

# Temperature sensors calibration

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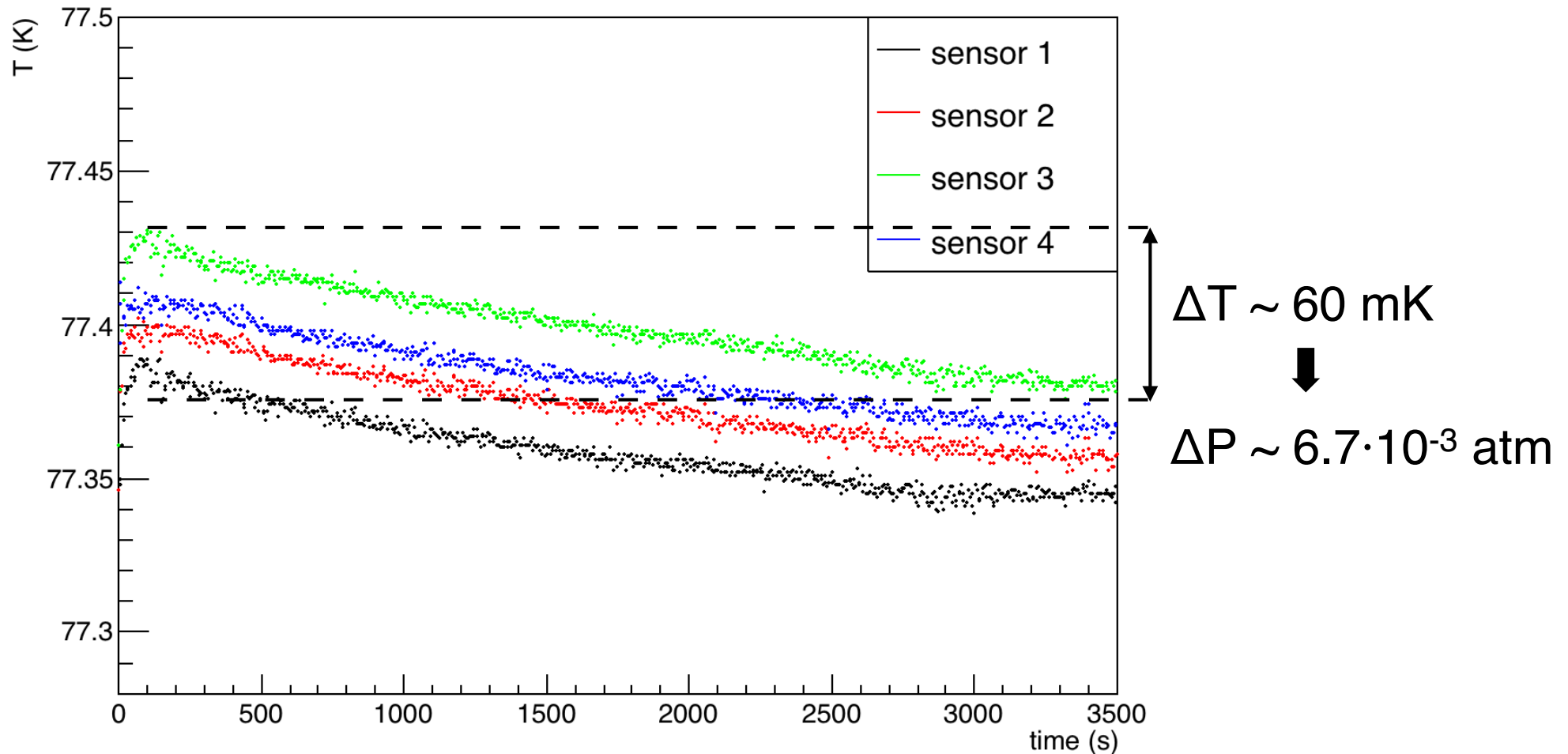
*IFIC - (CSIC & Univ. Valencia)*

# Outline

- Understanding the behaviour of the temperature measurements, i.e. decreasing tendency of temperature of  $\text{IN}_2$  with time (*see previous presentations*)
- New setup and further measurements with  $\text{IN}_2$
- Channel offset calibration with resistors

# Measurements with liquid nitrogen: *understanding temperature evolution*

Measurements with sensors inside  $\text{LN}_2$  show a decreasing tendency with time:

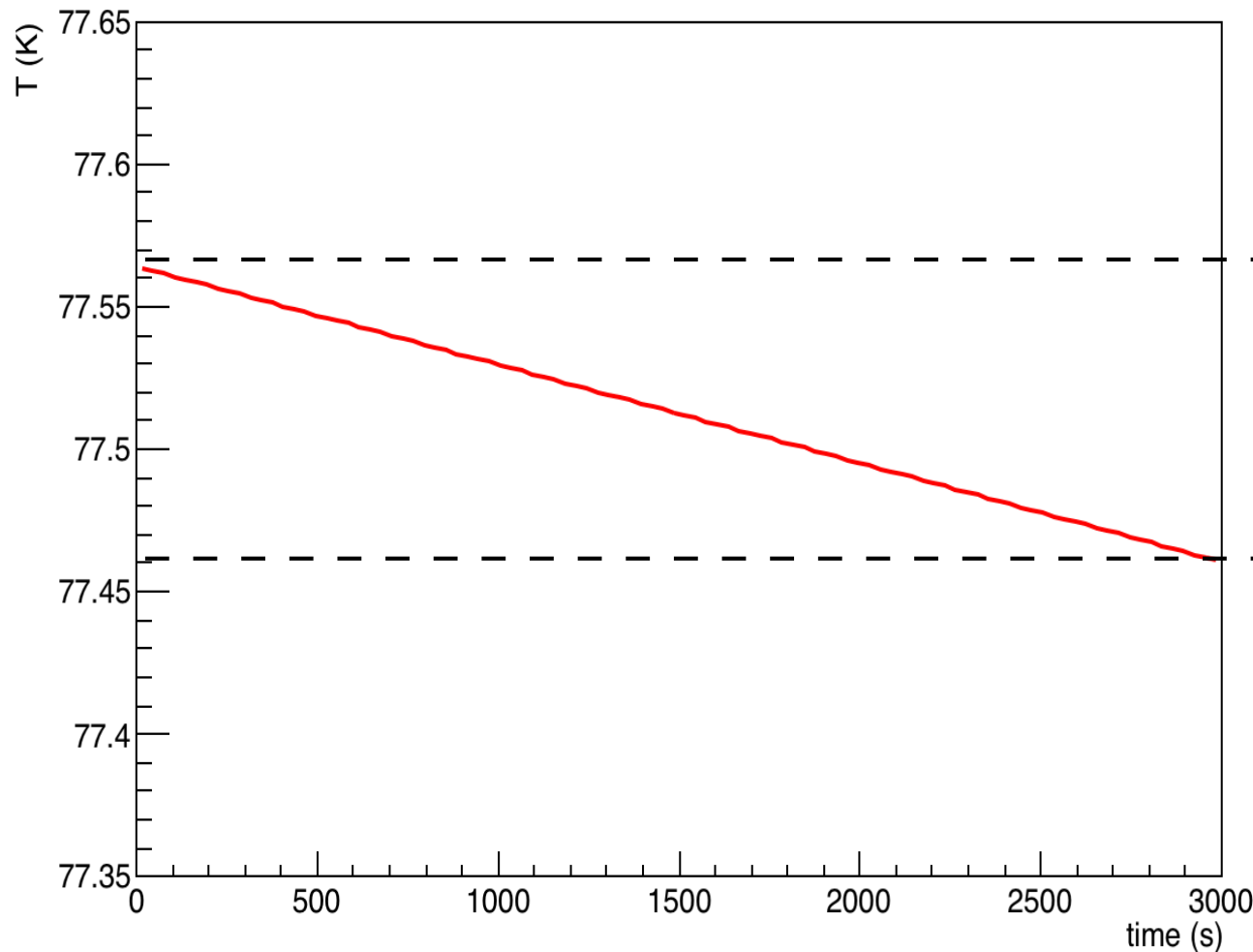


- > pressure evolution inside the vessel?
- > height of  $\text{LN}_2$  column?

# Measurements with liquid nitrogen: *understanding temperature evolution*

From Antoine equation for  $\text{LN}_2$ : and assuming a linear decreasing with time of the  $\text{LN}_2$  level due to evaporation (naive attempt):

$$T(K) = \frac{B}{A - \log_{10}P} - C + 273.15 = \frac{167.93}{5.73921 - \log_{10}(P_{atm} + \rho_{\text{LN}_2}g(0.21 - 0.15t/3000))} - 254.481 + 273.15$$



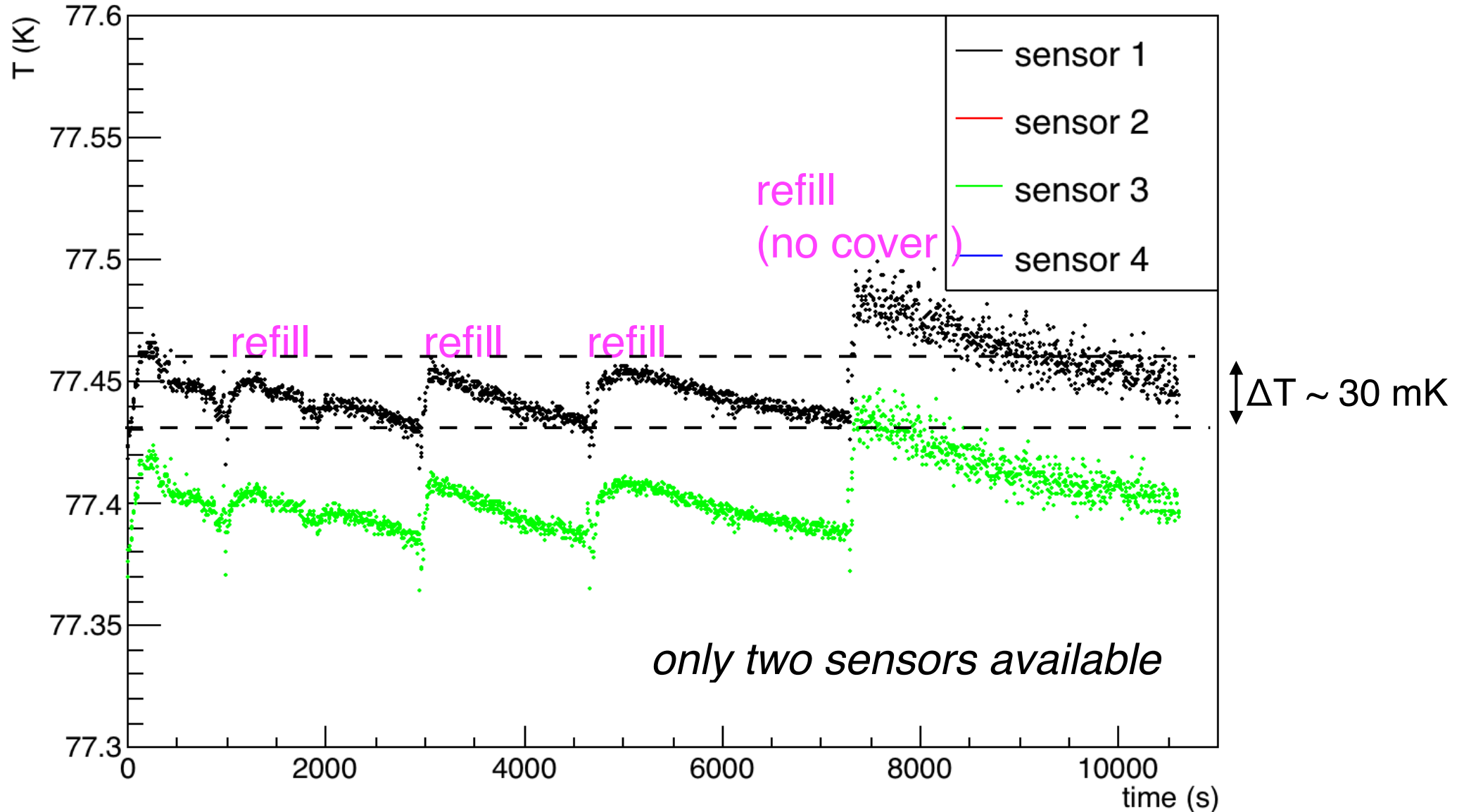
$\text{LN}_2$  column

$\Delta T \sim 90 \text{ mK}$

Reasonable first approx.  
given the lack of precise  
knowledge of our system

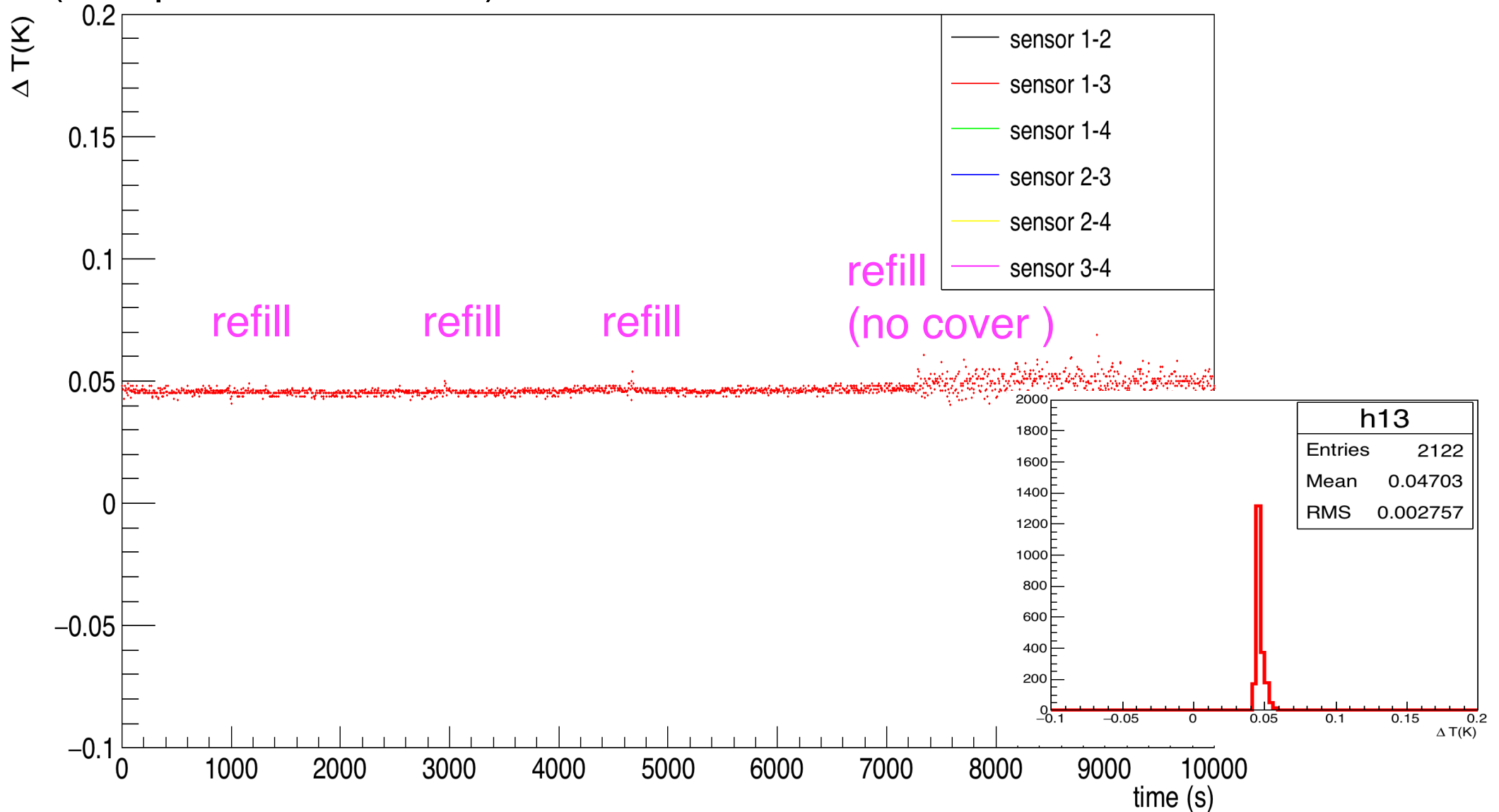
# Measurements with liquid nitrogen: *understanding temperature evolution*

For checking this, we made a long run where we open the polystyrene cover, refill with  $\text{LN}_2$  to maintain the height within  $\sim 5$  cm and cover again (except for the last one)



# Measurements with liquid nitrogen: *understanding temperature evolution*

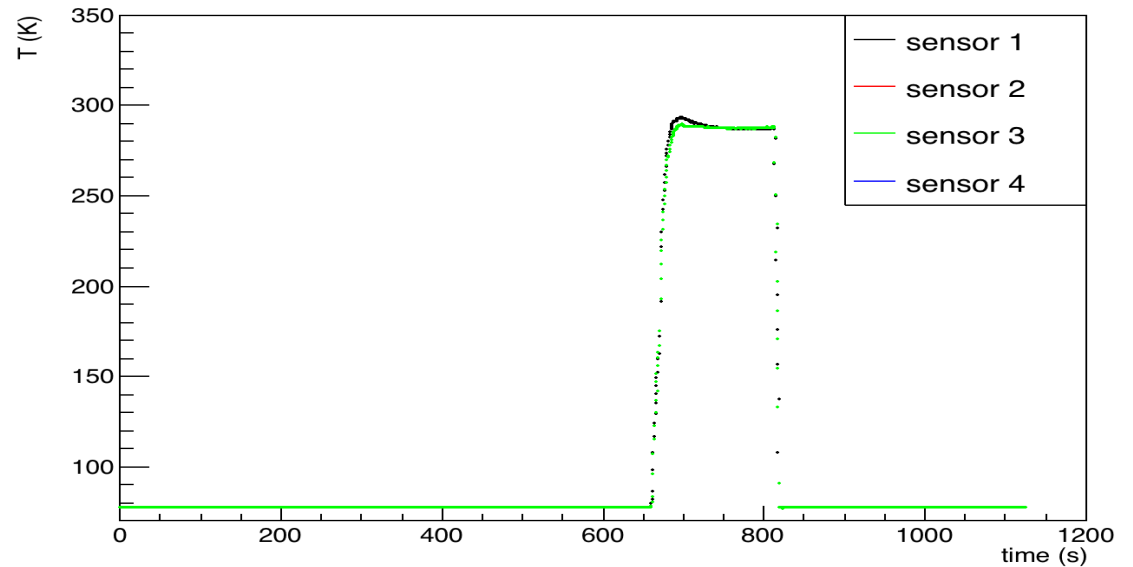
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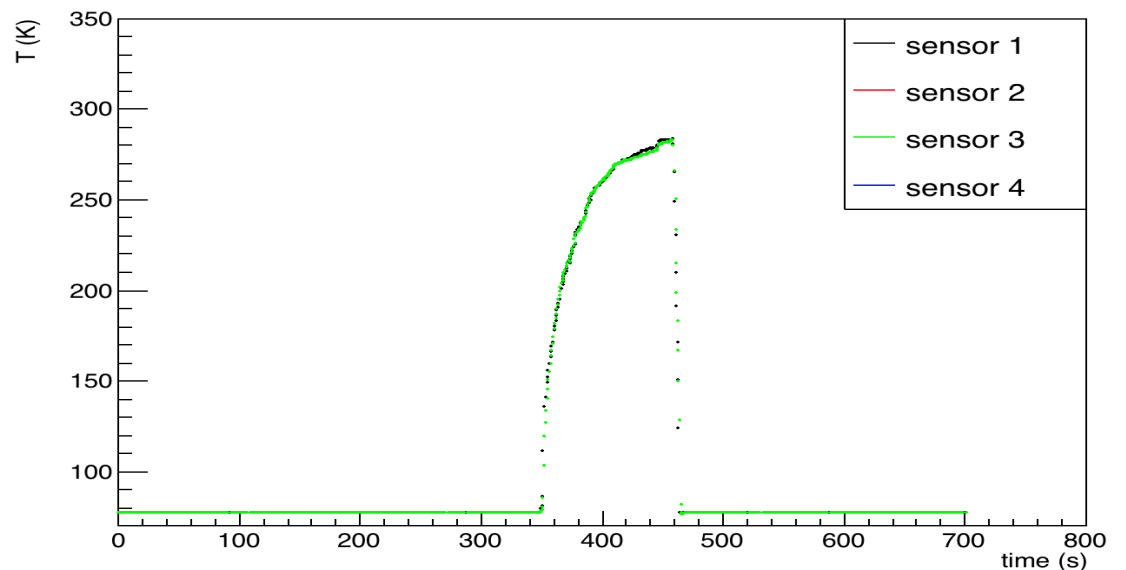
# Measurements with liquid nitrogen: *offset variation with rapid changes in temperature*

Check reproducibility of measurements after a rapid change in temperature. Two procedures were followed:

- Sensors into  $\text{LN}_2$ , take them out, condensation is removed with drier and put back into  $\text{LN}_2$

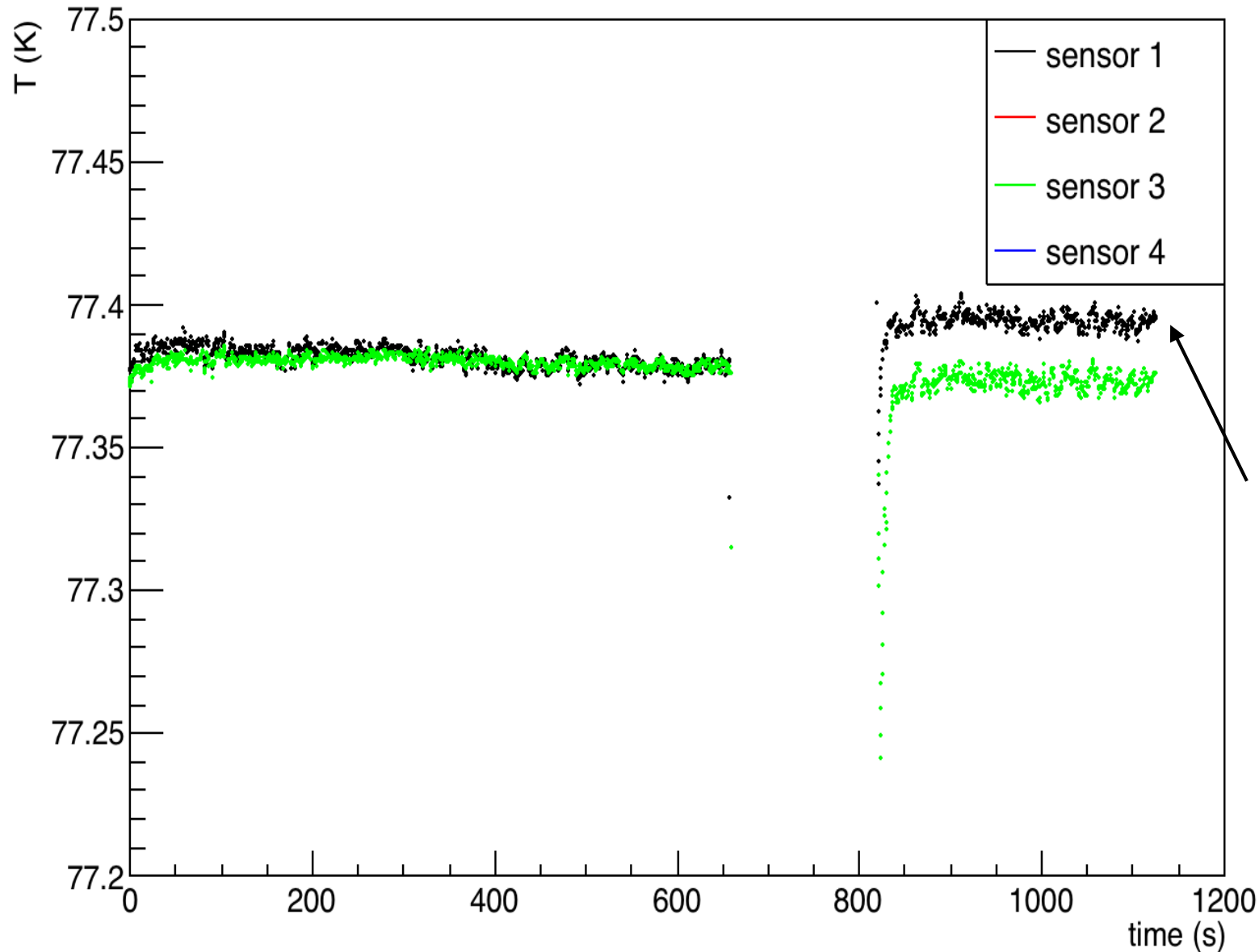


- Sensors into  $\text{LN}_2$ , take them out, condensation is removed with paper towel and put back into  $\text{LN}_2$



# Measurements with liquid nitrogen: *offset variation with rapid changes in temperature*

- Dryer (blowing 180 °C air):

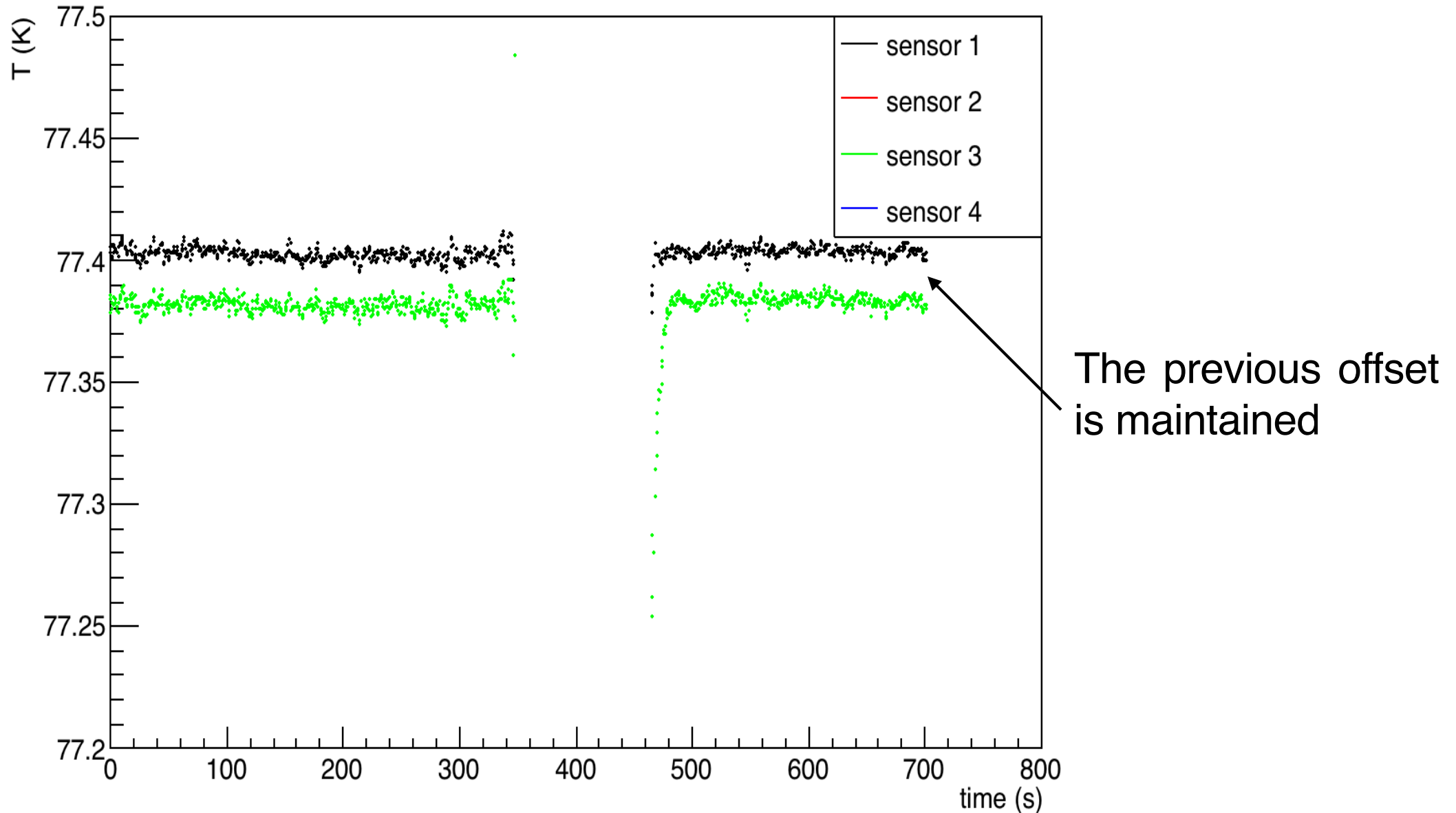


A significant offset is introduced

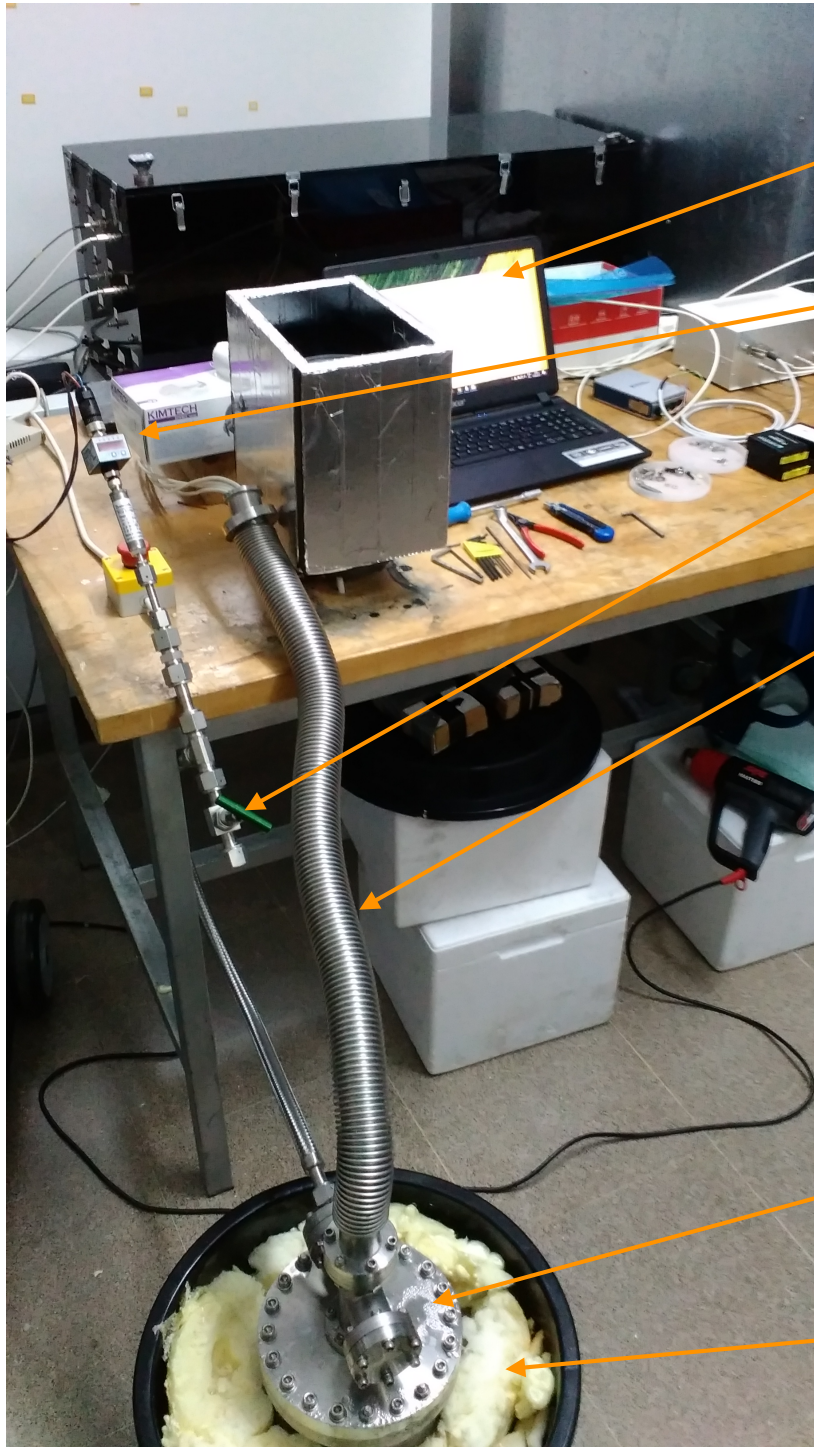
The understanding of this is crucial for the reproducibility

# Measurements with liquid nitrogen: *offset variation with rapid changes in temperature*

- Remove condensation with paper towel (after dryer measurement):



# Improvement of setup since last week



new computer (ours)

pressure sensor

manual release valve (provisional)

tube for wires (provisional, ordering a flange with connector)

On CF flange

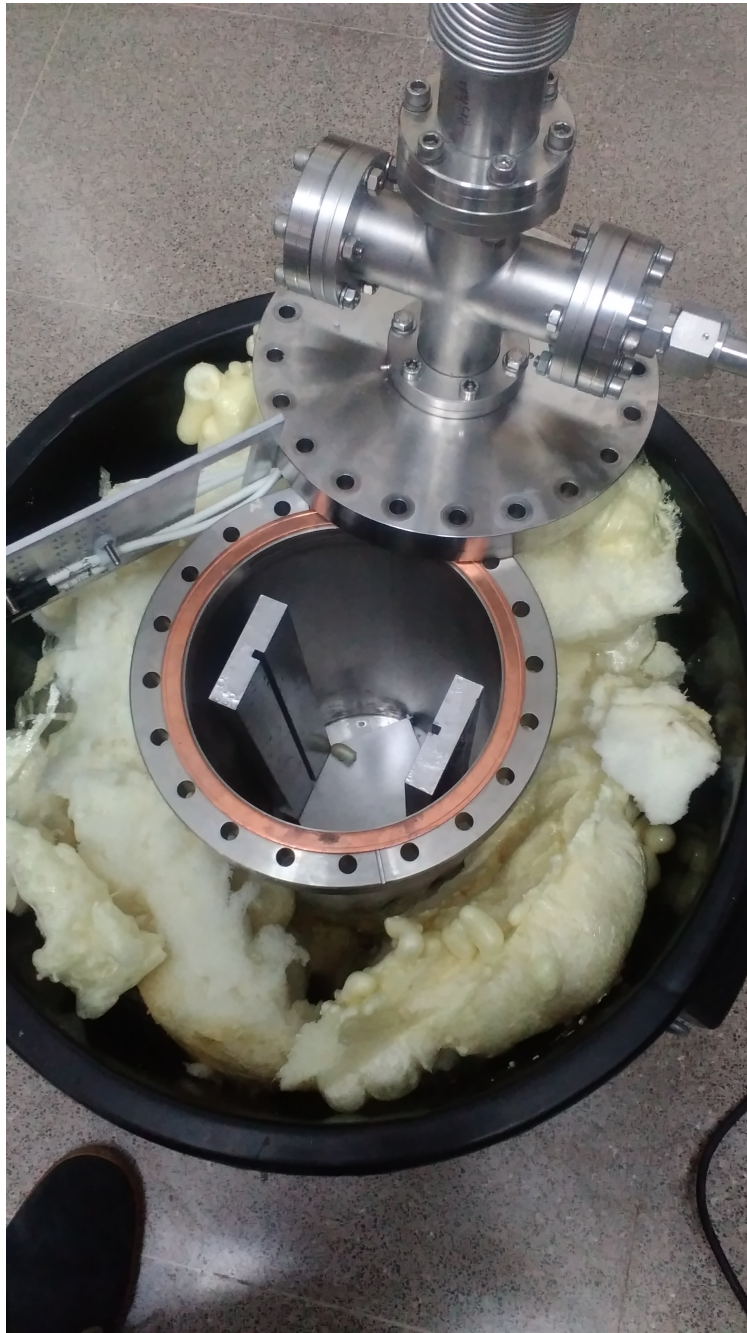
Order code	Flange	Number of pins
CF40-SUBD-9-DE-CE-SSG	DN40CF	9
CF63-SUBD-15-DE-CE-SSG	DN63CF	15
CF63-SUBD-25-DE-CE-SSG	DN63CF	25
CF63-SUBD-37-DE-CE-SSG	DN63CF	37
CF63-SUBD-50-DE-CE-SSG	DN63CF	50
CF100-SUBD-50-DE-CE-SSG	DN100CF	50

New flange

Improved isolation

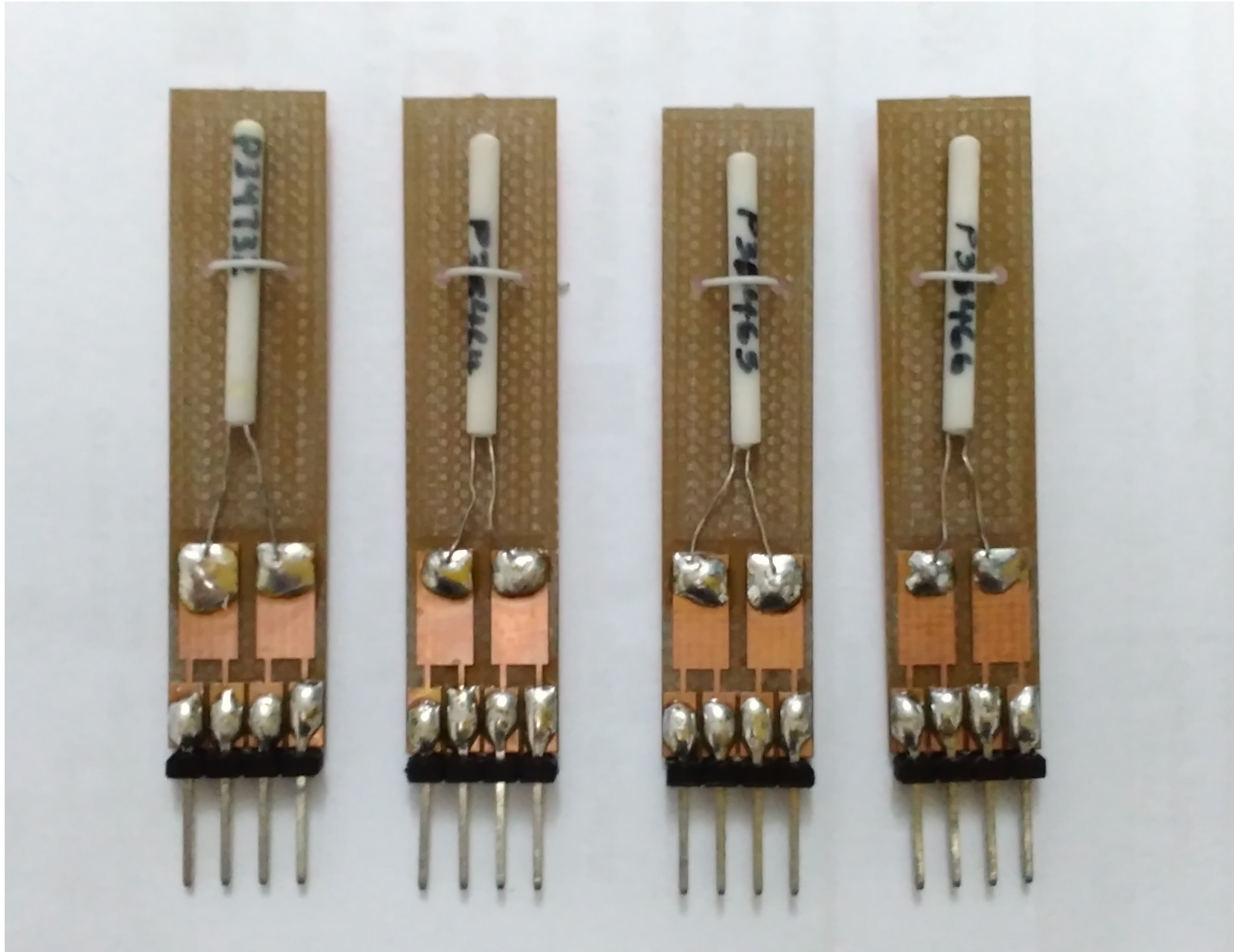
# Improvement of setup since last week

Inside the vessel



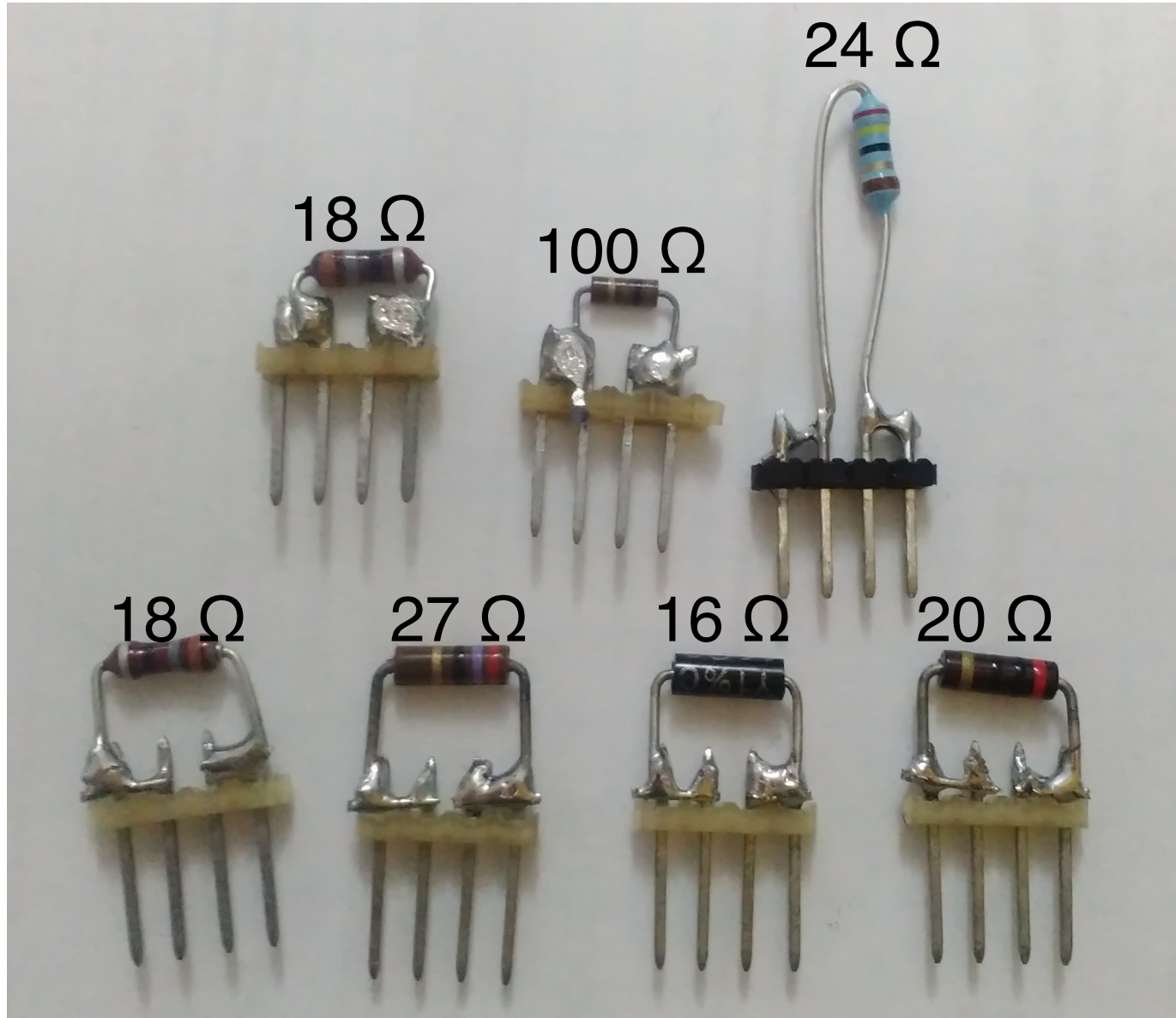
# Improvement of sensor layout

Previously, sensors were simply connected, but the connections are rather fragile and they could be easily moved, a dedicated support was build



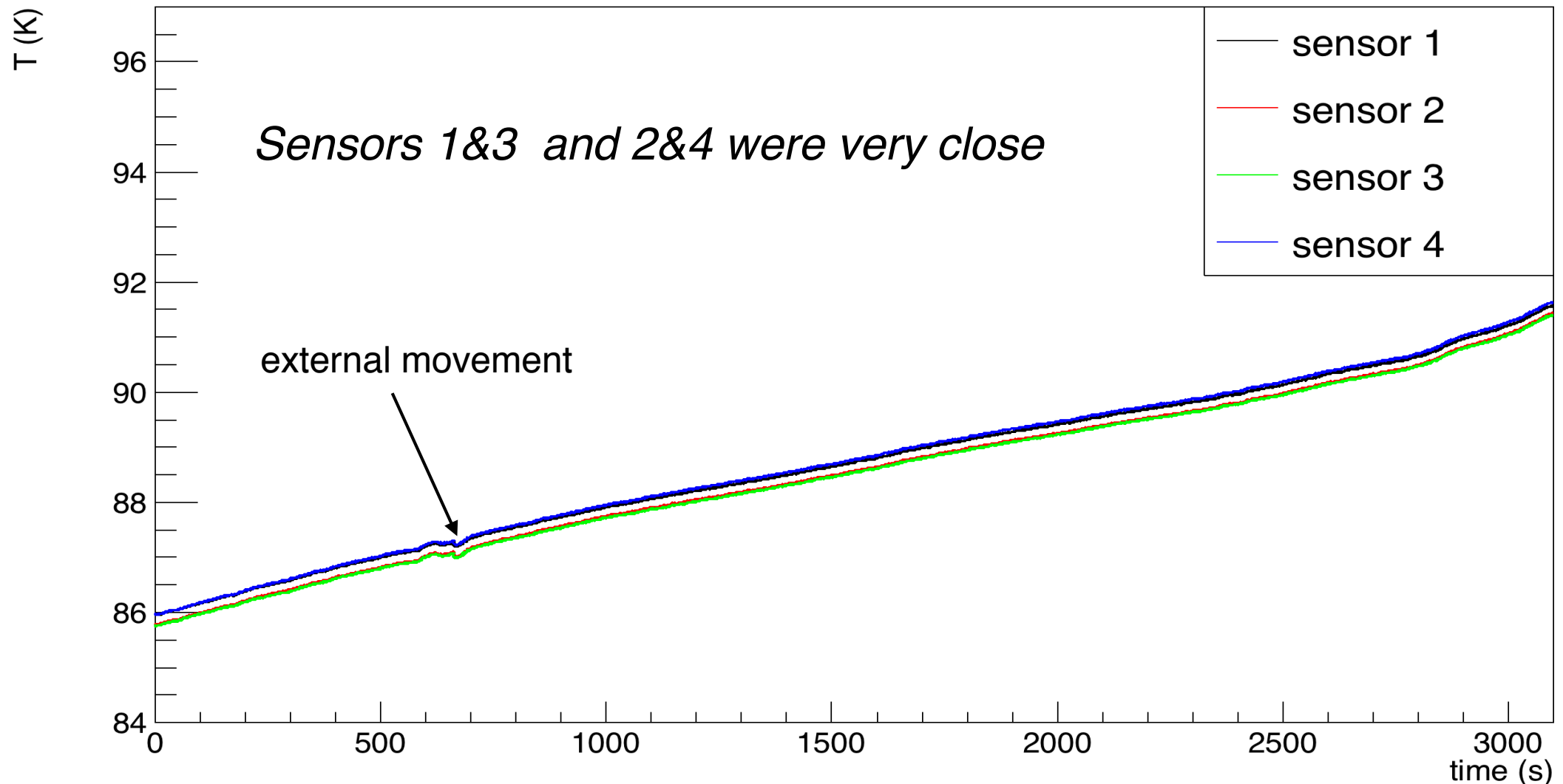
# More resistors

7 resistors in total for channel calibration

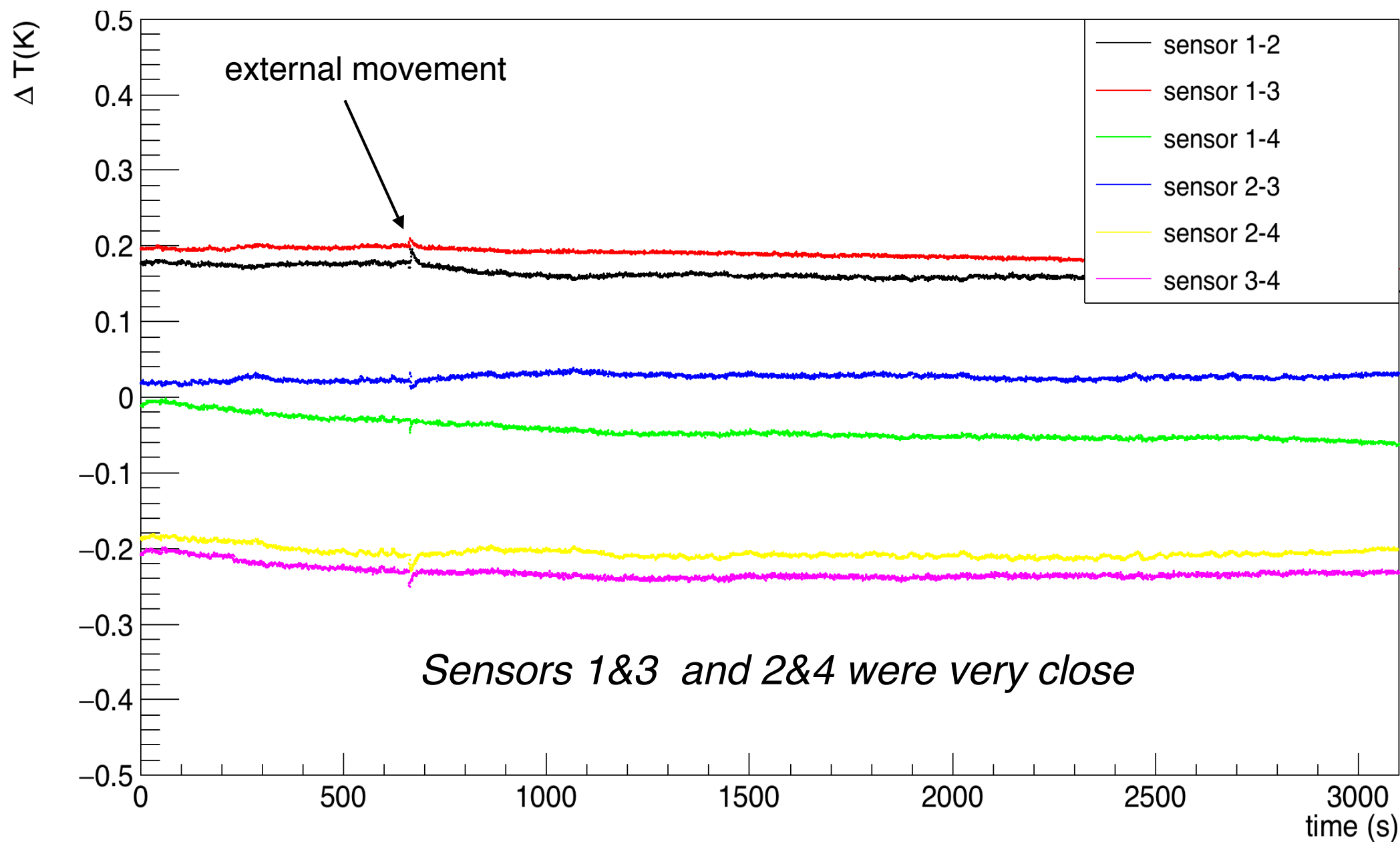


# Measurements with “liquid nitrogen” in new setup: *rising temperature*

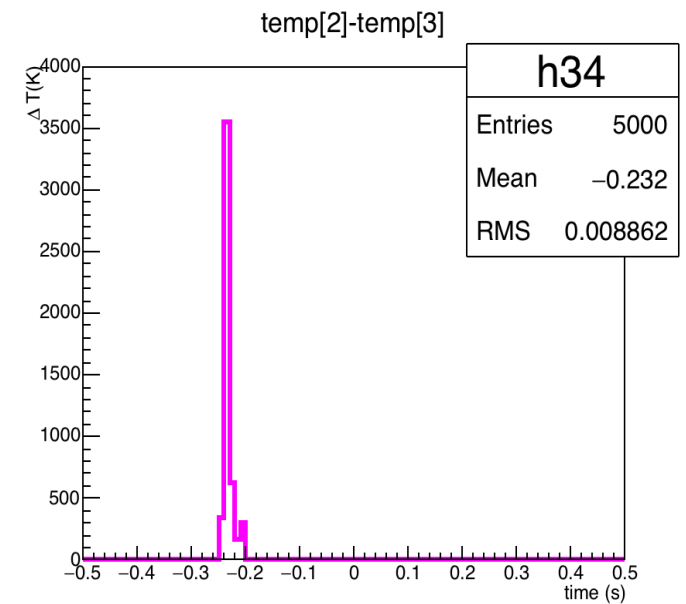
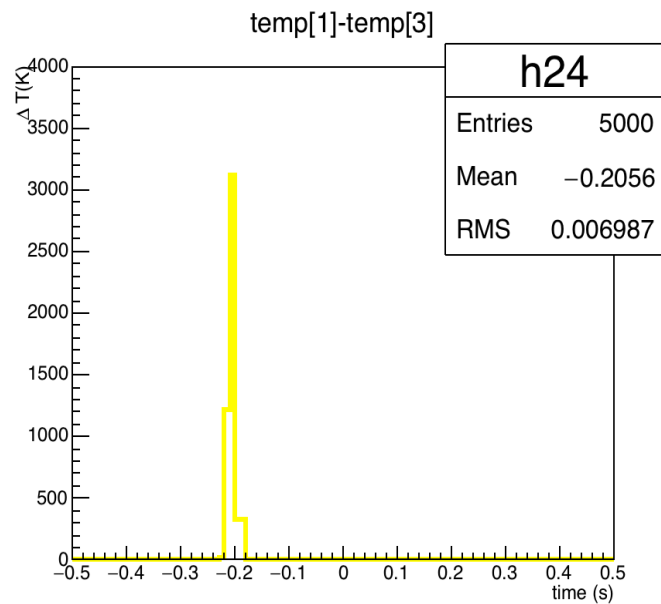
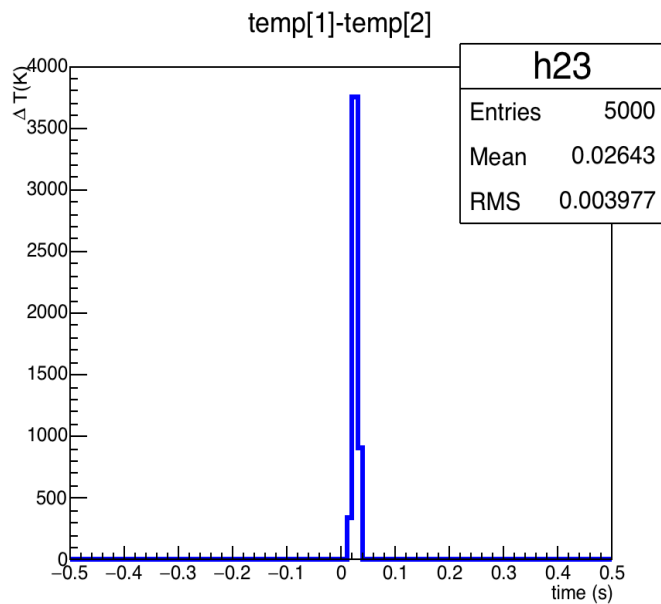
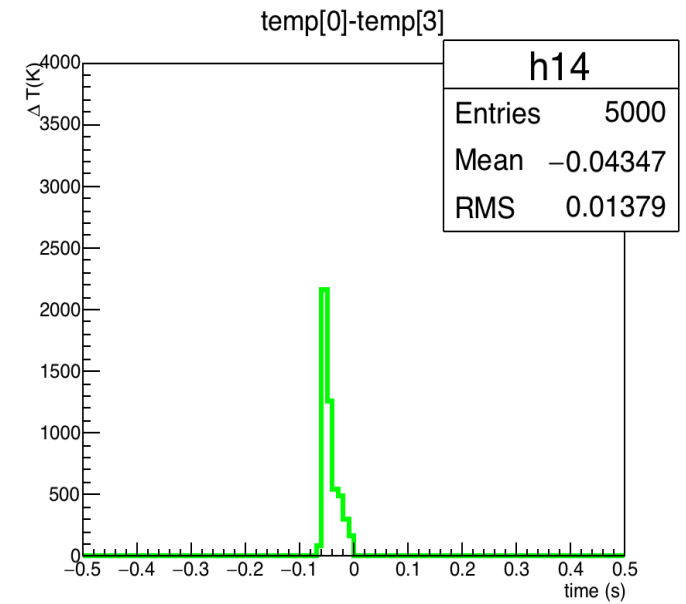
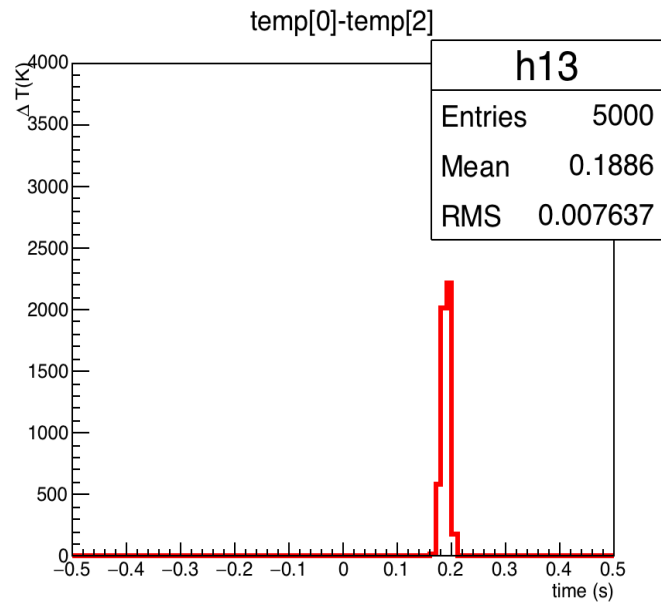
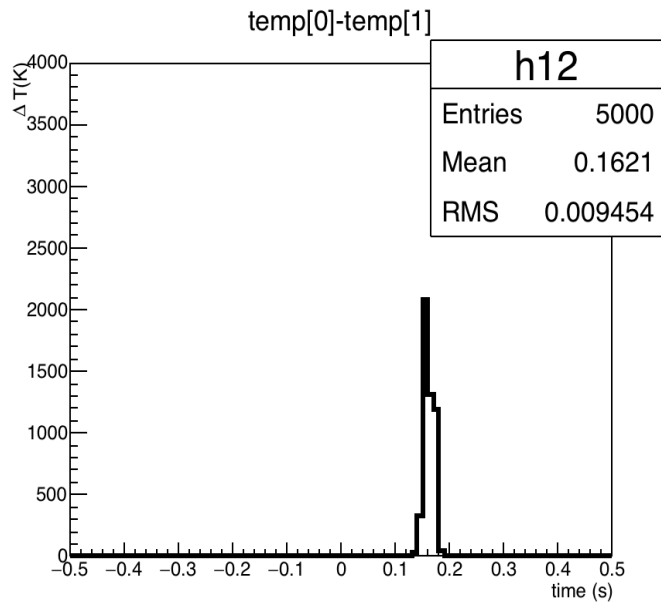
“liquid nitrogen” —> “Sadly”, we ran out of it by the time the setup was ready  
“Sadly” —> The vessel was very cold and we had a bit of  $\text{LN}_2$ , not enough to cover the sensors, but useful to make the temperature sufficiently low for a very interesting measurement



# Measurements with “liquid nitrogen” in new setup: *rising temperature*



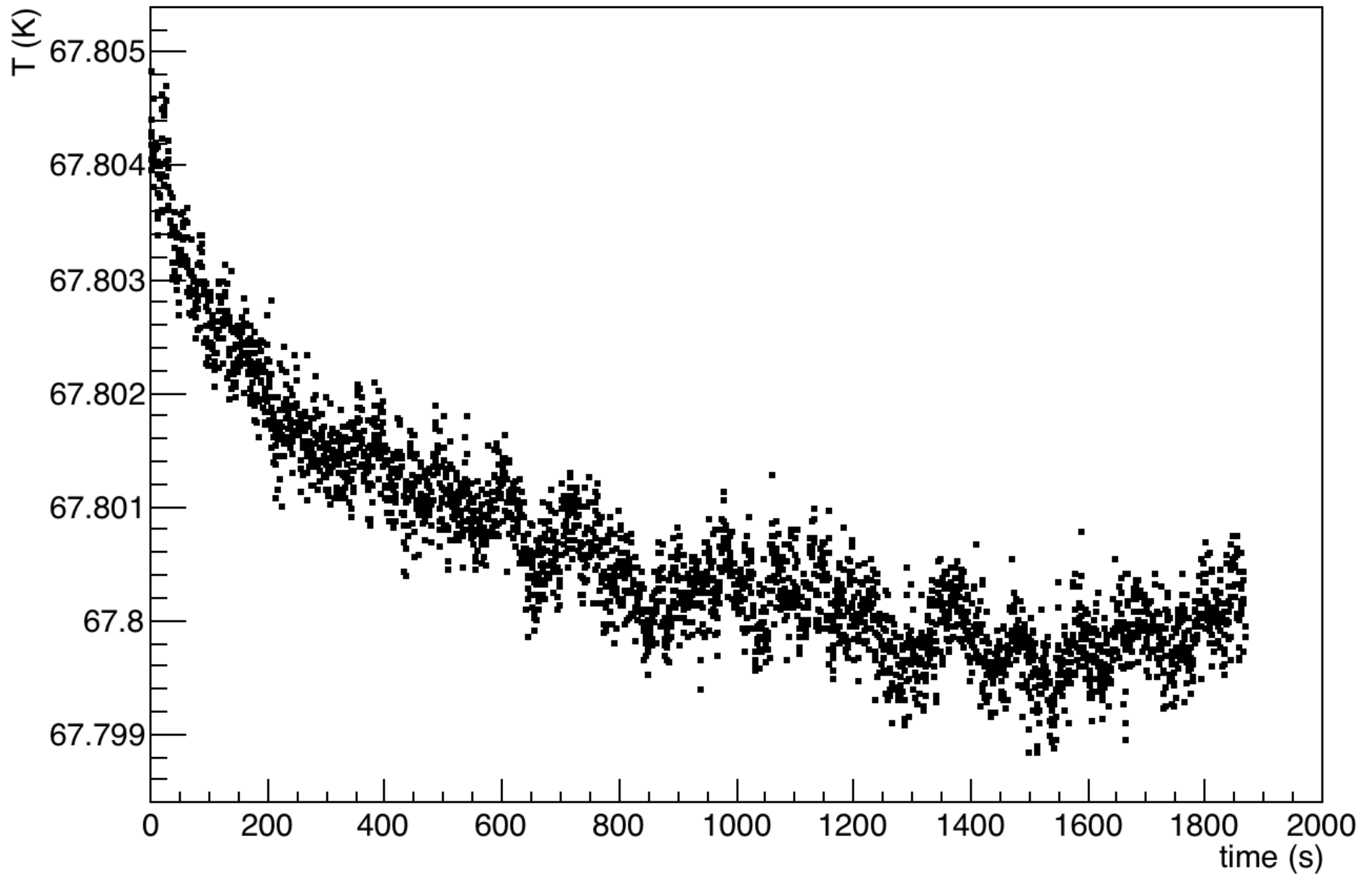
# Measurements with “liquid nitrogen” in new setup: *rising temperature*



*Sensors 1&3 and 2&4 were very close*

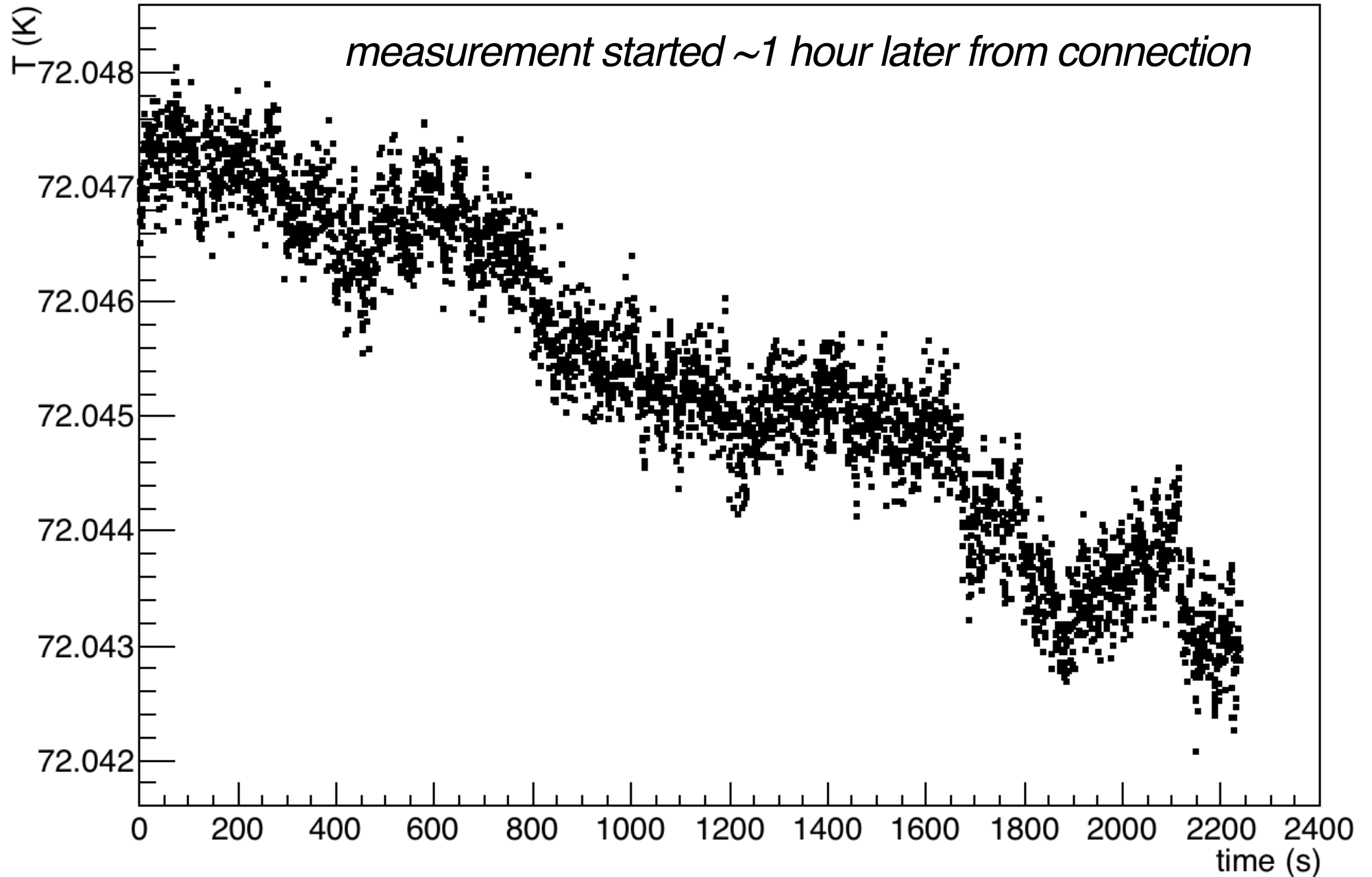
# Channel calibration with resistors

Detail view of all resistors in same channel (channel 1)



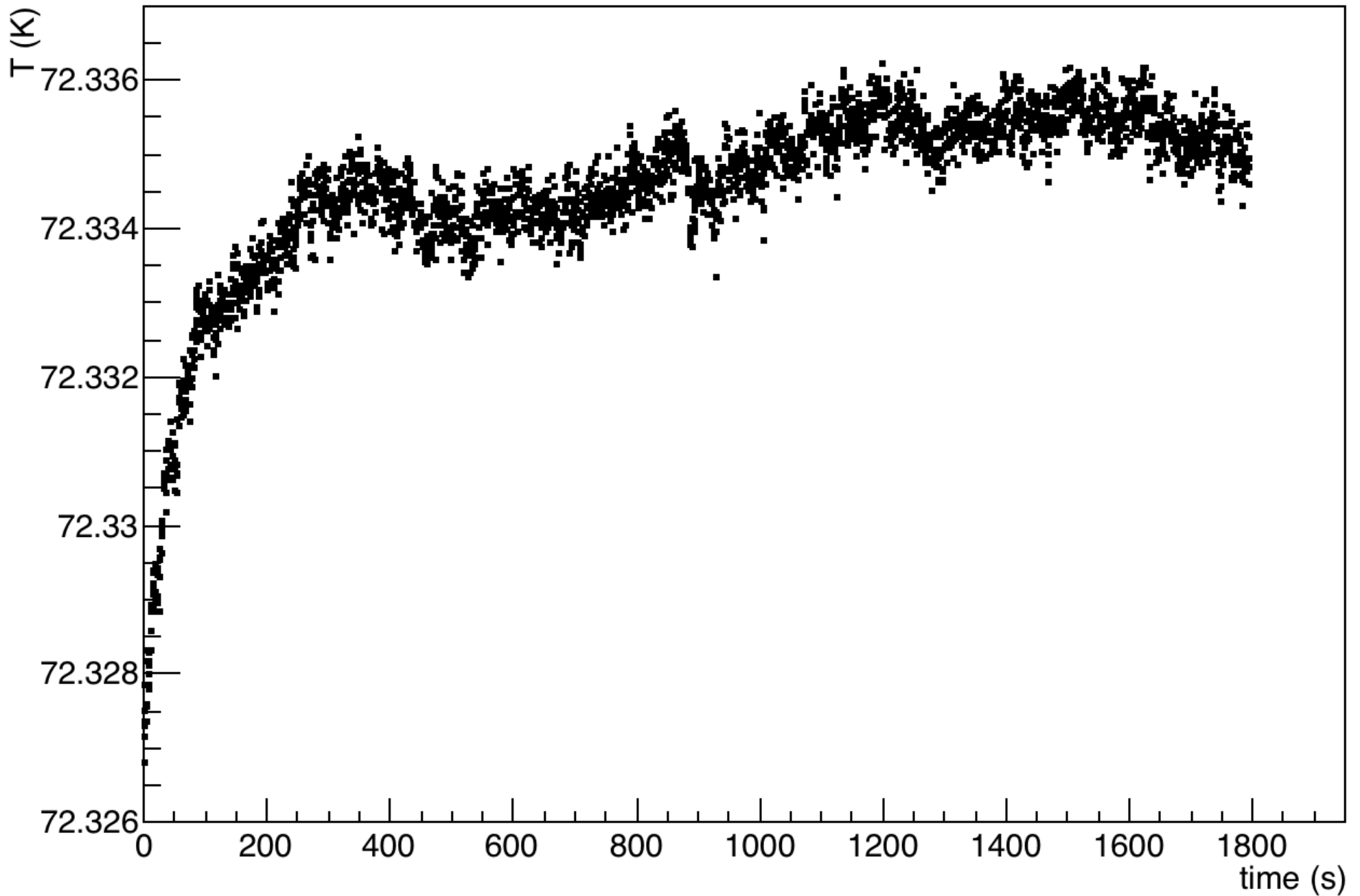
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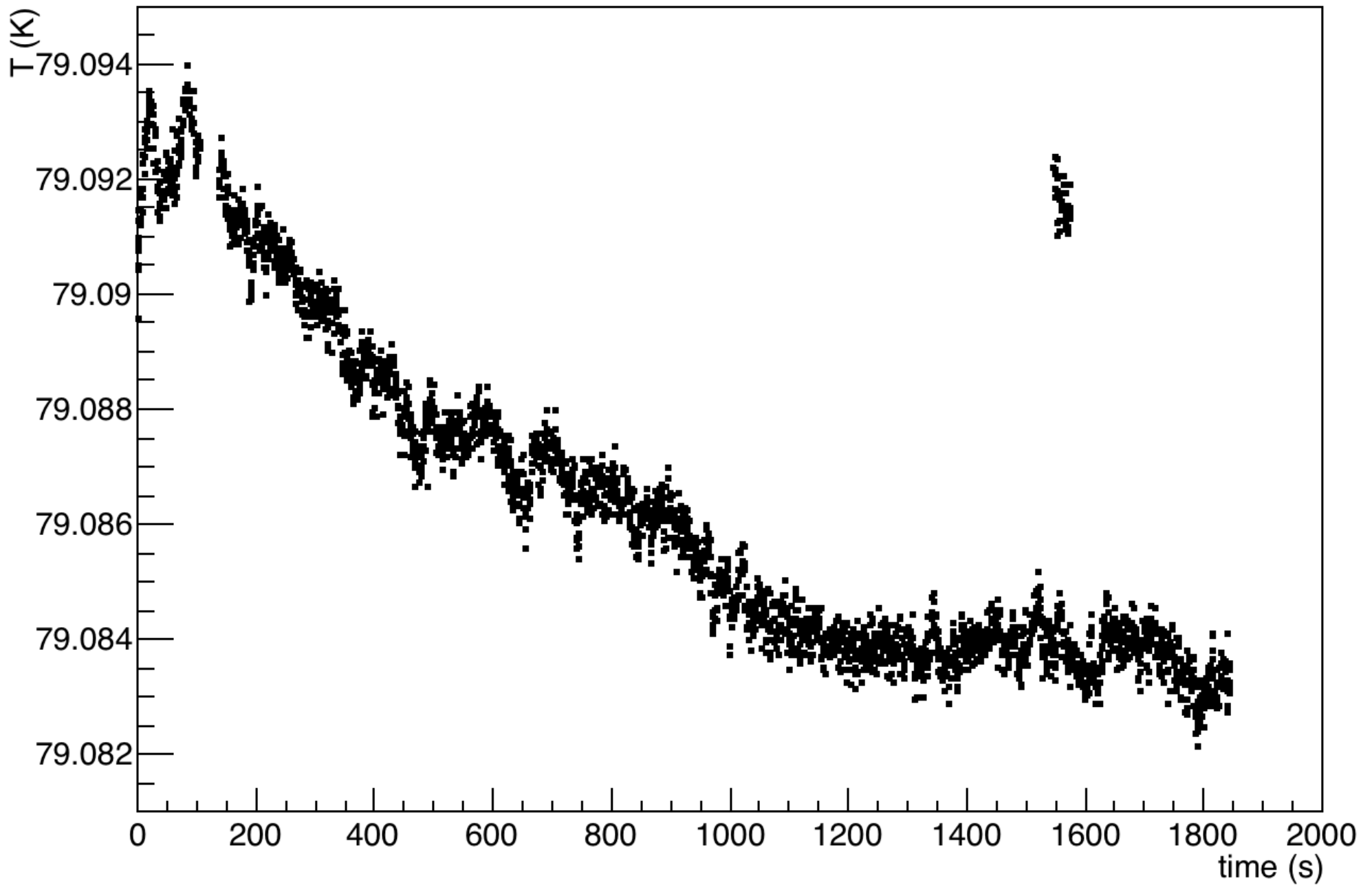
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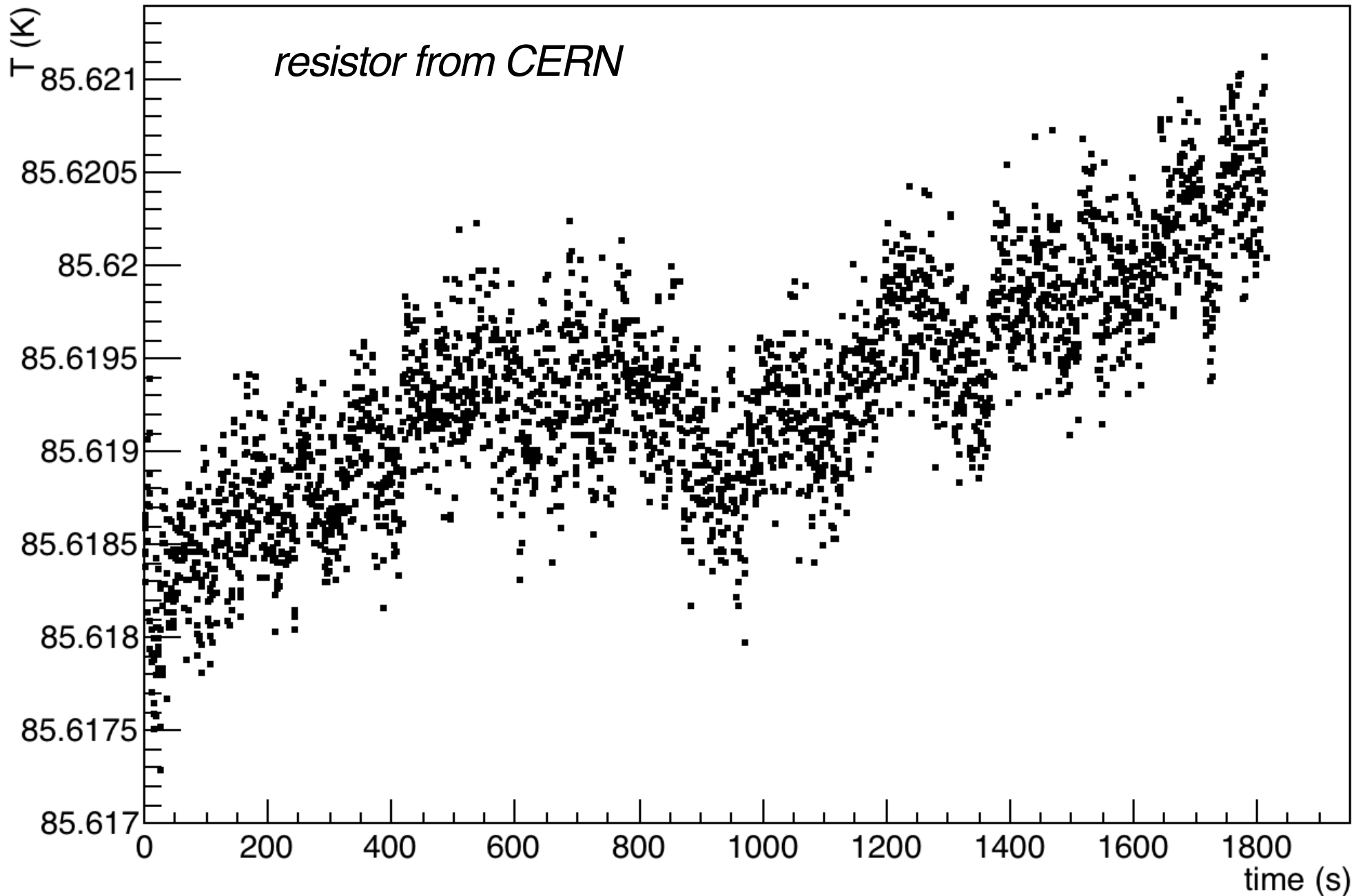
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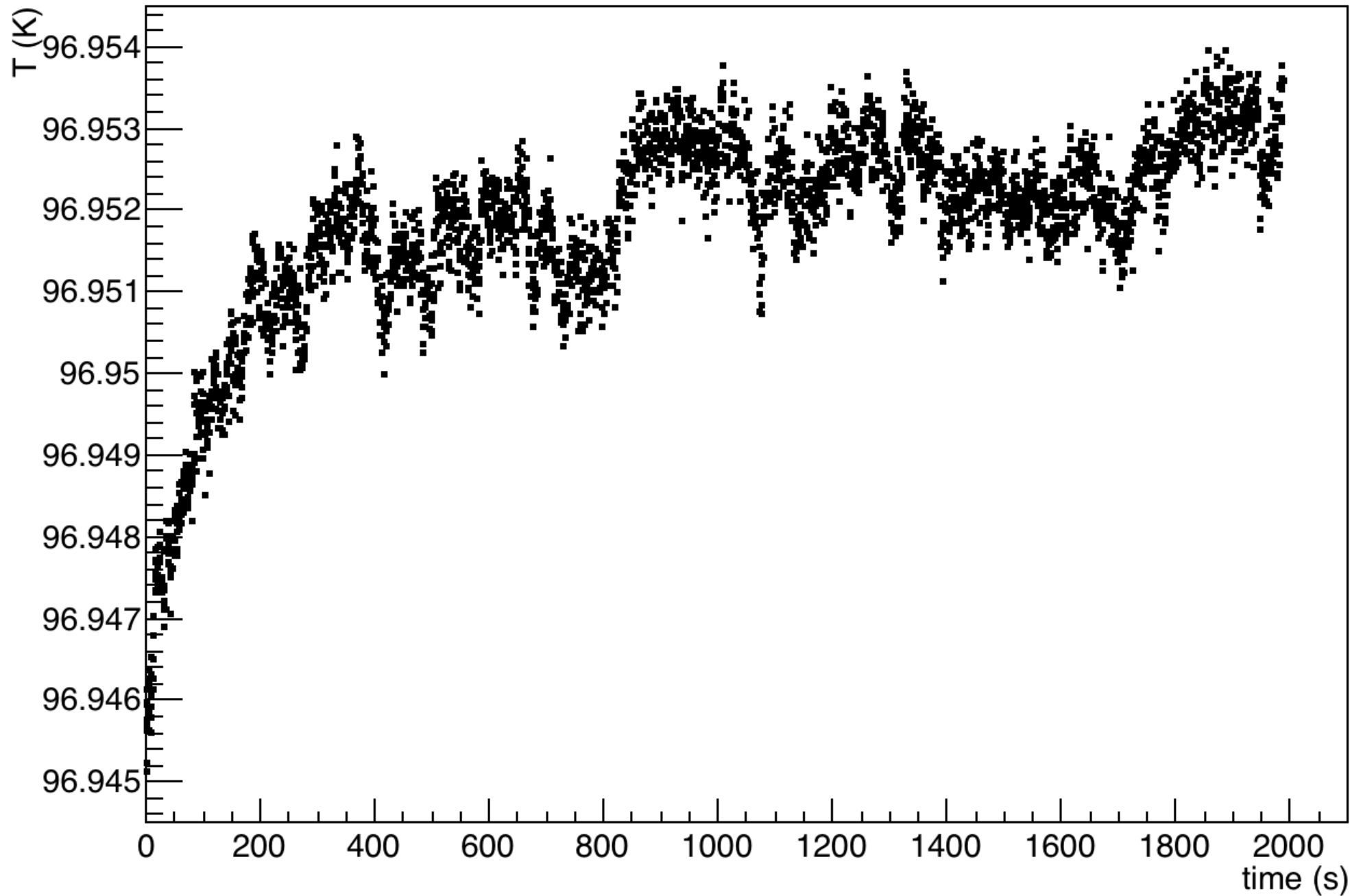
# Channel calibration with resistors

Detail view of all resistors in same channel (channel 1)



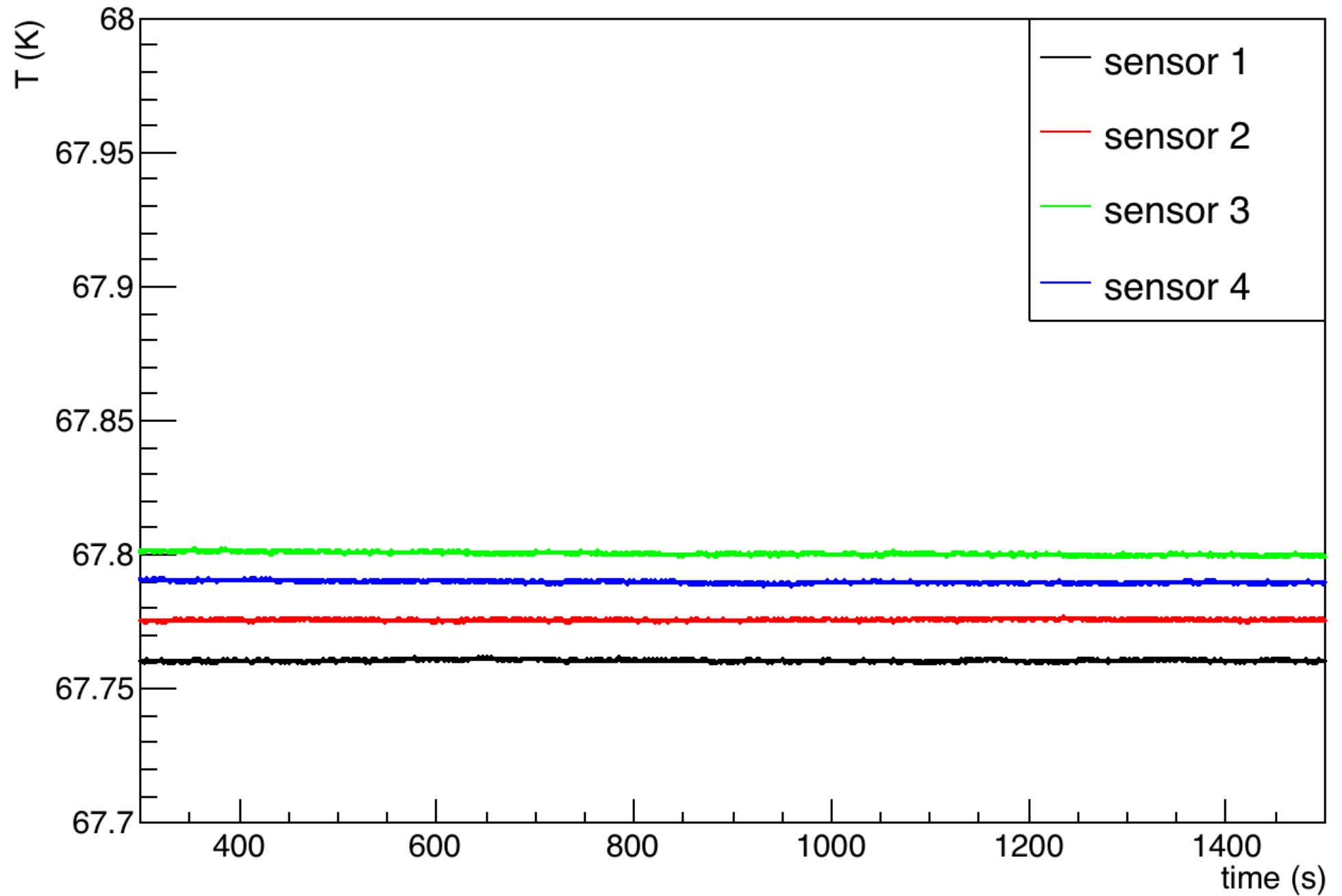
# Channel calibration with resistors

Detail view of all resistors in same channel (channel 1)



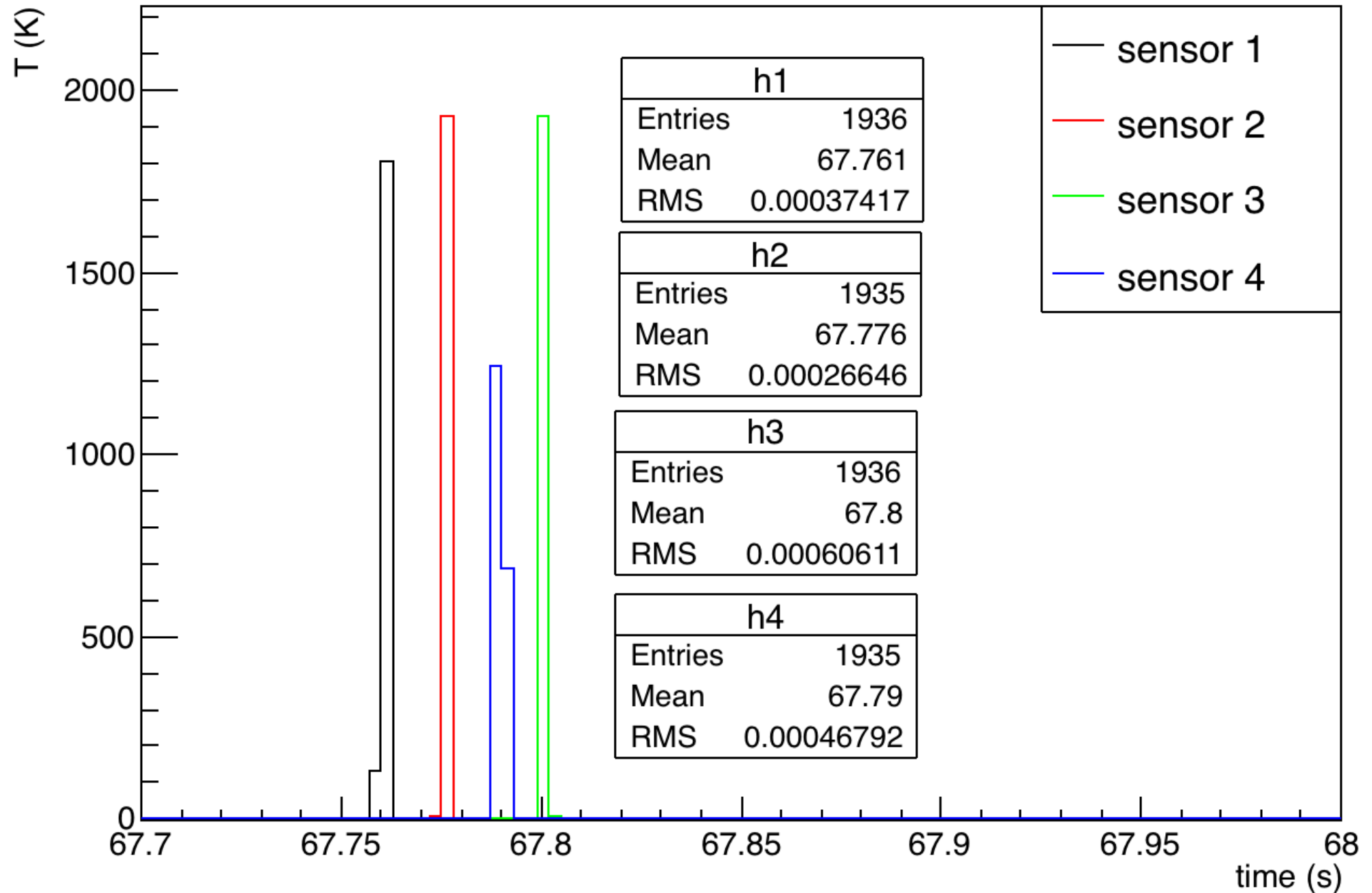
# Channel calibration with resistors

All four channels measurements for  $R = 16 \Omega$



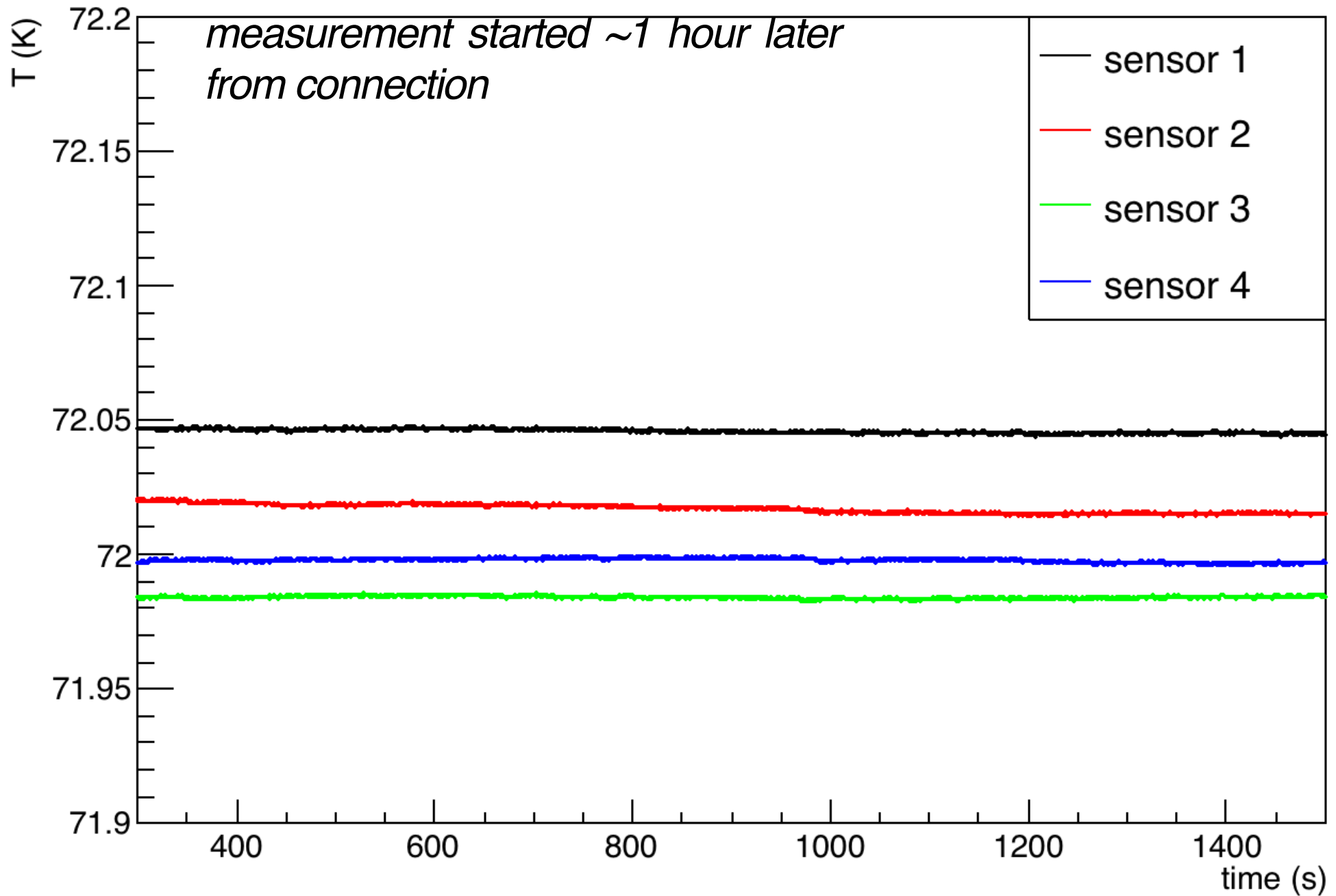
# Channel calibration with resistors

All four channels measurements for  $R = 16 \Omega$



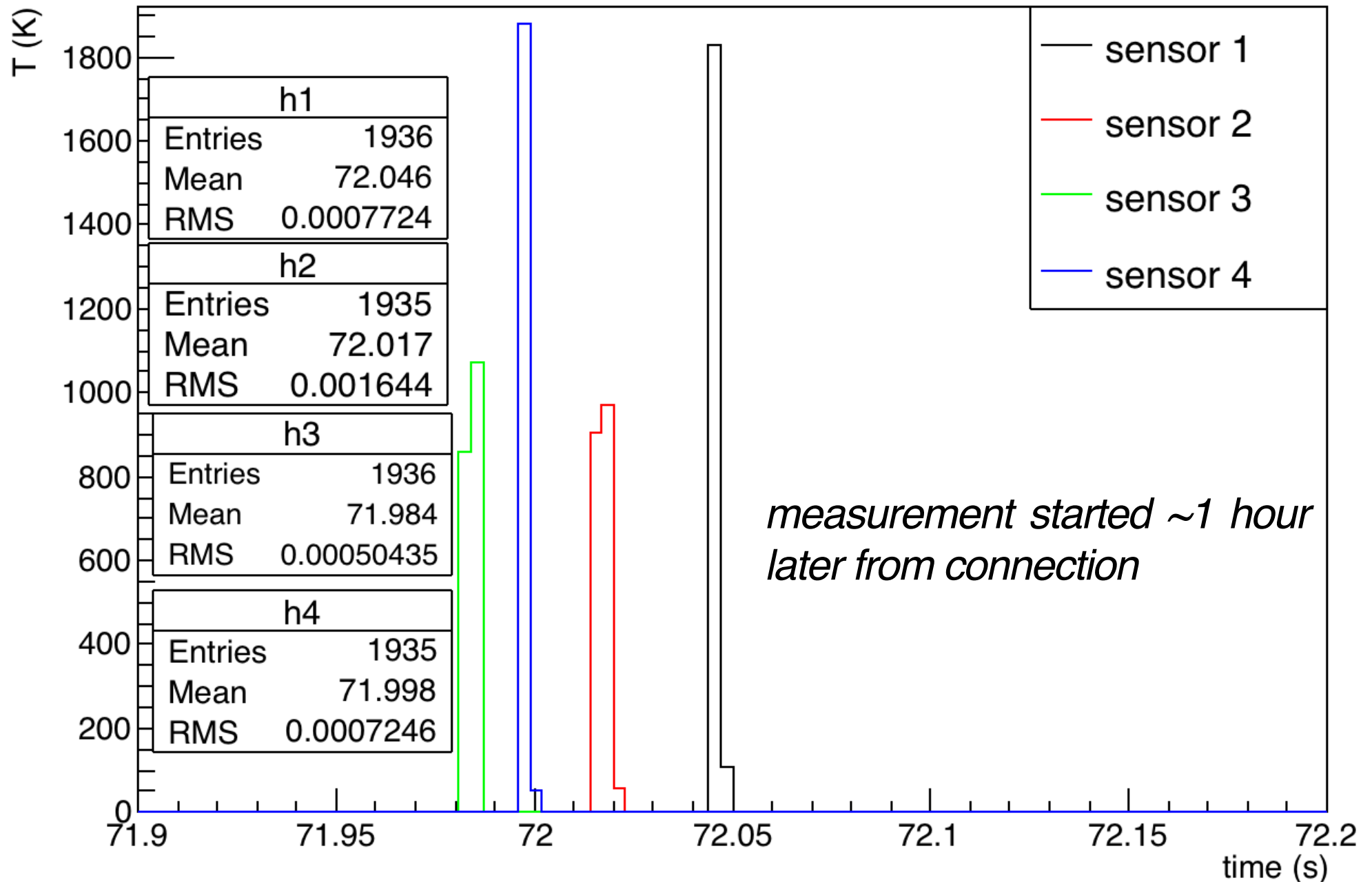
# Channel calibration with resistors

All four channels measurements for  $R = 18 \Omega$



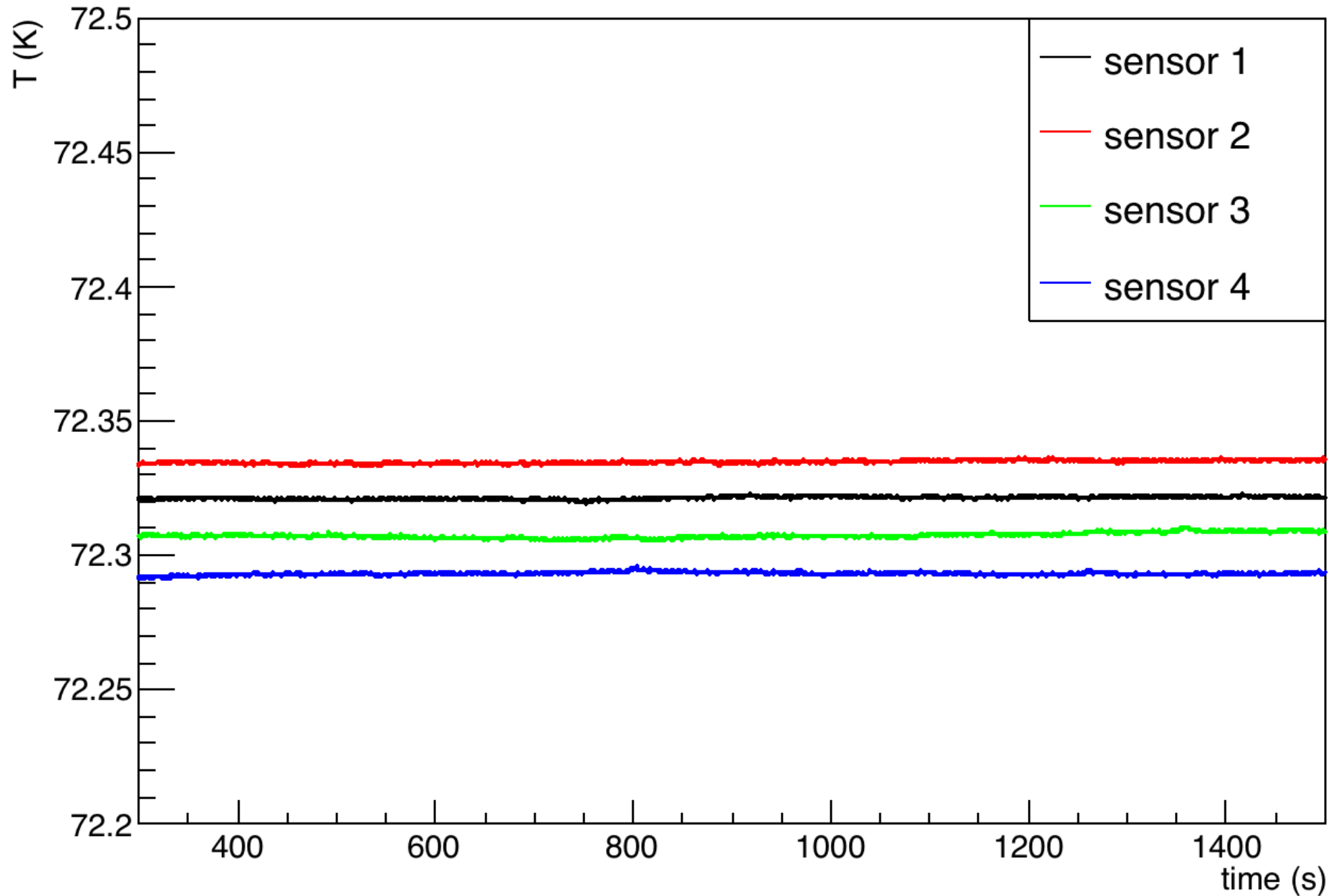
# Channel calibration with resistors

All four channels measurements for  $R = 18 \Omega$



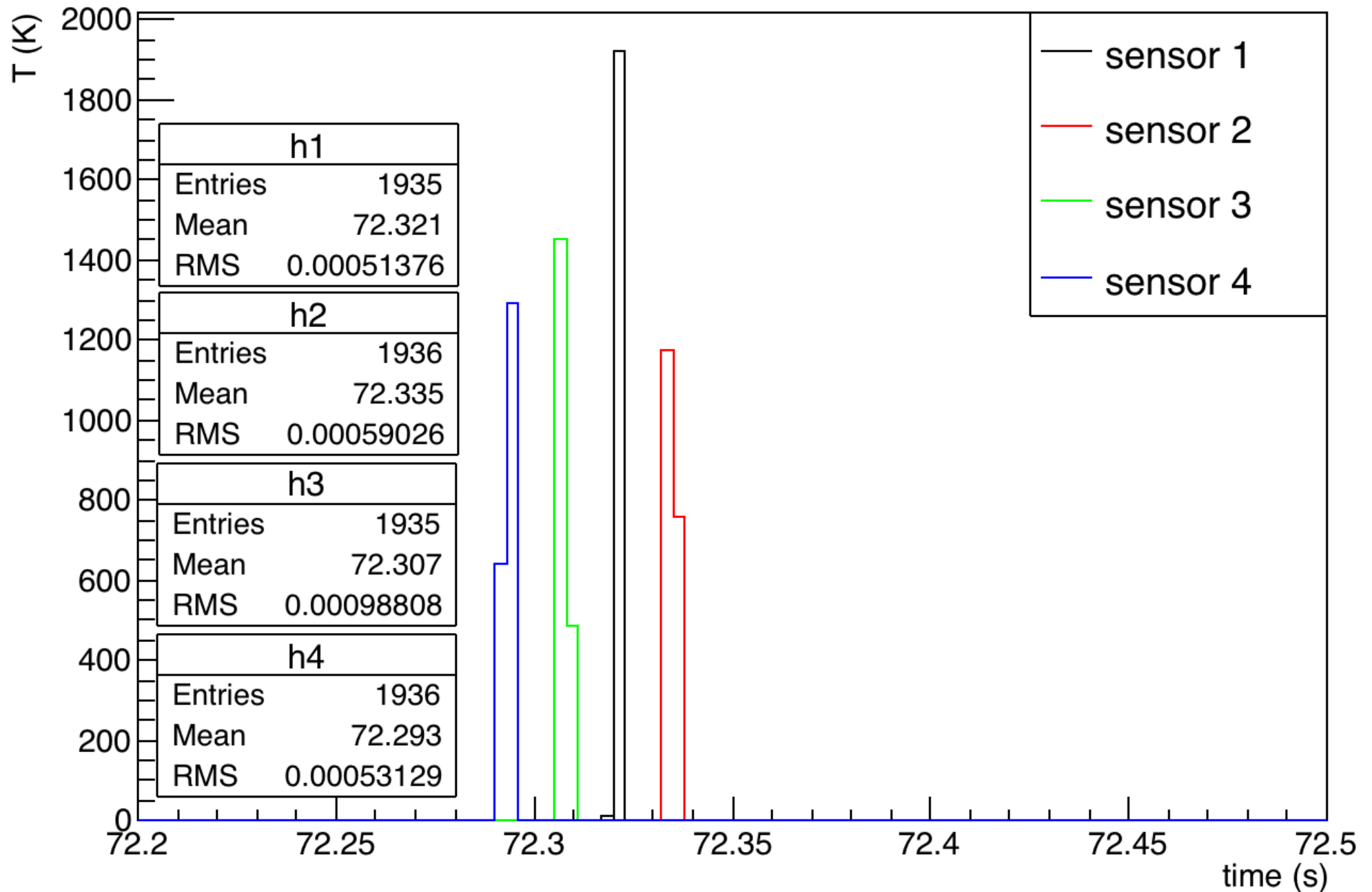
# Channel calibration with resistors

All four channels measurements for  $R = 18 \Omega$



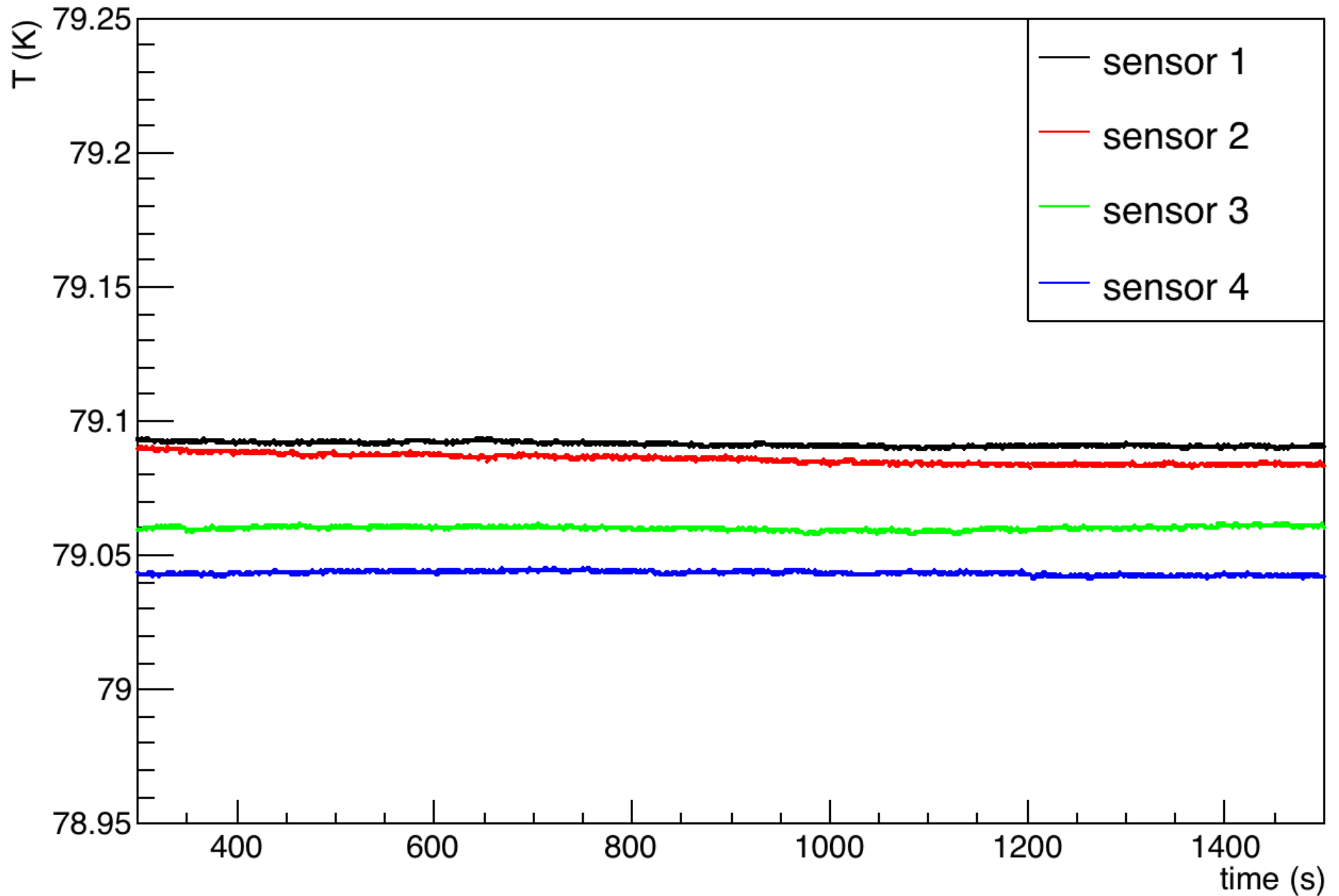
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All four channels measurements for  $R = 18 \Omega$



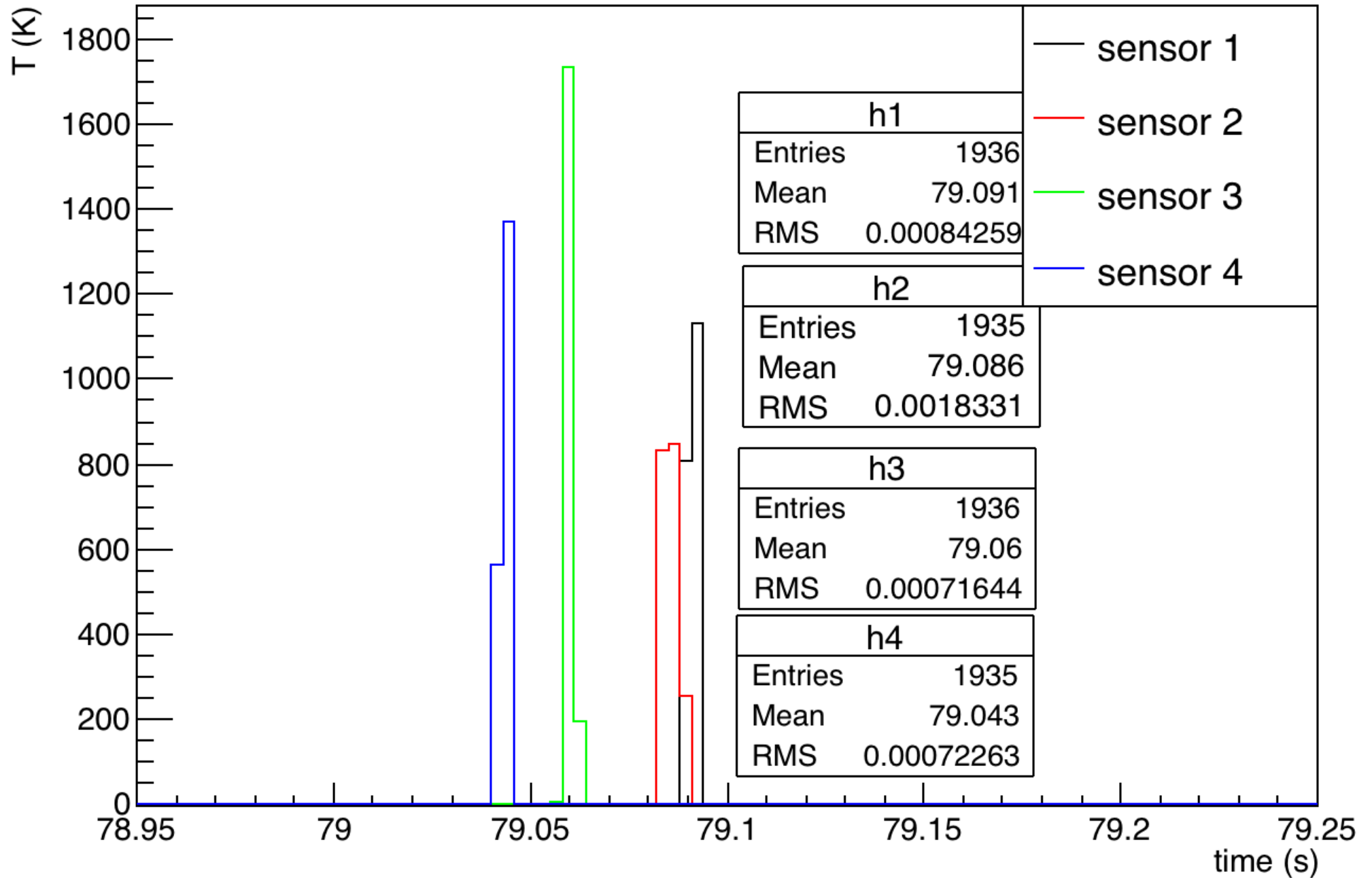
# Channel calibration with resistors

All four channels measurements for  $R = 20 \Omega$



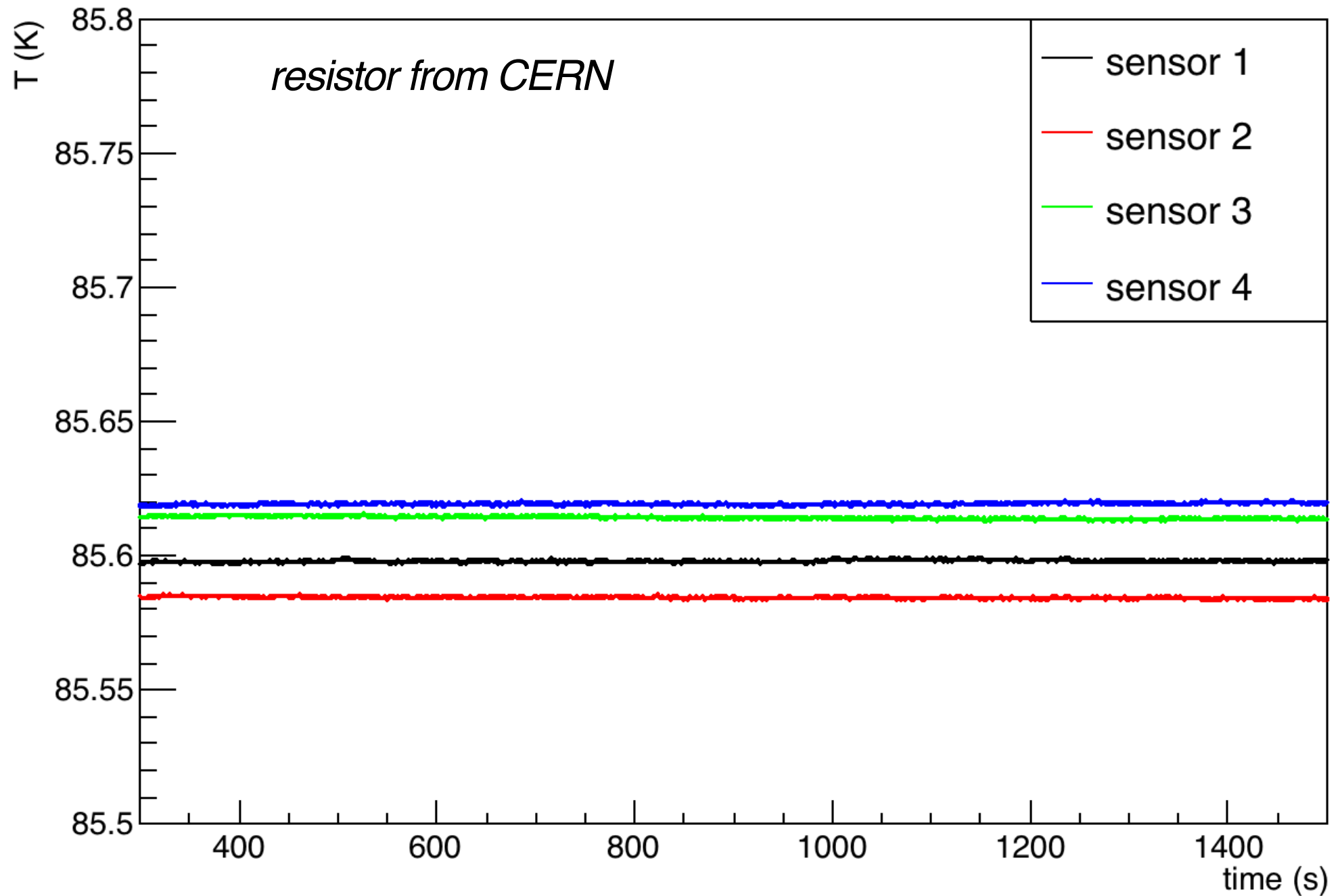
# Channel calibration with resistors

All four channels measurements for  $R = 20 \Omega$



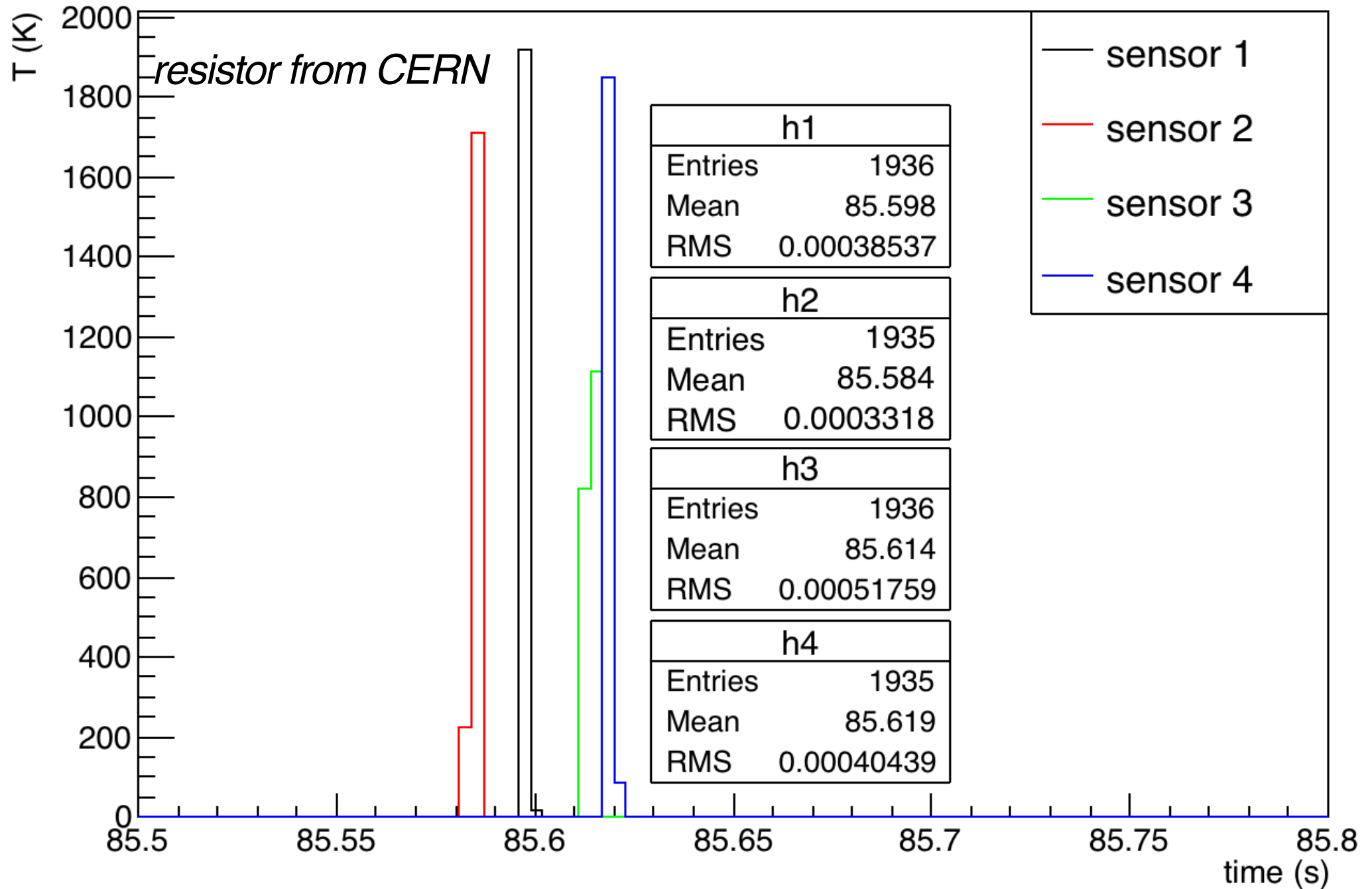
# Channel calibration with resistors

All four channels measurements for  $R = 24 \Omega$



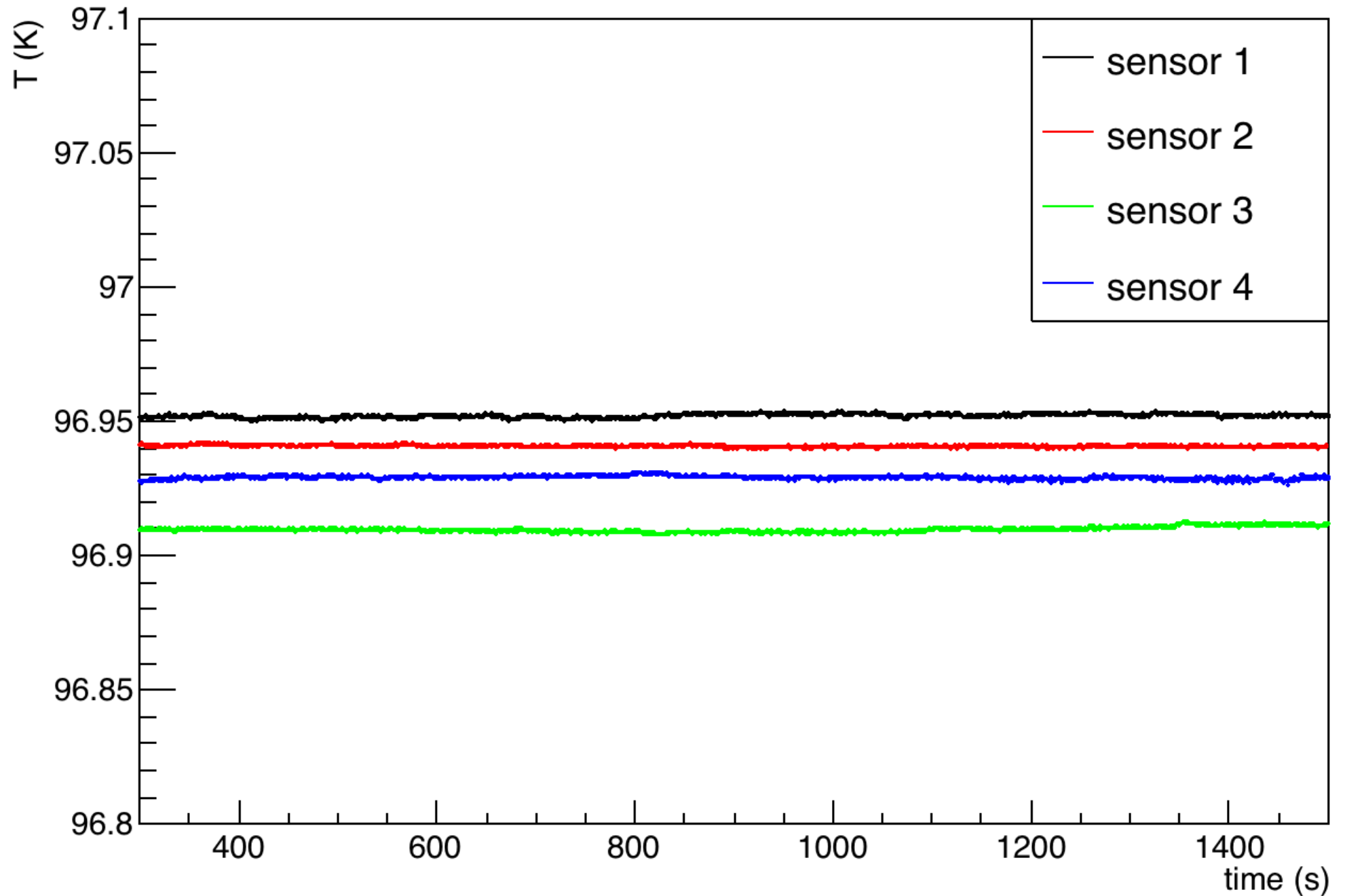
# Channel calibration with resistors

All four channels measurements for  $R = 24 \Omega$



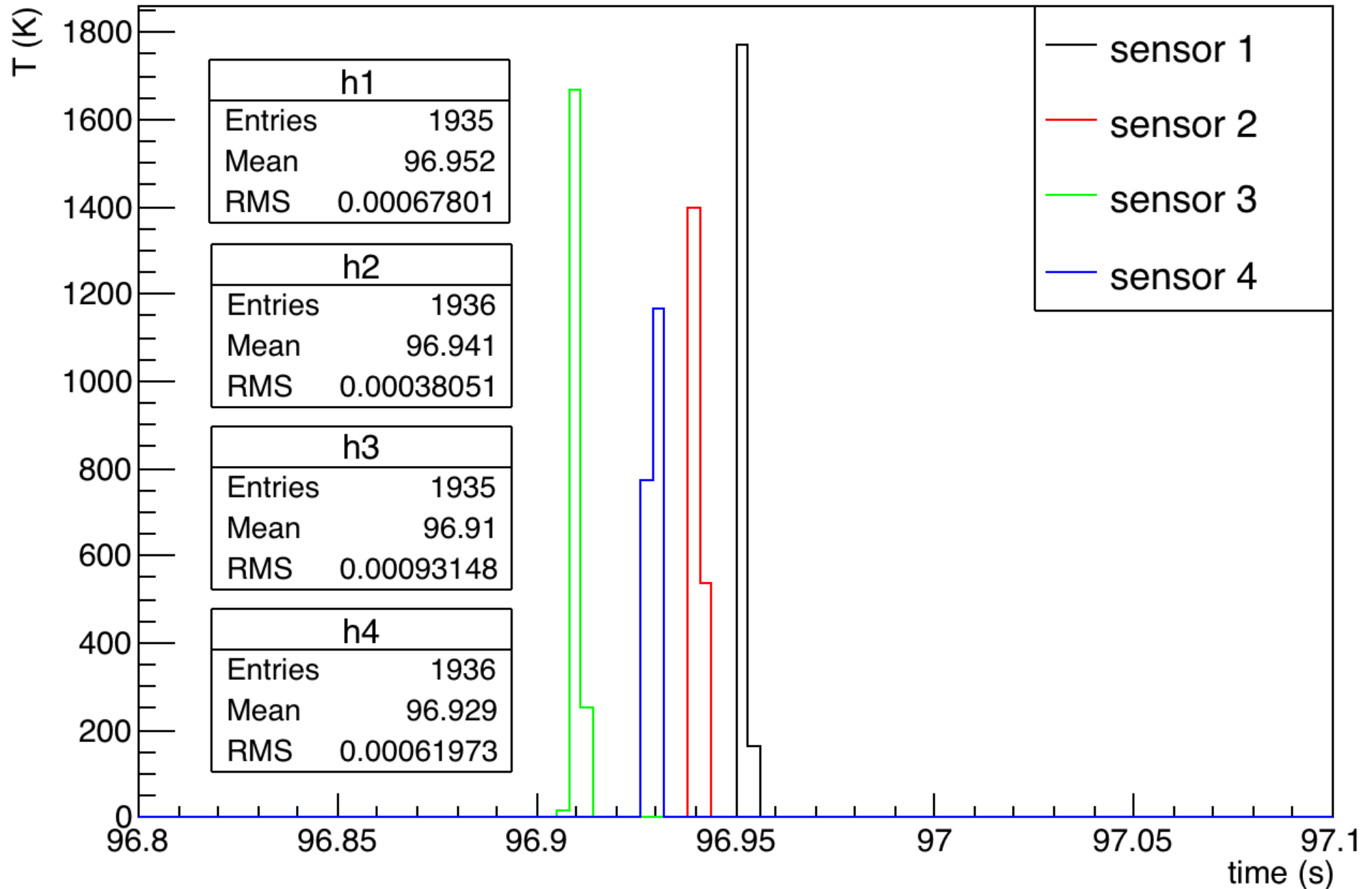
# Channel calibration with resistors

All four channels measurements for  $R = 27 \Omega$



# Channel calibration with resistors

All four channels measurements for  $R = 27 \Omega$



# Channel calibration with resistors

Offset dependence with temperature from previous resistor measurements

