PANDA Forward RICH FEE status

Sergey Kononov[ab]
on behalf of the PANDA Forward RICH group
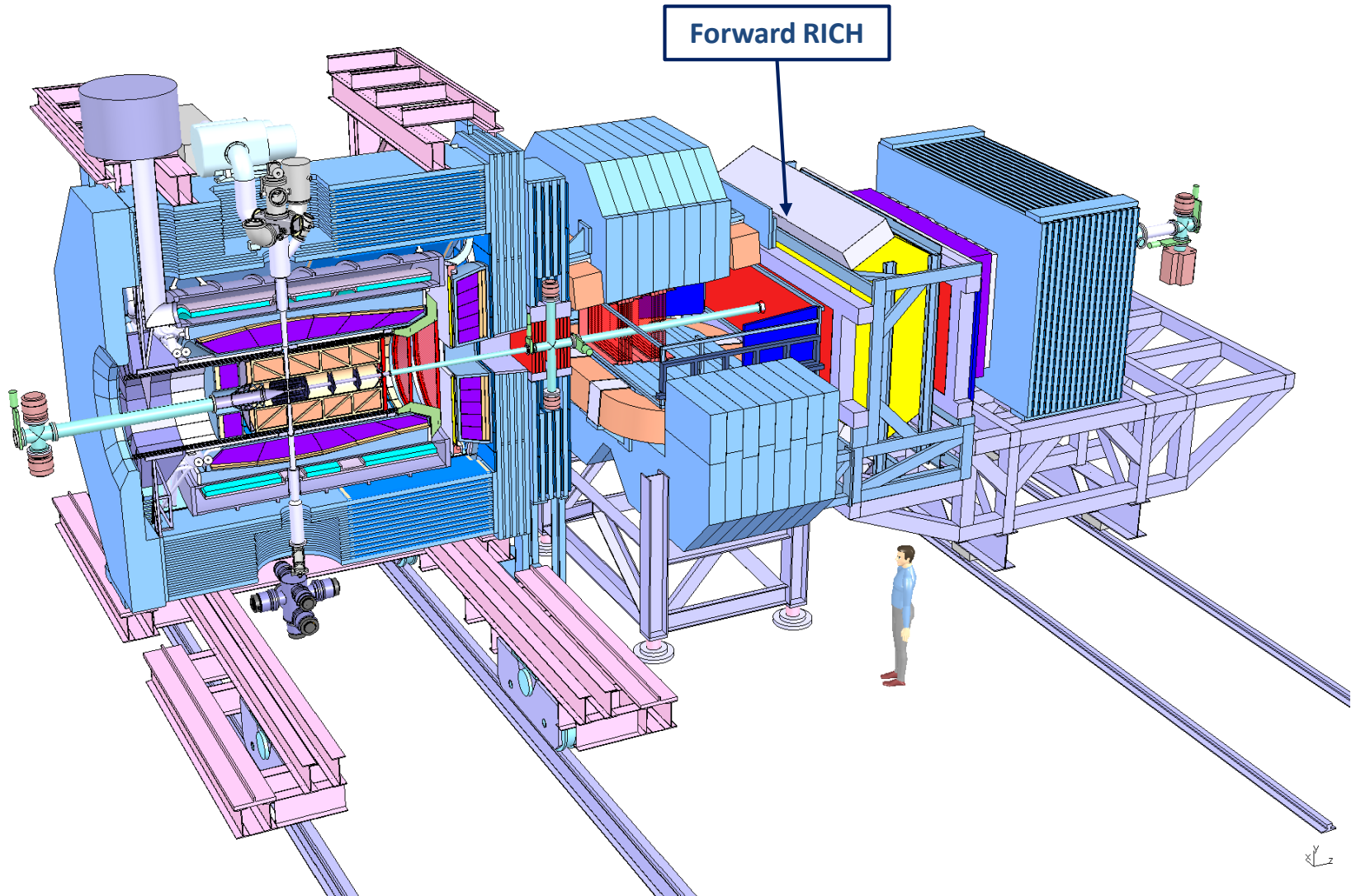
[a] Budker Institute of Nuclear Physics , Novosibirsk, Russia
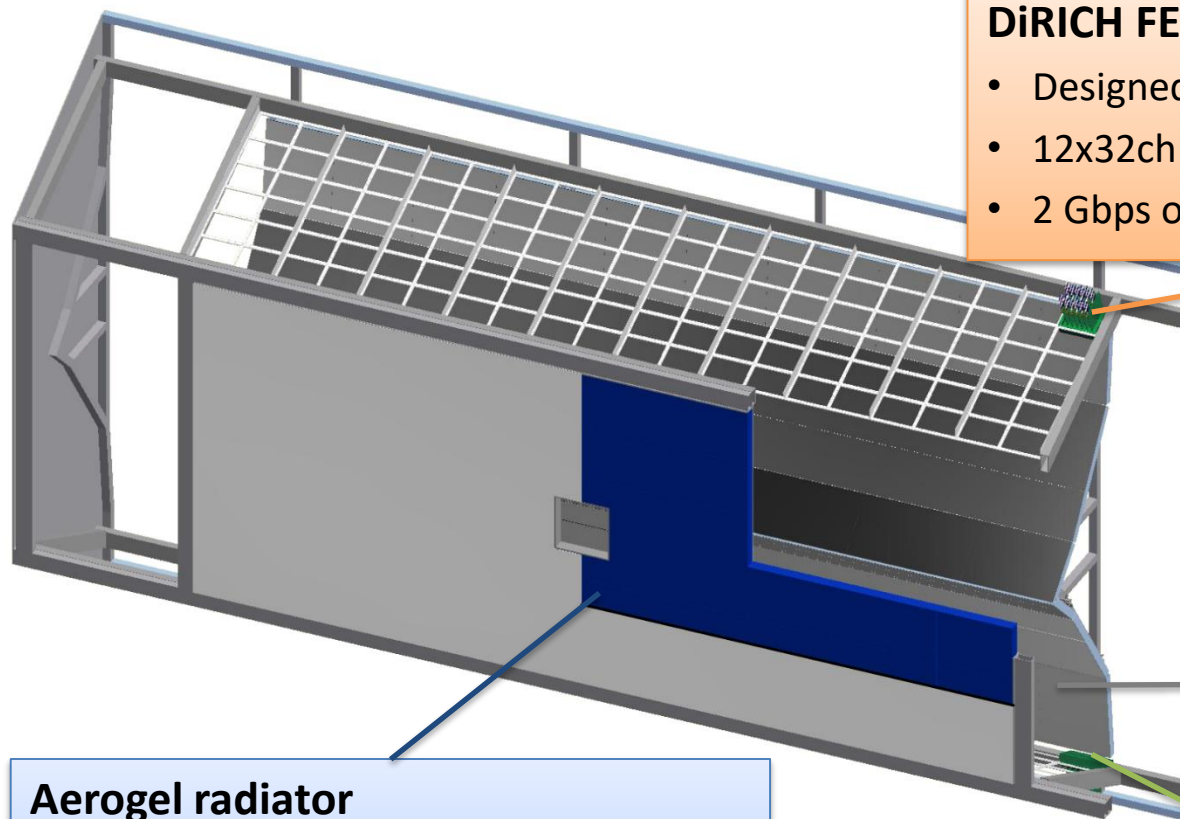*[b] Novosibirsk State University , Novosibirsk, Russia*
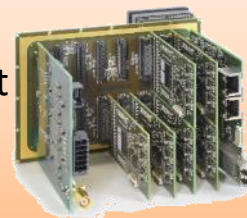
PANDA DAQ FEE Workshop

28.May.2018

PANDA detector

Forward RICH

Baseline design

DiRICH FEE (GSI)

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

Mirrors
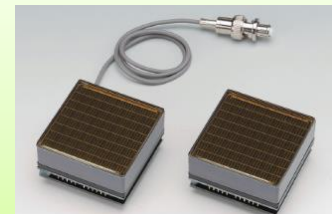
- 2 mm float glass
- Al+SiO$_2$ coating

Aerogel radiator

- Focusing 2- or 3-layer aerogel
- n=1.05
- 40 mm thick

Photon Detector

H12700 MaPMTs (Hamamatsu)

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

Reasons behind the choice of DiRICH

1. Lack of electronics engineers at BINP
2. DiRICH is designed for H12700 MaPMT readout in RICH applications (single ph.e. signals, precise timing)
3. Continuous support from developers at GSI Digital electronics group headed by Michael Traxler
4. Quite large collaboration of users:
   - HADES RICH upgrade (28k ch)
   - CBM RICH (60k ch)
   - PANDA Barrel DIRC (11k ch)
   - PANDA Forward RICH (92k ch)

DiRICH module

- Based on successful PADIWA and TRB3 designs

- ~10 ps TDC resolution

- Hosts 6 MAPMTs, 384 channels in total

- Power Module distributes external LV to electronics and HV to PMTs

- DCM concentrates data from 12 DiRICH cards by TRBNet 2-Gbit/s links

- 2 Gbit/s output optical link via SFP transceiver
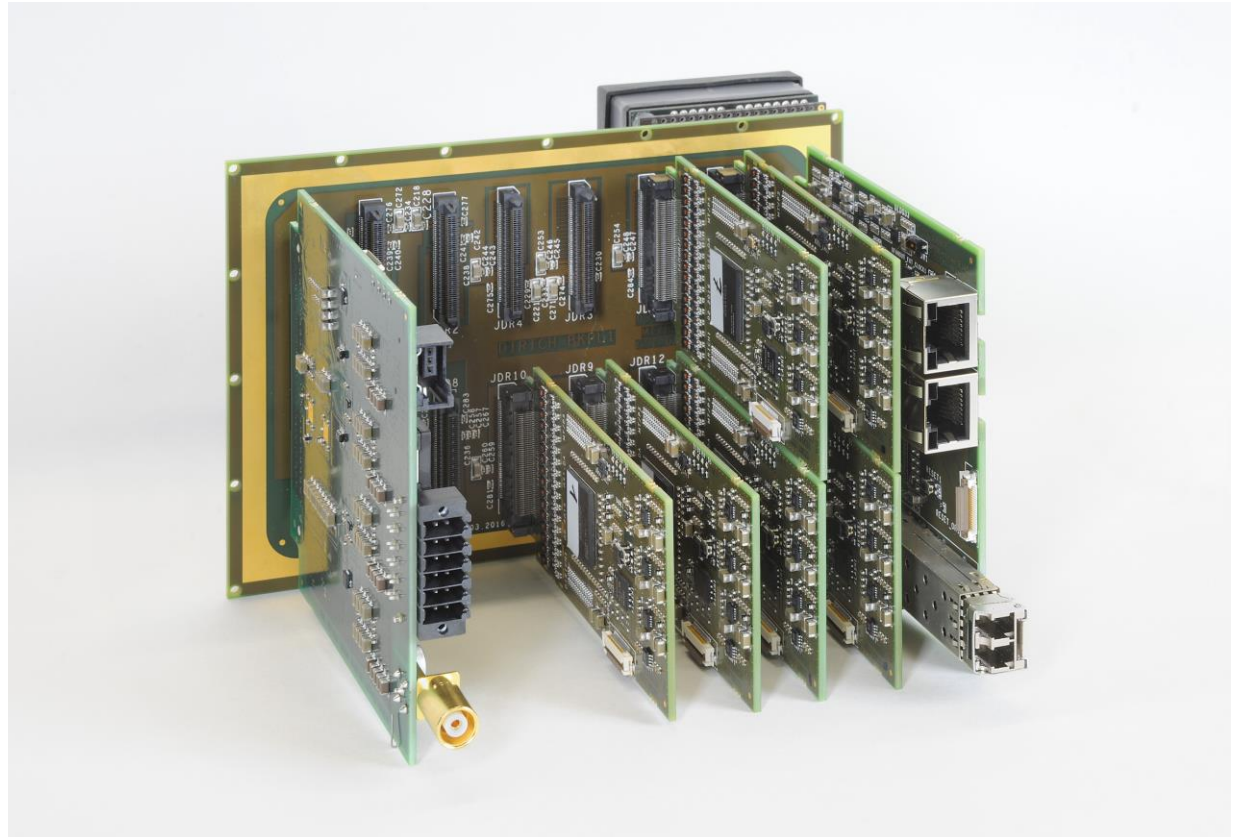
Further info: trb.gsi.de, M. Traxler talk @ DIRC17 workshop
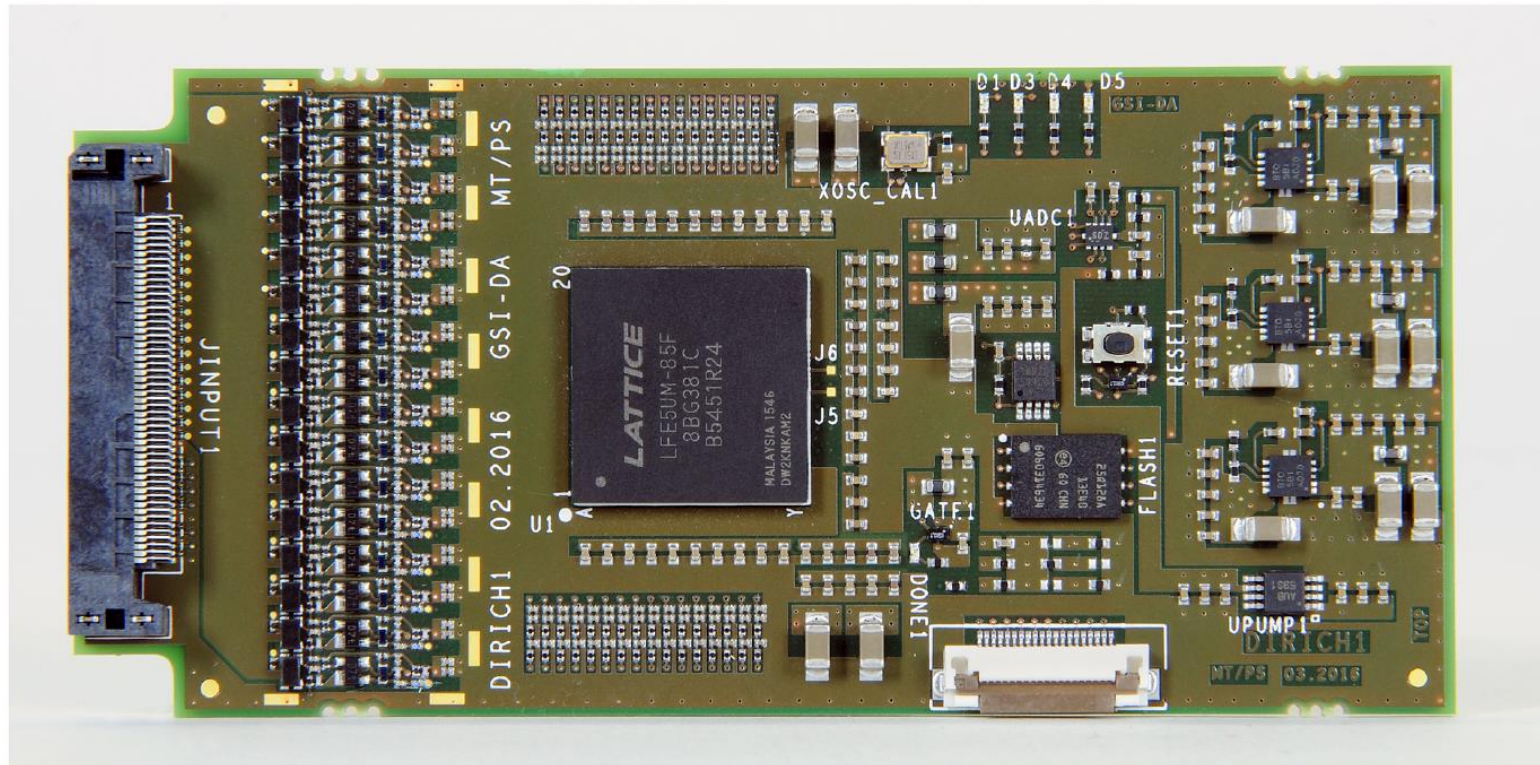
- 47mm x 100mm area, $300\mu m \times 600\mu m$ components, 0201 (imperial)
- transformer, gain 30 amps, 16bit-DAC, discriminator, high precision TDC, DAQ + TrbNet (2Gbit/s SERDES), slow-control and voltage-regulation

Hit and data rate estimations (1)

Input from full sim (PandaRoot) & datasheets

- Nearly uniform channel occupancy by photons and particles

- 0.8 effective charged particle multiplicity (Cherenkov radiation intensity weighting) per $\bar{p}p$ collision for 10 GeV/c beam momentum

- 28 photon hits for relativistic particle

- Direct particle hits: 200 hits/s/ch

- H12700 MaPMT dark current: 80 counts/s/ch

- Timestamp size: 4 bytes

- Leading+trailing timestamps: 8 bytes

- Epoch counter (for every frame of 10 µs): 4 bytes

Hit and data rate estimations (2)

Source	Per channel	Per DiRICH board (32 ch)	DiRICH module (6 PMTs)	Per system (240 DiRICH modules)
Cherenkov photons	5.2 kcps	170 kcps	2 Mcps	480 Mcps
Direct particle hits	200 cps	6 kcps	77 kcps	18 Mcps
Dark current	80 cps	2.6 kcps	30 kcps	7.2 Mcps
Total hit rate	5.5 kcps	180 kcps	2.1 Mcps	500 Mcps
Raw data flow	**0.53 Mbps**	**17.3 Mbps**	**200 Mbps**	**48 Gbps**

Concept of readout scheme

240x DiRICH modules	40x DCBs based on TRB3	10x 1/10G commutators
DiRICH	TRB3	
DiRICH	TRB3	1/10G commutator
DiRICH	TRB3	
DiRICH		
DiRICH		
DiRICH		

GbE commutators maybe used at this level if it is less expensive

DAQ
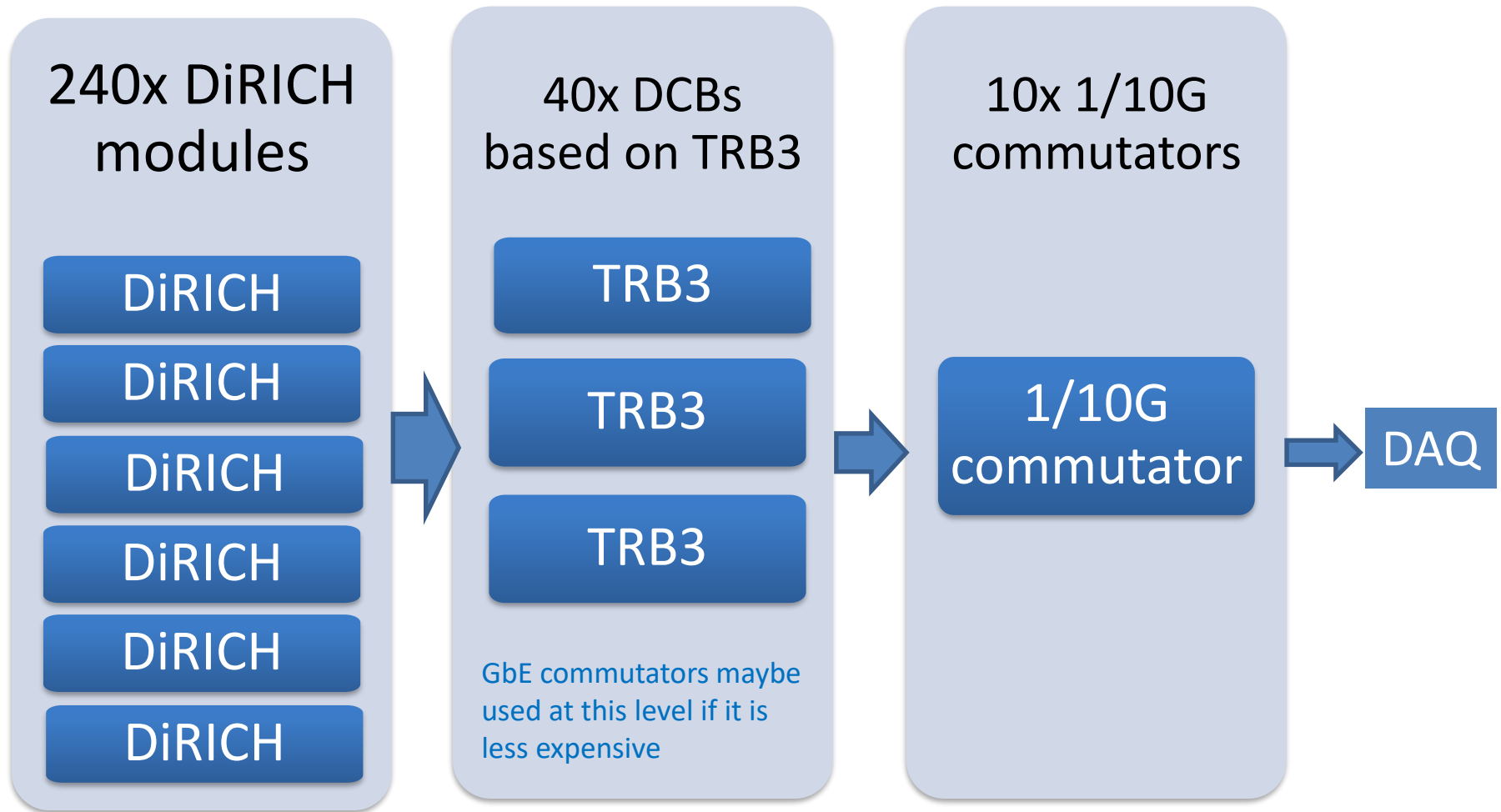
Status & outlook

- In 2016 developed a custom adapter board to couple 4 PADIWAs to MaPMT

- Testing 2 TRB3 and 14 PADIWAs at test beam of the BINP FRICH prototype with 4 64-ch PMTs

- Long learning how to deal with this electronics due to lack of experts in the group

- Plan to buy and test one DiRICH module this year

- Detailed readout scheme to be developed this year relying on the experience of the HADES&CBM RICH

Slave

Master