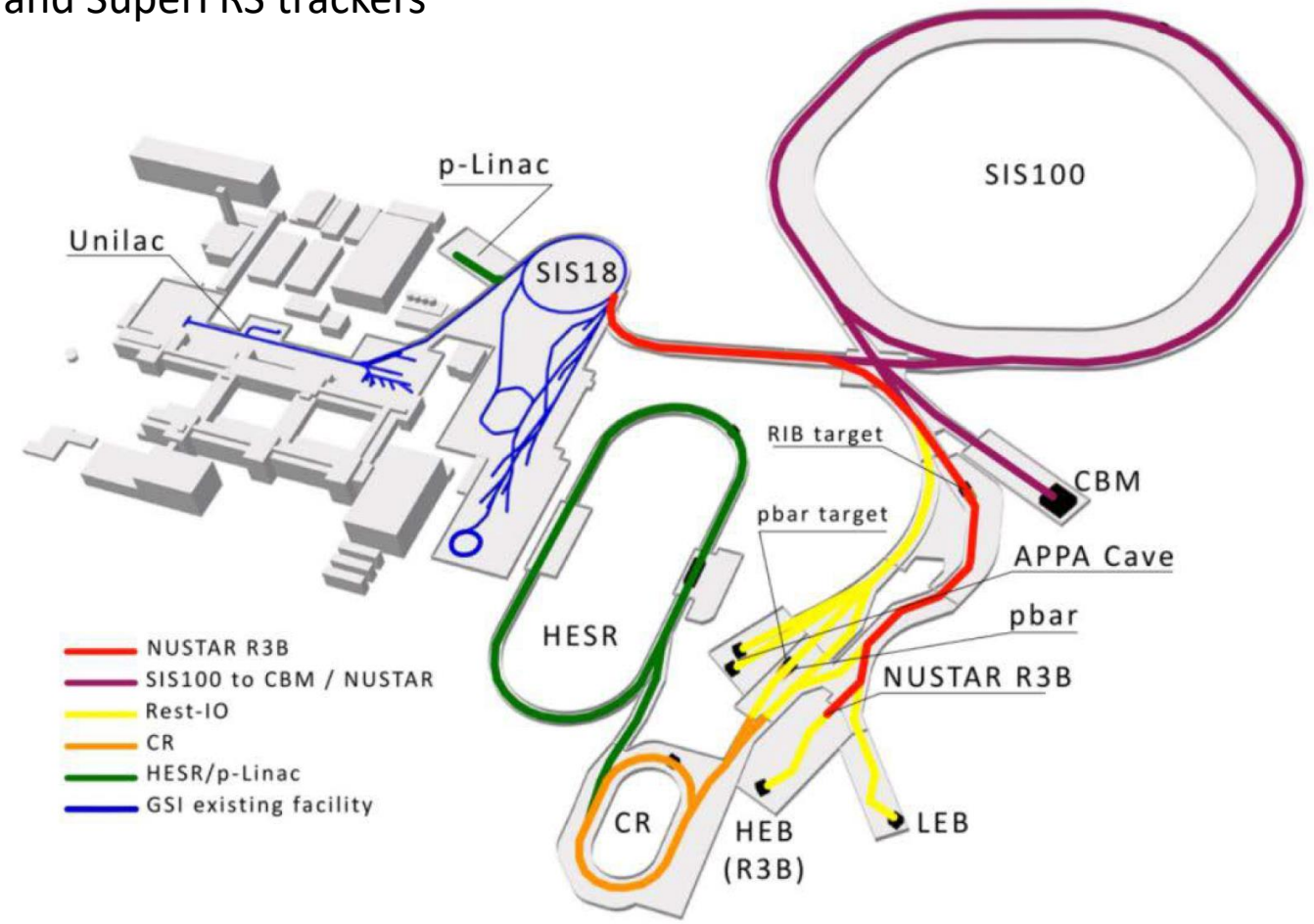
SciFi detectors development at GSI

C.Caesar, H.Heggen, I.Brandherm, M.Heil, P.García-Gil, D.Körper, Deniz Savran

Annual MT Meeting 2025

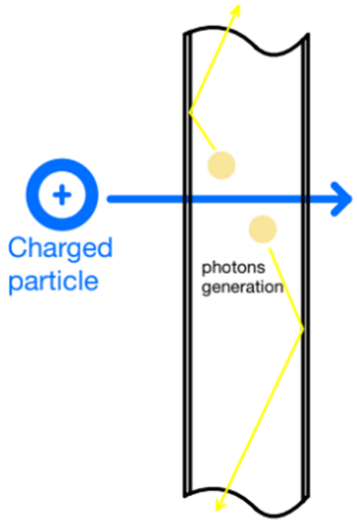
Our focus

We focus on the development of scintillating fiber detectors for the NUSTAR collaboration at GSI. We have produced several detectors for the R3B sub collaboration and we work in the production of the new generation of R3B and SuperFRS trackers



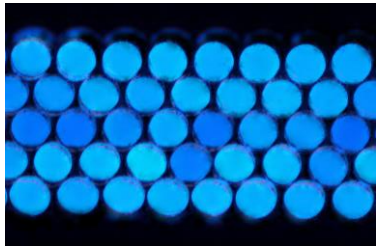
SciFi detectors

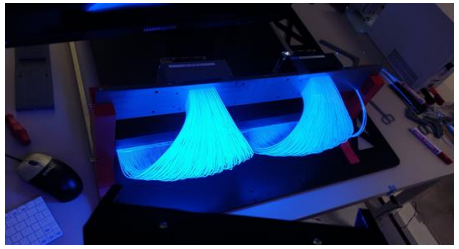
Active medium



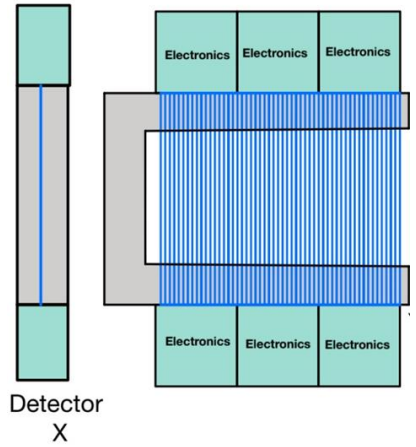
3x Square fibers -200µm

5x Round fibers -250µm

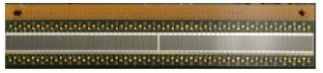




Photon detection



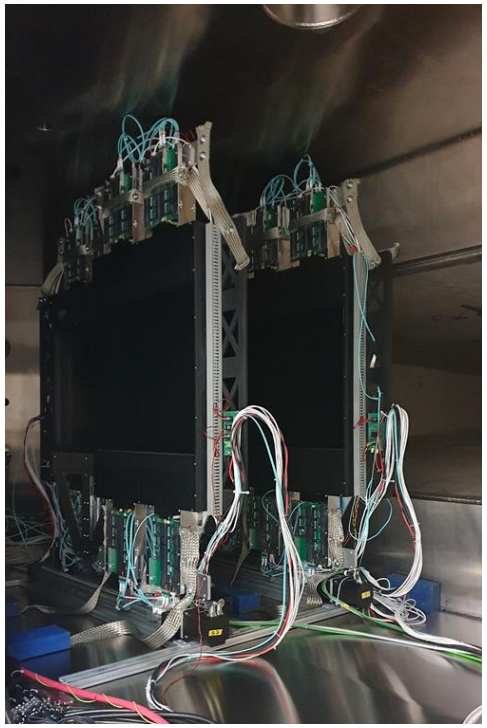
MaPMTs

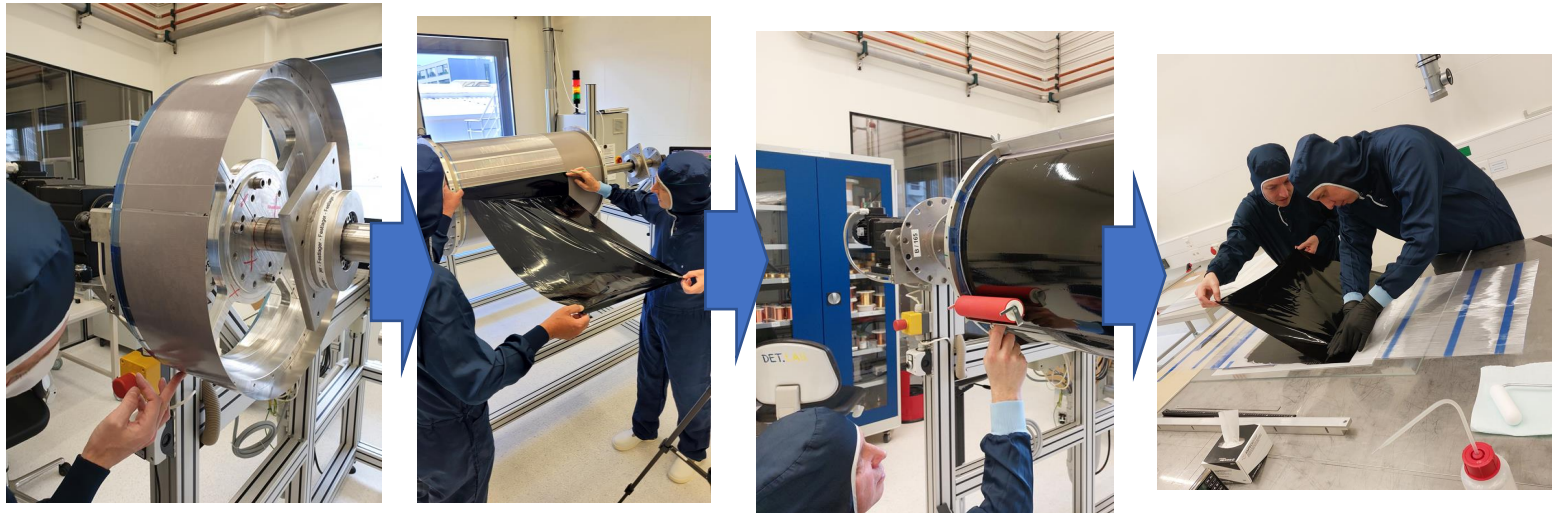


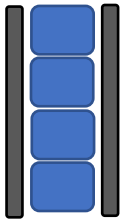
SiPMs (MPPCs)

Our experience

We started producing SciFi detectors in house in 2018. First with MaPMTs and fibers from 500 to 1000 µm.







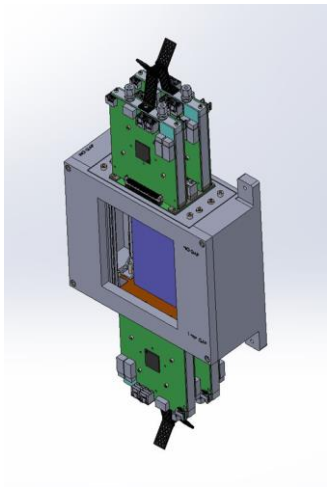
10 µm foil
1000 - 500 µm square fibers
10 µm foil

Our experience

We started producing SciFi detectors in house in 2018. First with MaPMTs and fibers from 500 to 1000 µm.

Our experience

First test with SiPMs in 2023. First SiPMs detector fully commissioned in 2025

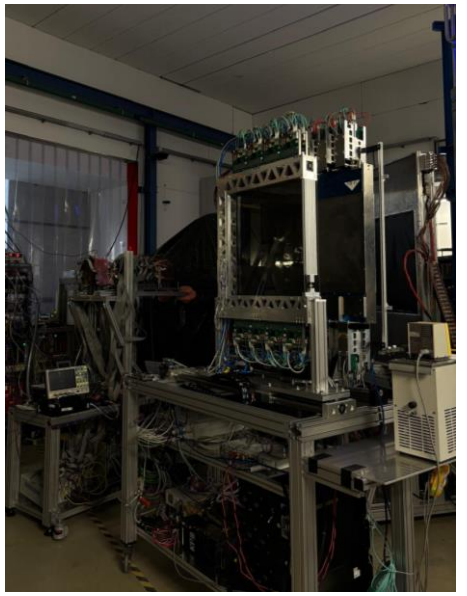


First SiPMs prototypes
2023

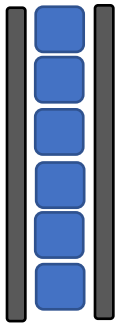
Fib70 detector mechanics
April 24

Fibbers production
May 24

Final mounting
November 24



Final commissioning
February 25



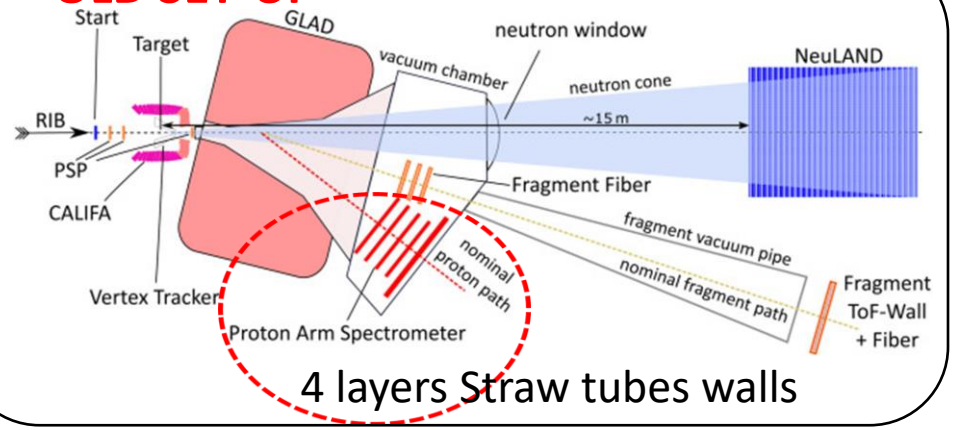
10 µm foil
200 µm square fibers
10 µm foil

Hamamatsu
S13552

The proton arm spectrometer

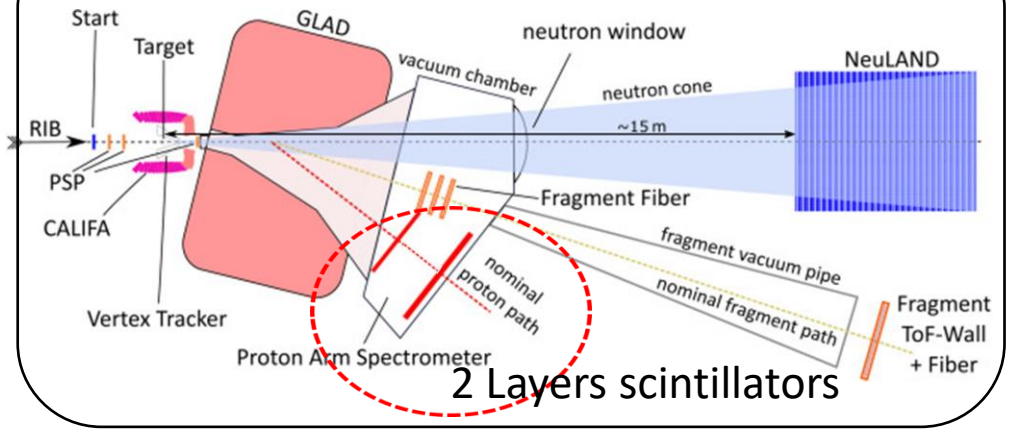
SiPMs modular solution taking advantage of the developed technology

OLD SET-UP

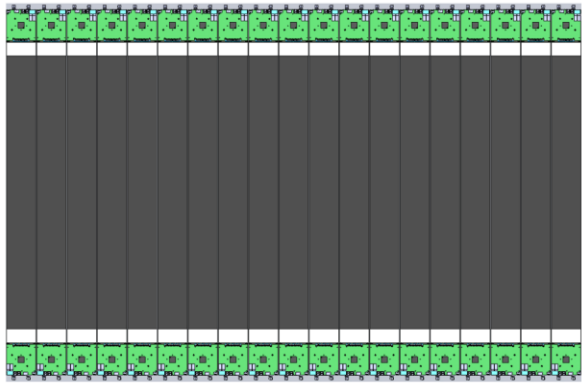


4 layers Straw tubes walls

NEW SET-UP



2 Layers scintillators

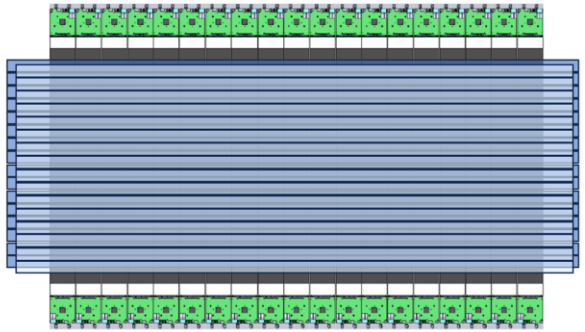


layer 1 - X1 Modules

3 layers 500µm
SiPMs readout

X2 layer - Modules
3 layers 500µm
SiPMs readout

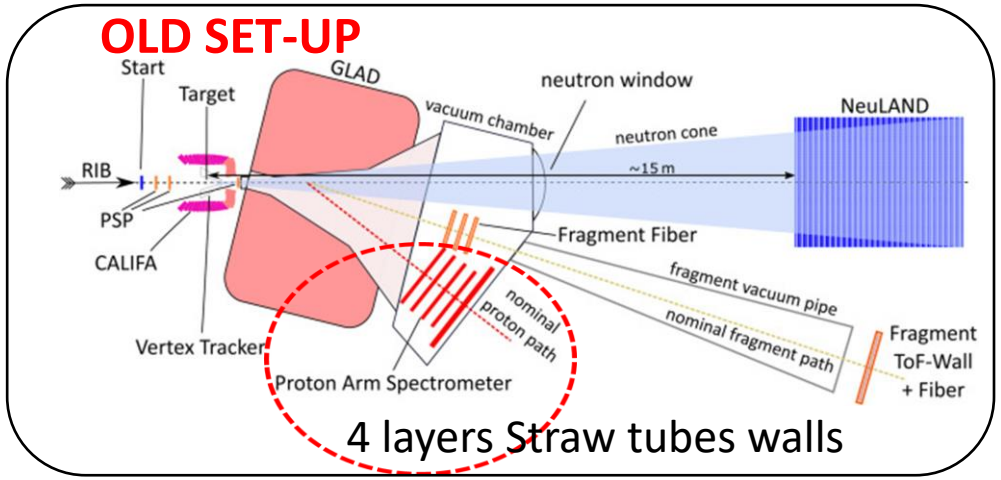
y layer
ToF wall + y coordinate
Scintillating bars two layers shifted

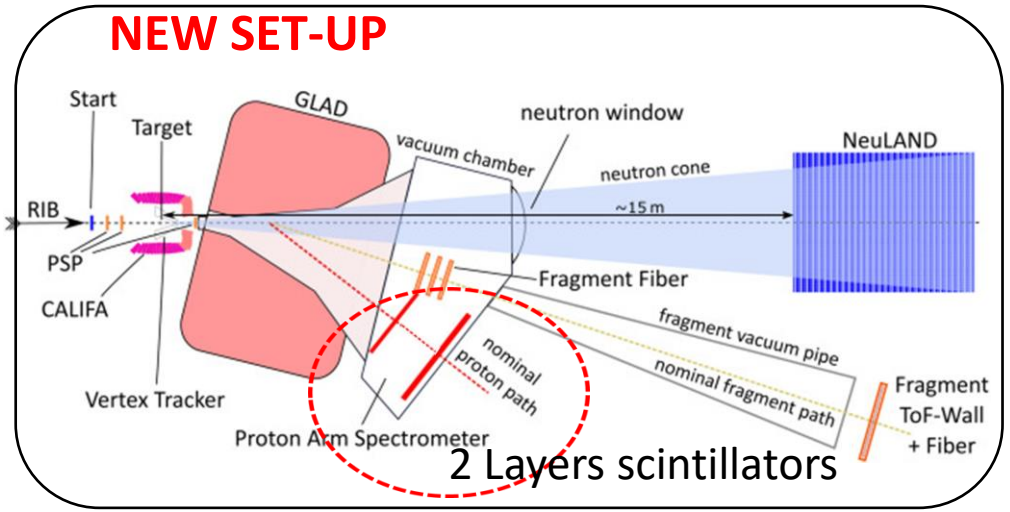


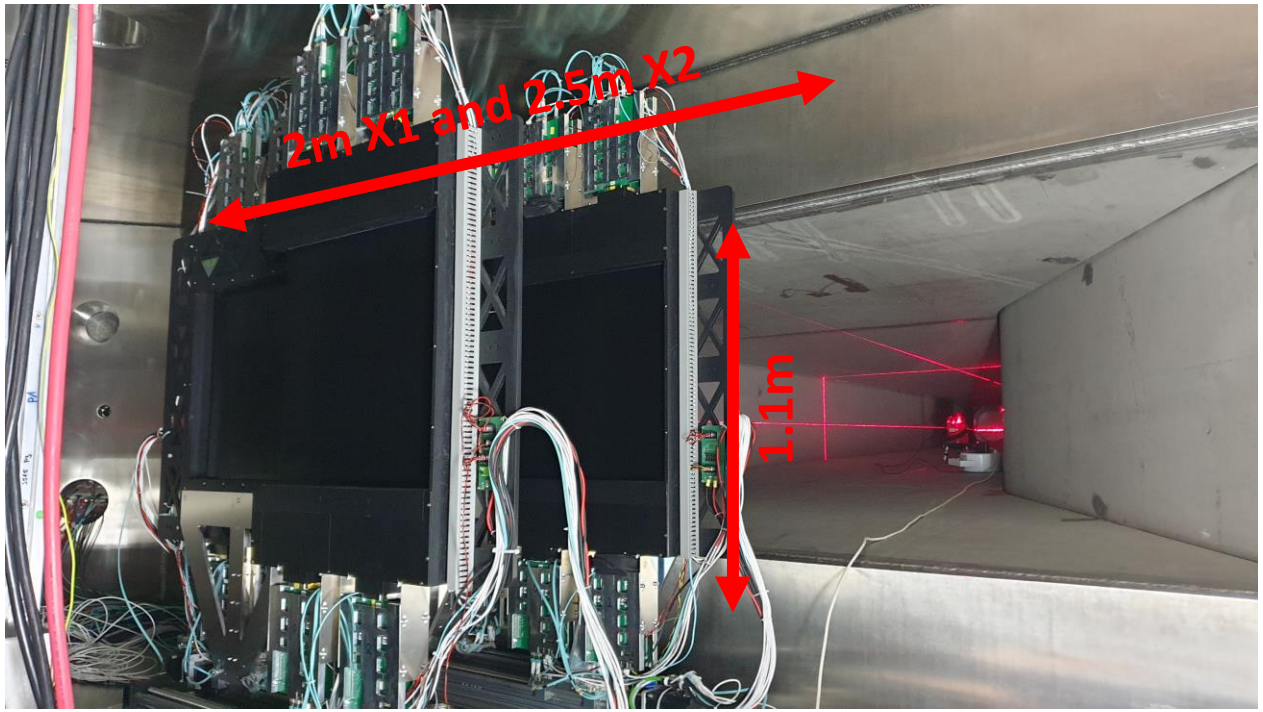
Concept – not to scale

The proton arm spectrometer

SiPMs modular solution taking advantage of the developed technology

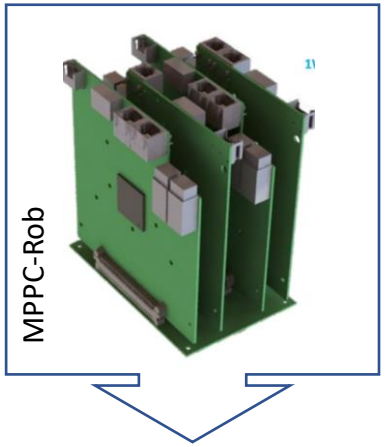




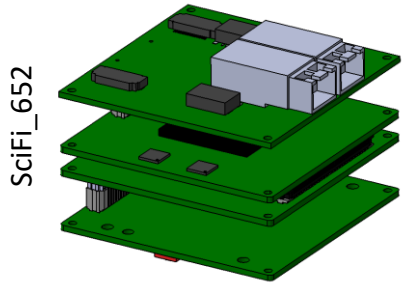


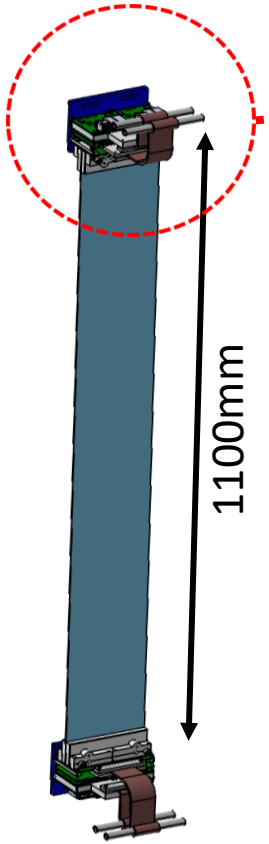
The proton arm spectrometer

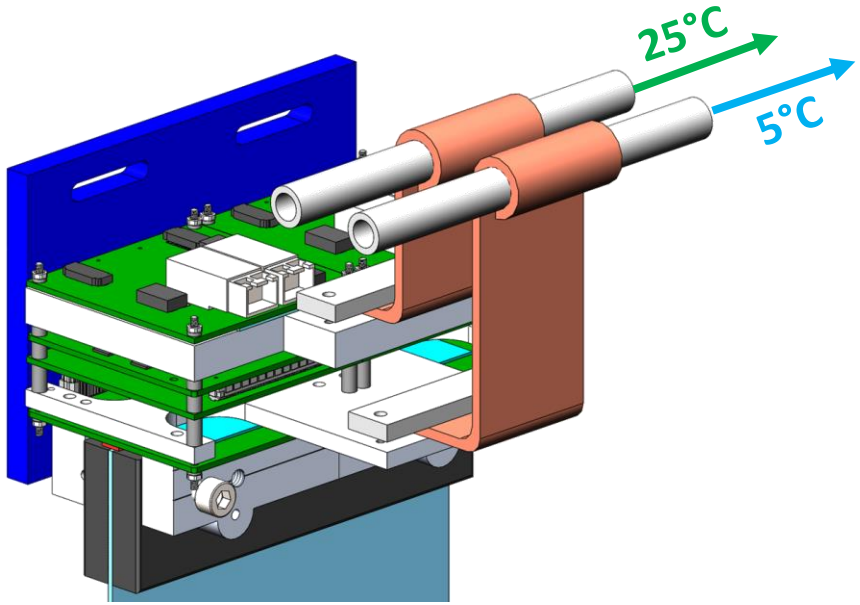
OLD ELECTRONICS

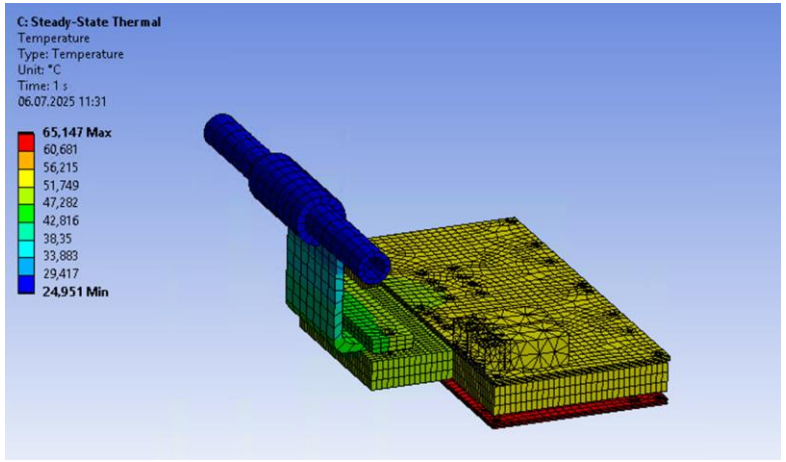


NEW ELECTRONICS

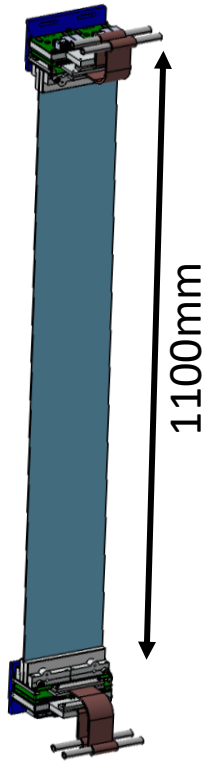




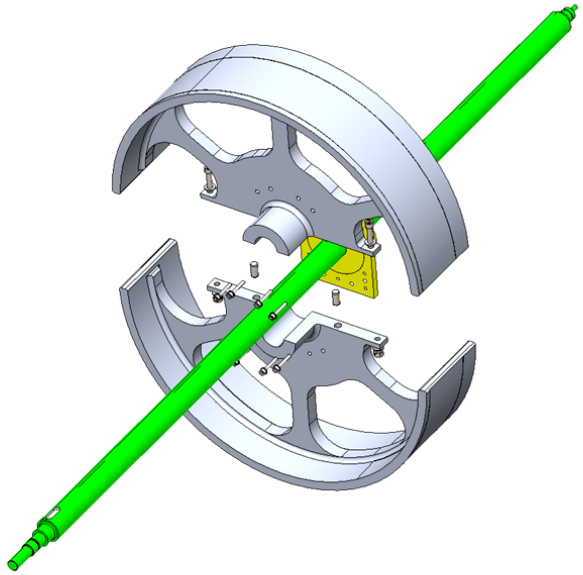




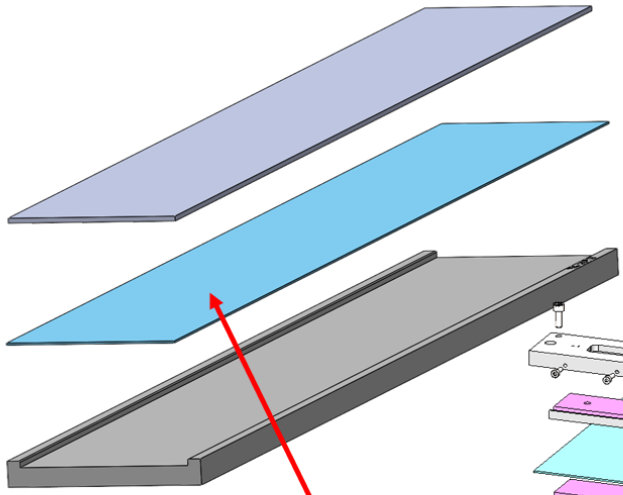
The proton arm spectrometer



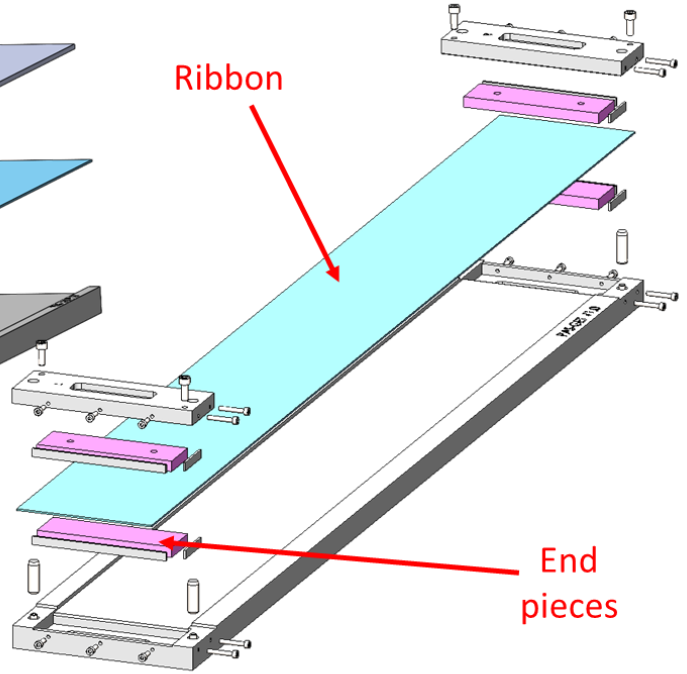
Wheel for fibers sorting



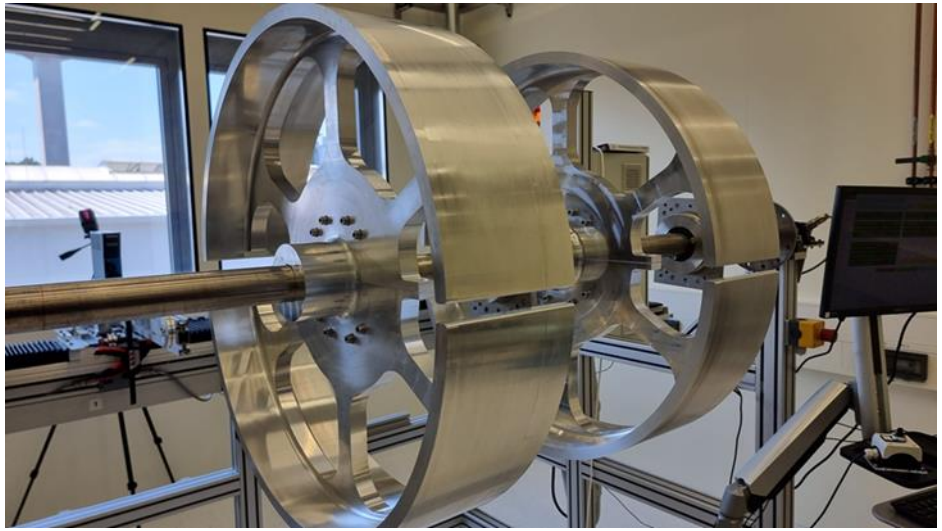
Layers gluing



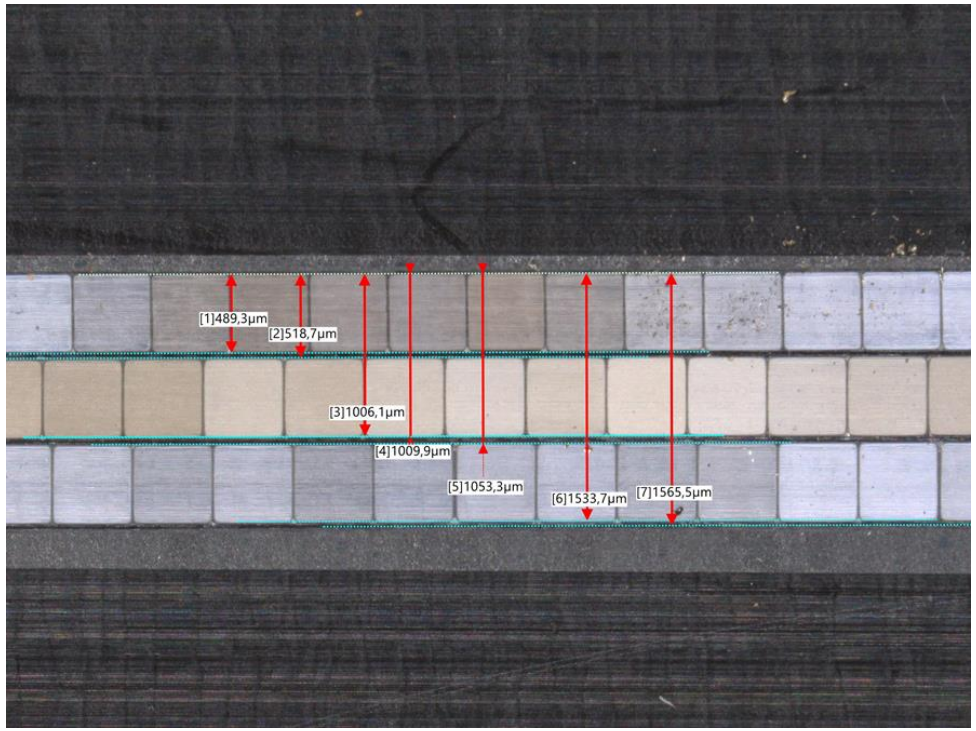
End pieces gluing



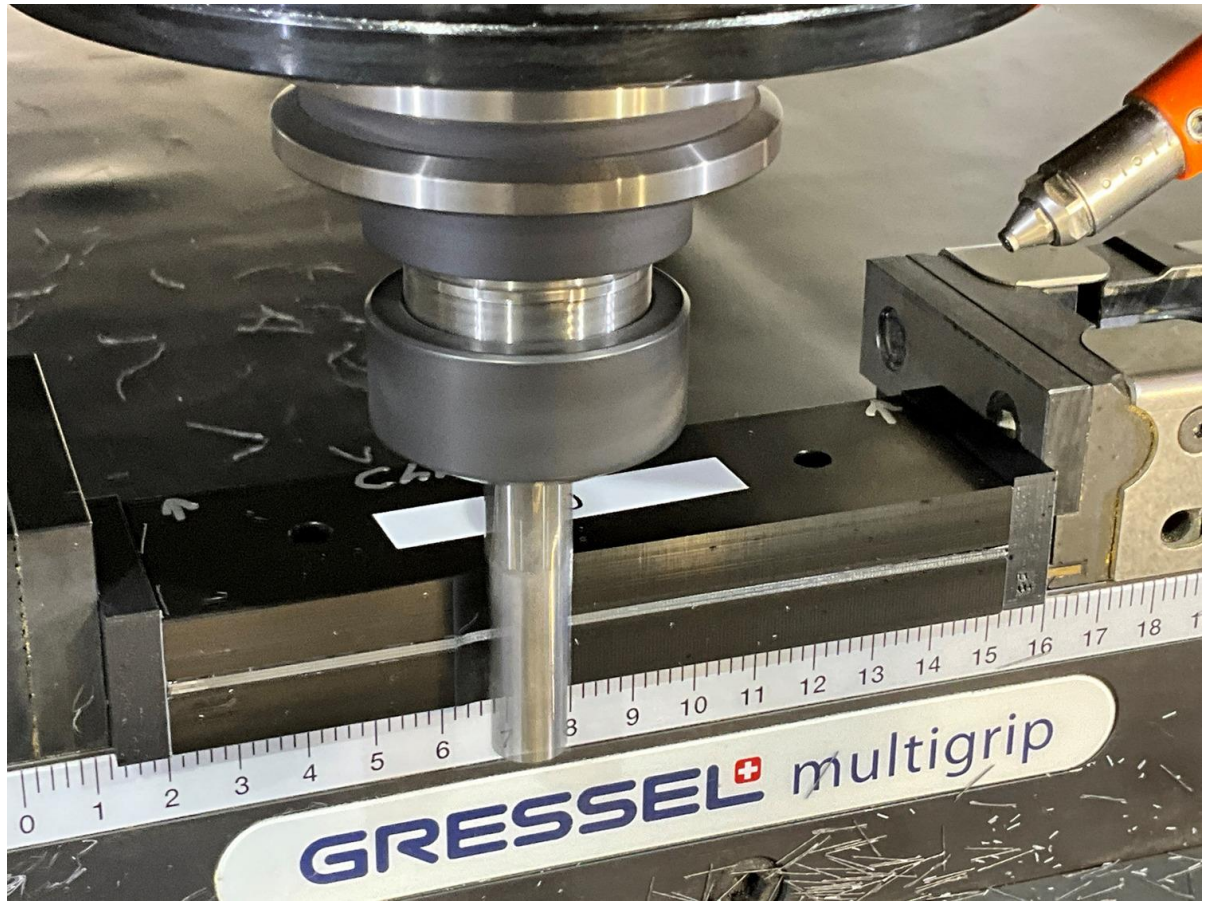
The proton arm spectrometer

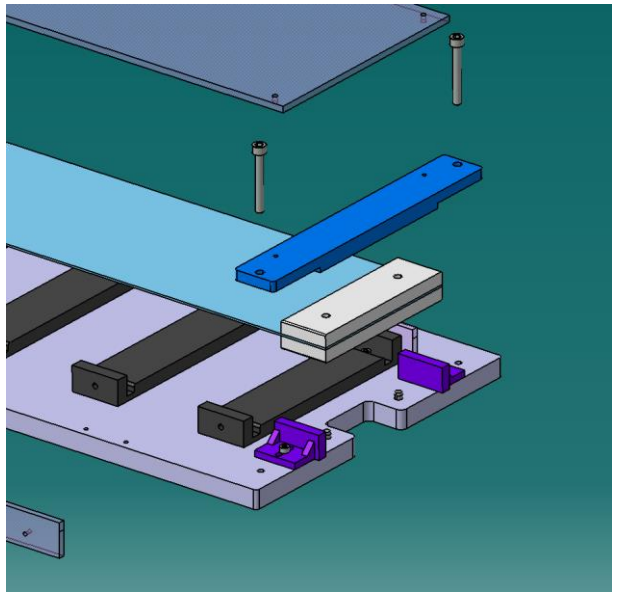


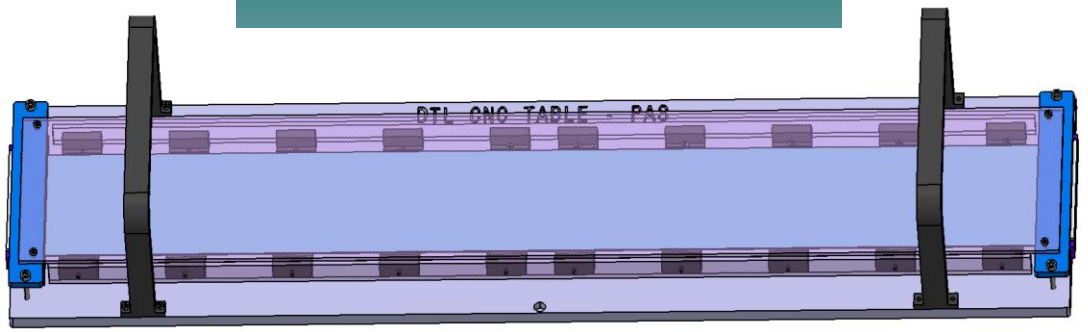
The proton arm spectrometer



The proton arm spectrometer

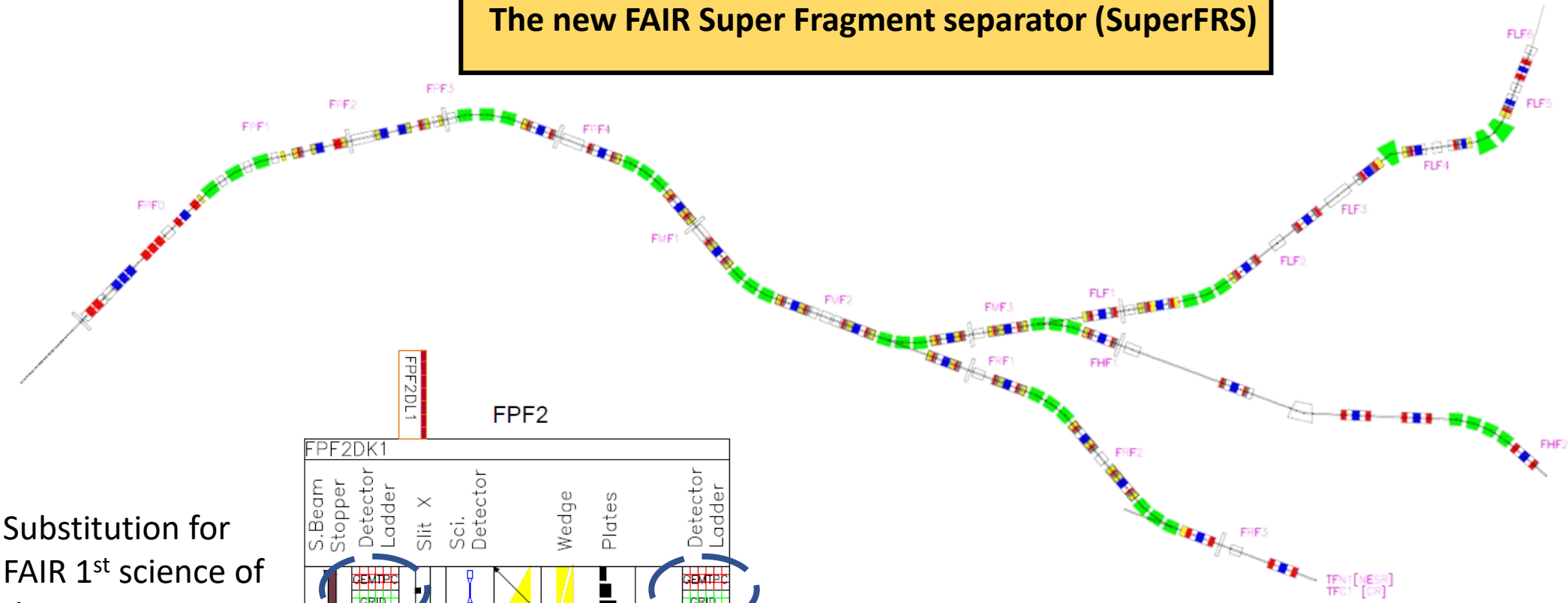






Super FRS SciFi trackers

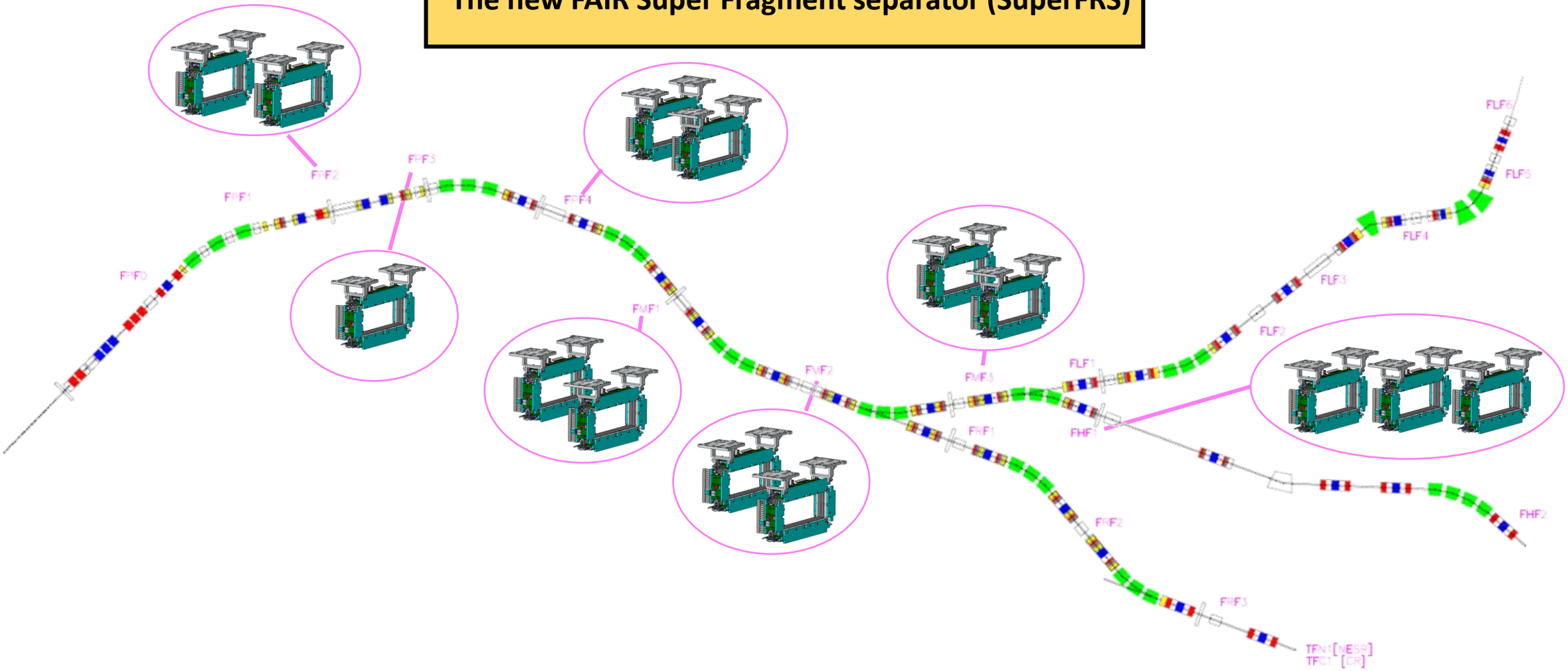
The new FAIR Super Fragment separator (SuperFRS)



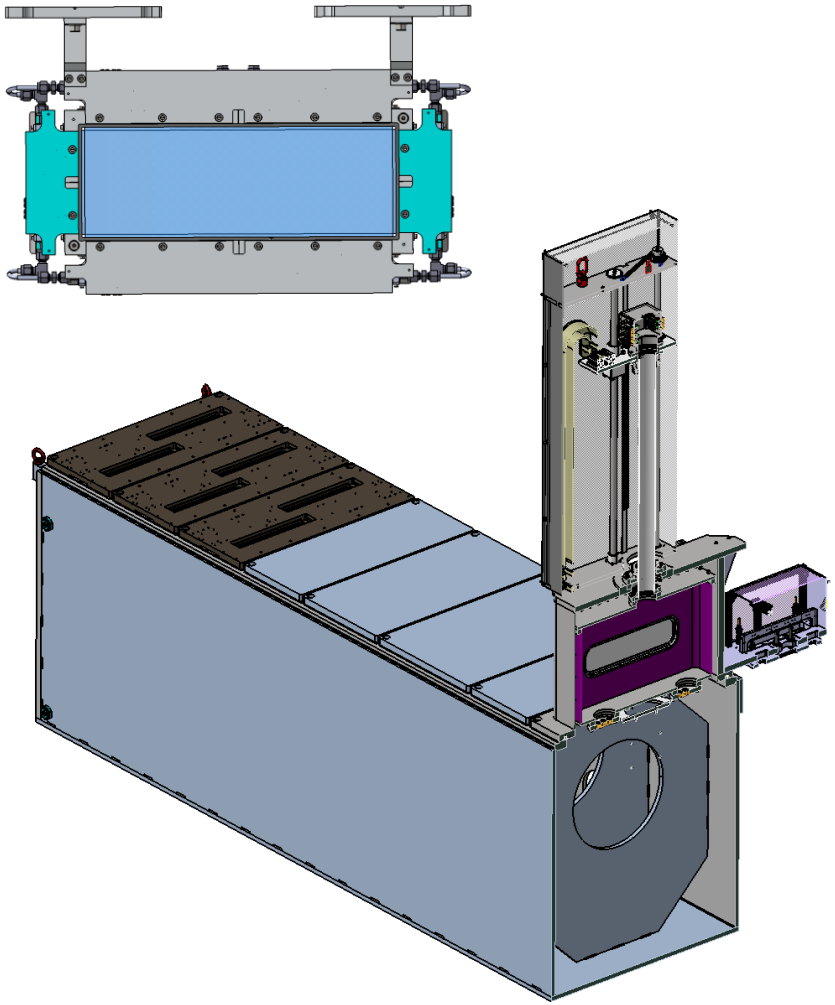
Substitution for FAIR 1st science of the GEMTPCs

Super FRS SciFi trackers

The new FAIR Super Fragment separator (SuperFRS)



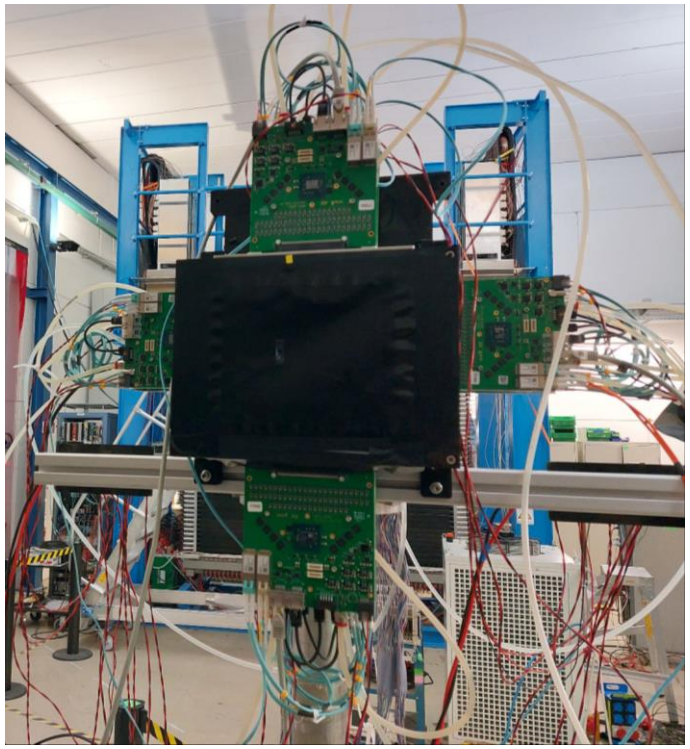
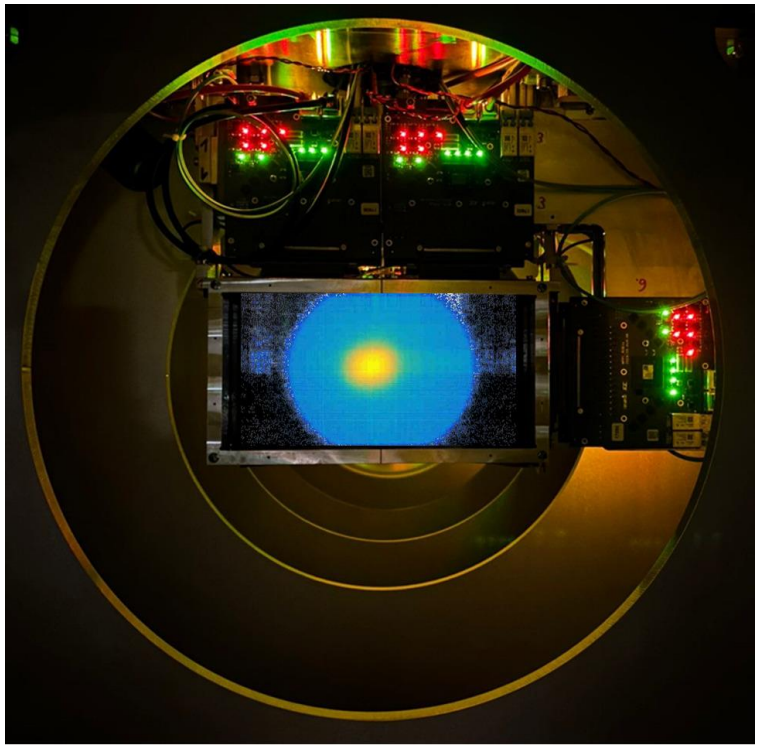
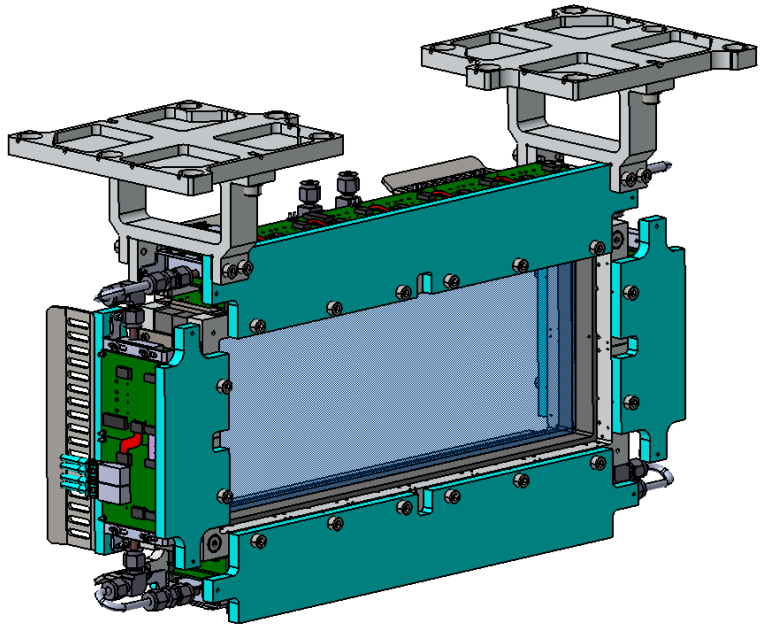
Super FRS SciFi trackers



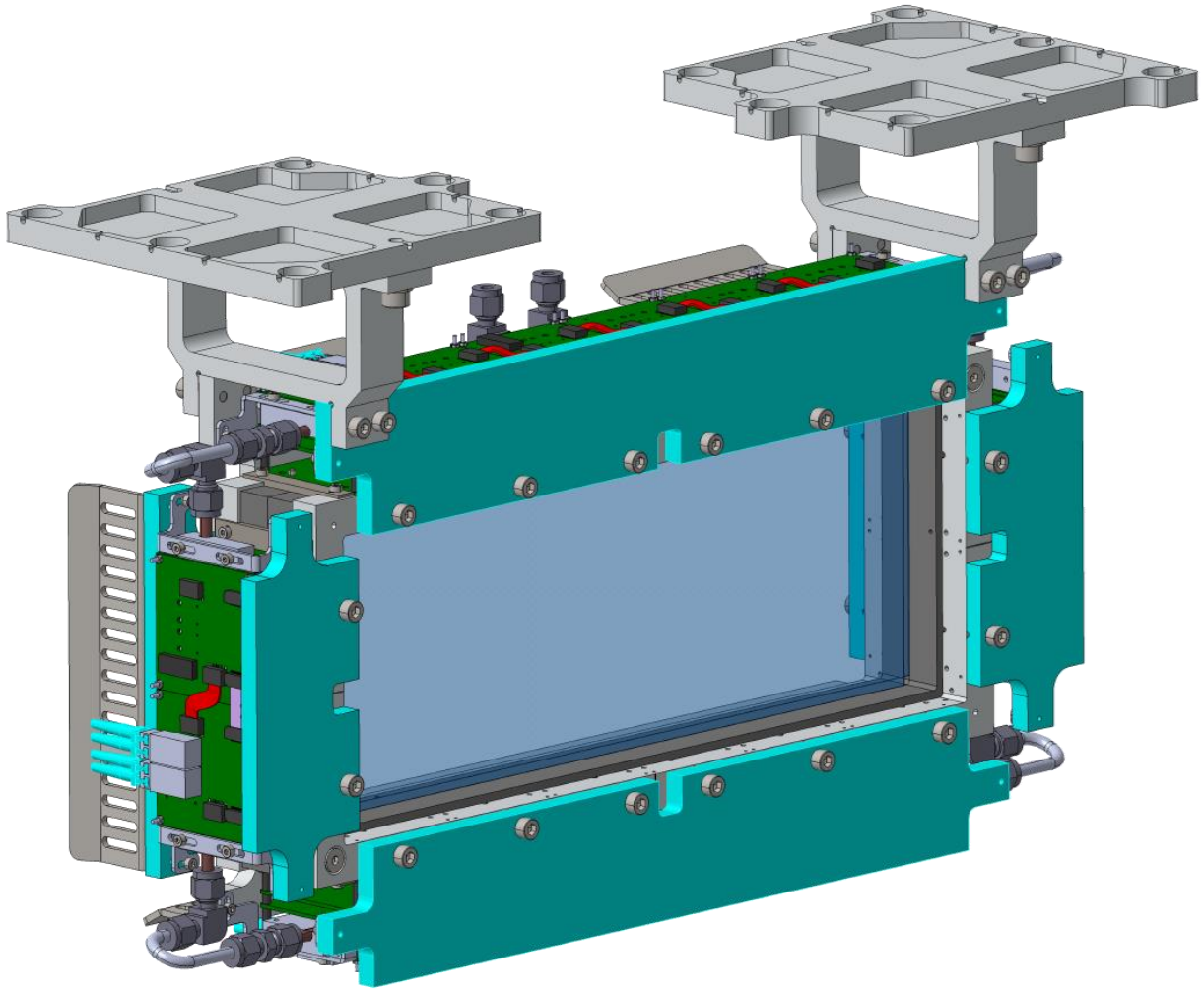
Requirements

- $\sigma_x = \sigma_y$ => 0.2mm
- X-Y profile In one detector
- Mountable in the ladder system – Movable in Y
- Cooling - possible operation in vacuum or in AIR but confined
- Maximum material homogeneity possible – Minimum material budget

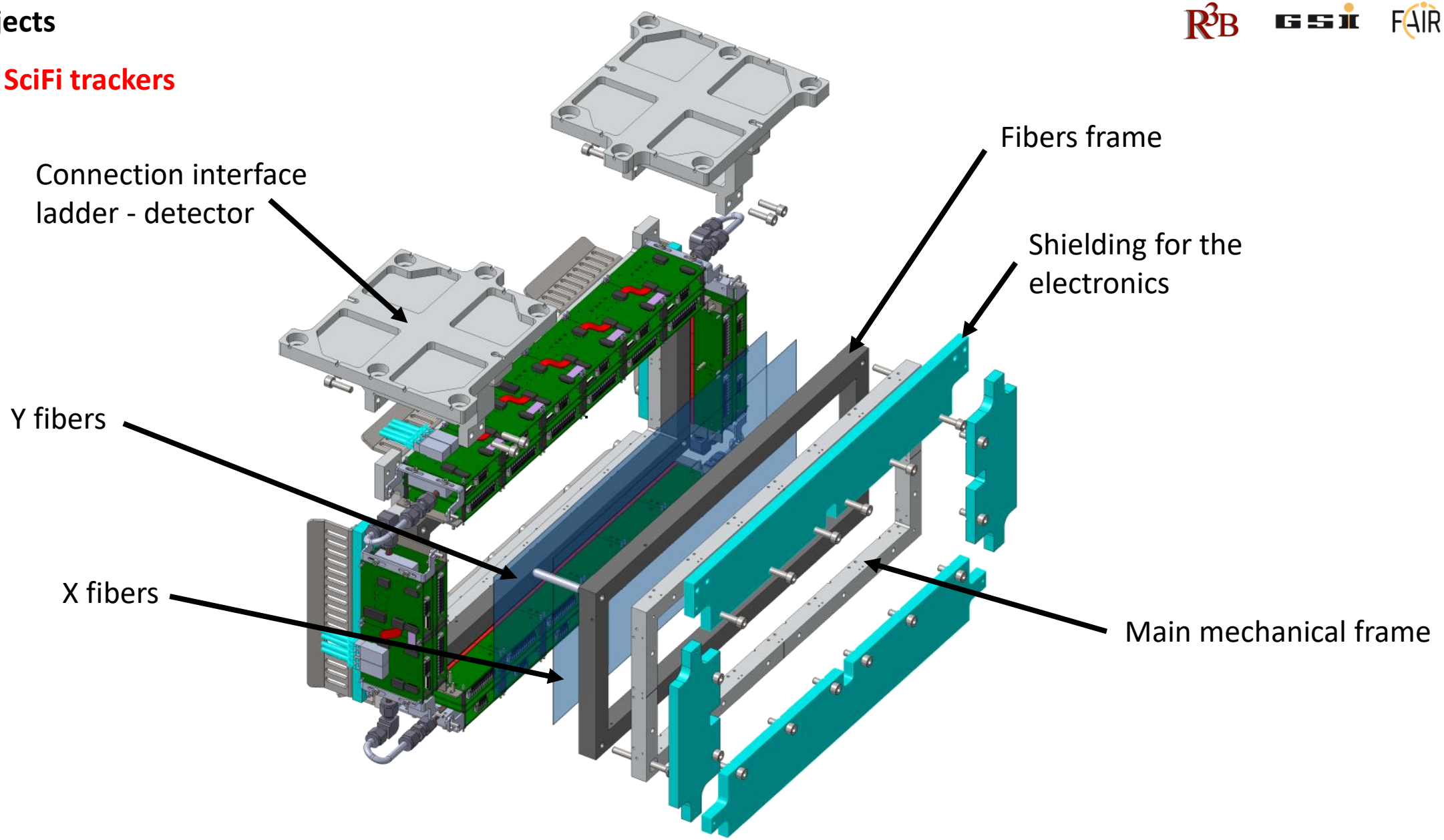
Super FRS SciFi trackers

Prototype Dec 2023	FoS Feb 2025	Series End of 2025
		
First electronics –MPPC-Rob Double side readout Air testing Rapid prototyping mechanics	First electronics –MPPC-Rob Single readout Vacuum testing Alu mechanics	New electronics –SciFI-652 Double readout Vacuum operation Alu and steel mechanics

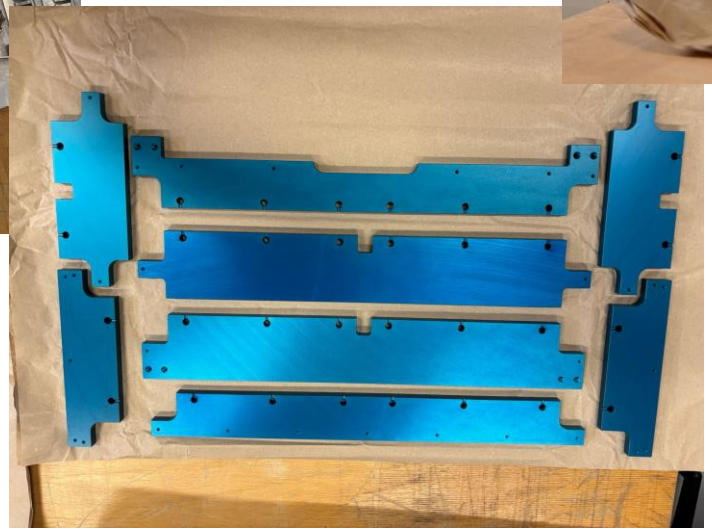
Super FRS SciFi trackers



Super FRS SciFi trackers



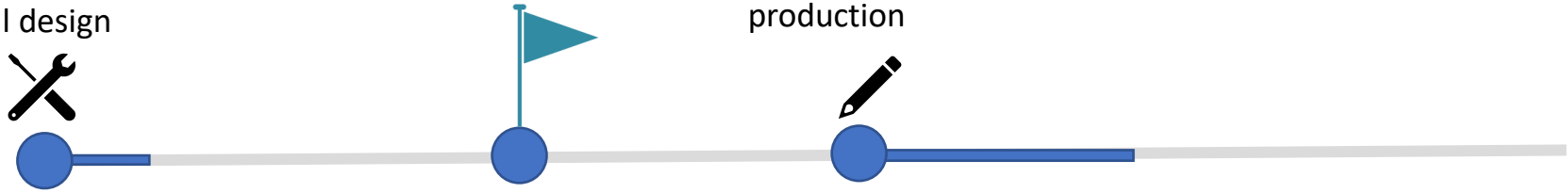
Super FRS SciFi trackers



3. What is coming

Nov-Dec 2025
PAS modules prototype
SuperFRS final design
first detector

Q1 2026
Close design of PAS
Start the structure production



13th December
Beam time – SuperFRS detector and PAS module in beam to test characteristics

Test new PASyToF prototype

2026 – 2027
PAS SERIES PRODUCTION

2026 – 2027
SFRS SERIES PRODUCTION

WE KEEP WORKING

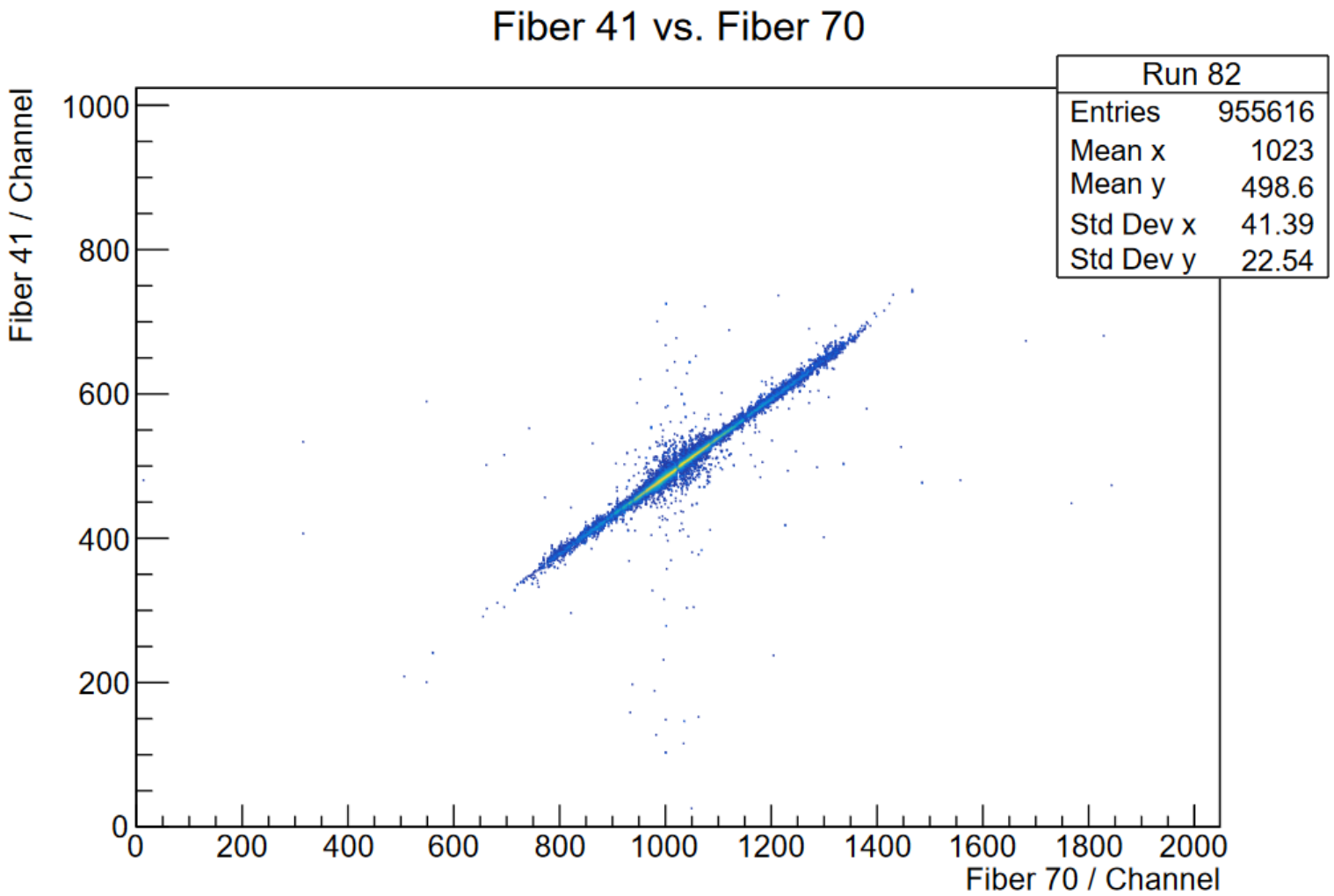
Backup slides

C.Caesar, H.Heggen, I.Brandherm, M.Heil, P.García-Gil, D.Körper, Deniz Savran,

Annual MT Meeting 2025

1. Fibs update

Fib 40 and Fib70 beam reuslt



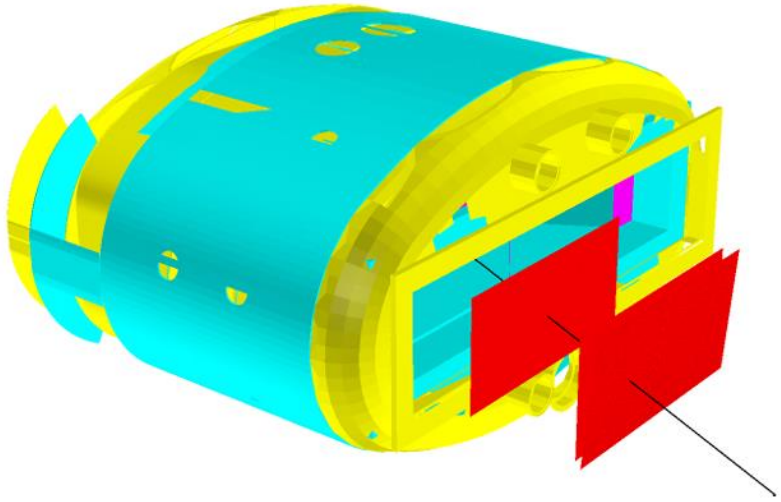
Plot from Isabelle Brandherm

PAS REQUIREMENTS

Better momentum resolution tan 1%

More scintillating material → Better detection efficiency

More angular scattering → Worse momentum resolution

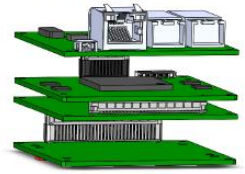


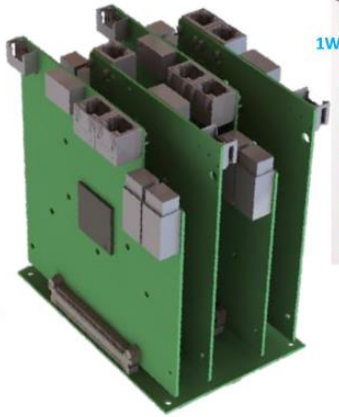
fiber thickness in mm	0.1	0.5	1.0	1.5	2.0
dp in %	0.022	0.028	0.041	0.050	0.059

ELECTRONICS

- ***Readout Electronics @ Exp. Elec. Department***

SciFi_652



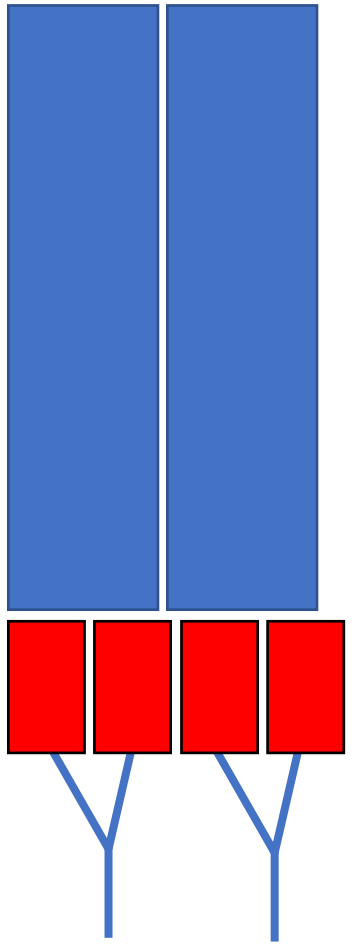


Upgrade

MPPC_ROB

- Power consumption under 90mW/Ch
- Individual threshold
- Recording of the leading and trailing edges with a 170 ps resolution. (FPGA TDC)
- TDC data is read out via a 5 Gbps optical link

Hamamatsu S13552



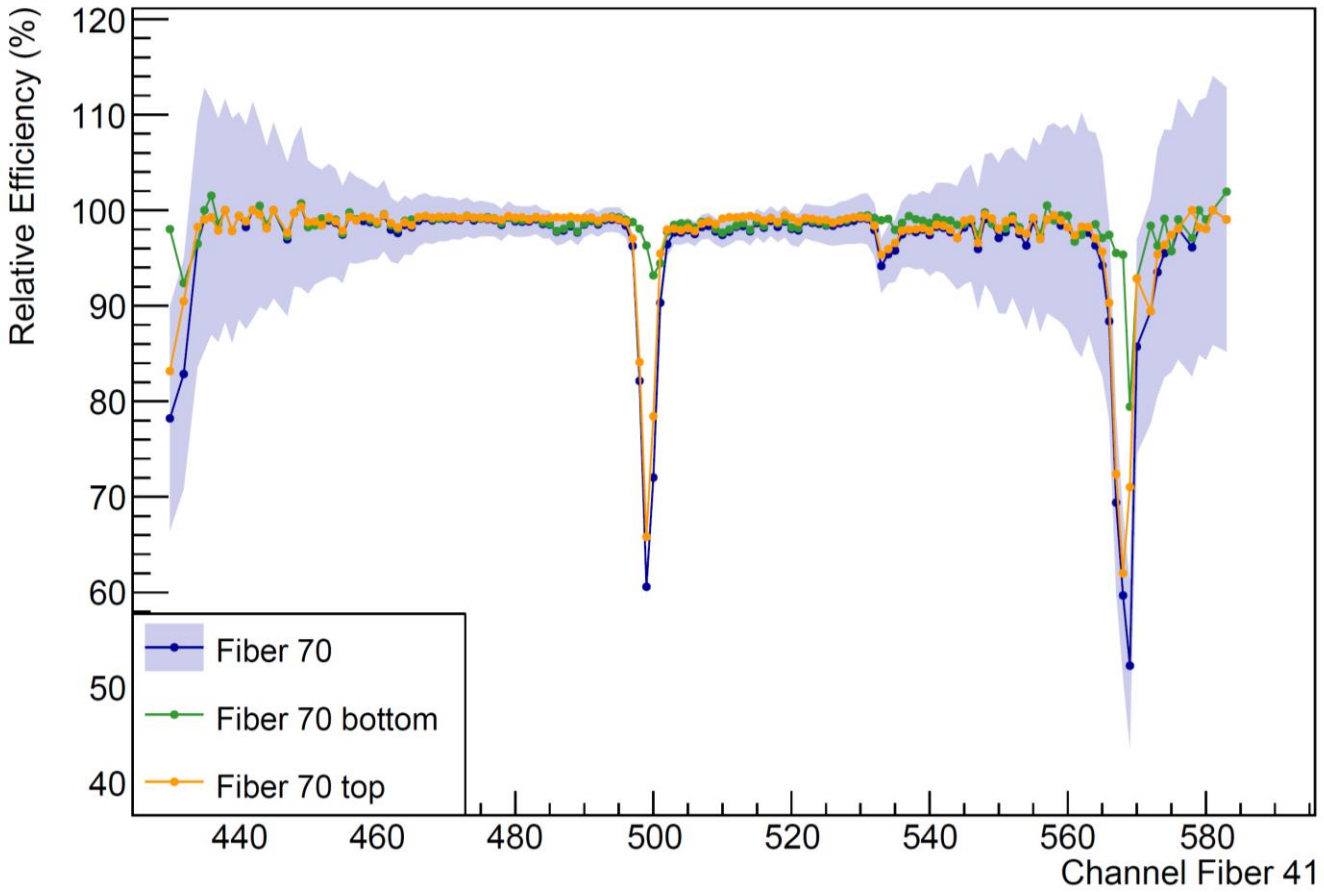
Fibers 500µm

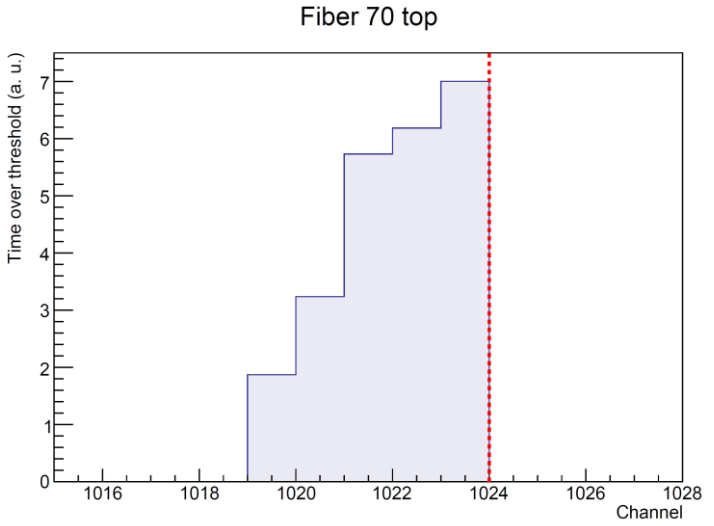
SiPMs 250µm pitch

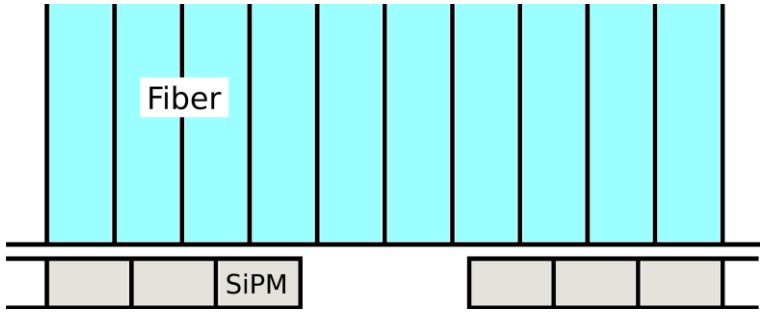
Plot from Isabelle Brandherm

1. Fibs update

Fib70 results







Plots from Isabelle Brandherm