Status of VXD Thermal Mock-up

H. Ye, C. Niebuhr, R. Stever, K. Gadow, C. Camien

DESY Belle II group

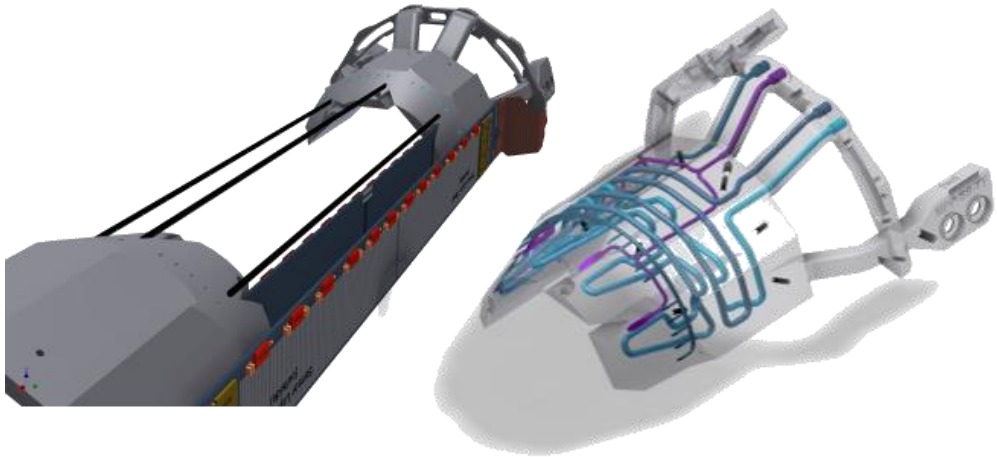
2016.1.13-15, 9th Belle II VXD Workshop

IFIC-Valencia

(hua.ye@desy.de)

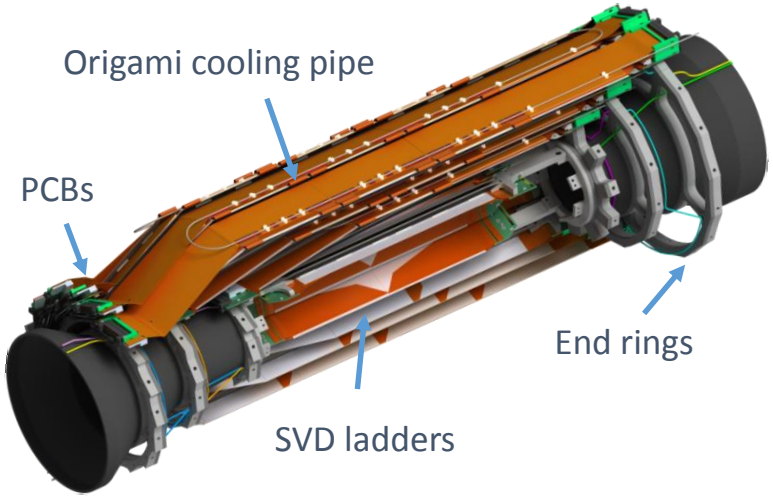
VXD Cooling System

Cooling of the PXD



Combined Support Cooling Block (SCB), manufactured using 3D printing technology, with CO_2 and *N2* channels inside.

Cooling of the SVD

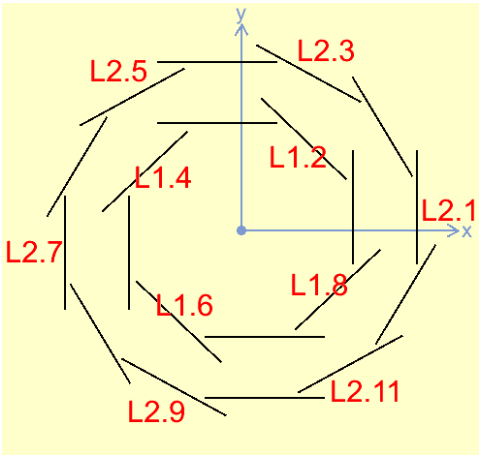


Requirements

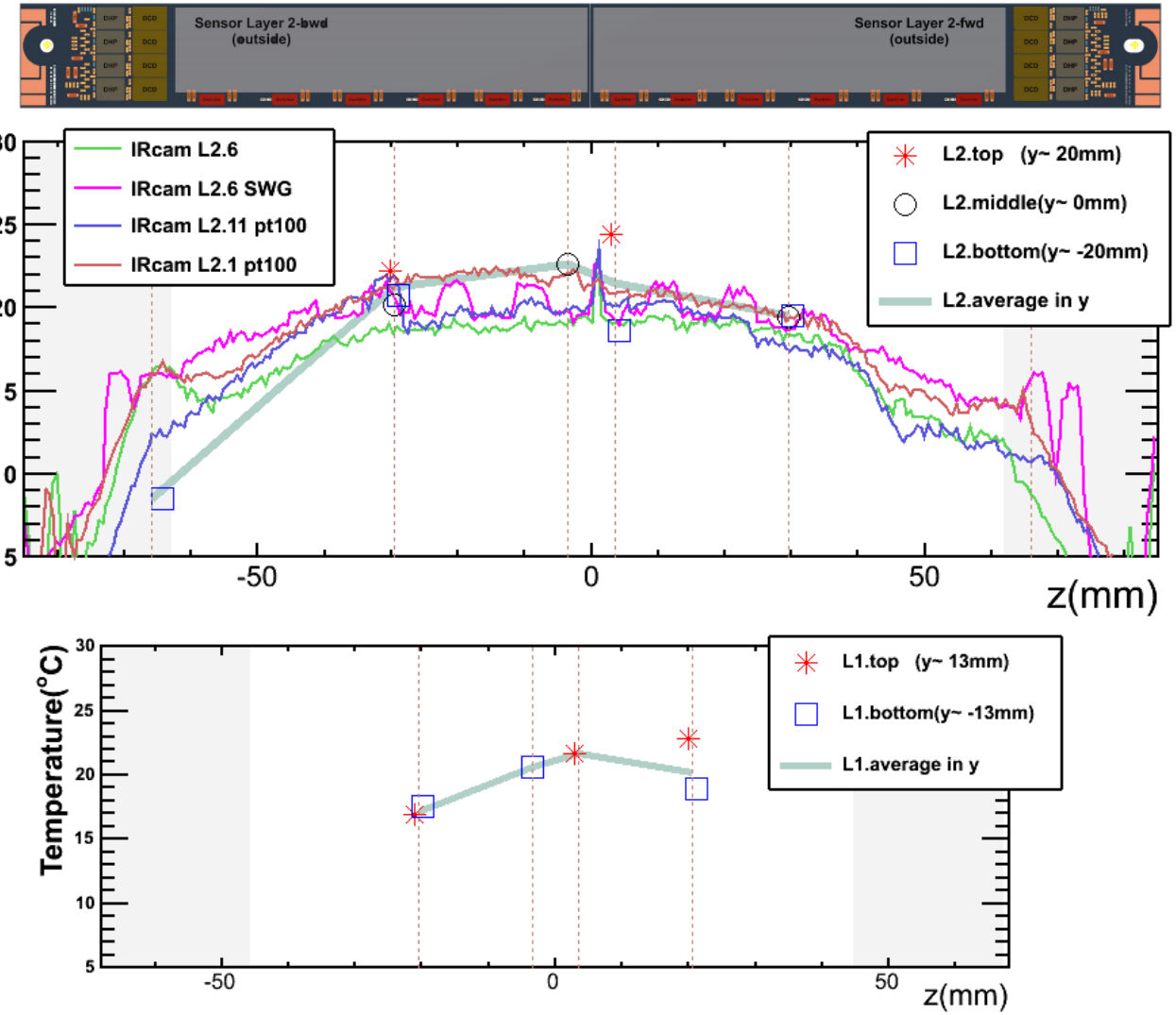
- ❑ PXD: Sensor < 25°C to minimize shot noise due to leakage current; ASICs < 50°C to avoid risk of electro-migration;
- ❑ SVD: APV25 readout chips surface@~0°C for SNR improvement;
- ❑ Power consumption: PXD 360W; SVD 700W, required cooling capacity of 2-3kW.

Temperature distribution on PXD

CO_2@-30°C; N_2 23L/min @room Temperature

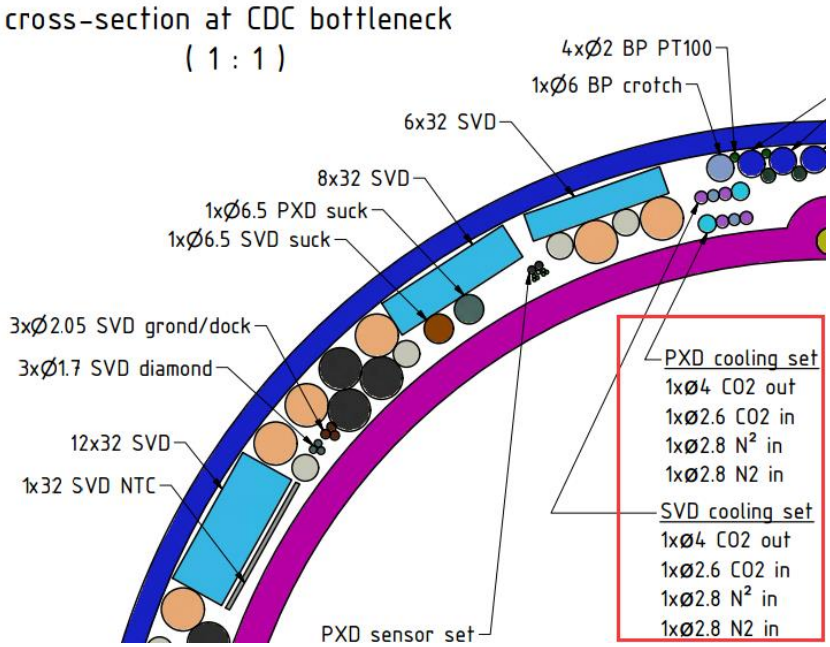


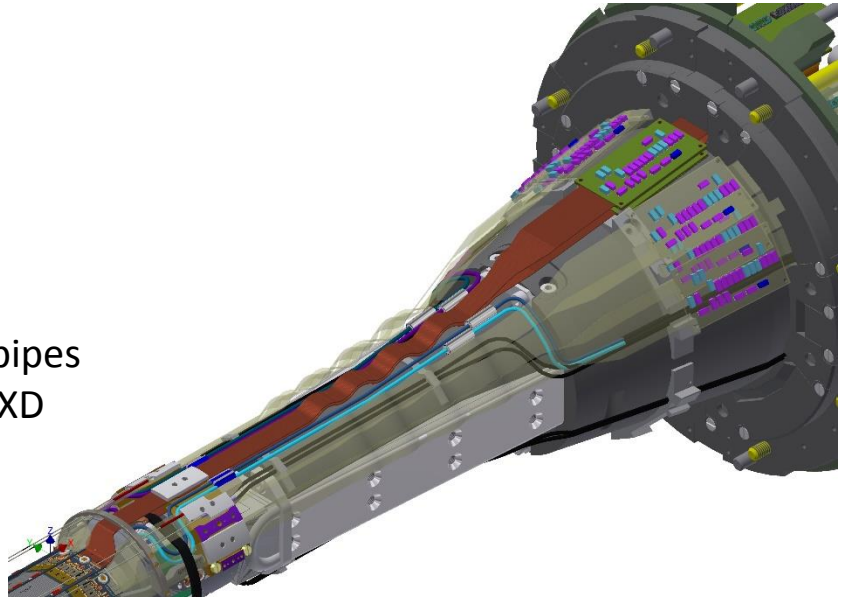
Detector Layout



More detail in *https://indico.mpp.mpg.de/conferenceDisplay.py?confId=3915*

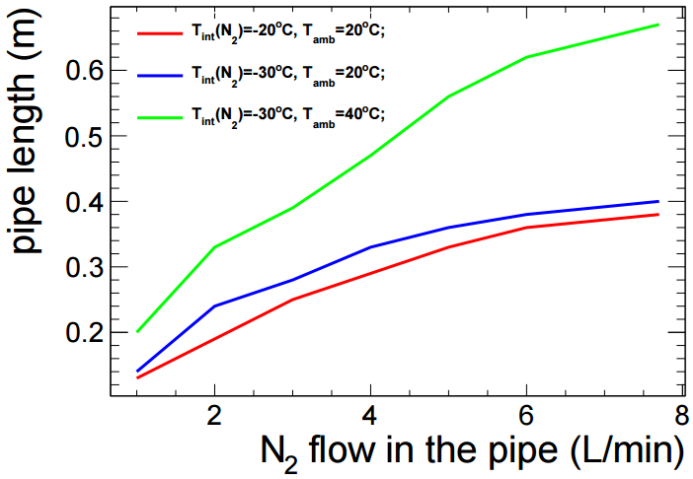
Temperature of the injected N_2





8N_2 pipes for PXD

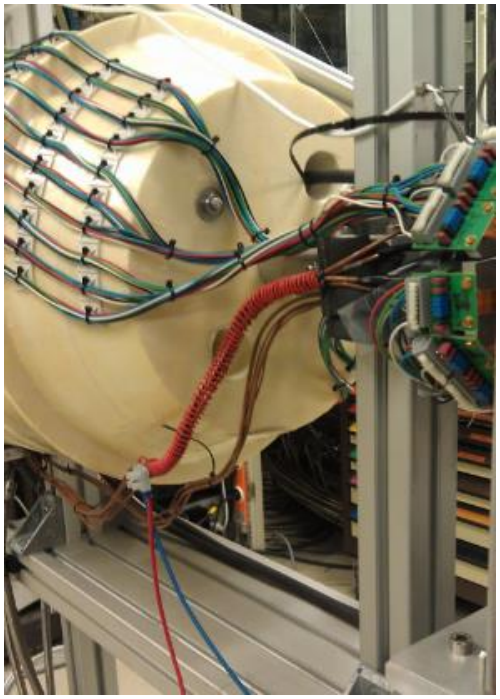
The CO_2 and N_2 tubes will be separated before arriving SCB, this means we can not have cold N_2.

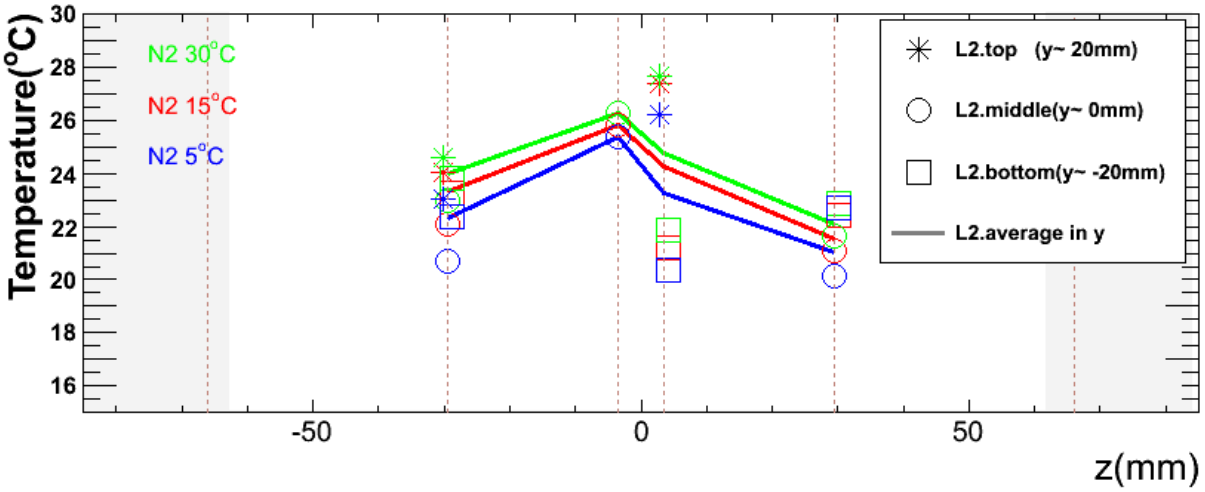


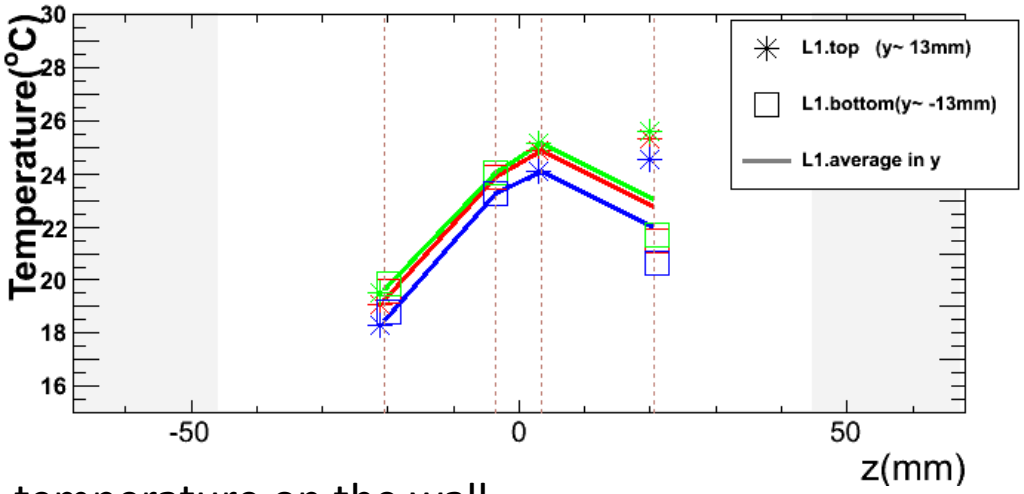
The N_2 will get the ambient temperature after about 0.3-0.4m.

More detail in
https://indico.mpp.mpg.de/conferenceDisplay.py?confId=3915

Different temperature of the injected N_2





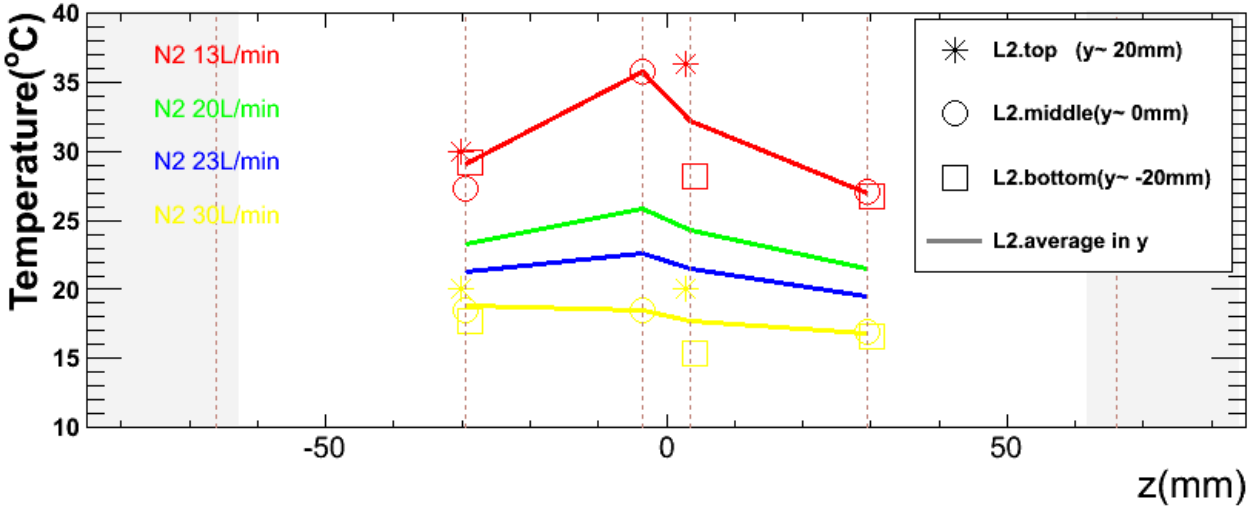


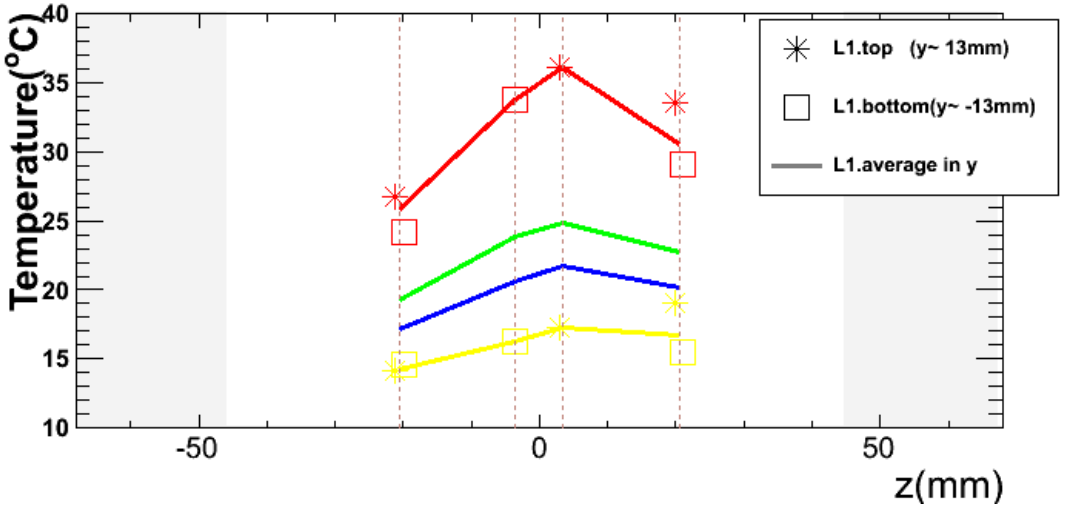
30W of power is given to heat N_2, temperature on the wall of pipe will reach about 25-30°C before going into SCB.

More detail in *https://indico.mpp.mpg.de/conferenceDisplay.py?confId=3915*

Different flow of the injected N_2

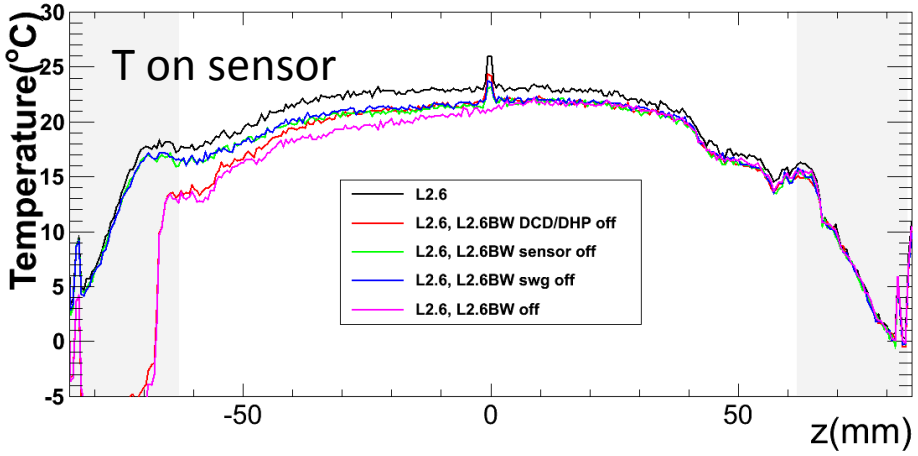
CO_2@-30°C, room temperature N_2 injected.

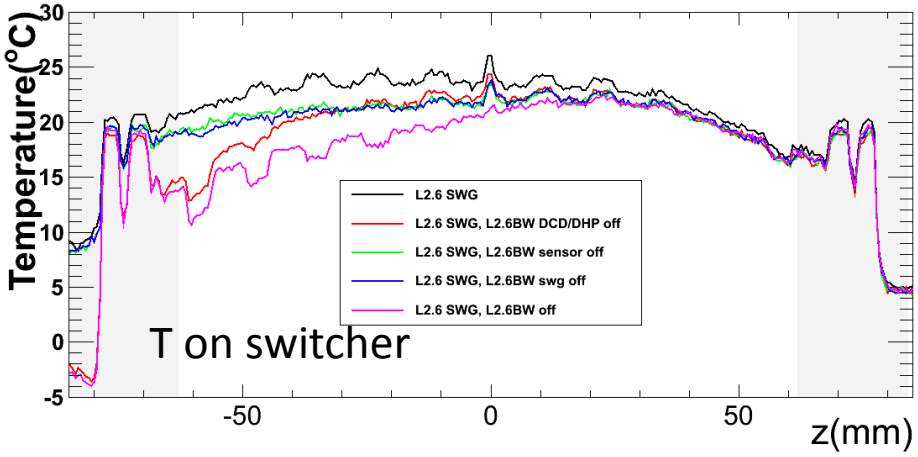




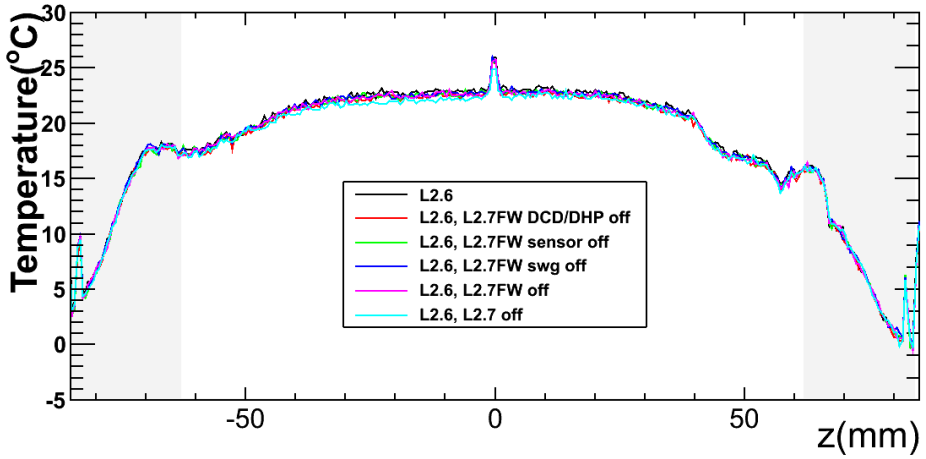
Thermal Influence between Sensors

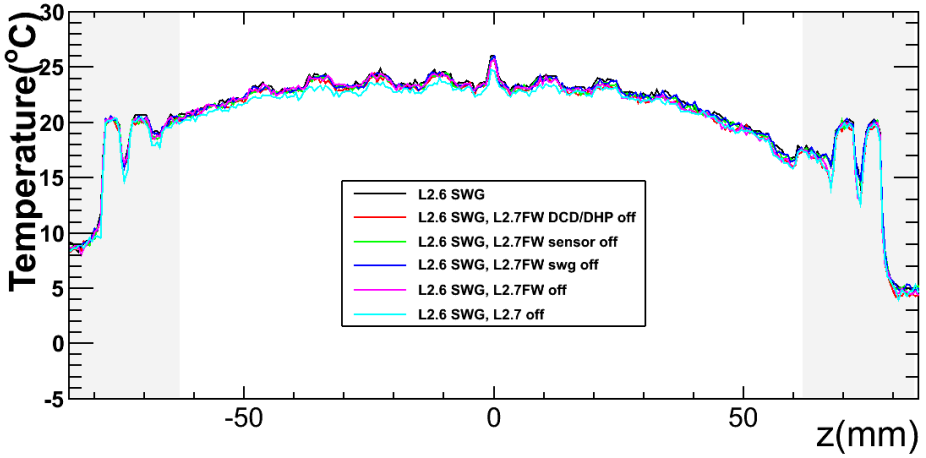
Temperature distribution on L2.6, when L2.6BW shut off. ΔT<5°C





Temperature distribution on L2.6, when L2.7BW shut off. ΔT<1°C





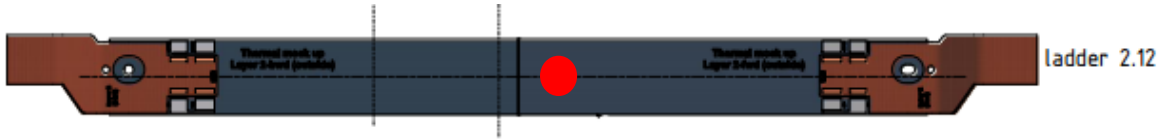
Vibration and deformation Measurements

Using non-contact

capacitive (sensitivity of 0.05um, band width of 5kHz)

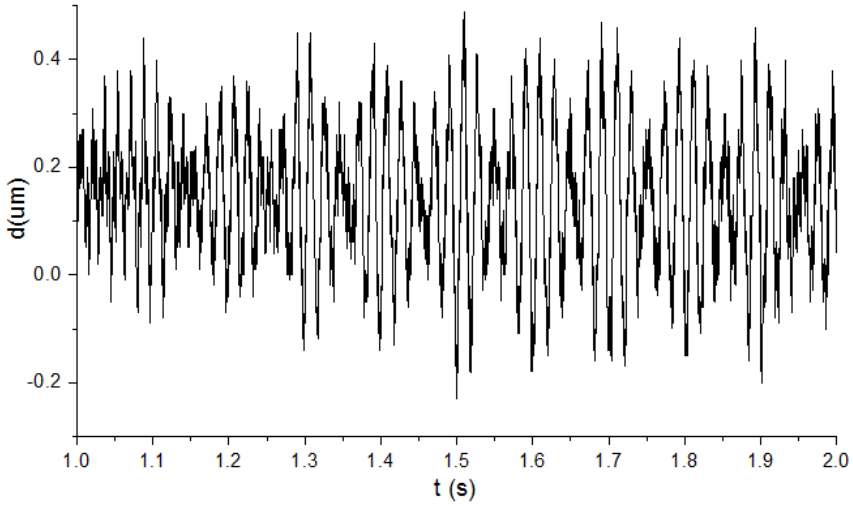
laser (sensitivity of 0.02um, band width of < 50kHz)

displacement sensors.

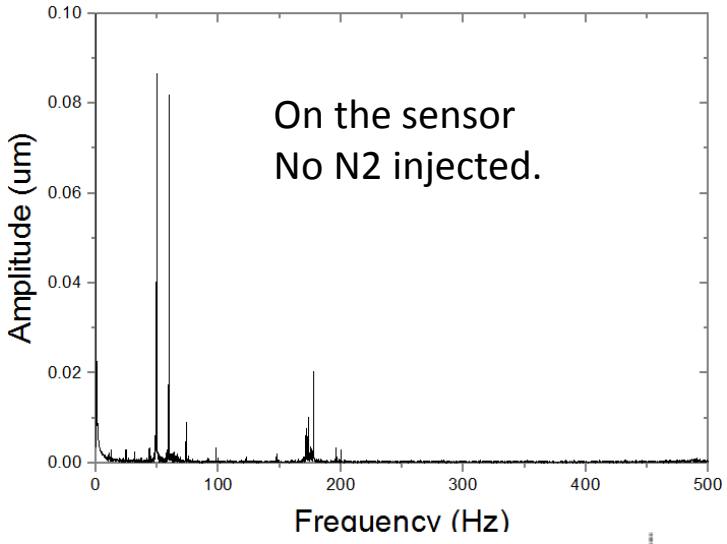


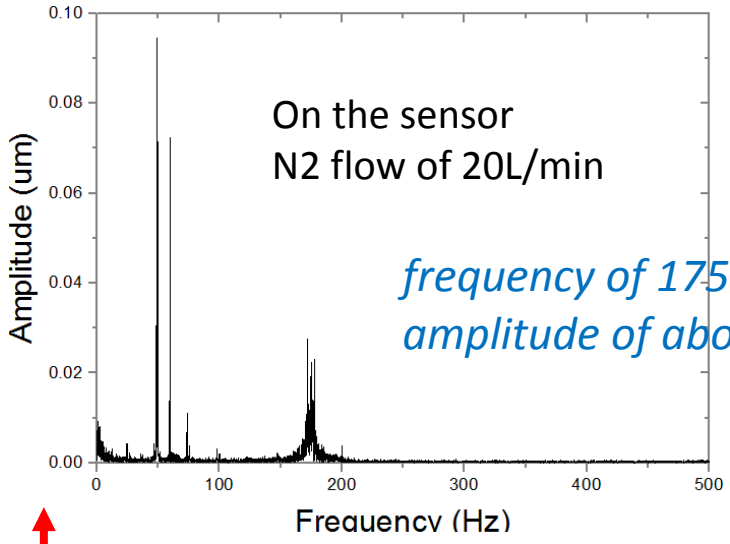
No N2 injected.

Vibration with RMS amplitude about 0.2um.

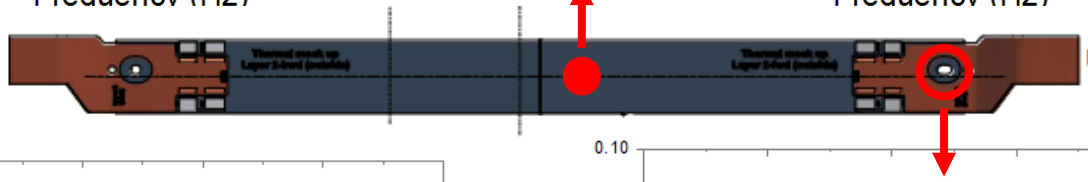


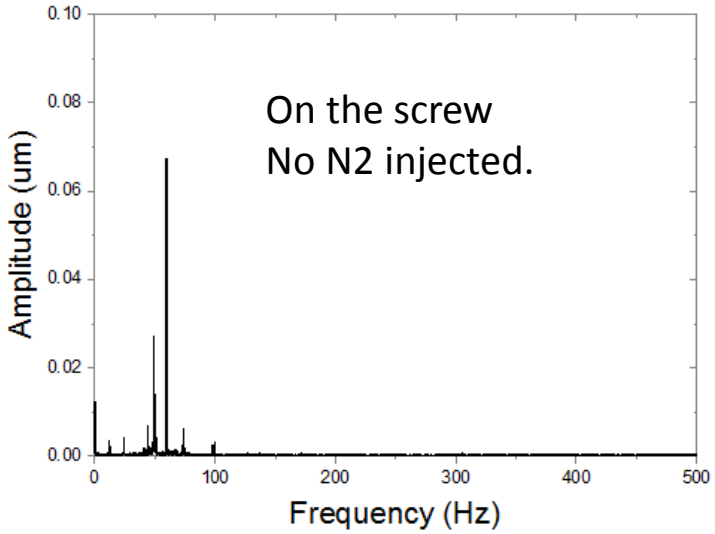
Vibration on Layer.2

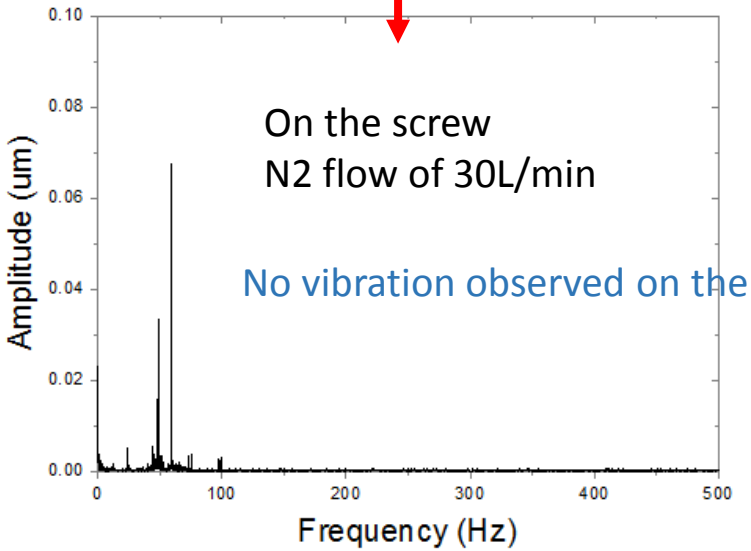




frequency of 175Hz,
amplitude of about 0.02um.

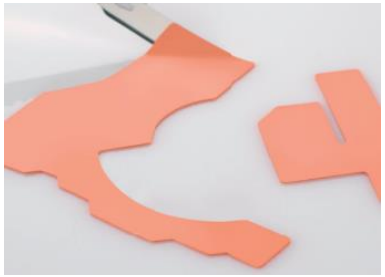






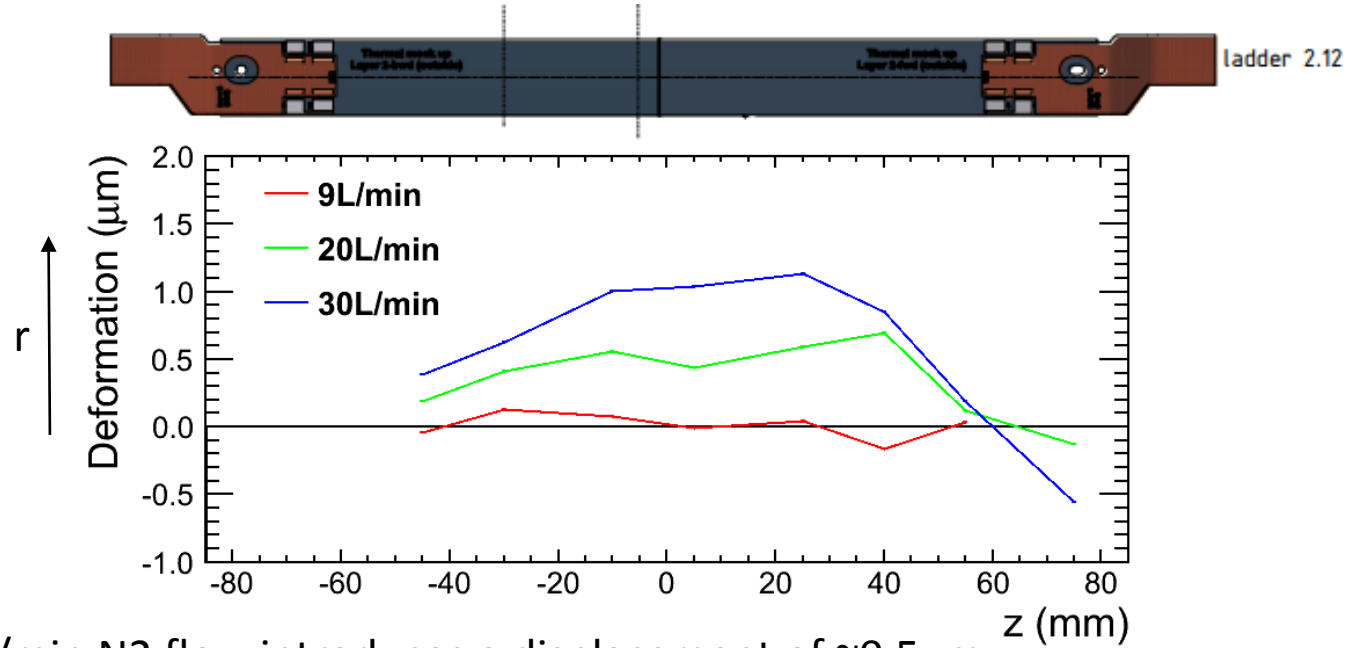
No vibration observed on the supporter.

Vibration and Displacement Measurements



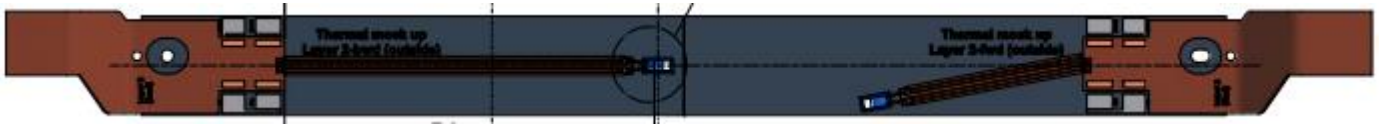
We also try to attach a piece of Kerathem (~0.3g) on to simulate the Switchers, the vibration stays.

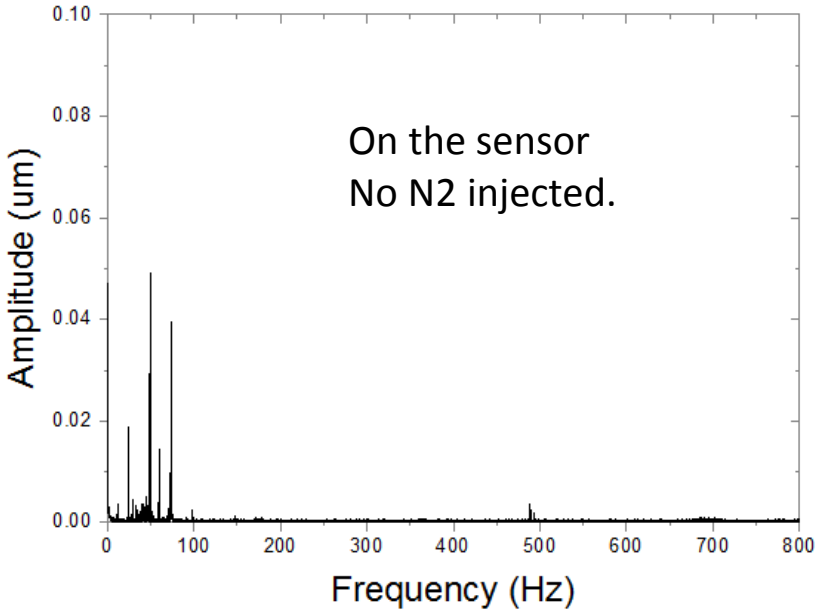
Displacement Measurement

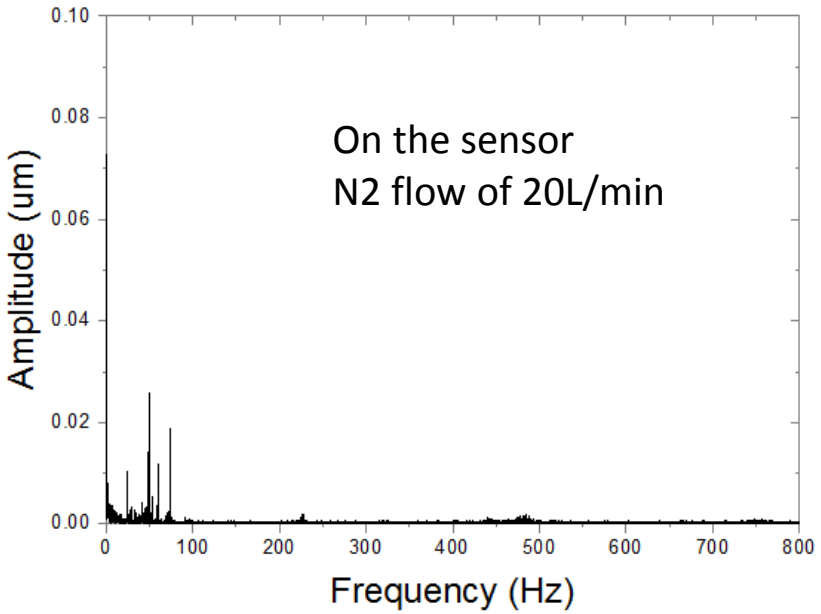


20L/min N2 flow introduces a displacement of ~0.5um.

Vibration at the sensor with Pt100s



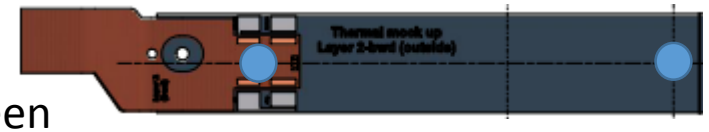




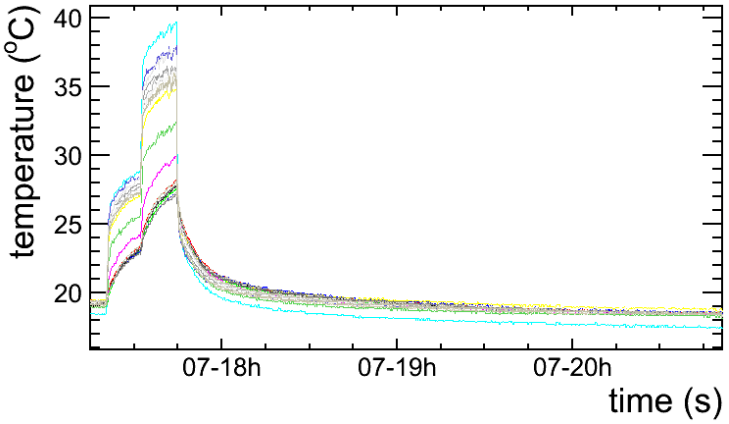
No 175Hz vibration, smaller amplitude due to the fixation from the glued pt100s.

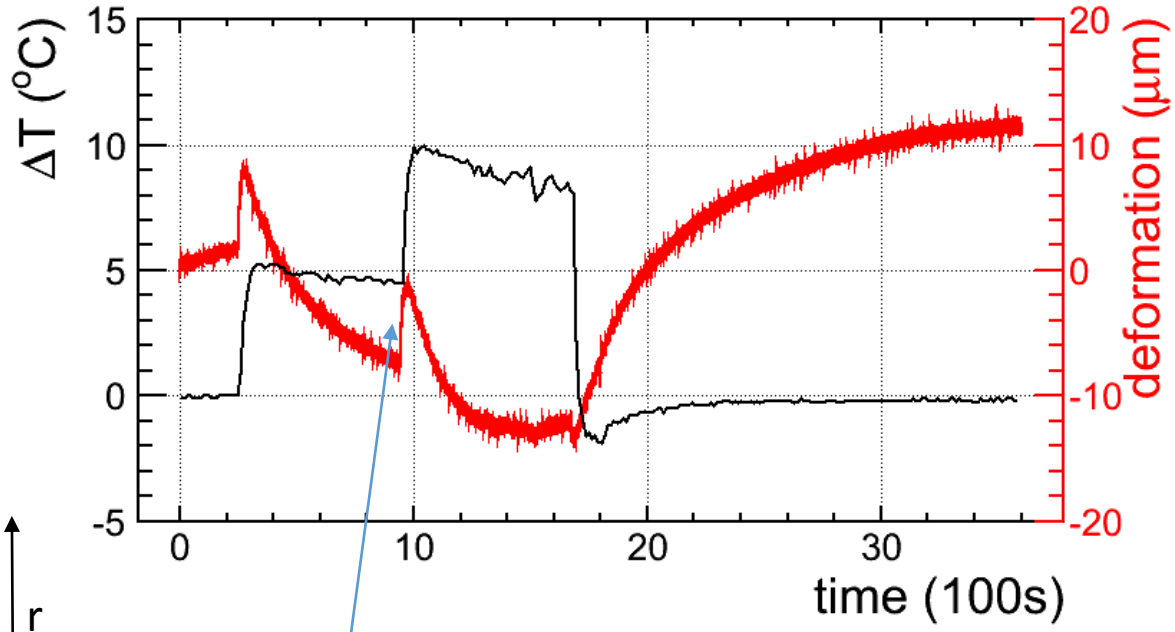
Deformation due to Temperature Gradient

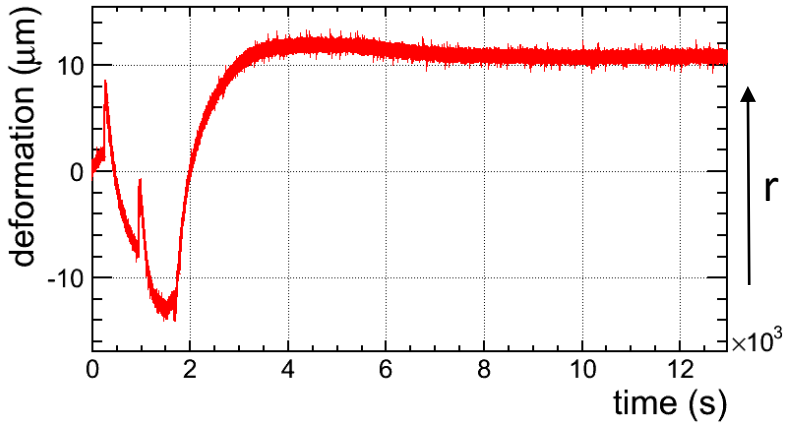
Sensor L2.12

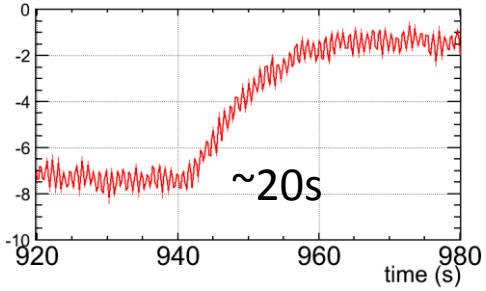


ΔT between





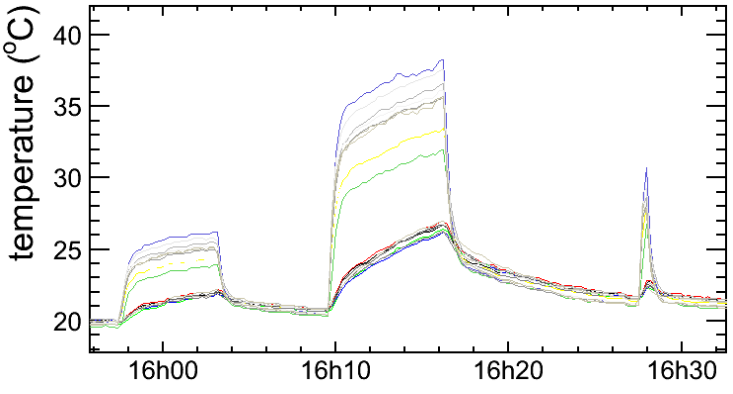


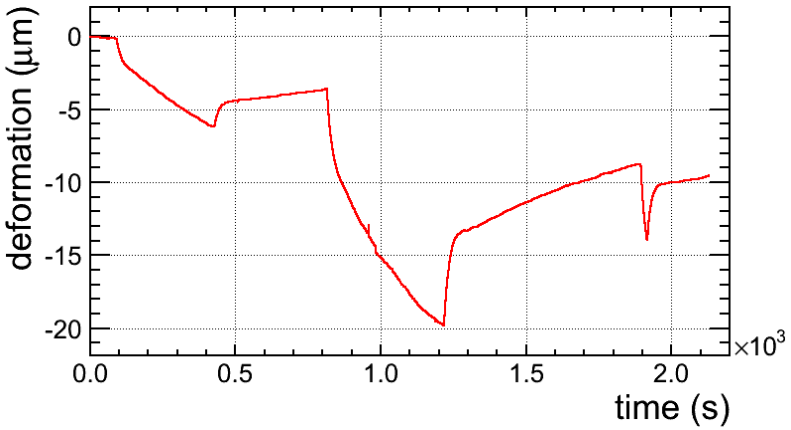


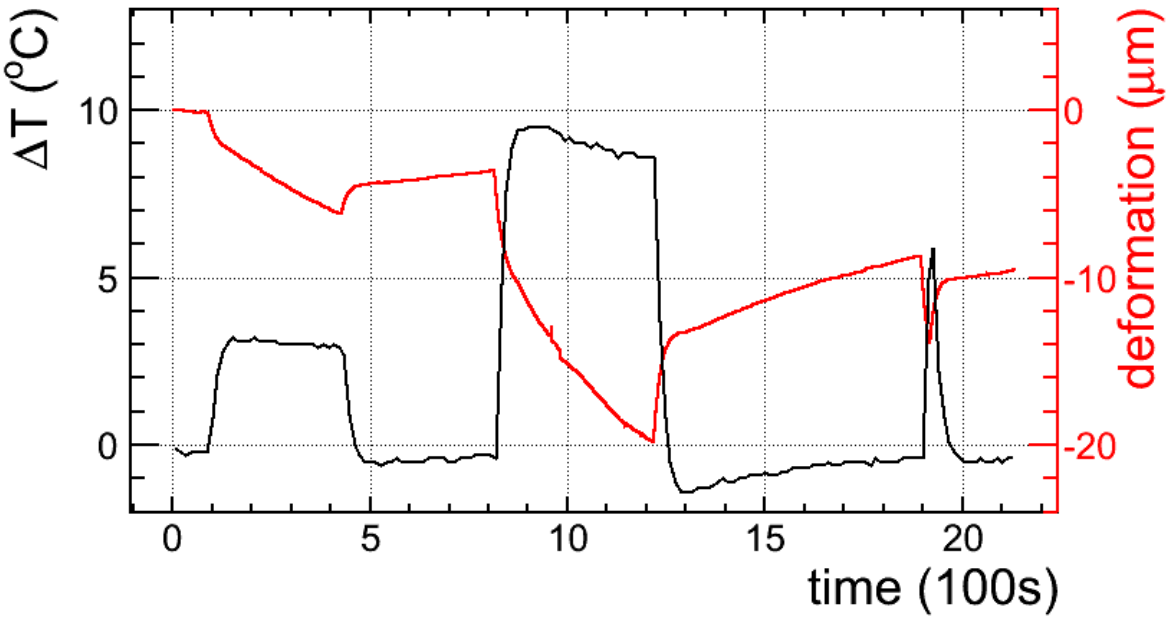
More studies are necessary to understand this deformation.

Deformation due to Temperature Gradient

Sensor L2.1 (with pt100s glued)



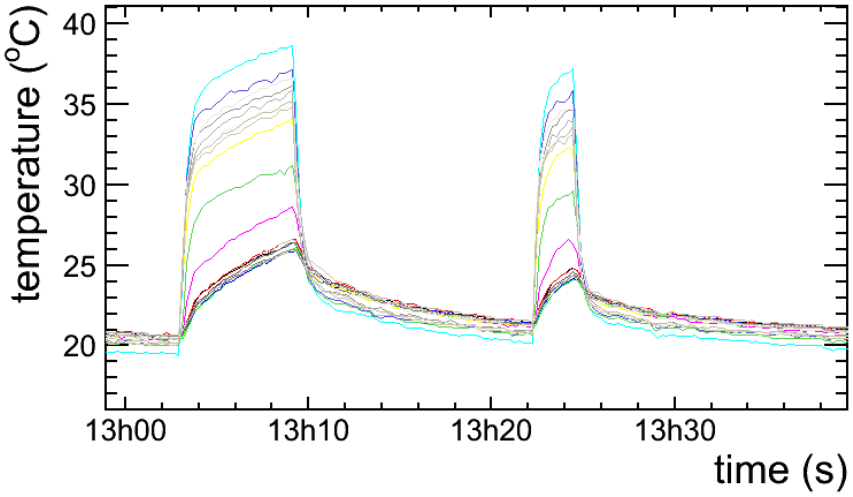


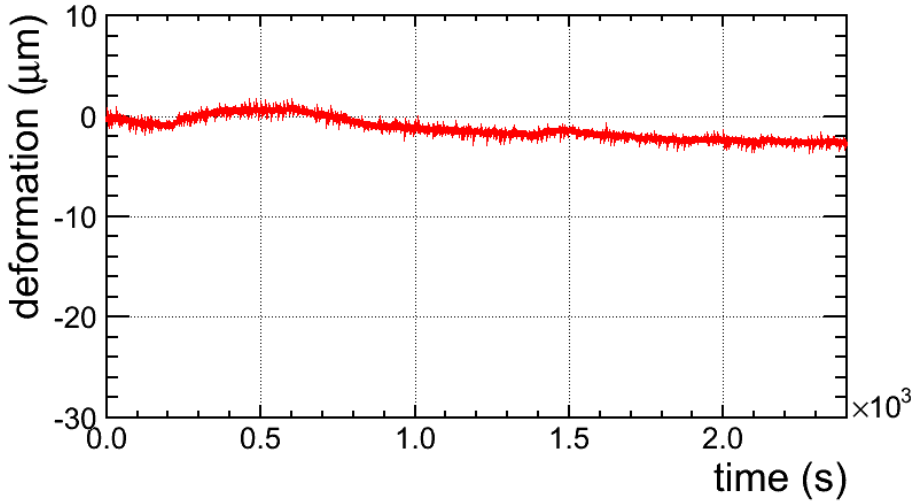


The “+r” increase disappear.

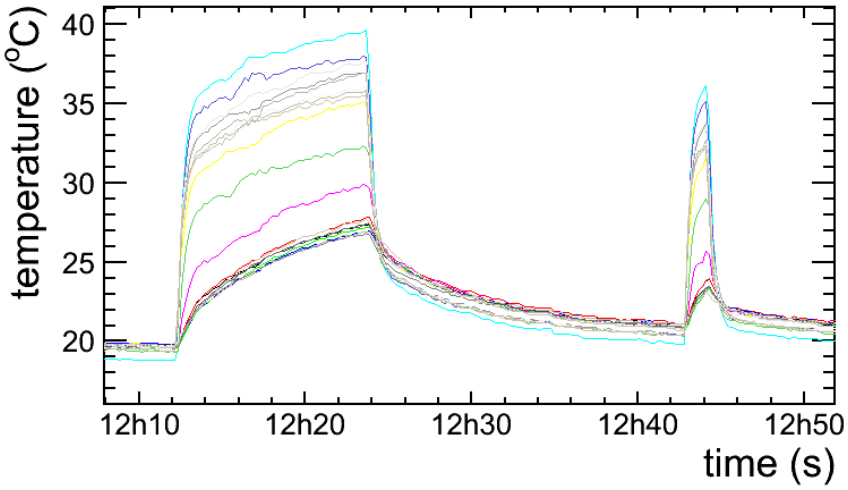
Deformation due to Temperature Gradient

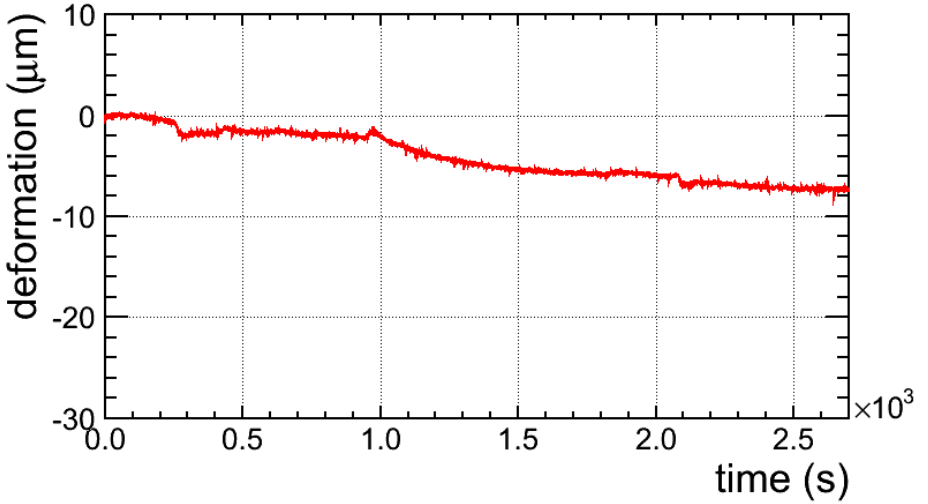
BW screw





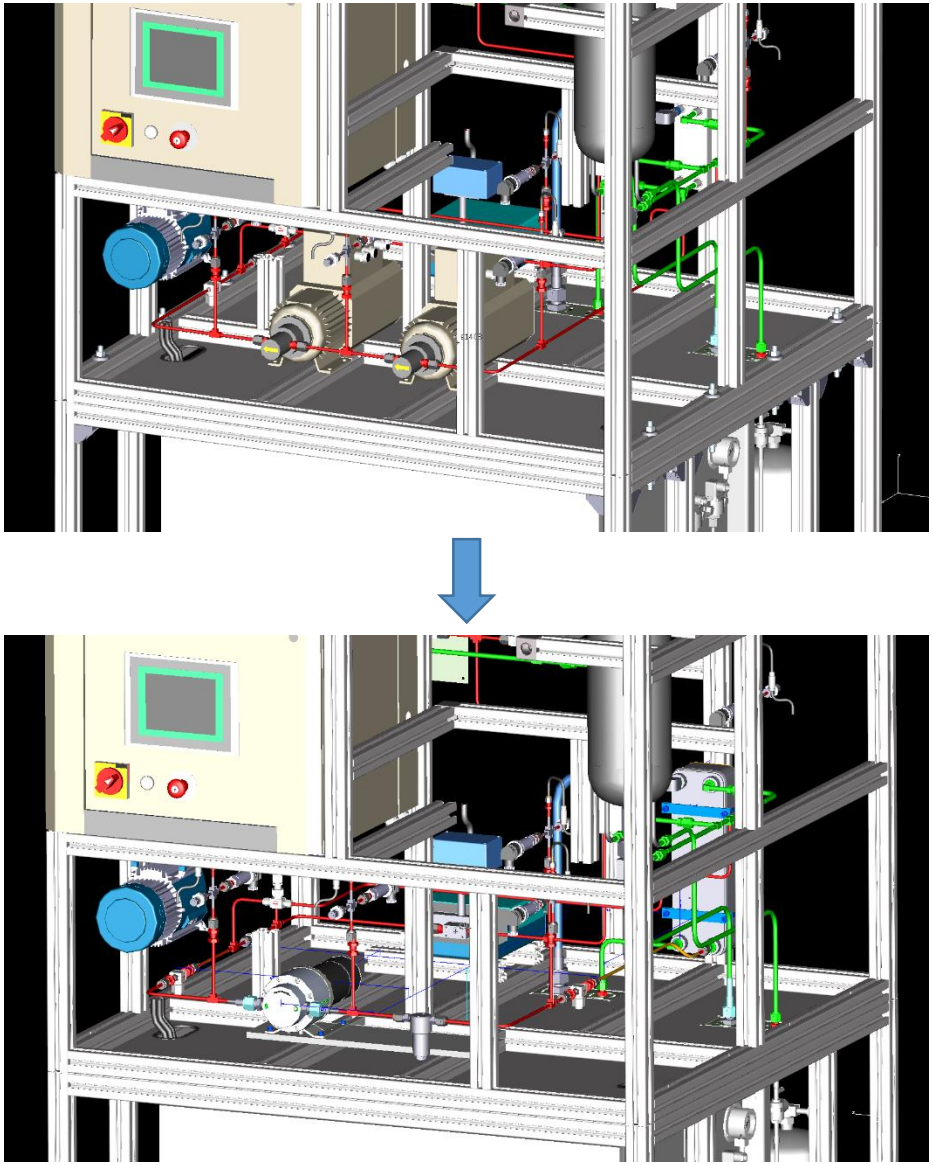
FW screw





Torque of 7N·mm is given to fix the screws.

Schedule for New Pump refit



Schedule

- Dismount the old heat-exchanger and pumps,
- Weld work and test,
- Modify tubes,
- Mount new pump,
- Pressure test,
- Adapt control system (Jan.20).

Preparation of SVD parts

Components:

- Endring.
- Distributer.
- The SVD ladders.
- 8m flex lines.
- Cooling pipes.

Commissioning work

Layer.3 will come soon in Febuary.

Summary

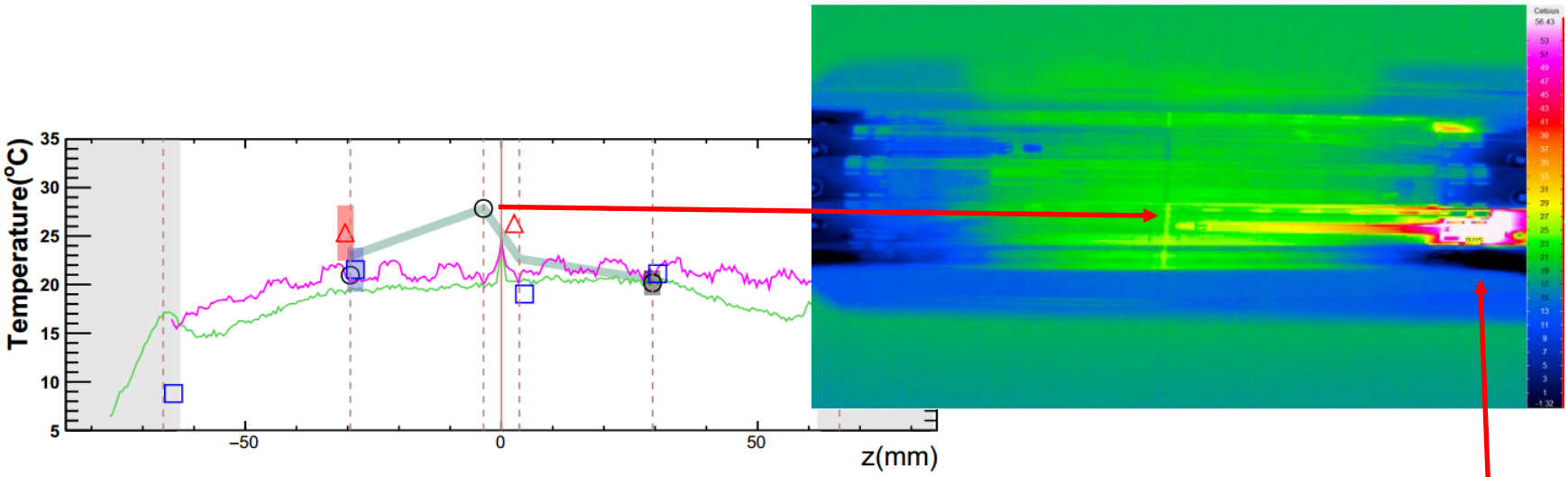
- Update the temperature distribution on PXD sensors, ΔT is about 7-10^{o}C when giving the corrected N2 flow of 20L/min.
  - The 20L/min's N2 flow introduce a vibration with the frequency of 175Hz, amplitude of about 0.02um, and a displacement of 0.5um.
  - The 7-10^{o}C's temperature difference introduce a deformation of several 10um, more studies are necessary to understand it.
- The temperature of injected N2 does not introduce much influence.
- MARCO upgrade is ongoing, expected to be finish this month.
- Layer.3 of SVD will come in February.

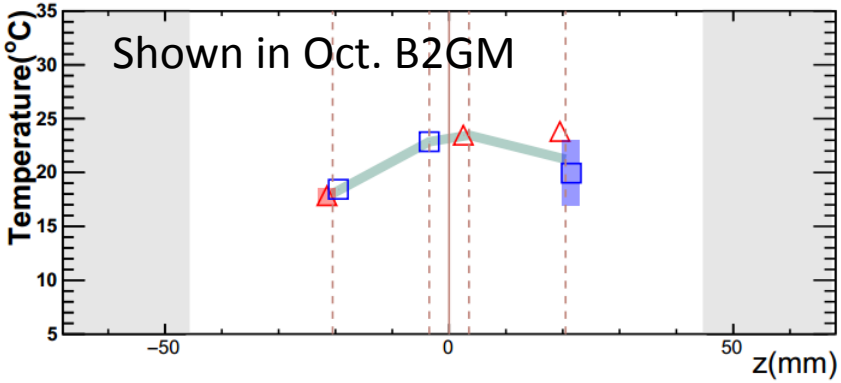
Thank you!

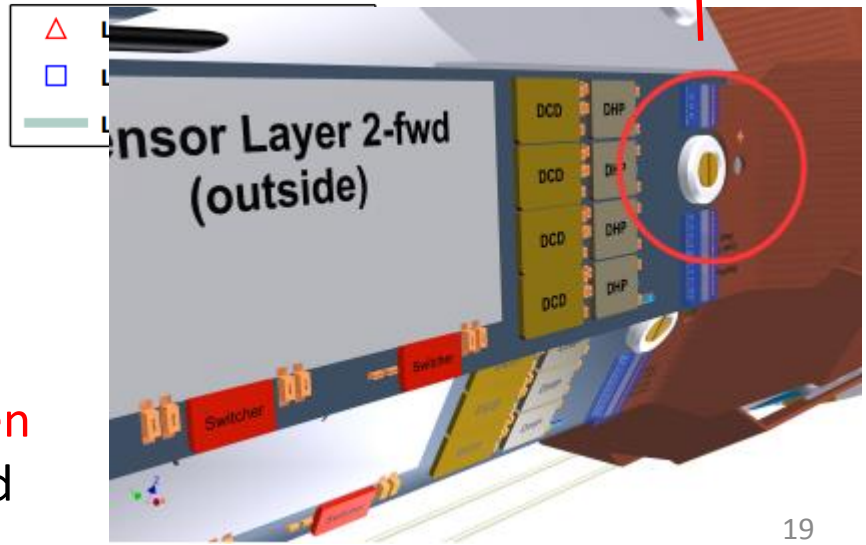
Backup

Loosen screws cause hot ASICs

N_2 flow 23L/min, 0°C; CO_2@-30°C; power on.

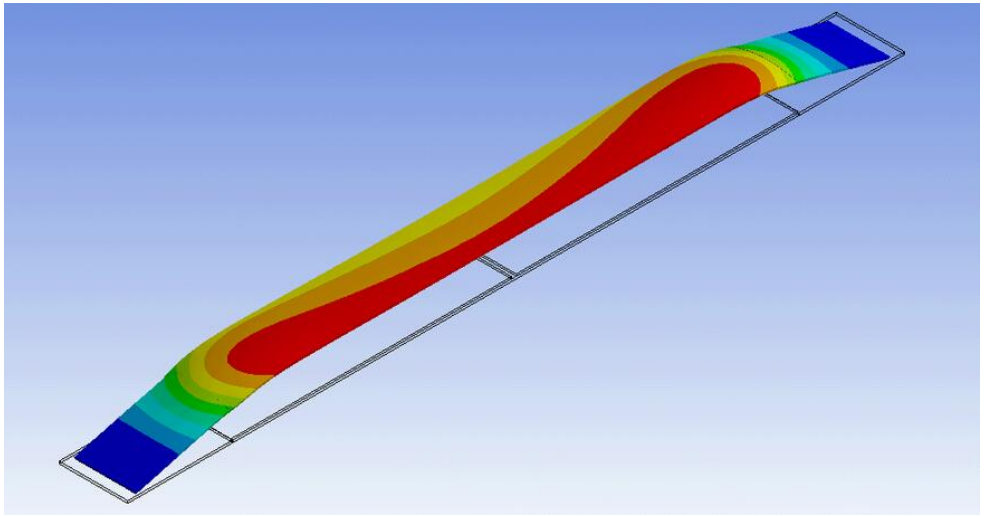


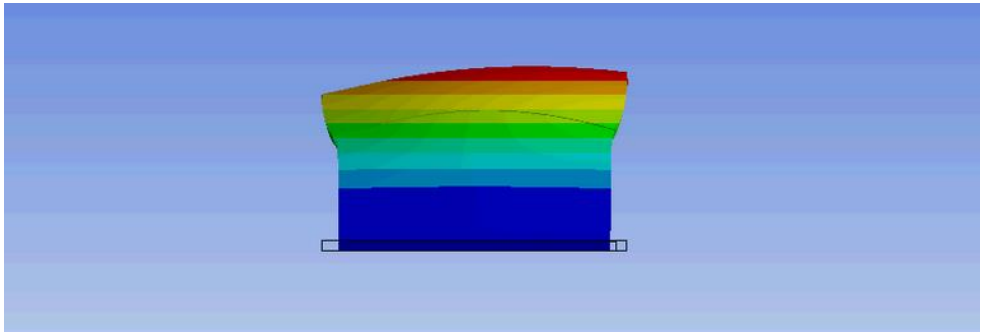




Several hot ASICs are found, due to loosen screws or blocked holes, should be tested before mounting sensors.

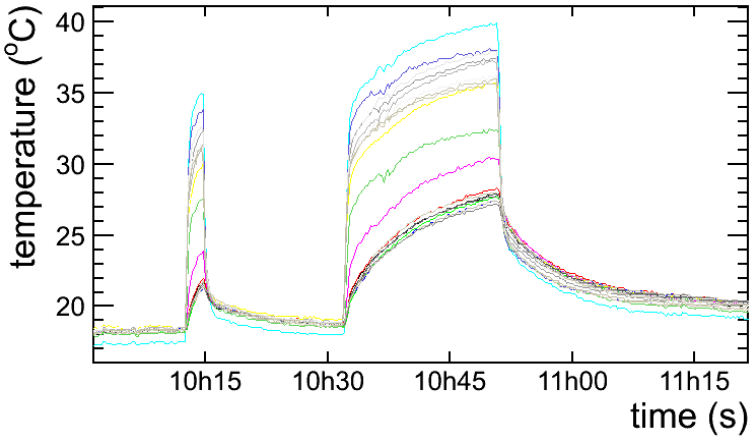
Deformation Simulation

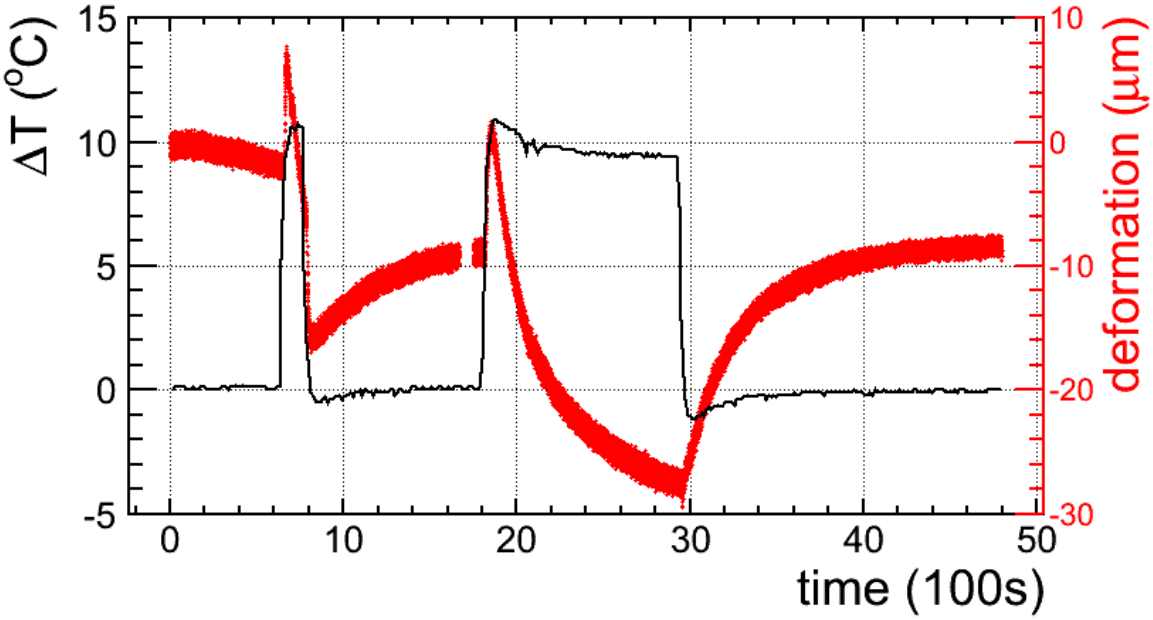




Deformation due to Temperature Gradient

Sensor L2.12; test2





Start heating (ΔT ~7°C),

An 10um's increase to "+r" direction (takes ~20s),

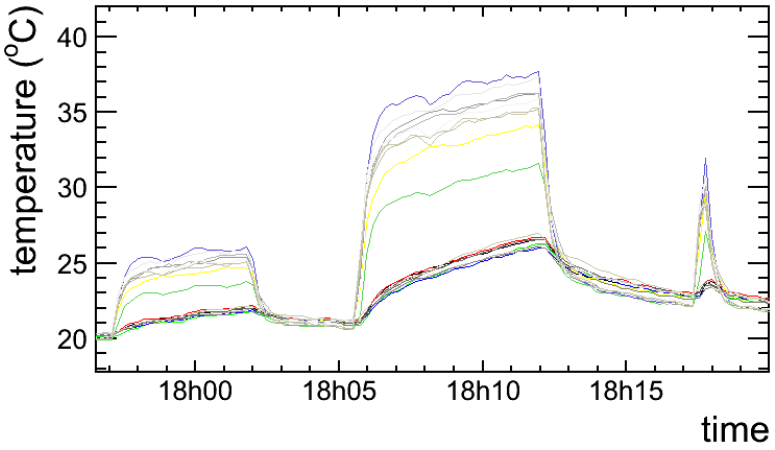
Keep deforming to "-r" direction, about 20-30um,

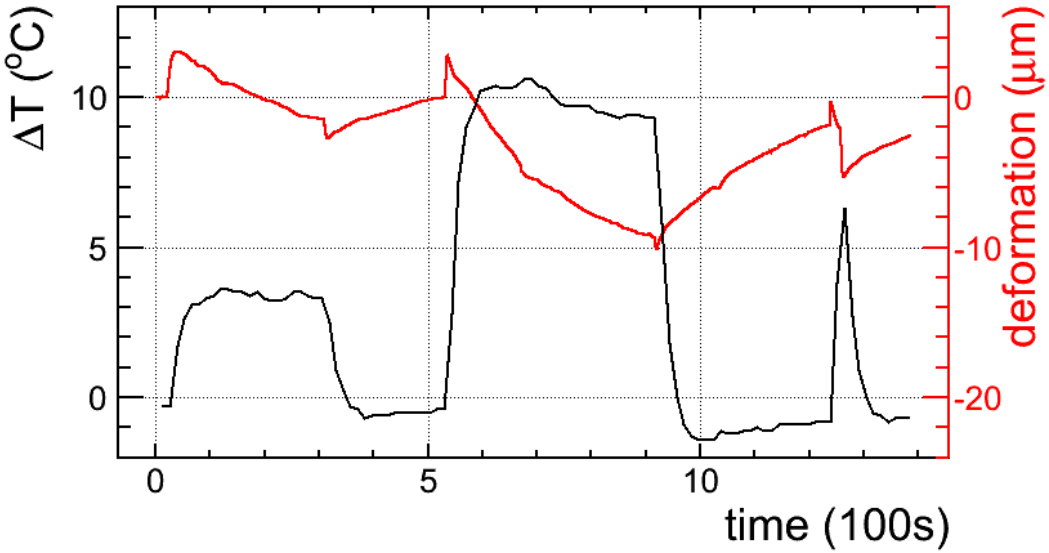
Stop heating,

Deform towards (not reach) the origin position.

Deformation due to Temperature Gradient

Sensor L2.6





Start heating (ΔT ~10°C),

An ~10um's increase to "+r" direction (takes ~20s),

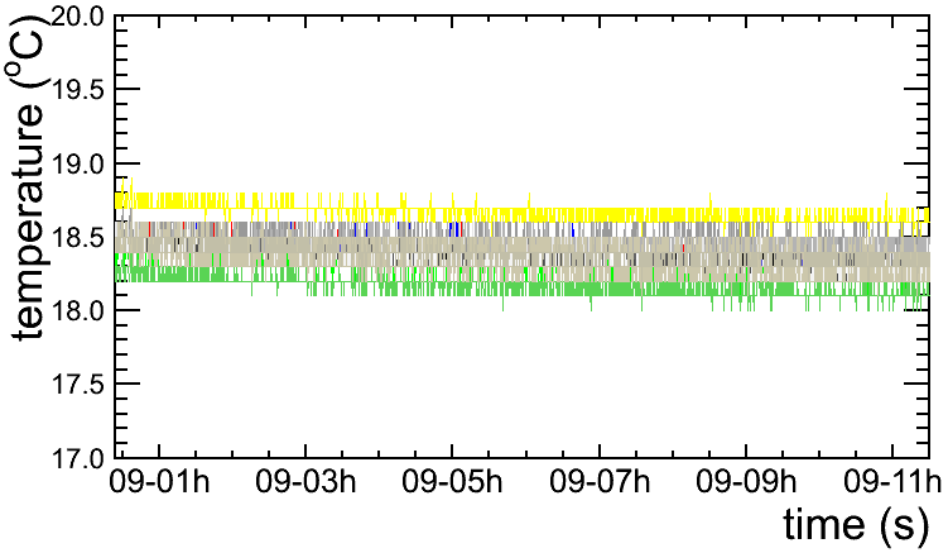
Keep deforming to "-r" direction, about 20-30um,

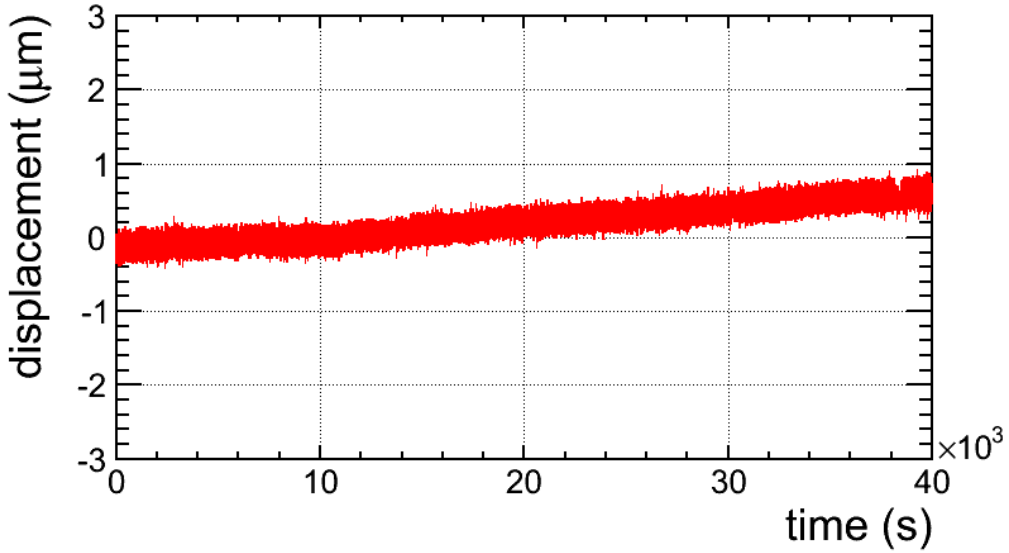
Stop heating,

Deform towards (not reach) the origin position.

Vibration and deformation Measurements

Laser displacement sensor (long term)
L2.1 (with pt100s)





Formula 3: to calculate the calibration factor

$$K_\delta = \sqrt{\frac{\delta_E}{\delta_B}},\quad K_t = \sqrt{\frac{293}{(273+t)}},\quad K_p = \sqrt{\frac{p}{1000}}$$

How to use the correction factor:

Formula 4:

$$Volume(gasmeter) = scale(rotameter) \bullet K_\delta \bullet K_t \bullet K_p$$