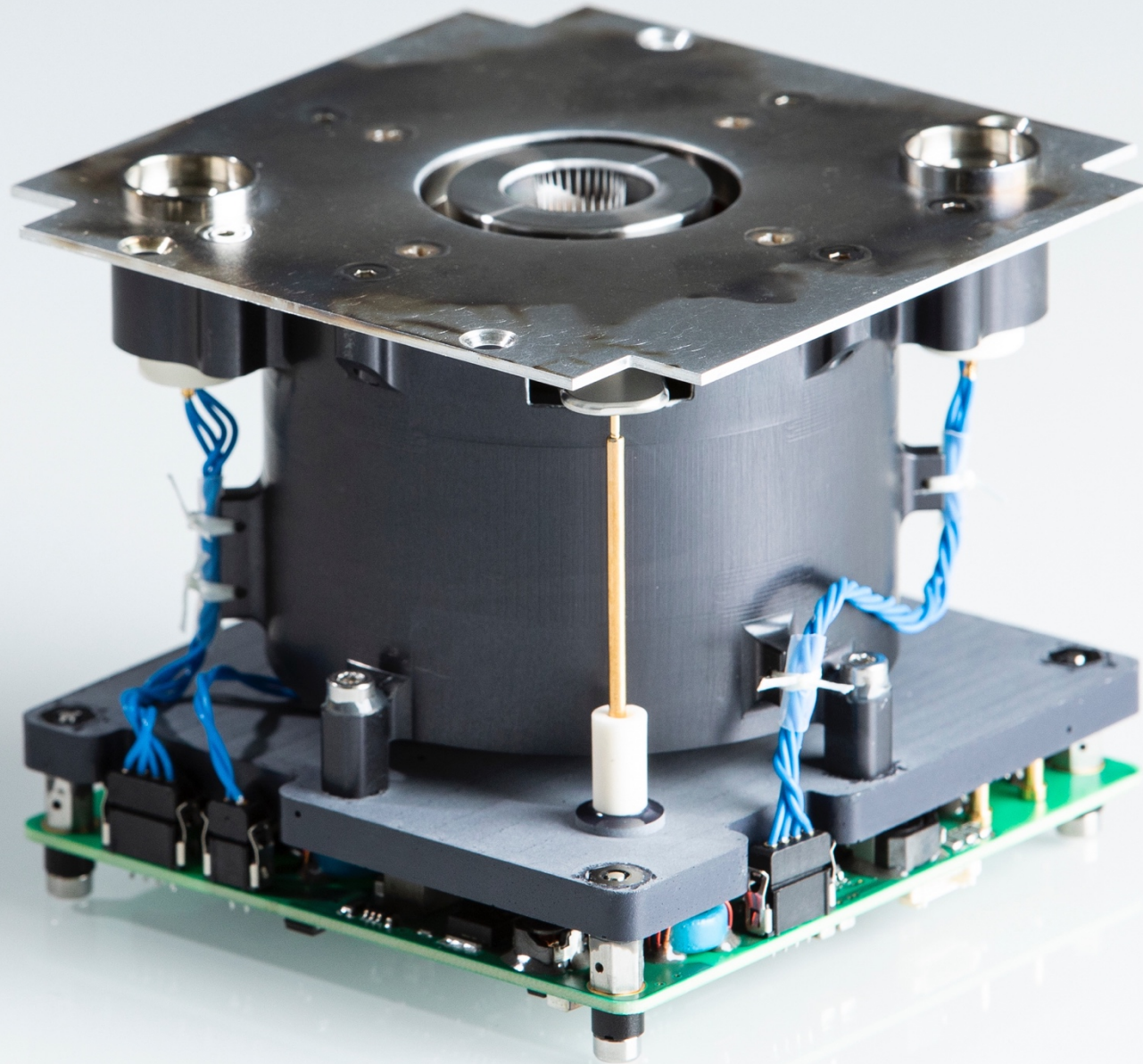


Direct Thrust Measurements and Full Performance Mapping of the IFM Nano Thruster at ESA ESTEC Facilities



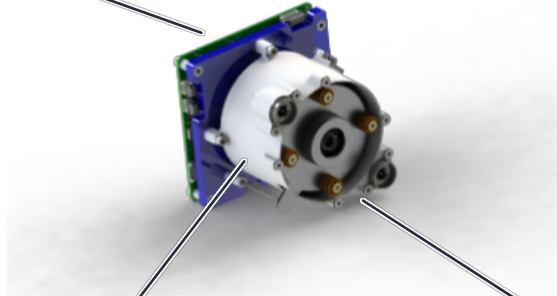
David Krejci et al.





IFM Nano Thruster

Power Electronics

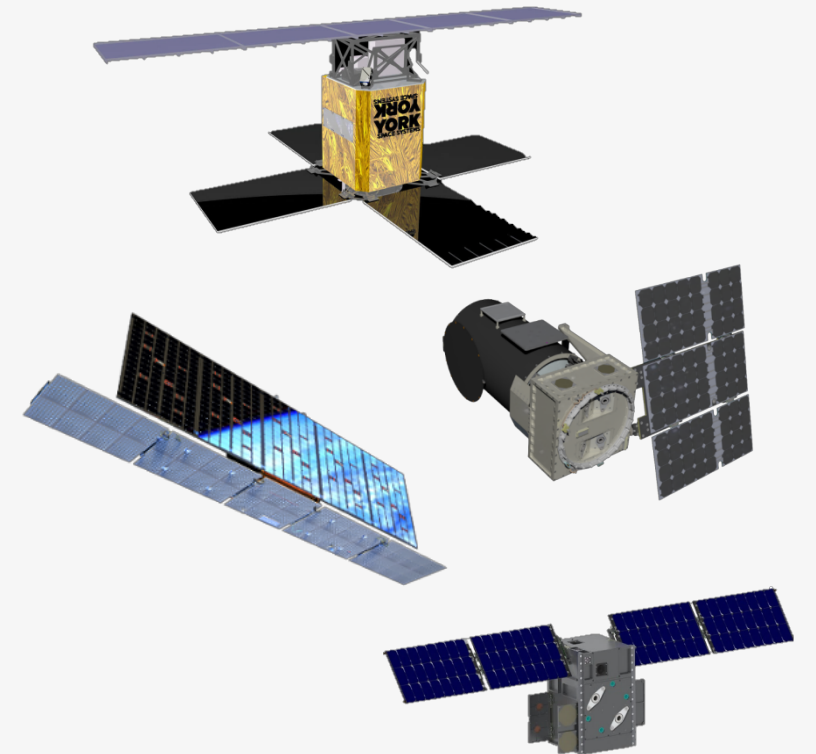


Propellant Reservoir for 5000 Ns

Ion Emitter

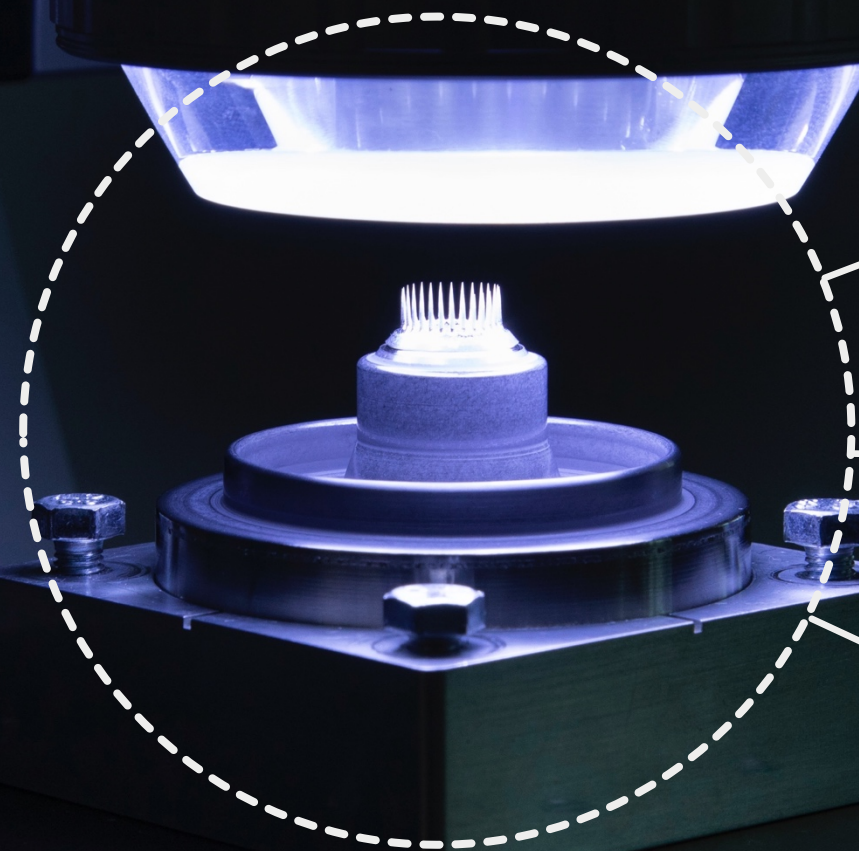
MODULARIZATION

- > STANDARDIZATION
- > MULTIPLE CONSTELLATIONS



INDIUM FEED
ion emitter

Building on
30 Years
of Development
at FOTEC



Debris safe

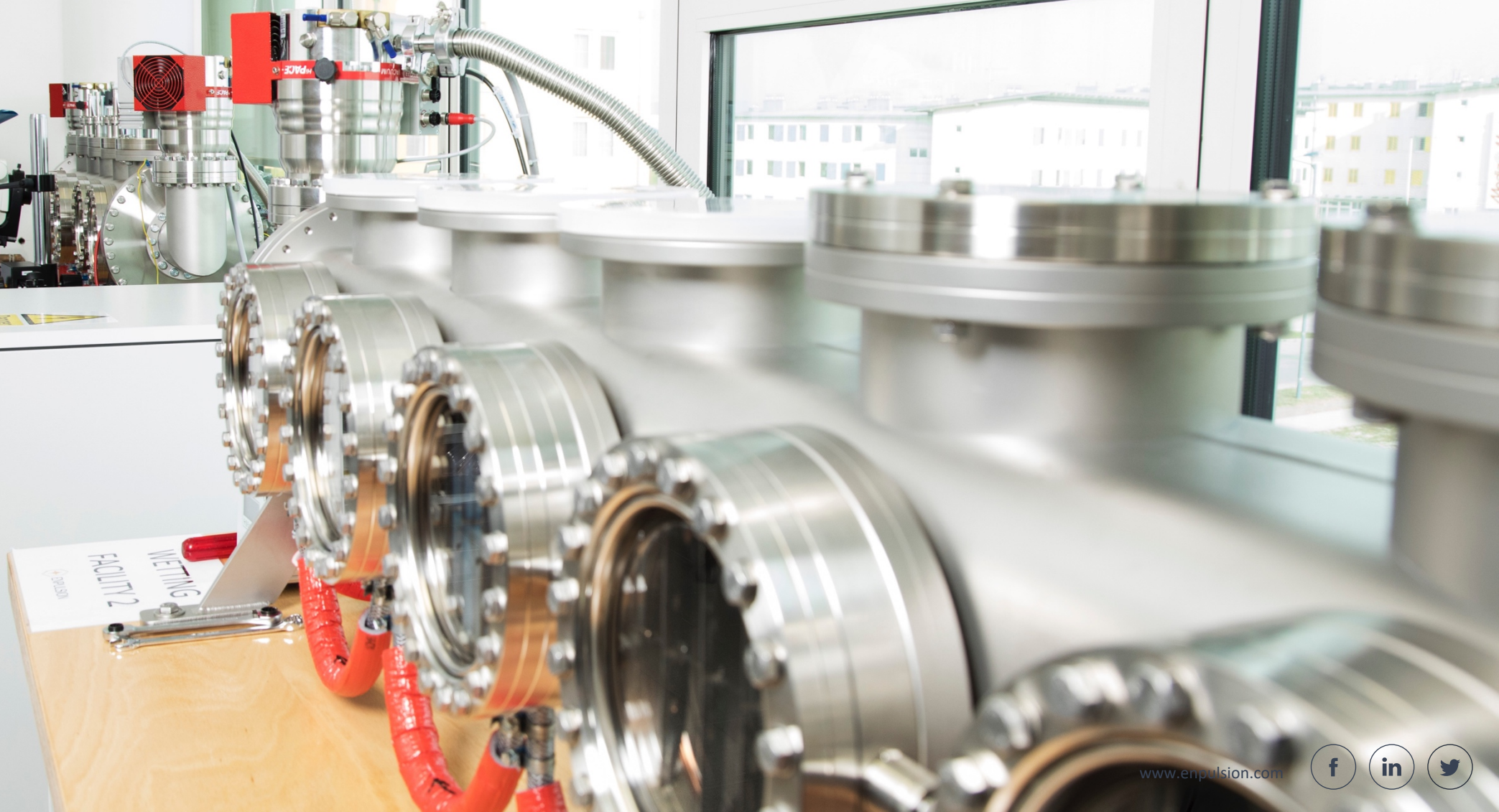
No Pressure

Non-Toxic



ENPULSION

- **100% INCOMING INSPECTION OF ALL MECHANICAL PARTS**
- **100% TRACEABILITY OF ALL PARTS, MANUFACTURING AND TESTING**
- **LEAN PRODUCTION (KANBAN) FOR HIGH THROUGHPUT**
- **BATCH TESTING ON PART, COMPONENT AND SYSTEM-LEVEL**



ENPULSION
WETTING
PHASE 2

- **100% Testing: Every emitter fired 2x**
- **Batch testing to increase throughput**



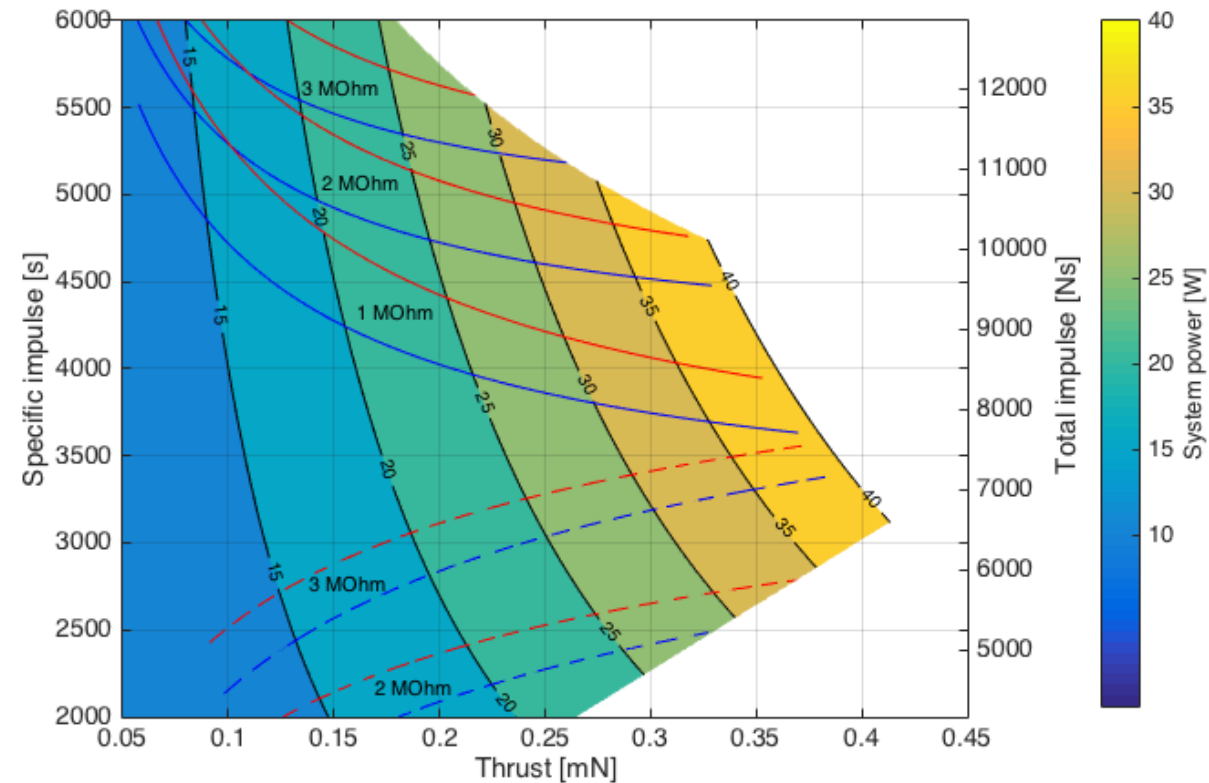
ESA performance mapping

ESA thrust
balance

2 identical
thrusters

2 thrusters with low impedance emitters were selected

- Allow to maximize thrust at low power
- Do not allow to reach $I_{sp} > 4000s$

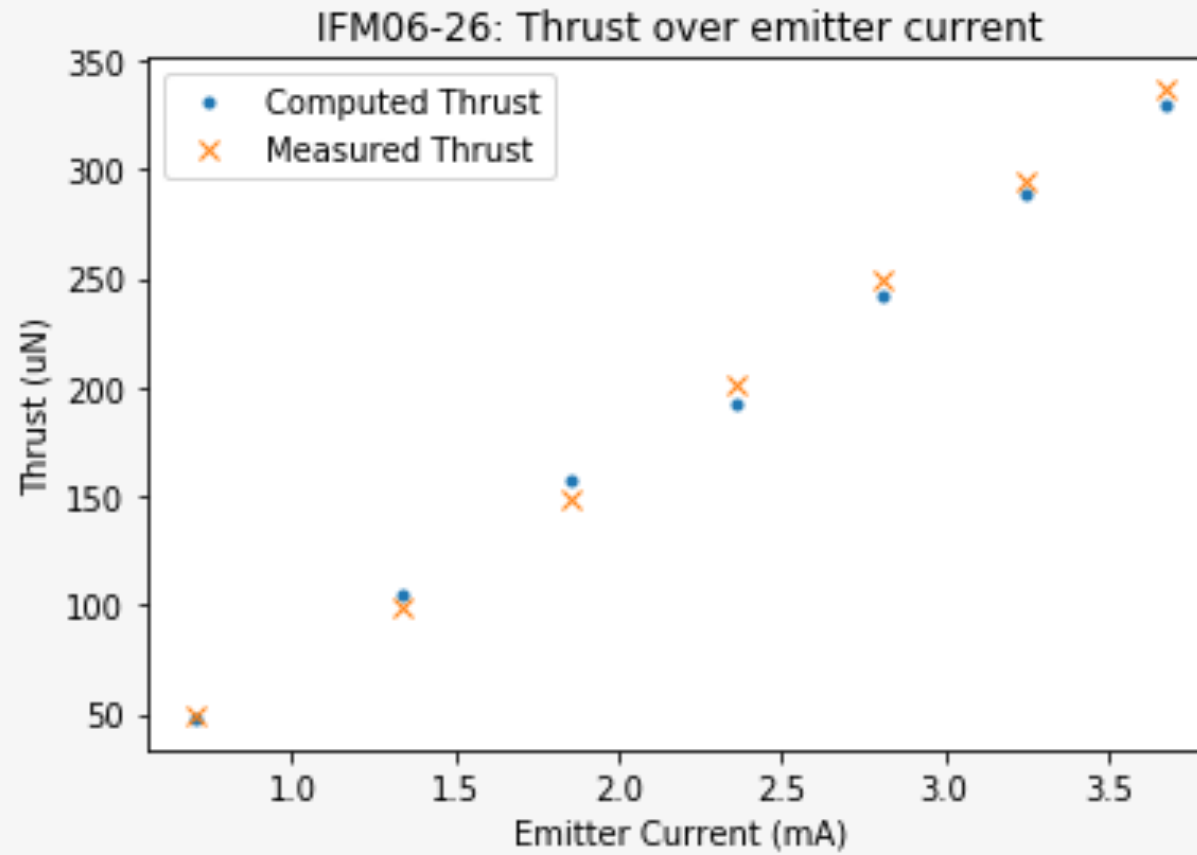


ESA thrust
balance

2 identical
thrusters

thrusters
with low
impedance
emitters
were
selected

Verification of thrust telemetry with direct thrust balance measurements

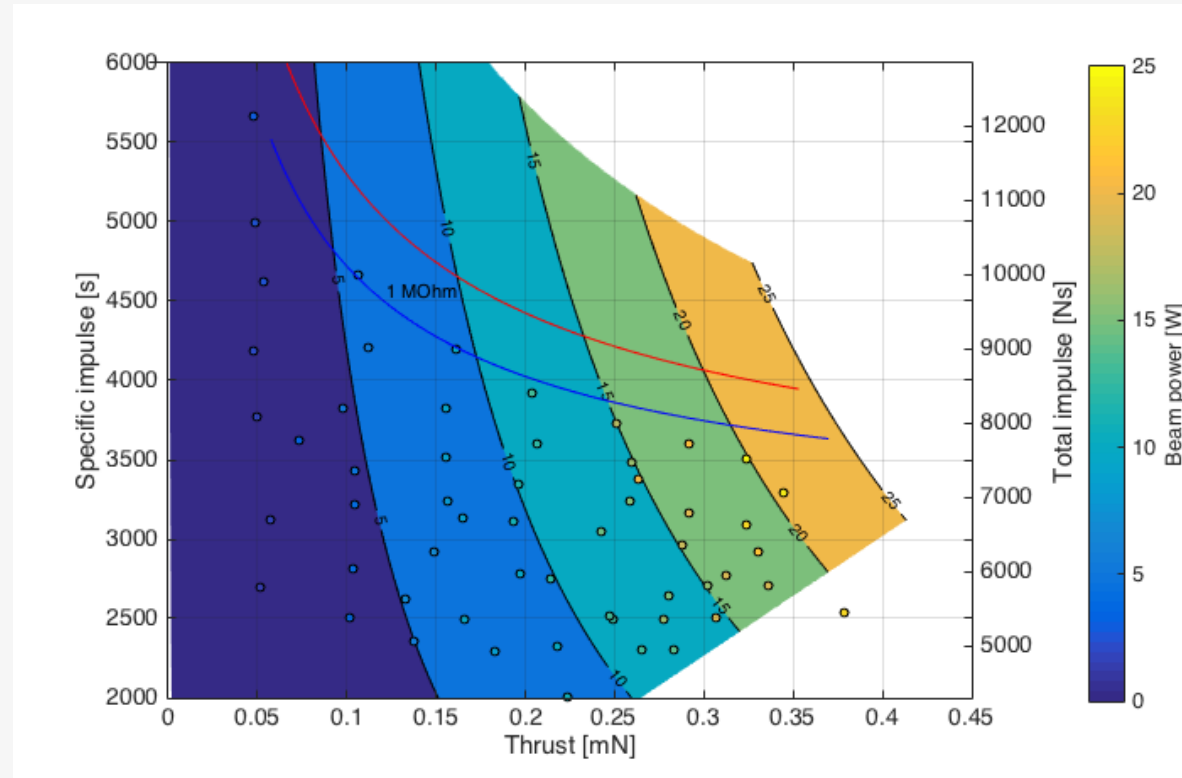


From: Krejci et al: Full Performance Mapping of the IFM Nano Thruster including Direct Thrust Measurements, submitted to JoSS

ESA thrust
balance

2 identical
thrusters

2 thrusters with low impedance emitters were selected for testing

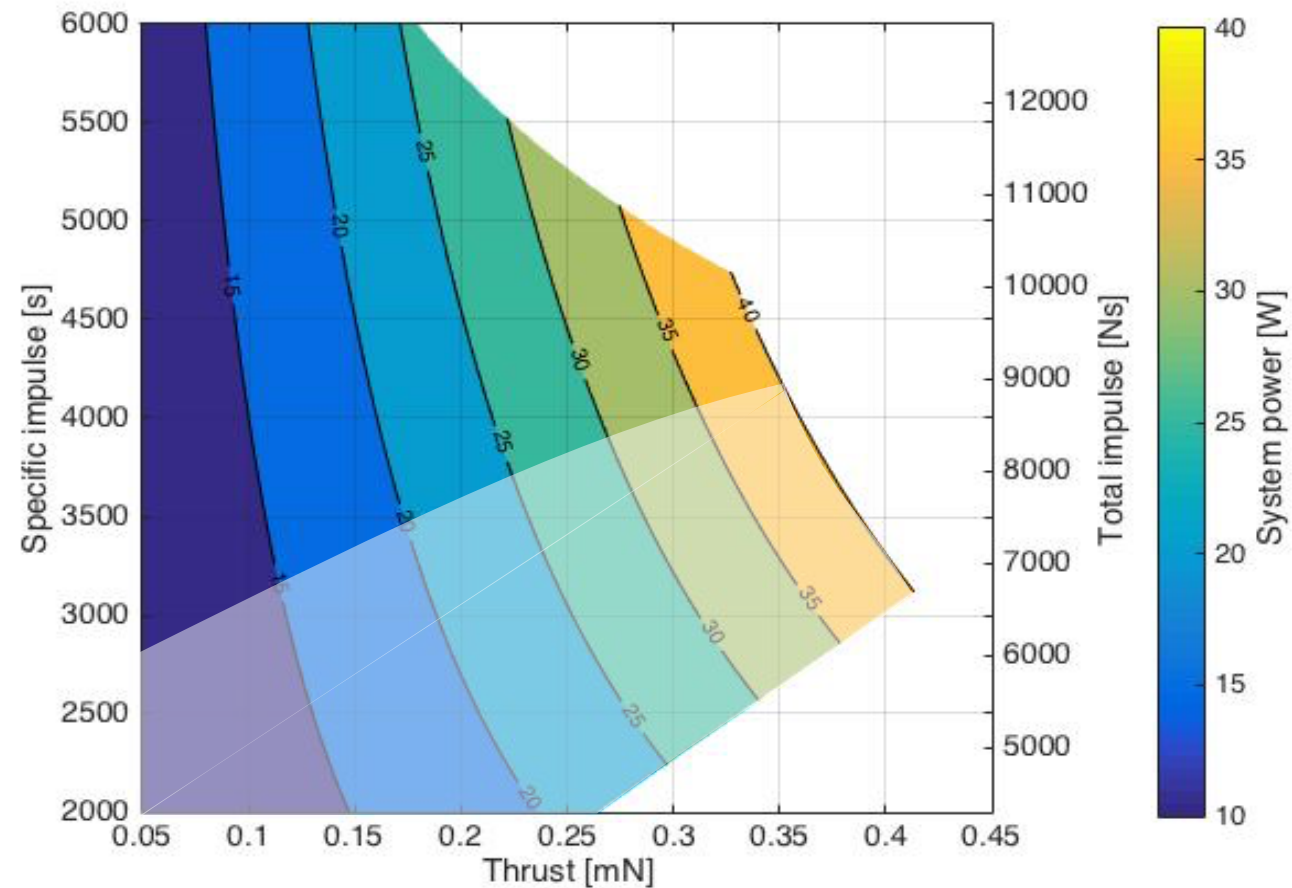


From: Krejci et al: Full Performance Mapping of the IFM Nano Thruster including Direct Thrust Measurements, submitted to JoSS

High Δv optimized thrusters

High emitter impedance selection optimized for high delta V missions

Thrusters currently in delivery: high impedance to increase total impulse

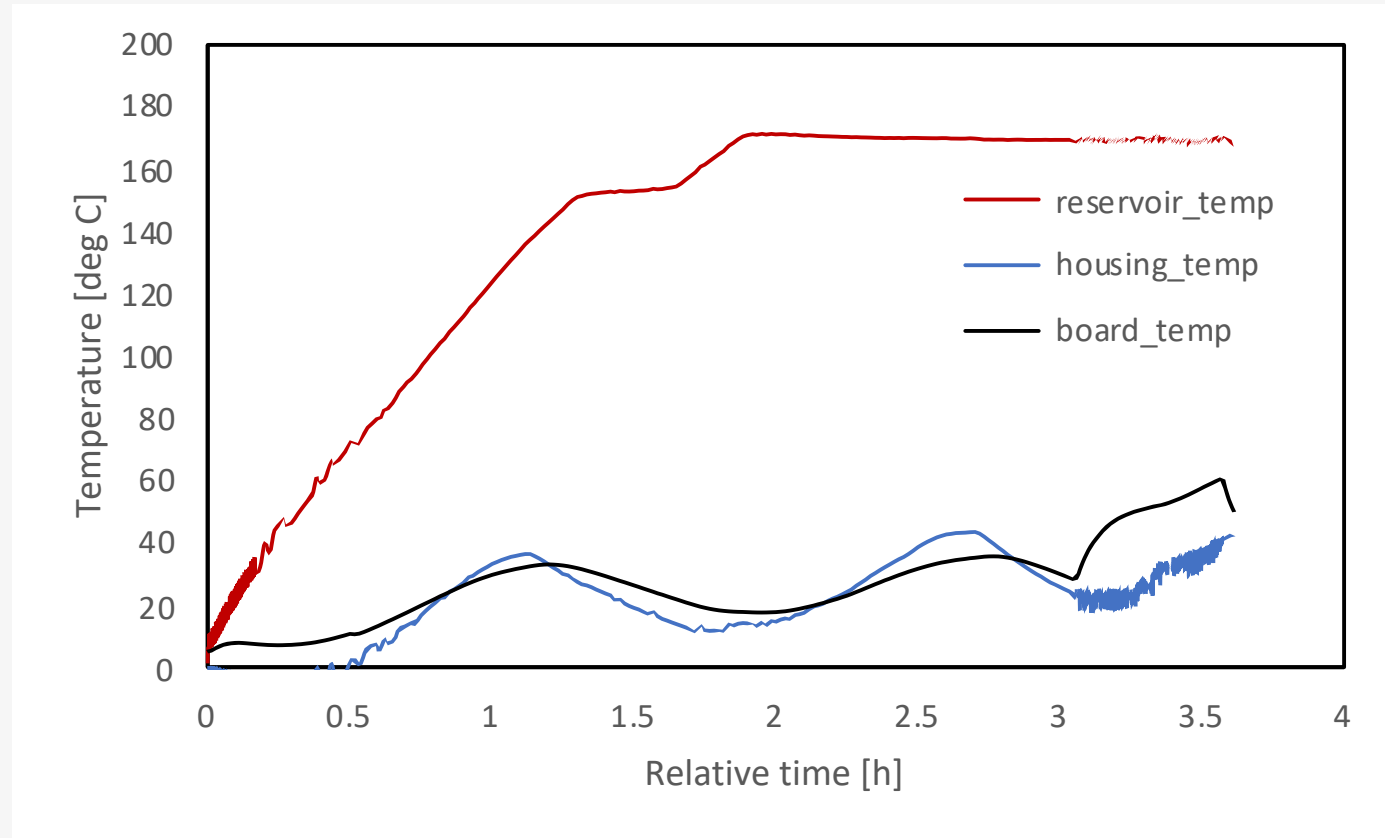


Latest inorbit data

3U Cubesat
SSO orbit

After full commissioning verifying all subsystems

30 mins firing



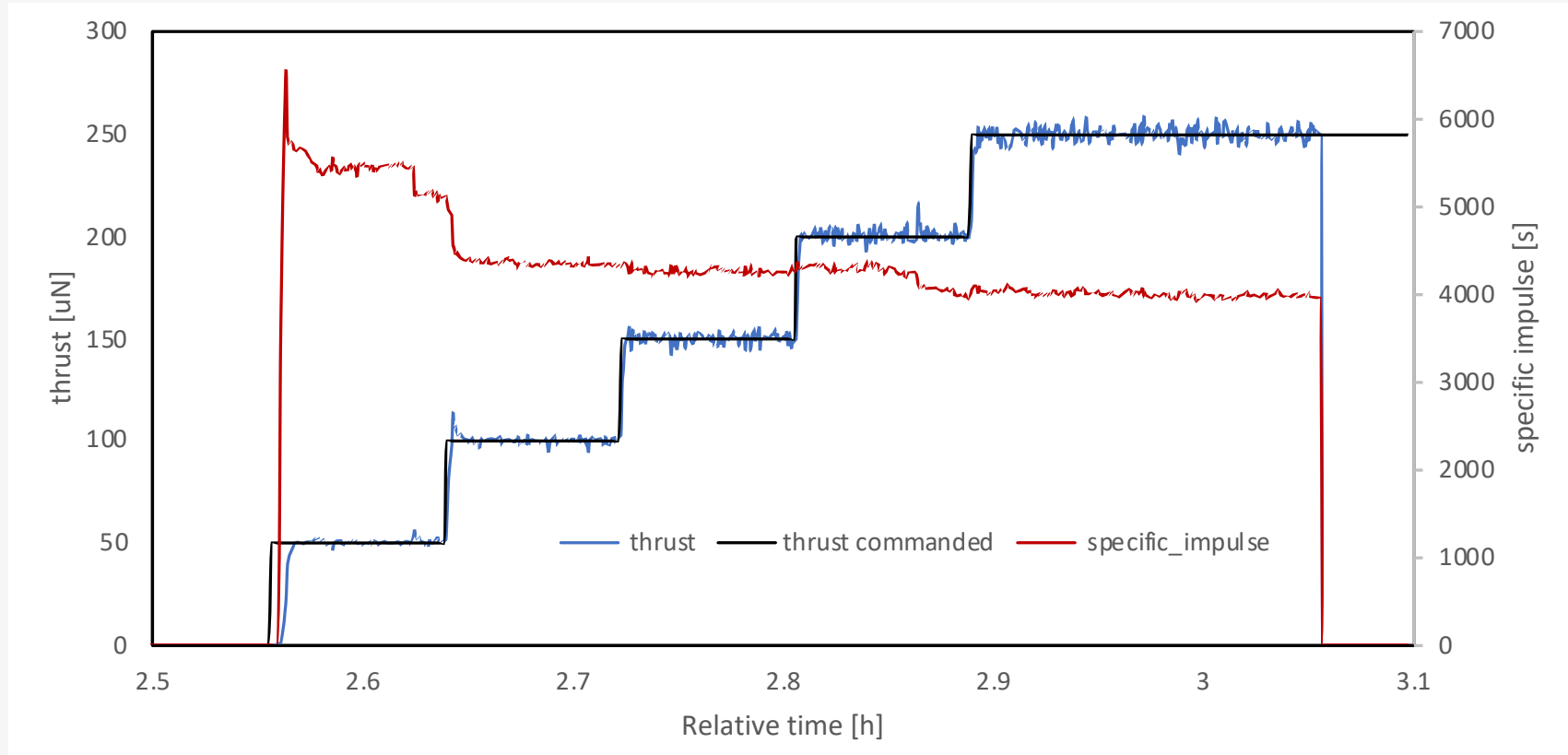
Latest inorbit data



3U Cubesat
SSO orbit

After full commissioning verifying all subsystems

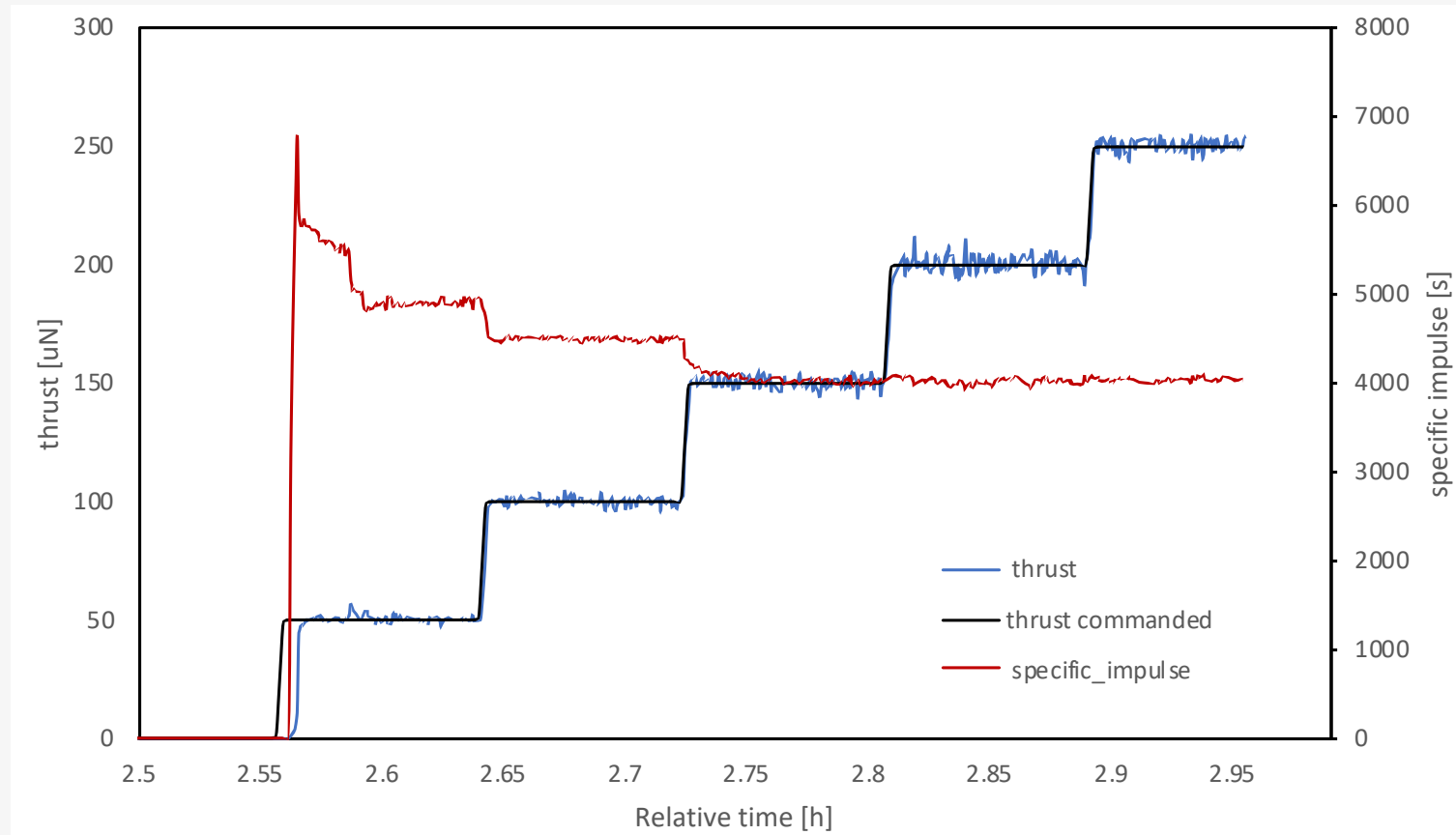
Thrust steps: uncontrolled steps



3U Cubesat SSO orbit

After full commissioning verifying all subsystems

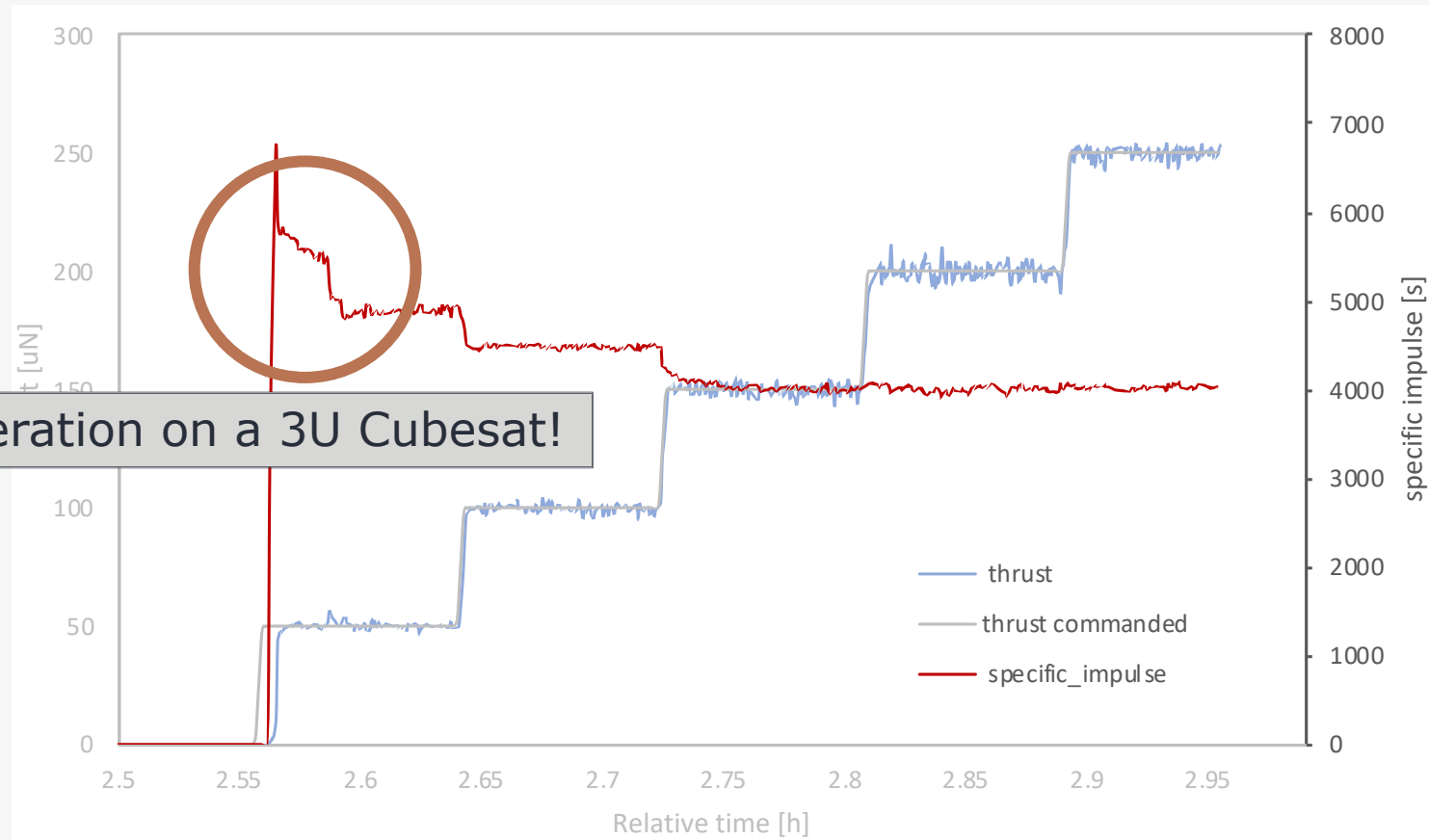
Thrust steps with controlled transients



3U Cubesat
SSO orbit

After full commissioning verifying all subsystems

Thrust steps with controlled transients



>5000s Isp operation on a 3U Cubesat!

Conclusion



High rate

Multiple thrusters per week shipped to customers, enabled by standardization and batch testing

Independently verified performance envelope

Performance mapping at ESA thrust facility provided additional verification of thrust models to measured thrust and showed capability to operate at any operational point within the performance envelope

In-orbit verification

Double digit number of thrusters in space now, firing tests presented show good controllability of thrust

Record-setting

Operation at >5000s impulse on a 3U Cubesat

IFM06-SER 33



ENPULSION

SPACECRAFT TECHNOLOGY