



Status of the Forward RICH R&D

Sergey Kononov^{ab}

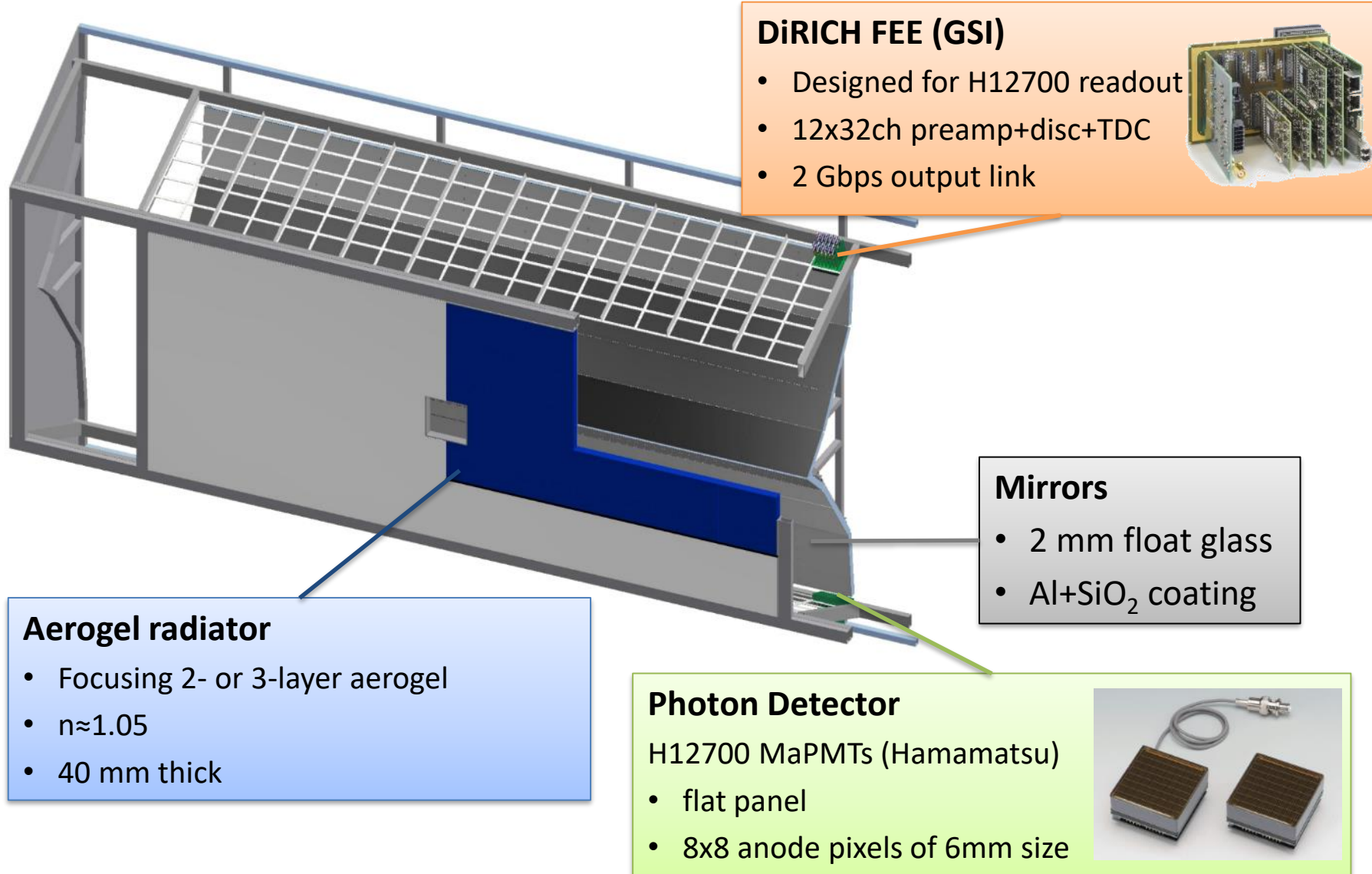
on behalf of the PANDA Forward RICH group

^a *Budker Institute of Nuclear Physics, Novosibirsk, Russia*

^b *Novosibirsk State University, Novosibirsk, Russia*


25.June.2019

Baseline design



DiRICH FEE (GSI)

- Designed for H12700 readout
- 12x32ch preamp+disc+TDC
- 2 Gbps output link



Aerogel radiator

- Focusing 2- or 3-layer aerogel
- $n \approx 1.05$
- 40 mm thick

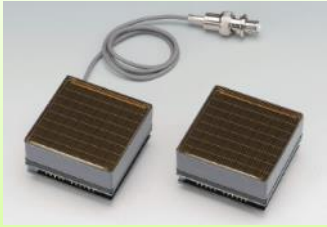
Mirrors

- 2 mm float glass
- Al+SiO₂ coating

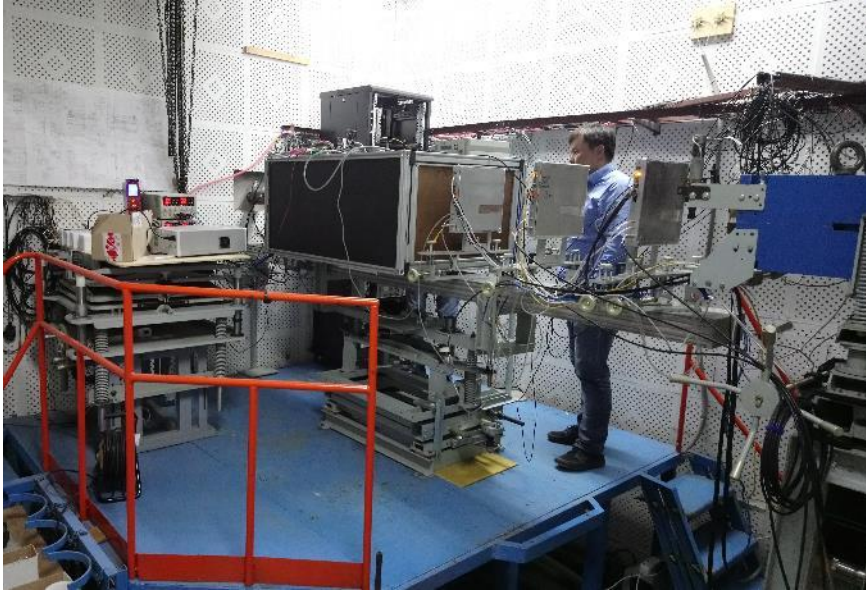
Photon Detector

H12700 MaPMTs (Hamamatsu)

- flat panel
- 8x8 anode pixels of 6mm size

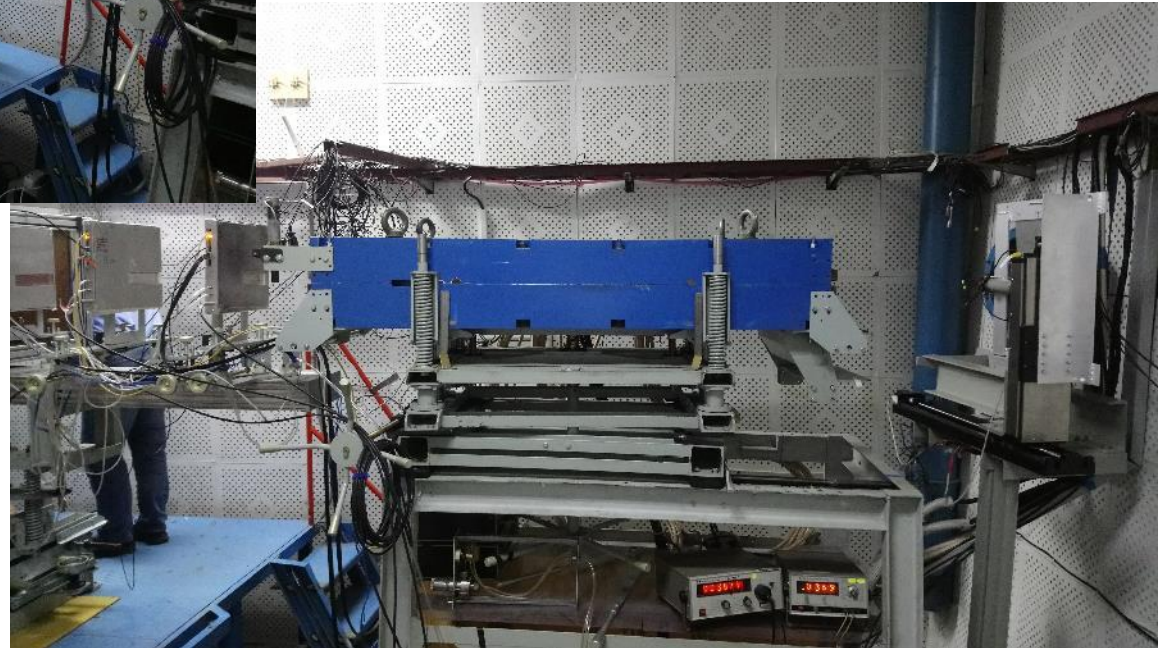


Test beam in June 2019

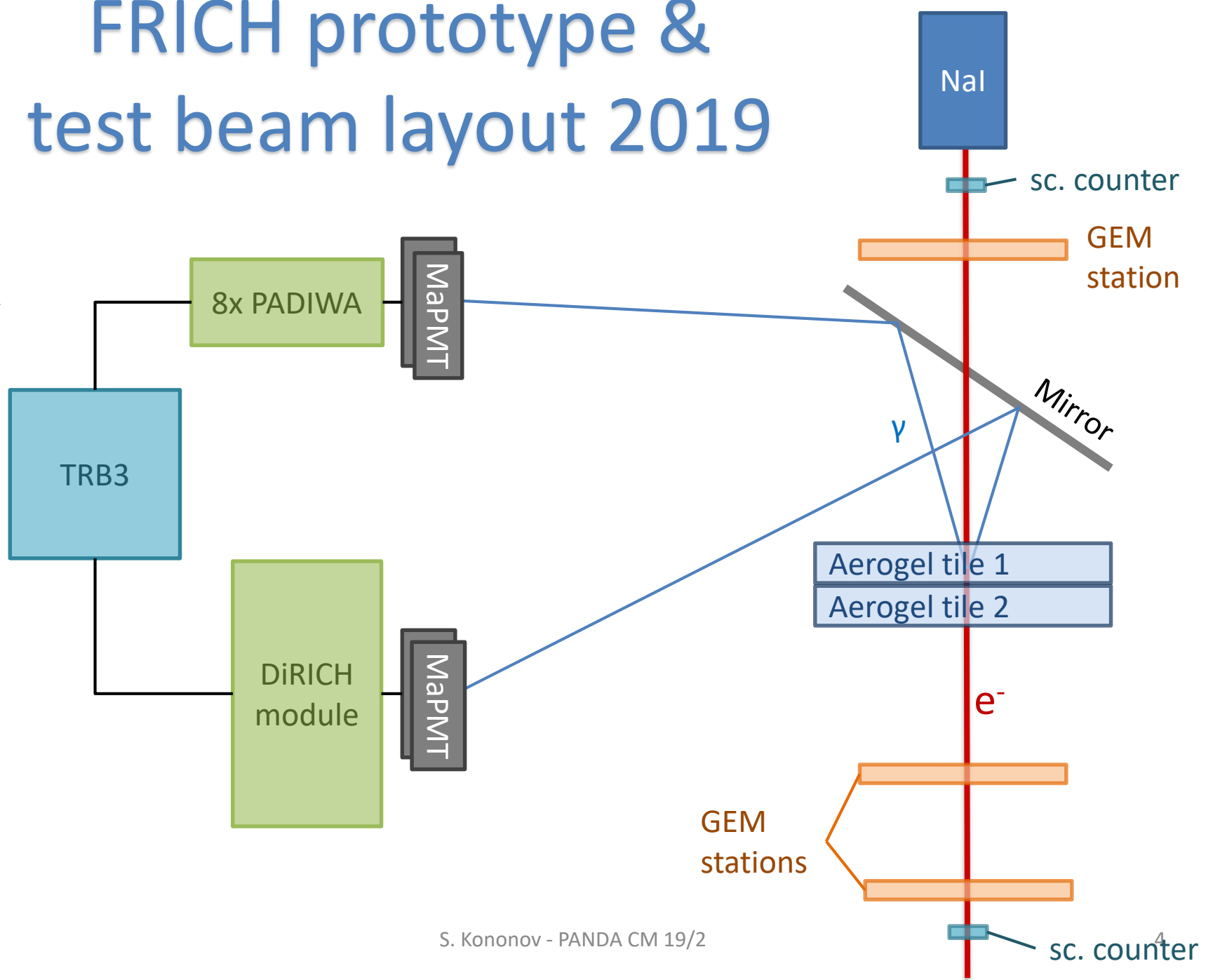


Electron and gamma test beam facility at BINP VEPP-4M accelerator

- 3 GeV electrons
- 2 scintillation counters for triggering
- 3 GEM tracker stations with 70-200 μm resolution
- NaI calorimeter



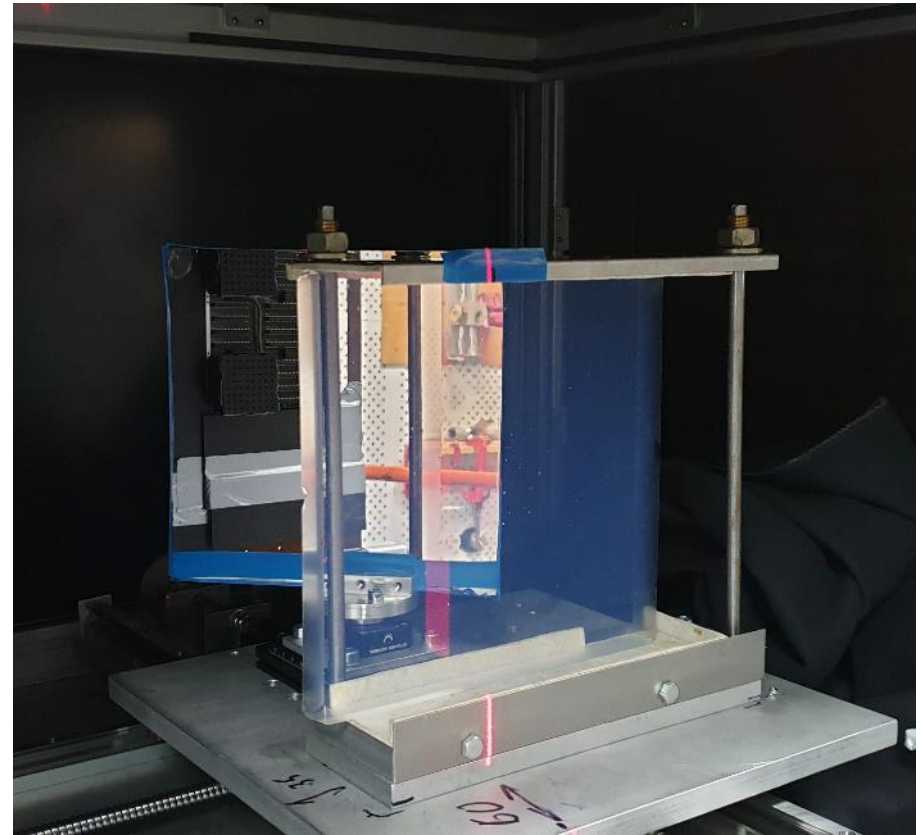
FRICH prototype & test beam layout 2019



FRICH prototype with DiRICH&PADIWA&TRB3 readout in 2019



4 MaPMTs readout in half by PADIWA and DiRICH. 256 channels in total.



Aerogel sample with a flat mirror installed at 45° w.r.t. the PD and aerogel.

Aerogels tested for PANDA FRICH test beam 2019

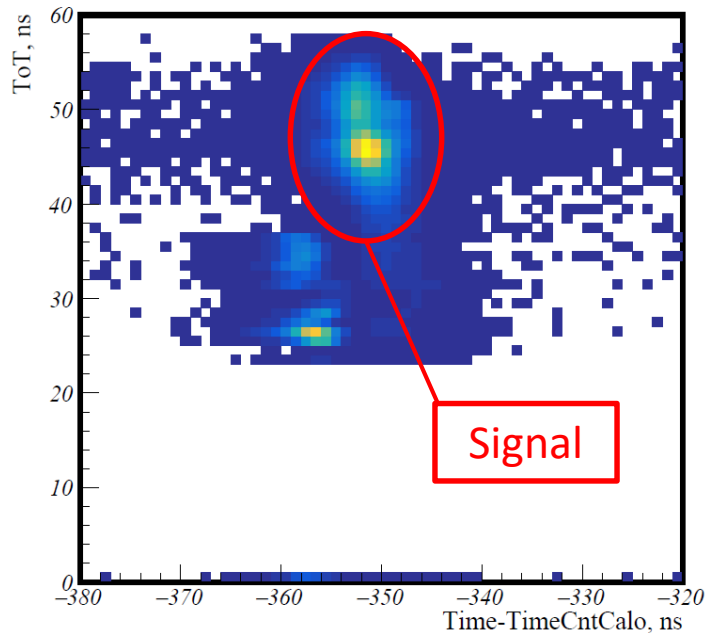
N	Configuration	Ref. index	Thickness
1	Focusing 2 layers	1.0526+1.0500	2 cm + 2 cm
2	Focusing 2 layers	1.0538+1.0511	2 cm + 2 cm
3	Single layer	1.0526	2 cm
4	Single layer	1.0538	2 cm

Distance from the aerogel to the PD in air – 56 cm
which is typical for PANDA FRICH

Time and ToT vs channel test beam 2019

Timing is measured w.r.t. a scint. counter (~few ns resolution)

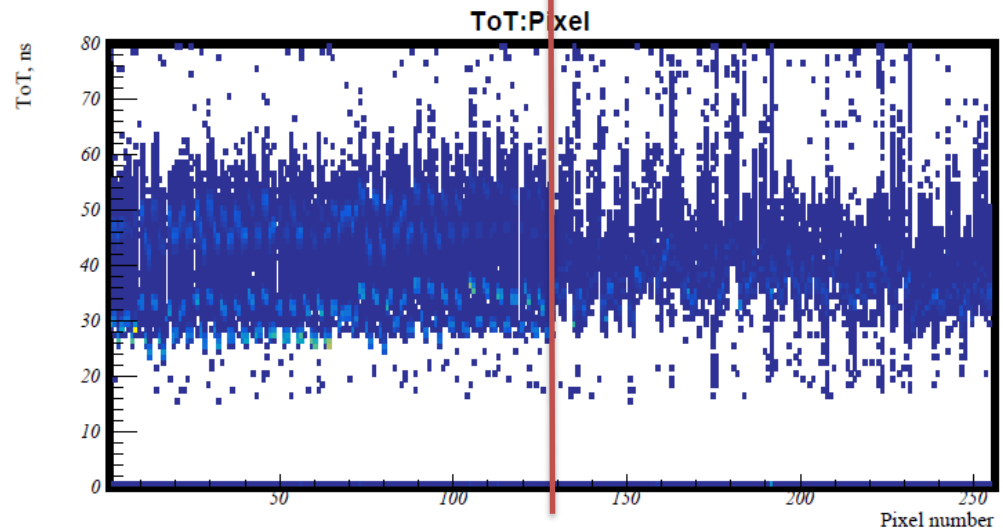
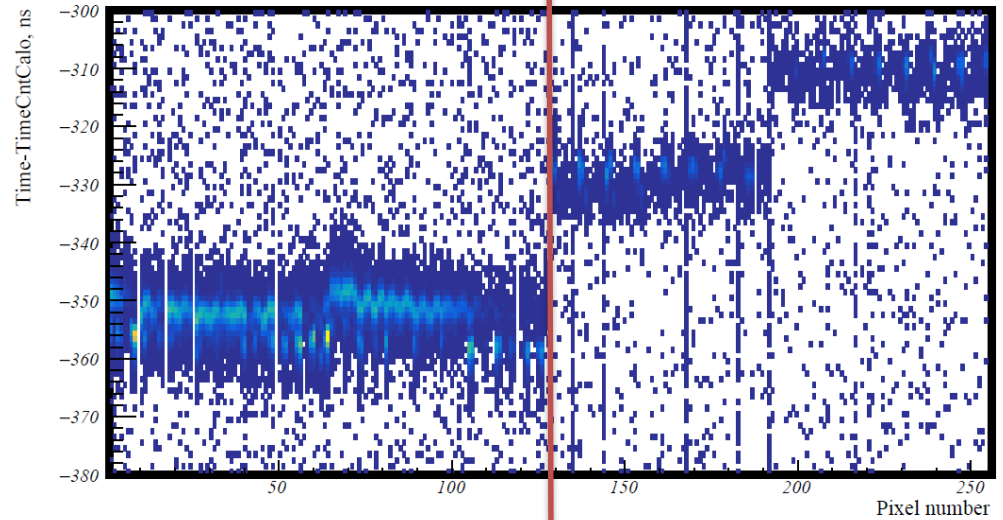
ToT vs Timing for DiRICH channels



DiRICH half

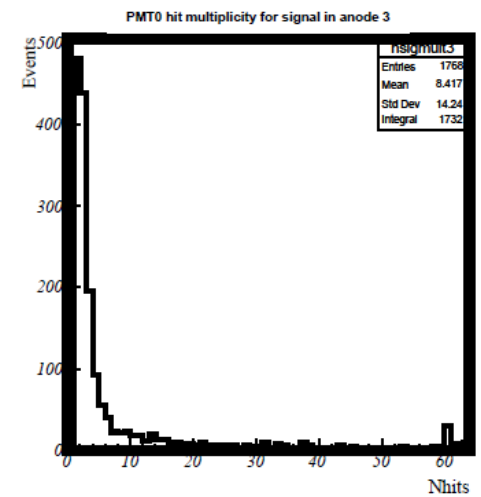
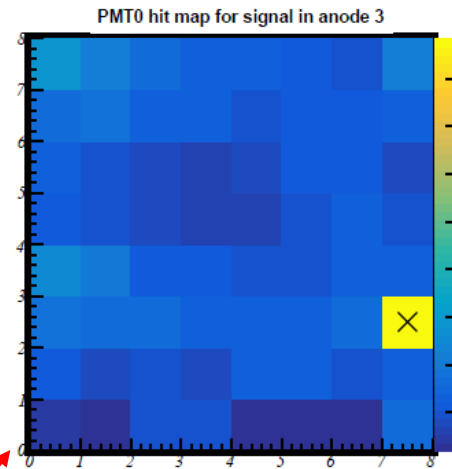
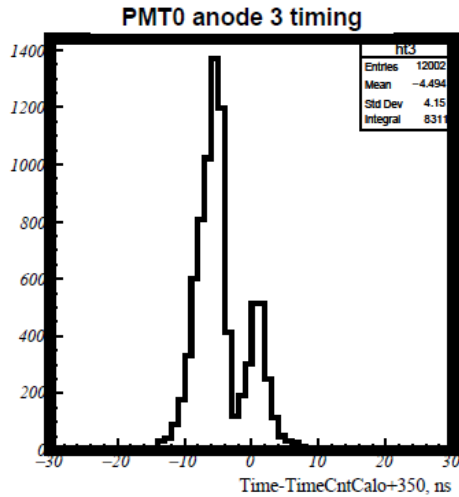
PADIWA half

t:Pixel {ToT>10}

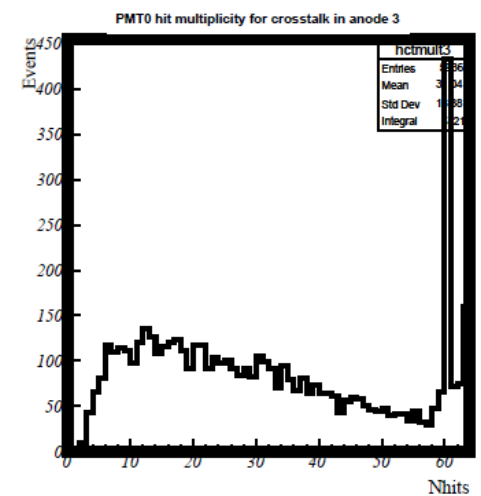
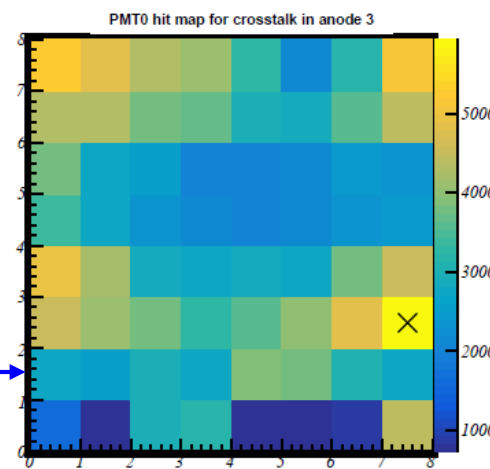
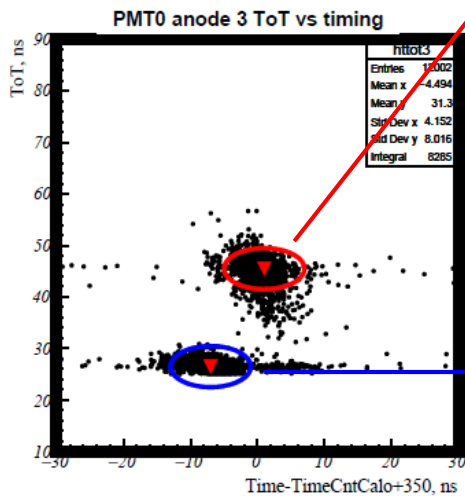


Cross talk issue in 2019

Signal
coming
later in time
and have
higher ToT

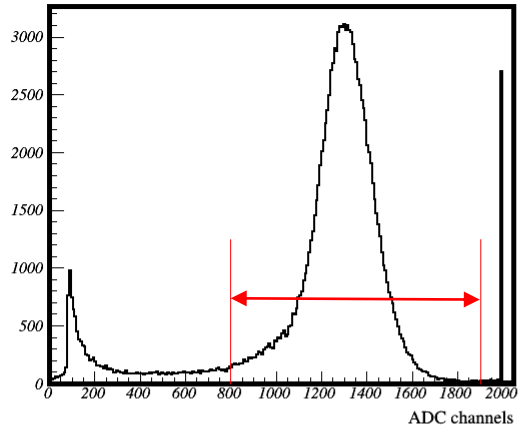


Crosstalk
coming
earlier in
time and
have lower
ToT

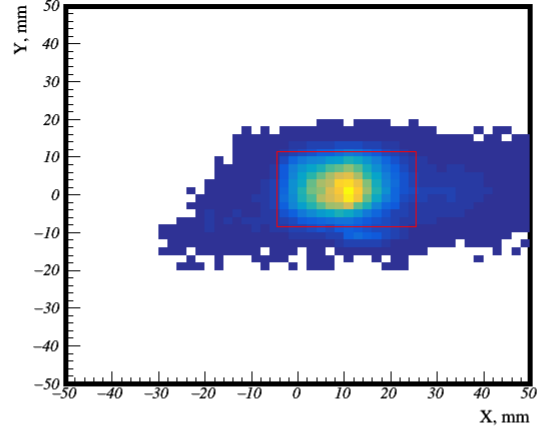


Event and hit selection test beam 2019

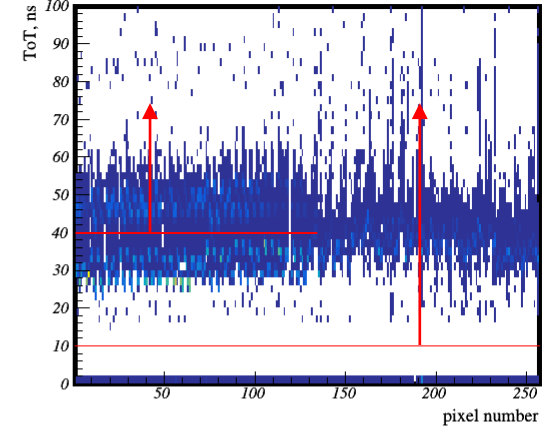
Nal amplitude



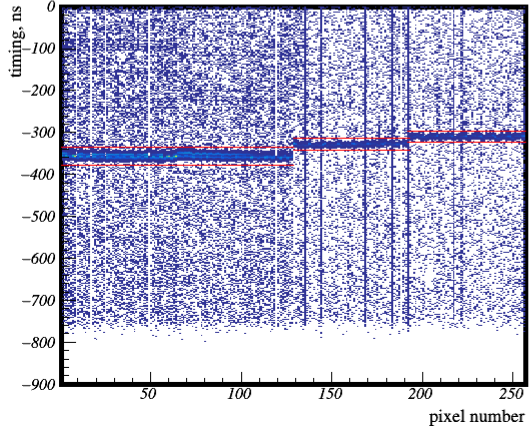
Track XY position by GEMs at PD



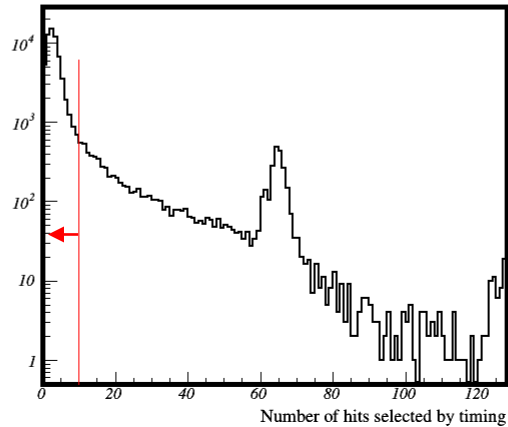
Time-over-threshold vs Pixel



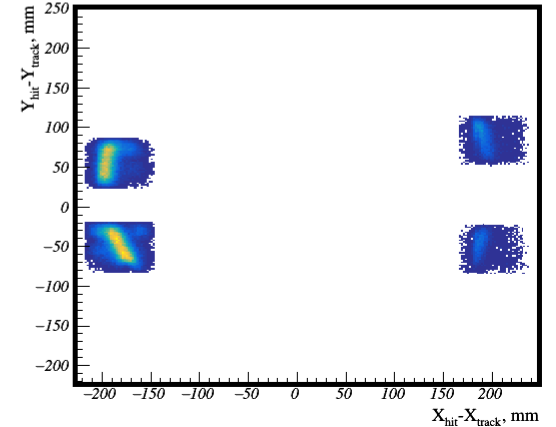
Timing vs Pixel



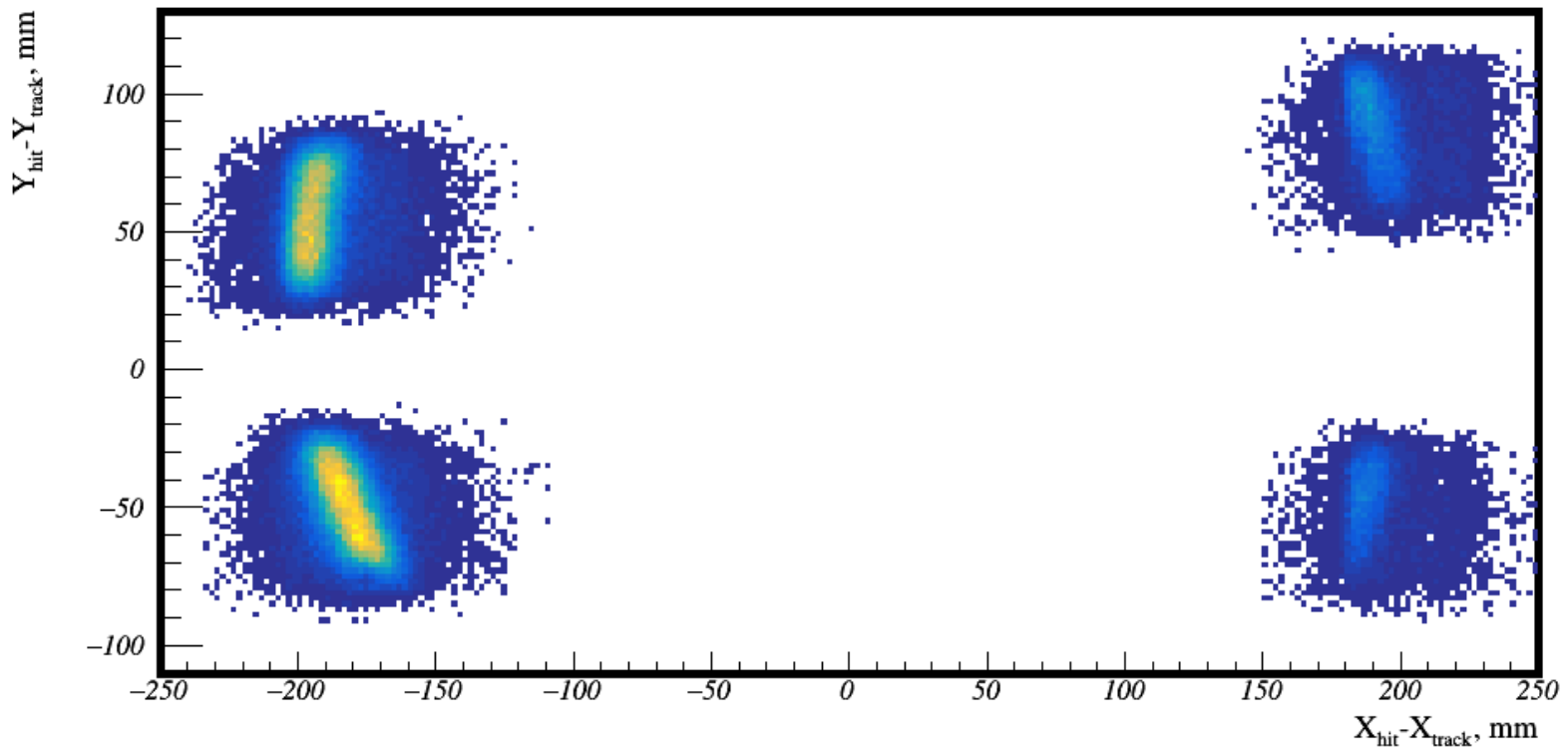
Hit multiplicity



FARICH ring



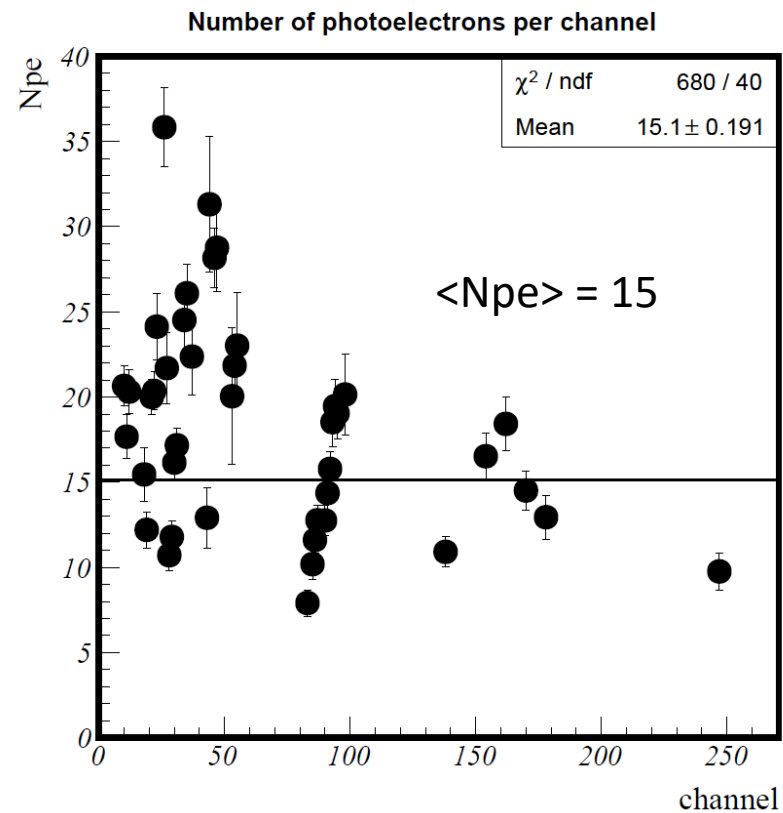
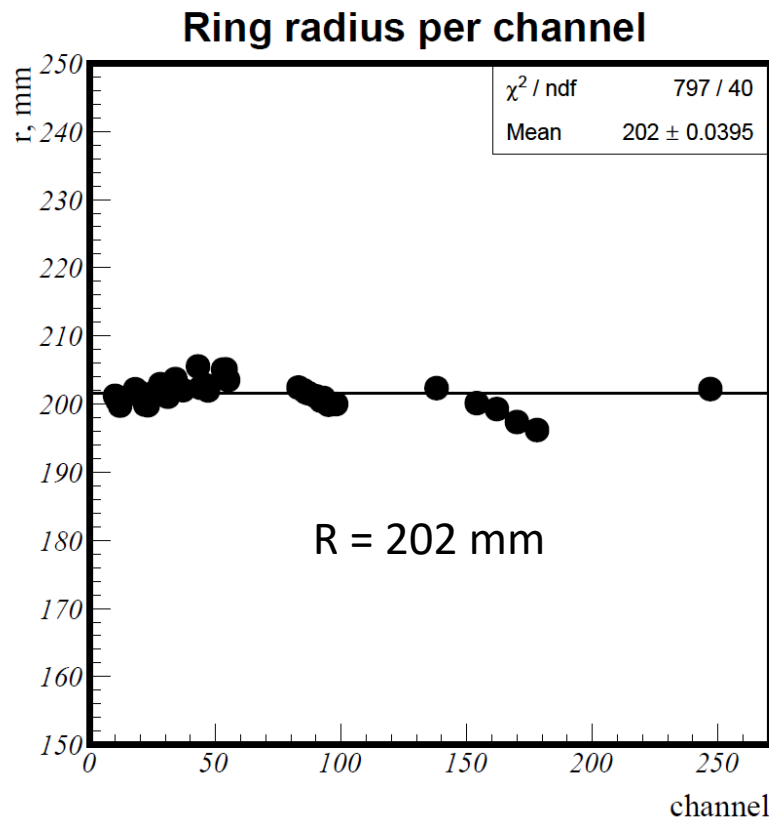
Track adjusted hit map – Cherenkov ring test beam 2019



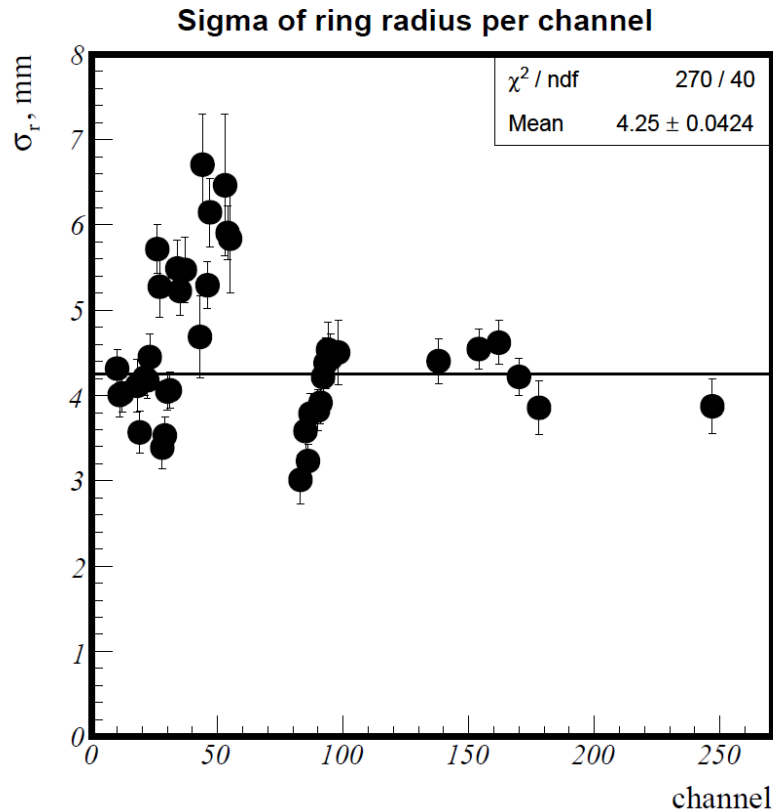
Cleaner picture for more fine ToT hit selection

Preliminary 2019 test beam results (1)

1-st layer: $n=1.0526$, $t=2\text{cm}$
2-nd layer: $n=1.0500$, $t=2\text{cm}$



Preliminary 2019 test beam results (2)



Radiator configuration:

1-st layer: $n=1.0526$, $t=2\text{cm}$

2-nd layer: $n=1.0500$, $t=2\text{cm}$

Parameter	Test beam 2019	Calculation
N _{pe}	15 (7–35)	46
R, mm	202	199
$\sigma_{R, 1pe}$, mm	4.3 (3–6.5)	3.1

Difference in SPR may be due to tracking resolution, multiple scattering, anode charge sharing, aerogel inhomogeneity

Conclusion & outlook

- Forward RICH prototype with 4 MaPMTs and DiRICH & PADIWA & TRB3 readout was assembled and tested on the electron test beam at BINP in June 2019
- Data collected for 4 aerogel radiator configurations
- Npe, SPR obtained for one 2-layer aerogel radiator
- 2.5 difference in terms of the track Cherenkov angle resolution.
- Test beam 2019 analysis is in progress