

FARICH or SuperB

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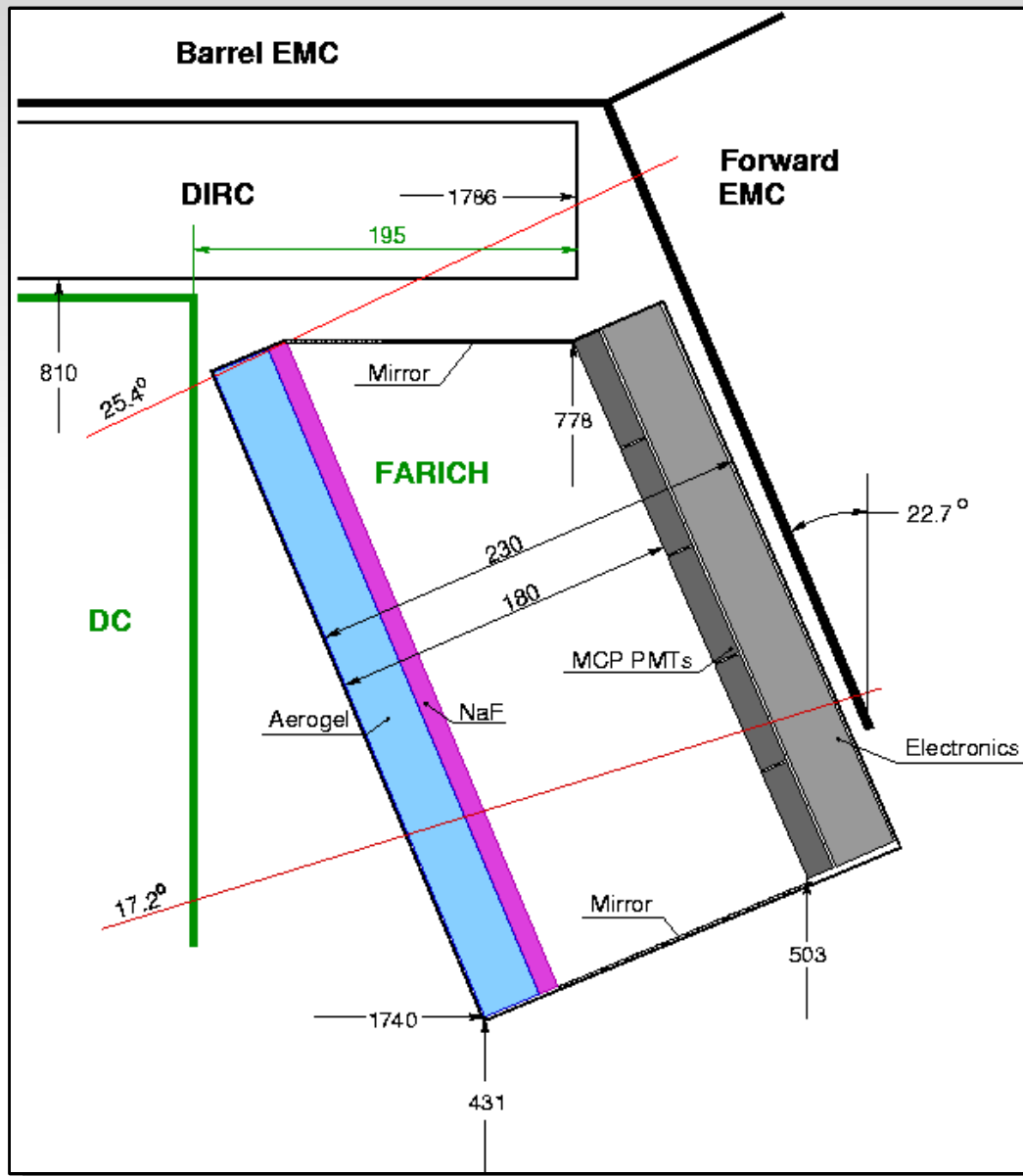
presented by Evgeniy Kravchenko
Budker INP

*XV SuperB PID meeting, Caltech,
December 15, 2010*

Introduction

- It is a hard task to improve BaBar – one of the best detectors which was optimized for B-meson physics. BaBar already has a very powerful PID system covering large solid angle.
- The boost at SuperB is smaller than at BaBar. This made solid angle of barrel part of SuperB detector larger than at BaBar and endcap solid angle smaller.

FARICH for SuperB

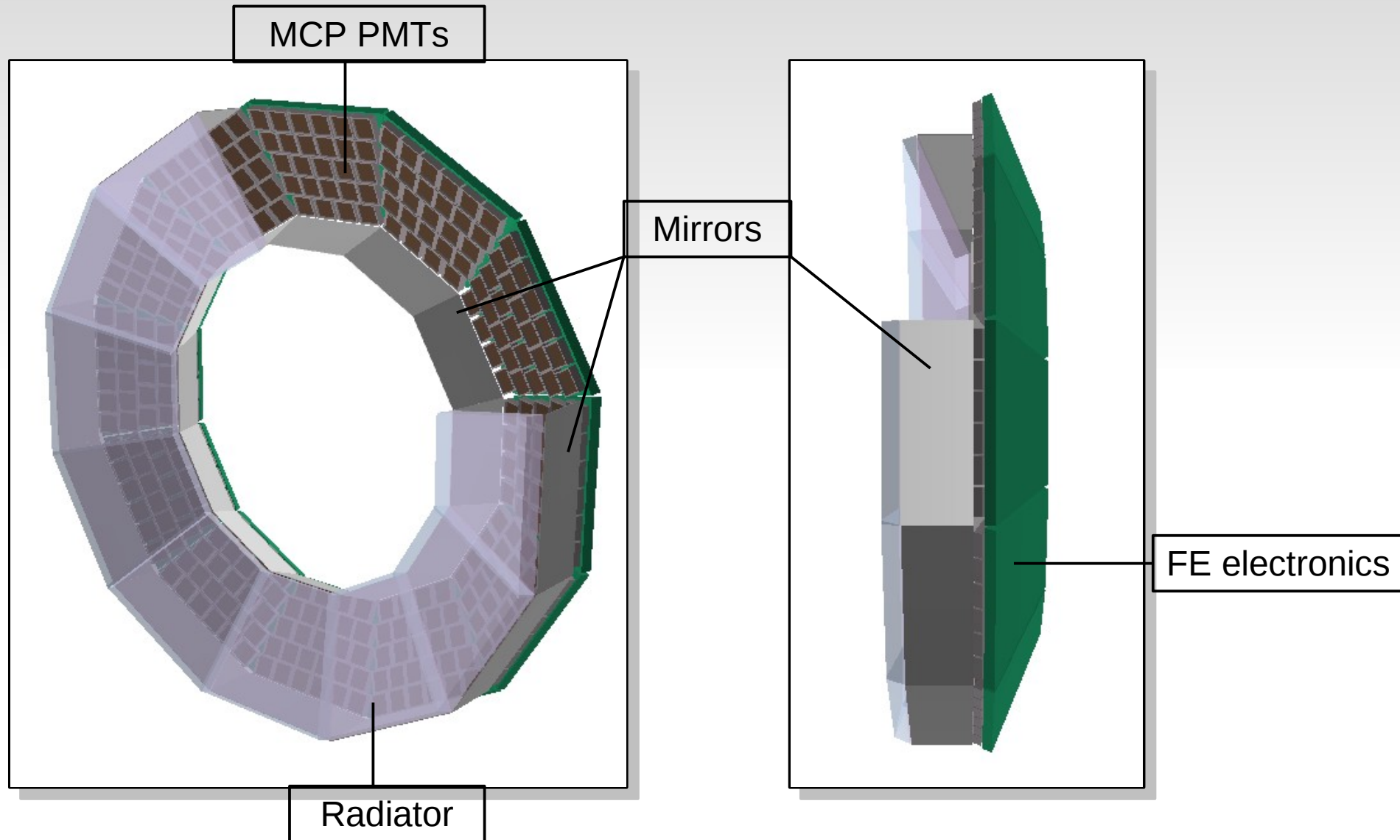


- Expansion gap ~ 180 mm
- 312 Photonis XP85012 MCP PMTs
- 3-layer focusing aerogel $n_{\max} = 1.07$, 40mm thickness
- NaF 5mm thickness

Material budget (X/X_0)

Aerogel	4%
NaF	4%
MCP PMT	10%
Support, electronics, etc	8%
Total	26%

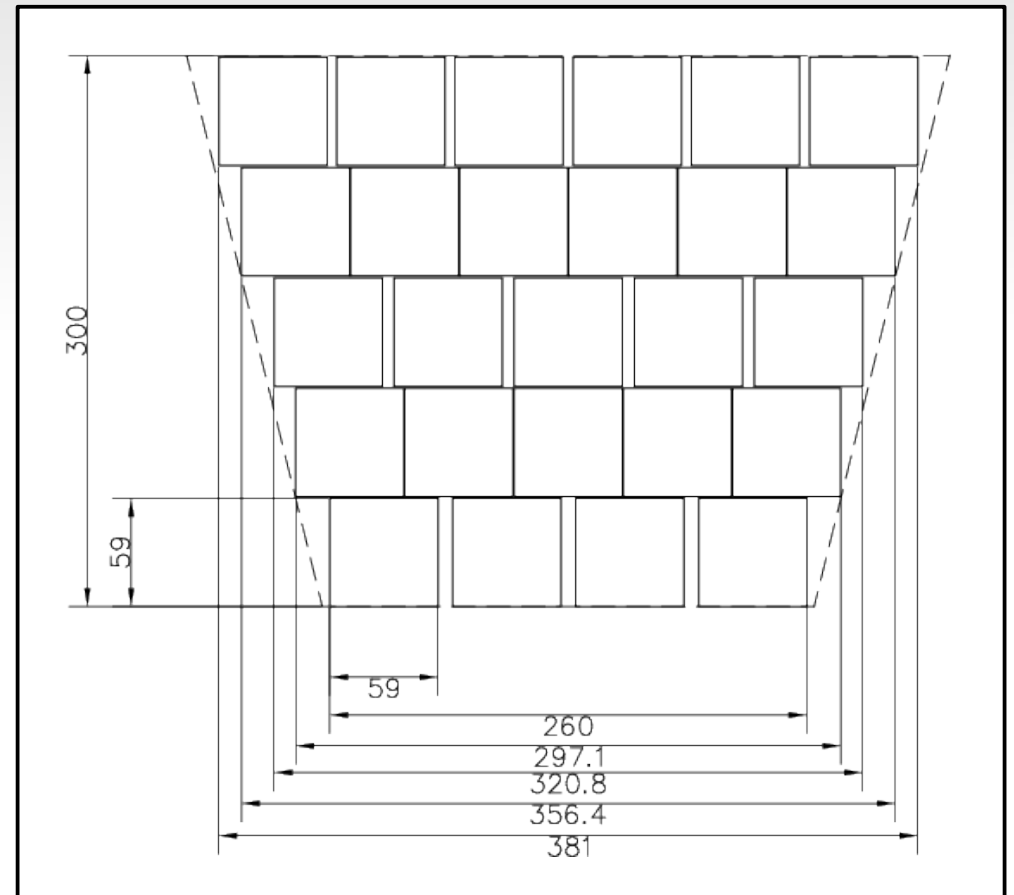
FARICH for SuperB



Read-out geometry

- 12 phi-sectors
 - 26 PMTs per sector
 - Total of 312 PMTs
 - 19'968 channels
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- FE ASIC and SCATS TDC as in DIRC
 - FEE seems to fit in 5 cm behind PMTs
 - Serious work on electronics design and integration is needed.

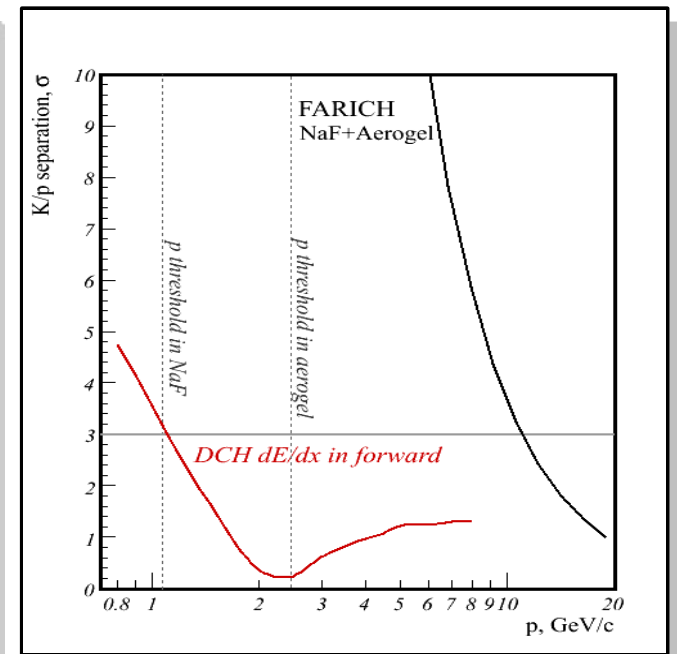
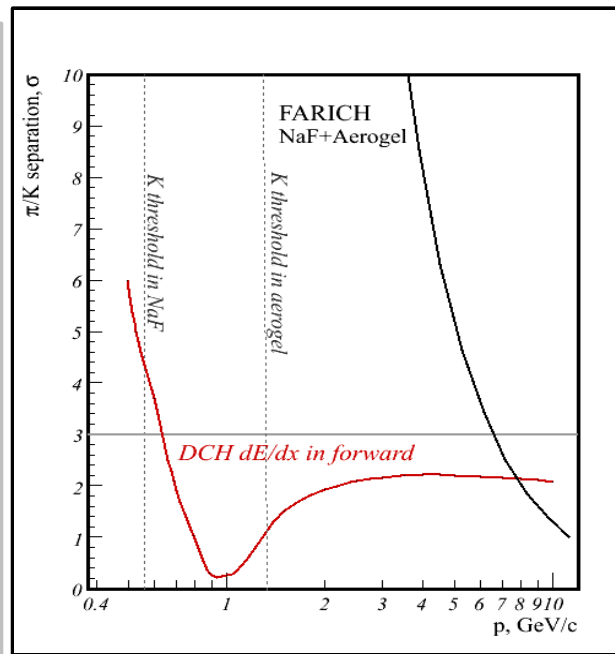
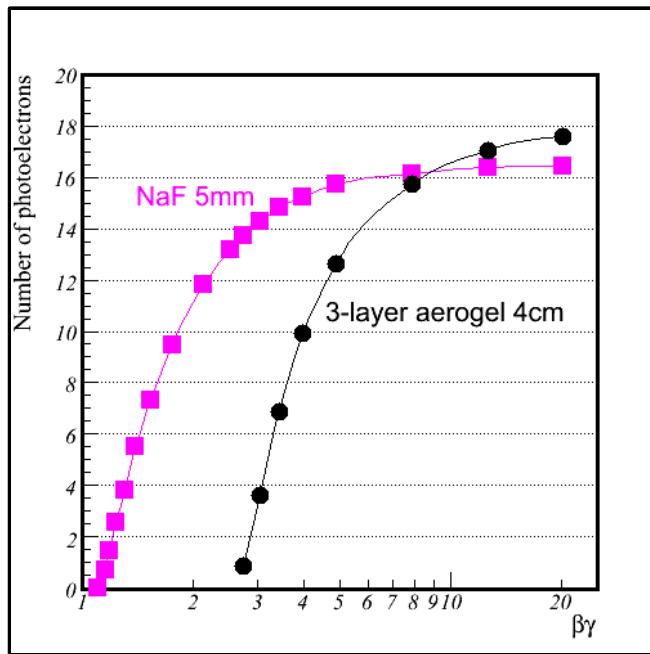
Layout of PMTs in a sector



FARICH performance

Aerogel + NaF

- excellent PID level:
 π/K better than 8σ (MC) for momenta $0.6\text{--}4\text{ GeV}/c$
- background is well under control
- less than 10% QE drop is expected in 5 SuperB years
- cost 3.4 M€



Background consideration

- **Pile-up noise**

Time resolution $< 1\text{ns}$

Occupancy: $6\text{p.e./}20000\text{ch} = 3 \cdot 10^{-4} \rightarrow$ less than one background hit within area of the rings – negligible for the ring reconstruction.

- **MCP PMT aging**

Gain: 10^5

Integrated anode charge:

$$6 \cdot 200 \cdot 10^6 \cdot 10^5 \cdot 3 \cdot 10^7 \cdot 1.6 \cdot 10^{-19} / (312 \cdot 5.3^2) = 0.07 \text{ C/cm}^2/\text{year}$$

P. Krizan et al. poster at RICH2010:

10% QE drop at 400mC/cm^2 (25 μm version) ~6 years of SuperB

Aging tests of 10 μm version are ongoing (P.Krizan)

- **MCP PMT gain stability**

Time between collisions: 5ns

Rate: $6 \cdot 200 \cdot 10^6 / (312 \cdot 5.3^2) = 140 \text{ kHz/cm}^2$ – no gain drop.

Detector integration

- The impact of Forward PID material on endcap EMC resolution was investigated by calorimetry group.
- FARICH need additional space
 - One need to cut $\sim 15\text{cm}$ from Drift Chamber
 - 25% degradatoin of momentum resolution for forward tracks.
 - This number is consistent with a simple estimation (the base of momentum measurement will be less by $\sim 10\%$ \rightarrow $\sim 20\%$ degradation of momentum resolution).

Cost estimation

3-layer aerogel, 3k€/tile	400
NaF, 2k€/tile	200
Electronics (scaled from FDIRC)	300
Mechanical structure	100
R&D (FARICH prototype)	100
Total Cost, k€	3400

*Price for MCP PMT with 25 μ m pores. 10 μ m version is under development and price is unknown.

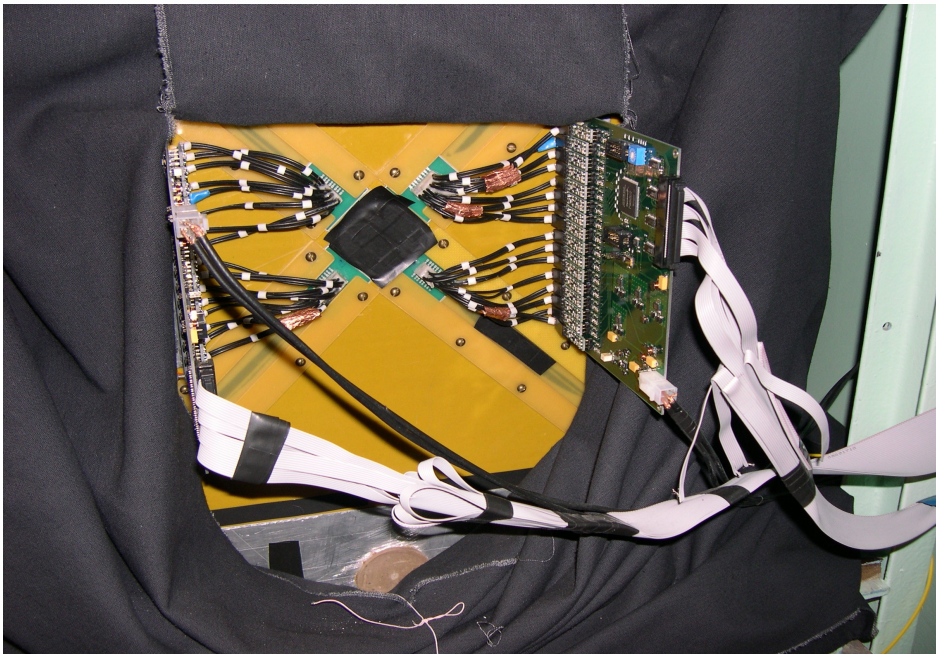
Last information from Emile Schyngs:

No restrictions to sell 10 μ m version abroad US.

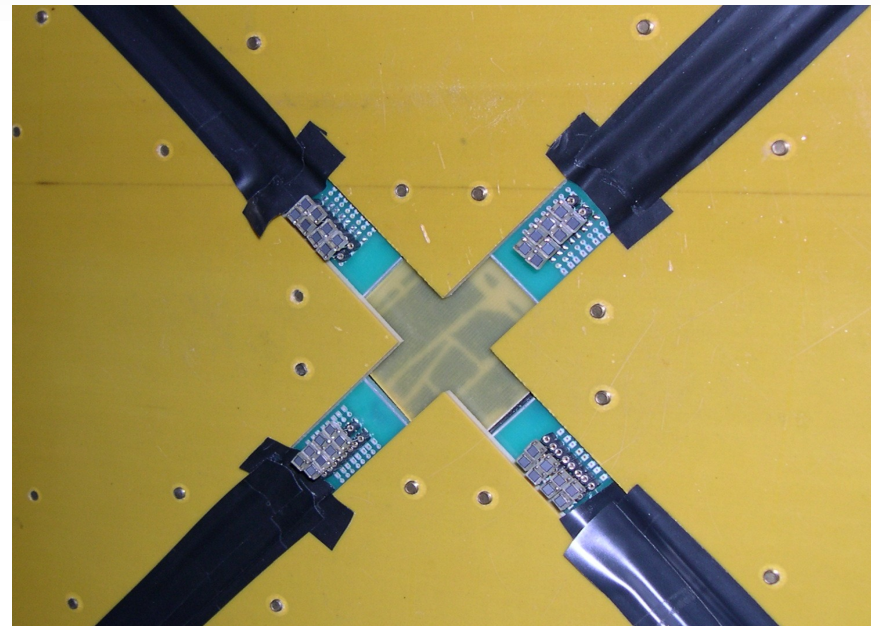
Several tubes were already delivered to Japan and Europe.

FARICH prototype

- Box is designed for radiator-PD distance 50–700 mm
- 32 MRS-APDs (SiPMs) as photon detectors
- Custom made discriminator boards
- CAEN V1190B 64-ch multi-hit TDC
- Two focusing aerogel tiles for SuperB are ready to be tested, 2 additional tiles were produced in October.



December 15, 2010



Evgeniy Kravchenko, Budker INP

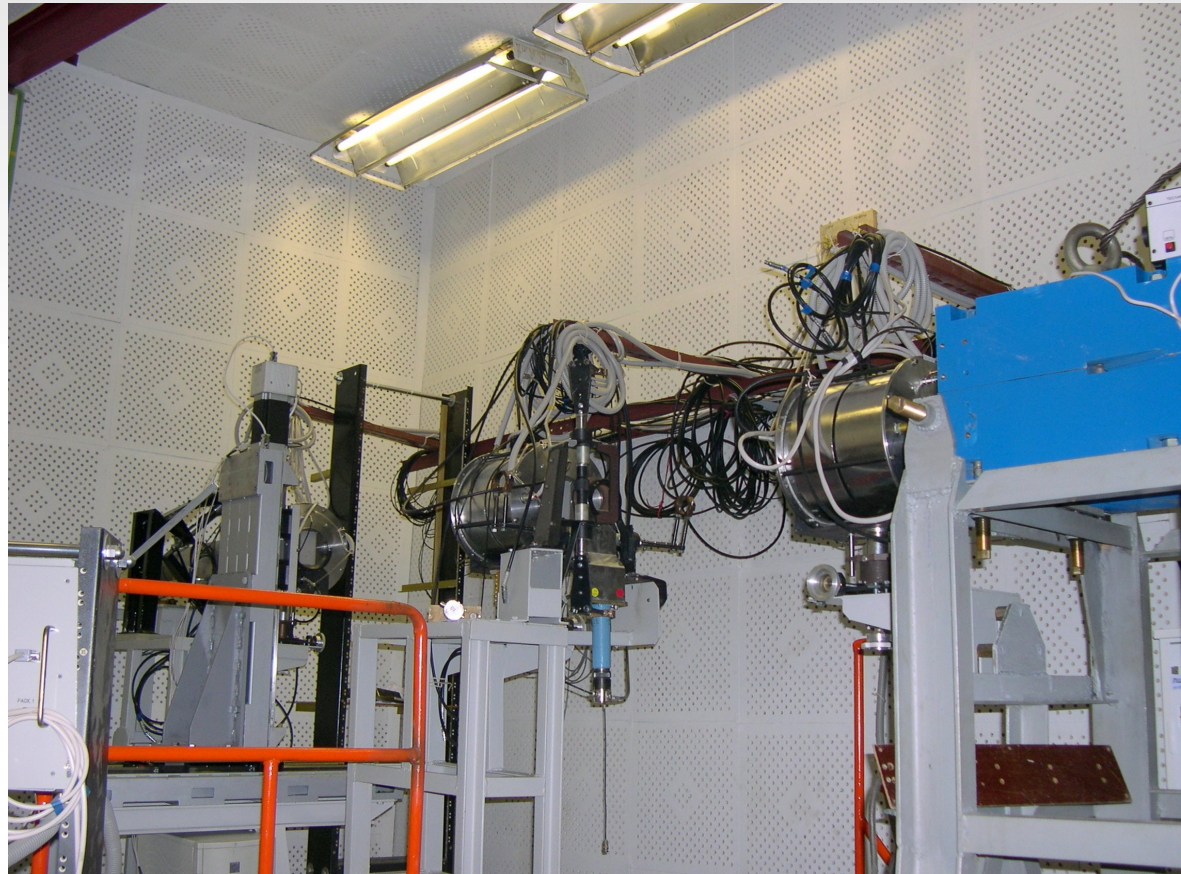
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Prototype's status

- G-APDs are tested for amplification, noise rate. Noise rate of channels in the prototype ranges from 6 to 12 MHz.
- TDC readout of G-APDs and discriminators is working
- Measurements with a laser diode are done. Time resolution with single photons ranges from 450 to 950 picoseconds.
- Prototype is ready for beam tests
- Beam tests January-February (Delay because of the problems with VEPP-4M and test beam apparatus commissioning).

Test beam facility at VEPP-4M, Novosibirsk

- Commissioning of the test beam apparatus is just finished
- Load from 1GeV electrons is ~ 2 Hz
- The move of FARICH prototype on the test beam is scheduled next week.



Conclusion

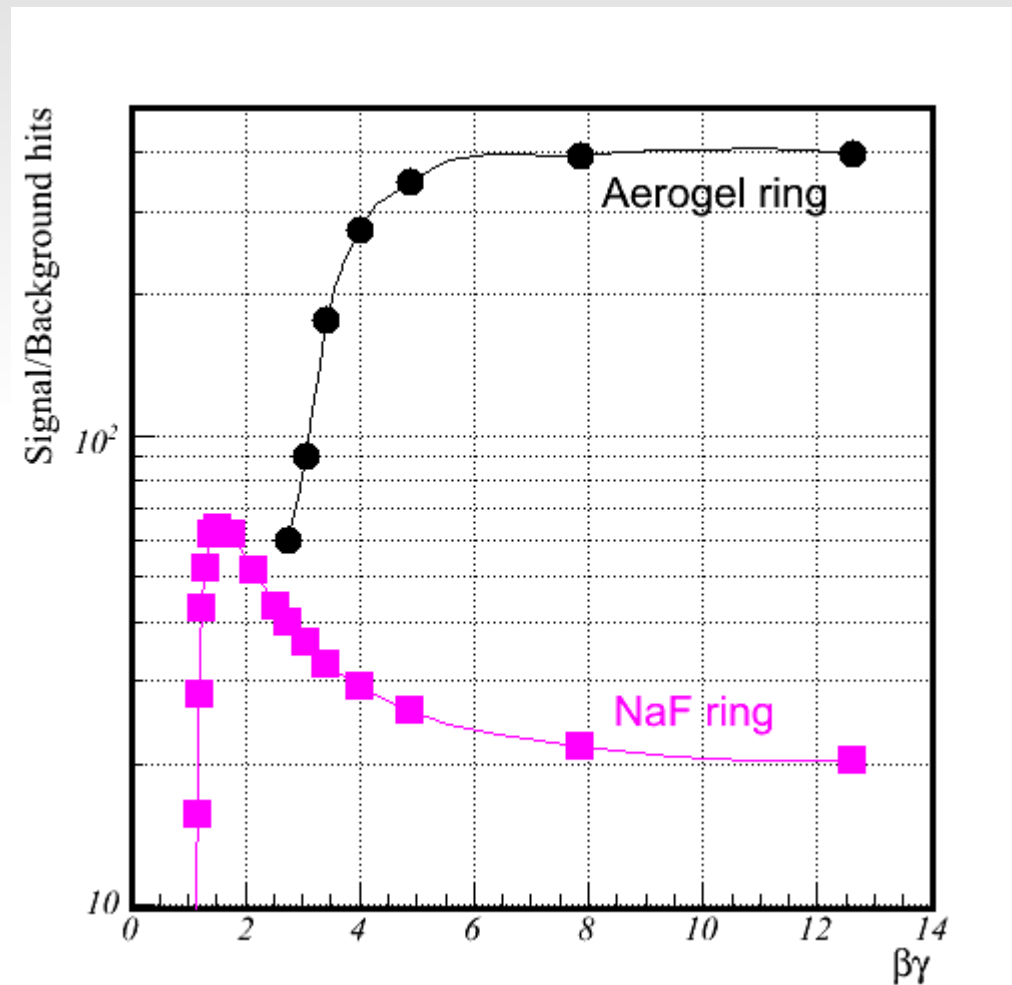
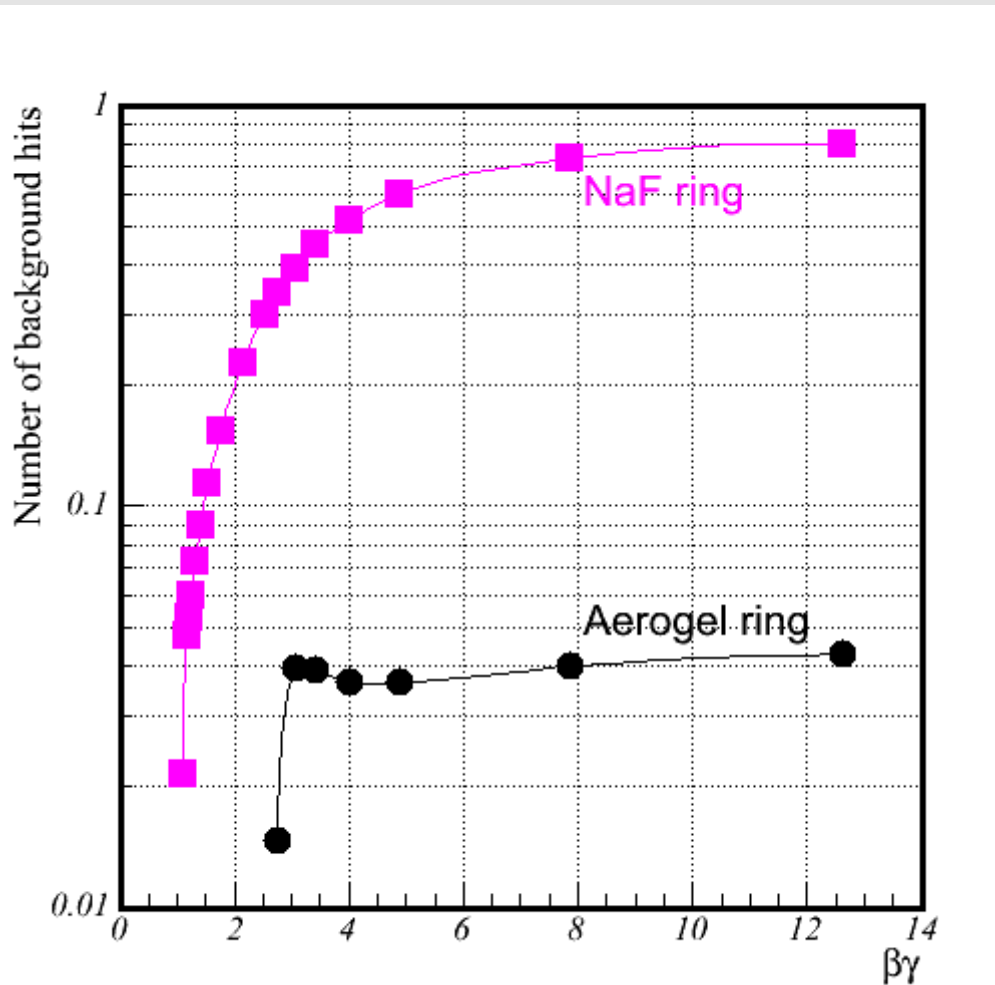
- **FARICH with an excellent performance is proposed.**
- **Background rate is under control.**
- **Aging of MCP PMTs is minor.**
- **25% of X0 of additional material in the endcap**
- **Degradation of momentum resolution for forward tracks**
- **Absence of experimental results from the prototype from our group**

The gain in efficiency for selected physics channels is about 5%.

The cost of the system is around 3.5 Millions Euros

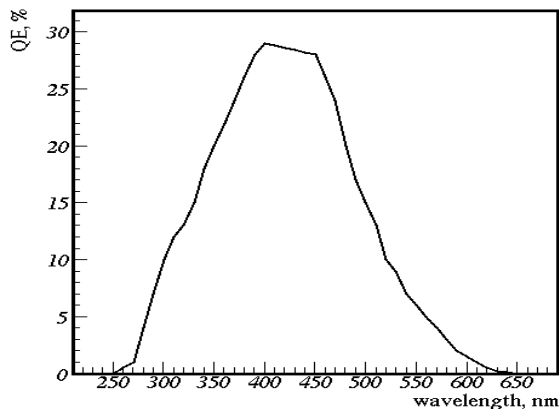
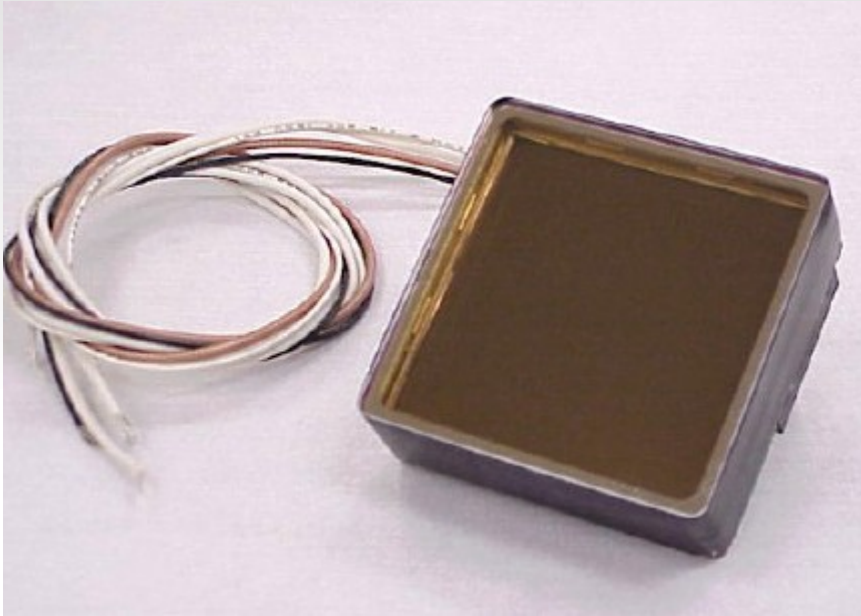
Additional Slides

Occupancy (NaF+Aerogel)



Photonis MCP PMT

XP85012



QE(λ)
J. Va'vra

- Chevron MCP configuration
- 8x8 anode pads with 6.5mm pitch
- Bialkali photocathode, QE(400nm)=29%
- Gain $\sim 5 \cdot 10^5$
- 25 μ m pores, need 10 μ m to work in 1.5T field with gain $\geq 10^5$
- MCP open area ratio ~ 70 %
- Size $\square 59$ mm
- Effective area fraction 81%
- excellent timing ~ 40 ps single photon