An hybrid liquid nitrogen system for the cooling Of the ESO OmegaCAM detector

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GOALS:

The 2.6-m VLT Survey Telescope (VST) will be equipped with the optical wide-angle camera OmegaCAM, which features a field of view and pixel scale that perfectly match the VST and Paranal, respectively.

OmegaCAM will be mounted in the Cassegrain focus, and the focal plane is populated with a mosaic of **thirty-two 2K x 4K CCDs** plus 4 virtually identical auxiliary CCDs for autoguiding and image analysis.

For the optimal trade-off between dark current, sensitivity, and cosmetics, these detectors need to be operated at a temperature of about **155 K**.

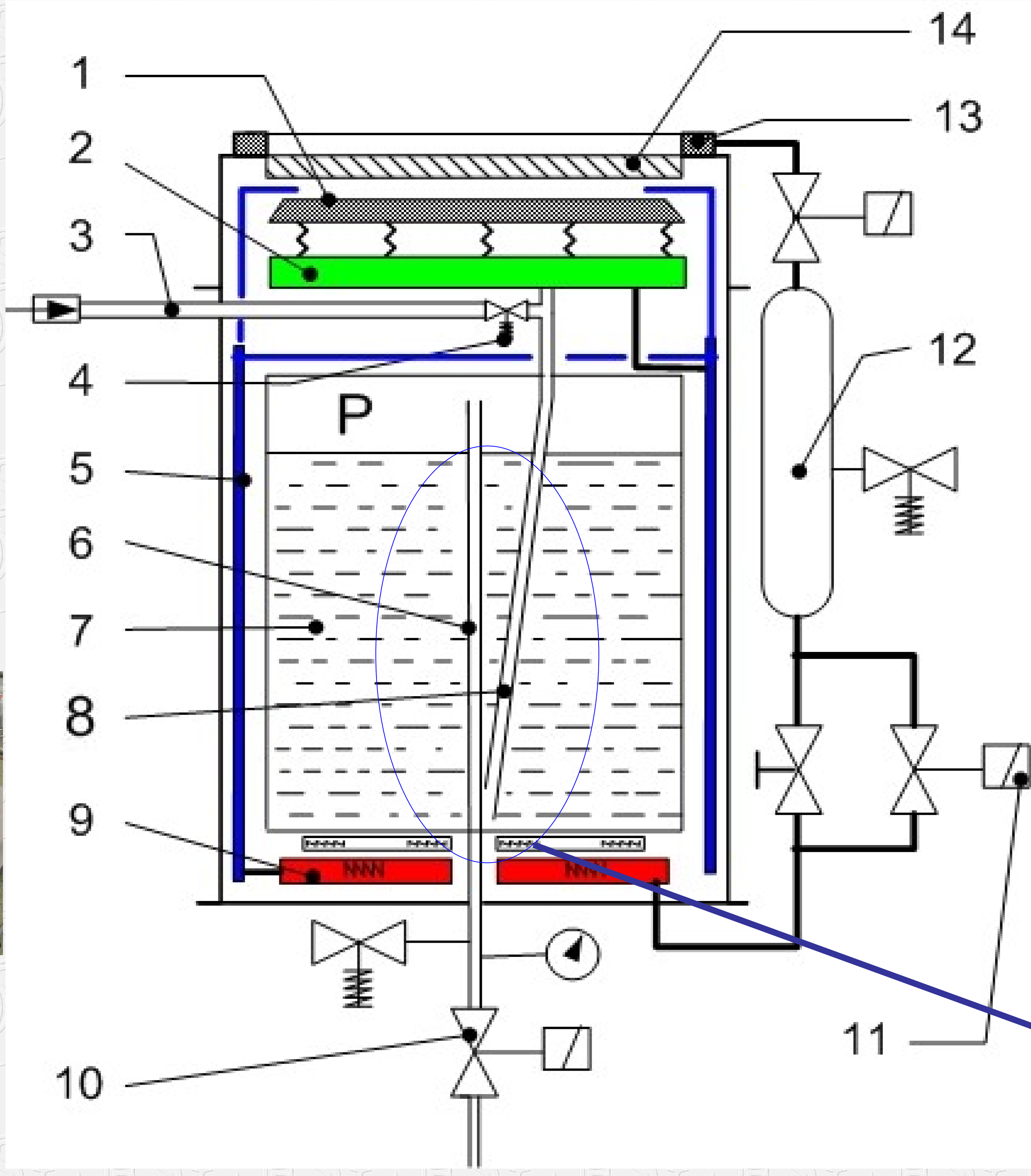
The detectors fill a total area of **630 cm²** and for obvious reasons have to face the dewar entrance window which, however, is in direct contact with the ambient air and temperature. Through this window, the detector is exposed to a considerable radiative heat load of roughly **30 Watts**. This is the factor dominating the thermal balance. But a detailed analysis shows that all other contributions (thermal conductance through the mechanical support structures and cables, dissipation in the electronics, etc.) add up to the same amount, bringing the total heat load to **60W**.

PRINCIPLE:

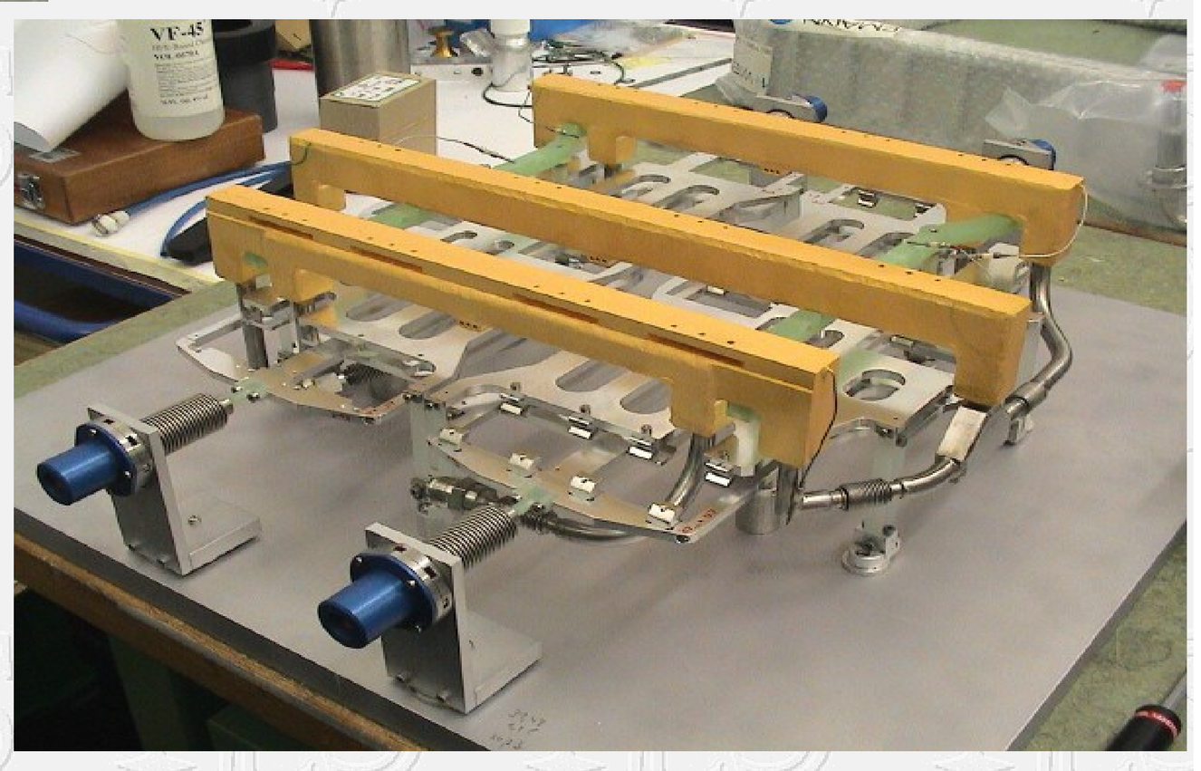
By its own pressure (P), the LN2 is forced to flow from the storage tank (7) through pipe (8) to and through a heat exchanger (2) which is in direct thermal contact with the mosaic base plate (1). The heat exchanger consists of three parallel bars in order to ensure good temperature homogeneity across the mosaic. After having absorbed the heat load, the now gasified nitrogen circulates through a special annular heat exchanger (5) which acts as radiation shield for the storage tank. A final heat exchanger (9) is used to (electrically) heat the gas to room temperature. On its way out of the instrument, the gas is captured in a small tank (12). Because it is now warm and anyway perfectly dry, it can serve a second purpose and be safely blown over the dewar entrance window to prevent the condensation of air humidity.

The thermal regulation employs a valve (11), which is supervised by a PID controller in order to maintain a constant operating temperature of the heat exchanger (2). The refilling of the internal tank is done from a standard 120 l storage tank via a vacuum-insulated line. When the latter is connected to refilling tube (3), this is detected by a proximity sensor, and valve (10) is opened in order to depressurize the internal tank so that the filling can begin. The valve is automatically closed when the tank is full (which is reported by 3 temperature sensors). The refilling port is fitted with a small spring loaded valve which is activated by the end of the refilling tube. This allows keeping the operating pressure while removing the tube.

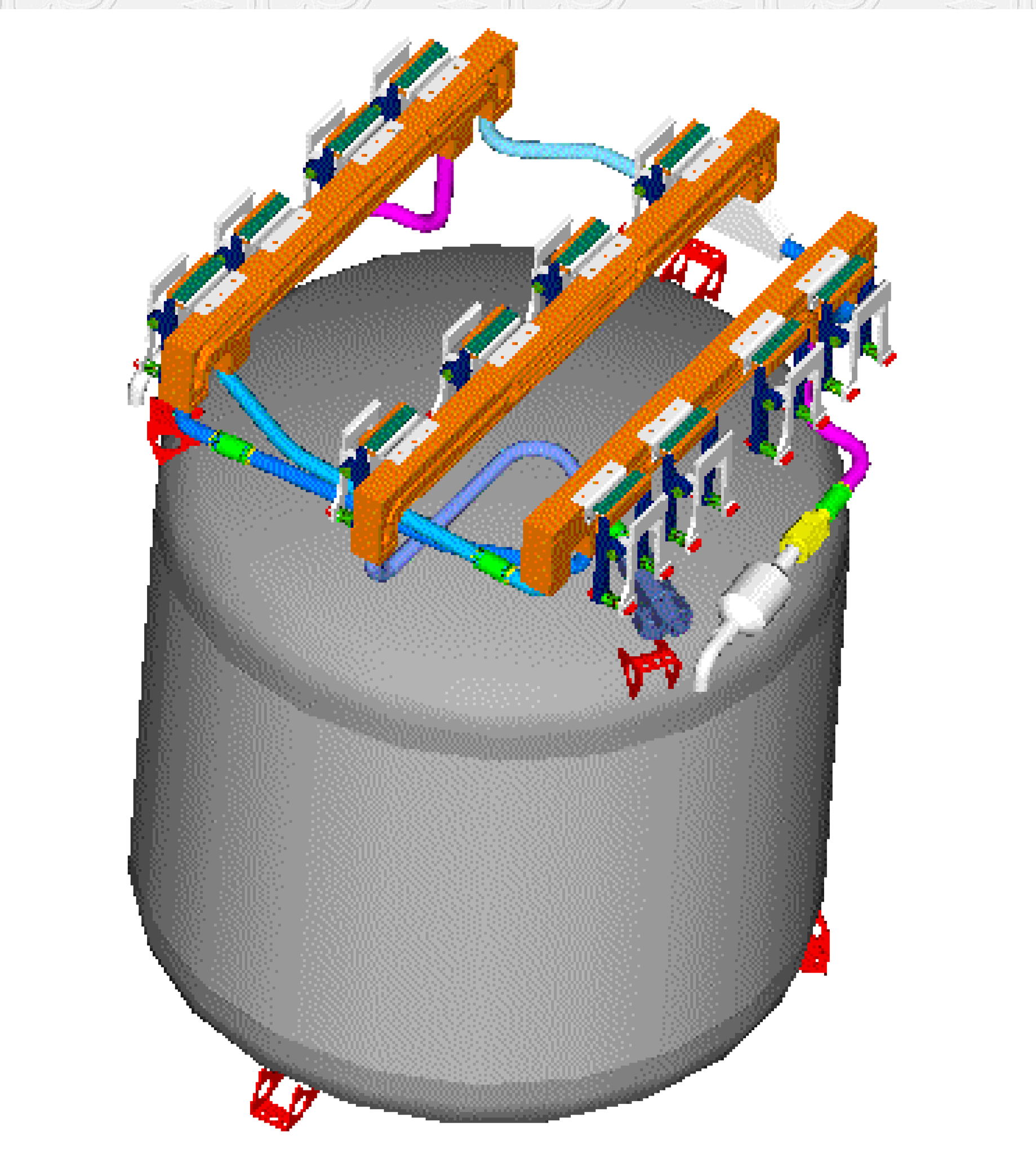
1	Mosaic plate	8	Cooling tube
2	Heat exchanger	9	Gas heater
3	LN2 feed	10	Re-filling valve
4	Feed valve	11	Temperature control valve
5	Radiation shield	12	Gas buffer tank
6	Vent tube	13	Defogging system
7	LN2 tank	14	Window



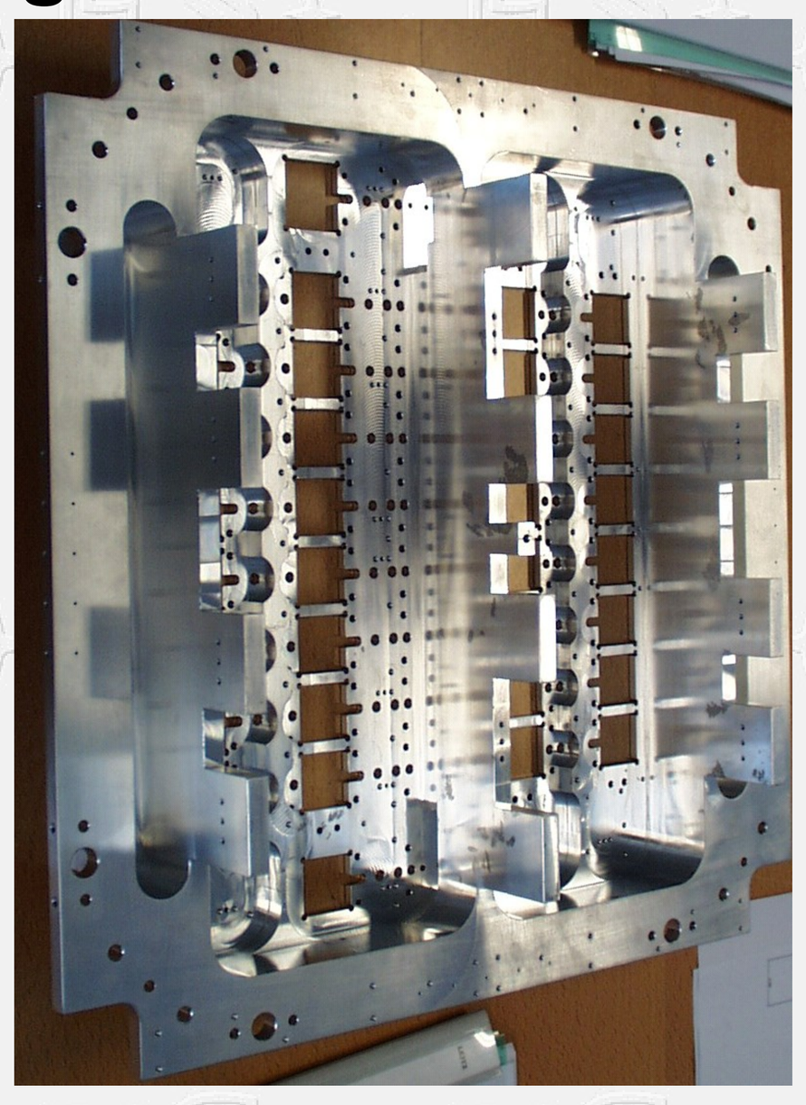
Heat exchanger

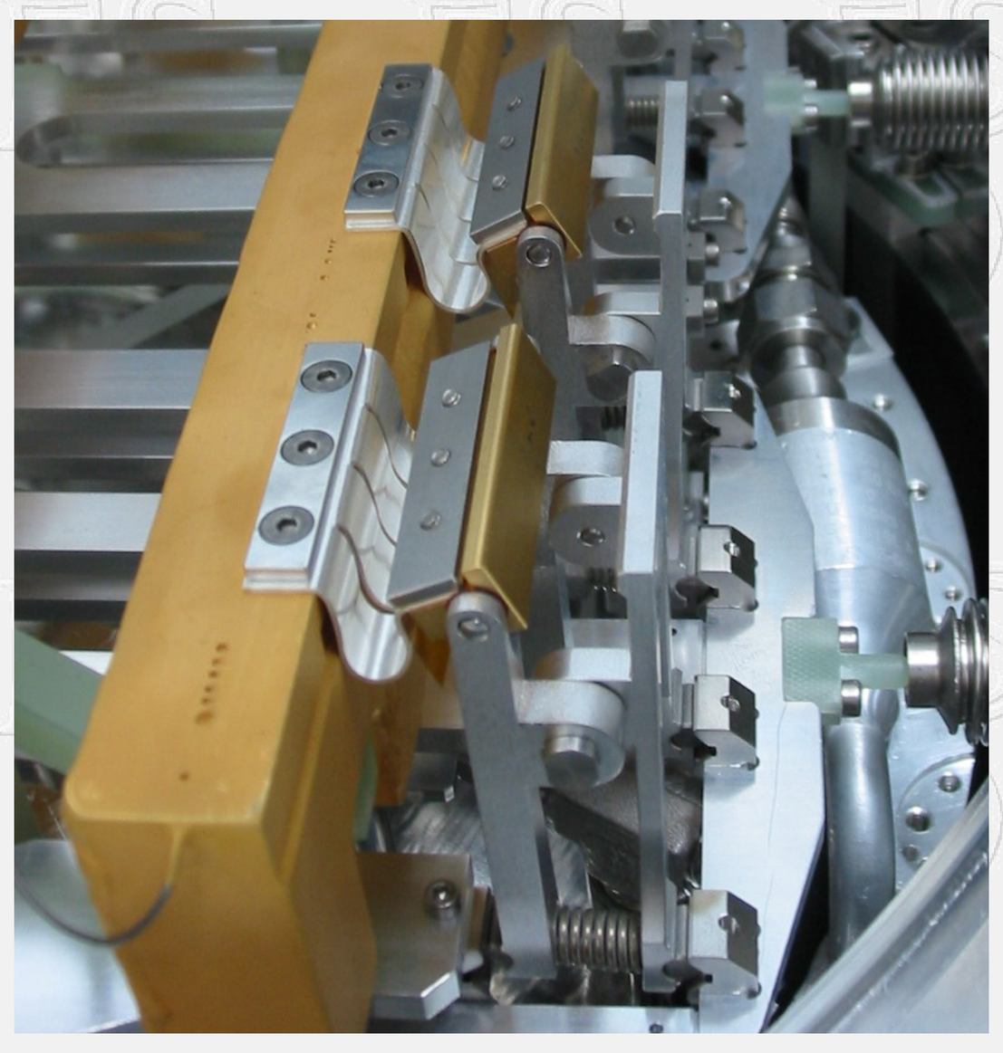


View of the heat exchanger in position on the top of the LN2 tank

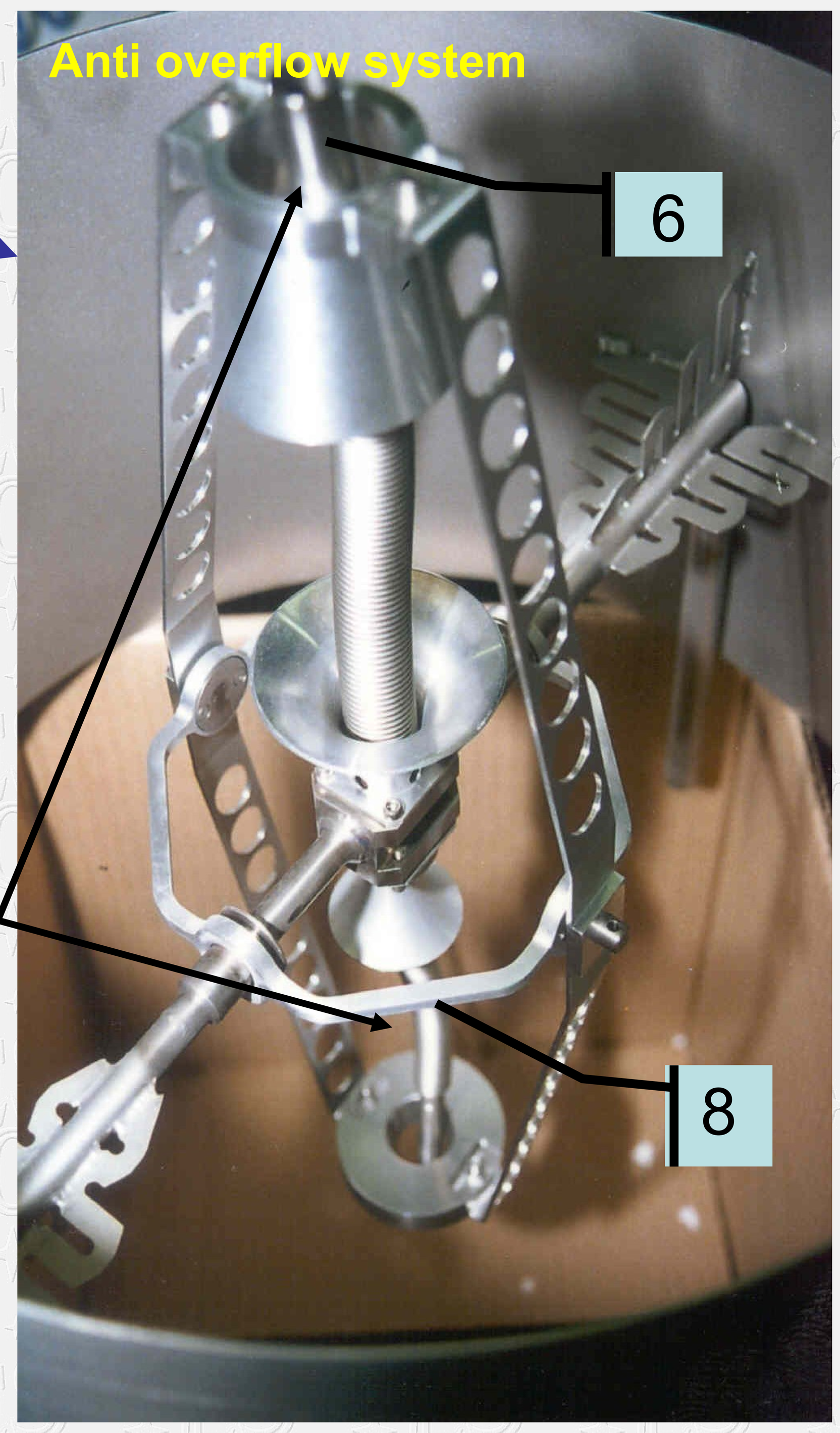


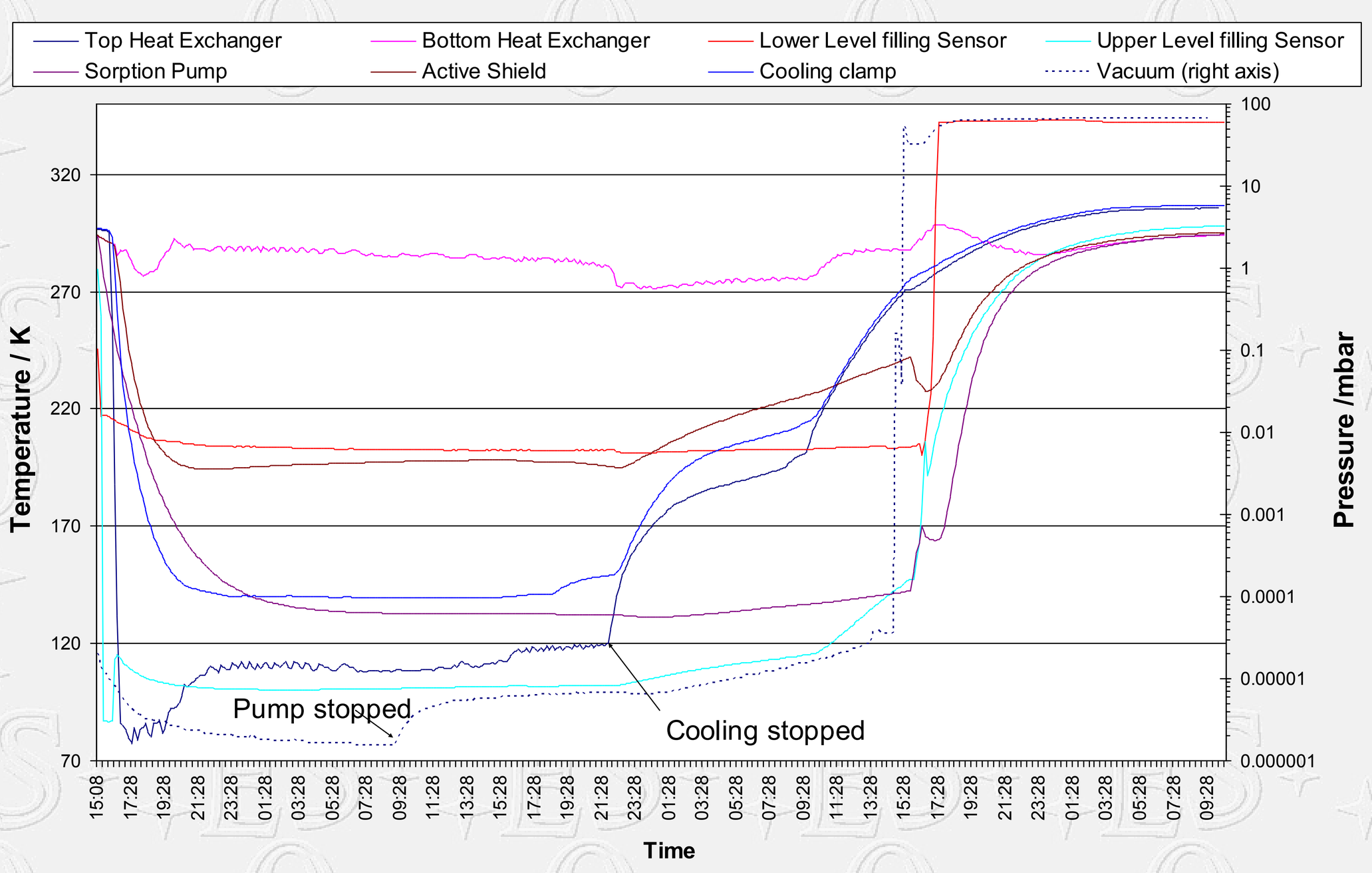
Mosaic plate with its 12 thermal contacts matching with the 12 thermal clamps



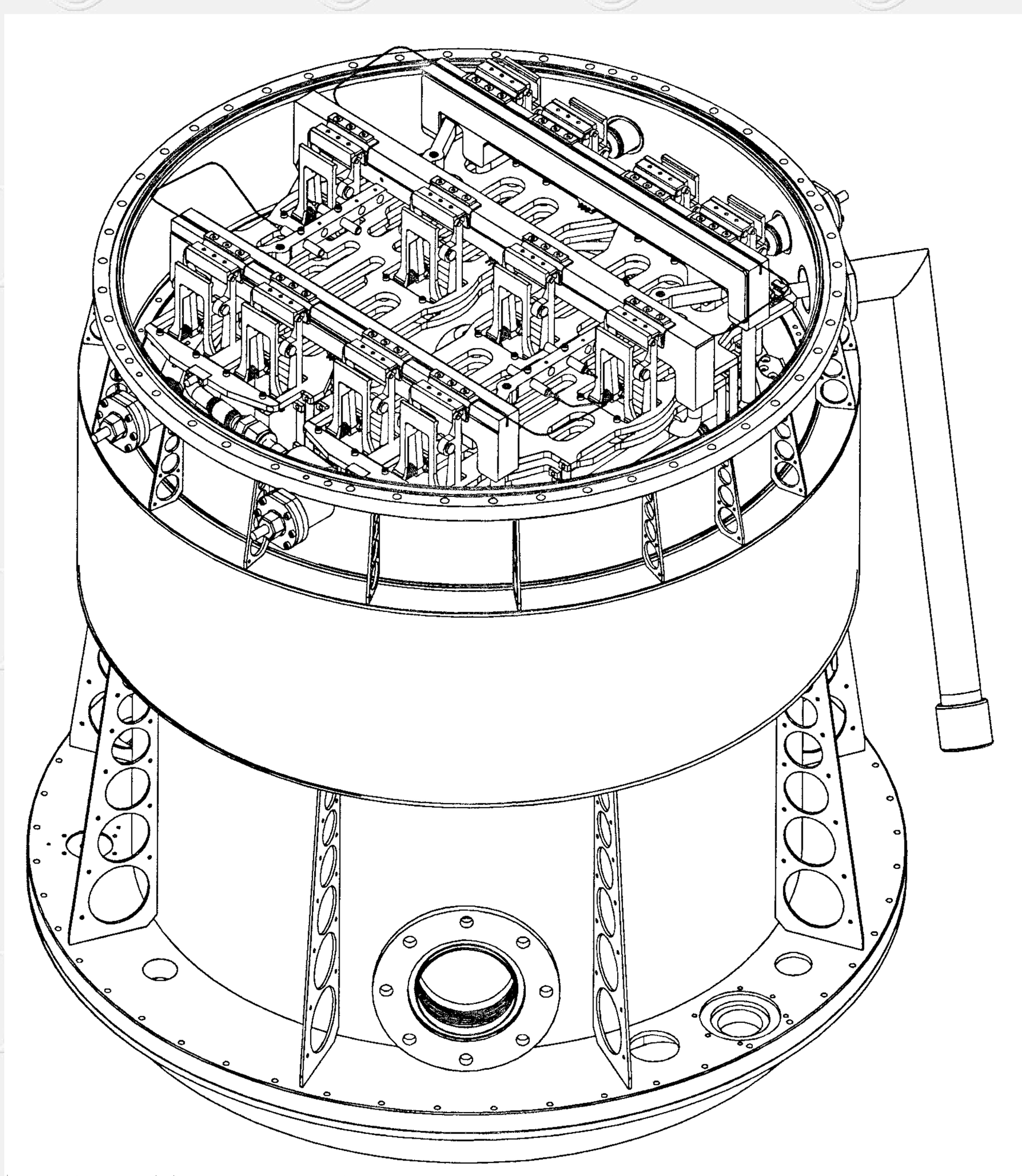


Heat exchanger with the thermal clamping system



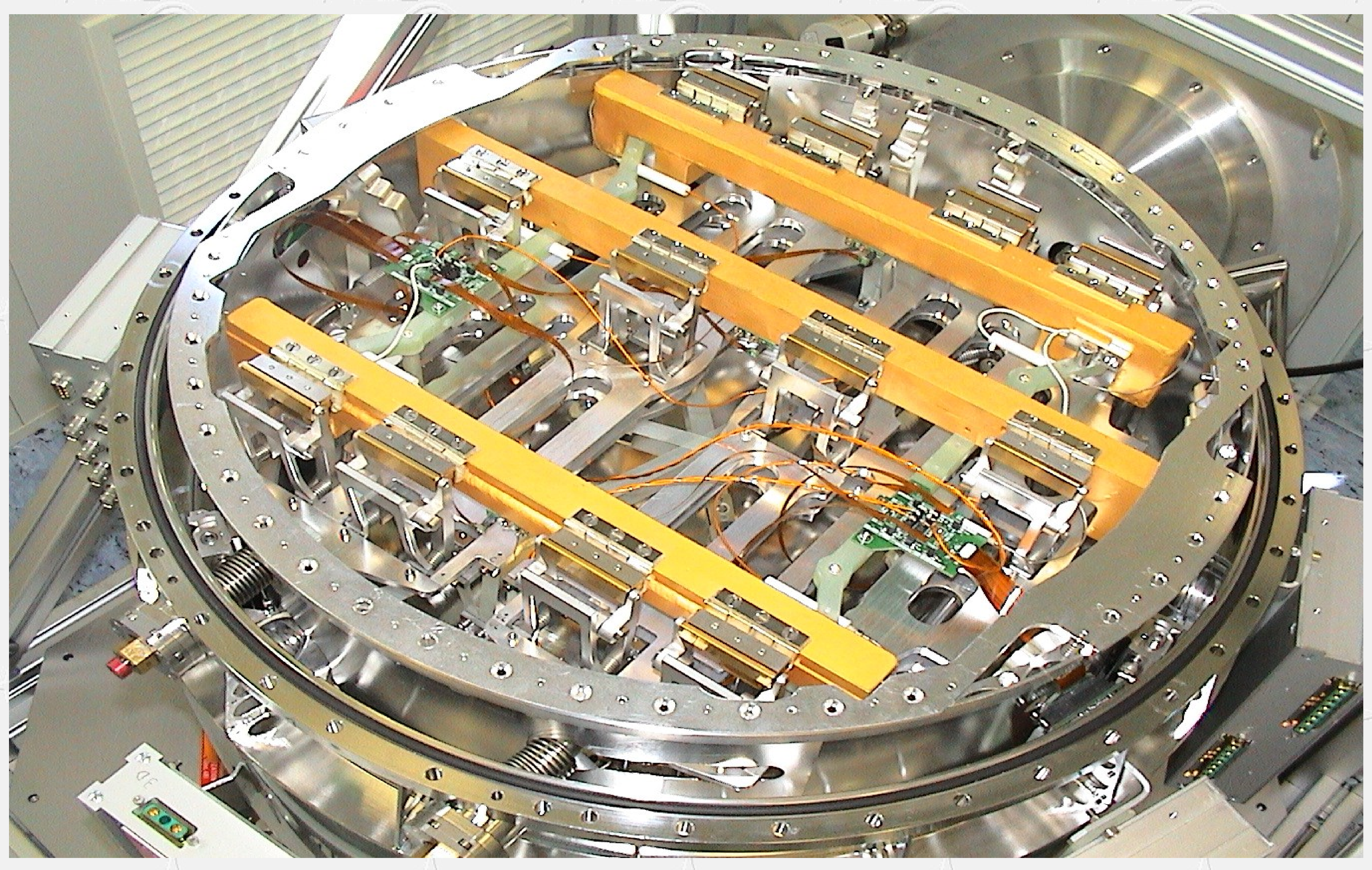


Gimball system with weight forcing tube 6 to be always on the highest point (gas bubble) and tube 8 to be at the lowest point (in the liquid)



FINAL PERFORMANCE:

Cool-down time: 7 hours
Tank capacity: 35 ltrs/95% refilling at any telescope position
CCD operating temperature: 153 K
CCD lower reachable temperature: 138 K
LN2 holding time in Telescope mode: 40 Hours
Temperature homogeneity: better than 10 K
Holding time in external tank mode: 4 days with 120 ltrs
Vacuum holding time: t > 2 years



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