MOLLER tracking system

Hall A winter collaboration meeting 2026
Jan 21, 2026

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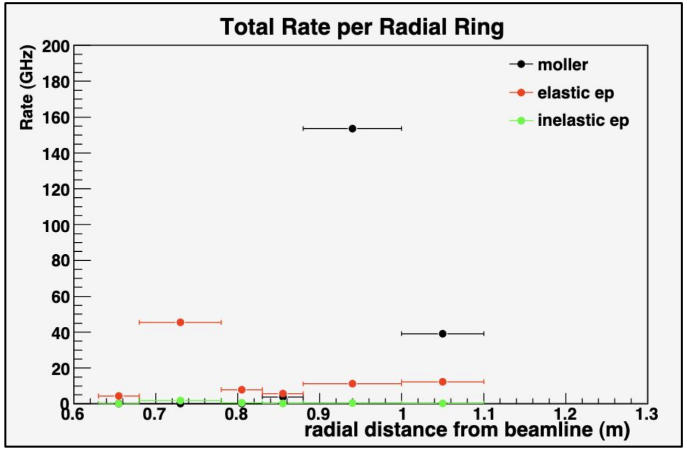
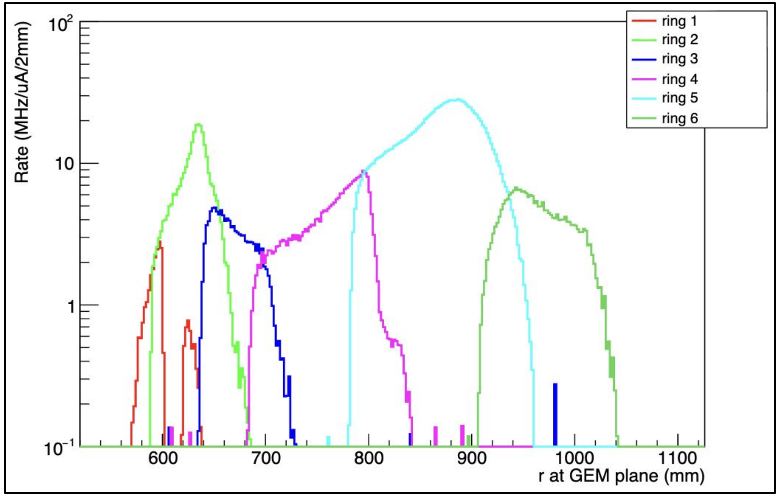
MOLLER

Stony Brook University

Jefferson Lab

Purpose



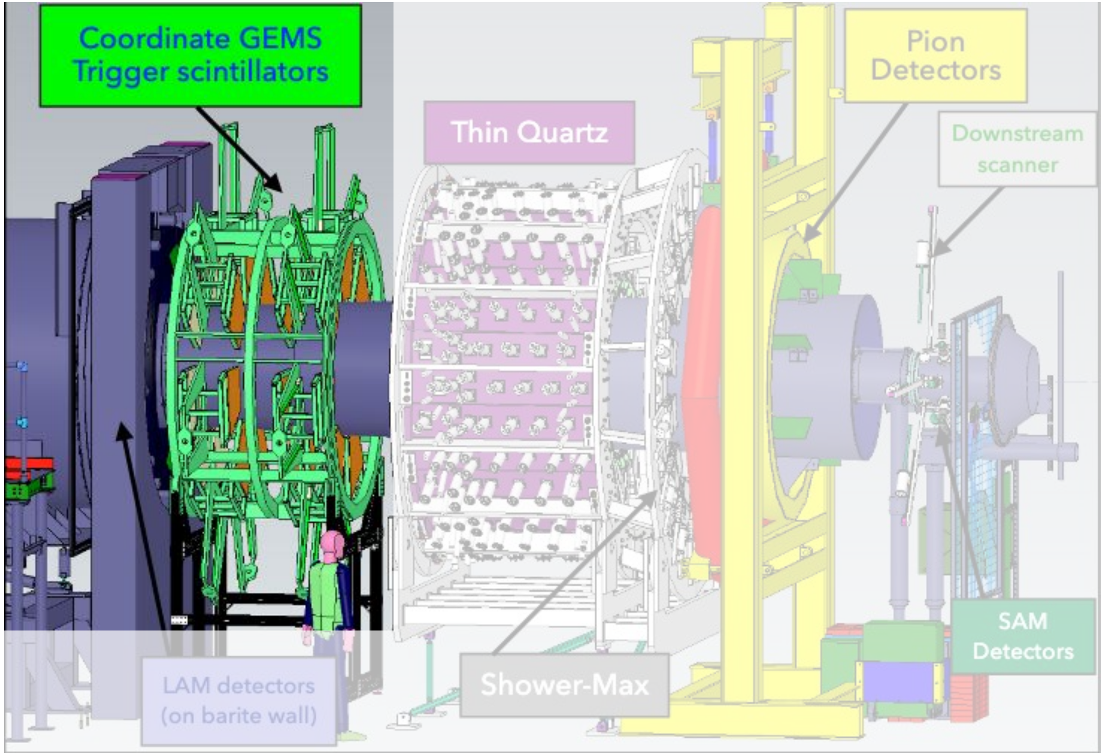


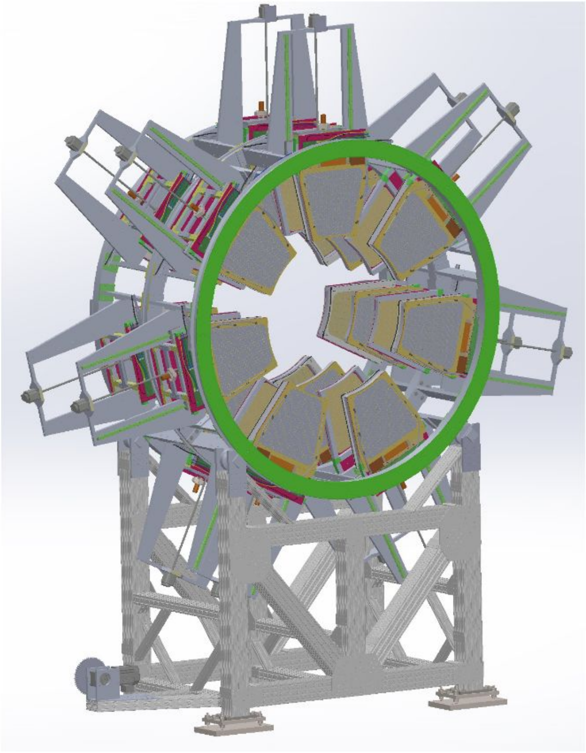
What main detectors “see”

What tracking system sees

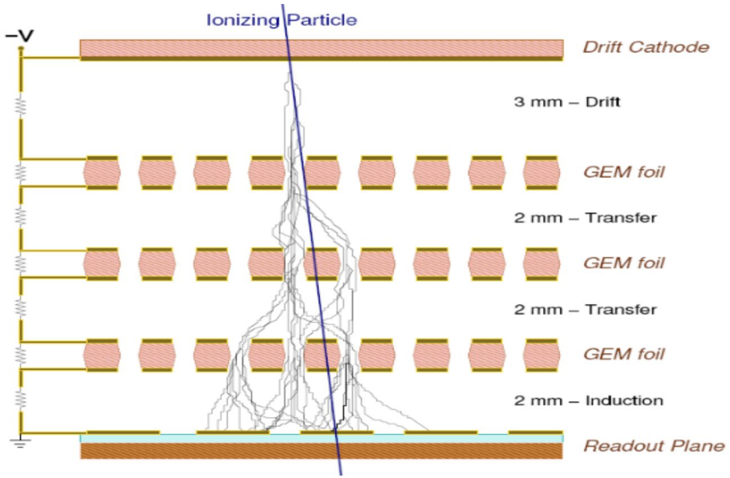
- Verify e+p/distributions
- Look for collimator-scraping or other unexpected backgrounds
- Can measure π / e ratio using pion detector

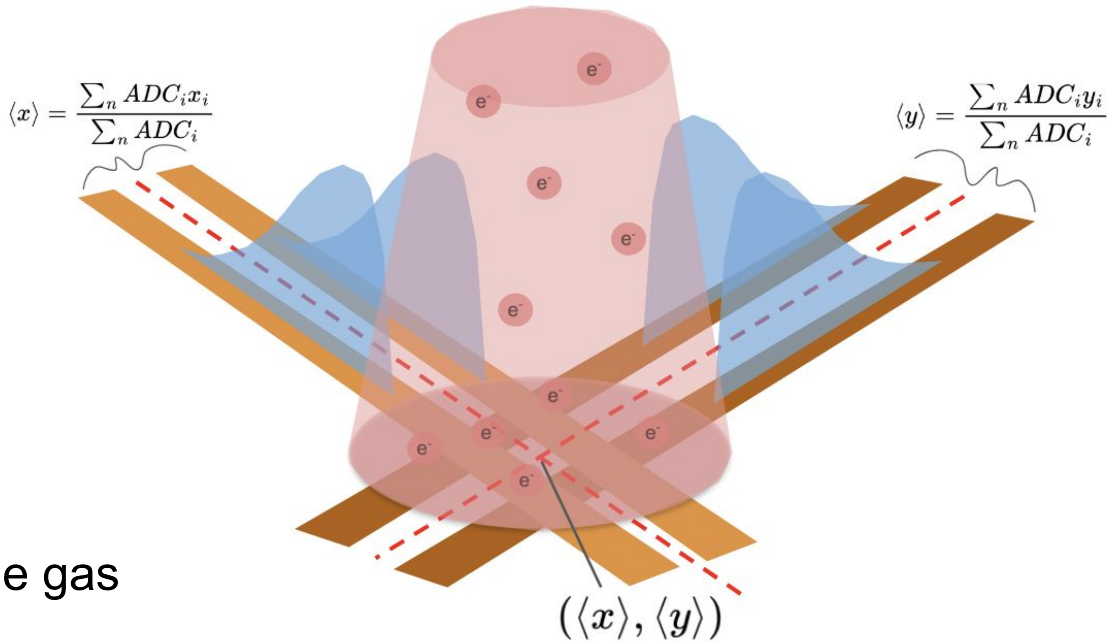
Tracking system





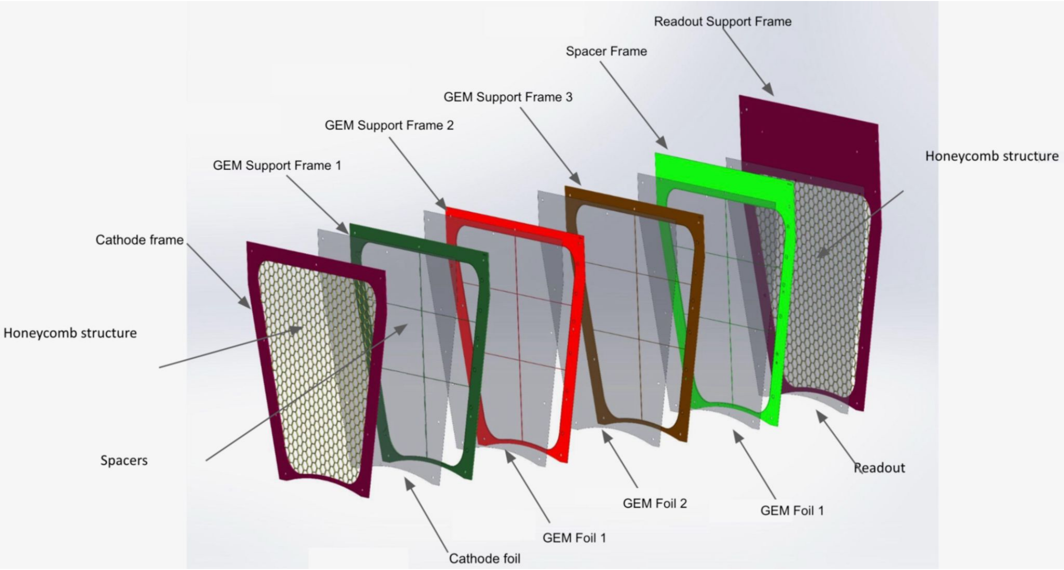
GEM (Gas Electron Multiplier) Technology

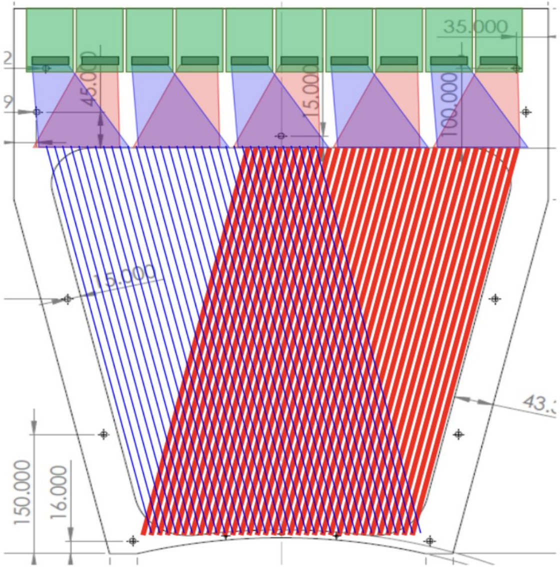


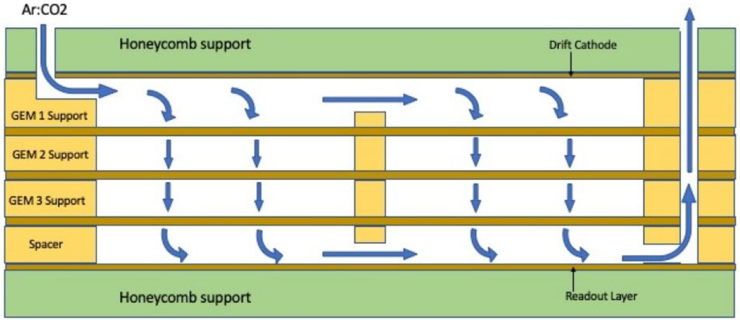


- Charged particles ionize a noble gas
- Electrons avalanche in the high E field in the holes
- Charge clouds incident on strips: can infer position of hit

MOLLER GEM design

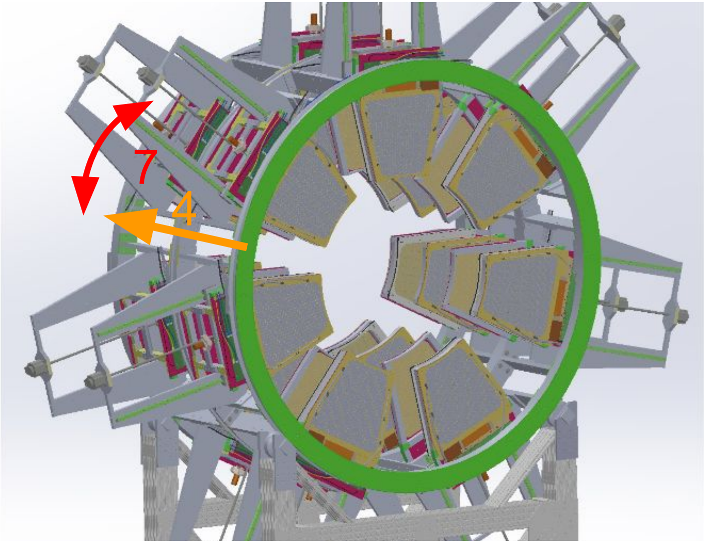






- Three gain stage GEM module
- U/V strip readout, 2000 cm^2 area, to be ran in 75:25 Ar:CO_2
- 20 isolated HV sectors

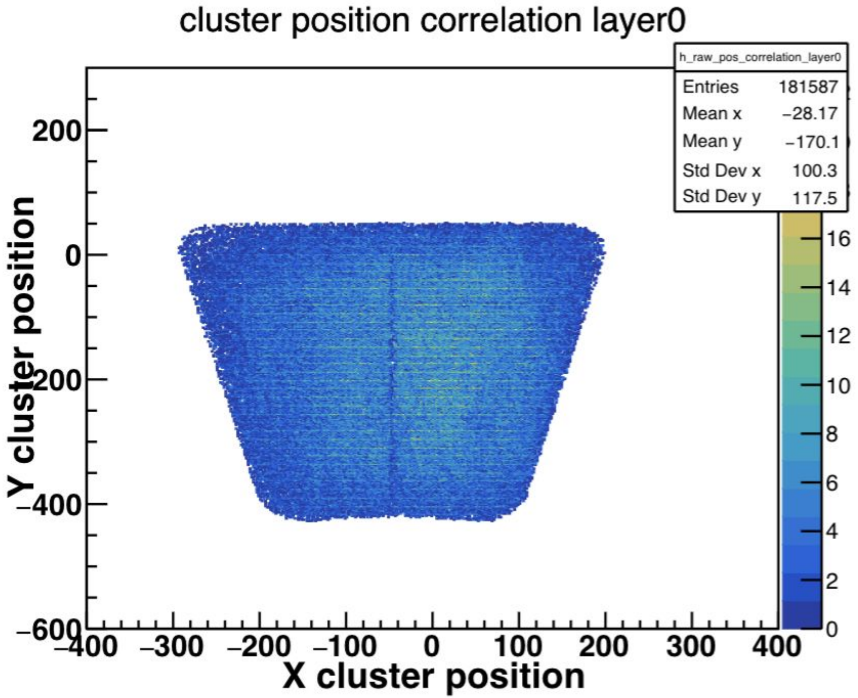
MOLLER GEM status



Need 4 x 7 = 28 modules
14 + 2 built at SBU, 16 + 2 at UVA

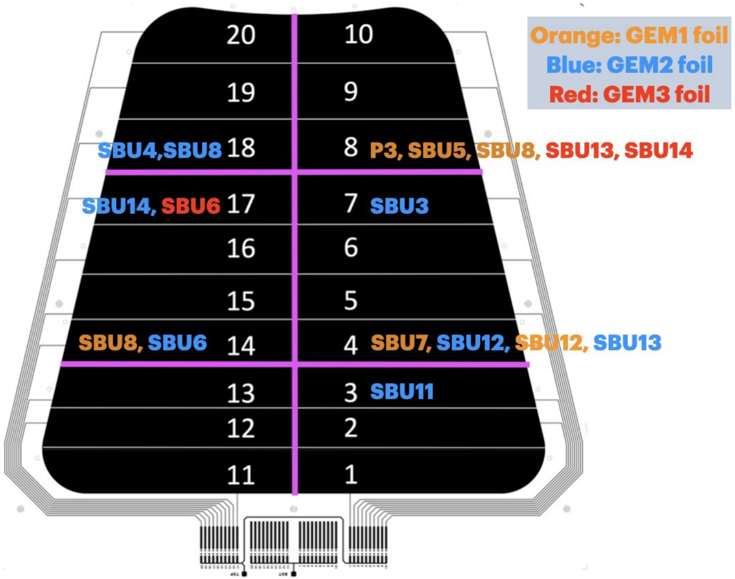
- The 16 Stony Brook modules were built Jan-June ‘25
- UVA has built 9 incl. prototypes,

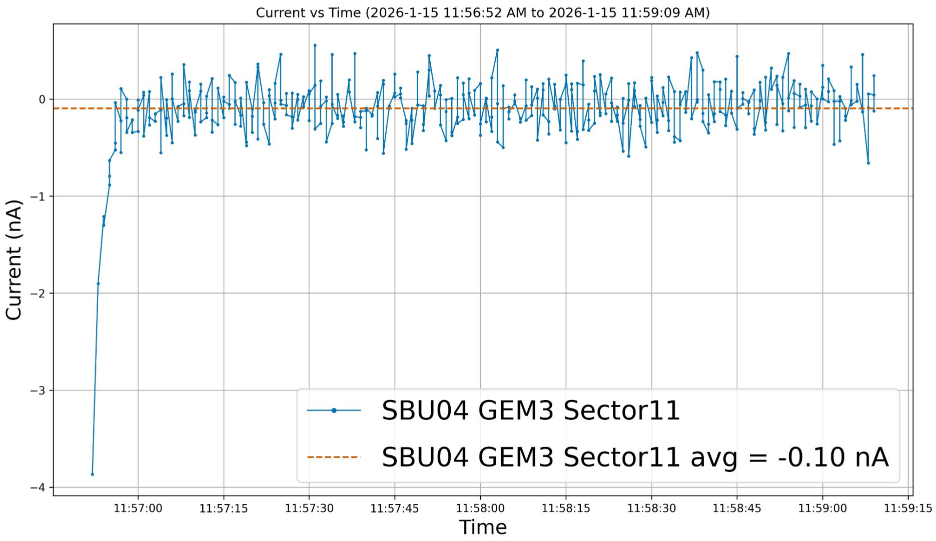
MOLLER GEM testing



- Cosmic testing underway in the test lab

MOLLER GEM testing - HV sector issues



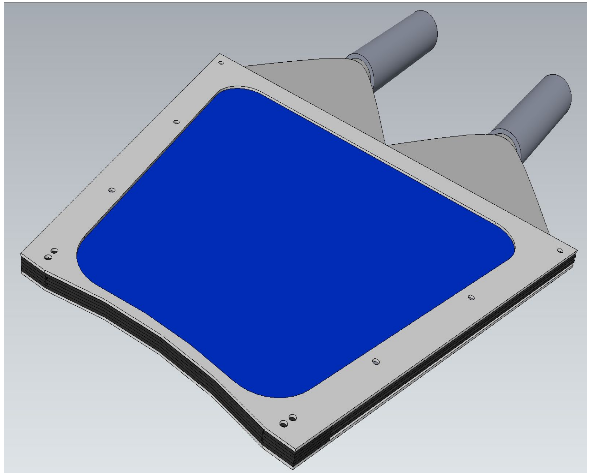


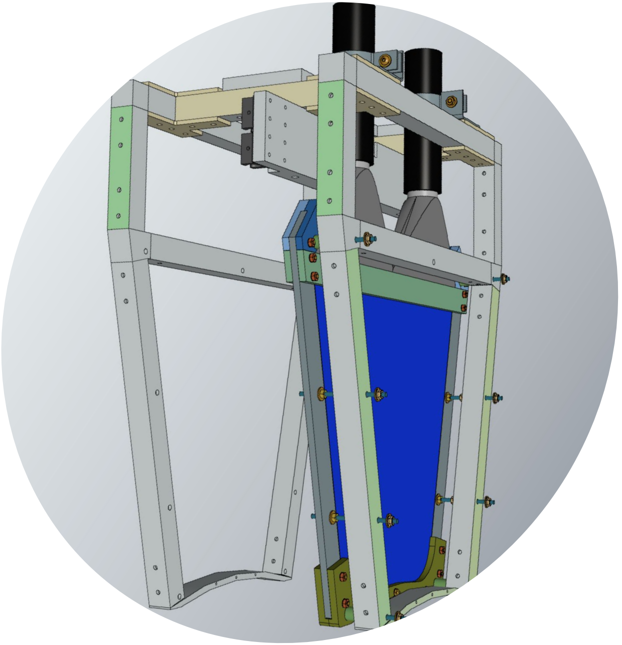
- Isolated HV sectors, can be disabled individually
  - ~5% of sectors have shorted during testing in Ar/CO_2
    - Potentially correlated with ribs

- Our Approach: retest every sector at 550V in N2
- High levels of redundancy, 4 layers, multiple rotations

Trigger Scintillators

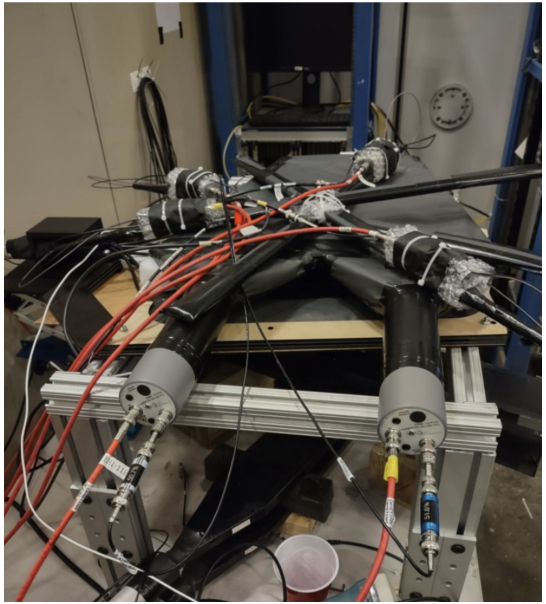
Independent tracking trigger system & study neutral backgrounds in main detectors





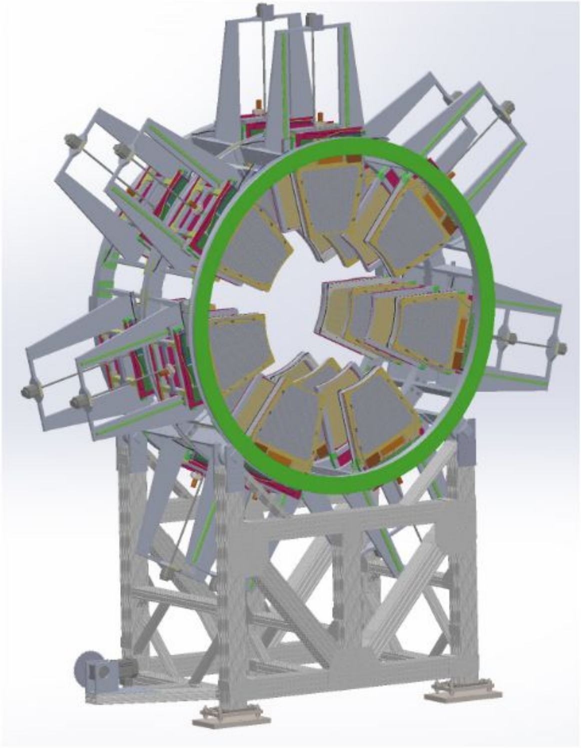
Original WLS fiber readout design changed to dual lightguide design

Prototype testing in test lab

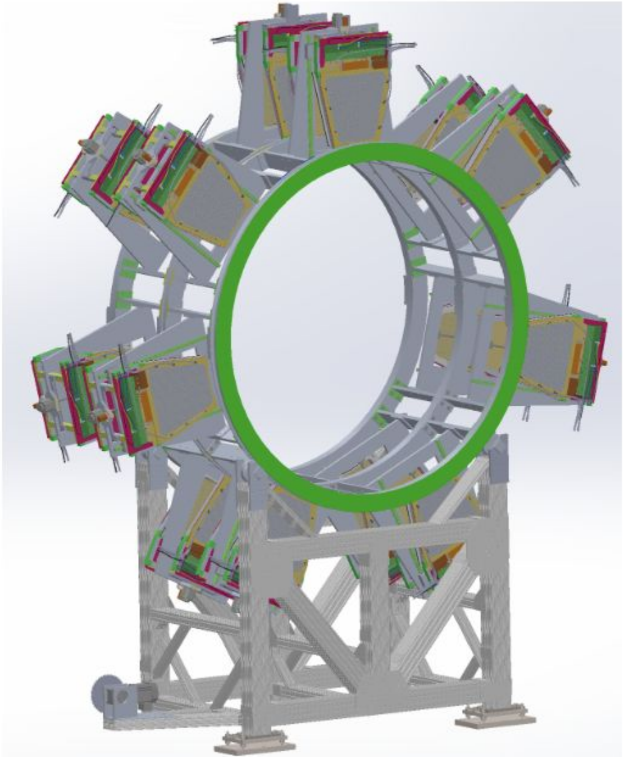


Rotator

Measurement position

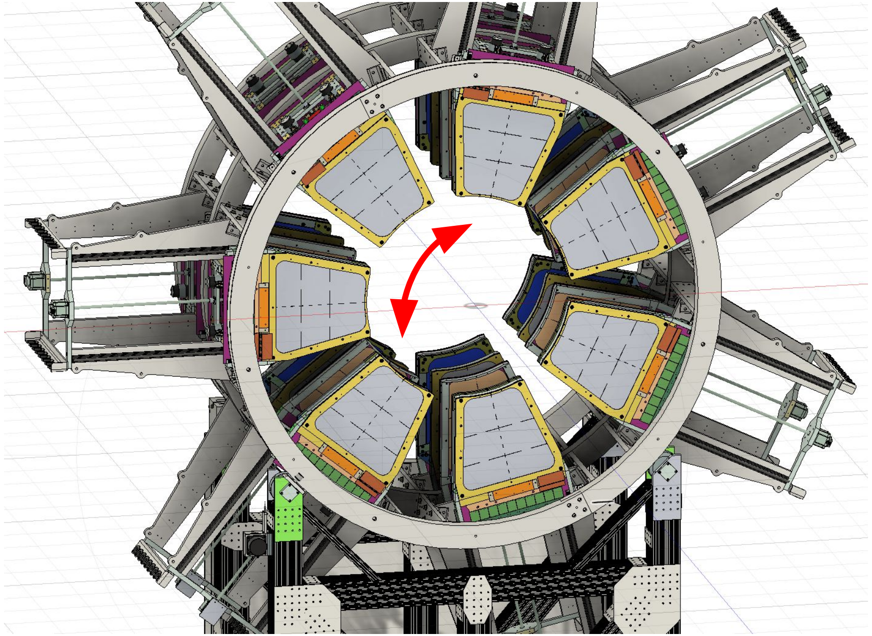


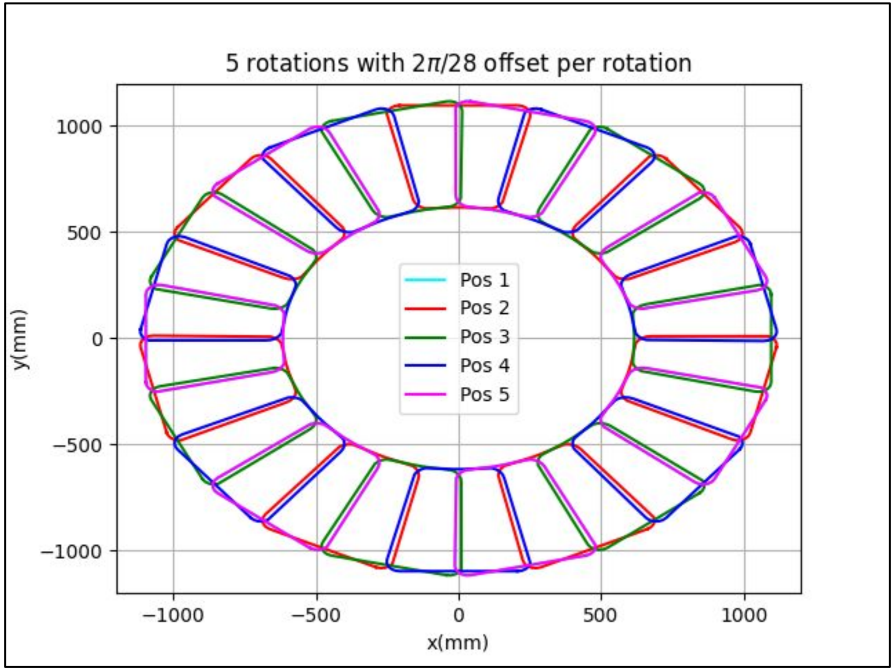
Parked position



- **Measurement position** for counting mode tracking data
- **Parked position** for integration mode asymmetry data taking

Rotator cont.





- Design Finalized
- Procurement in process

- With 5 positions, we can double cover every point with different sectors
- If we can rotate 3π/7, we can cover every point with different detectors

Thanks to the tracking hardware group!

University of Virginia

Stony Brook University

William & Mary

Ohio State

LA Tech

Jefferson Lab

Backups

Kinematic factor

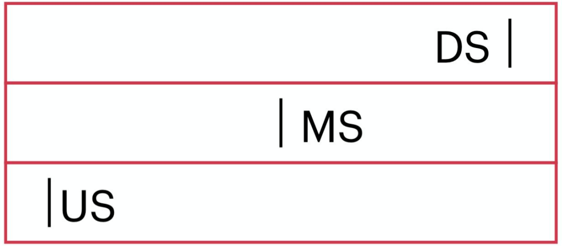
$$A_{PV} = \frac{\sigma_R - \sigma_L}{\sigma_R + \sigma_L} = mE\frac{G_F}{\sqrt{2}\pi\alpha}\frac{4\sin^2\theta}{(3+\cos^2\theta)^2}Q_W^e$$

Observables

Kinematic factor (θ/E')

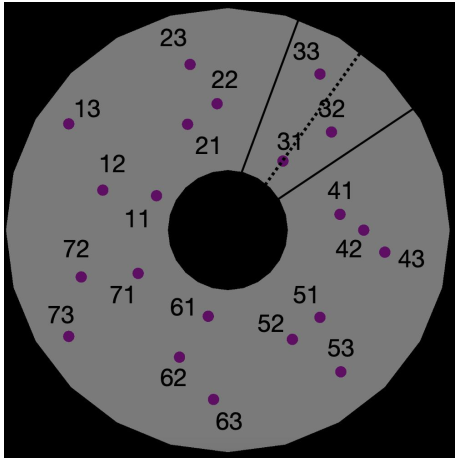
electron weak charge

Problems: Long target makes v_Z (and θ) hard

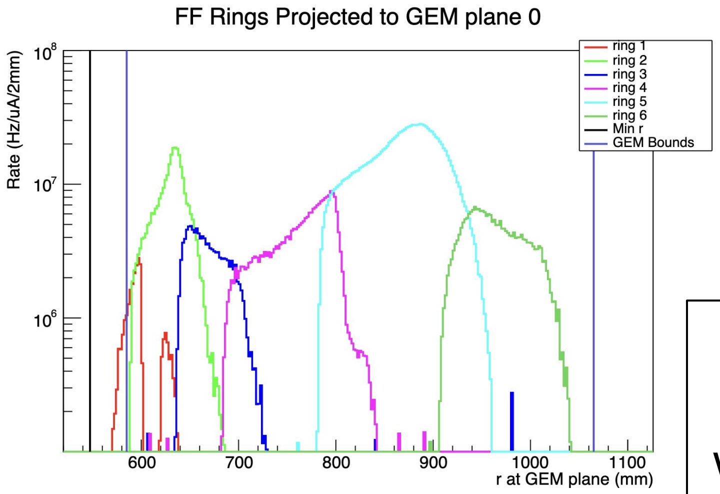


Three C foils in the target ladder

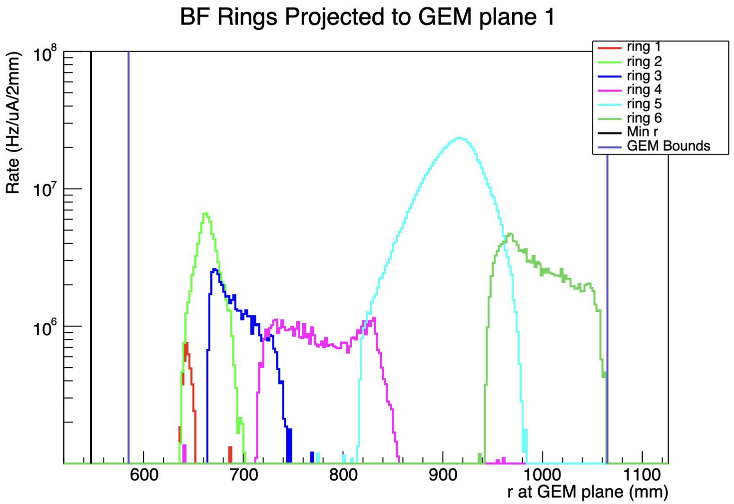
Add thin targets and a "sieve" collimator to constrain E', v_Z -> generate map



GEM r positions



Ratio of counts with gem r cut / without gem r cut



	ring 1	ring 2	ring 3	ring 4	ring 5	ring 6
pln 0	[[0.9163281	0.99985734	0.99999832	0.9990571	0.9999927	0.9999909]
pln 1	[0.99974998	0.99987869	0.99999832	0.9988995	0.99934178	0.99915261]
pln 2	[0.84399811	0.99856927	0.99999343	0.99905603	0.99991222	0.99995515]
pln 3	[0.99218793	0.99953572	1.	0.99873895	0.99883189	0.99114451]]