

# Preparations for a pfRICH beam test at CERN

**Alexander Kiselev (BNL)**

**ePIC TIC meeting, April 20, 2026**

# Goals

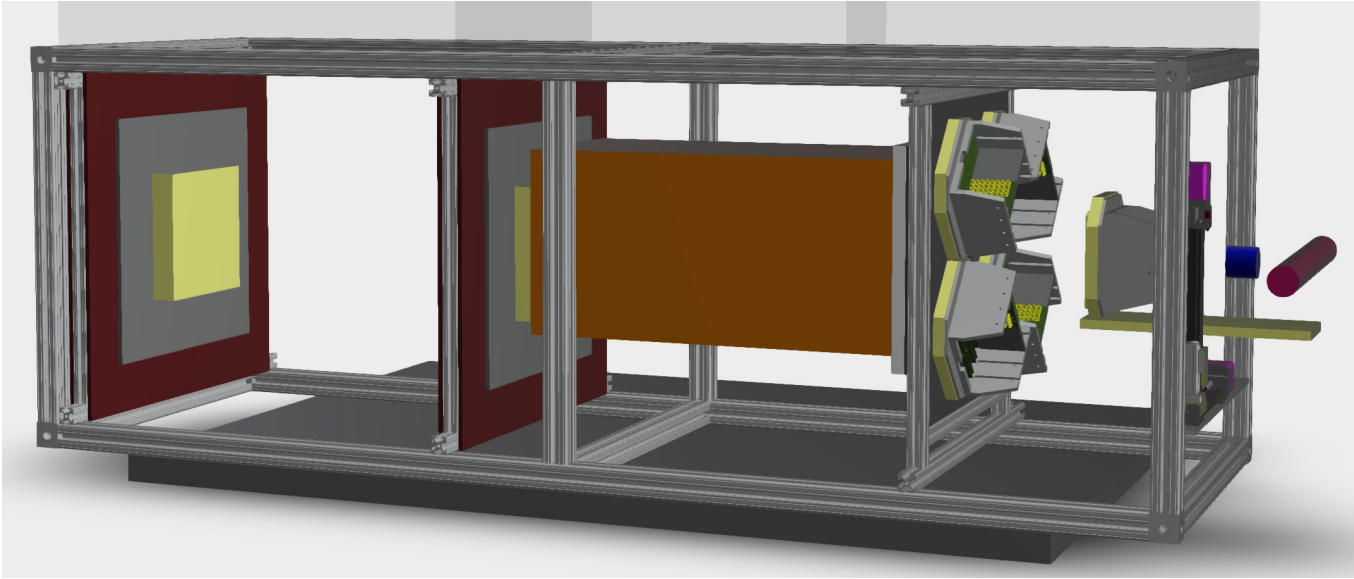
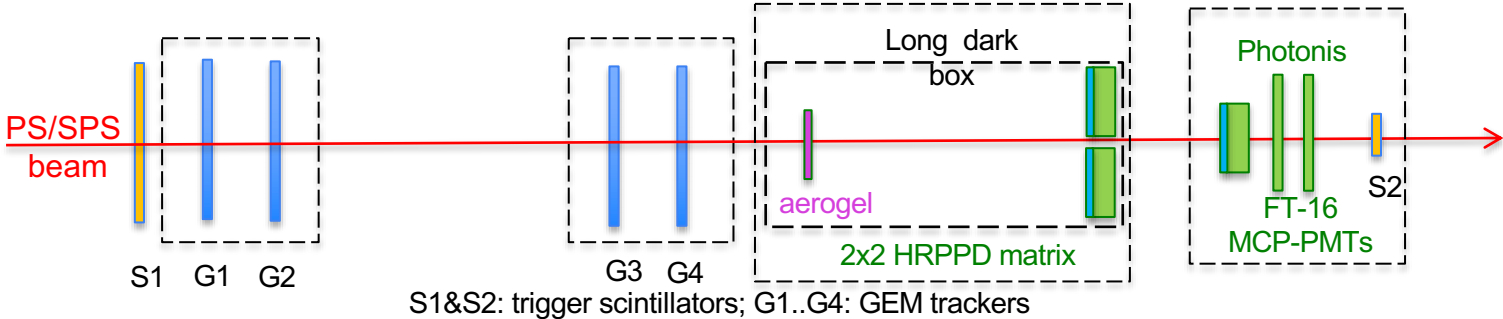
Goal	Priority	Comments
Perform first HRPPD particle beam measurements	HIGH	
Demonstrate timing & imaging performance at once	HIGH	
Directly measure $\langle N_{pe} \rangle$ for imaging purposes	HIGH	Aerogel / UV filter / HRPPD combined
Provide a $\pi/K$ separation estimate up to $\sim 7$ GeV/c	HIGH	
Provide an e/h separation estimate at low momenta	MEDIUM	If beam time allows
Verify mirror performance & usability in IRT reconstruction	MEDIUM	If ready for shipment in time
Verify FCFD analog frontend operation with a particle beam	LOW	If test stand validation succeeds

**HIGH** : critically important to validate pfRICH detector performance for ePIC

**MEDIUM** : less critical; perform the measurements if availability and time allow

**LOW**: “good to have” studies

# Hardware configuration



# Hardware availability

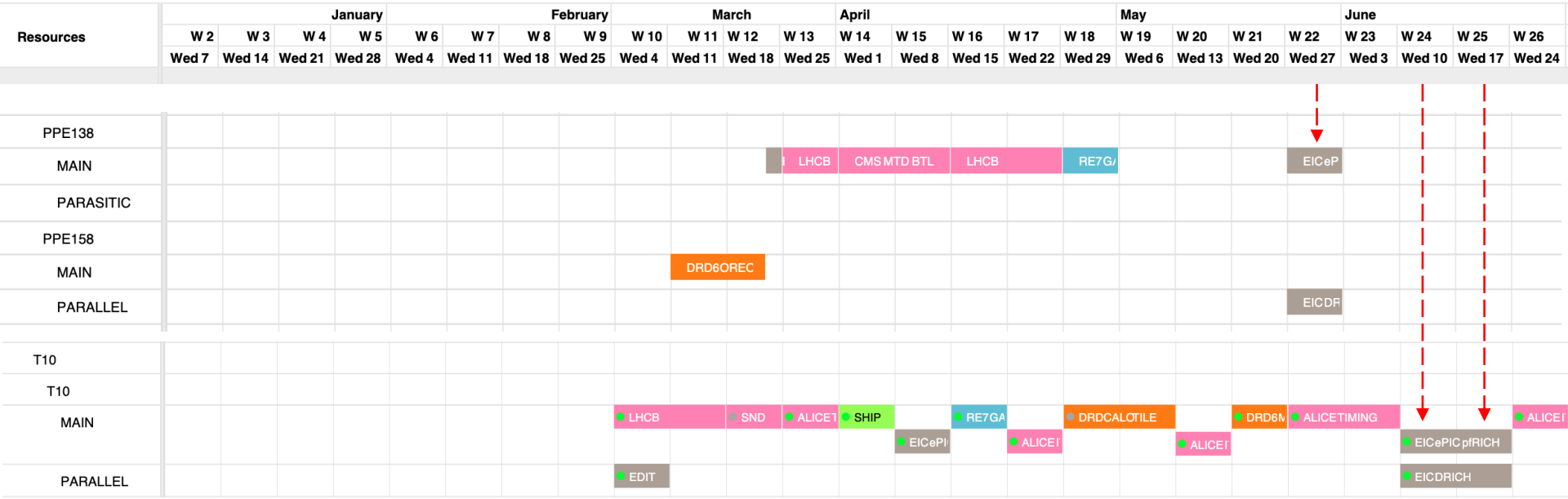
Parts	Available	Comments
HRPPDs	YES	#23 is presently @ Incom
HRPPD passive backplanes, interposers, MCX cables	YES	
MCX adapter cards	PARTLY	To be shipped from HK 04/21
V1742 digitizers & A3818 PCIe cards	YES	
GEM tracker chambers, gas panel, HV power supplies	YES	
DREAM FEU units, LV power supplies & cabling	YES	
VME & NIM crates, fast logic	YES	
Fast MCP-PMTs & trigger scintillators	YES	
Aerogel & UV-filters	YES	Aerogel still @ Temple
FCFD evaluation boards	YES (?)	Testing just started
Conical & pyramid mirror samples	NOT YET	Work in progress
Chassis, translation stages, dark box, 3D printed parts	PARTLY	Construction to be finished by 05/05
DAQ & Control room PCs, monitors, local network hardware	YES (?)	Trigger latch not yet ready
Scope, fast LED, DVMs, etc	YES	

# Component matrix

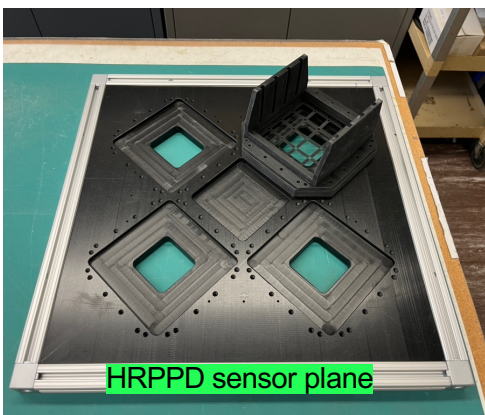
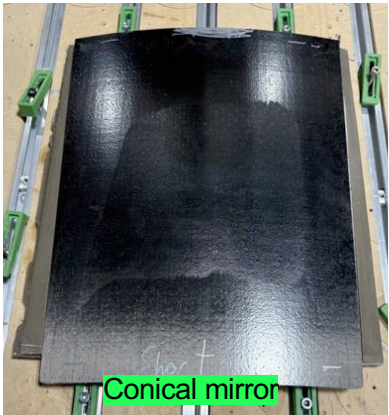
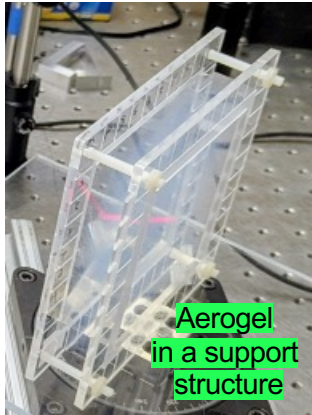
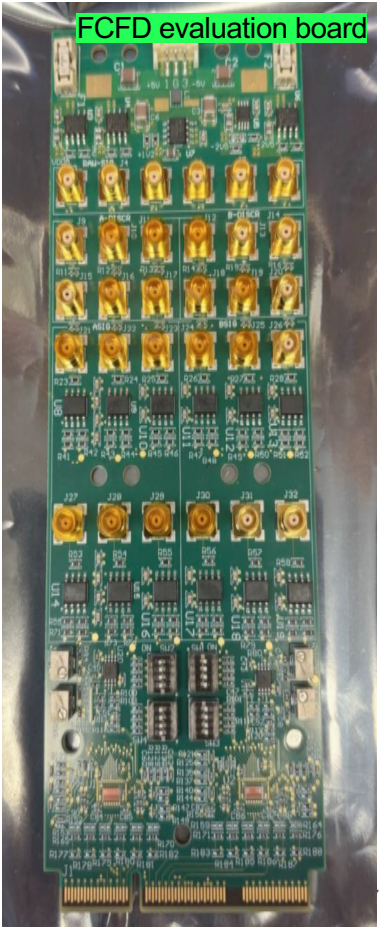
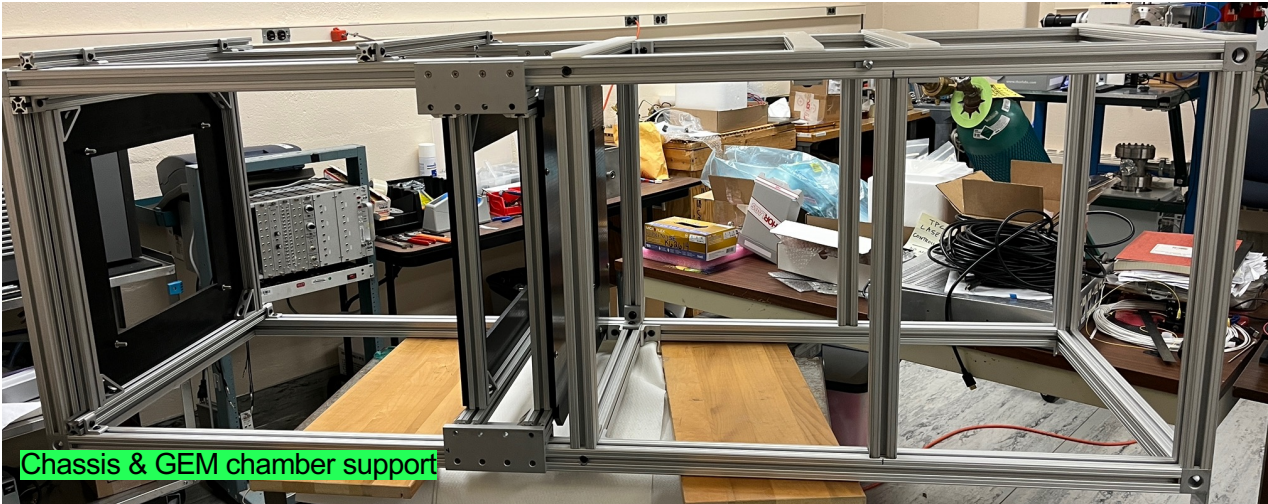
Parts	Match a final design?	Comments
HRPPDs	MORE OR LESS	Final design will be very similar
Compression interposers & backplane	MORE OR LESS	Final design will be very similar
Readout electronics	NO	Will hopefully test FCFD analog frontend though
Aerogel	YES	
UV filter(s)	MORE OR LESS	Will try different ones and choose
Mirrors	SOMEWHAT	Close enough prototypes
Vessel	NO	
HV & LV power supplies	PARTLY	A1515BV CAEN modules are final

# Schedule

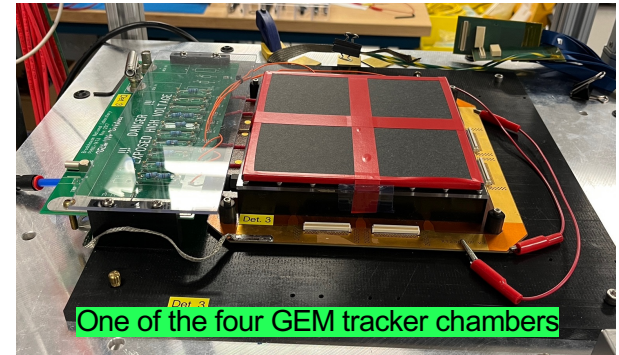
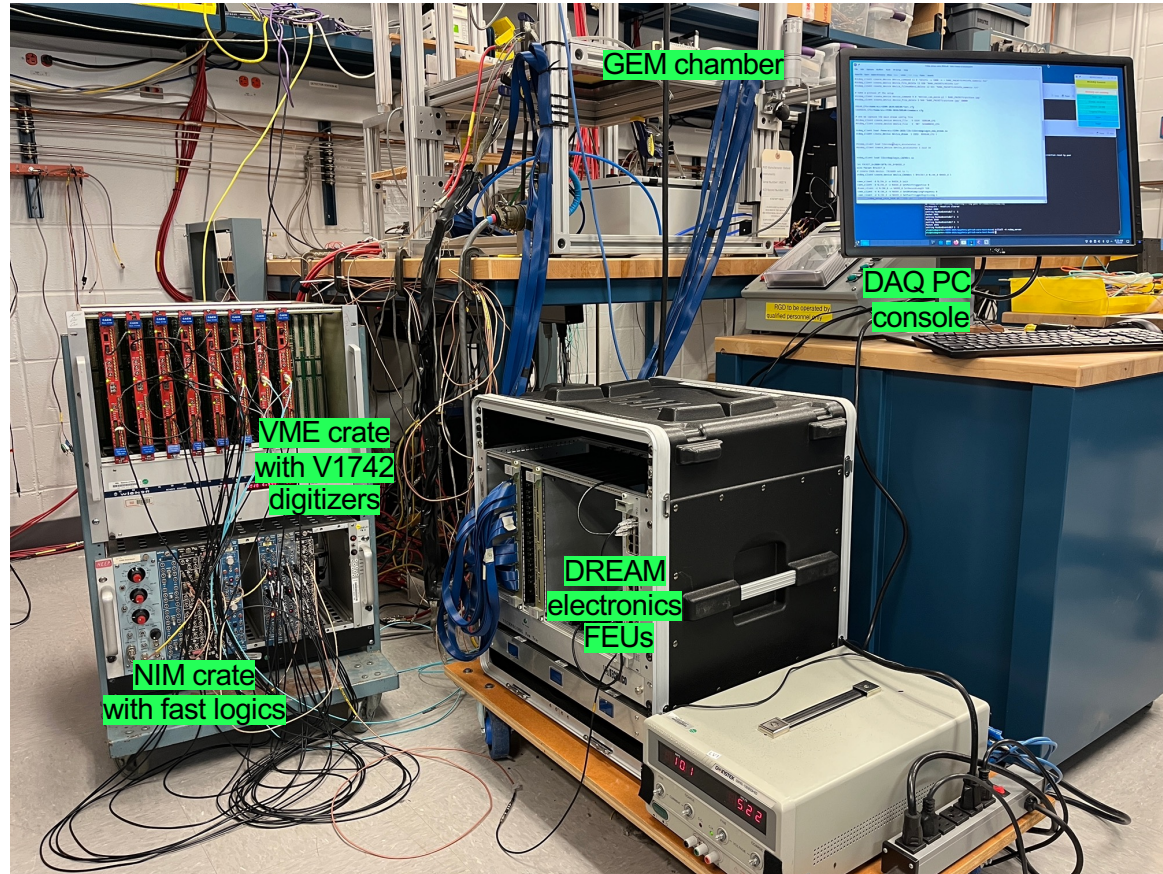
now  
 ↓  
 Shipment to CERN  
 ↓  
 MLP & AYK @ CERN  
 ↓  
 SPS run  
 PS run



# Construction, testing & assembly work pictures



# Tracker & readout hardware integration

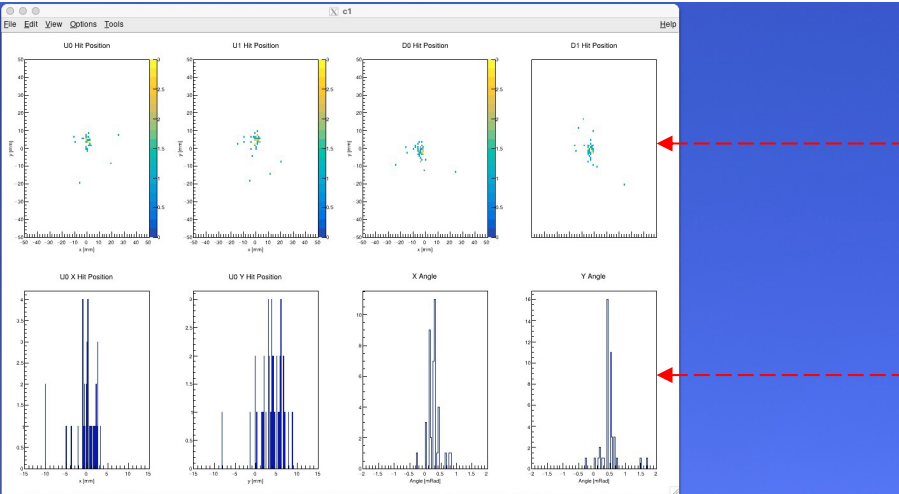


- DREAM RCDAQ driver revived and works fine
- As well as data decoding software
- GEM chambers will be tested next week
- Adding all 16 digitizers will take ~2 weeks more

# DAQ, online monitoring & data processing

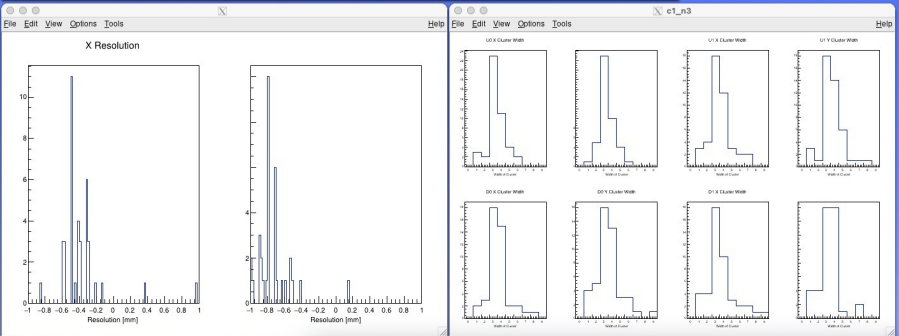
- DAQ PC will also be a disk server, a near-online analysis processor & VNC server
  - Exists & configured; 5 GHz CPU, 128 GB of RAM, 22 TB of RAID disk space
- Data will also be regularly transferred to BNL SCDF
  - Productions and next day analysis by people with SCDF accounts
- RCDAQ DAQ software is available
  - DREAM (tracking), V1742 waveform digitizer (HRPPD & MCP-PMT) drivers
- Monitoring tools: work in progress
  - Same scripts can connect to DAQ data stream & work with DAQ raw data files offline
- Reconstruction software: work in progress
  - Assumed to work the same way on GEANT simulated data and beam test data

# Online monitoring: tracking



2D beam profiles

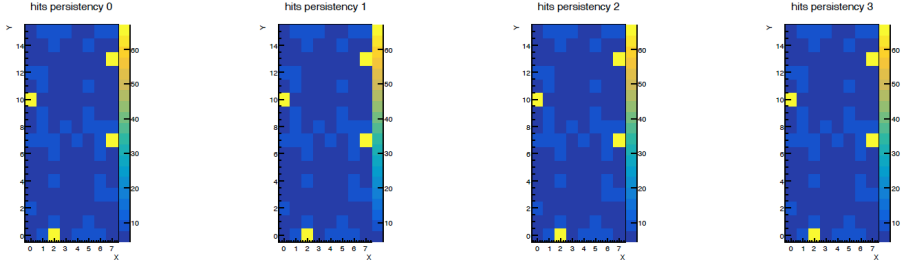
XY-coordinates & aerogel location & XY-slopes



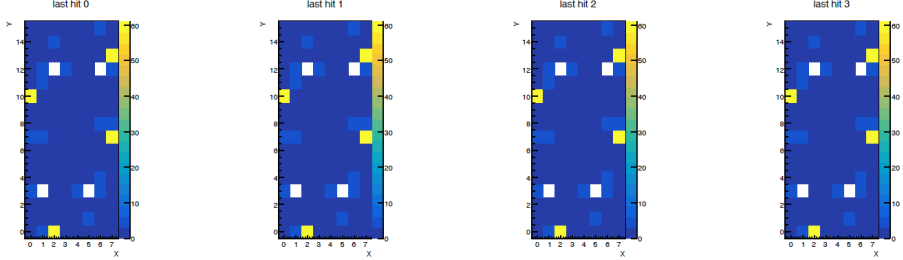
Tracker resolution estimate; GEM service info

Use 2021 Fermilab test run data for debugging

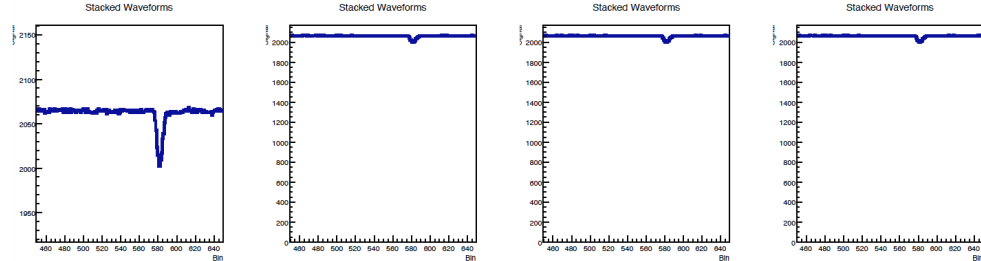
# Online monitoring: HRPPDs



← Accumulated HRPPD hit maps



← HRPPD hit maps of last event



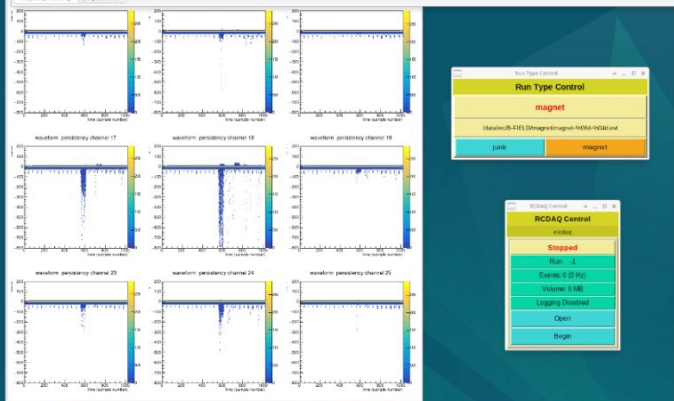
← Waveforms of hit pixels for last event

Use test stand HRPPD data for debugging

# Online monitoring: Control panel & other stuff

**2x CAEN HV windows**  
**HRPPD #5 plots**  
**MCP-PMT plots**  
**Timing**  
**Reconstructed quantities?**

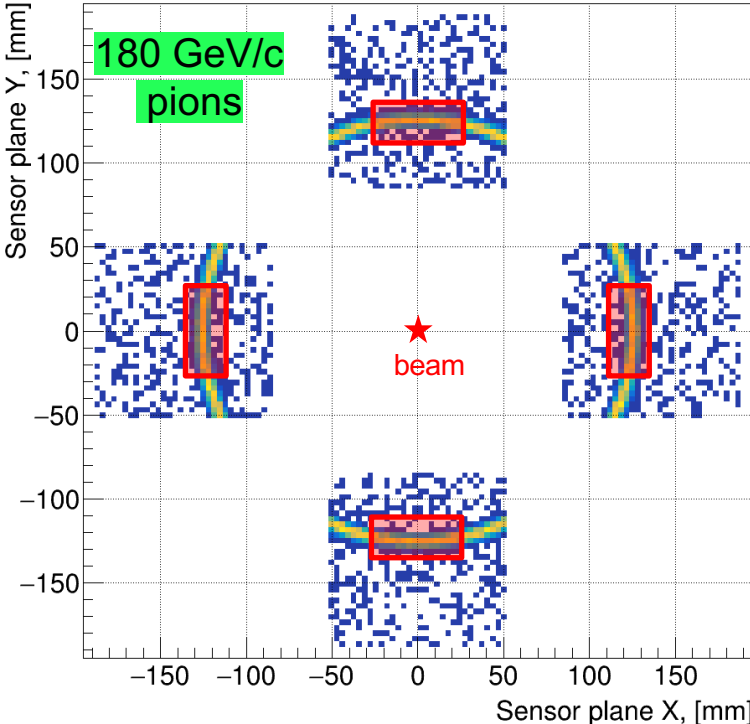
```
root [14] pupdate(c2)
root [15] pstop|
(int) 0
root [16] pclose|
(int) 0
root [17] pfileopen("/data/eic/0-FIELD/magnet/magnet-00201111-0000 evt")
(int) 0
root [18] prun(1000)
B Field x/yrz: 0.125 -2.001 0.007 total: 2.08476
using correction file calib_24973_56.dat
root [19] prun(1000)
root [20] prun(1000)
root [21]
```



System	Unit	Voltage	Current	Status
System000.000	30.000 uA	1000.00 V	0.0000 uA	OK
System000.001	300.000 uA	1700.00 V	0.0000 uA	OK
System000.002	600.000 uA	1075.00 V	0.0000 uA	OK
System000.003	900.000 uA	875.00 V	0.0000 uA	OK
System000.004	600.000 uA	200.00 V	0.0000 uA	OK

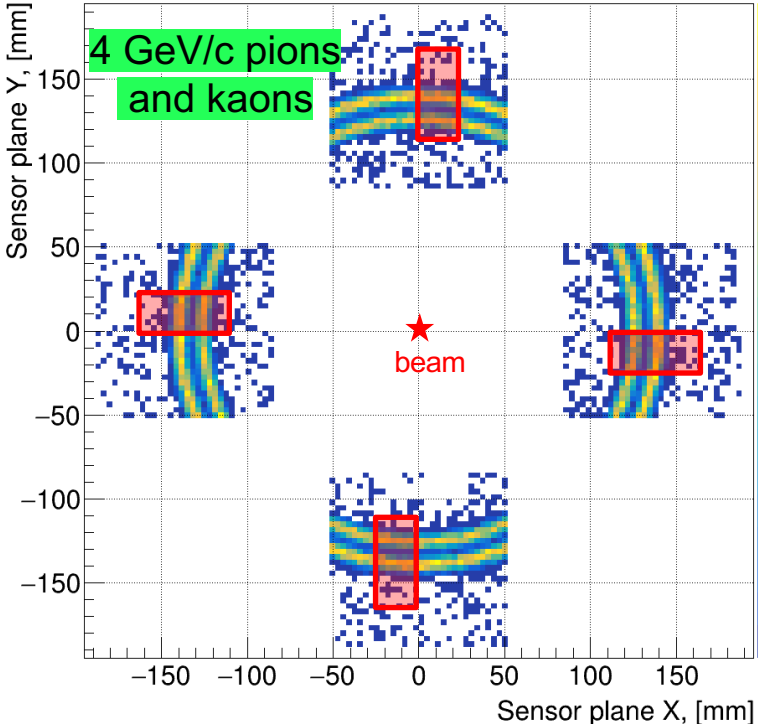
Recycle a recently used HRPPD B-field tests configuration

# GEANT modeling



“SPS acceptance”

(~1/4 azimuthally; saturated rings; ~403mm exp. volume)

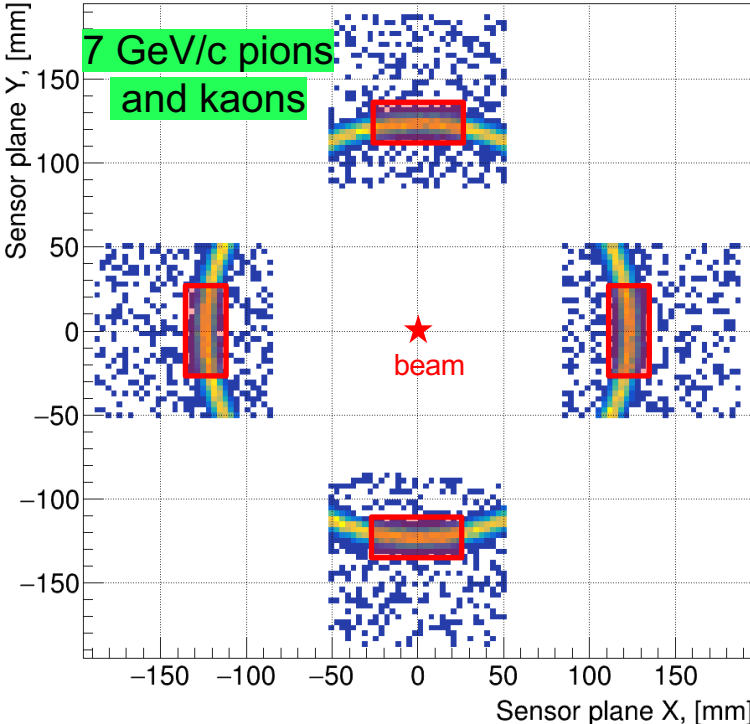


“PS acceptance”

(2x smaller acceptance;  $\pi/K$ ; ~453mm exp. volume)

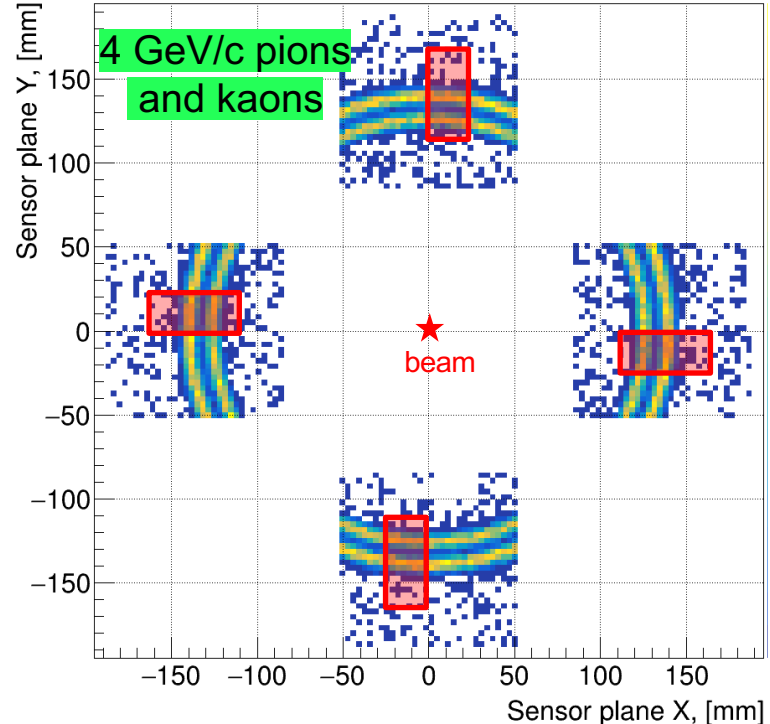
Same HRPPD instrumented area (no need in re-cabling; just a 90° rotation of every HRPPD)

# GEANT modeling



“SPS acceptance”

(~1/4 azimuthally; saturated rings; ~403mm exp. volume)

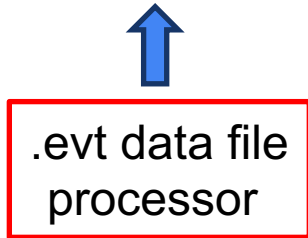
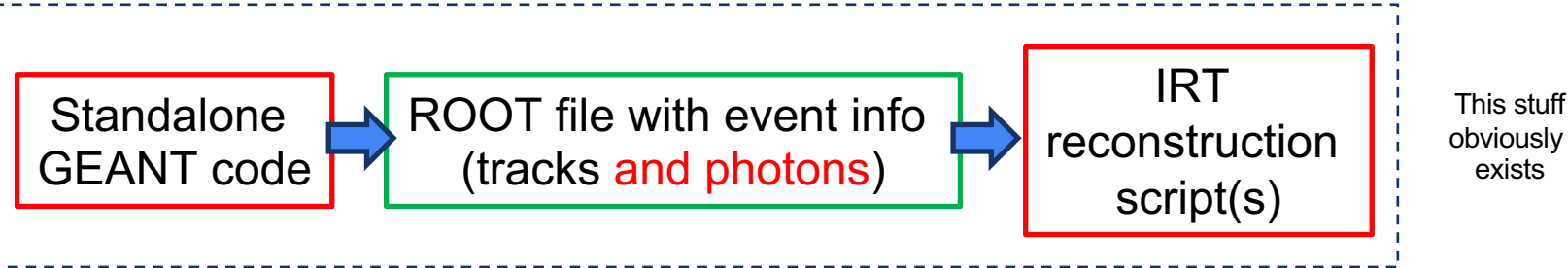


“PS acceptance”

(2x smaller acceptance;  $\pi/K$ ; ~453mm exp. volume)

Same HRPPD instrumented area (no need in re-cabling; just a 90° rotation of every HRPPD)

# Data analysis software scheme



- Adjustments to real data input
- Event merging (optional)

This stuff also exists (in pieces)

- V1742 decoder
- Mapping
- HRPPD clustering code
- HRPPD timing
- DREAM decoder & tracking
- Beam line instrumentation info

- The plan is that .evt data file processor will produce event-wise *ROOT trees in a pretty much the same format as the GEANT code does*
- Can be used on the DAQ PC @ CERN & in “official” productions on SCDF
- IRT reconstruction code will also be “standardized”

# Summary

\* Do you have all necessary hardware (components) available, and if not what is the timeline to receive them?

Almost (see slide 4)

\* Is the readout electronics and corresponding readout software running in the lab and thoroughly tested?

Getting there (see slide 8)

\* What type of "live QA" software do you have that helps you build confidence during the beam time that you are taking good data?

See slides 10-12

\* Describe your scientific goals and the specific measurements and parameter scans required to fulfill it.

See slide 2

\* What is the status of data analysis of previous beam tests? Which insights of previous beam tests are required to guarantee success of the upcoming beam test?

N/A (HRPPD B-field tests?)

\* Which components are matched to the ePIC detector design, and which ones are being used as intermediate/ad hoc solutions?

See slide 5