Muon geometry studies

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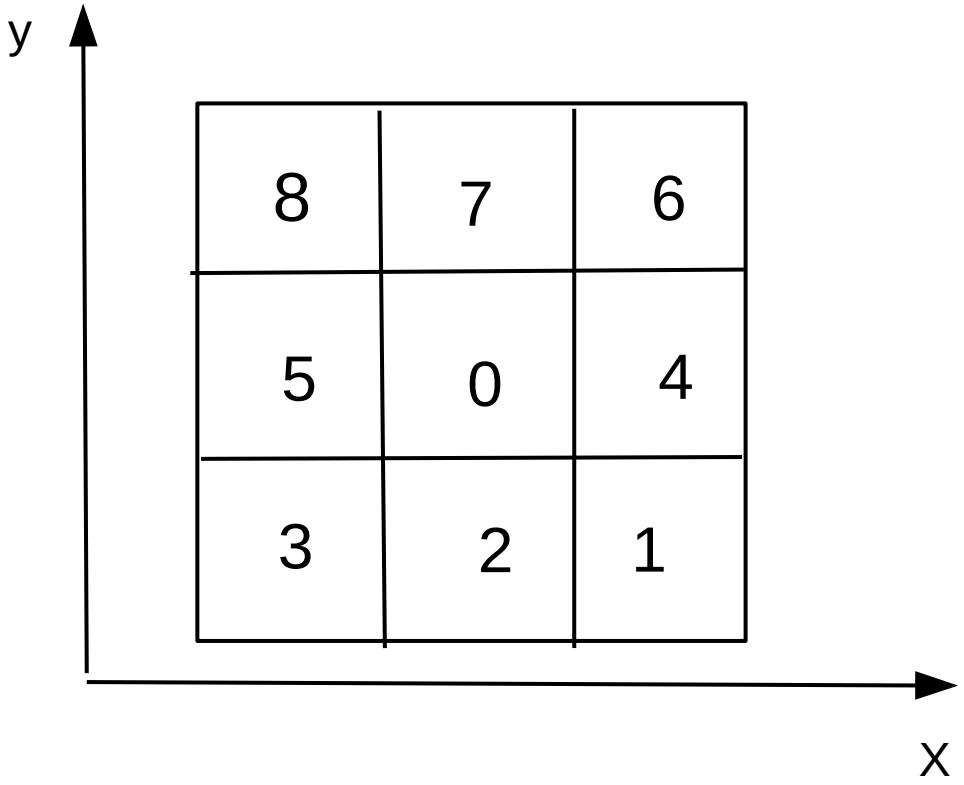
Introduction

Try to use muons to understand tb geometry, as a preliminary step to trying to use muons for SiPM equalisation

Reference frames from ntuple



Sign of x and y:
content of
XDWC2 and YDWC2
Cell numbers from
SPMTx variables

Table positions for e- energy scan Vert=2.5deg Hori=1.5deg

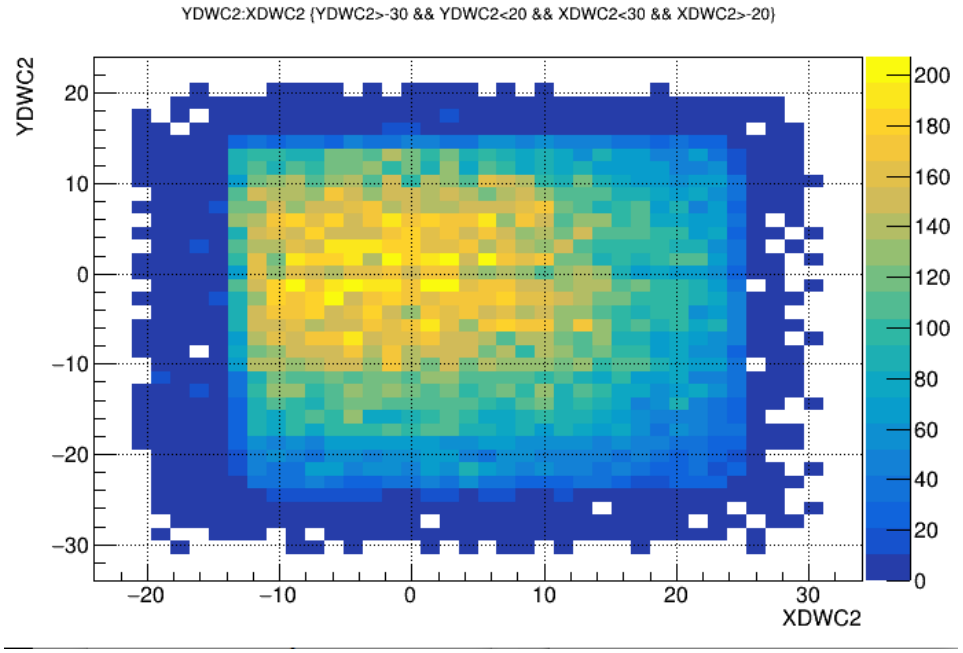
Runs 170-183 x=-4.1 y=1170

Runs 183-193 x=-4.1 y=1176

Mismatch of sign of angle and sign of x axis, already noticed by Lorenzo and Ruggero

Actual beam shape

Veto may be biasing beam shape: look at run 183 where no veto was applied

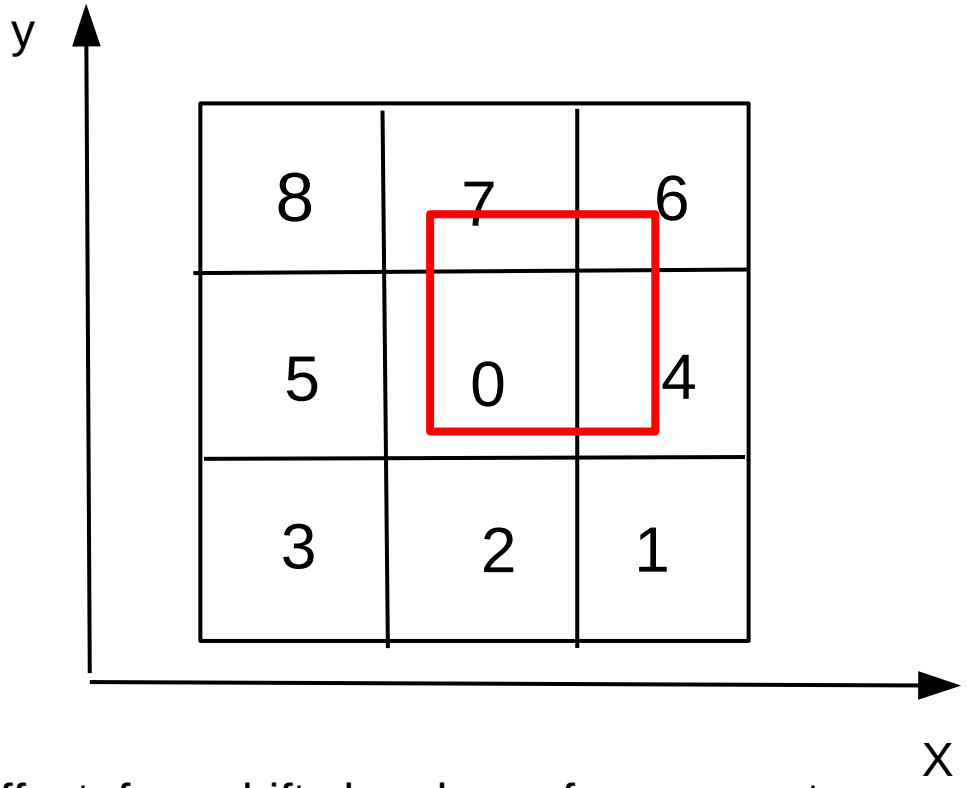


Run 183: no veto

Use chamber alignment defined in previous slides

Size of beam defined by trigger scintillators (~4x4 cm), and center of superposition of two scintillators off by ~5 mm wrt beam center

Centering with muons



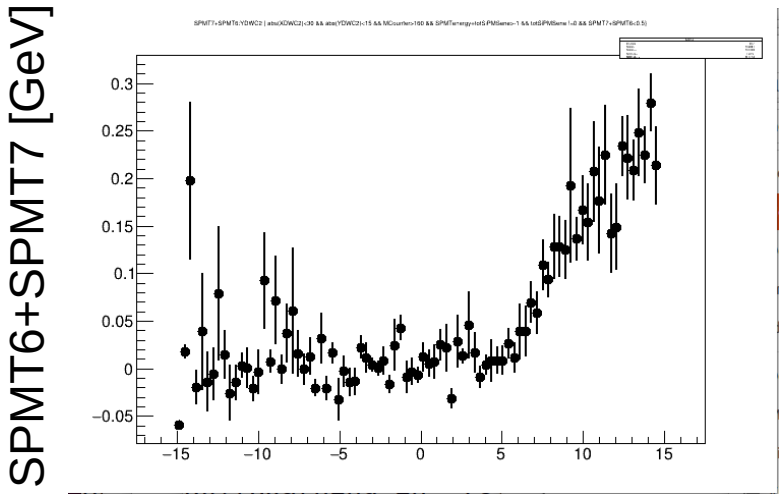
Red: beam for run 183

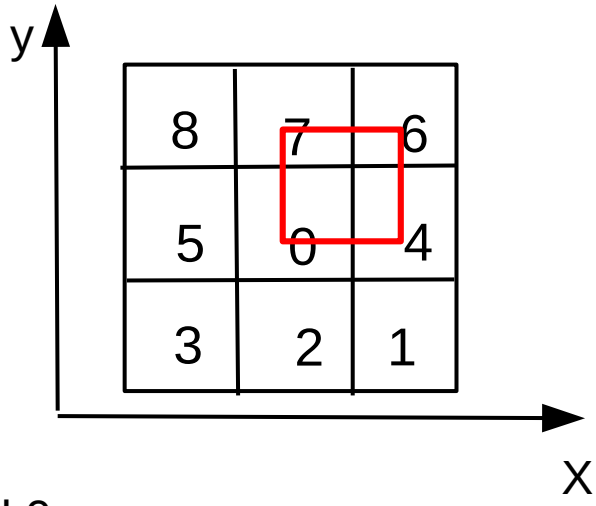
Angular orientation of beam

Find offset from drift chamber reference system and reference system with (0,0) in center of cell zero (SiPM):
Use fact that, due to angular inclination:

- If muon enters in central row, no signal is visible in upper row
- If muon enters in central column, no signal in right column

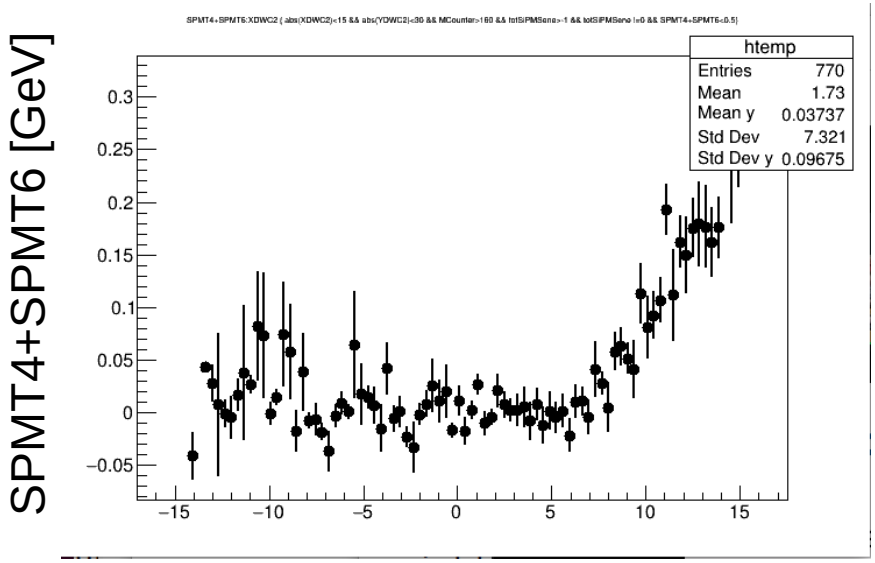
Select muons requiring MuCounter>160 counts





Upper edge cell 0:
YDWC2=5 mm uncertainty ~1mm
In cell reference system: Y= 17.5

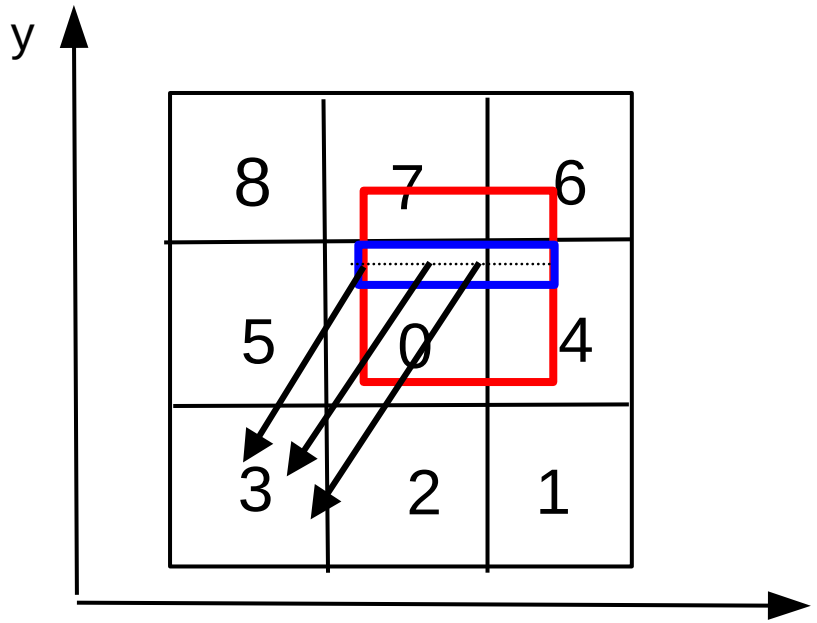
Ycalo=YDWC2+12.5

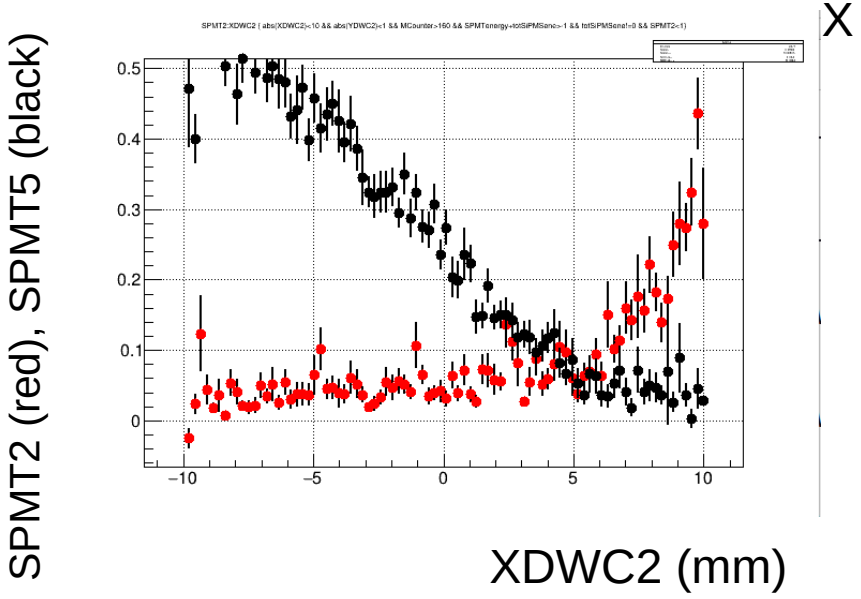


Right edge cell 0:
XDWC2=6 mm uncertainty ~1mm
In cell reference system: Y= 16.5

Xcalo=XDWC2+10.5

Angle calibration





Angle of beam in cell is

$\Delta x/\Delta y=\sin(\alpha_{oriz})/\sin(\alpha_{vert})$

→ one measures relative value of angles

Choose as narrow a bin in y as still gives some statistics (+-1mm).

Run 171: 120 GeV – hi stat

There is a position in X such that signal disappears in cell 5 and appears in cell 2, from that get angle

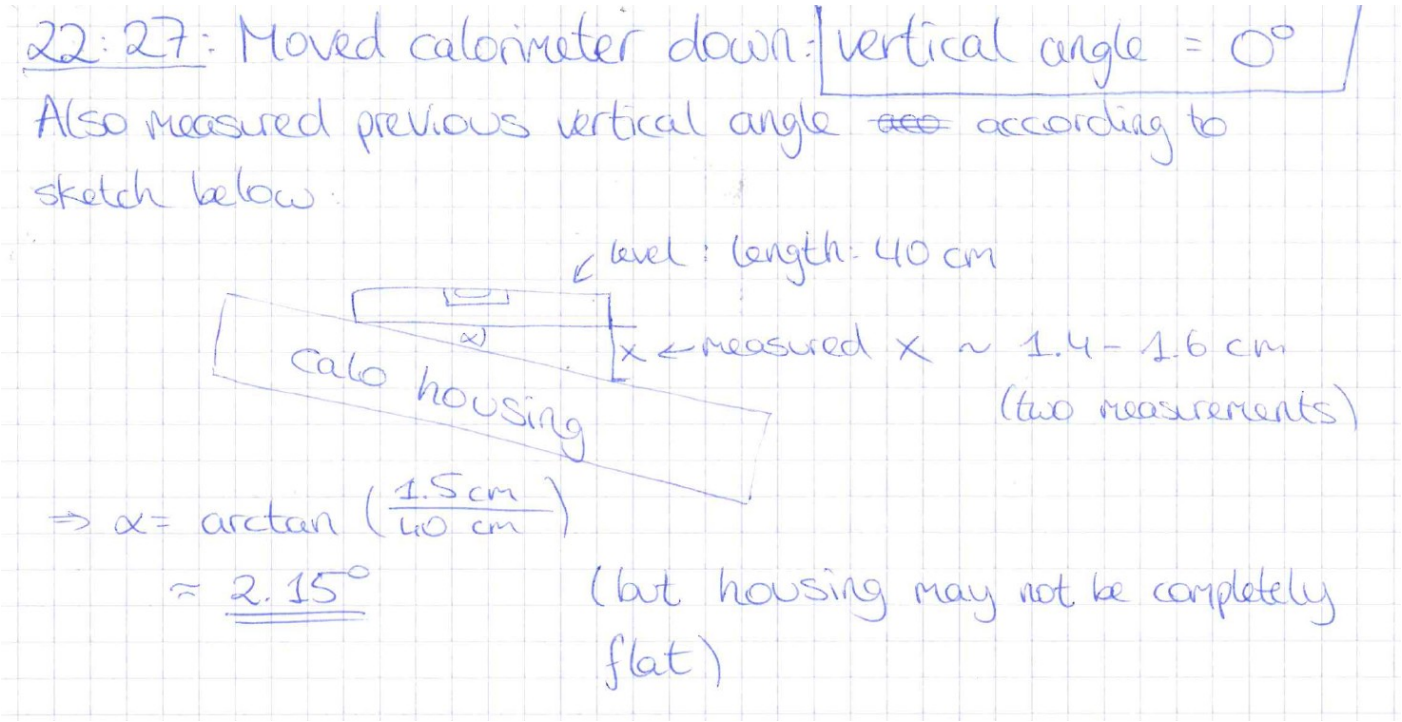
Corner position: (-16.5,-17.5) Calo (-27,-26) DWC

Beam position (5,0±1) DWC

$\Delta x=32$, $\Delta y=26(+-1)$

$\alpha_{oriz}=1.23\pm0.0.04 * \alpha_{vert}$

In absolute terms



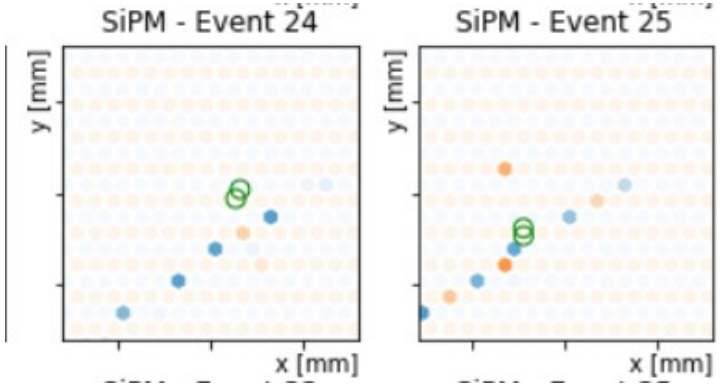
α_{horiz}=1.23*2.15˚=2.64˚

Nominal=1.5 Real=Nominal + 1 degree
Assuming only offset

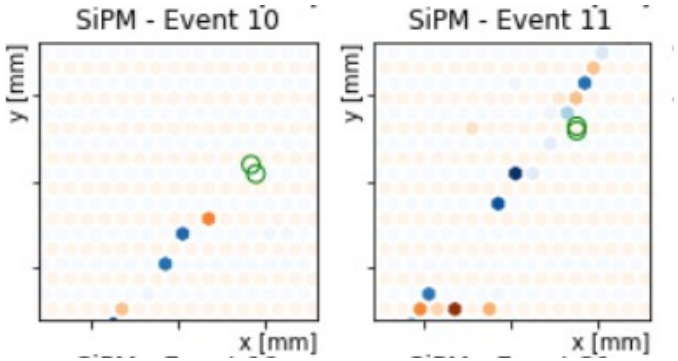
Alternative approach: use SiPM event displays

Use muon angular scan. Can fit angle event-by event, work in progress
Notice that nominal angle -1 degree is almost vertical (run 149) ,
1 degree difference probably overestimated, probably more like ~0.8

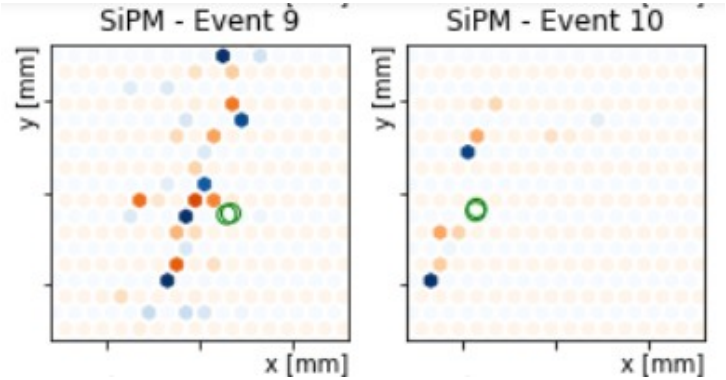
Run 136 h-angle 2.5 deg



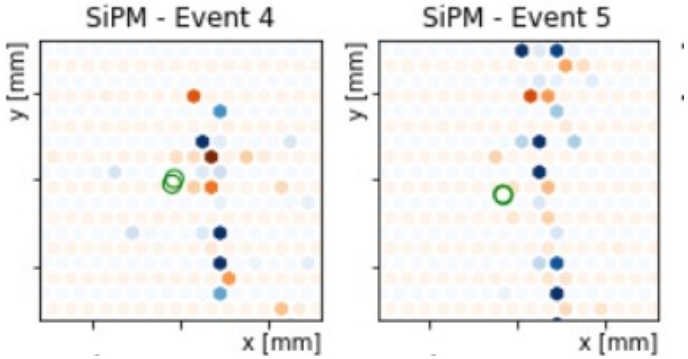
Run 146 1 deg



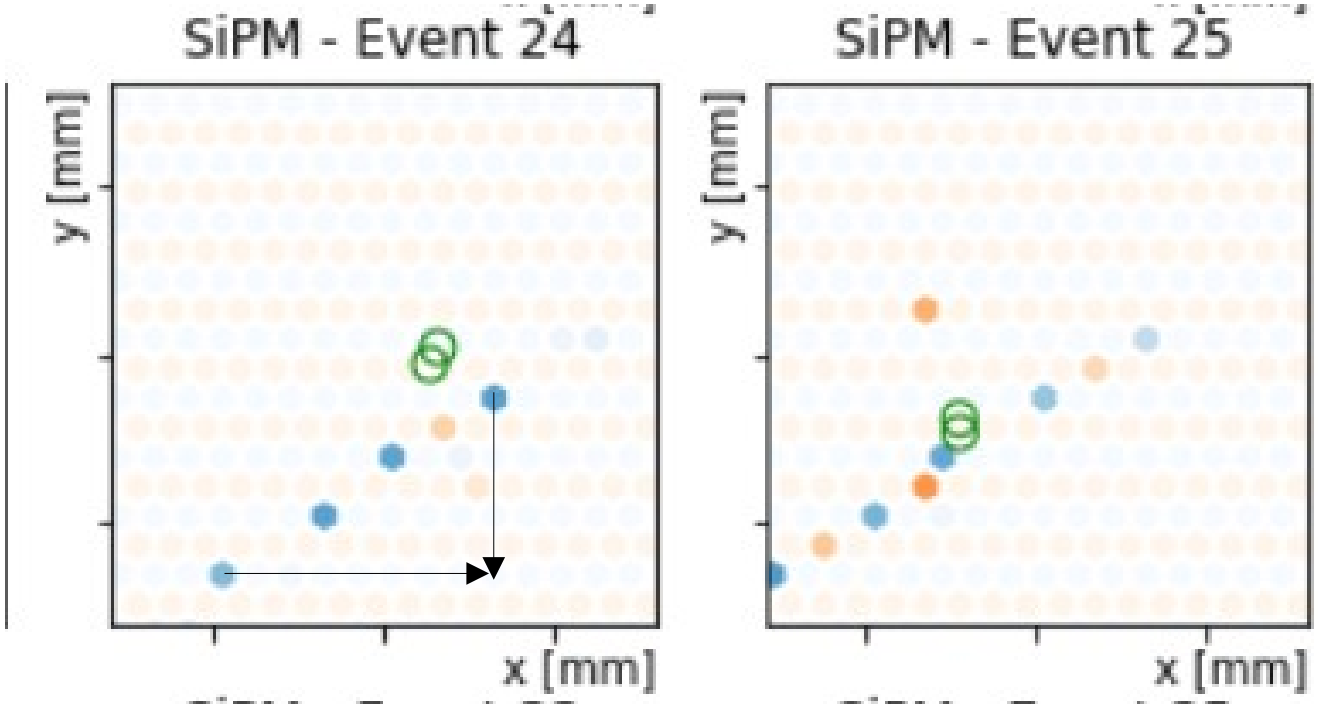
Run 145 0 deg



Run 149 -1 deg



Vertical angle fixed 2.5 deg



Run 136 h-angle 2.5 deg

Dx=8*2=16 mm
Dy=6*sqrt(3)=10.5 mm
Horiz=1.52* Vert
→ Horiz=1.5*2.15=3.3 deg

Dx=11*2=22
Dy=8*sqrt(3)=13.9
Horiz=3.4*2.15=3.4 deg

True-Nominal=0.8±1(?) degrees

Precision limited by inter-fiber distance, developing code for interpolating on hits
And mediating over many events

Conclusions

Progress towards calibrating angle and position of muon beam using geometry of detector

Obtained preliminary recalibration of both, more work needed to optimally use info from SiPM and increase precision on angles

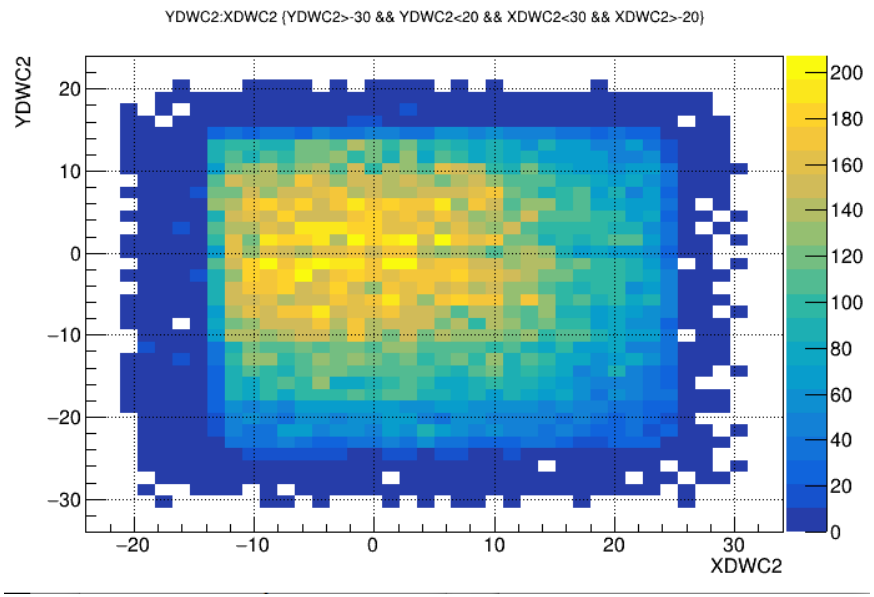
Together with a tracking program (~ready, to validate), use to predict path of each muon in a each cell from YDWC2, XDWC2 and nominal angles.

Backup

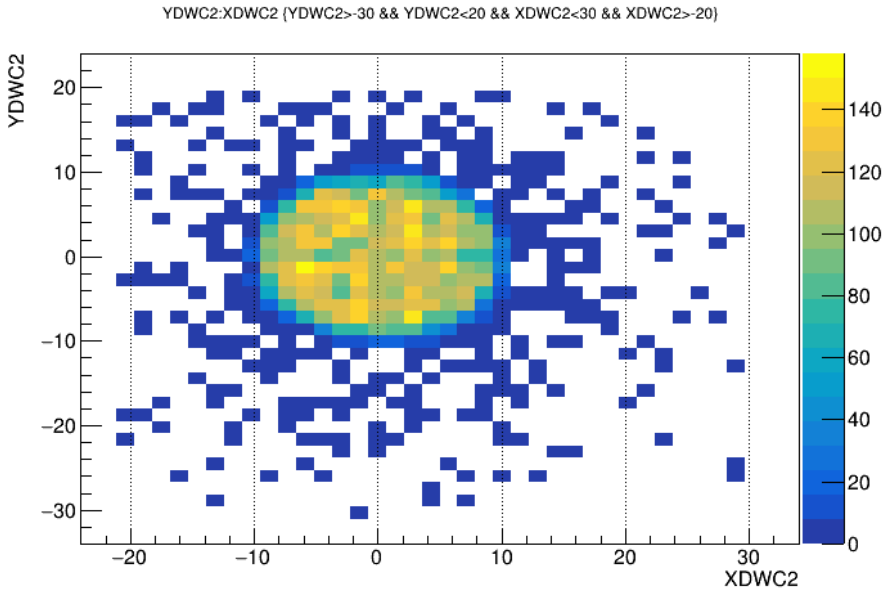
A few numbers for SiPM readout

```
ADC/Phe   ~25  HG   ~1 LG

Phe/GeV   Sci 291  C 69

ADC/GeV  7257  0.13 MeV/count Sci HG
          291  3.4  MeV/count Sci LG
         1725  0.59 MeV/count Cer HG
           69 14.   MeV/count Cer LG

Reading  triggered on FERS when>3.5 Phe
-> 88 ADC counts for at least 3 cells

Switch low/high gain: 140 Phe:

   ~0.5 GeV sci  ~3500 ADC counts
   ~2   GeV cer  ~3500 ADC counts
```

Veto position



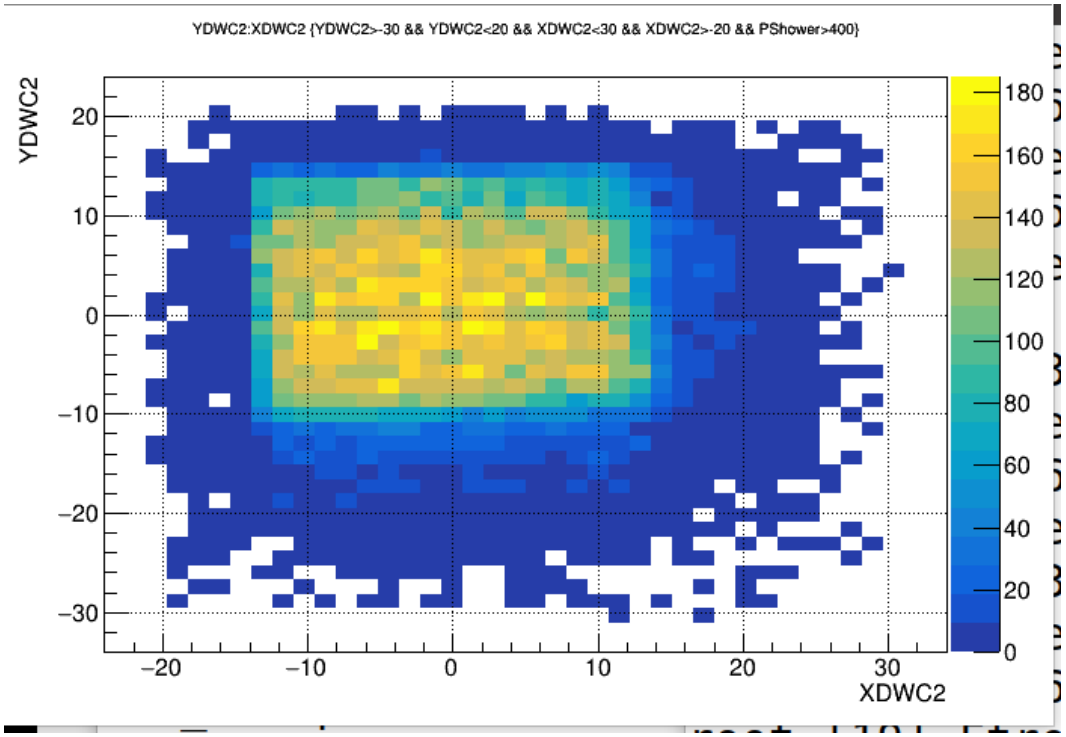
Run 183



Run 184

Veto well aligned with center of beam as well

Preshower position



Run 183

Require signal in Preshower (PShower>400)

Reasonable alignment with beam

Comments

‘Clean’ muons appear as lines in the detector

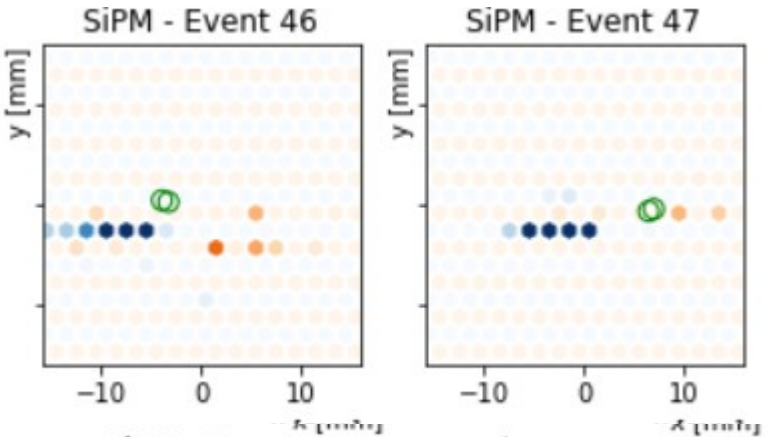
Slope of line is ratio of sines of vertical and horizontal angle

Expect vertical line for horizontal angle=0

This is not the case, angle zero seems to correspond to nominal angle of 0.5-0.8 degrees

Runs with 0 degrees vertical angle

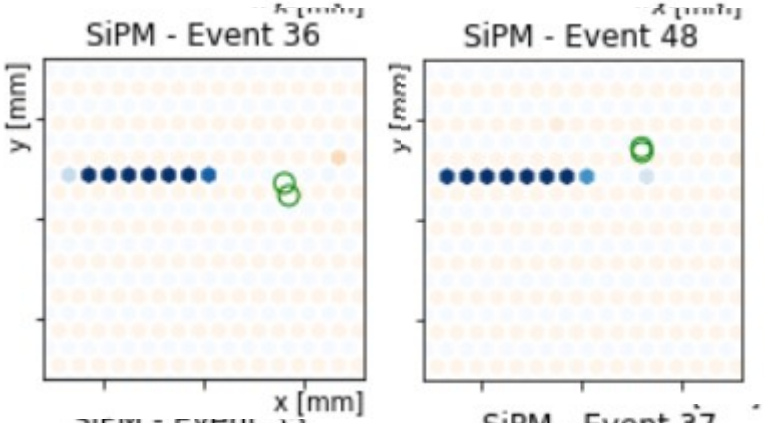
Run 229



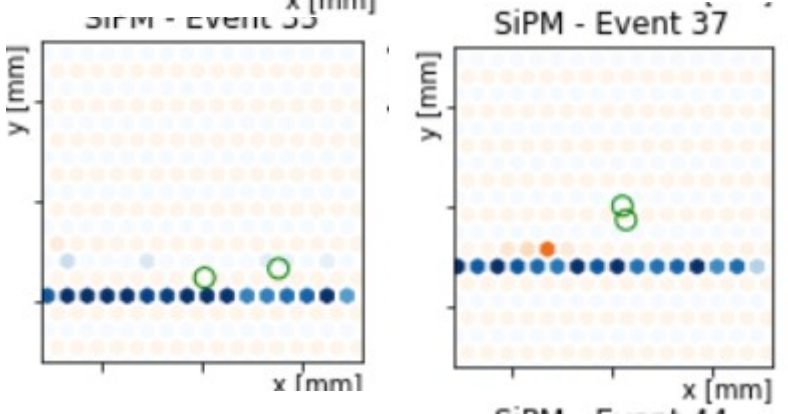
Detector looks indeed ‘in bolla’

Larger horizontal angles correspond to longer ‘lines’ in the detector

Run 202

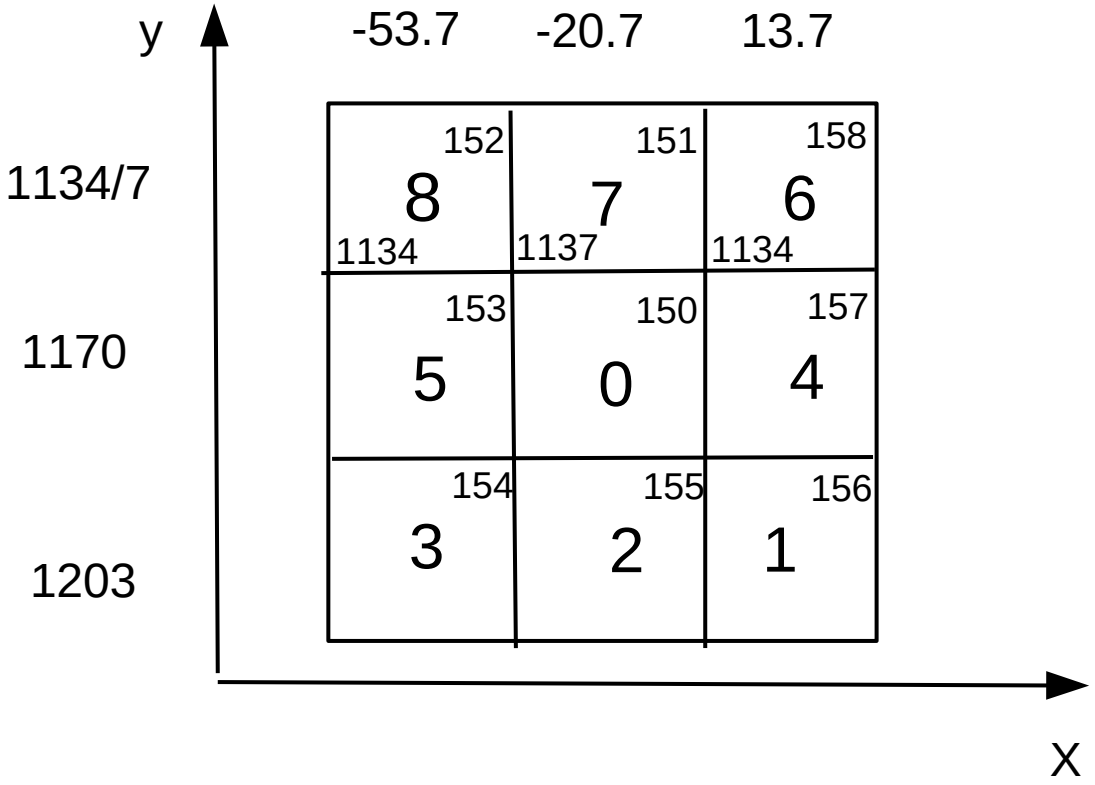


Run 225



Reference frame for analysis

View of calo from front



Tower=i

Cer=ADCs[i-1]

Sci=ADCs[i+7]

On the side: table positions for Vert=2.5deg Hori=2.5deg