



FARICH simulation in SPD

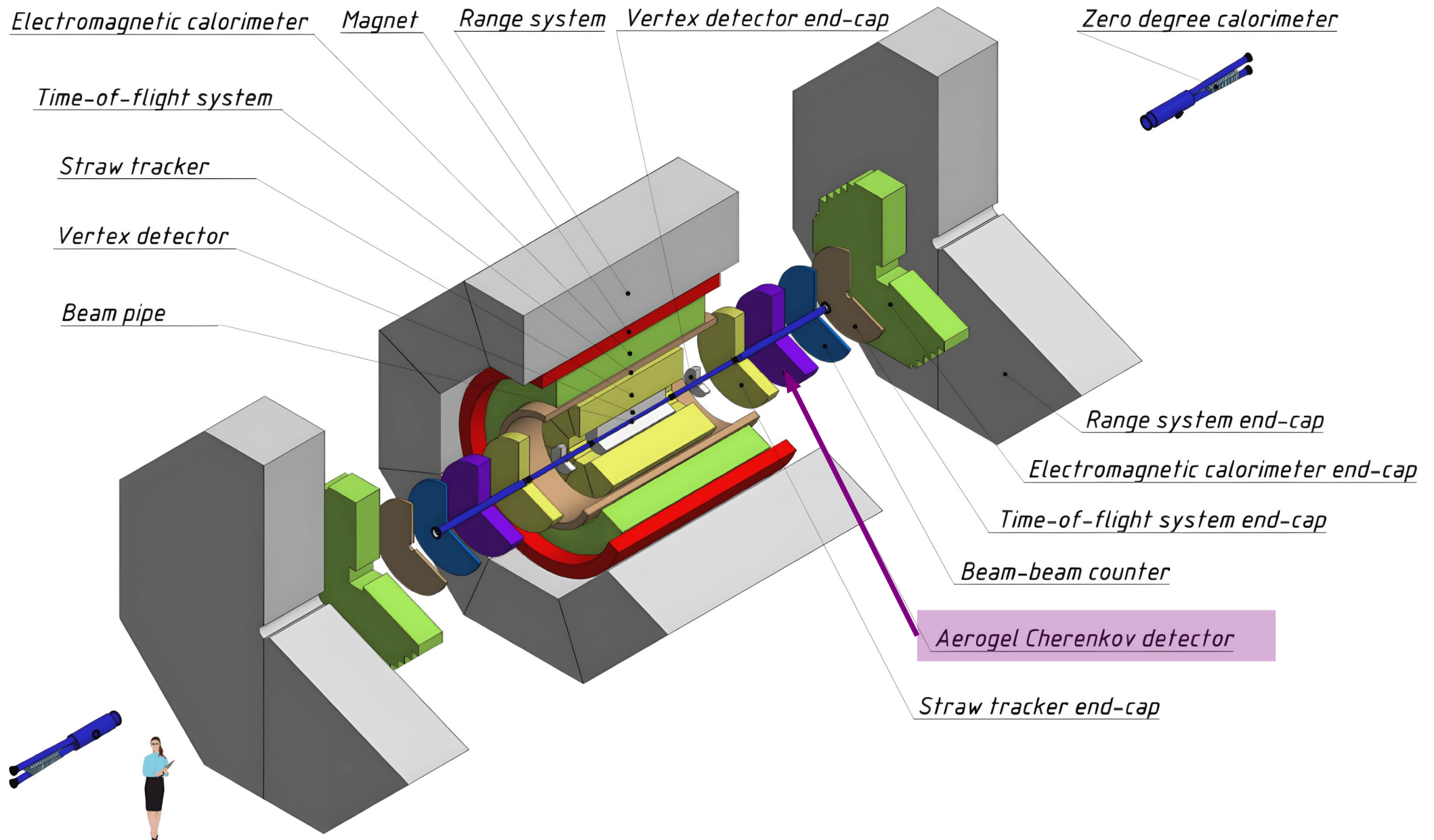
Artem Ivanov

On behalf of the SPD Collaboration

60th meeting of the PAC for Particle Physics

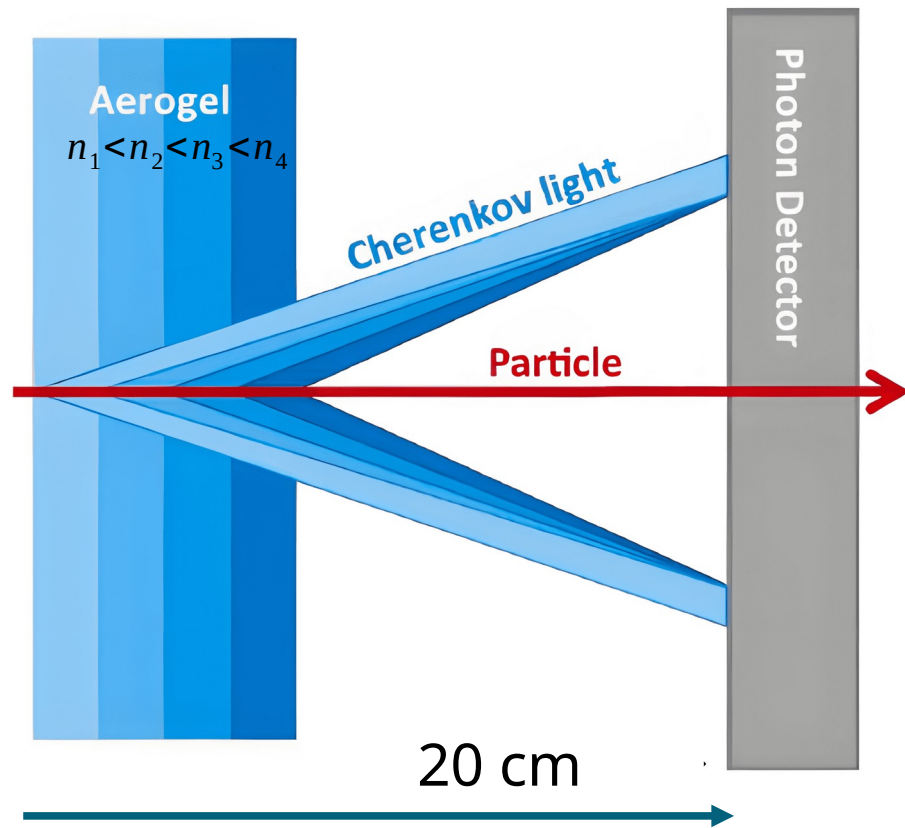
17 June 2024

Focusing Aerogel RICH detector in SPD

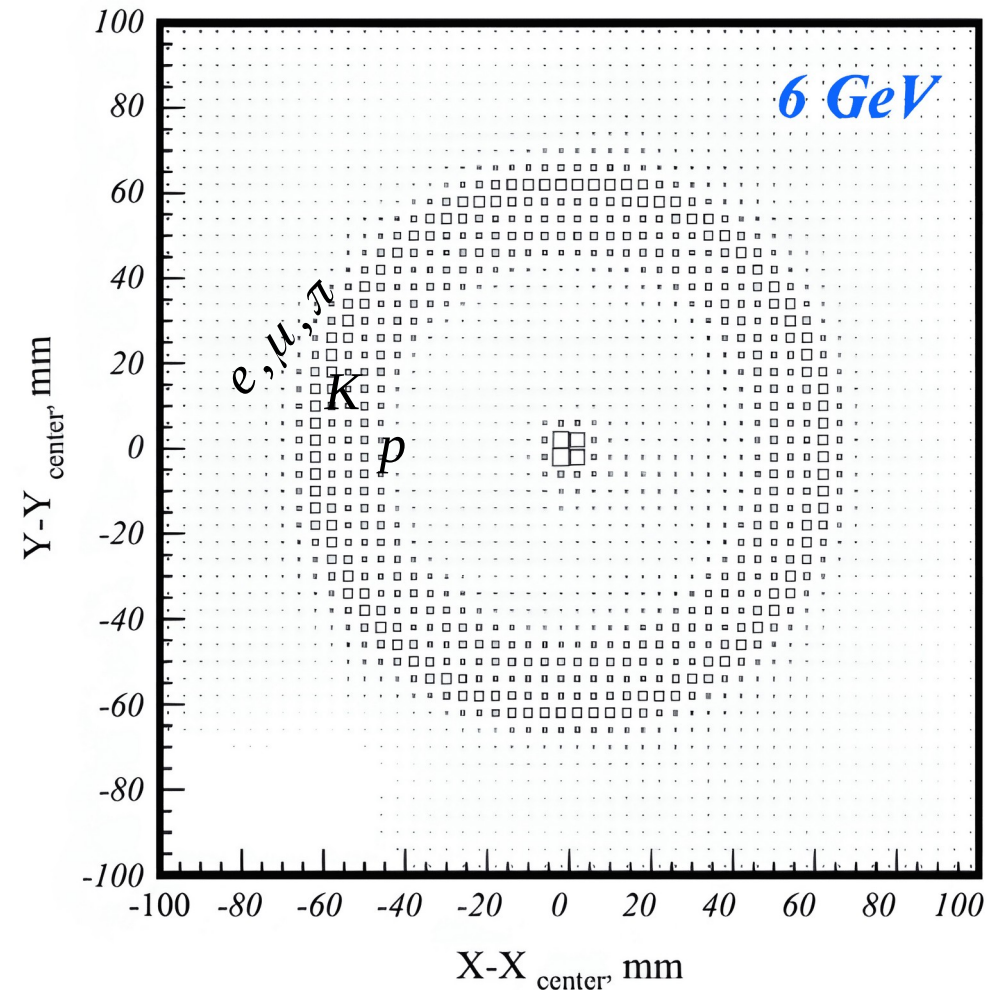


FARICH detector: basic principles

Principle of detector operation



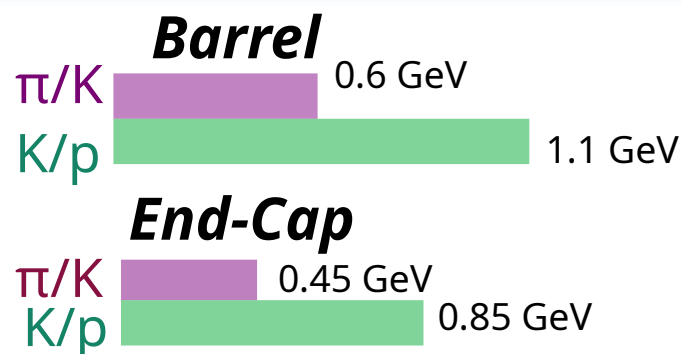
Accumulated xy distribution of hits



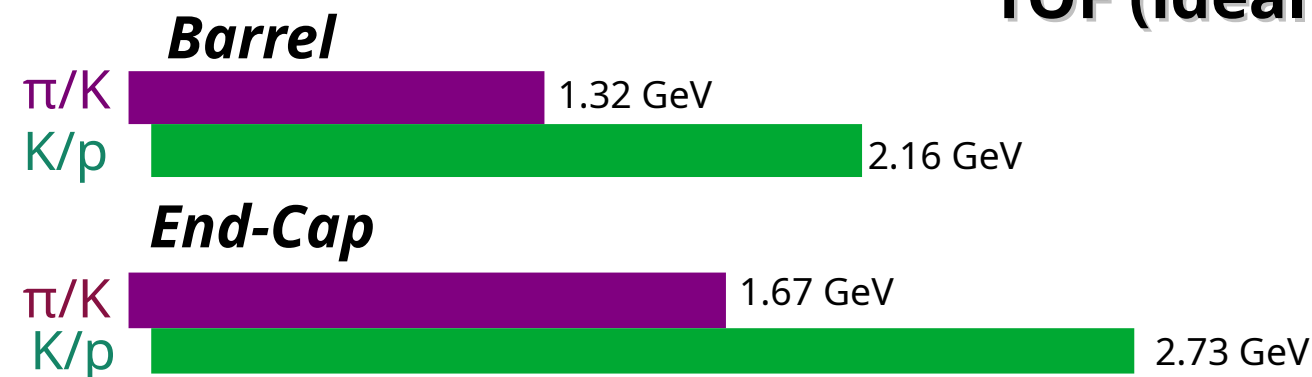
This work was carried out under the supervision of A.Yu. Barnyakov from the Budker Institute of Nuclear Physics, Novosibirsk.

Particle ID in SPD

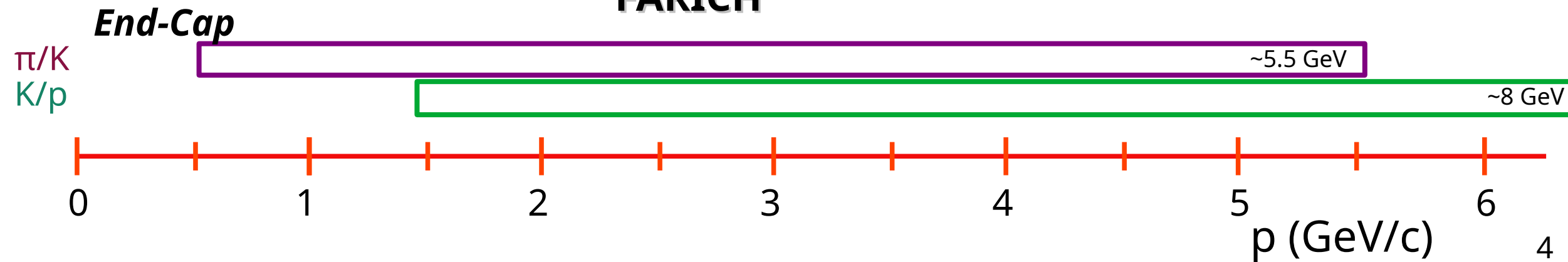
Straw tracker



TOF (ideal case without T0)

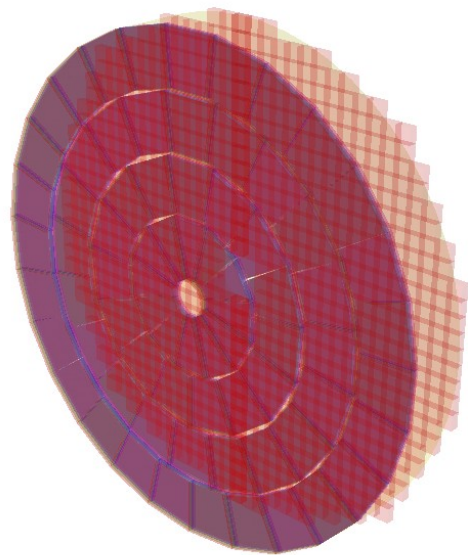


FARICH

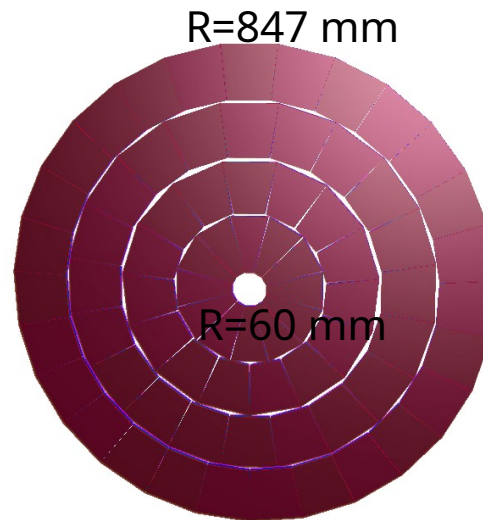


FARICH in SpdRoot: geometry

FARICH detector



Aerogel



Material:

SiO_2 - 97%

H_2O - 0.03%

$$density = \frac{(n^2 - 1)}{0.438}, [cm^3/g]$$

$n(400)=1.0370$, $L=7.00$ mm

$n(400)=1.0410$, $L=10.00$ mm

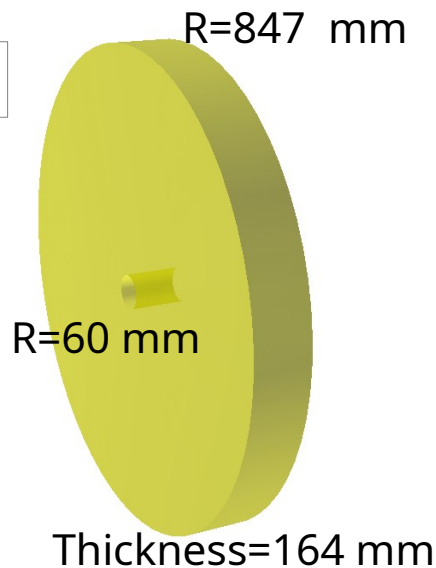
$n(400)=1.0430$, $L=9.00$ mm

$n(400)=1.0470$, $L=10.00$ mm

R=36 mm

Air

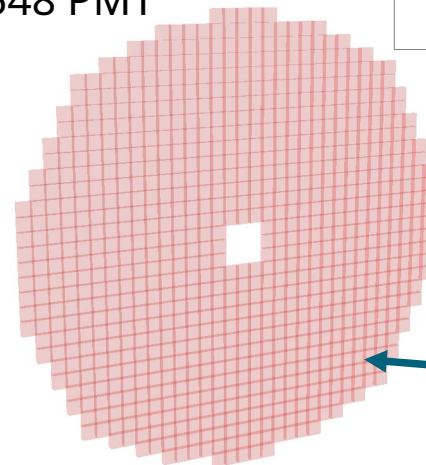
Material: Air



Photon detector

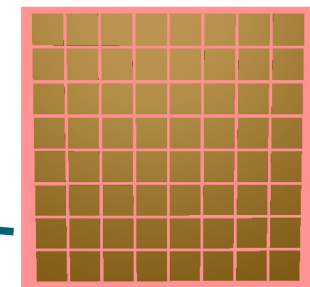
548 PMT

Material: Si



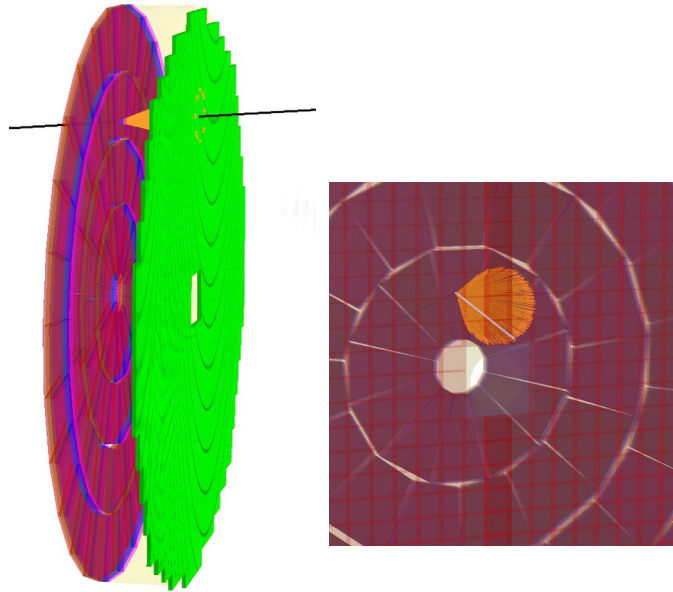
MCP PMTs N6021 from NNVT

- 8×8 pixels with size 5.8×5.8 mm²
- Lateral size 51×51 mm²
- Thickness = 1.7 mm

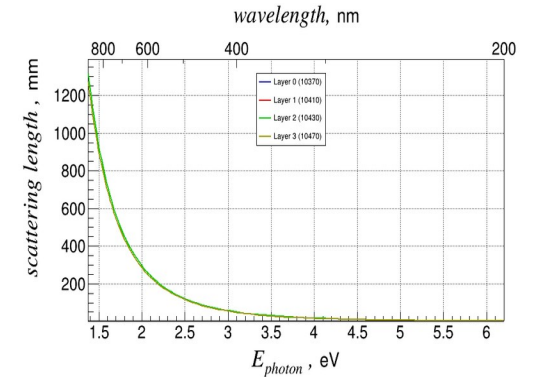
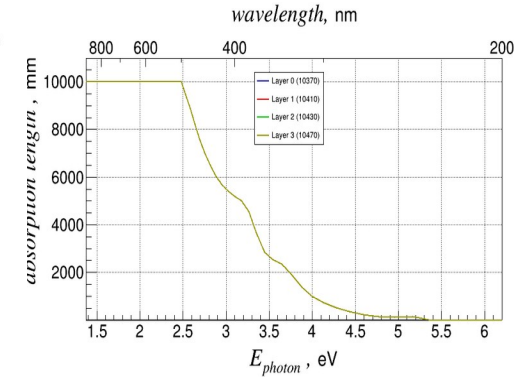
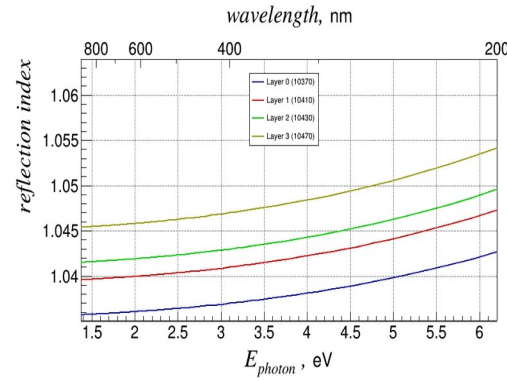


FARICH in SpdRoot: optical properties

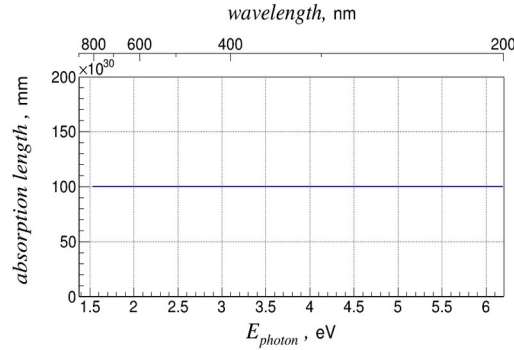
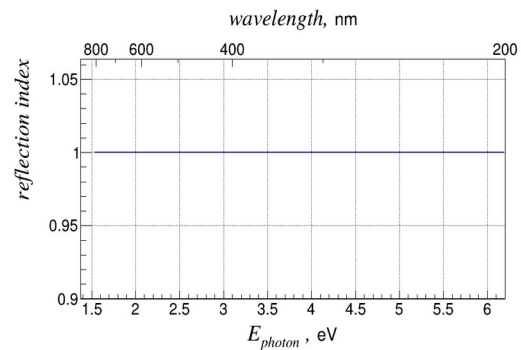
FARICH detector



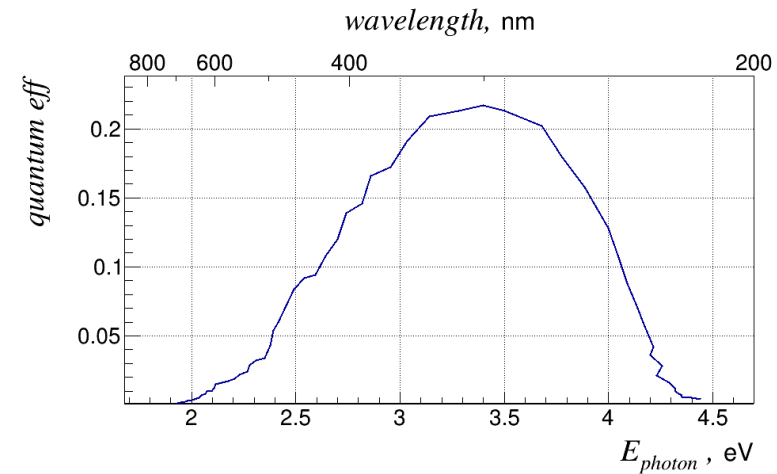
Aerogel



Air



Photon detector



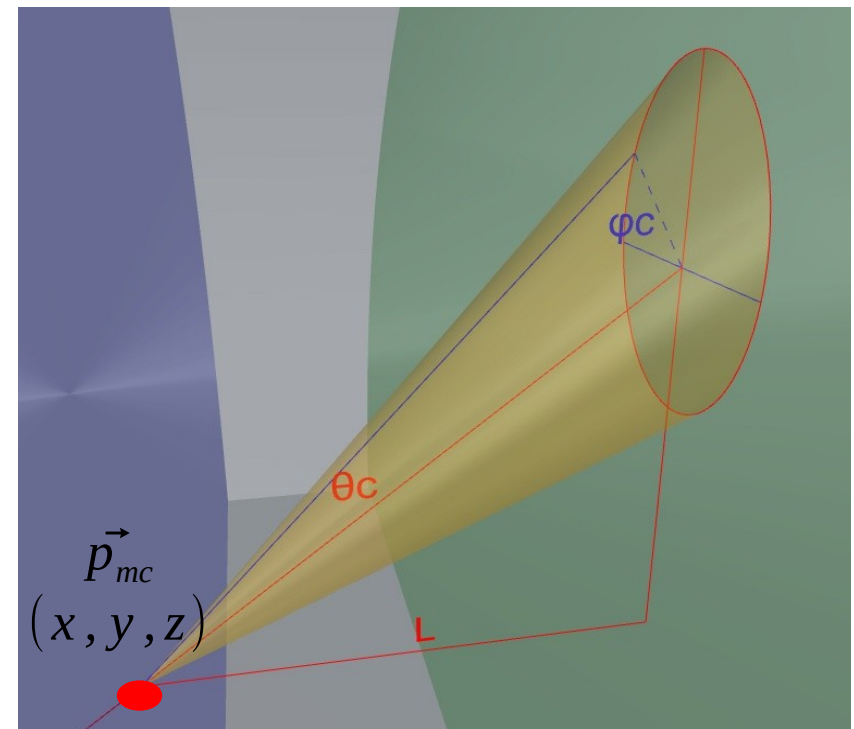
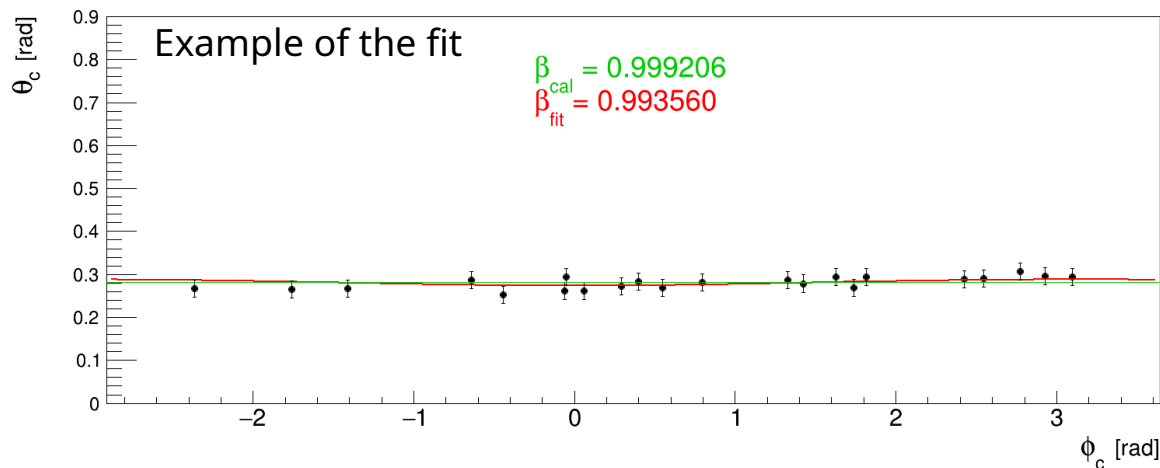
FARICH reconstruction: by dependence θ_c vs φ_c

The simulation of FARICH was done at the SpdRoot framework for set of particles: electrons, muons, pions, kaons, and protons. Momentum range is from p_{th} to 8 GeV. Currently, only Cherenkov photons from the ring are being studied.

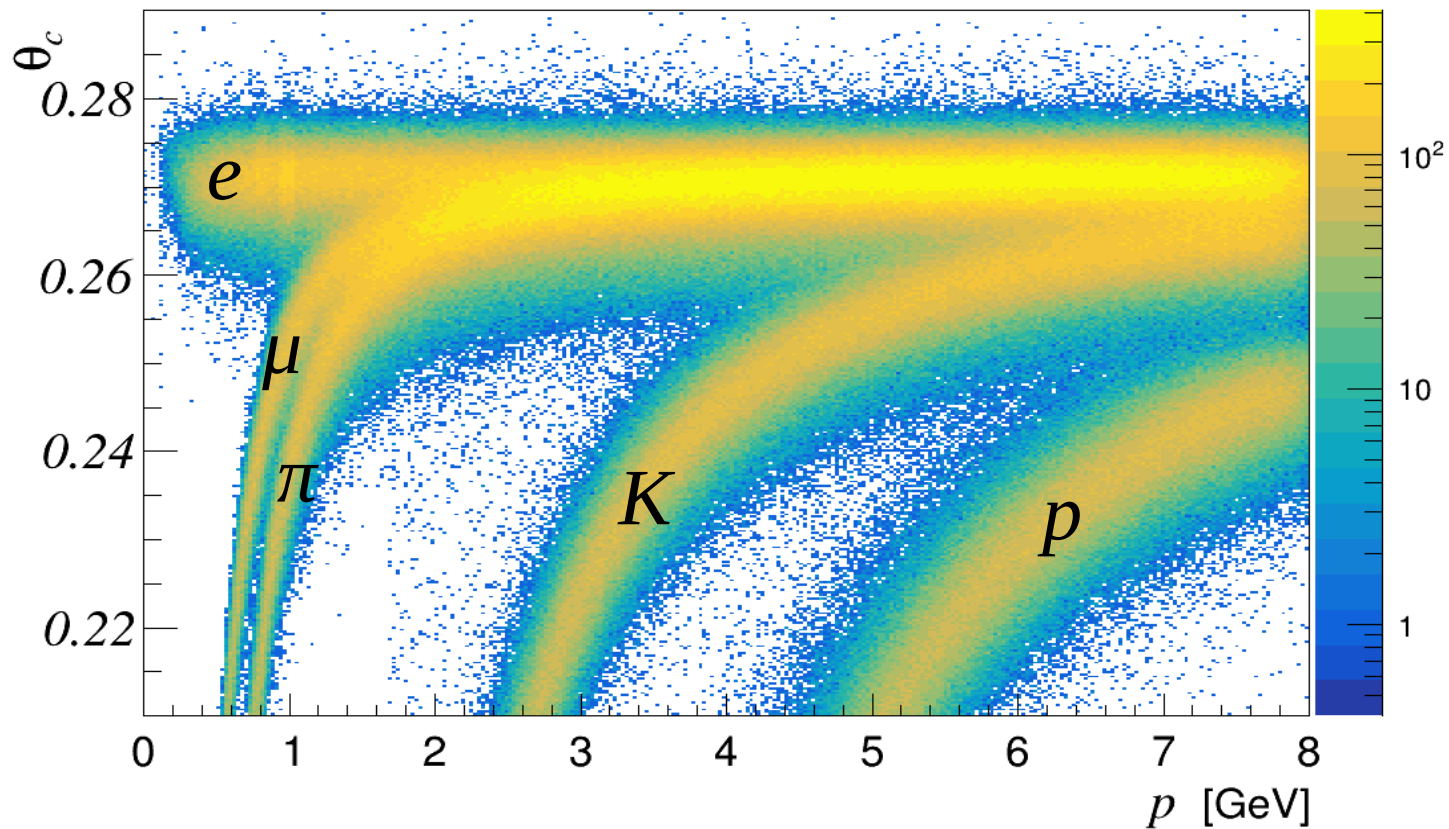
The dependence of polar angle of Cherenkov photons θ_c from azimuth angle φ_c are used for reconstruction

$$\theta_c(\varphi_c|\beta, n, \theta_t) = \arccos\left(\frac{1}{n\beta}\right) + \arccos\left(n(1 - (\vec{n}_0\vec{n}_\gamma)^2) + (\vec{n}_0\vec{n}_\gamma)\sqrt{1 - n^2(1 - (\vec{n}_0\vec{n}_\gamma)^2)}\right)$$

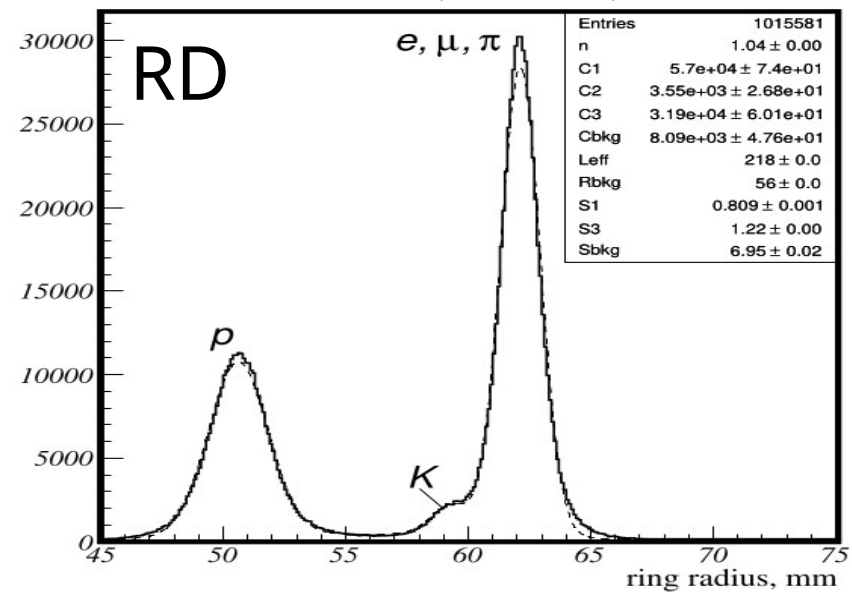
- n average value refraction index of radiator
- $(\vec{n}_0\vec{n}_\gamma) = \cos\theta_t/(n\beta) + \cos\varphi_c \sin\theta_t\sqrt{1 - 1/(n\beta)^2}$
- \vec{n}_0 and \vec{n}_γ vectors of the radiator and Cherenkov cone normal, respectively



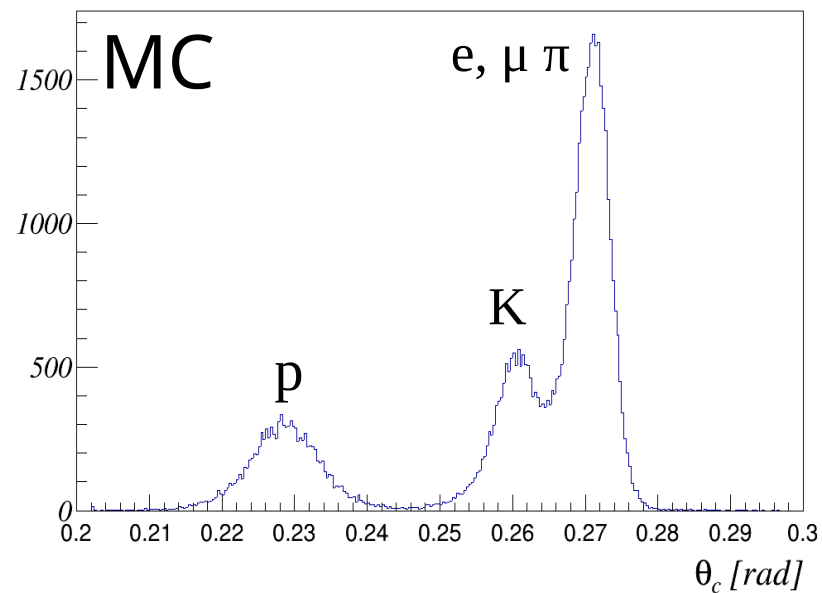
FARICH reconstruction: θ_c vs p_{rc}



Nucl. Instrum. Meth. A, 732:352–356, 2013



particles momentum 6 GeV/c



Conclusion

The detector is expected to perform separation at 3-sigma level

- π/K separation - from 0.6 to 5.5 GeV/c
- K/p separation - from 1.6 to 8.5 GeV/c

at 2-sigma level

- μ/π separation - from 0.48 to 1.25 GeV/c

