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AMS02 TRACKER THERMAL CONTROL COOLING SYSTEM OVERVIEW AND SPIN-OFF FOR FUTURE SPACECRAFT COOLING SYSTEM DEVELOPMENTS

Abstract

Consistent with the description of session C2.7. of the IAF. Materials and Structures Symposium inviting papers on Space Vehicles- Mechanical/Thermal/Fluidic Systems this paper deals with innovative cooling systems for delicate instruments requiring accurate temperature control.

The AMS Tracker Thermal Control System (TTCS) is a two-phase cooling system developed by NLR (The Netherlands) INFN Perugia (Italy), Sun Yat Sen University, Zhuhai (China), AIDC Taichung, Taiwan, Massachusetts Institute of Technology (USA), and NIKHEF (The Netherlands). The TTCS is part of the Alpha Magnetic Spectrometer (AMS02) experiment to be located on the International Space Station (ISS) truss. The TTCS is a mechanically pumped two-phase carbon dioxide cooling loop. Main objective is to provide accurate (¡ 3 K) temperature control and remove 140 W heat of the AMS02 Tracker front-end electronics. This is a challenge because the electronics are widely distributed and located in the magnetic field of the experiment. Conventional heat pipes and loop heat pipes could not be used because of the limited allowable metal mass and limited volume available. The paper first describes in short the function of the Alpha Magnetic Spectrometer instrument, a space born detector for cosmic rays built by a large international collaboration. Then the specific TTCS cooling requirements are described and the approach taken to tackle them

Subsequently the TTCS system design, the development status and some typical test results are described. The design fulfils the stringent temperature requirements in both hot and cold extreme conditions and also if subjected to extreme environmental changes. Engineering model tests are presented showing stable temperature control in some challenging orbital conditions. Currently the FM component boxes are subjected to a flight qualification programme Final integration of the system will be finalised mid 2009. The contributions of the various partners in this international cooperation effort are described. NLR is the overall technical, system design and safety responsible, co-ordinating the widespread project team. However the major contributions from INFN, SYSU, AIDC, MIT and NIKHEF were vital to the success of the project. In a special section of the report, the potential for spin-off of the development for mechanically pumped two-phase cooling loops is described. In particular to what extend the system can be used as cooling system for high-power communication satellites, future scientific spacecraft requiring tight temperature control and AMS-like terrestrial particle detectors used at CERN Finally the paper will give an outlook of new developments in two-phase mechanically pumped loops.