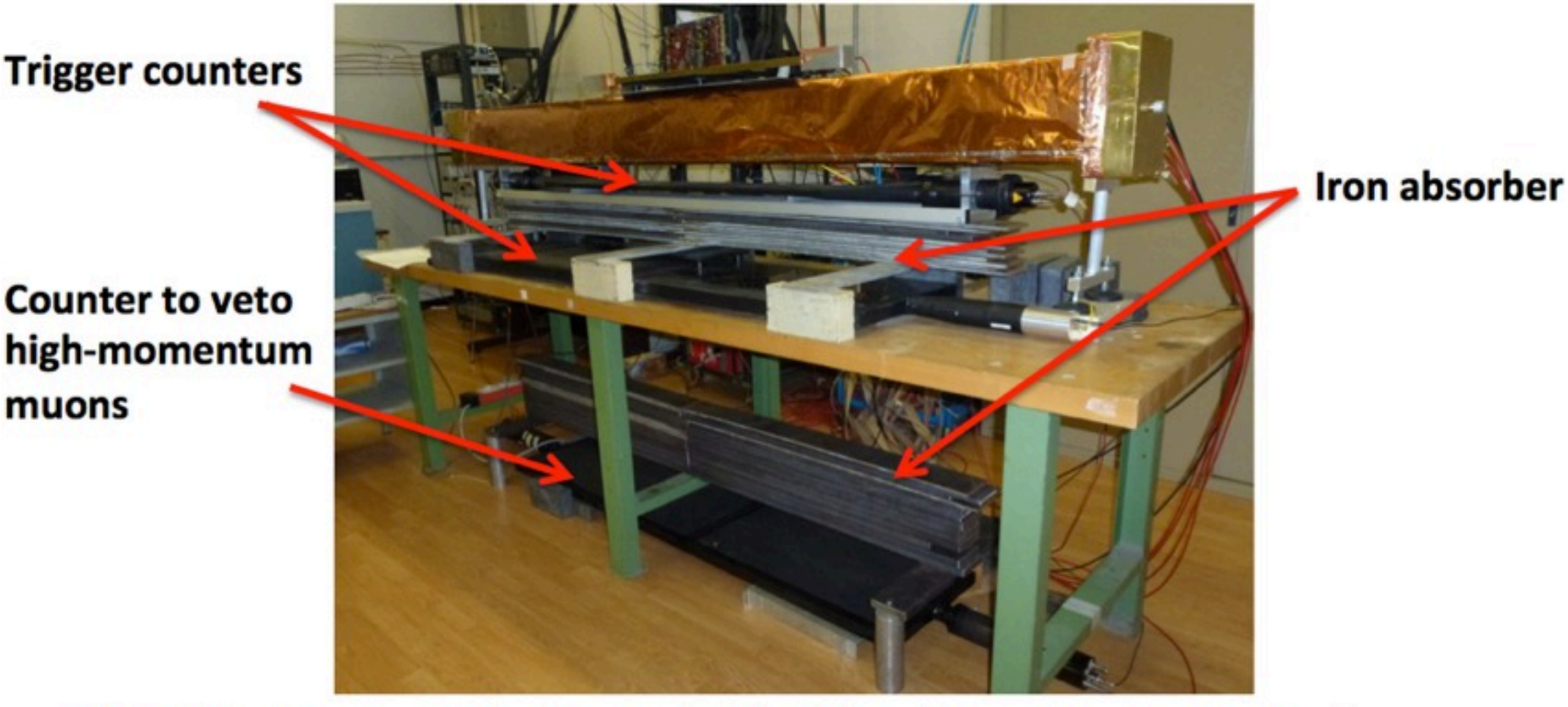
LNF Test Setup

R. de Sangro

CR Test Stand @ LNF

- The setup has been upgraded to:
  - exploit (almost) the full chamber length
  - select momentum region close to minimum ionizing cosmic muons

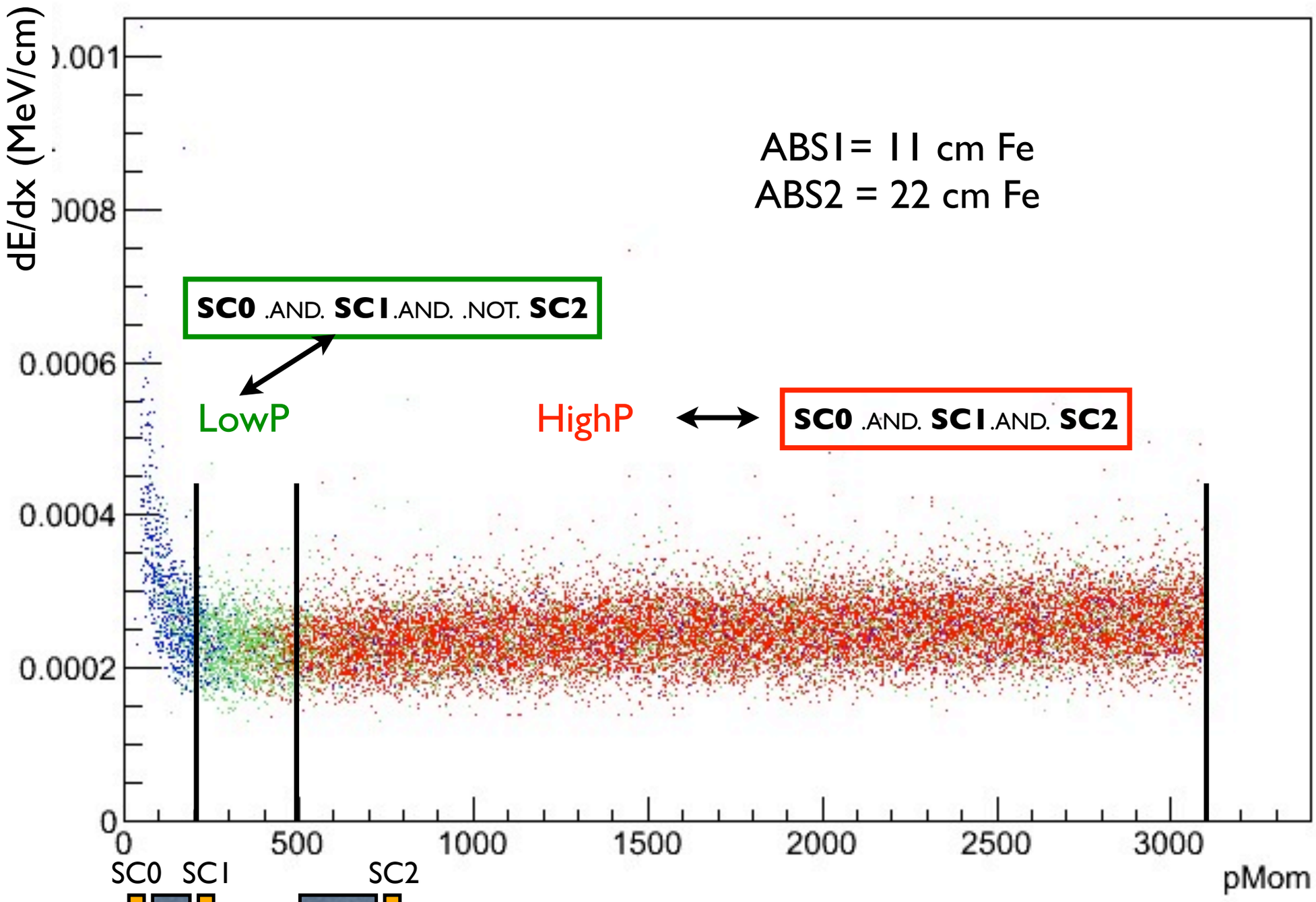


- Counters are read-out on both sides for measurement of longitudinal coordinate

Upgrade Goals

1. Increase trigger rate
2. Obtain a measurement of the *sensitivity* of the cluster counting technique
   - Measure the separation of dN_{cl}/dx for momentum selected samples
     - "highP" p>=500 MeV/c → "high" dE/dx
     - "lowP" p<500 MeV/c →"low" dE/dx
   - "nice to be able to do that even without a test beam"

Energy Loss



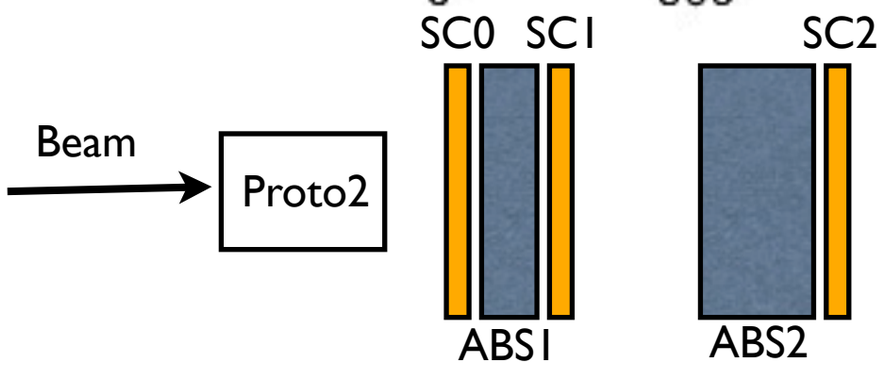
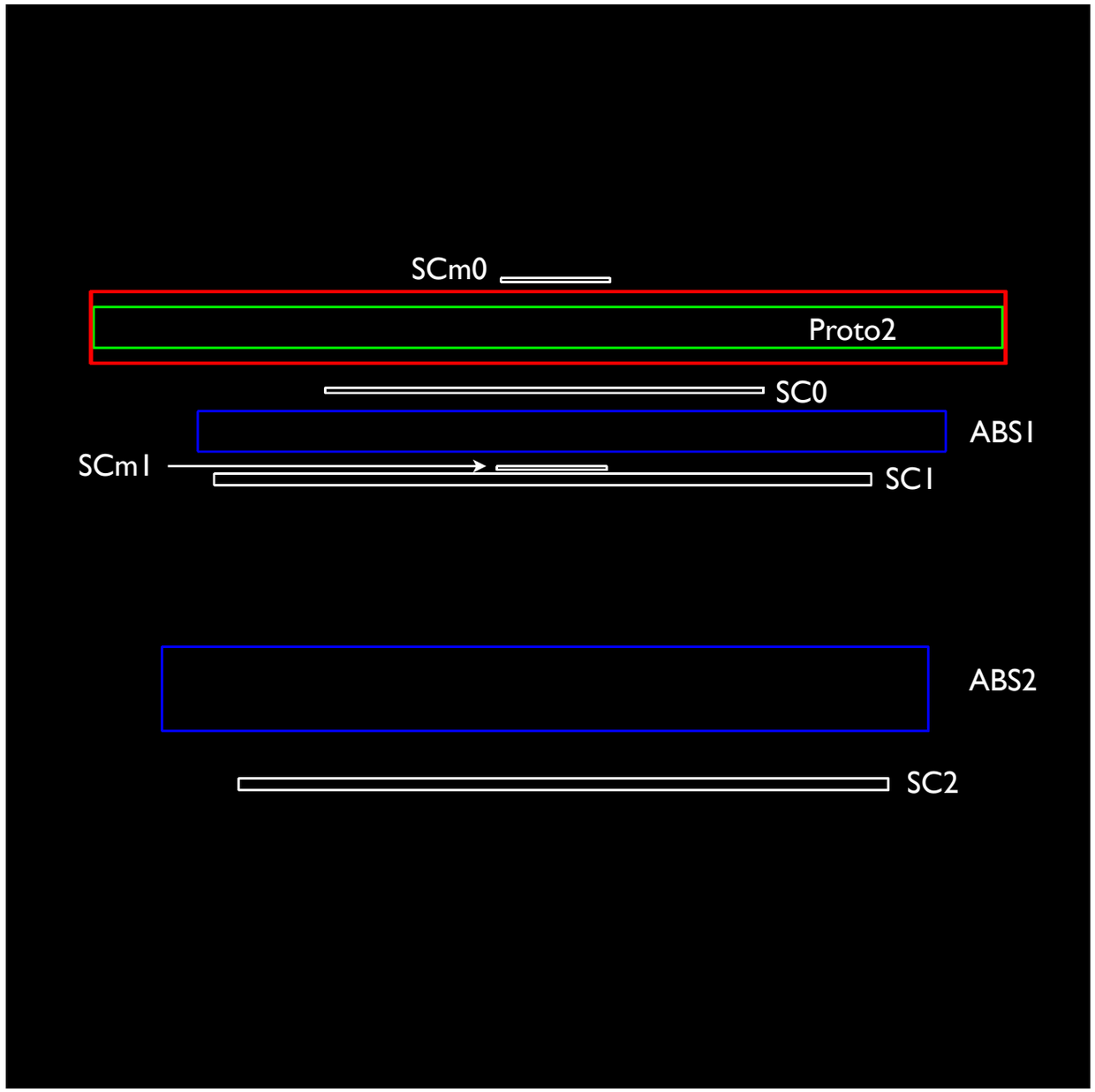


Illustration Only
Flat momentum spectrum

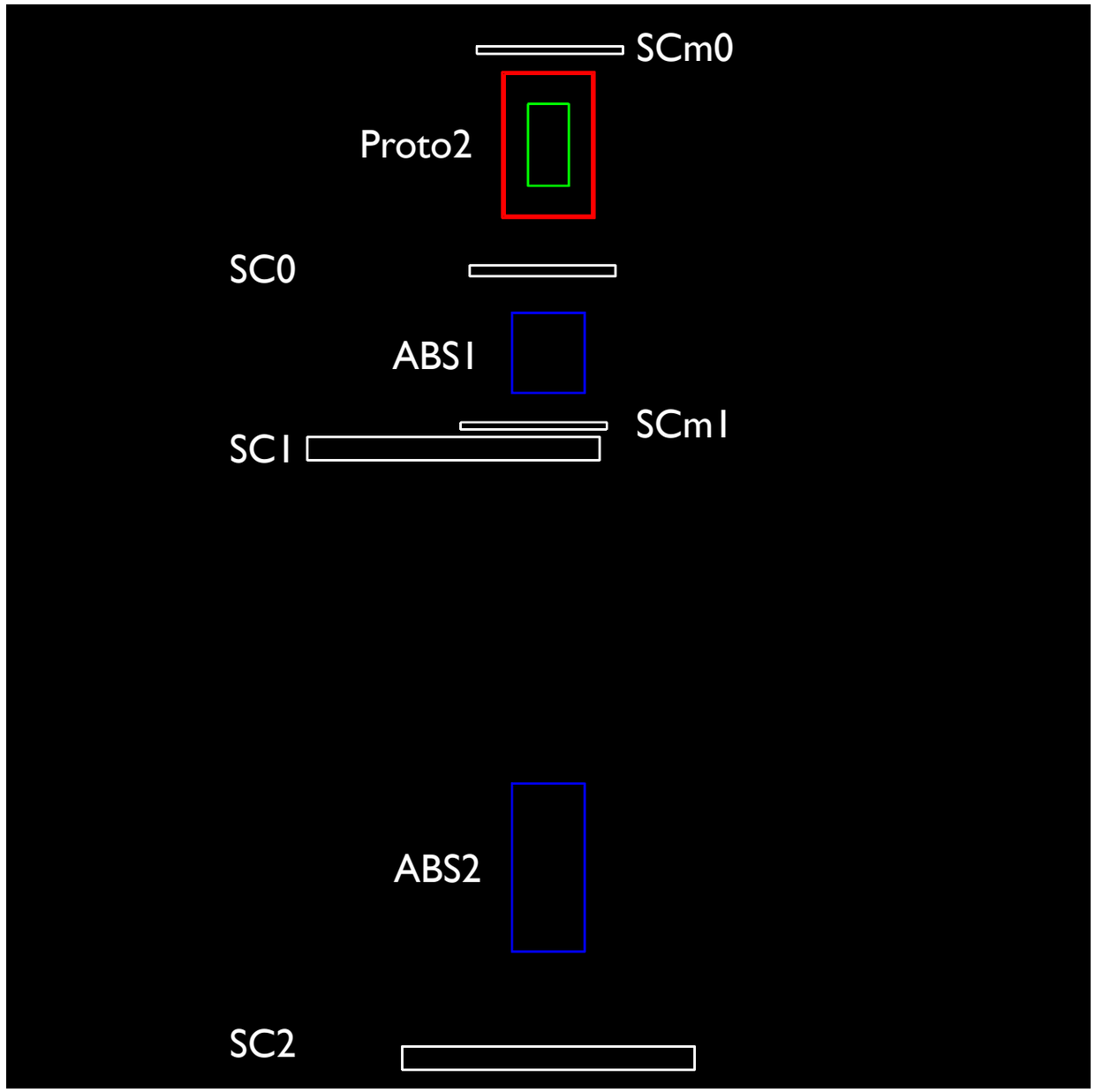
G4 Simulation

- Study setup performance
- Possibly optimize geometry and/or layout and/or absorbers' thickness
- Develop a tool of more general use (e.g. test beam)

Y-Z view

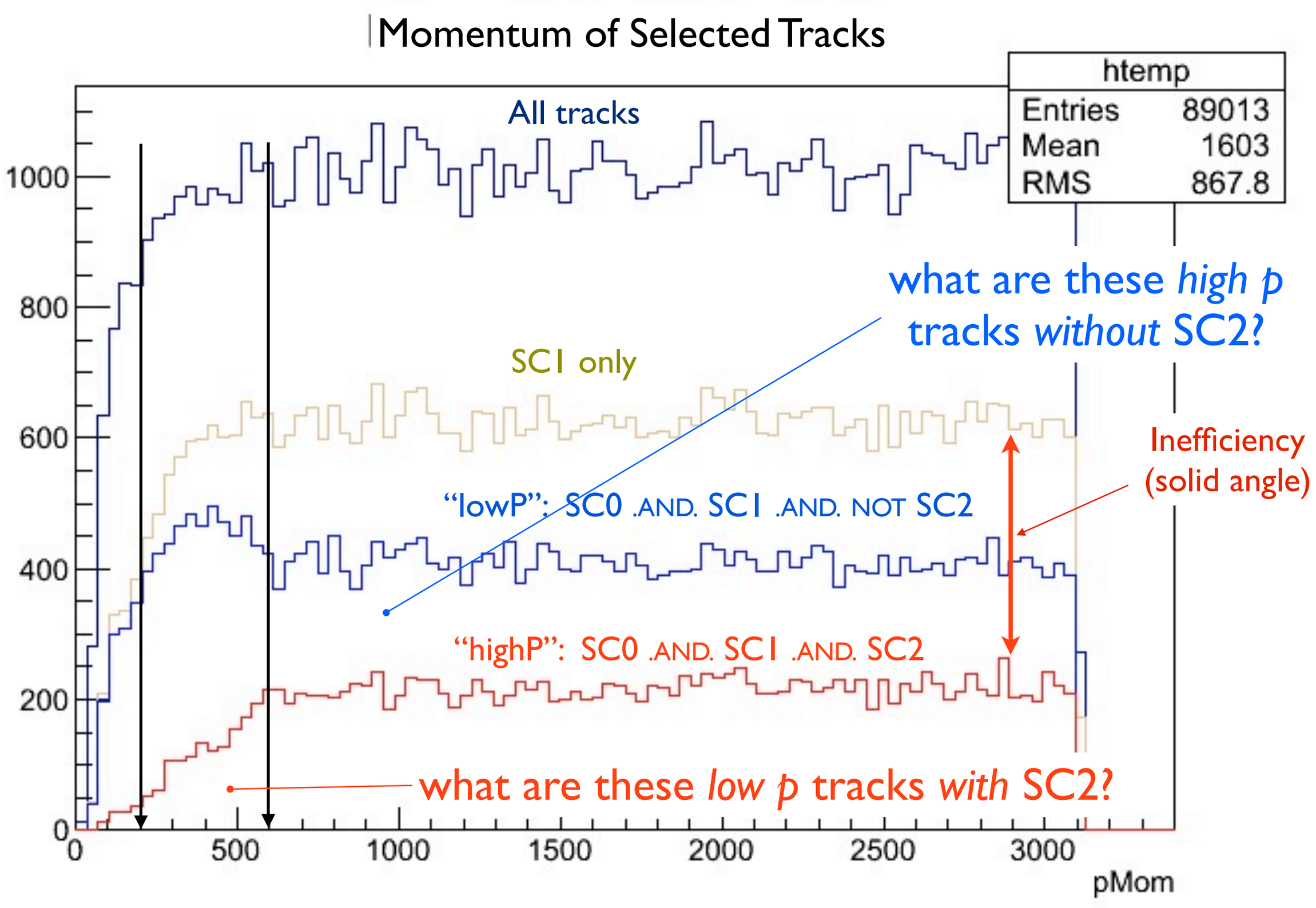


Y-X view



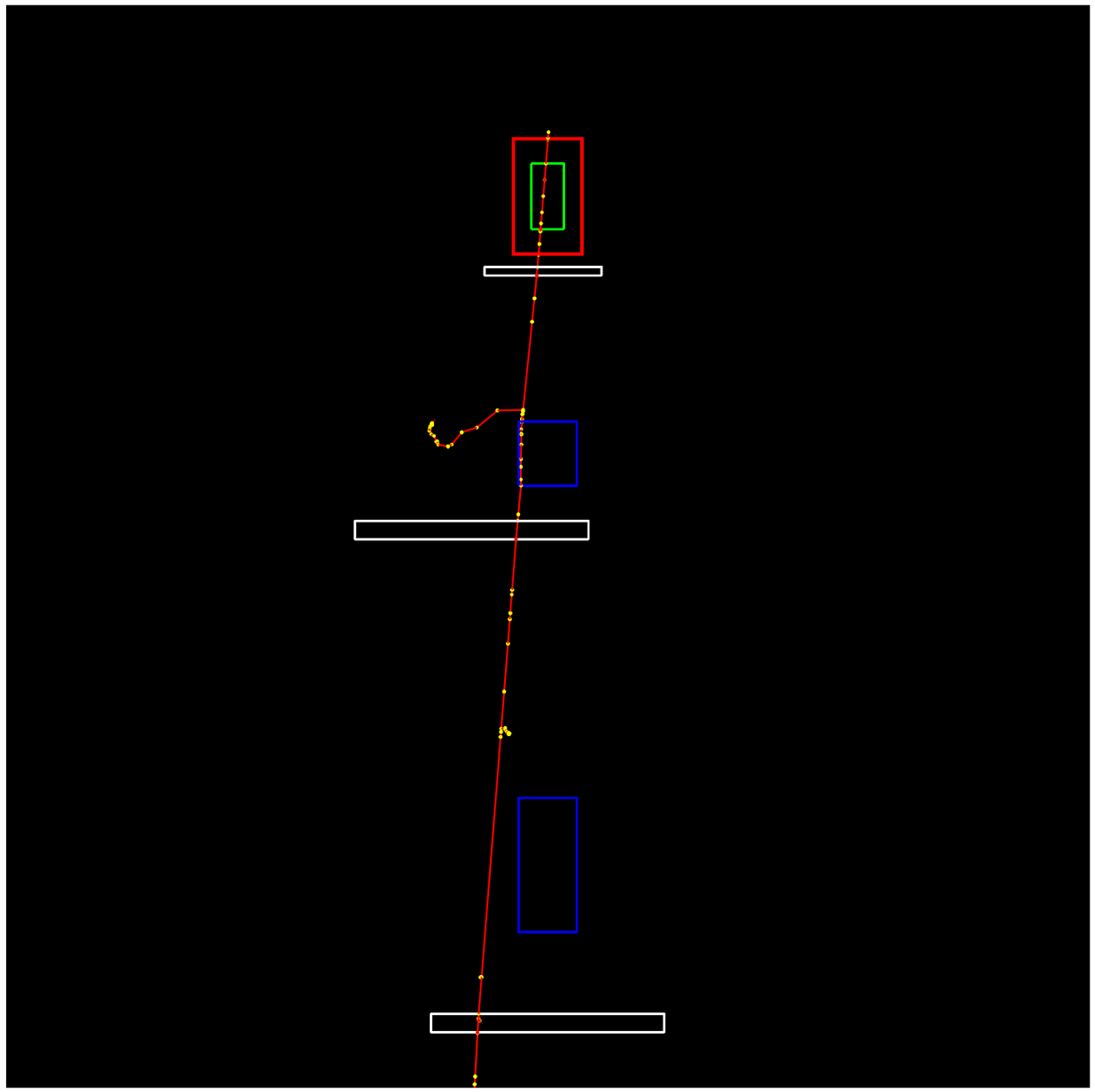
SCm0 and SCm1 used to limit θ range to ±30° around θ=90°

G4 Simulated Data: check method

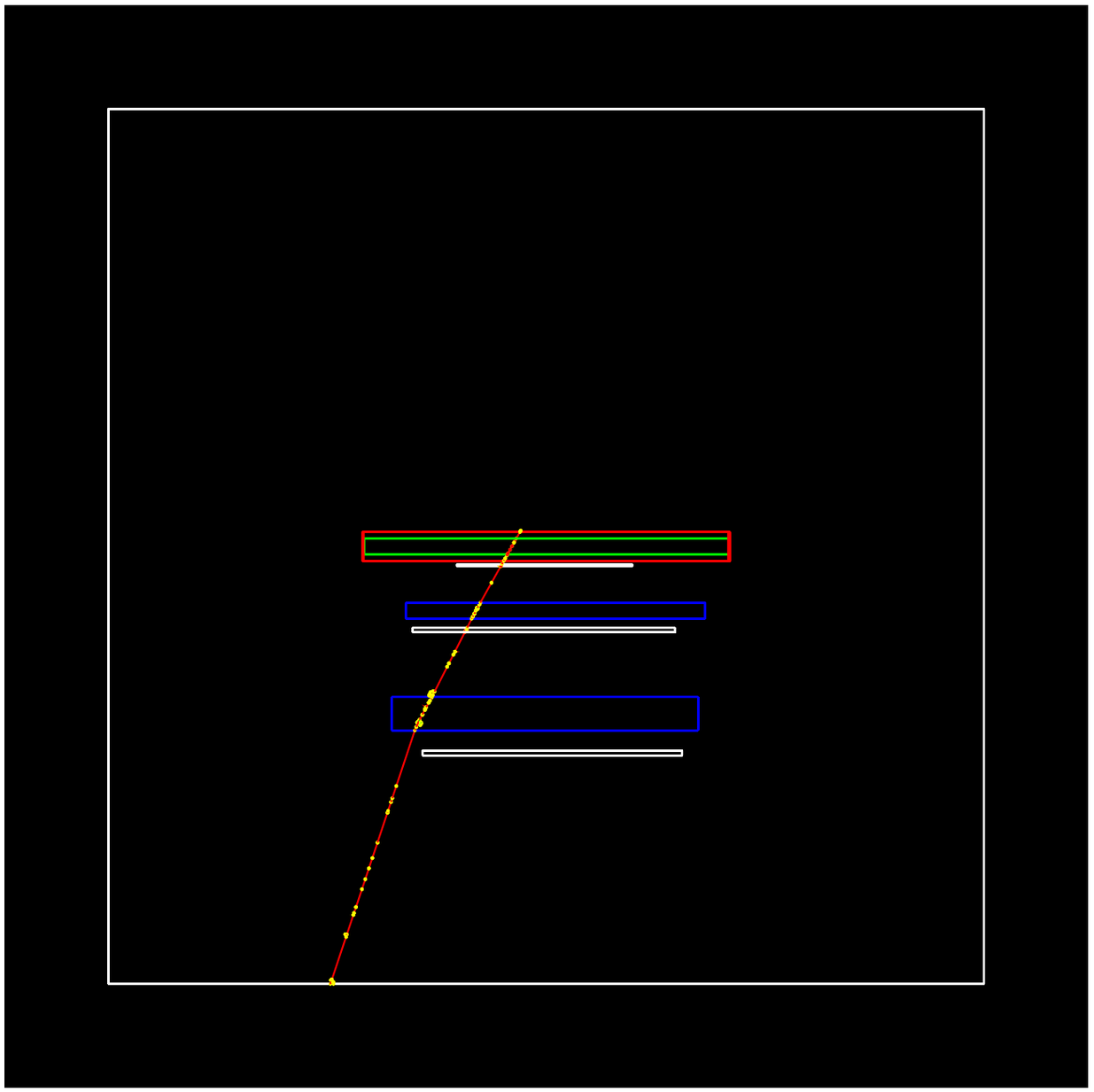


Flat energy spectrum generated

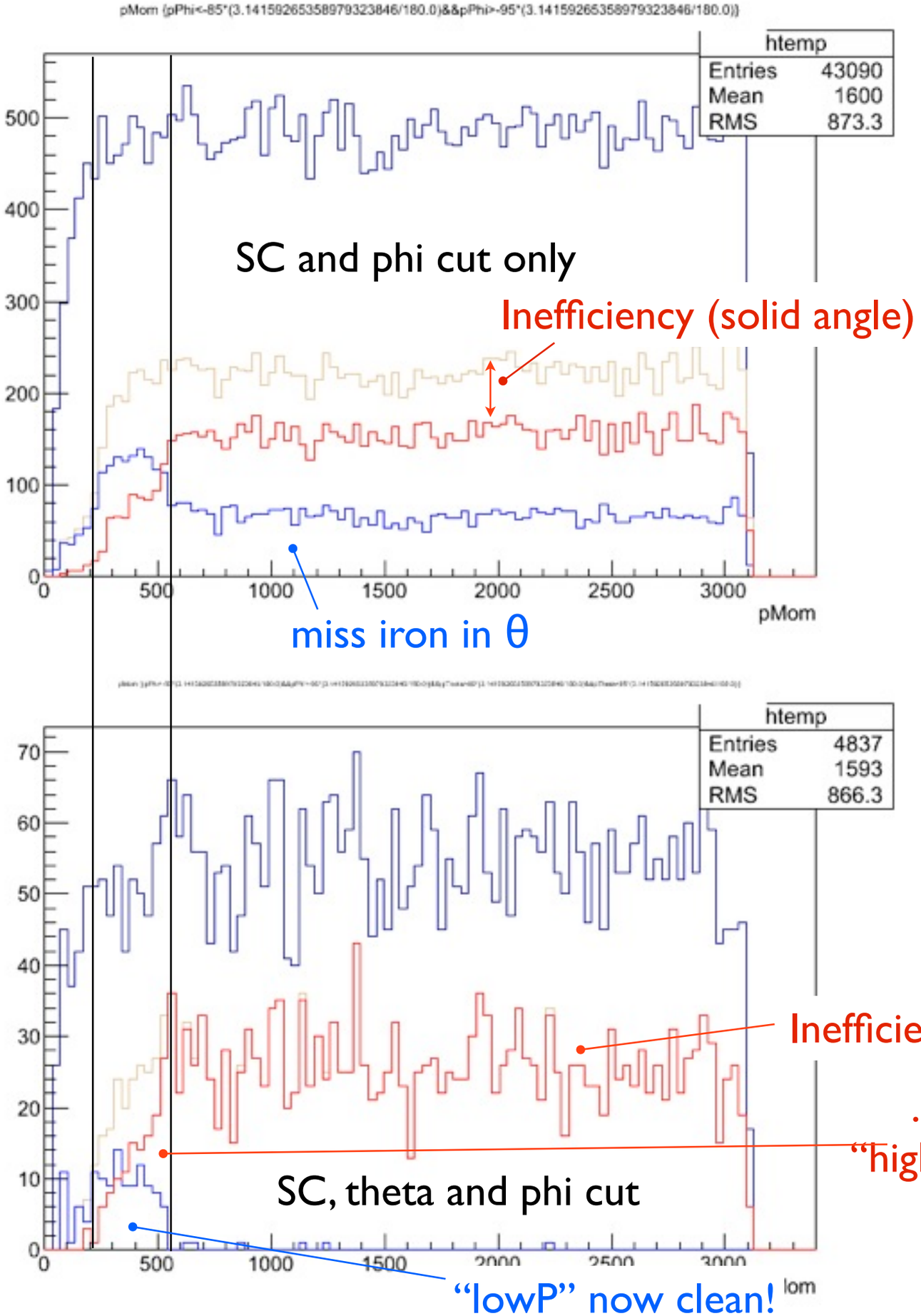
“lowP” *with* SC2

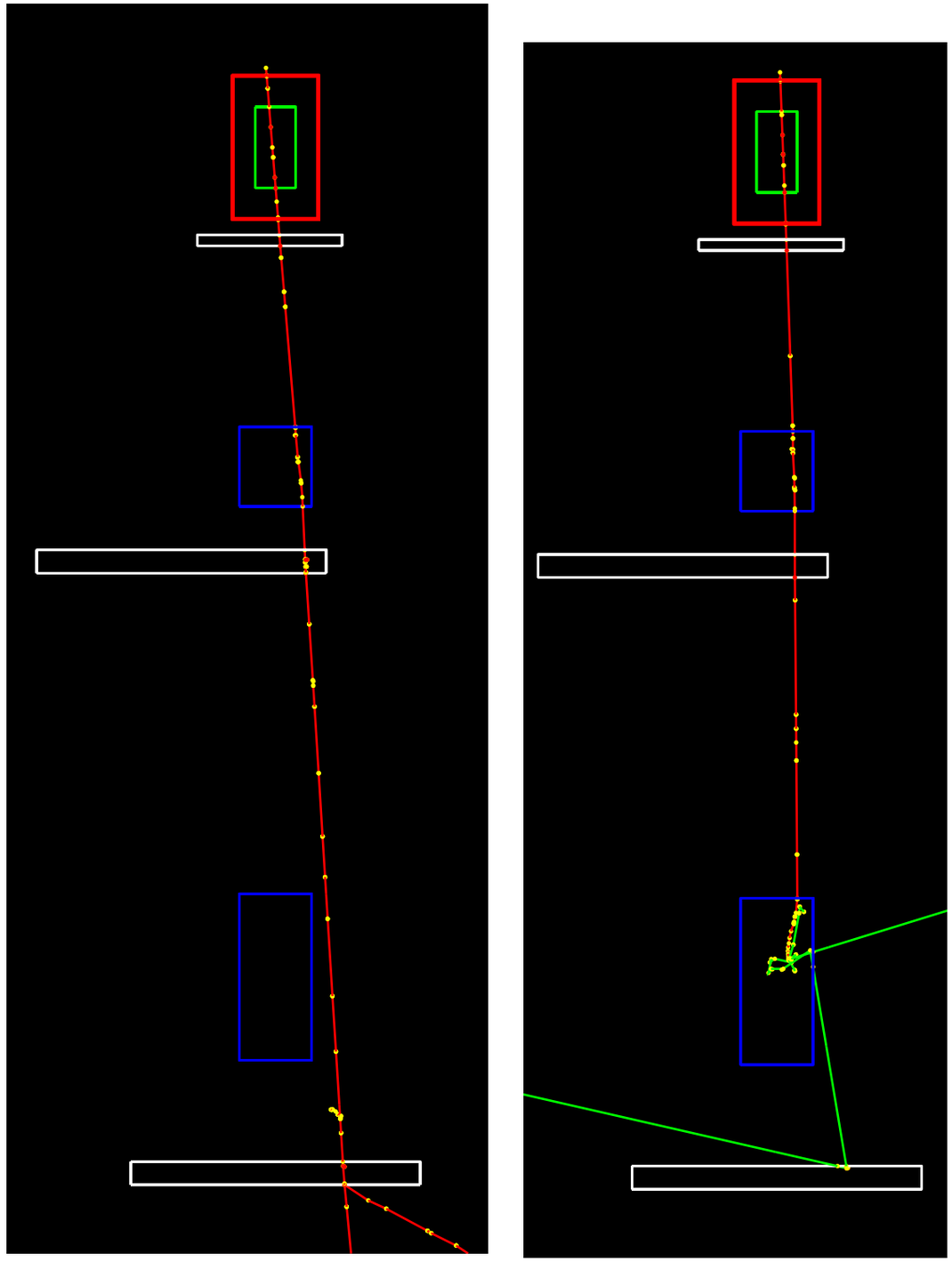


“highP” *without* SC2



Missing the Iron absorber! ⇒ need φ, θ fiducial cuts

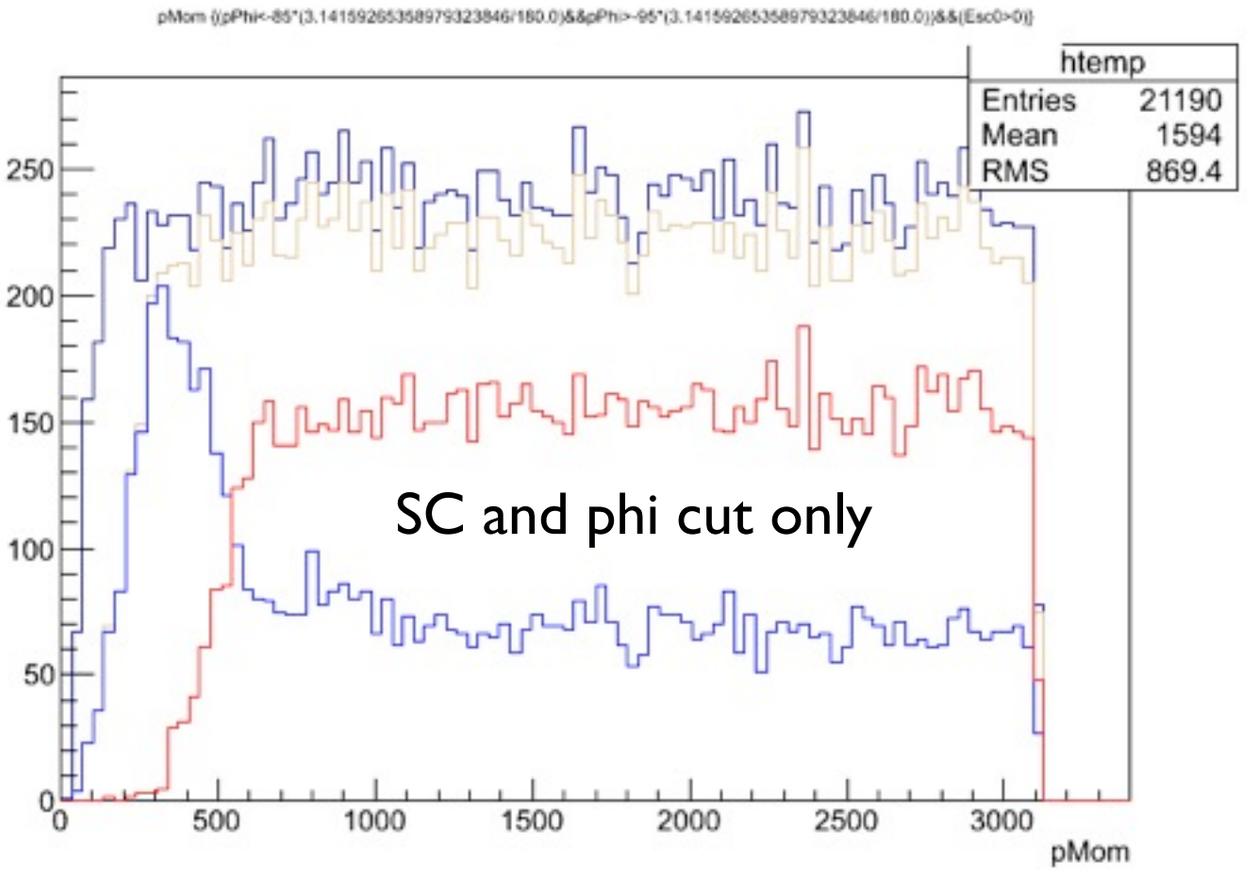


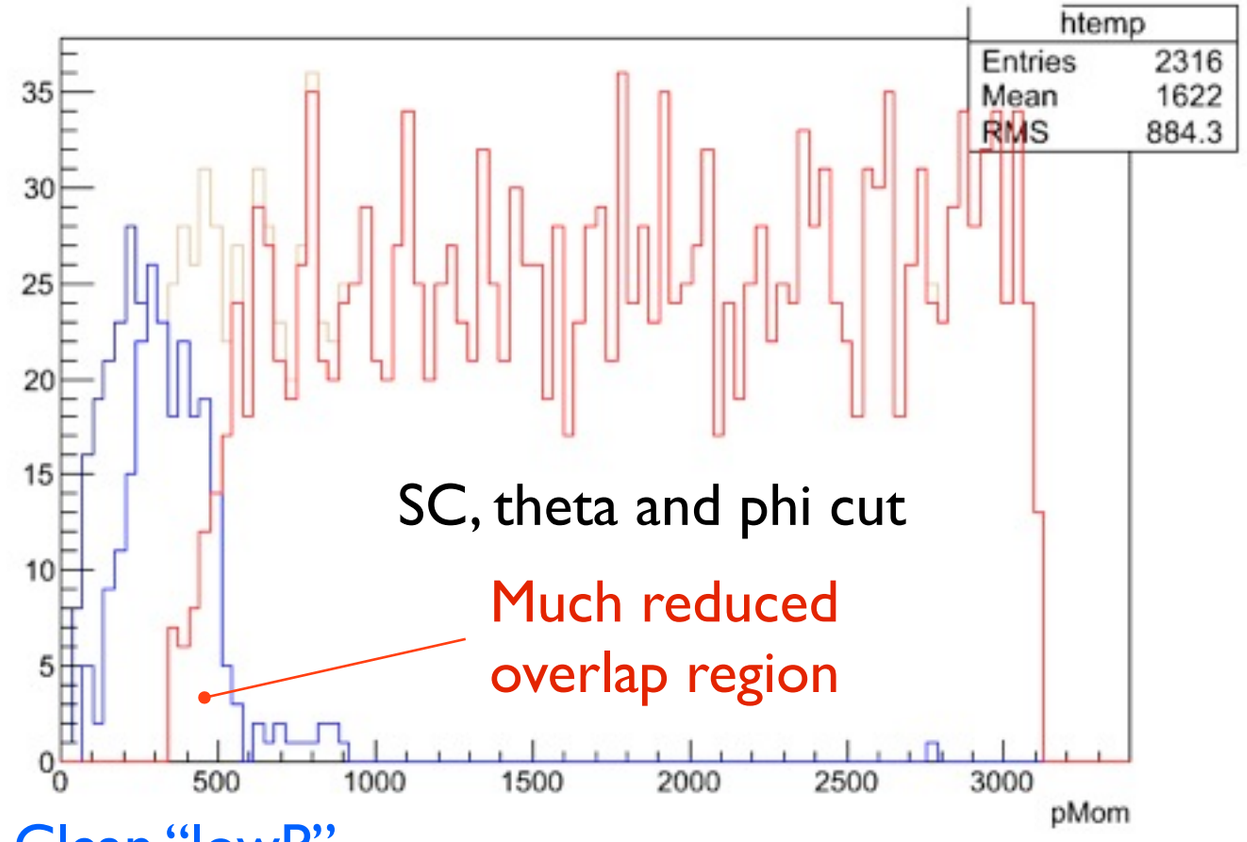


Inefficiency gone!

...but still contamination of
"highP" region from low p tracks!
what are these?

⇒Wider Iron





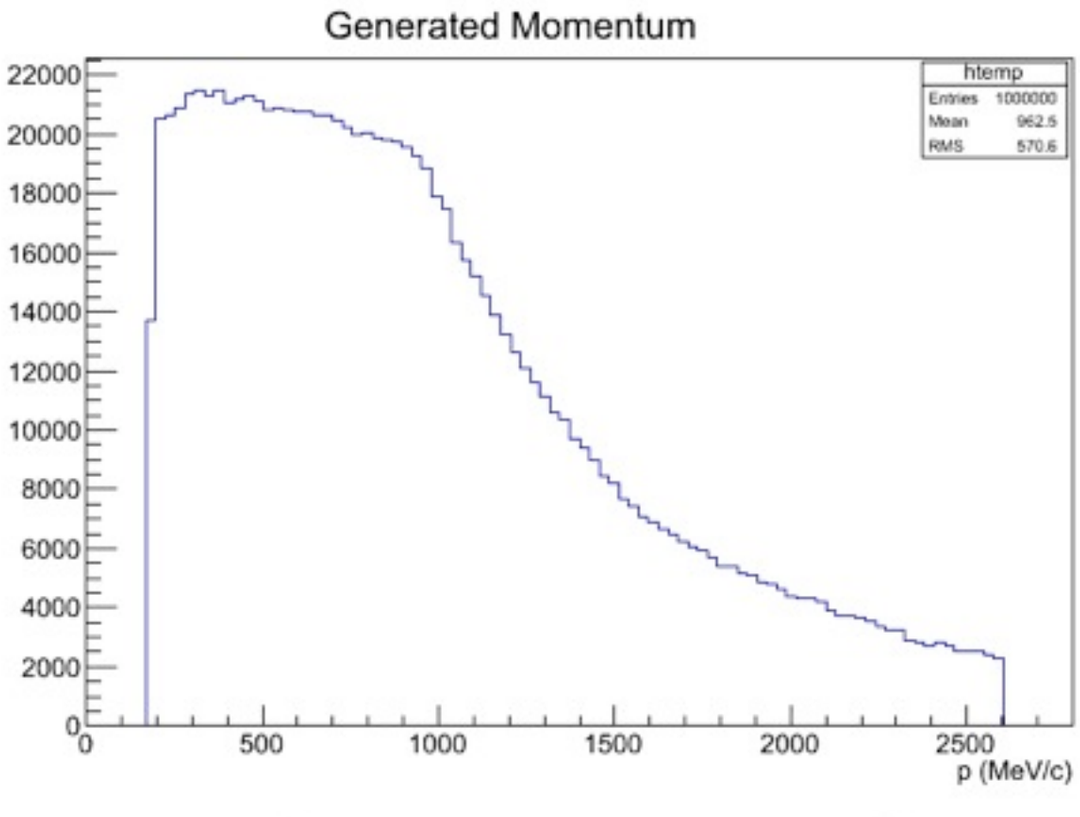
Clean "lowP"

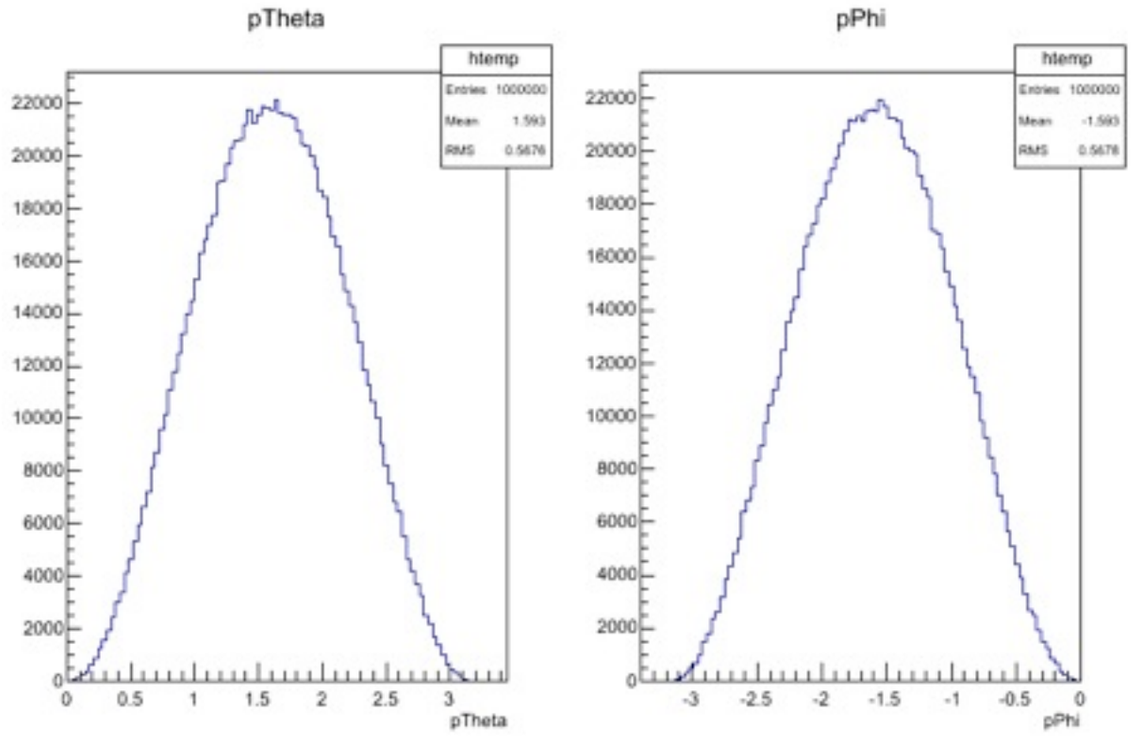
With wide Iron absorber and SC1 centered

Other improvements may be:

- Adding a third absorber layer to eliminate residual overlap
- Slightly increase ABS1 thickness to cut lower momenta

“More realistic” CR momentum spectrum

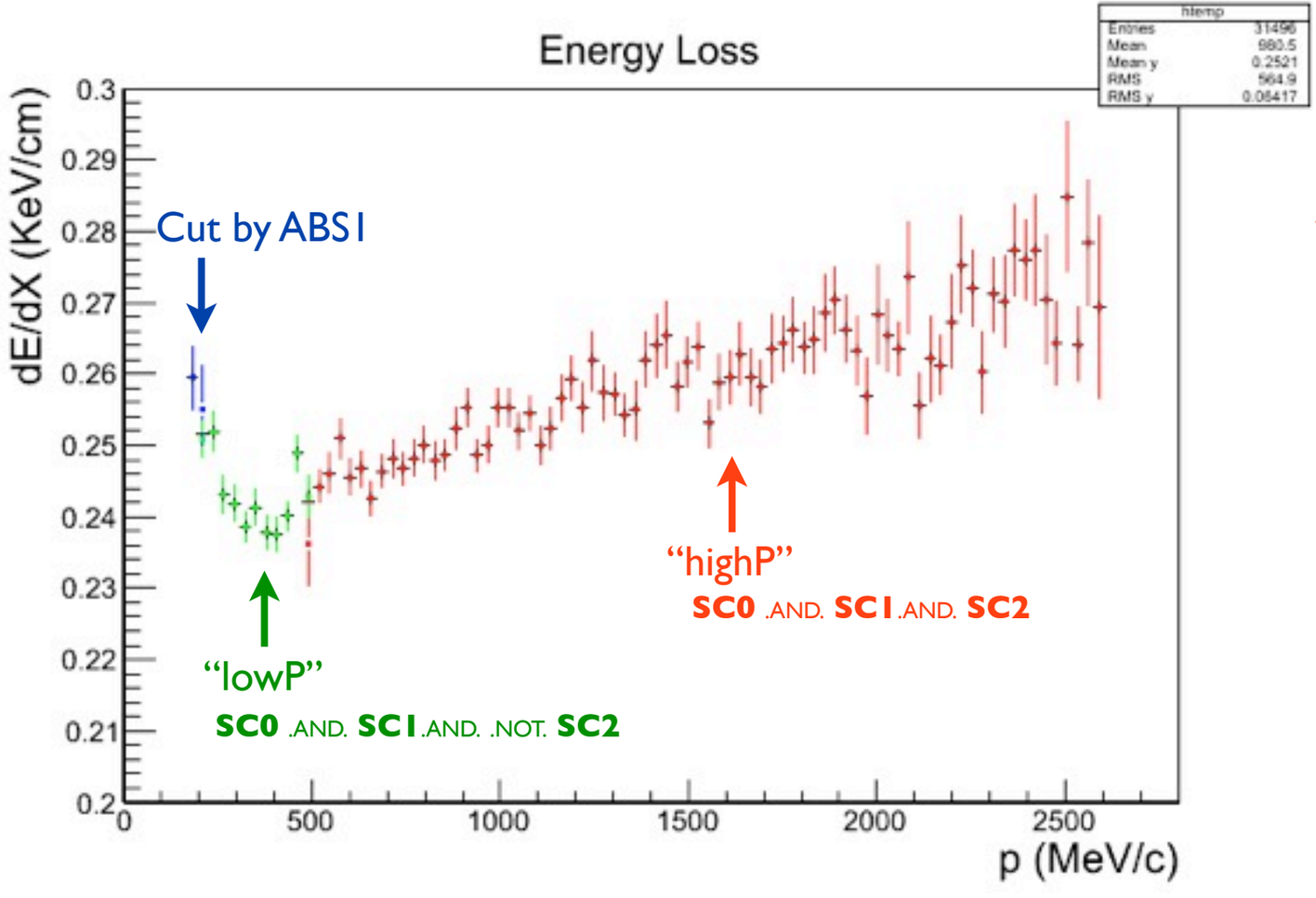




Rates (Hz)	G4	Data
SC0	40	44
SC0.AND.SC1 “L1”	27	10
SC0.AND.SC1 .AND.Proto2 “L2”	9	3.3
SC1	131	56
SC2	124	62

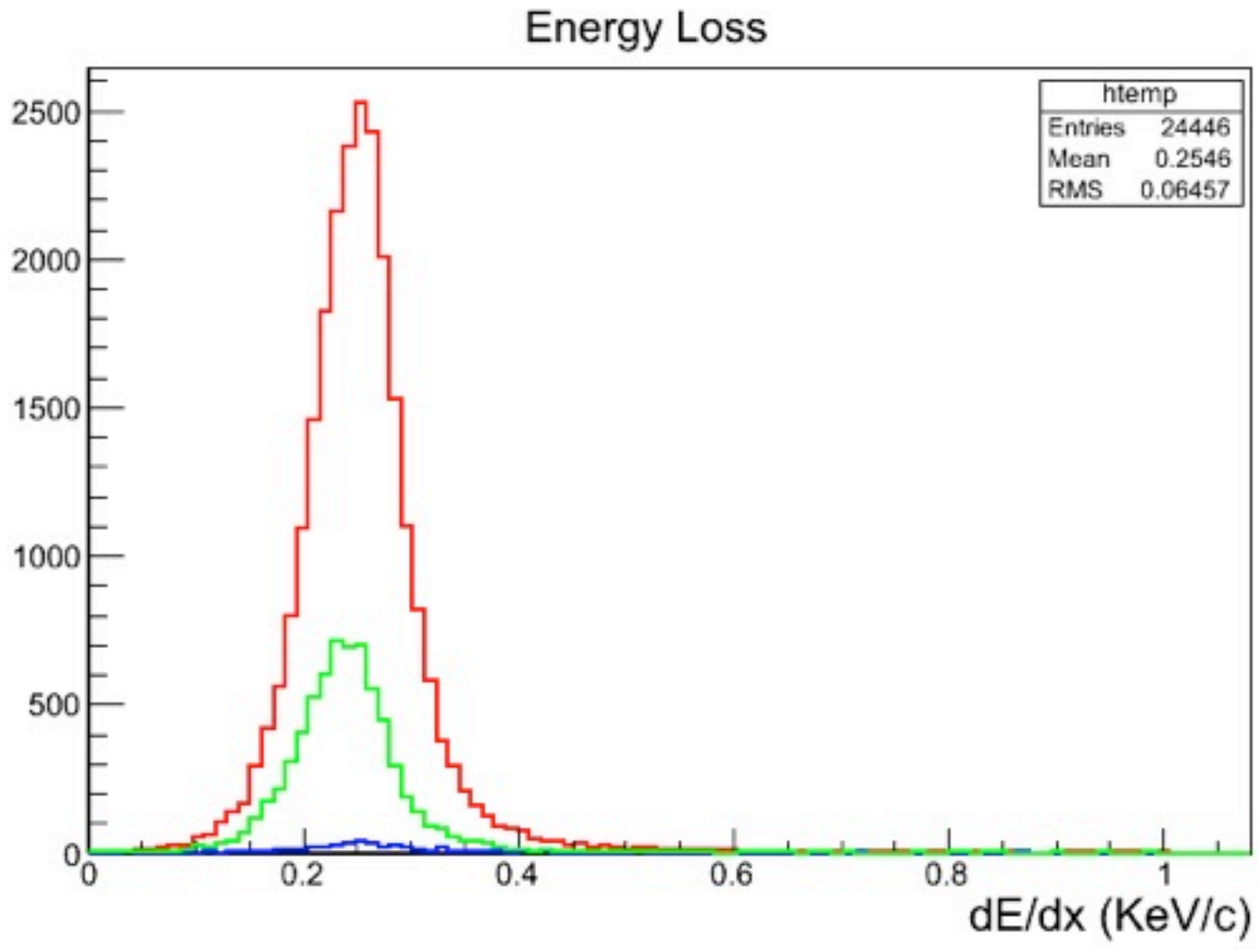
Ratios of trigger rates agree

Need more work to get agreement of absolute rate (e.g., SC inefficiencies are not simulated)



Expected Difference in dE/dx

NB: different p regions selected by direct cut on momentum, i.e. zero contamination



dE/dx (MPV, KeV/cm)

highP: 0.2491±0.0003

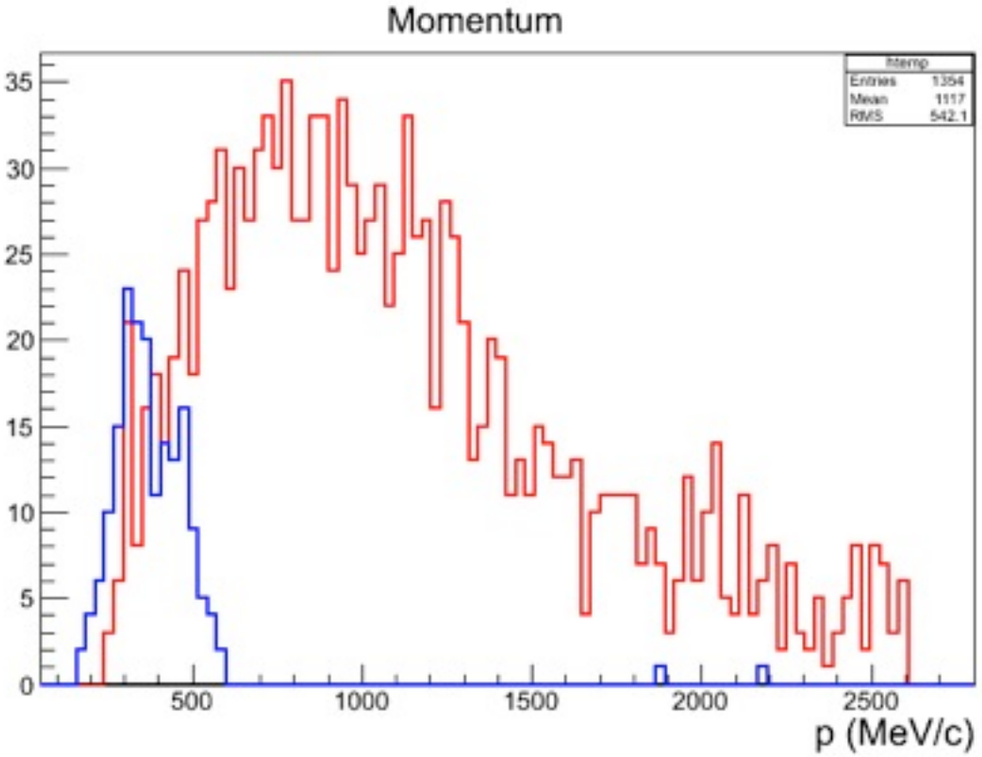
lowP: 0.2373±0.0005

$\Delta = 0.0118 \pm 0.0006$

~5% difference

Using G4 events like the data (do not measure L)

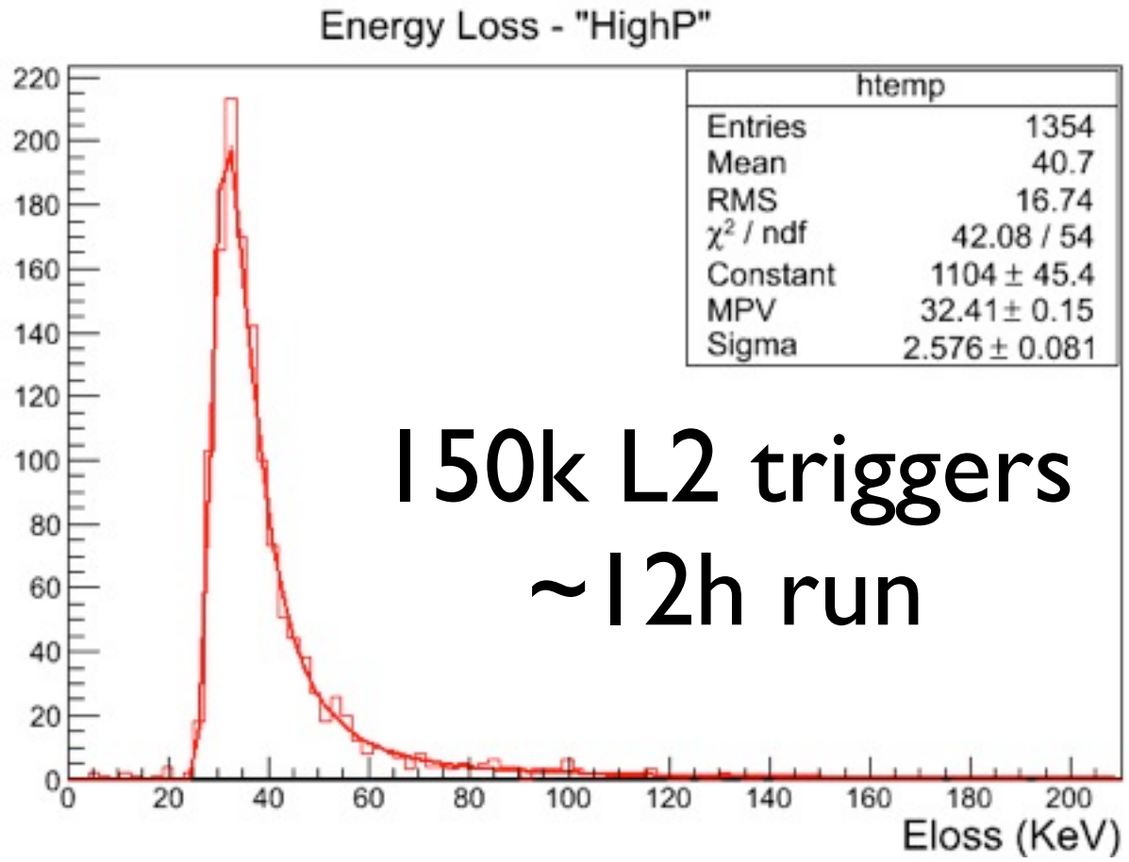
φ cut, and require SCm0 .AND. SCm1



$\Delta E_{loss} = 1.9 \pm 0.6$

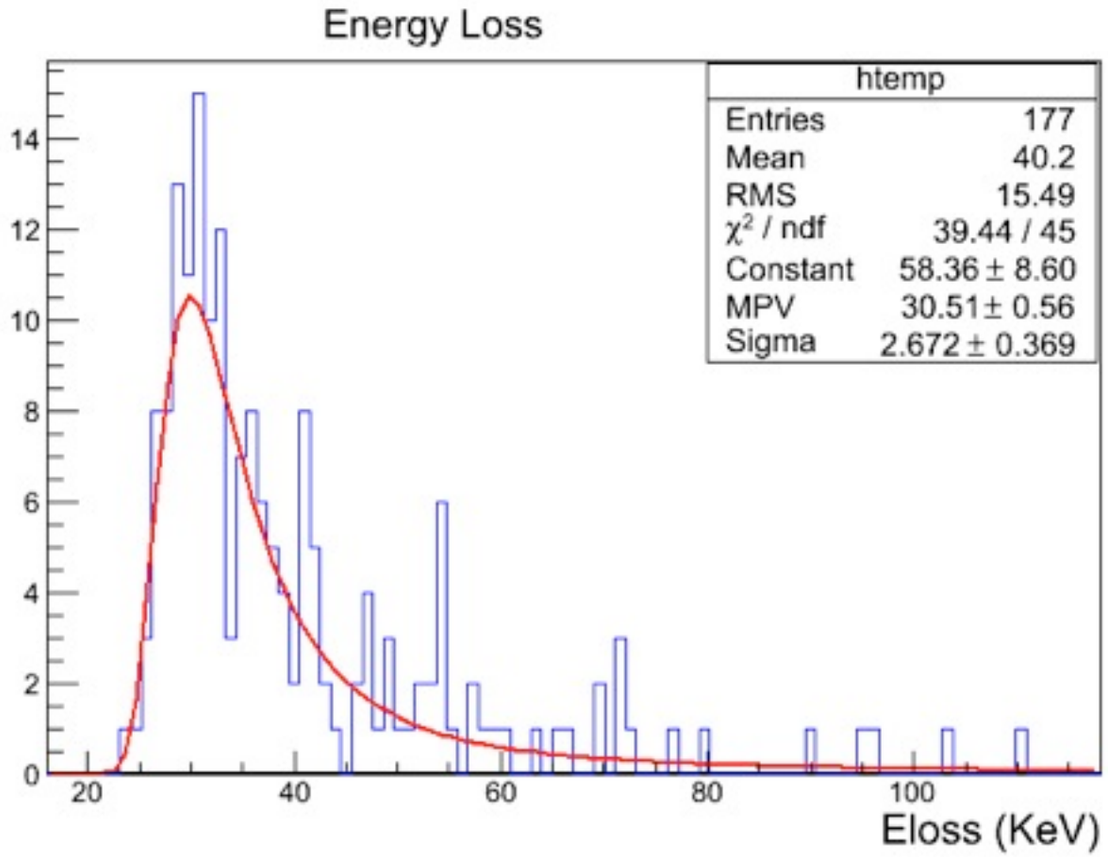
~6% difference

- This error is dominated by the # of events in the “LowP” sample
- # of G4 events in LowP vs HighP samples depend on the generated p spectrum
- In data, LowP sample ~ 5xHighP sample, so the generated p spectrum must be tuned



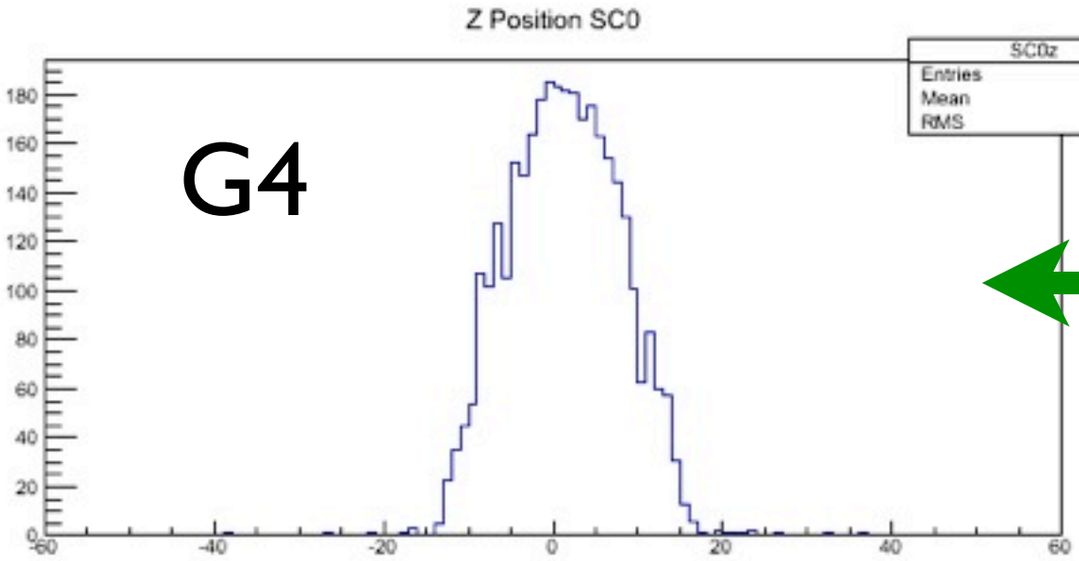
150k L2 triggers

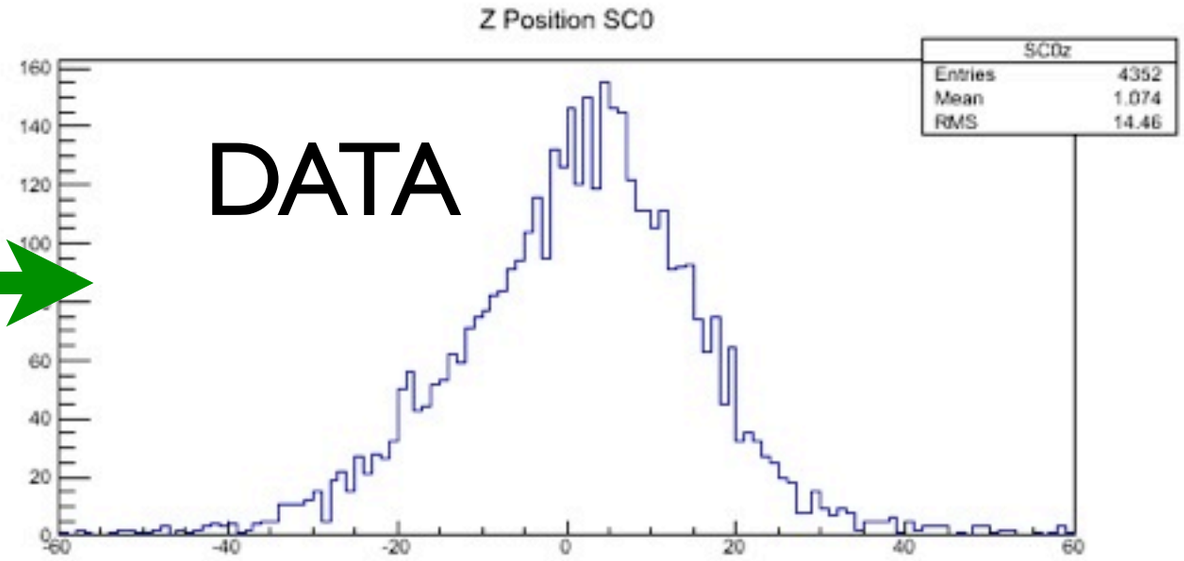
~12h run

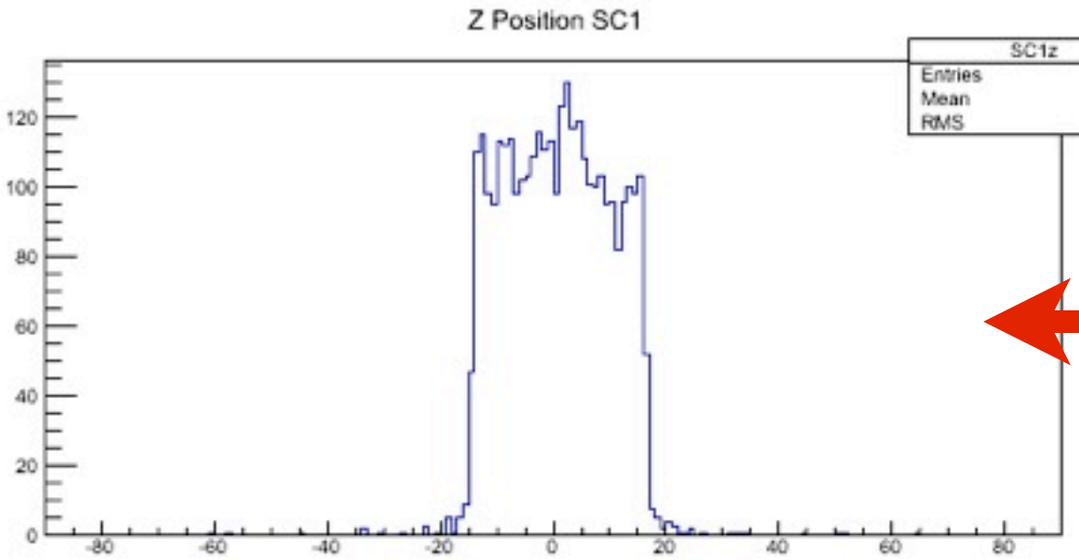


Z Coordinate

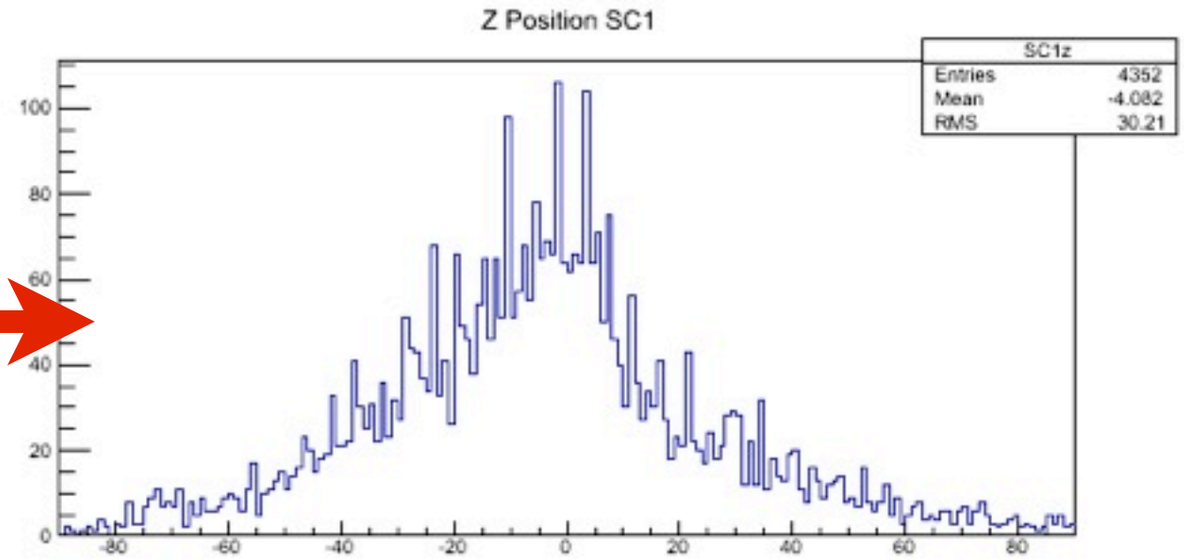
- Needed to compute/correct for track length without imposing strong cuts on theta
- Use PMT time difference to measure z in the scintillator counters
- Check using small SCm0 and SCm1 scintillator counters positioned in the centre (along z) of Proto2, SC0, SC1 and SC2
  - Equivalent to ±30° around θ=90°
- Compare G4 simulation with data

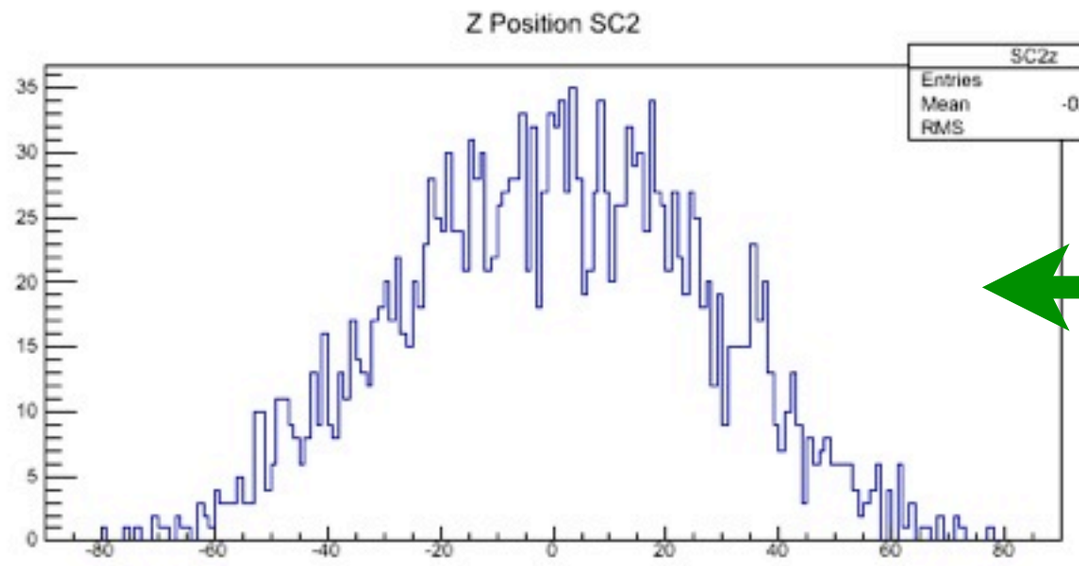

Z Position SC0
SC0z
Entries 3343
Mean 1.33
RMS 6.607
G4

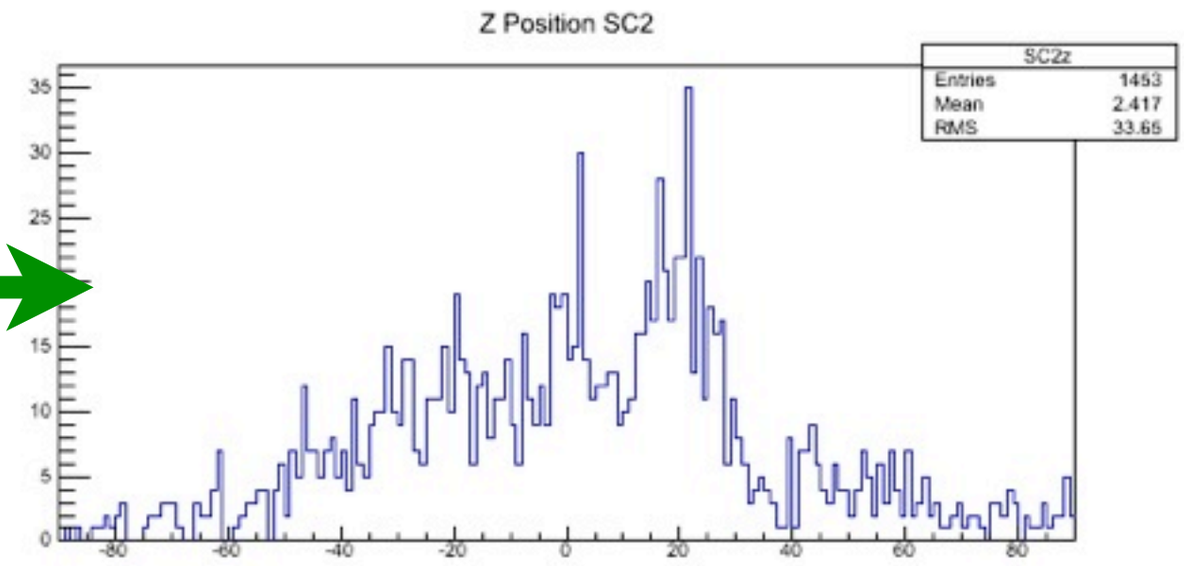

Z Position SC0
SC0z
Entries 4352
Mean 1.074
RMS 14.46
DATA

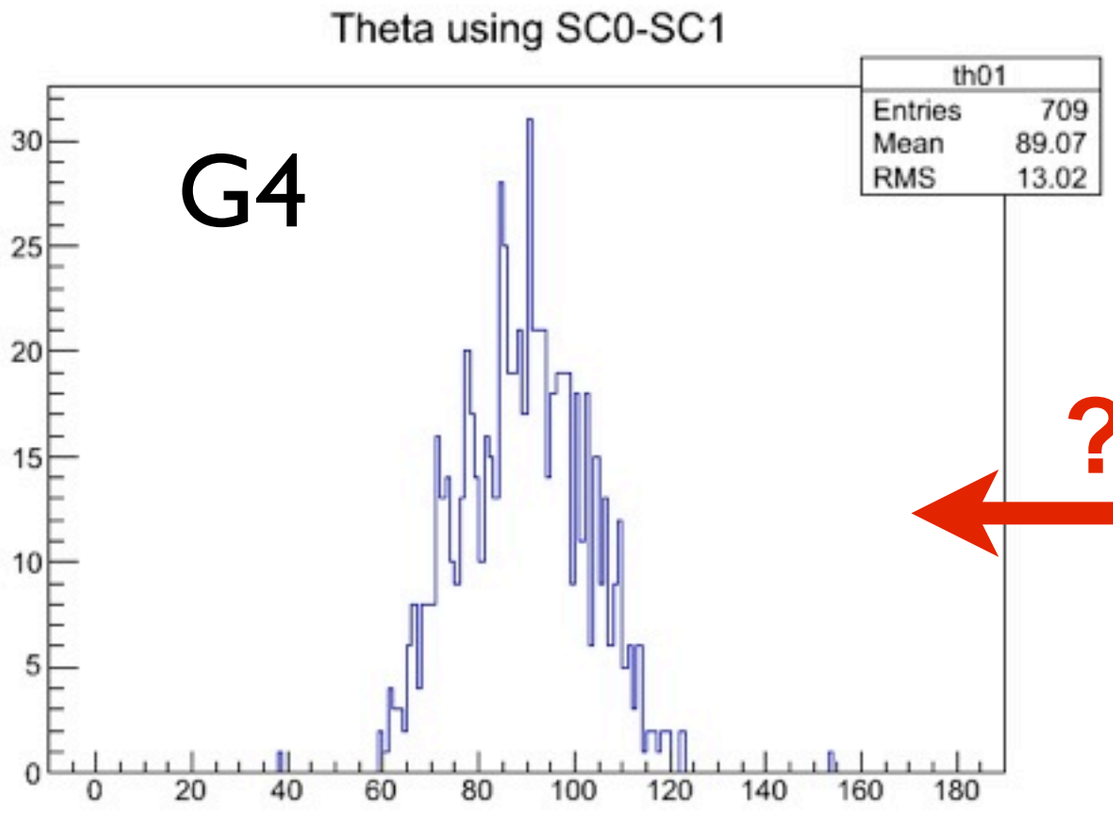

Z Position SC1
SC1z
Entries 3343
Mean 0.807
RMS 9.482

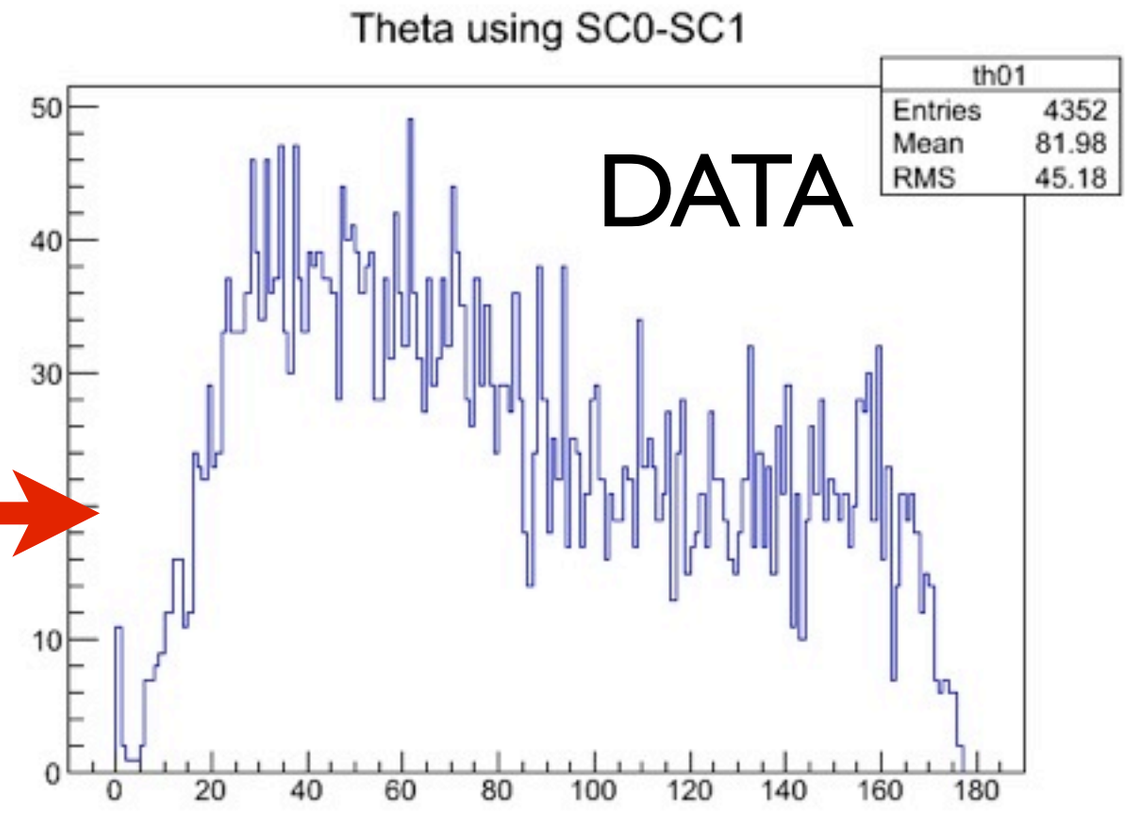
?


Z Position SC1
SC1z
Entries 4352
Mean -4.082
RMS 30.21

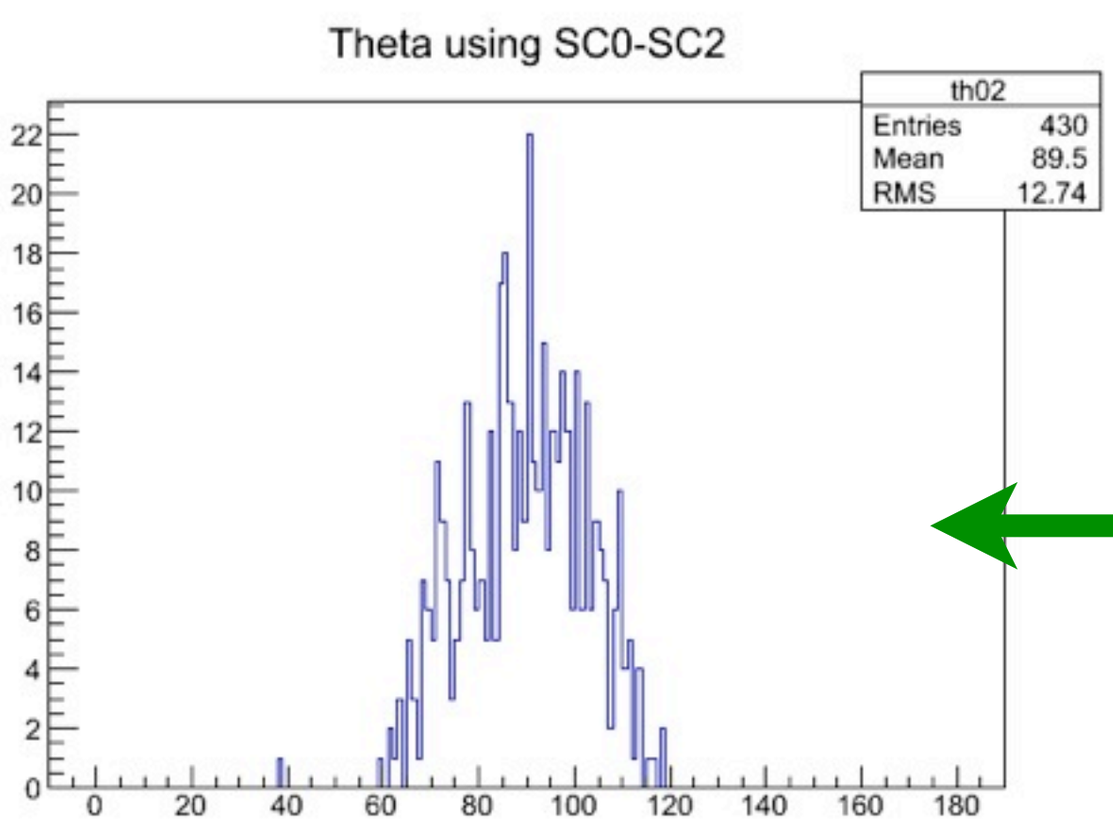

Z Position SC2
SC2z
Entries 2081
Mean -0.002108
RMS 26.93

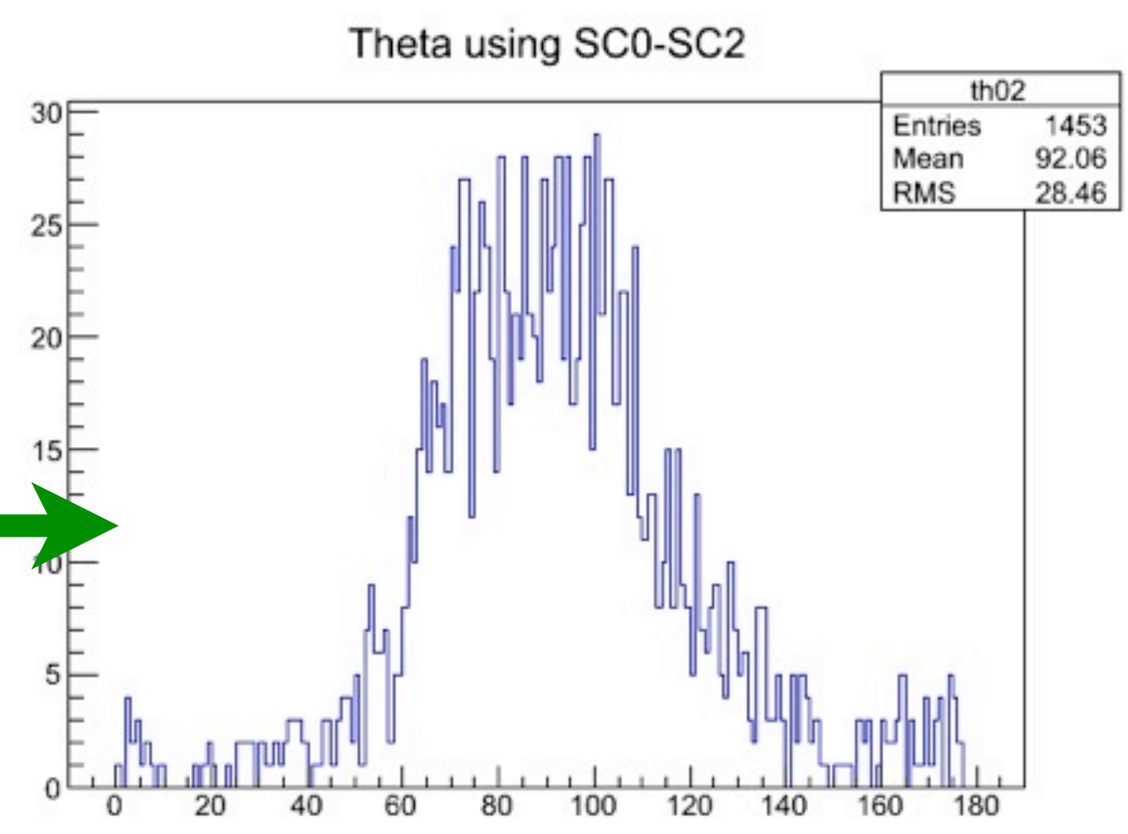

Z Position SC2
SC2z
Entries 1453
Mean 2.417
RMS 33.65


Theta using SC0-SC1
th01
Entries 709
Mean 89.07
RMS 13.02
G4


Theta using SC0-SC1
th01
Entries 4352
Mean 81.98
RMS 45.18
DATA

?


Theta using SC0-SC2
th02
Entries 430
Mean 89.5
RMS 12.74


Theta using SC0-SC2
th02
Entries 1453
Mean 92.06
RMS 28.46

Conclusion

- G4 simulation (as usual..) great tool to debug setup
- May be (should be?) used to simulate test beam
- Analysis of real data has started after the summer
  - needs lots of data with present setup as strong angular cuts and/or smaller scintillators are required
  - results soon on dE/dx VS dN/dx sensitivity