Impact of forward PID on |Vub| measurement and possible momentum resolution improvement

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Outline

- **$|V_{ub}|$ measurement from inclusive spectrum of charmless semileptonic B decays**
- **FARICH with MCP PMT**
  - Optimization for the momentum measurement
  - Optimization for low momentum PID

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

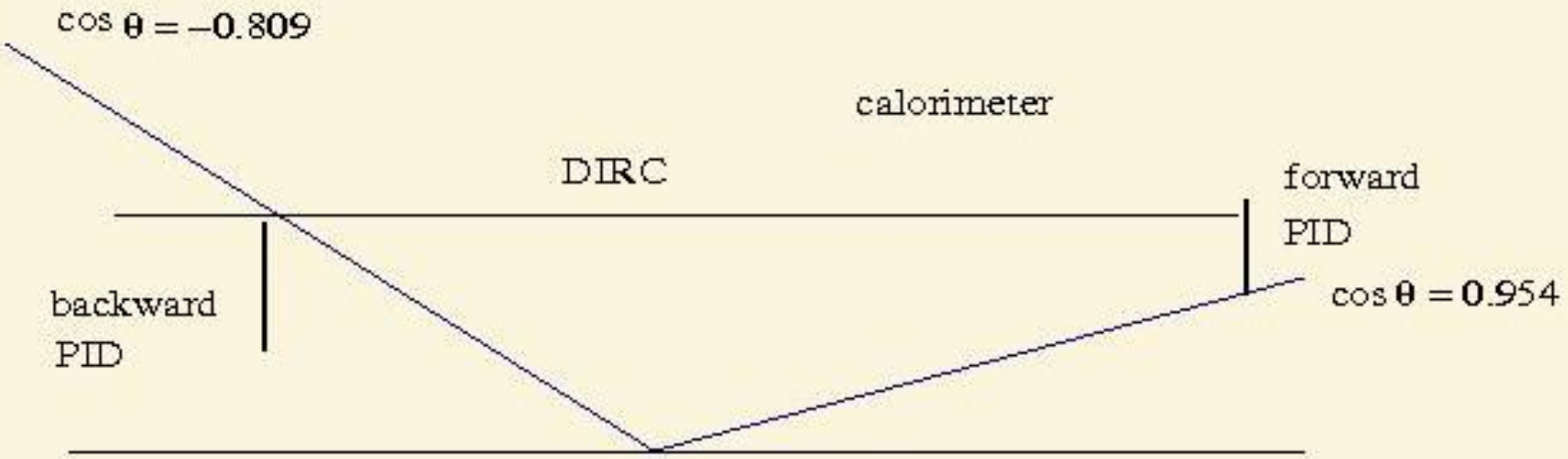
We look for the physics process where PID acceptance will play critical role:

- 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),

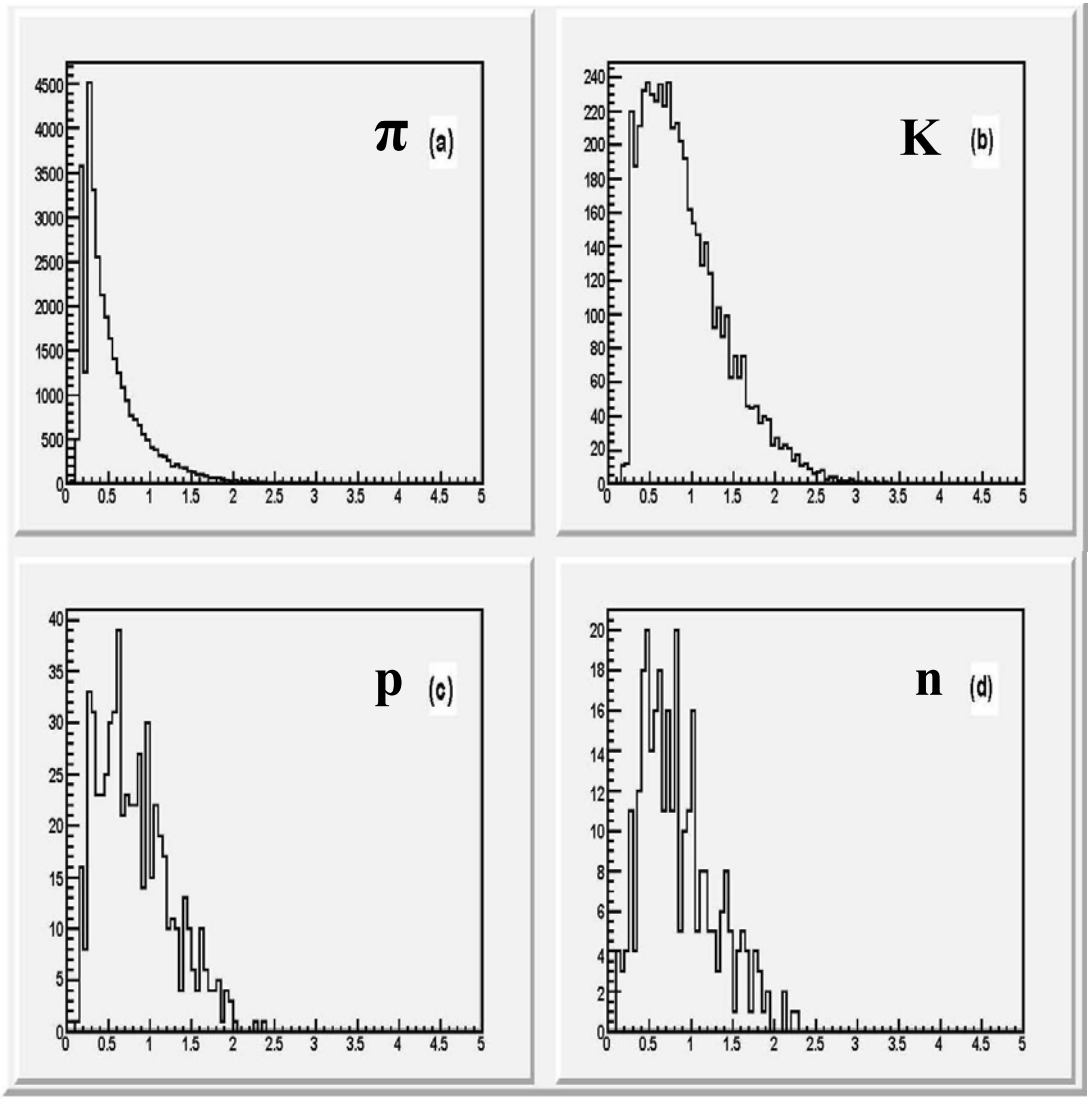
$cos\theta$ = -0.809 ÷ 0.954 (calorimeter),

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

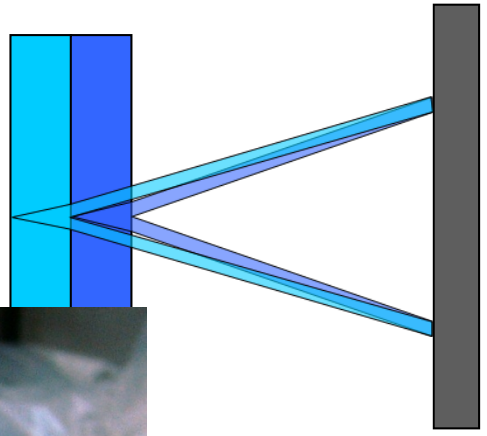
PID system	100% reco γ in calorimeter	no magnetic field	100% reco Kl and n(.n) in calorimeter	no decays $K^{\pm}$, $\pi^{\pm}$, $\mu^{\pm}$ in flight
barrel	0.82	3.23	7.03	12.88
barrel +forward	1.32	4.73	10.03	19.32
barrel +backward	1.23	4.23	9.00	16.95
barrel +forward +backward	2.0	6.25	13.00	25.84

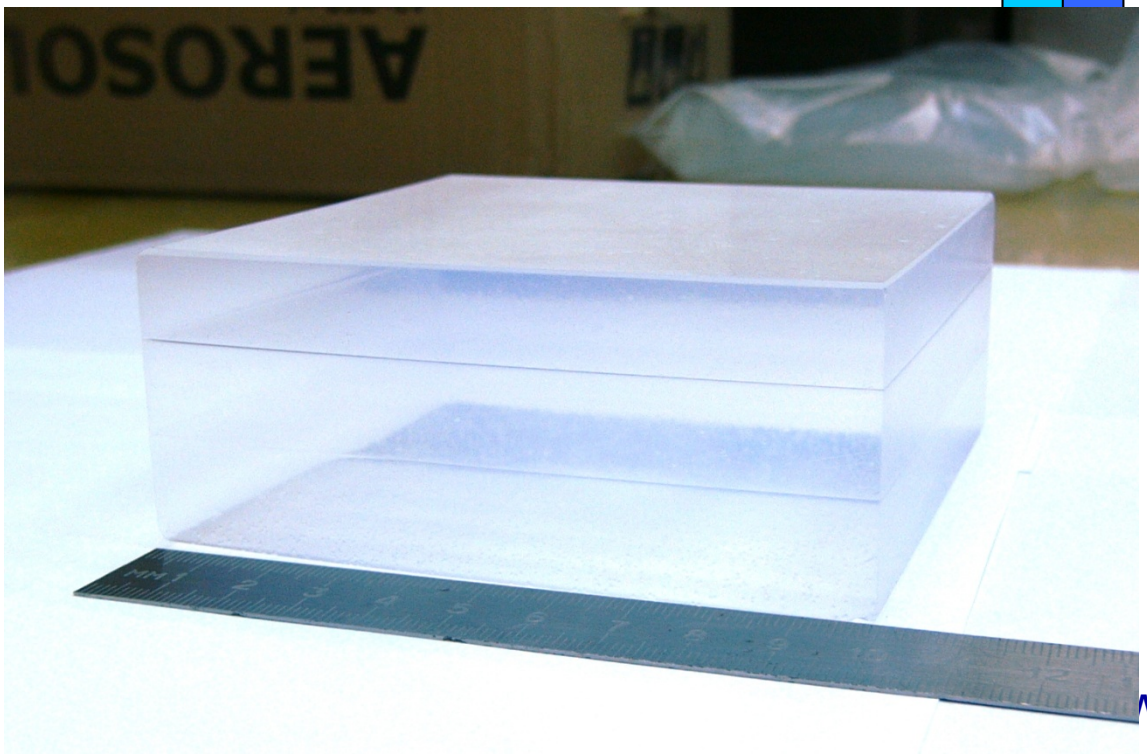
- Forward gives at least 30% increase in efficiency
- the loss of the detection efficiency due to decays is very large
- What about backward PID?

Focusing aerogel RICH concept

Objective: to reduce thickness contribution

Single ring
focusing

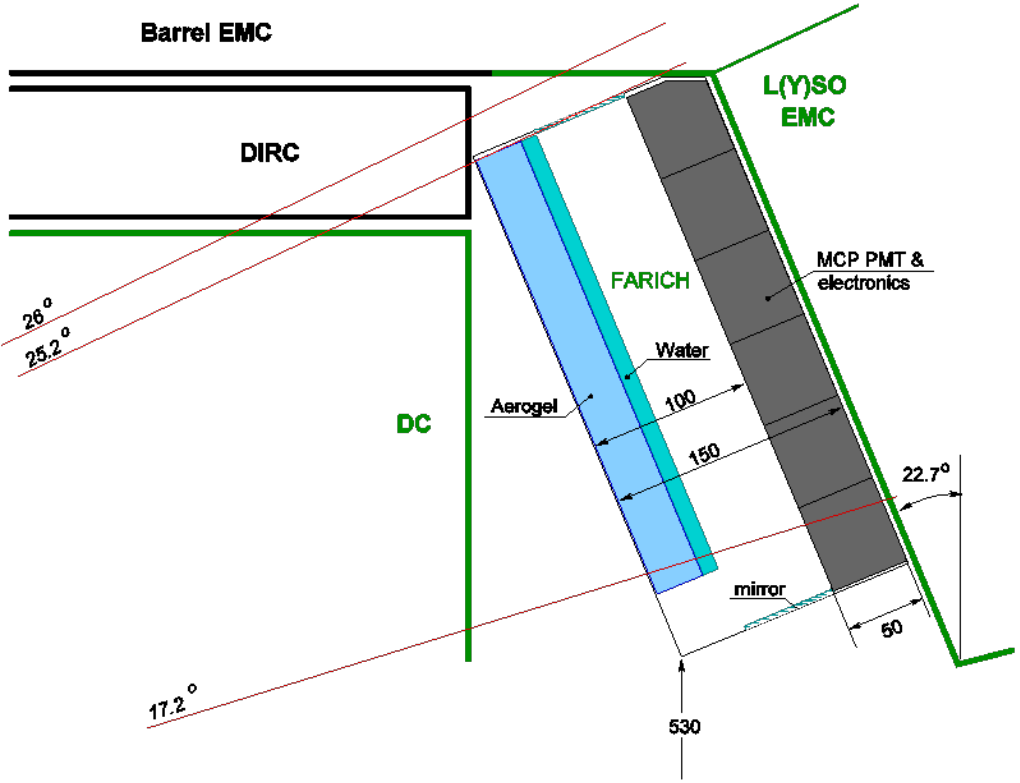




FARICH for the SuperB detector (MCP PMT)

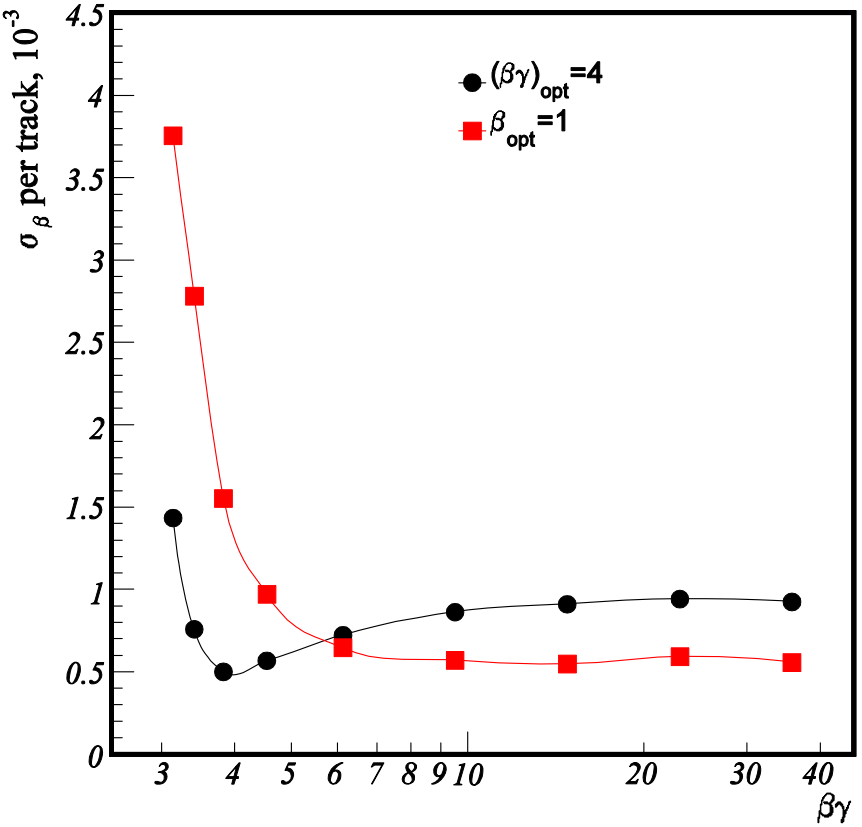
- Photon detector = MCP PMT from Burle
- We want to work also at low momentum region (< 1 GeV/c) = additional radiator with high index of refraction
- Particle momentum measurement = small granularity

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%

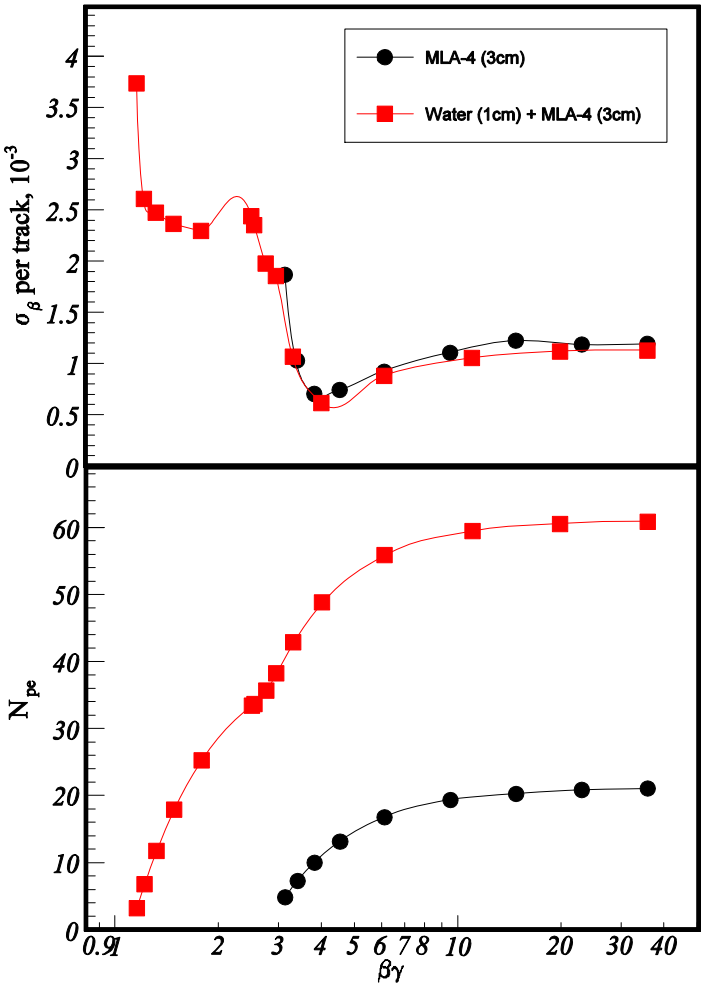
Optimizing FARICH momentum resolution

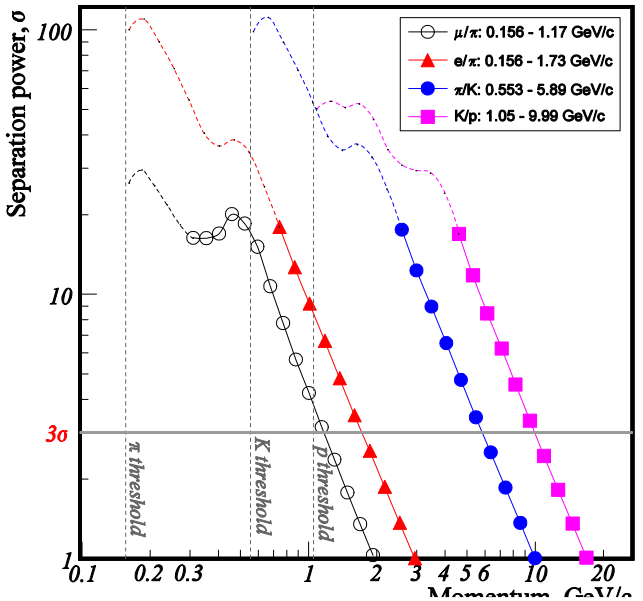


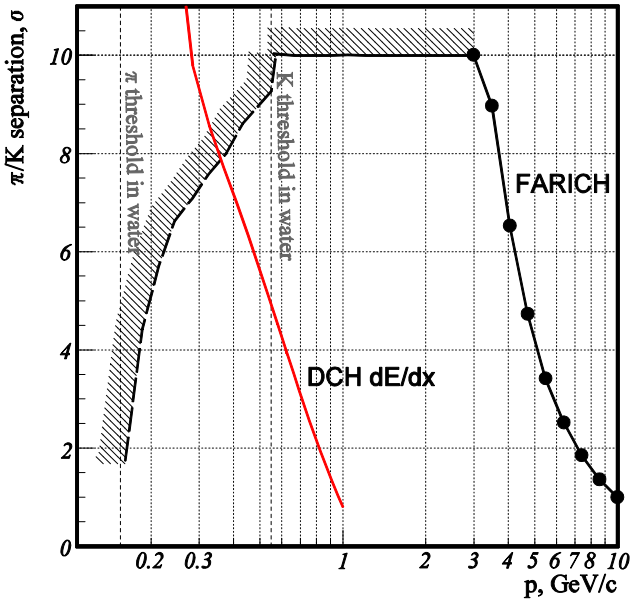
$\sigma P/P=\gamma^2\cdot\sigma\beta/\beta$

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

FARICH expected perfor
Carlo results





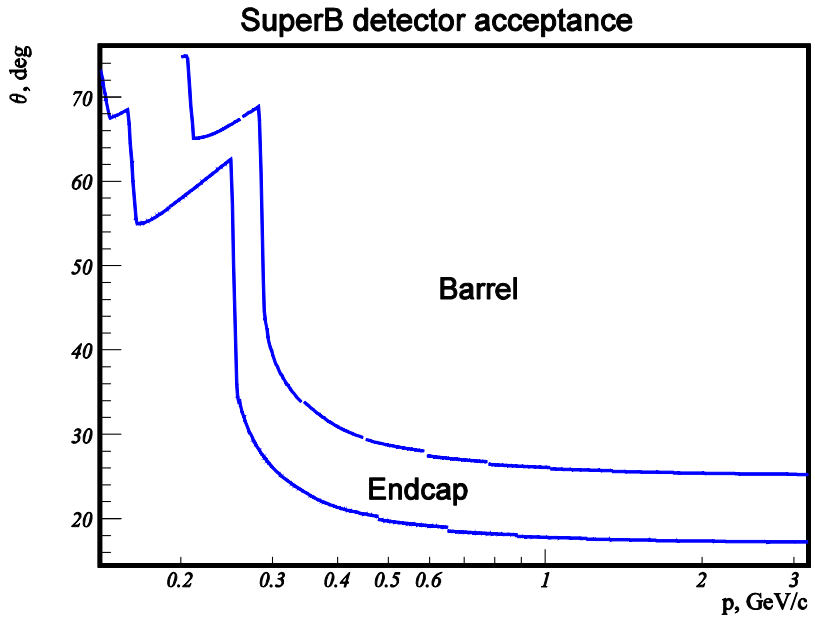


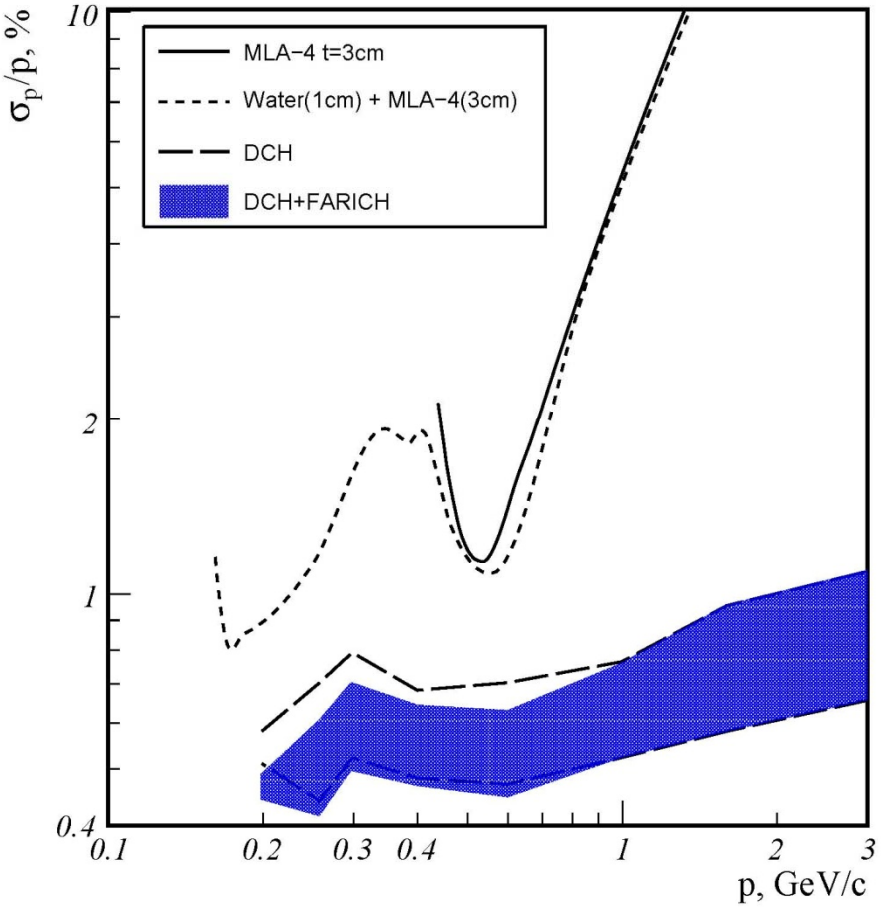
- N_{pe} = 20 + 40

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





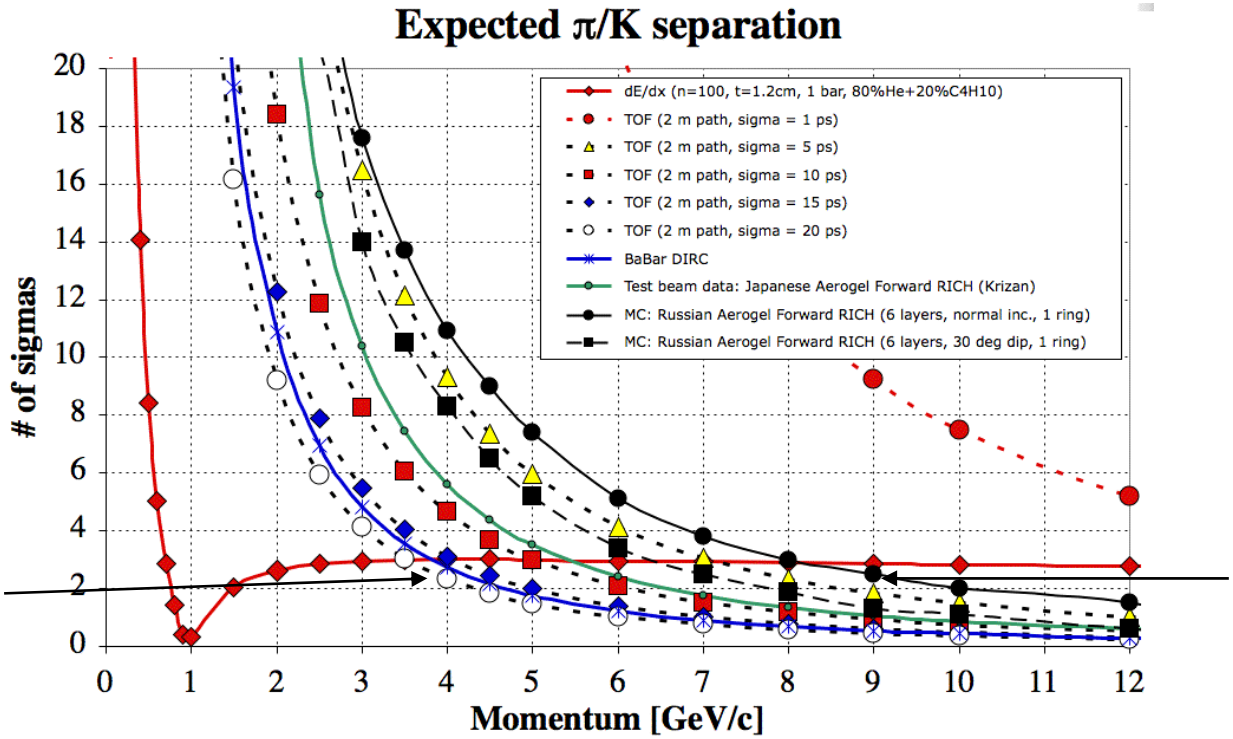
FARICH *pro* and *contra*

- 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

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