Ultra-lightweight materials and cooling systems for the new detector complex with the highest radiation transparency.

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Introduction

In the high energy physics experiments the new detector complexes with large granularity and the highest radiation transparency should be used for tracking of charged particles, providing minimal distortions due to the multiple scattering effects. In this case the minimum material budget is required for all materials have to be used within the sensitive area of the detective volume.In the giving report we present ultra lightweight layout for cooling and support systems for large area, thin (~20 um) silicon detectors.

Experimental setup

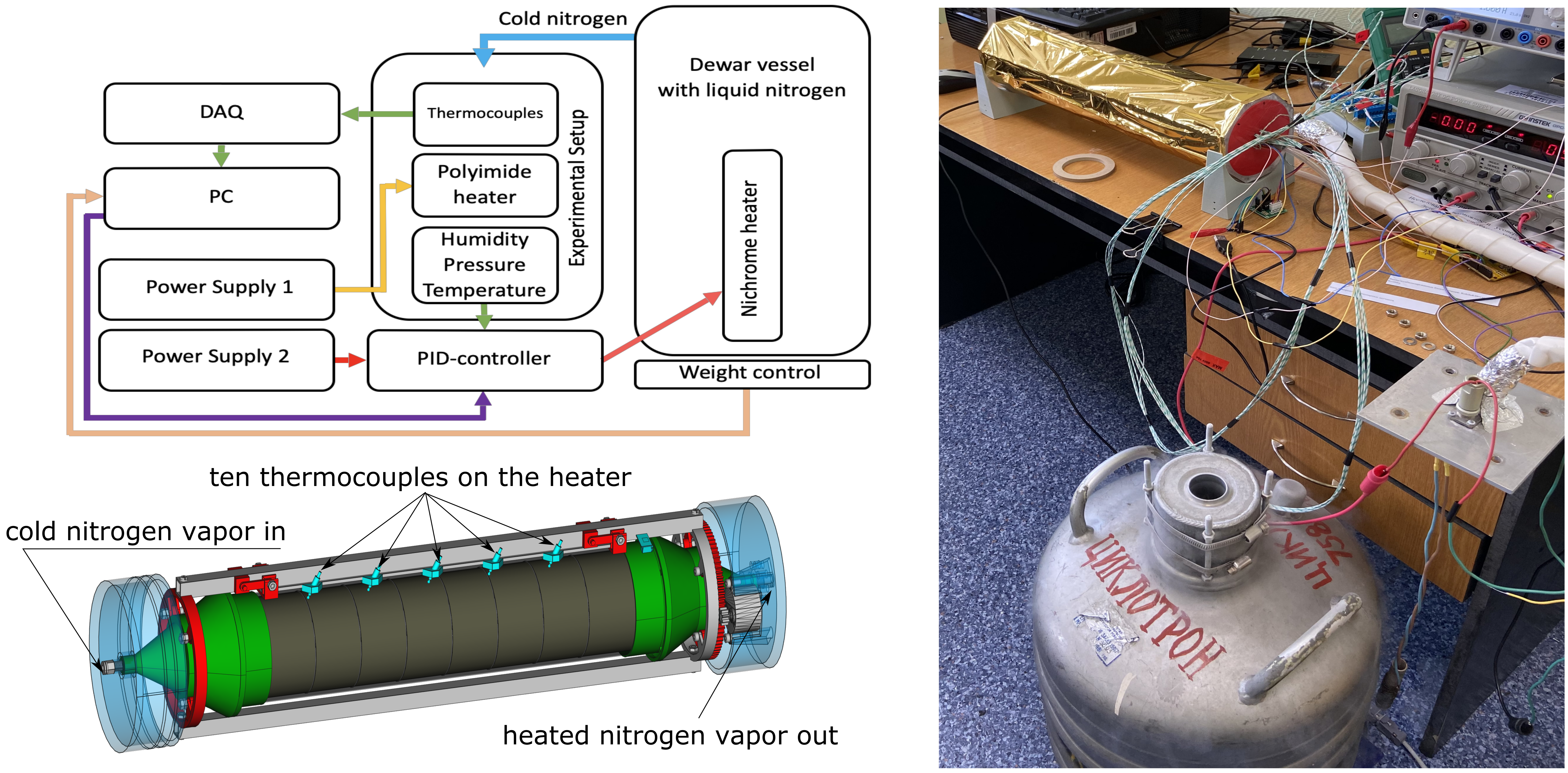

Figure 1. Experimental setup for cooling tests of the mockup of the bent full scale sensor layer.
Black cylinder - is imitating the outer silicon layer in the real geometry of the ITS3 (JPS Conf.Proc. 34 (2021) 010011)).
The heater is inside the closed volume of the cylinder, which imitates the real heat flow from the pixel large area sensor of the outer layer of the ITS3, the cooling of this sensor mockup is done by the low-speed flow of cold nitrogen vapor.
Ten thermocouples are used to collect temperature data from surface of the mockup layer.

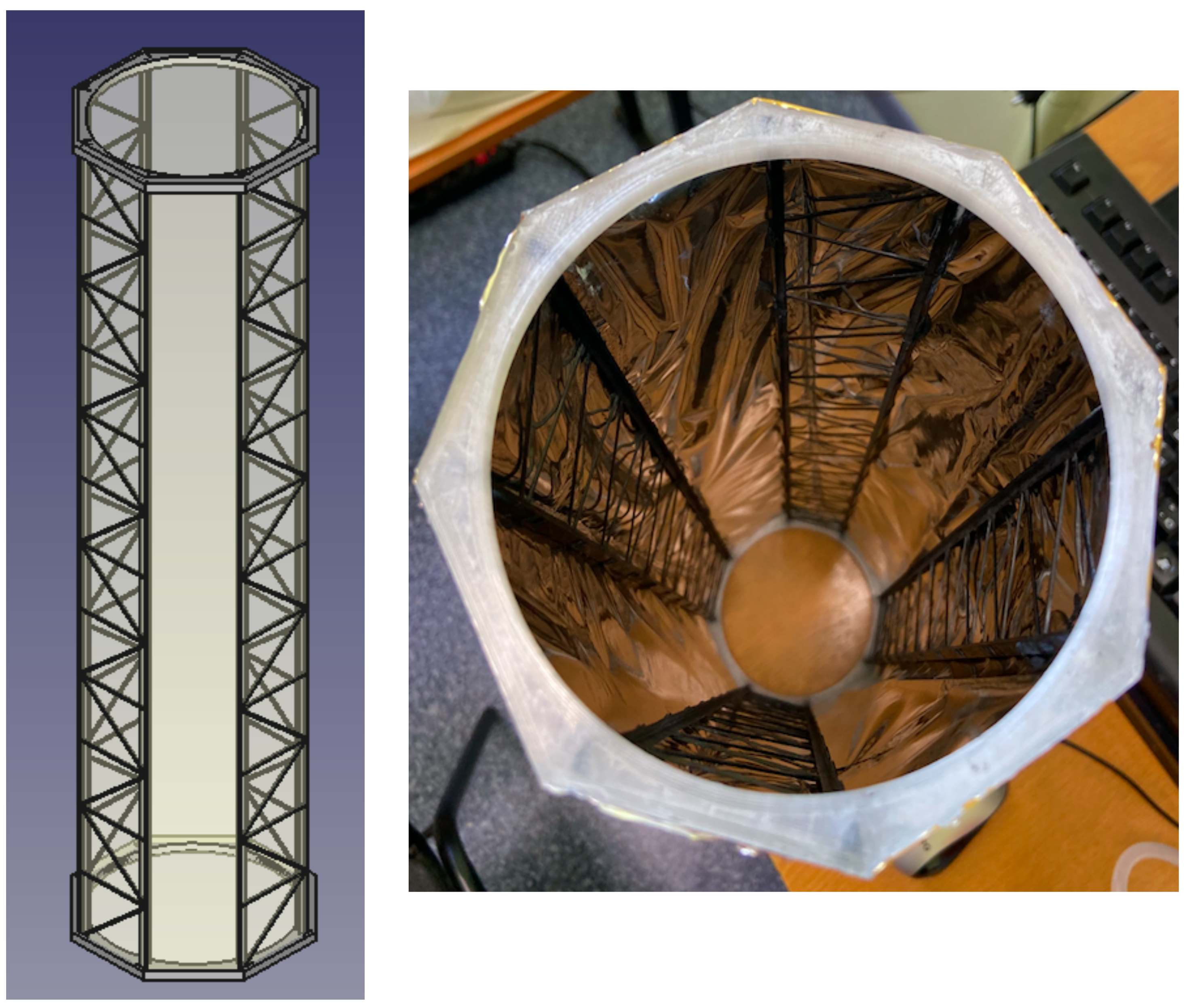

Figure 2. Protective heat shield capable to provide 10°C temperature gradient from the inner volume value to the surrounding atmosphere. Thin film shell is supported by the low-weight rigid carbon fiber (CF) bars

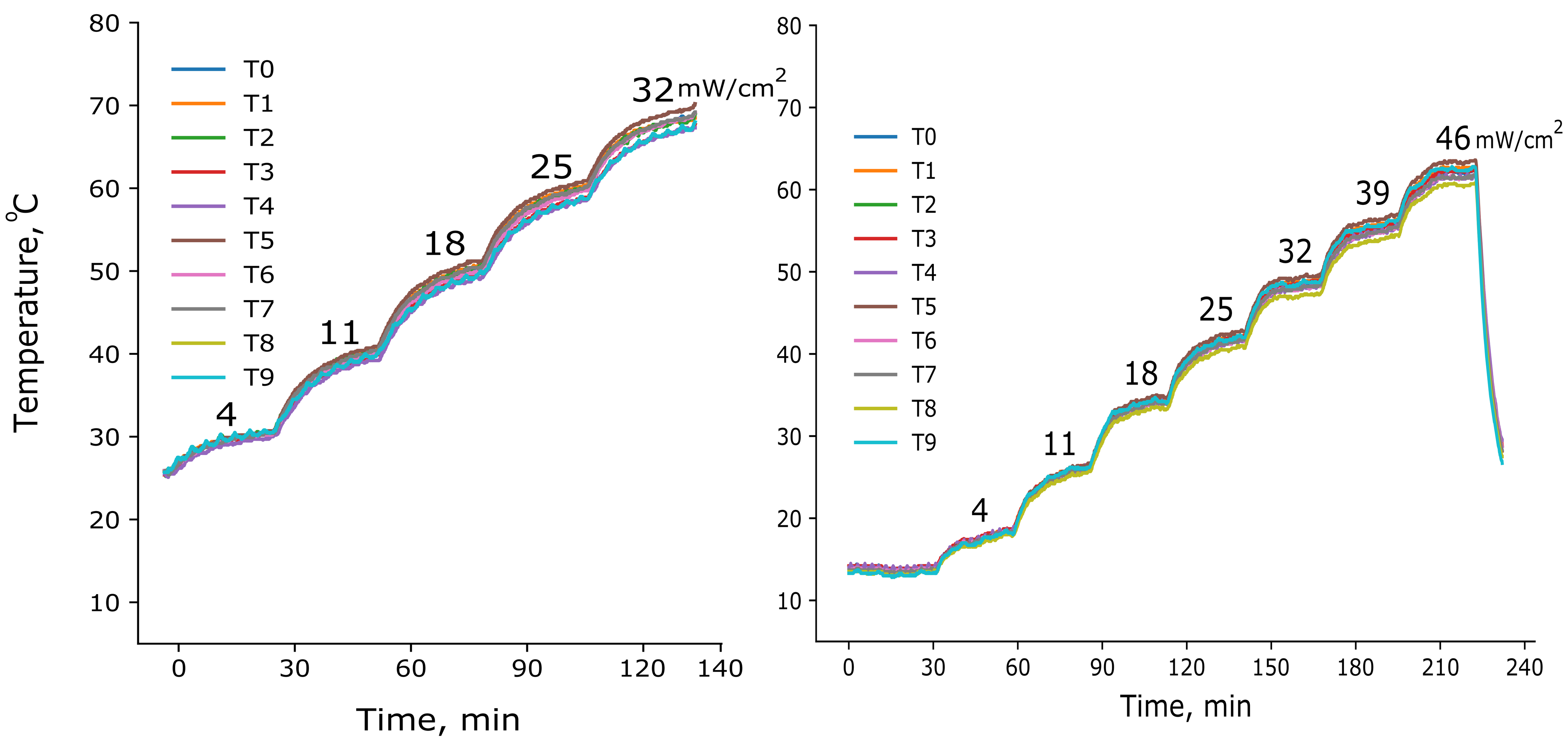

Figure 3. Results of temperature distributions neasured at different heat loads without netrogen vapor cooling (left) and with (right)

Summary

1. We demontstrate the capability of the cold nytrogen with the temperature of ~15°C coming with low speed flow(consumption of nitrogen is ~0,24g/sec) to keep the sensor heated surface producing 18 mW/cm2 at the operational temperature ~ 35°C (which is close to the desirable).
2. Application of gaseous cooling with very low-speed cold gas flows improves the radiation transparency of the whole setup and it should minimise possible vibrations of large area, thin (~20 um) silicon sensors.
3. Further studies will go in the direction of lowering the temperature of cold gas and setting up the limits of the given approach relevant to the efficiency of extra ligth-weight design of the general detector setup.