Cremlin+: WP 5, Task 6 (BINP) Tasks, plans and status

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Timeline: Task & Plans

	M1-M6	M1-M12	M13-M23	M24	M25-M36	M37-M41	M42	M43	M44	M45-M48
	Feb.2020-Jun.2020	Jul.2020-Feb.2021	Mar.2021-Jan.2022	Feb.2022	Mar.2022-Feb2023	Mar.2023-Jul.2023	Aug.2023	Sep.2023	Oct.2023	Nov.2023-Jan.2024
A1. FARICH simulation and reconstruction				to					P	
programs development				ect			e.		ť	
A2. FARICH prototype with full ring				det			Sug		lete	
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A2.1 DIRICH (FPGA-IDC from GSI) adjustment				e Si			in o		SC	
A2 2 Ream tests and SiPM Arrays comparison				÷			ę		the	
from different manufacturers				for			to to		ō.	
A3. Full-scale FARICH prototype to operate				E			teo		Ē	
at mixed hadron beams				ste			ę		ste	
A3.1 Compact readout electronics FPGA				l's c			5		Ś	
based TDC development (GSI)				H			e,		8	
A3.2 Photon detector plane design and				ы			ŧe		5	
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prototype and readout system tuning				×			ibu		ş	
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A4. Focusing aerogel radiator development				3R			<u> </u>		88	
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A4.2 Four layer aerogel with n(max)>=1.07				Le			ž		de	
AD1 Common EARICH and EDIRC mixed				tus			otc		ler	
hadrons beam test				Sta			2		Ē	
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AD1.1 Data taking, processing and analysis				<u>ں</u>			ē		<u>e</u>	
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AD1.2 Beam test resurts publication				-e-			ž		s.	
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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 8x8 pixels with 3×3 mm (4 from Hamamatsu and 6 from SensL) + 10 from KETEK are expected untill 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 6×64×3=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 planeed 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



 6×6 SiPM arrays, 2304 pixels 3×3 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 ~50÷100 mW/ch.
- Compactness ?!?!?
- Low cost R&D— (3kEuro/itteration)

TOFPET-II (PetSys, Lisboa)

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

SAMPIC (LAL, Orsay)

- Serial production is stoped now.
- Power consumption ~11.25 mW/ch.
- Compactness QFP package 14×14 mm² (crystal 8 mm² inside) for 16 channel chip
- Tested with PMTs, MCPPMTs, 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 \geqslant 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.

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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 100×100×35mm 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.