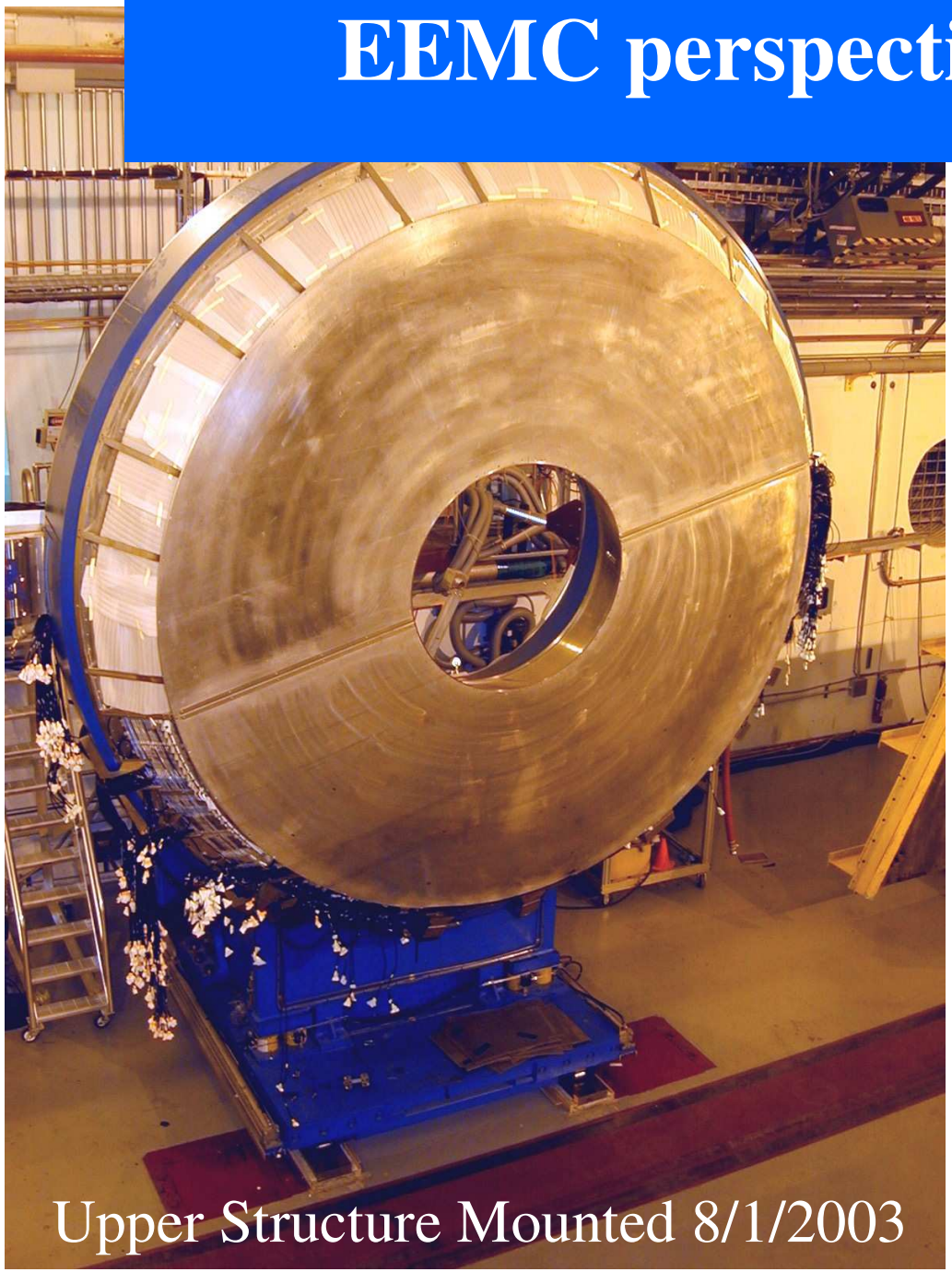
EEMC perspectives @ STAR


Upper Structure Mounted 8/1/2003

- Run 3
  - hardware
  - calibration
  - trigger
  - software
- Run 4
  - expectations
  - goals

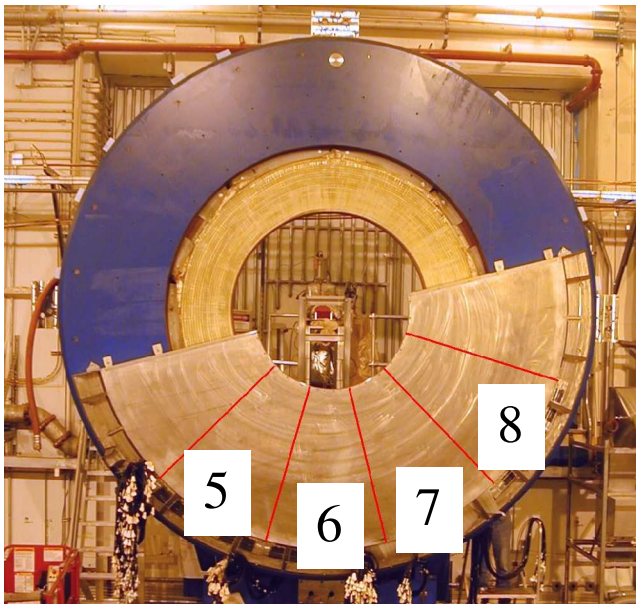
Jan Balewski, IUCF, Indiana

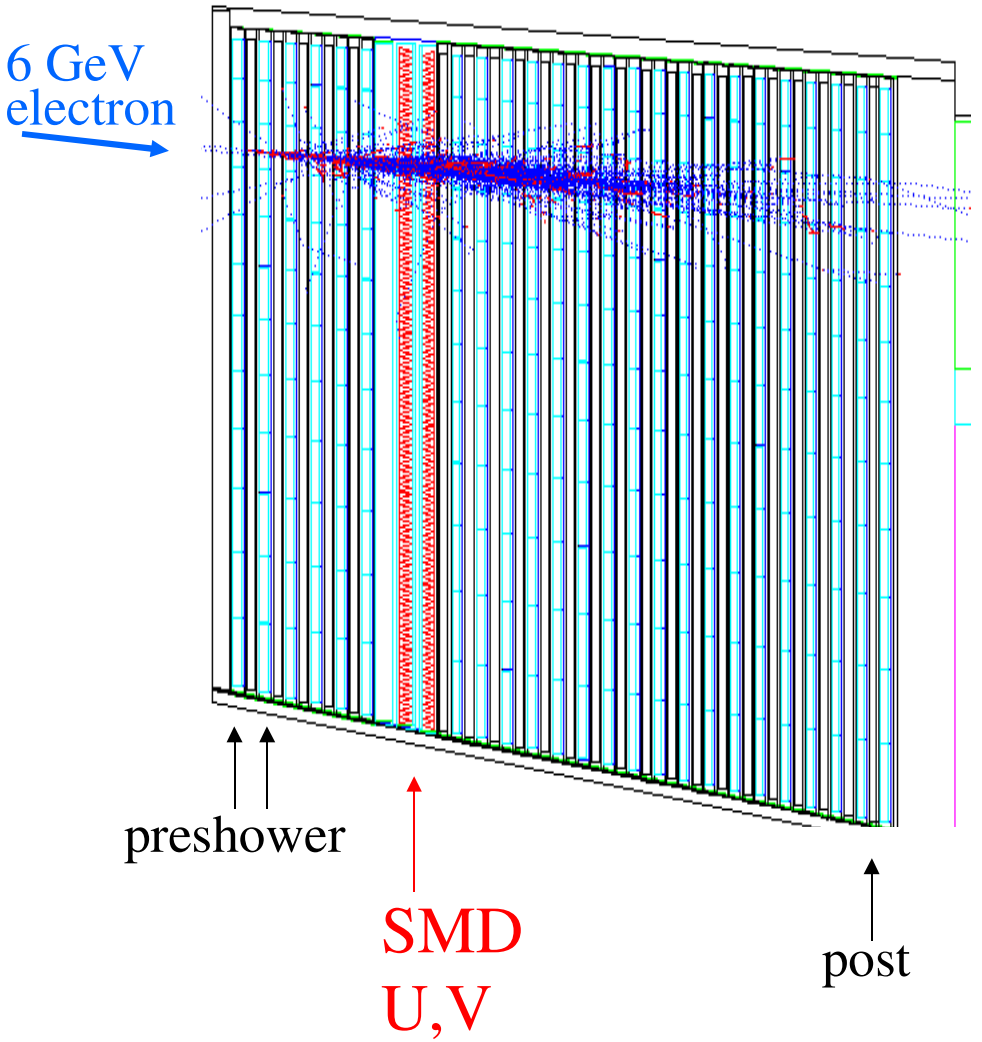
STAR Collaboration Meeting
MSU, August 2003

Instrumentation for pp Run 3

- Pb Scint sampling calorimeter
- 21 radiation lengths
- 240 of 720 projective towers
- Depth Segmentation
  - 2 preshower layers
  - High position resol. SMD
  - Postshower layer

  (no readout)
- L0 trigger:
  - high tower (working)
  - jet patches (problems)





EEMC Calibration Summary from 2003 STAR p+p Data

Three completely independent absolute calibration approaches agree at the 10-20% level:

2) **MIP peak location, assuming 5.0% sampling fraction (as per simulations);**

3) **reconstructed π^0 invariant mass from EEMC towers alone;**

4) **p/E from TPC-tracked electrons to EEMC.**

5) **"Isolated MIP slopes" used online gave reasonable gain matching for different ϕ bins at given η.**

Note:

π^0 reconstruction (after correction for simulated systematic shift for very asymmetric decays) and MIP peaks give consistent relative gains vs. η.

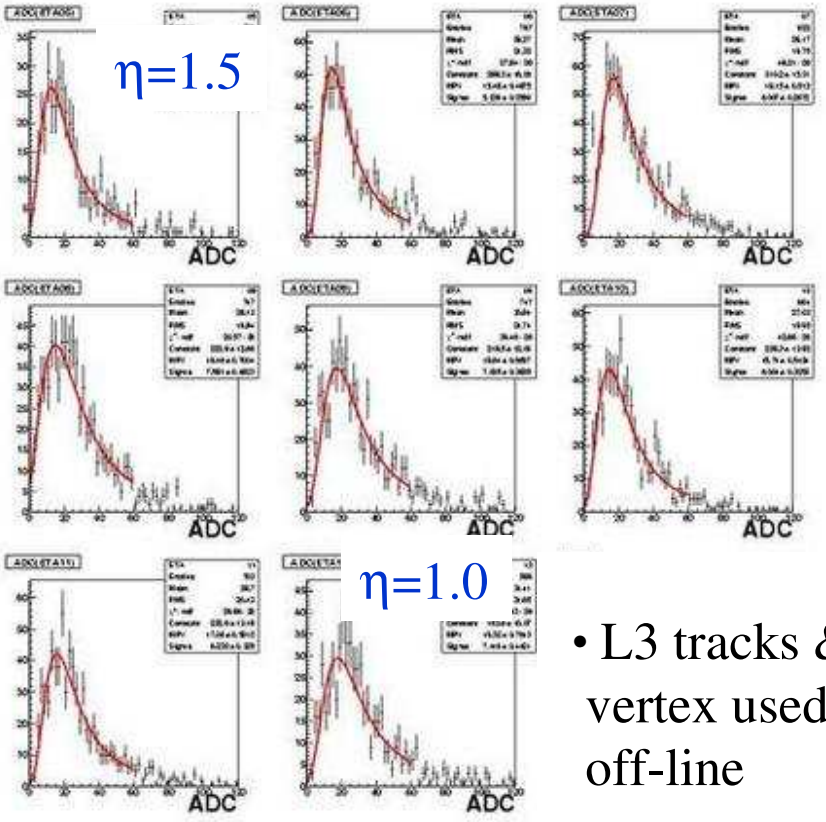
"Bootstrapping" approach, based on cosmic rays, ^{60}Co source, and isolated MIP's did not achieve desired E_T matching or absolute gains!

Following data from: R. Fatemi, J.Webb, P.Zolnierczuk, and J.B.

THANKS !

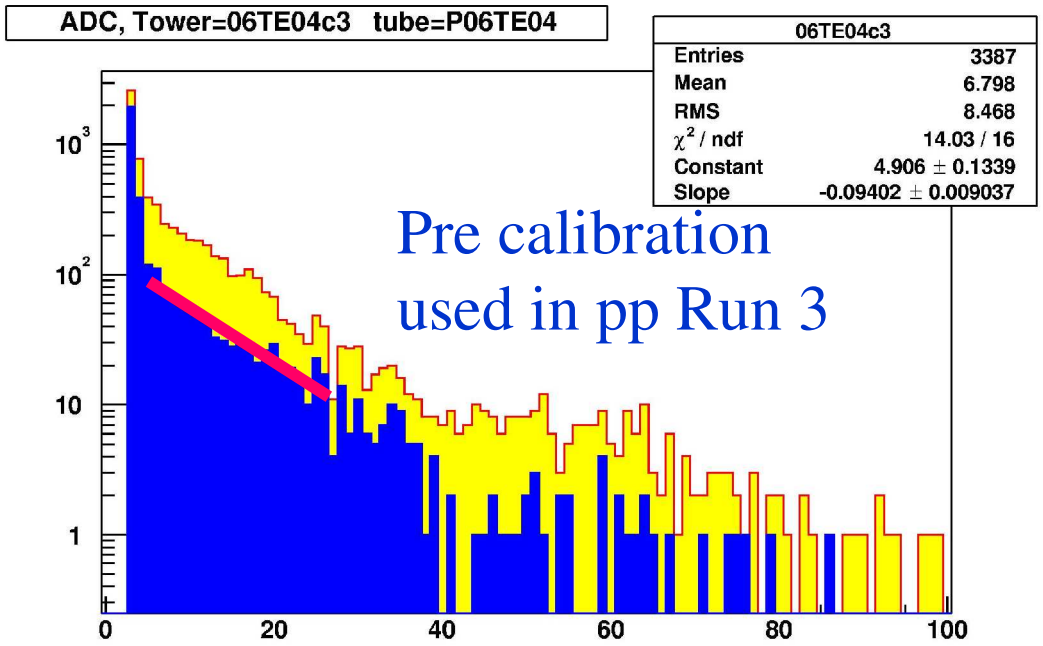
Relative Gains from MIP's

For 1.0 ≤ η ≤ 1.5 , use MIP's tracked from TPC to EEMC, where track predicted to enter and exit same tower. Landau fit to observed peak shape determines absolute gain of each tower illuminated, using 5.0% sampling fraction to convert to equivalent shower energy.

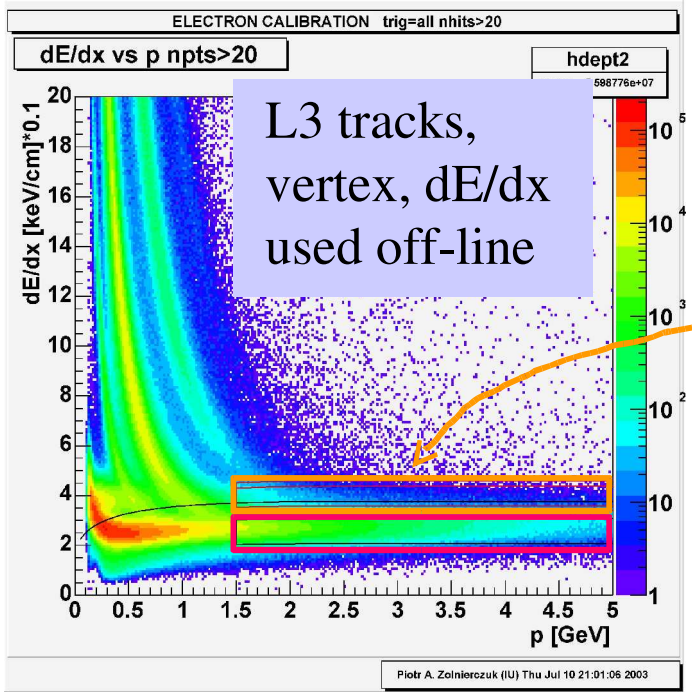


- L3 tracks & vertex used off-line

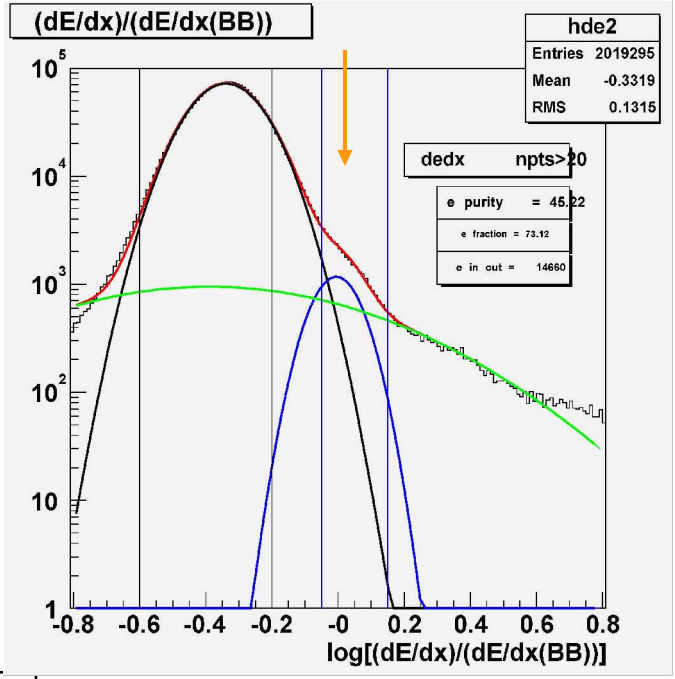
For towers where clear MIP peak not visible, or tracking not available, use slope of tower ADC spectrum in anti-coincidence with neighboring towers as measure of relative gain. This is correlated very well with MIP peak location where both available.



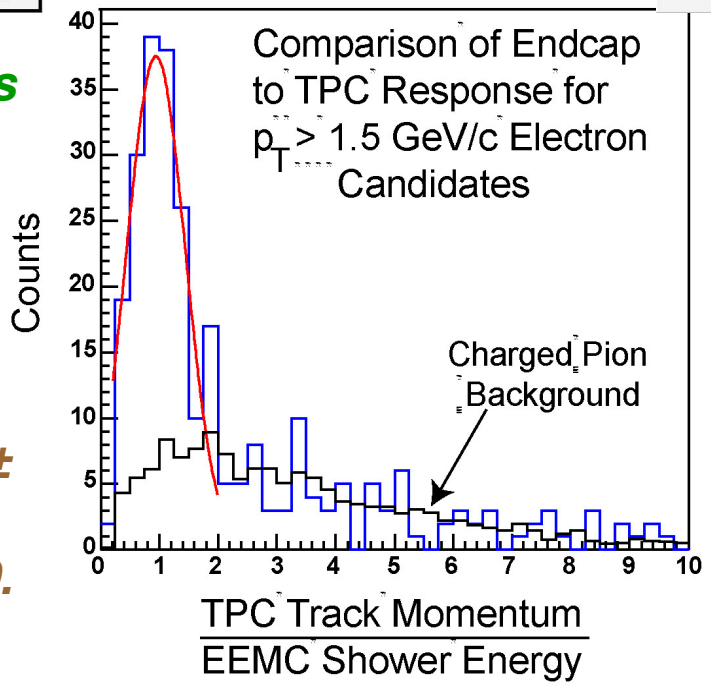
EEMC Response to Tracked Electrons



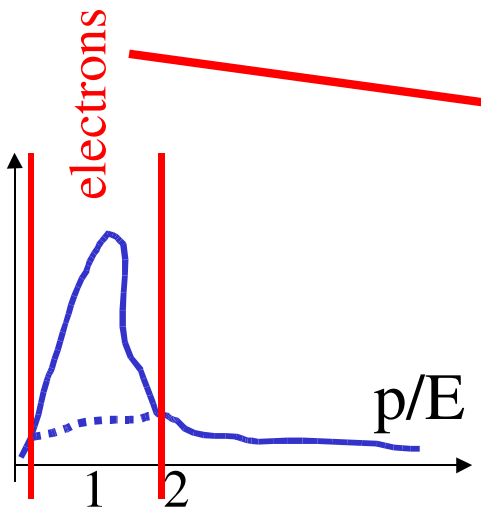
- *Use TPC dE/dx vs. p to select track region where electrons are (slightly) dominant.*
- *Use window on pions over same p range to estimate background EEMC response*



- *Take relative tower gains from MIP's, and adjust overall absolute calibration constant to match EEMC E to TPC p.*
- *With presently available statistics, this gives (55 ± 5) channels/ GeV on 'calibration' tower 5TB09.*

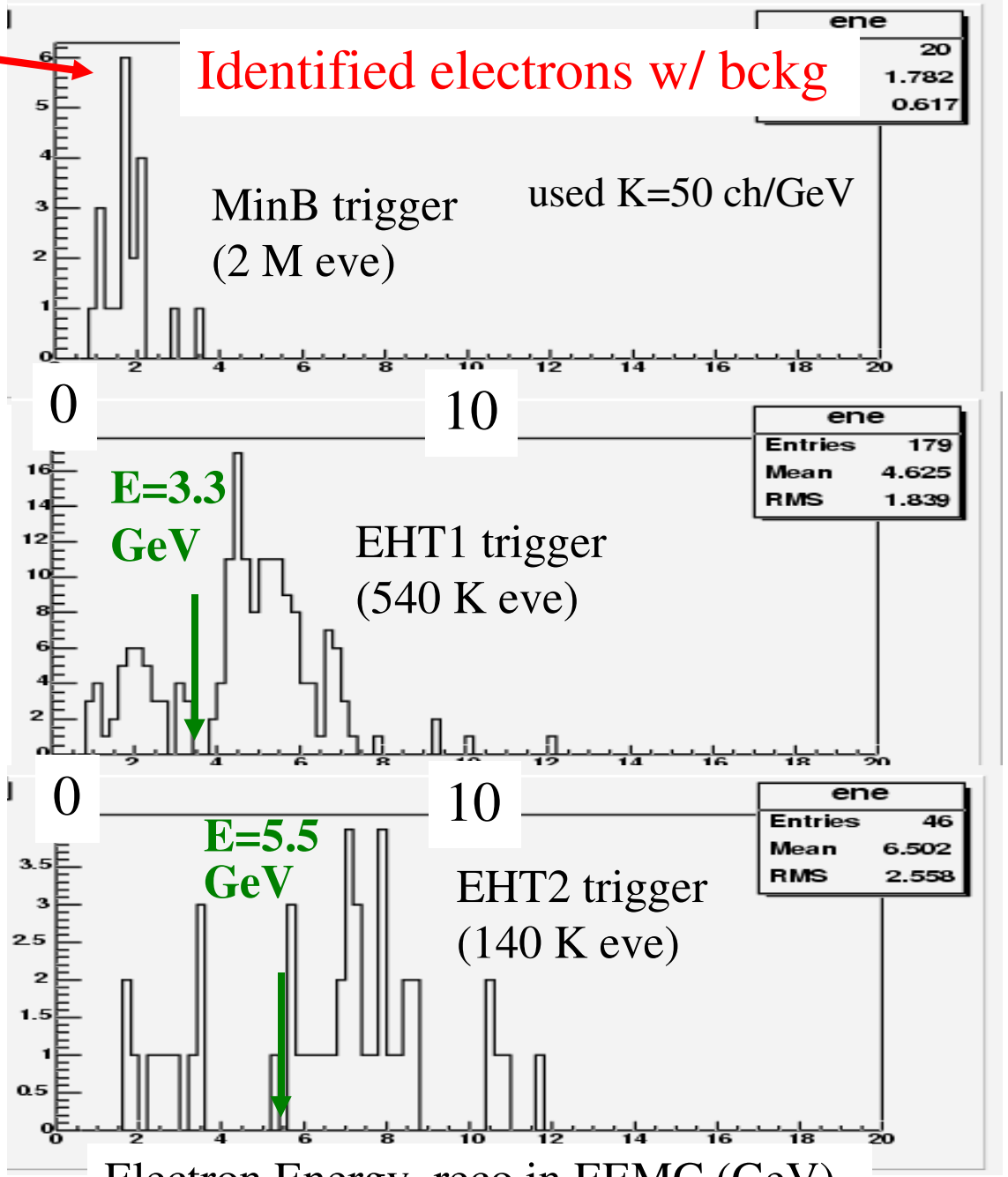


Electrons Trigger EHT-1.2



L2 Enrichment (potential)

- select trig tower and
  - require pre1 ~pre2 ≥ MIP
  - veto postshower
- not tested with M-C
- no data to play with
- factor 10 would do



EEMC (Tower Only) π^0 Reconstruction

γ_1 π^0 Θ_{12} γ_2

Cuts:
- seed >0.7 GeV
- seed/cluster >0.7

$$invM \approx \Theta_{12} * \sqrt{(E_1 * E_2)}$$

$$Z_{\pi^0} = \frac{E_1 - E_2}{E_1 + E_2}$$

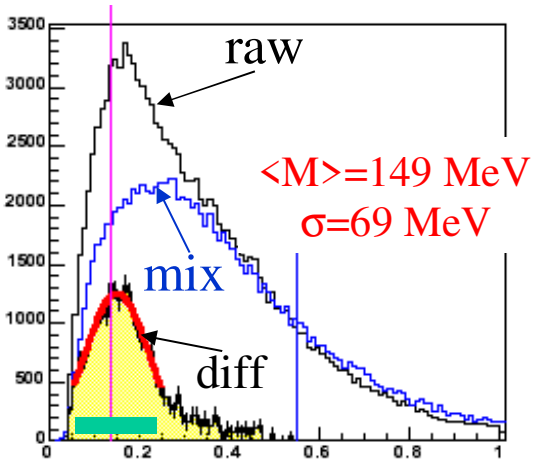
γ-γ Invariant Mass

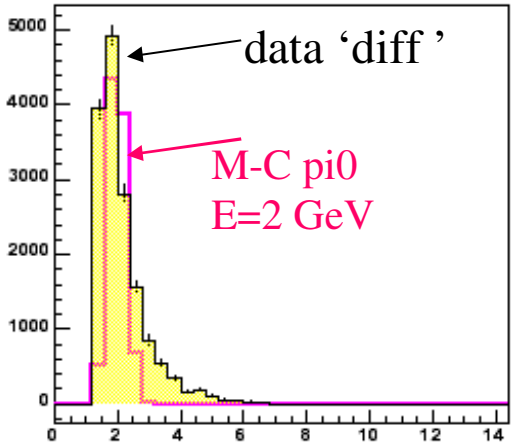
π^0 Total Energy

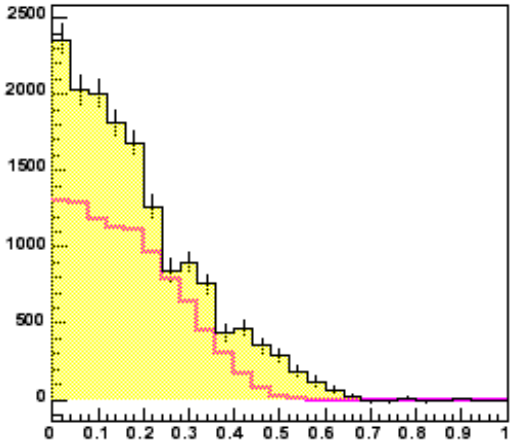
π^0 Energy Sharing

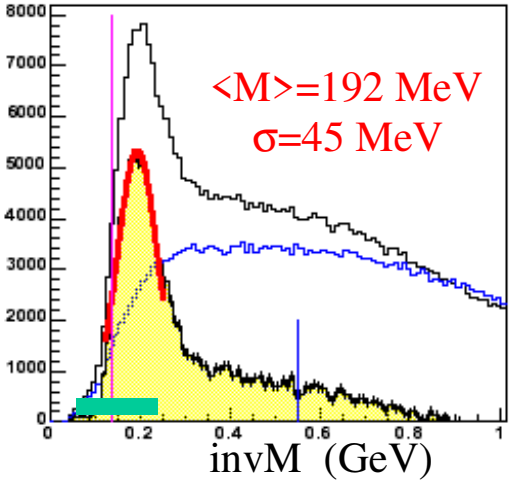
MinB Trigger data →

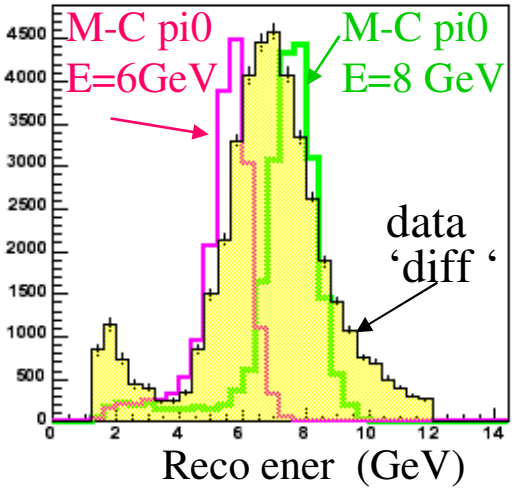
EHT-1&2 Trigger data →

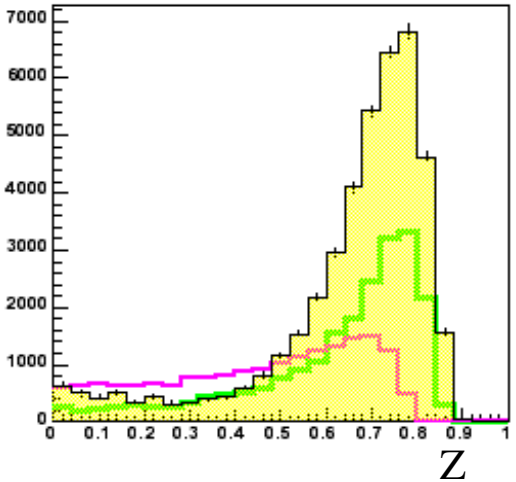




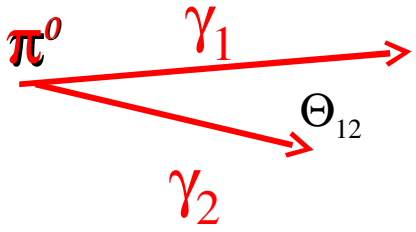








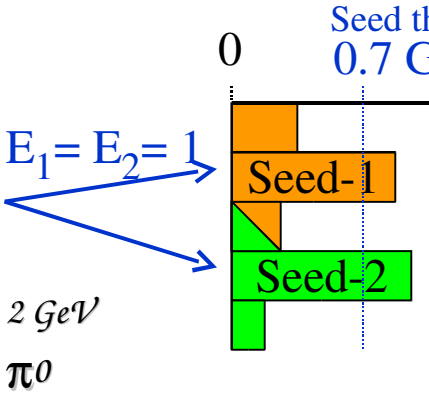
Reconstruction of π^0 with Limited Angular Resolution



Cuts:
- seed >0.7 GeV
- seed/cluster >0.7

$$invM \approx \Theta_{12} * \sqrt{(E_1 * E_2)} \qquad Z_{\pi^0} = \frac{E_1 - E_2}{E_1 + E_2}$$

MinB trigger yields **symmetric** decayed π0



$$E'_1 = E_1 \pm \delta \qquad E'_2 = E_1 \mp \delta$$

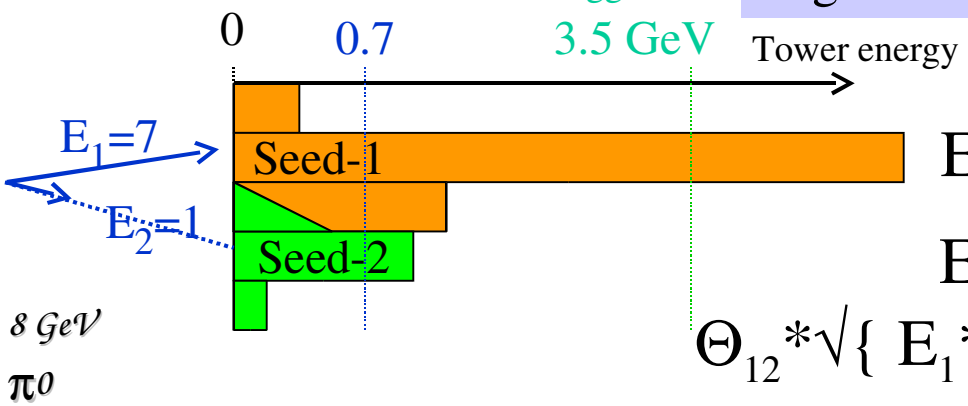
Overlap error

$$\Theta_{12} * \sqrt{\{ E_1 * E_2 \pm \delta(E_1 - E_2)\}} \approx m_{\pi^0}$$

($E_1 - E_2 \approx 0$)

$$Z_{\pi^0} \approx 0$$

High Tower trigger yields **asymmetric** decayed π0



$$E'_1 = E_1 - \alpha E_1$$

$$E'_2 = E_2 + \alpha E_1$$

Mostly overestimated

$$\Theta_{12} * \sqrt{\{ E_1 * E_2 + \alpha E_1^2\}} \approx m_{\pi^0} * (1 + \alpha E_1 / E_2)$$

($E_1 / E_2 = 7$)

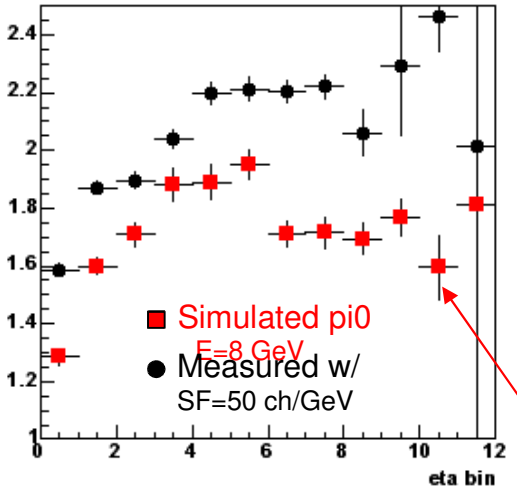
$$Z_{\pi^0} \approx 0.8$$

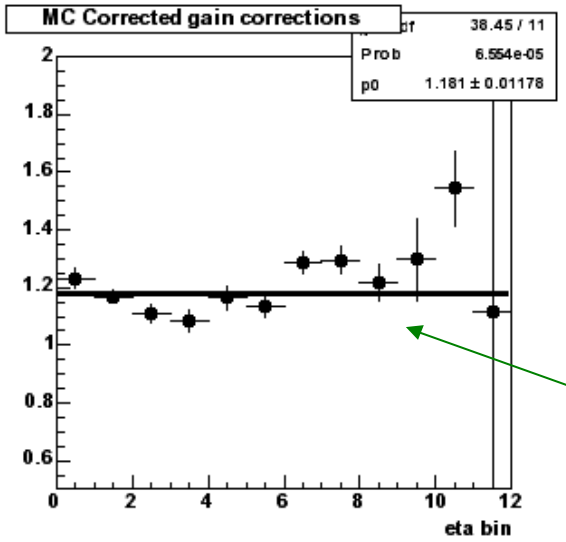
η-dependent Gains from Reconstructed π^0

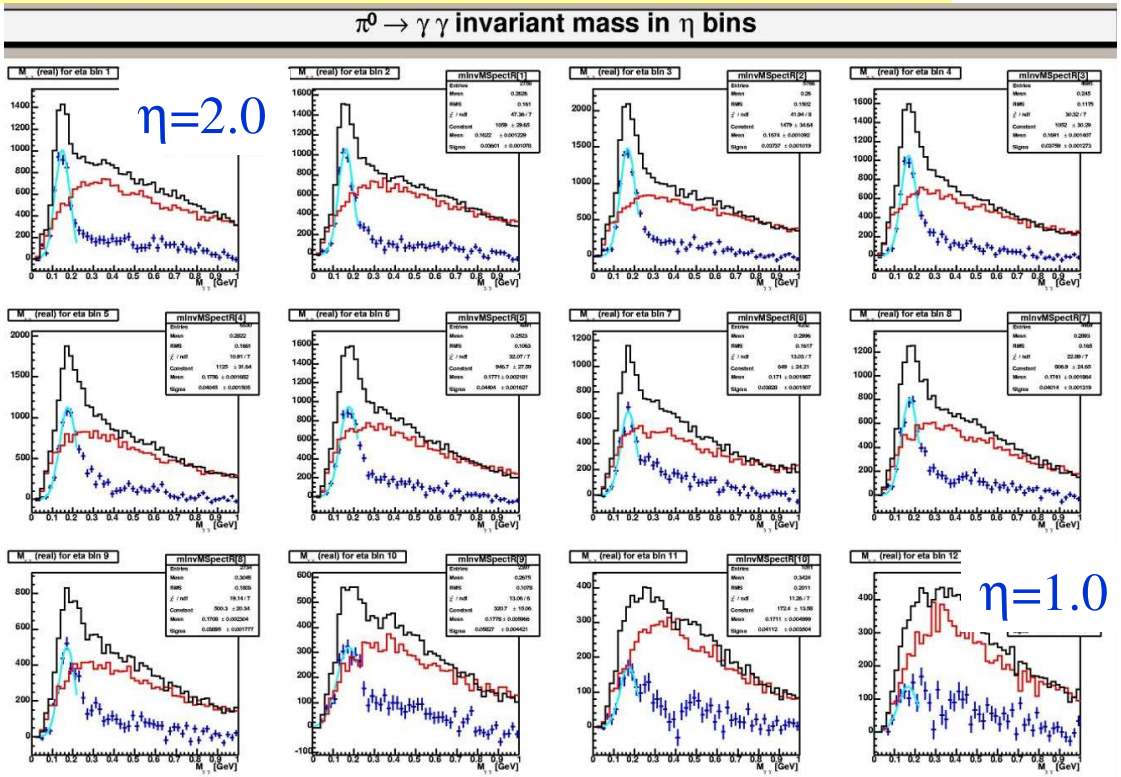
Events sorted according to η bin of the higher-energy cluster.

- *Data here triggered by EEMC high-tower in p+p.*

$\left(\frac{\text{invM}}{\text{M pi0}}\right)^2$







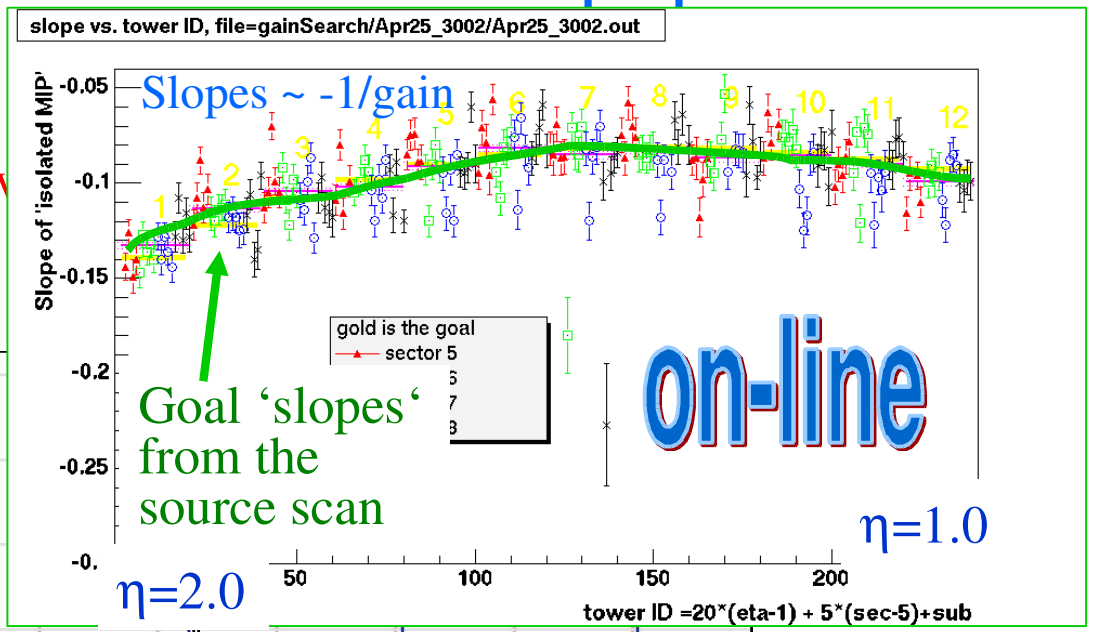
- *"Correct" mass determined from simulations, which take account of geometric effects and imperfect E sharing between clusters for the very asymmetric (E_1 / $E_2 \approx$ 7:1) decays that satisfy high tower trigger + tower min. θ_{open}.*

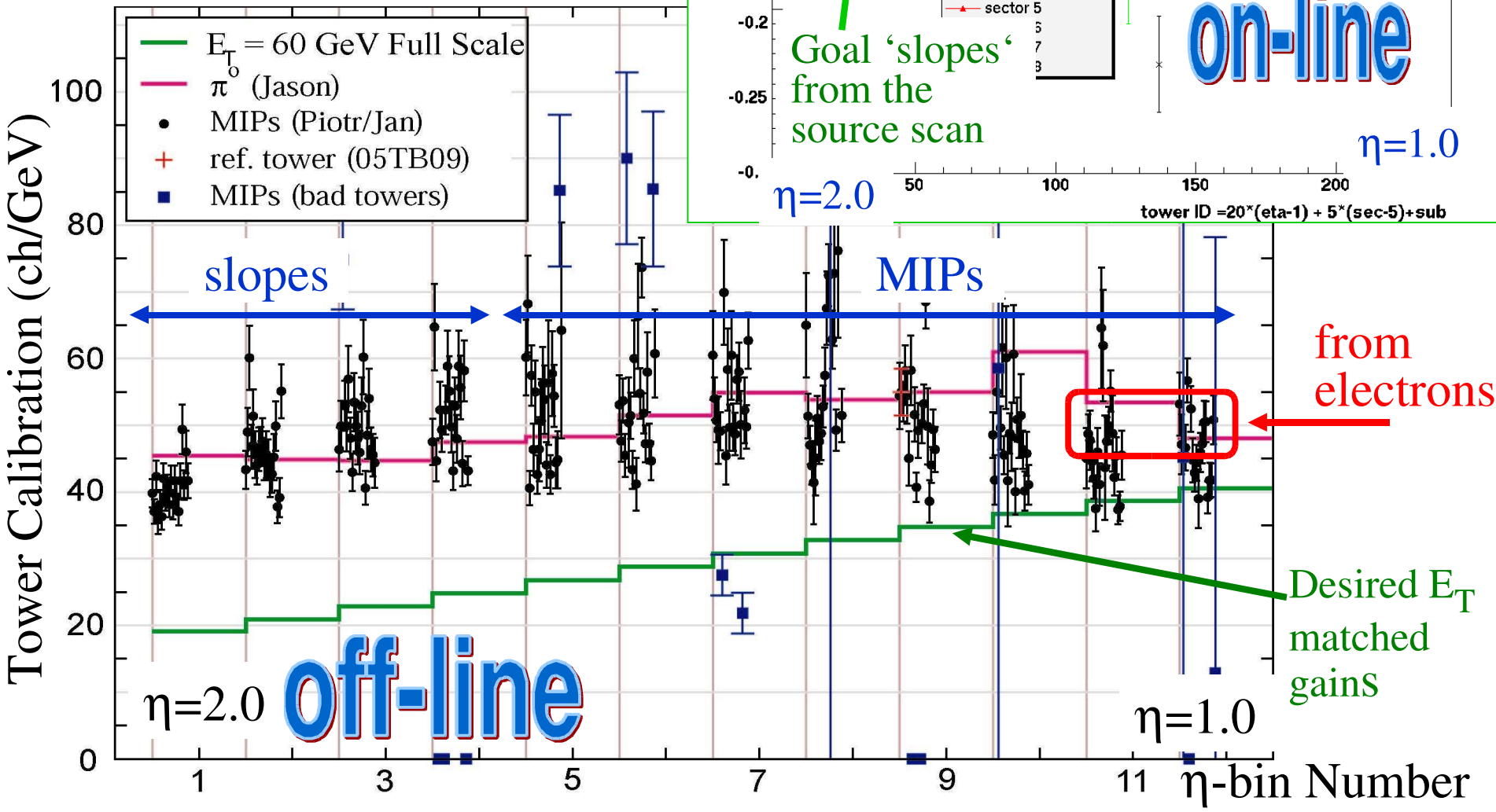
- *Relative gains within each η bin taken from MIP response. Absolute gains will be adjusted to place reconstructed π^0 peak at "correct" mass.*

EEMC Towers Calibration Run 3 p+p

Tower Gains in Run 3

- flat in energy ~50-60 ADC ch/GeV
- known from MIP or slope ± 10% (stdev
- HV matched ± 20% (stdev)

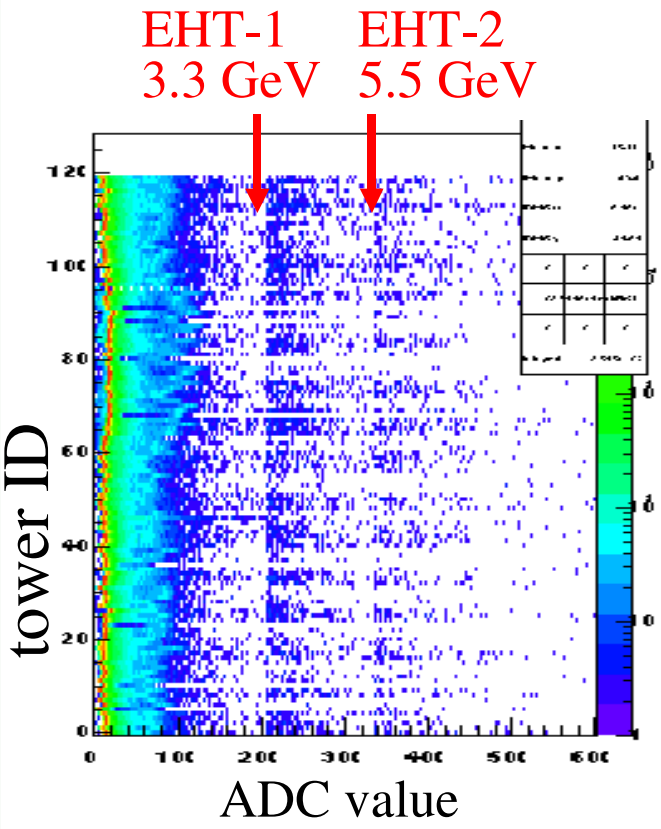




EEMC Trigger in Run 3

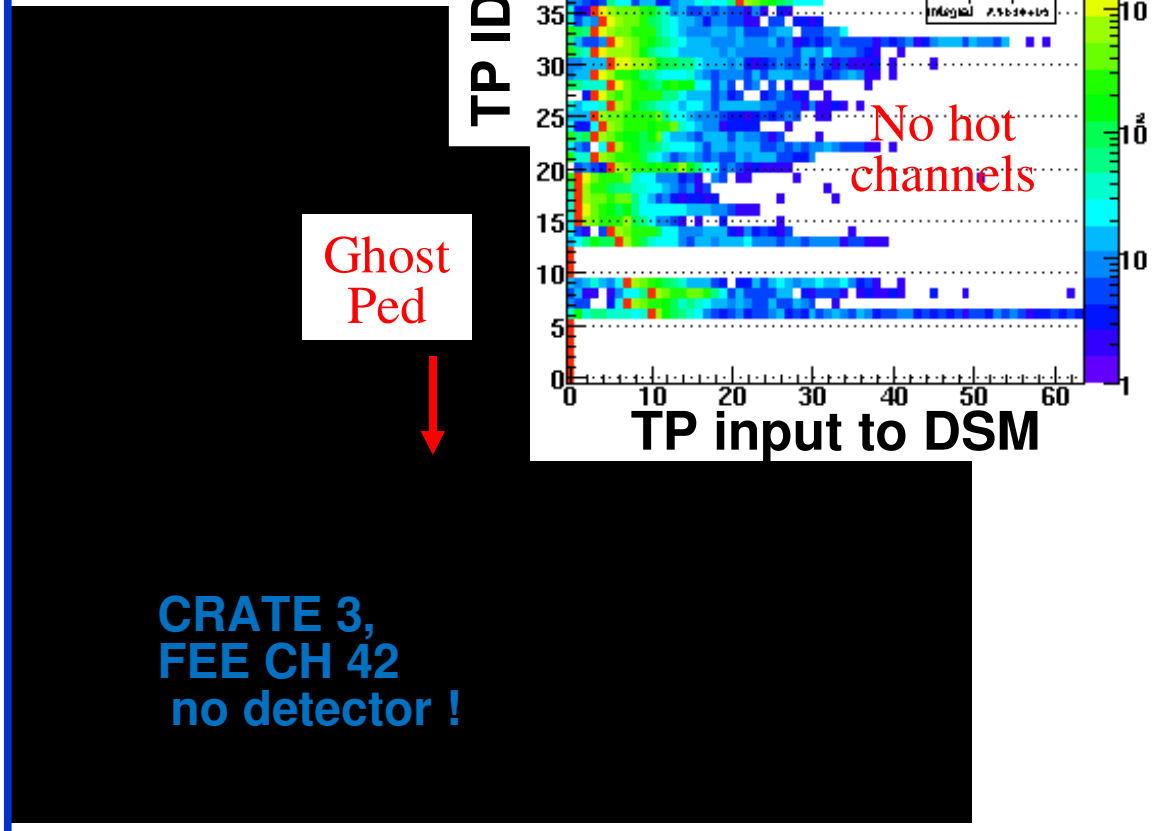
High Tower Trigger OK

- EHT1 @ E=3.3 GeV
  - slow 600 K events
  - fast 300 K events
- EHT2 @ E=5.5 GeV
  - slow 140 K events



Jet Trigger problems

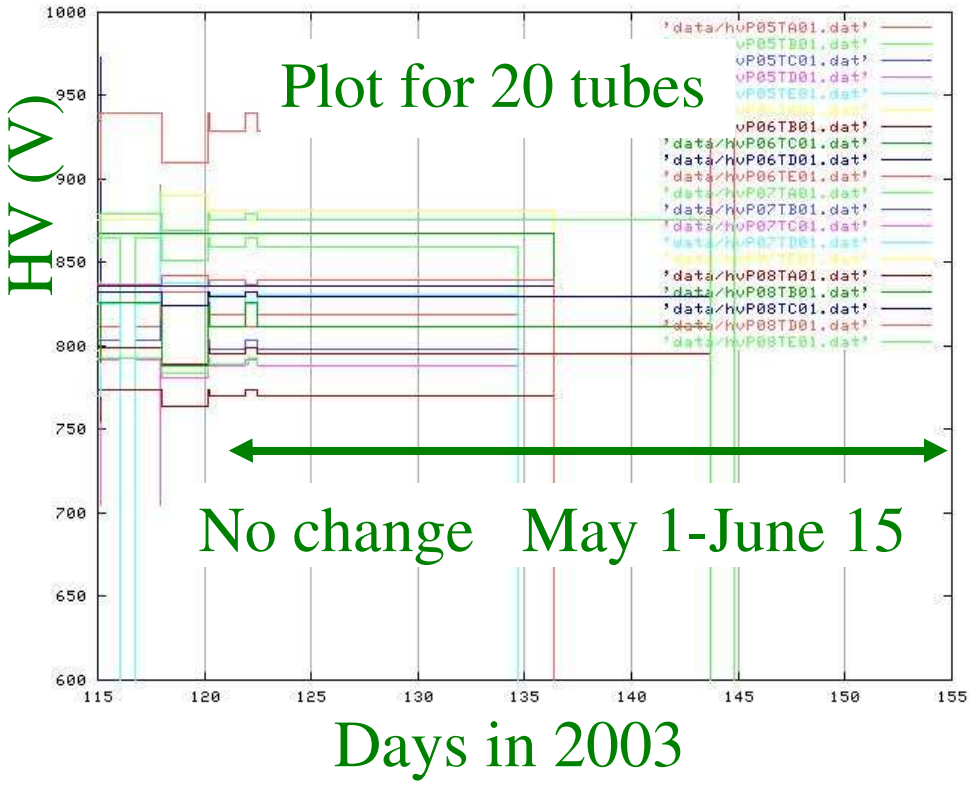
- ped close to N*16 – fixed in FEE
- correlated noise N*256 – veto E_{jet}>200 GeV
- correlated ghost ped - ?
- 1% data corruption - ?



EEMC (Tower) Database for Run 3

On-line

- **monitor** HV every 5 minutes
- **record** any change for any tube



Off-line

- **map** of FEE channel vs. tower
- **gains**, one set from day 120+
- **ped**, new set each RHIC fill,
  (changes below 1 ADC ch)

- available in root4star

Software & Simulations (done)

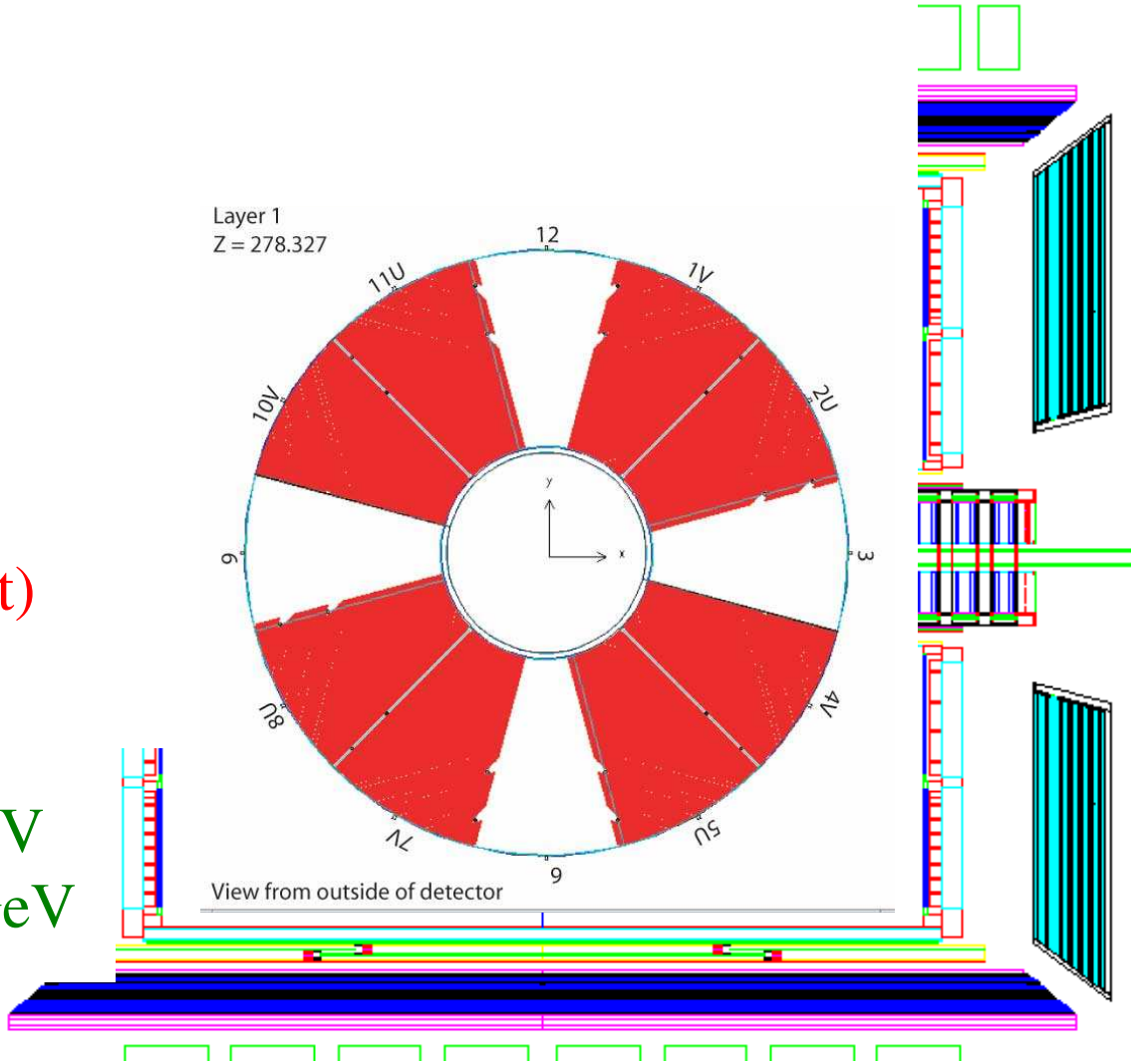
Software

- EEMC geometry in GSTAR (Oleg Rogachevski)
- fast simulator for towers/ pre/ post/ SMD
- DAQ reader (tower energy, Herb)
- DAQ ezTree (Piotr)
- StEvent (Akio)
- StEvent muDst (Alex)

Data sets

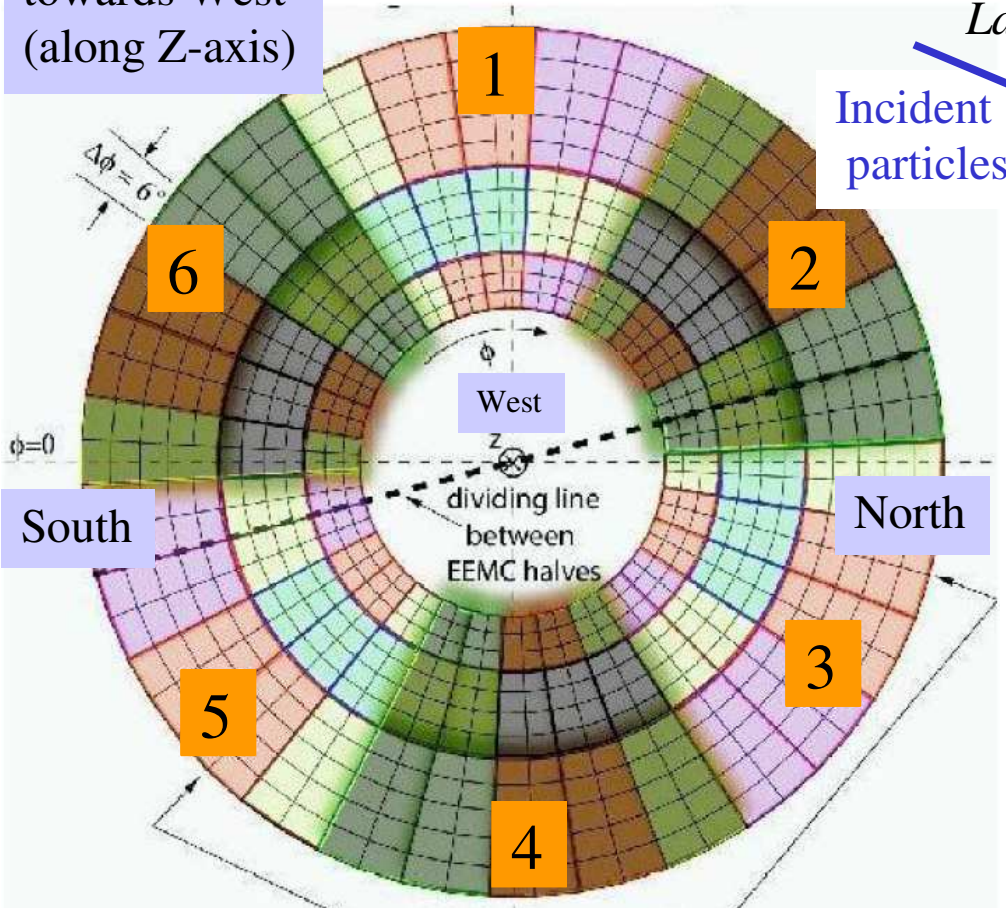
- DAQ pp200 (towers):
  - 2 M minB events
  - 1 M EHT-1/2

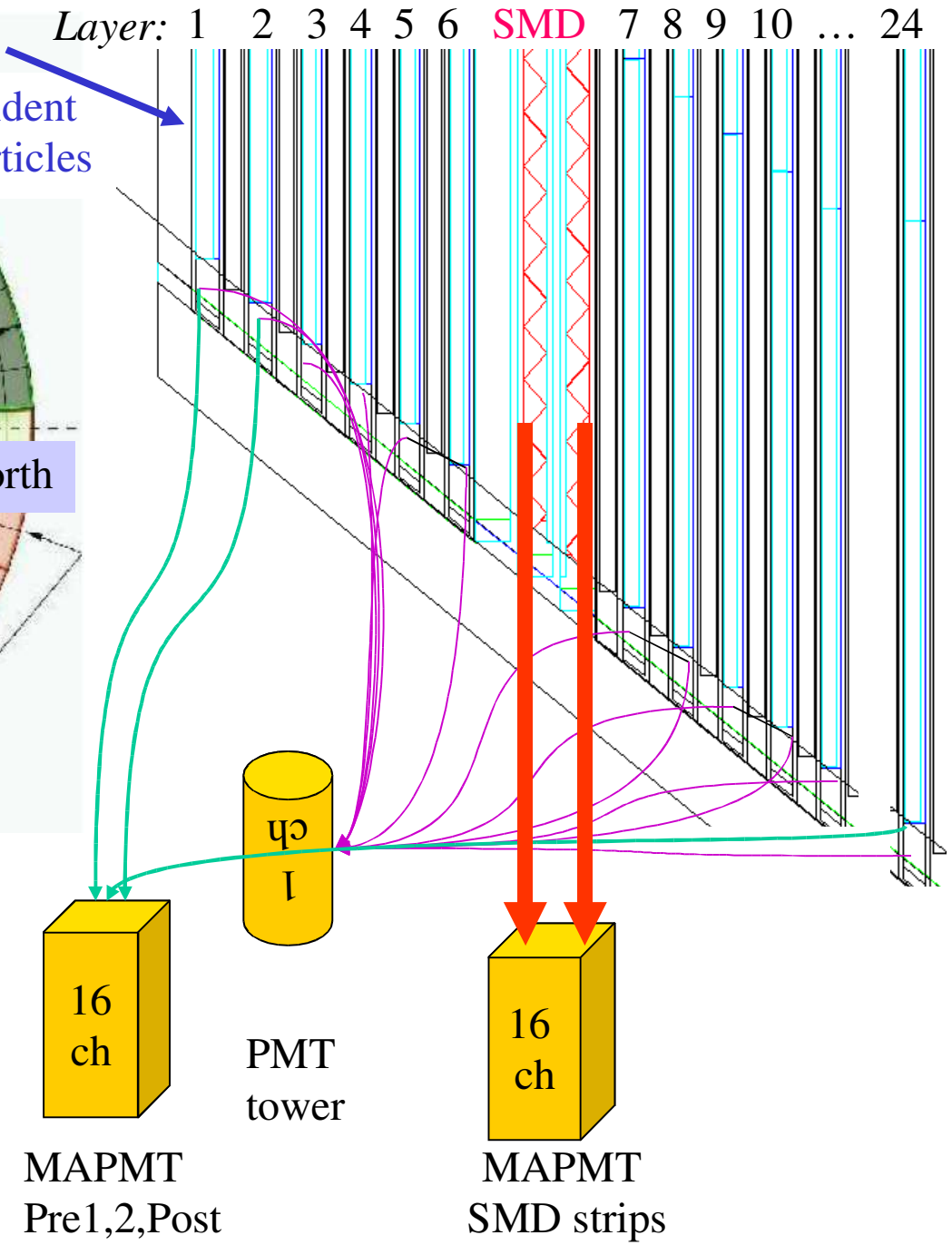
  (available in ezTree format)
- M-C PYTHIA, geom2003:
  - 1.3 M minB
  - 0.5 M partonic pT>5 GeV
  - 0.5 M partonic pT>15 GeV



Run 4 Instrumentation

View from IR towards West (along Z-axis)





- L0 trigger:
  - high tower
  - **jet patches**
- readout
  - 720 towers
  - 5/12 pre/post
  - 5/12 SMD

Run 4 Calibration Plan

Goals:

- towers ± 10% (used in trigger)
- Pre/post/SMD 50% (in the range of ADC)

Commissioned 240 **towers**

- fix ~10 dead ch
- change gain to E_T-match with LED
- check gains with MIP and pi0

New 480 **towers**

- before beam
  - set initial HV based on known gains
  - verify all channels with LED/laser
- in beam (early)
  - use 'slopes' , gain match ± 50%

    (E_T-match to calibrated towers)
  - use pi0 in dedicated run to gain match ±10%
- off-line
  - MIP, pi0, electrons

New **pre- post- shower, SMD**

- verify mapping: LED (or sourse)
- set initial HV based on known gains
- in beam set gains with MIP
- for SMD try pi0
- pre/post: gains set high to see 1.e.e. ?

Physics Goals of Run 4

- contribute to jet trigger @ eta>1
- contribute to J/Psi and/or Upsilon in AuAu
- trigger on high energy gamma
- reco pi0 up to ~20 GeV
- deal with pileup

STAR EEMC Institutions

- High Energy Physics Division, Argonne National Laboratory
- Physics Division, Brookhaven National Laboratory,
- Laboratory of High Energy Physics, Joint Institute for Nuclear Research
- Indiana University Cyclotron Facility
- Department of Physics, Kent State University
- Cyclotron Institute, Texas A&M University
- Department of Physics & Astronomy, Valparaiso University

Detailed Software Tasks

- Slow control: (Wei Ming/Valpo)
  - gui+VME HV sys
  - STAR alarm: HV & FEE ped
  - laser control
  - main EEMC gui – DSM, Tower, SMD
  - documentation for shifts
  - ped loaded to trigger FEE online DB
  - MAPMT box temperature
- SMD/Pre/Post Commissioning: (Scott/Steve)
- online histos : (Dave and Hal)
  - define & implement (Paniatkin plots)
- display : (Paul Nord?/Valpo)
  - EEMC on L3 screen or
  - automate tower+SMD+pre/post+track (online)
  - (predict) fired SMD strips with LED pulser

- calibration : (Piotr/Jan/Wei Ming)
  - Pedestals: smd/pre/post - duplicate tower code
  - Gains: pre/post - duplicate tower code for MIP
    SMD – MIP finder code exist
    write to DB, test

STAR tasks list:
www.star.bnl.gov/STAR/Comp/general/task.html

- off-line database (Jan/Piotr)
  - pre/post : duplicate tower info
  - SMD : as tower + box mapping
    -calibration code (SMD) (Wei Ming)
  - access in root4star ?
- L2 programming : (Renee/Steve/Jason)
  - enriched calibration trigger (pi0/e/MIP)
- tracking at eta>1.5 : (MIT/Jason)
  - not existing, use ITTF
- merge hits: (ANL/Valpo/Piotr)
  - pi0 reco at ~20 GeV
  - pi0/gamma/hadrons ID
- EEMC contribution to jet energy (Renee)
- trigger simulator (Renee)

Join us !

Unsupported Software Tasks

- pre/post/SMD data StEvent
- pi0 reco : port FPD algo (tw+smd)
- EEMC slow simulator
- EEMC embedding
- vertex reco :
  - integration with ITTF
  - pileup : B+E-EMC, SVT
- display : EEMC on L3 plasma-screen

Join us !