

pfRICH CERN Testbeam Summary

Brian Page – for the pfRICH Team

TIC Meeting

September 21, 2026



Five Weeks at CERN

Week	Description
May 20-27	Partial assembly & pre-commissioning
May 27 - June 3	Final assembly & SPS run (aka commissioning)
June 3 - 10	SPS -> PS transition; re-assessment of the PS run goals
June 10 - 24(27)	Re-assembly, PS run (main part of the beam test), dis-assembly

Personnel

Initial Setup and SPS Running

PS Running and Tear-Down

[illegible]

SPS to PS Transition

Location Location Location



Overall Topics and Goals

- ❑ HRPPD performance in particle beam
 - Imaging photons
 - Window flashes
 - Timing
- ❑ Direct N_{pe} measurement (aerogel + filter + HRPPD PDE)
- ❑ Cherenkov angle resolution (comparison to MC)
- ❑ π/K and e/π separation
- ❑ FCFD first look
- ❑ Mirror evaluation (conical and pyramid)
 - ID reflected photons
- ❑ Laser monitoring system
 - Delay calibration using PiLas laser

Week of May 20 - 27

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Week of May 20 – 27: Summary

- ❑ Alexander, Martin, and Preet @ CERN
- ❑ Unpack crates
- ❑ Setup computing infrastructure
 - Local network, online monitoring, DAQ PC
- ❑ Setup DAQ hardware (NIM logic)
- ❑ Setup online monitoring tools
 - VNC sessions, tracker & imaging, GECO
- ❑ Assemble HRPPDs
- ❑ Assemble 8020 chassis
- ❑ Area infrastructure
 - Gas, DESY table, rack location, beam line Cherenkov instrumentation

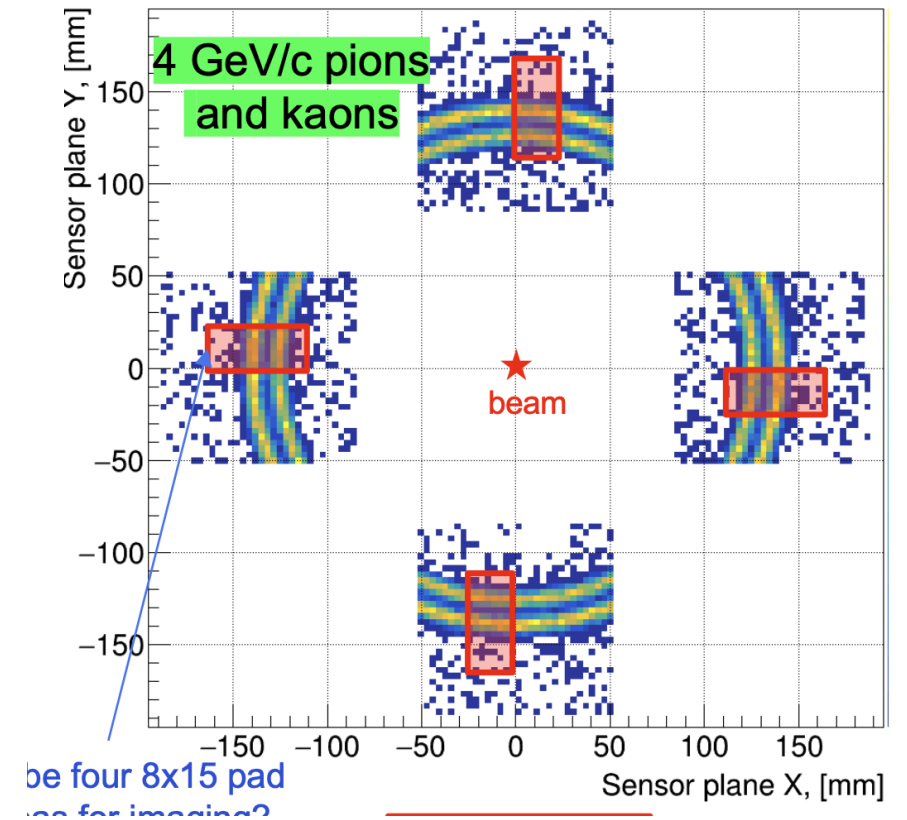
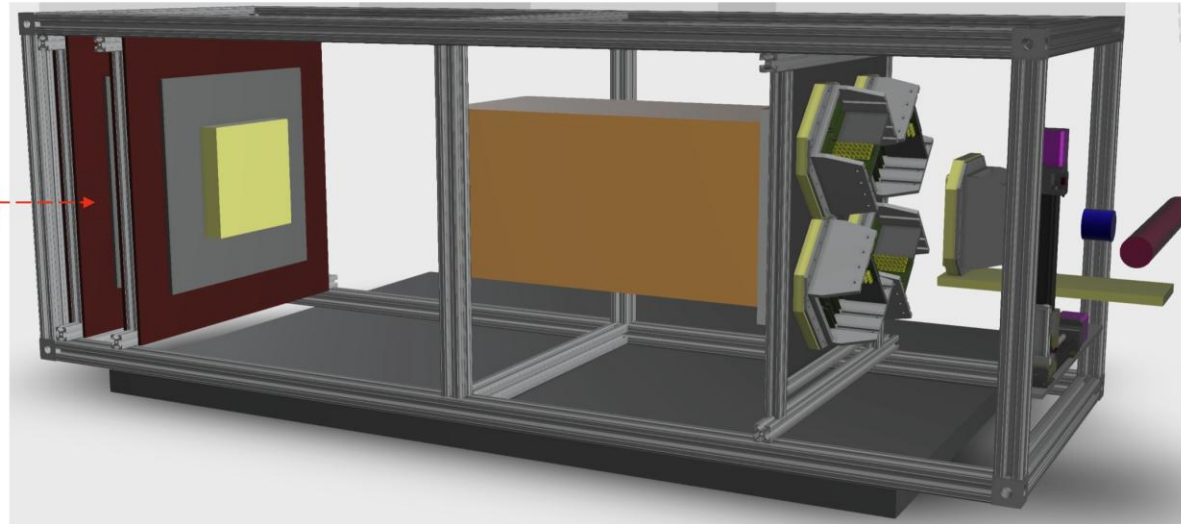
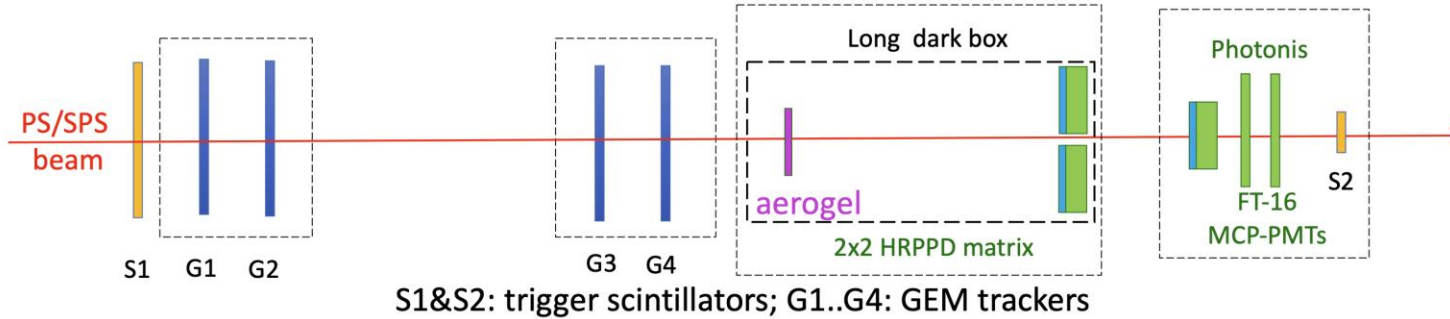
Week of May 27 – June 3

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Week of May 27 – June 3: Summary

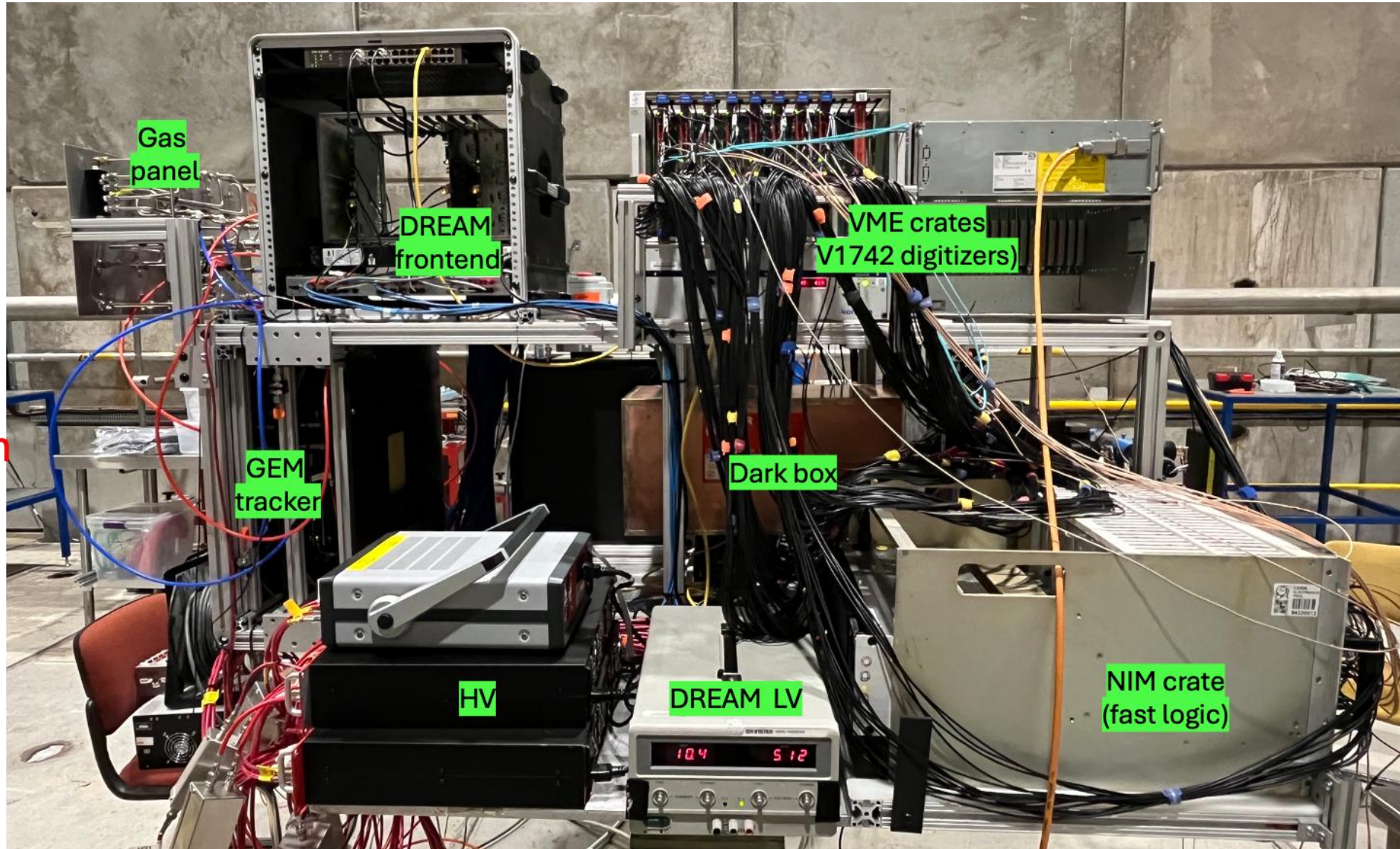
- ❑ Alexander, Bob, Jihee, Martin, and Preet @ CERN
- ❑ May 27 – 28: Move equipment into beam area and assembly
- ❑ May 29: Obtain safety clearance (for laser as well)
- ❑ ~Three days of commissioning work
 - Beam alignment and profiling
 - Collected data with window flashes in HRPPD 5
 - Collected data with laser monitoring system
- ❑ June 1 @ ~1 pm: Linac failure -> end of SPS run

Apparatus Layout and HRPPD Readout

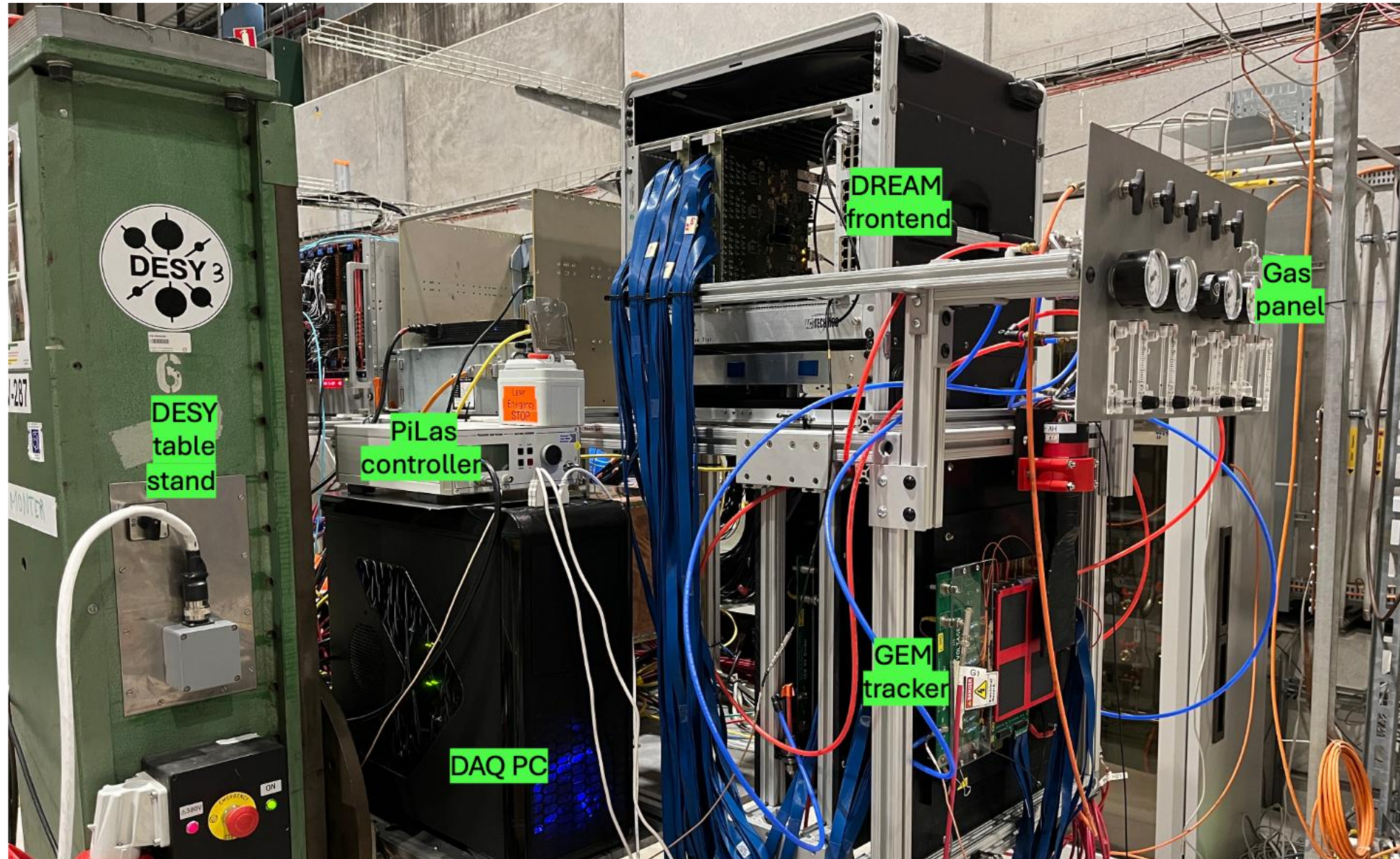


SPS Installation

SPS beam
→



SPS Installation



SPS Installation

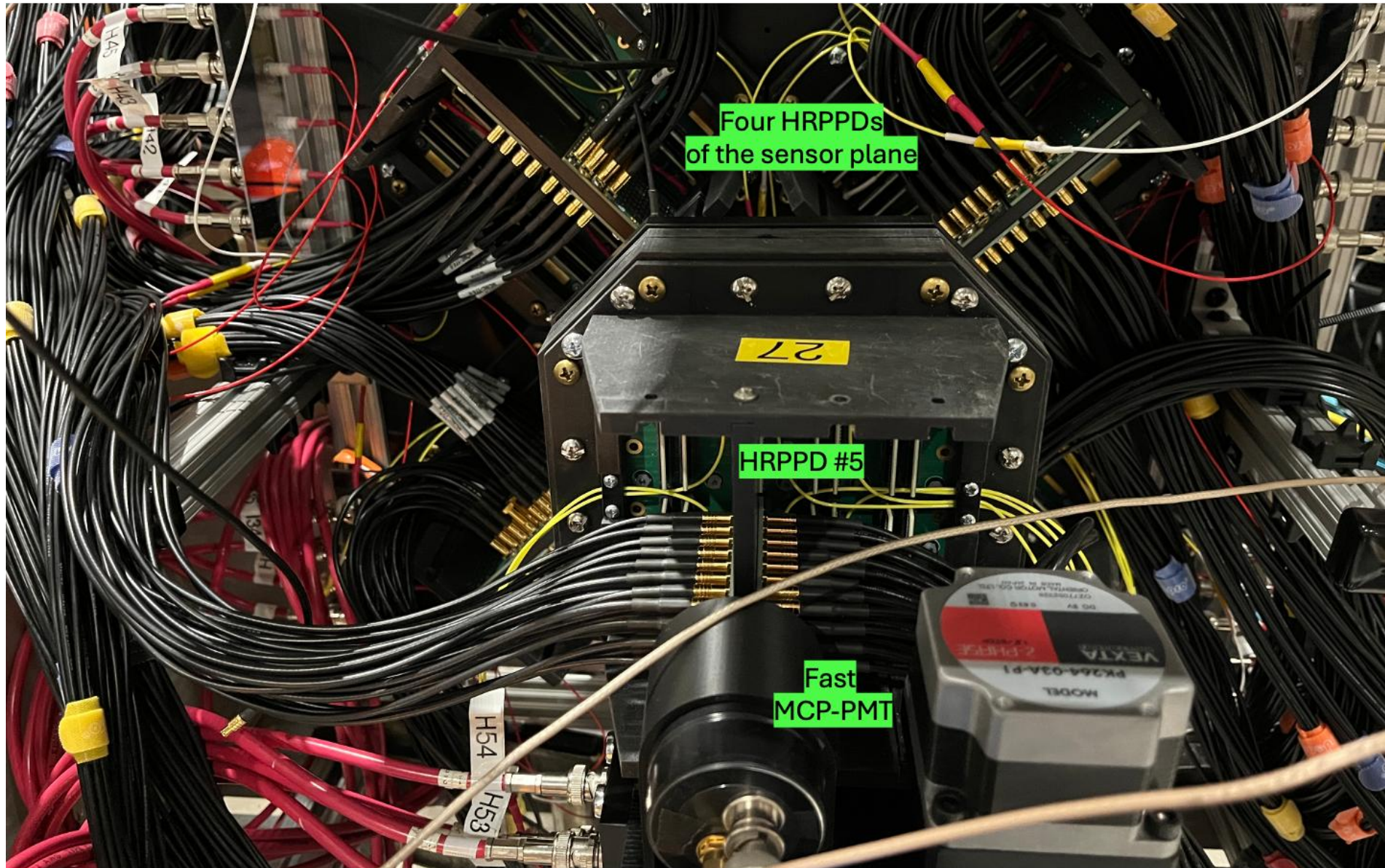


Finger
scintillators

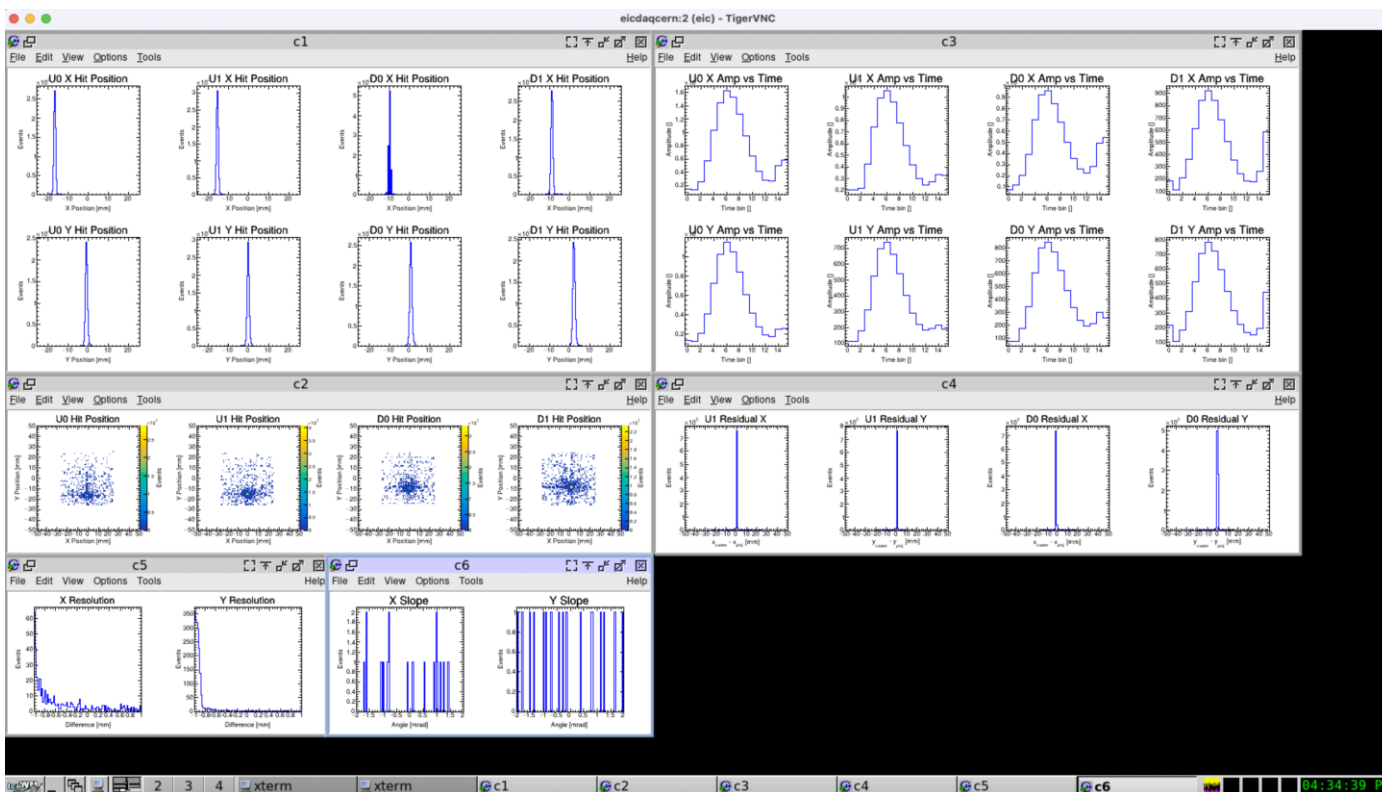
Fast
MCP-PMTs

Trigger
scintillators

SPS Installation

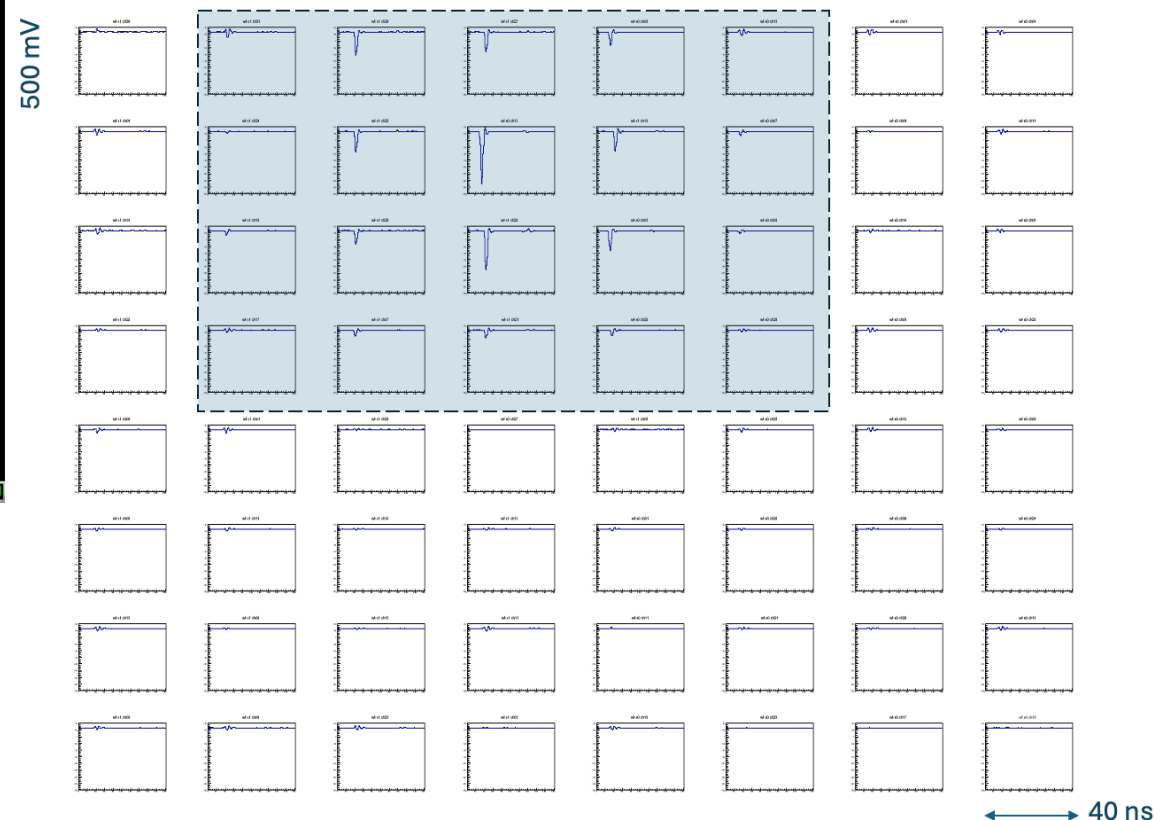


SPS Monitoring and Online Results



Above: Example of online monitoring plots for GEM trackers showing hit positions, amplitudes, residuals, etc.

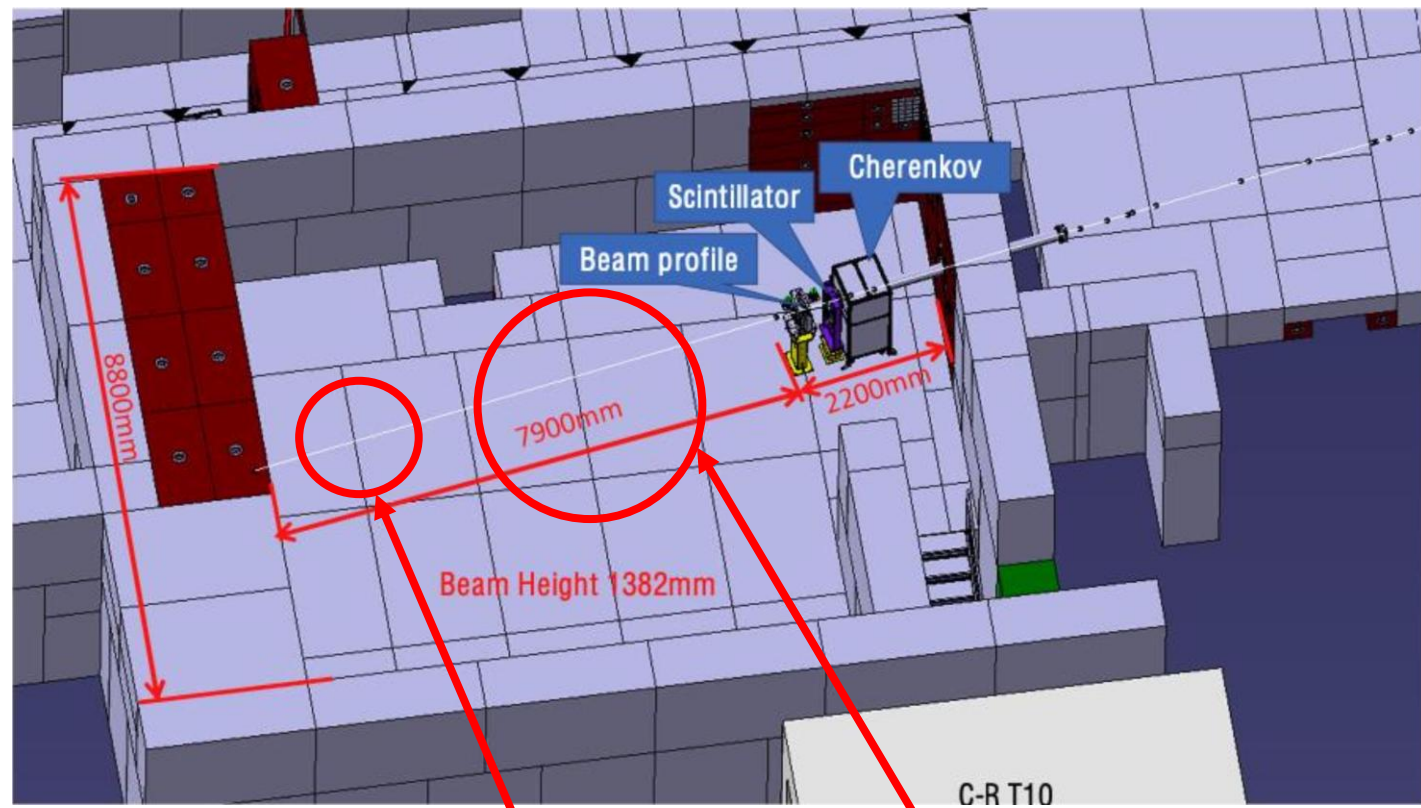
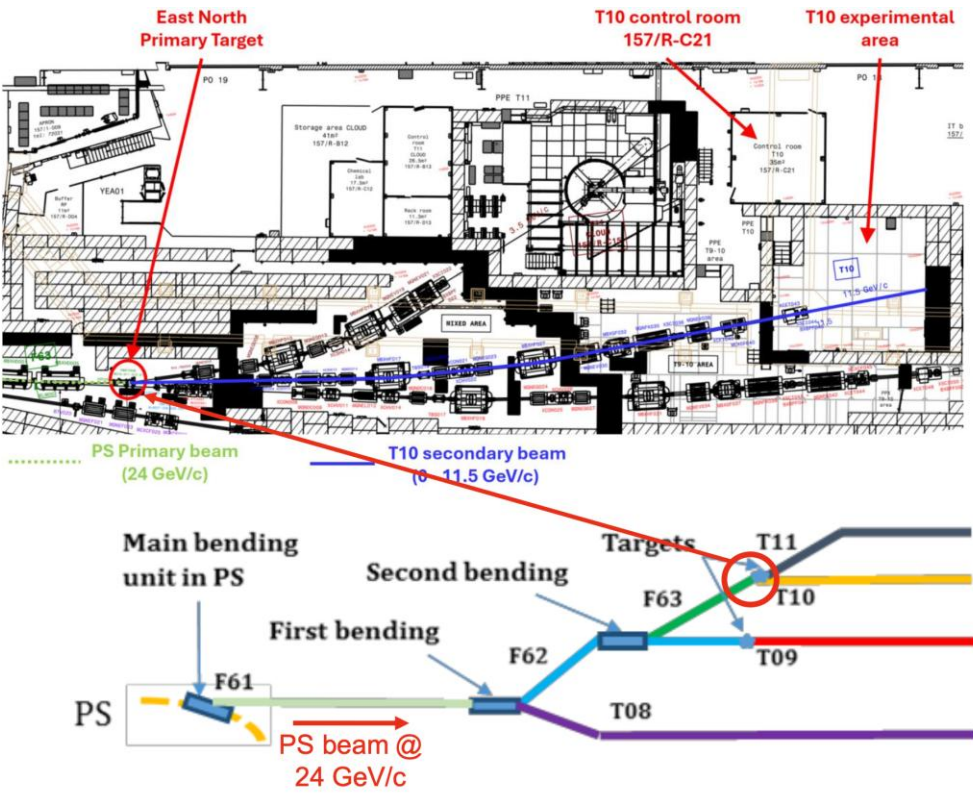
Below: A single events with waveforms of a multi-photon flash produced by a beam particle in the HRPPD #5 window (8x8 pad area)



Week of June 10 – 24(27)

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PS T10 Beam Line



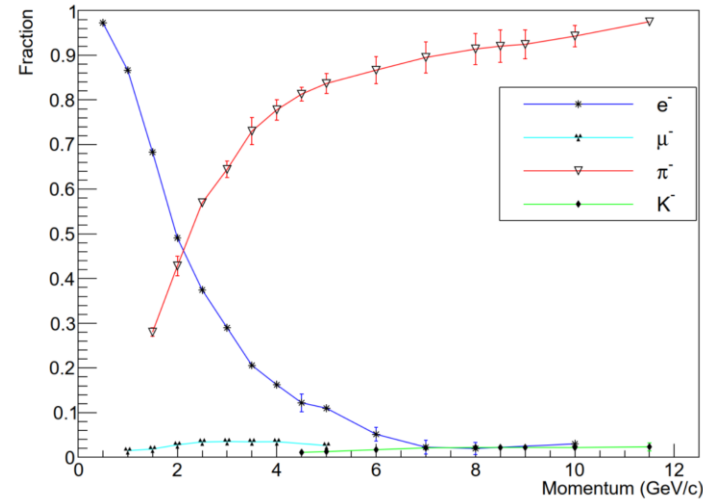
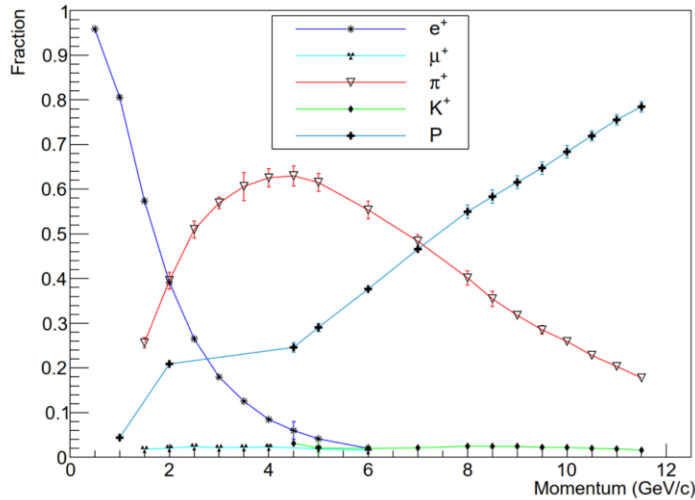
pfRICH

dRICH

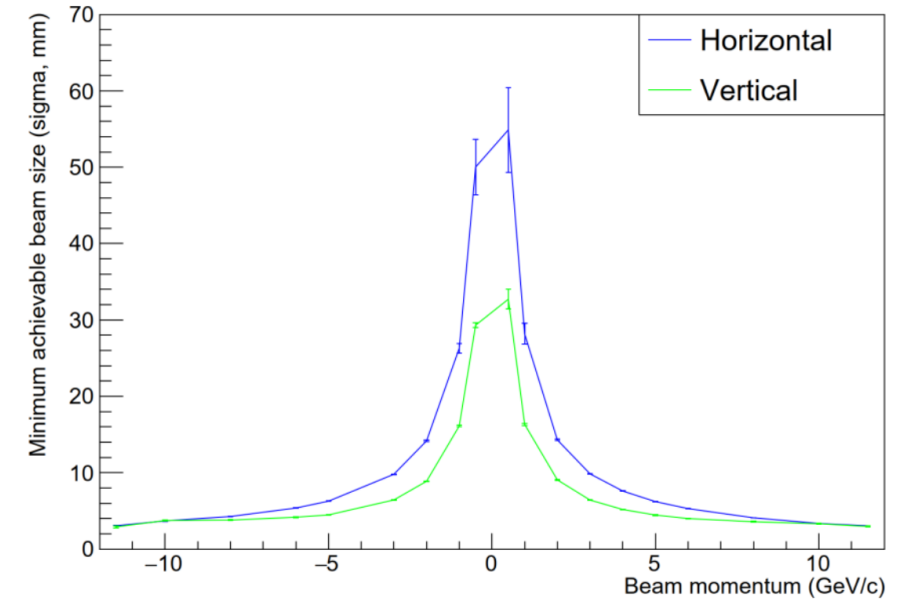
Parameter	T09 Target	T10/T11 Target	
Beam Line	T09	T10	T11
Secondary beam Max Momentum (GeV/c)	15	11.5	3.5
$\Delta p/p$ (%)	± 0.7 to ± 15.0	± 0.7 to ± 15.0	± 0.7 to ± 15.0
Maximum intensity/spill (hadrons/electrons)	$\sim 10^6$	$\sim 10^6$	$\sim 10^6$
Available particle types	Pure electrons (T09 only) or mixed/pure hadrons or muons		

PS T10 Beam Line

Beam Particle Content

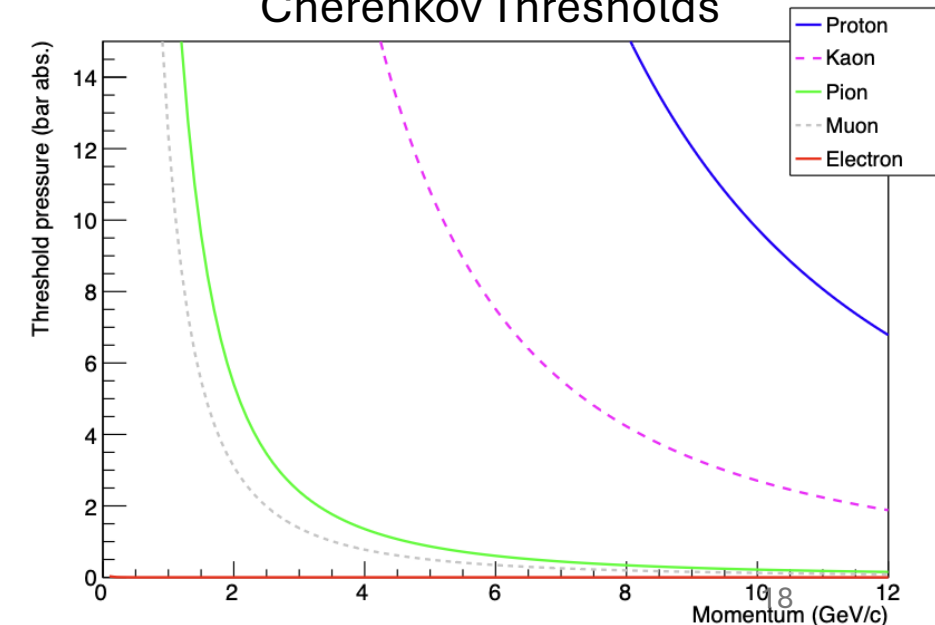


Beam Size

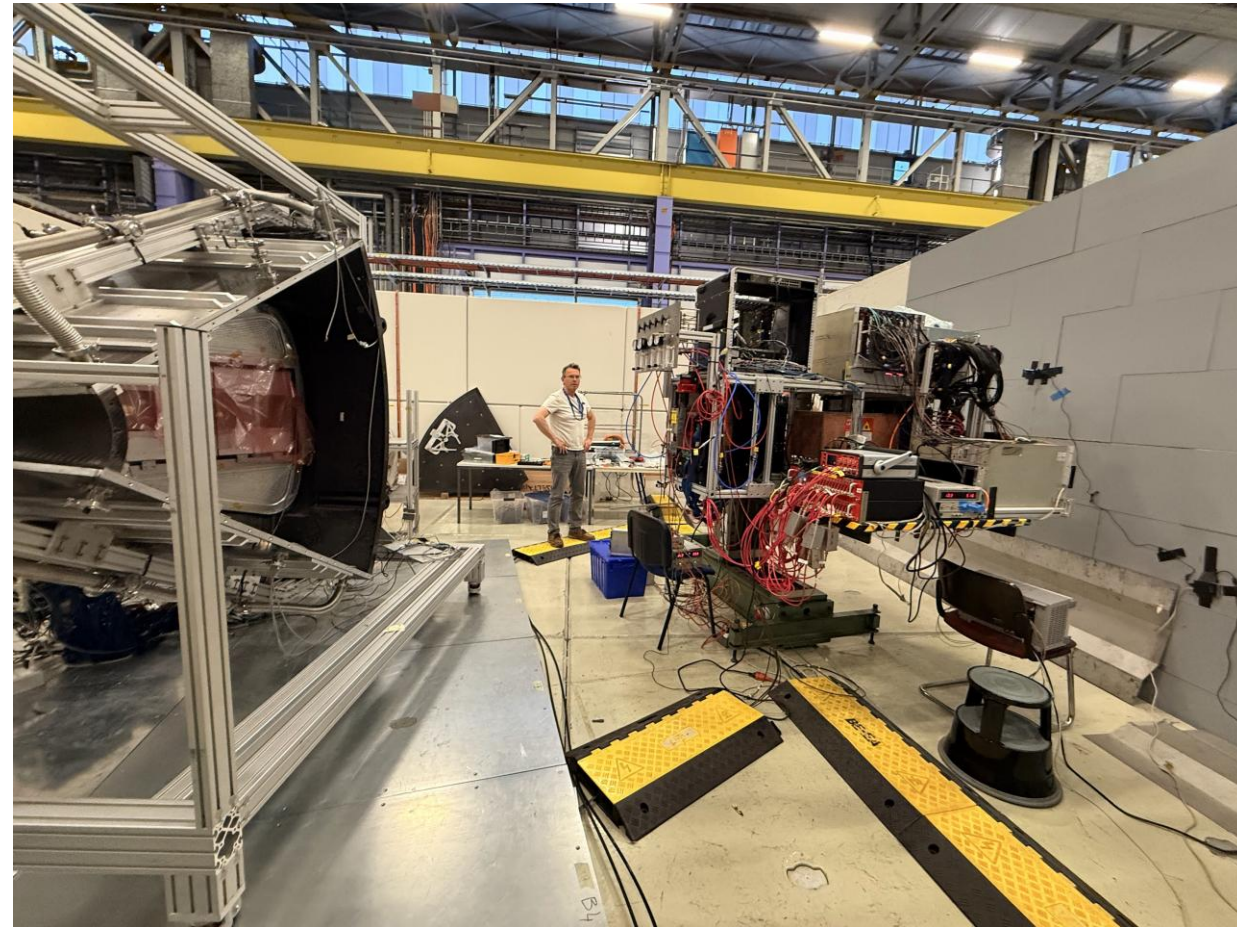


- ❑ User control of many beam aspects, including charge sign, energy, intensity and focus
- ❑ Particle content of beam vs energy shown above – note the small kaon fraction
- ❑ Beam size largely determined by momentum selection with some influence from choice of focus position
- ❑ Access to beamline scintillator and Cherenkov signals and user control of Cherenkov gas pressure settings
- ❑ Challenging duty cycle – between 1 to 4 spills per minute / 0.4s flattop

Cherenkov Thresholds



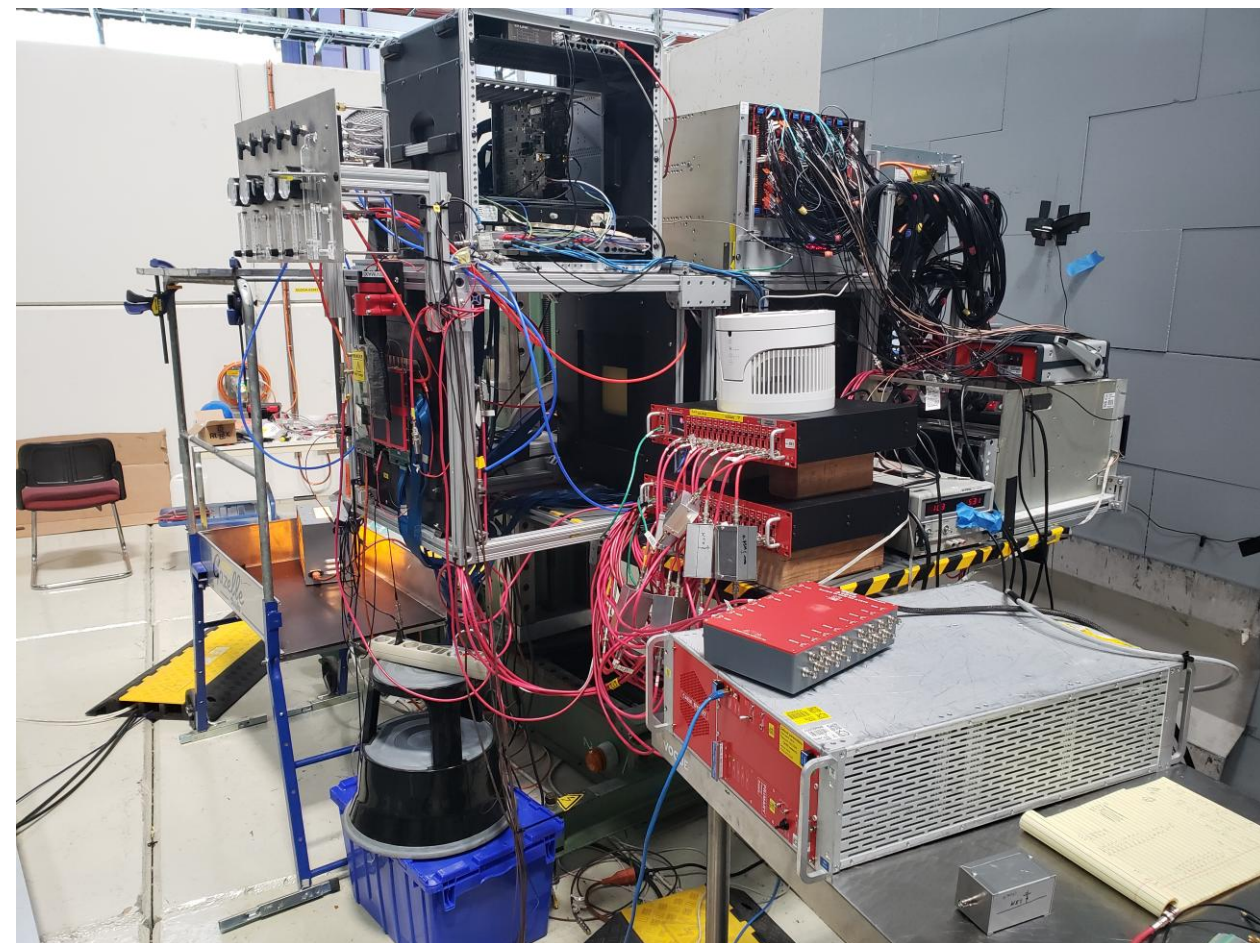
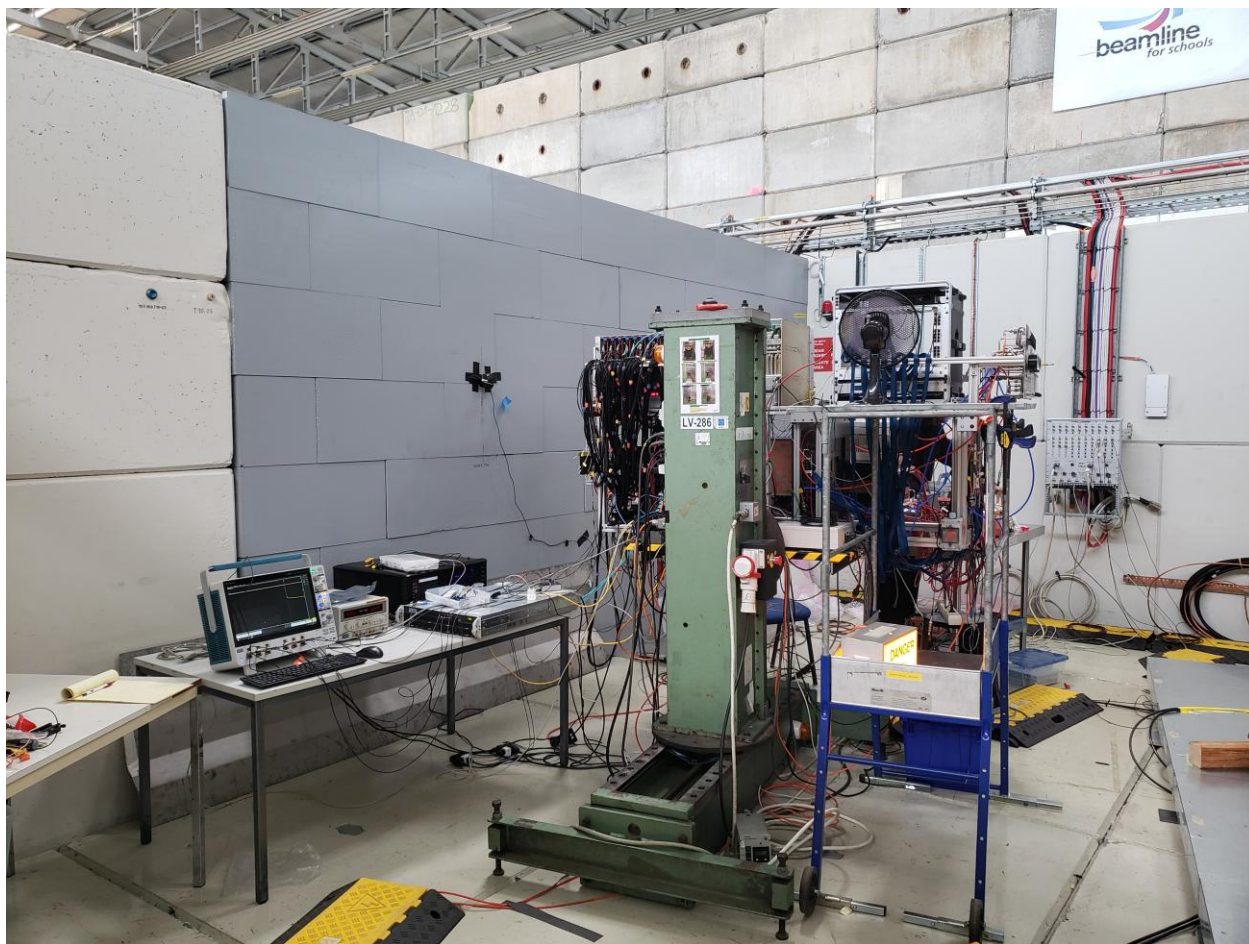
PS Installation



Week of June 10 – 24: Summary

- ❑ Jihee (6/4), Bob, and Martin (6/12) leave – Andrew, Bradyn, Brian, & Kathleen arrive
- ❑ June 10 & 11: Assemble test stand
 - Safety inspection passed ~ 3pm on the 11th
- ❑ June 12 – 19: Troubleshoot various issues
 - DAQ problems (computer crashes, computer swaps, synch issues)
 - Trigger setup / logic
 - Rate optimizations
 - Digitizer configuration
 - Power supply
- ❑ June 19 - 24: ~Stable running
 - Energy scans
 - Expansion volume scans
 - FCFD
 - Mirrors
 - Timing
 - Dedicated electron ID

PS Final Configuration

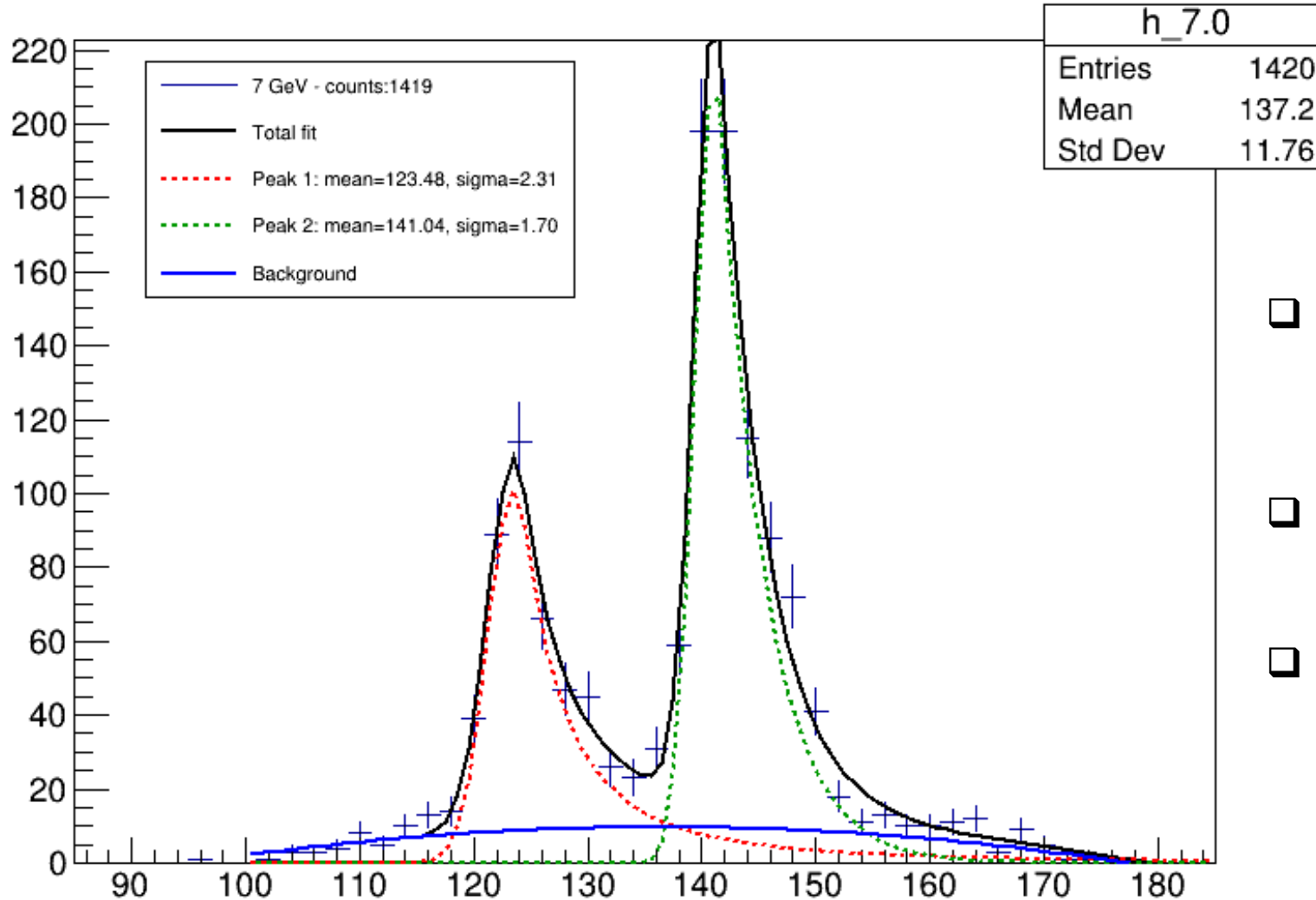


PS Data Set

T		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
T		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
T		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
T		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
T		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
T		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
T		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
T		B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
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- ❑ Took roughly 3.2 million events over the 2 week period
- ❑ About half of these came in the last 5 days – stable running period
- ❑ Initial run quality assessment performed
 - ❑ 2M good events
 - ❑ 600K medium events
- ❑ Also took several thousand events with high precision scope – beam duty cycle and scope acquisition speed made data taking difficult

Example Fast Offline Money Plot

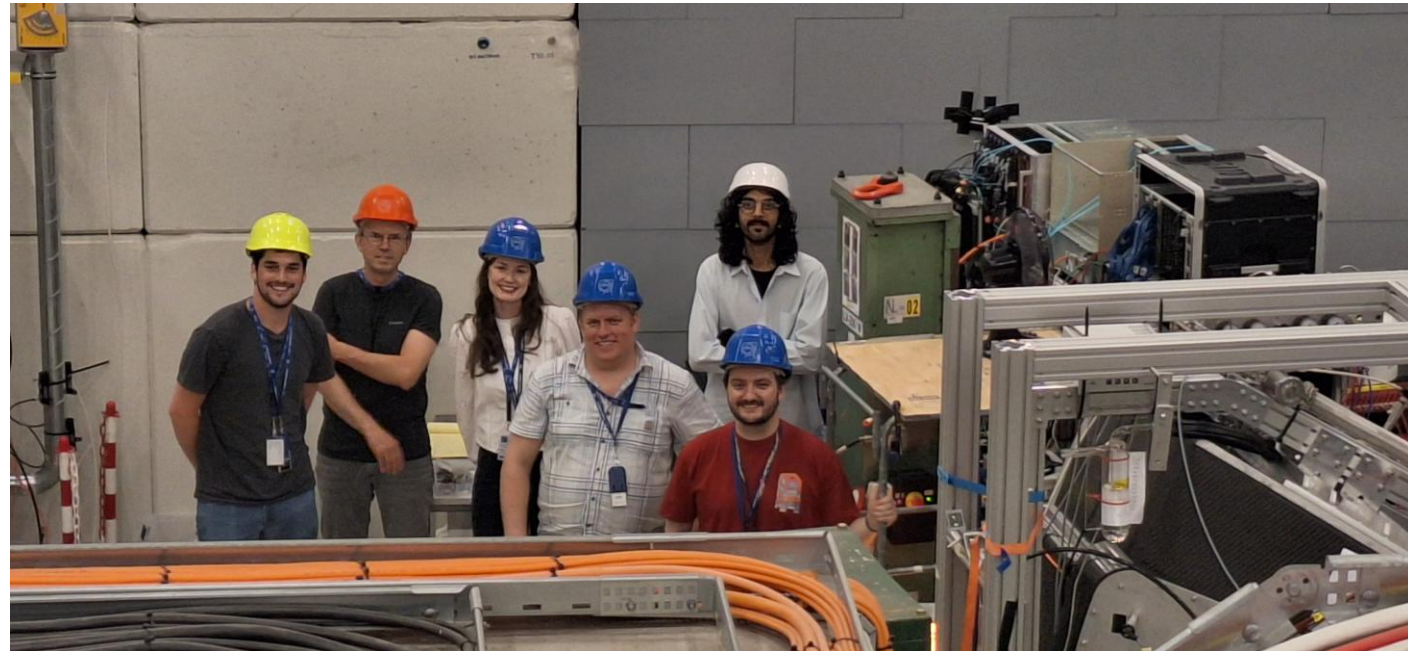


- ❑ Distance from track to photon at the sensor plane (in mm) from a 7 GeV run – Cherenkov ring radius at the HRPPDs
- ❑ Pion (right) and proton (left) peaks clearly visible – Kaon fraction will be tiny
- ❑ Peak positions roughly consistent with aerogel refractive index, expansion distance, and refraction at aerogel-gas boundary

Summary

- ❑ HRPPD performance in particle beam ✓
 - Imaging photons
 - Window flashes
 - Timing
- ❑ Direct N_{pe} measurement (aerogel + filter + HRPPD PDE) ✓
- ❑ Cherenkov angle resolution (comparison to MC) ✓
- ❑ π/K and e/π separation ✓
- ❑ FCFD first look ✓
- ❑ Mirror evaluation (conical and pyramid) ✓
 - ID reflected photons
- ❑ Laser monitoring system ✓
 - Delay calibration using PiLas laser

- ❑ Decision made to apply for CERN beam time in ~January, meaning we had < 6 months to fully implement a program at an entirely new facility – huge effort by all involved
- ❑ Despite loss of beam at SPS and difficult conditions at PS, we took significant data in most planned configurations
- ❑ Data analysis is starting – aim to have many results ready by early next year
- ❑ PS should be back on-line in 2028...



Big Thanks to All Involved!

Bob Azmoun - BNL

Andrew Cheyne - Glasgow

Jihee Kim - BNL

Alexander Kiselev - BNL

Preet Mann - MSU

Brian Page - BNL

Martin Purschke - BNL

Bradyn Quintard - Yale

Kathleen Ramage - Glasgow

Sean Stoll - BNL

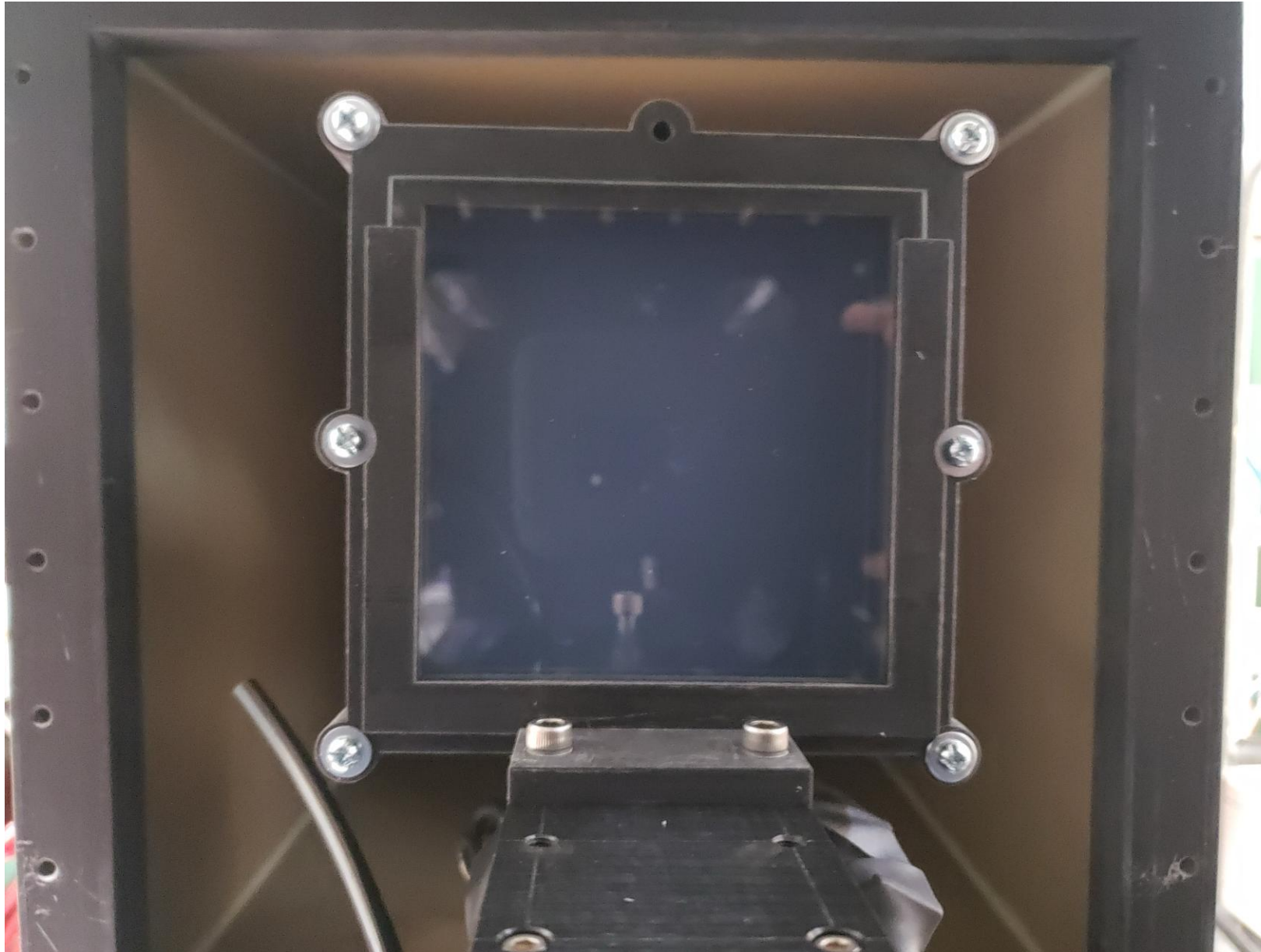
Ping Wong - BNL

dRICH Team

BNL Support Staff

CERN Support Staff

Aerogel and Filter



View of the Hall



View of the Darkbox (During Disassembly)



Removal of the Chassis



dRICH Installation

