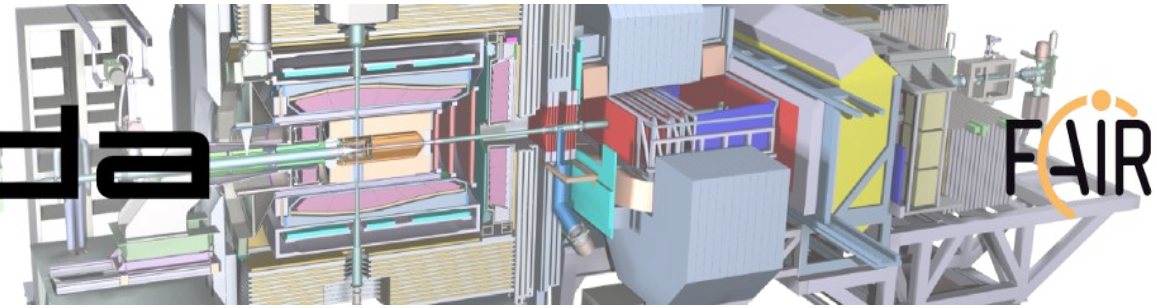
JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN



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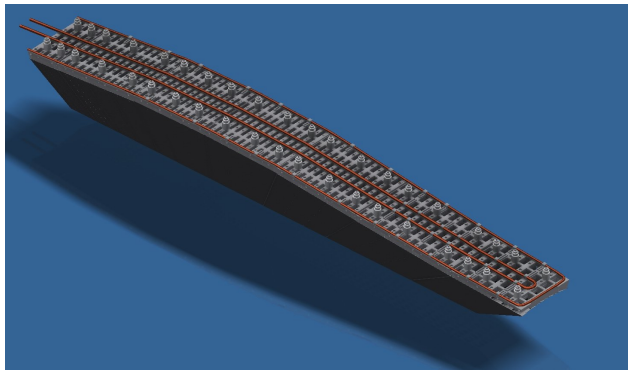
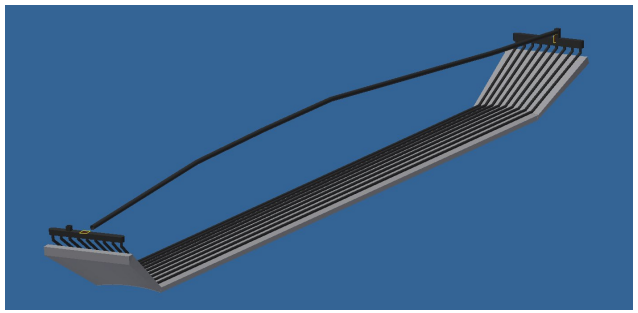
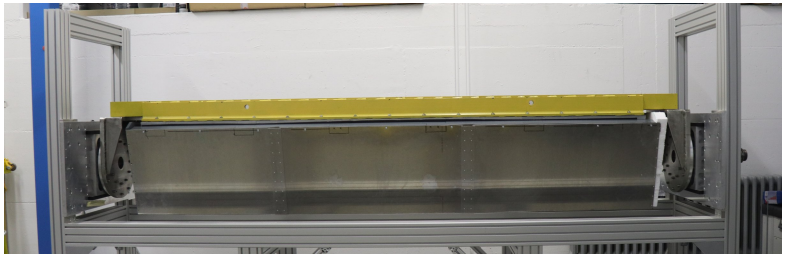
CM Oct 2022 – Barrel EMC Slice Cooling Status

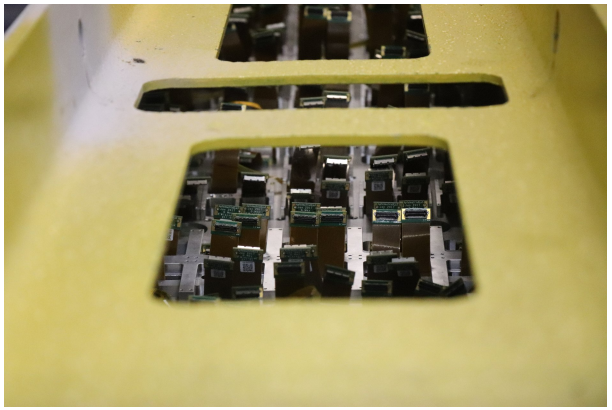
Testing the Barrel EMC cooling design - General Setup



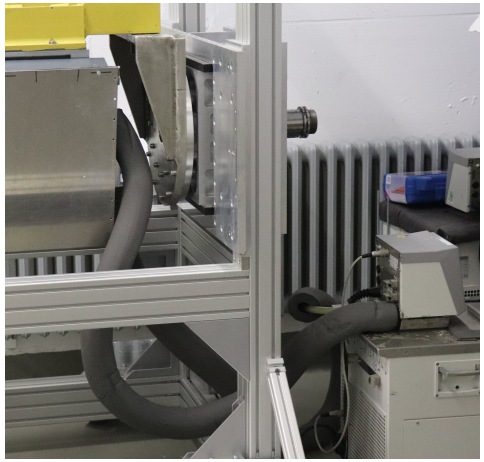


- Main and Front cooling are installed
- Slice is installed in VIP-insulated Test box on rotating device, lid of Support Beam not installed
- Box is constantly flushed with dry air from both ends



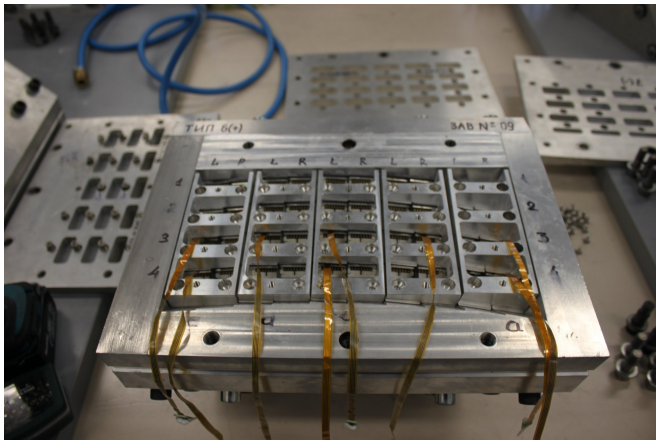


Testing the Barrel EMC cooling design - General Setup

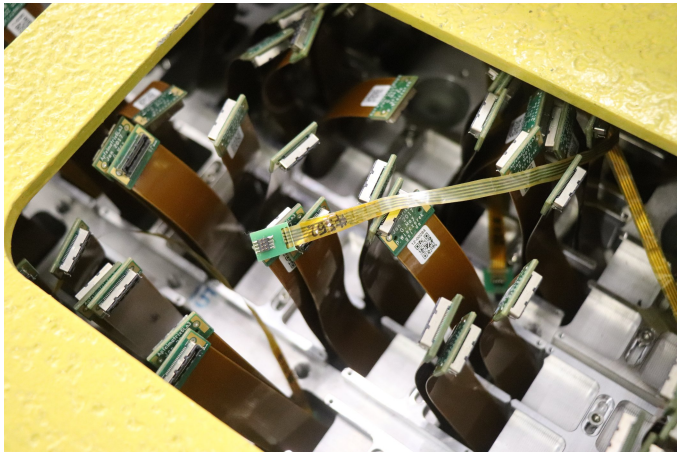


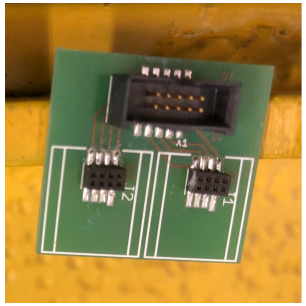
- Liquid cooling : Julabo FP50 open bath cooler running Ethanol/Water (changed to methanol/water later) – max. cooling power at -20° is rated at <500W
- Additional cooler is being prepared to cool down the dry air supply (at 100l/min ~50K Temperature difference introduces heat load of about 100W) – air supply lines will be run through the liquid coolant
- Panda THMP for the 72(*) PT100 and additional sensors are set up to monitor temperatures, humidity, pressure and flow.

Testing the Barrel EMC cooling design – Sensors



- During assembly of the Pre-Series Slice 72 PT-100 sensors were build into the slice, can not be removed/recovered/replaced
- 9 rows of 8 sensors each, 3 APD side, 3 beam-side and 2 center put on the crystals
- Pt100 cables are fragile and easily lose the connector when support beam is moved by crane - some sensors are broken beyond repair
- Adapter boards can not be integrated into barrel electronics because of footprint
- Attach PT100 cables to nearest flex PCB?



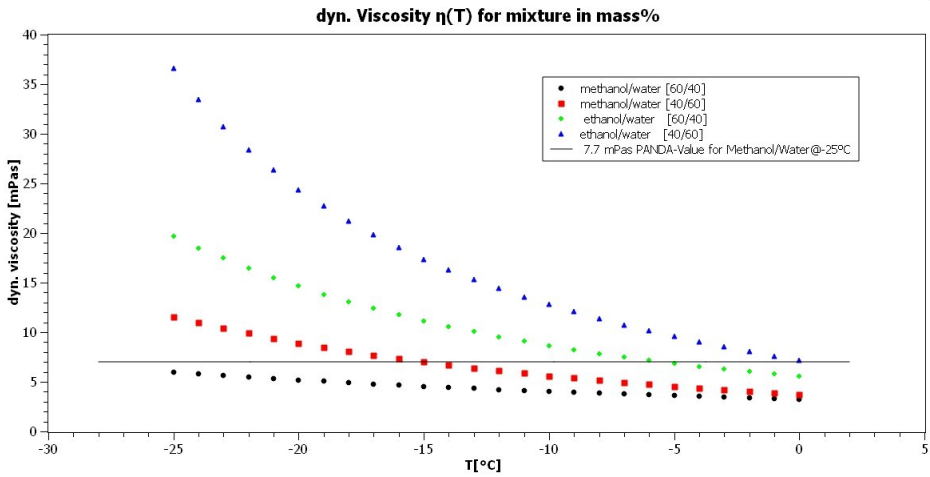


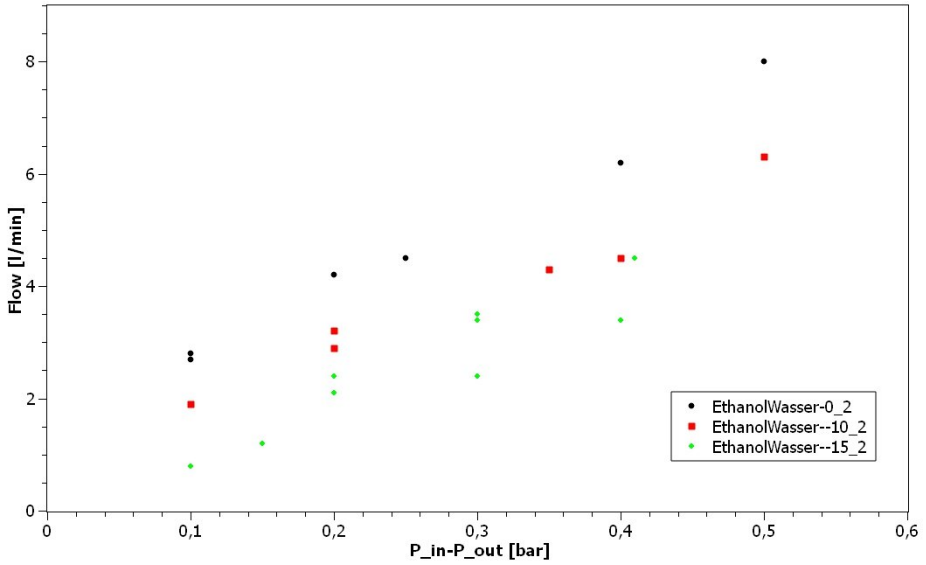
Testing the Barrel EMC cooling design – Conditions

- After assembly of the slice in the test box, dry air flushing began, using a compressor attached to a membrane dryer through various filters (Independent of external supply)
- Rel. Humidity in the box was monitored using the PANDA THMP and SHT31 commercial sensors without running the cooler for multiple days
- Box had to be re-sealed multiple times to achieve a dew point low enough for operating the slice at PANDA conditions
- After a few weeks, the compressor could no longer deliver air dry enough (water and Oil build up and needed to be emptied every day now) and was replaced.
- With external Air supply PANDA Conditions could be achieved

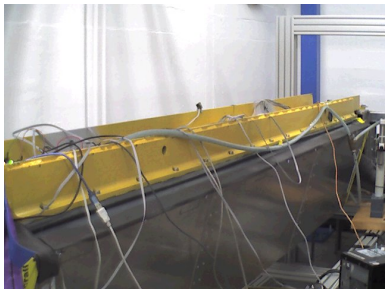
Testing the Barrel EMC cooling design - Test runs

- Ethanol/water was used for safety but has a higher viscosity
- Flow rate was reduced at the maximum achievable pressure drop of 0.4..0.7 [bar]
- a bypass was used to regulate the inlet pressure

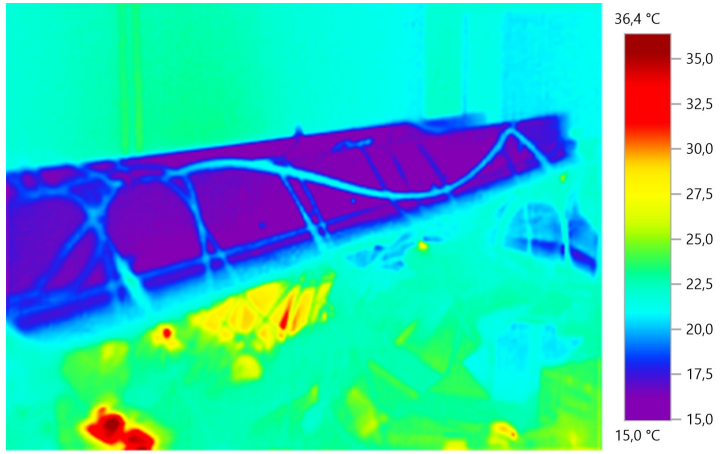




Testing the Barrel EMC cooling design - Test runs



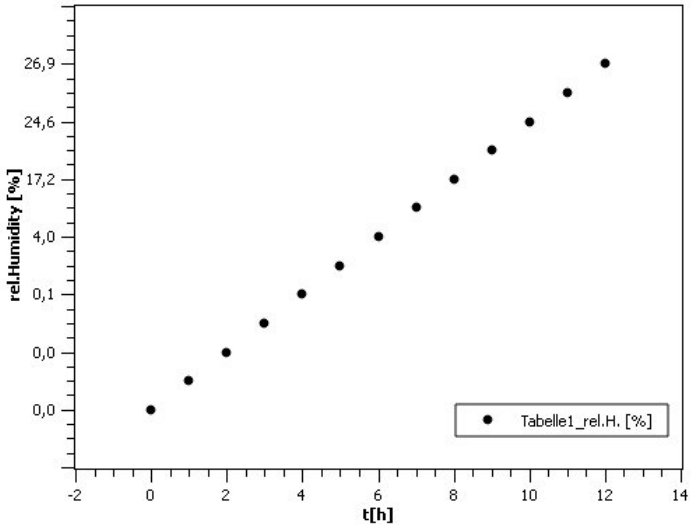
- After the Box was dry enough (monitoring for 5 days) first test runs were started setting the liquid cooler to -28°C

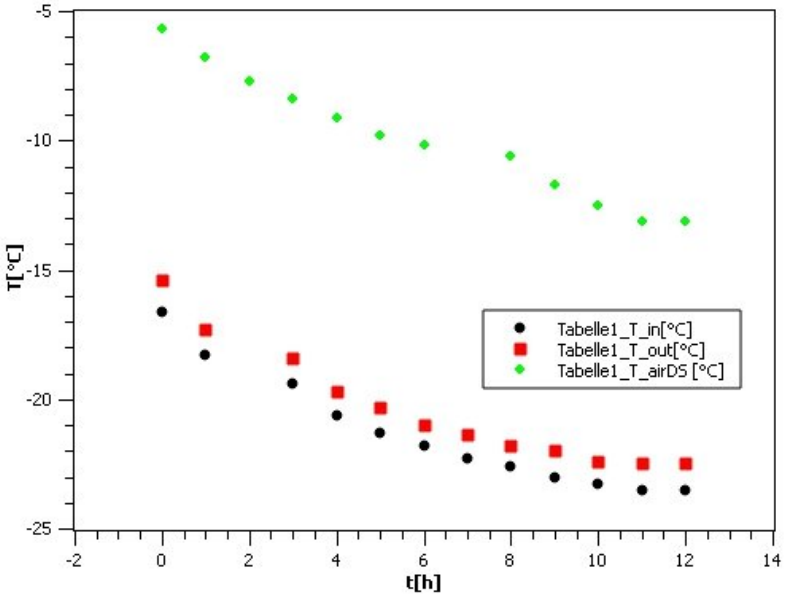


- the support beam and the massive technological beam cools down (large heat exchanger)
- In PANDA the S-Beam would be held up only by the rings at either end (simulation/calculation for heat transfer now ongoing)

Testing the Barrel EMC cooling design -Test Runs

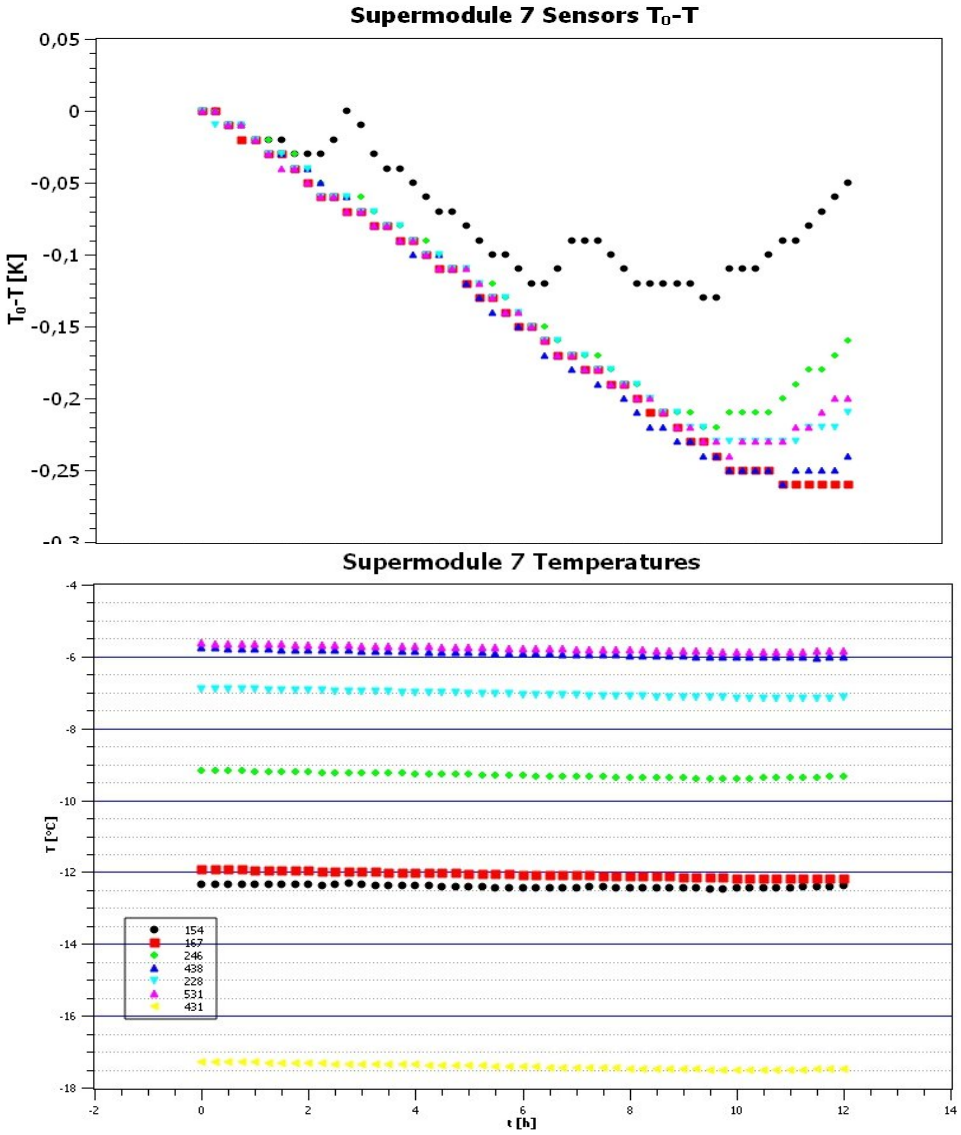
- Cooler was set to -28°C but could not reach below -26.7°C (PT100@THMP)
- T_in – T_out was maintained at 1-1.5K (T_in -24.5°C)
- estimated cooling power: ca. 400W
- Without additional cooling of the inlet air, the air temperature within the box does not reach desired temperatures



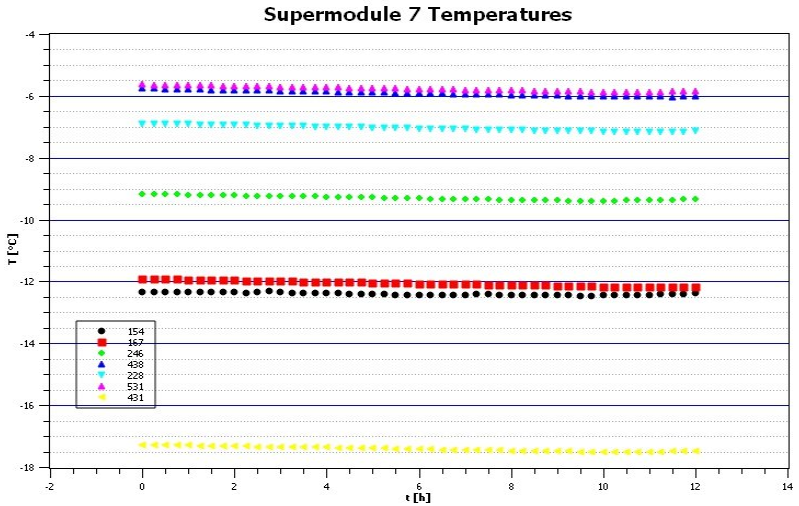


Testing the Barrel EMC cooling design – Test Runs

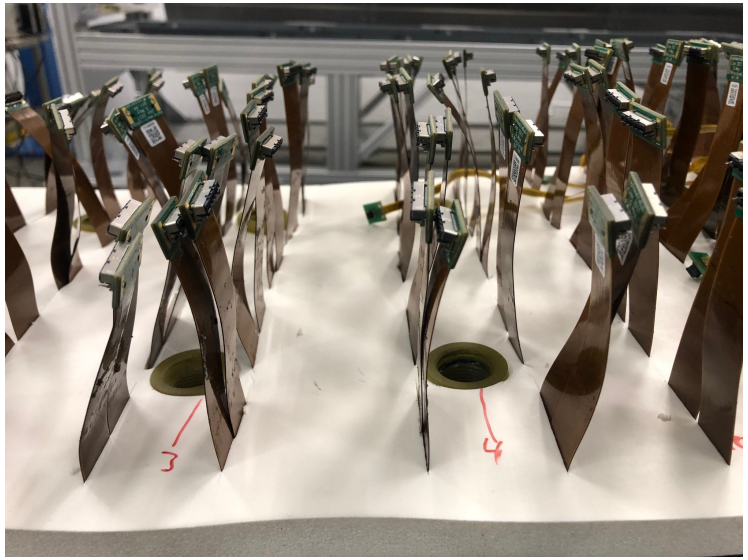
- PT100 data shows mostly even drop in temperature before the cooler is reducing power on overload protection
- Measurements appear to be consistent at first but will be re-checked by switching sensors and piggy back boards
- Within one row of sensor value gradients after 12h are unexpectedly high
- Suggesting very small actual thermal conductivity between crystals



Testing the Barrel EMC cooling design – Summary&Outlook I



- Dryer and box setup allow for testing the slice
- Additional Cooler is needed to provide air at low air temperature evenly within the box
- Supportbeam cover and insulation may have to be installed to reduce heat transfer from technological beam
- Neighbouring sensors show very different temperatures – additional PT100 sensors should be added
- Pressure drop of 0.4..0.5 bar over the cooling pipes for ethanol/water at 0°C meets simulations and is sufficient for PANDA leakless cooling design



Testing the Barrel EMC cooling design – Testing station proposal

- All resources to cool, dry and monitor the pre-series slice and further slices should permanently be combined to a test stand for slice production
- An additional pump and reservoir would help to regulate inlet pressure and temperature better than by the current bypass
- Testing station should be used for testing FEE and all slices in the future