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BECCAL – COLD ATOMS ON THE INTERNATIONAL SPACE STATION

Abstract

The International Space Station (ISS) offers experiments unlimited time of microgravity, setting up an opportunity to investigate ultra-cold atoms with unmatched free evolution time. The Bose-Einstein Condensate - Cold Atom Laboratory (BECCAL) is a high precision quantum optics experiment designed for operation on the ISS. BECCAL is designed in a bilateral collaboration established between NASA and DLR.

Classic cold atom laboratories are typically big ground based instruments without any requirements on the thermal or mechanical interface. However, a proper design of the system and the interfaces is mandatory in order to install an experiment onboard the orbiting platform and is one big task of the systems engineering for BECCAL.

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. The instrument withstood harsh environments like the vibrational and acceleration load of the VSB-30 rocket motors. The planned ISS experiment benefits from the experience of MAIUS and will inherit many components. Even though BECCALs design strongly resembles MAIUS, a completely new concept 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 the new solutions to overcome the challenges identified for the design of the ISS experiment, while giving a detailed view on the current architecture prepared for the preliminary design review of BECCAL.