

Cremlin+: WP 5, Task 6 (BINP)

Tasks, plans and status

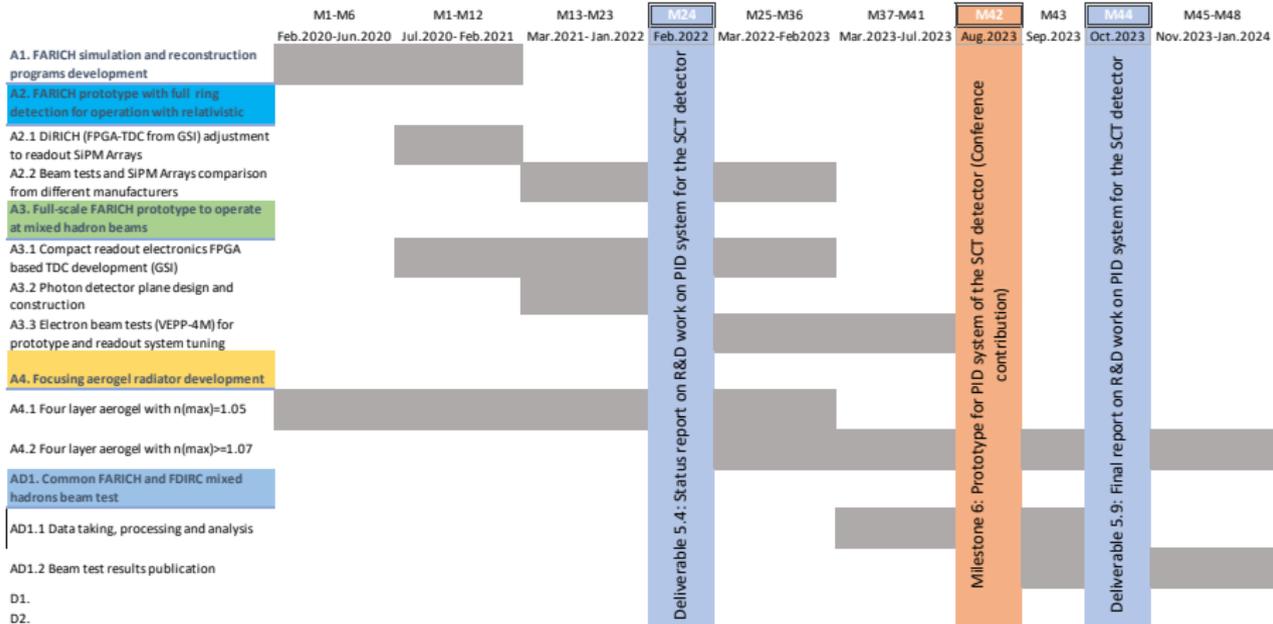
A.Yu. Barnyakov and other.,

Budker Institute of Nuclear Physics , Novosibirsk 2020

29 September 2020



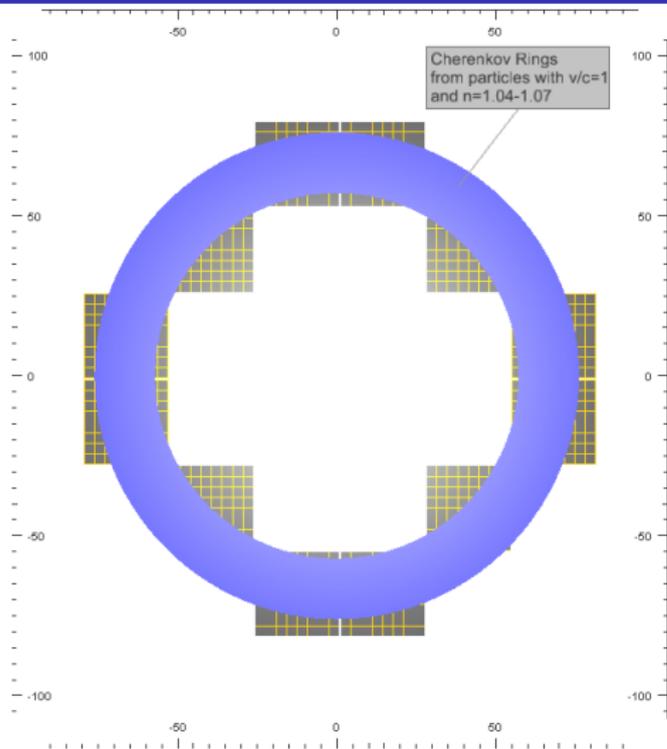
Timeline: Task & Plans



WP5.6 TASKS

The experience of several research groups will be combined to come up with proposals for the optimum PID system for the SCT project with respect to performance and cost. Detector prototypes are going to be constructed and tested to verify the performance of these novel detector concepts and their readout systems.

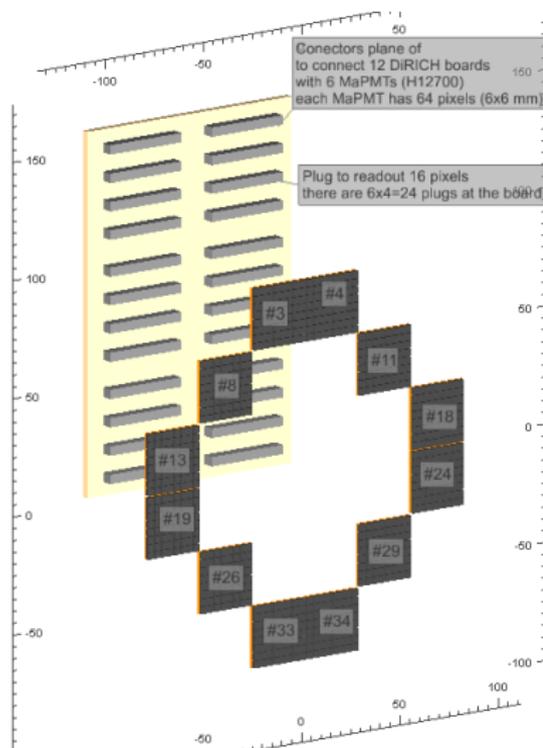
A2. FARICH prototype for full ring detection with electron beams



- 12 SiPM arrays (28×28 mm) are enough to detect 80% of the ring (768 pixels 3×3 mm).
- We have 10 SiPM arrays 8×8 pixels with 3×3 mm (4 from Hamamatsu and 6 from SensL) + 10 from KETEK are expected until the end of the year.

12 SiPM arrays (28×28 mm) and Cherenkov ring

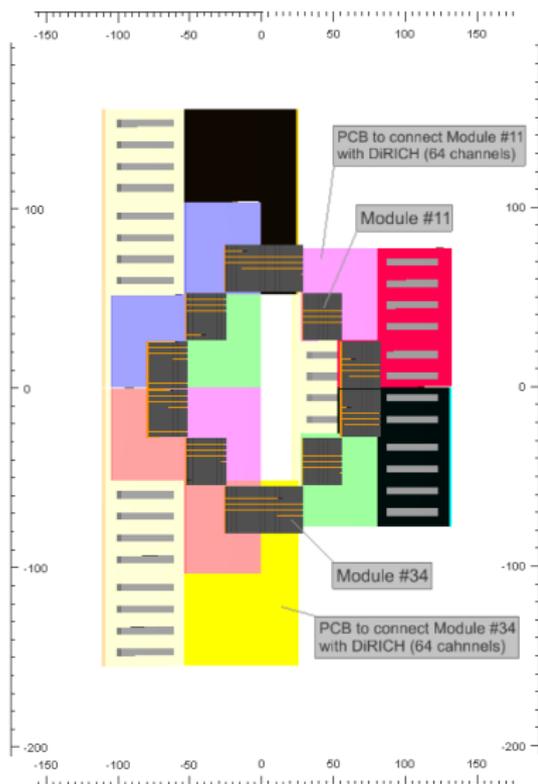
A2.1 Readout electronics based on DiRICH



12 modules + DiRICH board

- We have 3 DiRICH boards to readout $6 \times 64 \times 3 = 1152$ pixels.
- It is easy to connect H12700 and XP85012 PMTs with 6×6 mm 8×8 pixels.
- To readout SiPM arrays with 3×3 mm 8×8 pixels especial PCB-connectors are needed.

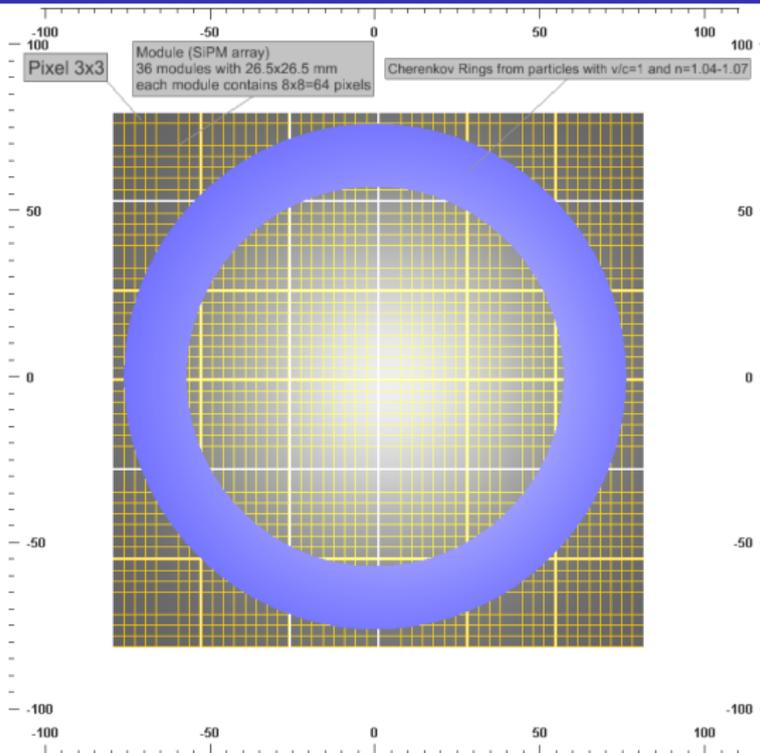
A2.1 Readout electronics based on DiRICH #2



- Each DiRICH board readouts 4 SiPM arrays. It is easy to change some arrays to H12700 MaPMTs.
- Development and production of special PCBs to connect SiPM arrays with DiRICH are planned until the end of the year.
- Development of the cooling system for FARICH prototype based on LAUDA is in progress.

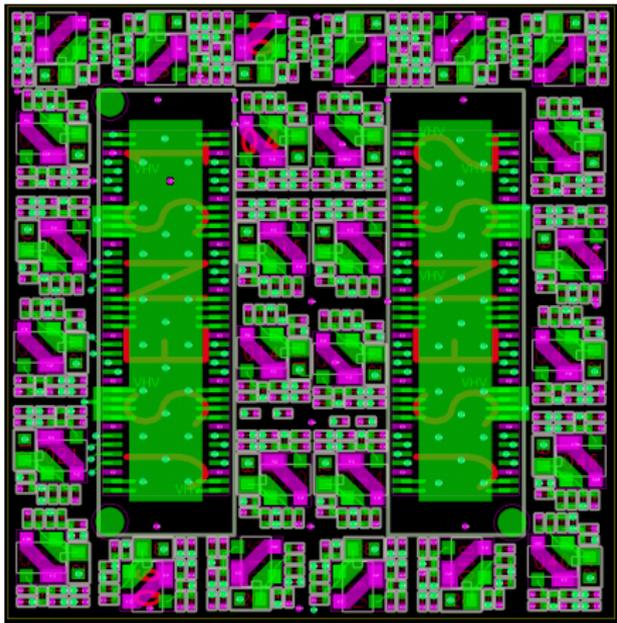
12 arrays + 3 DiRICH boards with PCB-connectors

A3. Full-scale FARICH prototype

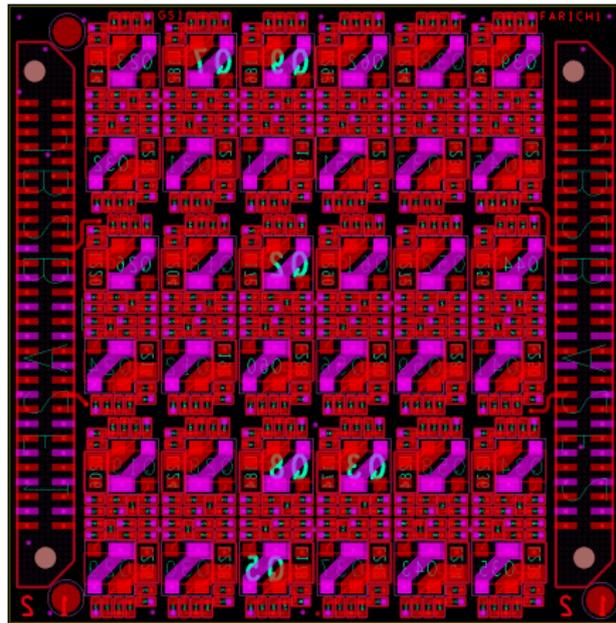


6x6 SiPM arrays, 2304 pixels 3x3 mm in total, readout electronics in 4 times compact than DiRICH boards (RICH-CBM, RICH-HADES and FRICH-PANDA) are required

A3.1 Compact readout electronics FPGA-TDC



Top view (sensor side) of 14-layer amplifier circuitry for KETEK-SiPM 28x28 mm



Bottom view (FPGA-TDC side) of 14-layer amplifier circuitry for KETEK-SiPM 28x28 mm

Designed by M. TRaxler and H. Kayan (GSI)

A3.1 Why not ASIC?!

FPGA-TDC

- Power consumption $\sim 50 \div 100$ mW/ch.
- Compactness — ?!?!?
- Low cost R&D— (3kEuro/iteration)

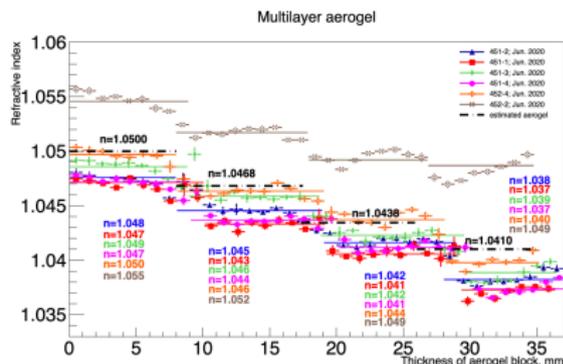
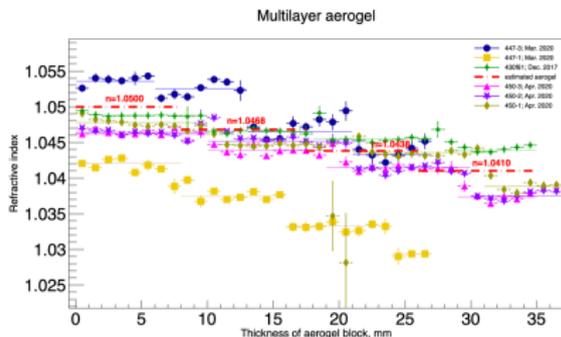
TOFPET-II (PetSys, Lisboa)

- Serial production ~ 900 Euro/chip for batch ≥ 100 pcs (in Moscow)
- Power consumption ~ 12.5 mW/ch.
- Compactness — $14 \times 14 \times 1.5$ mm² for 64 channel chip
- Optimized for PET — works with SiPM properly, **there is no external trigger!**
- **Optimization — 20kEuro/iteration!!!**
- Next version TOFHir will be soon!

SAMPIC (LAL, Orsay)

- Serial production is stopped now.
- Power consumption ~ 11.25 mW/ch.
- Compactness — QFP package 14×14 mm² (crystal 8 mm² inside) for 16 channel chip
- Tested with PMTs, MCPMTs, APDs, SiPMs, fast Silicon Detectors
- External trigger — YES.
- **Weak radiation hardness!!!**
- New version of the chip based on TSI 0.18 um technology was submitted to production in June of 2020!

A4. Focusing aerogel development



Due to regular production process in 2020 we have 9 4-layer focusing aerogel samples with transvers sizes $\geq 90 \times 90$ mm

First task is to find out why the refractive index in multilayer aerogels is systematically less than in single layer aerogels.

Summary

- Concept of Full-scale prototype based on 36 or 64 SiPM arrays 8x8 pixels with 3x3 mm size (28x28mm external size) from KETEK is developed:
 - SiPM arrays are purchasing (in two batches: 10 samples are expected until the end of the year and about 40 samples in next two years);
 - R&D and production of compact readout electronics with FPGA based TDC was started in July 2020 by GSI group;
 - Design of cooling system for prototype readout electronics and sensors plane are under development
- As a first step the FARICH prototype for full-ring detection based on only 12 SiPM arrays will be constructed in beginning of 2021 to work with relativistic electron beams at VEPP-4M complex:
 - Existing DiRICH (from GSI) boards will be used as readout electronics;
 - PCBs to transfer the signals from SiPM sensors to DiRICH are under development and production process.
- Multilayer focusing aerogel production is going:
 - About ten focusing 4-layer aerogel samples with $n_{\max}=1.05$ and 100x100x35mm size are waiting for beam test with electron beams at VEPP-4M complex;
 - Until the summer 2021 several new focusing aerogel samples will be produced and tested to study stability and reproducibility of aerogel production technology.