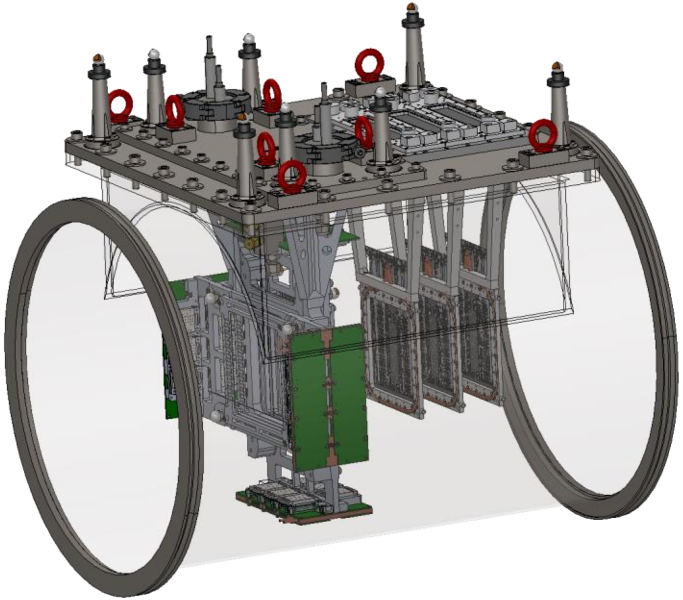
UTS for 2022 and plans for 2023



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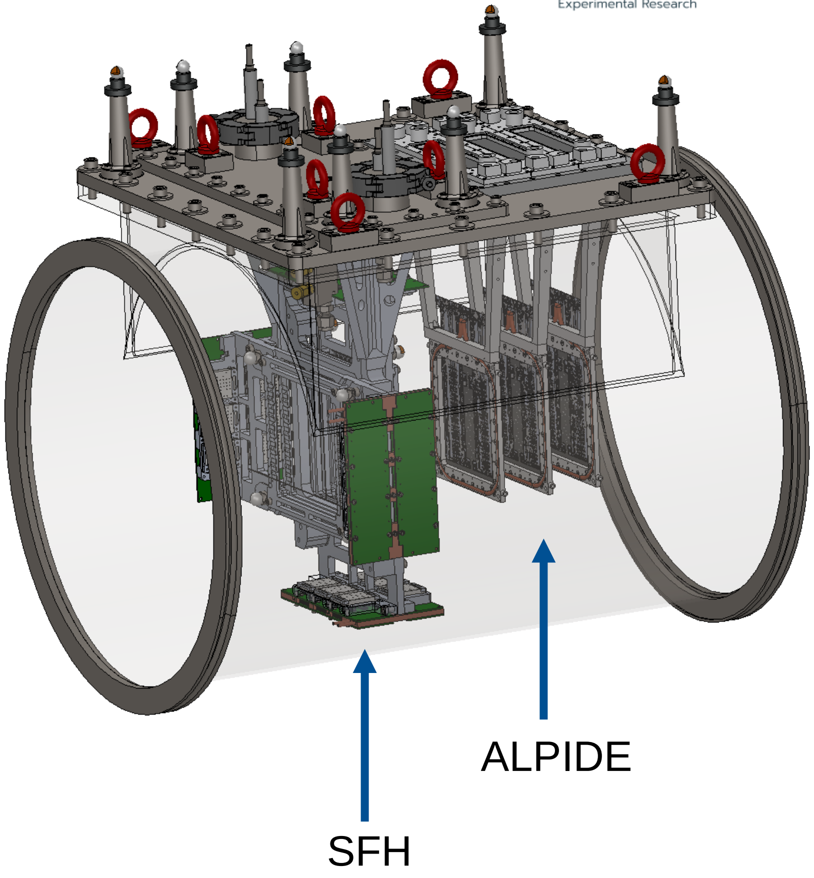
COMPASS – AMBER Technical Board

September 20th, 2022

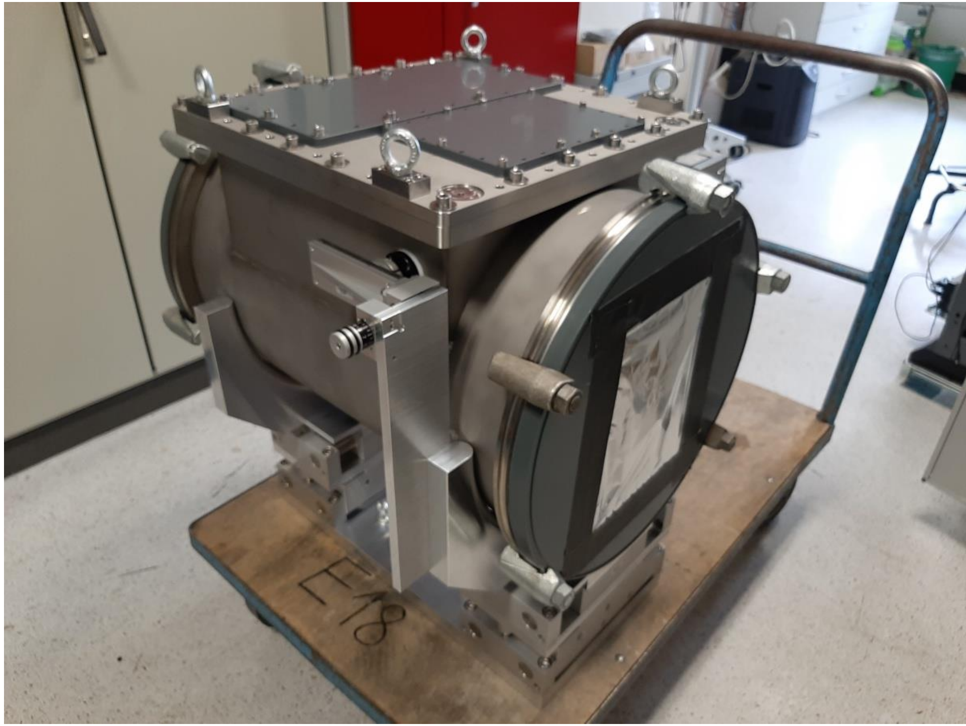
Unified Tracking Station (UTS)

- Combined muon tracking for the proton radius measurement
- Silicon pixel detector (ALPIDE) and scintillating-fiber hodoscope (SFH) combined in unified tracking station in common vessel
- Three layers of pixel detectors in combination with four planes of scintillating fibers (2X, 2Y)
- In total 4 stations will be used

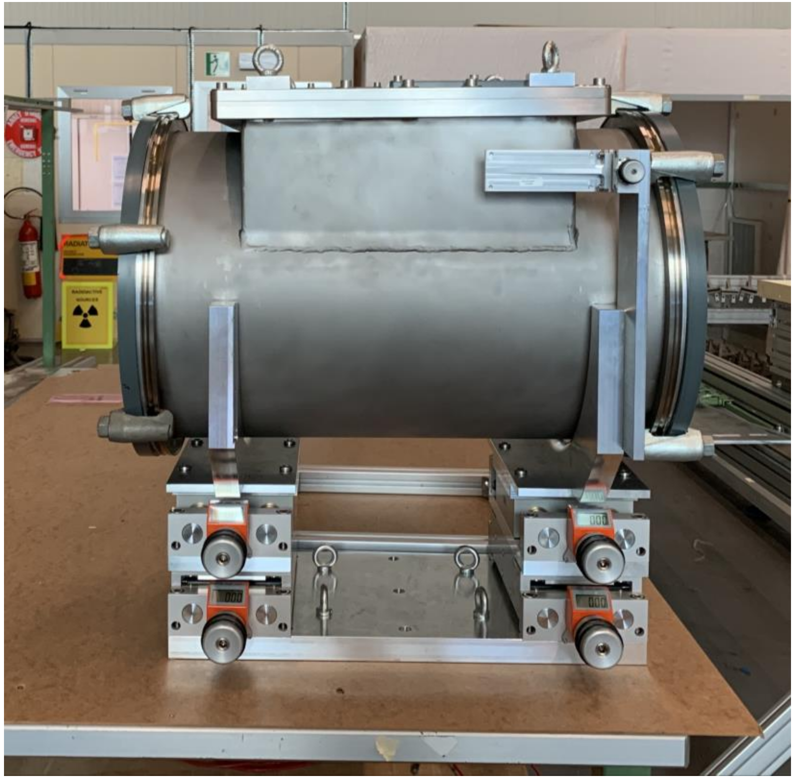


UTS vessel and Positioning System

- First detector vessel has been manufactured
- Includes positioning system
- By hand adjustment including rotations along all three axis and movement in X (±36 mm) and Y (±12 mm) direction
- Blind flanges for both detector flanges and end caps with 1mm beam windows out of PVC
- Has been tested for light tightness with SiPM
- Estimated weight of 120kg (66kg + 54kg) without detectors from CAD model (± 20 %)

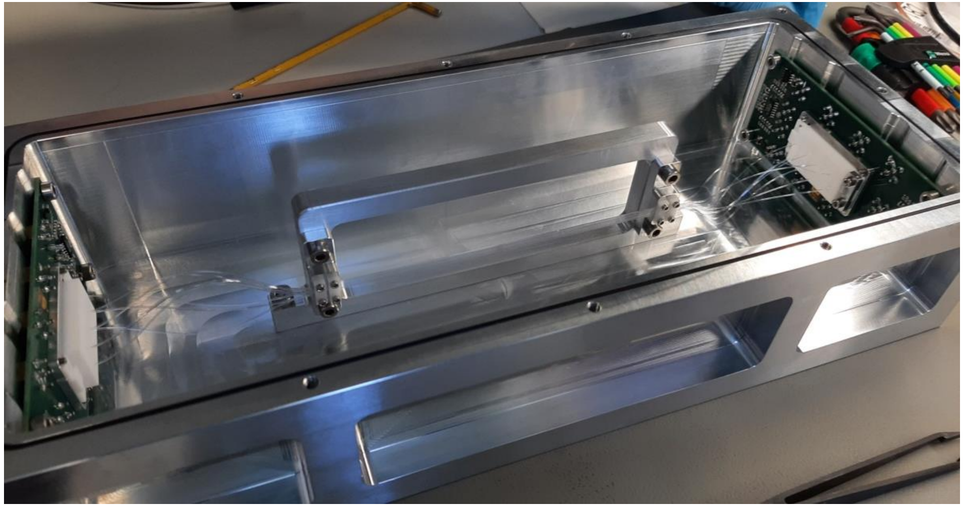


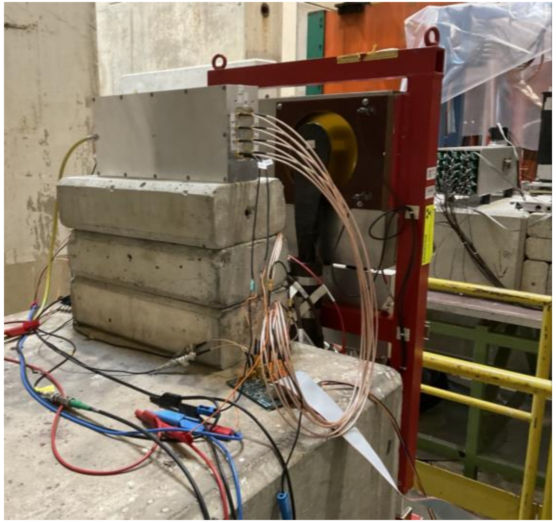
UTS vessel and Positioning System



- Prototype has arrived at CERN on 18.09.22, currently in clean area and ready for fitting / detector tests
- First vessel: deformation of tube and other vessel components due to welding during manufacturing
- Second version with optimized production process is currently build at TUM workshop

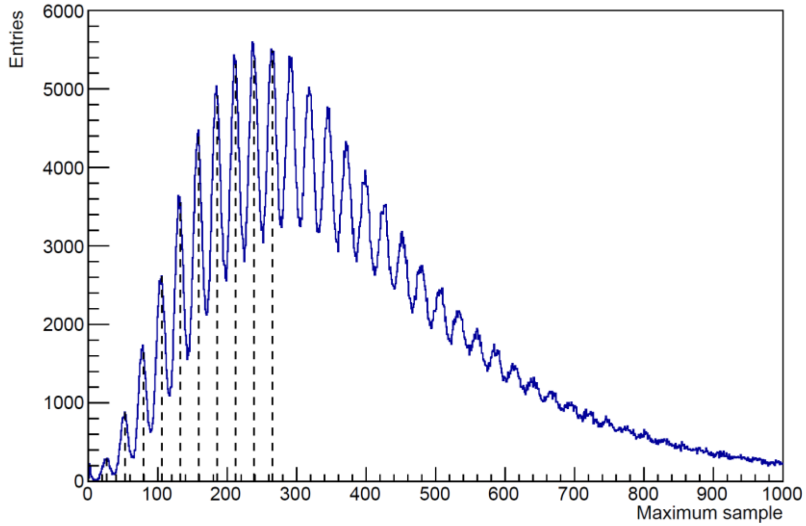
Results from Beam Test





- Simplified setup with 8 fibers to measure light yield and expected signal height in SiPM
- Fiber length and mechanics for holding and coupling to SiPM similar to SFH
- Stand-alone readout and DAQ (MSADC)
- Was installed downstream of COMPASS in the beam dump area for parasitic tests

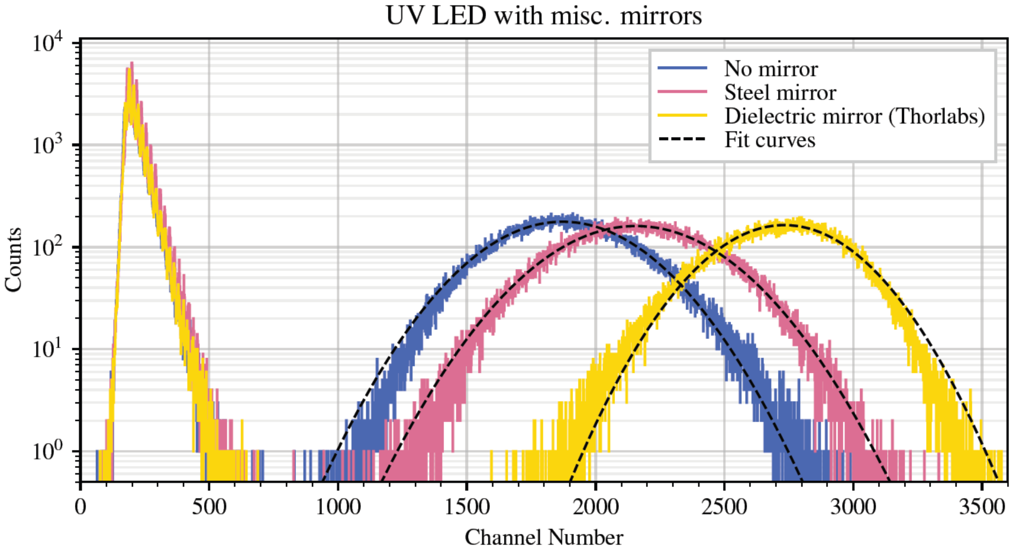
Results from Beam Test

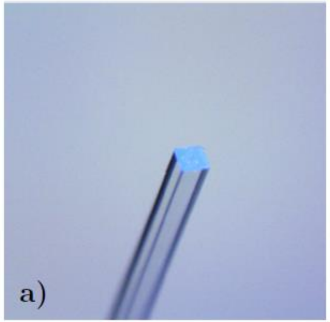


- First result from beam test: Mean light yield at ~15 photons
  → *Suppression of dark counts in the lower end of the spectrum required to distinguish signal from background*
- Suppression of dark counts via double sided read-out or signal enhancement via mirroring of fibers possible options

Mirroring Test Results

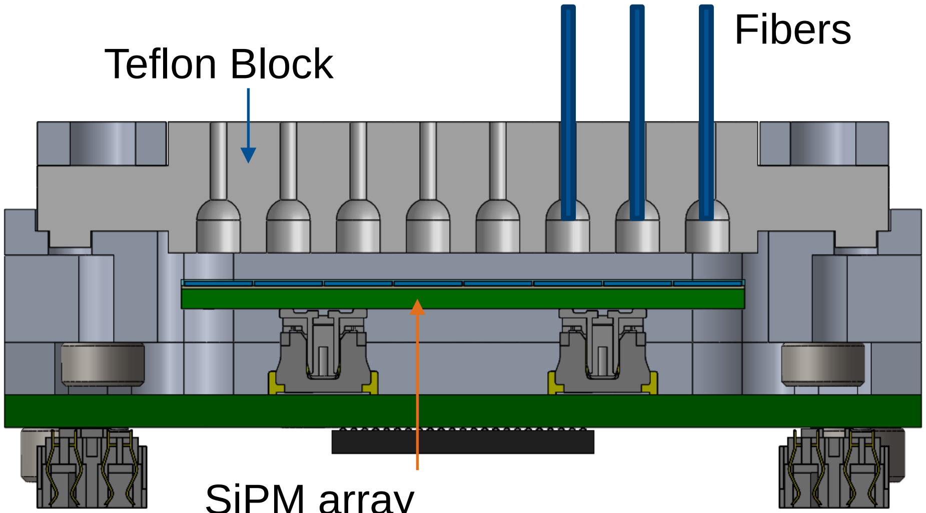
F. Mindl



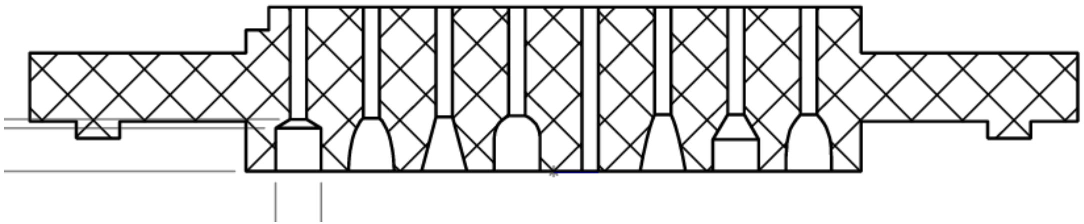


- Injection of UV light into scintillating fiber to trigger primary scintillation and testing the effect of
- Comparison of fiber cuts and mirror options
- Light yield increase of ~70% can be achieved
- Preparations for possible test of mirrored fibers in SFH prototype ongoing

Fiber Coupling Tests

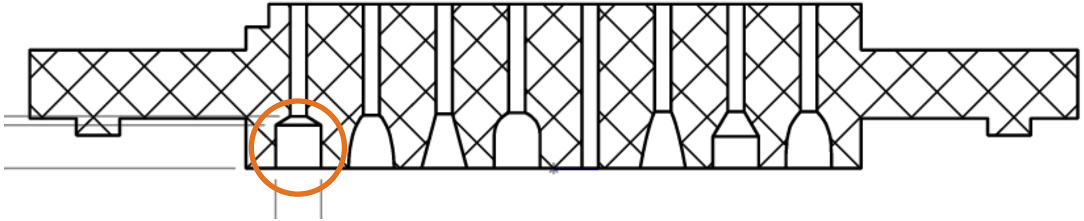


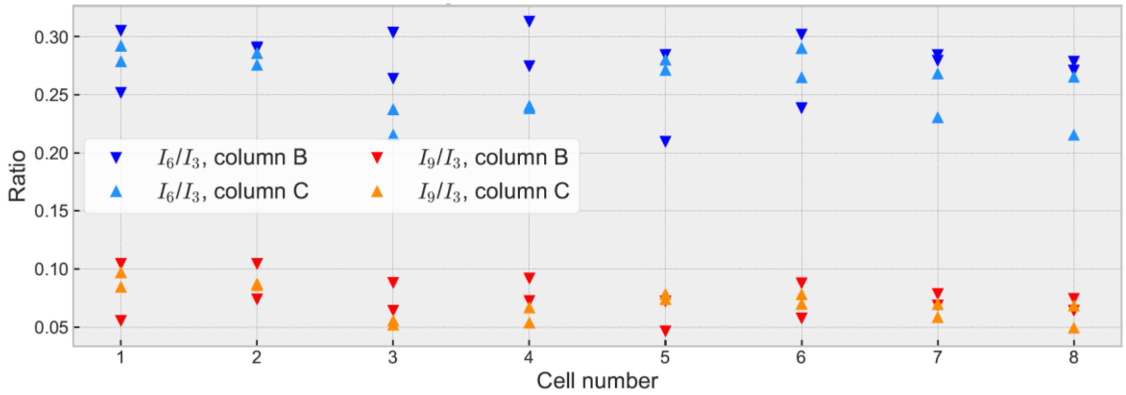
- Scintillating fiber ends with 0.5mm edge length are glued into Teflon block and pressed against SiPM array (64x64)
- Light cone reflects photons leaving the fiber onto the SiPM (3x3 mm^2)



A. Pechan

Fiber Coupling Tests



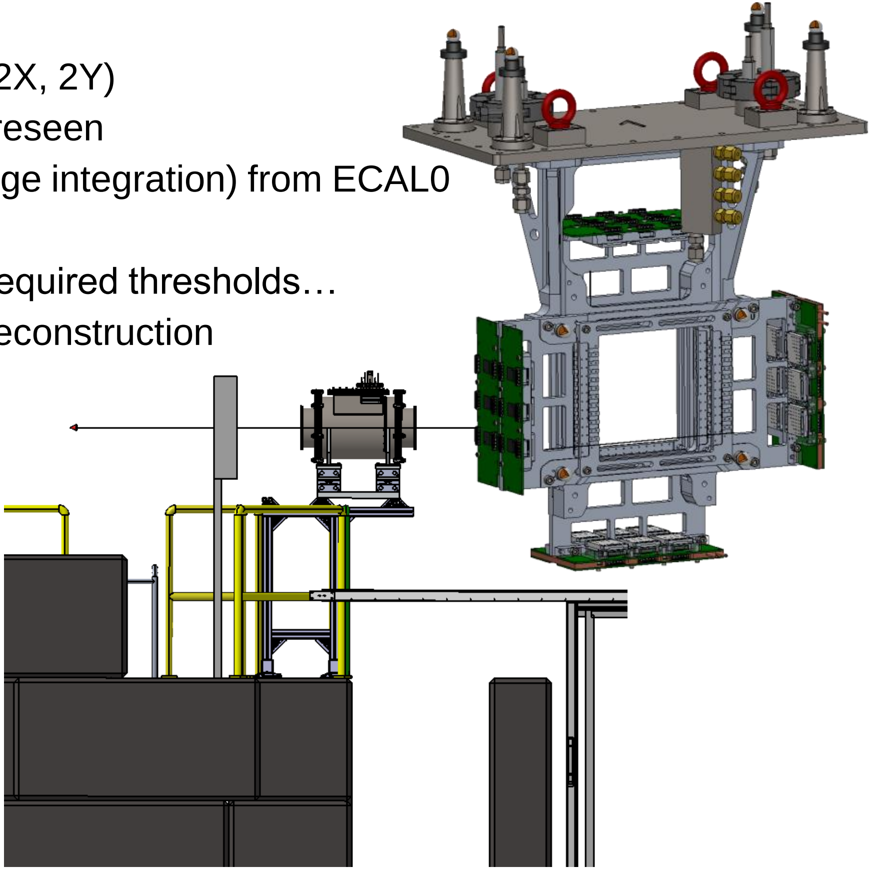


- Different cone shapes have been tested to optimize light yield
- Tests with Sr-90 source show no significant dependency on cone shape in Teflon block
- Drilled hole has been chosen for SFH due to manufacturing reasons

Plans for 2022 – SFH

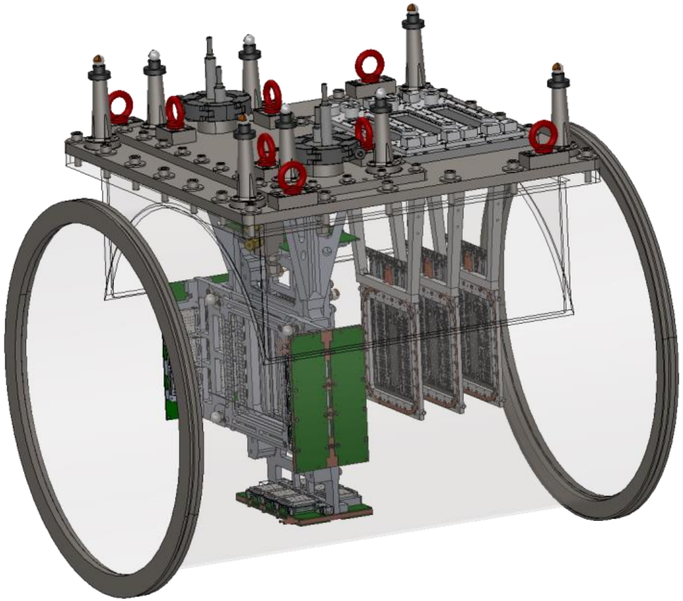
- Prototype with 64 fibers in each of 4 detector planes (2X, 2Y) with partial readout of minimum 32 fibers per plane foreseen
- Detector will be read out with preamp + MSADC (charge integration) from ECAL0 and connected to COMPASS DAQ instead of iFTDC
  Advantages: - Better insight into detector properties, required thresholds…
  - COMPASS silicons available for track reconstruction

- Positioned in front of COMPASS target
- Detector efficiencies to be determined and matching with ALPIDE data can be tested
- Due to low energy consumption close to SiPMs and operation in winter commissioning of fluid cooling system low priority, flushing with cold gas possible scenario for temperature stabilization



S. Levorato

Plans for 2023



- Based on this years beamtime: Test of SFH with modified frontend electronics (CITIROC) and iFTDC readout in beam
- Operation with water cooling system for stable operation below 20°C with significant power consumption close to SiPM arrays
- As soon as beam is available: Test of finalized detector design in parasitical beam (e.g. in beam dump area)

- In parallel: production of remaining UTS vessels and mechanics for SFH, assembly of the detector stations

Current Status of SFH prototype

- Production of detector hardware has started
- For some crucial CNC - milled parts of the prototype: manufacturing problems due to limited availability of local workshop, exceptional delivery times of raw material and lack of capacities in external companies

→ Delays in manufacturing of parts and assembly of SFH prototype, readiness in mid October potentially in danger

Ideas for delayed installation scenarios:

i. During MUonE beamtime until 26.10
ii. Shortly before beam test on 01.11
iii. At the end of the antiproton test run on 09.11

Summary

- UTS vessel and positioning system prototype are manufactured and shipped to CERN for detector tests, second UTS vessel is in production
- Measurements on SFH signal levels, possible mirroring of scintillating fibers and coupling to SiPM arrays have been successfully performed
- Test measurement in beginning of November with MSADC readout
- 2023: Test of finalized detector station, in parallel production of remaining detector stations
- Delays in production of SFH detector production possibly endangering 2022 timelines, possible scenarios with delayed installation of SFH might be required