Active Target project – status and plans
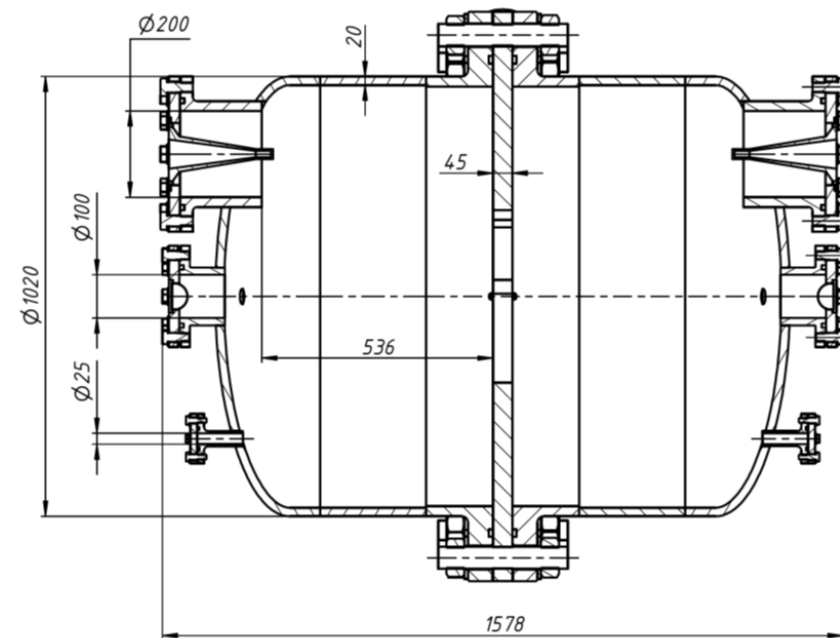
OLEG KISELEV

GSI DARMSTADT

Pressure vessel ACTAF1

Agreement between GSI, TUM, University of Bonn and University of Mainz to build a TPC for PRM AMBER and R3B

CE certified, all welded connections tested by X-rays

Documentation about all materials and processes

Accembled and tested at the company on 17.10.2023
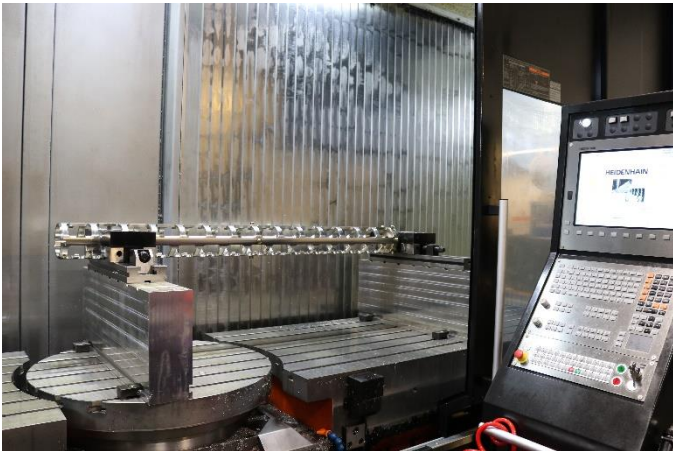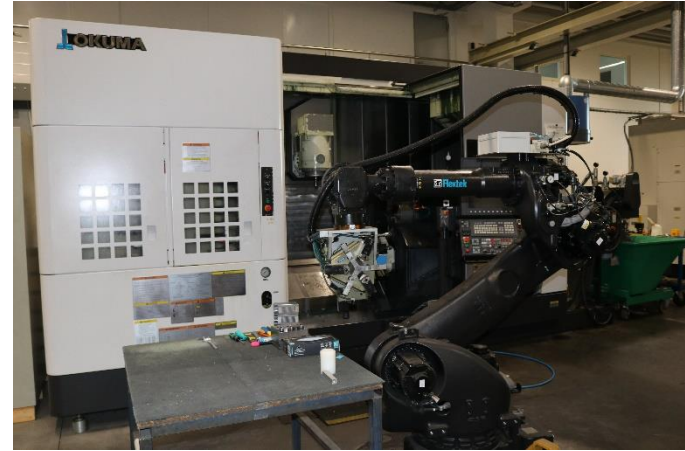
Pressure vessel - photos

Ready to be delivered
Postponed due to the production of the middle flange and overpressure test

Pressure vessel - photos

9-axis CNC machines
Parts up to 2.m long
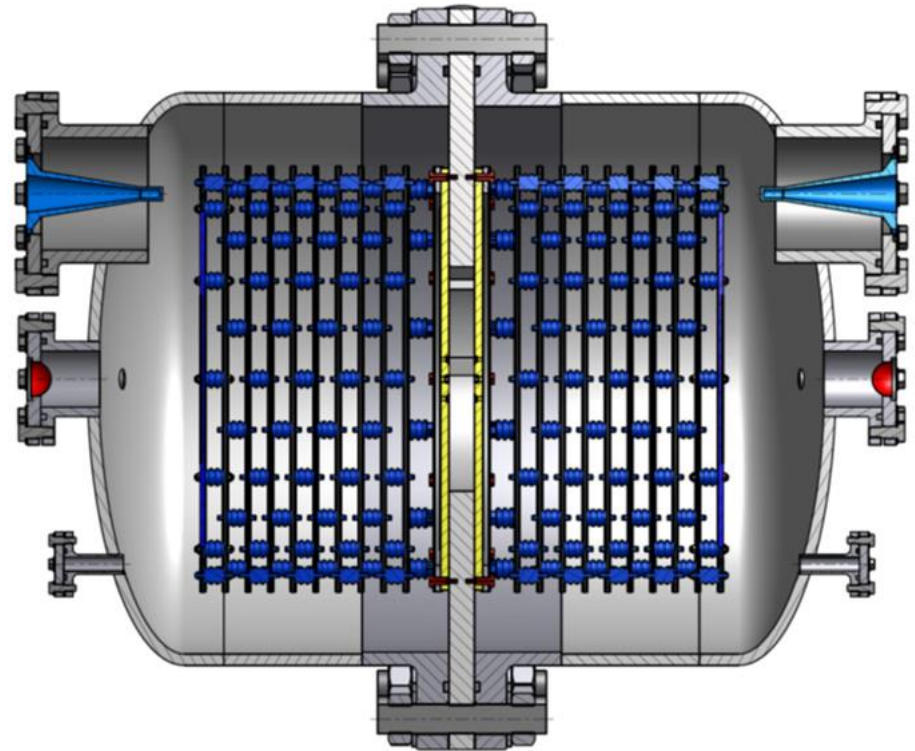CMM machine for measuring
the parts

MC Uldall, Denmark

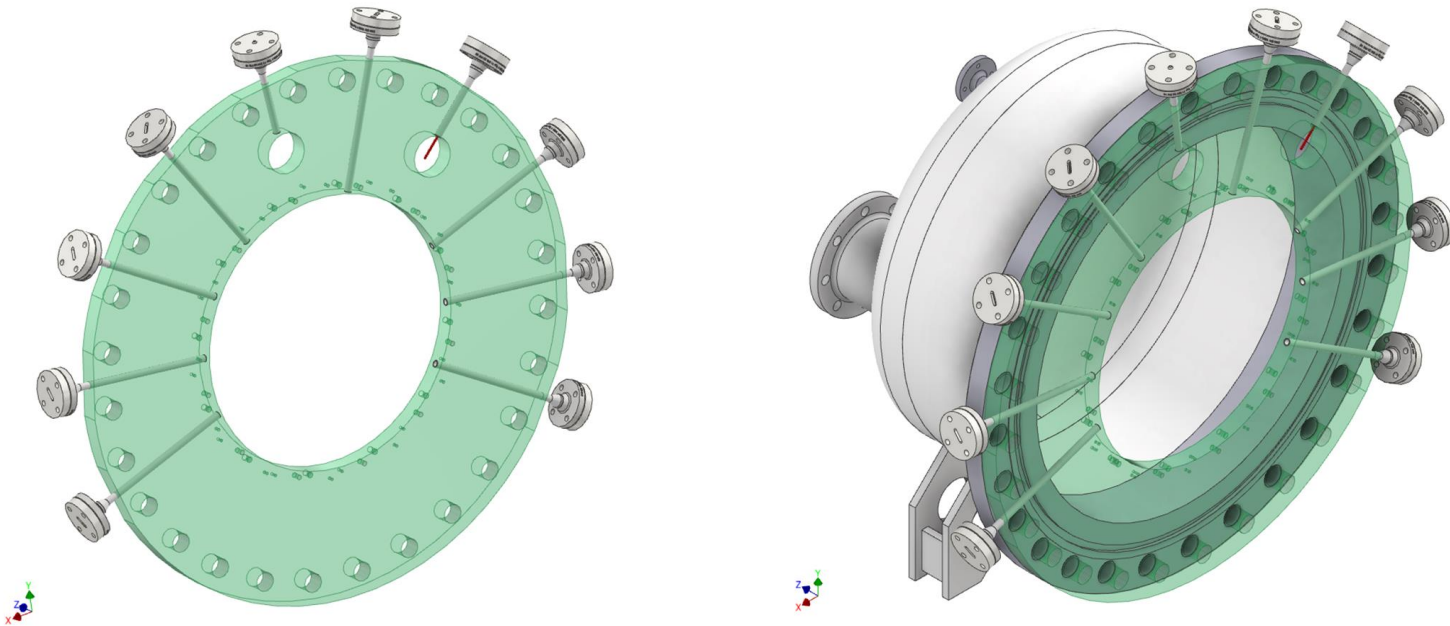# Active Target – electrodes on a middle flange

Anode diameter – 600 mm

Drift length – 400 mm

Deformation-free construction - inner electrodes are fixed to the middle flange
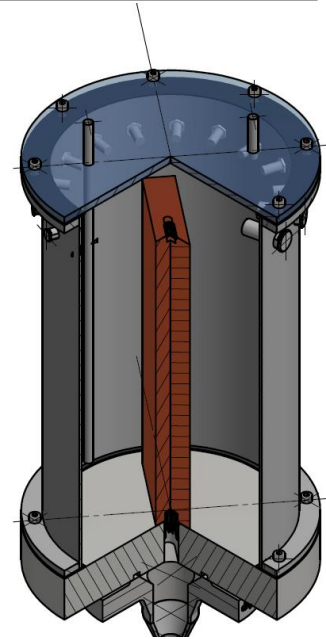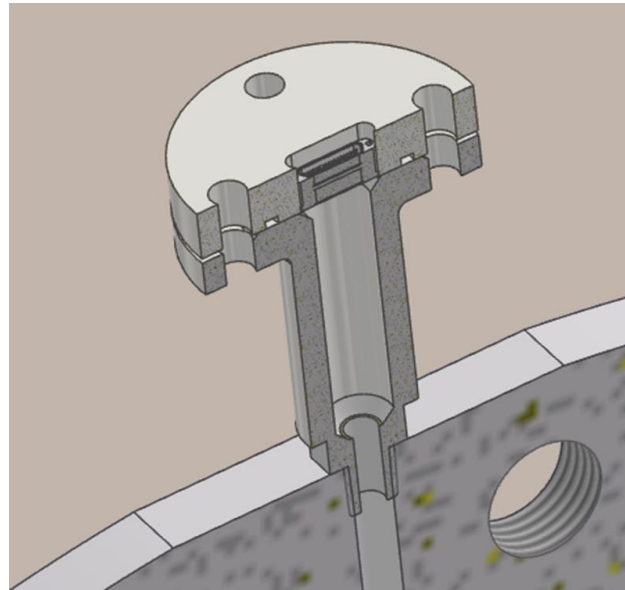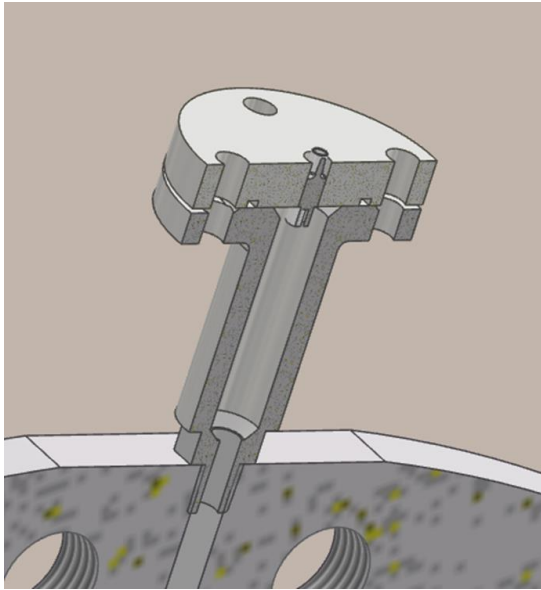
Middle flange

Base holding structure for all innere elements

Must be precise and fitting the electrodes, field shaping rings

Middle flange

8 small flanges for preamps

1 small flange for 15 kV HV connectors

All small flanges covered by the protection (N_2-filled) cylinders
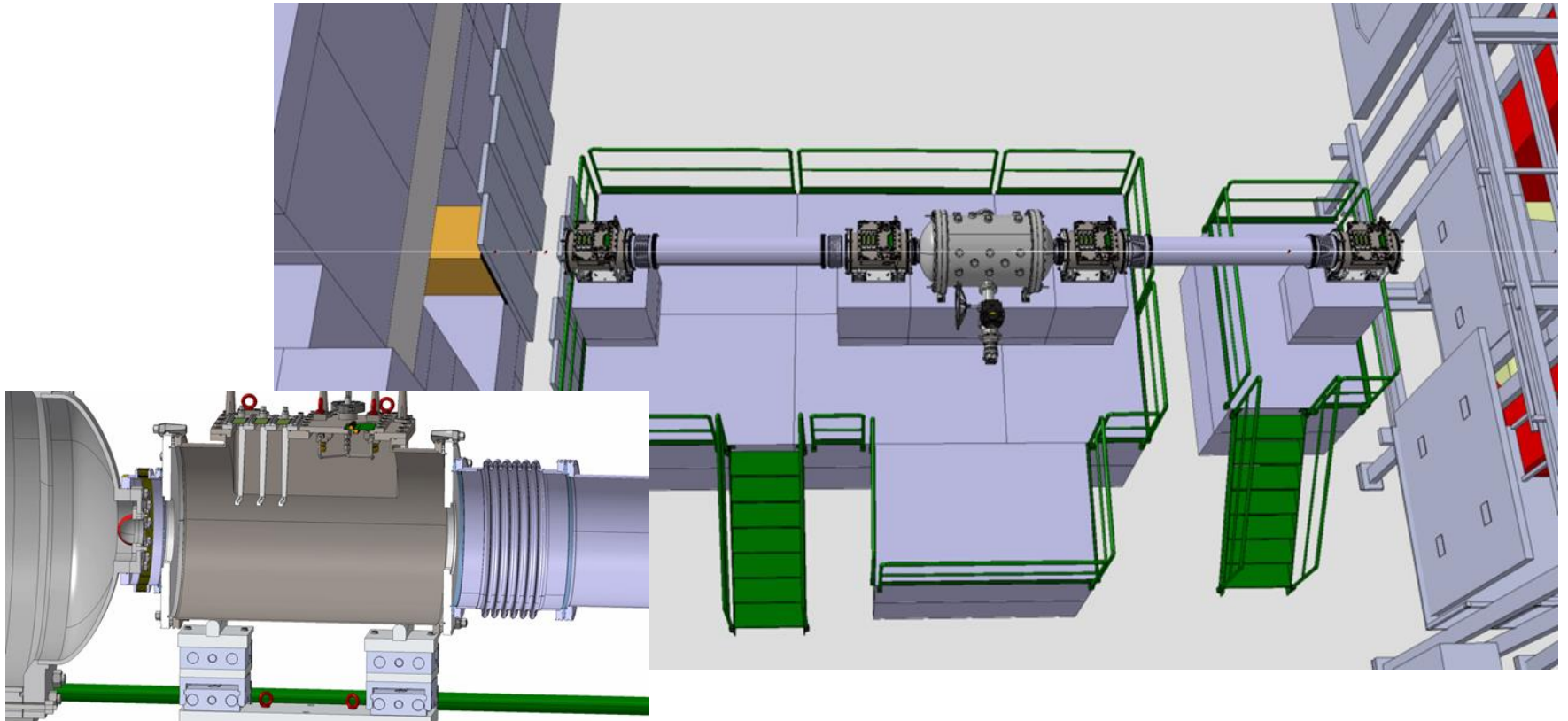
1 small flange for temperature sensor

Middle flange with all small flanges produced by the same company as the pressure vessel

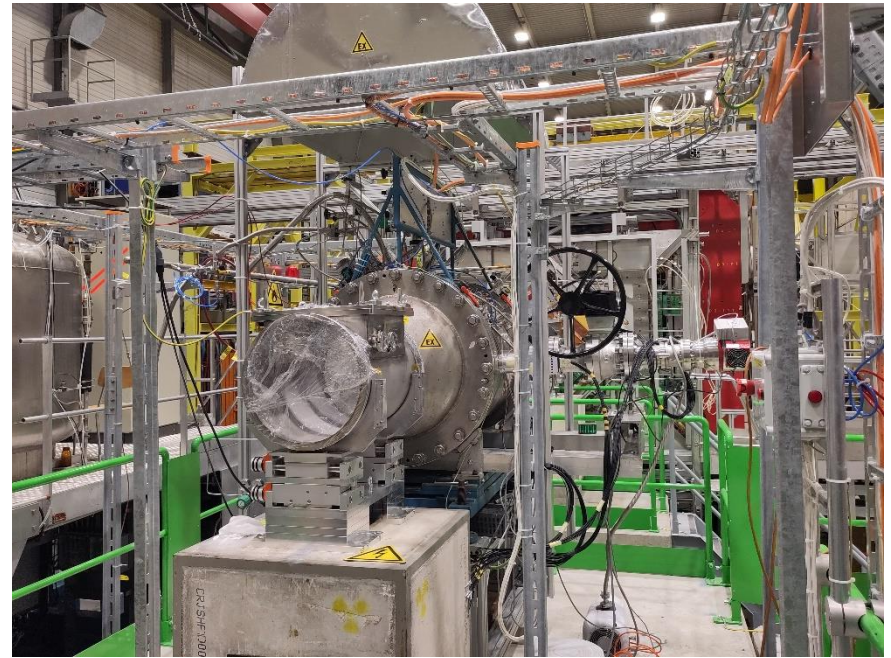# PRM test run, September 2023

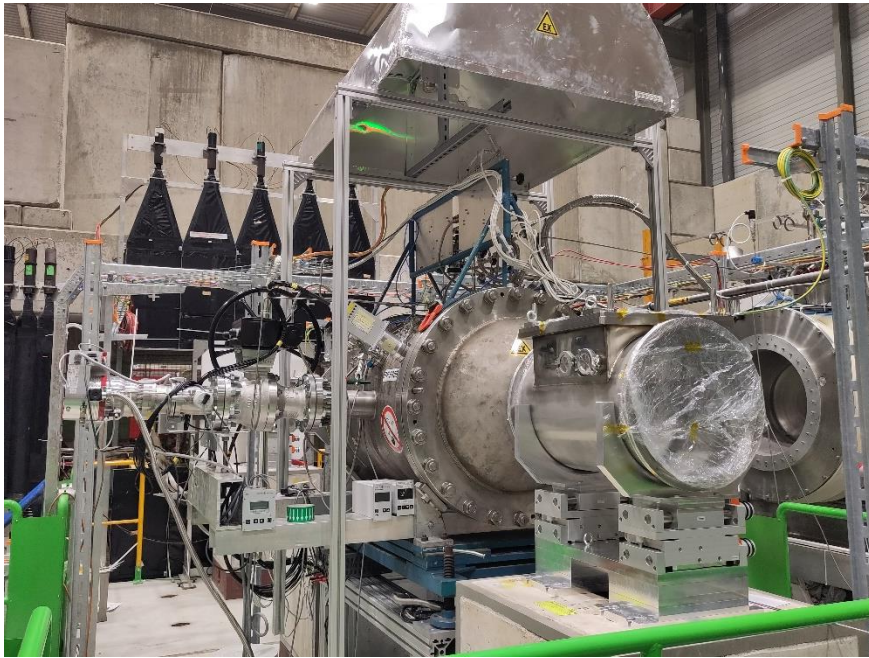First combined test of IKAR TPC with the fibers and ALPIDE-based tracker

Components of the new trigger-less DAQ

Upgraded IKAR on the target platform at CERN

Basically new detector (only pressure vessel remained from the old IKAR)

Vacuum, HV, gas, PLC/slow control systems new

Advanced safety system

Gas P&ID system
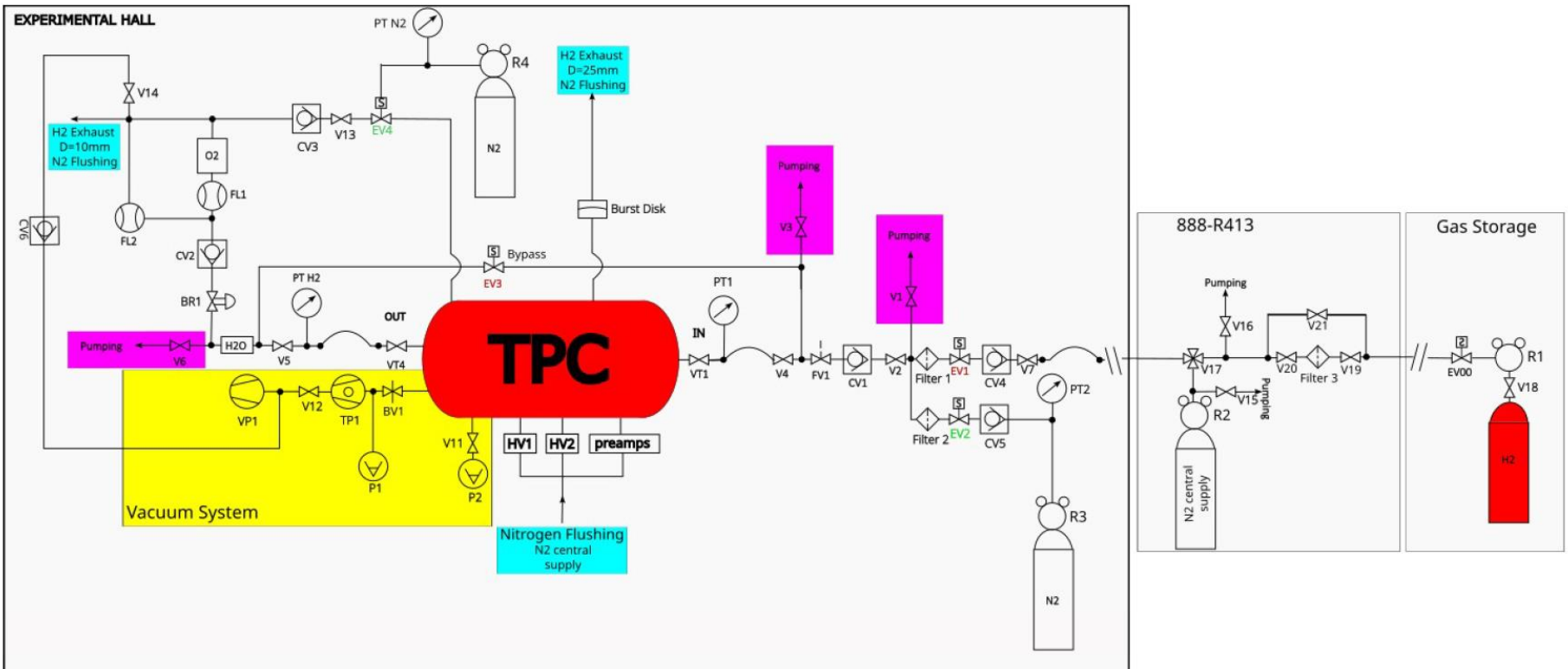
Complex, PLC-controlled system

More complex (due to recirculation) is needed for the main TPC

GSI VME readout (detached from IKAR)

Scheme to run in a standalone mode
Sync via time stamp
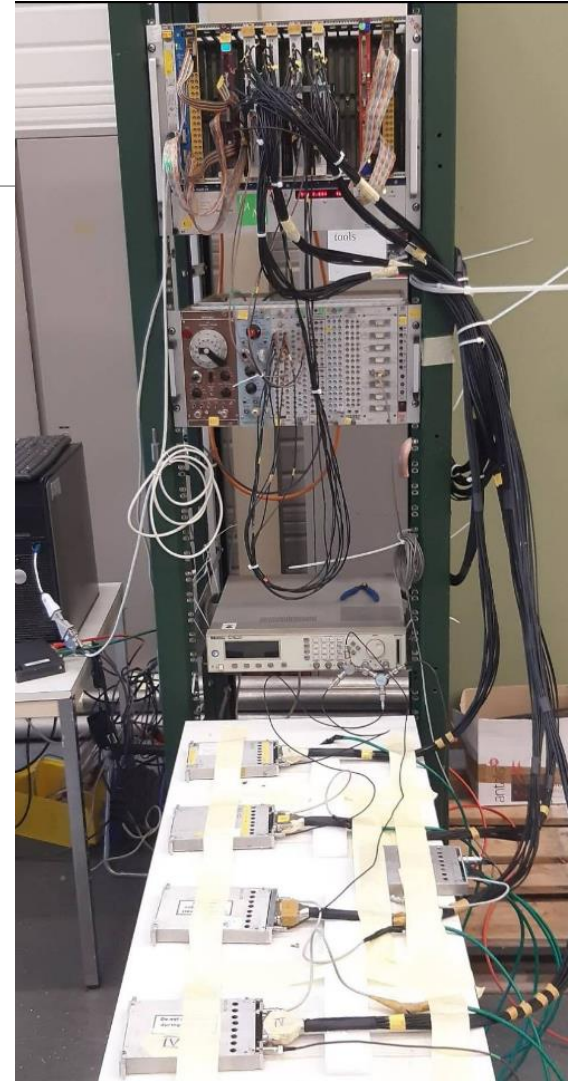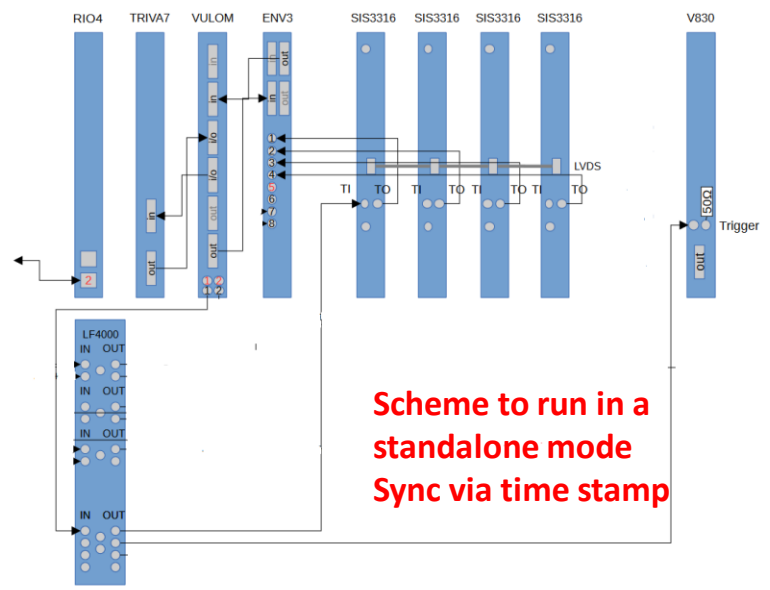
Bastian Löher, Alexander Inglessi and Oleg Kiselev

GSI Ethernet readout
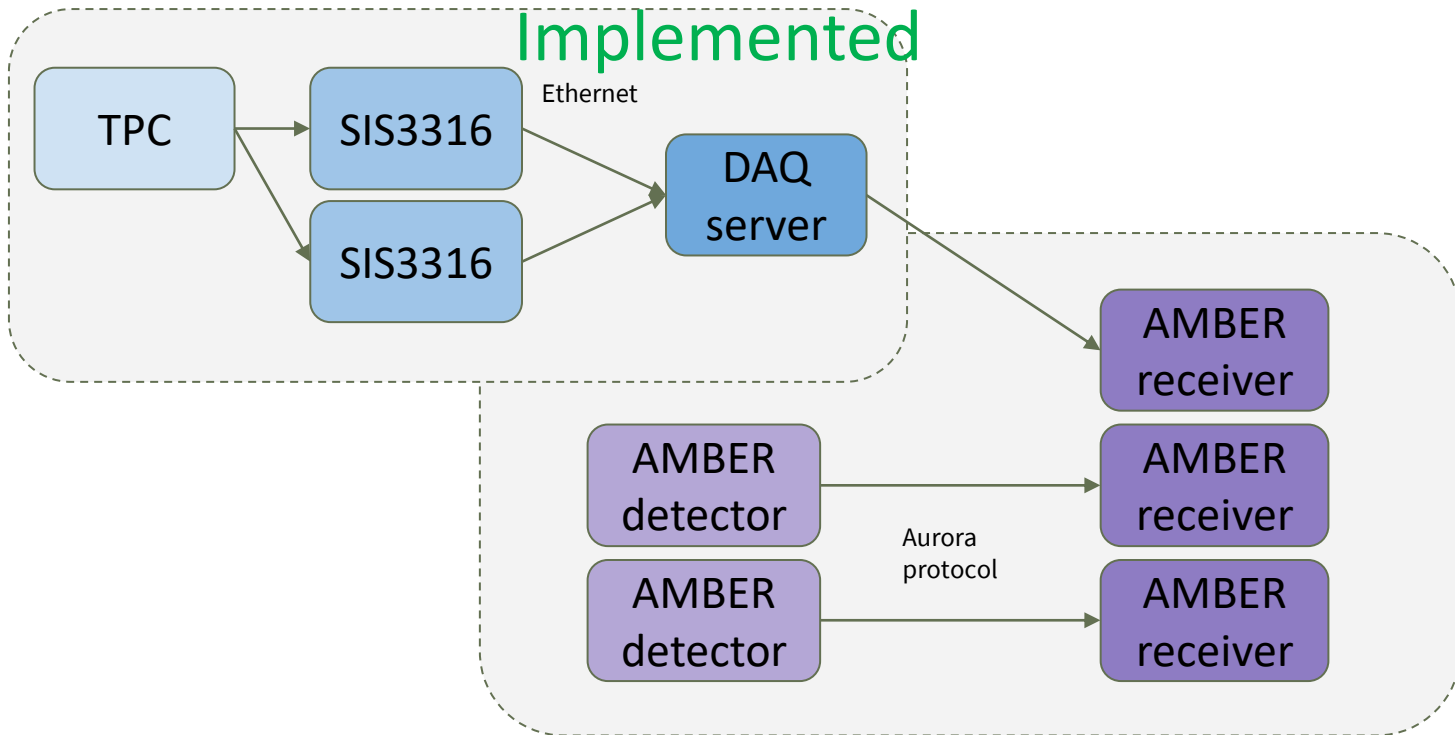
Trigger system

- **TPC trigger** is OR of all SIS3316 trigger outputs
- Sent to AMBER TCS
- AMBER TCS emits readout trigger aligned to image boundary
- SIS3316 switch memory banks and record data

Implemented
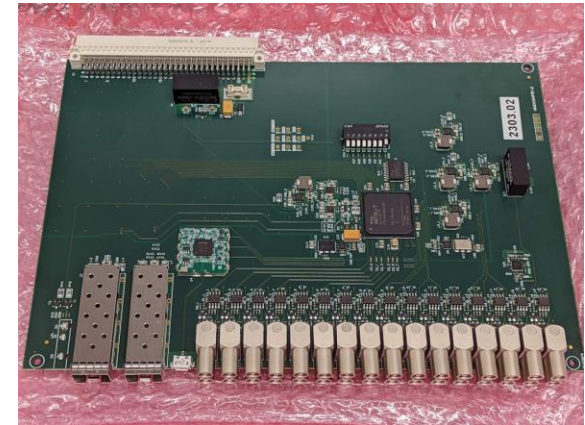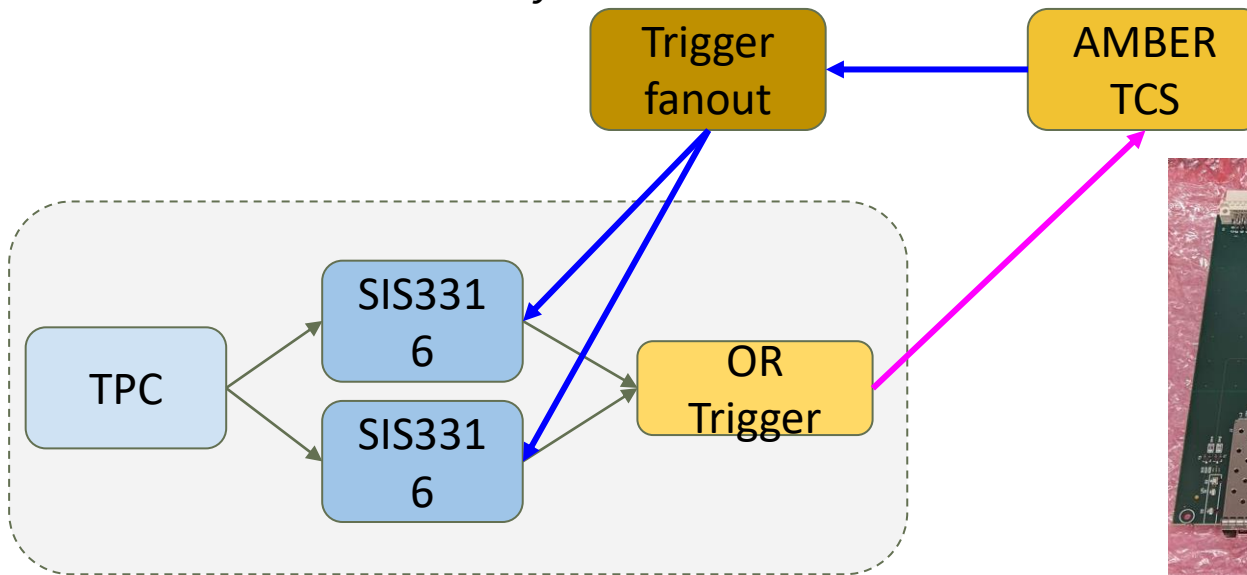
AMBER TCS

Clock synchronisation

- 19.44 MHz base clock from TCS, possibly paired with rataclock to include AMBER timestamp information
- Distributed to SIS3316 modules to label clock edges with absolute timestamps
- Check synchronisation of SIS3316 ADCs continuously
- Check synchronisation of TPC data with other AMBER detectors

Rataclock fanout

AMBER TCS

Implemented

TPC

SIS3316

SIS3316

AMBER TCS
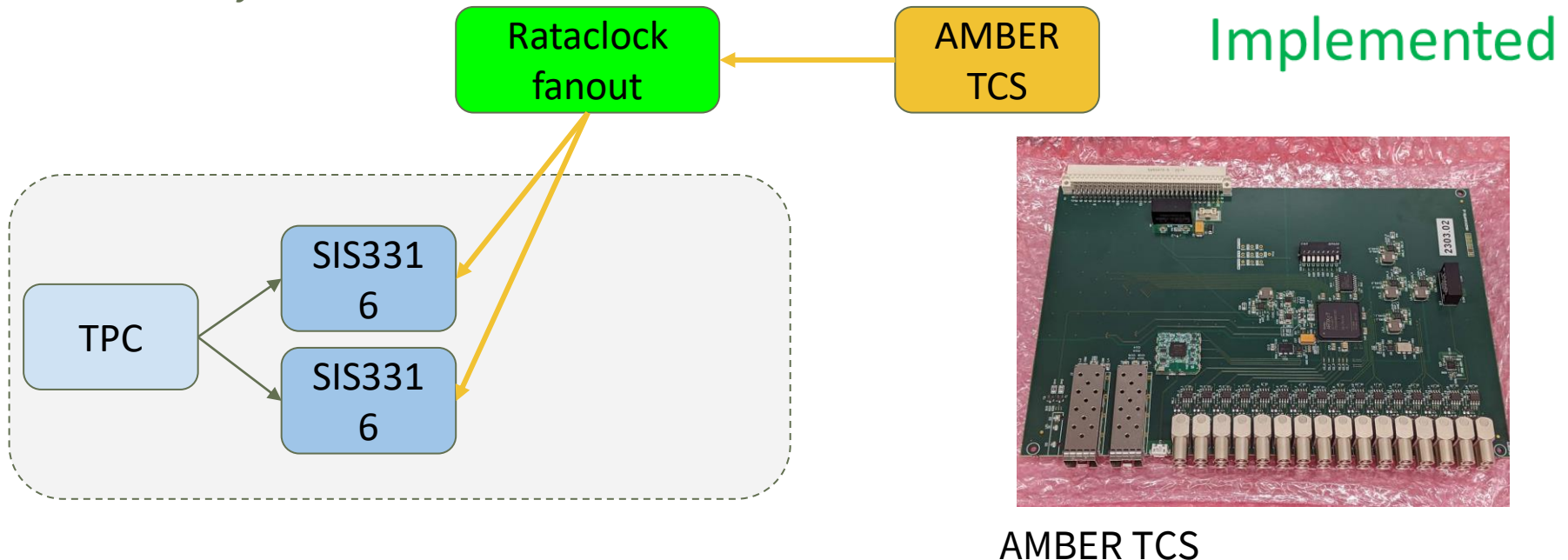
DAQ server

- 1 HE supermicro server
- 16 core AMD Epyc 7313 CPU
- 256 GByte RAM
- Mellanox Ethernet card (25 GBit/s)
- PCIe FPGA card with 4x SFP+
  for data sending

Implemented

Data In

Data Out

Assembled in
Netherlands
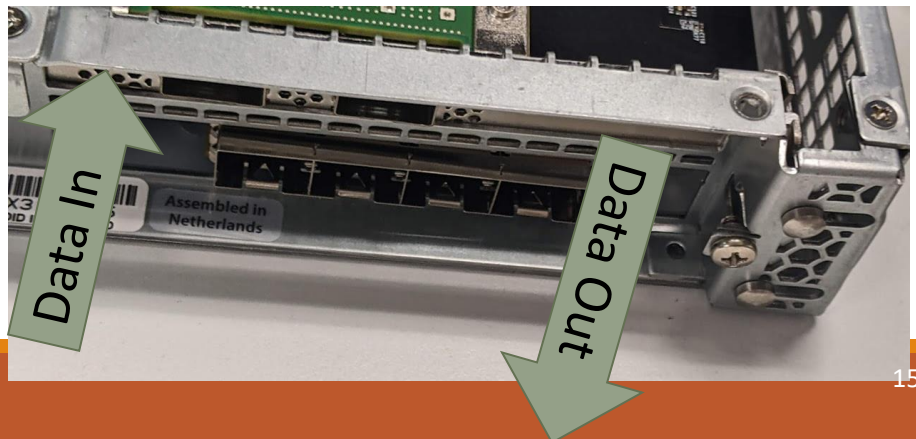
New TPC DAQ

Network-based readout

Larger data transfer possible

Each FADC is independent readout core

DRASI environment

Event server for data storage, online and merging into the main DAQ

Synchronisation via common clock, start/stop of spill, physics and sync trigger

Proved during the test run in September

Merging into the main AMBER DAQ is needed, via software or FPGA card in the DAQ server (firmware!)

Active targets status

ACTAF2 pressure vessel with electrodes is built according to the contract between FAIR and PNPI, contract is cancelled and will be not coming to FAIR

IKAR TPC is rebuilt; was used at CERN in September 2023 for the first PRM run

ACTAF1 / AMBER TPC can be constructed in 2024 but –

some components are designed in Russia and (most probably) need to be designed again,

many components are not yet available (gas / safety system, electrodes, preamps, holding platform)

Redirect funds for re-procurement from ACTAF2 for ACTAF1
ECE/ECSG meeting in two weeks, list of components will be made soon

TPC – resolutions

➢ Gas purification/circulation system is foreseen, gas purity can be ~1 ppm

➢ Pressure and temperature will be measured with high precision, providing the proton density with precision ~0.03% and the number of protons with precision ~0.05%

➢ Energy resolution should be 20-40 keV (depending on the number of pads and beam intensity)

➢ Vertex resolution is expected to be ~0.4 mm (sigma)

➢ Resolution on recoil scattering angle – 10 – 15 mrad

➢ Rate capability to up to 1 MHz, heavy ions should be possible to use

➢ *All parameters are much better as we had before using IKAR TPC*