Status report of the Novosibirsk activities

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Outline

- Monte Carlo simulation:
  - $|V_{ub}|$ measurement from inclusive spectrum of charmless semileptonic B decays
  - FastSim simulation of the forward FARICH
- FARICH optimization:
  - SiPM radiation hardness
  - MCP PMT option
    - Optimization for the momentum measurement
    - Possible geometry option
- Test beam line at Budker INP, status

$|V_{ub}|$ measurement from inclusive spectrum of charmless semileptonic B decays

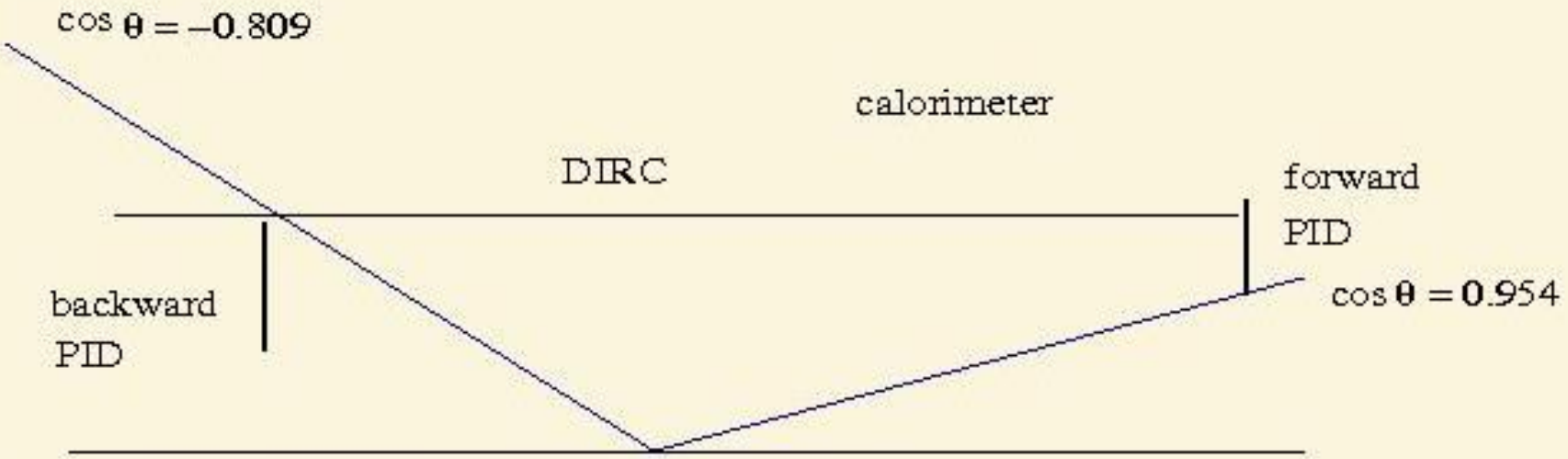
We look for the physics process where PID acceptance will play critical role:

- classical, important
- large multiplicity
- need PID

- $|V_{ub}|$ plays a critical role in testing of SM
- Currently one of the most promising procedure for $|V_{ub}|$ measurement is to extract it from inclusive $B \rightarrow X_u l\nu$ decays where theoretical uncertainties are significantly reduced:
- needs full reconstruction of tagging B-mesons to receive clean sample (PID!)
- needs good measurement of X_u invariant mass to suppress background from X_c (PID!)

$|V_{ub}|$ measurement from inclusive spectrum of semileptonic B decays

- The first step is the geometry efficiency study.



$cos\theta$ = -0.830 ÷ 0.955 and p < 700 MeV (DC PID)

$cos\theta$ = -0.892 ÷ 0.906 (DIRC), 0.894 ÷ 0.955 (forward PID), -0.956 ÷ -0.825 (backward PID),

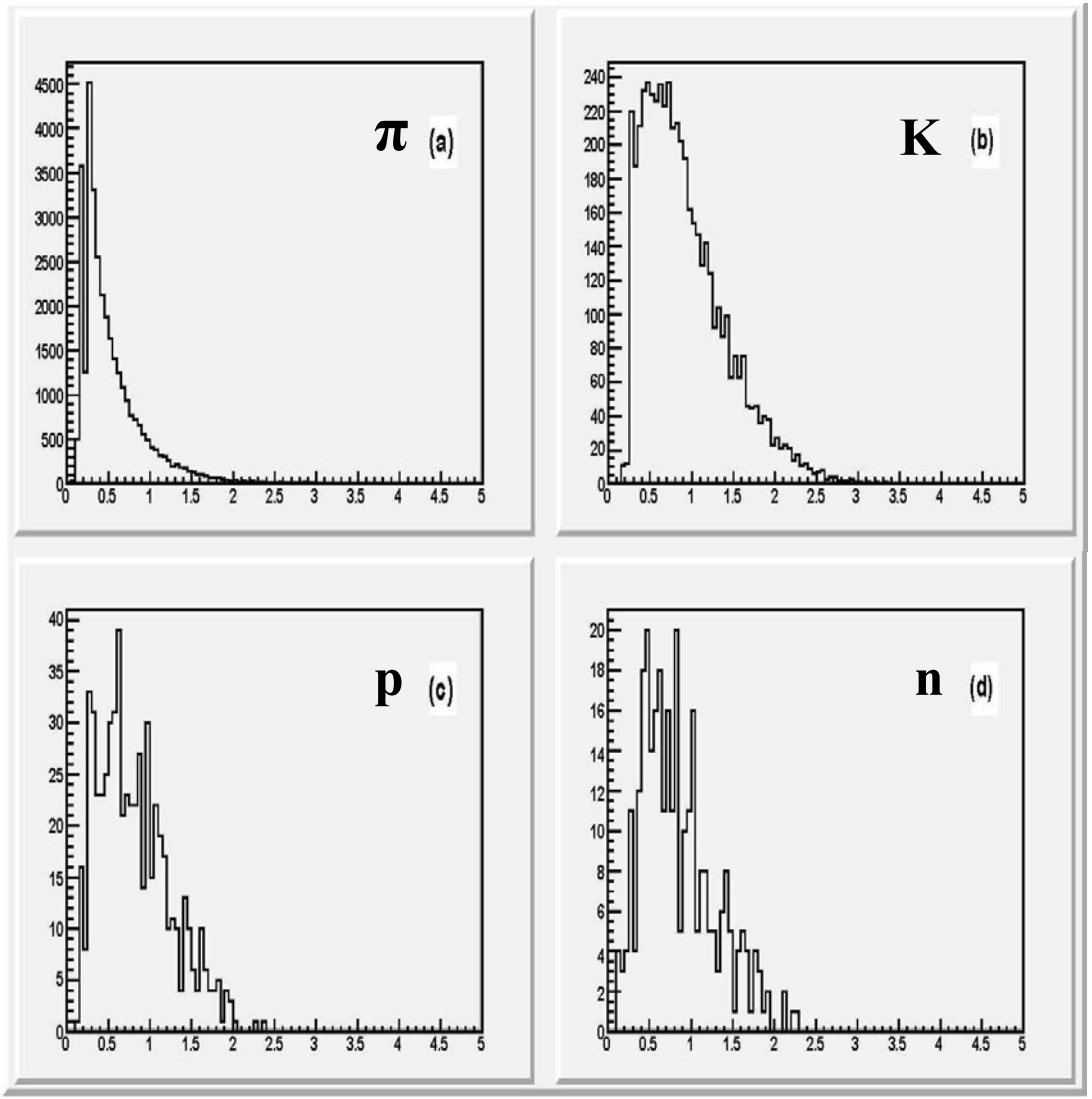
$cos\theta$ = -0.809 ÷ 0.954 (calorimeter),

E_{e-} = 7 GeV E_{e+} = 4 GeV B = 1.5 T

EvtGen → GEANT4 → For charged PID the first cross is calculated, all other crosses and the secondary particles are ignored. For neutral particles, the cross of calorimeter = the solid angle of calorimeter.

$|V_{ub}|$ measurement from inclusive spectrum of semileptonic B decays

Particles momentum spectrums



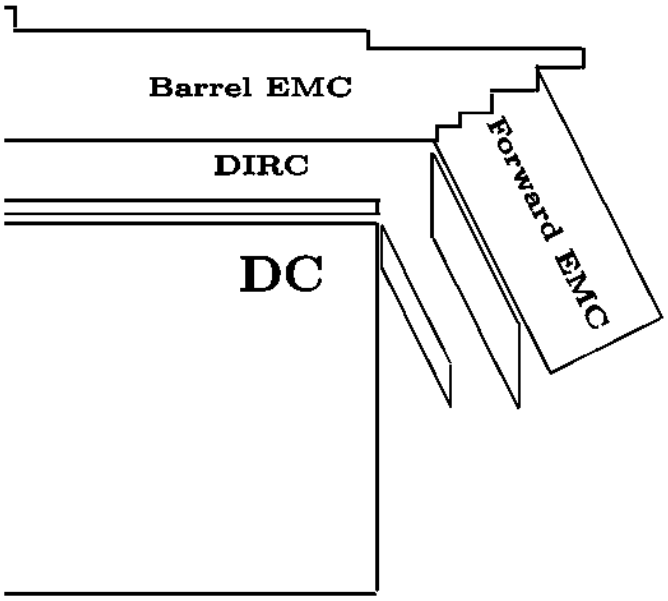
- for 50% of pions P > 400 MeV
- for 50% of kaons P> 800 MeV

$|V_{ub}|$ measurement from inclusive spectrum of charmless semileptonic B decays

PID system	100% reco γ in calorimeter	no magnetic field	100% reco Kl and n(.n) in calorimeter	no decays $K^{\pm}$, $\pi^{\pm}$, $\mu^{\pm}$ in flight
barrel	0.82	3.23	7.03	12.88
barrel +forward	1.32	4.73	10.03	19.32
barrel +backward	1.23	4.23	9.00	16.95
barrel +forward +backward	2.0	6.25	13.00	25.84

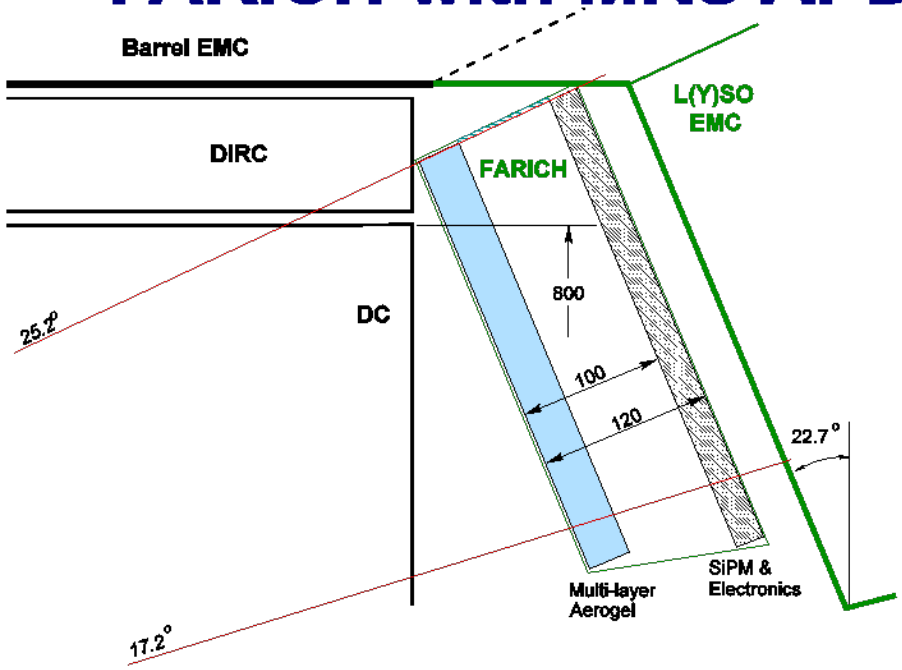
- Forward gives at least 30% increase in efficiency
- the loss of the detection efficiency due to decays is very large
- What about backward PID?

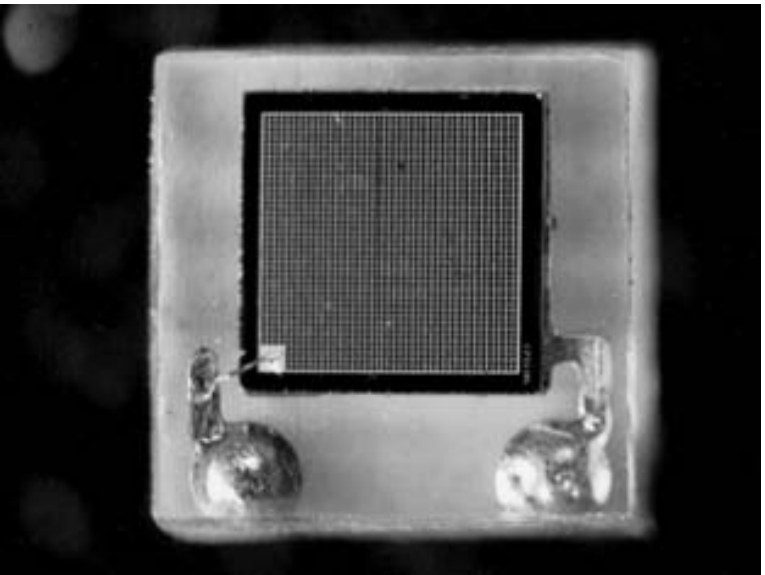
FastSim of the Forward FARICH



- Amount of material 24% of X_0 (option with MCP PMT)
- Will be ready next week

FARICH with MRS APD



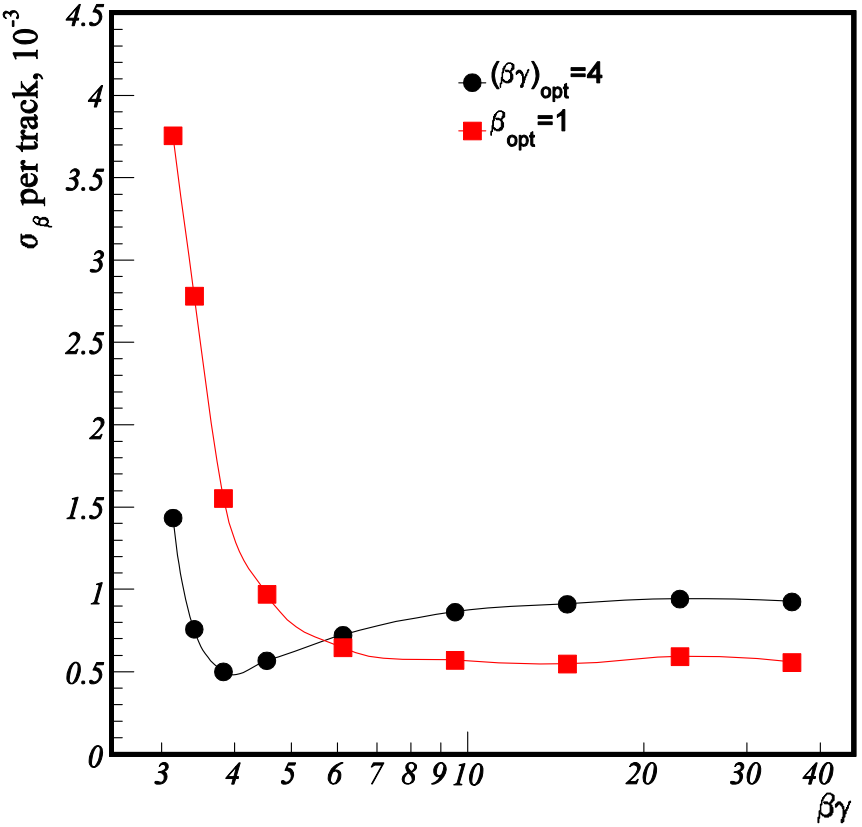


- Noise increase by a factor of 2 after 10^{10} neutrons (1-2 MeV) per cm^2 :
  - BaBar rates - ~ $5 \cdot 10^{11}$ in a year at the EMC endcap (at $7 \cdot 10^{33}$ cm^{-2} sec^{-1}) (J. Va'vra)
  - Belle rates - $4 \cdot 10^{11}$ in a year at the EMC endcap (P. Krizhan)
- Currently SiPM can not be used at SuperB FARICH unless some serious efforts will be done:
  - Cooling up to -50 C^o
  - Annealing at 250 C^o
  - Progress in initial radiation hardness (move from p type to n type)

FARICH for the SuperB detector (MCP PMT)

- Photon detector = MCP PMT from Burle
- We want to work also at low momentum region (< 1 GeV/c) = additional radiator with high index of refraction
- Particle momentum measurement = small granularity

Optimizing FARICH momentum resolution

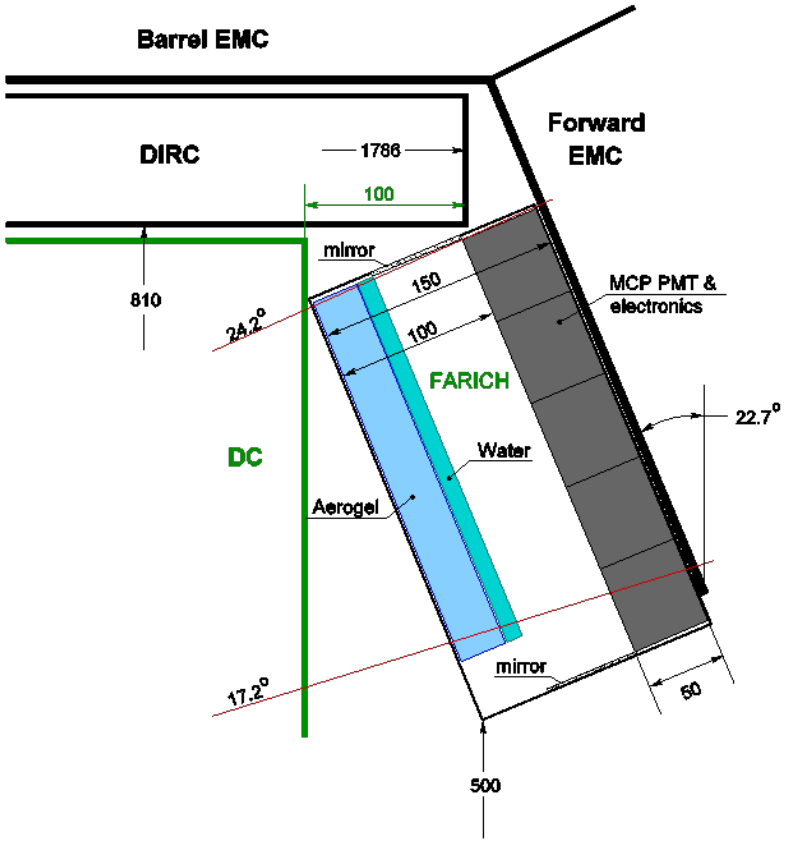


$\sigma P/P=\gamma^2\cdot\sigma\beta/\beta$

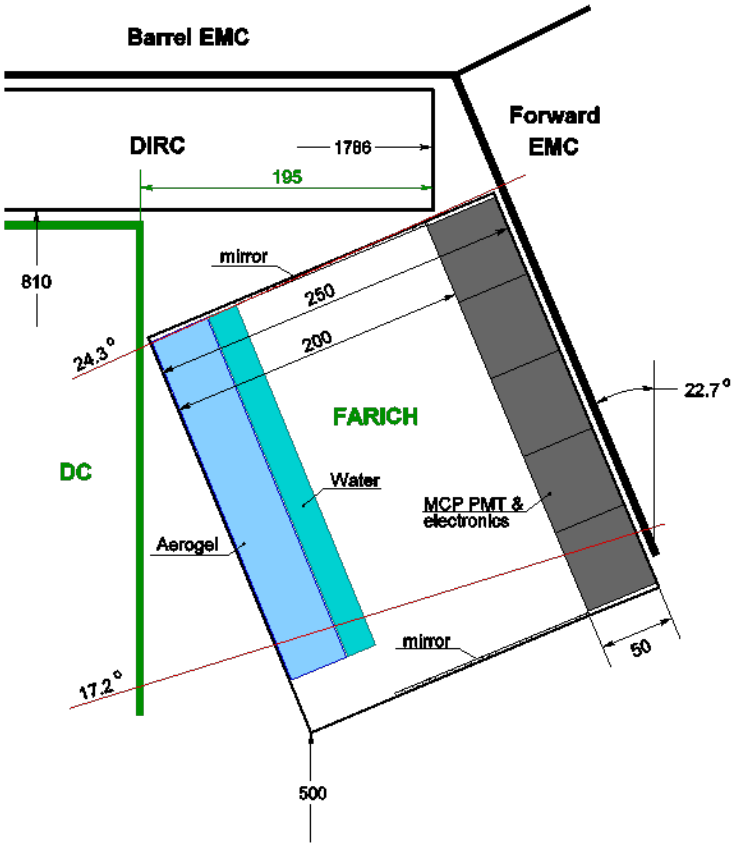
- Change of the momentum focus for aerogel from β_{opt}= 1 to $\beta\gamma_{opt}$= 1

FARICH possible designs for CsI EMC endcap

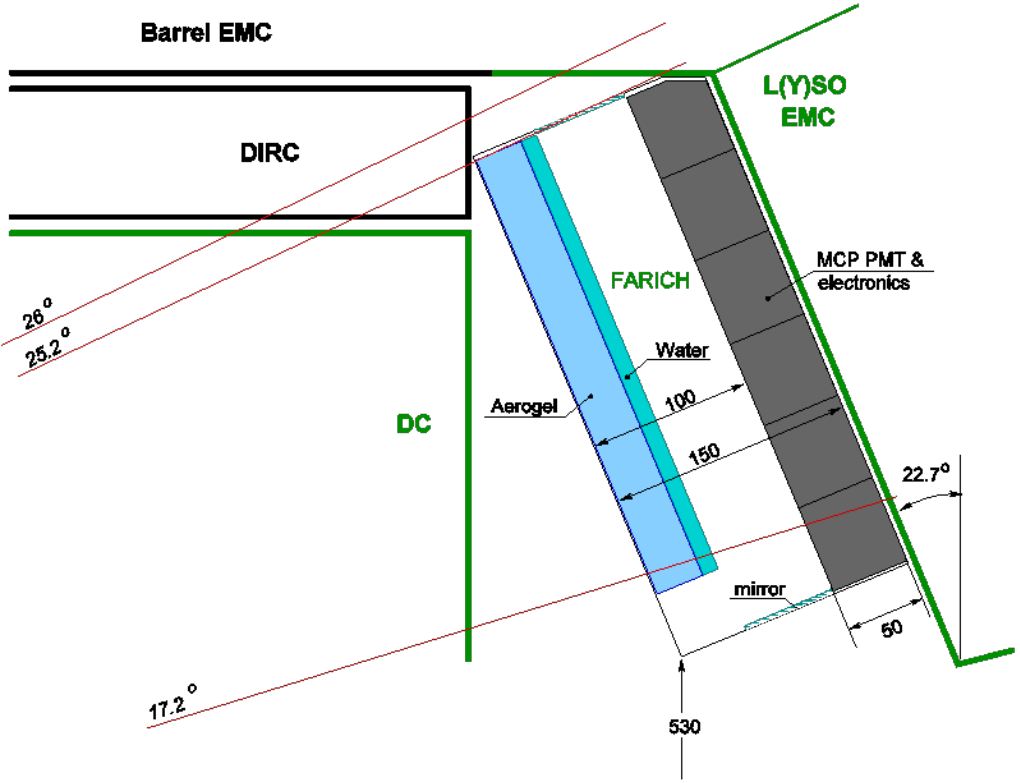
100 mm DC cut



200 mm DC cut

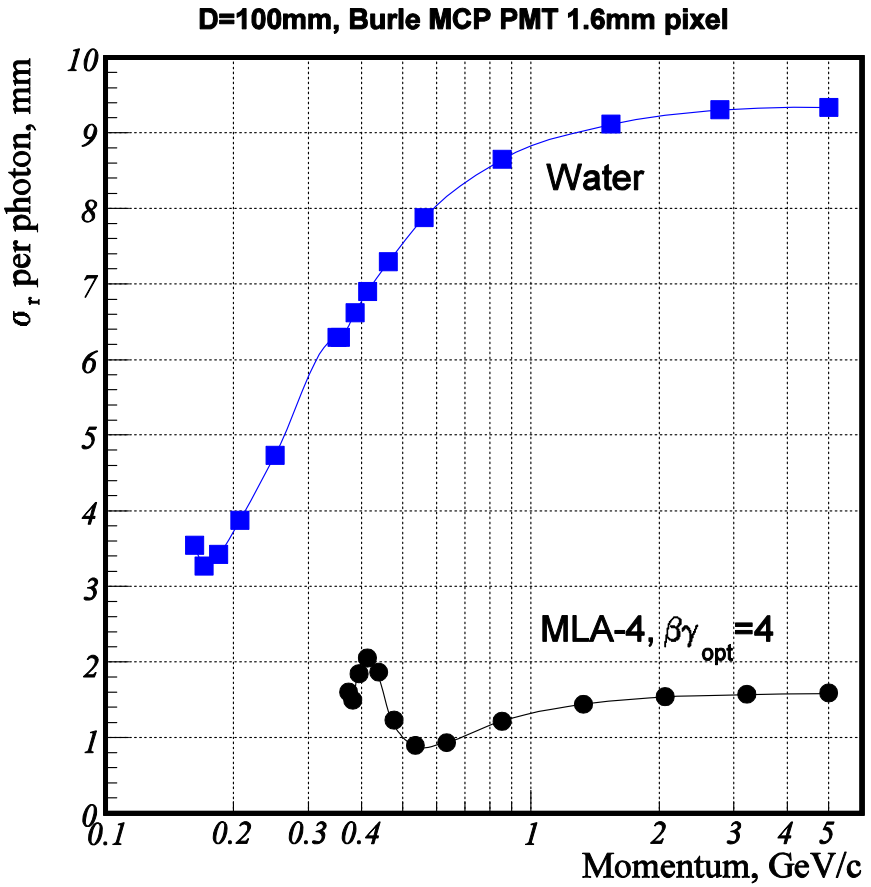


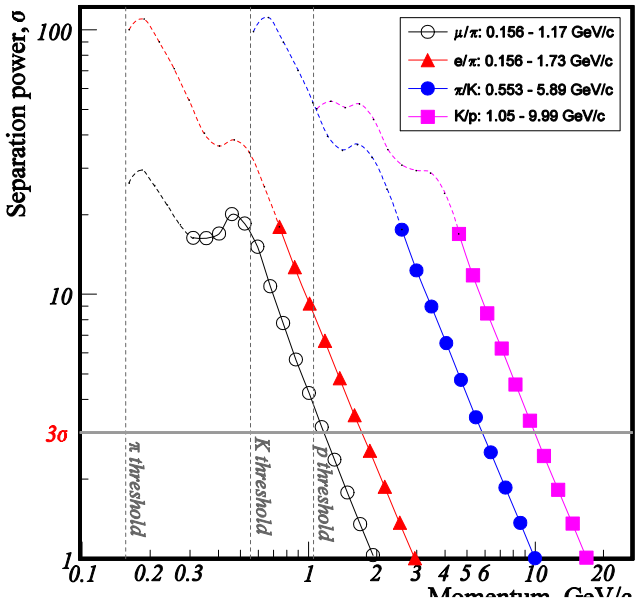
FARICH for the SuperB detector (MCP PMT)

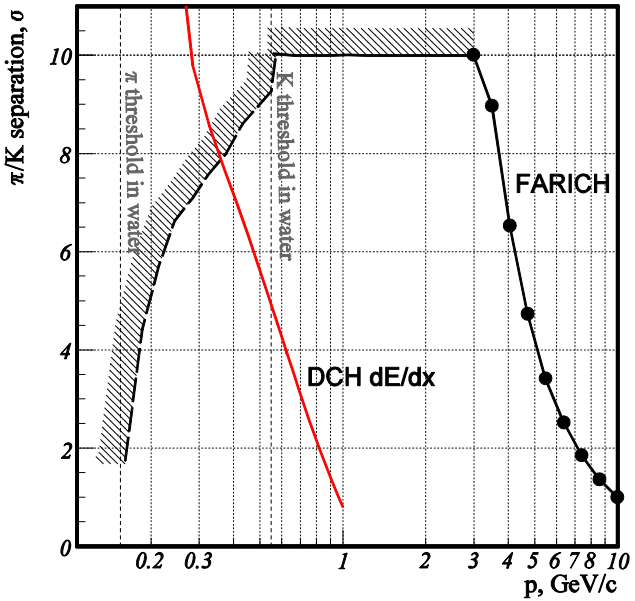


- Burle MCP PMT with 1.6x1.6 mm pixels (32x32 matrix), photoelectron collection efficiency 70%, geometrical factor 85%
- 3-layer focusing aerogel, n_{max}=1.07, total thickness 30 mm
- Number of PMTs - 550
- Number of channels – 550000
- Amount of material, (X_0) = 3.5%(aerogel)+ 2.5%(water)+ 14%(MCP PMT)+8% (support, electronics, cables) ~ 28%

FARICH expected perfor
Carlo results





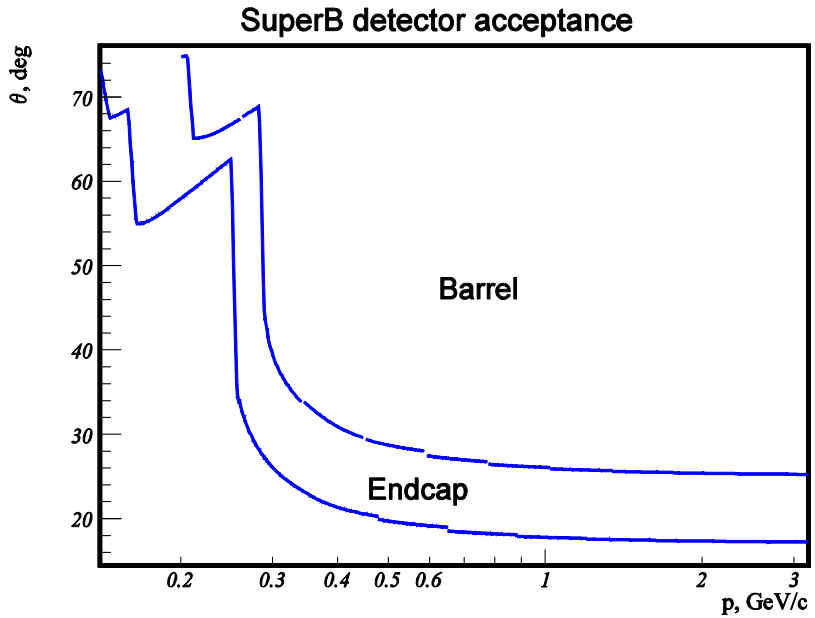


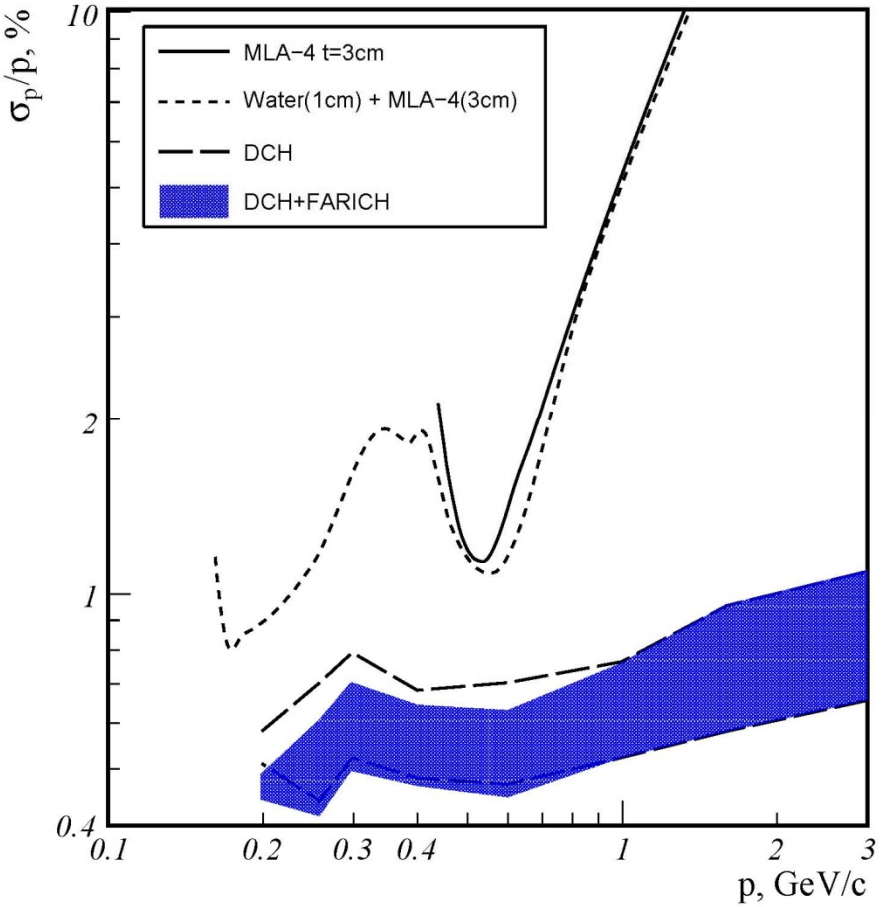
- N_{pe} = 20 + 40

FARICH momentum resolution

- Data for the DC momentum resolution are from the FastSim (decays are switched off!)
- need to take into account real polar angle of the particle
- Improvement in momentum measurement resolution from 10 to 15% in the working region –

the same improvement will be if we add 10-15 cm to DC

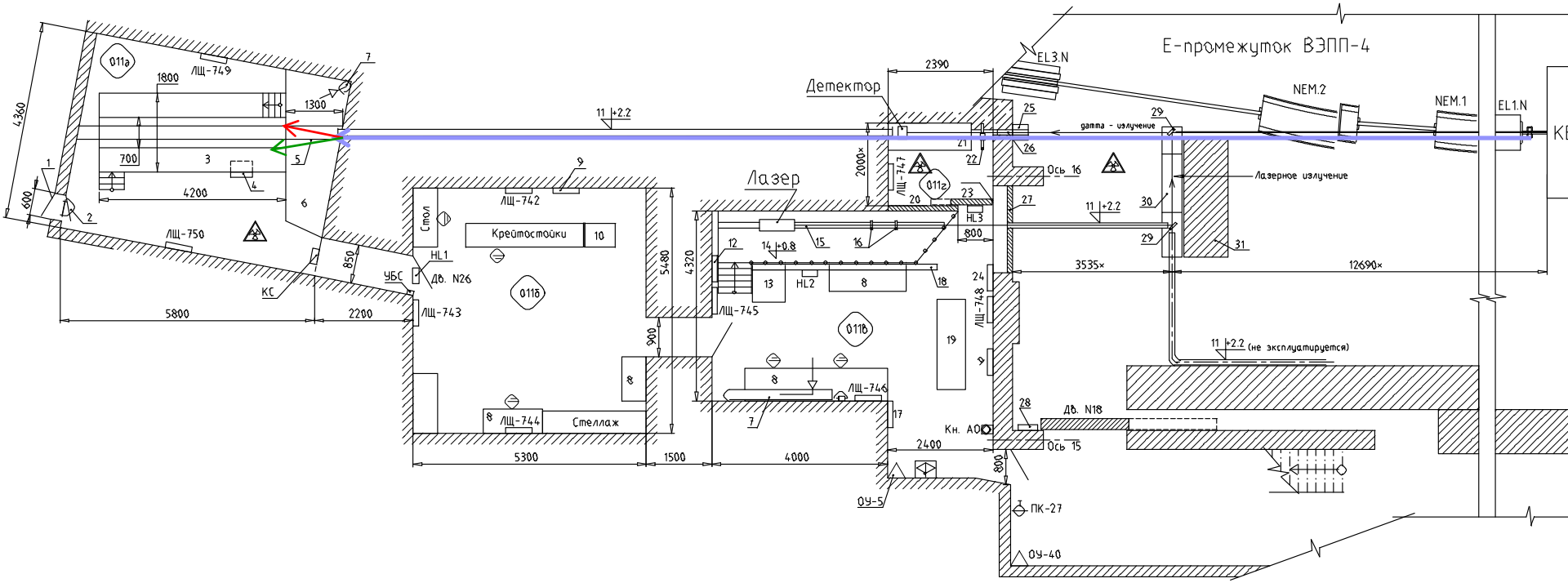




FARICH *pro* and *contra*

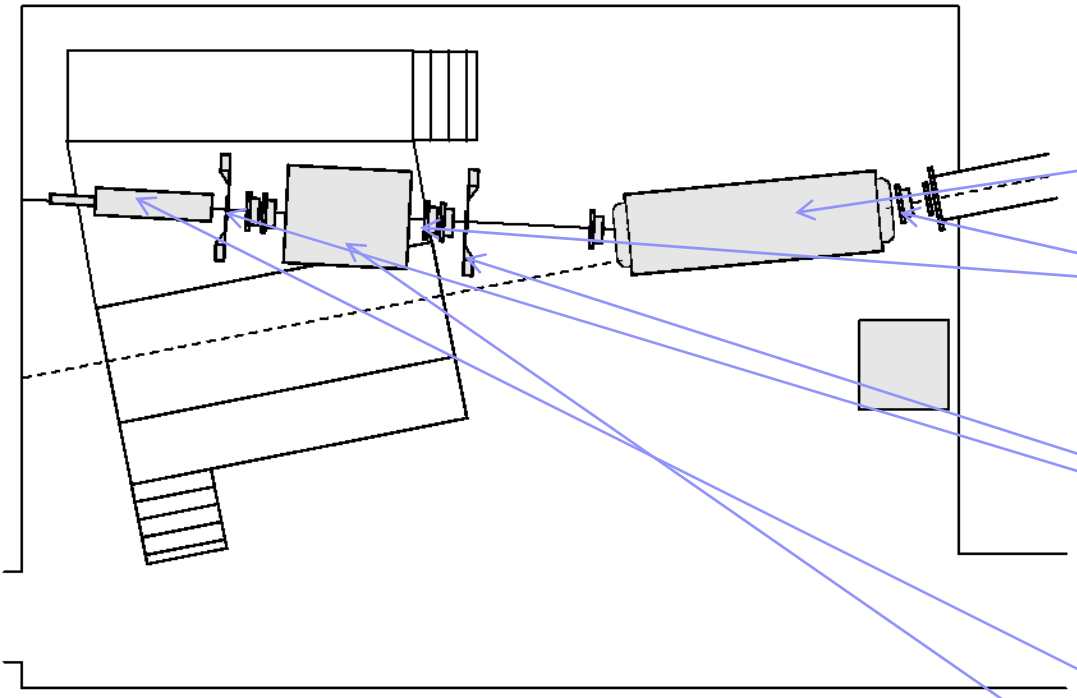
- Good PID in wide momentum region (π/K separation from 0.6 to 6 GeV/c)
- Improvement of the momentum resolution by 10-15% in the forward region
- In flight decays detection (?)
- Amount of material is about 28% of X_0
- Large number of channels

Test beam at VEPP-4M, Novosibirsk



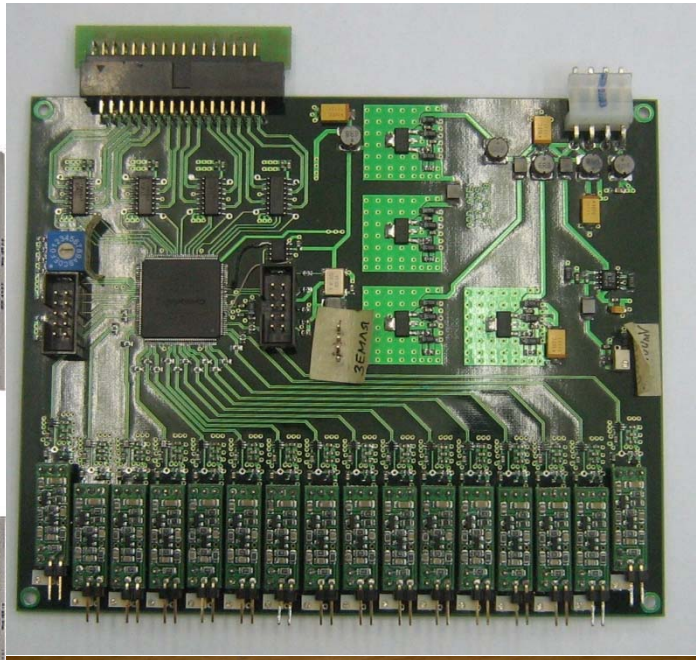
- E_{max}beam = 5.5 GeV
- We insert the converter in the beam halo to obtain bremstrahlung gammas or use the bremstrahlung gammas from the residual gas
- We convert gamma-quanta to electron-positron pairs in the target.
- To select electrons (positrons) with the required energy we use the magnet

Test beam apparatus

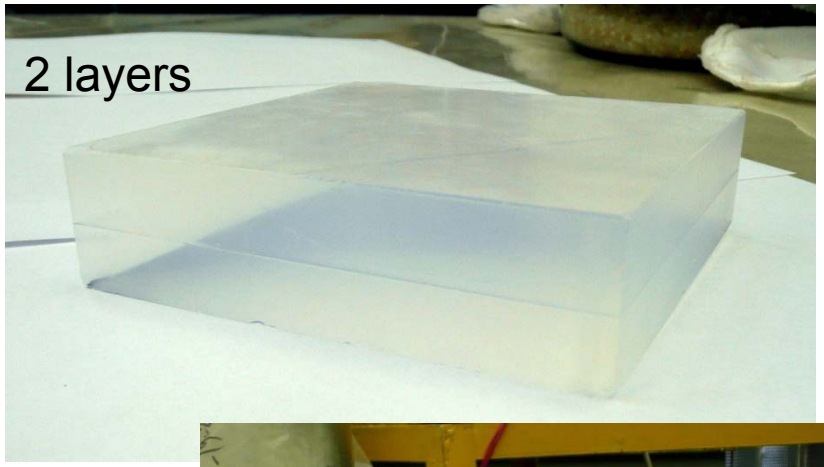


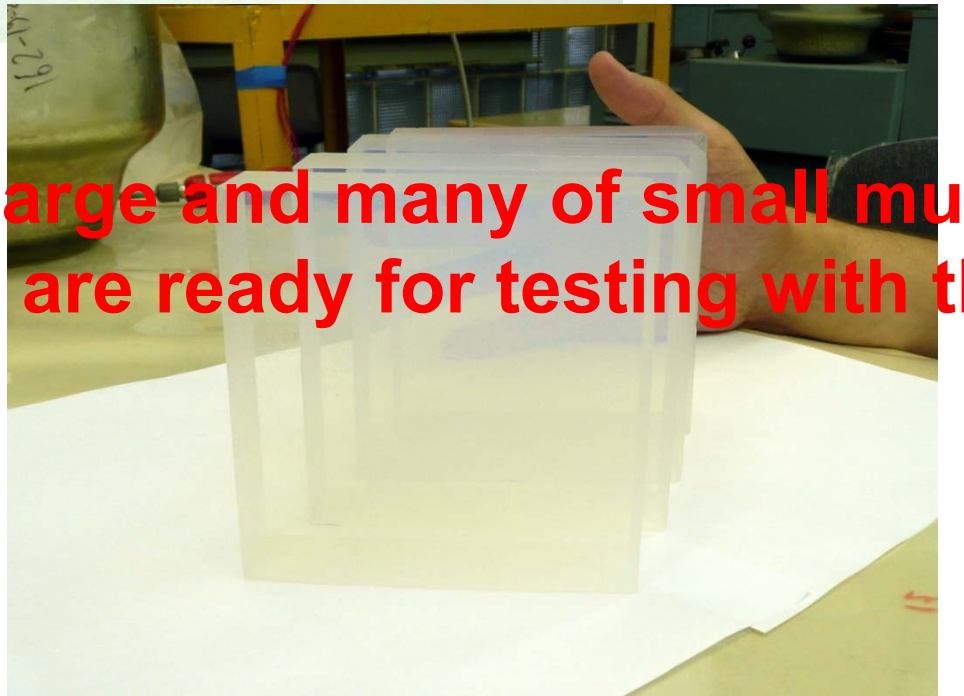
- Magnet
- Coordinate chambers
- Veto and trigger counters
- NaI calorimeter
- FARICH prototype

What we have for the test beam and prototype



Some new aerogel photos





These 4 large and many of small multylaer aerogel blocks are ready for testing with the beam

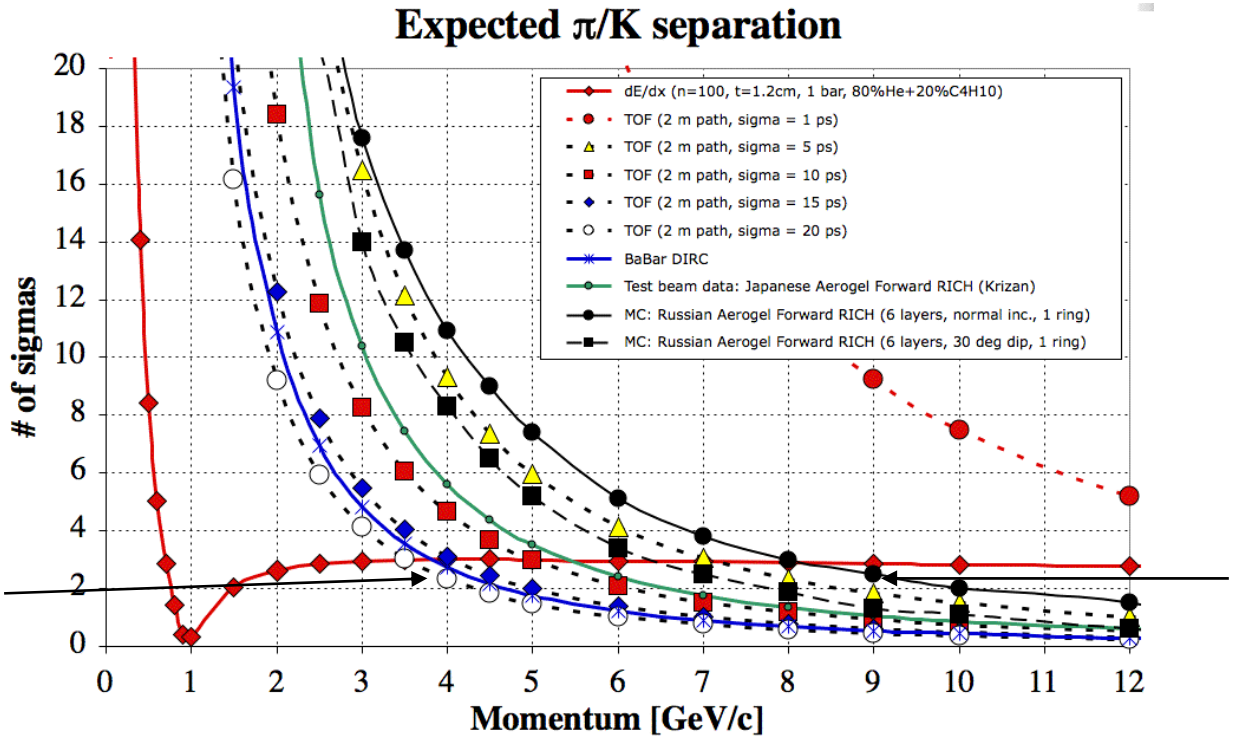
Our plans for test beam and prototype

- We investigating possibilities to purchase Burle MCP PMT
- Magnet will be installed during summer time
- The work with prototype will start at September-October
- The first experiment – November-December 2009

Backup slides

Forward TOF and FARICH comparison

TOF

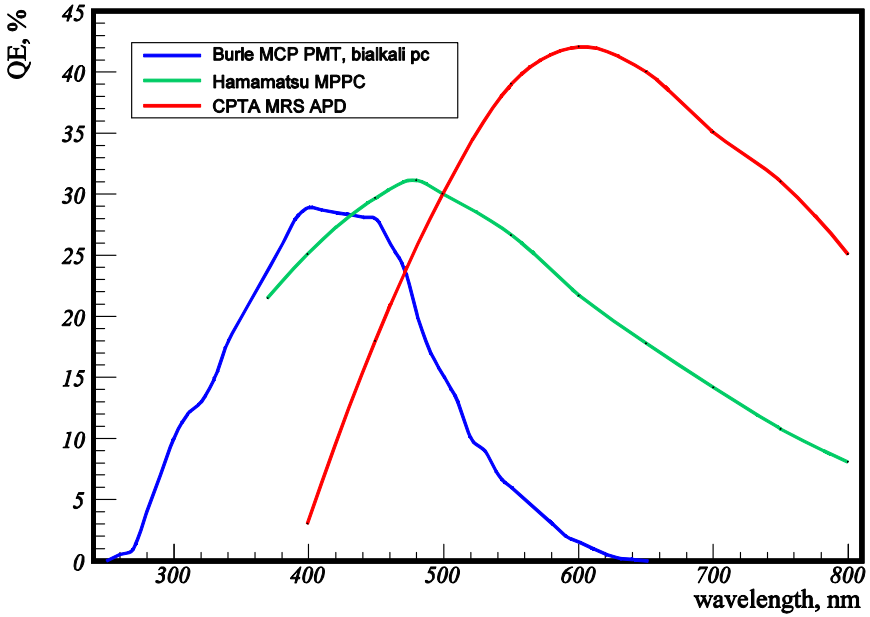


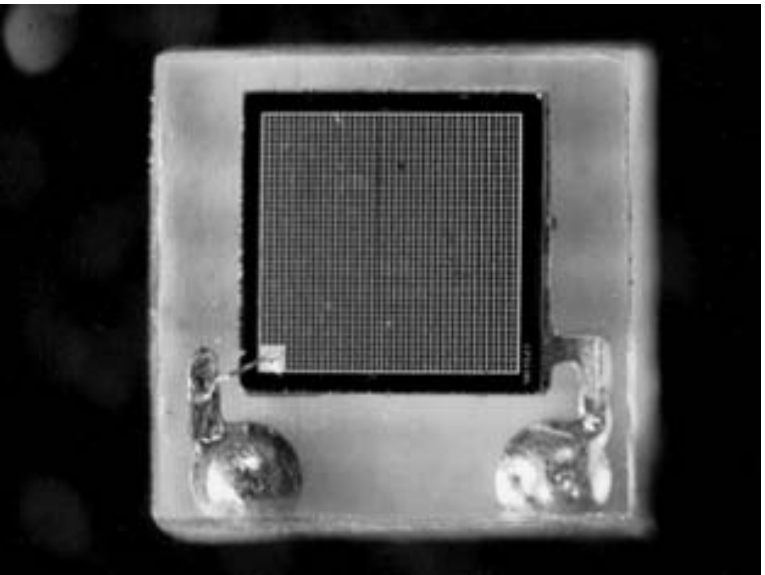
FARICH

Pro	Contra
• Much better π/K,μ/π,e/π identification • Momentum measurement improvement in the forward • Better background endurance	• 15 cm of additional space • 10 times more channels • Price (?)

The amount of material is almost the same

MRS APD parameters





- Producer - Center of Perspective Technology and Apparatus – CPTA, Moscow http://www.spta-apd.ru/
- Genuine name - MRS APD (other names: silicon photomultiplier, PPD,MPPC…)
- 2.1x2.1 mm sensor
- 4x4 mm case size
- PDE=40% @ 600 nm
- Gain ~ $4 \cdot 10^5$
- Time resolution ~100 ps
- Dark counts ~10 MHz (0.5pe threshold)