FEEP | FIELD EMISSION
ELECTRIC PROPULSION

ENPULSION NANO R³

as of Mai 2022

The **ENPULSION NANO R³** is the next-generation FEEP (Field Emission Electric Propulsion) system based on the flight-proven success story that is the ENPULSION NANO (formerly IFM Nano Thruster). Incorporation of lessons learned from a large number of acceptance test campaigns and *in-orbit performance verifications* led into an *updated electronics design, thermostructural concept, and software functionality.* The resulting product — the ENPULSION NANO R³ — features *increased reliability, radiation tolerance,* and *environmental resilience.*

RAD-TOLERANT ELECTRONICS

All EEE components of the ENPULSION NANO R³ are procured in **lot-controlled batches**. Selected sets of these batches are subjected to radiation testing, so that each thruster can be traced back to a fully representative qualification model. EEE components were selected and integrated to be more tolerant to TID and SEE.

FLIGHT HERITAGE

The ENPULSION NANO R³ is an updated version of the space proven ENPULSION NANO **with more than 100 units in space.*** It is directly building on its heritage, leveraging the proven design and the component selection.

PROTECTIVE CASING

The thruster is assembled into a protective casing that **shields the electronics** from the hazardous space radiation environment, that **facilitates handling** during integration, and allows **side mounting.**

VERSATILE PERFORMANCE

Thrust can be controlled through the electrode voltages, providing **excellent controllability** over the full thrust range and a low thrust noise. Due to the efficient ionization process, the ENPULSION NANO R³ can provide a higher specific impulse than any other ion propulsion system currently on the market.

SAFE AND INERT SYSTEM

The ENPULSION NANO R³ contains **no moving parts** and the indium propellant is in its solid state at room temperature. Avoiding any liquid and reactive propellants as well as pressurized tanks significantly simplifies handling, integration, and launch procedures.

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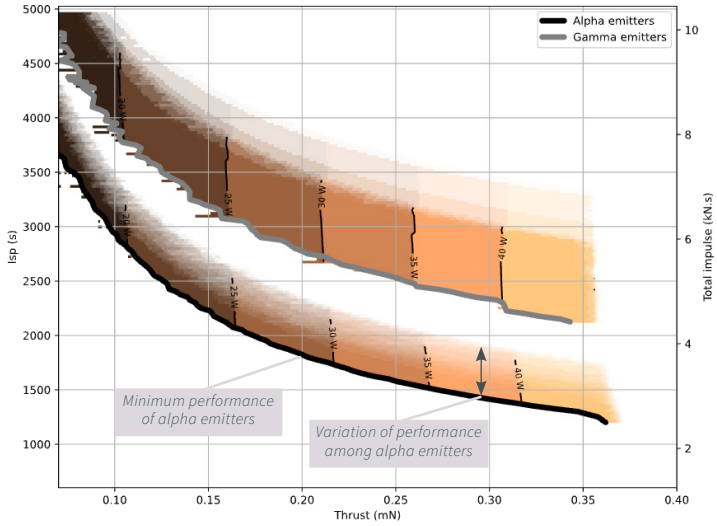
ENPULSION

NANO R³

PROPERTIES AND PERFORMANCE

While the required power to operate the **ENPULSION NANO R³** starts at around 15 W, at higher thrust levels one can choose between high-thrust and high-specific-impulse operation. The ENPULSION NANO R³ can operate at an I_{sp} range of 1500 to 5000 s.

At any given thrust point, higher I_{sp} operation will increase the total impulse, while it will also increase the power demand. The thruster can be operated along the full dynamic range throughout the mission. This means that high I_{sp} and low I_{sp} maneuvers can be included in a mission planning, as well as high-thrust orbit maneuvers and low-thrust precision control maneuvers.



Depending on available power the user can choose from any operational point—data shown is for 12 V configuration

DYNAMIC THRUST RANGE:[1]	10–350 µN
NOMINAL THRUST:	350 µN
SPECIFIC IMPULSE:	1500–5000 s
PROPELLANT MASS:	220 g ±5%
TOTAL IMPULSE:[2]	MORE THAN 4000 Ns
POWER AT NOMINAL THRUST:	45 W INCL. NEUTRALIZER
OUTSIDE DIMENSIONS:	98.0 × 99.0 × 95.3 mm
MASS (DRY/WET):	1180 g (DRY)/<1400 g (WET)
TOTAL SYSTEM POWER:	15–45 W
HOT STANDBY POWER:[3]	4–7 W
COMMAND INTERFACE:	RS422/RS485
SUPPLY VOLTAGE: (OTHER VOLTAGES UPON REQUEST)	12 V, 28 V

Since the founding of the company in 2016 we have delivered to customers *hundreds of thrusters, more than 100 of which are currently in space.* We have, therefore, developed an empirical understanding of the intrinsic variation of the performance and parameters of emitters in these thrusters in their production process and in their application in different types of missions. This enables us, starting from January 1st, 2022, to offer you our new **Emitter Selection Service** which allows you to select between *three distinct types of crown emitters:*

- ▷ **Alpha (α) emitters** provide the best balance between price, performance, and guaranteed delivery times. This is the perfect solution for commercial constellation applications.
- ▷ **Beta (β) emitters** are the best solution whenever cost optimization is the most important driver.
- ▷ **Gamma (γ) emitters** are hand-picked for their guaranteed peak performance and especially appropriate for your missions in deep space, exploration, and others where emitter output needs to be taken to extremes.

1 *The ENPULSION NANO R³ can be operated at a wide range of thrust and specific impulse, depending on the power level available. The operational envelope is based on total system power including typical heater and neutralizers consumption. Performances shown above correspond to maximum thrust to power curves for different grades of emitters.*

2 *Strongly depends on emitter option. See performance map for selection options.*

3 *Depends on accommodation and resulting thermal environment.*