Towards ^ Understanding Absolute Luminosity for pp Collisions at STAR

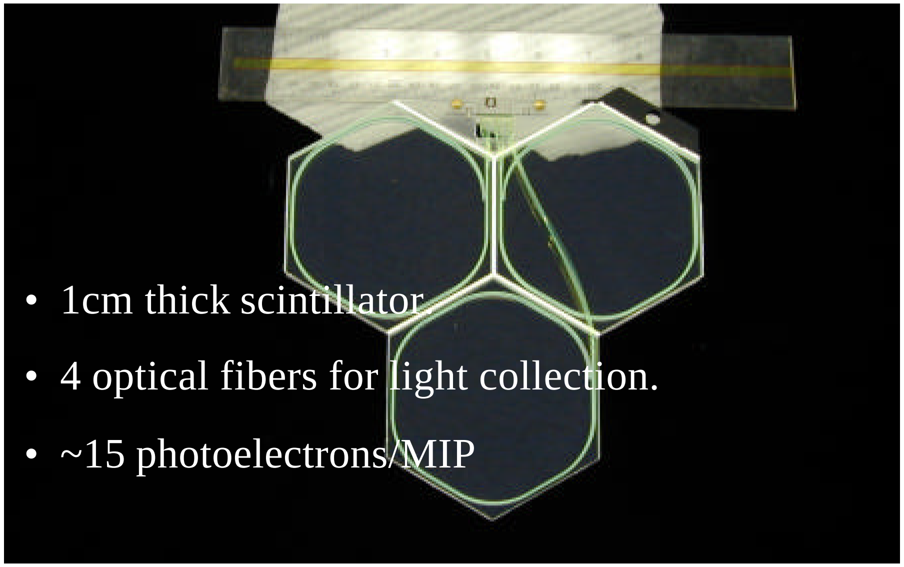
STAR beam-beam counters (BBC) (with J. Kiryluk)

- Description of BBC
- Comparison of data to simple model
- Backgrounds

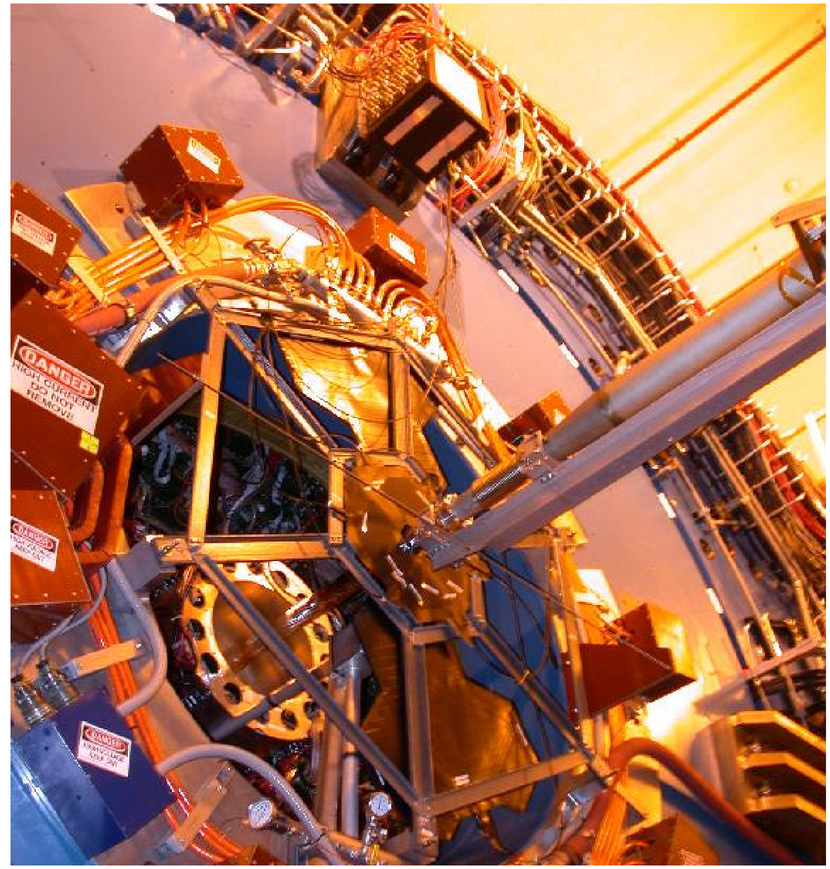
Towards determination of large-η π^0 cross section (G. Rakness)

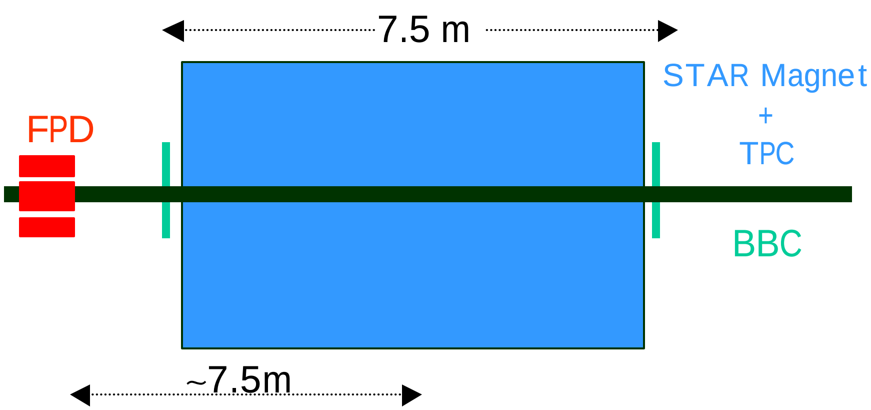
L.C. Bland
BNL

STAR Beam-Beam Counter (BBC)



- 1cm thick scintillator.
- 4 optical fibers for light collection.
- ~15 photoelectrons/MIP

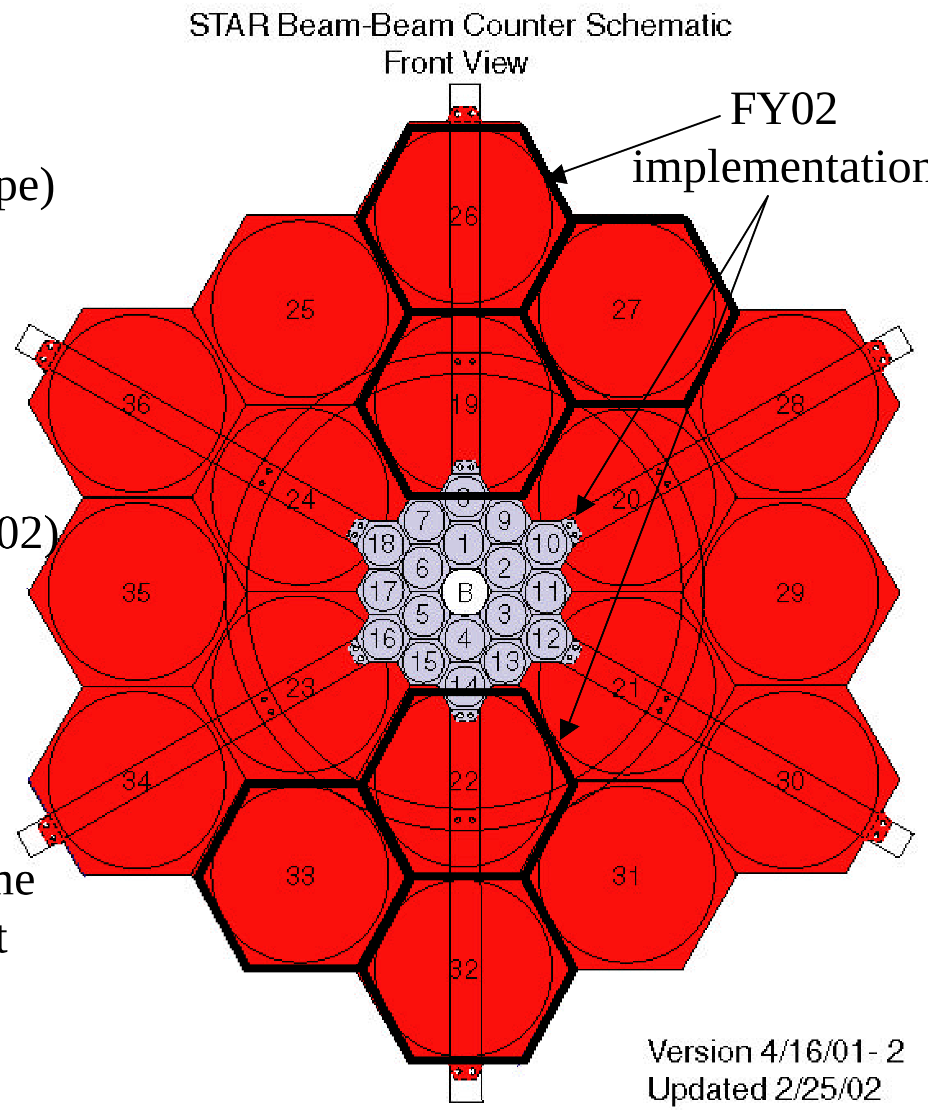


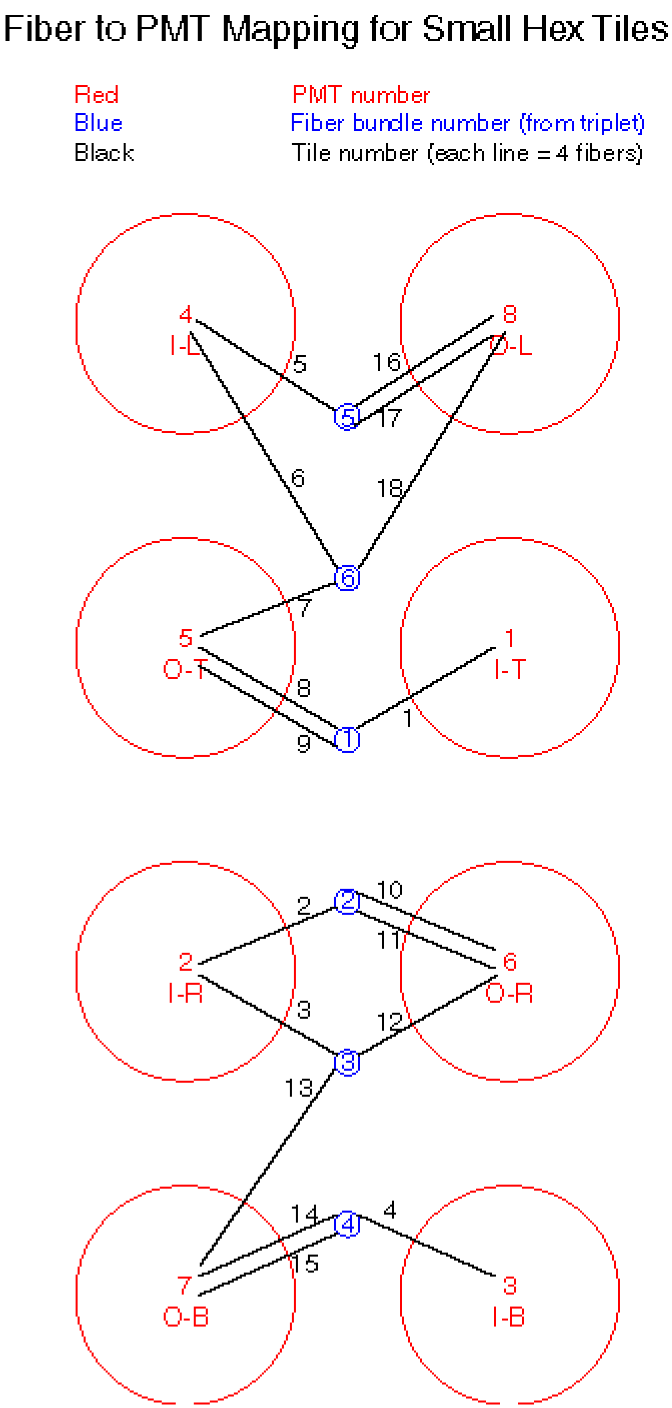


- BNL, UCLA, Penn State and Wayne State involved in project
- BBC scintillator annulus installed on west poletip of STAR magnet. Similar annulus installed on east poletip of magnet.
- BBC E•W coincidences defined STAR triggers and monitored luminosity for different polarization states ($\mathbf{L}_{\uparrow/\downarrow}$).

Scintillator Annuli

- All scintillator is 1cm thick SCSN81 (Kuraray)
- Small hexagonal annulus (complete for FY02)
  - o 9.6 cm ID (1 cm clearance around beam pipe)
  - o 48 cm OD $\Rightarrow$ $3.5 < \eta < 5.0$
  - o 18 total pixels (6 inner + 12 outer)
  - o 4 PMT/eta ring $\Rightarrow$ azimuthal segmentation
- Large hexagonal annulus (30% complete for FY02)
  - o 38 cm ID
  - o 193 cm OD
  - o 18 total pixels, only 6 installed for run
- Annuli are supported by fiber-glass channel frame attached to the STAR poletips on the east and west sides.

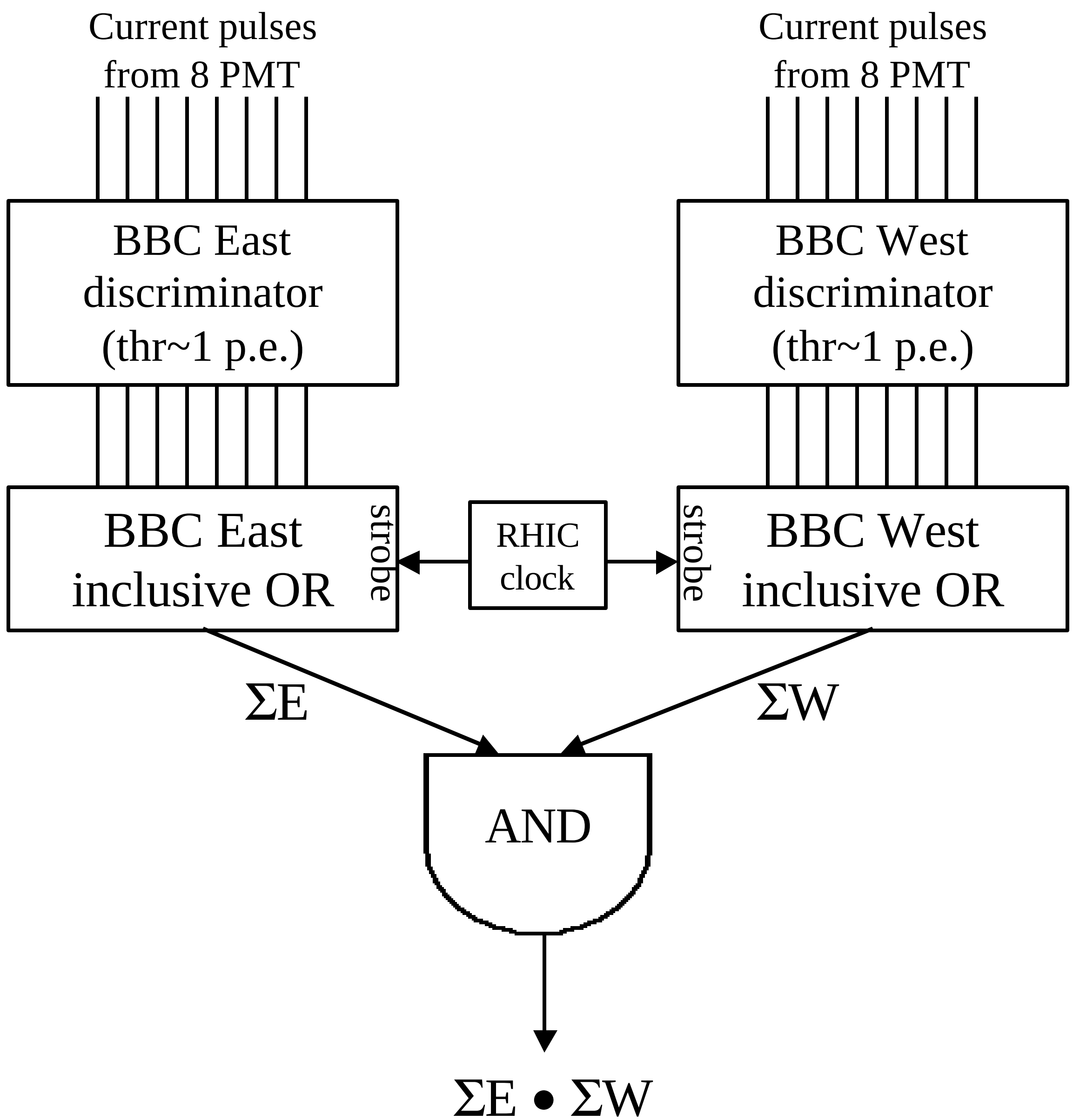




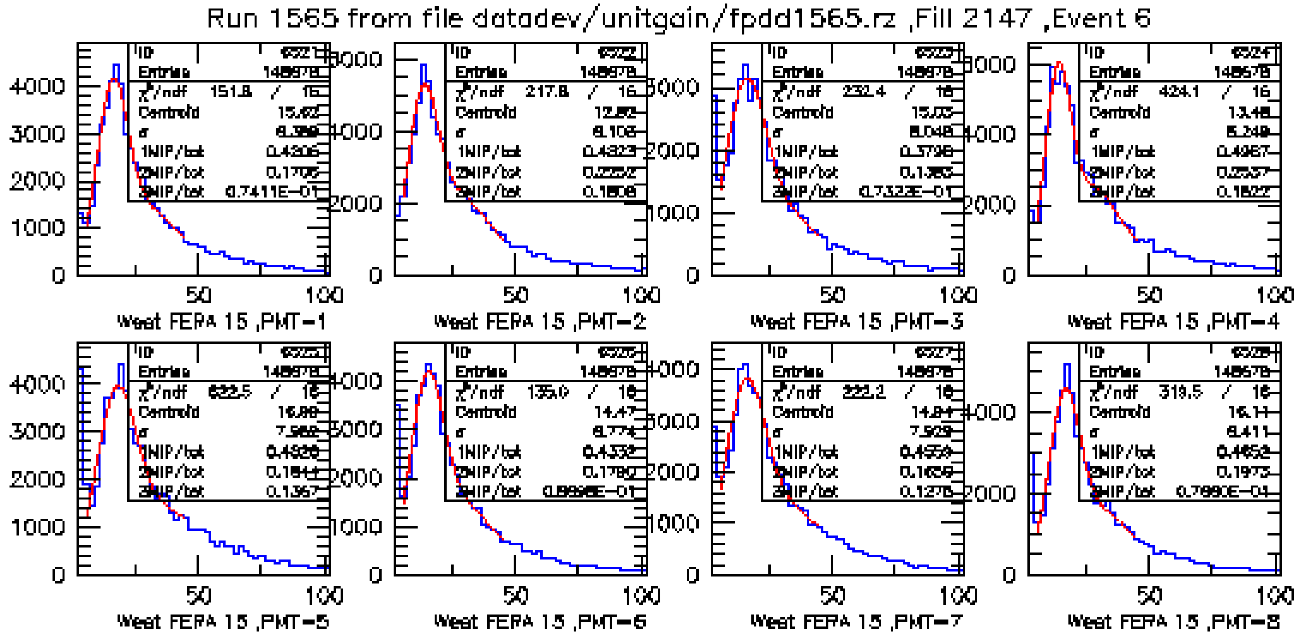
Fiber to PMT Mapping for FY02 pp Run

- 4 PMT's used to collect light from each tile annulus (inner=I; outer=O).
- Preserved azimuthal segmentation of individual tile rings (left=L; top=T; right=R; bottom=B).
- Similar mapping planned for future implementation of large hex tiles ⇒ use clear fiber bundles from FY02 small hex tile readout.

Schematic BBC Trigger Logic

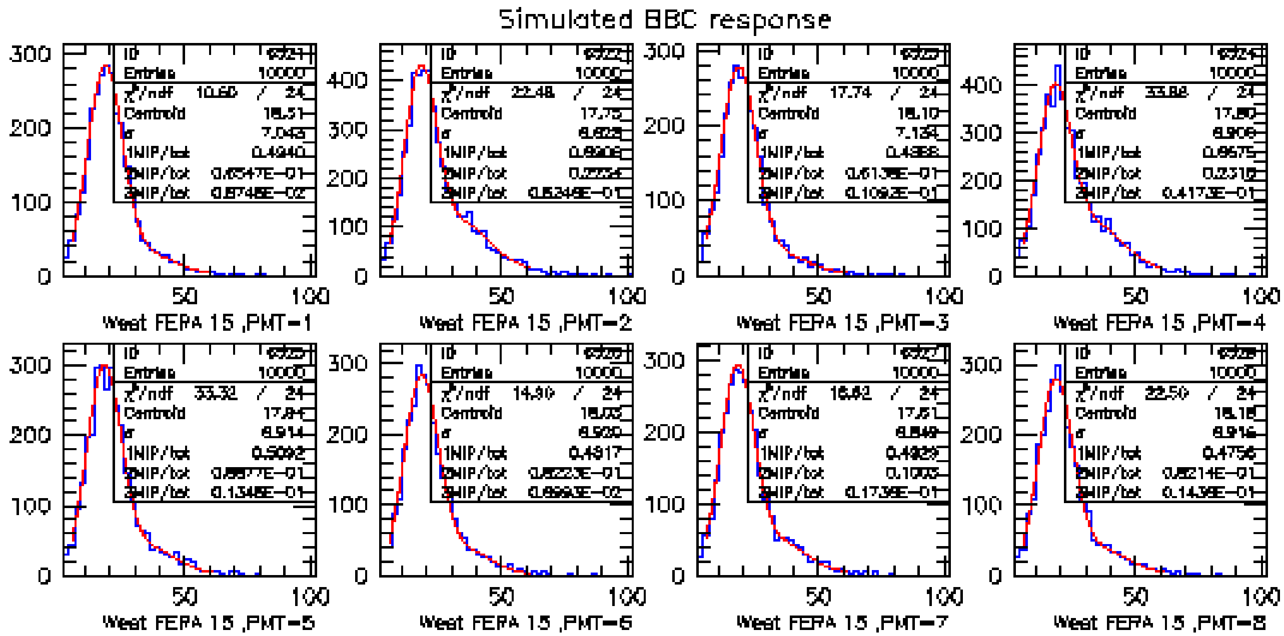


ADC Distributions for Min-Bias Events



- Prominent peak from minimum ionizing particle (MIP).
- PMT gains found to be stable throughout run.
- Represent spectra as sum of Gaussians: $\sum_n \frac{a_n}{\sqrt{2n\pi}\sigma_1} e^{-\frac{1}{2}\left(\frac{x-nx_1}{\sqrt{n}\sigma_1}\right)^2}$
  - o underpredicts large amplitudes (require Landau tail)
  - o single MIP peak has ~ equal amplitude for all PMT

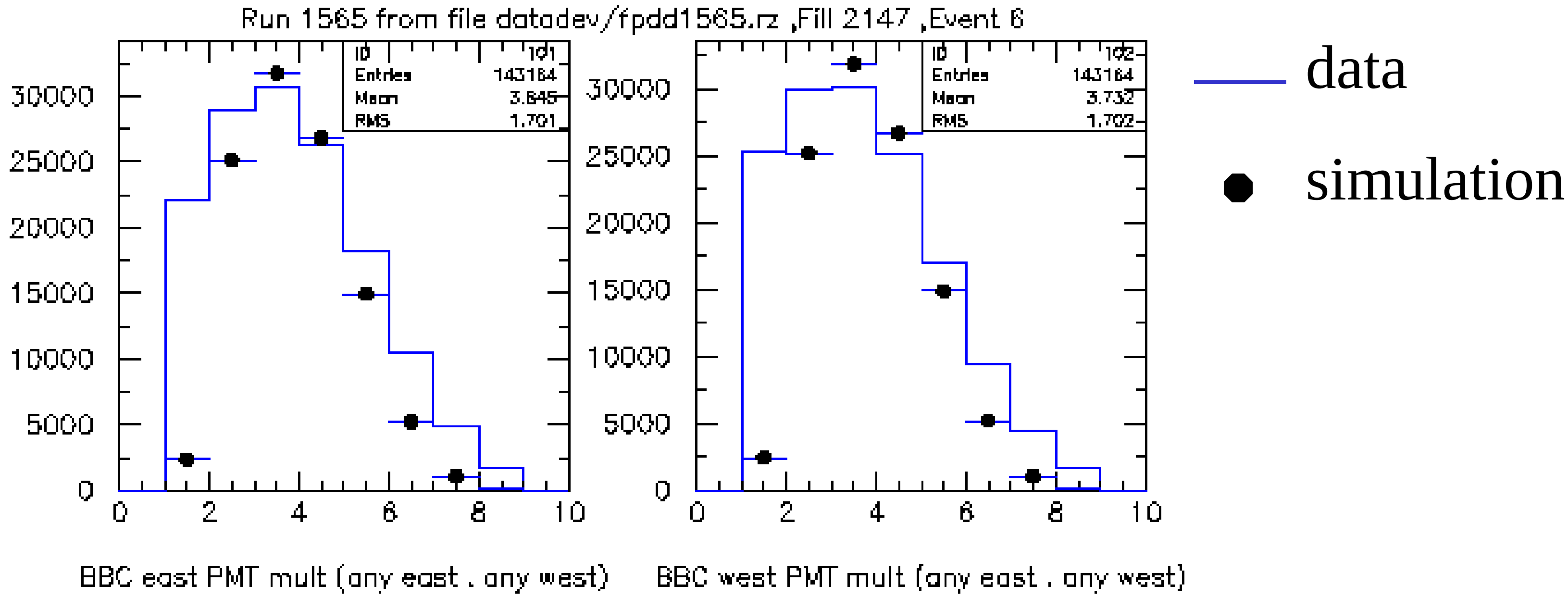
Simulated ADC Distributions



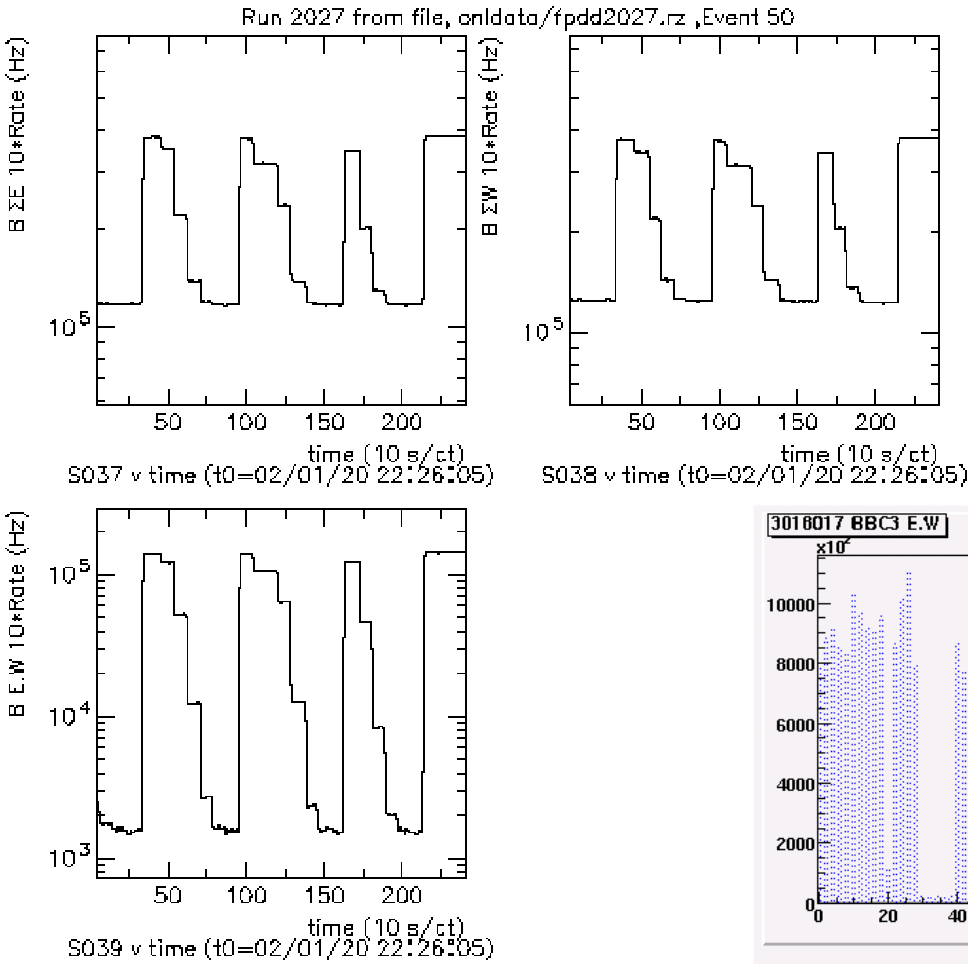
- Generate PYTHIA events and transport particles to hexagonal tiles.
- Assume Gaussian response for minimum ionizing particle (MIP). Assumes single MIP from γ, to account for ~$1X_0$ of material between IP and BBC
- Comparison to data:
  - o qualitative agreement with data
  - o overpredicts single MIP fraction of PMT 2,4 (inner L/R tiles).
  - o underpredicts large amplitude events (Landau tail).

$\Rightarrow$ Require full GEANT simulation to obtain quantitative agreement

Hit PMT Multiplicity Distribution



- Qualitative agreement with simple simulation. Most probable hit PMT multiplicity is accounted for.
- Large disagreement with single PMT hits for both east and west.
- Large multiplicities not accounted for by simple model. Require full GEANT simulation to include secondary production.

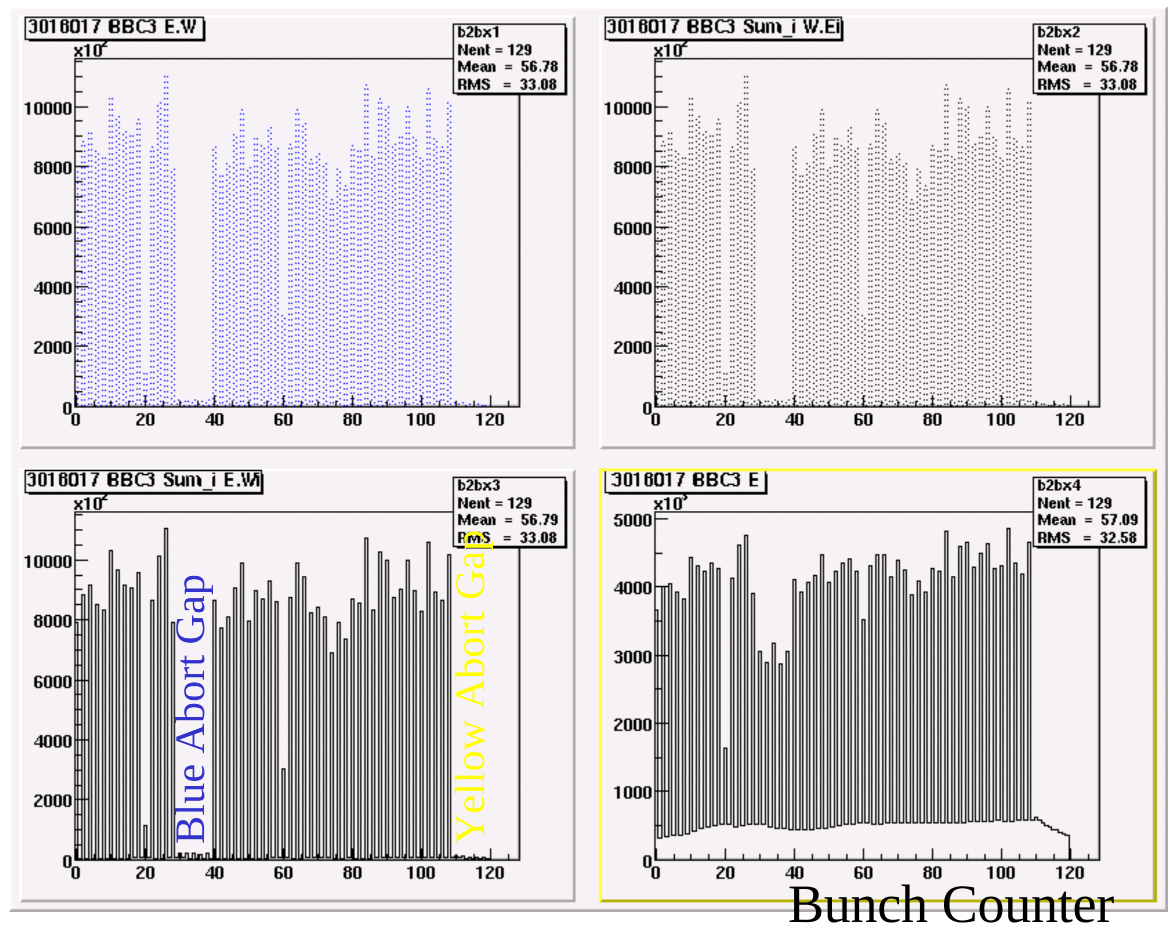


BBC Backgrounds

Measure time dependence of count rate from BBC for data collected during Van der Meer scan conducted at STAR for RHIC fill 2277.

⇒ ~1% background for no collisions

Continuously monitor total number of ΣE • ΣW counts versus bunch counter using STAR bunch crossing scalers. From abort gap yields, get ~1% background.



Simulated Acceptance of BBC

$$\varepsilon = \frac{N_{trig}}{N_{gen}}$$

Uses Gaussian distribution for interaction diamond (σ_z=70 cm) and beam line coincident with detector symmetry axis.

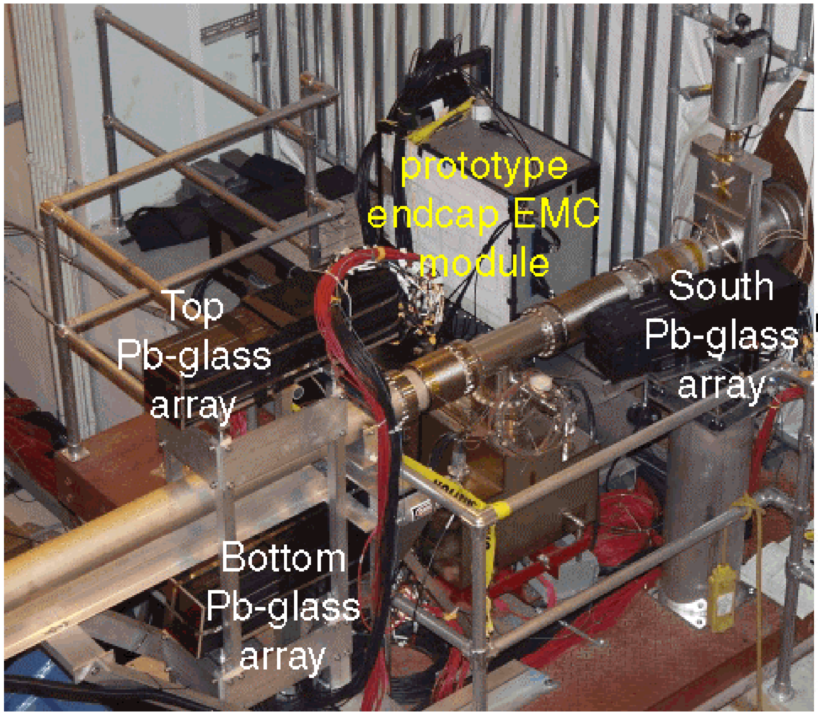
	charged only	charged + γ
Non-elastic, non-single diffractive	0.65	0.84
Includes elastic, single diffractive	0.42	0.54

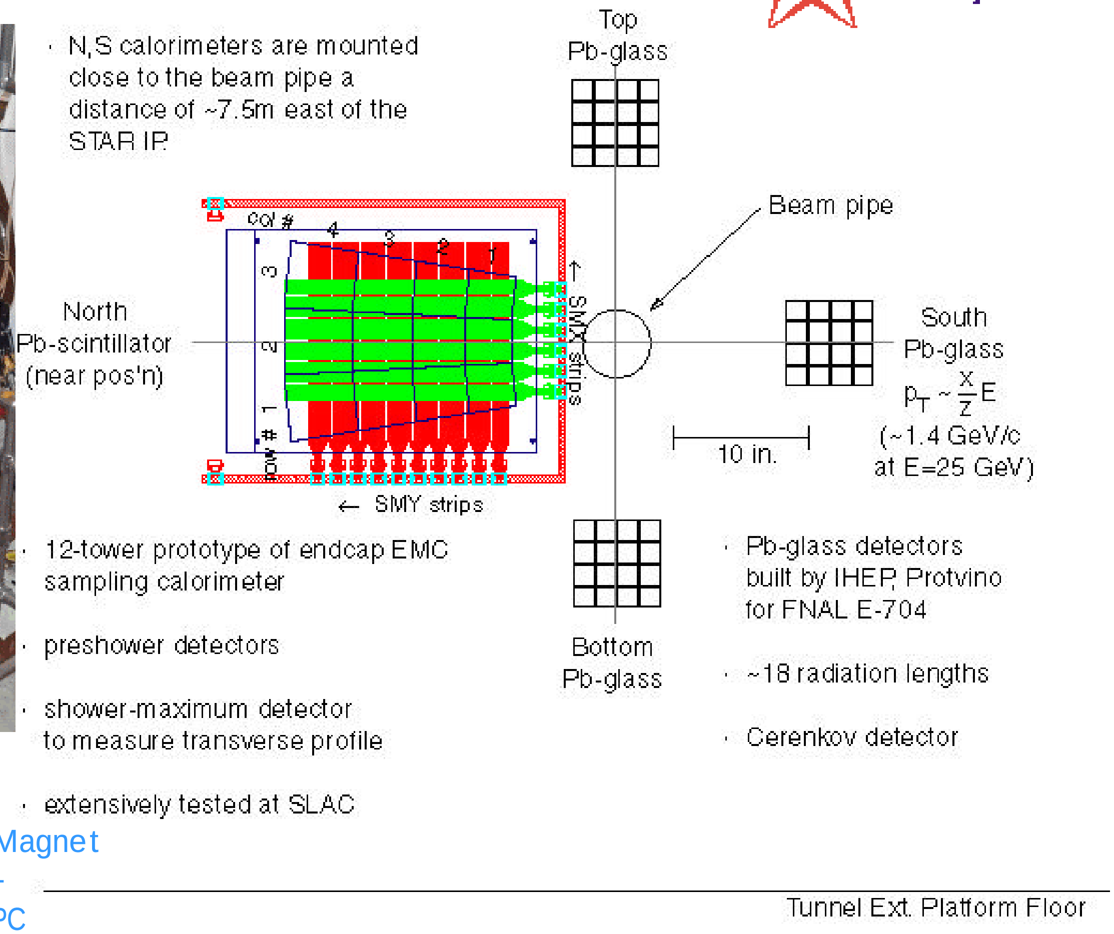
Find that acceptance efficiencies are:

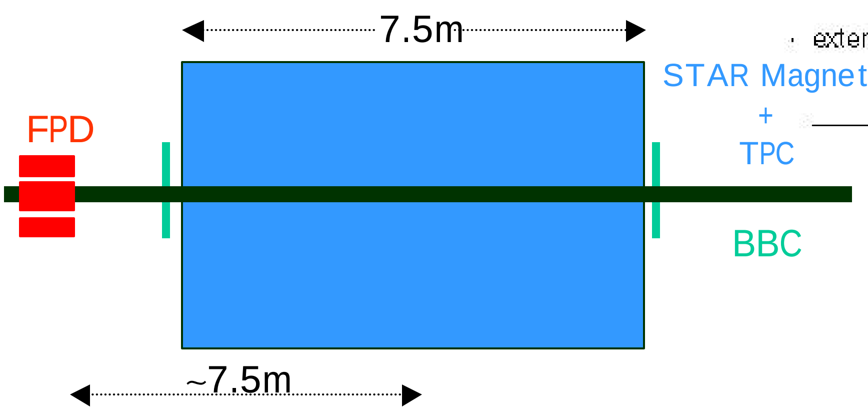
- independent of diamond size
- independent of transverse beam position

(NOTE: azimuthal acceptance asymmetry strongly depends on beam position relative to detector axis.)

STAR Forward π^0 Detector







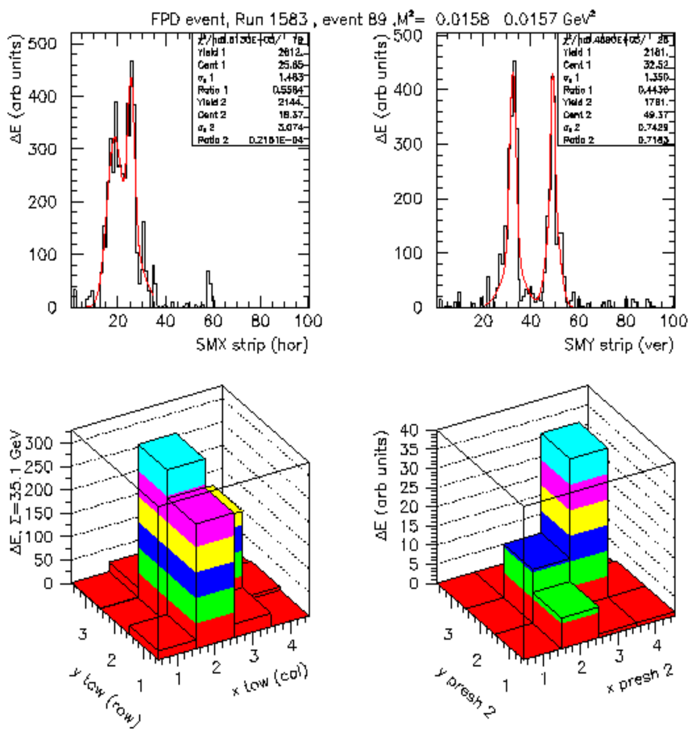
FPD allows detection of π^0 with x_F>0.2 and 1 <p_T < 4 GeV/c and triggering of STAR readout.

π^0 signal extraction

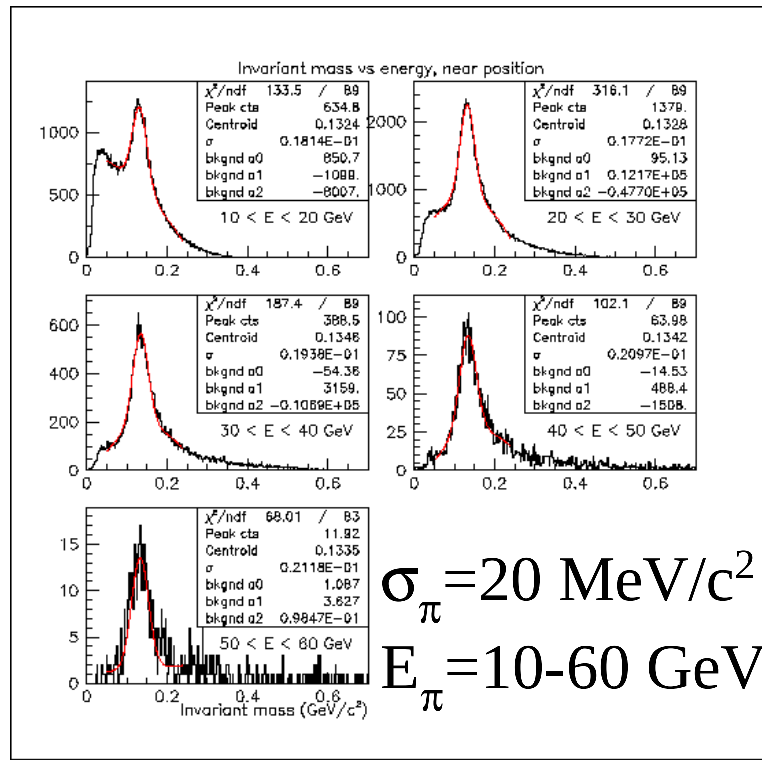
$M_{\gamma\gamma} = E_{tot}\,\mathrm{sqrt}(1-z_\gamma^2)\,\sin(\phi_{\gamma\gamma}/2)$

- E_{tot}=sum over towers ($\delta E/E=17\%/\mathrm{sqrt}(E)$)
- γ separation from centroid separation of two peaks
- $z_\gamma=|E1-E2|/(E1+E2)$ from relative yield in two peaks in SMD profile distribution ($\delta E/E=30\%/\mathrm{sqrt}(E)$)
- Assume Z_{vertex}=750cm

Single event analysis:



Results in π^0 as a function of E_π:



σ_π=20 MeV/c^2 for E_π=10-60 GeV...

G. Rakness (IUCF), Quark Matter 02

Simulation of pEEMC in STAR

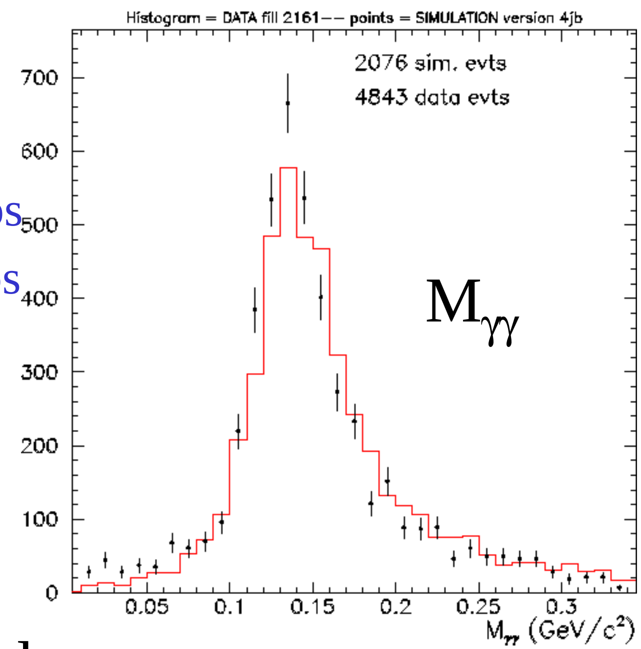
Use simulation for background and efficiency correction…

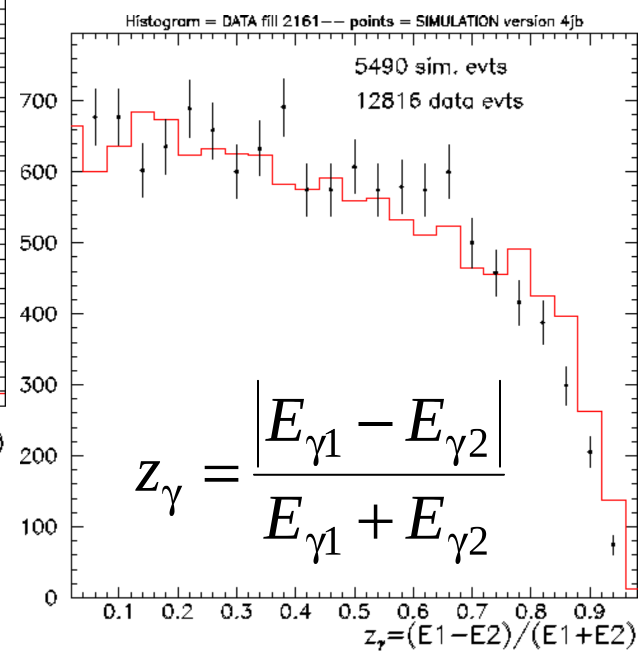
Scheme:

- Events generated with PYTHIA (min bias)
- Events stored if >25 GeV pointing to "box"
- Full PYTHIA record included with events
- GEANT simulation of pEEMC
- Reconstruct using algorithm applied to data

Cuts applied:

- E_{tow}>31 GeV
- 13 < SMD-Y centroid < 90 strips
  12 < SMD-X centroid < 48 strips
- SMD-X or SMD-Y > 1 peak
- z_γ<0.3



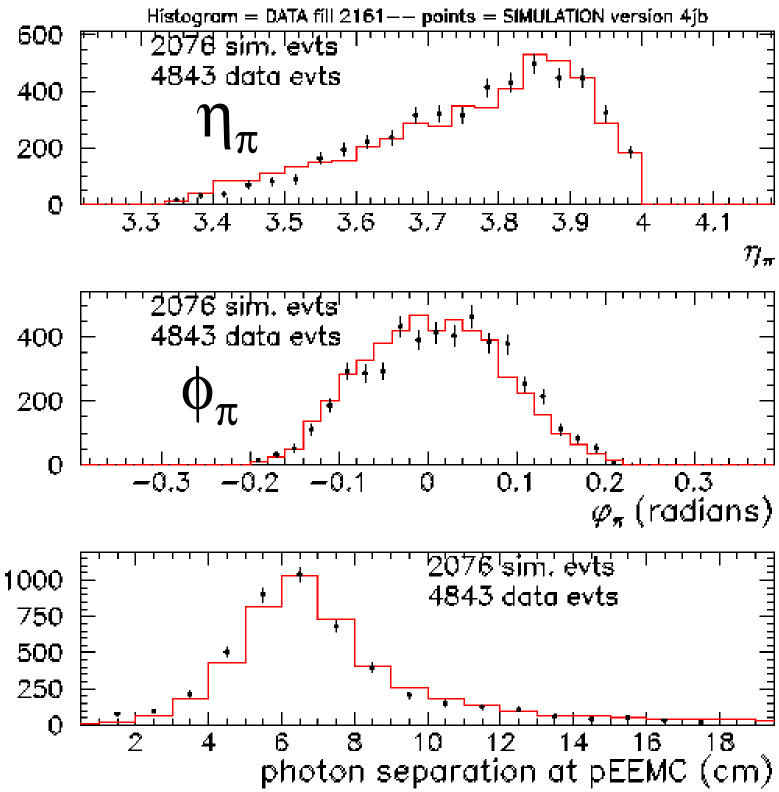


$$z_\gamma = \frac{\left|E_{\gamma 1} - E_{\gamma 2}\right|}{E_{\gamma 1} + E_{\gamma 2}}$$

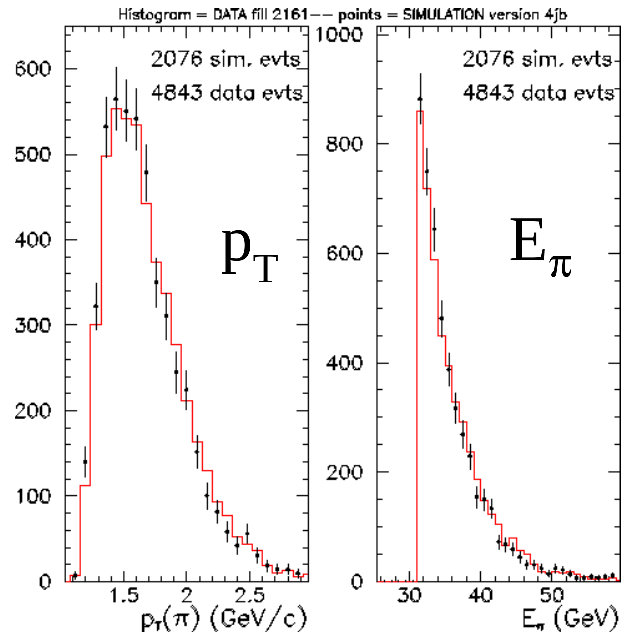
- Histogram = data
- Points = simulation norm. to data

Simulation of pEEMC (cont.)

Angular variables:



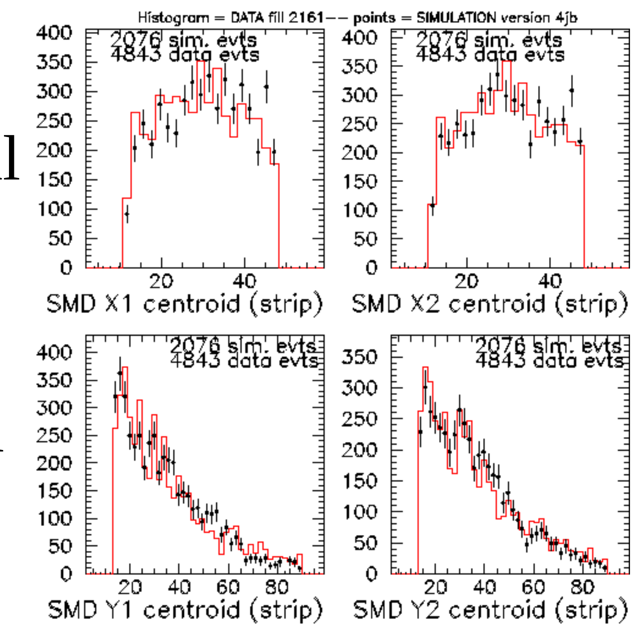
Photon separation at pEEMC



Single photon positions:

vertical

horizontal

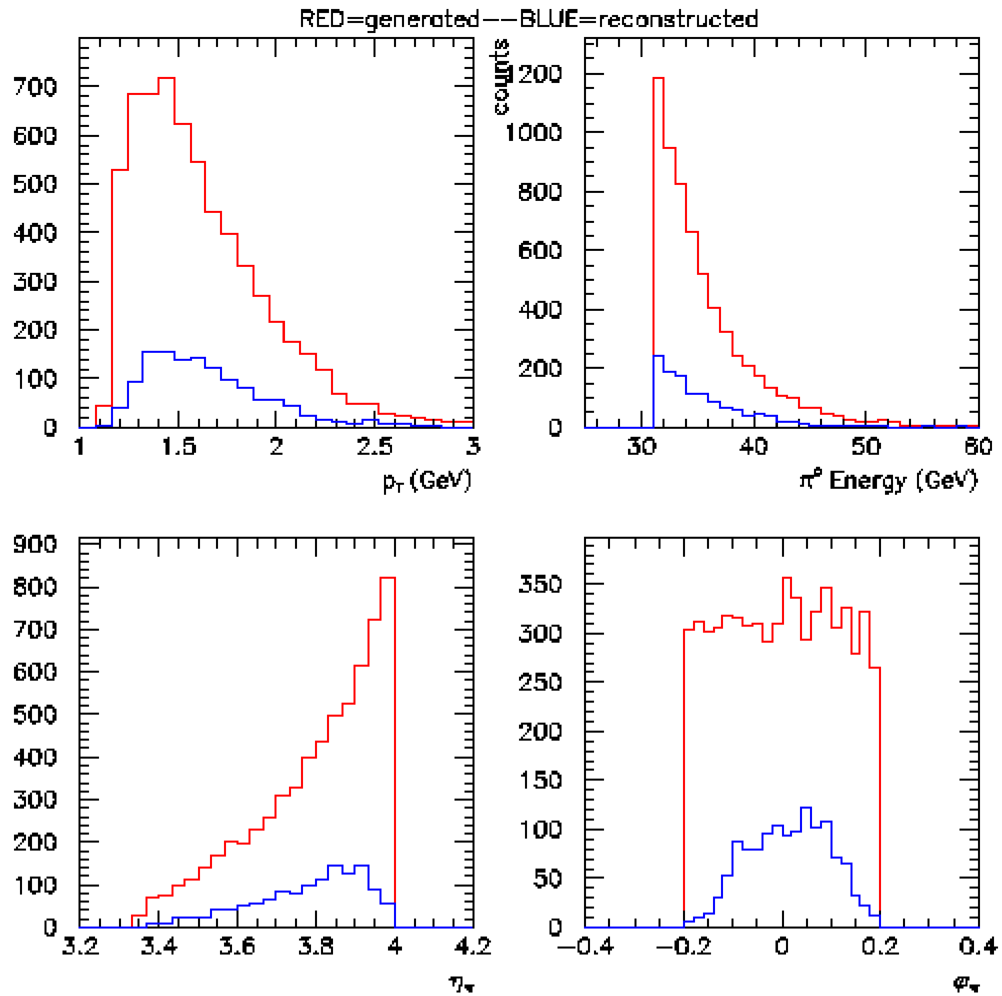


Simulation describes data and general features understood…

Efficiency/Acceptance Correction Performed with Monte Carlo Simulation

- Red= π^0 simulated events generated into "box" defined by η and ϕ

- Blue=full PYTHIA simulated events reconstructed with identical fit model and cuts as used for data



Correction to be performed simultaneously as a function of p_T and h...

Summary:

Well on our way to extracting differential p^0 cross-section…

•Signal extraction—robust

•Livetime/luminosity correction—yields stable to ~15%

Simulations describe signal and background well:

•Background shape/magnitude—amount of background dependent on z_γ cut, correction to be performed, systematic uncertainty to be estimated

Efficiency/acceptance correction— size of correction dependent on z_γ cut, correction to be performed vs. p_T and η, syst. uncertainty to be estimated

•Absolute angle uncertainty from beam position monitors from accelerator physicists—transverse position to ~few mm

•Absolute energy scale from π^0 mass—effect from uncertainty on absolute knowledge of z-vertex <1%, stability to be determined

•Absolute normalization uncertainty from comparison of van der Meer scan with estimated Beam-Beam Counter acceptance of σ_{tot}(pp)