



# Forward Endcap EMC Cooling

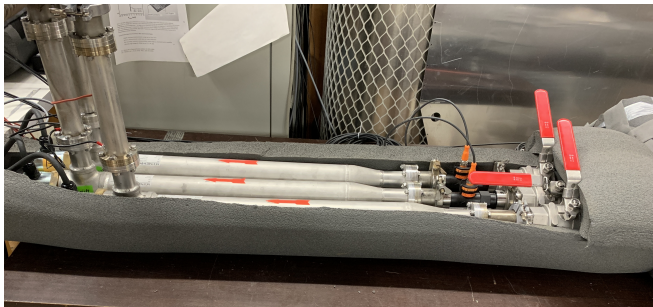
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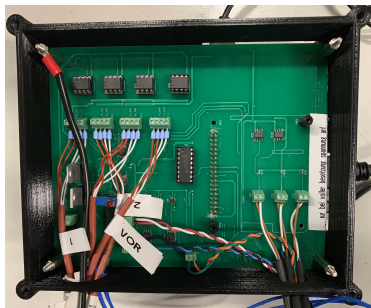
# Cooling Setup

- Coolant heated to  $-25\text{ }^{\circ}\text{C}$  shortly before entering the detector
- Three pipe radiators on each side of the detector will heat the coolant up
- Temperatures are measured behind every pipe radiator

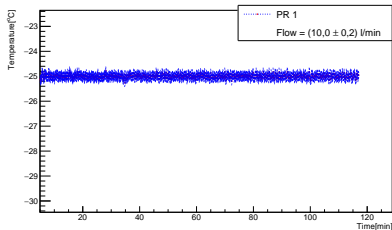
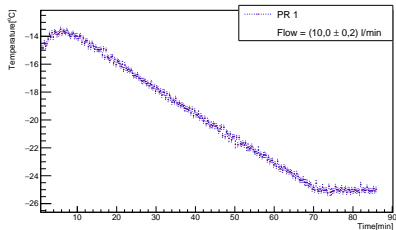


## Cooling Setup

- Power of each pipe radiator will be managed by a PID regulator
- Pipe radiators will be powered by thyristor controllers
- Three states of operation: cooling, maintaining, heating

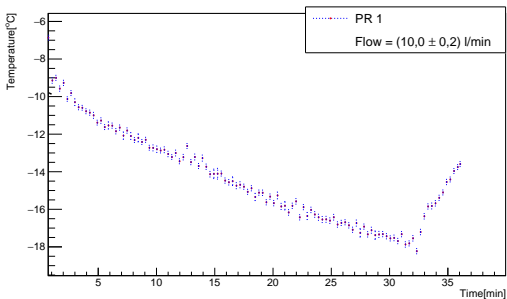


# Cooling and Maintaining Phase



- Set gradient to  $0.2\text{ }^{\circ}\text{C}/\text{min}$  and set temperature to  $-25\text{ }^{\circ}\text{C}$
- Measured gradient at  $(0.19 \pm 0.005)\text{ }^{\circ}\text{C}/\text{min}$  and measured temperature at  $(-25.00 \pm 0.06)\text{ }^{\circ}\text{C}$

# Cooling and Heating Phase



- Software bug led to higher temperature gradient than set
- Closing the terminal instead of the PID-GUI
  - ▶ DAC output hasn't been set to 0 V



## New Safety Precautions

- Control the temperature gradient over a minute each minute
- Control the total cooling liquid flow in every program loop
- Power contactors between thyristor controller and electrical outlet
- Power contactors will be controlled with a 12 V line
- In each 12 V line a thermal fuse will be build in
- 12 V line can be opened and closed by a relay, which can be controlled by a Raspberry Pi

# New Safety Precautions





- Implementing the power contactors inside the thyristor box
- New measurements concerning the cooling, maintaining and heating phase
  - ▶ Tests with different flows inside the pipe radiators
  - ▶ Tests with different temperature set points
  - ▶ Tests with an endcap dummy

Thanks for your attention!