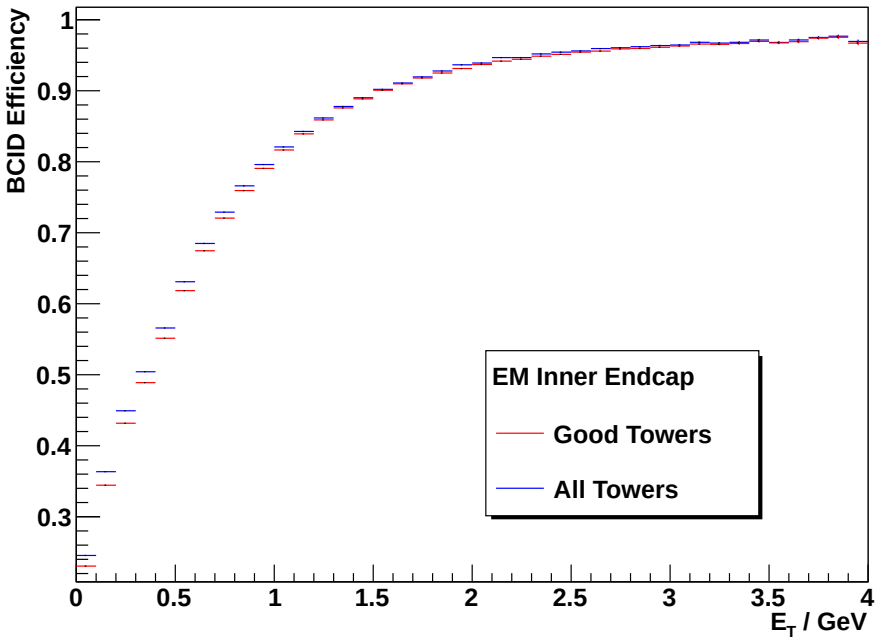




EM Steeper Turn On Curves When All Towers Included

- Initially surprising result: EM Barrel and Inner Endcap show steeper turn on curve for All towers

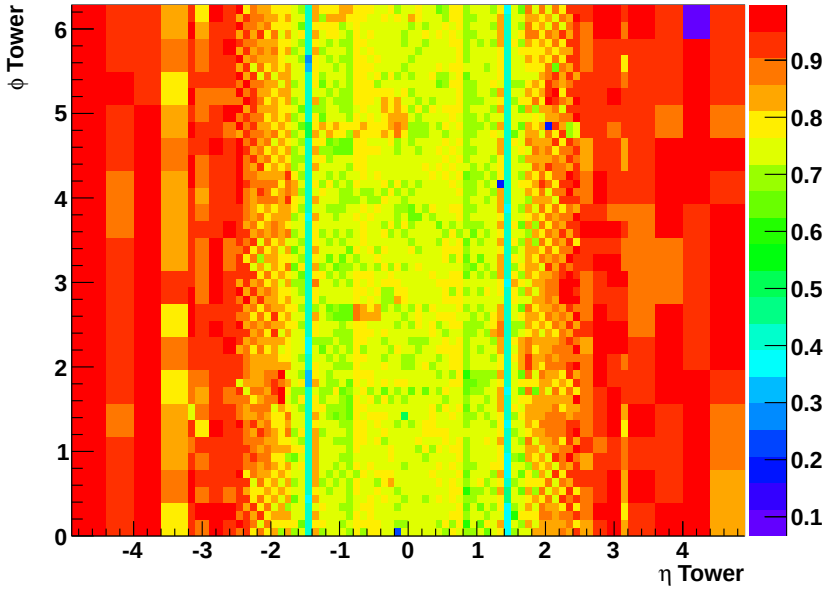




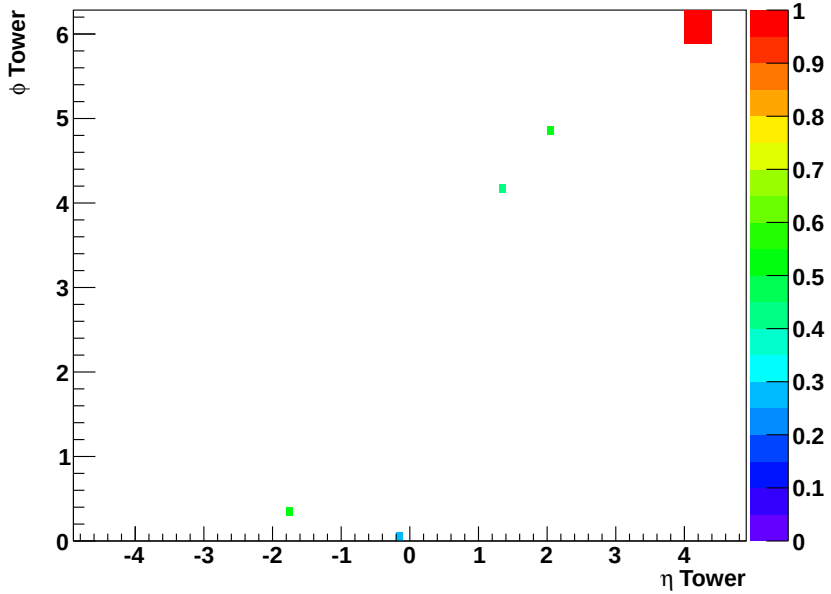
- Dead towers not really a problem in EM Barrel/Inner EC $\rightarrow$ Difference solely from BadCalo Towers
- EM Bad Calo Towers are missing front end board $\rightarrow$ OTX prob
- OTX problems causing Calo readout to miss part of energy so some tower deposits belong in higher bin than they're found in

EM Efficiency Map for E_T = 0.5 - 2 GeV and > 2 GeV

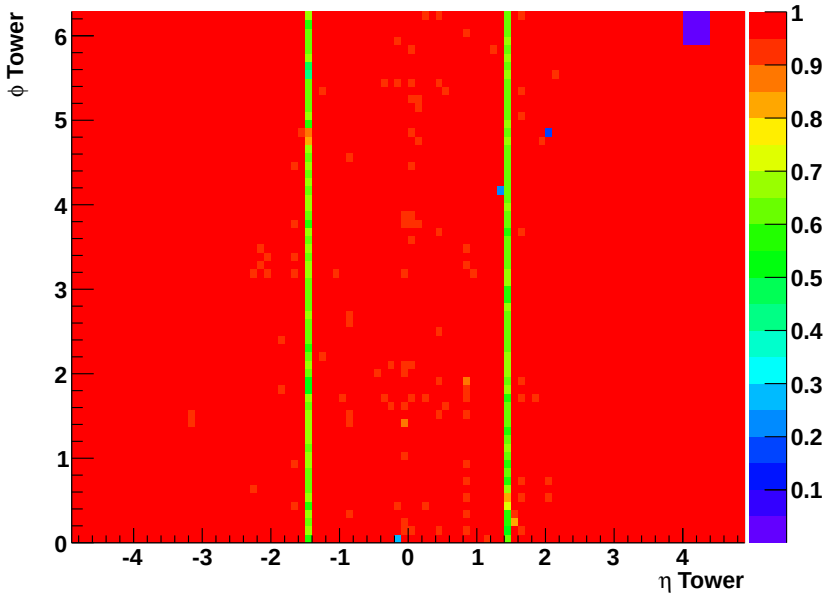
E_T = 0.5 - 2 GeV:



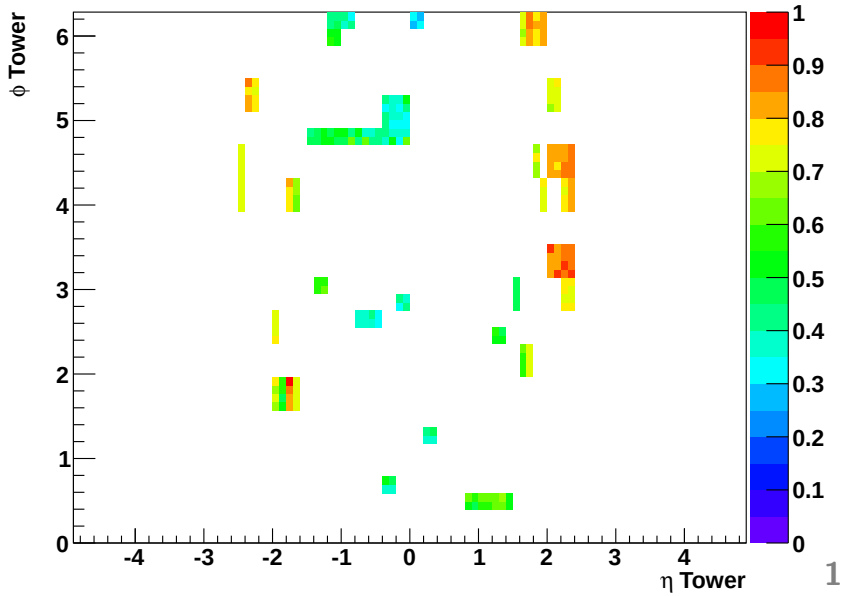
Dead Towers:



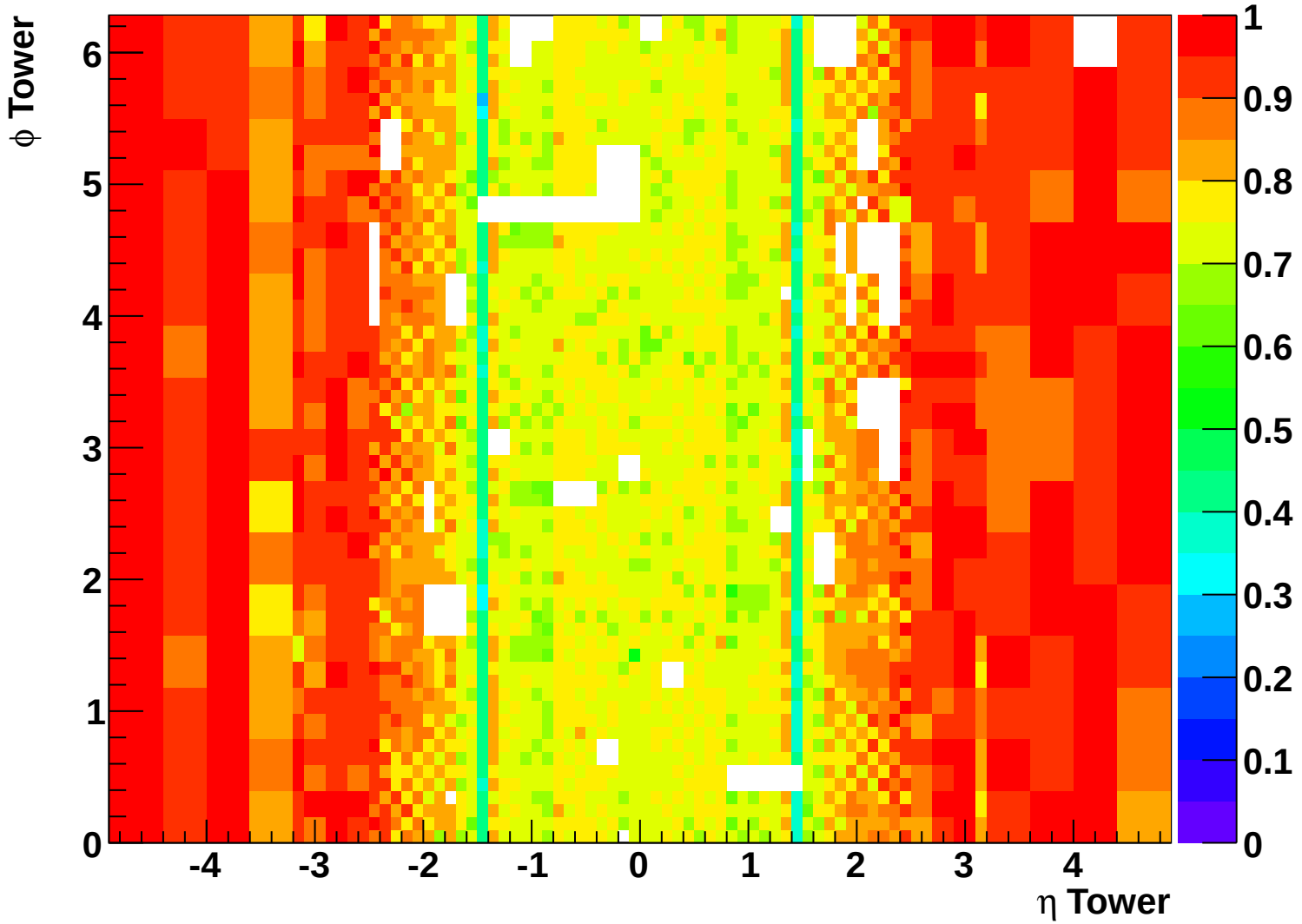
E_T > 2 GeV:



Bad Calo Towers:

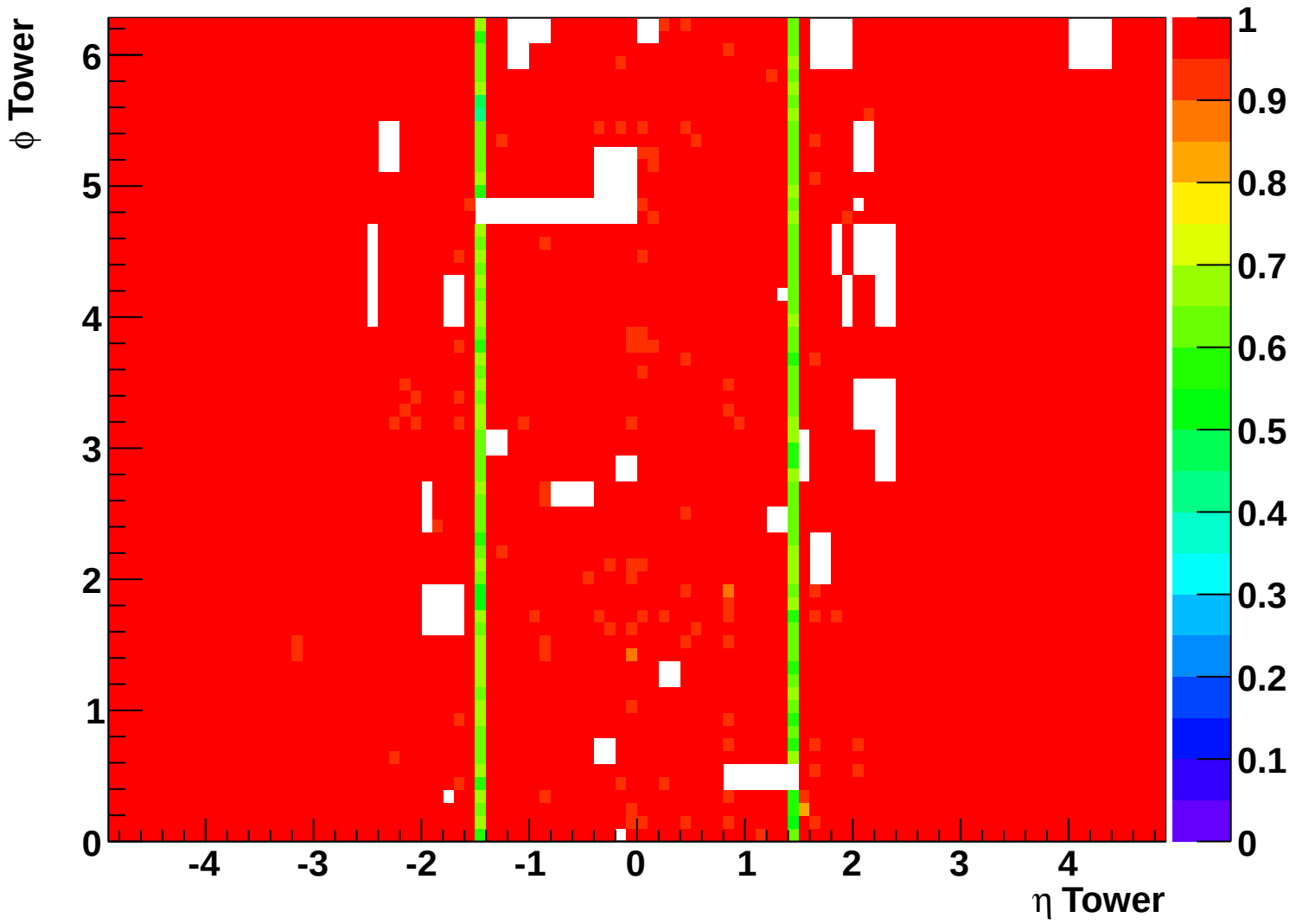


EM Efficiency Map for Good Towers E_T = 0.5 - 2 GeV



- Crack region shows lower efficiency
- Checkboard noise clearly visible

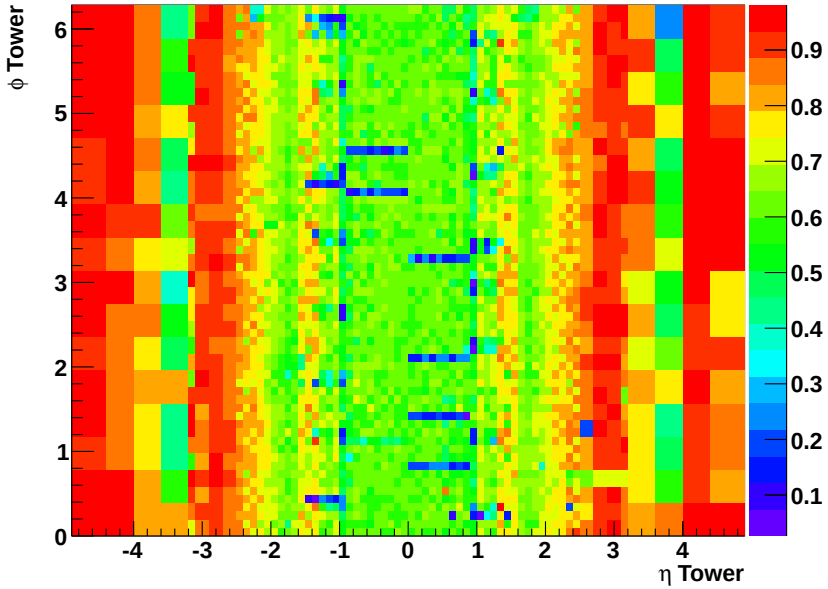
EM Efficiency Map for Good Towers $E_T > 2$ GeV



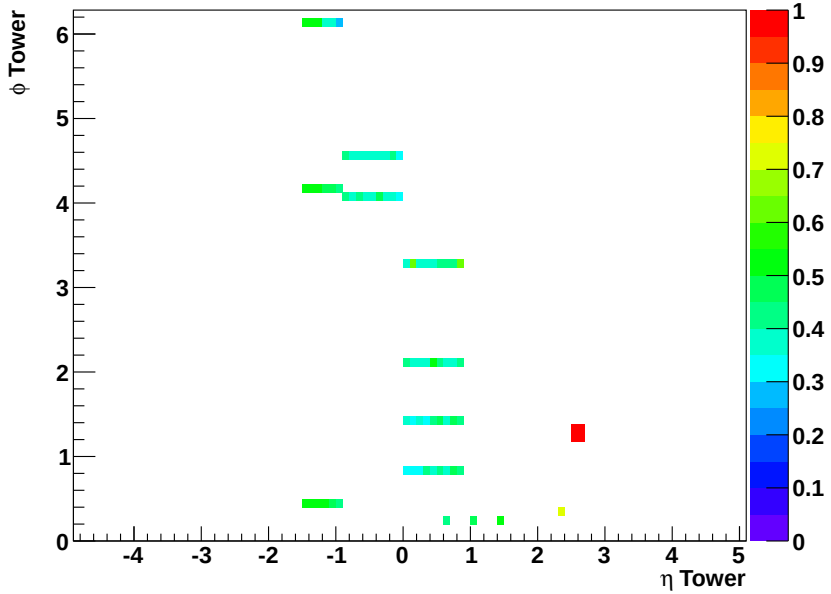
- Crack still performs poorly at higher E_T
- Some towers lagging behind

Had Efficiency Map for E_T = 0.5 - 2 GeV and > 2 GeV

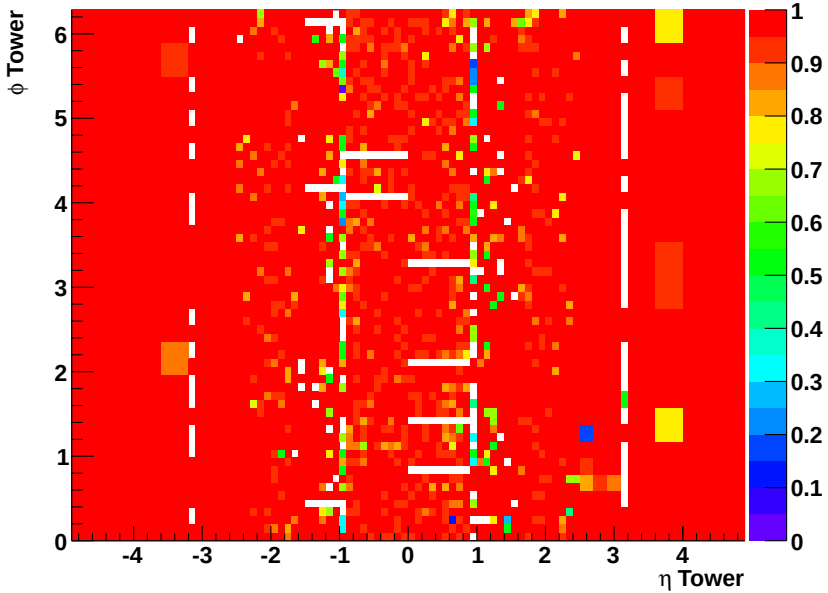
E_T = 0.5 - 2 GeV



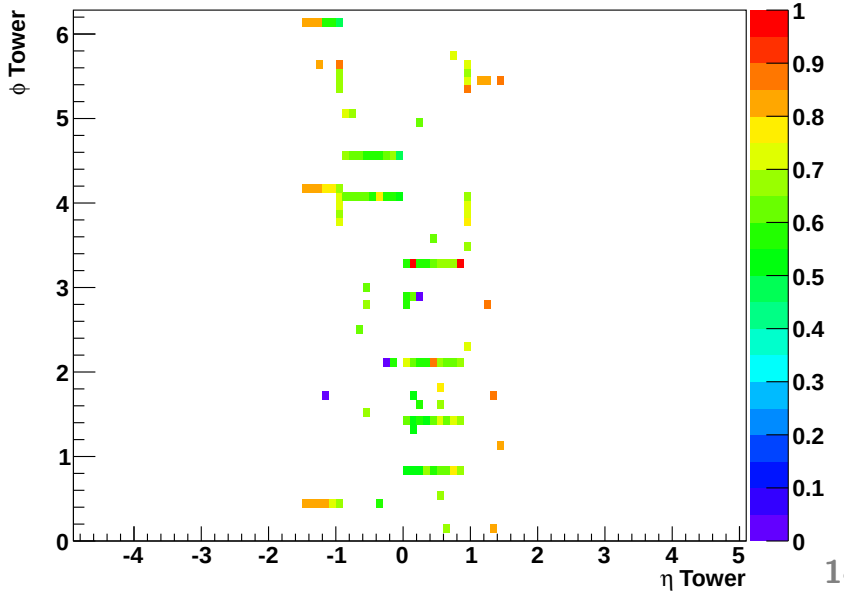
Dead Towers



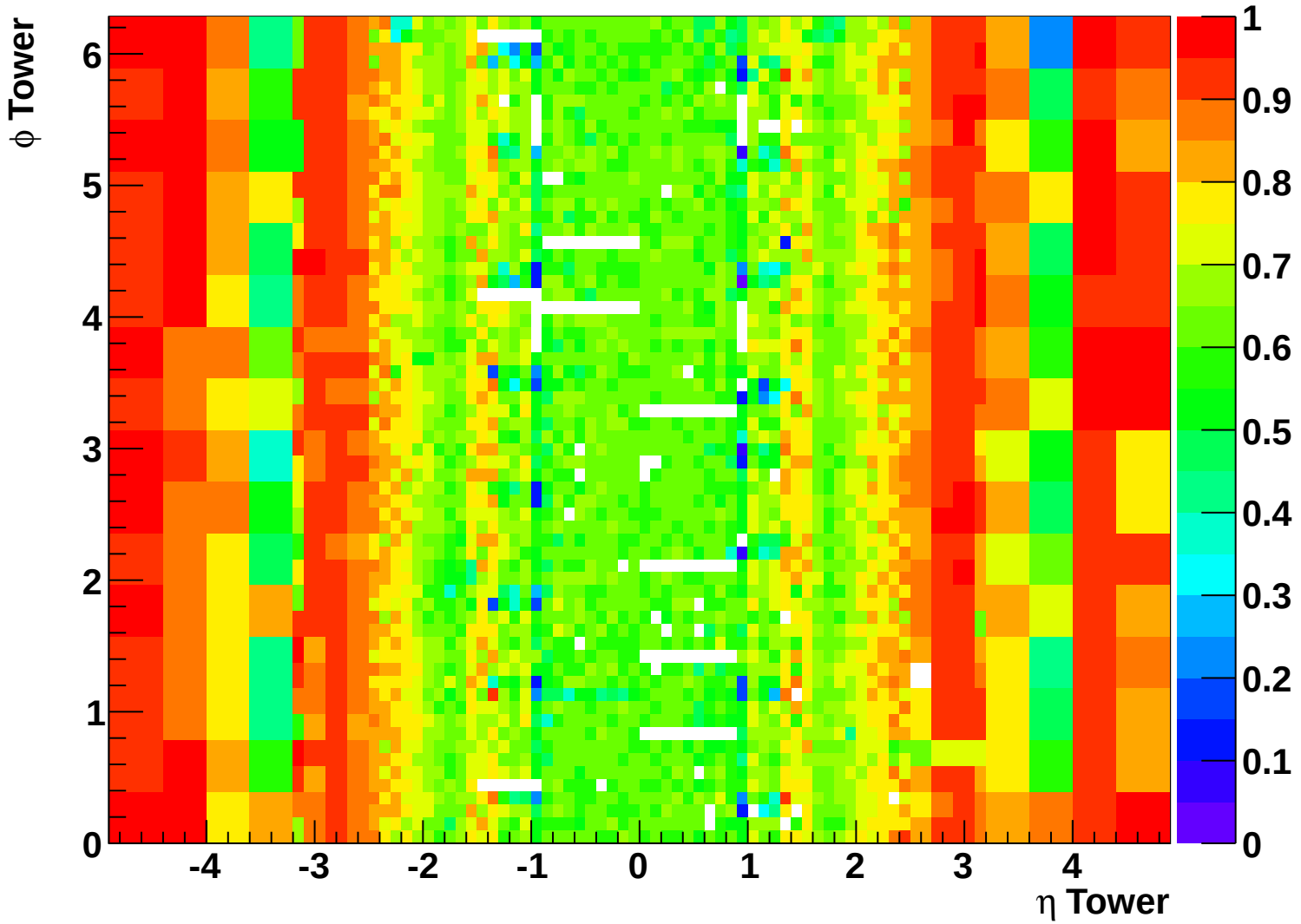
E_T > 2 GeV



Bad Calo Towers

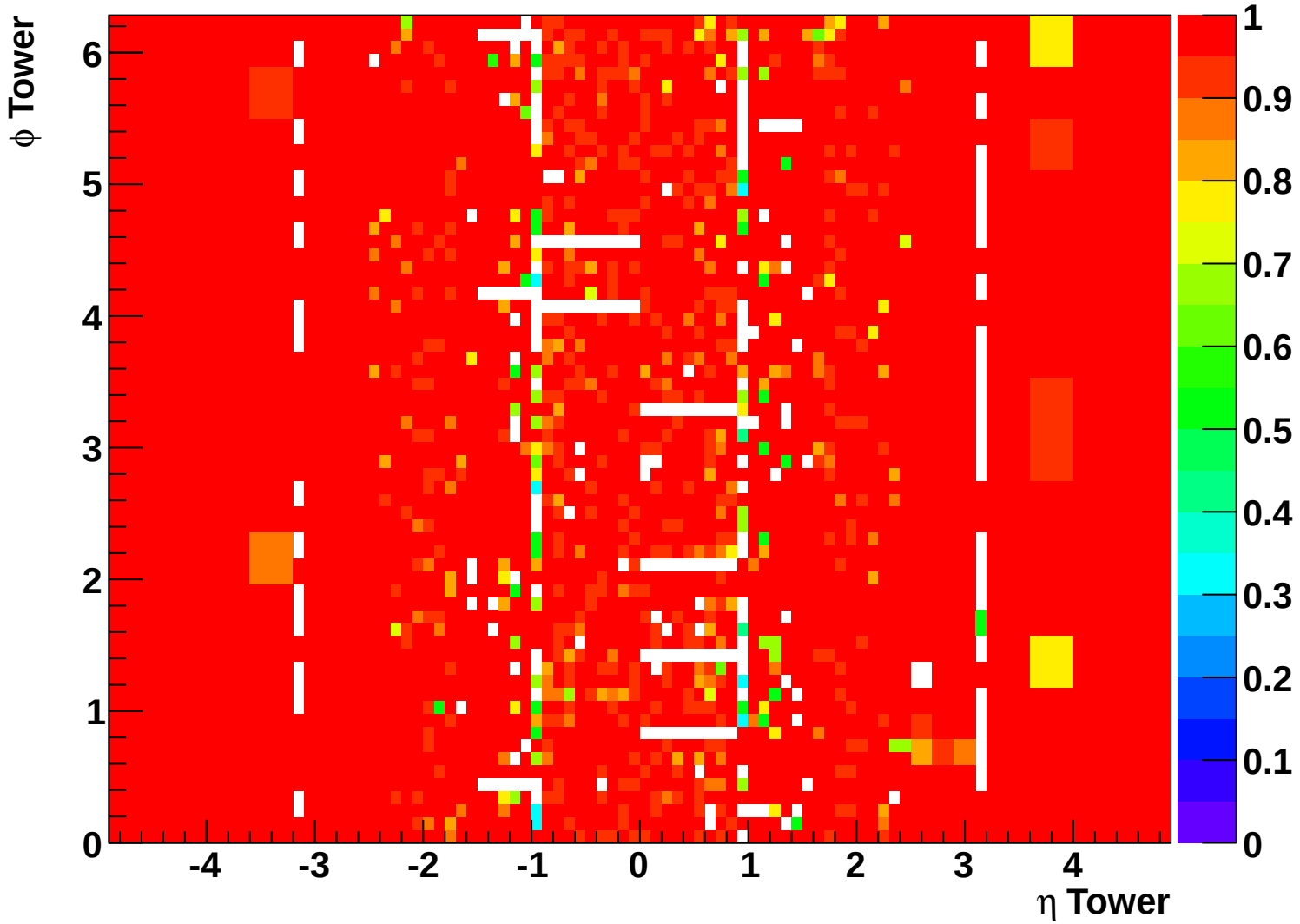


Had Efficiency Map for Good Towers E_T = 0.5 - 2 GeV



- FCAL tower ordering opposite in +/- η
- Problems at joins, e.g. Barrel to Ext Barrel at $\eta = 1$
- Checkerboard noise again

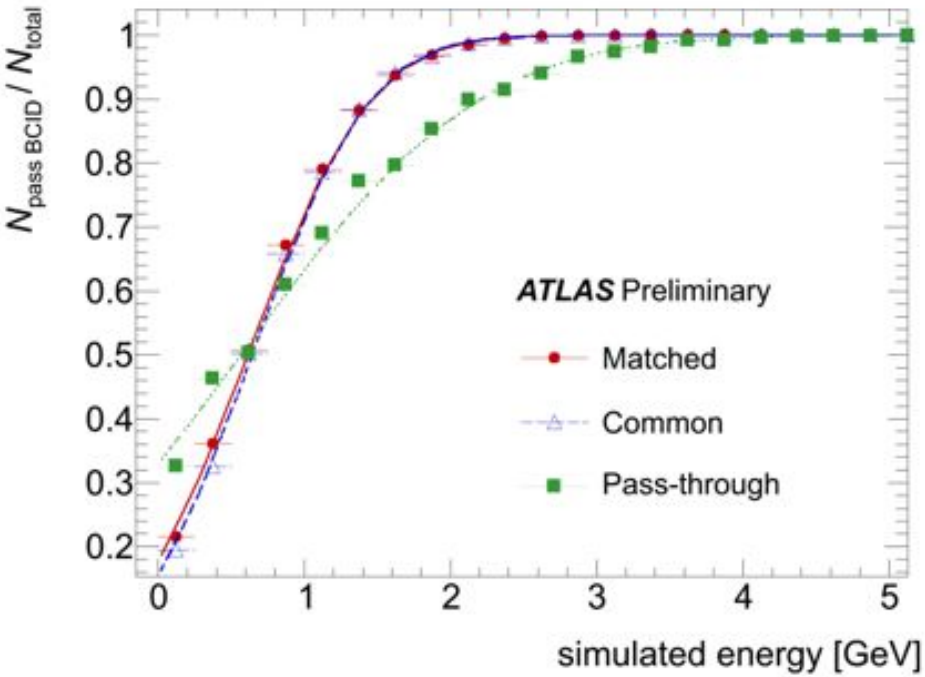
Had Efficiency Map for Good Towers $E_T > 2$ GeV

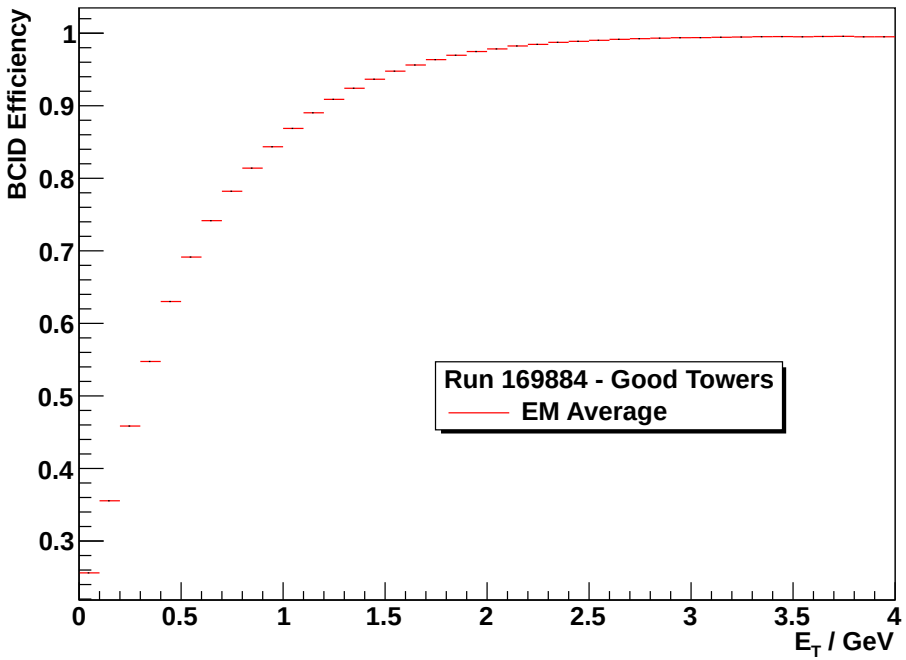


- Problems at joins, e.g. Barrel to Ext Barrel at $\eta = 1$
- Lots of "Good" towers still performing badly

Very Brief Comparison to Simulation

- Comparison of average EM BCID Efficiency with Simulation made by Dave Hadley





- Multiplicities not equal so not entirely trustworthy
- Different methodology so even less trustworthy
- Simulation appears to show faster Turn-on
- Requires proper Athena study

Conclusions

- BCID performing well
- Fully efficient from fairly low E_T
- EM Crack region horrible but will hopefully improve
- Barrel requires higher E_T for full efficiency
- OTX problems make efficiency appear improved: Illusion
- Data and Simulation are of slightly unknown agreement

To Do List:

- Measure improvement in newly cabled EM crack region using this year's early data
- Perform study on simulated data within Athena
- Compare to a pp data study
- Feed any differences/corrections into L1Calo Simulation
- Noise Study