Paper ID: 40107
oral
student

15th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations (IP)

Author: Mr. Christoph Montag
Institute of Space Systems, University of Stuttgart, Germany

Mr. Jonas Simolka
Institute of Space Systems, University of Stuttgart, Germany
Dr. Rene Laufer
Baylor University / University of Cape Town, United States
Mr. Ralf Srama
Max-Planck-Institute for Nuclear Physics, Germany
Prof.Dr. Georg Herdrich
Institute of Space Systems, Germany

DESIGN OPTIMIZATIONS FOR INCREASED MUZZLE VELOCITIES OF A COMPACT SINGLE-STAGED LIGHT GAS GUN FOR ENVISAGED TWIN FACILITY SETUPS

Abstract

Due to the steadily increasing number of satellites and other spacecraft in Low Earth Orbit (LEO) the probability of collisions with objects like micro meteorites, dust particles as well as artificial objects like space debris increases. In order to investigate these interactions a single stage light gas gun has recently been developed and built within a collaboration between the Institute of Space Systems (IRS) at University of Stuttgart, Germany and the Center for Astrophysics, Space Physics and Engineering Research (CASPER) at Baylor University, Waco, Texas, USA and set up at the CASPER Space Science Lab. The single stage light gas gun is designed to be operating with helium as well as other driver gases with higher molecular masses like nitrogen. The tank pressure can be up to 25 MPa. The advantage of this stand-alone design is its compact footprint (length of 0.65 m and a mass of about 13 kg), cost effective set-up and operations as well as the ability to accelerate projectiles with almost no constrains regarding composition (including ice particles) of sizes in the micro meter to millimeter range to velocities up to 1000 m/s. This enables a wide field of application including material impact testing, the calibration of dust instruments and investigations in impact physics. An interface for connecting the light gas gun allows connection to various facilities, i.e. an Inductively-heated Plasma Generator (IPG) or a calibration chamber. Initial performance experiments of the light gas gun at the CASPER Space Science Lab already showed promising results, but also revealed potential for further increase of the projectile escape velocity by optimizing the dimensions of the barrel. Additionally, the particle carrier, a so-called sabot, is improved by combining it with a rupture disk. A second and third device (twin facilities) are planned to be set up at IRS and as well as the SpaceLab at the University of Cape Town (UCT) implementing these design improvements. The paper will shortly describe the overall design of the single stage light gas gun as well as the operating principles. Moreover, the improved sabot and optimized barrel design are presented concluding in an analysis tool for predicting escape velocities dependent on metadata like the type of gas, the gas pressure and projectile dimensions. Additionally, an approach of a first experimental setup will be outlined enabling the analysis and comparison of the performances of the twin facilities at IRS and UCT.