# Simulation progress: software updates and recent PVDIS results

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# Outline

- Software updates
    - User header variables
    - Random number saving
    - Trajectory history saving
- Recent PVDIS results
    - Copper reduction (DocDB 131-v1)
    - New field map (DocDB 135-v1)

# User header variables

n GEMC versions <= 2.5, LUND inputs including event weight written to variables var1, var2, var3... in the "header" bank of the EVIO output file.

In GEMC >= 2.6,  written to variables userVar001, userVar002, userVar003... in the "userHeader" bank.

evio2root did not handle userHeader properly! This has now been fixed. Event weight is userHeader.userVar010 instead of header.var08. Not backward compatible but an easy change to make.

# Random number saving

Problem: E.g. visualization of rare events. You don't want to click through 10000 event visualizations to get to the next such event.

Solution: save the random number generator state (as of the start of the event) for such events. Use to initialize RNG and rerun single events with visualization.

-SAVE_SELECTED="<id>, <pid>, <low limit>, <high limit>, <variable>, <directory>"

Use GEANT4 /random/resetEngineFrom command to set up an event to rerun.

# Trajectory history saving

Event banks like “flux” save some information about the mother a particle causing a hit. But sometimes one wants to trace the ancestry deeper to understand a background.

New command line option:

-SAVE_ALL_ANCESTORS=1

Writes a new bank with information on all tracks ancestral to a hit. evio2root correctly writes this to a new tree in ROOT file.

# Status

User header variables:

- Completed, tested, incorporated into official GEMC development version.

Random number saving

- Completed first version (some caveats, needs further work to make more usefule), tested, pull request pending.

Trajectory history saving

- Completed, testing.

# Backgrounds from Cu in GEMs

From a presentation a couple years ago

## EIC Forward Tracker with standard GEM foil

| | Quantity | Thickness $\mu m$ | Density g/cm3 | X0 mm | Area Fraction | X0 % | S-Density g/cm2 |
|---|---|---|---|---|---|---|---|
| **Window** | | | | | | | |
| Kapton | 2 | 25 | 1.42 | 286 | 1 | 0.0175 | 0.0071 |
| Drift | | | | | | | |
| Copper | 1 | 5 | 8.96 | 14.3 | 1 | 0.0350 | 0.0045 |
| Kapton | 1 | 50 | 1.42 | 286 | 1 | 0.0175 | 0.0071 |
| **GEM Foil** | | | | | | | |
| Copper | 6 | 5 | 8.96 | 14.3 | 0.8 | 0.1678 | 0.0215 |
| Kapton | 3 | 50 | 1.42 | 286 | 0.8 | 0.0420 | 0.0170 |
| **Grid Spacer** | | | | | | | |
| G10 | 3 | 2000 | 1.7 | 194 | 0.008 | 0.0247 | 0.0082 |
| **Readout** | | | | | | | |
| Copper-80 | 1 | 5 | 8.96 | 14.3 | 0.2 | 0.0070 | 0.0009 |
| Copper-350 | 1 | 5 | 8.96 | 14.3 | 0.75 | 0.0262 | 0.0034 |
| Kapton | 1 | 50 | 1.42 | 286 | 0.2 | 0.0035 | 0.0014 |
| Kapton | 1 | 50 | 1.42 | 286 | 1 | 0.0175 | 0.0071 |
| NoFlu glue | 1 | 60 | 1.5 | 200 | 1 | 0.0300 | 0.0090 |
| **Gas** | | | | | | | |
| (CO2) | 1 | 15000 | 1.84E-03 | ~~18310~~ | ~~1~~ | ~~0.0819~~ | ~~0.0028~~ |
| | | | | | **Total** | ~~0.471~~ | **0.090** |
| | | | | 141270 | 1 | 0.0106 | |
| | | | | | Total | 0.400% | |

Error in gas X0 corrected

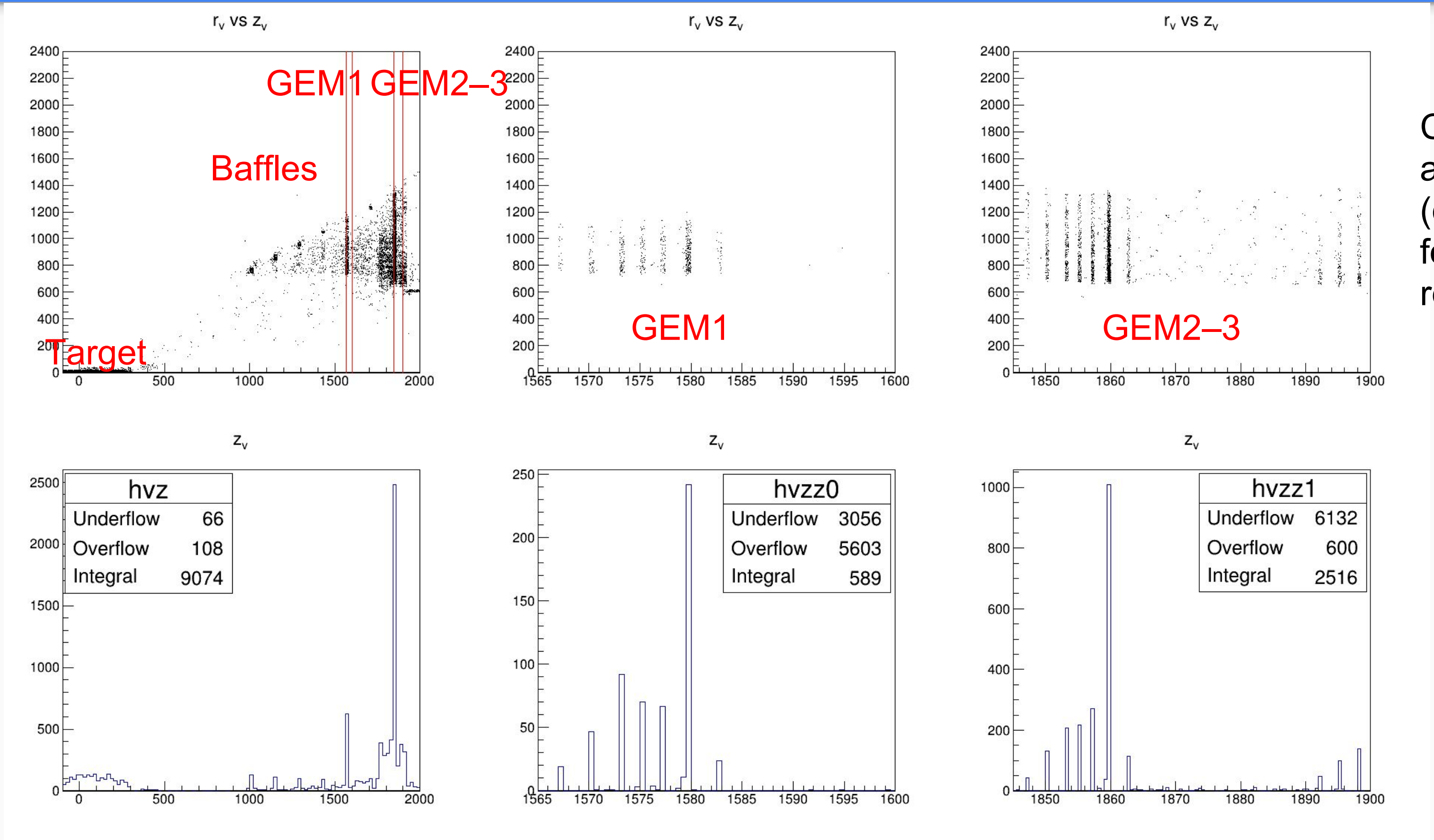
Cu is ~ half radiation thickness of GEM

Might be possible to reduce this.

Also might need to increase this! Study needed.

What are effects of Cu on GEM backgrounds?

# GEM3 (immediately downstream of GEM2 and upstream of LGC)



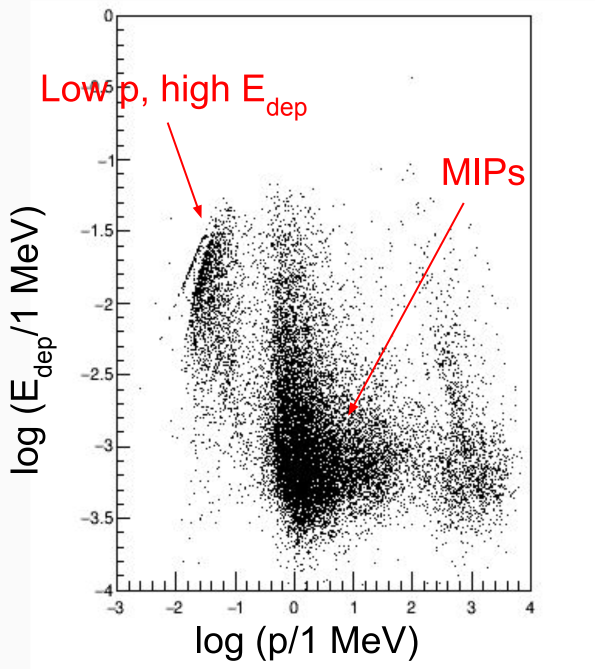

Cu layers are visible (cathode, 3 foils, readout)

# Energy deposition

What matters for DAQ is not just rate but also energy.

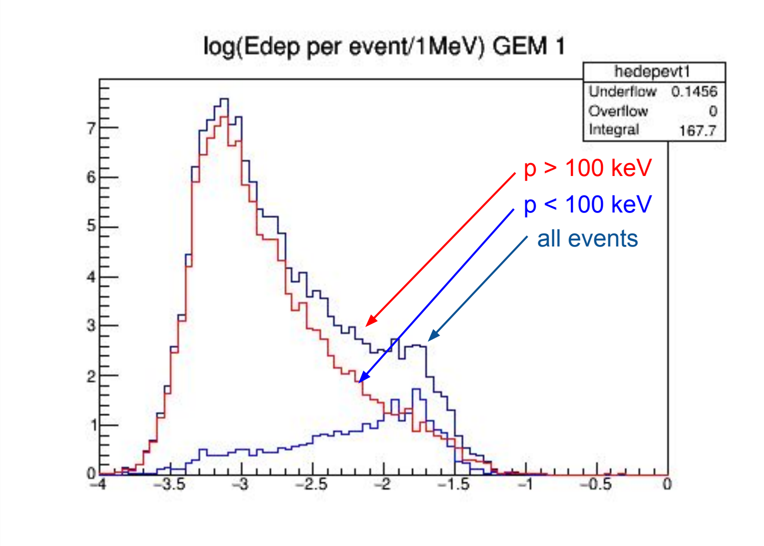
Low energy photons (10–100 keV) are associated with high energy deposition in the GEMs.

This in turn deposits charge on larger numbers of strips, increasing occupancy more than higher energy photon hits.

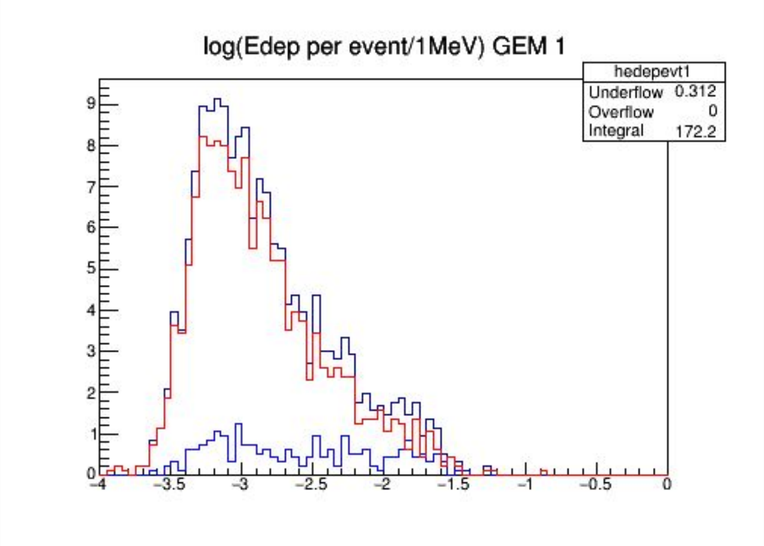


# Energy deposition with/without copper

With Cu




Without Cu




Significant reduction in high $E_{dep}$ events

*Edit: Normalized y axis to rate in MHz/sector*

# Occupancy

Occupancy for three data sets:

- Standard
- No Cu in GEMs
- Cut tracks with E < 100 keV

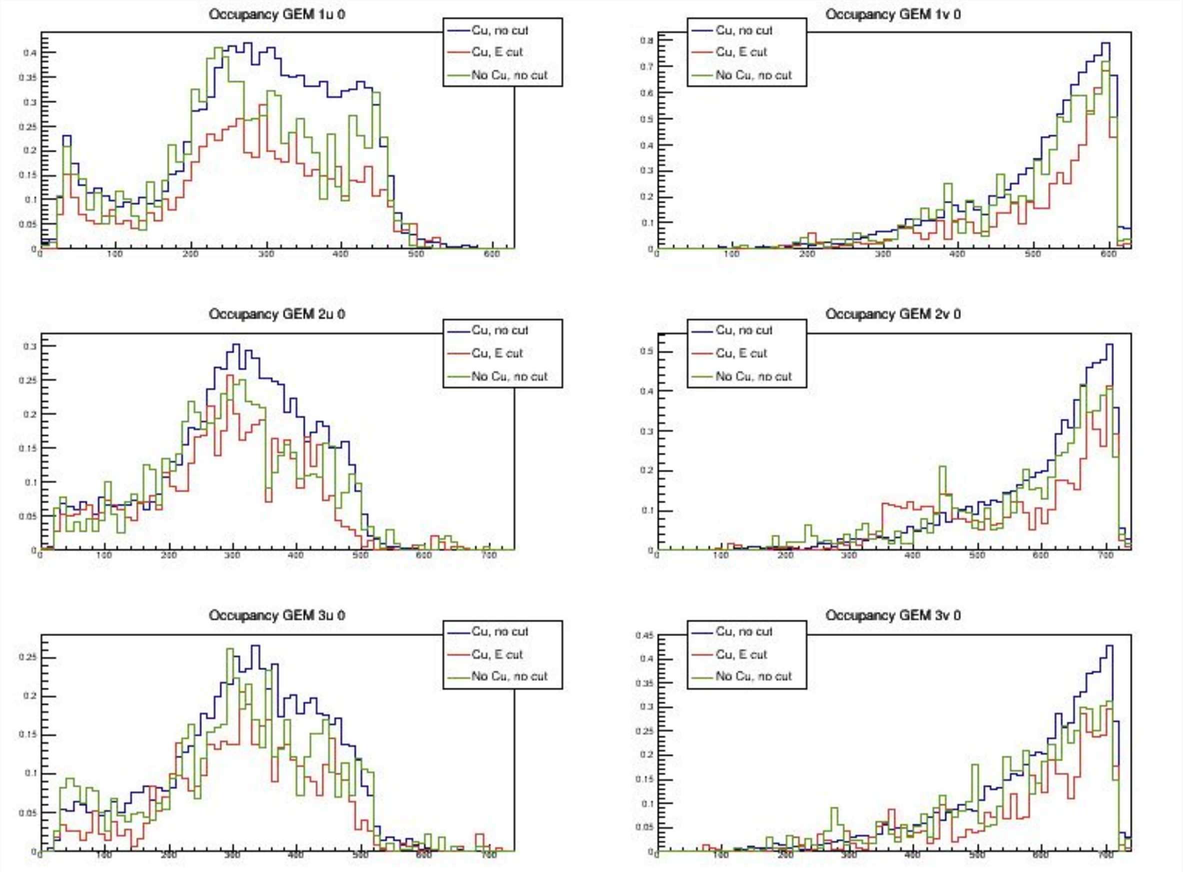
(Latter two are smaller statistics -> noisier)

For GEM1 u strips, see ~30% reduction in occupancy with E cut; maybe ~20% with no Cu.

For GEM1 v strips, see ~10% reduction in peak occupancy (70–80%) but larger reductions away from peak.

High occupancy is hard to reduce (if >>1 hit per event, even a large rate reduction doesn't much change probability of hit)

Smaller reductions in GEMs 2–3.



# New field map

- To date the SoLID B field has been modeled with a 2-dimensional model assuming continuous azimuthal symmetry
- Jay Benesch has modeled the SoLID B field in 3 dimensions
- Zhiwen has created a field map file from Jay's results
- Development version of solid_gemc, based on GEMC 2.7, has new code to read and interpolate this field map... now debugged and appears working
- What effect on PVDIS physics?

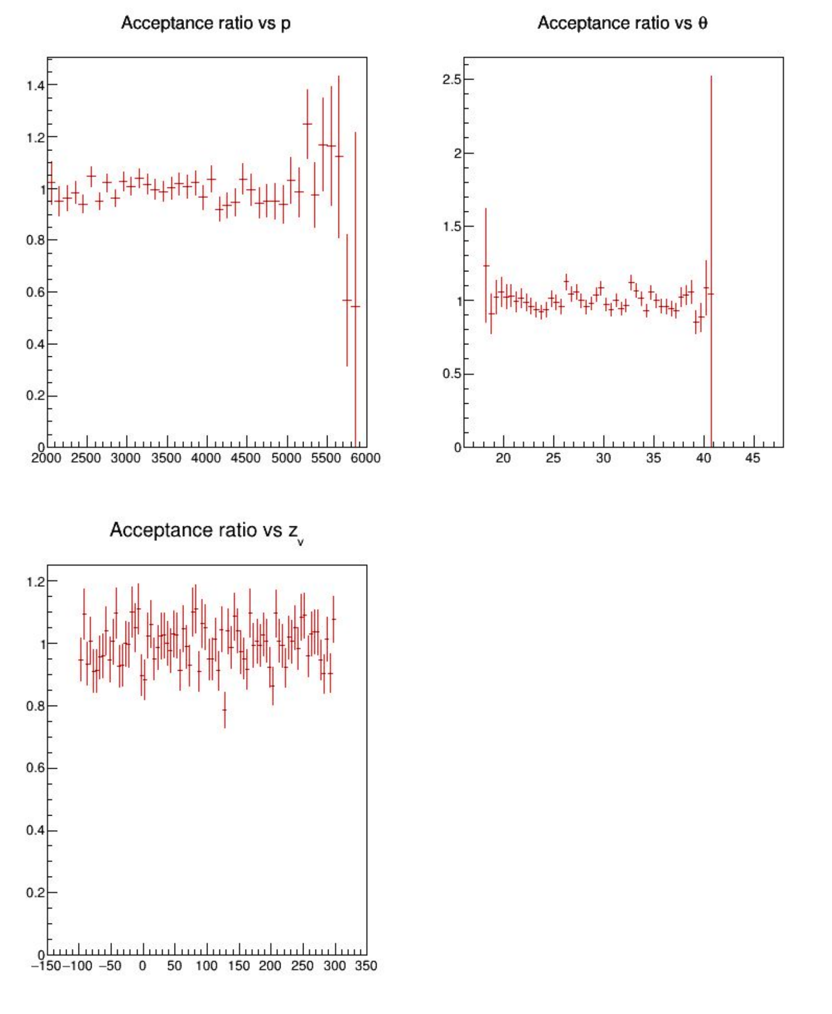
# Geometric acceptance for electrons

Throw 1e6 electrons in p = 2–6 GeV/c, θ = 15° – 45°, ϕ = -180° – 180°, $z_v$ = -100 — 300 mm

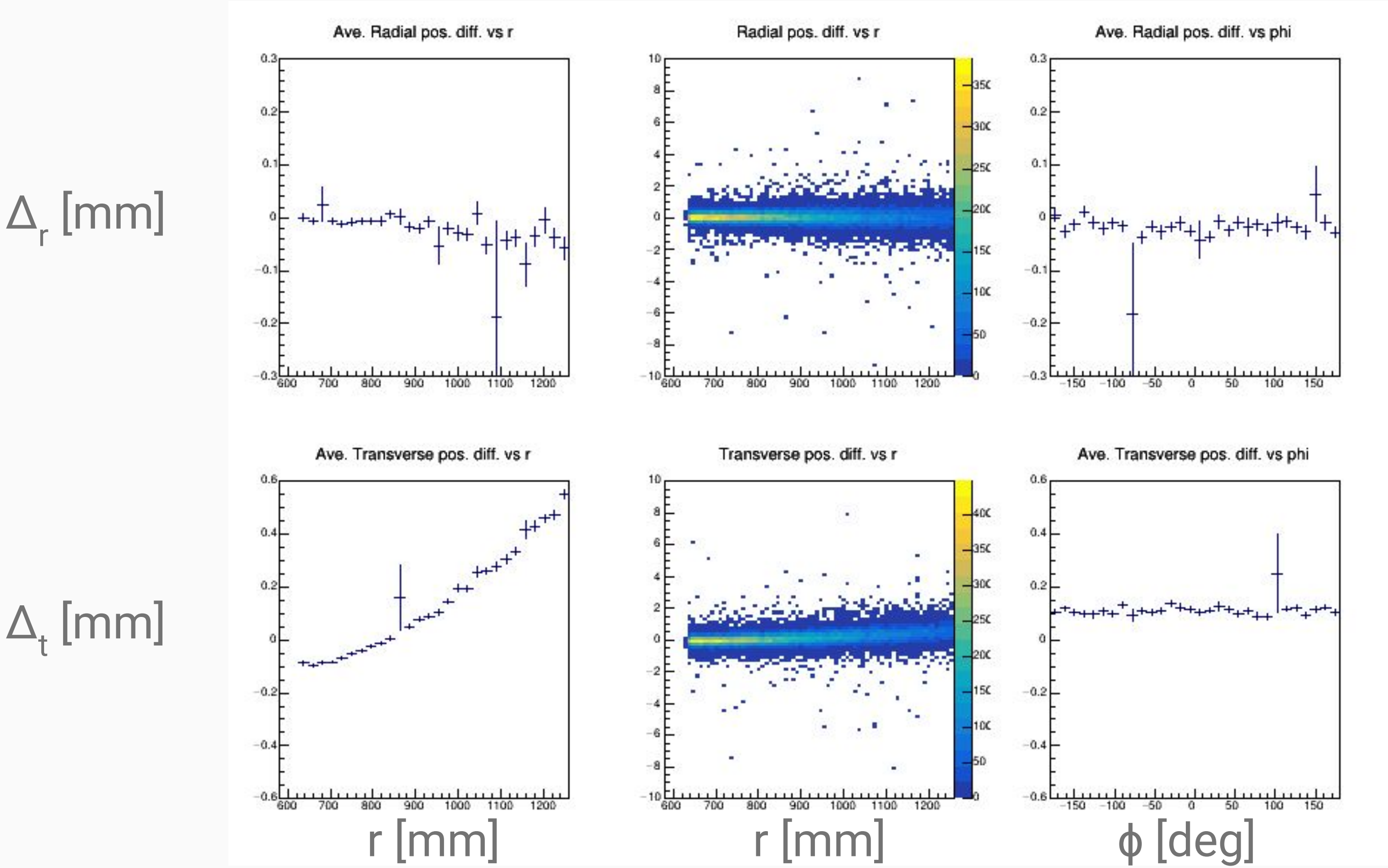
Apparatus is Kryptonite baffles and solenoid, virtual planes around baffles

Acceptance = (# electrons reaching downstream end of baffles) / (# electrons reaching same z without baffles)

Plot is ratio of acceptances for new, old field.

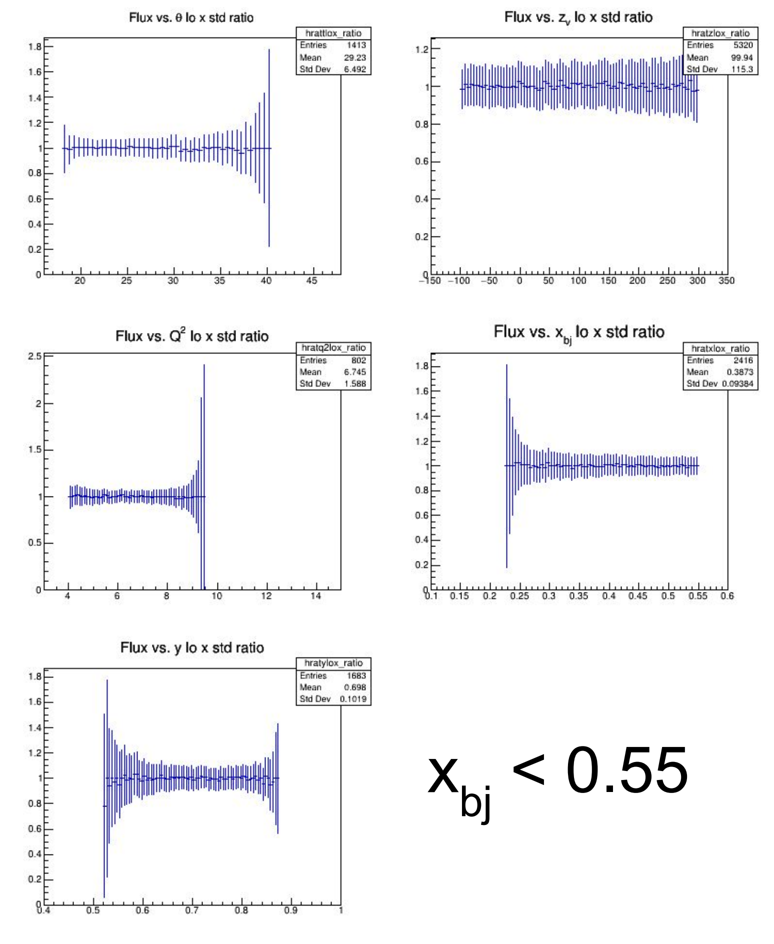


# Small position shifts at large r (DIS generator)

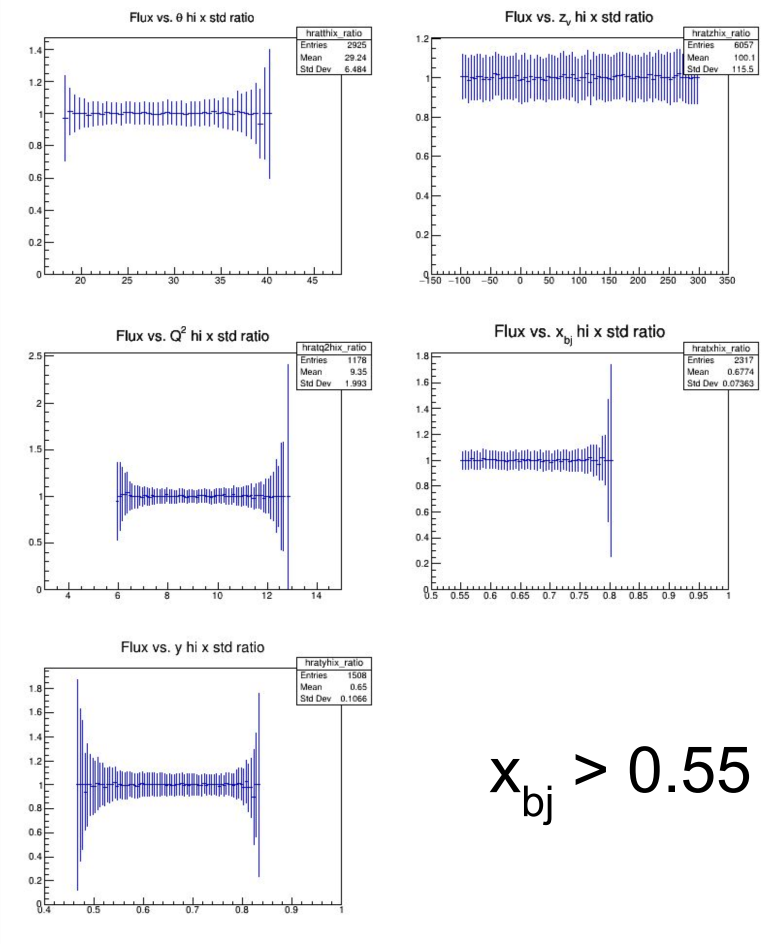



No azimuthal dependence

# DIS flux comparison




$x_{bj} < 0.55$




$x_{bj} > 0.55$