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E-TEST: cryogenic radiative cooling of a 100kg suspended payload, from design to test.

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E-TEST (Einstein Telescope Euregio-Meuse-Rhine Site and Technology) was a project funded by the European program Ineterreg Euregio Meuse-Rhine. One of the goals of the E-TEST project was to develop a prototype whose suspended payload would be cooled radiatively, i.e. without contact, to cryogenic temperature below 25K.

The prototype architecture relies on an active platform providing low-frequency active isolation on top of which is mounted an inverted pendulum. From the inverted pendulum platform is suspended a marionette through a GAS filter. The cryogenic payload is then suspended from the marionette. The payload consists of 100kg dummy mirror suspended itself from a cold platform hosting cryogenic sensors.
The cooling strategy is based on an external cryostat acting as heat sink for the internal cryostat supported by the suspended cold platform. The external cryostat is completely mechanically decoupled from the suspended assembly. The external cryostat is composed of a LN2-cooled radiative shield limiting the heat load towards the internal layer that is actively cooled by gaseous Helium provided by our Linde TCF20 Helium refrigerator.

Radiative cooling to cryogenic temperature usually requires very large radiating area to evacuate the heat from the payload. The estimated heat to be evacuated is around 250mW. Considering an emissivity of 50%, a heat sink at 20K and a target temperature of 25K, the required exchange area to evacuate the heat load would be 75m². To provide the necessary radiative exchange factor between the internal and external cryostat, an innovative compact radiative radiator concept was therefore developed. The ensure compactness, the exchange area is increased by interleaving non-touching fins mounted on the suspended and external cryostat. The thickness of the fins was optimised with respect to stiffness and heat spreading while minimising the mass to avoid jeopardizing the cooling time. A specific paint was then applied to ensure a high emissivity at cryogenic temperature.

The test was conducted in the FOCAL6.5 vacuum chamber at the Centre Spatial de Liège between November 21st and December 12th 2023. After 19 days of cooling, the dummy mirror and cold platform reached 22K.
The presentation will give an overview of the project, review the key design features of the prototype and its cryostat and summarise the achieved temperatures during the test.

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