



ILD DHCAL Occupancy Study *GigaZ & Nominal Beam*

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Outline

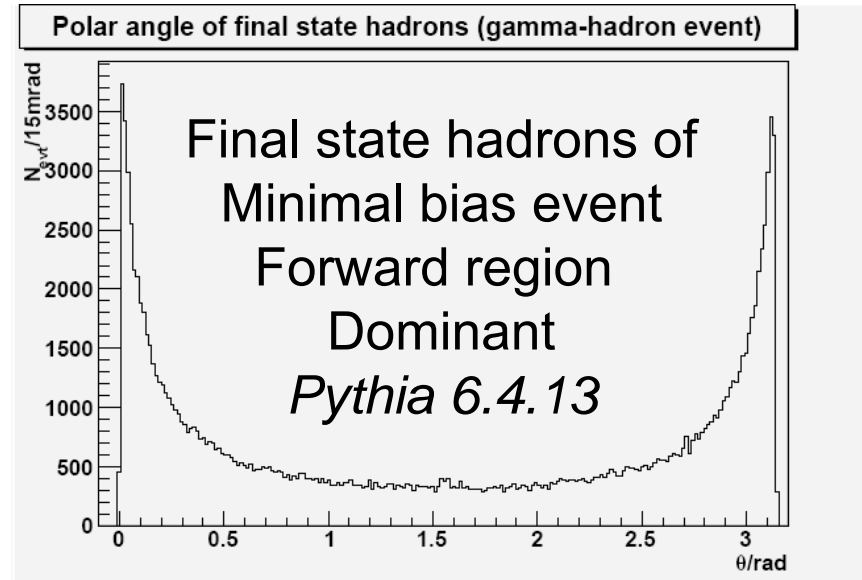
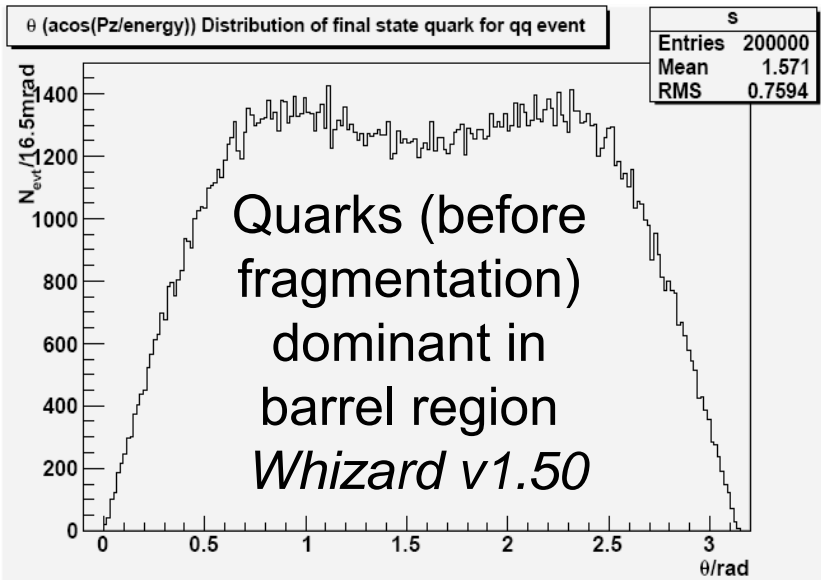
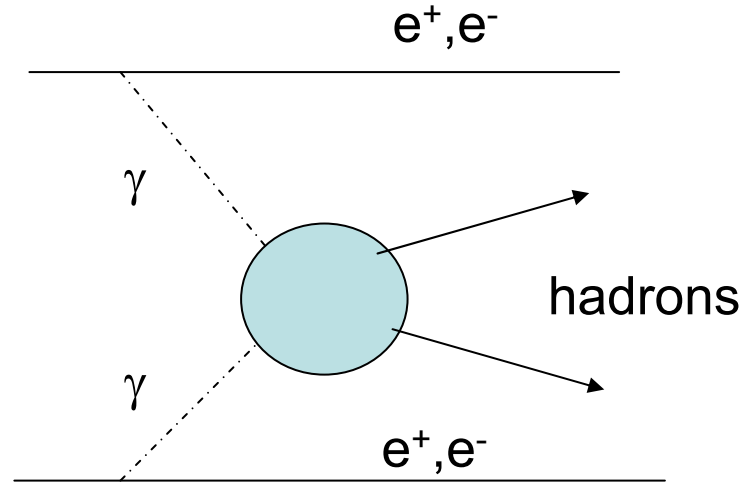
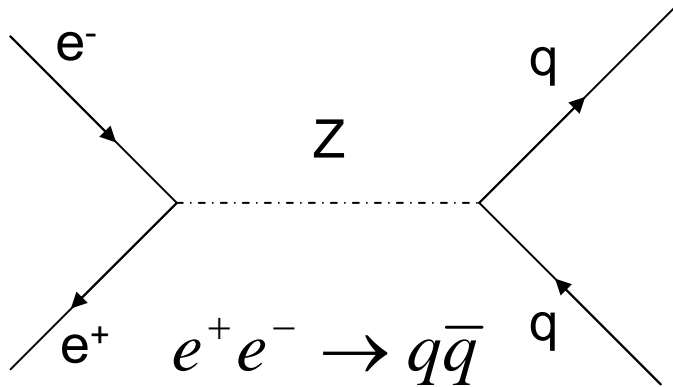


- Motivation & Introduction
 - Cross section & Event geometry
 - ILD DHCAL geometry
- DHCAL occupancy with $e^+e^- \rightarrow q\bar{q}$ events at Z threshold (GigaZ)
- DHCAL occupancy with minimal bias events at 500GeV (Nominal Beam Parameter)



- Estimate the requirement on the DAQ system: for each second (beam bunch crossing/ train),
 - How many DHCAL cells/Asics are hit?
 - Hits spatial distribution?
- Beam parameter:
 - Giga Z: $\sqrt{s}=91.2\text{GeV}$, $10^{33}\text{cm}^{-2}\text{s}^{-1}$
 - Nominal: $\sqrt{s}=500\text{GeV}$, $2*10^{34}\text{cm}^{-2}\text{s}^{-1}$

Event Geometry



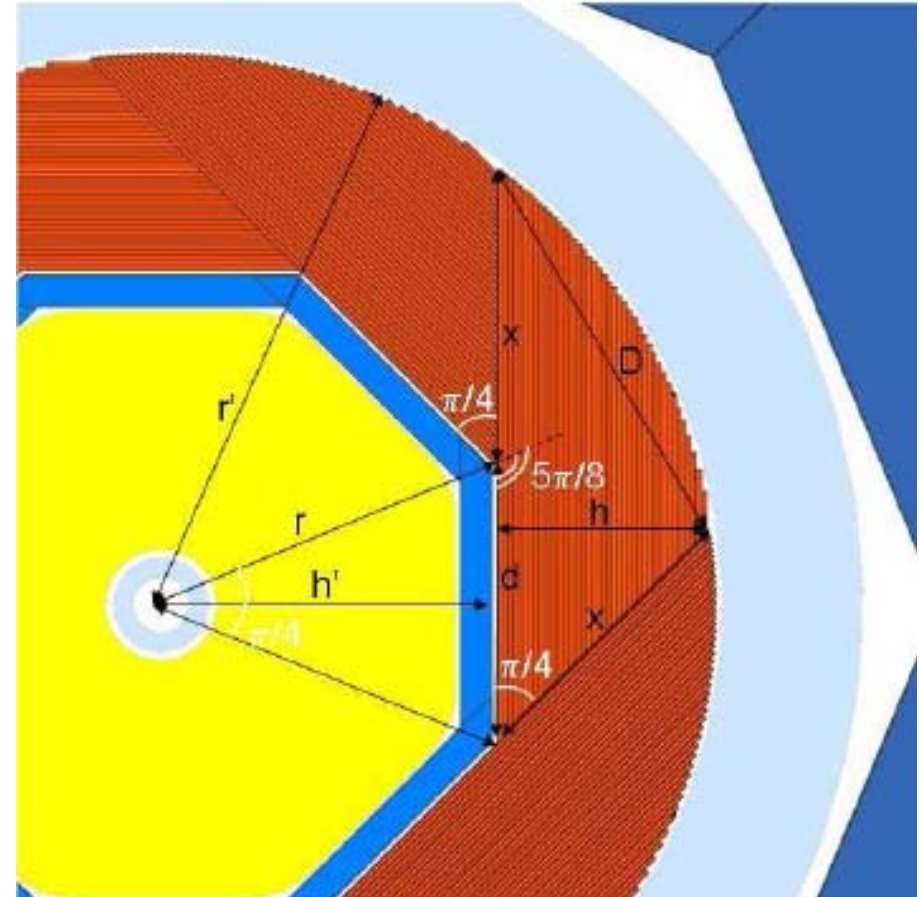
X section/event rate



	Giga Z: 91.2GeV, $10^{33}\text{cm}^{-2}\text{s}^{-1}$	Nominal: 500GeV, $2 \times 10^{34}\text{cm}^{-2}\text{s}^{-1}$
$e^+e^- \rightarrow qq$	3.0×10^7 (fb)	7.9×10^3 (fb)
	30evt/s ~ 6evt/train	0.16evt/s ~ 0.032evt/train
MC Statistic	75.5k	
Minimal bias LO: VMD*VMD	1.0×10^7 (fb) 6.6×10^6 (fb)	3.3×10^7 (fb) 2.2×10^7 (fb)
	10evt/s ~ 2evt/train 6.6evt/s ~ 1.3evt/train	660evt/s ~ 132evt/train 440evt/s ~ 88evt/train
MC Statistic	9.5k	22.3k

Simulation; Mokka v06-07,
Detector concept ILD00, SHcal04

- Barrel region: 8 staves, 5 modules, 48 layers.
1 DIF for each module each layer, thus totally 1920 DIFs
- Ring: 2×4 staves, 6 layers
- Endcap: 2×4 staves, 48 layers
- Cell size ~ 1cm×1cm. Each asic is response for 8×8=64 cells. (unless locate at the edge)



$$e^+ e^- \rightarrow q\bar{q}$$

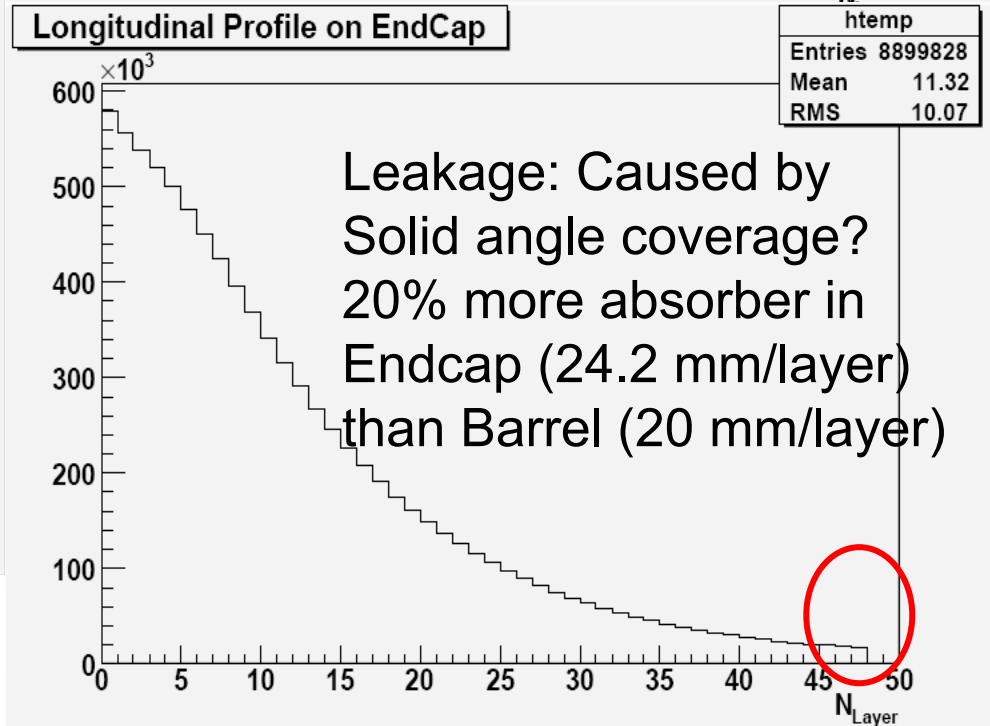
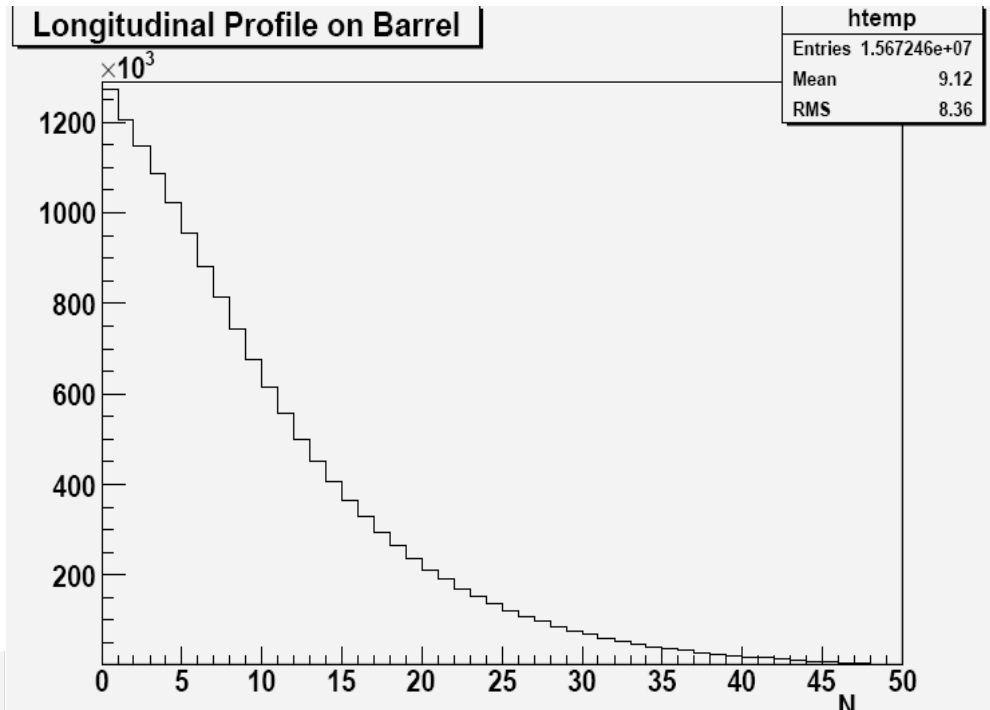
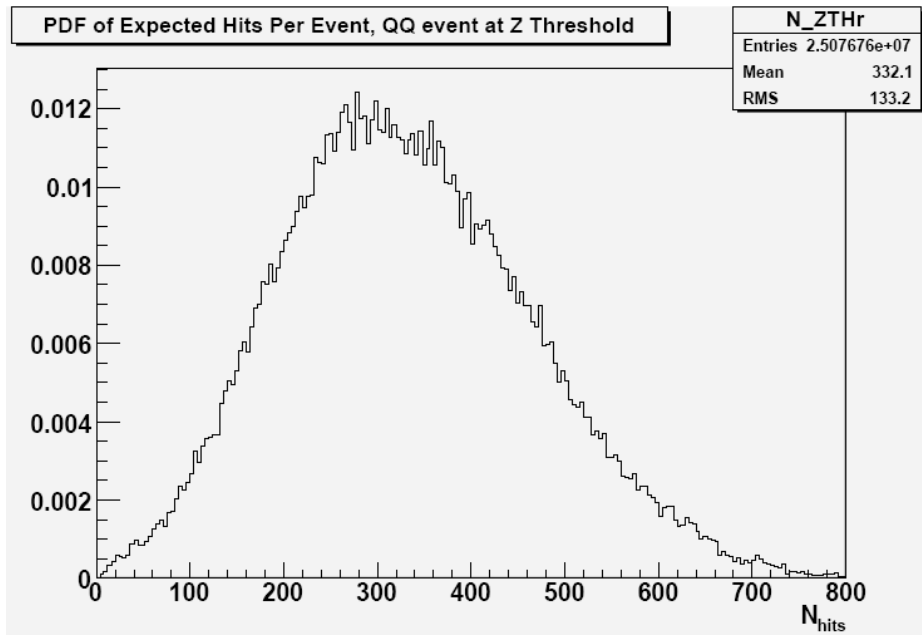
Longitudinal Profile:

Expected N_{Hits} per event

Barrel: 207.6

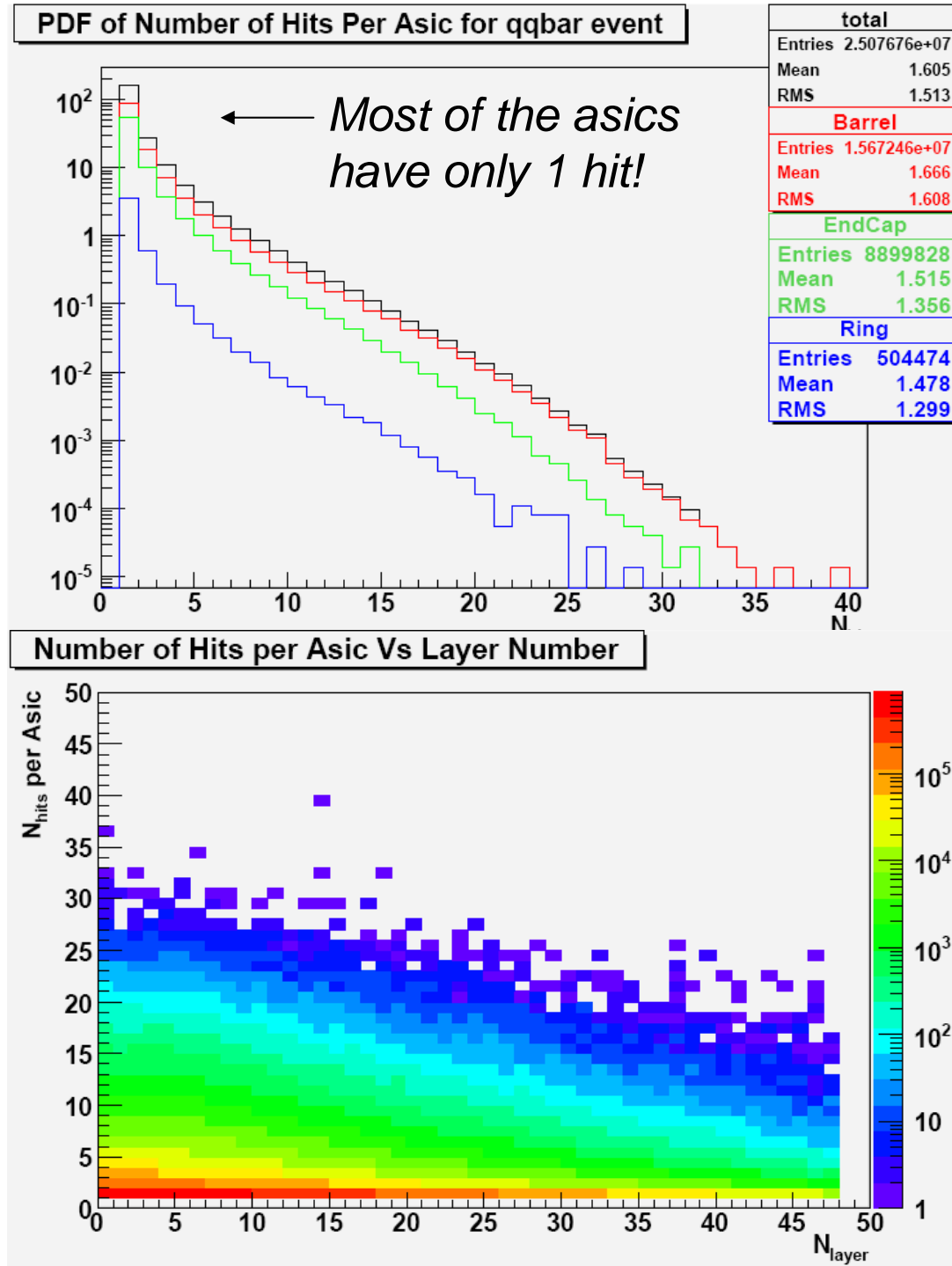
Endcap: 117.8

Ring: 6.7



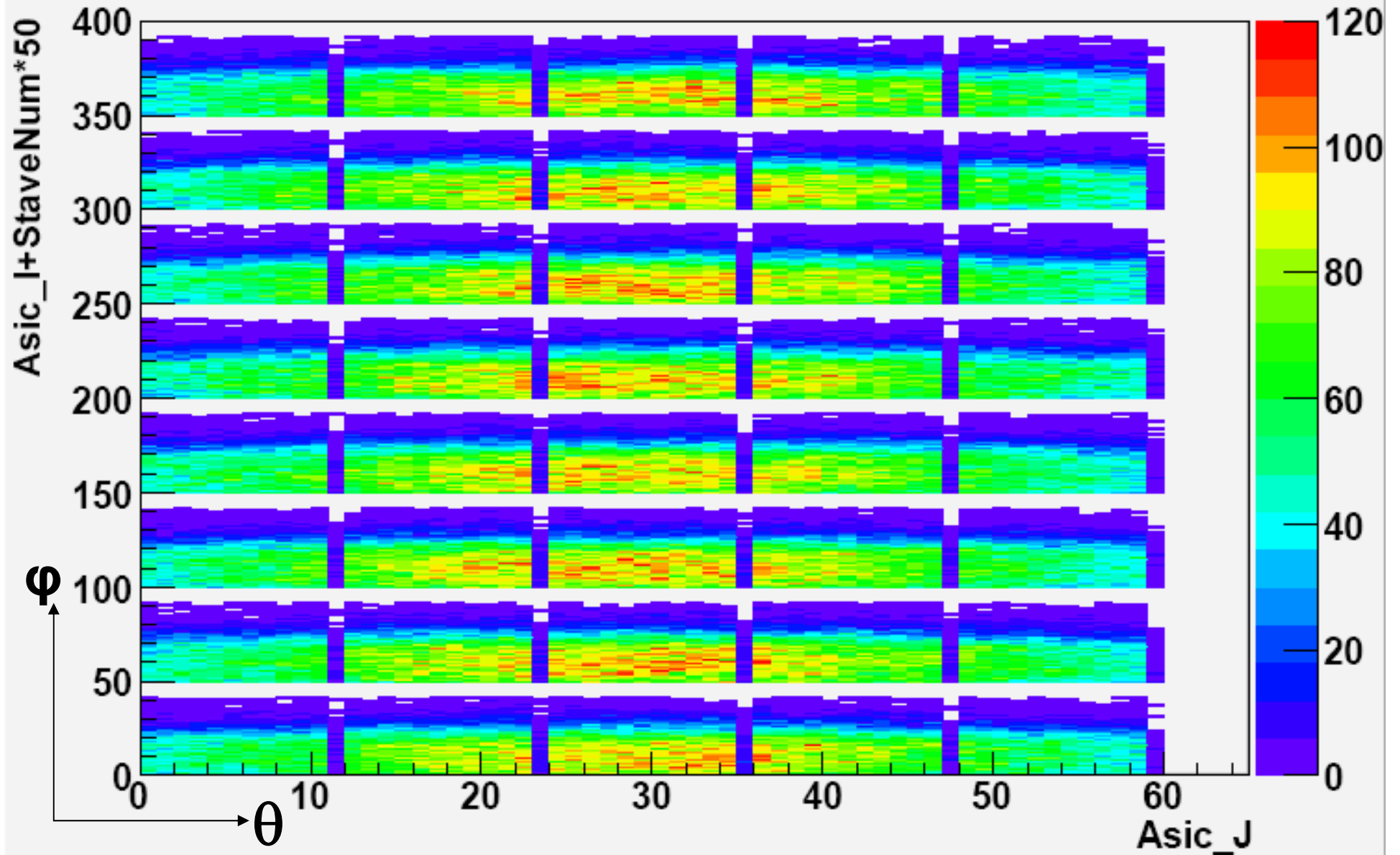
$$e^+ e^- \rightarrow q\bar{q}$$

Expected N_{Asic}
Per Event
Barrel: 124.6
Endcap: 77.8
Ring: 4.5



Asic Occupancy for Layer 0 in the Barrel

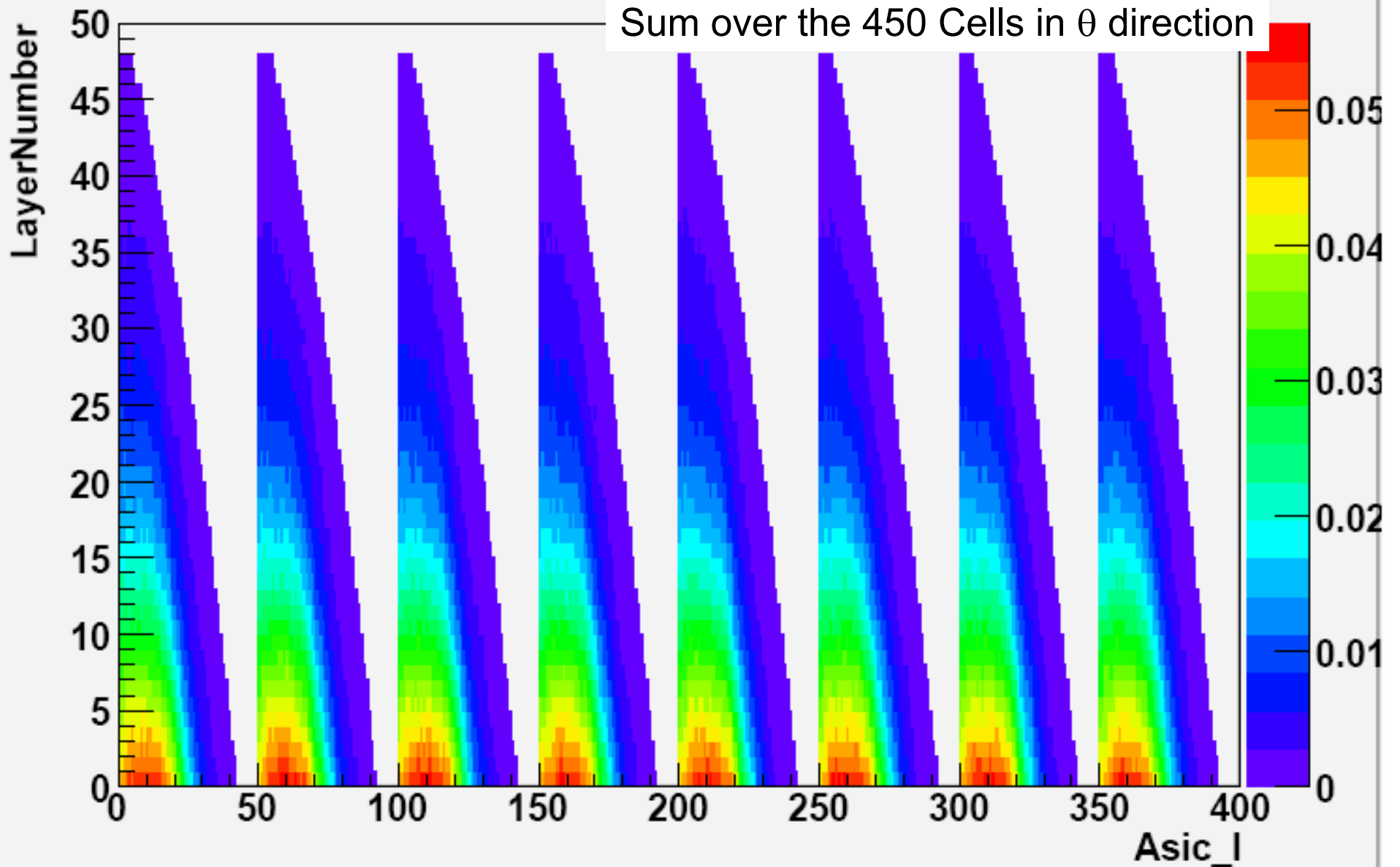
75.5k $e^+e^- \rightarrow q\bar{q}$



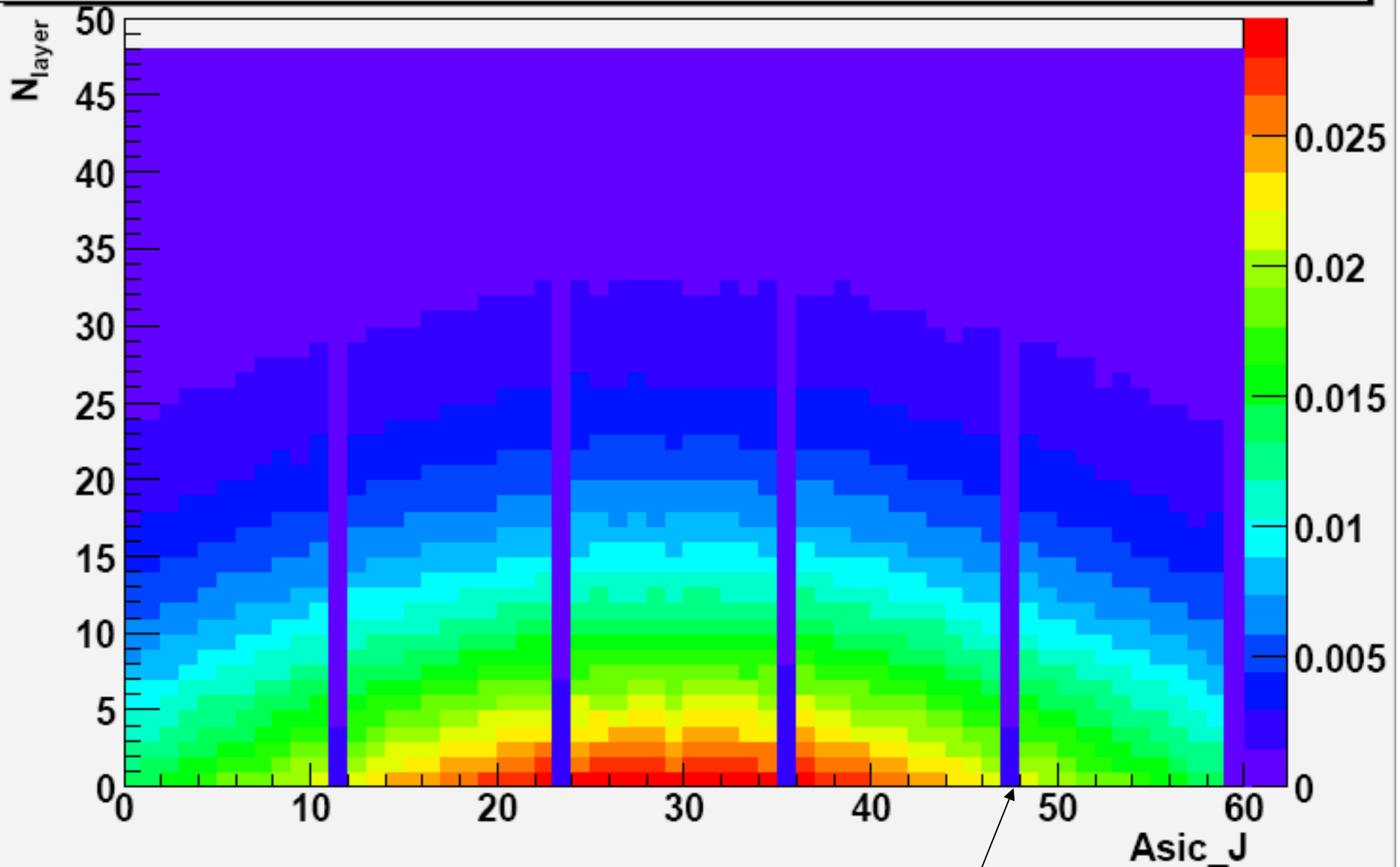
22/01/2009

Hottest Asic: 0.0016 times/evt \sim 0.05 times/s
0.0032 hits/evt \sim 0.1 times/s

Asic Occupancy per layer in Barrel Region (PerEvent), I direction



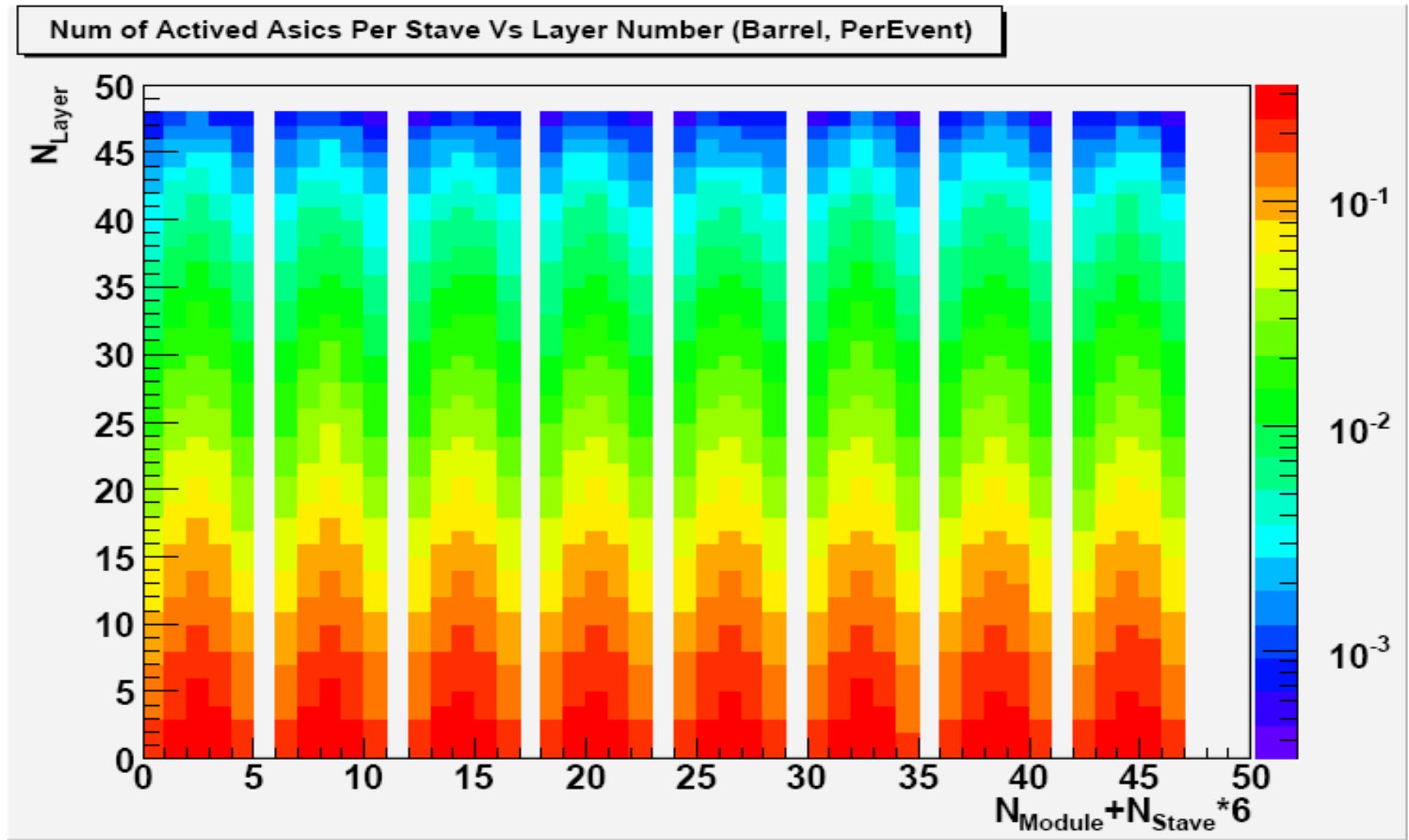
Asic Occupancy per layer in Barrel Region (PerEvent, sum over on ϕ direction in one Stave)



θ direction: $N_{\text{hit}} \sim \text{Solid angle}$

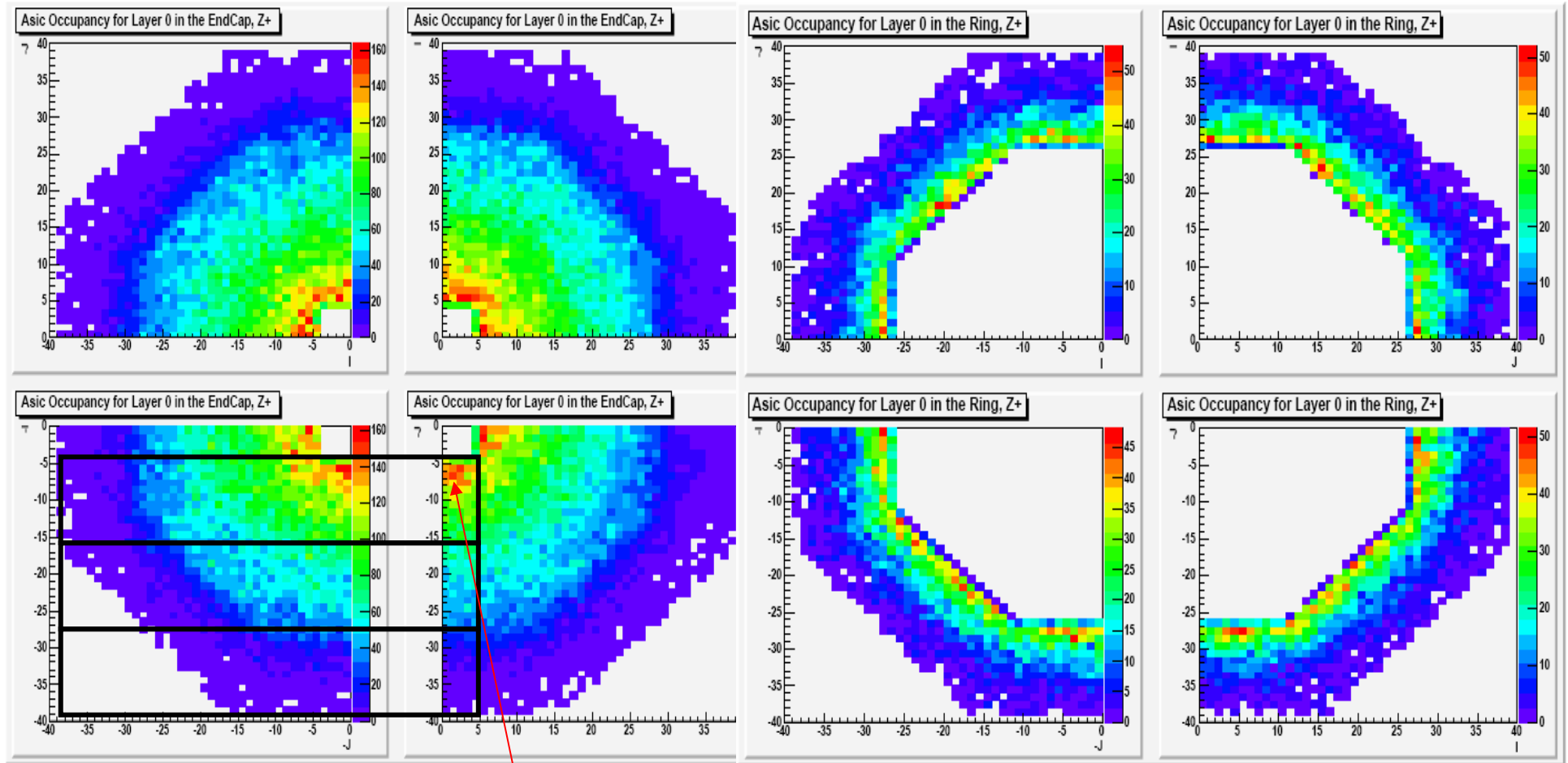
Gap between Modules: Each module has 90 ($=11 \cdot 8 + 2$) cells in θ direction 11

Expected Number of Activated Asics Per DIF (Barrel)



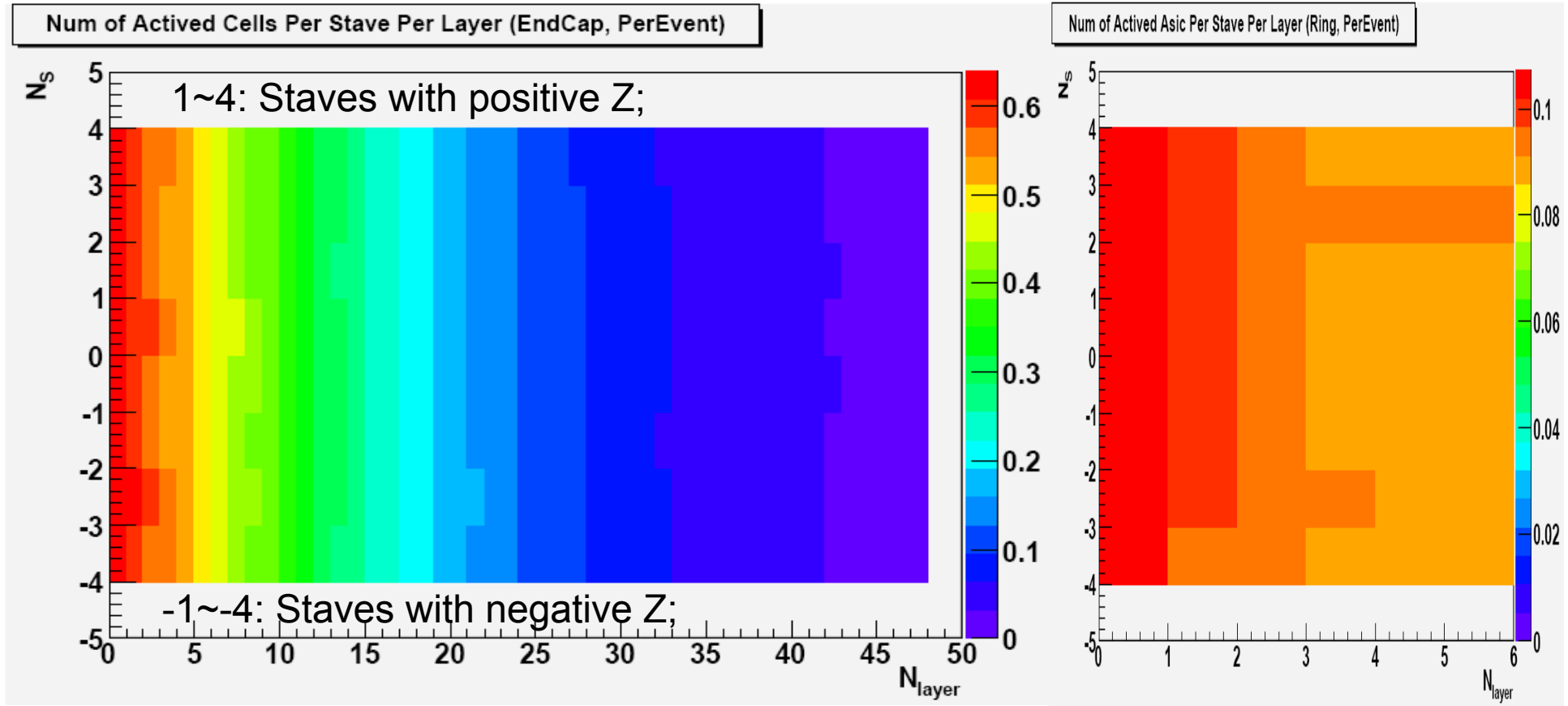
22/01/2009 Hottest DIF: ~ 0.3 asics/evt in the barrel (first layer) ¹²

$e^+ e^- \rightarrow q\bar{q}$ Hit Asics in the Endcap/Ring (first layer)



Hottest Asic: 0.002 times/evt ~ 0.06 times/s
 0.0032 hits/evt ~ 0.1 times/s

Expected number of hits per event Vs (stave&layer) in the Endcap/Ring.



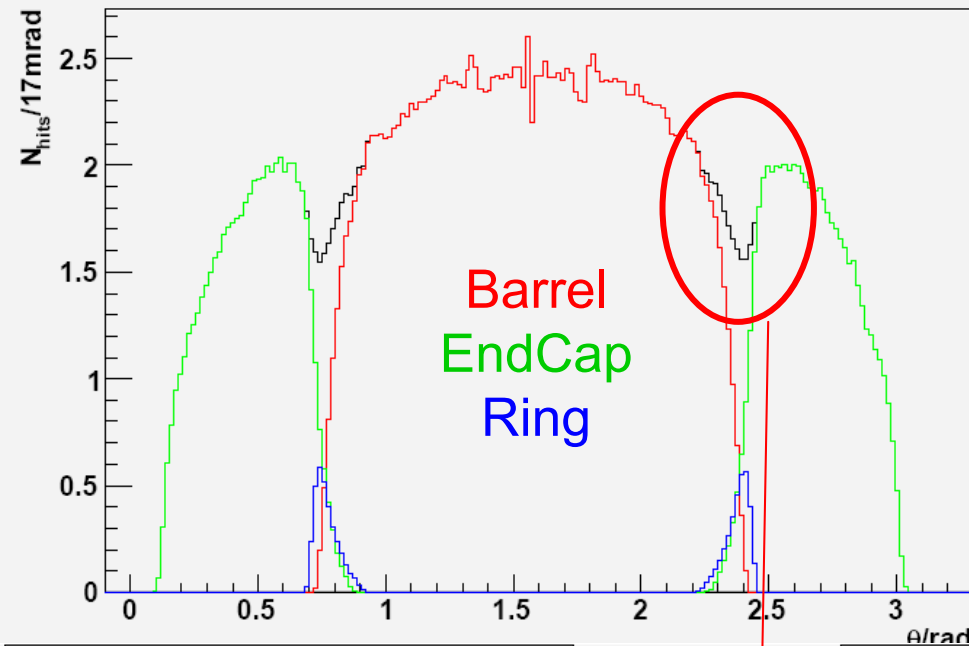
For one event:

22/01/2009

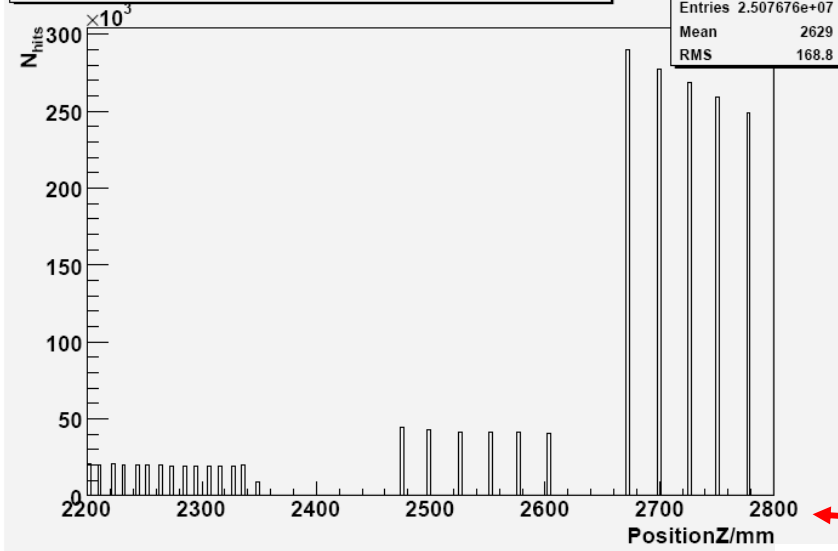
	EndCap	Ring
Expected N_{hits}	117.8	6.7
Expected N_{asic}	77.8	4.5

Efficiency drop in
Ring region --
space between
Ring, Barrel/Endcap

Polar angle distribution of Hits for qq event at Z Threshold

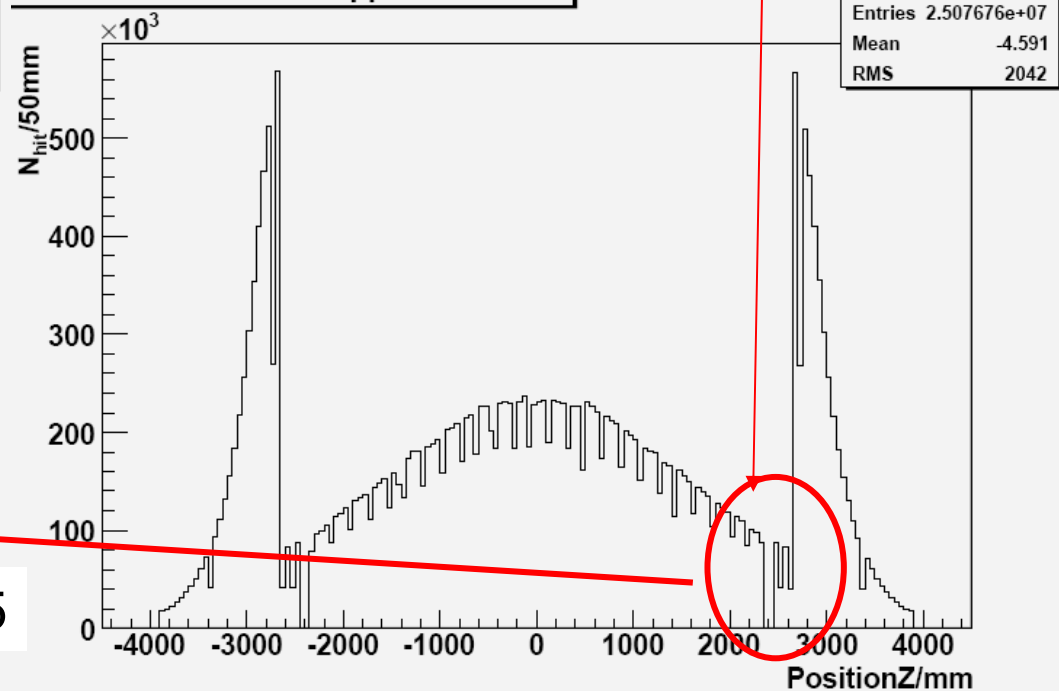


Spaces between DHCAL Barrel, Ring and EndCap



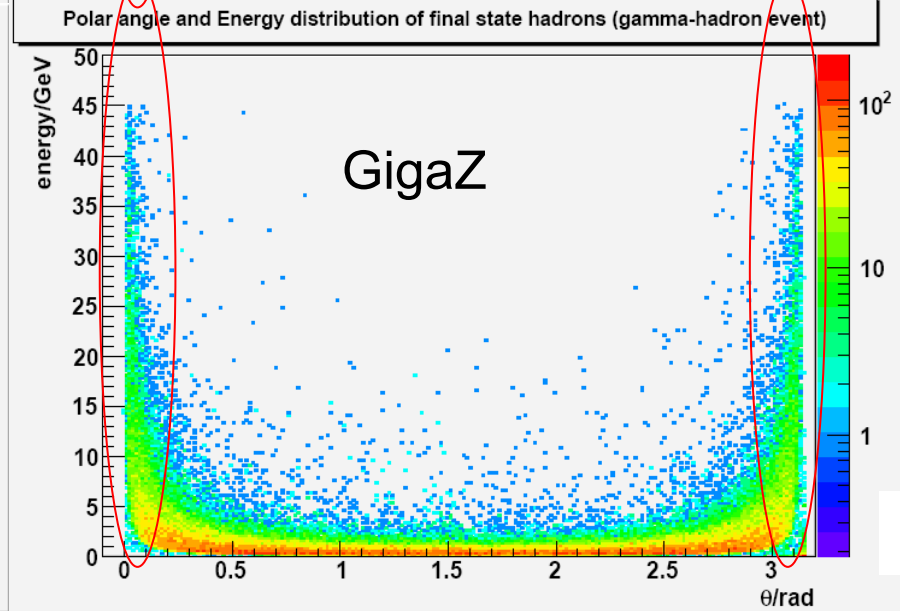
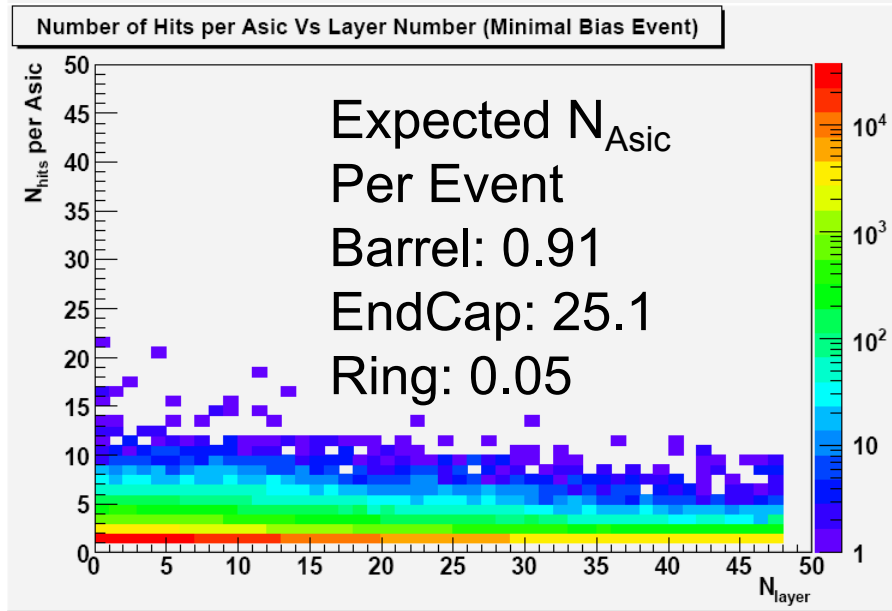
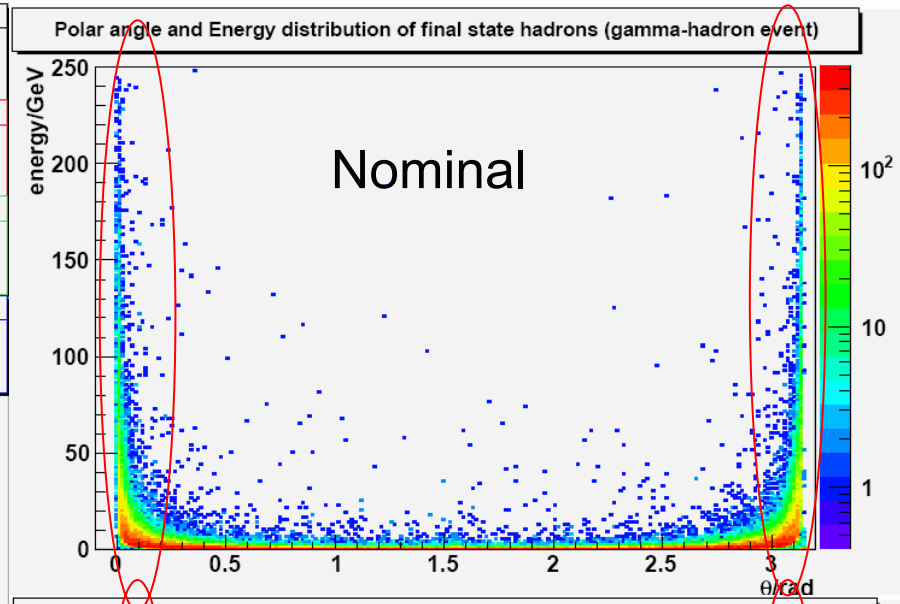
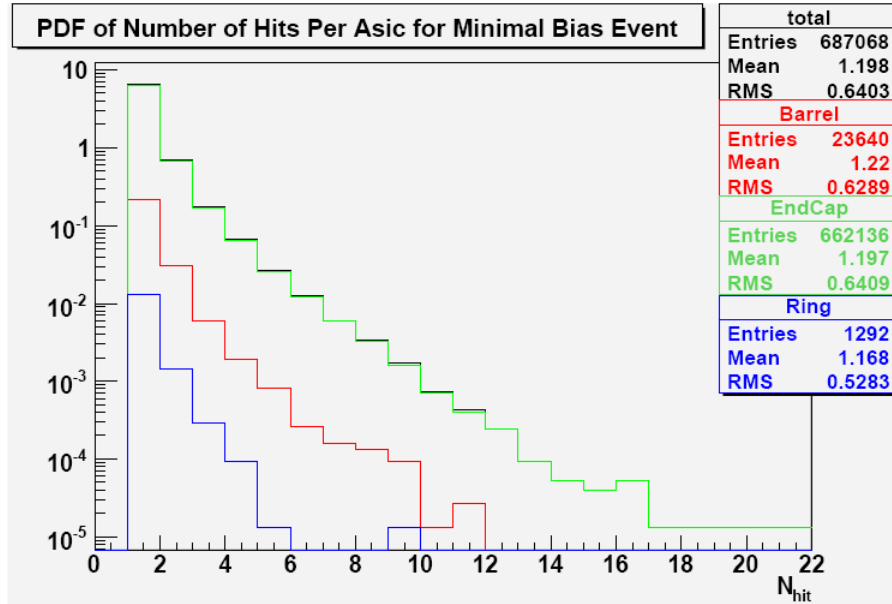
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Z Position of hits in qqbar events



15

Minimal bias: energetic final state hadrons dominant in forward region



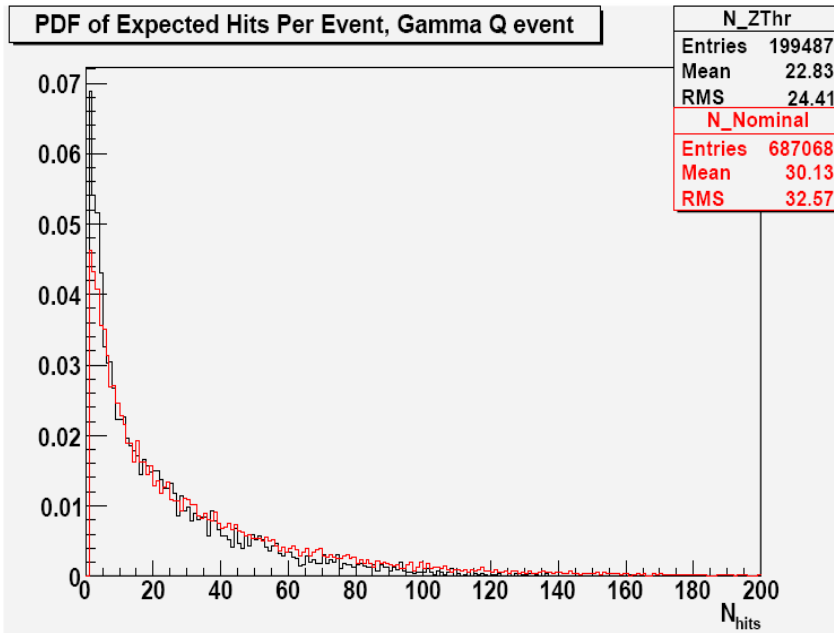
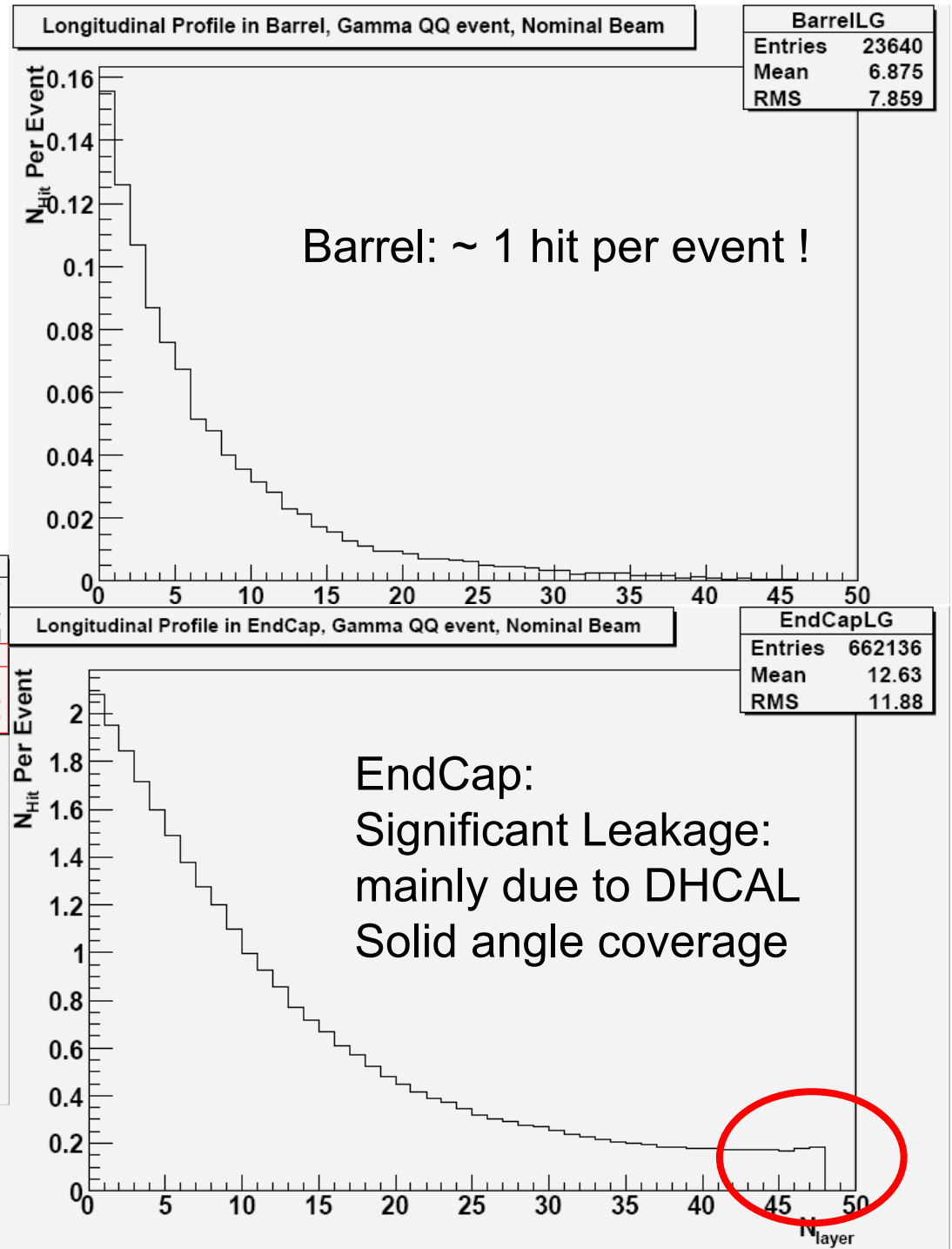
Minimal bias event Longitudinal Profile:

Expected Nhits per event:

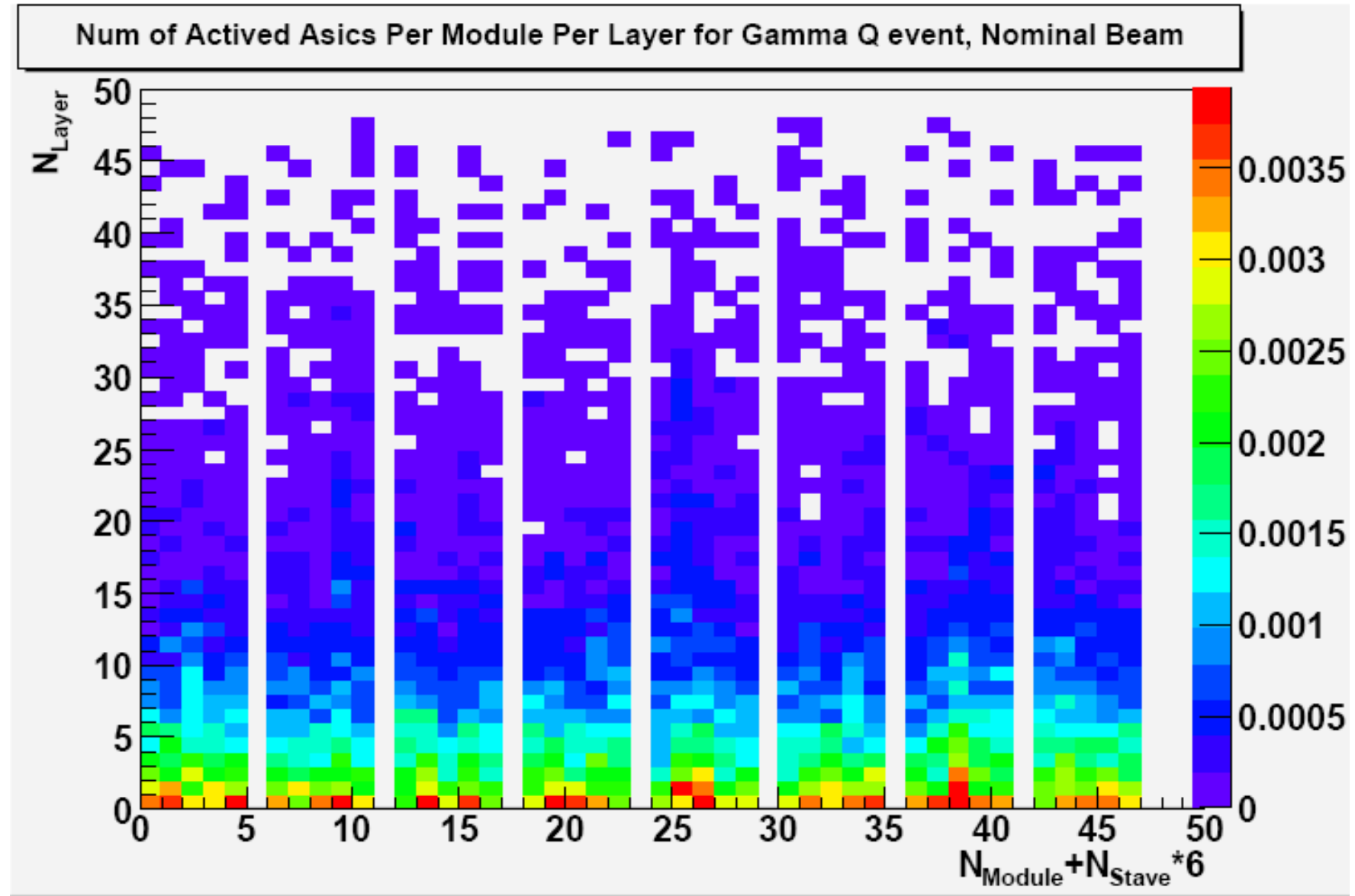
Barrel: 1.06

EndCap: 29.67

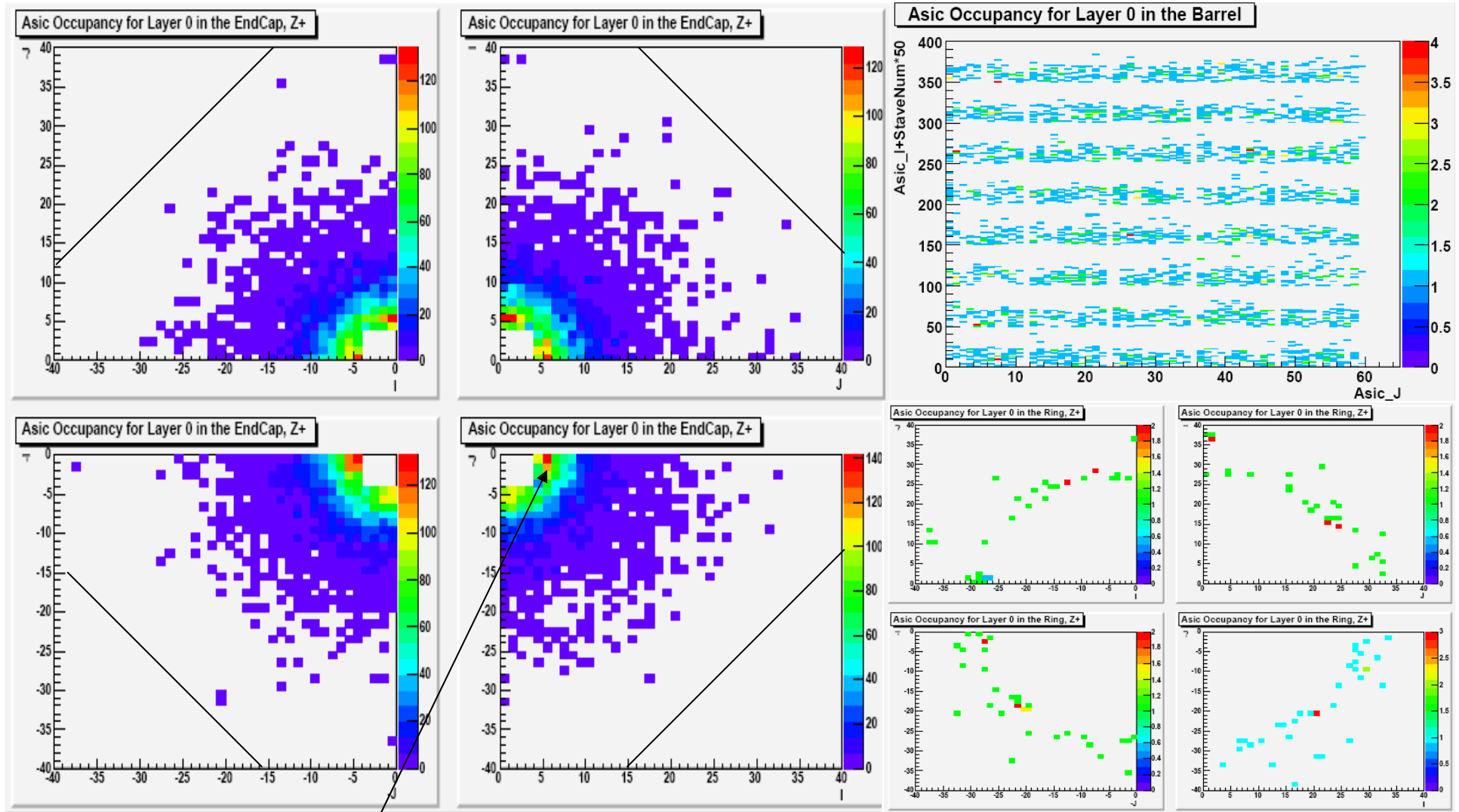
Ring: 0.058



Expected number of hit Asics per DIF



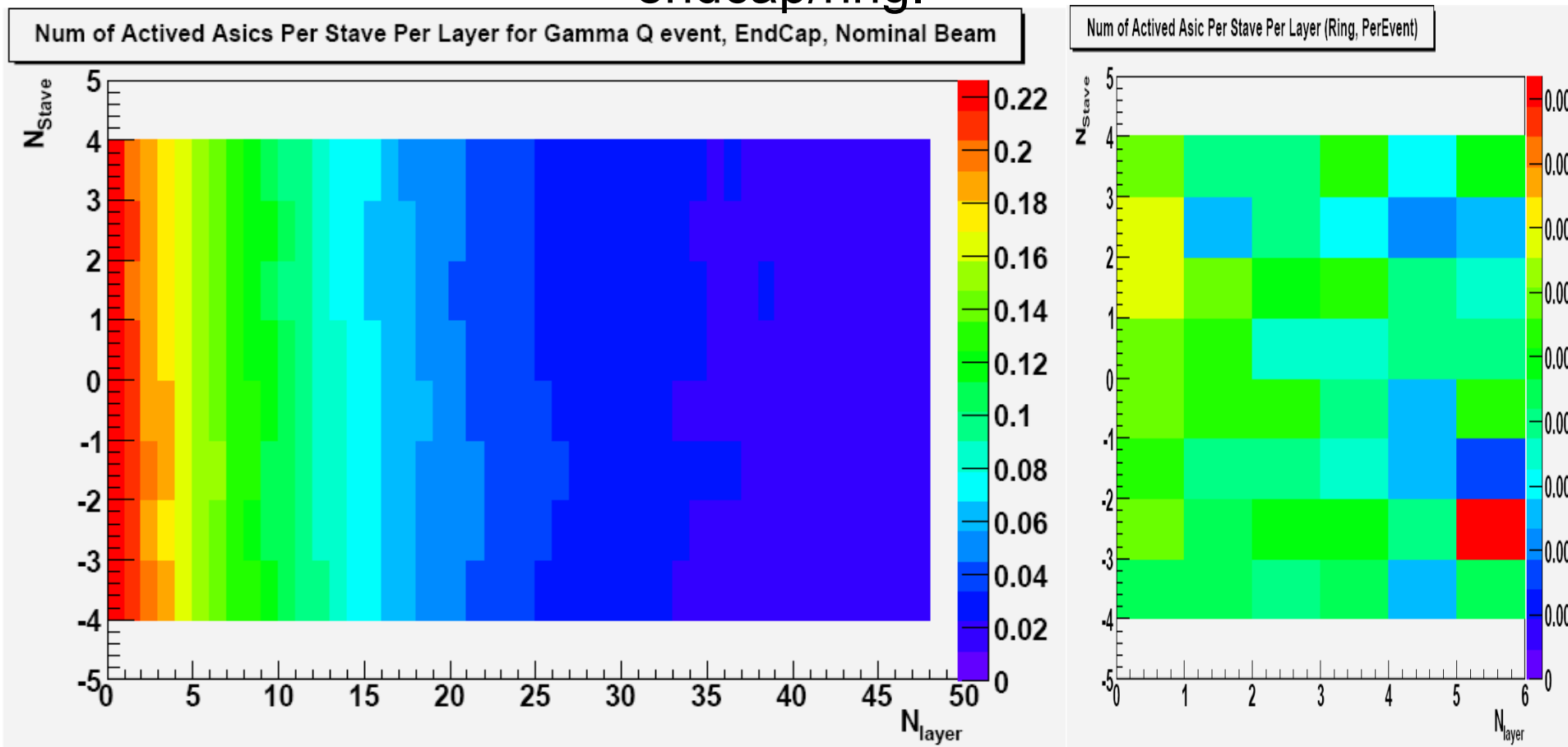
Minimal bias evts: Hit Asics in the Endcap/Ring (first layer)



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Hottest Asic: 0.006 (times actived)/evt ~ 4 times/s
 0.007 hits/evt ~ 4.6 hits/s

Expected number of Asics per event Vs (stave&layer) in the endcap/ring.



For one event:

22/01/2009

	EndCap	Ring
Expected N_{hits}	29.7	0.058
Expected N_{asic}	25.1	0.05

20

Summary



	Barrel N_{hits}	Barrel N_{asic}	EndCap N_{hits}	EndCap N_{asic}	Ring N_{hits}	Ring N_{asic}
$e^+e^- \rightarrow qq$ GigaZ, 30evt/s	207.6 6.2k/s 0.1/s	124.6 3.7k/s 0.05/s	117.8 3.5k/s 0.1/s	77.8 2.3k/s 0.06/s	6.7 201/s 0.036/s	4.5 135/s 0.02/s
Minimal bias GigaZ, 10evt/s	0.78 7.8/s	0.64 6.4/s	20.2 202/s 0.06/s	17.0 170/s 0.05/s	0.038 0.38/s	0.033 0.33/s
Minimal bias Nominal 660evt/s	1.06 700/s	0.91 600/s	29.7 19.6k/s 4.6/s	25.1 16.6k/s 4/s	0.058 38.3/s	0.05 33/s

Black: expected $N_{\text{hits}}/N_{\text{asic}}$ per event;

Blue: expected $N_{\text{hits}}/N_{\text{asic}}$ per second;

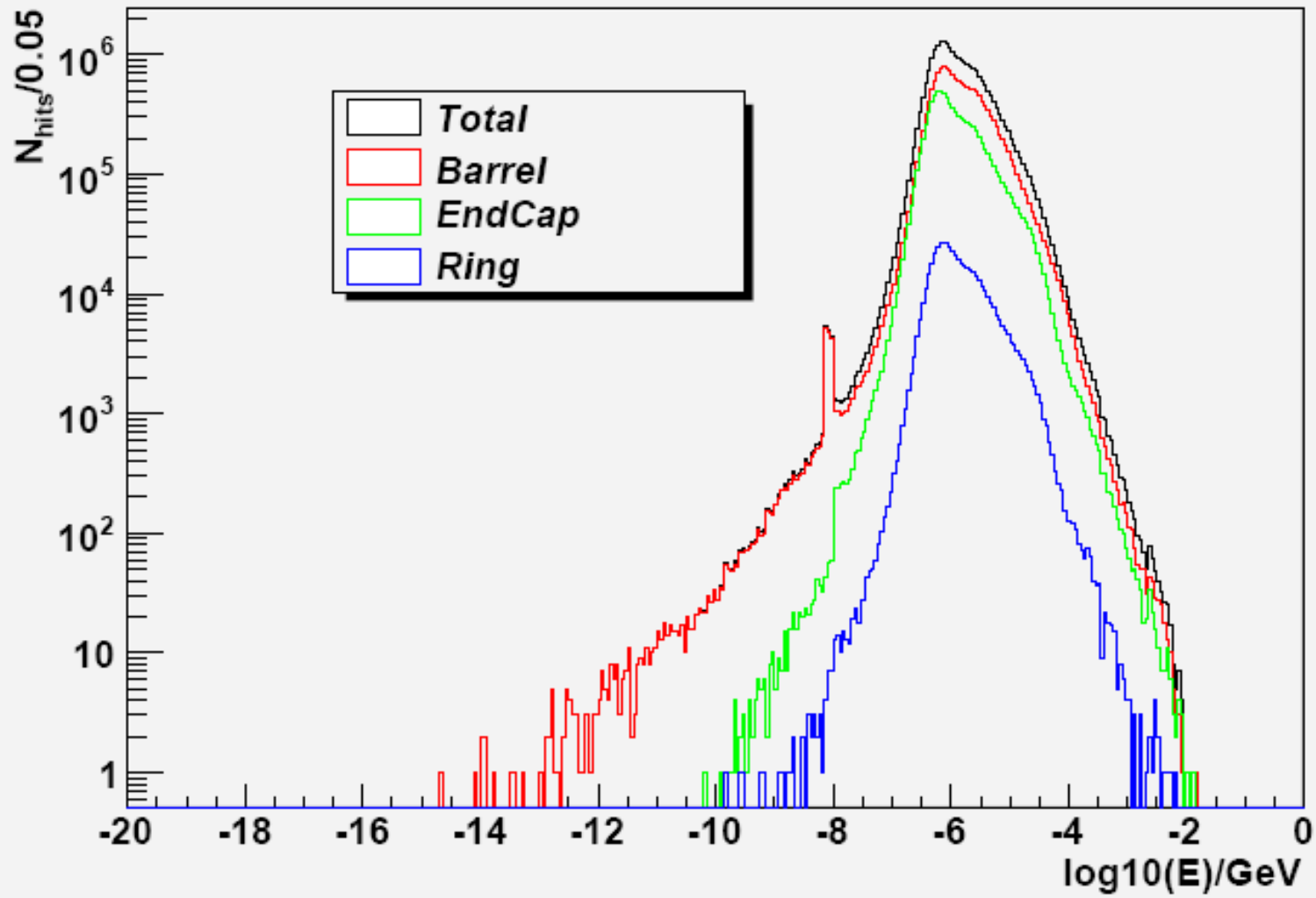
Red: $N_{\text{hits}}/N_{\text{asic}}$ per second on the hottest Asic

Problems



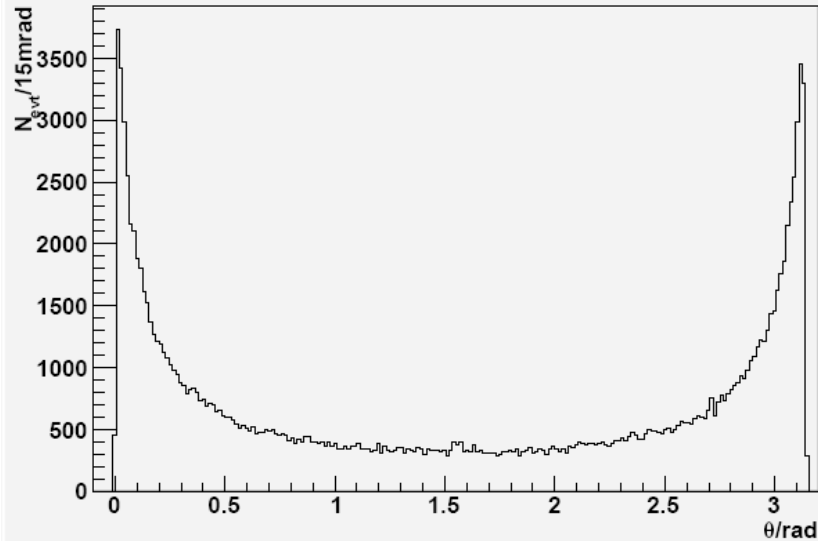
- Grid Mokka data missing...
 - Whole file missing;
 - Files with 500GeV beam energy incomplete: 350 of 500 event simulated...
- Strange peak in energy spectrum
- More details about Pt cut & Beam condition implementation for minimal bias events in PYTHIA
(I believe the beam parameters will greatly affect the density/energy spectrum of BS photons, thus affect the final X section of the minimal bias events...but yet not find the beam condition description in PYTHIA);

Energy spectrum per hit for qqbar event at Z Threshold

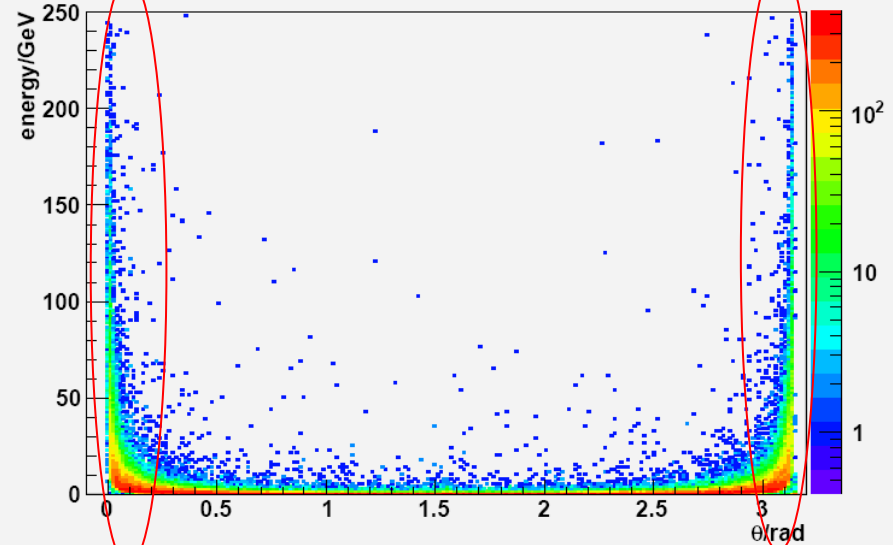


Minimal bias: energetic final state hadrons dominant in forward region

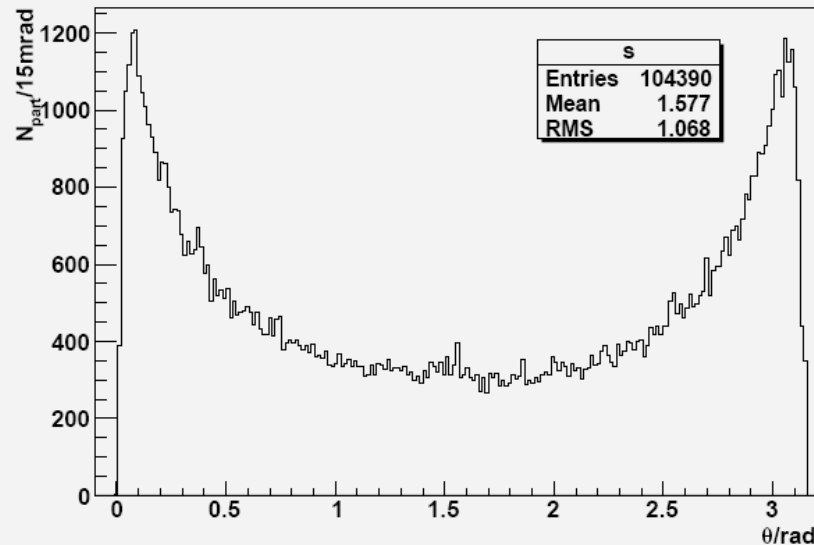
Polar angle of final state hadrons (gamma-hadron event)



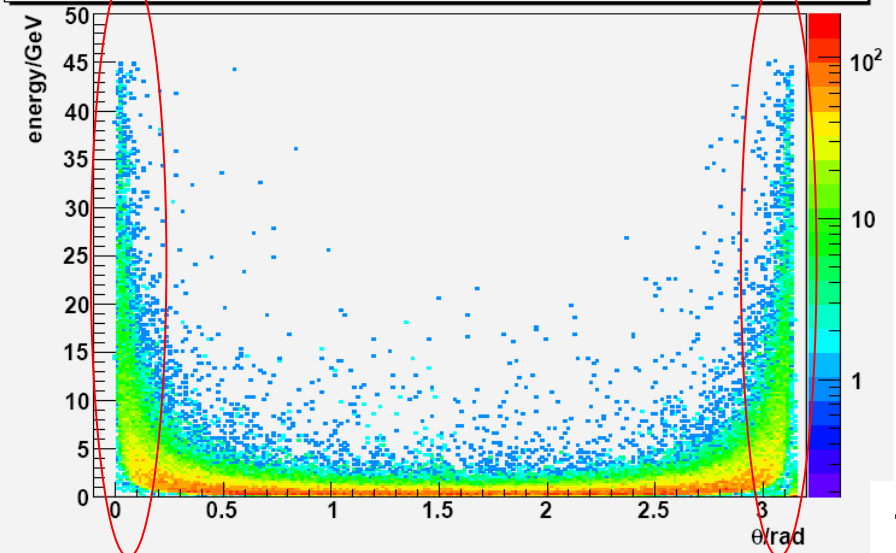
Polar angle and Energy distribution of final state hadrons (gamma-hadron event)



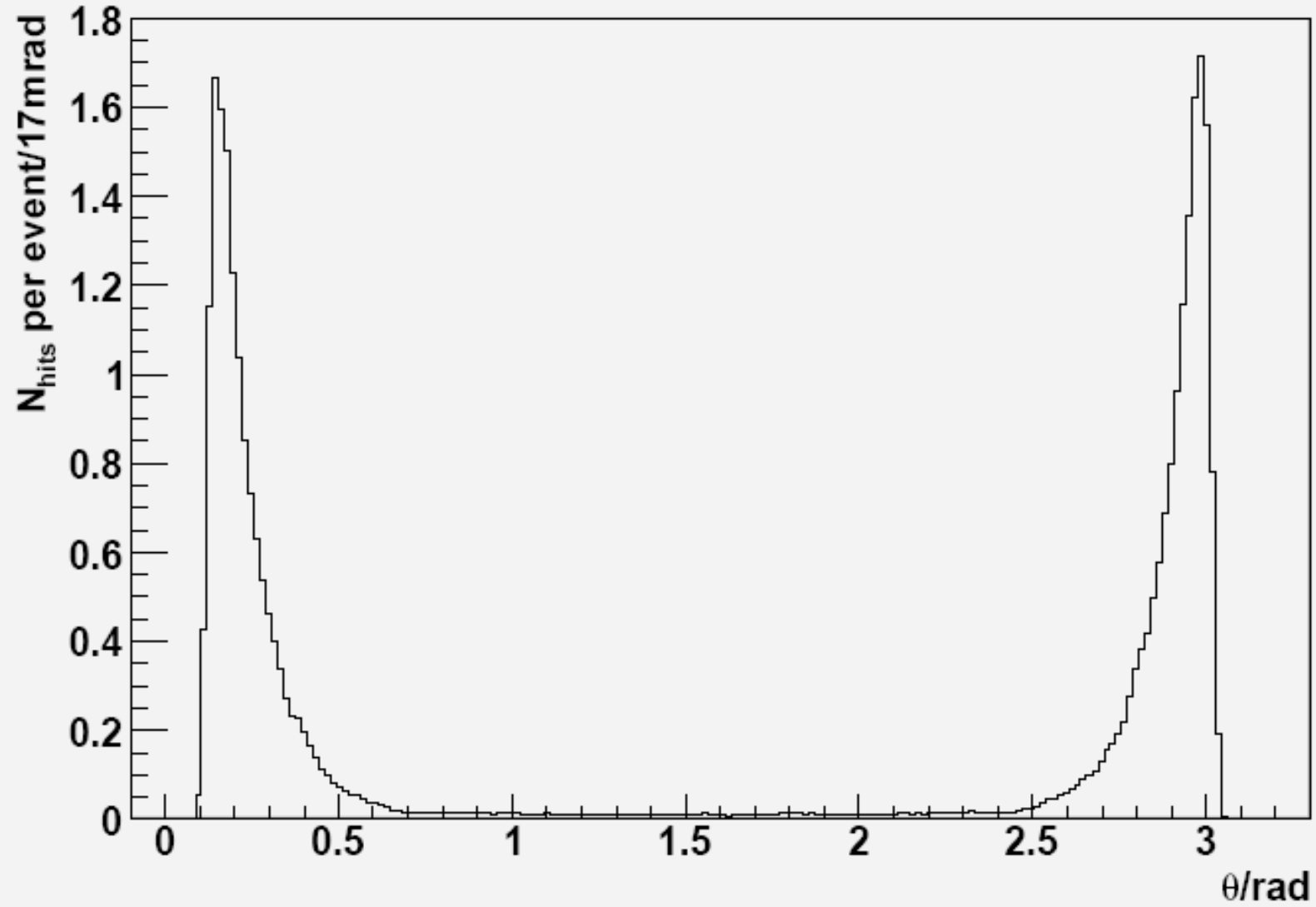
Polar angle of final state hadrons of gamma-hadron event



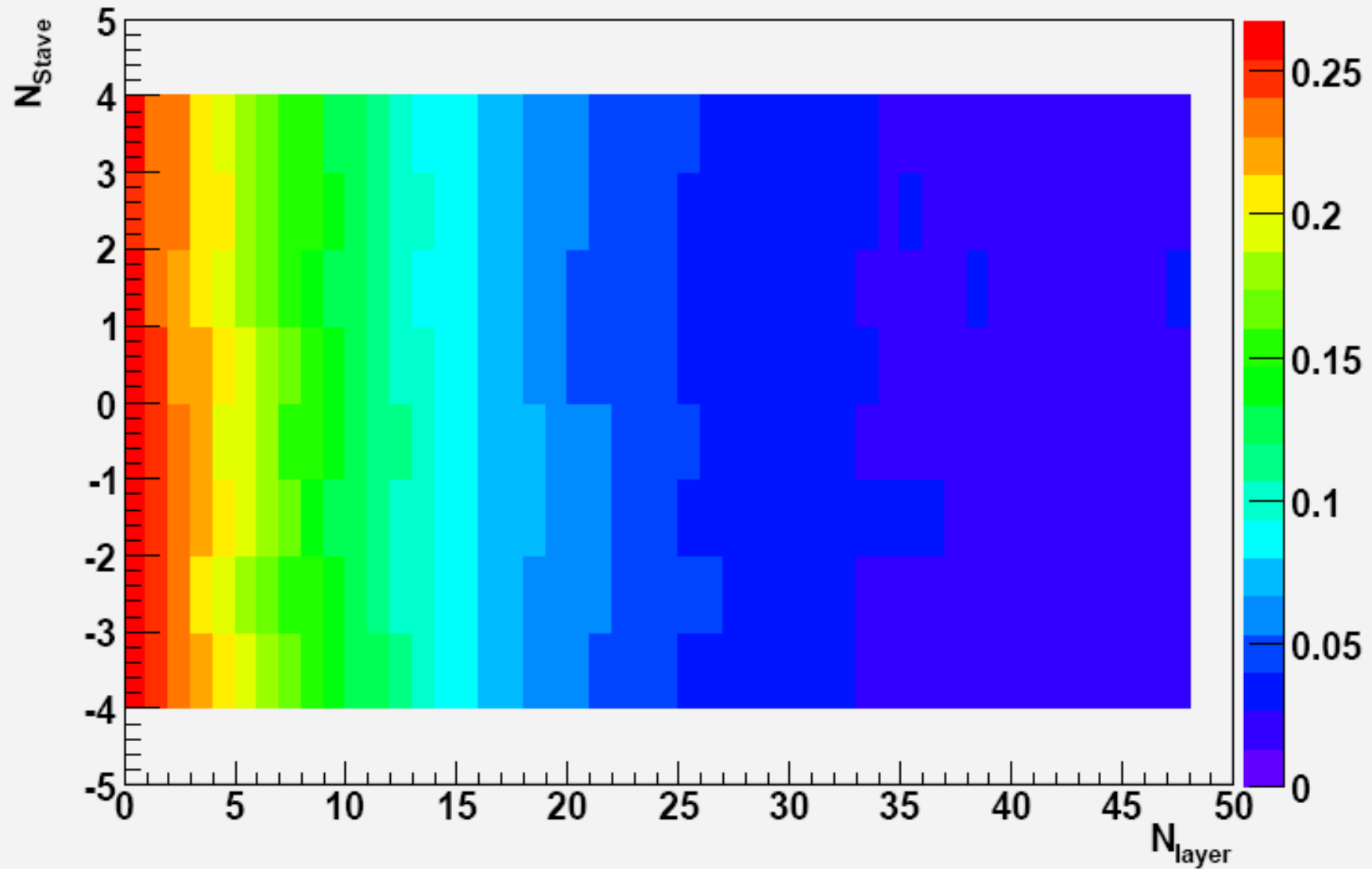
Polar angle and Energy distribution of final state hadrons (gamma-hadron event)



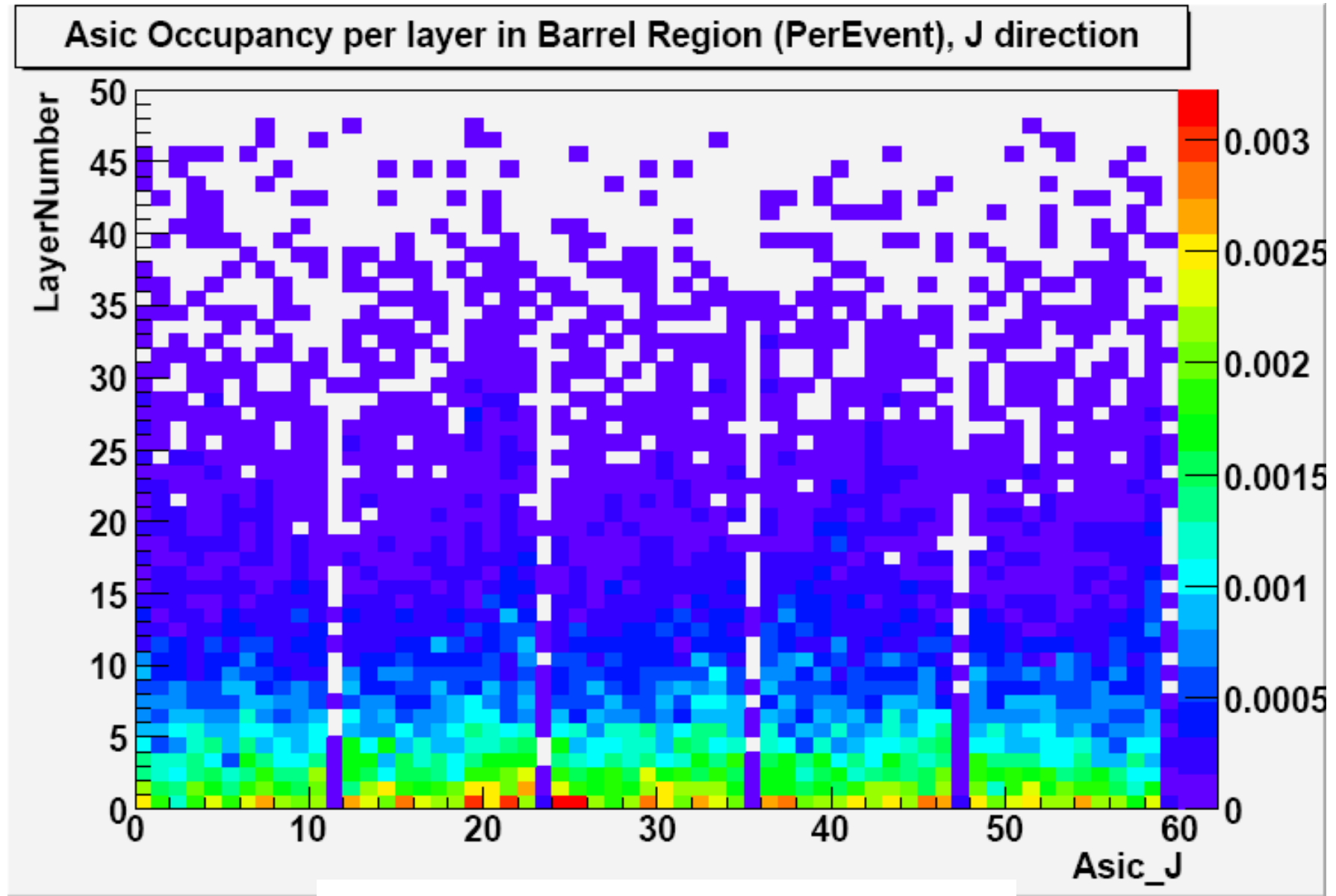
Hits Polar Angle Distribution of GammaQ event, Nominal Beam



Num of Activated Cells Per Stave Per Layer (EndCap, PerEvent)



Sum on 8 staves

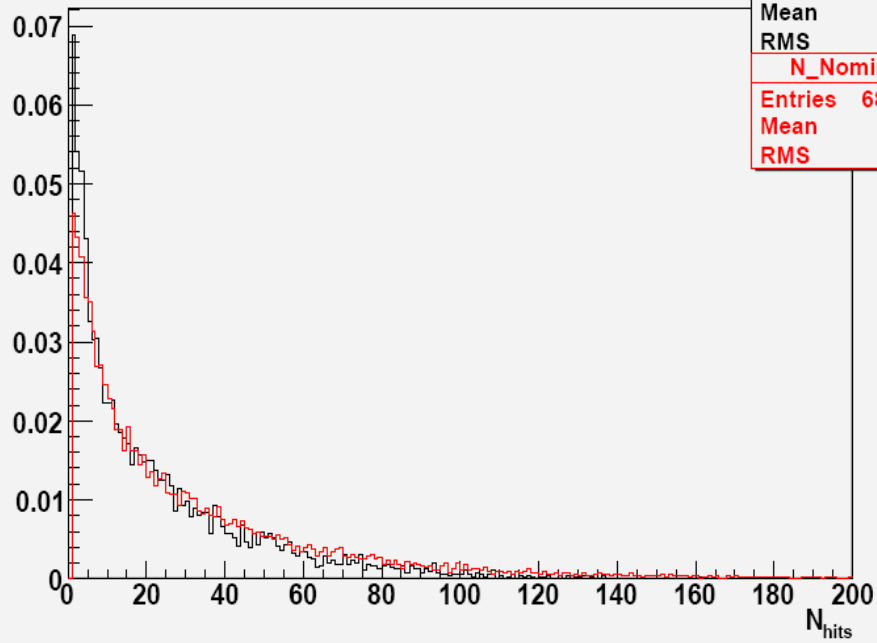


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Almost flat distribution in Barrel region

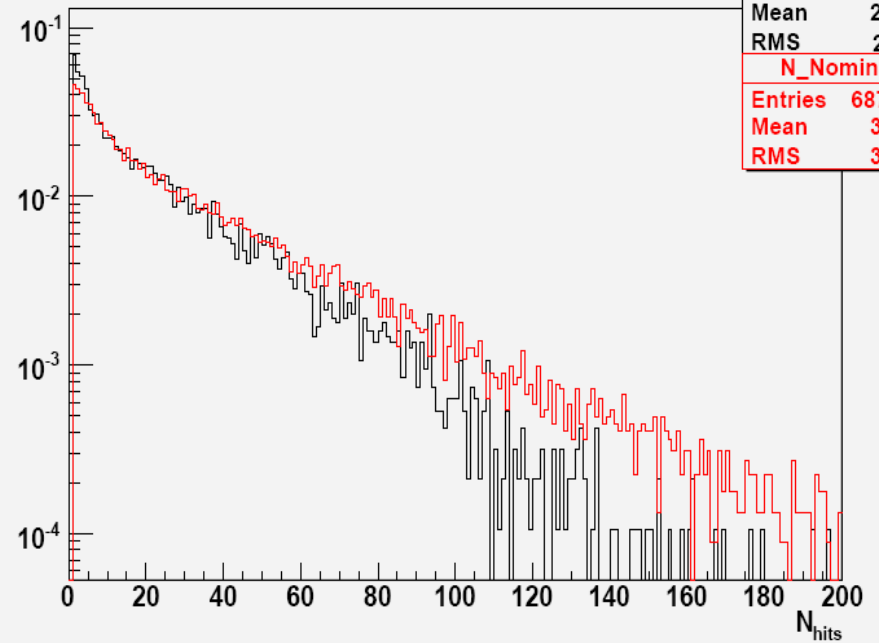
27

PDF of Expected Hits Per Event, Gamma Q event



N_ZThr	
Entries	199487
Mean	22.83
RMS	24.41
N_Nominal	
Entries	687068
Mean	30.13
RMS	32.57

PDF of Expected Hits Per Event, Gamma Q event



N_ZThr	
Entries	199487
Mean	22.83
RMS	24.41
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Entries	687068
Mean	30.13
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