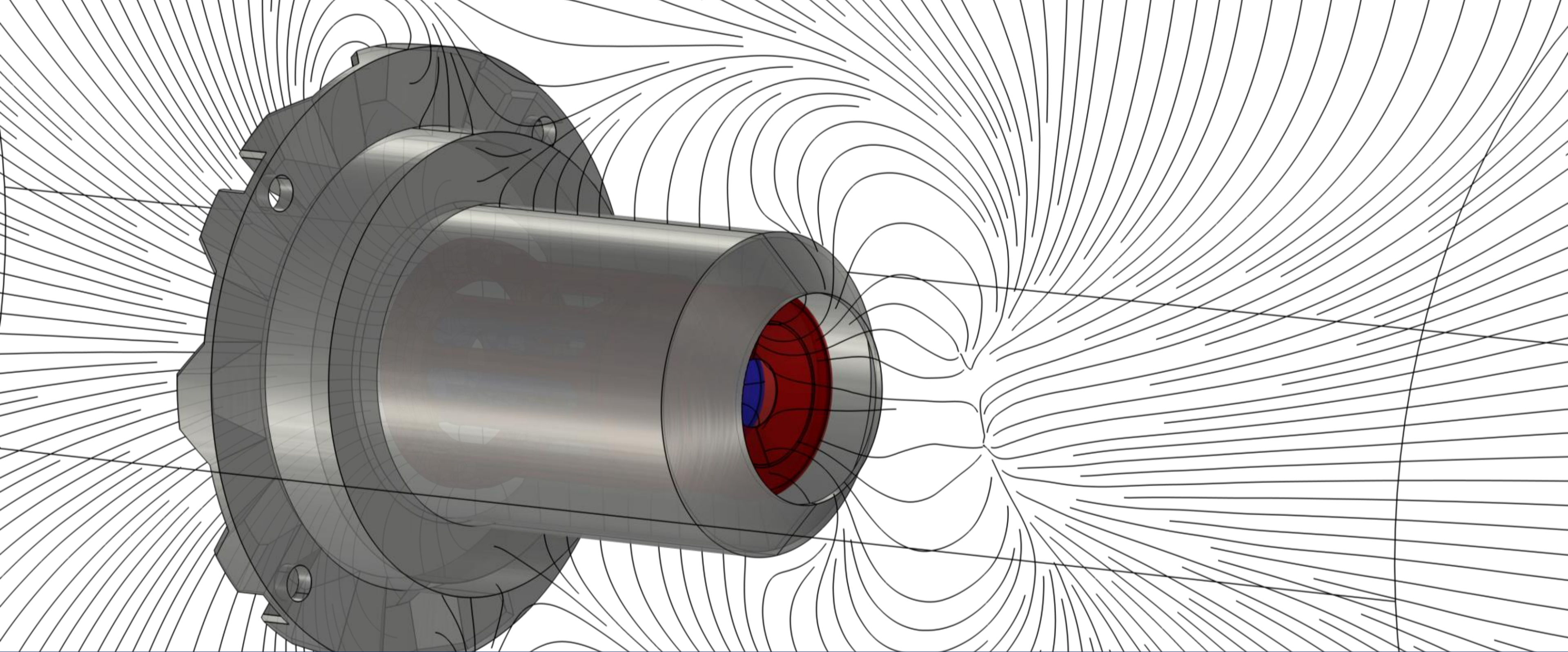


Development of a Spacecraft Neutralizer

COMSOL Conference 2024 | October 22-24, 2024 | Florence, Italy

Linda Oster, Bernhard Seifert, Andreas Siegl
FOTEC Forschungs- und Technologietransfer GmbH, 2700 Wiener Neustadt, Austria

FOTEC
Research Subsidiary of
— FH Wiener Neustadt —

Overview

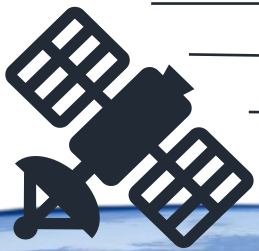
FOTEC
Research Subsidiary of
FH Wiener Neustadt

Contents

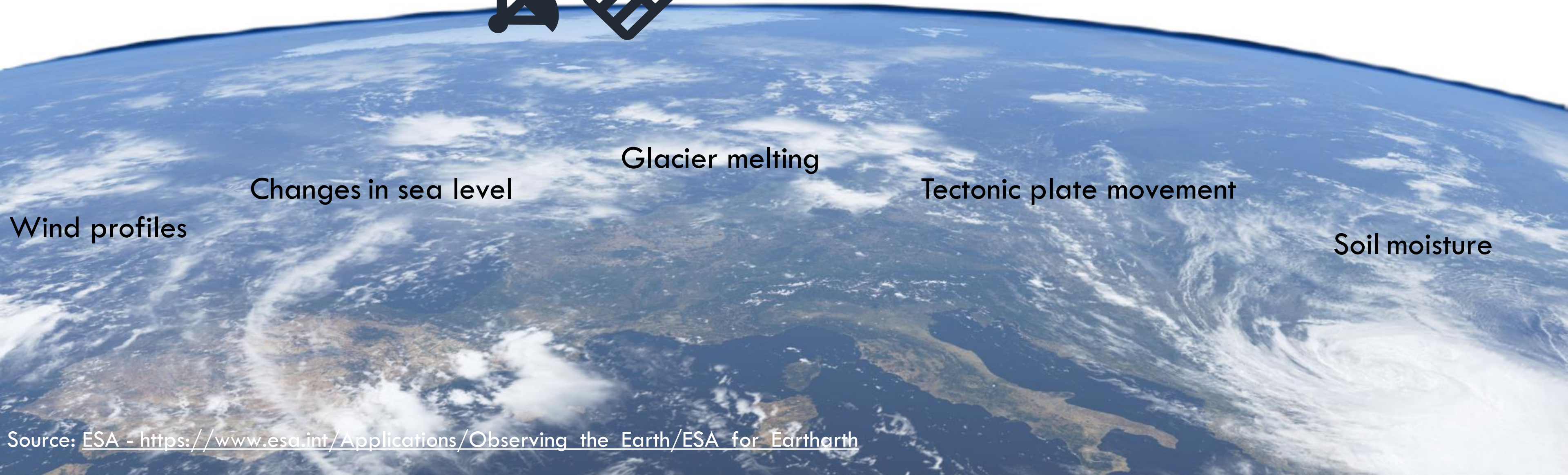
- Introduction and Background
  - Earth Observation Missions
  - Neutralization
  - Dry Neutralizer System
- Simulations with COMSOL Multiphysics
- Results
- Conclusion and outlook

Introduction and Background

Earth Observation Missions



- Sensitive measurement devices
- Limited power budget
- Mission requirements
- Thruster



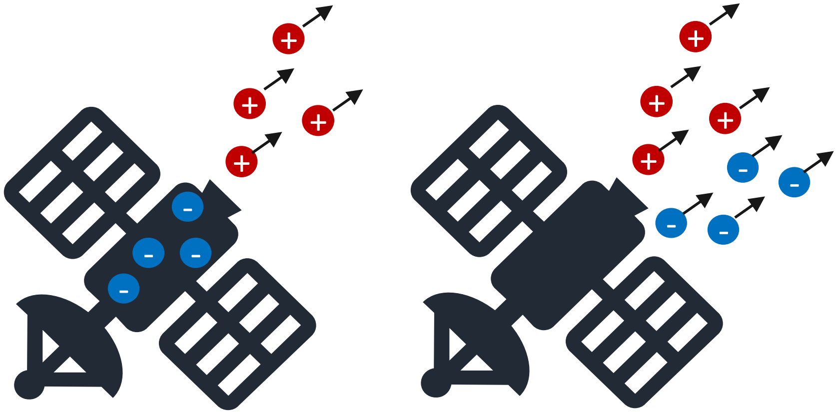
Source: ESA - https://www.esa.int/Applications/Observing_the_Earth/ESA_for_Eartharth

Introduction and Background

Neutralization

Risk

- Spacecraft charging effects due to plasma interaction, solar winds, photoelectric effect or ion thrusters
- Compromise spacecraft measurement equipment or can lead to
- sparkovers can damage components



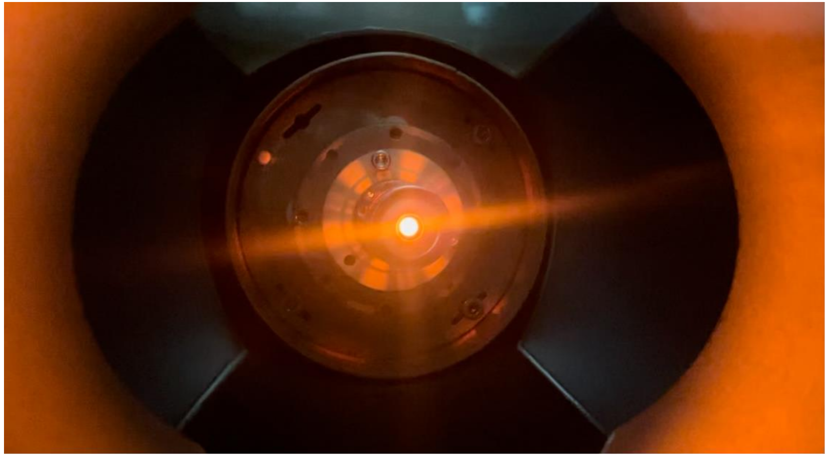
Negatively charged space craft (left) and neutral space craft (right).

Introduction and Background

Dry Neutralizer System

Design Drivers and Features

- Current up to 80 mA
- Low power consumption
- Propellant less
- Thermionic electron source
- Optics to form a laminar beam



Dry Neutralizer during operation at FOTEC's test facilities

Simulations with COMSOL Multiphysics

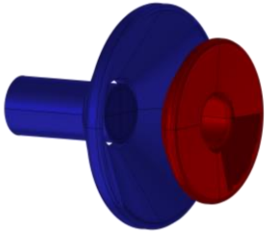
Challenges

Laminar electron beam with 80 mA

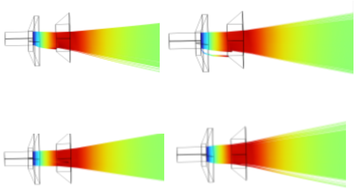
- Geometry
- Potentials of the electrodes
- Influence of dimensions and potentials on the electron beam
- Verification of the resulting mechanical design

Simulations with COMSOL Multiphysics

Methodology

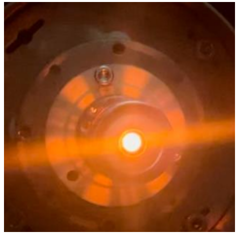


Basic Configuration



Optimization

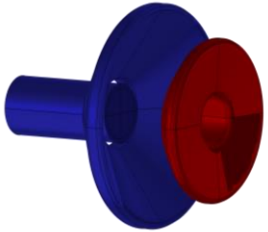
Mechanical Design

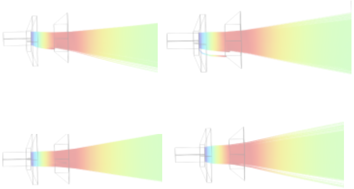


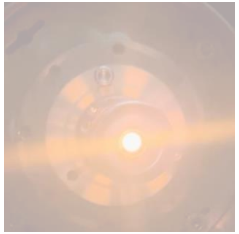
Experimental Verification

Simulations with COMSOL Multiphysics

Methodology





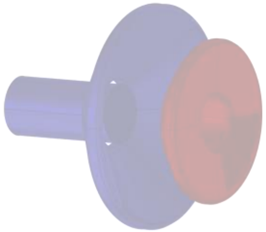


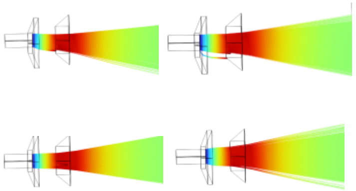
Basic Configuration

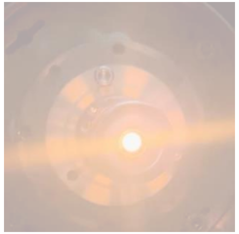
- Pierce design
- COMSOL AC/DC module and charged particle tracing
- Electric particle field interaction

Simulations with COMSOL Multiphysics

Methodology





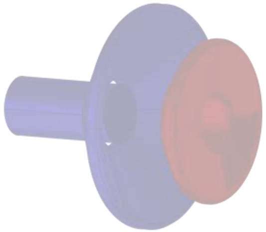


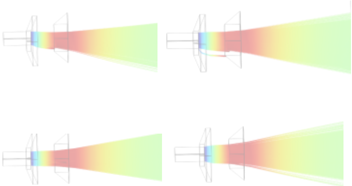
Optimization

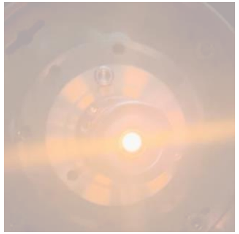
- Parametric sweeps
  - Dimensions
  - Electric Potentials

Simulations with COMSOL Multiphysics

Methodology





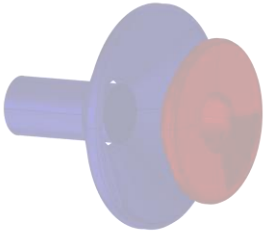


Mechanical Design

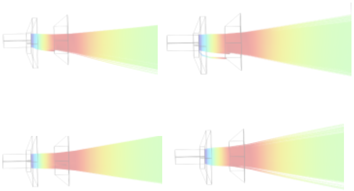
- Derived from simulation results
- Verification by computing electric fields and particle trajectories

Simulations with COMSOL Multiphysics

Methodology

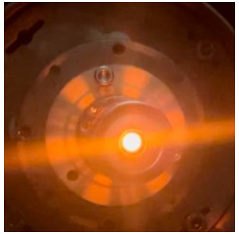


Basic configuration



Optimization

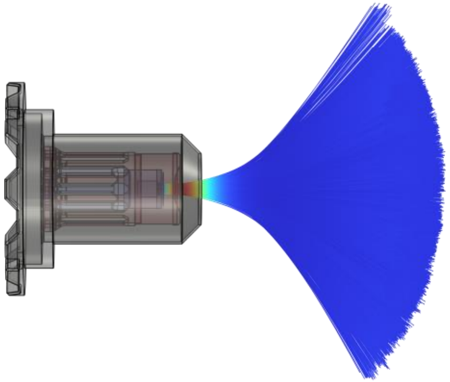
Mechanical Design

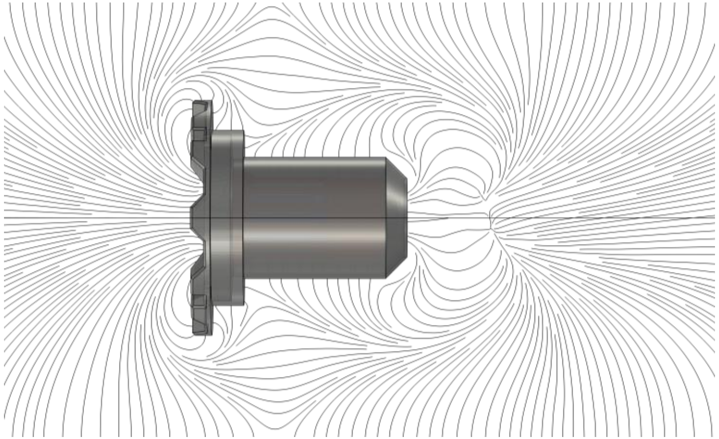


Experimental Verification

- Influence of misaligned electrodes
- Different anode shapes
- Chamber effects

Results

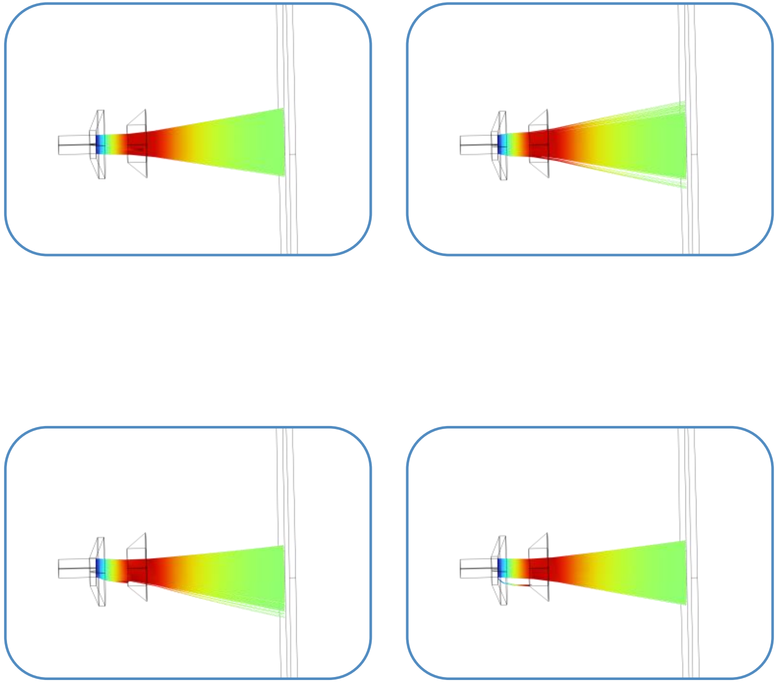


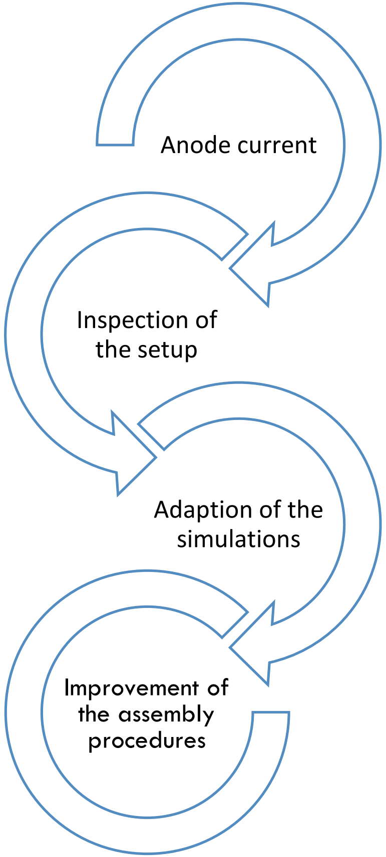


- Experimental results show that the electrons leave the aperture as expected
- Mechanical design was derived from simulation results
- Key challenge: bring together reality and simulation
  - Simulations were used to explain effects observed while testing
  - Results helped to improve the assembly

Results

Misaligned electrodes



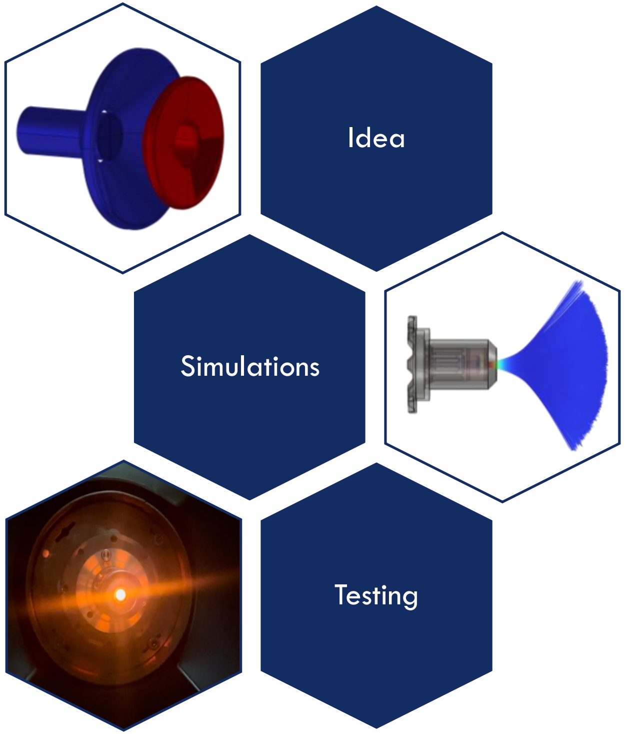


Conclusion and outlook

The use of COMSOL Multiphysics until now and in future

- COMSOL Multiphysics supported the complete design process from the idea to the first tests
- First bradboard model manufactured and under test

- Further use of COMSOL Multiphysics:
  - In parallel with experimental efforts
  - Further optimization



Thank you for your attention!

Feel free to ask your questions

Follow us on

Linked in

Linda Oster

Aerospace Engineering Junior Researcher

Viktor Kaplan-Strasse 2
2700 Wiener Neustadt | Austria
+43 5 0421 8415
oster@fotec.at
www.fotec.at