IFM NANO THRUSTER

For **15 years**, FOTEC has followed a **technology push from ESA** developing a FEEP propulsion technology for a precise orbit control of scientific satellites in formation flight. This very mature and worldwide unique technology is meeting a **strong need in an emerging market of satellite constellations** (hundreds of small satellites performing a task together). ENPULSION has been founded as a Spin-Out together with FOTEC to meet this market demand by preparing to scale the production of this thruster to several hundred units per year.

FLIGHT HERITAGE

The IFM Nano Thruster was successfully tested in orbit on a customer spacecraft in early 2018, performing independently confirmed orbit changes.

DYNAMIC PRECISE THRUST CONTROL

The thrust can be controlled through the electrode voltages, providing excellent controllability over the full thrust range and a low thrust noise.

MATURE TECHNOLOGY

The IFM Nano Thruster is a mature technology, developed under ESA contracts for 15 years. In this time more than 100 emitter have been tested and an ongoing lifetime test has demonstrated more than 20,000 h of firing without degradation of the emitter performance.

CONTROLLABLE SPECIFIC IMPULSE UP TO 6,000 S

Due to the efficient ionization process, which allows the capacity to ionize up to 60% of the evaporated indium atoms, the IFM Nano Thruster can provide a higher specific impulse than any other ion propulsion system currently on the market.

SAFE AND INERT SYSTEM COMPLIANT DURING LAUNCH

The IFM Nano Thruster contains no moving parts and the 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.

REDUNDANT NEUTRALIZER CATHODES

As the IFM Nano Thruster expels an ion current of up to 4 mA, the module needs means to prevent spacecraft charging. This is achieved by the use of two cold-redundant electron sources acting as neutralizers. Once electrons have left the neutralizer, they will be pulled towards the positive potential of the ion plume. The PPU is able to measure and control this charge balancing electron current.

COMPACT BUILDING BLOCKS

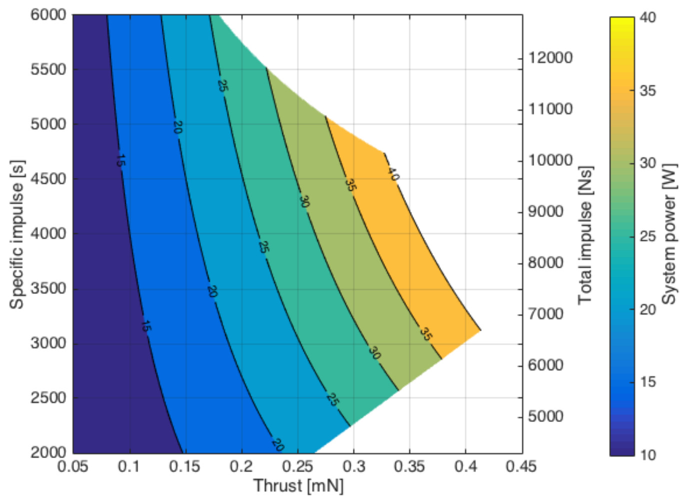
The IFM Nano Thruster module is used as a compact pre-qualified building block in order to provide custom solutions at a commodity price and ultra-short lead times. Although building blocks are completely self-contained propulsion systems, the whole cluster can be operated as a single plug-and-play unit.

PROPERTIES AND PERFORMANCE

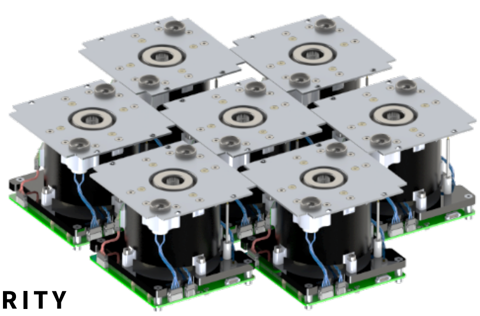
While the required power to operate the IFM Nano Thruster starts at around 8 W, at higher thrust levels one can choose between high thrust and high specific impulse operation. The IFM Nano Thruster can operate at an I_{sp} range of 2,000 to 6,000 s.

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 maneuver and low thrust precision control maneuvers.

DYNAMIC THRUST RANGE	10 µN TO 0.4 mN
NOMINAL THRUST	350 µN
SPECIFIC IMPULSE	2,000 TO 6,000 s
PROPELLANT MASS	230 g
TOTAL IMPULSE	MORE THAN 5,000 Ns
POWER AT NOMINAL THRUST	40 W INCL. NEUTRALIZER
OUTSIDE DIMENSIONS	100.0 x 100.0 x 82.5 mm
MASS (DRY / WET)	670 / 900 g
TOTAL SYSTEM POWER	8 – 40 W
HOT STANDBY POWER	3.5 W
COMMAND INTERFACE	RS422/RS485
TEMPERATURE ENVELOPE (NON-OPERATIONAL)	-40 TO 105°C
TEMPERATURE ENVELOPE (OPERATIONAL)	-20 TO 40 °C
SUPPLY VOLTAGE	12 V, 28 V, OTHER VOLTAGES UPON REQUEST



Depending on available power, the user can choose from any operational point - data shown corresponds to 12 V configuration



MODULARITY

The IFM Nano Thruster can be clustered in order to **meet any specific mission need**. As we are using a number of pre-qualified modules (building blocks), this customization can be done **without increasing the cost or lead times of the thruster.**

Number of Modules	1	2	3	4	5	6	7
Total Impulse	> 5 000 Ns	>10 000 Ns	> 15 000 Ns	>20 000 Ns	>25 000 Ns	> 30 000 Ns	>35 000 Ns
System Mass (wet)	1 kg	2* kg	3* kg	4* kg	5* kg	6* kg	7* kg
System volume	0.8 dm³	1.6 dm³	2.4 dm³	3.2 dm³	4 dm³	4.8 dm³	5.6 dm³

*Additional mass for brackets of housing might be necessary depending on the accommodation of the thruster modules on the spacecraft

Δv [m/s]

Spacecraft Mass [kg]							
3	2204						
5	1442	2540	3404	4103			
10	773	1442	2026	2540	2996	3404	3771
15	528	1007	1442	1839	2204	2540	2850
20	401	773	1119	1442	1743	2026	2291
30	271	528	773	1007	1229	1442	1645
40	204	401	591	773	949	1119	1283
50	164	323	478	628	773	915	1052
70	118	233	346	456	564	670	773
100	83	164	244	323	401	478	553
150	55	110	164	218	271	323	375
200	42	83	124	164	204	244	284