# Focusing Aerogel RICH for SuperB detector forward PID

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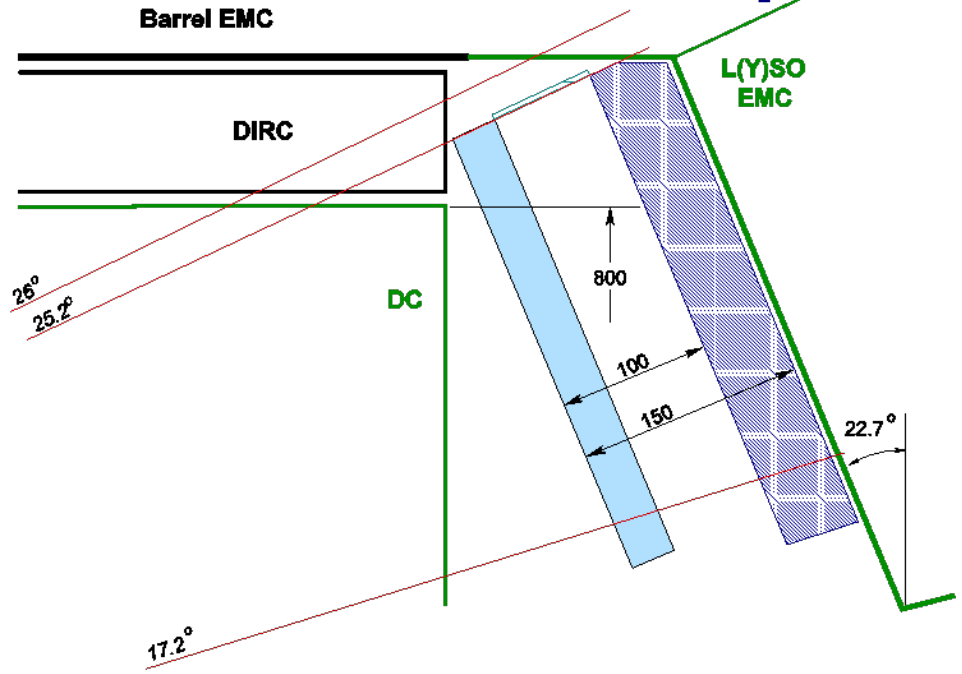
# Outline

- **Introduction**
- **FARICH for the endcap**
  - **MCP PMT option**
  - **MRS APD (SiPM)**
    - MC results
    - Suggestion for read-out electronics
- **Test beam line at Budker INP, status and plans**
- **Plans on Forward PID fast simulation.**

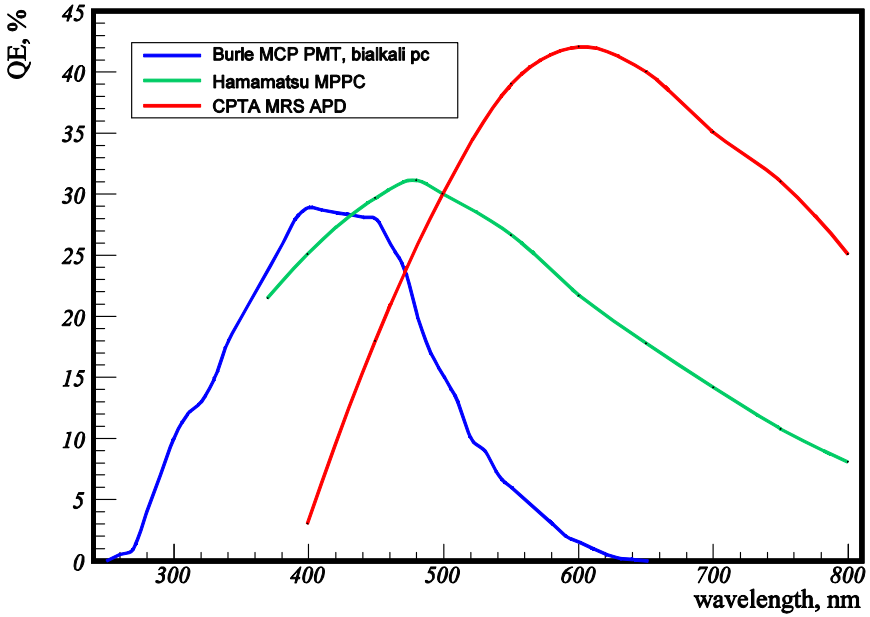
# FARICH for the SuperB detector (MCP PMT)

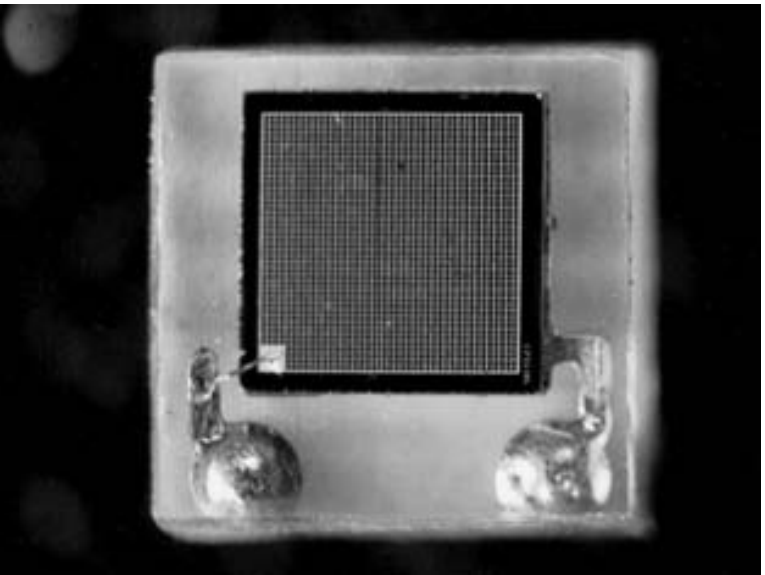




- Burle MCP PMT with 3x3 mm pixels (16x16 matrix), photoelectron collection efficiency 70%, geometrical factor 85%
- 3-layer focusing aerogel, $n_{max}$=1.07, total thickness 30 mm
- Number of PMTs - 550
- Number of channels – 140000
- Amount of material, ($X_0$) = 3.5%(aerogel)+14%(MCP PMT)+5÷10% (support, electronics, cables) > 23÷28% !

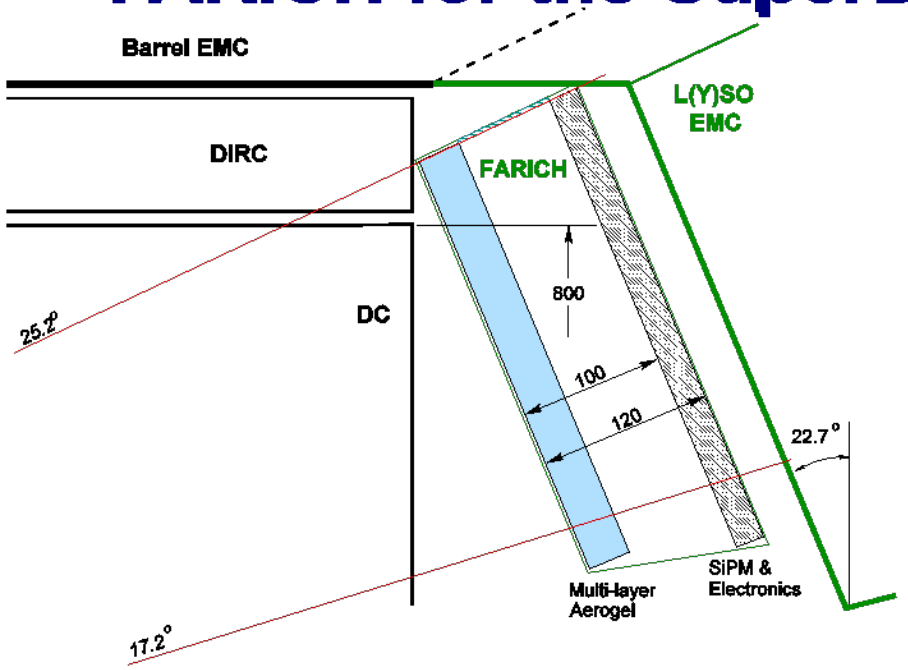
# MRS APD parameters

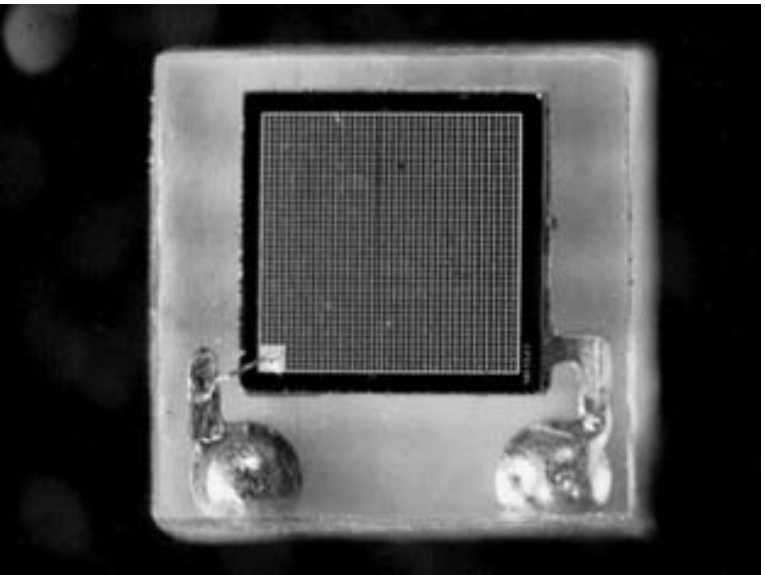


- Producer - Center of Perspective Technology and Apparatus – CPTA, Moscow http://www.spta-apd.ru/
- Genuine name - MRS APD (other names: silicon photomultiplier, PPD,MPPC…)
- 2.1x2.1 mm sensor
- 4x4 mm case size
- PDE=40% @ 600 nm
- Gain ~ $4 \cdot 10^5$
- Time resolution ~100 ps
- Dark counts ~10 MHz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

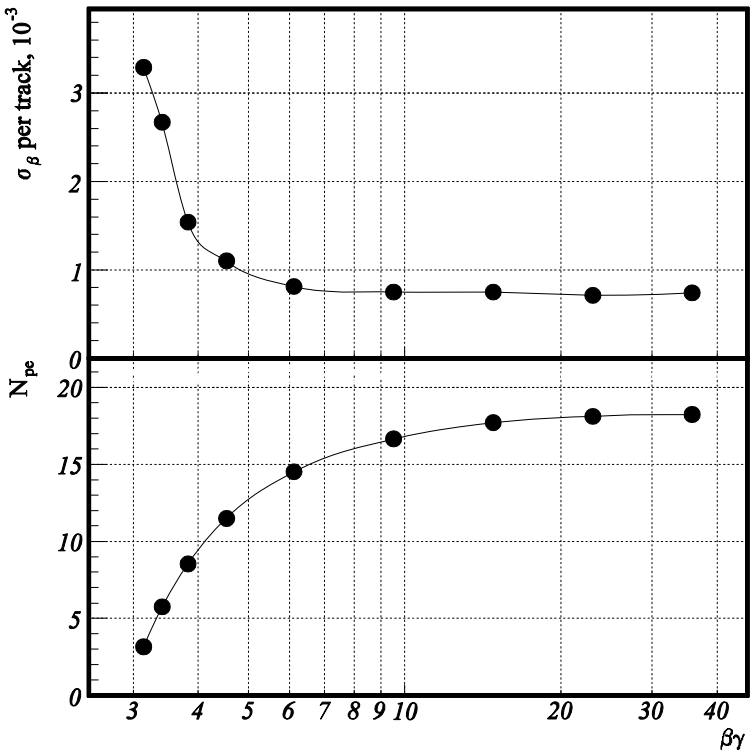
# FARICH for the SuperB detector (MRS APD)

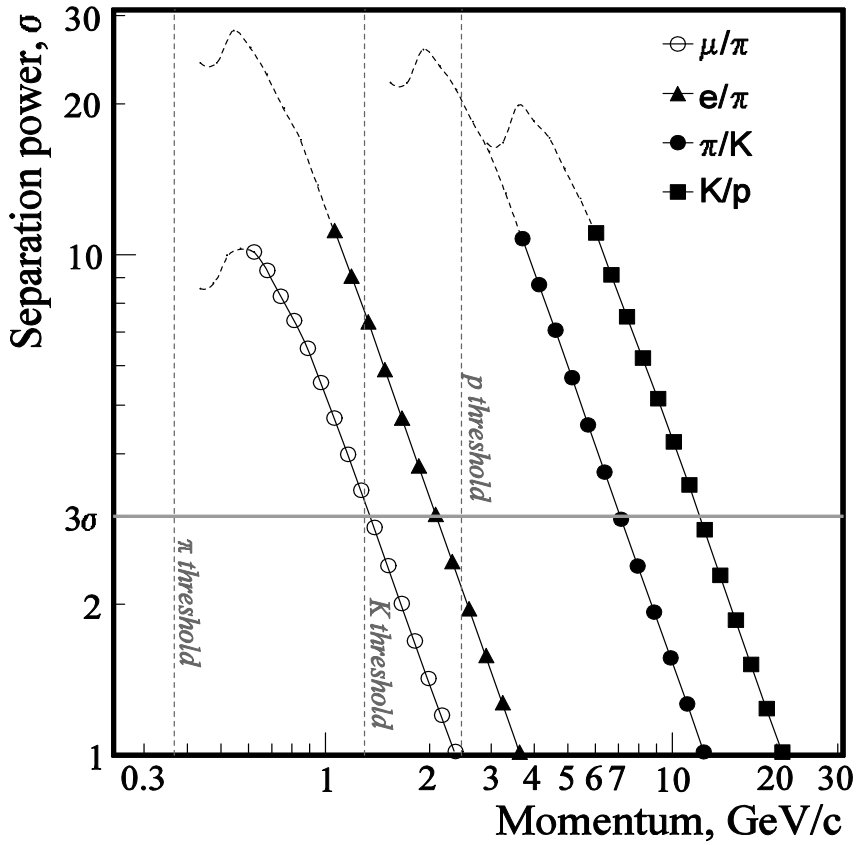


- CPTA MRS APD (Moscow) --- silicon photomultiplier
  - 2.1x2.1 mm sensor
  - 3x3 mm case size (50% active/total area)
  - PDE=40% @ 600 nm
- 3-layer focusing aerogel, $n_{max}$=1.07, total thickness 25 mm
- Number of channels – 160000
- Amount of material, ($X_0$) = 3%(aerogel)+1%(SiPM)+6%(?) (support, electronics, cables) = 10% !

# FARICH expected performance, Monte Carlo results



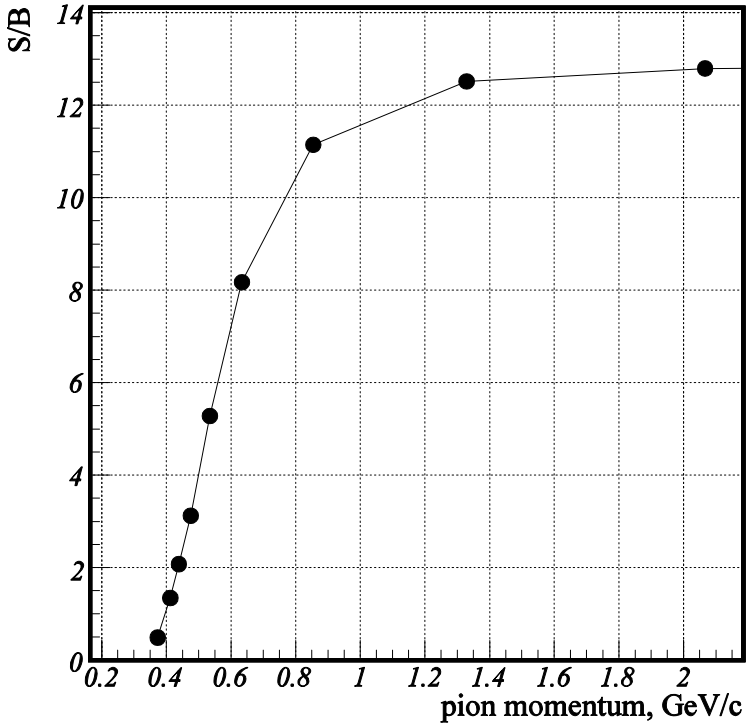

- $N_{pe}$ = 18
- $\sigma\beta/\beta = 8 \cdot 10^{-4}$

# What about noise?

Estimation

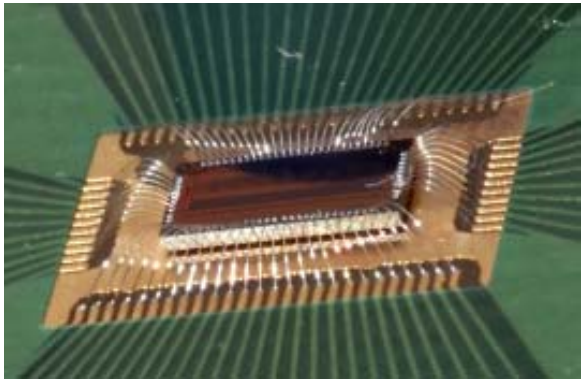
$S/N = N_{pe}/(N_{px} \cdot f_n \cdot \tau)$,
where :

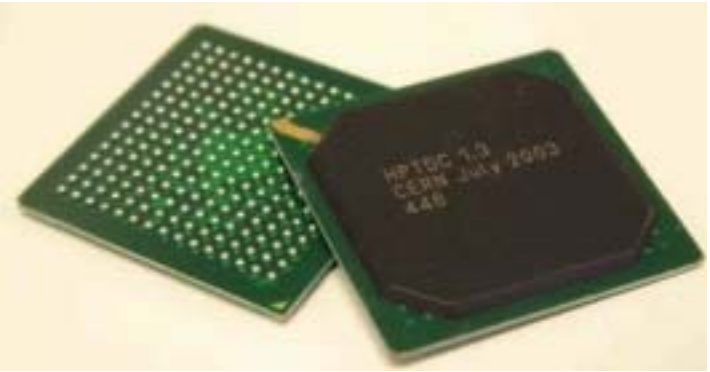
- $N_{pe}$ – number of Cherenkov photons,
- $N_{px}$= ring area/(pixel size)$^2$ – number of pixels in the ring of the width $\pm 3\sigma_r$,
- $f_n$ – noise rate,
- $\tau$ – time window.




$f_n$ = 10 MHz
$\tau$ = 1 ns

# Suggestion for the read-out electronics

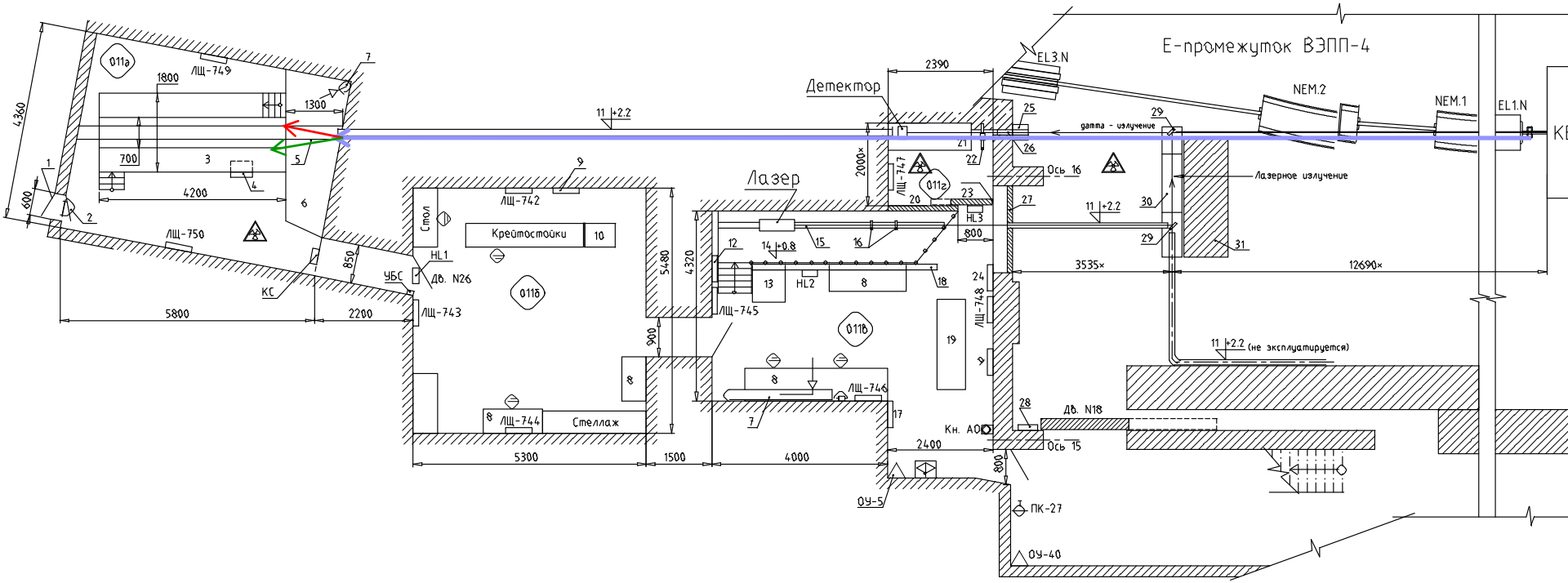




CERN has developed for ALICE TOF high performance chips (high rate, small dead time):

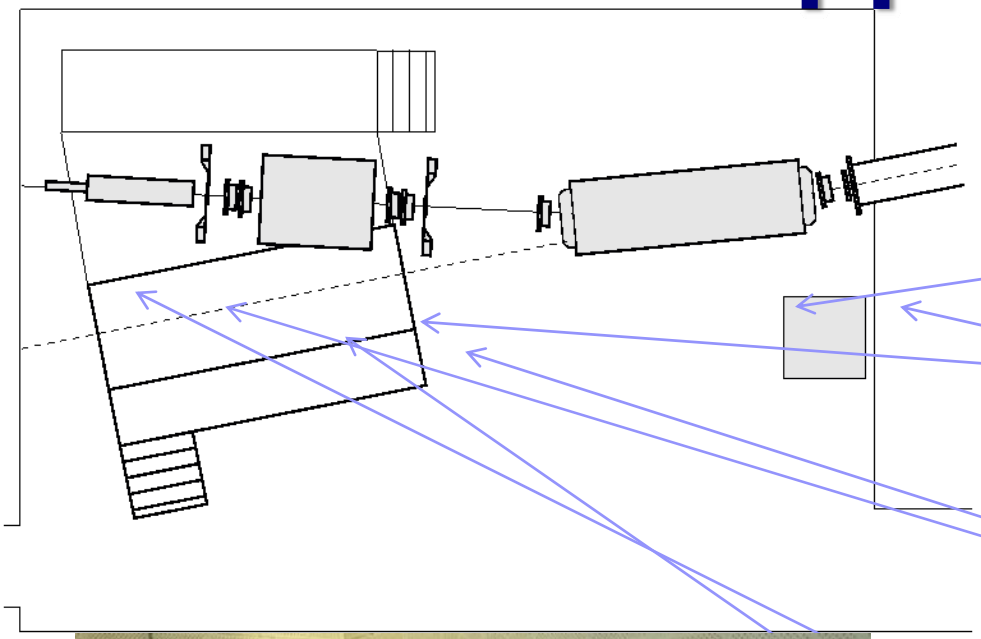
- 8-channel NINO ASIC chip (low power front-end amplifier discriminator )
- 32-channel HPTDC ASIC chip (programmable TDC with time resolution between 25ps to 800ps)

# Test beam at VEPP-4M, Novosibirsk




- $E_{max}$beam = 5.5 GeV
- We insert the converter in the beam halo to receive bremstrahlung gammas
- We convert gamma-quants 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


- 35 MRS APD for the first stage

64 channel TDC
CAEN - V1190B
Based on 2 HPTDC chips

# What we have for the test beam and prototype

- Experimental hall reconstruction is n progress.
- Magnet+power supply (B = 1.5 Tesla)

# Our plans for the test beam

- Magnet will be ready in April-May
- Prototype will be ready at June-July
- The first experiment – November-December 2009
- MRS-APD tests and characterization we are planning to do together with Padova group

# Plans on forward PID fast simulation

o Alexey Berdyugin will come to Padova next week (Visit is supported by Padova group).

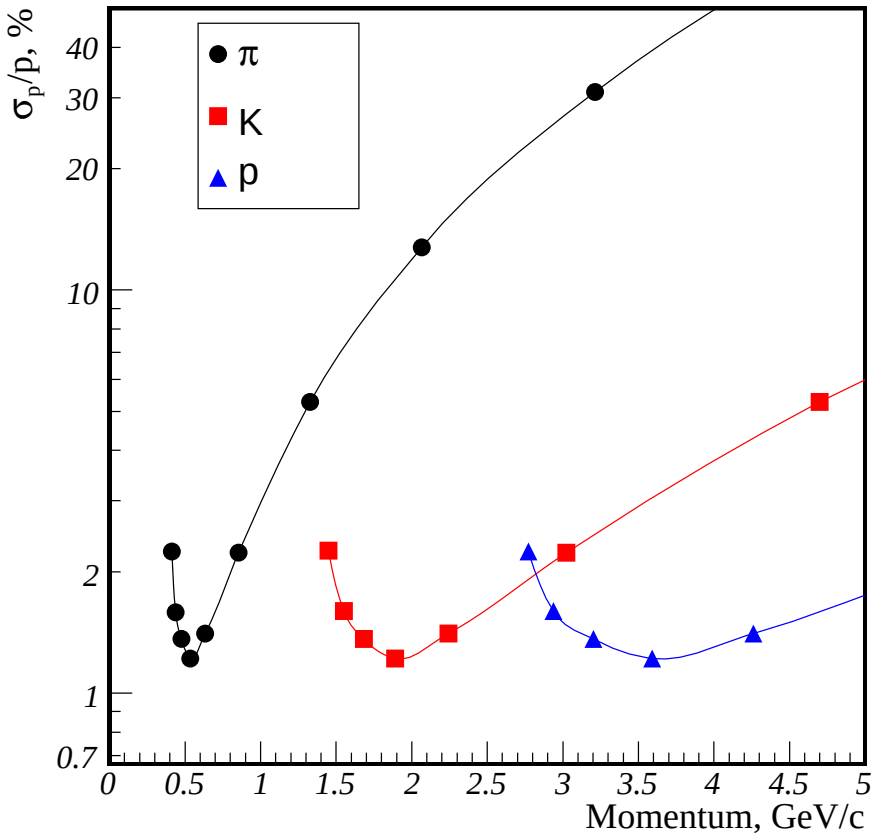
- Geometry and material description
- PID performance according to MC simulation

# Additional slides

# FARICH momentum resolution

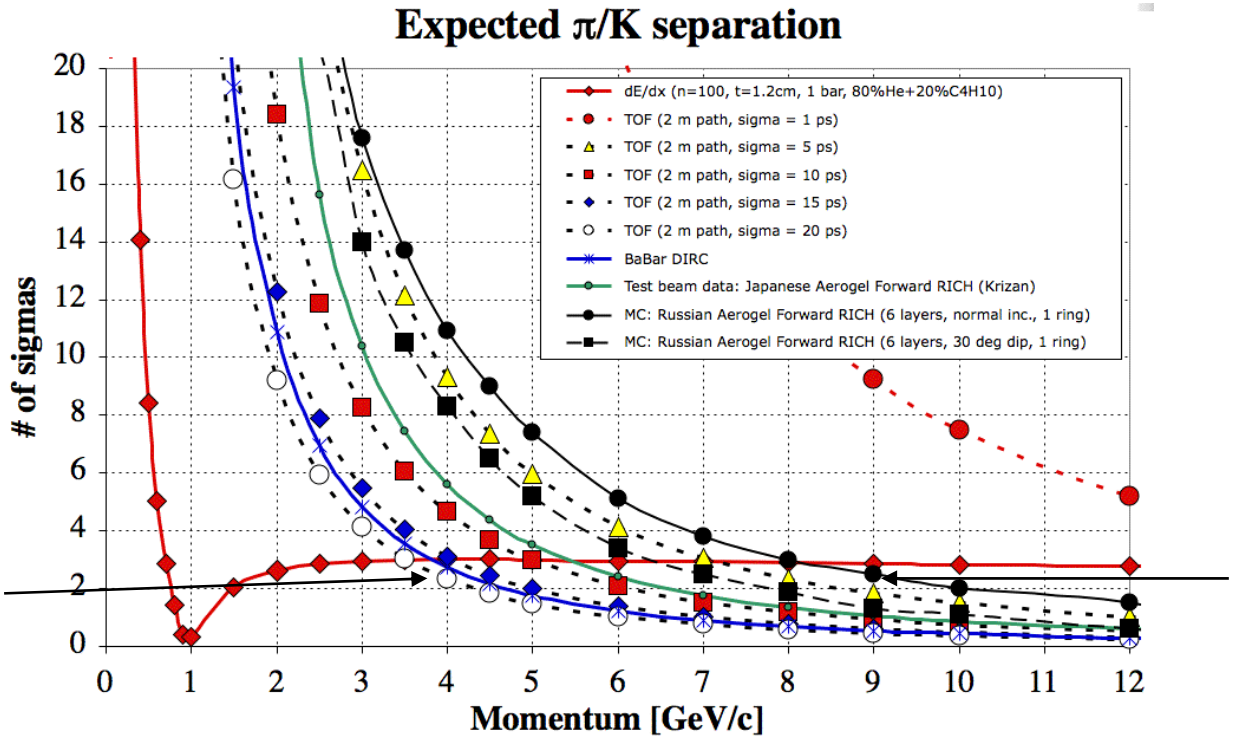
$\sigma\beta/\beta = 8 \cdot 10^{-4}$

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



# Forward TOF and FARICH comparison

TOF

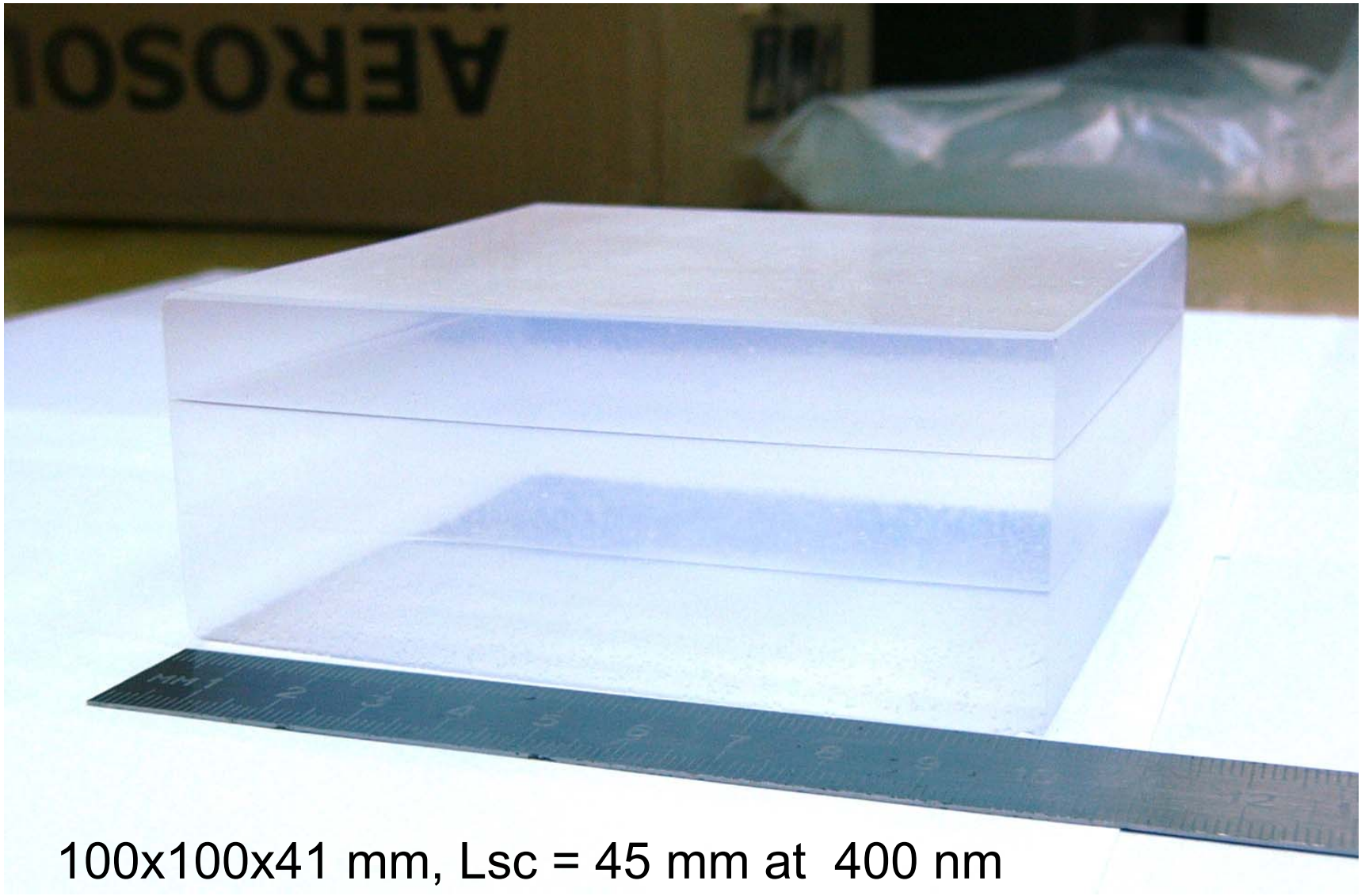



FARICH

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

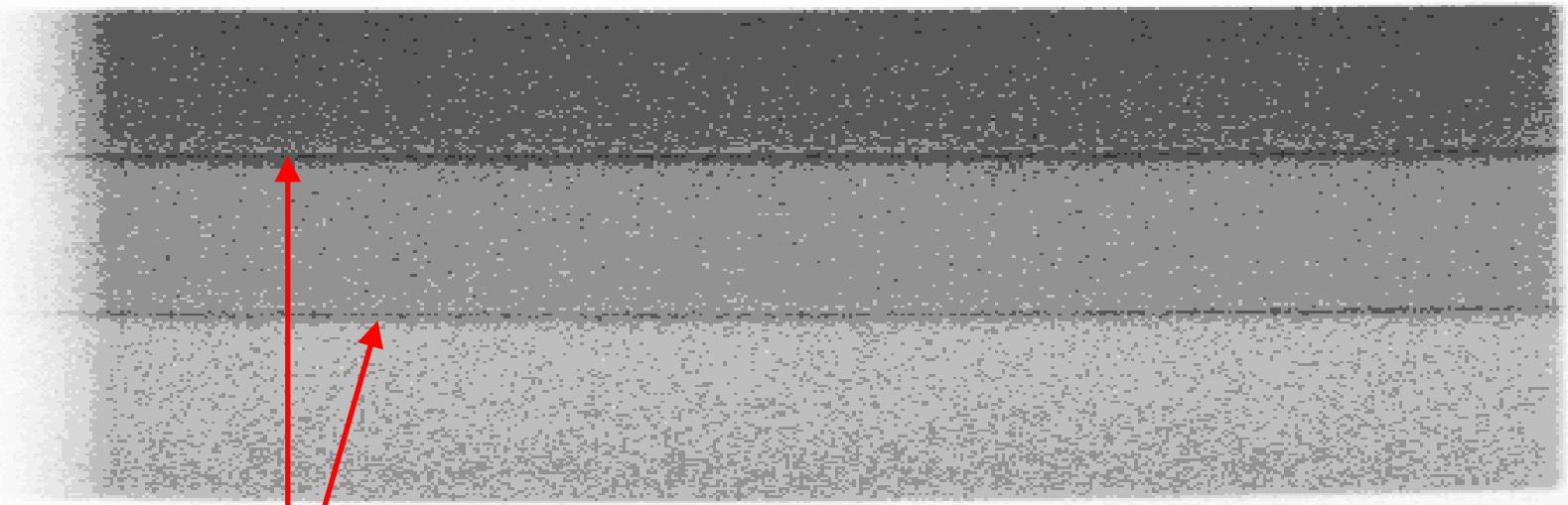
The amount of material is almost the same

# Multilayer aerogel characterization



100x100x41 mm, Lsc = 45 mm at  400 nm

# Xray measurement, density distribution



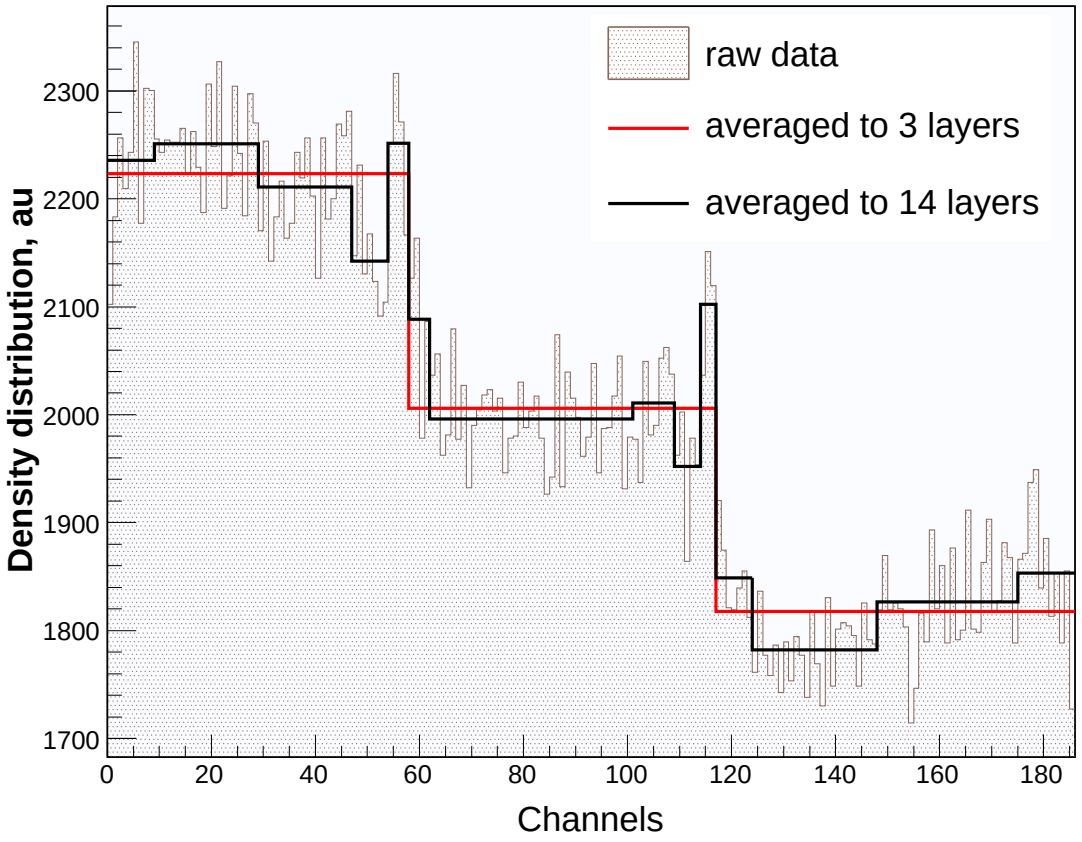
The increase in density at the internal borders is the result of the production procedure (diffusion).

Does it effect the performance?

| Layer | <n> | n, (optimal) | n, (design) | h, mm | h, mm (design) |
|---|---|---|---|---|---|
| 1 | 1.046 | 1.046 | 1.050 | 12.6 | 12.5 |
| 2 | 1.041 | 1.040 | 1.044 | 13.2 | 13.3 |
| 3 | 1.037 | 1.035 | 1.039 | 15.2 | 14.2 |

# Monte Carlo simulation of longitudinal refractive index fluctuations

- 200 mm expansion gap
- 3 types of radiators
  - 3layer as designed (ideal)
  - Xray data avereged to 3 layers
  - Xray data avereged to 14 layers



# Simulation results, π/K separation

- Npe =14
- $\sigma_\beta = 5 \cdot 10^{-4}$
  - ‘optimal’ radiator → best resolution for 4 GeV/c pions
  - ‘real’ experimental radiator → best resolution for 3.5 GeV/c kaons
- π/K separation up to 8 GeV/c (>3σ)