

hpDIRC CRT Updates

2025 hpDIRC Annual Meeting

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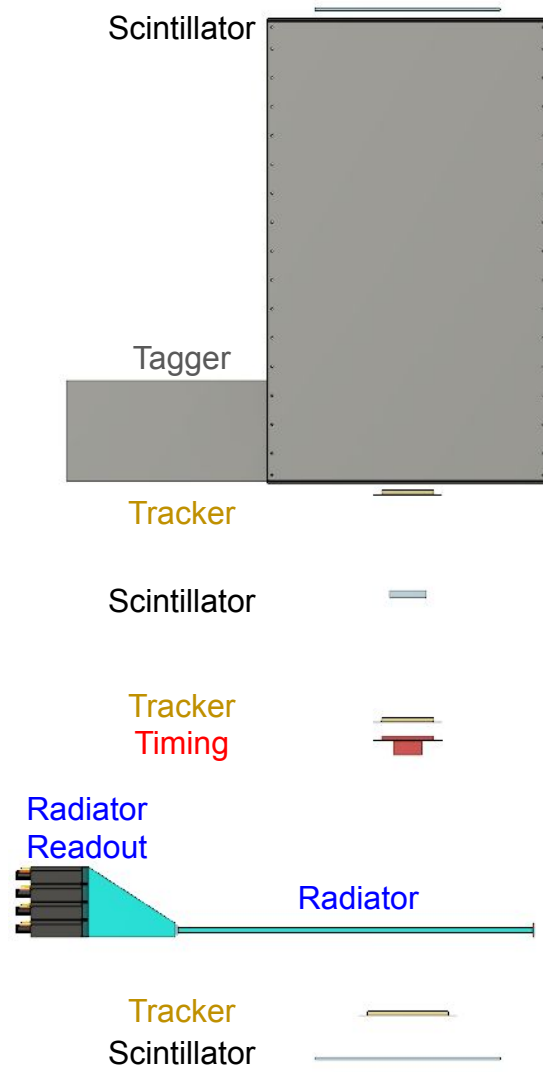
eRD103 Project R&D for EIC

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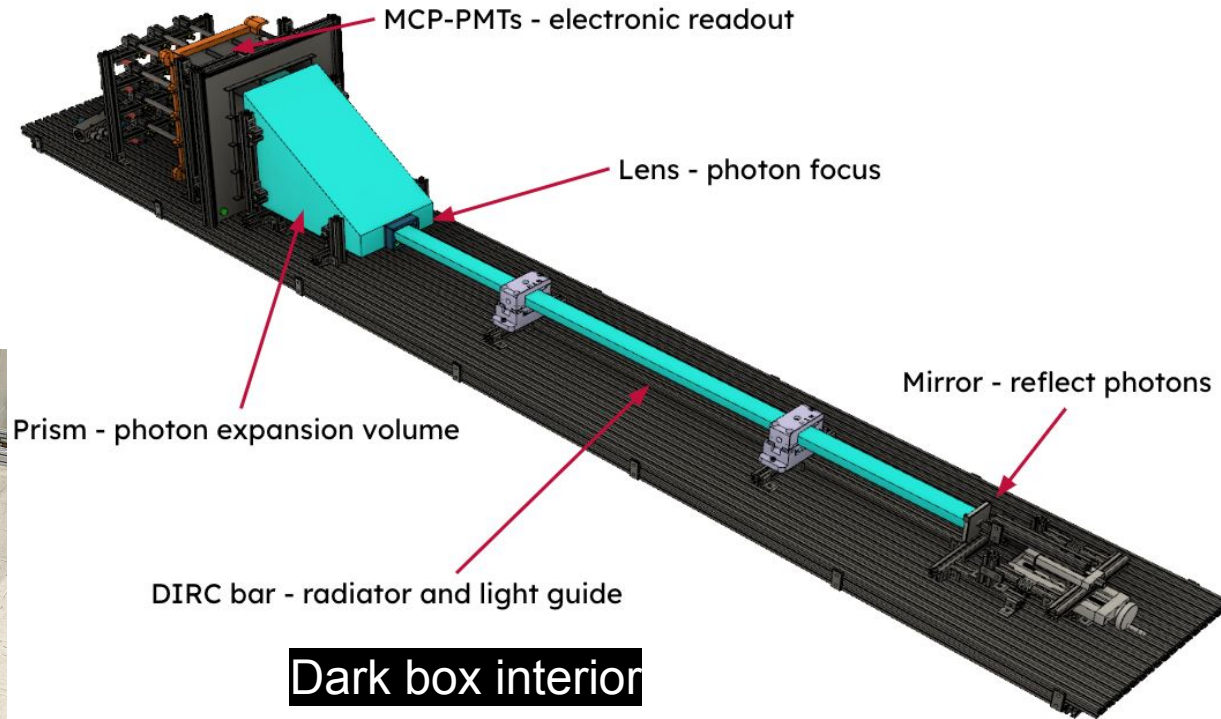
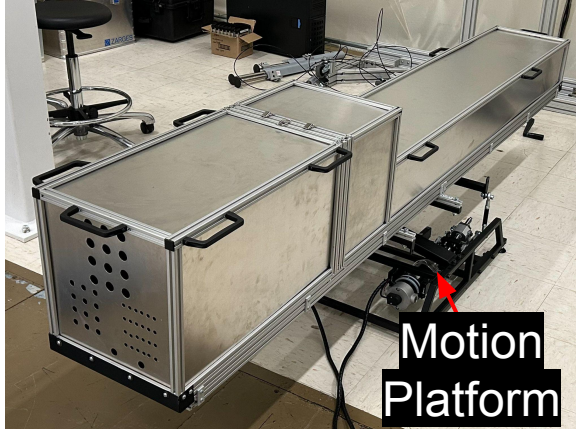
Cosmic Ray Telescope

- Characterization of DIRC radiators and optics
- “Vertical slice” of the hpDIRC detector
- Scintillators (trigger)
- Cherenkov Momentum Tagger ($p > 3.5 \text{ GeV}/c$)
- μ -RWELLS (trackers)
 - 0.5 mrad angular resolution (goal)
- PICOSEC (timing)
 - ~ 54 ps timing resolution
- DIRC Prototype in dark box
 - bar/lens/prism
 - MCP-PMT array, electronics
- DAQ for tagger/trackers/timing/prototype
- Motion platform to scan polar and azimuthal angles (not shown)

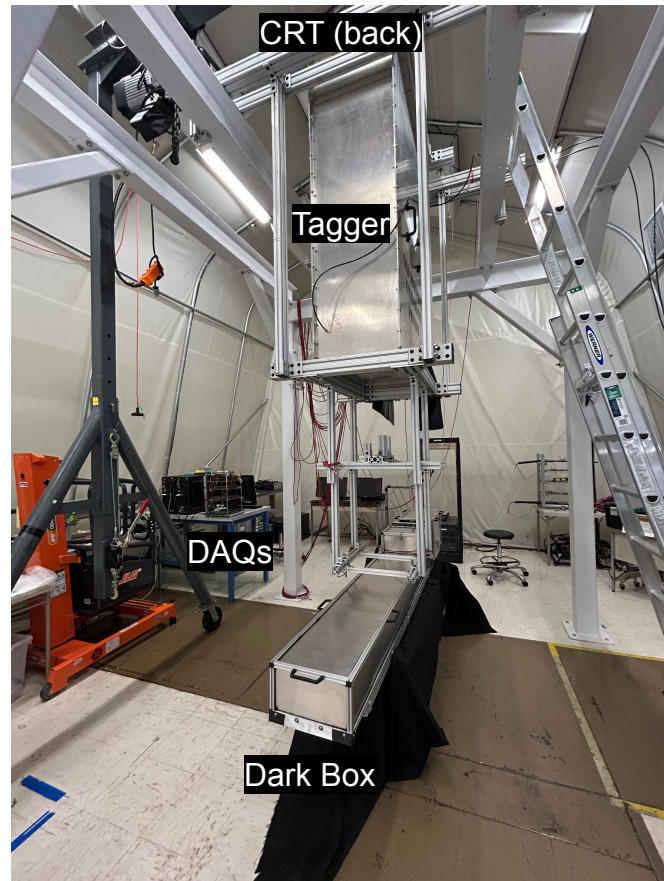
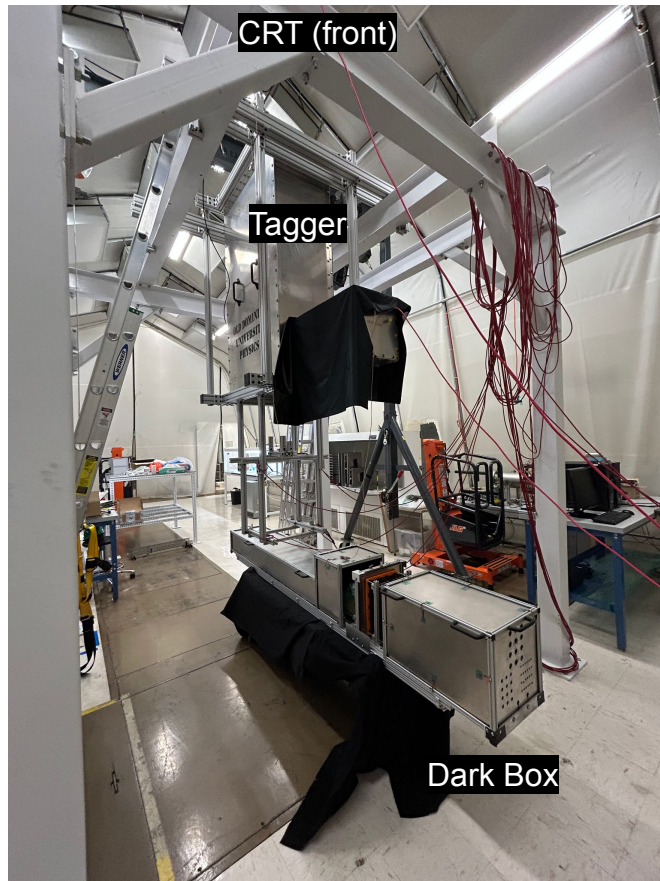
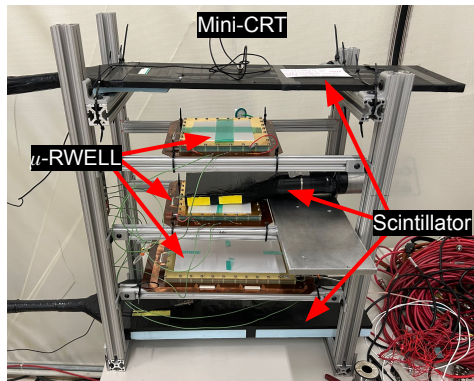
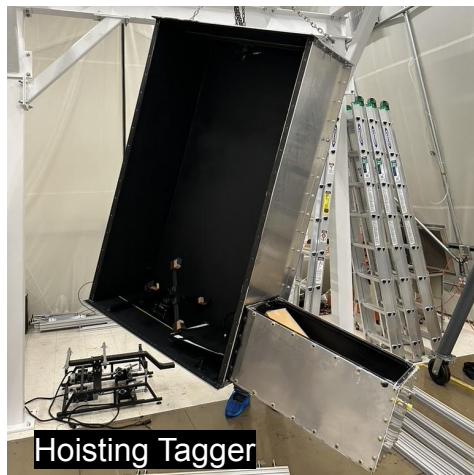


Dark Box

- Easy access to DIRC components
- Motion Platform
 - Multiple incident angles
 - $\pm 20^\circ$ Pitch and Roll (capability)

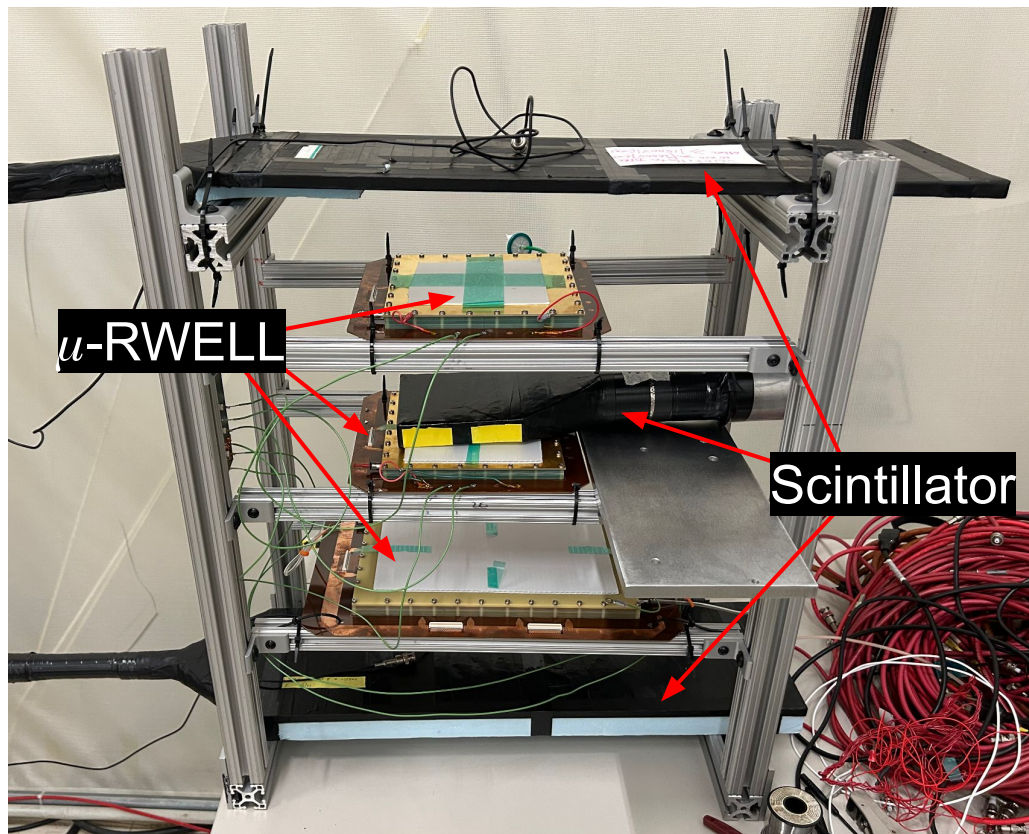
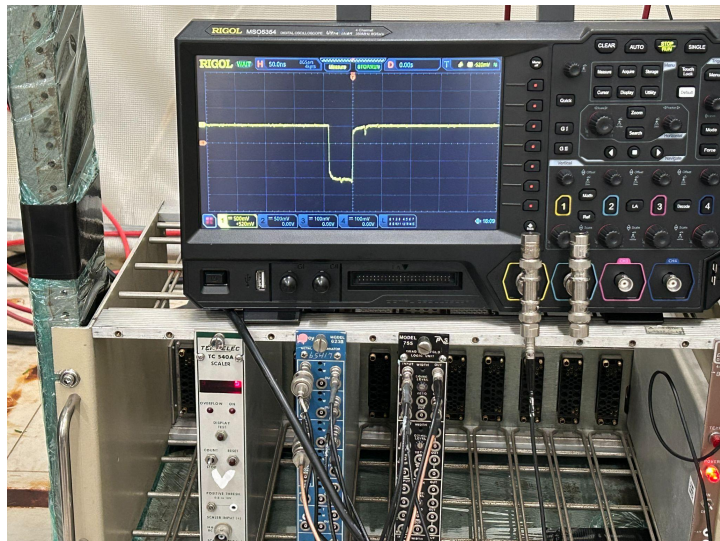


Construction



Mini-CRT

- Scintillators and trackers in a mini-CRT for easy access during testing
- Coincidence between scintillator PMTs



20 x 64 x 1 (cm)

12.75 x 12.75 x 2.5 (cm)

20 x 64 x 1 (cm)

Meepco III

Channel vs Value

xChannel	S	Meas uA	Meas V	Target V	V-
x 10.0		-0.3	0.0	0.0	x
x 10.1		-0.1	1.4	0.0	x
x 10.2		0.2	0.4	0.0	x
x 10.3		-0.4	0.2	0.0	x
x 10.4		0.2	-0.8	0.0	x
x 10.5		0.0	0.0	0.0	x
x 10.6		0.0	-0.4	0.0	x
x 10.7		0.3	-0.8	0.0	x
x 10.8		-0.2	-1.4	0.0	x
x 10.9		-0.0	-0.5	0.0	x
x 10.10		0.4	-1.0	0.0	x
x 10.11		-0.2	-0.9	0.0	x

VT Key Map

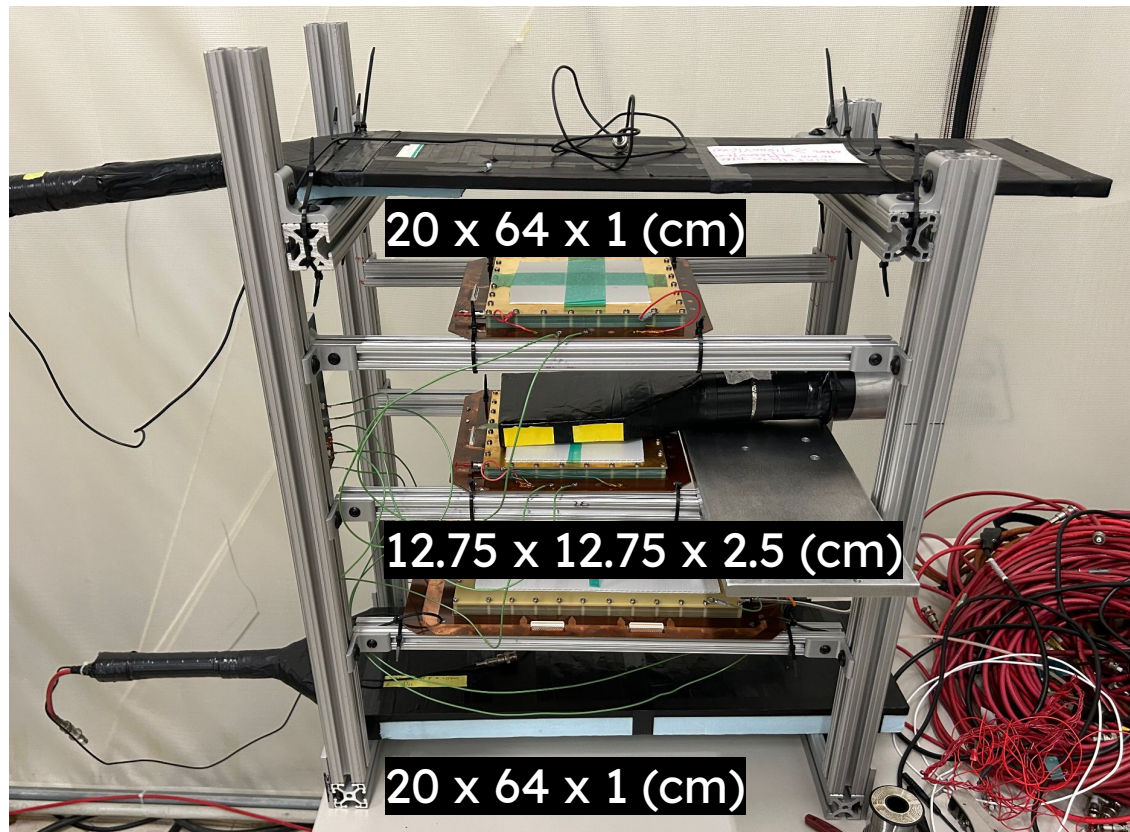
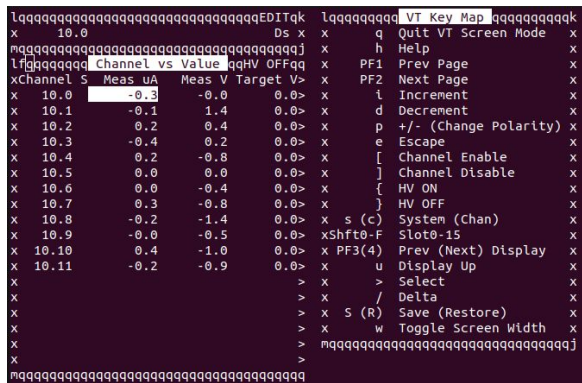
q	Quit VT Screen Mode
h	Help
PF1	Prev Page
PF2	Next Page
i	Increment
d	Decrement
p	+/- (Change Polarity)
e	Escape
[	Channel Enable
]	Channel Disable
{	HV ON
}	HV OFF
s (c)	System (Chan)
xShft0-F	Slot0-15
x PF3(4)	Prev (Next) Display
u	Display Up
>	Select
/	Delta
x S (R)	Save (Restore)
w	Toggle Screen Width

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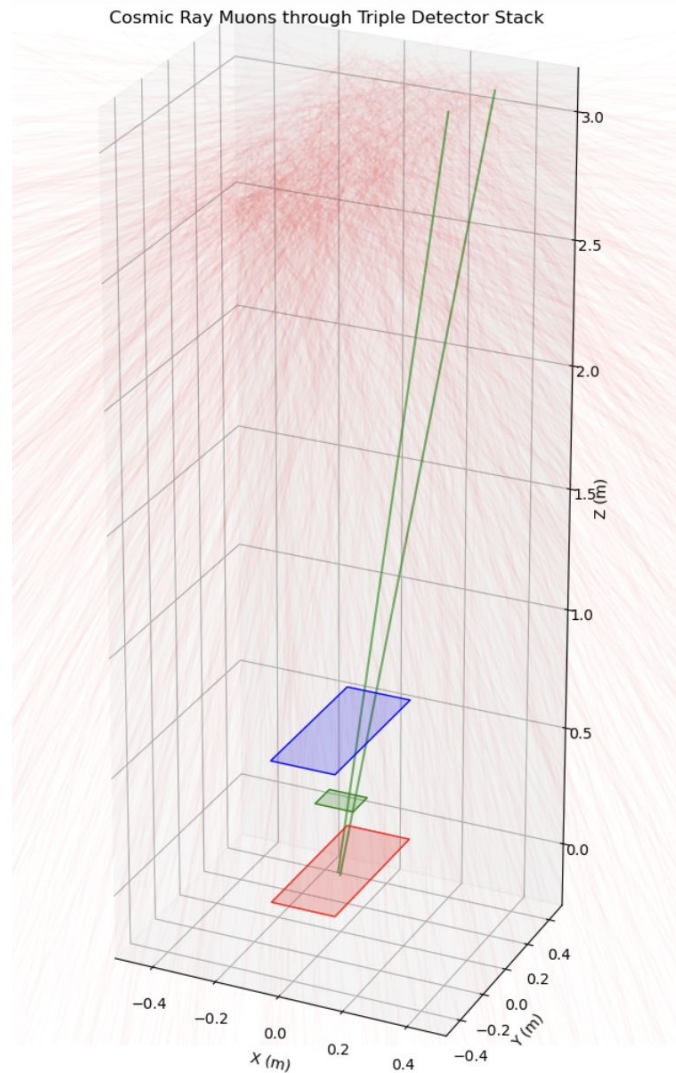
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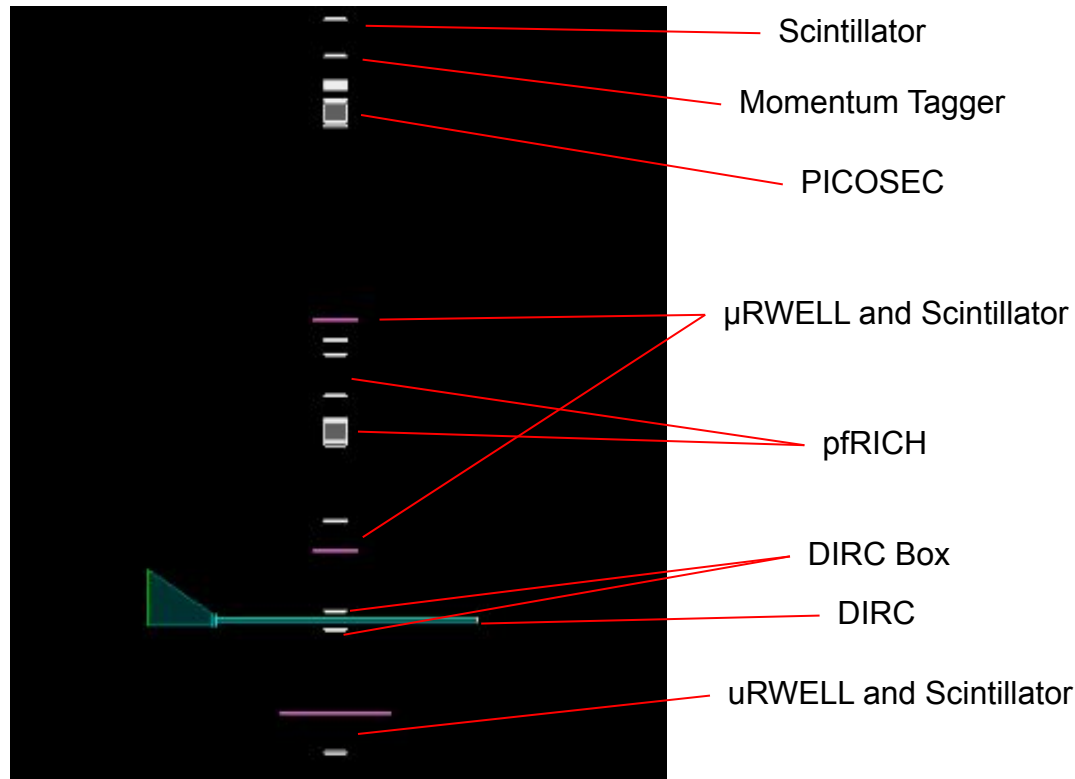
Muon Flux (Scintillators)

- From last run
 - Thresholds for the voltage signals from the PMTs
 - Top 61 mV
 - Middle 34 mV
 - Bottom 103 mV
 - 120 minutes
 - 1668 coincidences
 - 13.9 coincidences/minute
- Simulated Cosmic Rays
 - Events = 500,000
 - Coincidences = 288
- This is preliminary information
- We need to use more up-to-date runs and simulations to get the muon flux

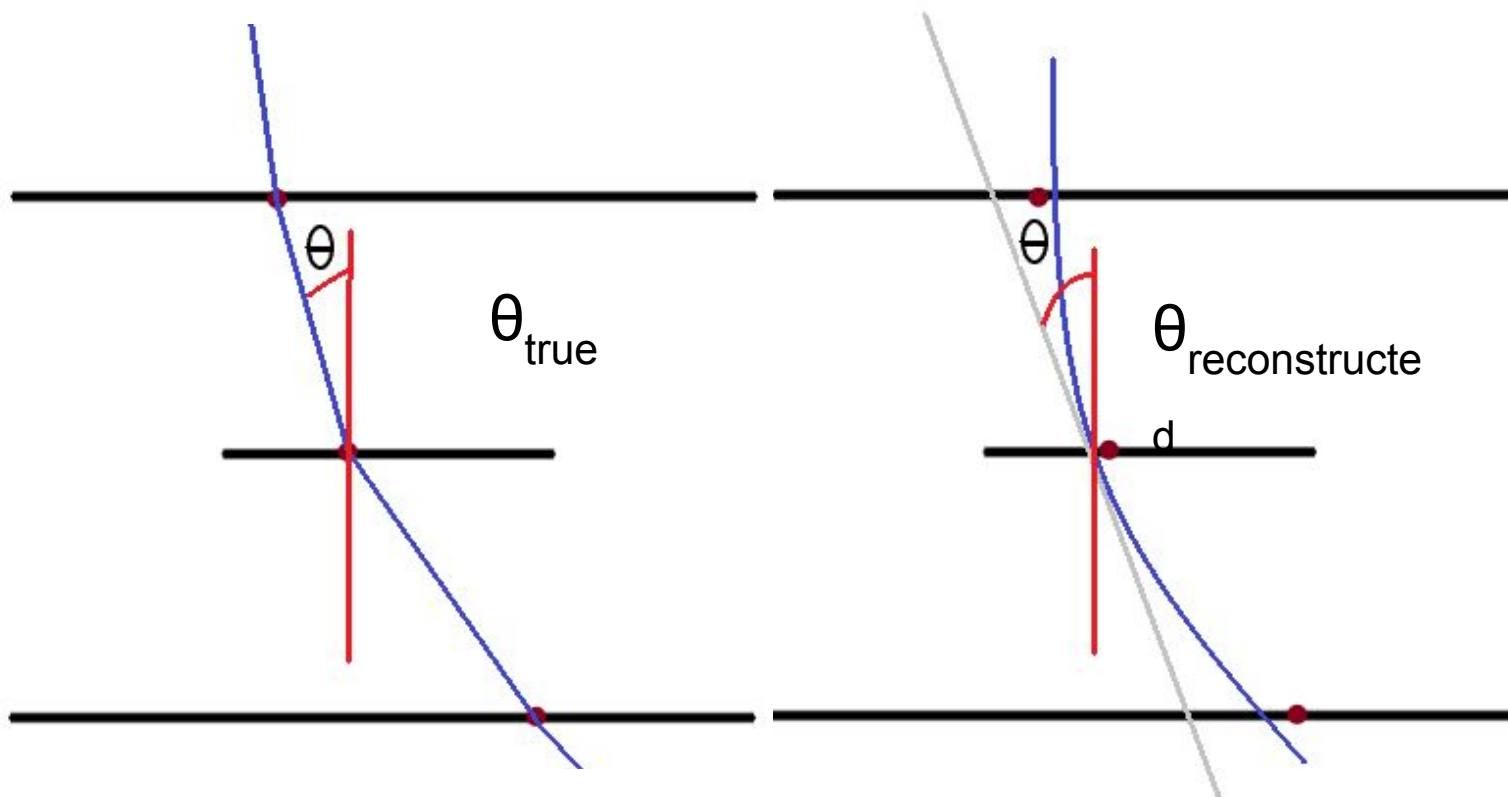


CRT Simulation

- Dead Materials
 - Momentum Tagger
 - 12mm Aluminum
 - PICOSEC (Based on Marinko Kovacic's Design)
 - 25.4mm, Aluminum
 - 14.2mm, Steel
 - .2mm, Copper
 - 76mm, 60% Glass 40% Epoxy Resin
 - [Source Material](#)
 - pfRICH (Copy of PICOSEC)
 - (Electronics Design not yet known)
 - 12mm Aluminum
 - 14.2mm, Steel
 - .2mm, Copper
 - 76mm, 60% Glass 40% Epoxy Resin
 - DIRC Box
 - 12mm Aluminum

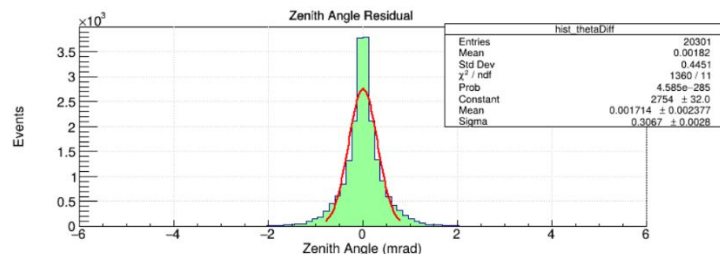
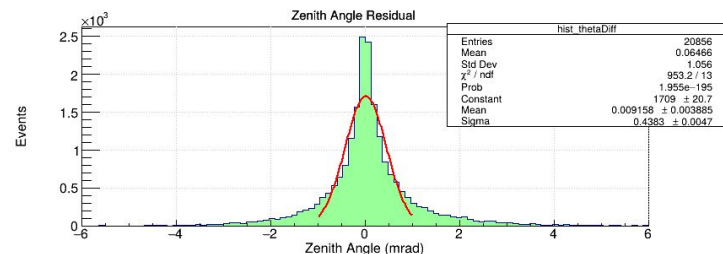
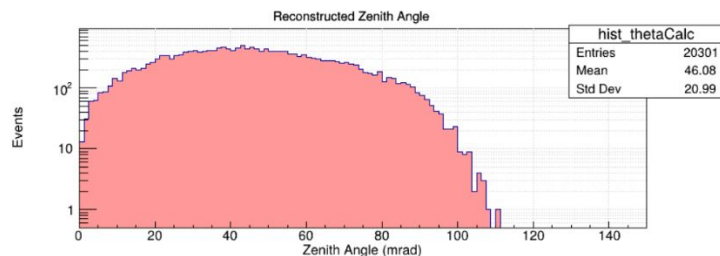
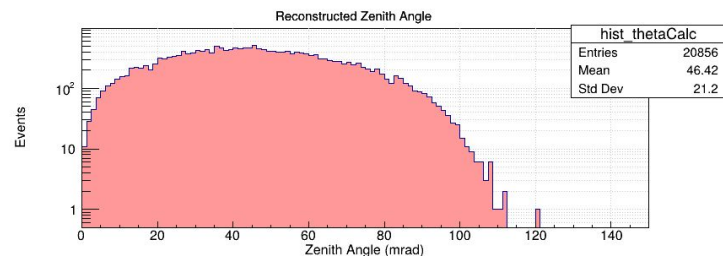
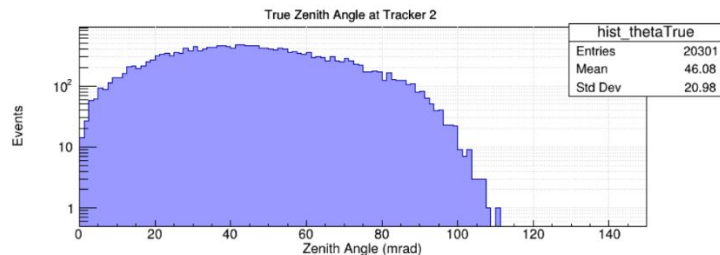
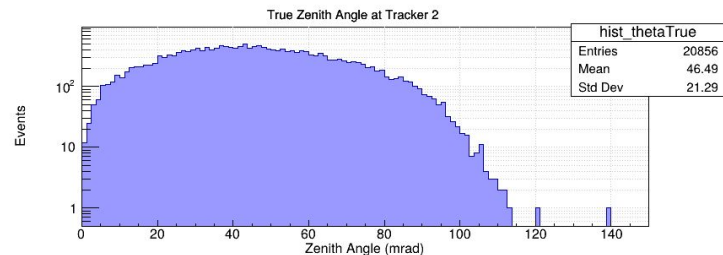


Angular Resolution

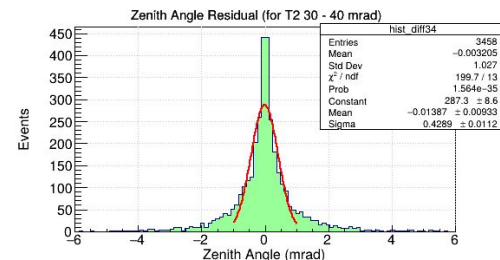
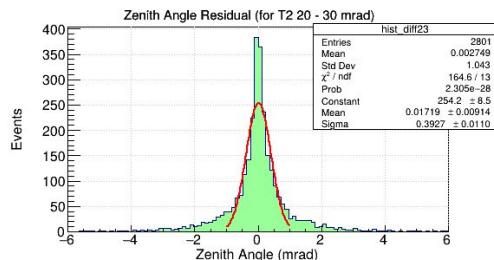
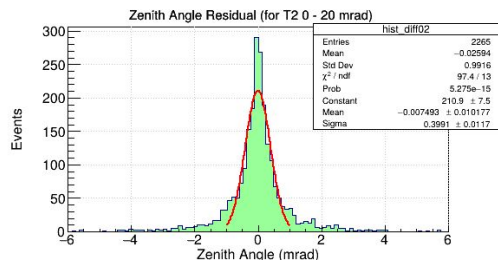
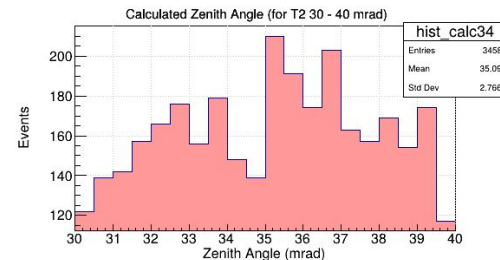
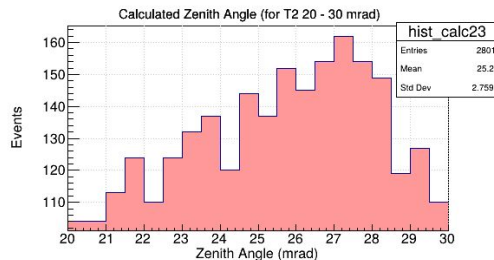
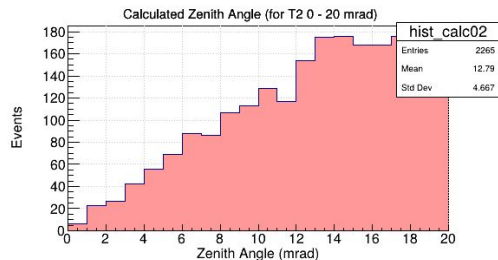
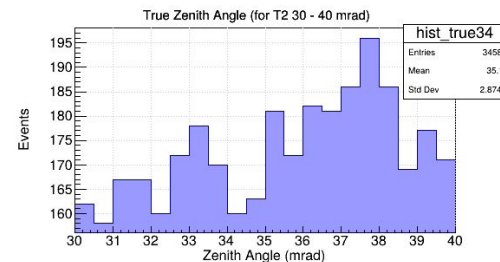
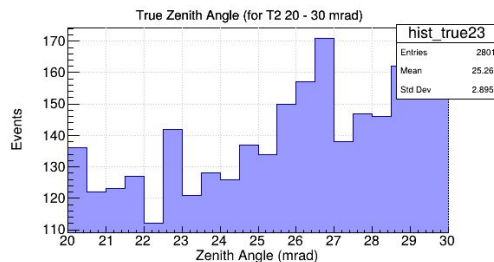
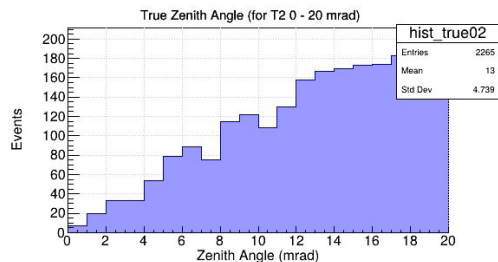


$$\frac{\text{Residual}}{\theta_t - \theta_r}$$

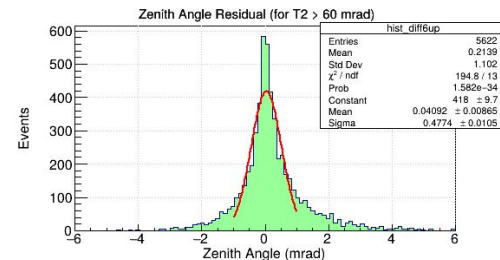
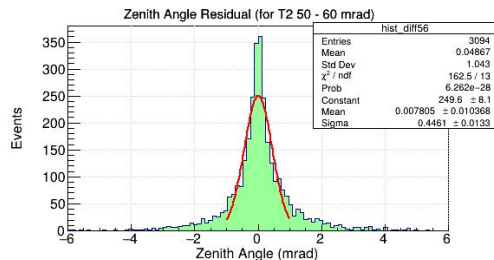
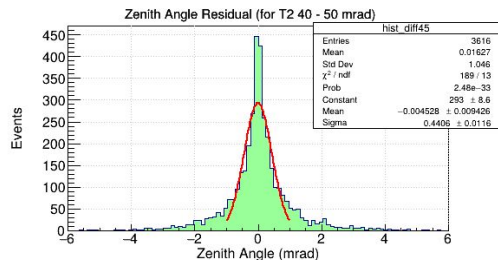
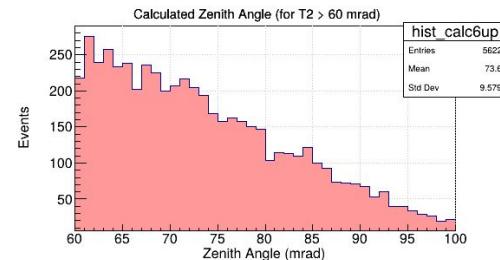
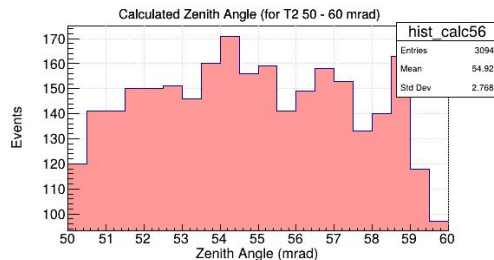
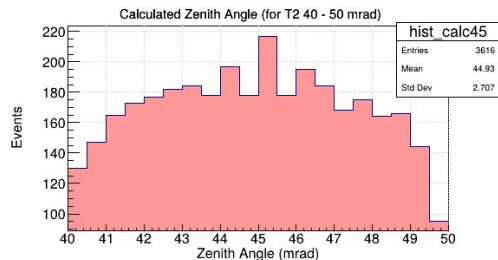
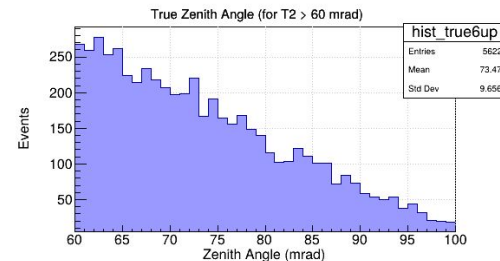
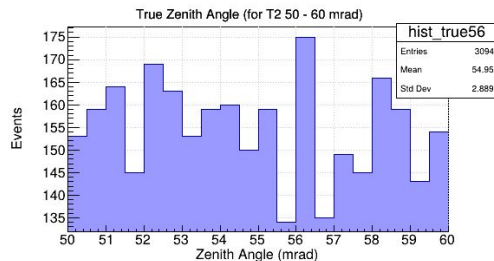
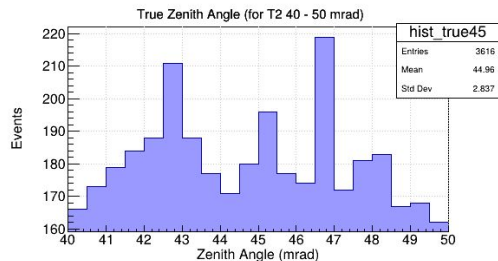
Zenith angle (all angles)



Zenith angle (0-40 mrad)

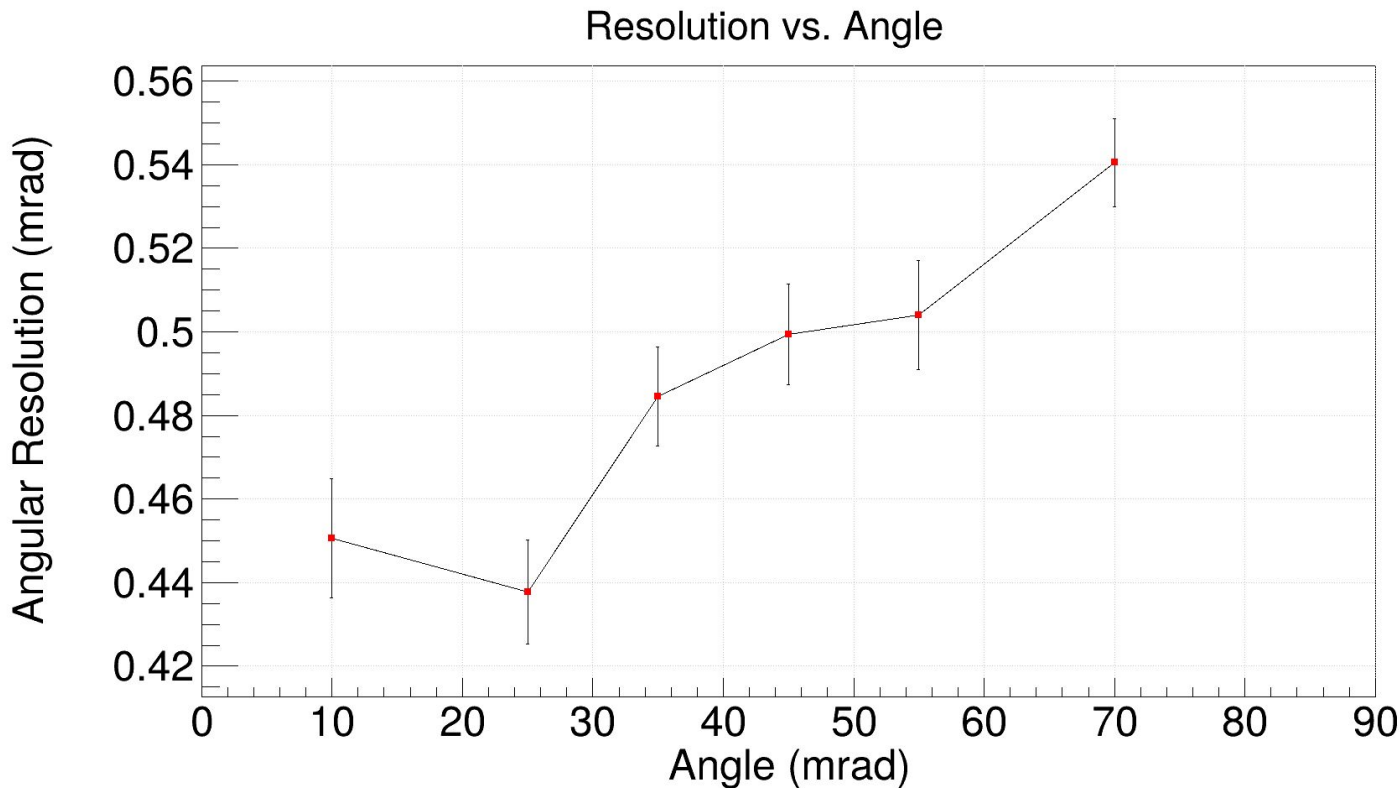


Zenith angle (>40 mrad)



Patterns in Angular Dependant Angular Resolution

- General upward trend
- High uncertainties
- Need more events



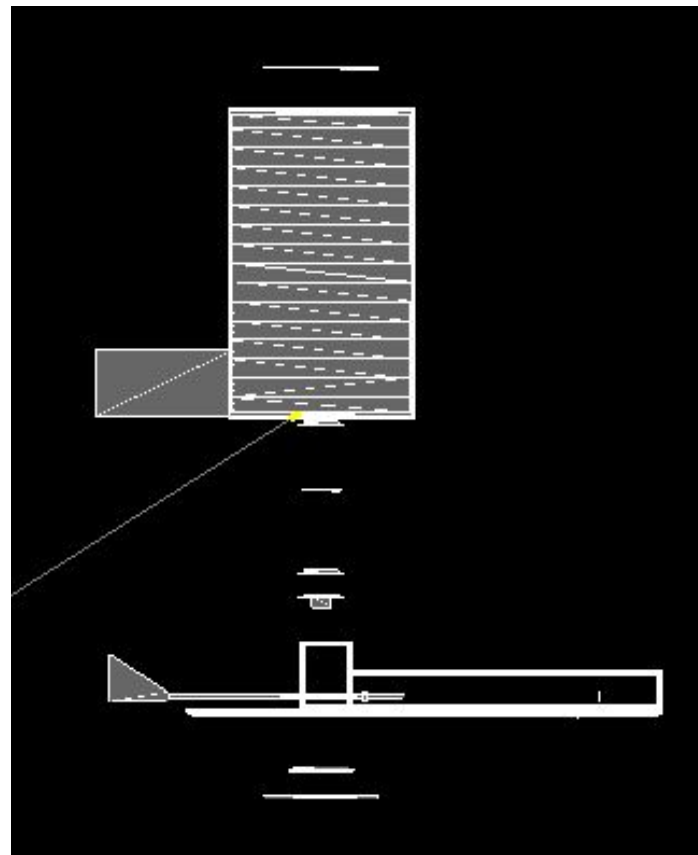
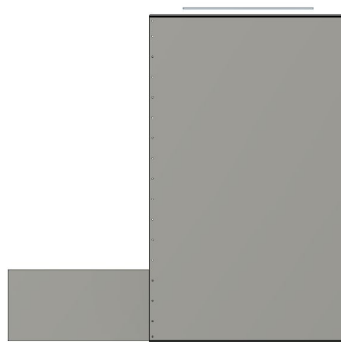
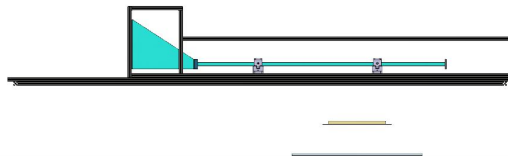
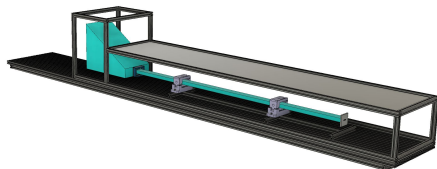
Current Resolution Results

PICOSEC Location	Current Resolutions (mrad)
Below Tagger	0.4383
Below DIRC	0.4578
Below GEM	0.433
No Dead Material	.3067

- Comparison with different locations of the PICOSEC detector
- The PICOSEC was originally meant to be above the dark box as close to it as possible (Below Tagger position)

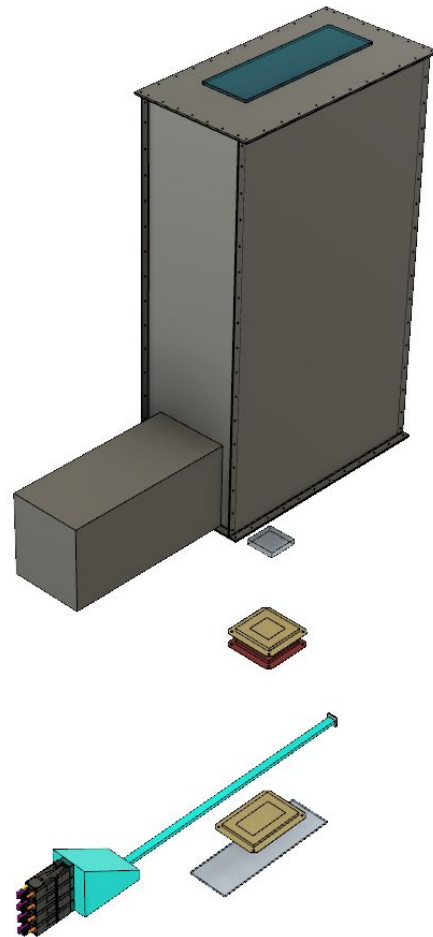
More Accuracy

- ACTS
(reconstruction
software)
- Implementation
of the Geometry
Description
Markup
Language
(GDML)
- CAD to Geant4



Summary

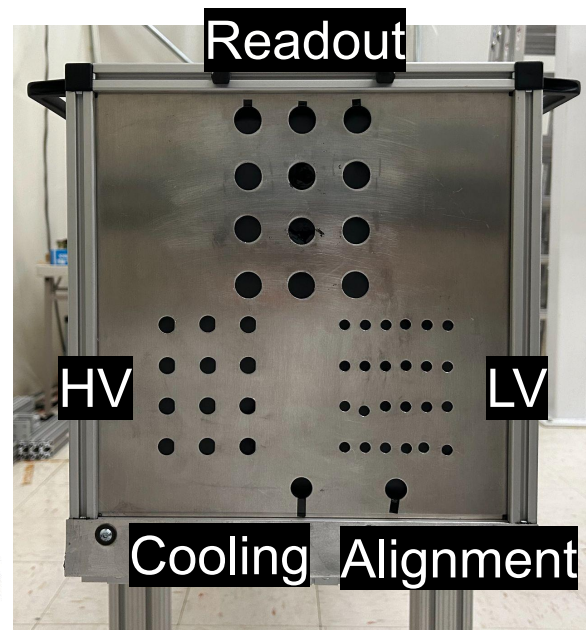
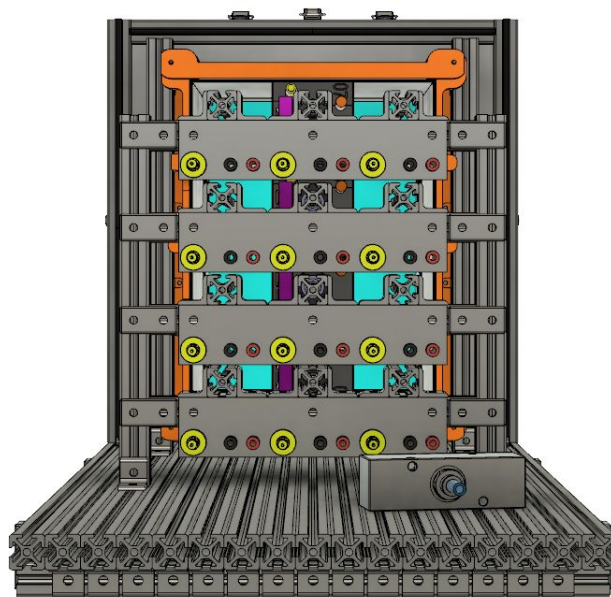
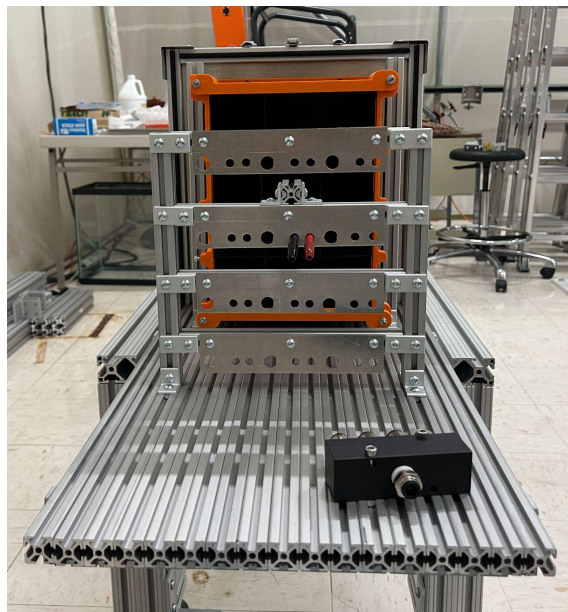
- CRT for characterization of hpDIRC radiators and optics
- Current work:
 - Scintillator PMTs
 - Testing them
 - Installing into CRT
 - Configuring DAQ software for data acquisition
 - Angular resolution simulations
- Next steps:
 - Test trackers
 - Test tagger
 - Test PICOSEC
 - Synchronization of DAQ systems
 - Finalize motion platform control
 - Commissioning of CRT
 - Installation, commissioning of hpDIRC prototype
 - Cosmic data taking
 - ~ 100 reconstructed events per day
 - ~ 15-35 detected photons per incident muon
- Future
 - **Test other EIC detector prototypes in CRT facility? Possible candidate ePIC pFRICH.**



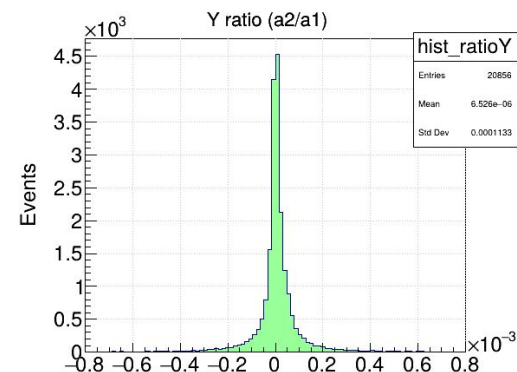
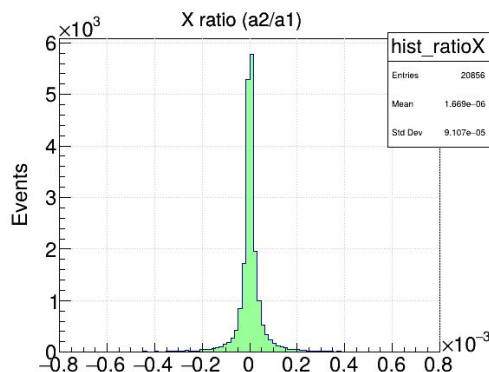
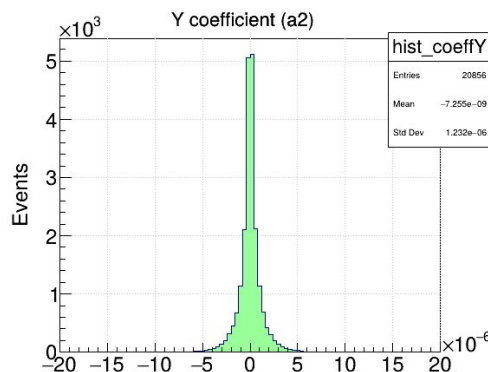
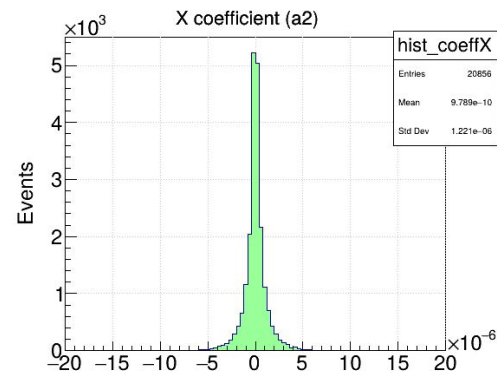
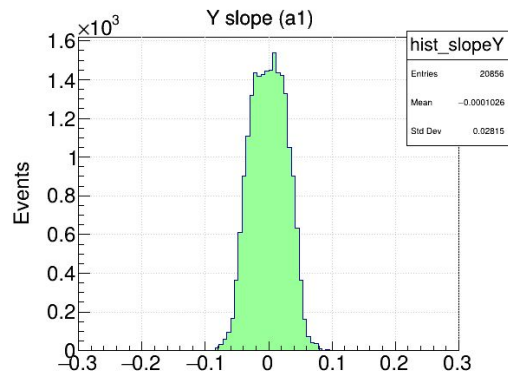
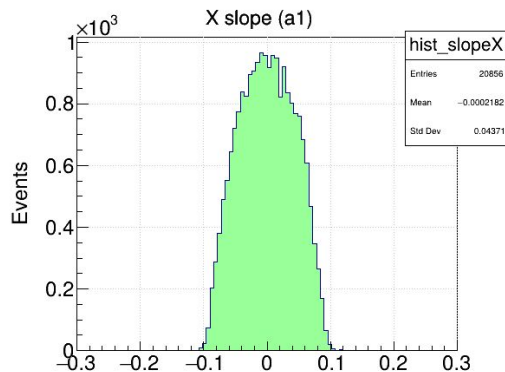
Extra

Radiator Readout

- Readout cables
- High voltage for MCP-PMTs
- Low voltage for Padiwa pre-amplifiers
- Cooling for MCP-PMTs
- Hole for aligning DIRC optics



Polynomial $\sim$ Line



Trajectories

