Curious Features putting hits on tracks in the 2009 pp500 and pp200 runs

Enclosed are several plots that compare the performance of the STAR tracking system with the TPX electronics active compared to our old TPC electronics in year 2008 data. I believe the data suggest that there is something mistuned with the TPX readout electronics, or we are damaging them with beam, or both.

The enclosed plots show hits-on-tracks and the tracks were subject to the following cuts:

MinBias, Global tracks
1 vertex per event, not more
1 GeV < p_T < 2 GeV
0.1 < |η| < 0.35
DCA < 3 cm
ϕ angle selected to fall in the middle 15 degrees of each sector (avoid edges)
no selection on PID or Centrality
Plot data only if there are more than 13 hits in the outer sector (32 possible), no requirement on Inner.

Three of the four plots on each page show the number of hits, on tracks, as a function of padrow and sector number. For example, the lower left plot on each page shows pad rows on the vertical axis, and sector number on the horizontal axis. The number of hits, associated with tracks, is shown on the Z axis (in color). The fourth plot (in the lower right hand corner) comes from our online QA histogram files. It shows padrow number on the vertical axis and pad-number on the horizontal axis. The total charge recorded by each pad is indicated by the color of the pad … this plot has nothing to do with hits-on-tracks … it shows all charge collected by a pad, during triggered events, in one run.

Page 1 shows 2008 data with the TPX test sector in sector 16. The trigger rate for TPX was higher than the trigger rate for the rest of the TPC and so you see a higher yield of hits on tracks in this sector because there were more tracks recorded in sector 16. You will note that there is relatively uniform response from all sectors (i.e. the TPC sectors are relatively flat and equal in height from sector to sector). Pad Row 13 was turned off for the TPC electronics … and this shows up as the hole in the histogram at pad row 13. Pad Row 13 seems to work in the TPX sector and so you see that it is alive. Otherwise, the TPC doesn't show any significant variation in efficiency for putting hits on tracks as you scan your eye from the inner sector to the outer sector. This does not appear to be true for the TPX electronics. There is a some sort of gain shift, or efficiency shift, that varies with pad row number in the inner sector.

Page 2 shows the new TPX electronics with 2009 data. These data were taken during the 500 GeV run … although fairly early in the run. This run was characterized by a very high pile up rate in the TPC and HV channels kept tripping off on a regular basis. It was even difficult for the human eye to find the lasers in the online event display.

Several RDO 's and a few HV channels were turned off when these data were taken. The plot in the lower left hand corner of page 2 shows this best. The RDOs and HV channels that are off are shown in dark blue.

It is interesting to note that the efficiency of putting hits on tracks is not constant in the 2009 data. There is a clear association between row number and the efficiency. This was hinted at by the 2008 TPX data … but now it appears to be universal across all sectors of the new TPX electronics and appears to have the strongest correlation in the inner sector. The inner sectors have the highest track density and so perhaps the discriminator thresholds are set too low and the tracker is having a hard time finding the right hits to associate with the correct track? Or perhaps the pulse shaping parameters need adjustment? Or the cluster finder?

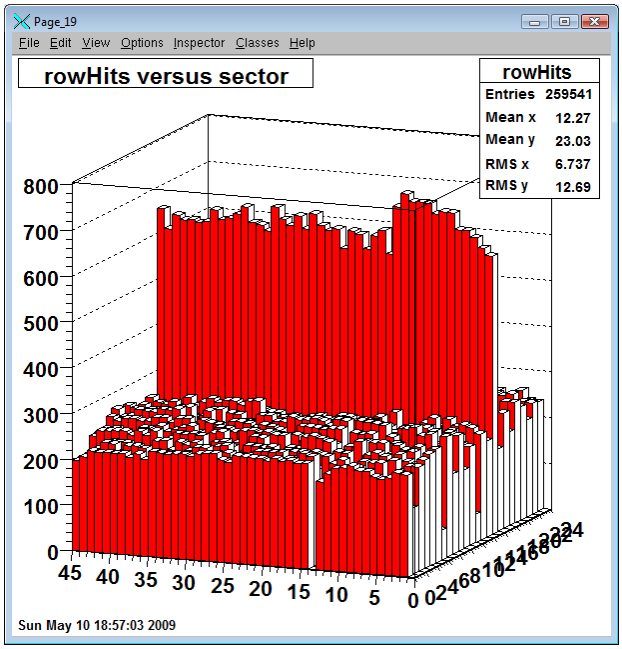
The panel in the upper right hand corner of page 2 also indicates that there are strong variations in efficiency from sector to sector.

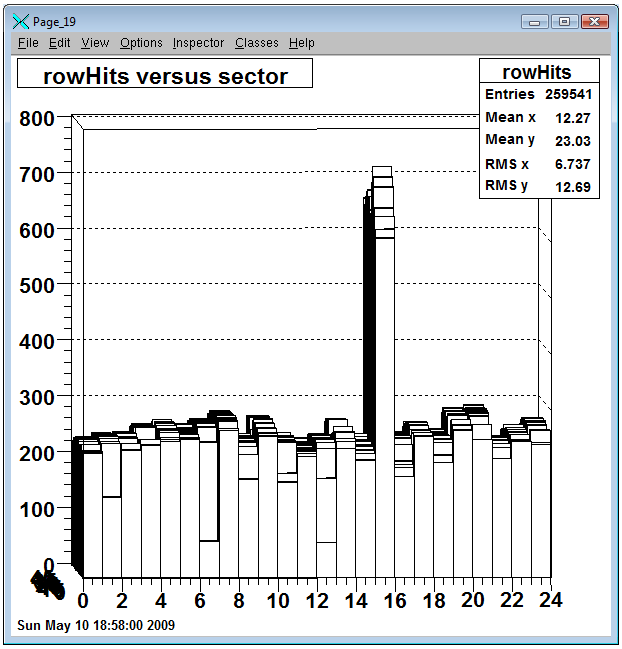
Page 3: After the 500 GeV run was complete, we turned to pp200 running. The upper right hand panel on page 3 suggests that the efficiency from sector to sector is now quite non-uniform. Did we do some damage to the anode planes or to the RDO electronics? This may be a premature conclusion … so first take note of the RDO and HV channels that are turned off. These are shown in blue on the lower left hand panel. RDO's 4-1, 5-5, 6-5, and 11-1 are all turned off because there is something wrong with them. I don't know when they were turned off but they were working at the start of the 500 GeV run and later had to be turned off.

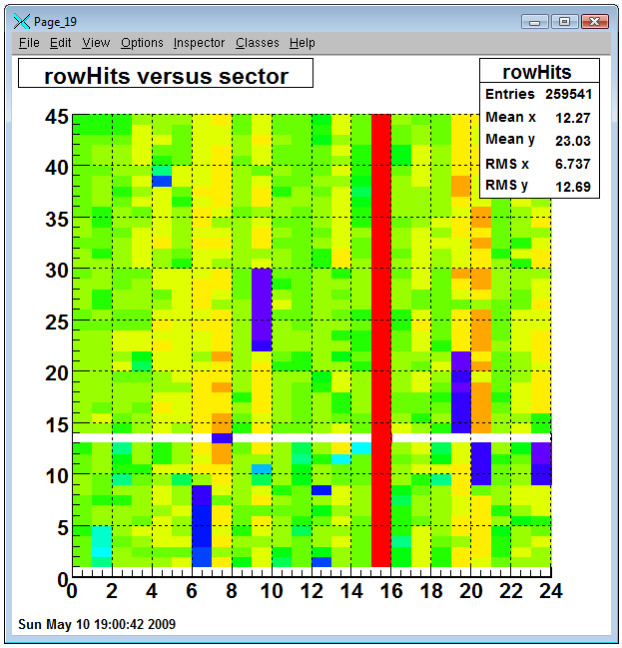
Note especially the partially efficient response in the first few rows of sectors 13 and 20. This is unusual. There areas are not on or off but rather they are about 75% efficient. The inefficiency does not extend over the full inner sector but rather extends to pad row 9 in both cases. Pad row 9 is the boundary for an RDO. (The inner/outer sector boundary is at row 13/14). This suggests that the anomalous behavior is not due to the anodes or HV channels, rather something strange is happening to the innermost RDOs in sectors 13 and 20. Is this radiation damage to the FPGAs? If you believe in conspiracy theories, note that sectors 11 and 13 are partners, as are sectors 4 and 20. 11 and 13 are lined up in Z and would both be damaged by a hot spot in the beam halo. Ditto for 4 and 20. Perhaps we have burned out the FPGAs in the inner part of sectors 4 and 11 (both on the West End) and we are about to burn out the innermost FPGAs in 13 and 20 (both on the East end)?

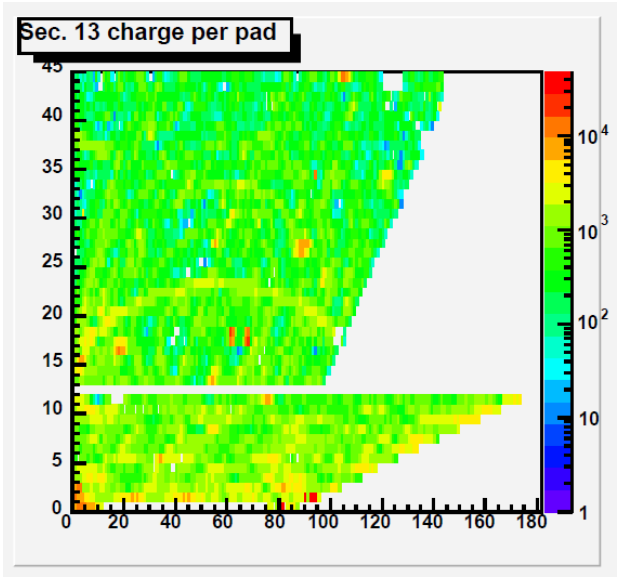
Two additional items qualify as food for thought. Page 3 was taken with pp200 running conditions. The pile up rate is high … but it is much lower than in the pp500 running conditions. This might affect how well the tracker can put hits on tracks; independent of the state of the TPX electronics. Also note that the charge per pad plot (lower right) on page three doesn't show any particular inefficiency in sector 13 (or any of the other sectors). The odd features we see seem to be associated with hits on tracks whereas each pad seems to see approximately the same amount of charge and so the raw hit pattern appears, to the naked eye, to be uniform across the row but does have a radial dependence.

2008 Data: ppProduction2008/ReversedFullField/P08ie/2008/067/* (i.e. 2008 run with TPX in 16)

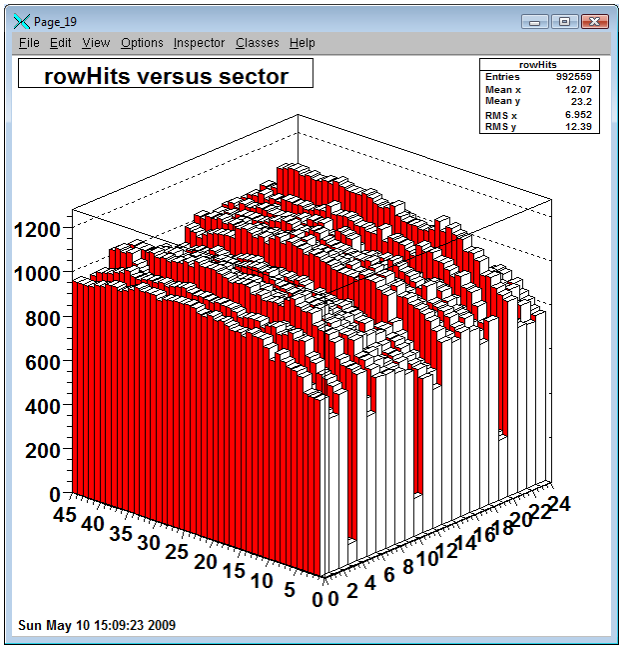


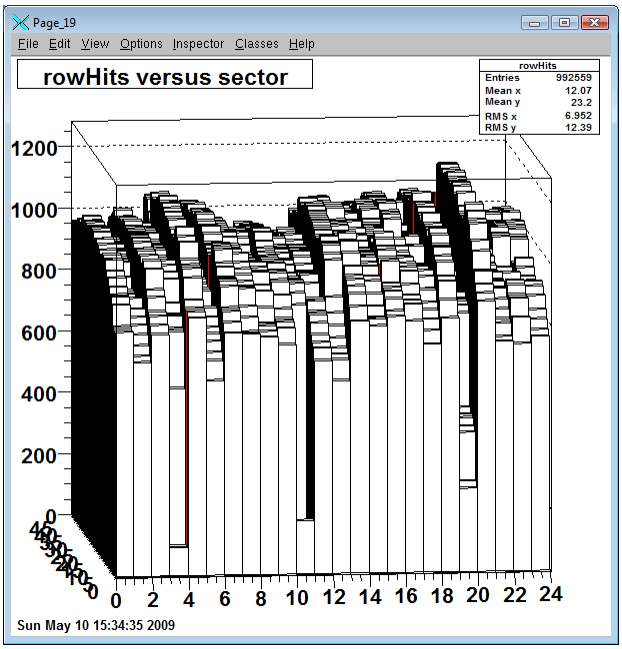


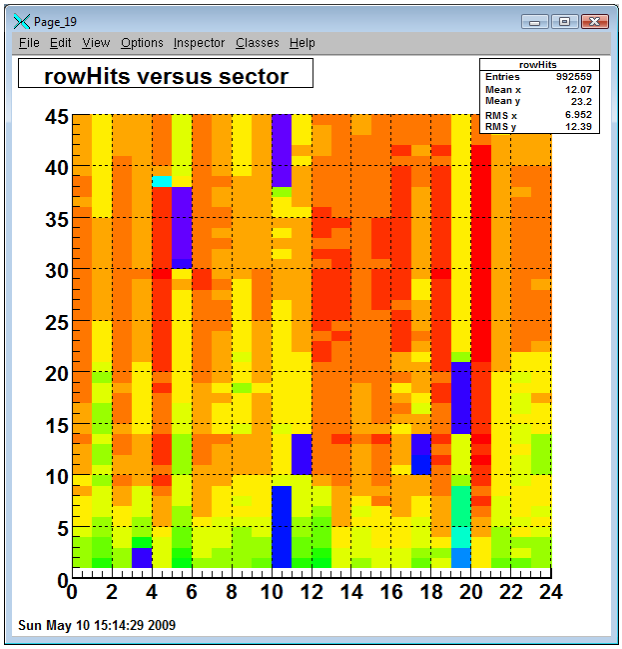


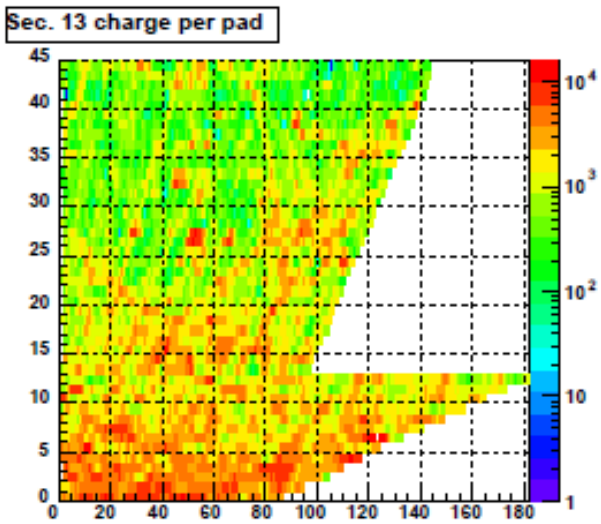


2009 Day 85: early in pp500 run, Runs 10085134 and 10085140,









2009 Day 125: pp200 data, after pp500 run, runs 10125024, 10125026, 10125027