ACD studies:

1. Light Yield Determination for top face ACD Tiles
2. Looking for holes (screws) in the ACD data

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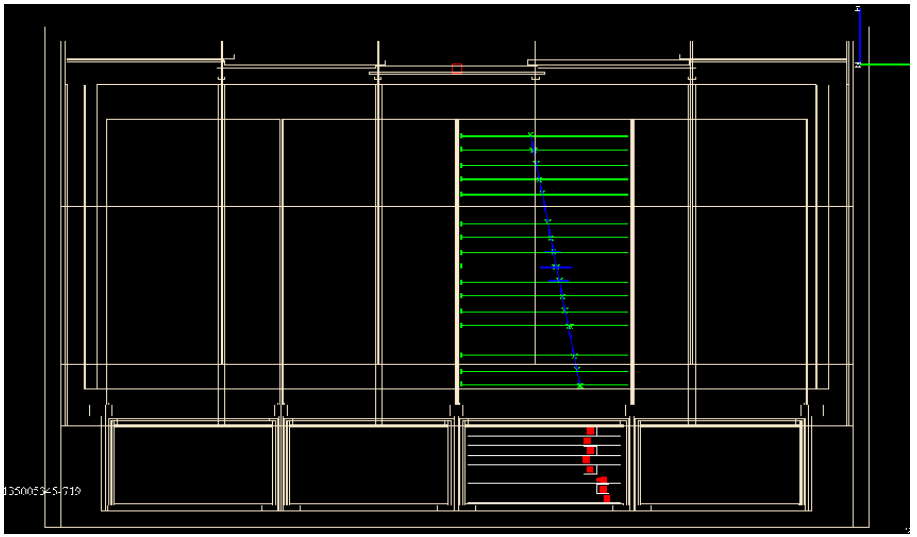
Instrument Analysis Workshop VI



February 28th, 2006

Light Yield Determination for top face ACD tiles

Procedure Outline:

- Obtain very clean muon sample -> MIP cuts
- Select relevant events for LY determination per every channel
- Calculate efficiency as a function of threshold and fit assuming a poisson distribution for the number of photoelectrons.

Data used:

- B2 and B30 runs -> ~37.4 M triggers
- digi v3r4p6, recon v3r4p6, svac v3r4p7
- Considered to use B2 runs with Muon Kalman hypothesis, but that wouldn't provide enough statistics

MIP Selection Cuts

- Tkr trigger is present, Tkr opens the trigger window "(GemConditionsWord&2)&&GemCondArrivalTimeTkr==0"
- Only one track "TkrNumTracks==1"
- Only one MIP found in CAL "CalMipNum==1"
- Energy deposition in CAL consistent with MIP "abs(CalMIPRatio-1.)<0.1"
- Self-veto gammas by using Tkr hits "Tkr1SSDVeto==0"
- Small χ^2 for the track "log10(Tkr1Chisq)<0"
- ~5.3 M (~15%) events left after cuts. These are the high confidence tracks that we can use to study the efficiency of the tiles.

Channel-Specific Cuts

- Select events where the only track intersects only the tile under consideration "AcdNumTkrIntSec==1&&AcdTkrIntSecTileId[0]==TILE"

- Stick to events "close" to normal incidence by restricting the max path length across the tile "AcdTkrIntSecPathLengthInTile[0]< 10(12) + 2."

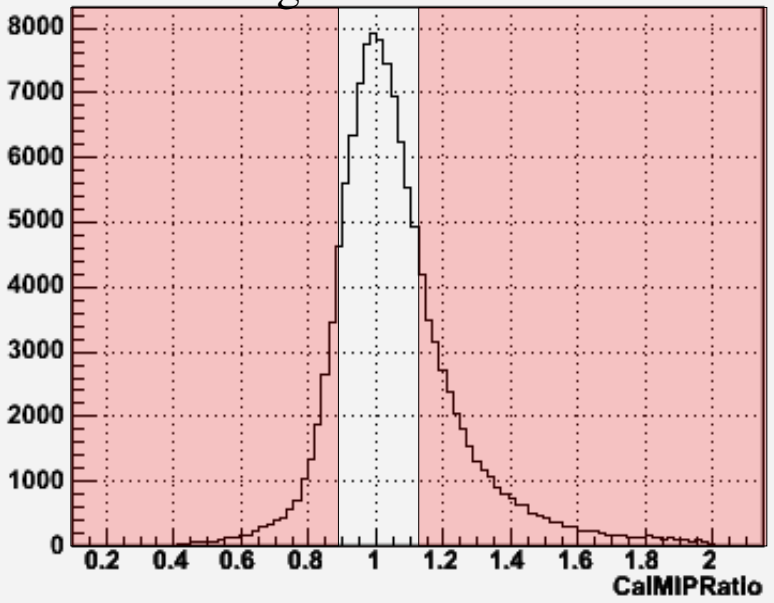
- Stay away from the edges (we are considering tiles in the top face only): "abs(AcdTkrIntSecLocalX[0])<100&&abs(AcdTkrIntSecLocalY[0])<100"

- Cut out events with large error in the point of intersection "log10(AcdTkrIntSecLocalXXCov[0])<1.&&log10(AcdTkrIntSecLocalYYCov[1])<1."

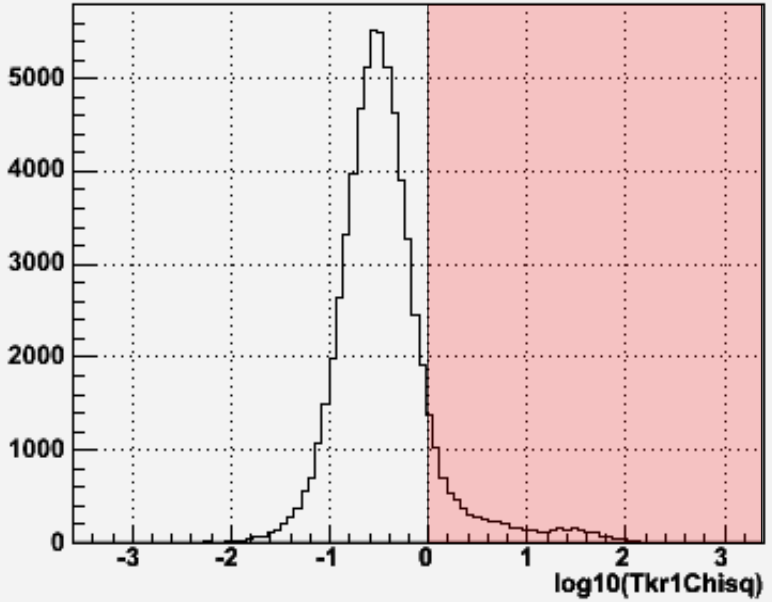
- Only allow events with normal range (range = 0) "AcdRange[TILE][PMT]<1"

Some of the cuts graphically...

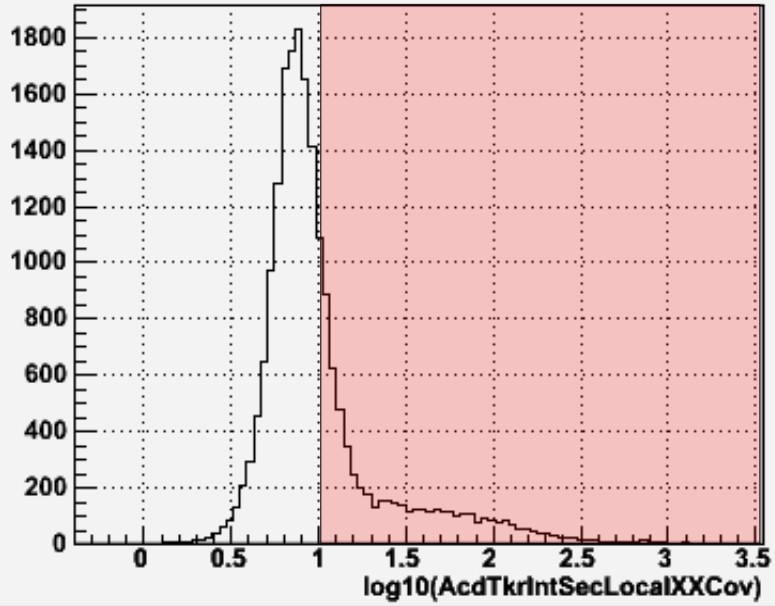
After TkrTrig+1track+Tkr1SSDVeto==0



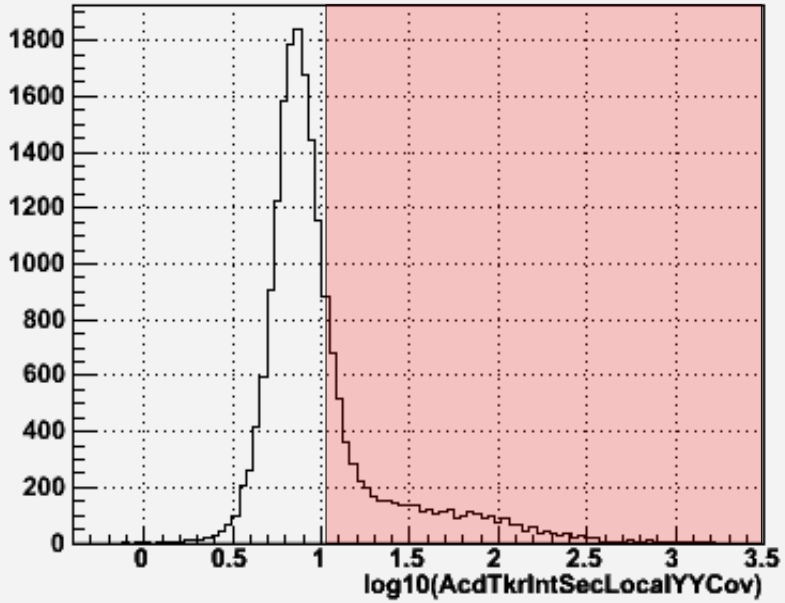
After TkrTrig+1track+Tkr1SSDVeto==0
and CalMIPRatio cut



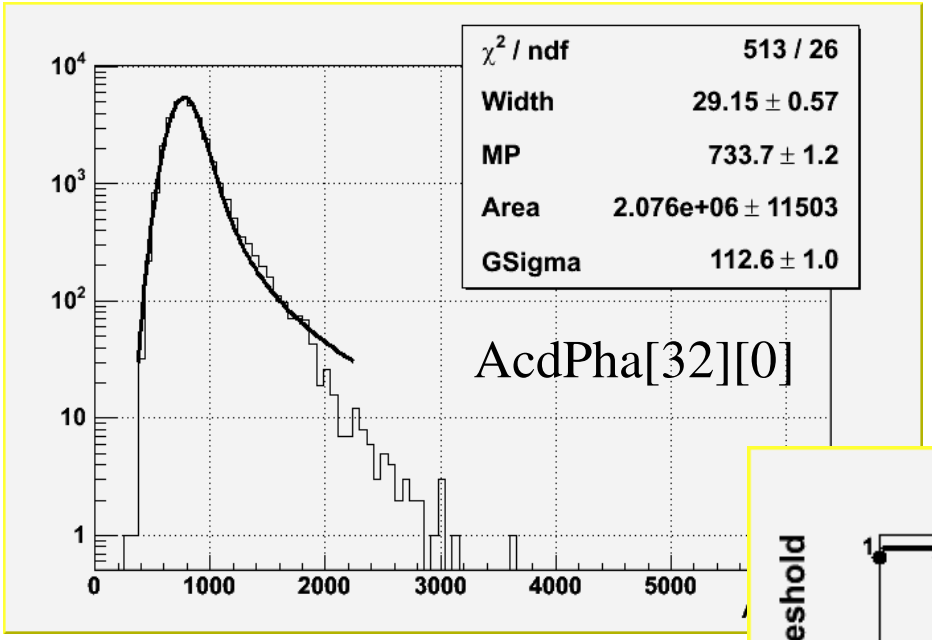
After MIP selection cuts:



After MIP selection cuts:



Efficiency as a function of threshold and number of photoelectrons determination



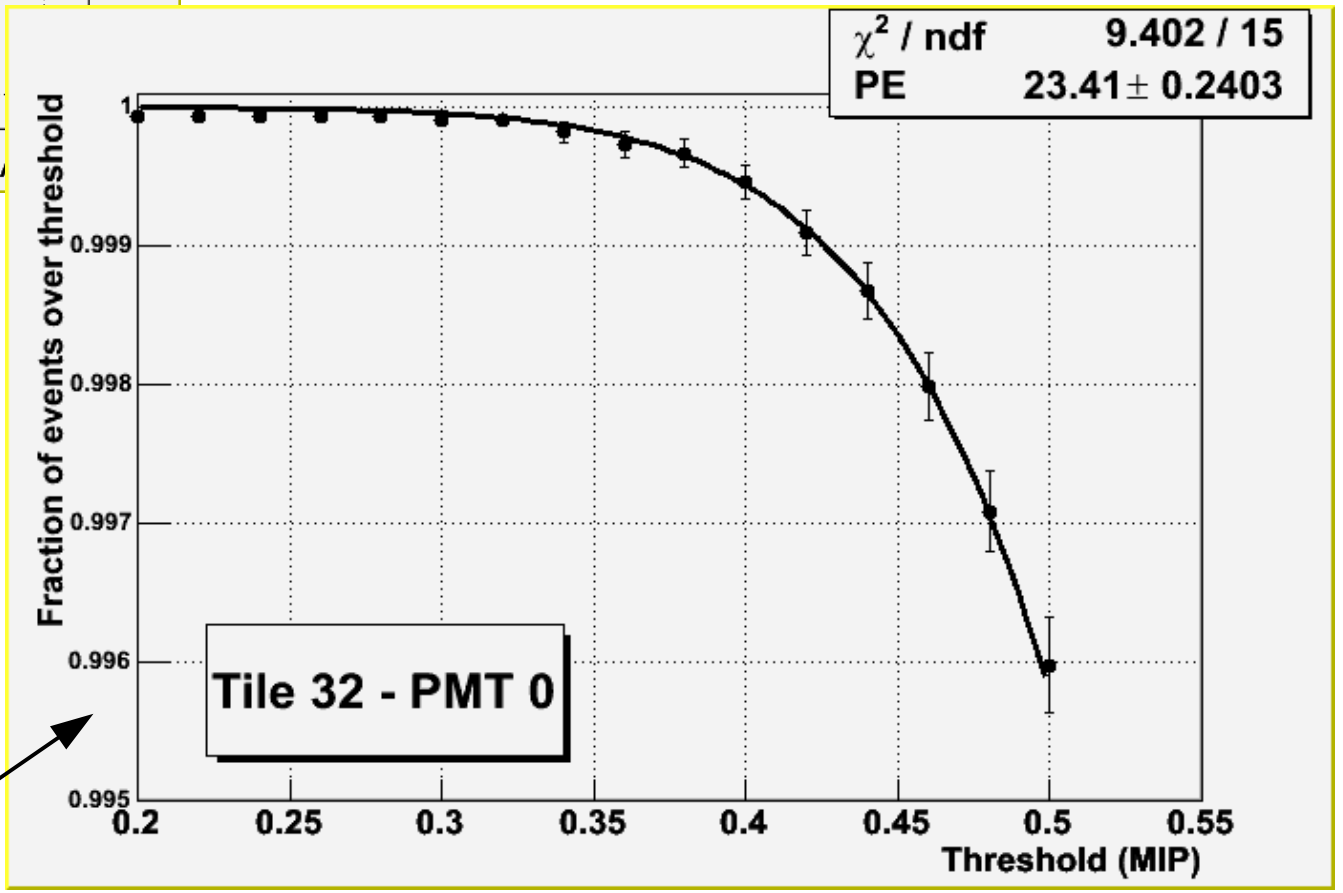
- Pulse height distributions for muon sample
- ✔Verified MIP peak positions by fitting to a landau distribution convoluted with gaussian.
- ✔For the calculation, MIP positions and pedestals from the B13 runs were used

Technique from Alex:

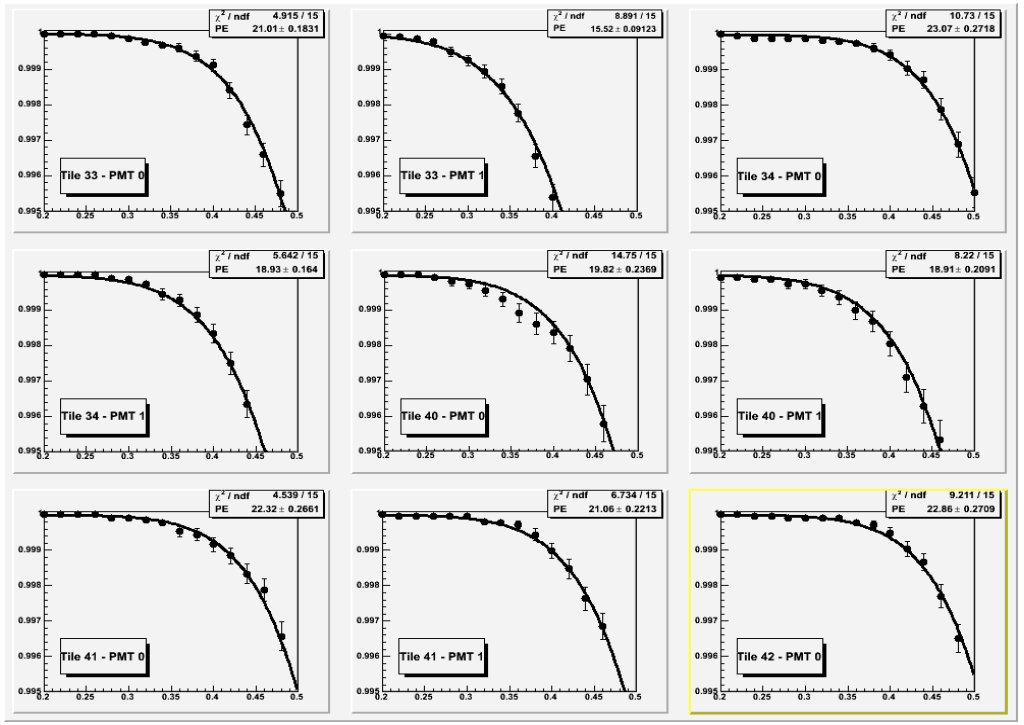
$$\text{Efficiency} = \frac{\text{Events over threshold}}{\text{Total Number of Events}}$$

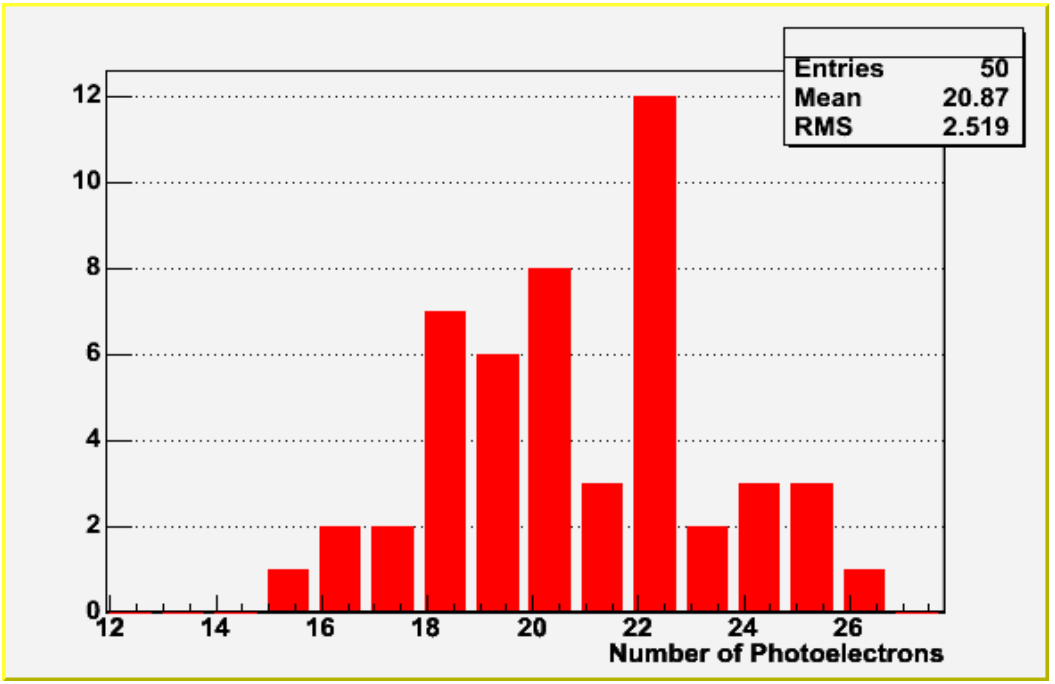
$$err = \sqrt{\frac{eff\,(1-eff)}{N}}$$

- ✔ From the fit we obtain the mean number of photoelectrons (mean value of the Poisson distribution)



Light yield for top face ACD tiles





Number of Photoelectrons:

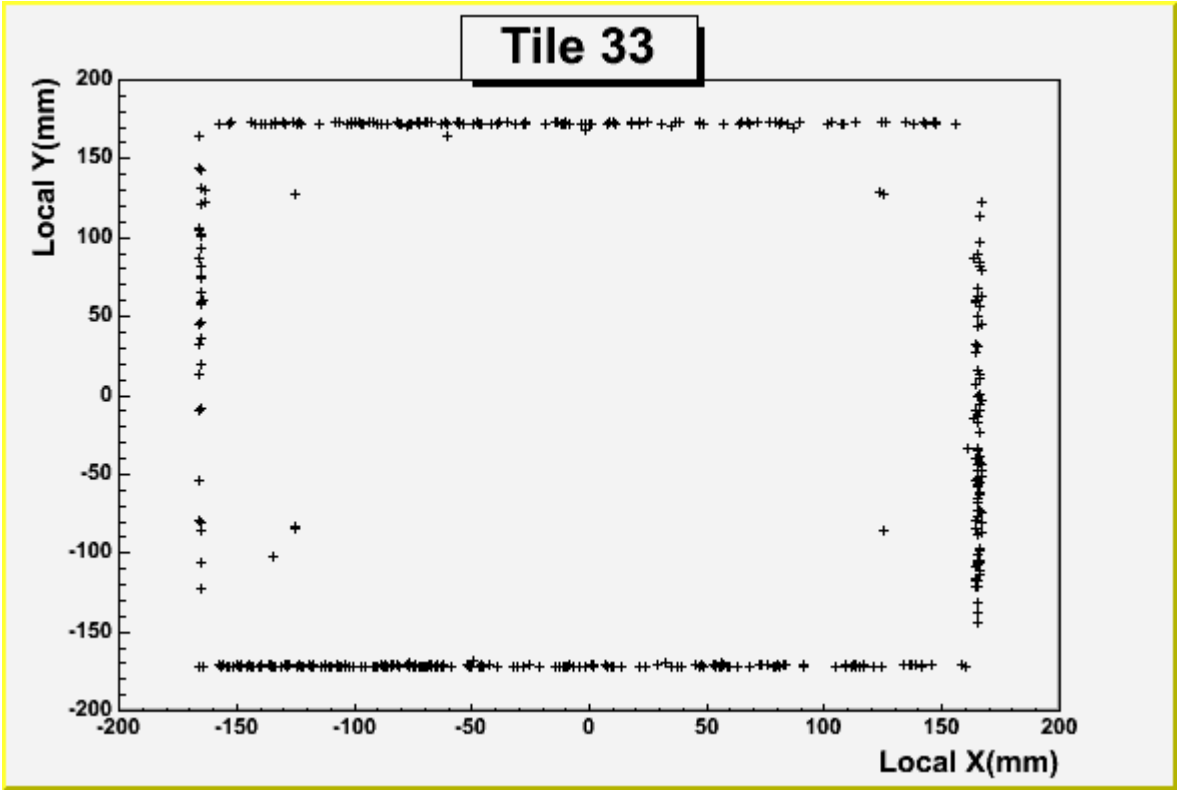
PMT A / PMT B				
19.82 18.91	22.32 21.06	22.61 17.52	20.52 18.87	21.46 16.66
18.80 19.78	18.80 18.36	23.41 22.74	21.01 15.52	22.91 18.83
23.59 24.66	25.28 22.52	22.4 22.74	26.05 25.86	25.25 24.19
17.05 20.20	19.59 18.02	24.47 22.18	20.59 20.34	20.66 22.52
22.21 19.19	21.87 20.24	22.61 19.31	19,63 20.97	18.92 22.51

Alex used these results to determine indirectly the Light Yield of the side tiles of the ACD.

Looking for holes (screws) in the ACD Data

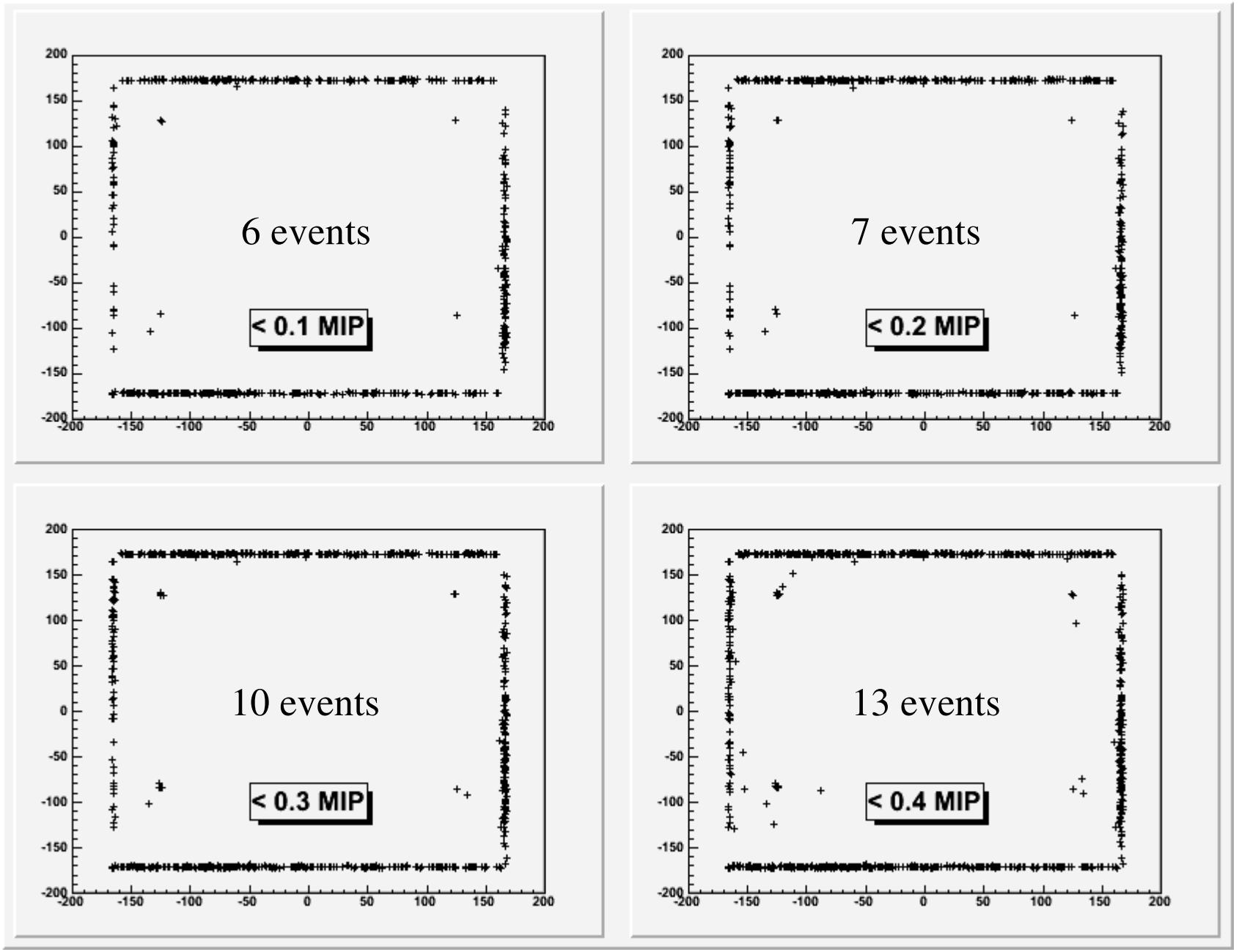
- Existence of holes (screws holding the tile) is one of the distinctive features of the ACD (not implemented in the geometry model yet)
- The very large and "pure" sample of MIPs should be useful to gather some of this information

With most of the same cuts as before but allowing events from the edges, let's plot the point of Track+Tile intersection for events with energy deposition in the tile below zero suppression:

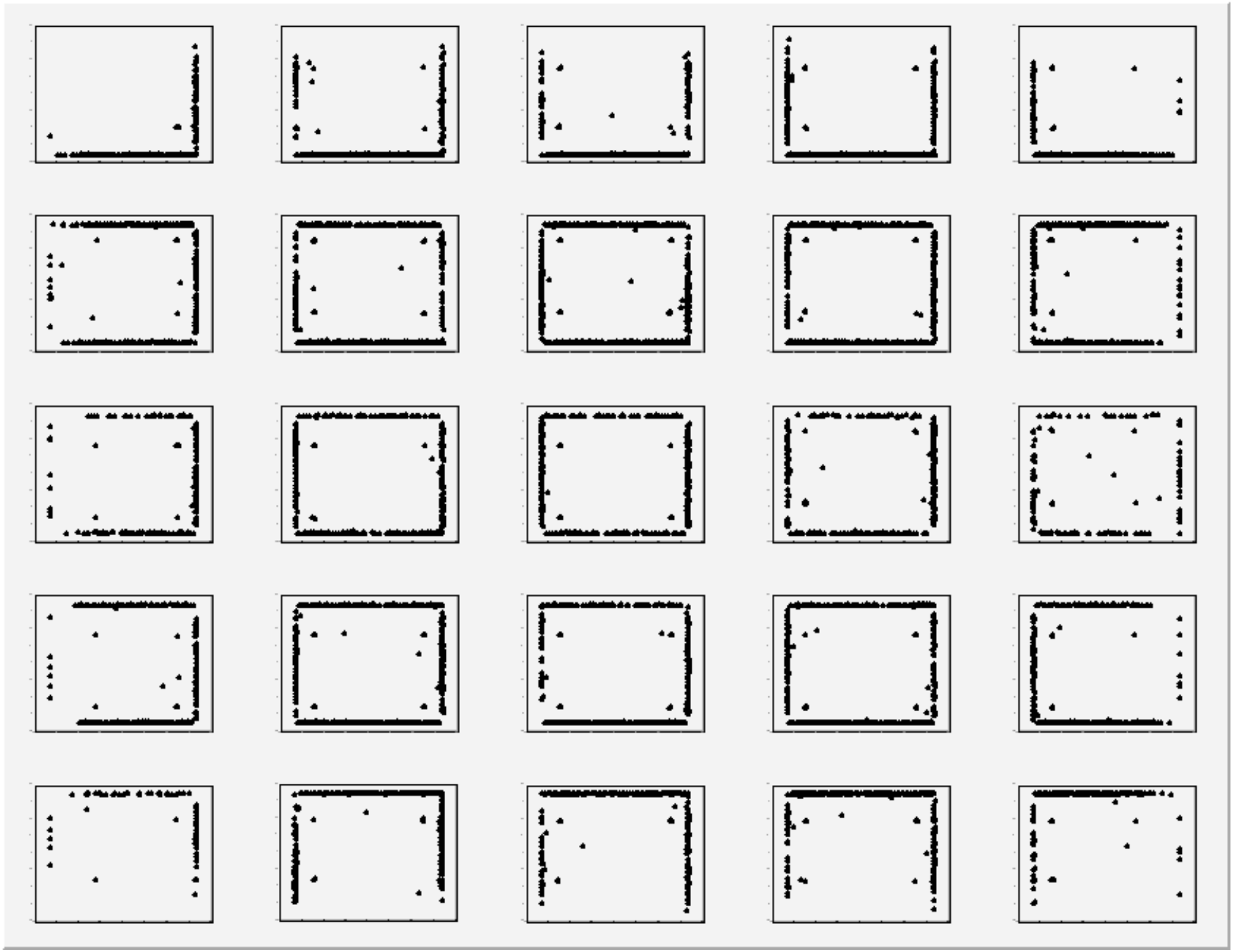


Number of hole-like events as a function of threshold

Tile 33



Holes and leaks in top ACD (threshold at 0.3MIP)



Procedure:

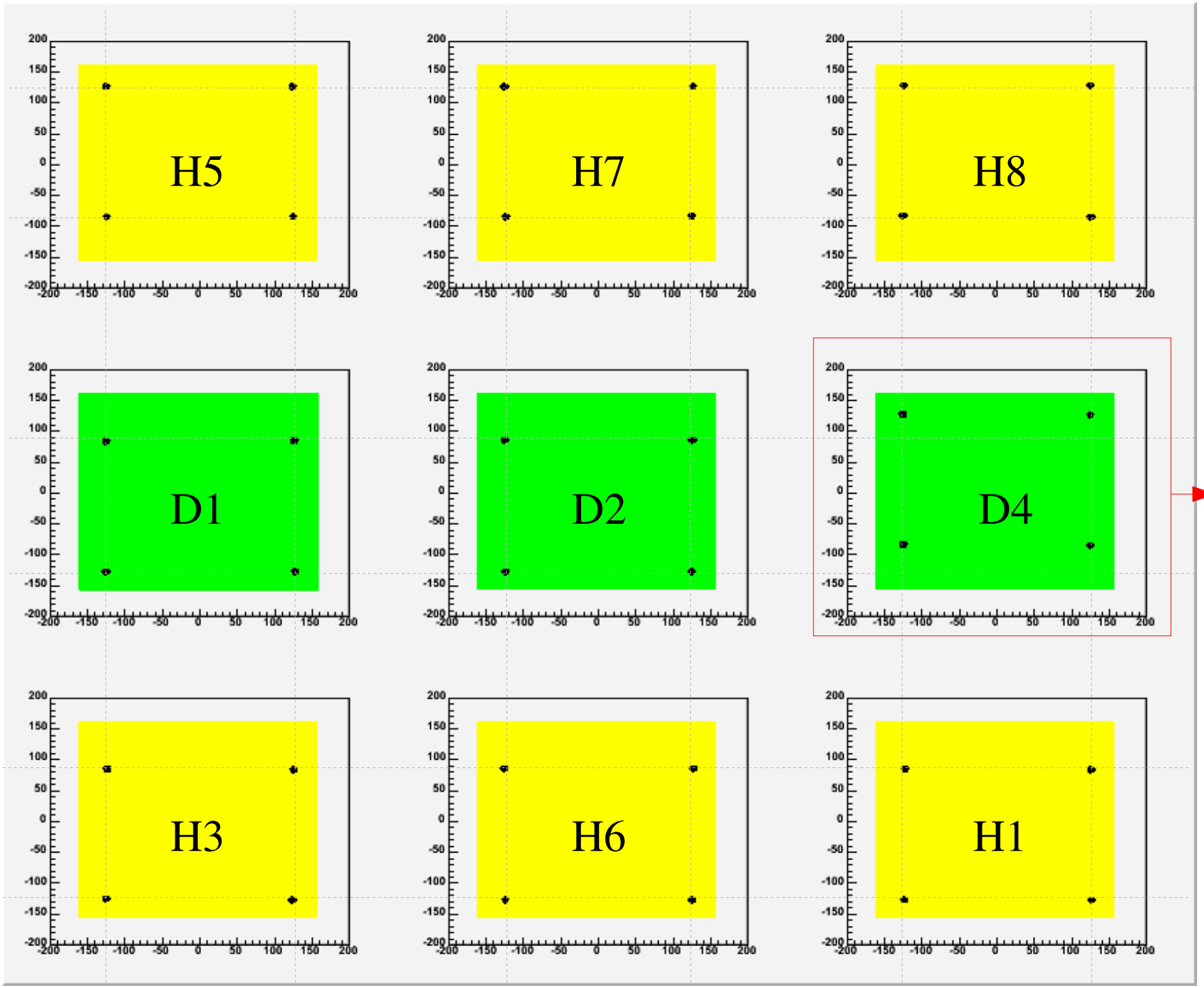
- Count number of holes in every tile as a function of the threshold (0. MIP, 0.1 MIP, 0.2 MIP, ...)
- Find the average coordinates and RMS for the hole in every corner of every tile
- Compare to what we expect from the top ACD design:

Color-coded distribution of tile types in top ACD

A1	B6	B4	B5	C3
K1	H5	H7	H8	L3
J1	D1	D2	D4	J2
L2	H3	H6	H1	K2
C1	B1	B7	B8	A3

- Holes (screws) are 3 mm in diameter
- Top ACD has symmetry with respect to the center
- Did you know that the holes are not in the same position for every tile?
- Tiles from the same type have holes in the same position, (modulus some rotation in a few occasions)

Central top ACD Tiles



~ 35mm

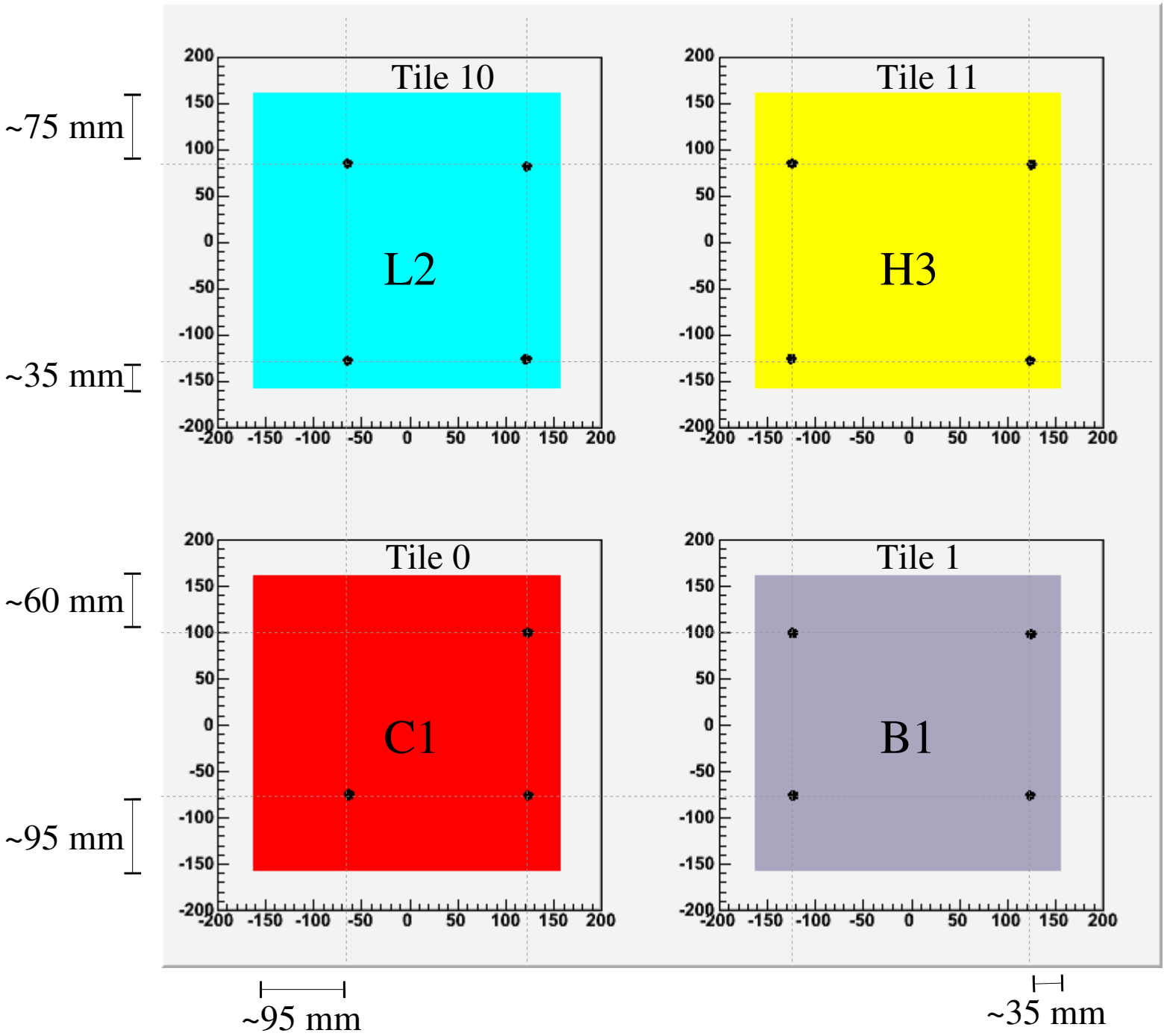
~75 mm

This tile is flipped along x axis because cables go in +y direction.

~75 mm

~ 35mm

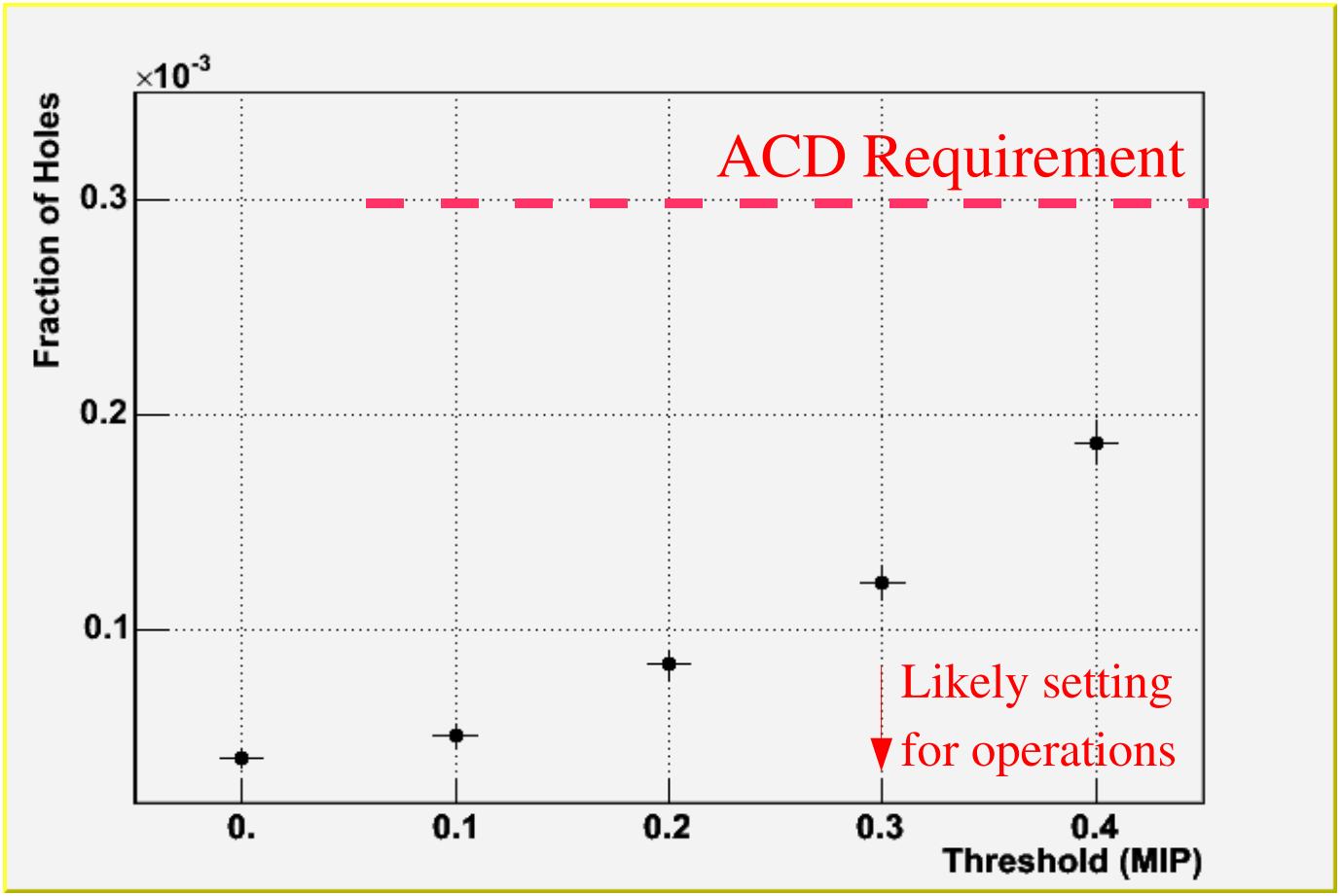
Tiles on the sides have screws farther away from the Edge:



Left Bottom Corner of top ACD

Fraction of hole-like events as a function of Threshold

Threshold	Hole-like
0. MIP	96
0.1 MIP	157
0.2 MIP	228
0.3 MIP	351
Total	1.87E+006



- Given the hole dimensions (3mm diameter x 10 mm length), a muon flux with $Cos^2\theta$ distribution would yield a fraction of ~2.6 x 10^{-5} at 0. MIP. (For an isotropic flux this contribution to inefficiency will go down)

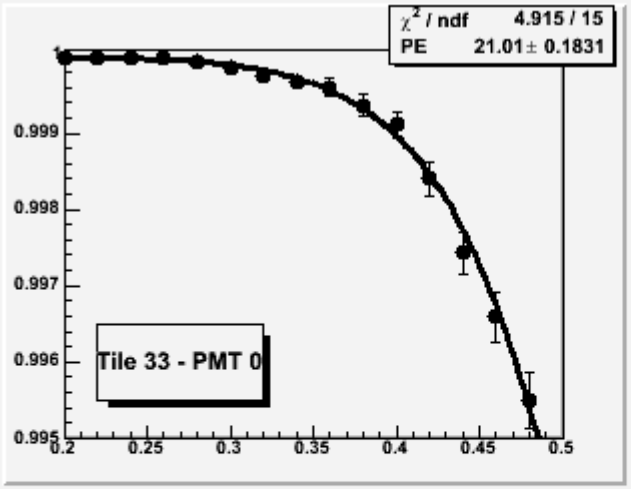
  ✔ We are in the right ballpark

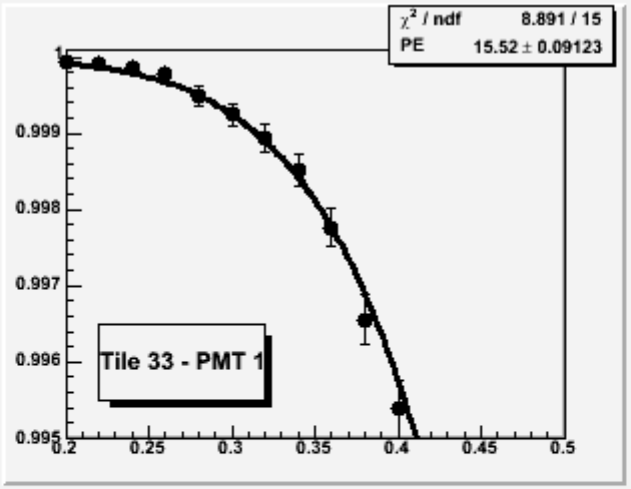
- Holes in the tiles are one of the few features that contributes to ACD inefficiency (should not take all ACD efficiency budget), these results help characterize that contribution

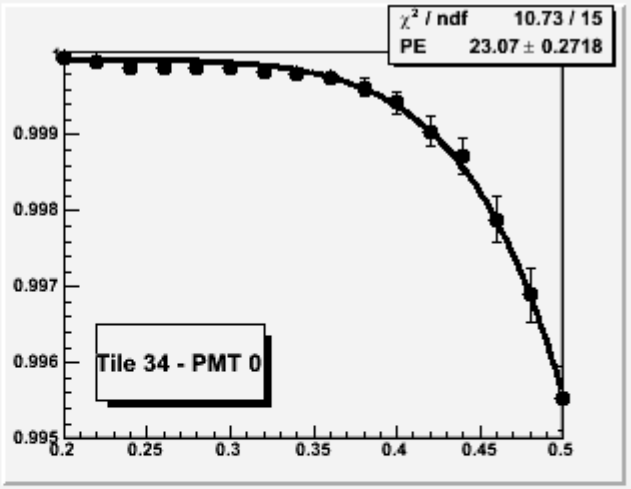
Summary

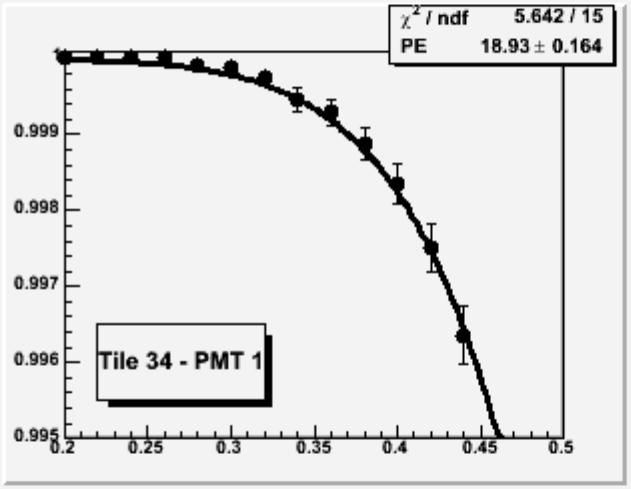
- Holes are there :)
- Their position was determined from the data
  - ➔ This could be useful input for the geometry model
- Fraction of events going through holes was calculated
  - ➔ Useful comparison to MonteCarlo once holes are modeled
- Could it be possible to use the hole positions for tile alignment studies? (comparing positions from data with positions from technical drawings) more statistics needed...., systematics?

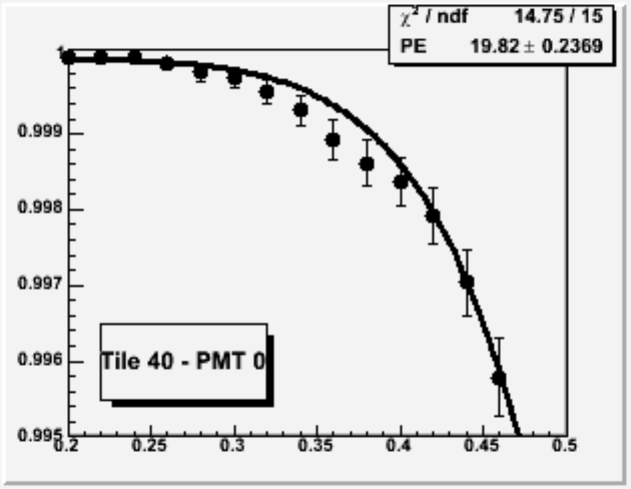
BACKUP SLIDES

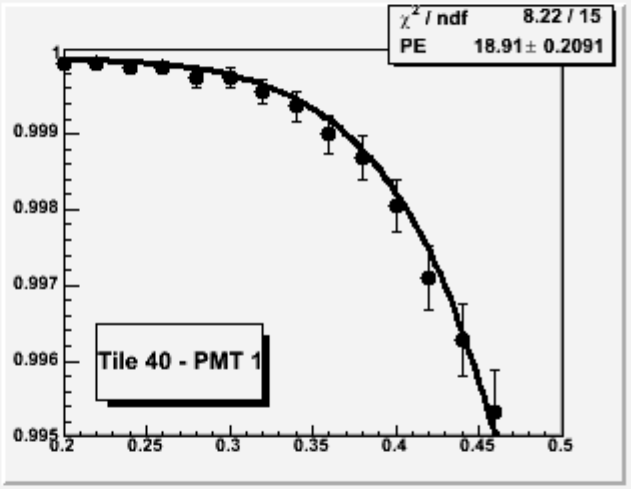

χ² / ndf 4.915 / 15
PE 21.01 ± 0.1831
Tile 33 - PMT 0

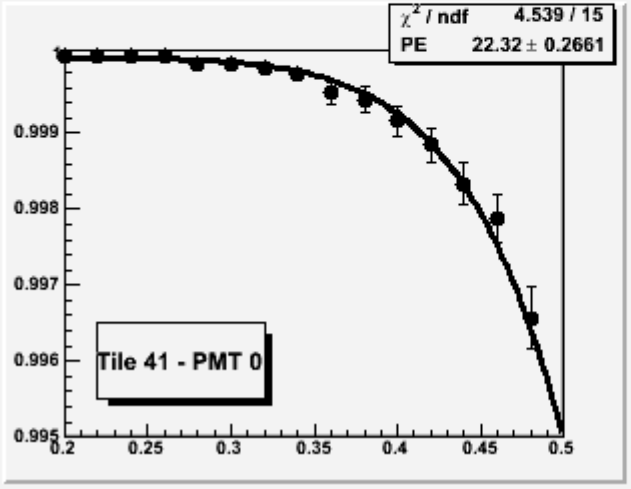

χ² / ndf 8.891 / 15
PE 15.52 ± 0.09123
Tile 33 - PMT 1

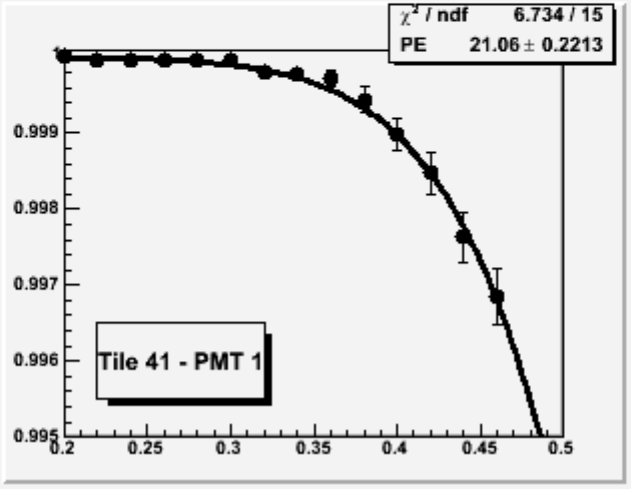

χ² / ndf 10.73 / 15
PE 23.07 ± 0.2718
Tile 34 - PMT 0

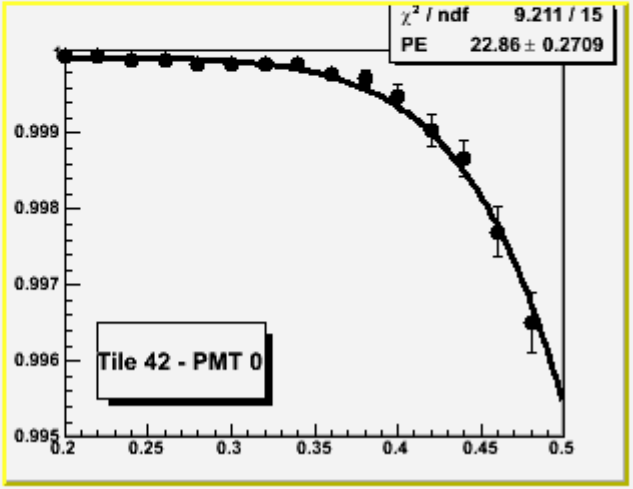

χ² / ndf 5.642 / 15
PE 18.93 ± 0.164
Tile 34 - PMT 1


χ² / ndf 14.75 / 15
PE 19.82 ± 0.2369
Tile 40 - PMT 0


χ² / ndf 8.22 / 15
PE 18.91 ± 0.2091
Tile 40 - PMT 1


χ² / ndf 4.539 / 15
PE 22.32 ± 0.2661
Tile 41 - PMT 0


χ² / ndf 6.734 / 15
PE 21.06 ± 0.2213
Tile 41 - PMT 1


χ² / ndf 9.211 / 15
PE 22.86 ± 0.2709
Tile 42 - PMT 0