



Beam test of the FARICH prototype with charged hadrons at the SPASCHARM facility of the U-70 accelerator

Ivan Kuyanov on behalf of BINP Aerogel team.

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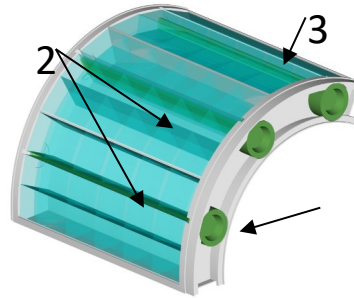
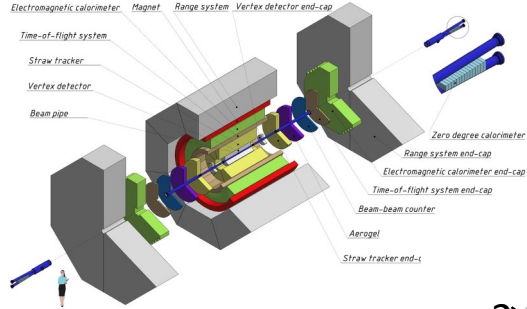
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INSTR 2026, USTC, Hefei, China

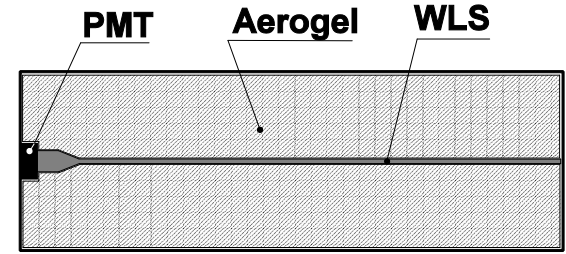
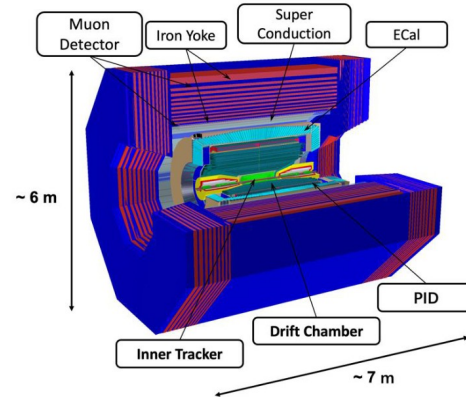
13 October 2026

Aerogel-based particle identification systems at the BINP

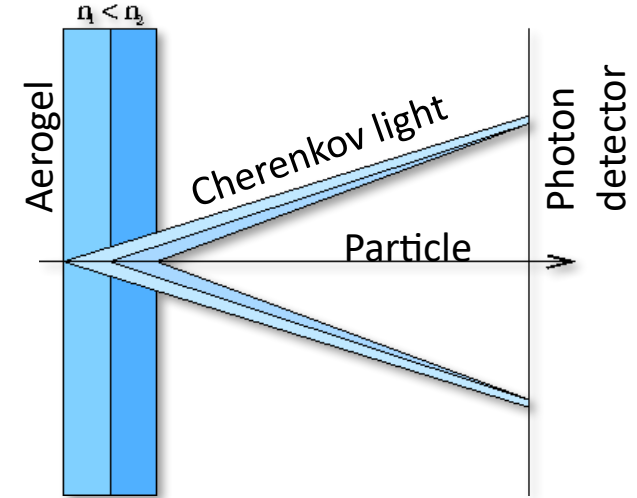
- FARICH for the SPD, NICA
- ASHIPH counters for the Super Tau-Charm facility
- SND detector ASHIPH counters upgrade (PMT-MCP->SiPM)



1 - PMT, 2 – aerogel, 3 - WLS



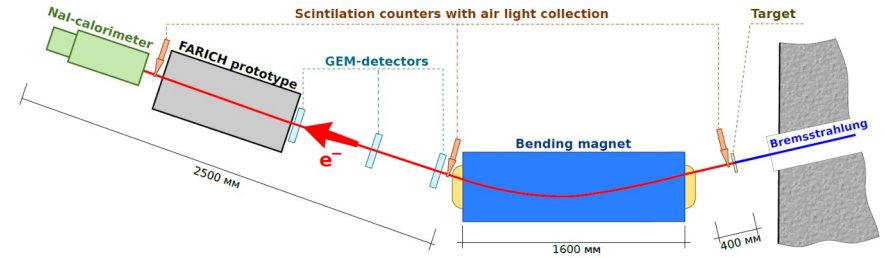
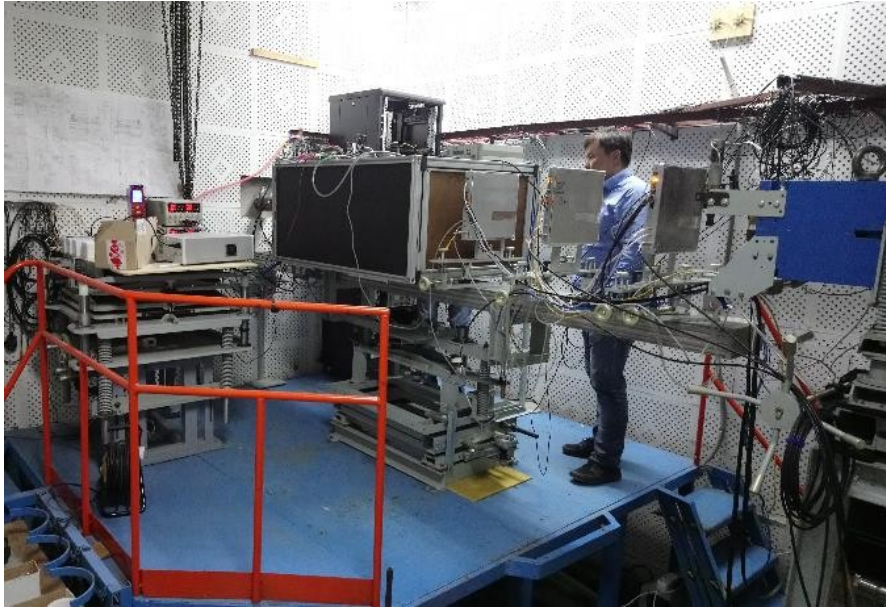
A. Onuchin et al. NIM A315, 1992, 517-520



T.Iijima et al., NIM A548 (2005) 383

A.Yu.Barnyakov et al., NIM A553 (2005) 70

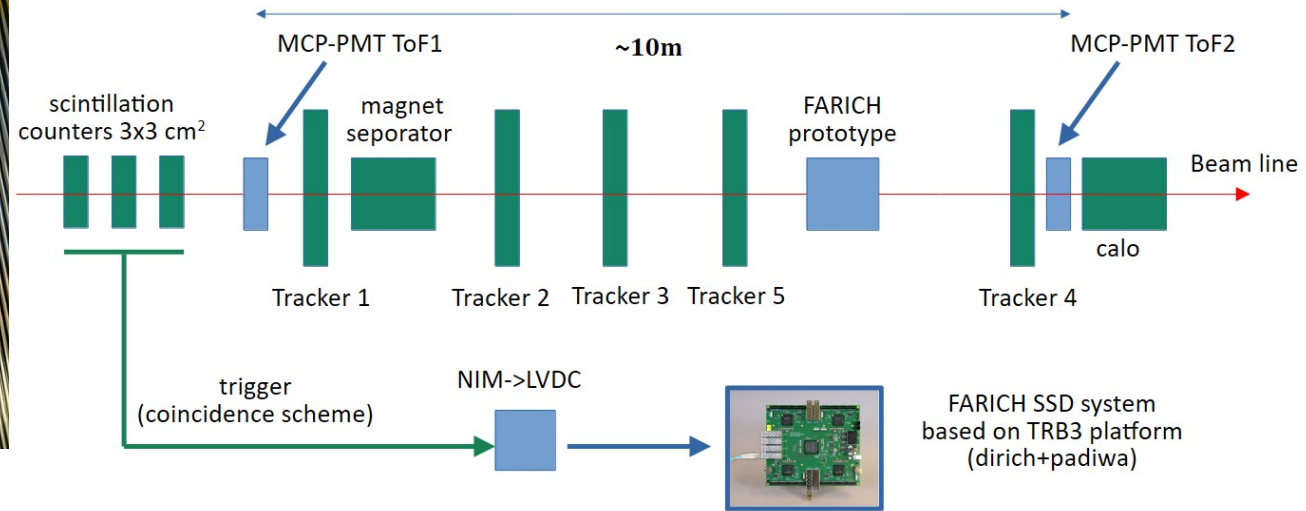
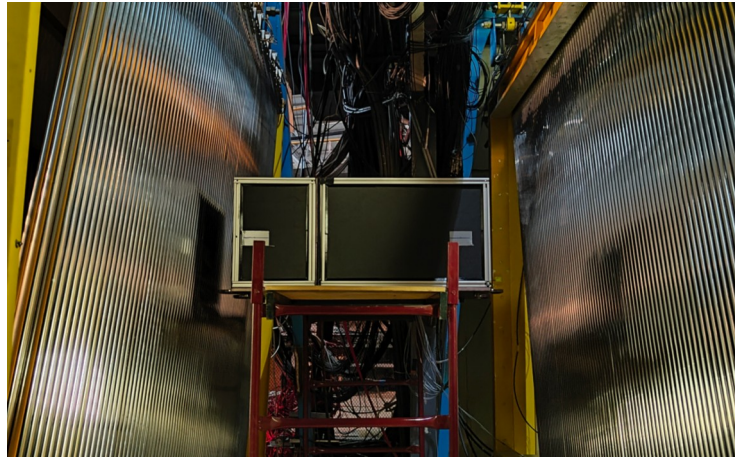
Testing of prototypes using charged-particle beams: VEPP-4 beam test facility



Electron beam parameters:	
Energy range	up to 2.5 GeV
Averaged intensity	up to 100 e ⁻ / s
Energy spread	2.6%

G N Abramov et al 2014 JINST 9 C08022

Beam test at the SPASCHARM (SPin ASymmetries in the production of CHARMonium) facility of the U-70 accelerator



- Primary particles – protons;
- Secondary particles produce in Al-target
- Momenta $1.5 \leq P \leq 12 \text{ GeV}/c$
- • Beam content: π^+ (~75%), p (~25%), K^+ (<1%), e (<1%)

S.F. Reshetnikov et al. Phys. At. Nucl. 88, 2026, 2534–2539

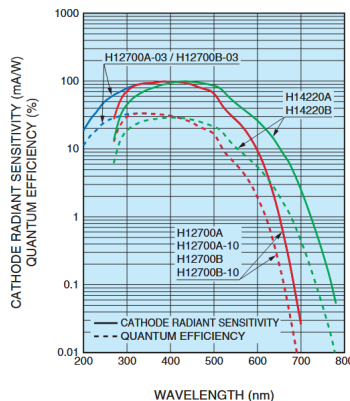


FARICH prototype

Photon Detector:

4x H12700 MaPMTs (Hamamatsu):

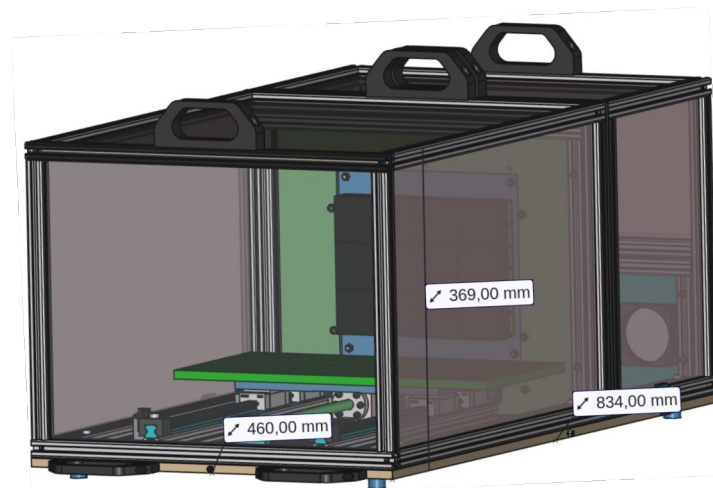
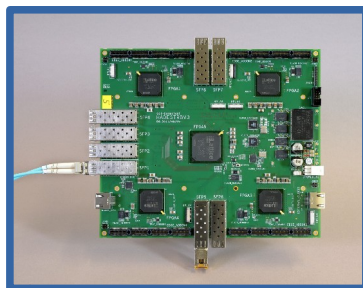
- flat panel
- 8x8 anode pixels of 6mm size
(52mm detector size)



Electronics:

GSI TRB3 platform:

- TRB3 board
- PADIWA (2 TOF counters)
- DIRICH module
(4x 64-channel PMTs)

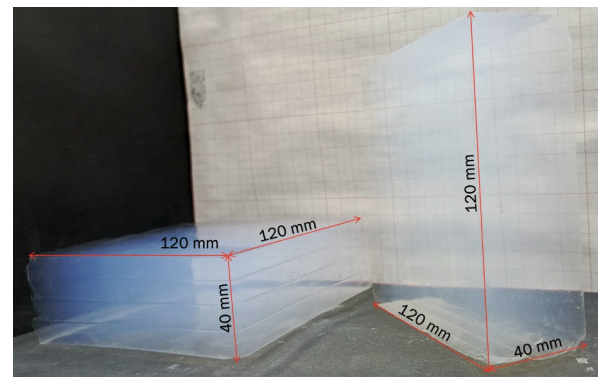
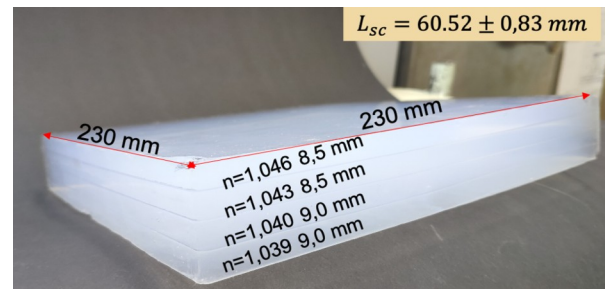
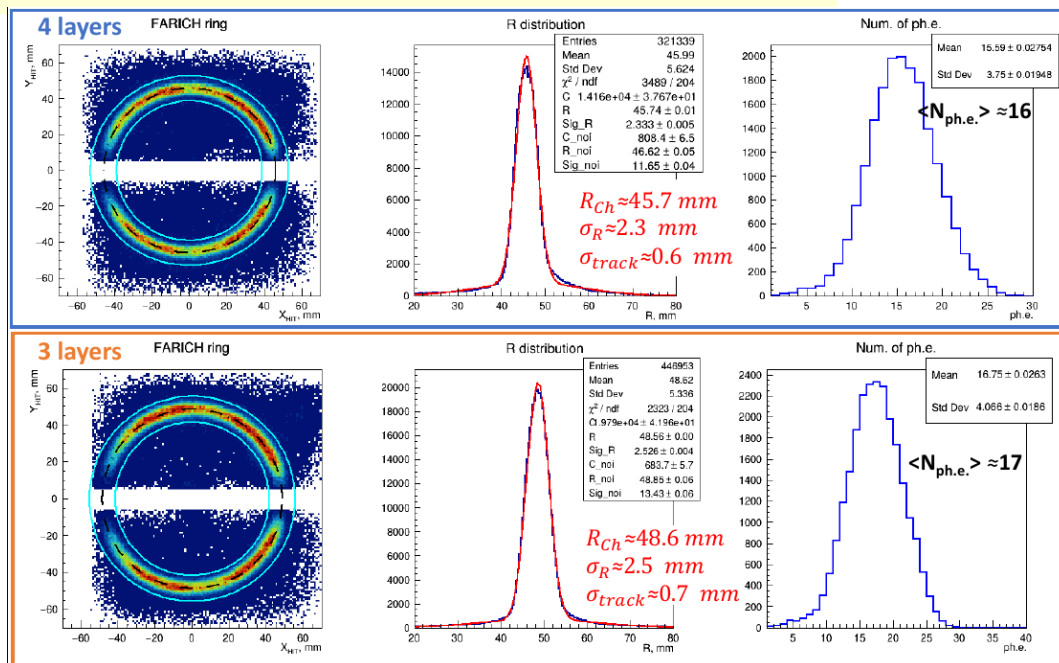


Aerogel samples

- 4-layer, $n_{\max}=1.046$, $t=35$ mm, 230×230 mm²;
- 4-layer, $n_{\max}=1.040$, $t=40$ mm, 100×100 mm²;
- 3-layer, $n_{\max}=1.040$, $t=40$ mm, 100×100 mm²;

Optimized for SPD FARICH, tested on an electron beam. Estimated “ π/K ” separation at 6 GeV/c $\sim 4.1\sigma$

Geom. Eff. ~ 0.8



DAQ

Two different data Data Acquisition systems:

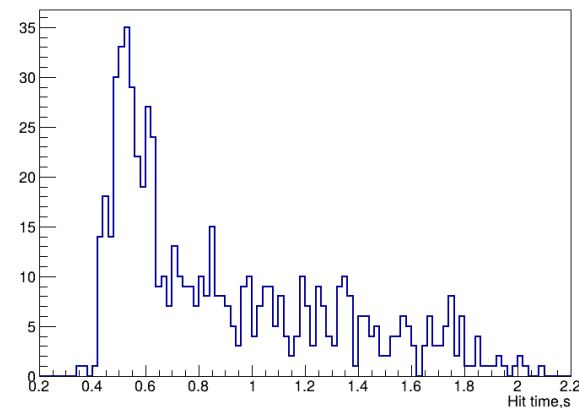
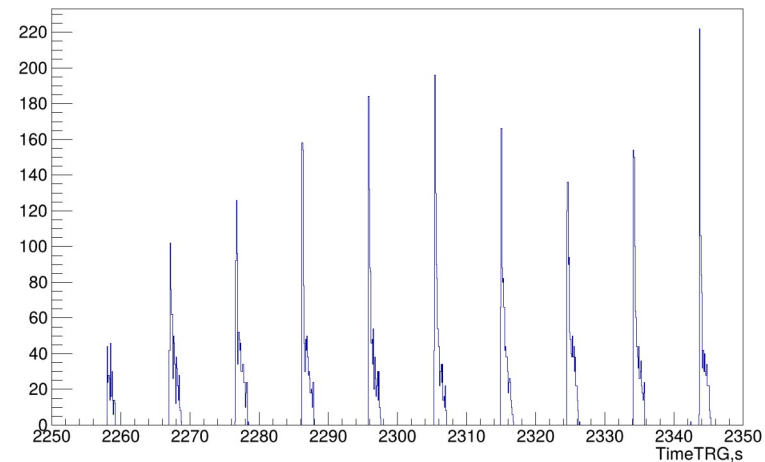
- FARICH prototype and MCP PMT based ToF counters are readout in FARICH DAQ based on DiRICH-TRB3.
- Tracking system is readout in SPASCHARM DAQ,

Beam data:

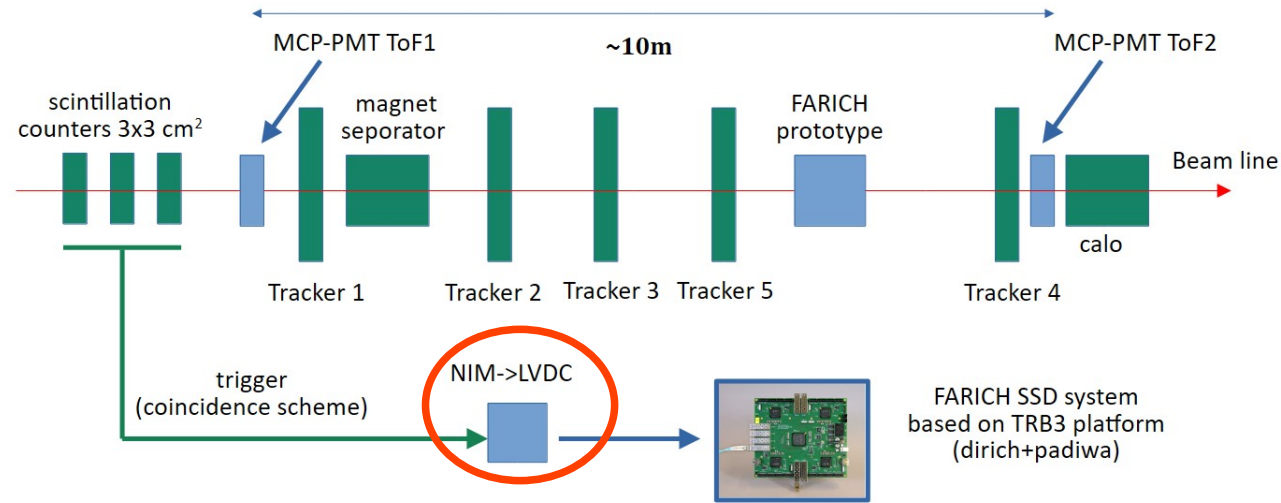
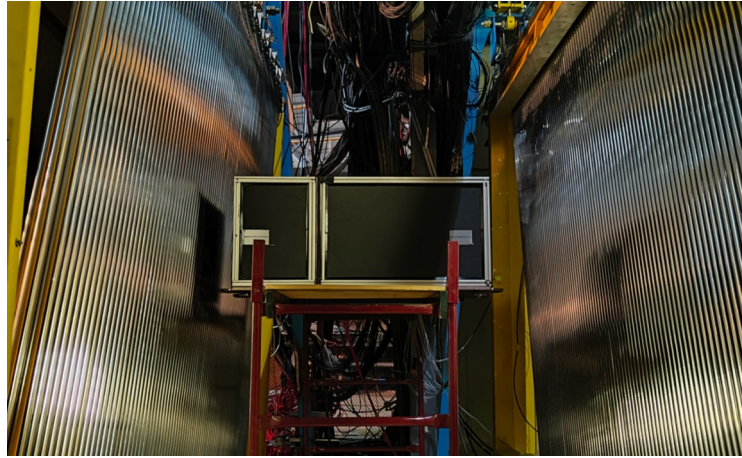
- Particle track,
- Momentum,
- Energy,
- Hit time.

Data mismatch between DAQ FARICH and SPASCHARM DAQ!

Track information cannot be used!



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- Beam content: π^+ (~75%), p (~25%), K^+ (<1), e (<1)?

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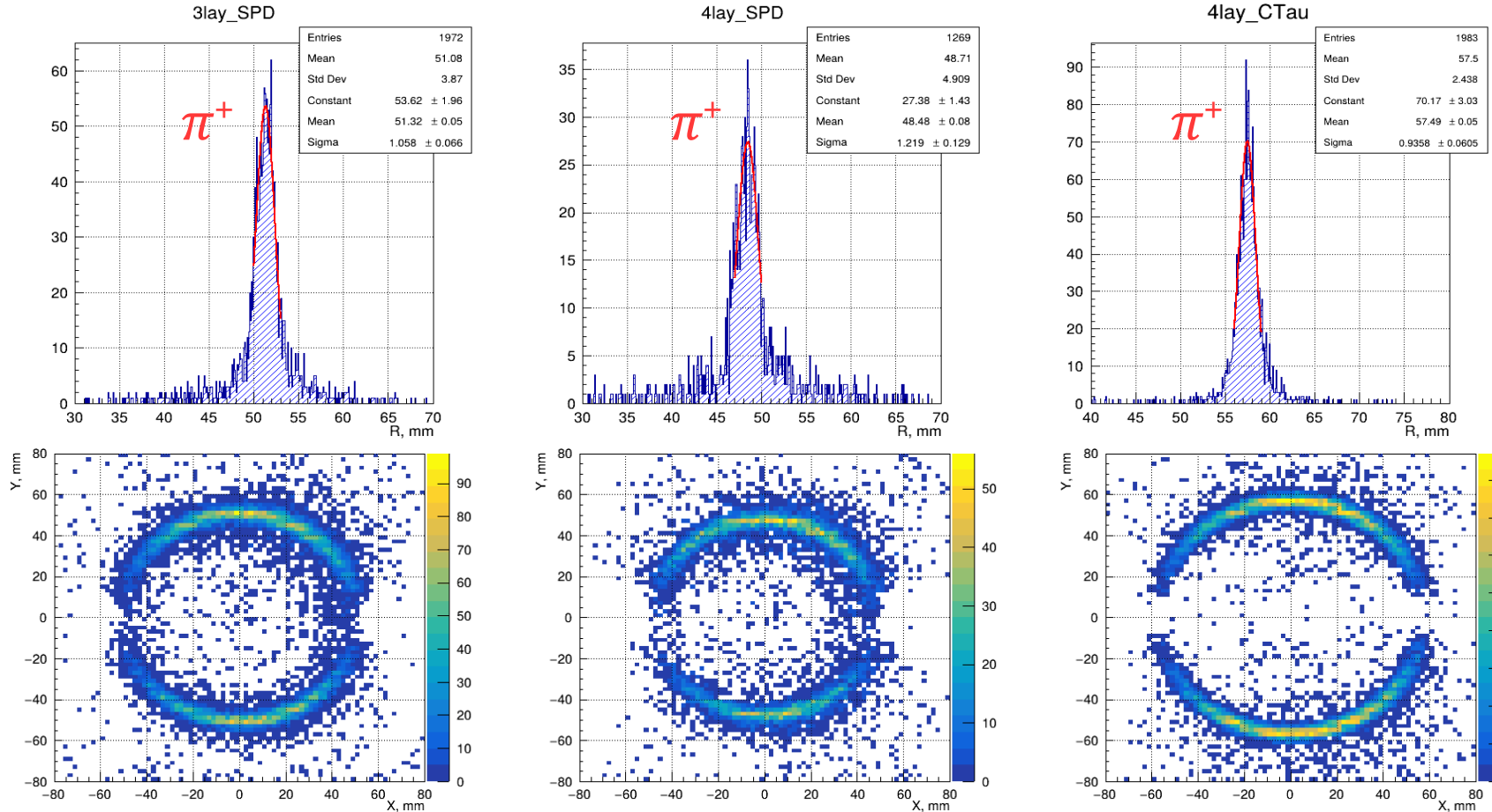
13.10.2026

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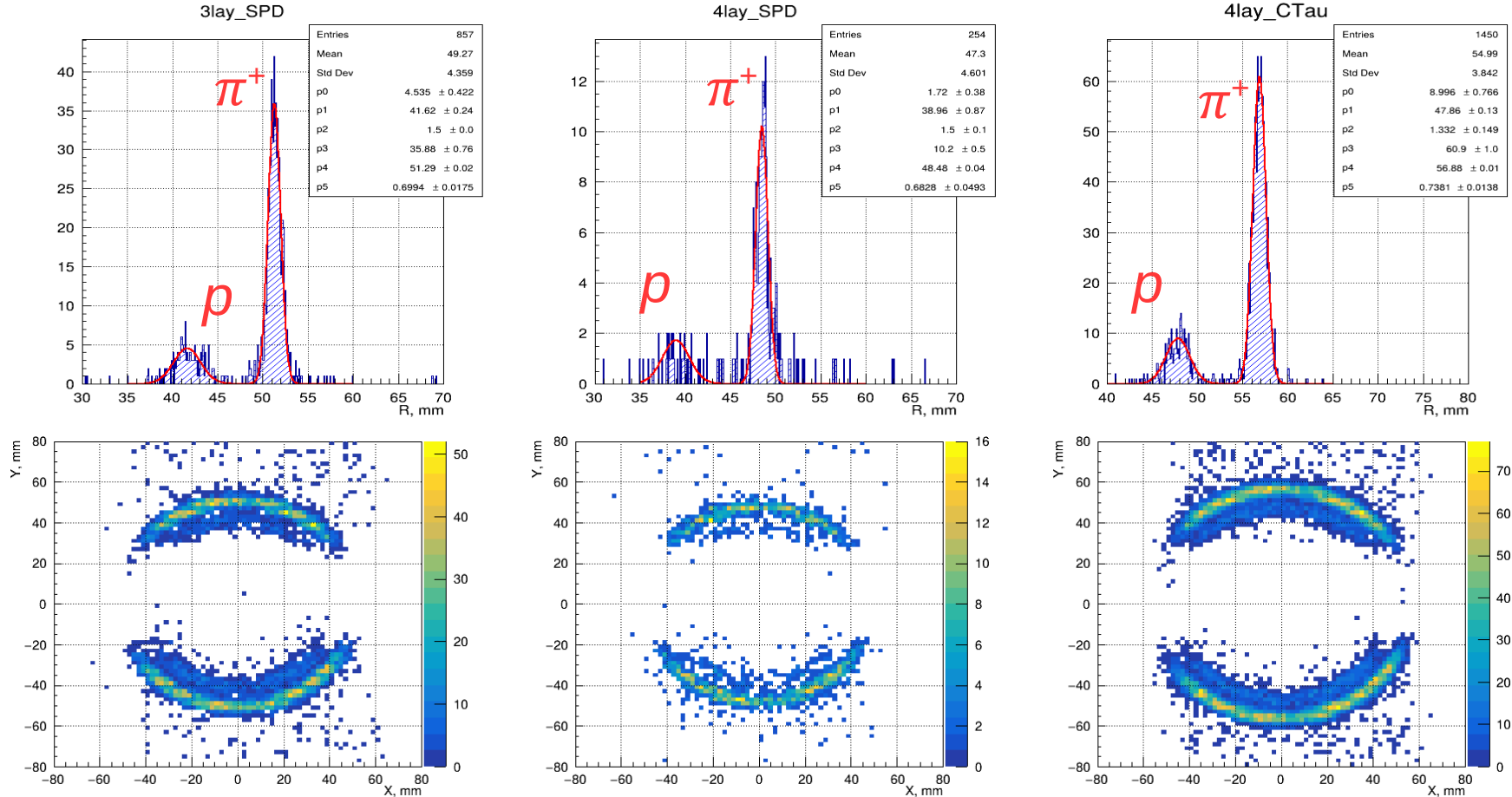
Results (without a tracking information)

The aerogel samples were tested at beam momenta of 3, 6, and 10 GeV/c.:



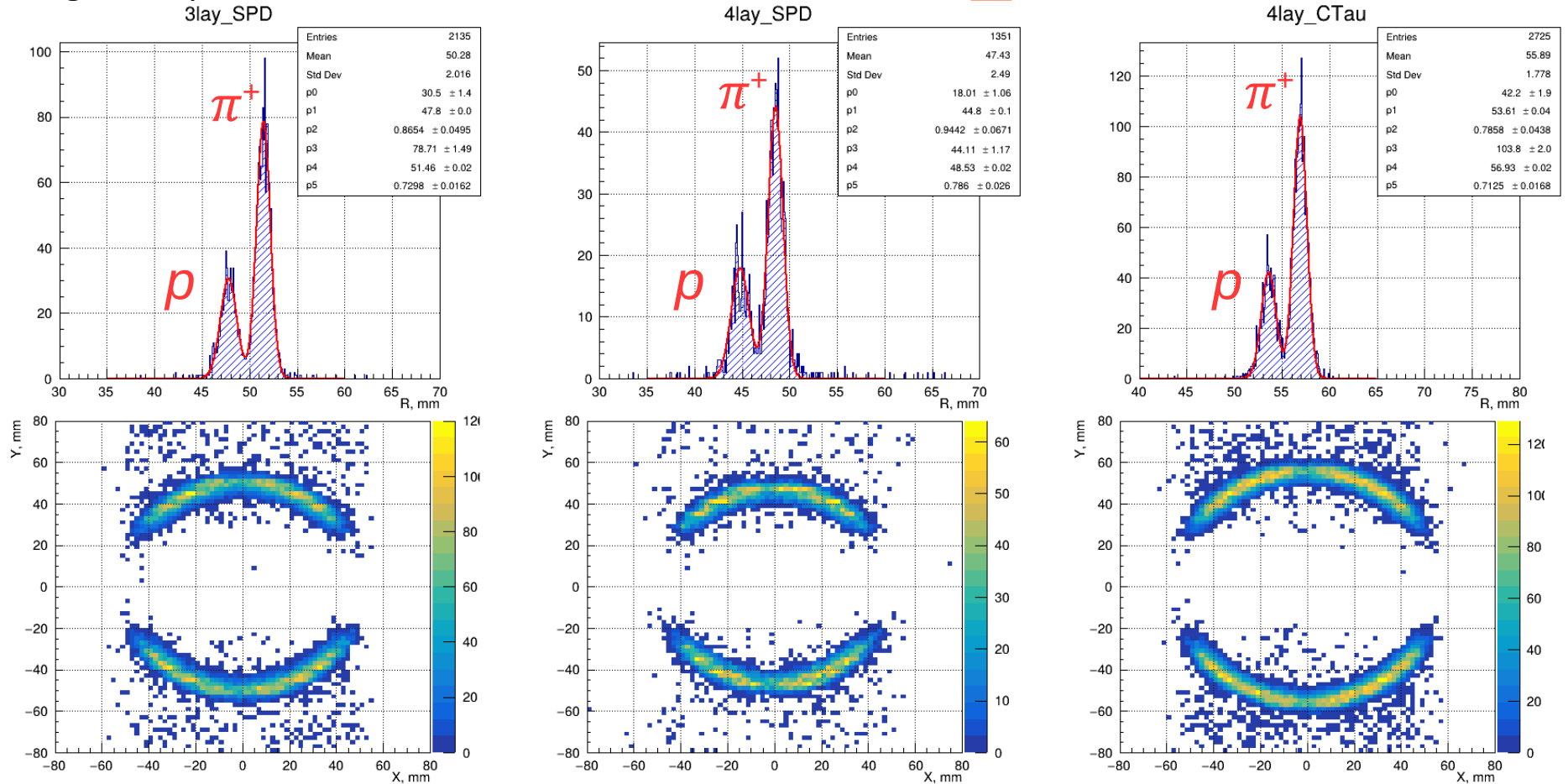
Results (without a tracking information)

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Results (without a tracking information)

The aerogel samples were tested at beam momenta of 3, 6, and 10 GeV/c.:



Results

- The goal was to calculate π/K separation at 6 GeV/c, in order to compare it with previous measurements on the e^- beam.
- Not enough K^+ to define the π/K separation at 6 GeV/c due to the decrease in statistics, so we used 10 GeV/c protons instead of 6 GeV/c K^+ . (P at 10 GeV/cA corresponds to a K^+ at 5.4 GeV/c)

$$N_{\sigma} = \frac{(R^{\pi} - R^K)}{0.5(\sigma_R^{\pi} + \sigma_R^K)}$$

	Number of photoelectrons:					
	SPD 4-layer		SPD 4-layer		C-Tau 4-layer	
	p	π	p	π	p	π
3 GeV/c		9.5		8.3		12.3
6 GeV/c	7.2	12.0	5.8	9.9	9.2	13.2
10 GeV/c	10.5	12.6	8.5	10.7	12.5	13.8

π/K separation at 6 GeV/c:

- 3 – layer SPD = 4.5σ
- 4 – layer SPD = 4.5σ
- 4 – layer CTau = 4.3σ

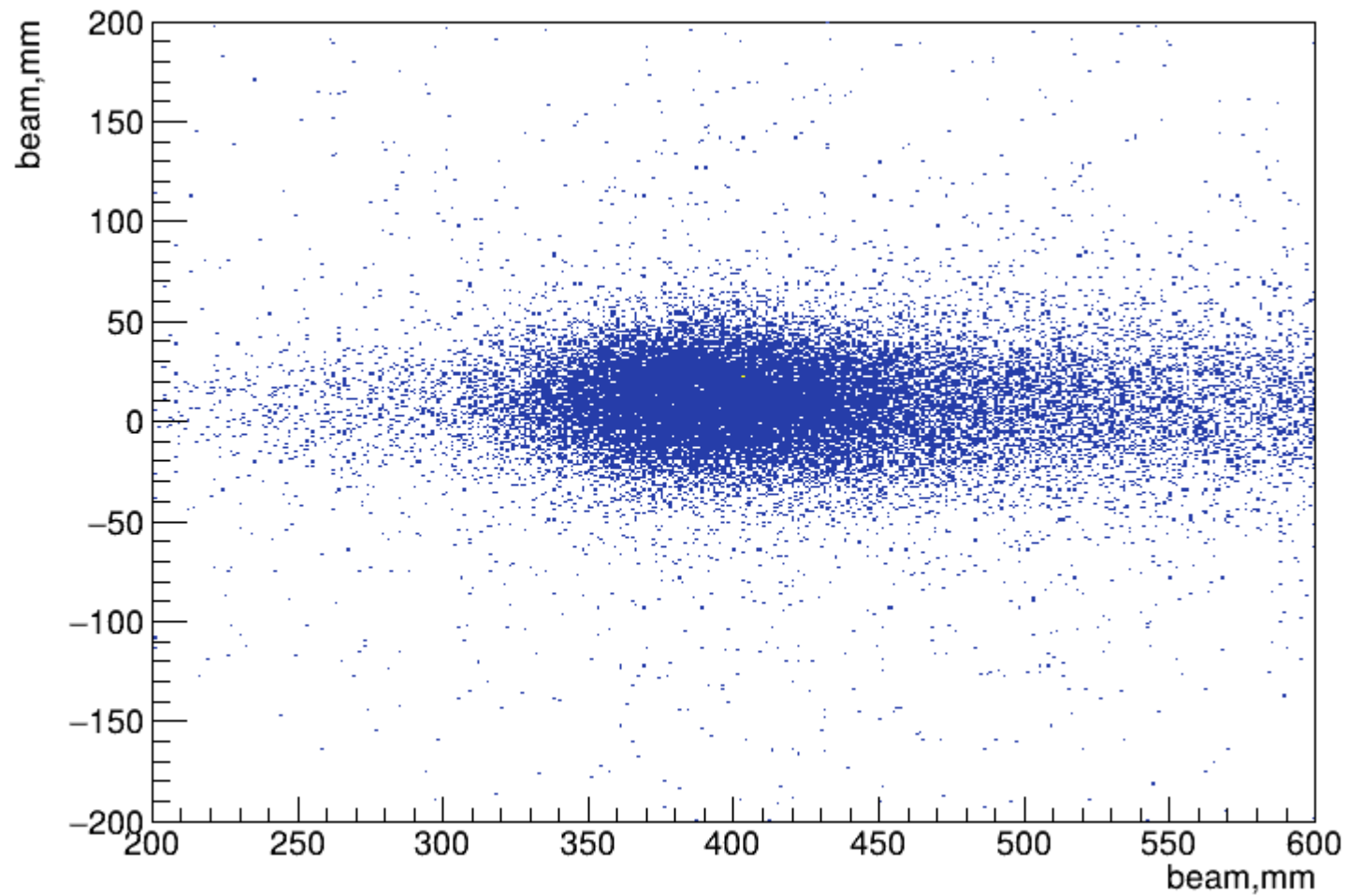
Estimated π/K separation at 6 GeV/c at electron beam is $\sim 4.1\sigma$

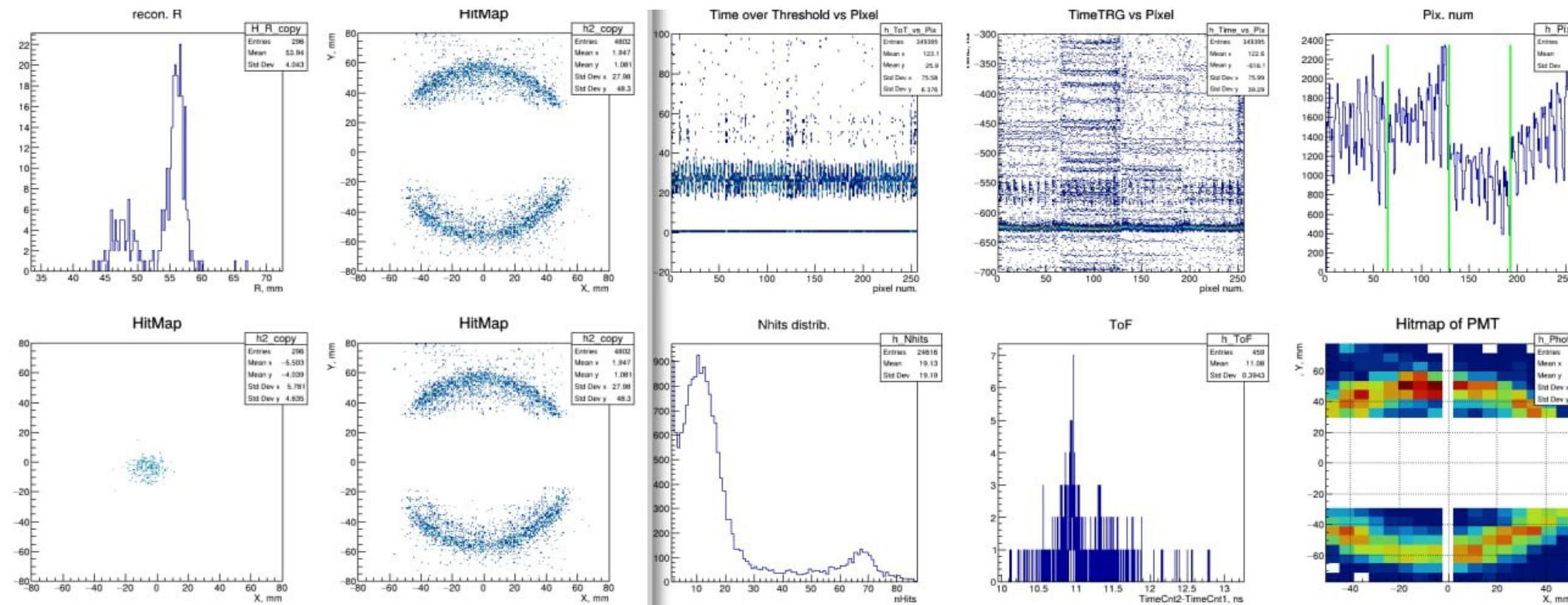
We obtained it using an electron beam:
 $16 * 0.6 = 9.6$ photoelectrons for SPD 4-layer
 $17 * 0.6 = 10$ photoelectrons for SPD 3-layer

Summary and further plans

- A FARICH prototype was tested in a charged hadron beam at SPASCHARM facility.
- Three aerogel samples were tested (with $\sim 1\text{M}$ events collected for each) at momenta of 3, 6, and 10 GeV/c.
- π/K -separation power of FARICH prototype is 4.5σ at 6 GeV/c was obtained.
- In future tests, it is necessary to solve the problem of synchronization of the data acquisition system of the FARICH prototype and the SPASCHARM DAQ system, in order to be able to identify K^+ and obtain the π/K separation directly.

Backup





CheckRun procedure
plots