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15 K LIQUID HYDROGEN THERMAL ENERGY STORAGE UNIT FOR FUTURE ESA SCIENCE MISSIONS

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The X-IFU instrument for X-ray observation on ESA's new ATHENA satellite will employ a complex cryogenic chain for detector-cooling down to 50 mK, similar to the one foreseen for the European SAFARI instrument onboard SPICA (JAXA). A problem that typically arises from the use of such systems is the existence of heat peaks during the recycling stages of some parts that can compromise the stability of the entire chain.
Like previously developed Energy Storage Units (ESU) [1, 2] a liquid hydrogen ESU is presented as a solution for absorbing the heat peaks released by the recycling of a 300 mK cooler, without significant temperature increase. This device is capable of storing 400 J of thermal energy between 15 and 16 K, by taking advantage of the liquid-to-vapor latent heat of hydrogen in a closed system.
The ESU is composed by a low temperature liquid hydrogen reservoir, two interfaces for gas precooling and a hydrogen gas storage vessel at room temperature. This vessel can either be an expansion volume (for preliminary testing) or, at an advanced stage, a canister filled with a metal hydride, LaNi4.8Sn0.2, that chemically absorbs hydrogen. This largely reduces the volume of the vessel, since its storage density is higher than that of liquid hydrogen. Metal hydrides might also enable working at near-constant pressure and temperature in the cold cell, comparable to what would be achieved at a triple-point transition.
Along with preliminary results on ESU performance, challenges such as microgravity, mass/volume budgets and meeting specific ESA requirements that arise from working on space-ready systems are addressed and discussed.

[1] Afonso, J. *et al.*, Cryogenics 51 (2011) 621
[2] "40 K Liquid Neon Energy Storage Unit", Martins D. *et al.*, 2014 ICEC Proceedings, Physics Procedia 2015

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