Phase-2 Pixel Data Rates and Cluster Properties

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First look (for me) at the EPix rates and cluster parameters.

I have used:

1) the standard (TDR) geometry in CMSSW "Extended2023D17"
2) "relval" simulated events "2023D17PU200"
3) automatic GT "phase2_realistic"
4) a clone of my old phase0/1 code to look at hit pixels (digis) and clusters.

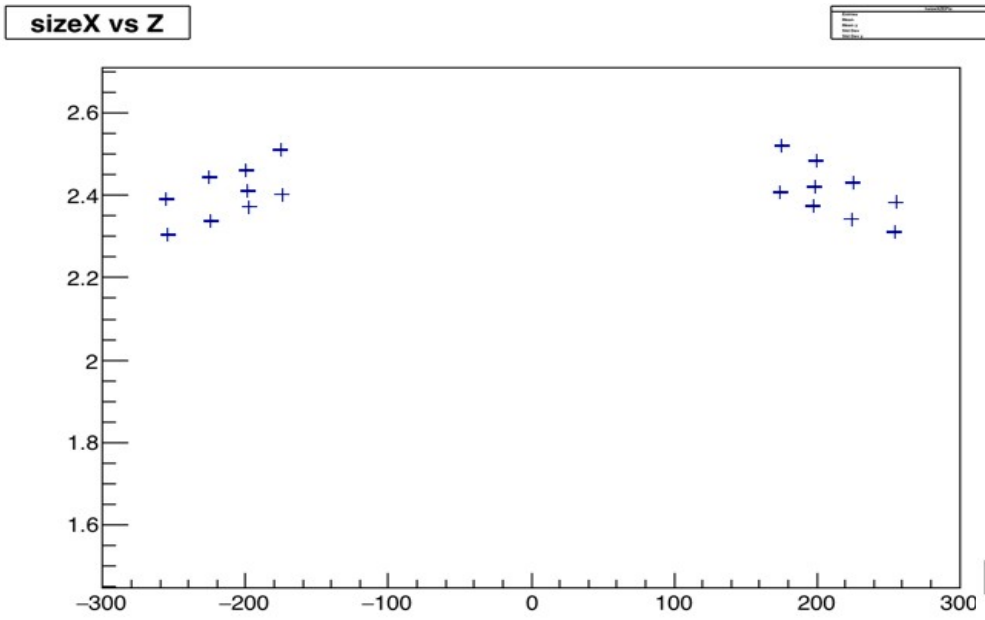
I certainly do not understand everything I see yet!

Some basic pixel parameters:
Sensor thickness 150um
Pixel 25um * 100um
Lorentz Angle like in phase0/1 (~ tan(LA)=0.4)
Thresholds 1000 electrons

Vocabulary

Cluster – a group of pixels, assumed to come from a single track
Cluster size – number of pixels in a cluster
SizeX – cluster size in the X direction, 25um pixels
(in bpix along phi, in f/epix along phi)
SizeY – cluster size in Y direction, 100um pixels,
(in bpix along z, f/epix along R)
Pixel charge – charge collected by a single pixel
Cluster charge - charge of all pixels in a cluster.

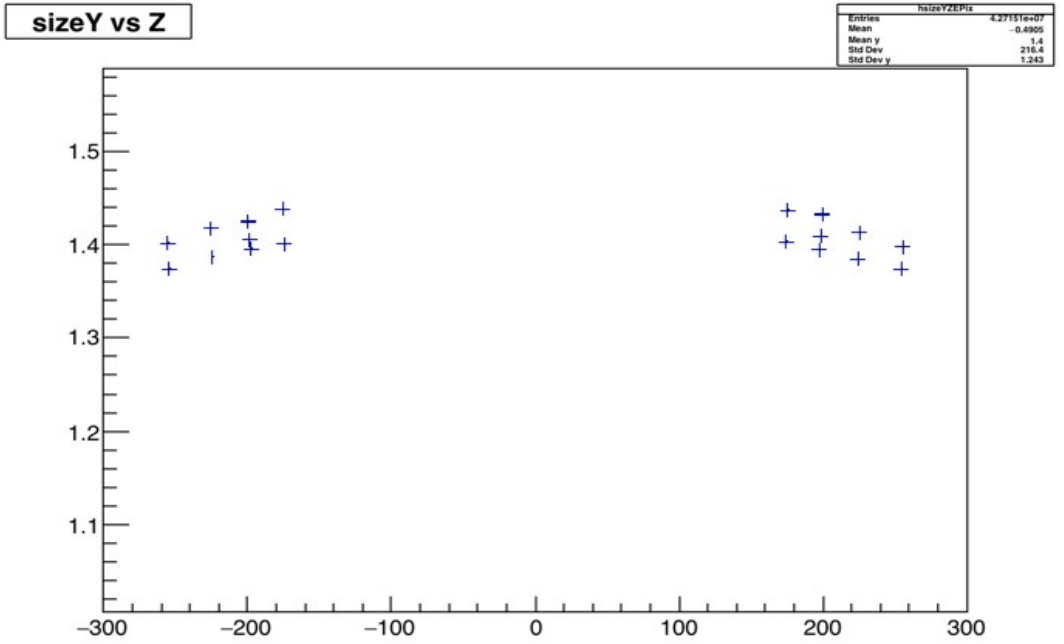
EPix - Disk (Z) dependence



Cluster SizeX versus Z

Small!

Cluster SizeY versus Z



The variation between disks
is small (10%).
For data rates it is even smaller.

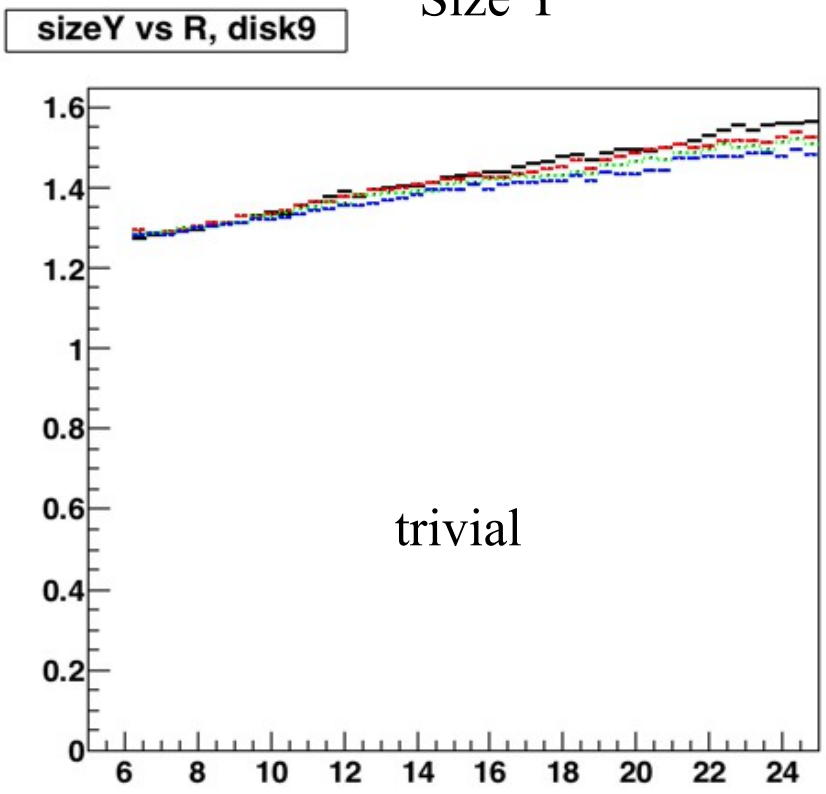
A Summary

Part	Hits/ROC	Hits/cm2	MHz/cm2	Gbps/link*	Clu-Size	x/y	Clu-charge	Pix-charge
Layer 1	279	77	2210	0.766(6)	7	3.8/4.0	33.4	5.0
Layer 2	68	19	535	0.557(2)	5.2	3.7/2.4	23.2	4.6
Layer 3	32	8.8	252	1.1(1)	5.0	3.9/1.9	21.4	4.5
Layer 3	22	6.0	172	0.72(1)	5.2	4.1/1.8	21.3	4.3
Fpix 1-8								
Ring1	103	29	817	0.57(3)	2.6	2.0/1.4	14.5	5.7
Ring2	60	16	472	0.49(2)				
Ring3	33	9.1	262	0.55(2)				
Ring4	23	6.2	178	0.74(1)				
Epix 9-12								
Ring1	46	13	361	0.75(1)	2.3	2.1/1.3	14.7	5.6
Ring2	27	7.3	210	0.44(1)	2.6	2.3/1.4		
Ring3	20	5.5	157	0.65(1)	2.8	2.4/1.5		
Ring4	15	4.2	119	0.50(1)	3.1	2.7/1.5		
Ring5	13	3.6	103	0.43(1)	3.2	2.8/1.5		

(*) - compression factor of 2 assumed

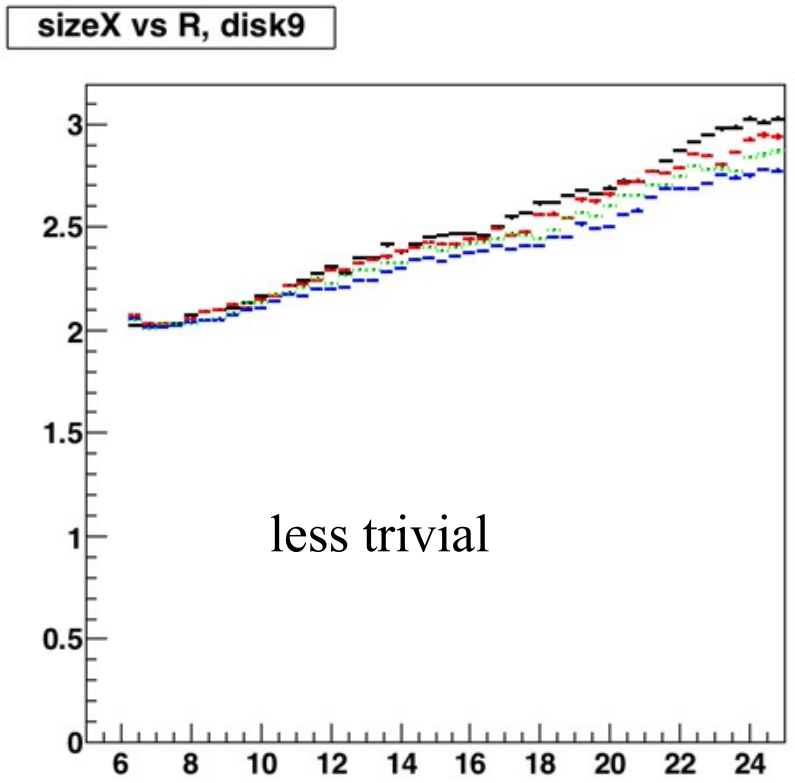
EPix - Cluster size versus radius

Size Y



R

Size X



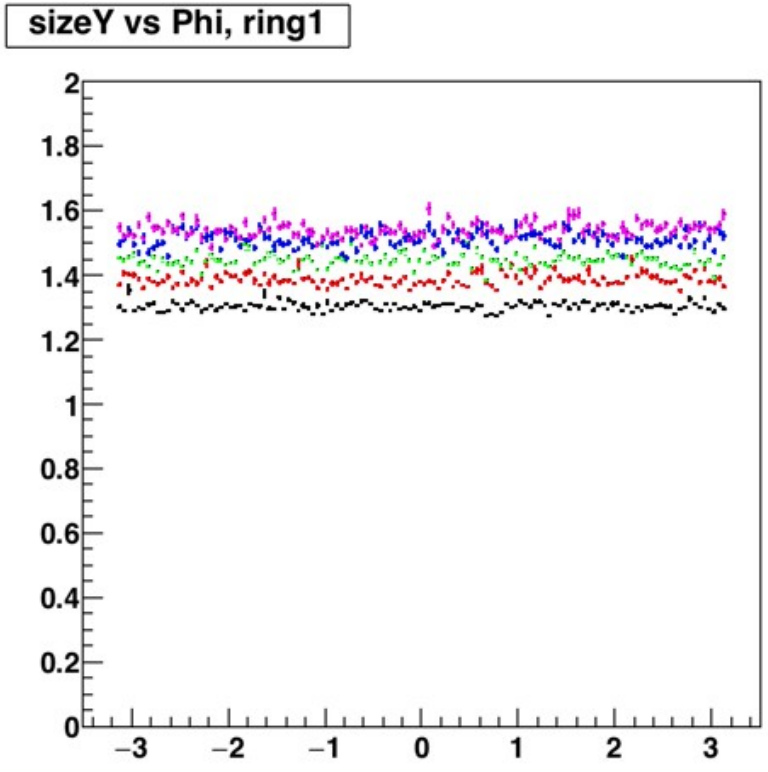
R

large charge sharing in X?

black - disk 1, red - disk 2, green - disk 3, blue – disk 4

EPix – Cluster size versus Phi (disk 9)

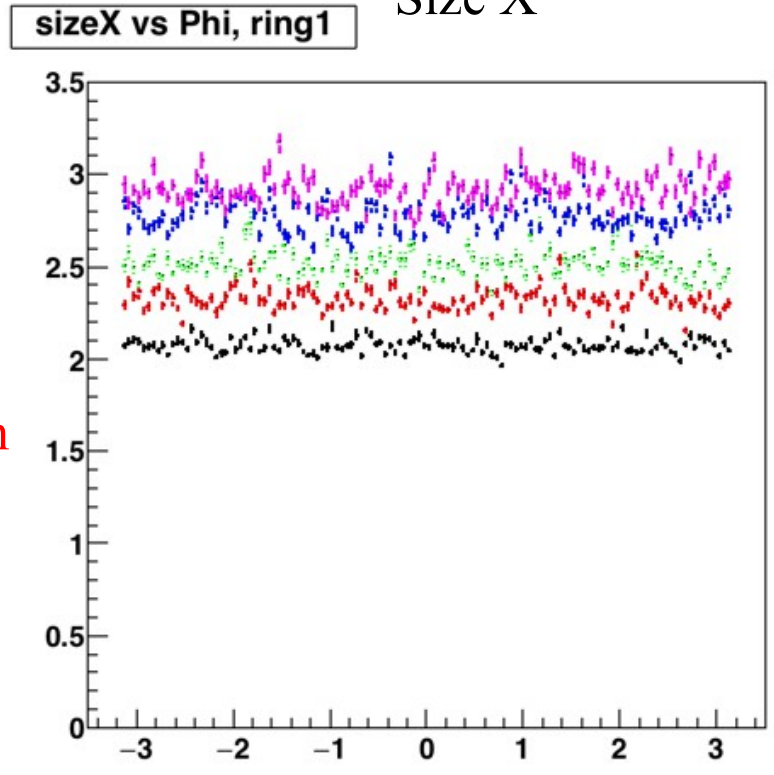
Size Y



Phi

no variation

Size X

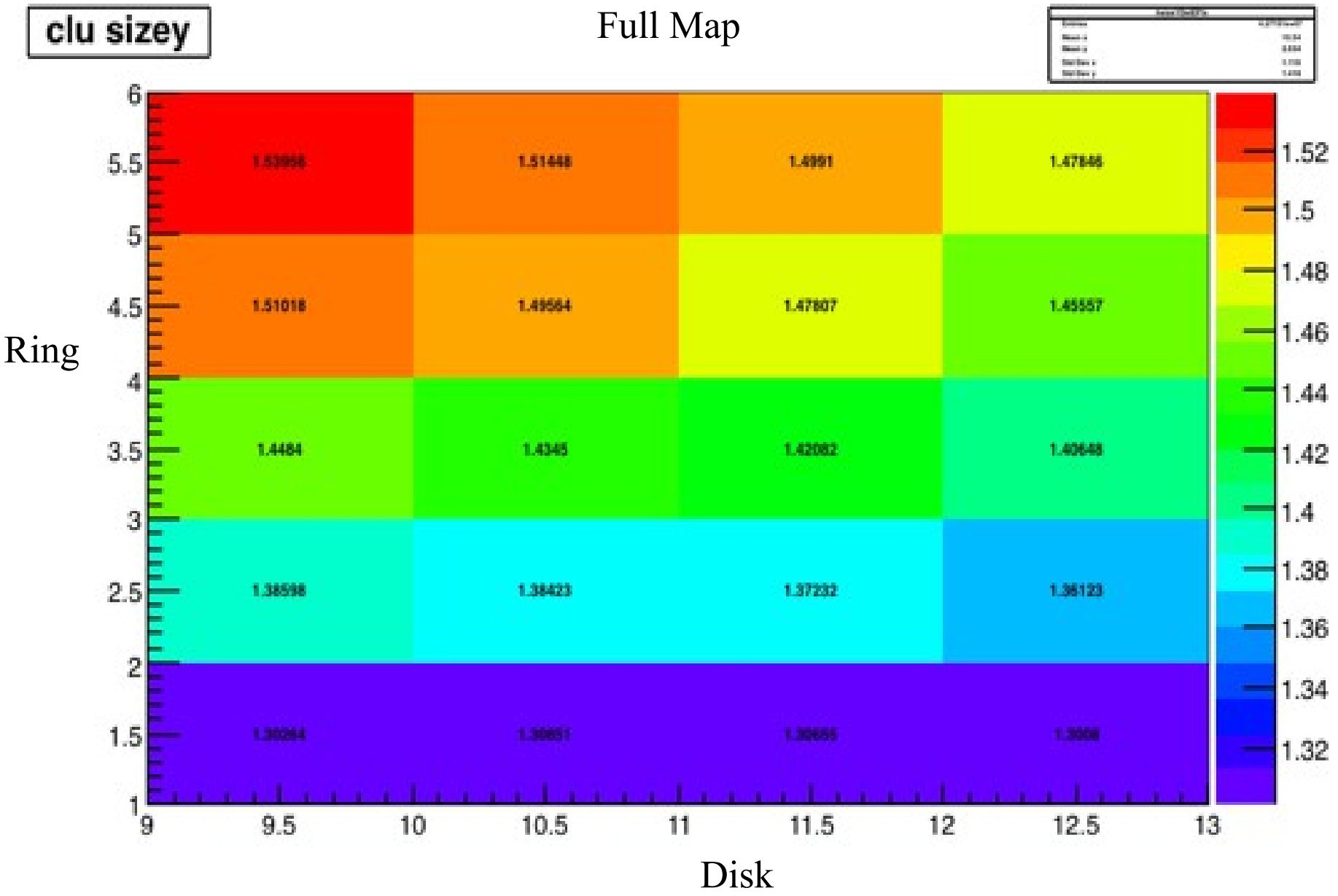


Phi

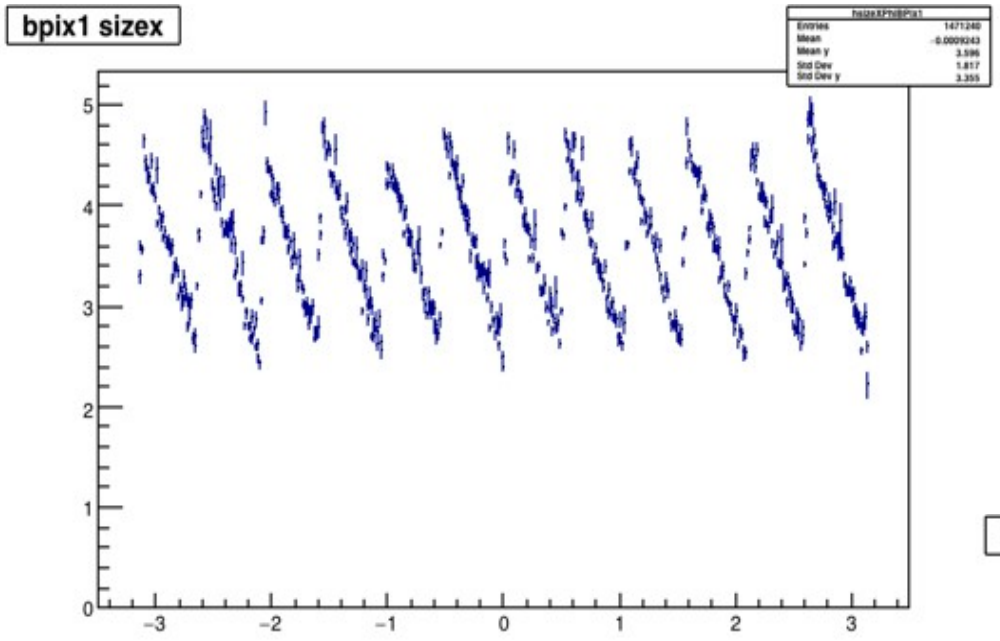
black - ring 1, red – ring 2, green - ring 3, blue – ring 4, magenta – ring 5

Expected some structure in X versus Phi. Probably disks too far from the IP.

EPix – Cluster size Y



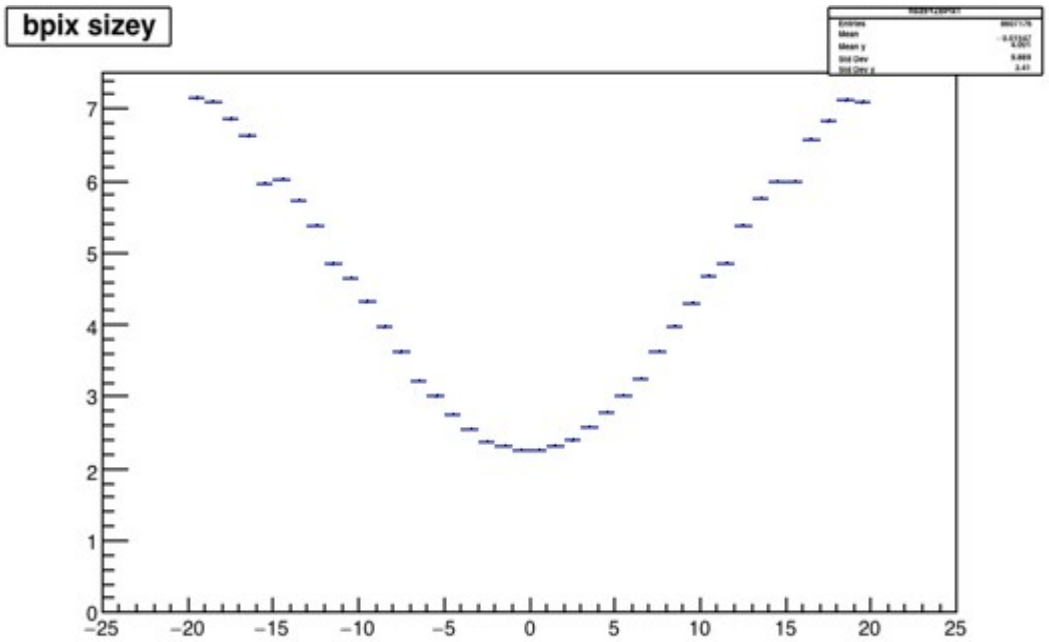
BPix – Cluster size



Phi

SizeX versus Phi

average is at 3.5, expected 2.4 from LA charge -sharing
Large effect of charge diffusion?



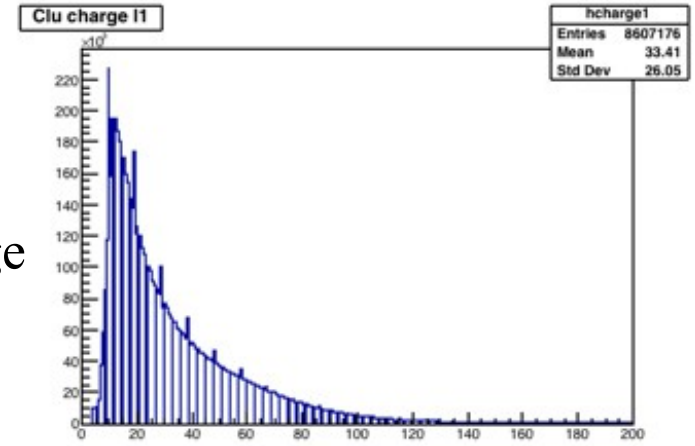
z

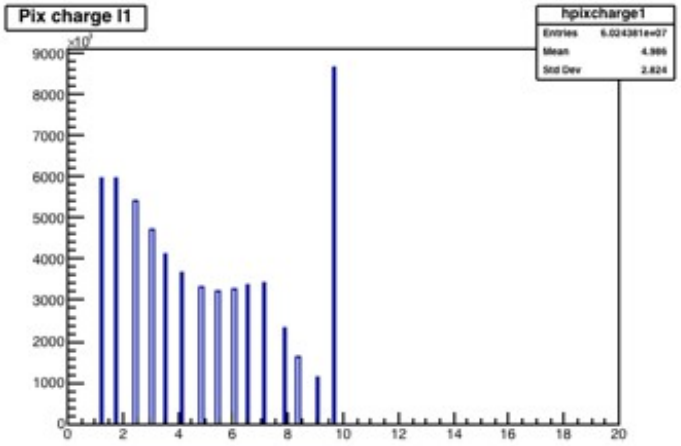
SizeY versus z

Expected 1 - 10

Charge distributions

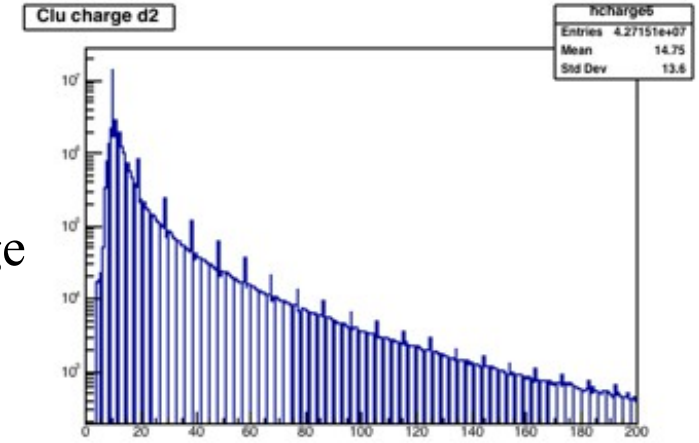
BPix1
cluster charge

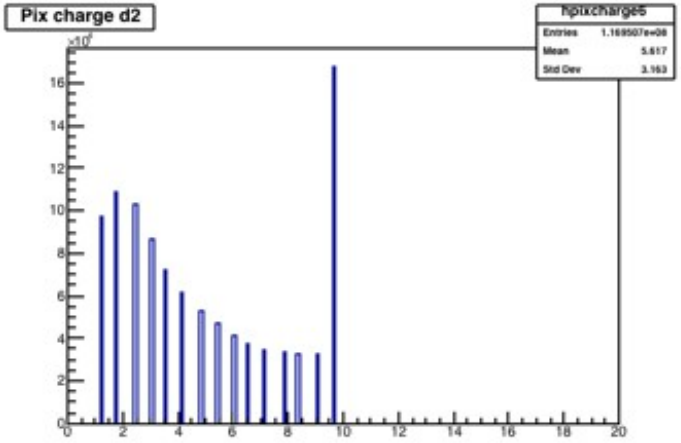




BPix1
pixel charge

EPix
cluster charge
{log scale)

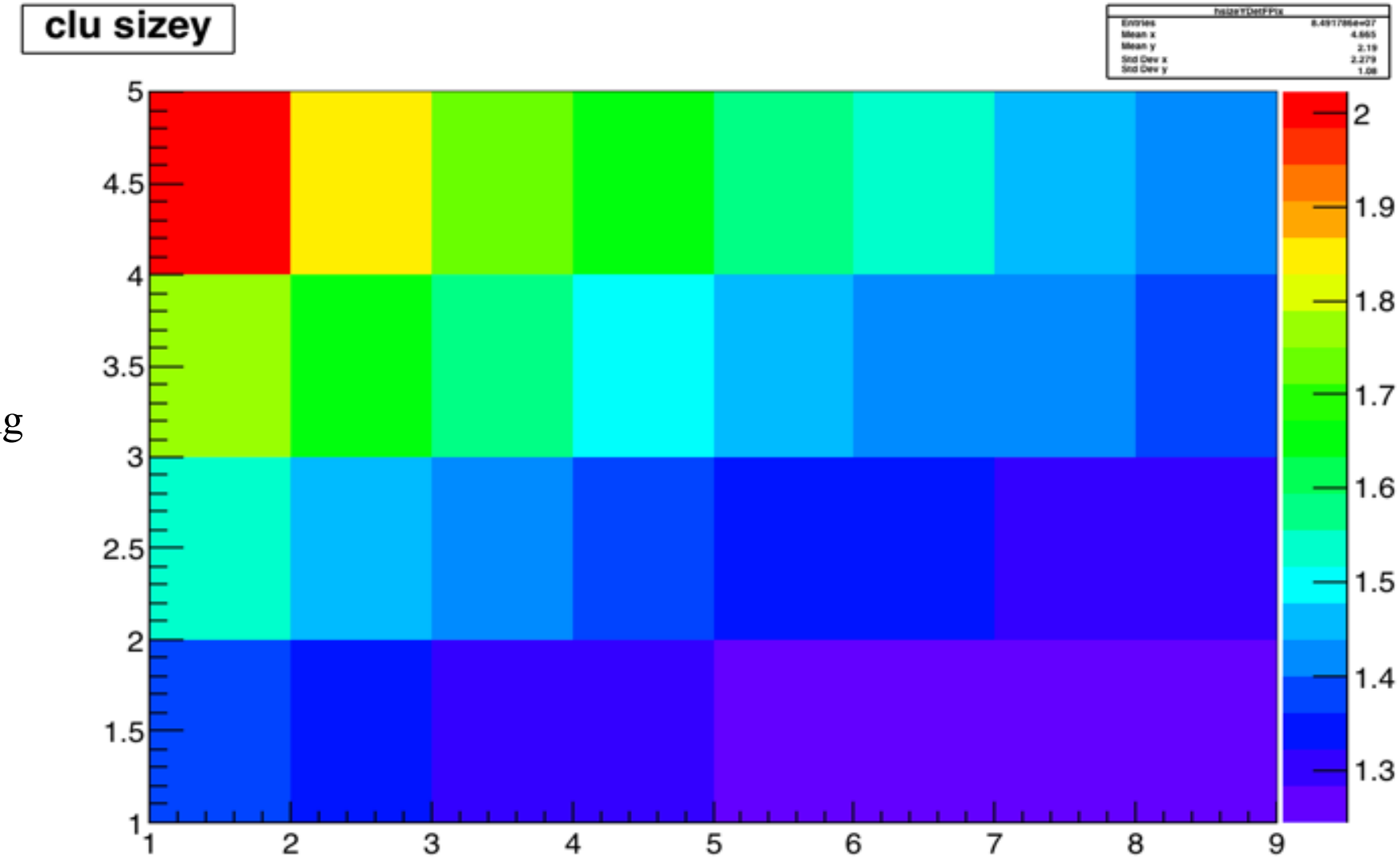




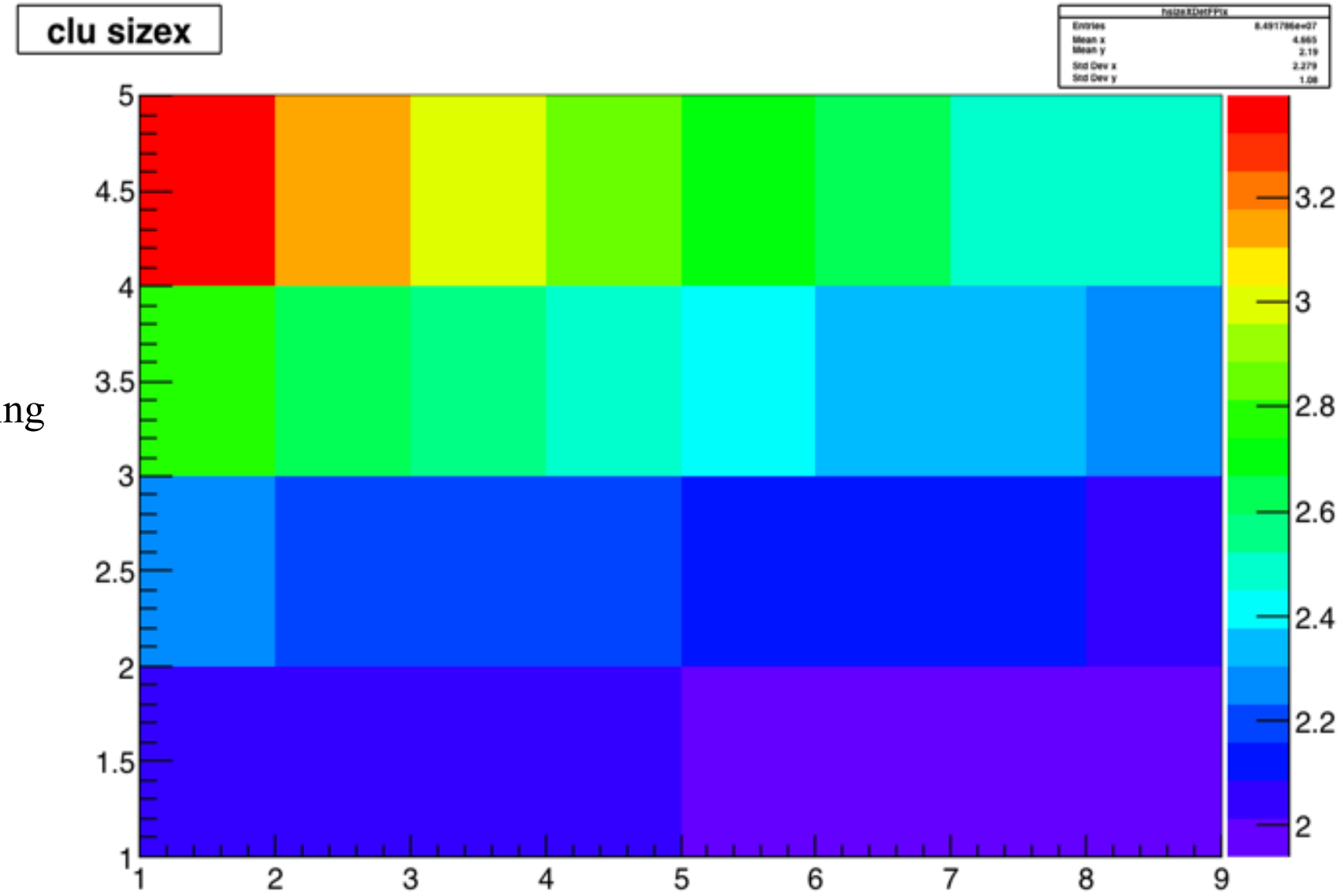
EPix
pixel charge

Is the saturation point optimal?

FPix – Cluster Size Y

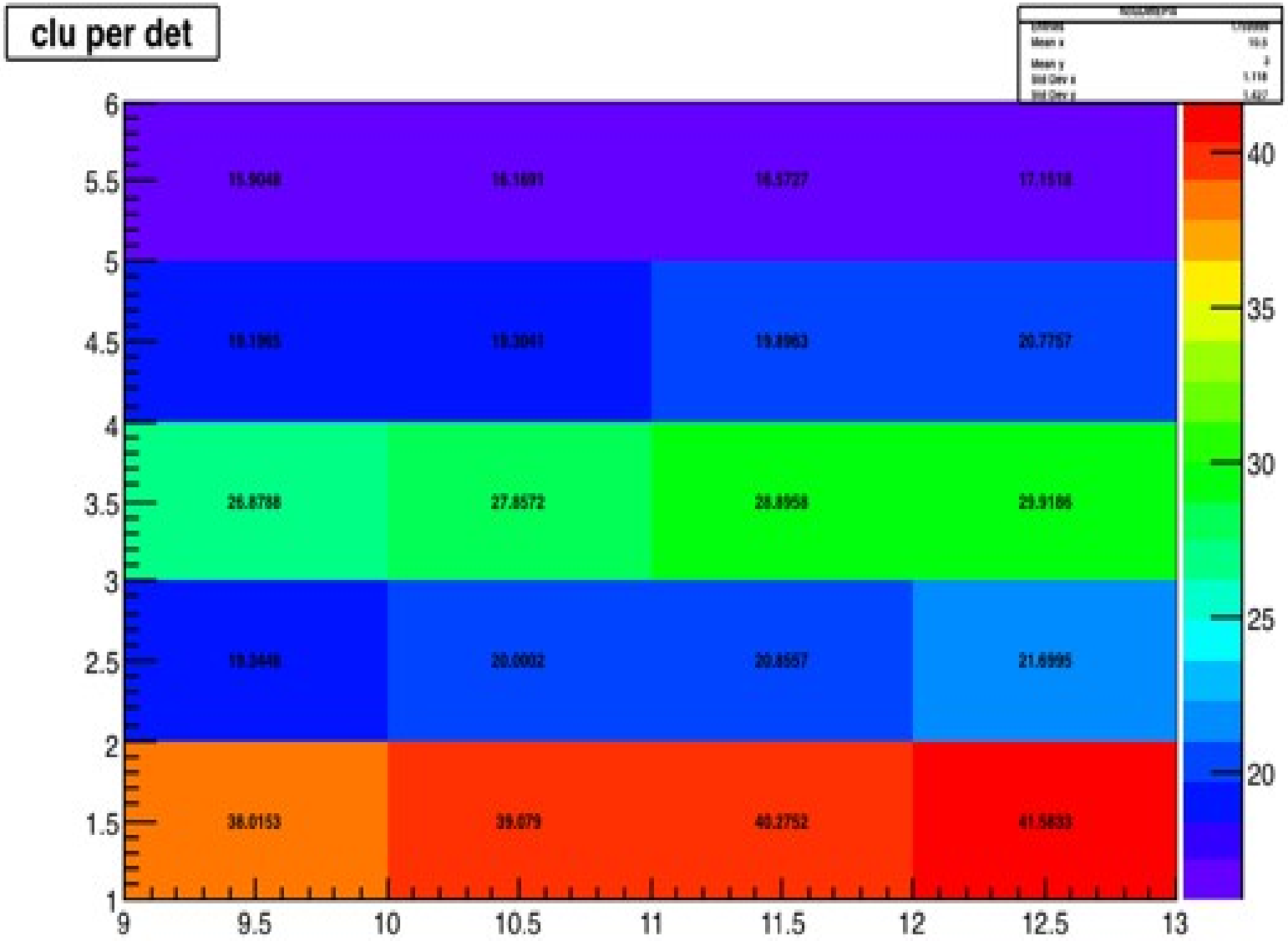


FPix – Cluster Size X



Backup

EPix – Clusters per module



FPix – Clusters per module