Development of the FARICH detector as a possible upgrade of the ALICE HMPID system

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For the upgrade of the CERN ALICE high momentum PID (HMPID) system the construction of the Focusing Aerogel Ring Imaging Cherenkov (FARICH) detector is proposed. The goal of the FARICH is to extend the working momentum range of the charged particle identification at ALICE in a high transverse momentum P_T region up to 10 GeV/c for the pion–kaon separation and up to 15 GeV/c for kaon–proton separation. It will enable to investigate the parton-medium effects at LHC energies and, in particular, to study in details the phenomenon of the "baryon puzzle" or "jet quenching effect" observed at RHIC. In this presentation the FARICH detector concept and the detector construction on the basis of a multi-layer aerogel radiator and photosensitive MRS APD focal plane are given.

The main idea of the FARICH detector is to employ a Cherenkov radiator composed of several aerogel layers with different index of refraction. Index of refraction of each layer is gradually increased along the particle direction, so that Cherenkov ring images produced by different layers coincide in the focal plane and form a narrow ring image. Simulations were made for a multi-layer radiator based on the Geant4 software toolkit. Results of the FARICH Prototype test on the 6 GeV/c negative pion beam of the CERN PS T10 test channel are presented. Taking into account the FARICH Prototype geometrical efficiency the FARICH Cherenkov angle resolution (sigma) of about 2,1 mrad was determined.

An important experimental direction of the study in physics of heavy ion collisions is the measurement of the yield of high-Pt particles. The main problem is

to study the dominant mechanism of parton energy loss in compressed nuclear matter.

"Jet quenching effect" by RHIC PHENIX Collaboration (K.Adcox et al., Phys.Rev.Lett. 88 (2002) 022301)

gives the indication on a different loss of energy by partons and gluons in nuclear matter.

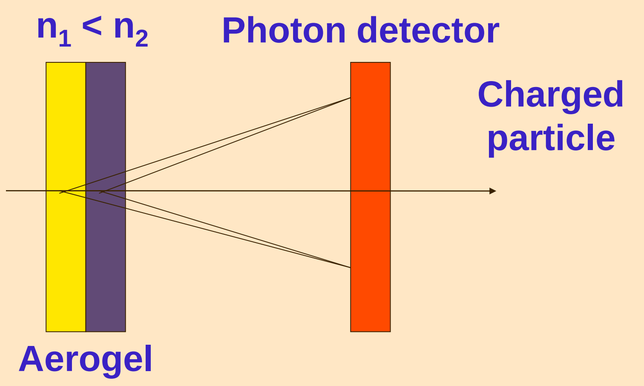
Data by RHIC STAR Collaboration (C.Adler et al. Phys.Rev.Lett. 89 (2002) 202301)

show the effect of supression of high-Pt particles up to a momentum ≥ 10 GeV/c

Physical requirements to characteristics of the ALICE HMPID-system Upgrade:

π / K sep. in the momentum range from 3 to 10 GeV/c

K / p sep. in the momentum range from 5 to 15 GeV/c



The main goal of the FARICH concept is

- to increase the number of photons by using thicker radiator;
- to use of several layers of aerogel for focusing of Cherenkov cones on the detector sensitive plane without degrading the angle resolution.

Refractive indices are determined by different proximity gaps.

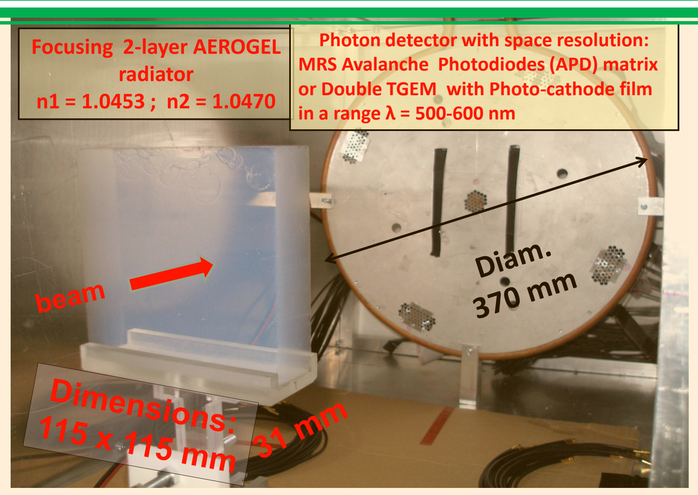
References on this concept:

Belle group:

1. P.Krizan, Aerogel RICH, talk given at Super B Factory Workshop in Honolulu, Hawaii 19-22 January 2004, http://www.phys.hawaii.edu/superb04
2. S.Nishida, et al., Studies of a proximity focusing aerogel RICH for the Belle upgrade, Proceedings of the IEEE Nuclear Science Symposium Rome, Italy, October 17- 22, 2004.
3. T.Iijima, S.Korpar et al., Nucl. Instr. and Meth. A548 (2005) 383.
4. S.Korpar et al., Nucl. Instr. and Meth. A553 (2005) 64-69

Novosibirsk group:

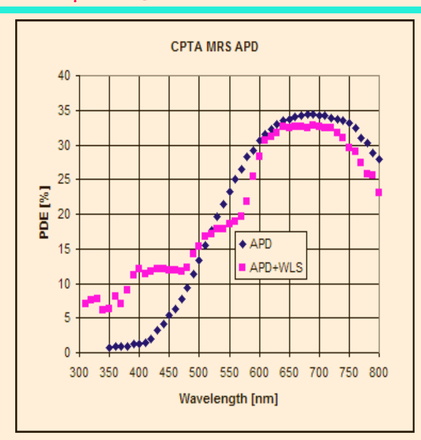
started discussions of the use of a multy-layer aerogel – April 2003,
Alexander Danilyuk – production of 4-layered aerogel May 2004
A.Yu. Barnyakov et al., Nucl. Instr. and Meth. A553 (2005) 70.



Results of the simulation for momentum 10 GeV/c

Radiator version	N layers	T total mm	N_{pe}	r, мм	$\sigma_{r,\ 1pe}$, мм	Ring area, mm2 (+/_3σ)	σ(θ), mrad	π/K sep, σ
n=1.03	1	23.5	15	120.5	1.9	8.63E+03	0.92	4.9
	2	33.1	20	121.3	1.5	6.86E+03	0.65	7.1
	3	45.8	26	121.5	1.4	6.41E+03	0.53	8.7
n=1.03 with WLS	1	38.5	29	118.6	3.1	1.39E+04	1.10	4.2
	2	52.6	35	120.1	2.5	1.13E+04	0.81	5.6
	1	22.3	24	156.5	2.5	1.48E+04	0.91	3.9
n = 1.05	2	35.6	35	157.2	2.0	1.19E+04	0.61	5.8
	3	50.0	47	157.4	1.9	1.13E+04	0.49	7.2
n=1.05 with WLS	1	40.2	49	153.6	4.1	2.37E+04	1.04	3.4

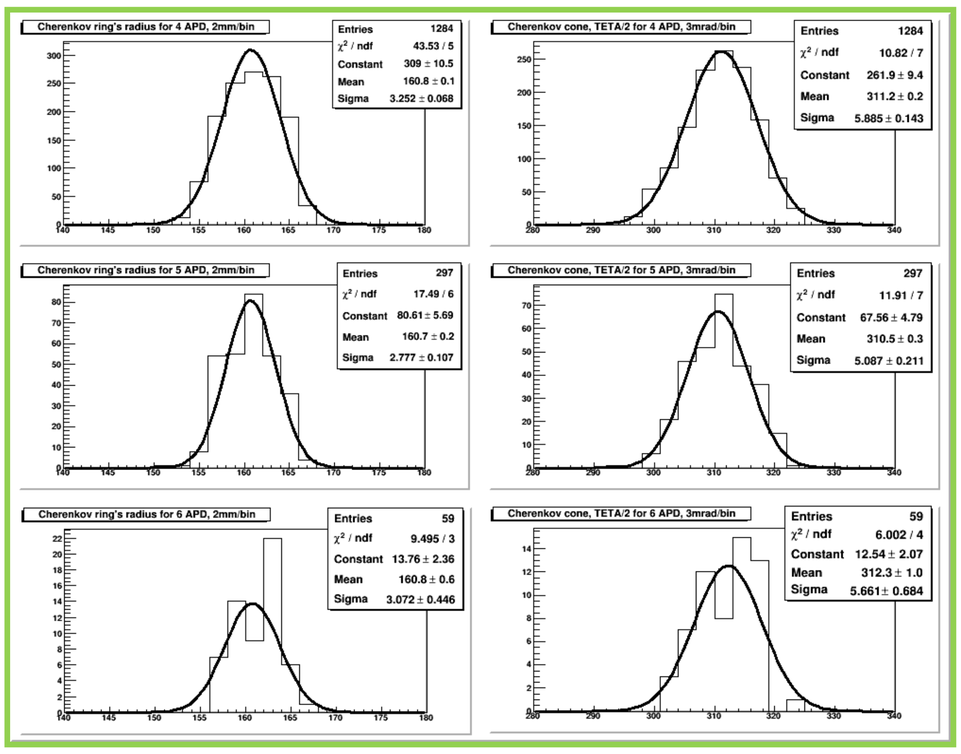
MRS APD spectral **performance** (CPTA, Moscow)



TEST RESULTS: FARICH experimental Cherenkov ring radius and cone angle TETA/2 distributions for 4, 5 and 6 hits on rings (PS T10 test beam run, November-2010)

For five hit rings,
R = 160,70 mm (sigma = 2,78 mm) and
TETA/2 = 310,50 mrad (sigma = 5,09 mrad)
have been measured.

Taking into account the FARICH Prototype geometrical efficiency the FARICH Cherenkov angle resolution (sigma) of about 2,1 mrad was obtained.



REFERENCES

1. A.I. Berlev, et al. **Developmentof FARICH-detector for ALICE experiment at CERN**, Nucl. Instr. and Meth. **A 598** (2009) 156-159.
2. Report-present. by A.Reshetin (INR RAS, Moscow) et al., **Development of FARICH-detector for the ALICE experiment at CERN**. Int. Conference INSTR08, Novosibirsk, Russia, Feb.27 – March 5, 2008.
3. Report-presentation by A. Reshetin **STATUS of the Focusing Aerogel RICH-PROTOTYPE for the ALICE HMPID Upgrade,** ALICE Upgrade Forum, CERN, June 28, 2010.

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