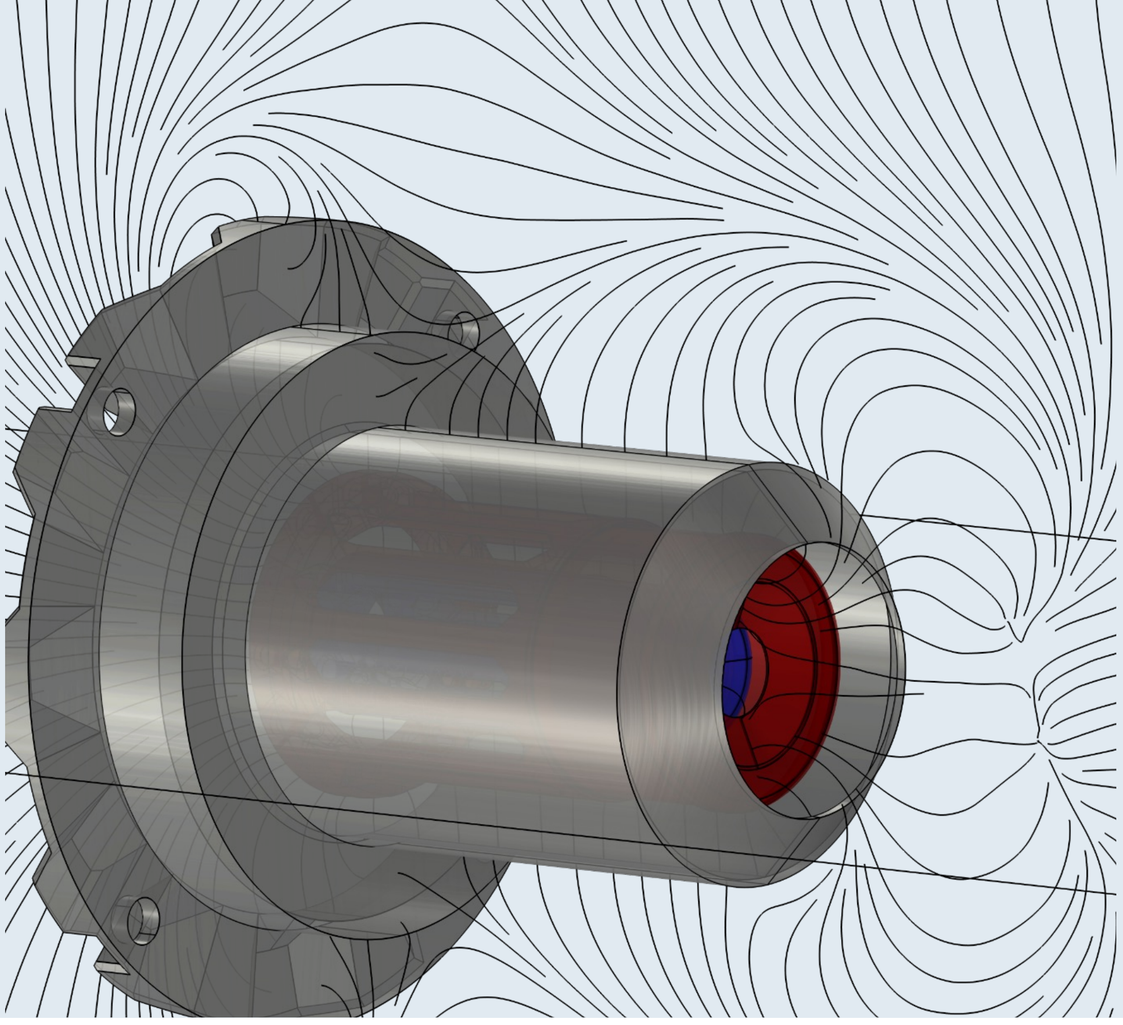

Development of a Spacecraft Neutralizer

Design and optimization of an electron gun for future earth observation missions.

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Introduction

For future earth observation missions, the demand of ion thrusters to propel satellites, equipped with sensitive instruments, increases. To compensate the occurring charge due to ion emission or plasma interaction, an electron-emitting neutralizer needs to be used. While common neutralizers require the carriage of gas (such as hollow cathodes), the dry neutralizer, being developed at FOTEC, only needs electric power to operate, which increases the efficiency of the electric propulsion system and decreases the integration complexity. The neutralizer is composed of a thermionic electron source (dispenser cathode) and a set of electrodes to shape a laminar electron beam and to reduce the beam divergence. The simulations with COMSOL Multiphysics® provide insights into the interaction of electric fields and the electron beam, which is crucial to determine the optimal shape of the electrodes and to support the design process.

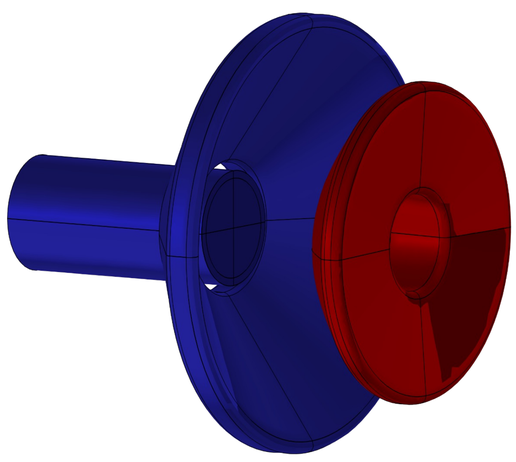

FIGURE 1. Geometry of a simplified Pierce gun configuration

Methodology

To get started with the design process, a simplified Pierce gun configuration was modelled to find mechanical dimensions and electric potentials in accordance with the mission requirements, such as power budget or electron energy. The AC/DC Module and the Particle Tracing Module were used to simulate the electric fields and to compute the particle trajectories. Parametric sweeps in a bidirectionally coupled particle tracing study were performed.

Results

A geometry to achieve a laminar electron beam was found and the mechanical design was derived from these results. The design is shown in Figure 2, together with the resulting particle trajectories. The neutralizer prototype was manufactured and tested. The experimental results showed that the electron beam leaves the aperture as expected.

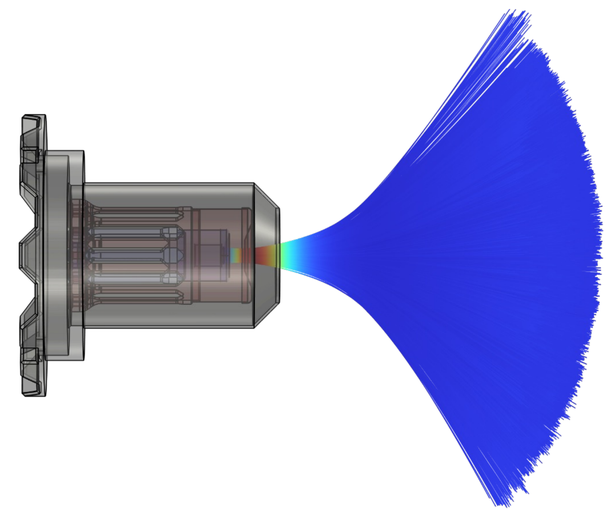

FIGURE 2. Particle trajectories of the electron beam formed by the electric fields

REFERENCES

1. Bettiol et al., “Development and Qualification of the FEEP Technology for the upcoming ESA’s Earth Observation Mission NGGM“.

Excerpt from the Proceedings of the COMSOL Conference 2024 Florence