PVDIS Response

R. Holmes 12/2/2016 SoLID Collaboration Meeting

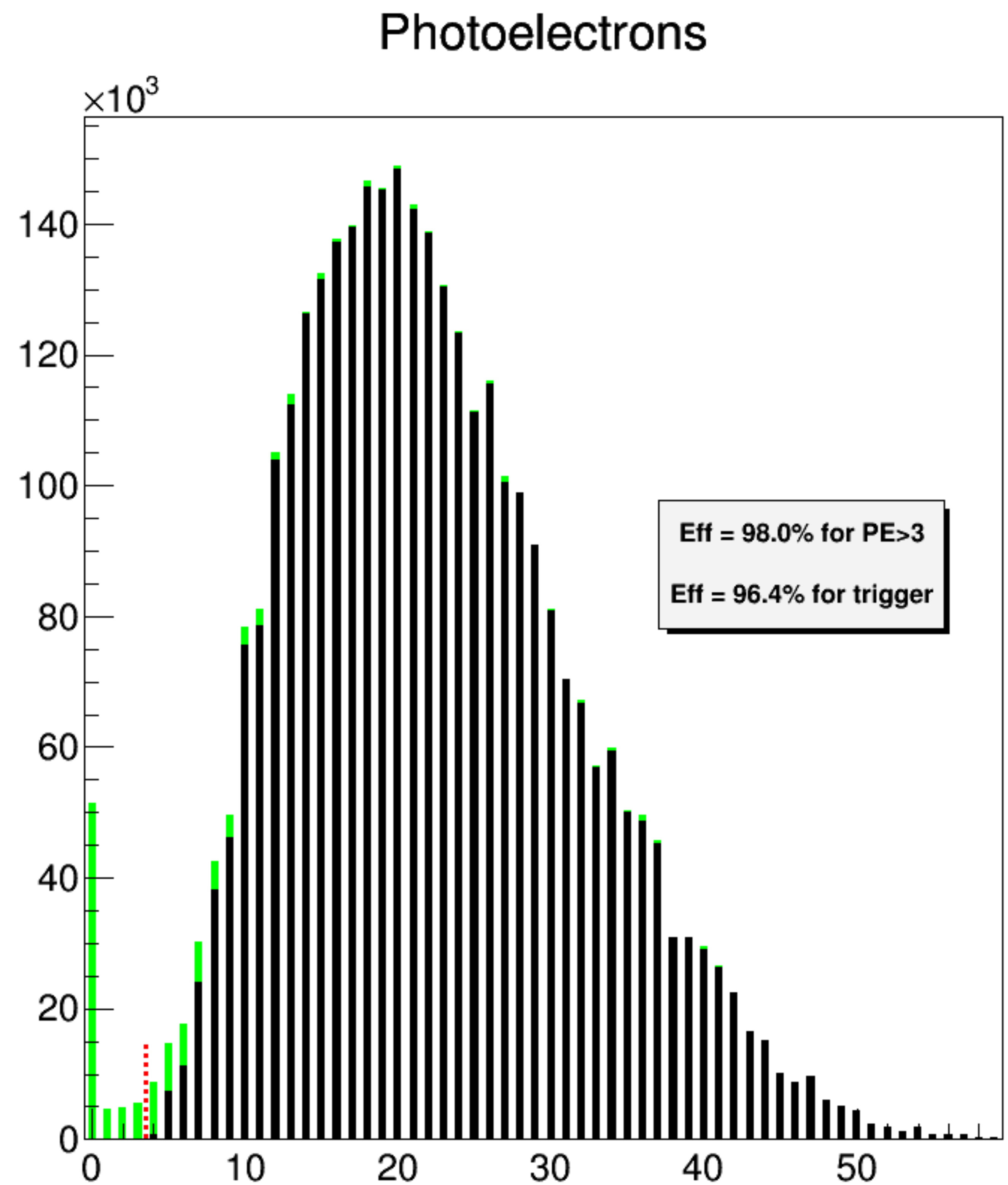
Acceptances, efficiencies, and systematic uncertainties should be simulated for each of the core measurements

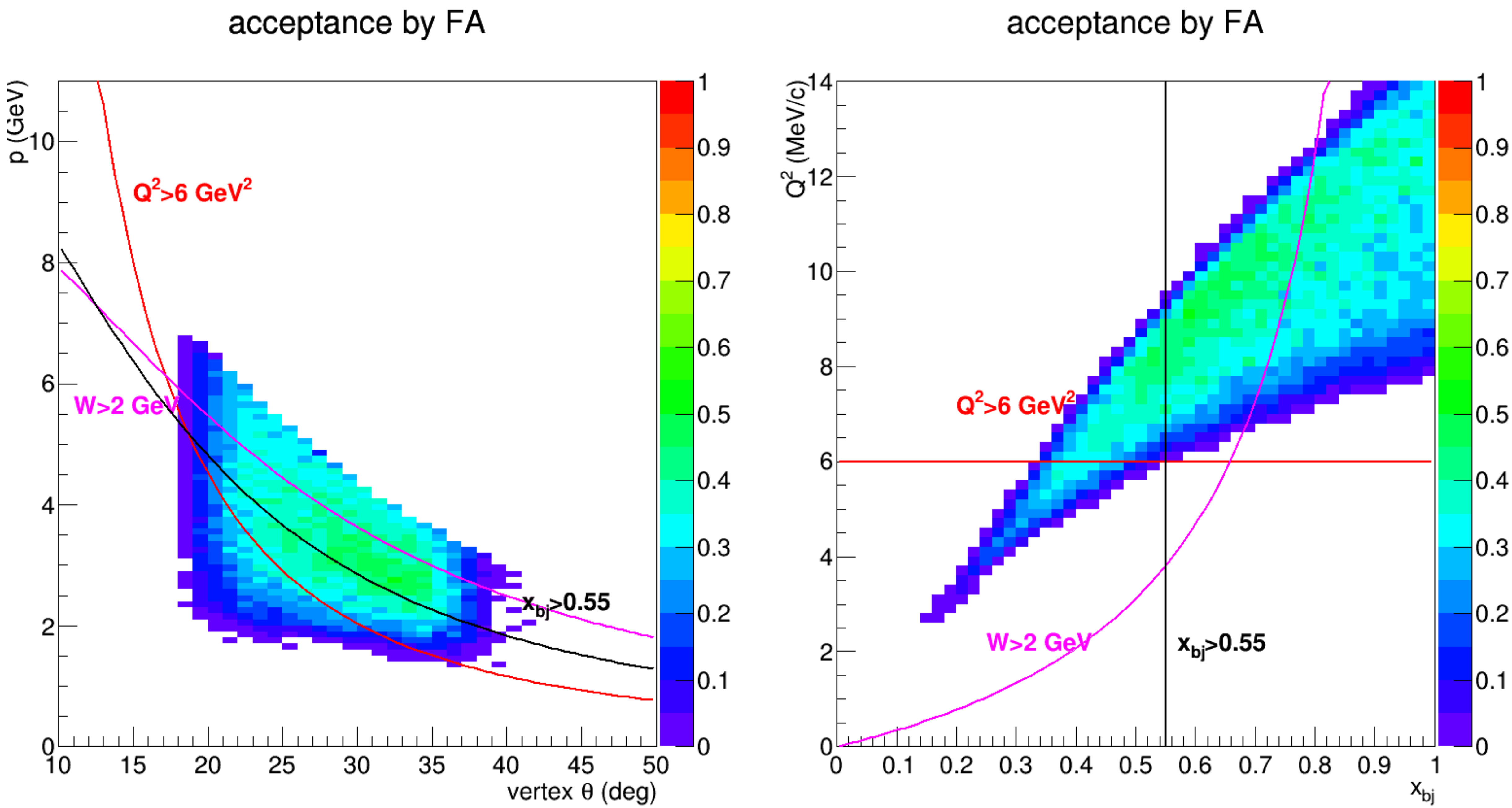
- Full Monte Carlo simulation that includes layer by layer energy deposition in the electromagnetic calorimeter (EC) and optical physics in the light gas Cerenkov (LGC).
- Input events to the Monte Carlo are electrons from a DIS generator using cross sections from the CTEQ6 parton distribution fits.
- Integrate primary electrons reaching EC after passing through all five GEMs.

LGC response

For acceptance we require >= 3 photoelectrons in sector matching the EC hit (red line). For efficiency require >=2 PE in each of >=2 PMTs in matching sector (black histogram).

In the histogram kinematic cuts of $Q^2>6$ GeV^2, W<2 GeV, and $x_{bj}>0.55$ are applied.





Acceptance in most of the kinematic range of interest is ~ 40%

Efficiency

- Calorimeter efficiency of ~95% as reported in the pre-CDR.
- LGC: Note changes in the gas and PMT quantum efficiency since pre-CDR. Requirement of >2 photoelectrons in each of >2 PMTs in the sector matching the EC yields 96% efficiency.
- The GEM detection efficiency is 97% per plane. From our studies using a tree search algorithm with realistic and correlated superimposed backgrounds and our current model of digitization, at present a track finding efficiency of ~90% appears to be achievable. Development of the track finding software is continuing.
- Combining these yields an estimate of 82% for our overall efficiency.

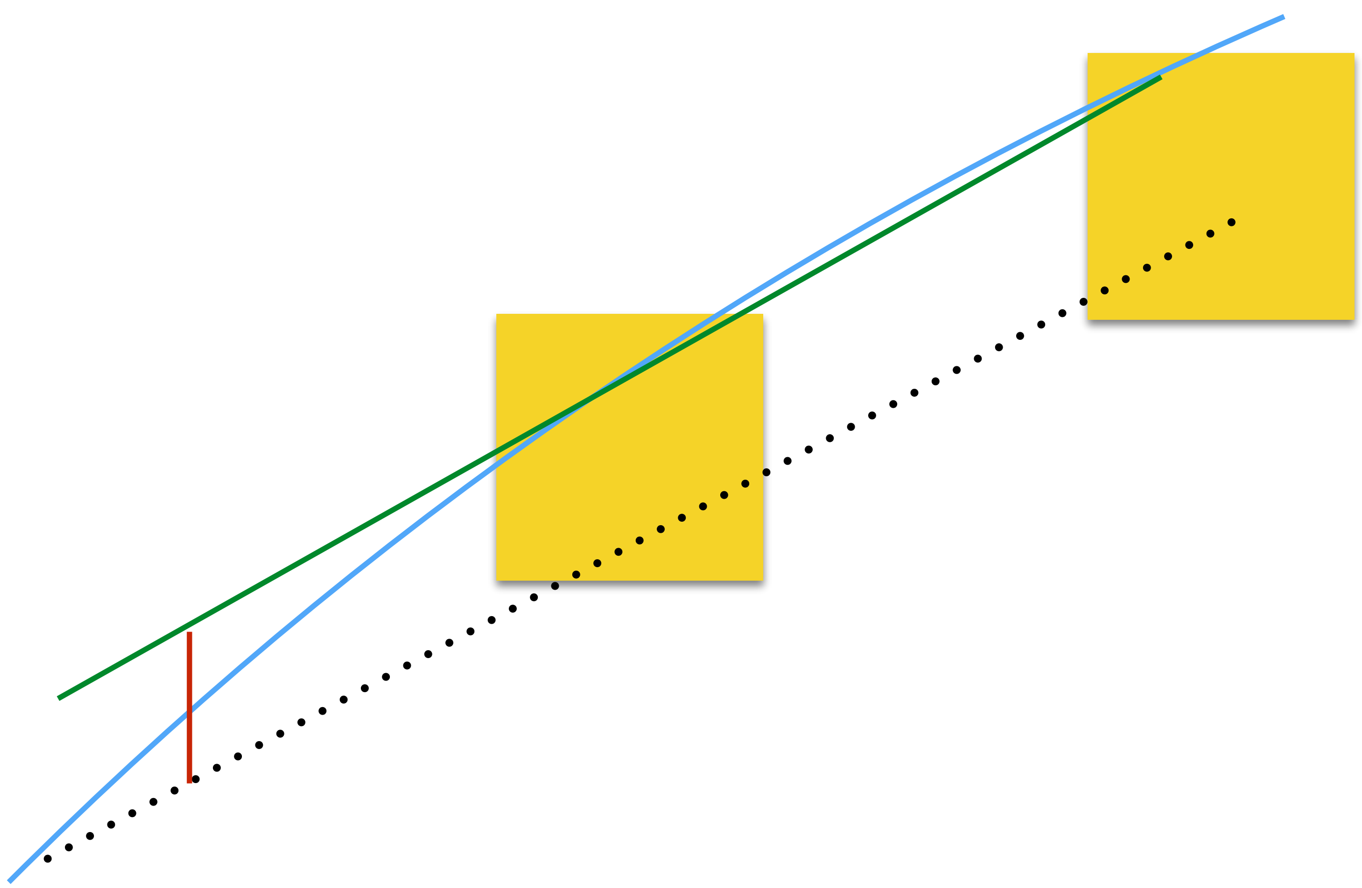
Systematics	
Polarimetry	0.4%
Q2	0.2%
Radiative corrections	0.2%
Reconstruction errors	0.2%
Total	0.6%

- Polarization: The present state-of-the-art is 0.6%. Laser polarization is below 0.2%. Experience gained with MOLLER will be valuable.

- Radiative corrections are similar to those computed for the HERA experiments. Many of the important radiative corrections come from tails of events at larger *x*, which are small for the SoLID high *x* kinematics.

- Reconstruction errors, including DAQ issues and particle identification: Pion contamination is expected to be below 1% for most bins and the required corrections should be valid to at least 10% of that. Work on the DAQ is in progress to demonstrate that the pile-up and dead-time corrections can be kept to below 0.15%.

For the PVDIS measurements, the viability of the elastic scattering calibration procedure, to determine absolute Q2 should be demonstrated by simulations for similar scattering angles to those probed in DIS, and with realistic misalignments



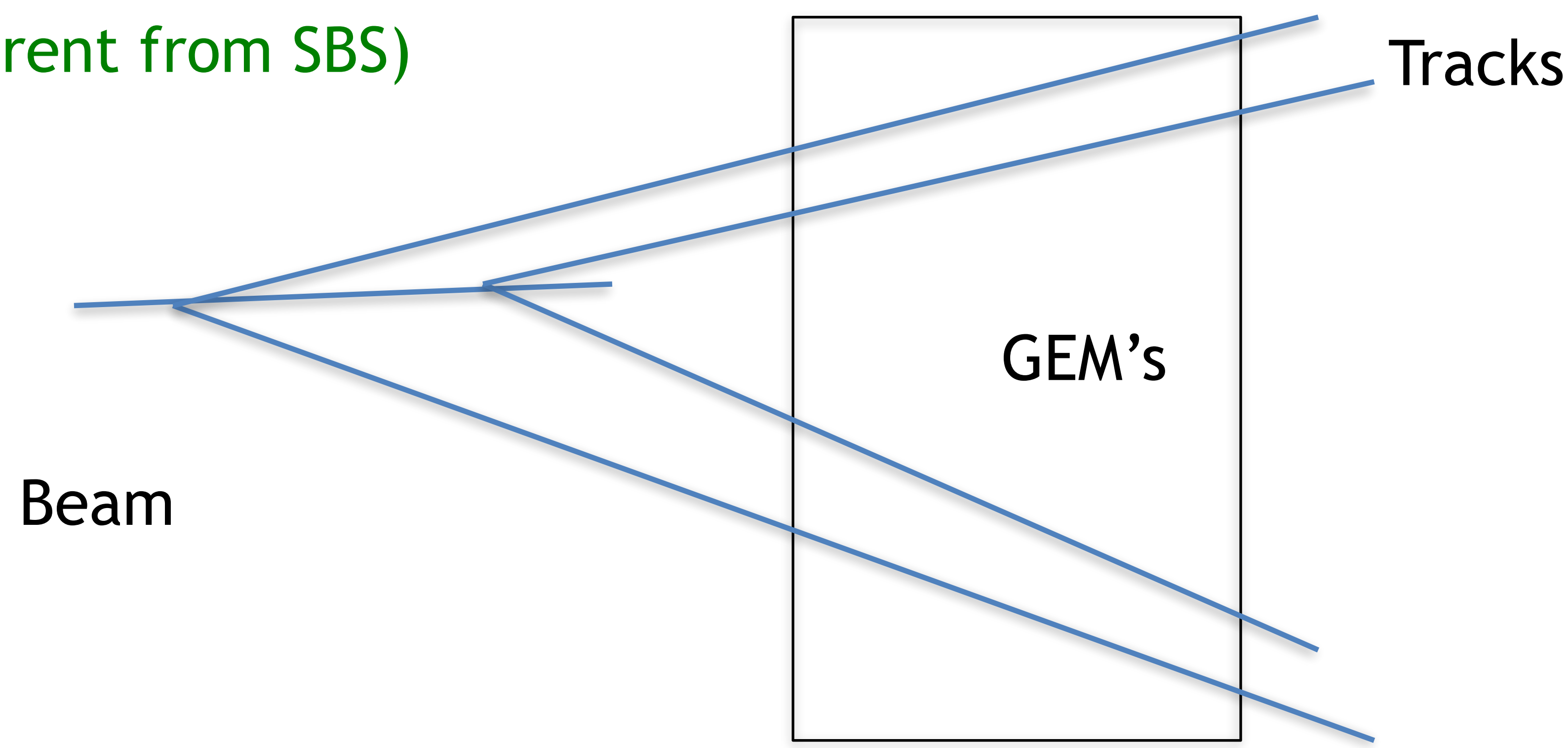
- For uniform field, closest distance from beam line to line extrapolated through 2 GEM hits is linear in $1/p$
- ~10 cm implies GEM transverse position alignments at ~100μm for $\delta p/p \sim 10^{-3}$

GEM alignment

- Using simulations with realistic field, we find transverse alignments need to be understood at 200 μm level
- Longitudinal position requirement ~ 3 mm
- Standard surveys should be good to within 100 μm
- Verify and check for GEM motion using electrons and x-rays

Alignment Plan: Use Tracks

Due to the symmetry of the apparatus, the Q2 is independent of misalignments. (ROM) Issue is estimating second order effects. (Different from SBS)

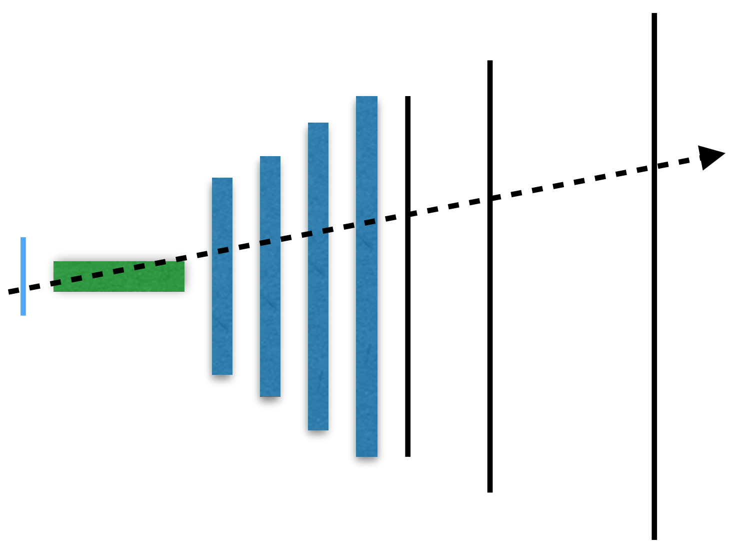


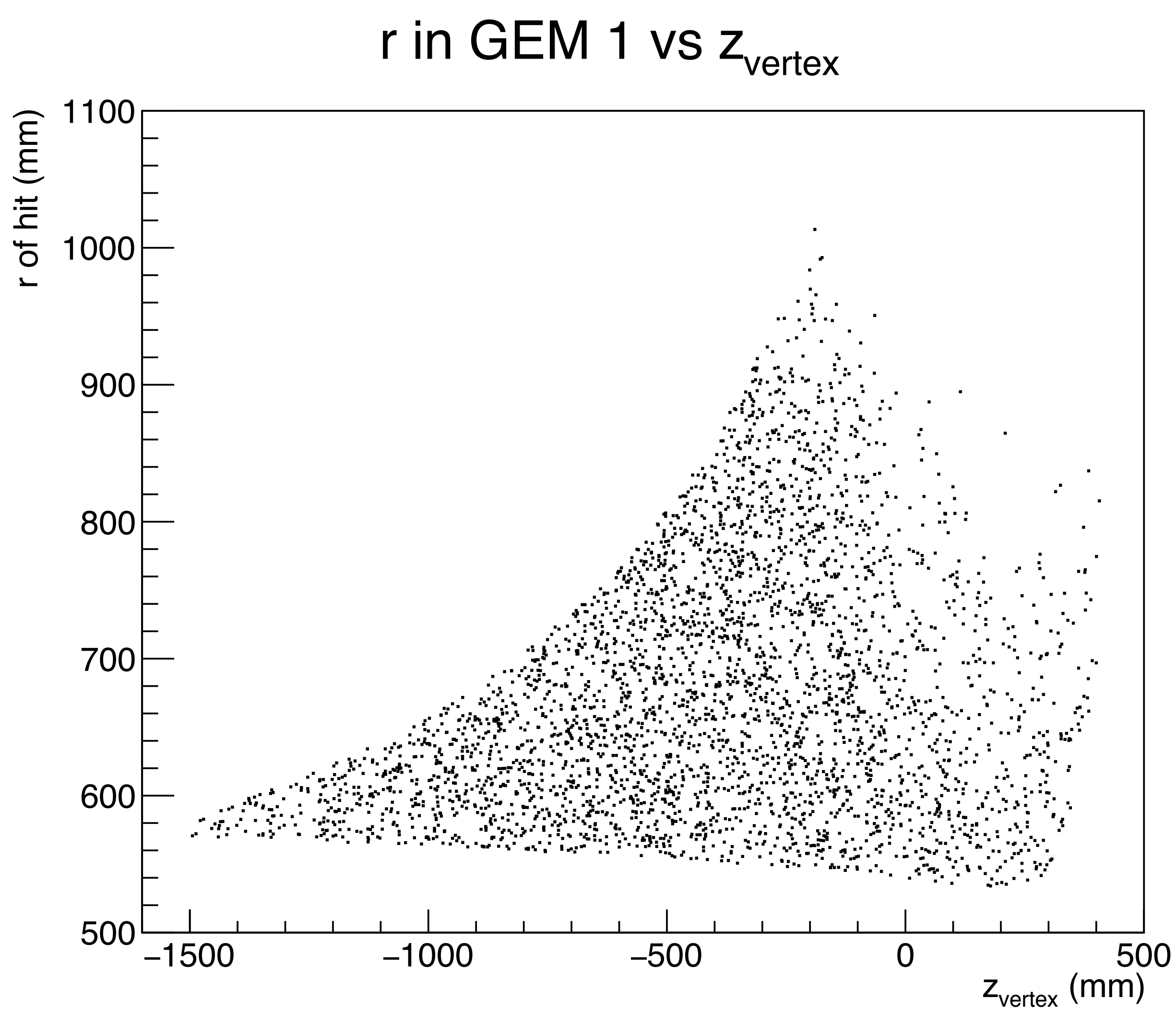
GEMs are mounted so that relative positions of all anode strips are precisely known. (Don't mount GEM's separately on baffles.)

Problem:
know alignment of GEM package relative to beam axis (2 angles, 2positions)

If tracks were straight, alignment would be simple. Tracks are approximately straight.

- Acceptance for straight tracks through baffles to illuminate most of GEM area is maximized at z_{vertex} ~ -200 mm (10 cm upstream of LD2 target)

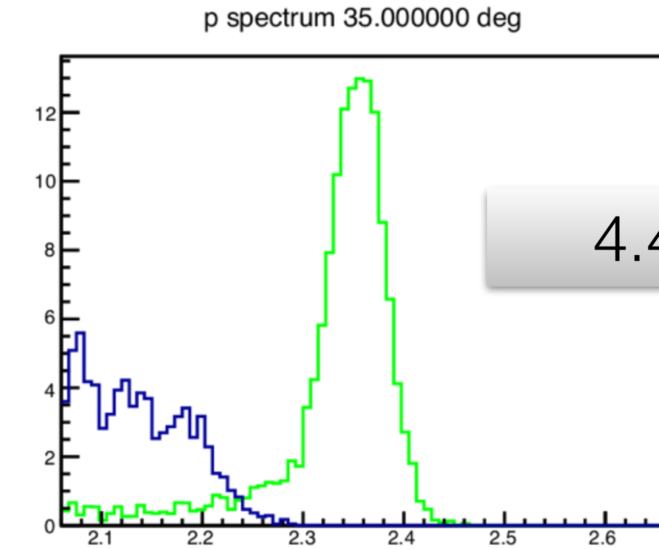




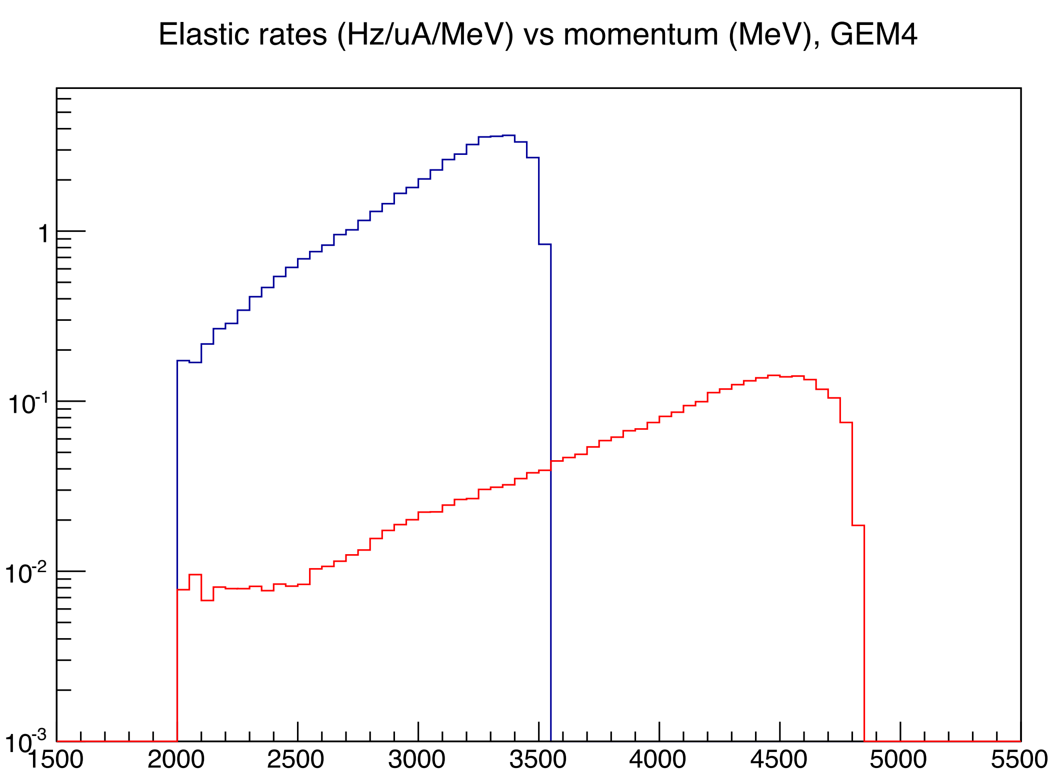
- Electron tracks with magnet off will establish GEM alignments. X-rays through a sieve with magnet off, on will verify stability.

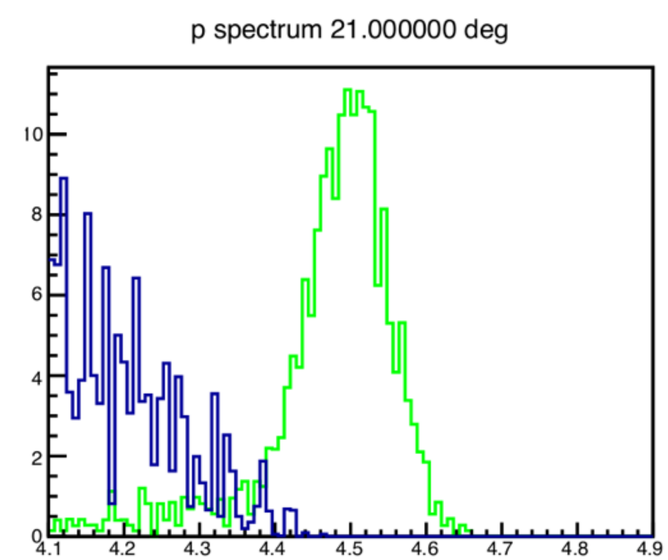
Calibration

- Momentum calibration using elastics at 4.4, 6.6, 11 GeV
- Elastics (green) cleanly separated from inelastics (blue)

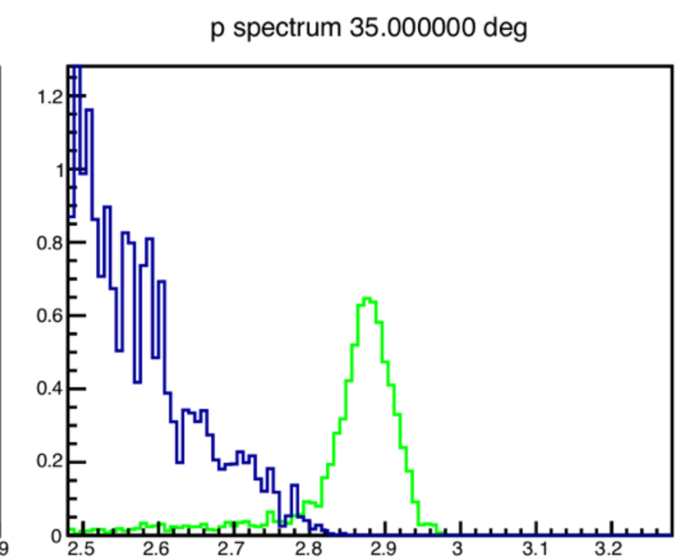


4.4 Gev, 35°





6.6 Gev, 21°

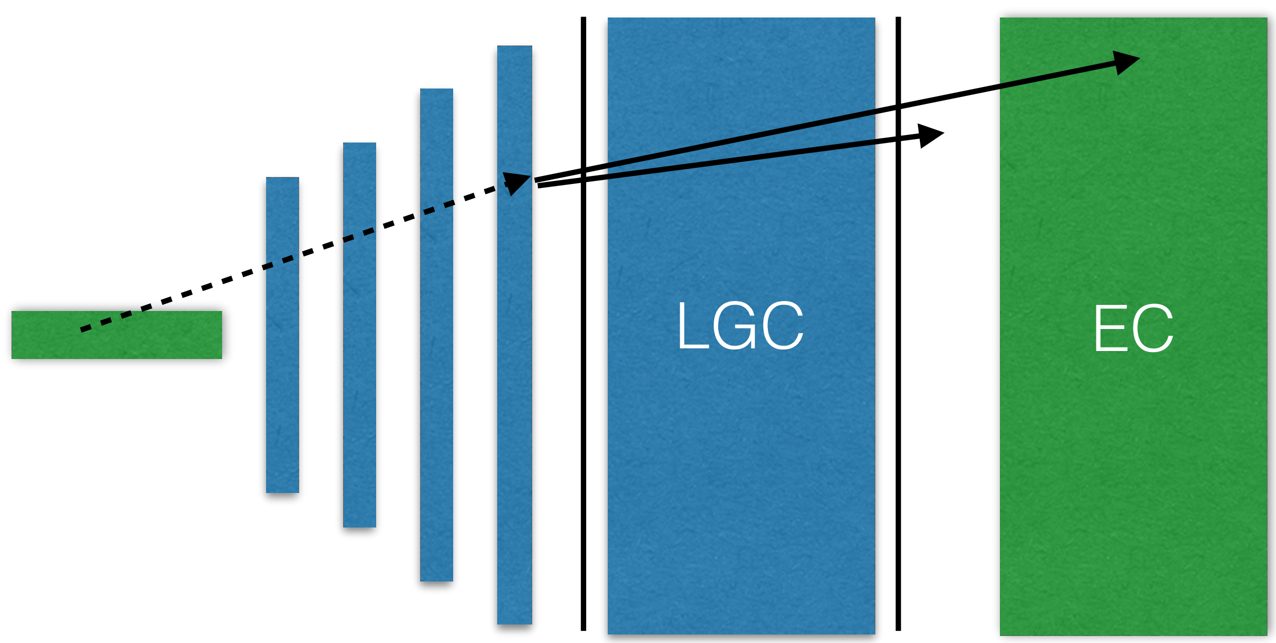


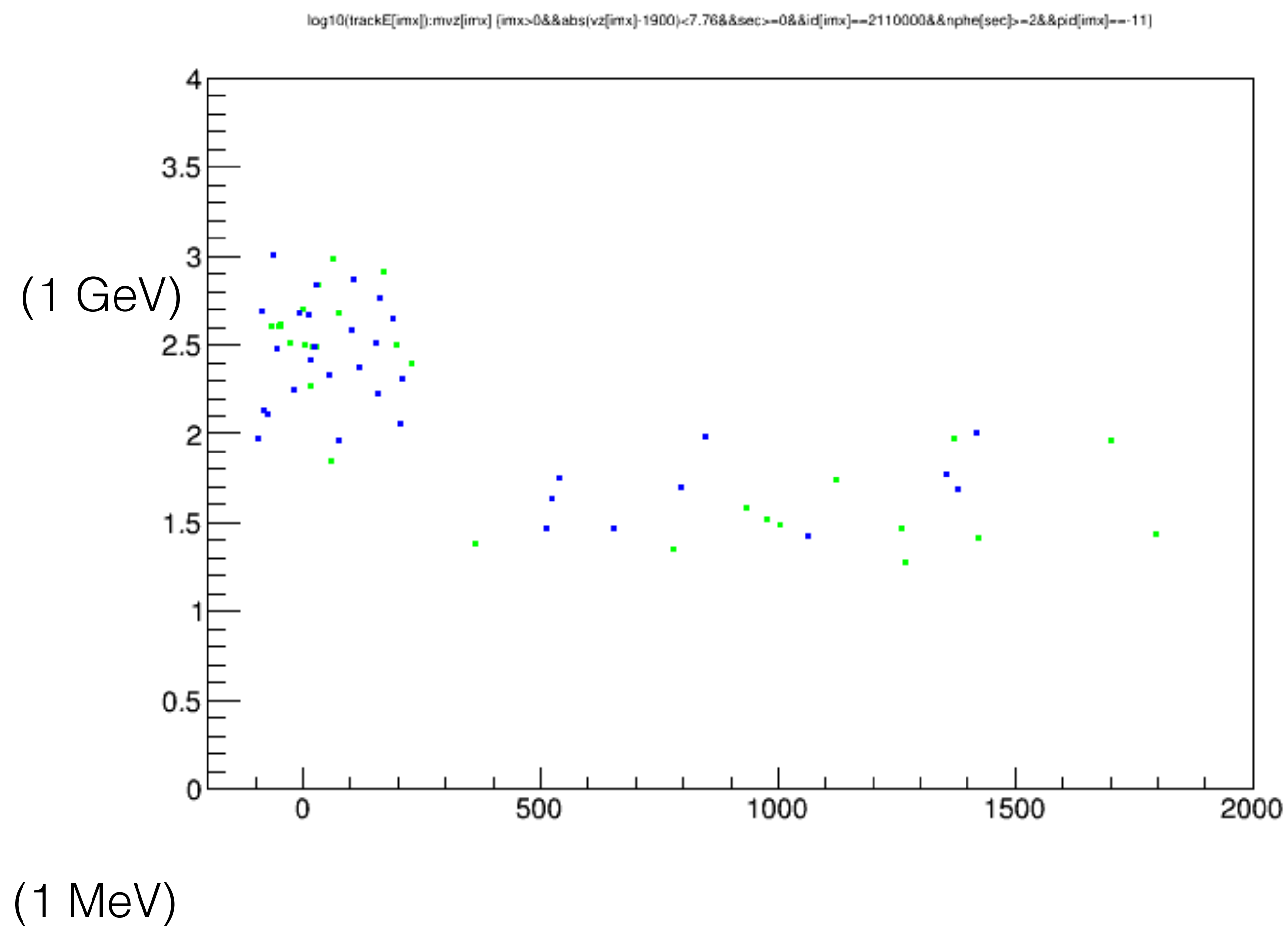
6.6 Gev, 35°

- Ample rates, 150 Hz/μA at 6.6 GeV => few minutes

LGC backgrounds

- Low energy, large angle electrons/positrons predominantly from π^0
- Reduce by optimizing hardware?



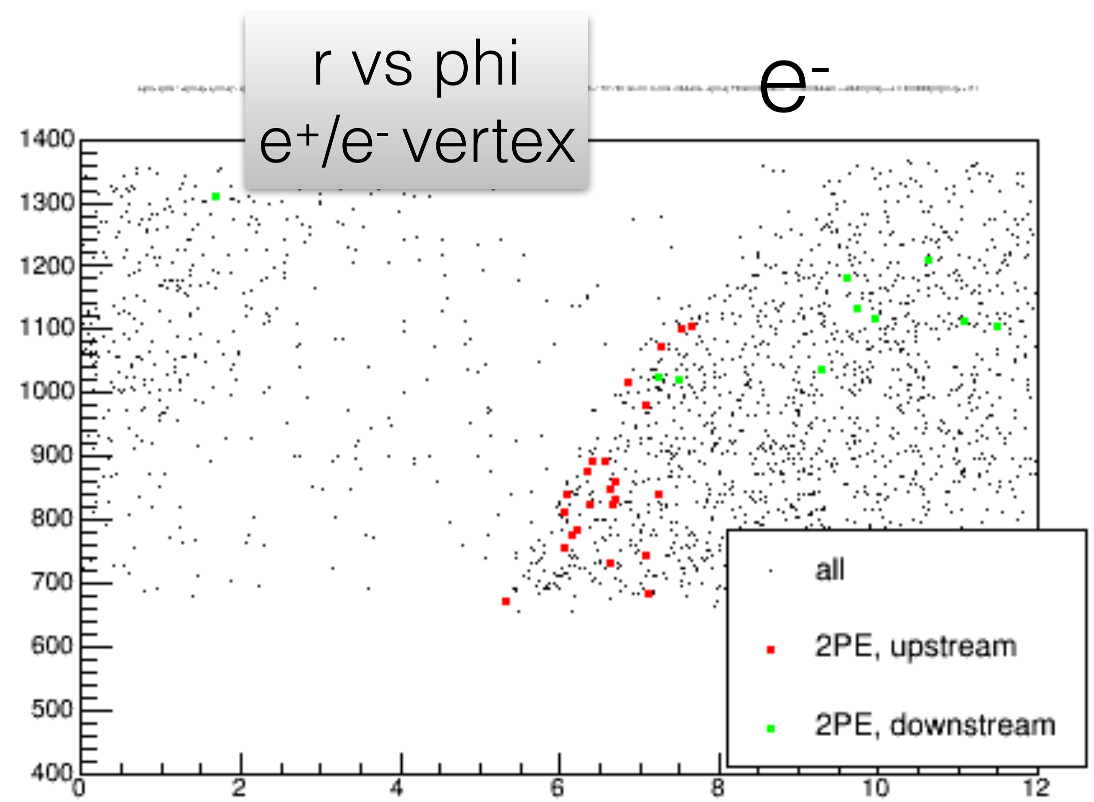


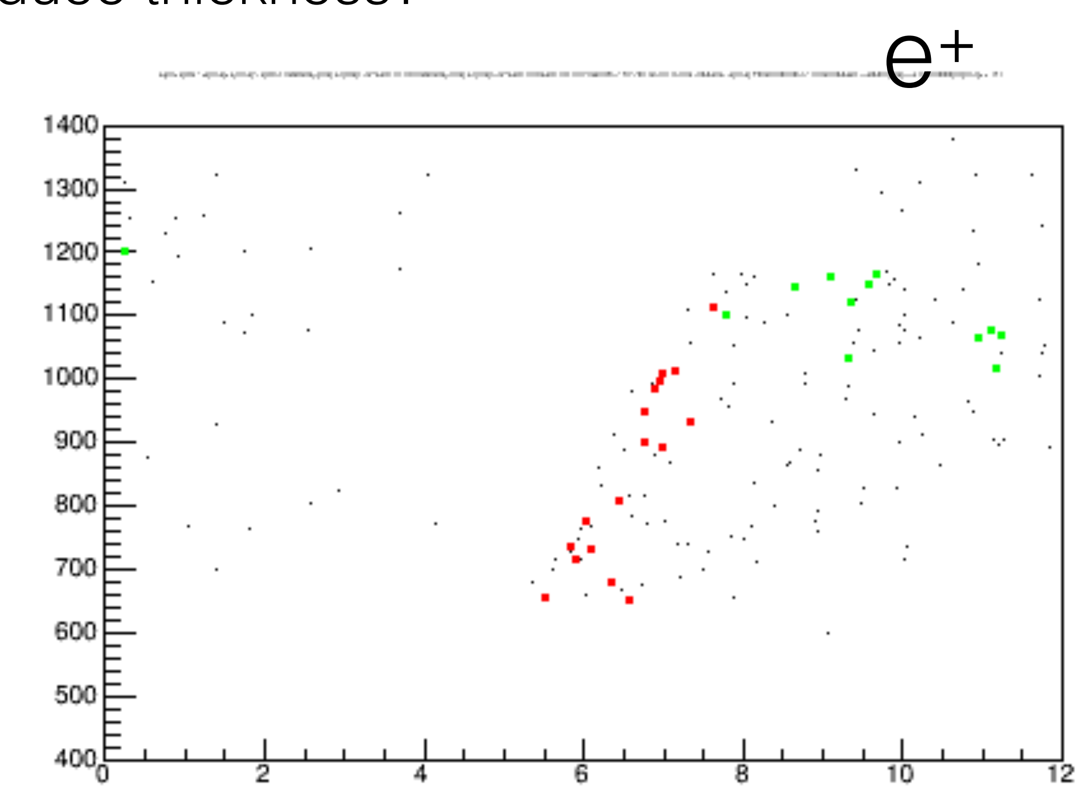
log(E) vs photon vertex z

2 populations: few hundred MeV tracks from primaries; few tens MeV from secondary photons

Higher energy tracks produced at slit edges; lower energy tracks produced in GEMs

Reduce thickness?





Cross

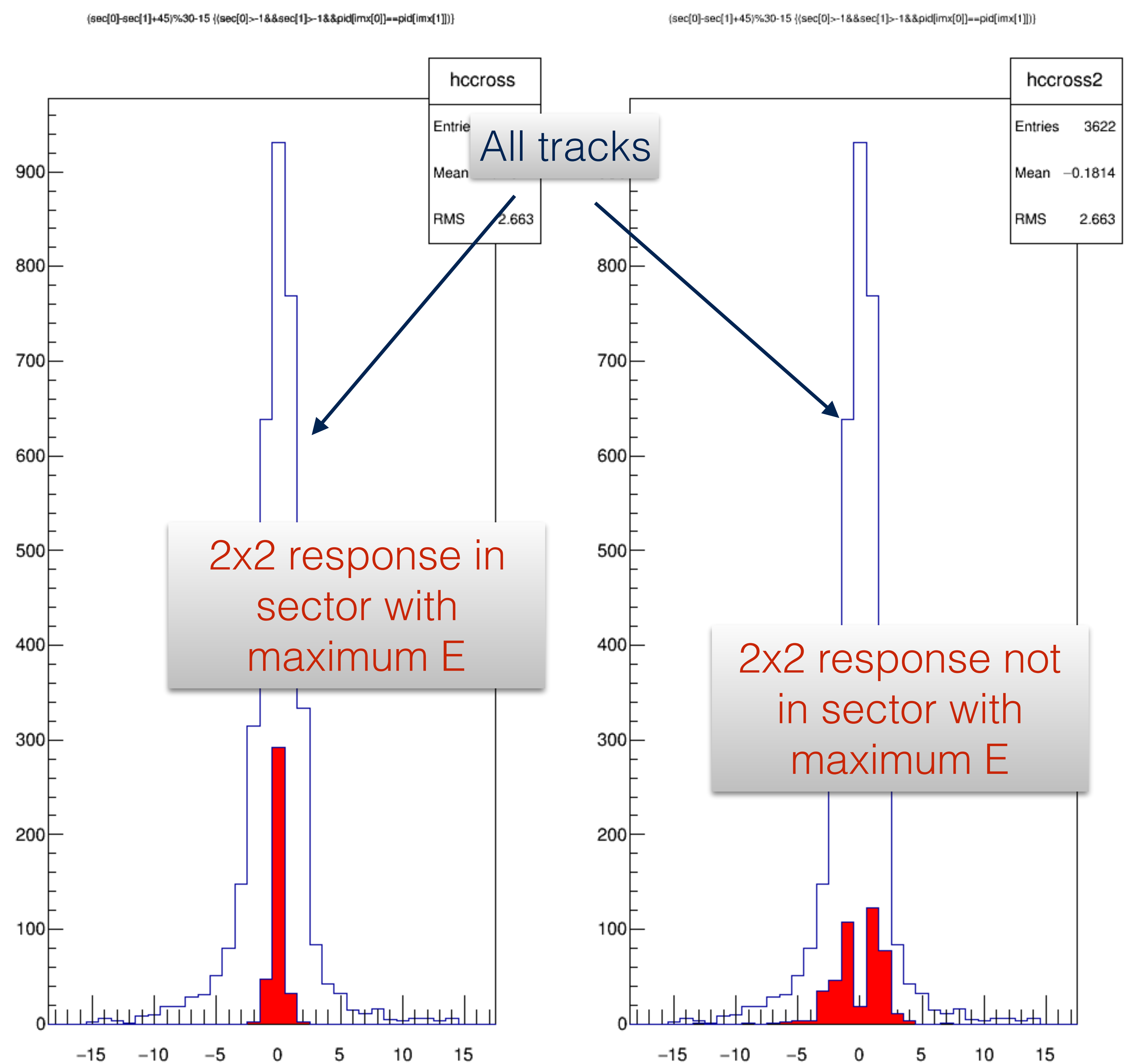
For DIS electrons 96% of LGC rate (2x2) is in sector hit by e^-. For e^+/e^- from π^0, 40%.

Is this due to e^+/e^- or optical photons crossing sectors?

If the latter we could try optically blocking sectors

2x2 response not in the same sector as maximum energy e^+/e^- is almost always associated with track crossing sectors

Optical blocking might reduce rate but not by factor ~ 2



Front to back sector differences

Tracking progress

- Mismatch between simulation and data on cluster size: Addressed by more realistic model of charge spreading
- Crosstalk effects now in the model
- Progress on PVDIS track finding
- PVDIS occupancy numbers should be available very soon
- See Weizhi's talk