

Update on the Temperature Sensors Calibration

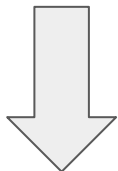
Jordi Capó (02/02/2022)

Carried out tasks

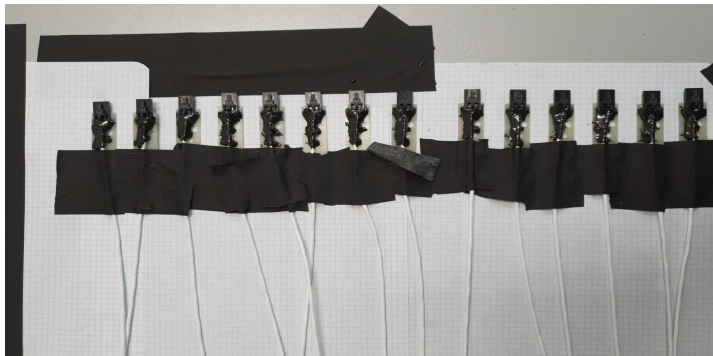
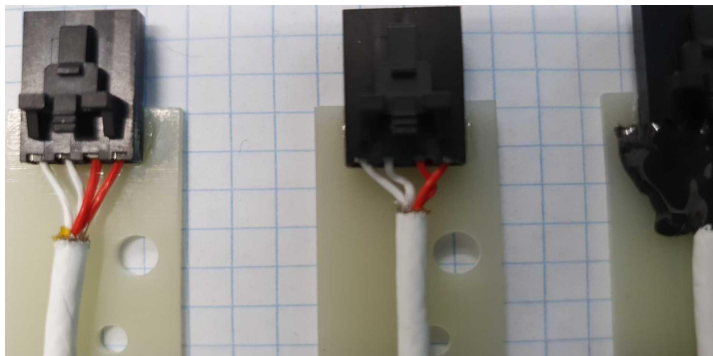
- Instrumenting the Temperature Monitoring System.
- Data Acquisition Software.
- Cleaning the Signal.
- Individual Channel Calibration.
- Liquid Nitrogen Calibration (First test in cold).
- Conclusions and Next Steps.

Instrumenting the TMS

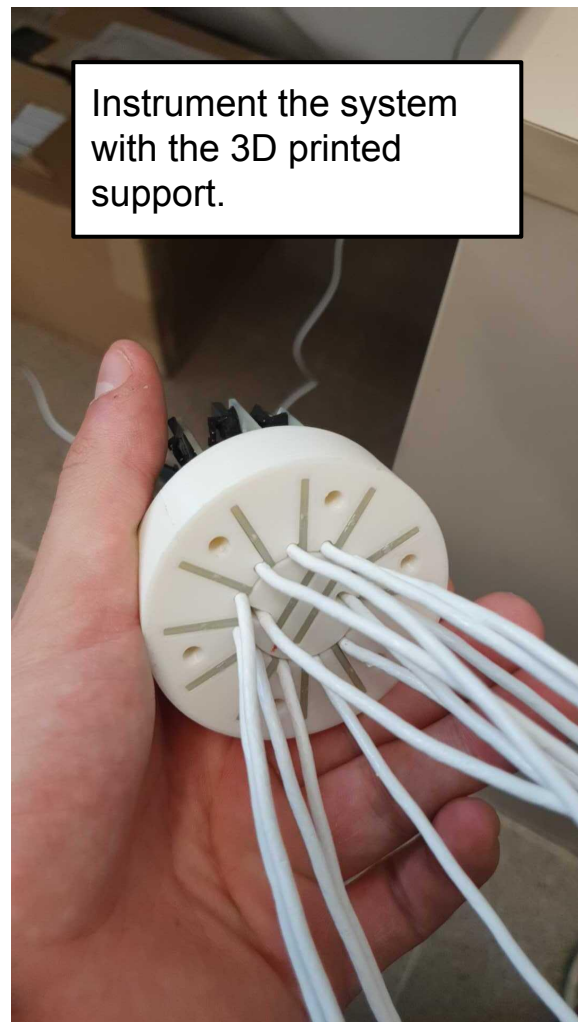
Glue connectors to FR4 plate.



Apply Epoxy on the connectors to protect them from LAr.



Instrument the system with the 3D printed support.

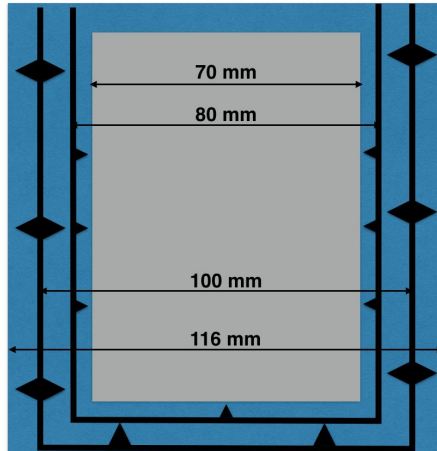


Instrumenting the TMS

Aluminium capsule



2-Volume Capsule

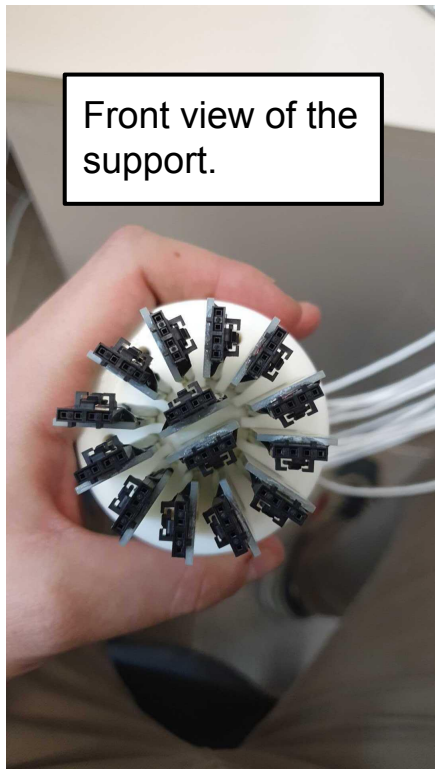


Teflon container

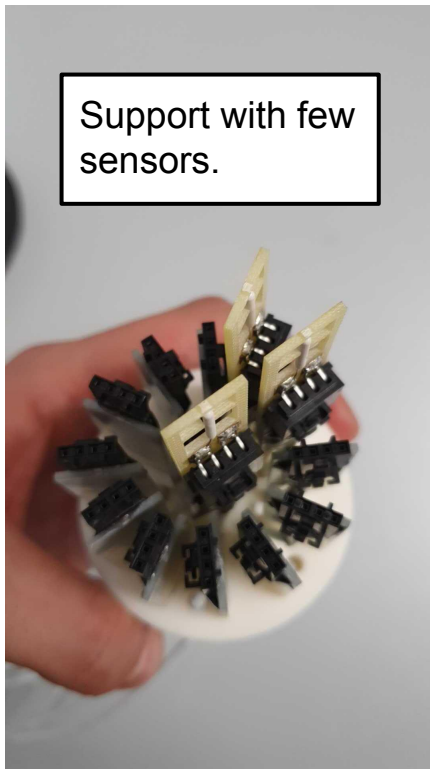


Instrumenting the TMS

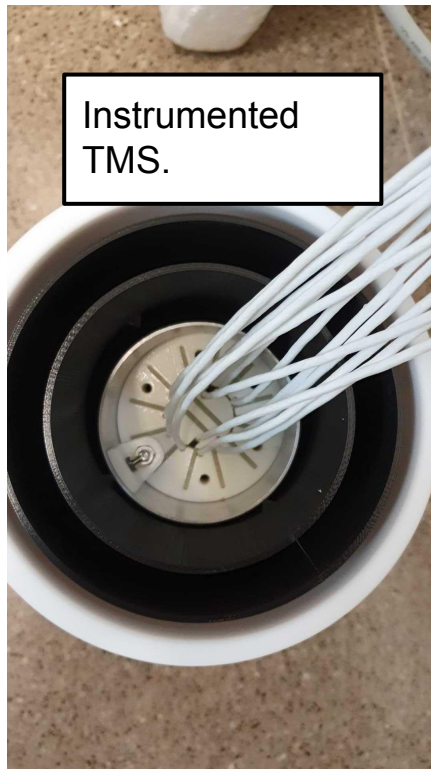
Front view of the support.



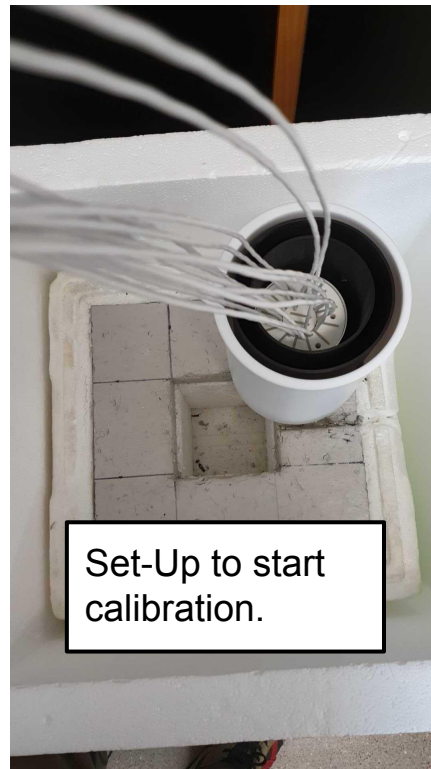
Support with few sensors.



Instrumented TMS.

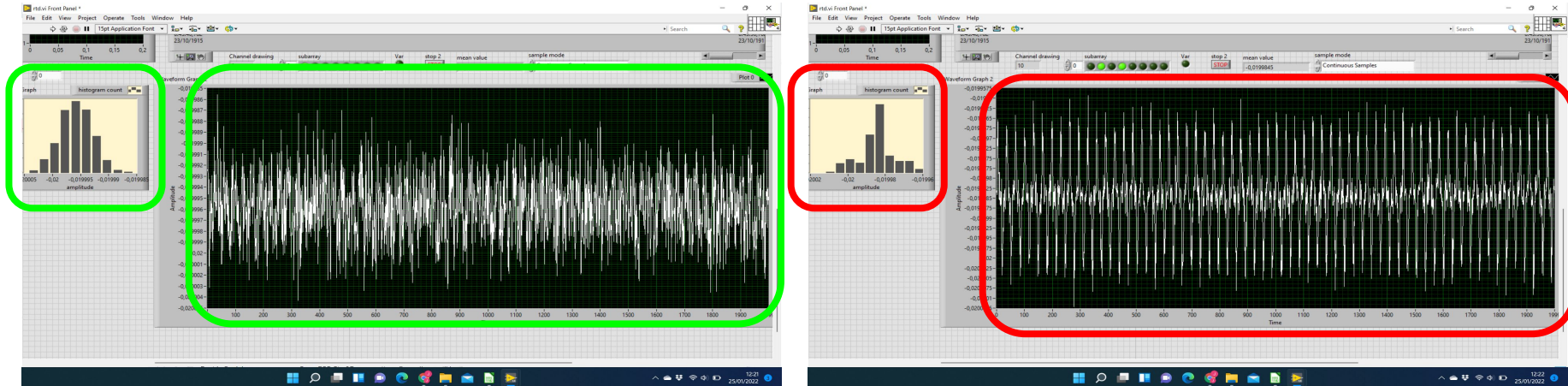


Set-Up to start calibration.



DAQ Software - LabView

- The DAQ acquires **N samples** during a certain period of time (tuneable) and out of that it calculates the **mean** which is transformed into the **readout Temperature**.
- The DAQ had a sampling time of the order of 18 s to read all 14 channels. We wanted to improve it around 3 s.
- Complete rebuilding of the DAQ allows us to read as fast as one wants (up to 50 kS/s = 3 s/14 ch).
- An issue was detected during the acquisition. A 50 Hz signal is contaminating the signal from we are averaging on.



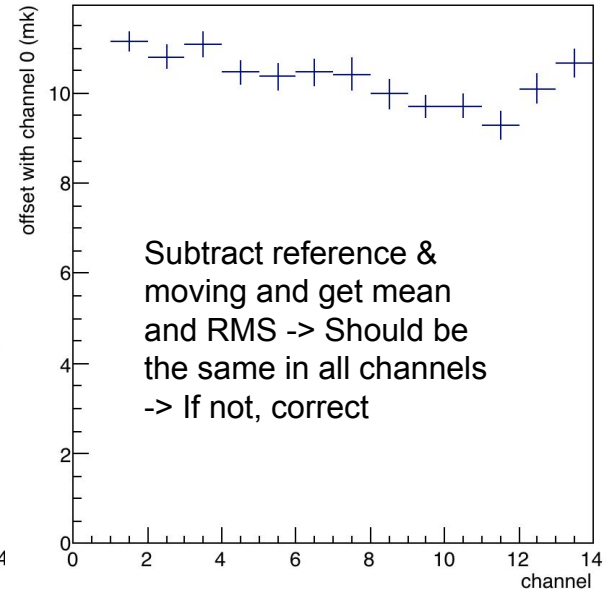
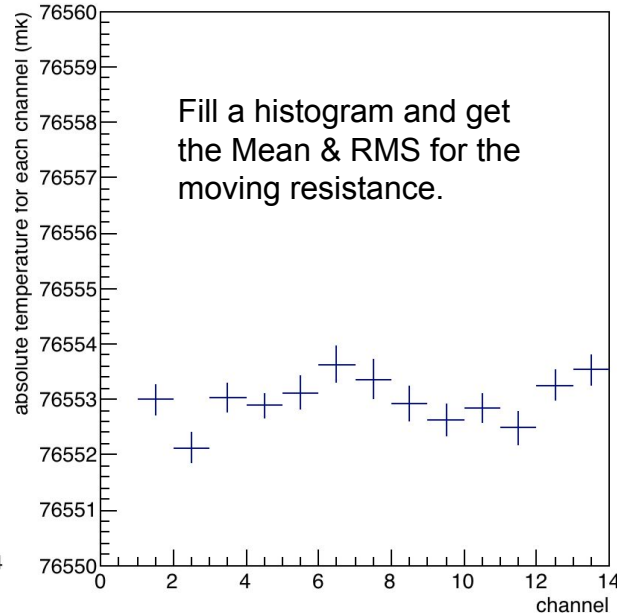
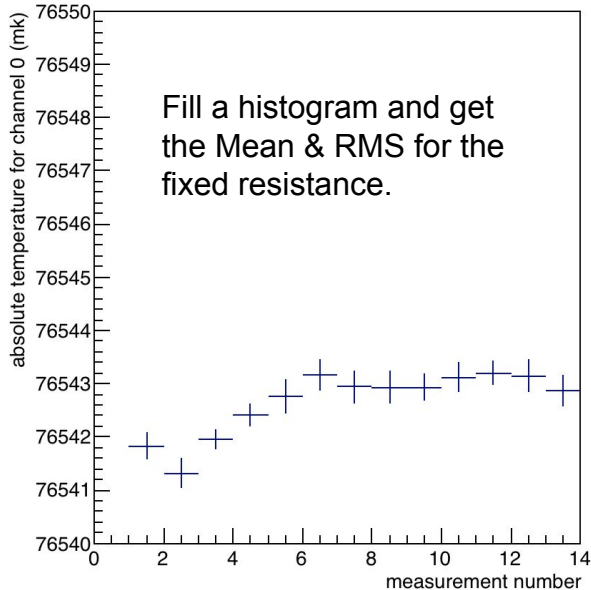
Cleaning the Signal

- By measuring the signal using the oscilloscope we were able to identify the source of the contamination: **capacitive reactance on the conductor that transmits the signal to the ADC**. Coming from the electric network (50 Hz AC).
- Connected it all on a power switch that contains a filter, special for these purposes. **Bought a new power switch** with pretty better performance.
- Continuous contact with Xavier Pons (**CERN engineer**). Who built the MUX board we are using for reading the channels one by one.
- Plans of **improve the shielding** of the wires and study the continuity to proper connect the grounds.
- Studying the possibility to build an **RC filter** (or a digital one) to subtract the 50 Hz noise and harmonics.



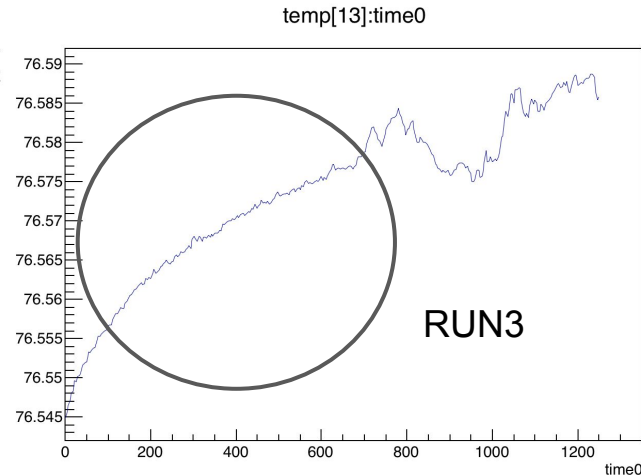
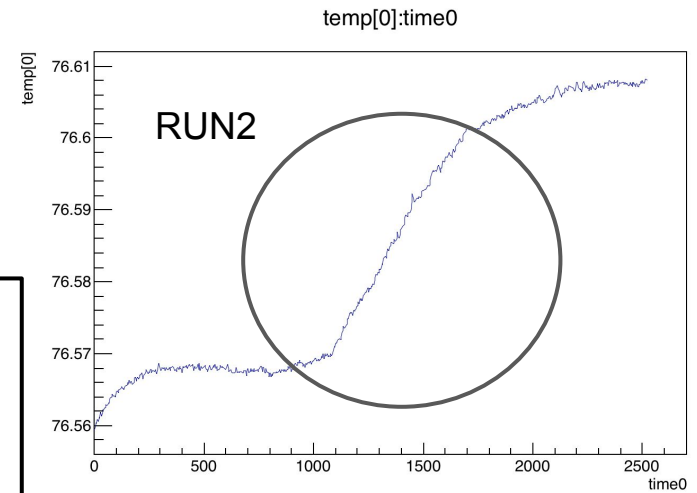
Individual channel Calibration

Select 2 **High-Precision 20 Ohm Resistances**: 1 fixed & 1 moving along the channels -> **Offsets between channels.**

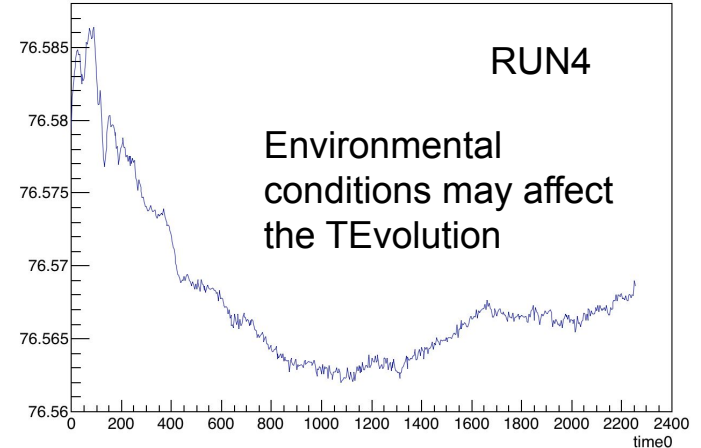


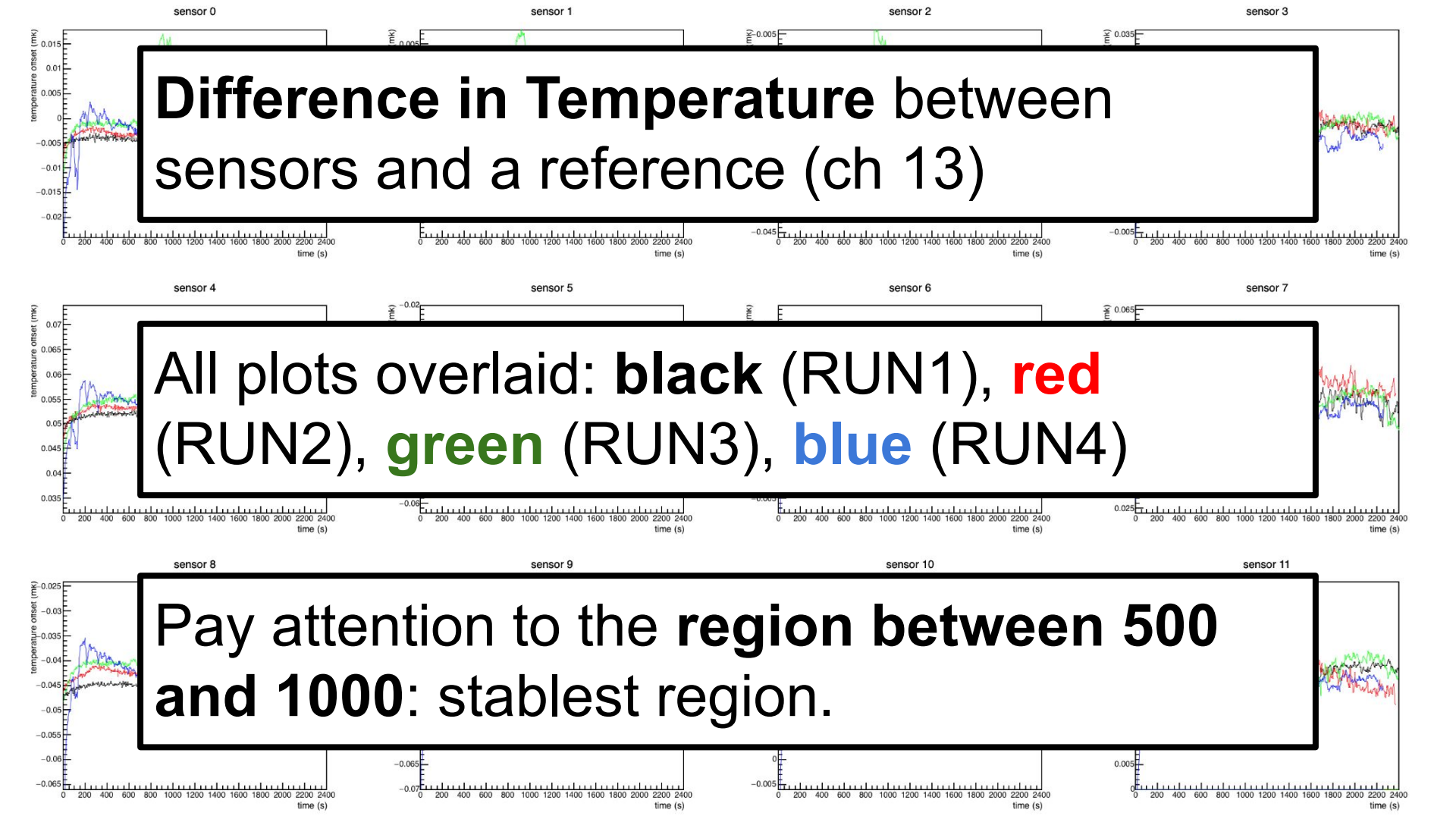
LN2 CALIBRATION

- **4 different RUNS** of 40 minutes + cooling and heating of the system (40 minutes).
- Different isolation among RUNS -> 1, 2&4 with a well fitted **polyurethane cover**; 3 without it, space for the gas.



Lots of things to understand:
pressure
seems to have
a crucial role in
the
temperature
evolution.



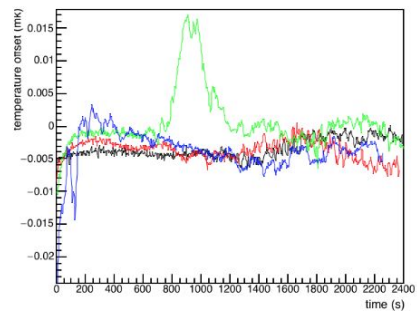


Difference in Temperature between sensors and a reference (ch 13)

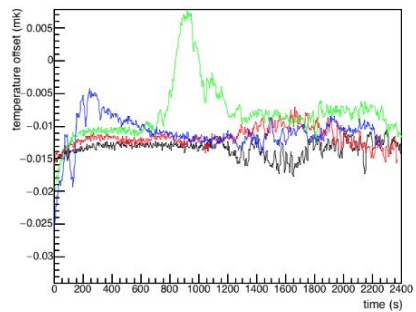
All plots overlaid: **black** (RUN1), **red** (RUN2), **green** (RUN3), **blue** (RUN4)

Pay attention to the **region between 500 and 1000**: stablest region.

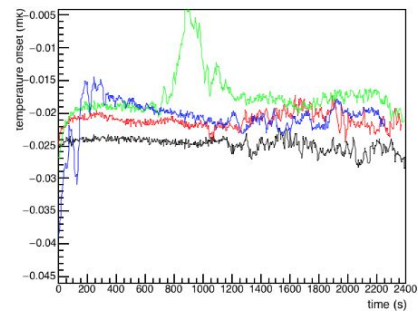
sensor 0



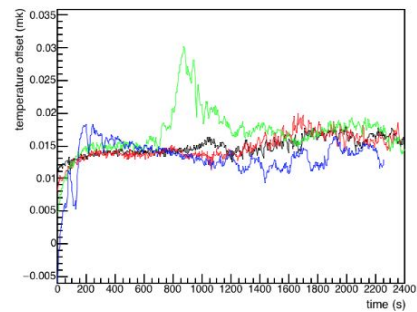
sensor 1



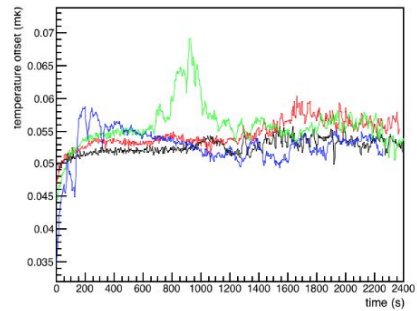
sensor 2



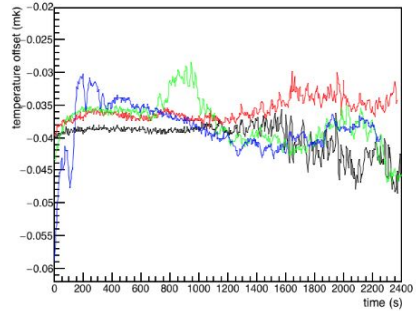
sensor 3



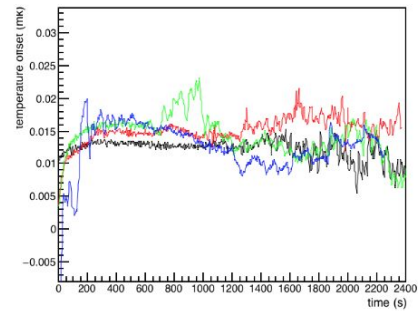
sensor 4



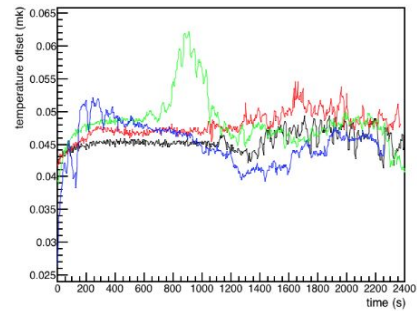
sensor 5



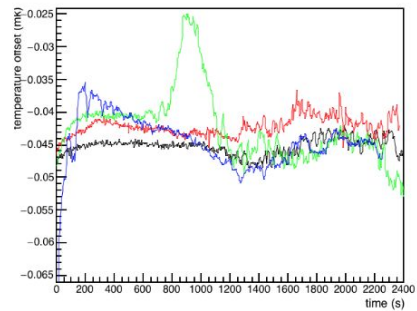
sensor 6



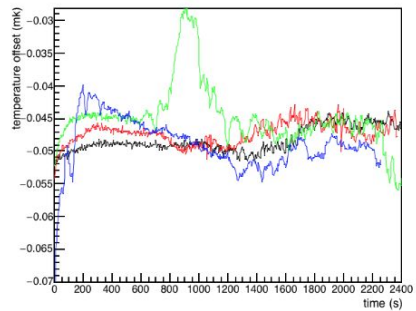
sensor 7



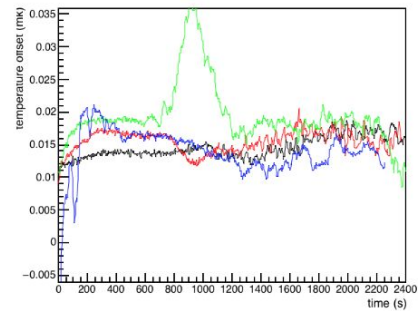
sensor 8



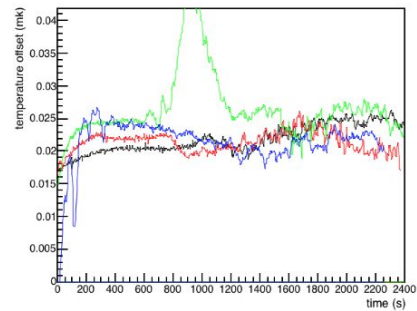
sensor 9



sensor 10



sensor 11



Conclusions

- **Offsets** between individual channels **exist** and must be corrected.
- The **Time Window** where the system is **stable** highly depends on the set-up + environment.
- Need to pay attention to the **details**: atmospheric pressure, pressure inside the box, condensation inside the cylinder...
- The well fitted cover set-up works better than the cover free set-up.
- Need to obtain an **stabler temperature profile** over time to reduce readouts among channels.

Next Steps

- Solve the **shielding problem** between the MUX and the ADC.
- Study the possibility to incorporate a **manometer** to correlate the change in temperature with the change in atmospheric pressure.
- Perform a **better heating + cooling** procedure in order to reduce the condensation and solidification of water.
- Find a way to **stabilize the temperature** profile for a larger Time Window.