Advanced electric propulsion activities at FOTEC

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Company overview

University of Applied Sciences Wiener Neustadt

- Founded in 1994
- 40 bachelor / master programs
- 4500 students

Subsidiary

FOTEC Forschungs- und Technologietransfer GmbH

- Research subsidiary, carrying out R&D Projects with industry. Owned by University.
- 30+ years of experience manufacturing flight hardware for scientific missions (ESA, NASA, …)

R&D Projects

AIRBUS DEFENCE & SPACE

ThalesAlenia Space

OHB

esa

Product Spin-Off

ENPULSION

Exclusive License to Commercialize FOTEC Propulsion technologies

Projects

OSIP Programme

Open Space Innovation Programme (OSIP):

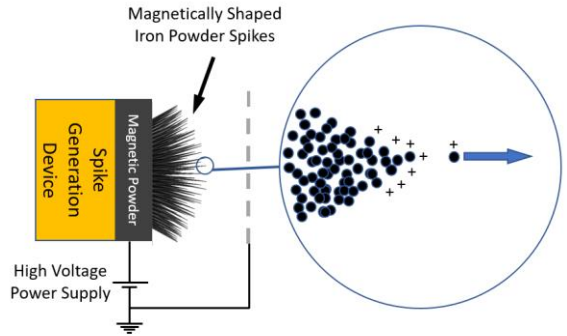
- ESA programme
- Main entry point for novel ideas
- Both in response to specific problems and through open calls for ideas
- Generally starting from very low TRL

OSIP Projects at FOTEC

MPEP and MAGNIFIED

MPEP

- Electrostatic micro-particle propulsion
- High thrust, low power
- ISRU possible
- From TRL 2 to TRL 3
- Project was concluded in 2022



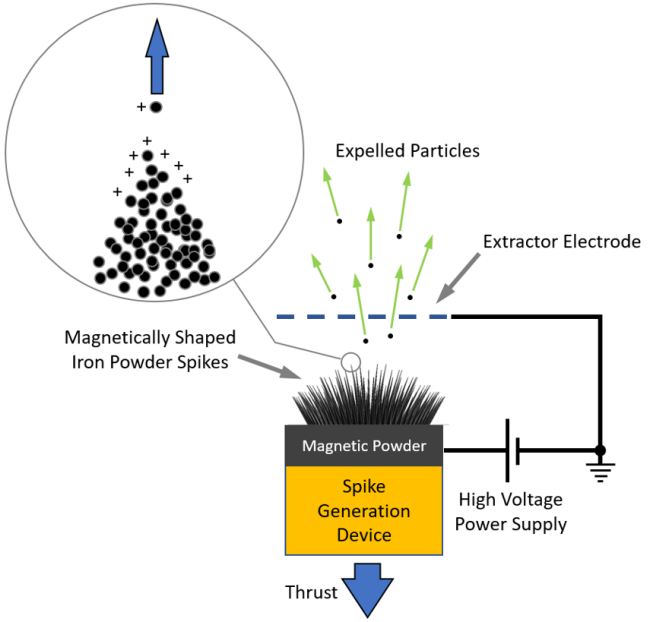
MAGNIFIED

- FEEP thruster with alternative design
- Proof of concept was already done at FOTEC
- From TRL 3 to TRL 4
- Project is ongoing

Magnetic Powder Electrostatic Propulsion - MPEP

Working principle

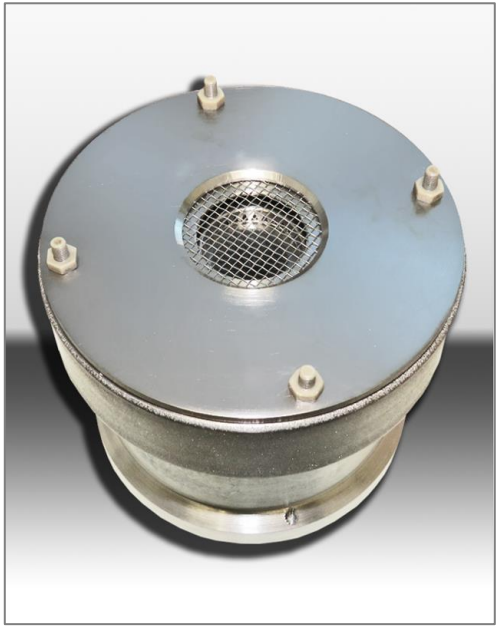
- **Magnetic powder** is shaped into an array of spikes by a magnetic field
- A voltage is applied between the powder and an extractor electrode
- **Electrically charged particles detatch from the tips** by the action of the electric field
- The charged particles are accelerated by the electric field
- Past the extractor, the particles will be expelled at the speed acquired during the acceleration phase
- **New spikes are continuously being generated by the spike generation device**
- The continuous flow of particles being emitted generates a thrust in the opposite direction.



Magnetic Powder Electrostatic Propulsion - MPEP

Thruster prototype

- The thruster prototype has been manufactured following the general guidelines used in our **FEEP design,** as far as it regards the distance between the electrodes and electrical insulation measures
- The module has been designed to withstand voltages in excess of 20 kV
- The thruster is very **compact,** with a diameter of 86 mm and a height of about 70 mm



Magnetic Powder Electrostatic Propulsion - MPEP

Propellant

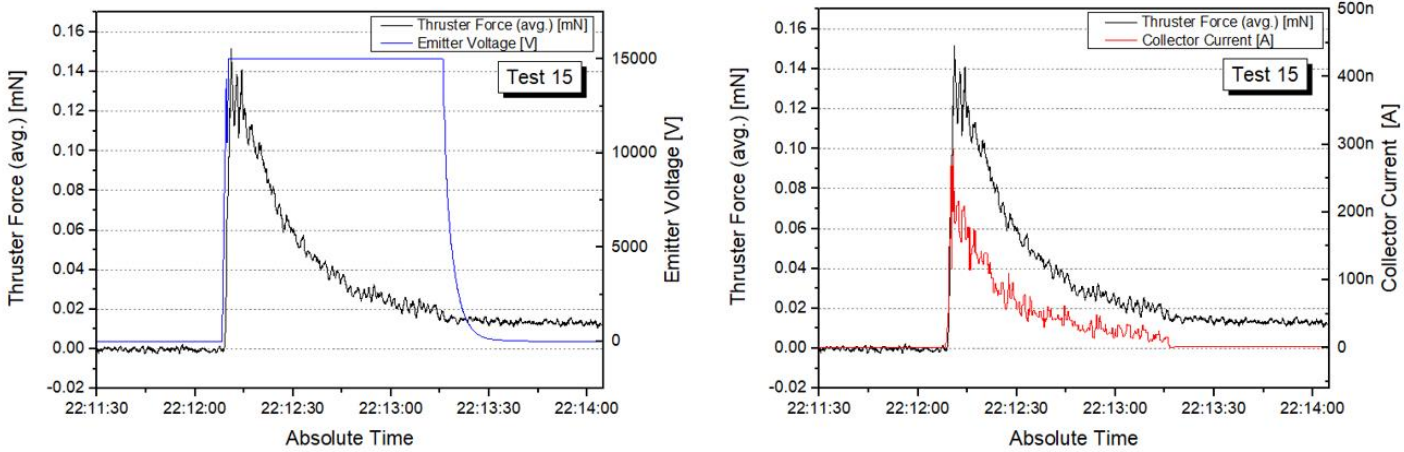
- Identify the most suitable propellant
- Several different propellant combinations were tested
- Aim: generate sharp spikes

Magnetic Powder Electrostatic Propulsion - MPEP

Performance test

- Thruster on FOTEC's thrust balance
- No reservoir -> only small amount of propellant available -> thrust drops rapidly

Typical Thrust and Current Profile at Fixed Voltage



Magnetic Powder Electrostatic Propulsion - MPEP

Key results and conclusions

Key results:

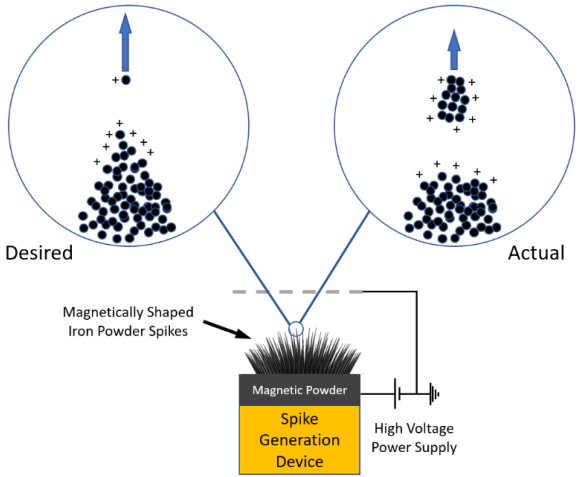
- Peak Thrust: 0.5 mN at 20 kV. Power: 30 mW
- Thrust to power ratio: 50 to 17 mN/W (depending on emitter voltage and thruster configuration)
- Low specific impulse
- Estimated average emitted particle diameter: about 100 µm

We demonstrated:

- continuous flow of charged particles, controllable both acting on the spike generation device and on the potential difference applied between extractor and spikes array

Further improvements:

- particle emission process, with the aim to increase the charge to mass ratio
- tank with a suitable feeding system should be implemented in order to keep the thrust stable and to increase the total impulse



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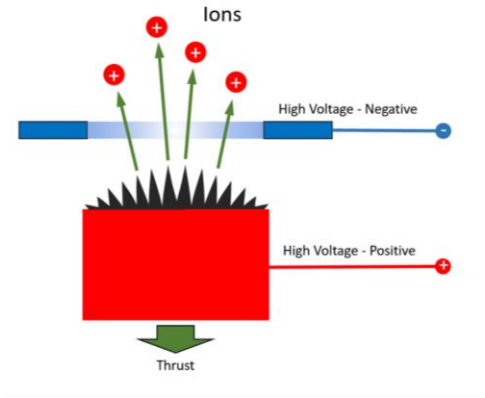
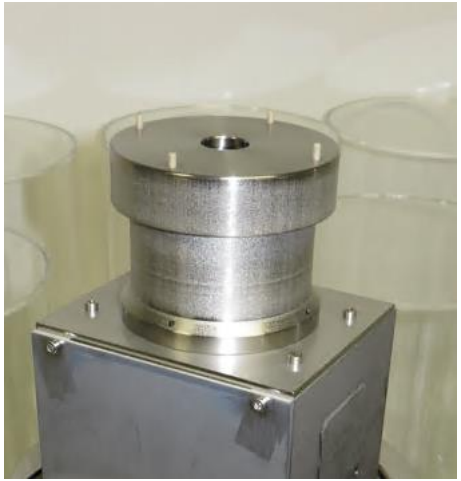
Project overview

- FEEP thruster with novel emitter design
- Higher number of needles w.r.t. current 28-needle emitter design → higher thrust possible within the same volume

- As part of this project, 37 emitters were manufactured, with different patterns/designs
- Thruster module design is the same for all emitters

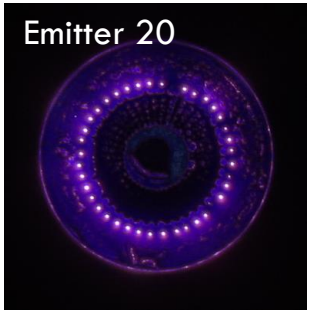


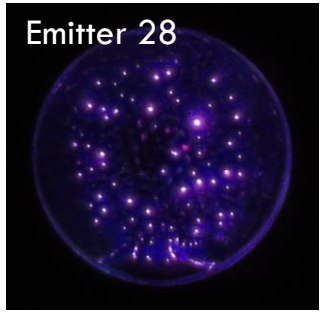


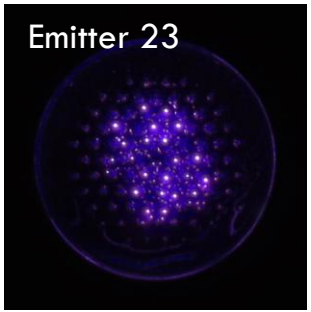
MAGNIFIED

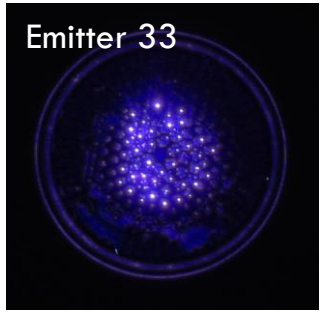
Key results

- 20 emitters have been performance tested
- Emitters can be operated with more than 100 tips firing at moderate voltages
- Up to 2 mN thrust was reached with one single emitter









- Endurance tests with most promising emitters are ongoing
- No strong degradation visible so far (short tests)
- I_{sp} in line with current FEEP emitter design (28-needle crown) for many tested emitters

Projects

Outlook

- MAGNIFIED project will run until end of Q3 2023
- Plan to do longer tests on several emitters
- Next steps: continue with a new follow up activity
  - further improvements of the technology
  - Small design changes foreseen
  - Implementation of lessons learned
  - Longer endurance tests

Thank you for your attention!

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