Cryogenics Margin and Uncertainty Philosophy for Spacecrafts, the ESA Perspective

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The management of technical margins and uncertainties in Spaceflight projects is a crucial tool, on which the project relies to deliver on time, on cost and on quality.

The European Cooperation for Space Standardization (ECSS), compiles normative documents and handbooks that recommend margin philosophies for most of the technical disciplines (Mechanical, Thermal, Power, Software and memories etc).

Spacecraft Cryogenics is for the moment not covered by such documents, and every European Space Agency (ESA) project proposes and manages Cryogenic Margins and Uncertainty Philosophy as they see fit, usually based on team heritage and expertise.

Cryogenics is an enabling technology at the cross-roads between the thermal domain and the mechanism domain, with its performance affected by complex multi-physics phenomenon (contamination, physical and thermo-optical properties variations, etc).

Defining a suitable Cryogenics Margins Philosophy is a delicate exercise which has a direct impact on technical budgets, cost and schedule.

This paper will touch upon the fundamental principles of Margin and Uncertainty philosophy within Space engineering. In a second part, the author will extend the generic approach to the distinctive challenges presented by the Space Cryogenics domain.

Finally, a survey of ESA's cryogenics projects is presented, spanning past, present, and in-development missions such as Herschel, Planck, MTG-I, MTG-S, LSTM, CO2M, Ariel, and Athena, establishing a status of the different margin and uncertainty philosophies proposed and confront it to test data and in-orbit performance when available.

In conclusion, a Cryogenics Margins Philosophy for Spacecraft is proposed.