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C3Or2A-03: Thermal analysis, cool down - and cryo-operational strategies for the Baby-IAXO magnet

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Baby-IAXO is a new helioscope, currently under construction design, which will look for axions or axion-like particles (ALPs) originating in the Sun via the Primakoff effect. The hypothetical particles can transform into photons in the presence of a strong magnetic field, and then be detected. The superconducting magnet for this system is composed of two 10-m long racetrack coils, spaced by 0.8 m, operated in a quadrupole configuration generating an average magnetic field of 2.9 T in the two 700 mm detection bores positioned in between the coils.

Both, cool down and operational cryogenic requirements are handled by a combination of Cryomech cryocoolers: 3 PT420 double stage and 2 AL600 single stage machines. In order to cool down the 15 t cold mass within a reasonable period, the use of the cooling power of the single stage cryocoolers is of paramount importance. The use of cryocirculators linking the AL600 cryocoolers to cold mass and shield is proposed to cool down from 300 K to 45 K. The heat loads in the system have been estimated, and given the cryocooler capacities, the cool down will take some 18 days.

The specific design of the 12 kA conduction cooled current leads is presented as well since at 45 K these cause the dominant heat load. As result of the magnet being operated in persistent mode and the leads being non-dismountable, a balance between energizing and operational heat loads has to be found. The current design, allows for a constant heat load of 350 W during operation, and a maximum of 1000 W during magnet charging and discharging.

Primary author: PAIS DA SILVA, Helder Filipe (CERN)

Co-authors: DUDAREV, Alexey (CERN); Dr BYKOVSKIY, Nikolay (CERN); TEN KATE, Herman (CERN)

Presenter: TEN KATE, Herman (CERN)

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