

BIC TEST BEAM PLANS

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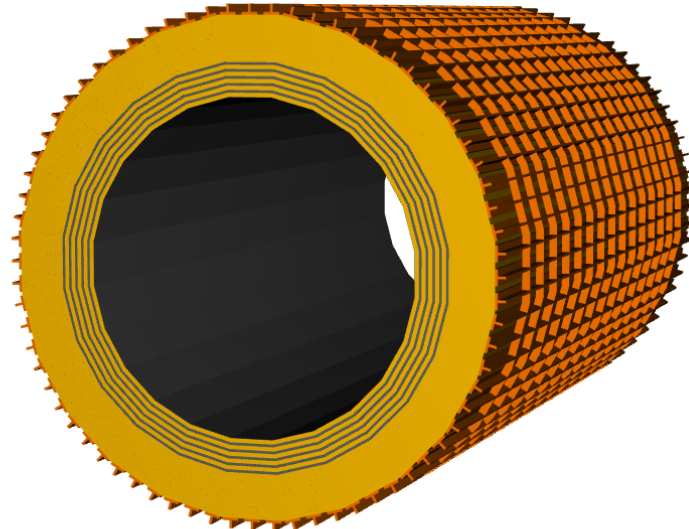
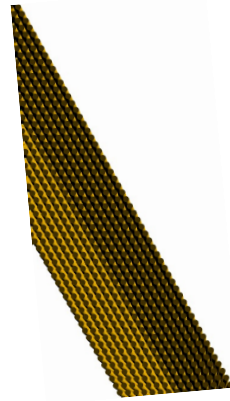
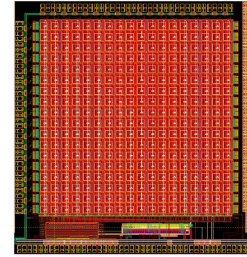


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TEST BEAM R&D GOALS

- Benchmark detector performance in as realistic a configuration as possible with different beams at FNAL
 - Demonstrate ability to operate AstroPix & SciFi in tandem
 - Study e/π separation and overall π response
 - Characterize SciFi energy resolution & linearity at higher energy than GlueX
 - Gain operational experience with the specific SiPM options to be used in ePIC BIC
- All of the above highlighted by comprehensive detector review report



GENERAL SETUP

- Add BIC prototype calorimeter behind existing Argonne ATLAS Pixel telescope with AstroPix setup at MTest
- Rotating stage to simulate particles incident at angles up to 45° ($\eta \sim 1$)
- Ability to lower BIC setup out of the beam, no need to uninstall for other experiments to run
 - Proximity to Argonne enables occasional opportunistic running

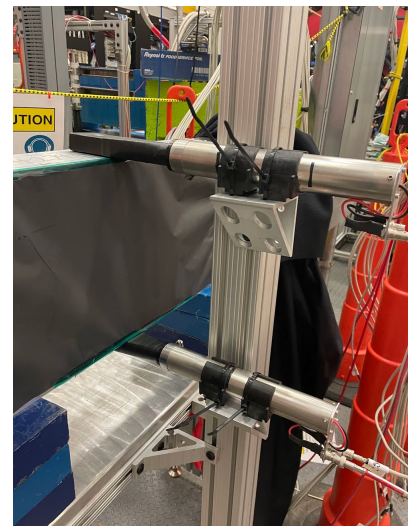


Current ANL AstroPix
Telescope Setup

Planned BIC Setup

GLUEX BCAL PROTOTYPE

- Thick SciFi portion of BIC approximated by the GlueX prototype
 - Studied in March '23 with positrons in Hall-D PS
 - Cosmic data taken in Hall-D, currently under analysis
 - More cosmics planned at ANL prior to installation at FTBF
- Overall well understood system!

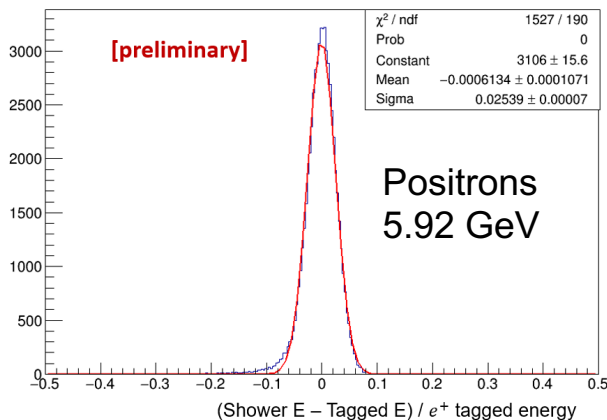


Baby BCAL in Hall D, 2023

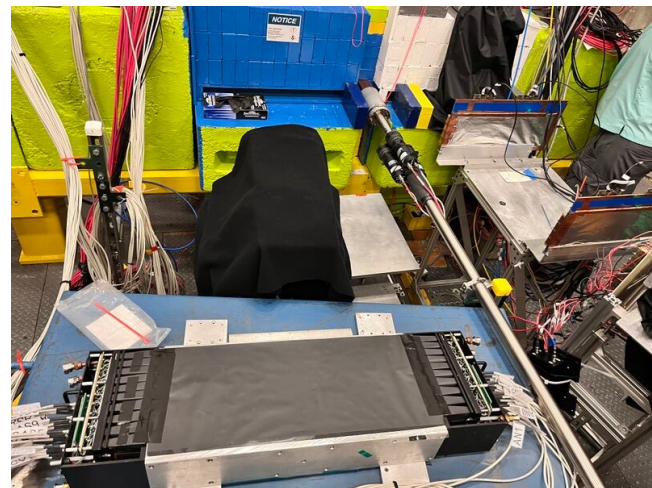
- e^+ energy = 5.92 GeV
- Resolution \approx 2.5%

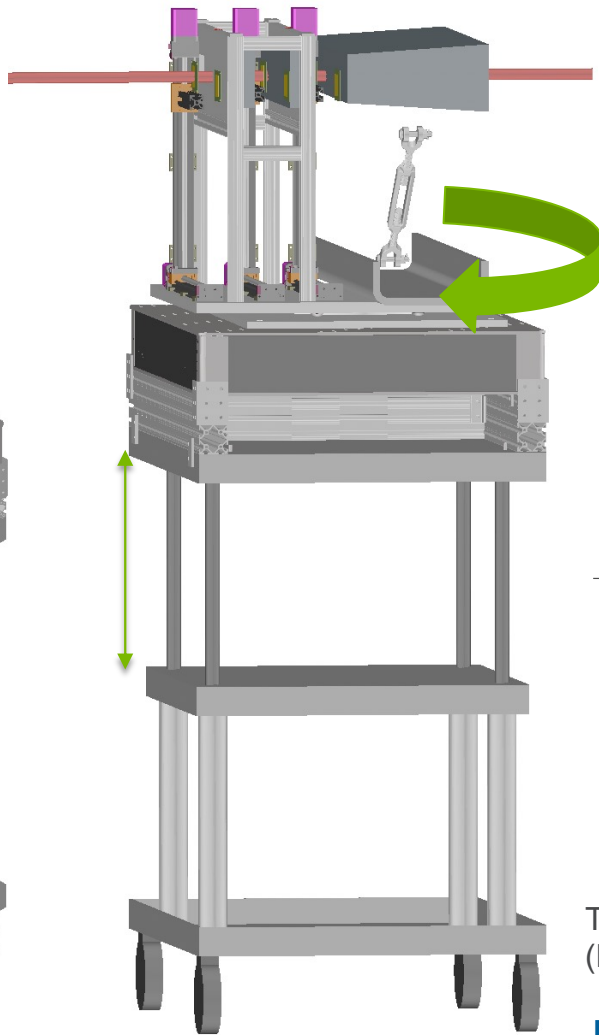
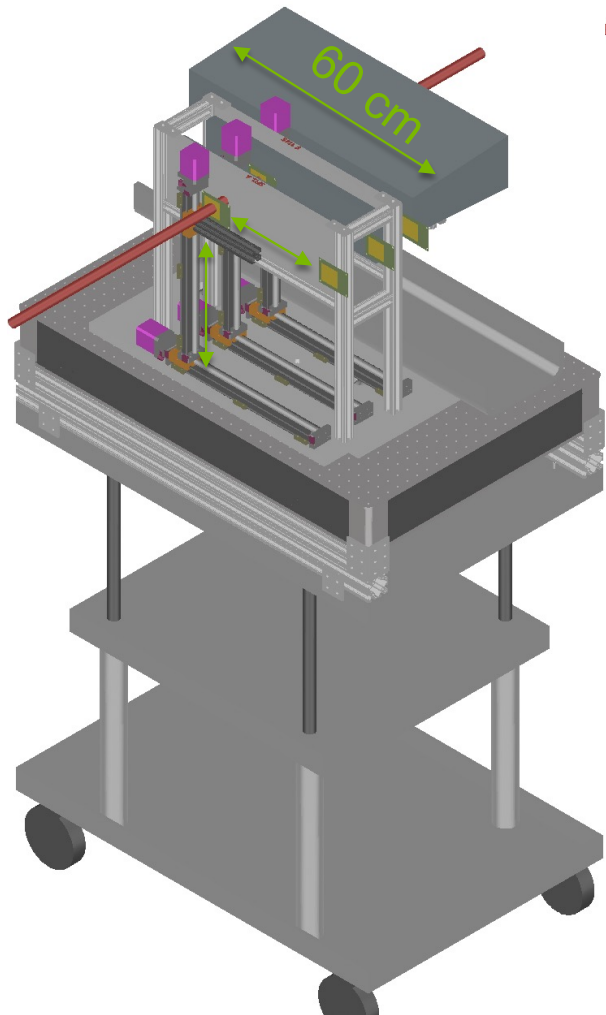
GlueX NIM, extrapolated

- Expect \approx 4.2%

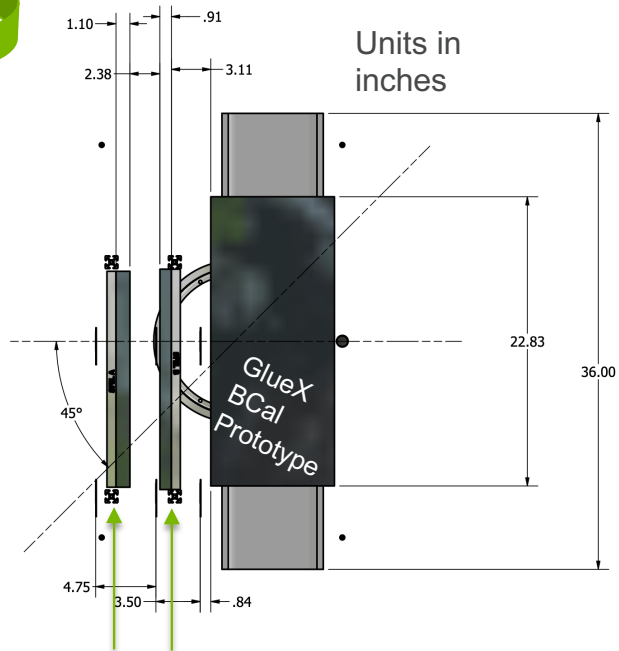


GlueX BCAL: $\frac{5.2\%}{\sqrt{E} \text{ (GeV)}} \oplus 3.6\%$
NIM A896 24-42 (2018)





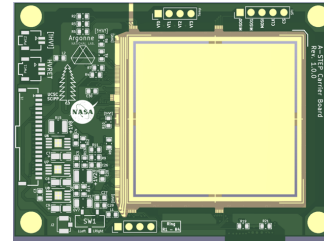
Rotatable
up to 45°!



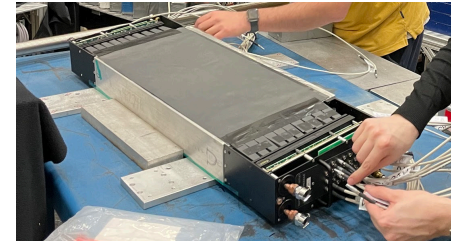
Thin SciFi Insert Layers
(Removable)

PLANNED STAGED SETUP – STAGE 1

- Start with GlueX BCal prototype with one AstroPix v3 quad in front
- Prior to installation at FTBF:
 - Characterize AstroPix v3 Quad sensor on the bench, noise scans, calibration, etc.
 - Take cosmics with GlueX prototype at ANL
 - Gain a good understanding of both systems individually



AstroPix v3 Quad
4x4 cm

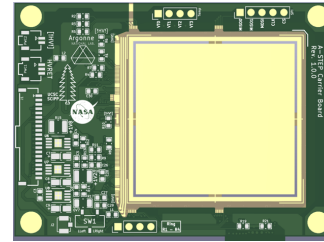


GlueX Prototype

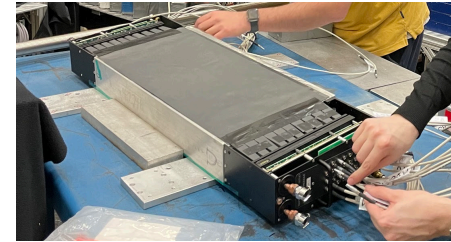


PLANNED STAGED SETUP – STAGE 1

- Once beam is available, work on combining information between the systems
 - Bringing the two detectors into time coincidence
 - Use AstroPix hit position information to seed clusters in the SciFi
- Test response of SciFi at different incidence angles



AstroPix v3 Quad
4x4 cm

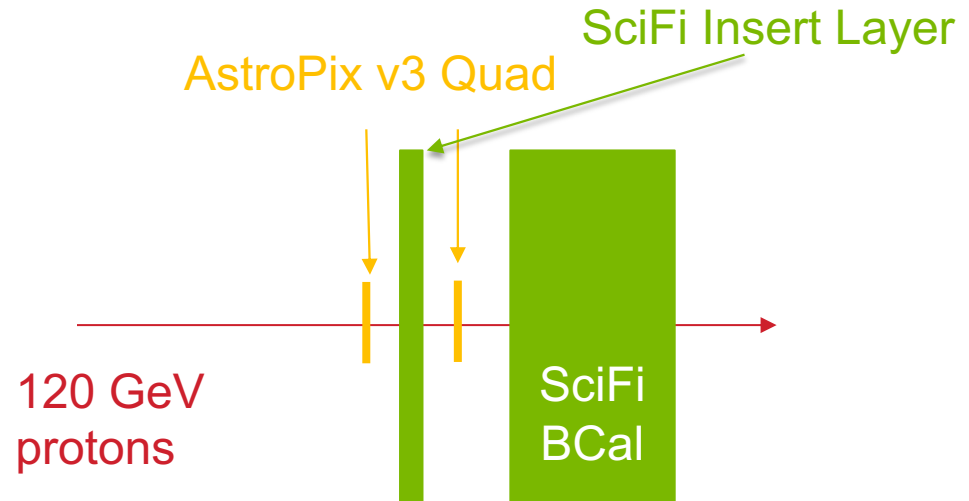
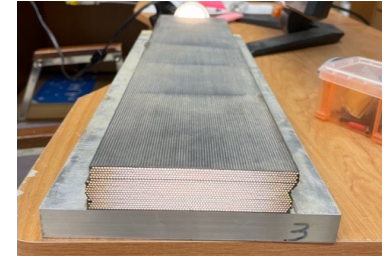


GlueX Prototype



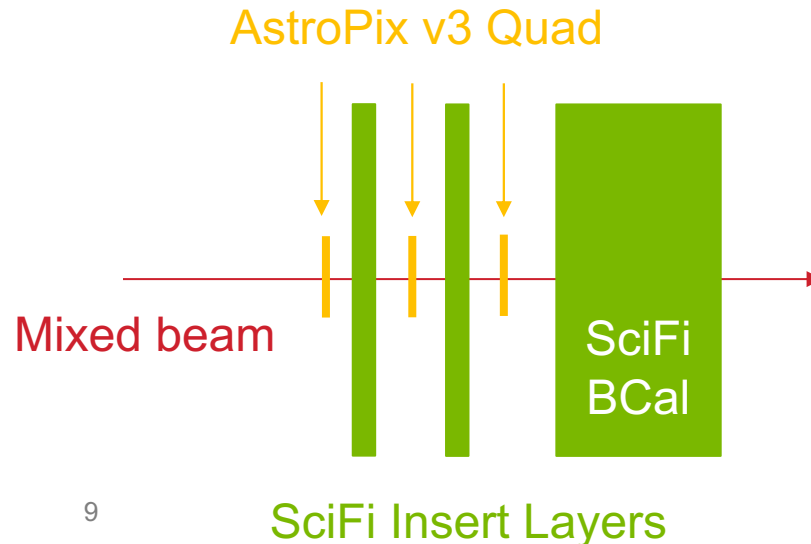
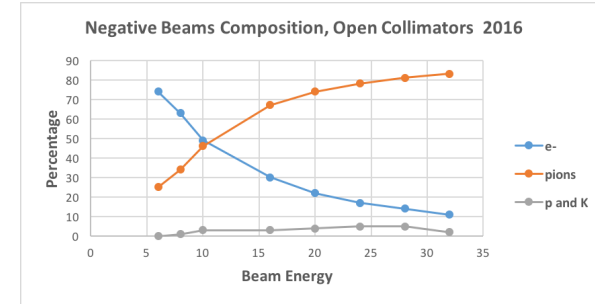
PLANNED STAGED SETUP – STAGE 2

- Add thin layer of SciFi from GlueX
 - Layers of SciFi in thickness similar to ePIC already exist, currently no SiPMs attached
- Opportunity for testing of SiPMs planned for use in the final design
 - Protons to test response to MIPs
 - Measure pulse shape & timing response with fast electronics



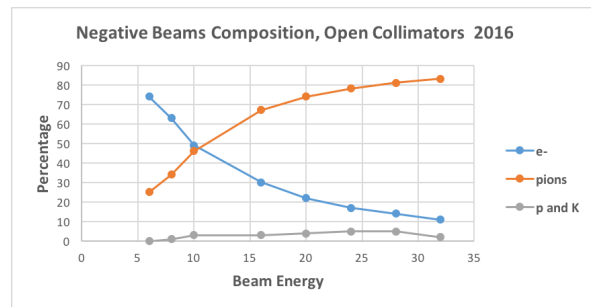
PLANNED STAGED SETUP – STAGE 3

- Add second thin layer of SciFi
 - Approach ePIC design
- Test e/π separation with mixed beam
 - Run at low rates to avoid pile up in SciFi
 - Possibility with AstroPix to tag two-particle events
 - Use FTBF beamline instrumentation to tag electrons
 - Possibly tag hadronic showers with detectors behind BCal

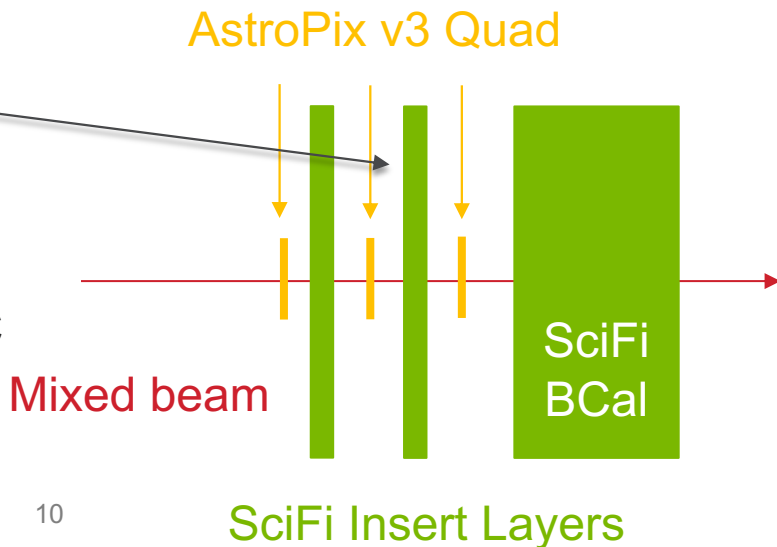


PLANNED STAGED SETUP – STAGE 3

- Test energy resolution & linearity up to 32 GeV
 - Near upper limit of what will be seen at EIC



- Second (downstream) SciFi layer should see significant energy deposits from 32 GeV electrons (especially at large angles)
 - Allow for characterization of ePIC BIC SiPMs with large N_{Ph} .



ANTICIPATED TIMELINE

- FTBF Beam schedule highly uncertain, original estimated schedule:
 - Stage 1: Setup prior to beam, Estimated Winter '23
 - Stage 2: Estimated Spring '24
 - Stage 3: Estimated Summer '24
- If only Spring '24 is available, can try to use cosmics to interleave AstroPix & Bcal information (approximate stage 1), skip stage 2, and go directly to stage 3
- **Any information regarding the FTBF schedule would be helpful, we are meeting to discuss our plans after this meeting**
- Aside from beam test, various construction activities planned for FY24
 - Lab space being acquired at Argonne for testing of SciFi construction equipment

BACKUP



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TABLE 1: Barrel Imaging Calorimeter SiPM Specs

Parameter	Specification	Notes
Active Area	3 mm x 3 mm (4 x 4 array)	Preassembled array covering 1.2cm x 1.2cm
Pixel Size	50 μm	
Package Type	Surface Mount	
Peak Sensitivity	450 nm	
PDE	$\sim 50\%$	
Gain	$> \sim 2 \times 10^6$	
DCR	Typ.: $\sim 500\text{kHz} / \text{SiPM}$ Max: $< 1.5 \text{ MHz} / \text{SiPM}$	DCR applies to each SiPM in the 4 x 4 array
Temperature coefficient of Vop	$< 40\text{mV/C}$	
Direct crosstalk probability	$< \sim 7\%$	
Terminal capacity	$\sim 500\text{pF} / \text{SiPM}$	Applies to each SiPM in the 4 x 4 array
Packing granularity		
Vop variation within a tray	$< 200 \text{ mV}$	
Recharge Time	$< 100 \text{ ns}$	
Fill Factor	$> 70\%$	
Protective Layer	Silicone ($n \sim 1.5\text{-}1.6$)	