Selection Considerations between Active Cryocoolers and Passive Radiative Coolers for Space Instrument Applications

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Active mechanical cryocoolers, passive radiative coolers and a hybrid of these two types of coolers all have been used to provide cryogenic cooling for optics and detectors in long-duration space missions. The cooler architecture decision for cryogenic instruments needs to be made in the early stages of the payload design. This paper aims to summarize the key considerations in selecting the cooler architecture for a given mission and instrument. This paper will discuss the major performance figures of different types of coolers, including mass, power, system exported vibrations, robustness to uncertainty in thermal environments and other environmental effects (e.g. lunar dust on lunar landers and rovers), integration complexity, and ground performance verification challenges. It will also discuss the impact of mission reliability requirements, instrument operating temperatures, optics jitter requirements, CONOPs, and cost and schedule constraints on the cooler architecture selection process.