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USE AND QUALIFICATION OF XUHV SYSTEMS ON SOUNDING ROCKET PAYLOADS

Abstract

The MAIUS experiment is a high precision quantum optics experiment about to fly on a sounding rocket in autumn 2014. The scientific objective of the mission is to demonstrate the feasibility of creating a Bose-Einstein Condensates and performing atom interferometry in Space.

In order to achieve this goal the experiment is using various sensitive instruments giving hard requirements to the thermal and mechanical design. Especially ultra-high (commercial) vacuum components (such as pumps, seals, etc.) are not designed to operate in the environment of a sounding rocket.

The experiment will fly on a two-staged VSB30 sounding rocket operated by the DLR MORABA and launched from Esrange in the north of Sweden. It will lift the payload to 260km in altitude providing approximately 360s of micro gravity. During ascent (burning phase) the motors will cause accelerations up to 16g. During re-entry the friction of the atmosphere will cause even higher accelerations of more than 20g. These high accelerations and the strong vibrations (8.1 g RMS qualification level) during motor burn have to be considered in the process of the mechanical design of the vacuum system.

The vacuum system of the MAIUS payload is designed to get along with as little seals as possible. The titanium chamber is silver brazed and manufactured in only three parts. Wherever necessary commercial conflate (CF) copper seals or self-prepared indium seals are used in the MAIUS vacuum chamber. For gauging and pumping a commercial cold cathode sensor, an ion getterpump and a titanium sublimation pump have been qualified for the use on a sounding rocket. The detailed design and the components of the MAIUS experiment chamber will be presented in this paper.

Moreover the problems on maintaining the XUHV pressure in the lower E-11mbar regime under vibrational loads will be exposed. By way of example the MAIUS team experienced a pressure rise of two orders of magnitude and significant ion pump malfunction (for certain models) during the qualification process. Hereby a dependency on the load level was proven in several test runs on vibrational table.

Beyond that, some test results from vibrational and steady load tests of both sealing techniques and components shall be investigated in detail. Solutions will be proposed to overcome the challenges identified so far.