

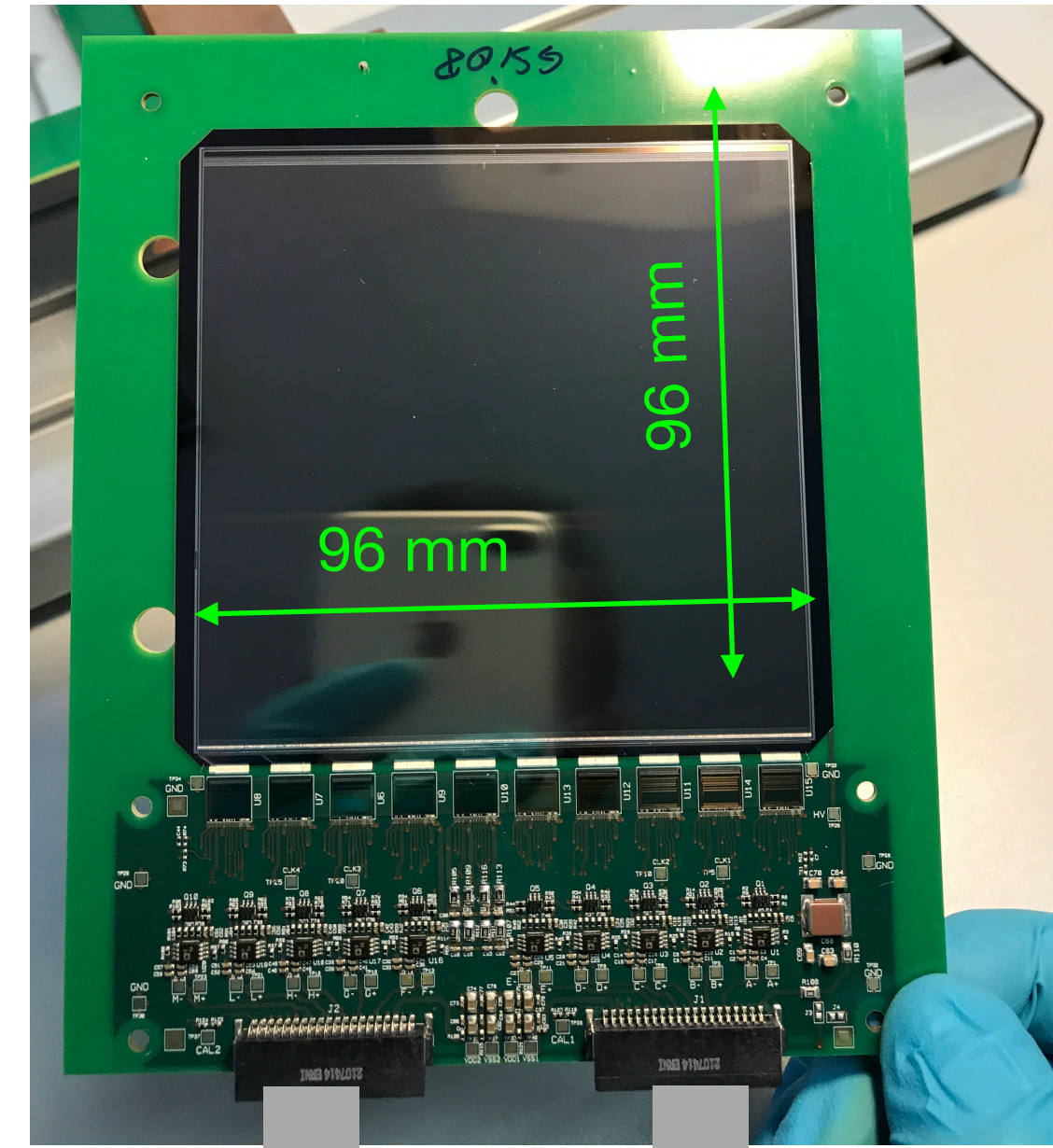
# **Status of the FOOT detectors**

Valerii Panin

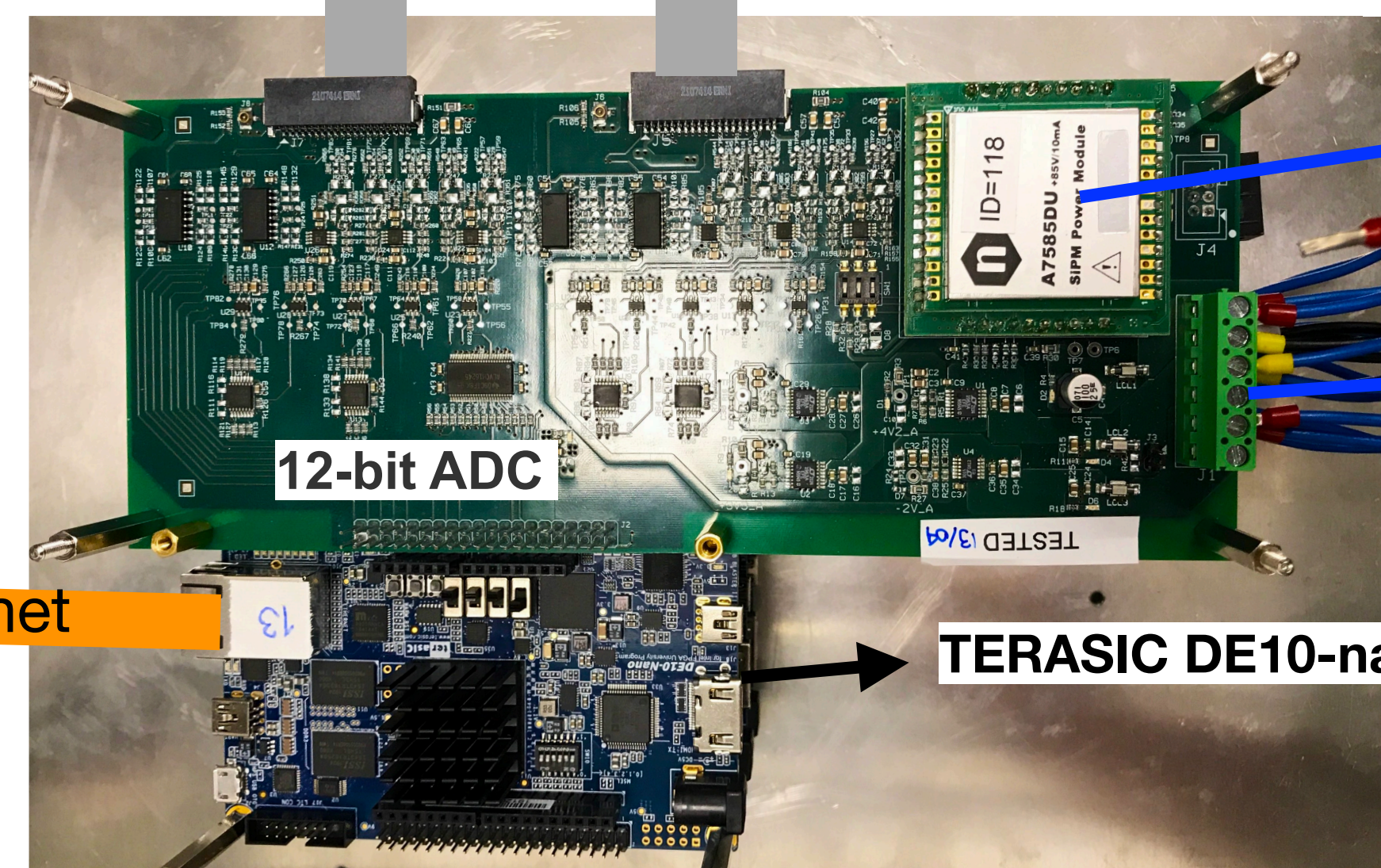
R3B Collaboration Meeting, Budapest 22-26 May 2023

# FOOT silicons for measuring fast protons and light ions

<b>Sensor type:</b>	single-sided
<b>Dimension:</b>	96 x 96 mm <sup>2</sup>
<b>Thickness</b>	150 μm
<b>Implant pitch</b>	50 μm
<b>Readout pitch</b>	150 μm, 640 ch
<b>Readout strips</b>	640
<b>Max trigger rate</b>	Up to ~6 kHz
<b>ASIC</b>	IDE1140 (VA140), IDEAS, Norway
<b>Readout:</b>	ADC board (Perugia) + de10nano FPGA



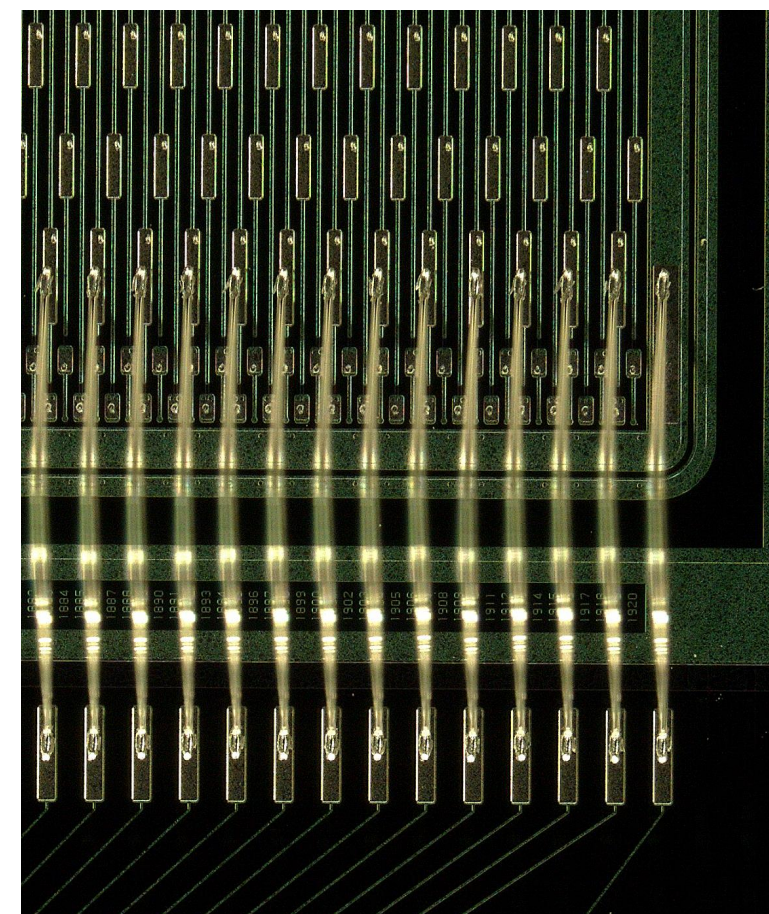
signal cables      vacuum feed-through



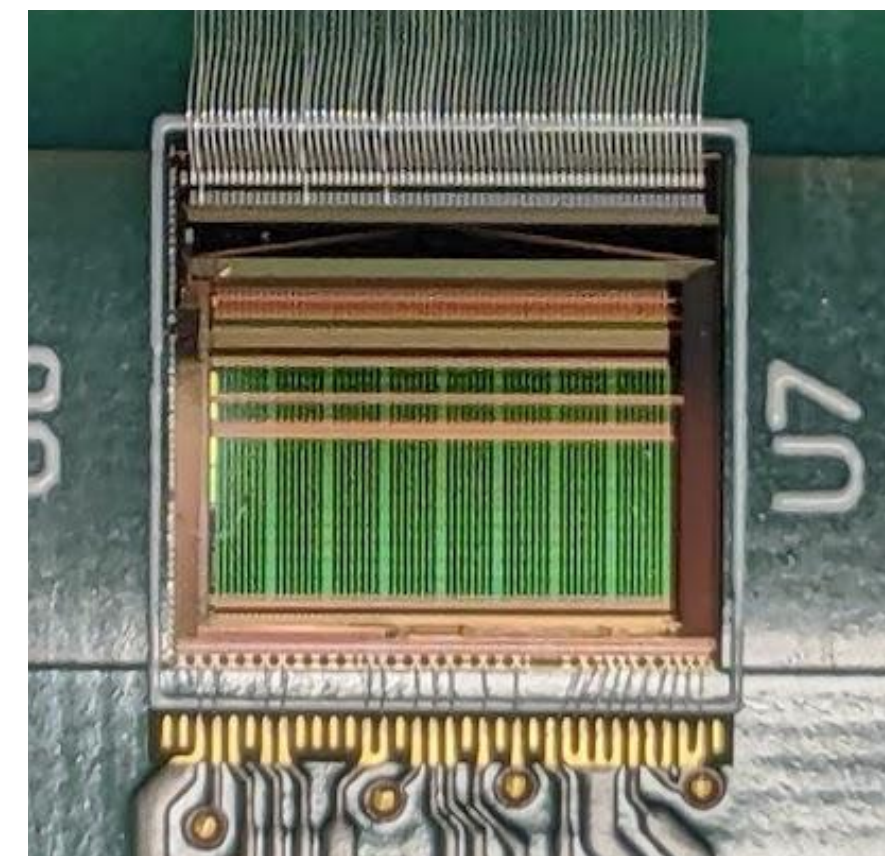
CAEN DC power unit for silicon bias (controlled by external ARDUINO)  
Low-voltage from DC supply

Ethernet      TERASIC DE10-nano FPGA

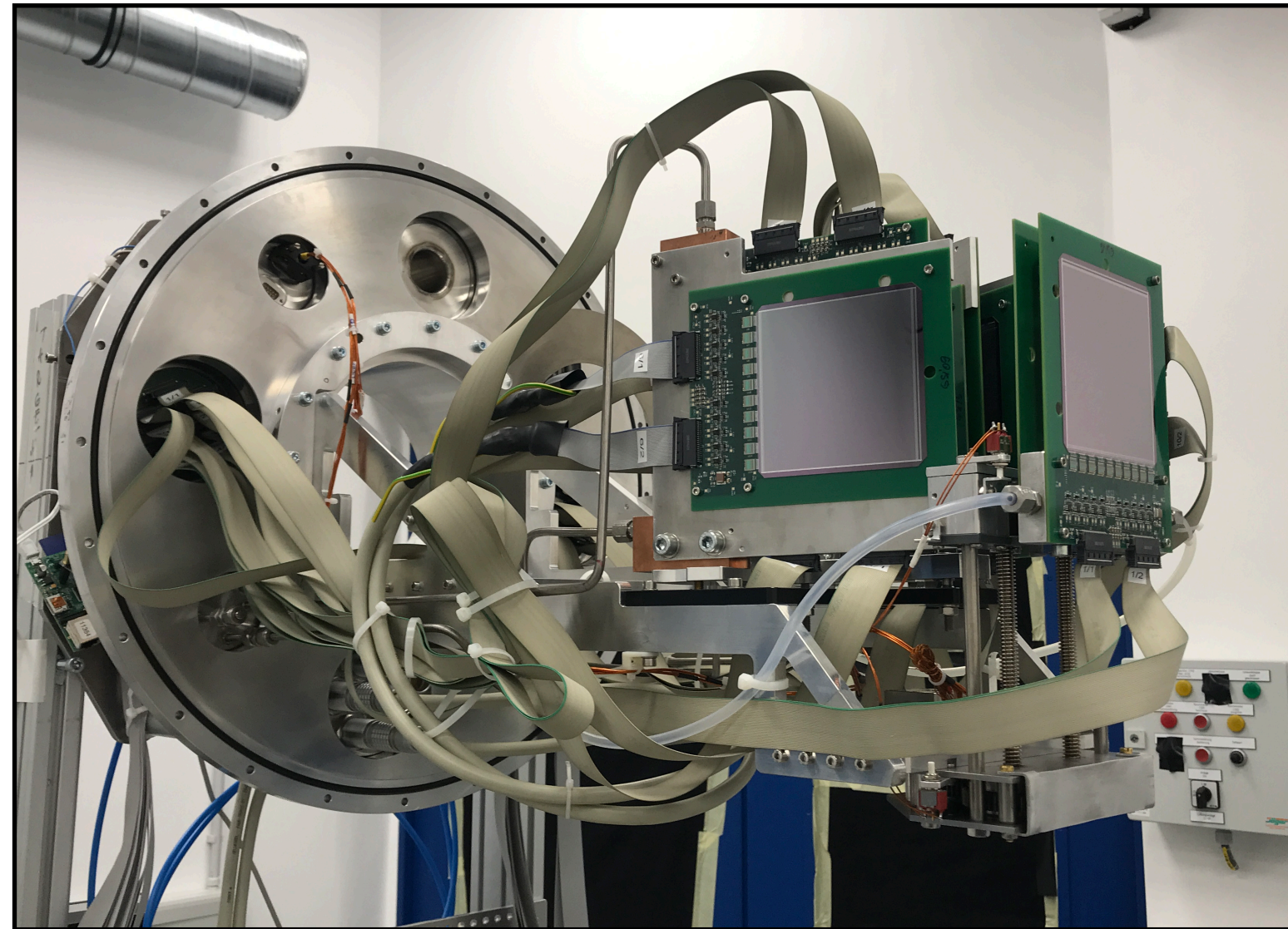
Every 3rd strip is bonded



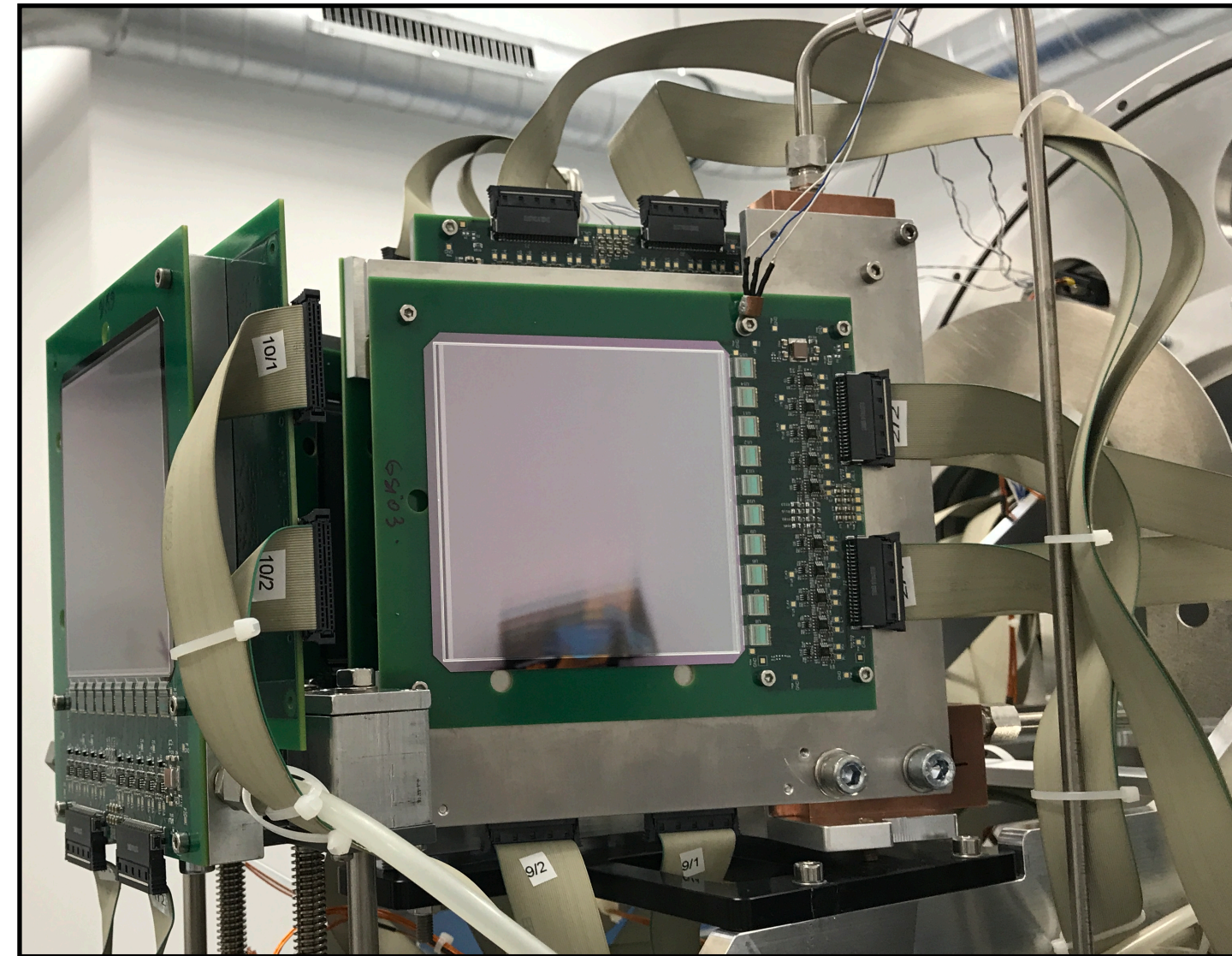
64ch CSA ASIC



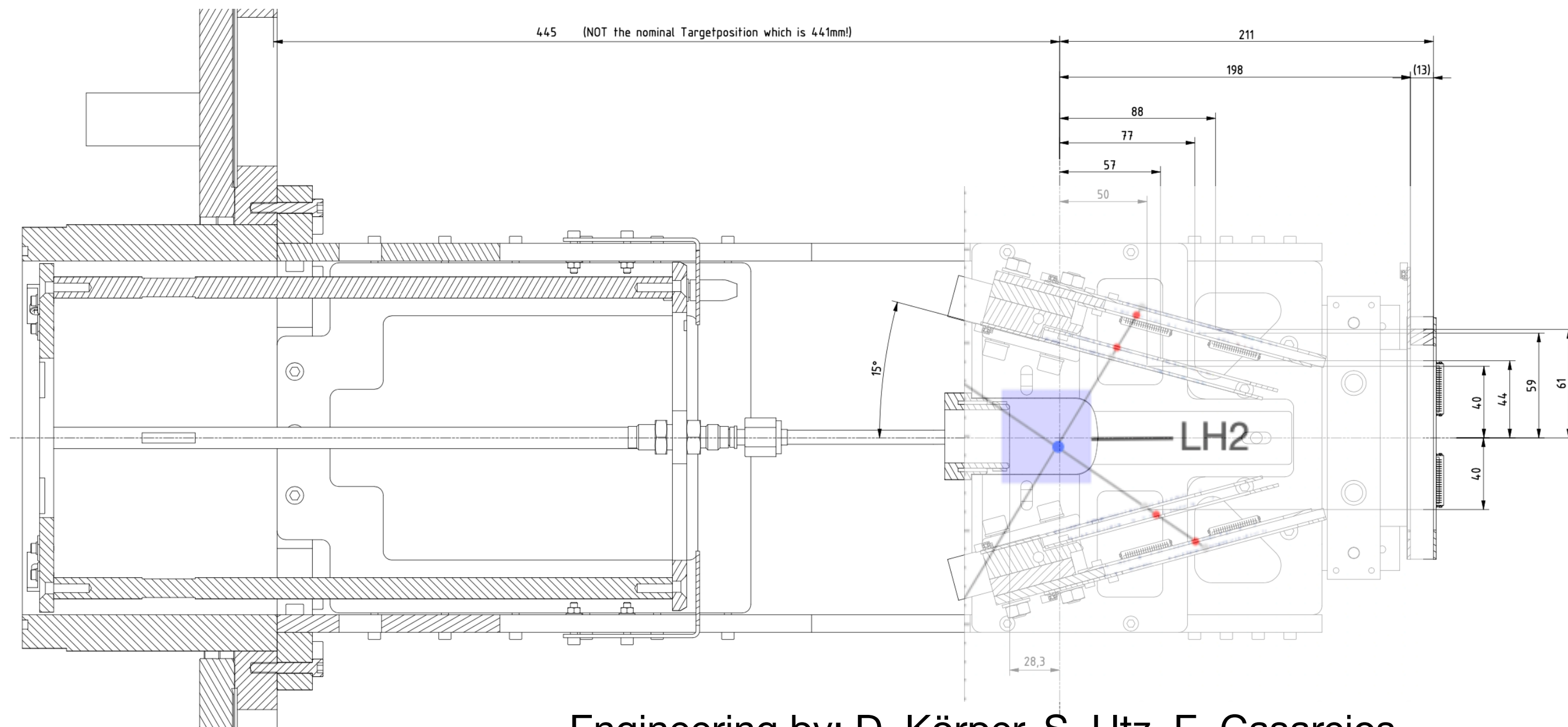
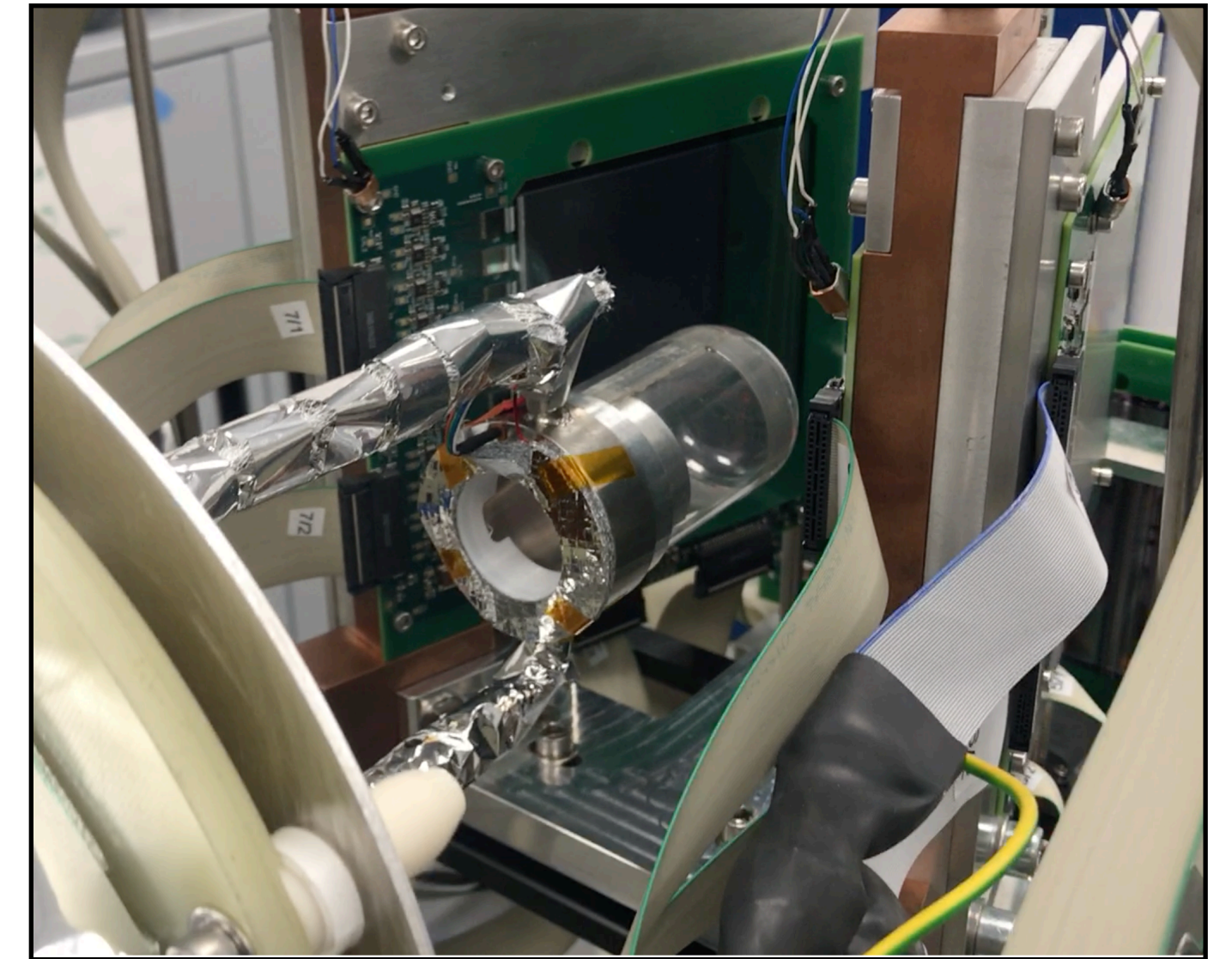
Final two-arm configuration in 2022  
10+2 FOOTs + 50 mm LH<sub>2</sub> target



Step-motor to move inbeam detectors



Active cooling of FE-boards



Engineering by: D. Körper, S. Utz, E. Casarejos

From R3BRoot simulations by A. Revel

Acc. (p,2p)	20%
Res. Theta	2mrad
Res. Vertex_Z	0,17mm
Res. MissM (p,2p)	4,5MeV
Acc. (p,2pn) t,u>0.5GeV/c <sup>2</sup>	35%
Res. MissP (p,2pn)	3,8MeV

# DAQ tree viewer with 12 FOOT

## Local DAQ node

## Common DAQ

DE	all-trig	±5o	±20o	miss	sync-trig	>20o
DE9						
DE1	-12 ± 13	100.0%	0.0%	0.0%	7 ± 12	0%
DE4	-6 ± 13	100.0%	0.0%	0.0%	6 ± 11	0%
DE6	-3 ± 13	100.0%	0.0%	0.0%	4 ± 12	0%
DE7	-1 ± 13	100.0%	0.0%	0.0%	6 ± 12	0%
DE12	-1 ± 13	100.0%	0.0%	0.0%	2 ± 12	0%
DE13	-8 ± 13	100.0%	0.0%	0.0%	8 ± 12	0%
DE11	-5 ± 13	100.0%	0.0%	0.0%	4 ± 11	0%
DE10	0 ± 13	100.0%	0.0%	0.0%	-3 ± 11	0%
DE2	-9 ± 13	100.0%	0.0%	0.0%	8 ± 12	0%
DE15	-14 ± 13	100.0%	0.0%	0.0%	8 ± 12	0%
DE16	-16 ± 13	100.0%	0.0%	0.0%	6 ± 11	0%

DE	Master	all-trig	±5o	±20o	miss	sync-trig	>20o
01	?	-10 ± 24	90.9%	0.0%	0.0%	11 ± 26	0%
02	S2	318 ± 6	99.9%	0.0%	0.0%	-	-
03	RPC	-35 ± 22	99.9%	0.0%	0.0%	-12 ± 20	0%
04	?	-4 ± 23	90.9%	0.0%	0.0%	15 ± 21	0%
06	?	-1 ± 23	90.9%	0.0%	0.0%	10 ± 22	0%
07	?	1 ± 23	90.9%	0.0%	0.0%	11 ± 23	0%
09	?	2 ± 23	90.9%	0.0%	0.0%	5 ± 20	0%
0a	CAL_M	1292 ± 23	1.5%	0.0%	0.0%	498 ± 20	0%
0b	CAL_W	1307 ± 22	1.5%	0.0%	0.0%	529 ± 19	0%
0c	?	1 ± 23	90.9%	0.0%	0.0%	7 ± 22	0%
0d	?	-6 ± 23	90.9%	0.0%	0.0%	14 ± 22	0%
0e	Music	231 ± 6	99.9%	0.0%	0.0%	234 ± 6	0%
0f	?	-3 ± 23	90.9%	0.0%	0.0%	10 ± 21	0%
12	?	2 ± 23	90.9%	0.0%	0.0%	4 ± 23	0%
13	?	-7 ± 23	90.9%	0.0%	0.0%	14 ± 22	0%
14	?	-12 ± 23	90.9%	0.0%	0.0%	12 ± 23	0%
15	?	-14 ± 23	90.9%	0.0%	0.0%	12 ± 23	0%

26.7k	localhost:9000	FootT0	23.9M	1.2%	-->	16778.2k	S127.0.0.		
-	-	-	-	-	---	-	S		
-	-	-	-	-	---	-	S		
-	-	-	-	-	-->	-	-		
-	-	-	-	-	<--	8395.5k	0.0%		
-	-	-	-	-	-	14679cdf11115	-1.319s		
-	-	-	-	-	-	-	-		
1496	o	10.99.2.38	Master	192.0k	0.1%	--><--	192.6k	0.0%	
-	-	-	-	-	-	-0.097s	-0.005ppm	-7.54us	
-	-	--><--	10.99.2.37	LOSV	165.4k	0.0%	--><--	167.8k	0.0%
-	-	--><--	10.99.2.91	LOST	108.1k	0.0%	--><--	108.8k	0.0%
-	-	--><--	10.99.2.125	FIB3133	1011.5k	0.4%	--><--	1019.3k	0.1%

20.7k	10.10.24.15	T0	18225.8k	0.2%	---	-	T
-	-	-	-	-	---	-	S10.10.24
02:19	9958.3M	/d/land7/202205_s522/lmd/idle_main0109_0001.lmd	-	-	-->	-	-
02:19	2677.5M	/d/land7/202205_s522/lmd/idle_main0109_0002.lmd	-	-	-	-	-

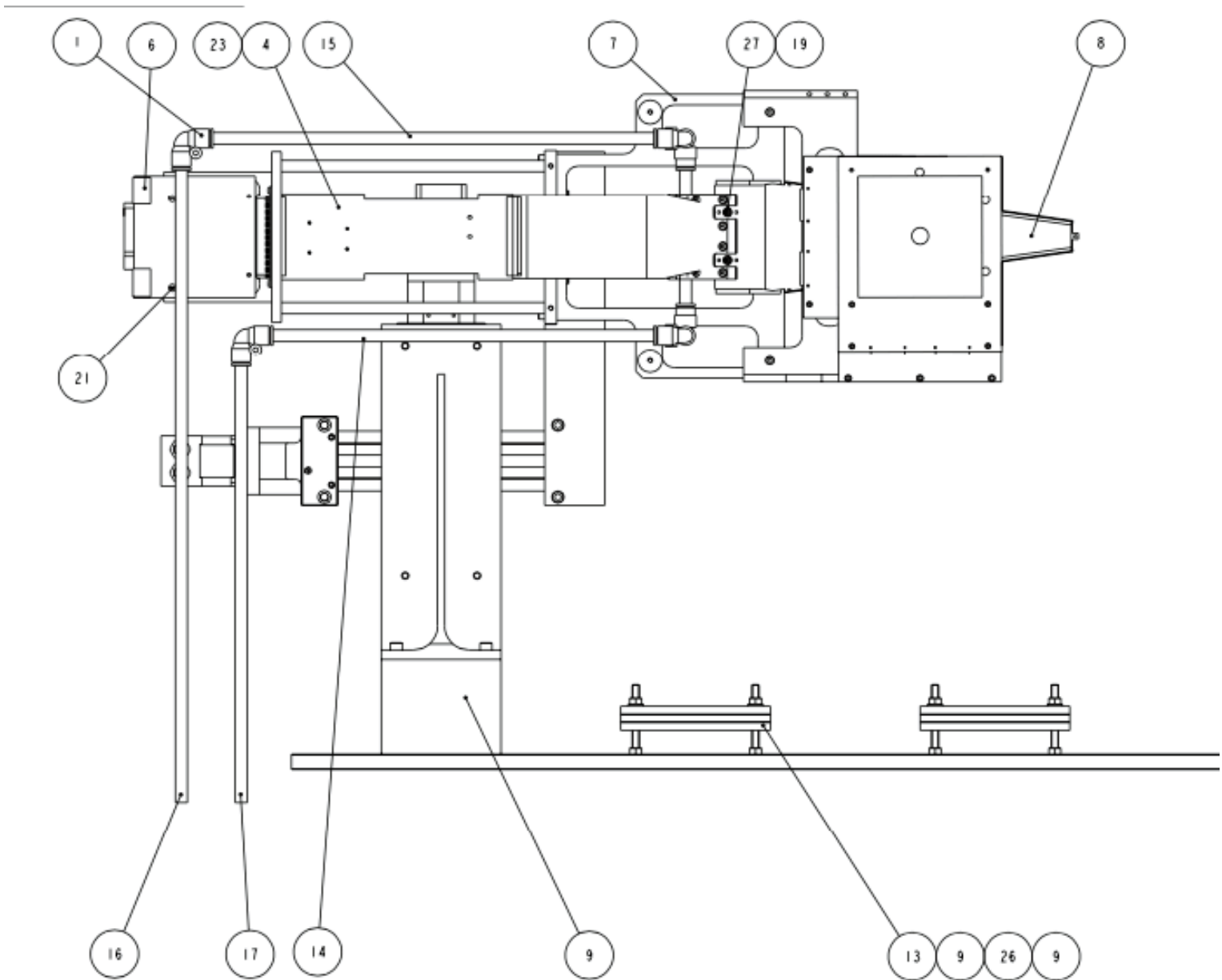
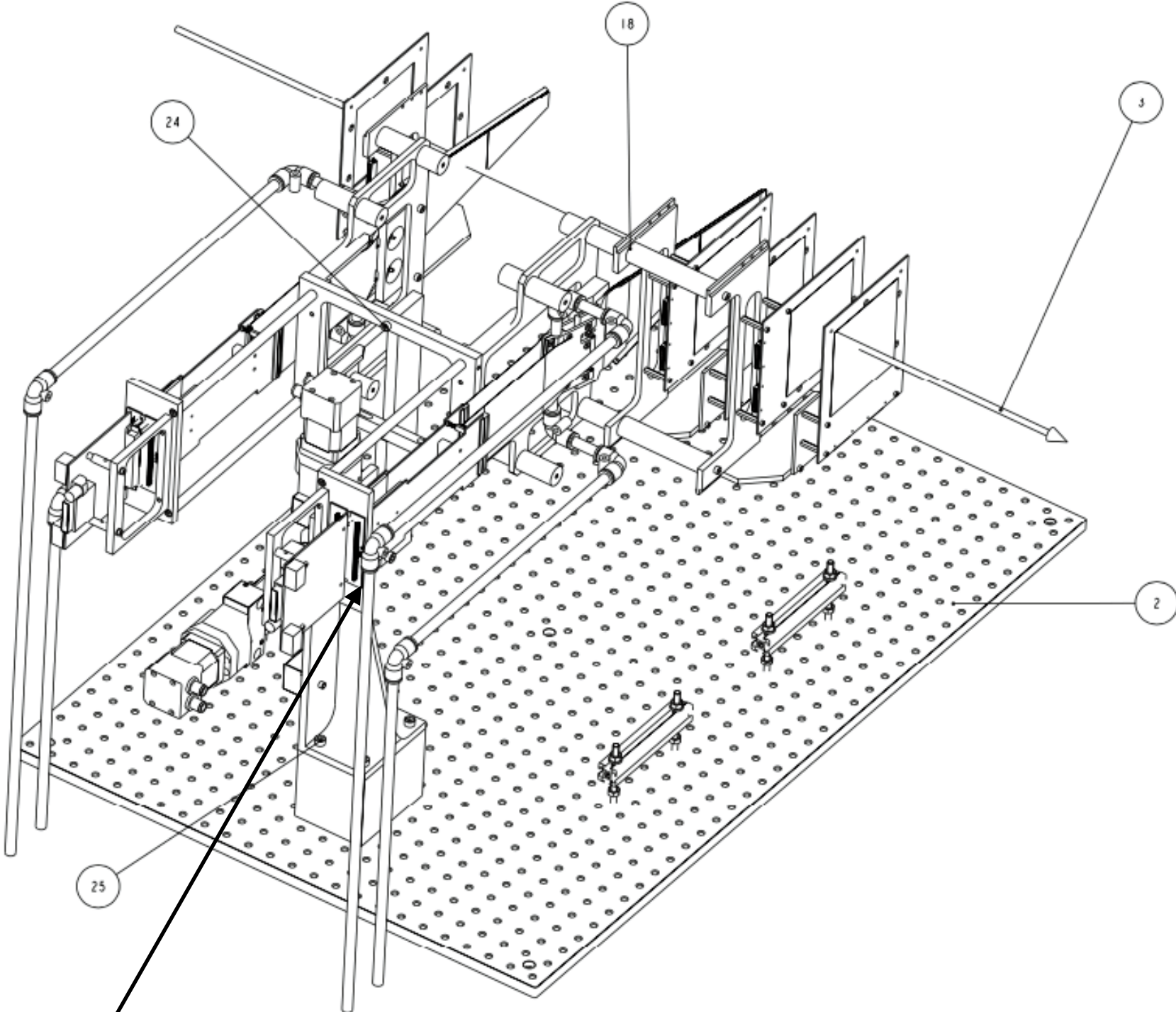
## Available detectors/electronics

- 10 for R3B + 6 for FRS
  - 3 are currently in Perugia for fixing broken bonds, will be picked up soon
- All necessary cables/connectors are available since 2022
- 5 additional sensors from HAMAMATSU are delivered to GSI
  - Will be transported to Perugia for FE assembly and bonding, ASICs are ready for all 5 dets
  - Expected to be ready in autumn 2023
- (DE10-nano + ADC boards + CAEN HV) x 15 - some ADC/HV have problems, will be tested
- New IR laser for testing silicons is available in the detector lab (safety checks are passed)
  - Mechanics for the test is not yet assembled
  - A system for moving the laser beam on the detector surface has to be prepared
- 8+2 detectors are available for the upcoming beamtime

# Jülich test in July 2023

Similar to FOOT-L3T setup from 2021 test in Jülich

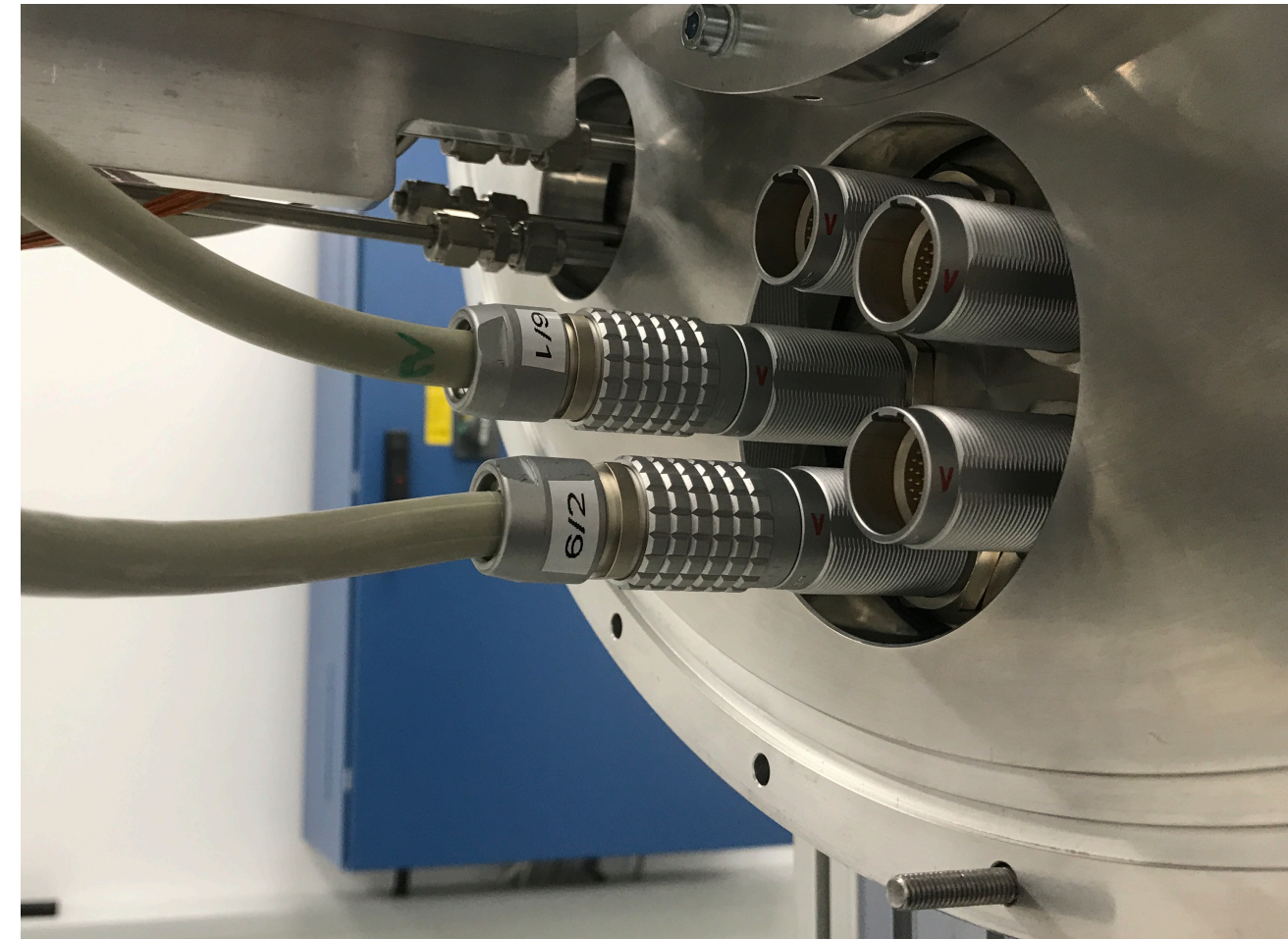
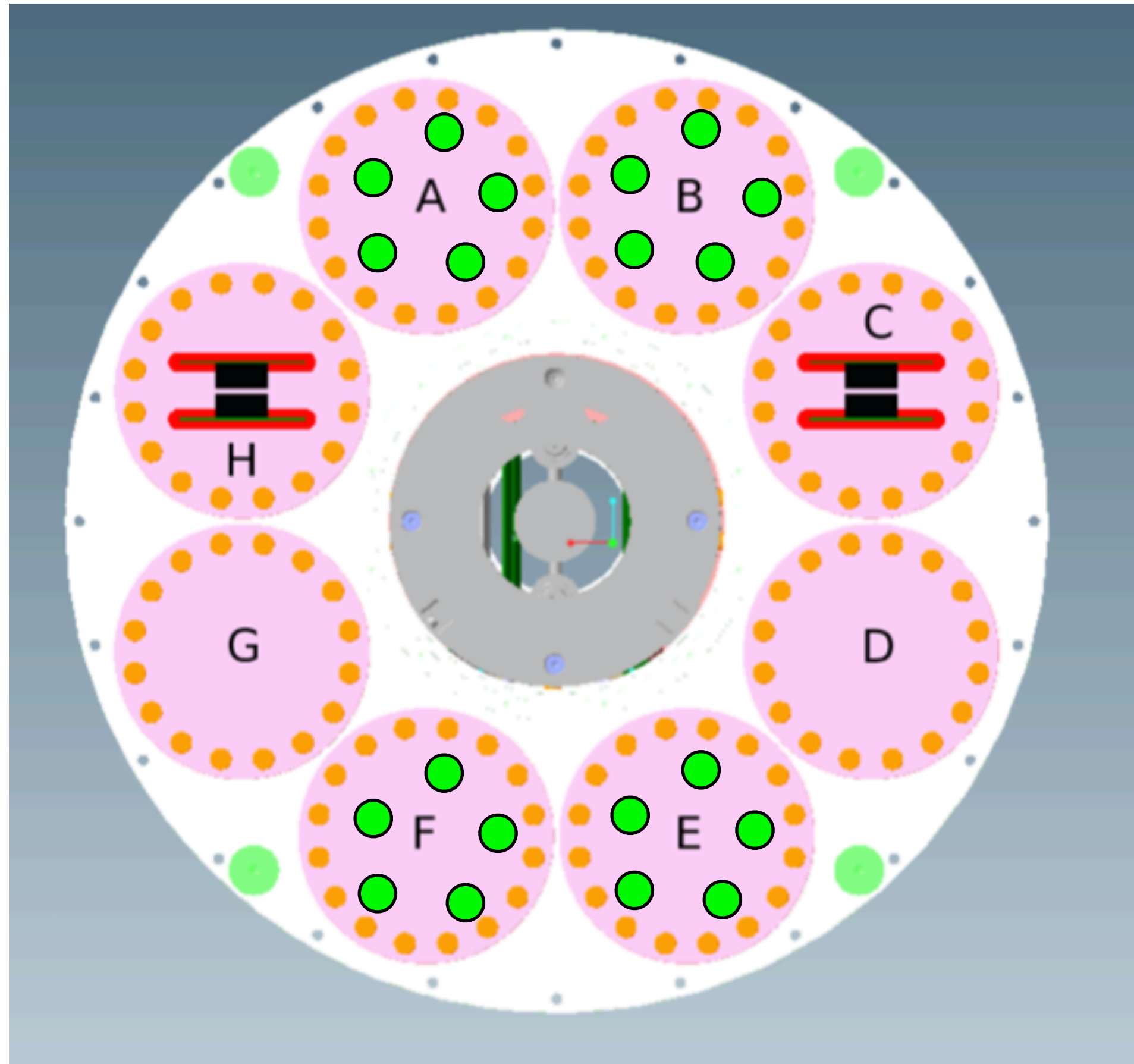
- Electronics box for two FOOTs



Moving arm

- Only 2 FOOTs (X,Y) are now foreseen for the test
- Each detector will be mounted in individual protection box

# New cables for the upcoming experiments



- Replacement of the temporary used flat cables
- All new LEMO cables are delivered (with ERNI connectors on the det side)
- Tested for only one FOOT during 2022 beamtime
- LEMO vacuum feedthroughs are available, 3 additional flanges will be prepared
- **The cables are bulky and stiff! May need to be shortened on the vacuum side**

1 FOOT = 2 LEMO

1 flange = 5 LEMO

10 FOOTs = 20 LEMO = 4 flanges

# Outlook

- Further analysis and investigations under different conditions are needed:
  - Varying trigger rates, physical rates and amplitudes of signal into ASICs
  - Testing with infrared laser
  - Trying alternative ASIC  $\longleftrightarrow$  FPGA communication
- Understanding “strange” signals in edge channels of every ASIC
- Increasing possible trigger rate as much as possible
  - At present full readout cycle is  $\sim 80$   $\mu\text{s}$ . In the experiment operated at max  $\sim 6$  kHz (deadtime set to  $\sim 150$   $\mu\text{s}$ )
- Testing readout with FEBEX4 (N. Kurz, K. Koch) instead of ADC - understanding dependence of the baseline on the trigger rate
- Possibility of getting a test board from IDAS (ADC+FPGA+firmware) with the Mezzanine board for the ASIC
- Modify/improving FE circuit?
- At present, no zero suppression is implemented in the DAQ  $\longrightarrow$  large data size
- Hybrid configuration with ALPIDE detectors for the upcoming experiments?

