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ON THE DESIGN OF BECCAL - A QUANTUM OPTICS EXPERIMENT ABOARD THE ISS

Abstract

The Bose-Einstein Condensate - Cold Atom Laboratory (BECCAL) is a high precision quantum optics experiment considered for operation on the International Space Station (ISS). BECCAL is a bilateral collaboration established between NASA and DLR. The facility shall satisfy the needs of both the American and German scientific community concerning cold atoms physic. The operation of this high precision experiment requires the employment of several instruments that are sensitive to the thermal and mechanical environment. Fitting the payload into the constraints of the ISS further exacerbates the imposed requirements. The predecessors to BECCAL are the sounding rocket campaigns MAIUS 1-3 (MAteriewellen Interferometrie Unter Schwerelosigkeit – Matter wave interferometry in microgravity). MAIUS was developed by a German consortium and produced the first BEC in space. Consequently, BECCAL inherits many systems and components from MAIUS, which are complemented by additional novel features. BECCAL consist of three main systems: The laser system, the control electronics, and the physics package. Even though BECCAL strongly resembles MAIUS, a completely new design of the infrastructure and thermal control system is necessary to fit the payload into the rack structure aboard the space station. The designated housing for BECCAL is a quad locker and a single locker inside an EXPRESS (Expedite the PRocessing of Experiments to Space Station) rack. Consequently, size, weight, power, and heat dissipation are critical budgets. Considering the available space in comparison to the size of MAIUS, structural downsizing of the apparatus is decisive. Supplementary, a modular architecture to allow for the exchange of life time critical objects via orbital replacement units, leads to an eminent growth of complexity for the interfaces between the subsystems. This contribution proposes solutions to overcome the challenges identified for the design of BECCAL, while giving a detailed view on the current architecture.