



# LET'S MAKE SATELLITES DANCE!

**Elena Toson**

2020 Cubesat Developers Workshop

## OUR COMPANY

T4i is born in 2014 as a Spin-Off of the University of Padua.

In T4i we develop innovative propulsion systems to serve small satellite platforms, to open unexplored form of mobility to small satellites and unlimited windows to access space.

We are now 20 employees

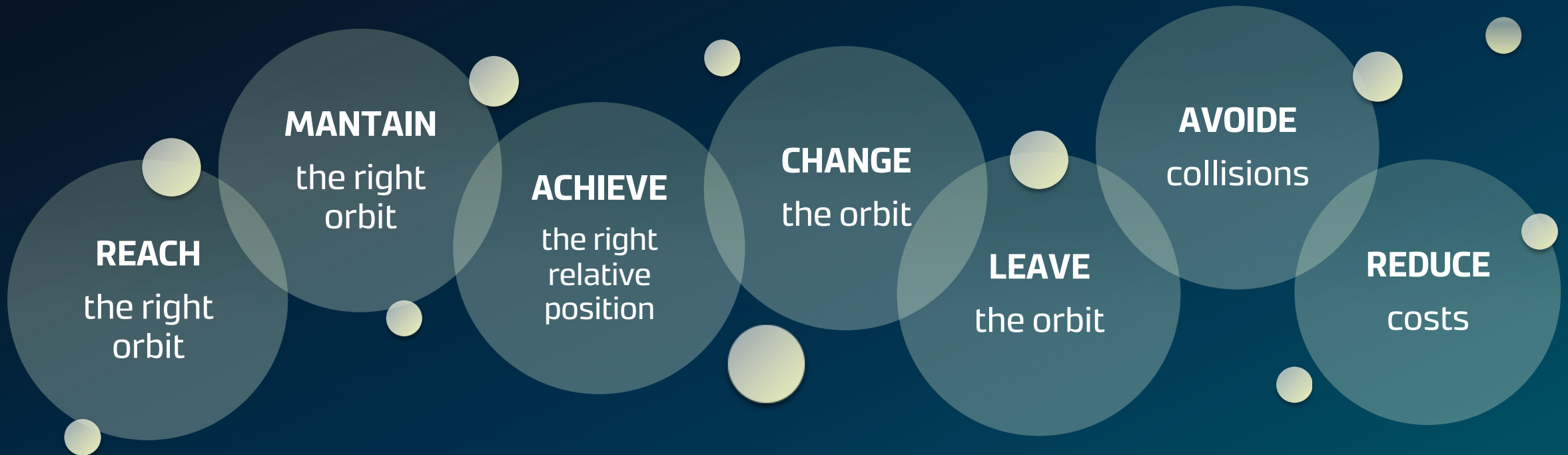
We have 1 international patent application and more solutions under patenting

Our First product, REGULUS, is scheduled for space qualification in Q3 2020

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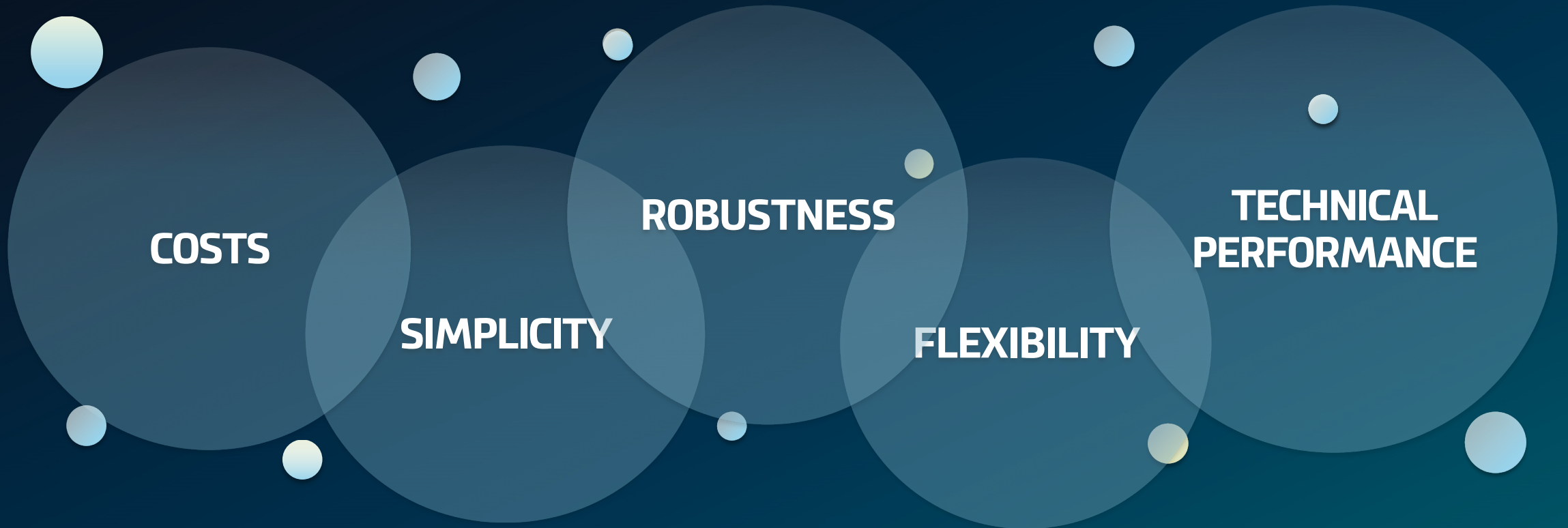
## 2. MICRO/SMALL SATELLITES NEEDS

### FUTURE SMALL-MICRO SATELLITES HAVE TO BE ABLE TO



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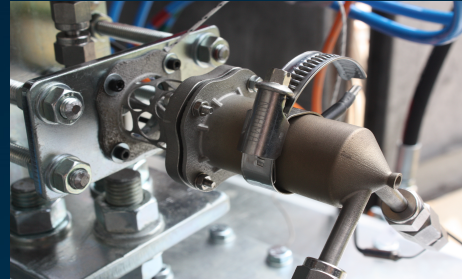
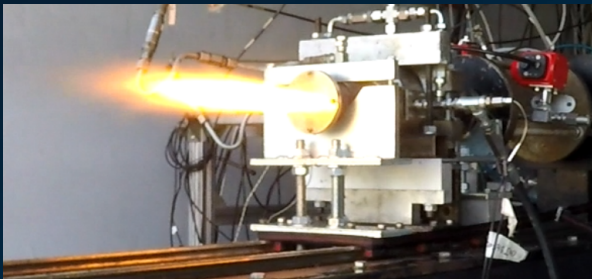
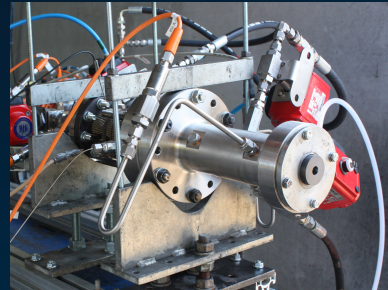
### OUR SOLUTIONS ARE THE BEST COMPROMISE BETWEEN



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### A SET OF INNOVATIVE PRODUCTS TO COPE WITH MOBILITY NEEDS OF MICROSATELLITES



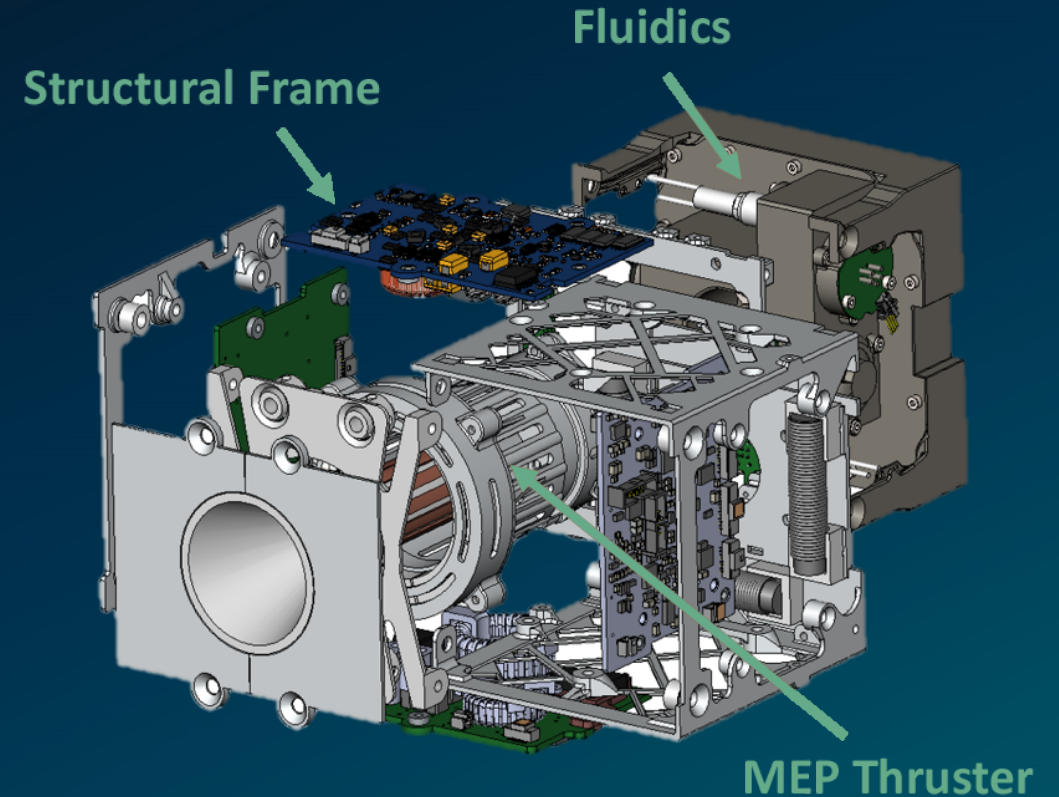
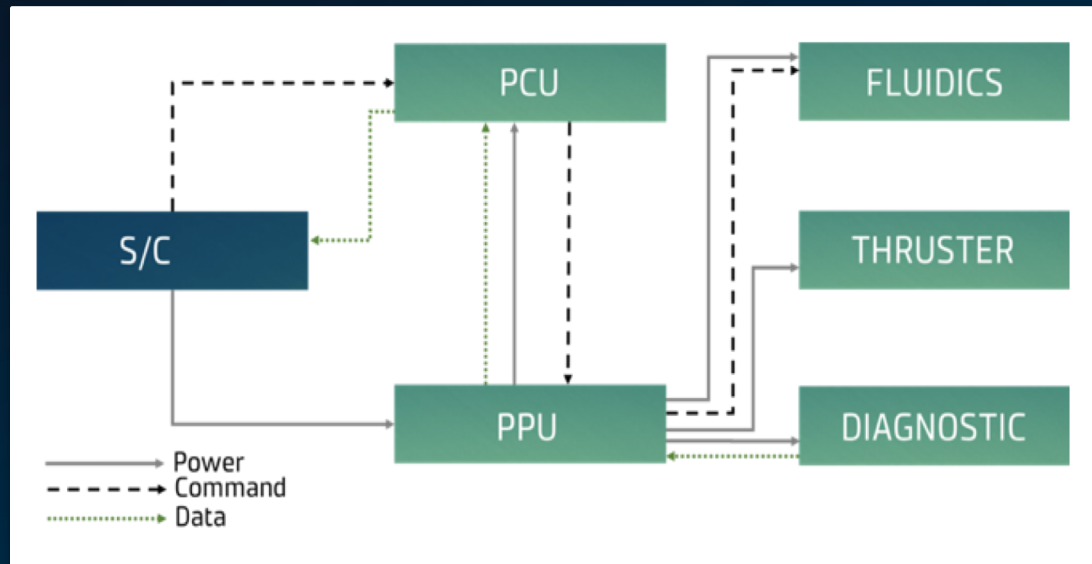
- EP complete systems based on RF plasma thrusters
- Cold gas different degrees of freedom
- Hydrogen Peroxide mono propellant 1 - 300 N
- Hydrogen Peroxide bi propellant 10 - 300 N
- Hydrogen Peroxide-Paraffin Hybrid rockets up to 10kN

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# 5. REGULUS EP SYSTEM

REGULUS is a “Plug & Play” Electric Propulsion system fed with iodine propellant, that integrates:

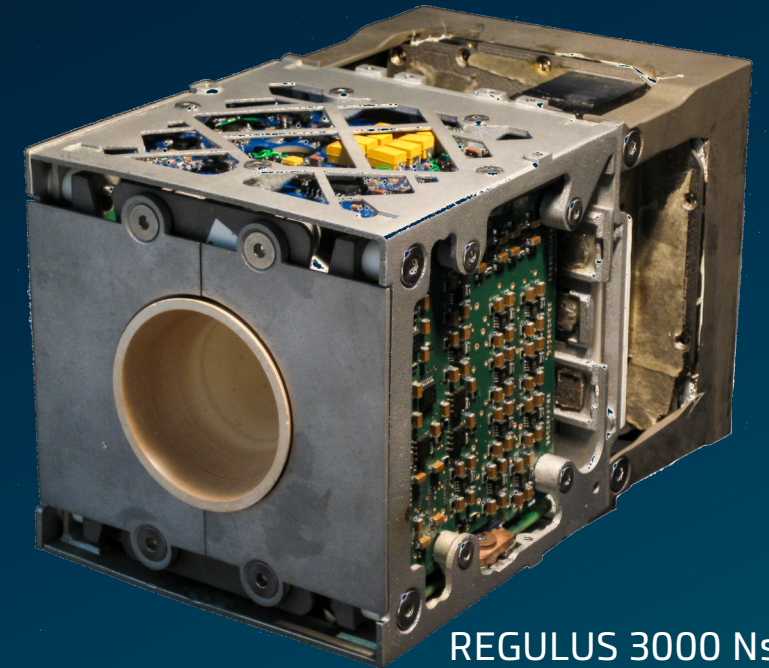
- Magnetically Enhanced Plasma Thruster
- Electronics
- Fluidic line
- Thermo-structural subsystem



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## 6. REGULUS EP SYSTEM

Thrust	0.25 – 0.65mN (0.55mN @ 50W)
Specific Impulse	Up to 650s (550s @ 50W)
Total Impulse	3000-11000 Ns (up to allowed tank size)
Required power	20 - 60W (50W nominal)
Mass flow	0.1 mg/s
Propellant	Solid Iodine (I <sub>2</sub> )
Volume	93.8 x 95.0 x 150.0 mm @ 3000 Ns 93.8 x 95.0 x 200.0 mm @ 11000 Ns
Weight	2.5 kg @ 3000 Ns
Electrical interfaces	12 Vdc regulated
Data interfaces	CAN BUS, i2C



REGULUS 3000 Ns  
Iodine version

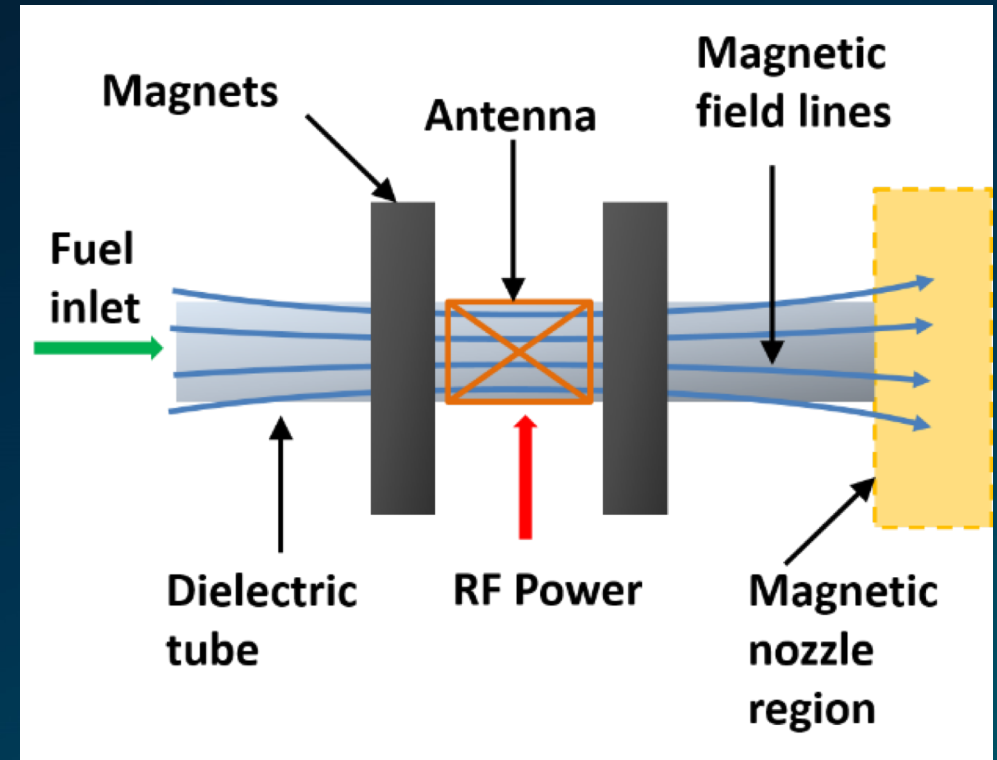
**NO ELECTRODES - NO GRIDS - NO NEUTRALIZER  
THUS NO ELEMENTS SUBJECTED TO EROSION**

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# 7. REGULUS MAGNETICALLY ENHANCED PLASMA THRUSTER

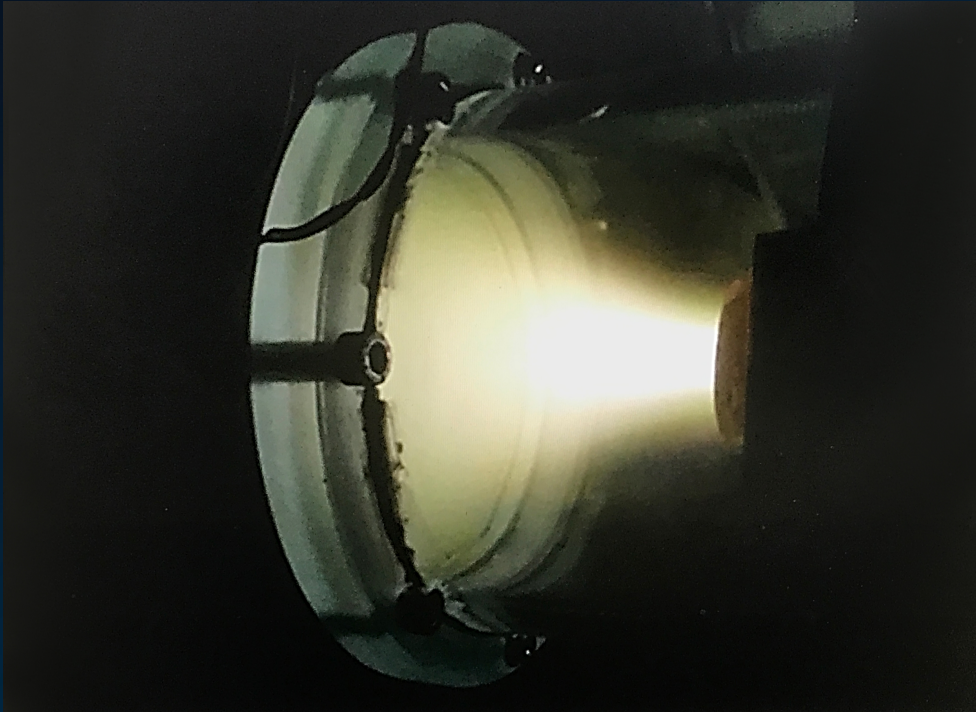
Main components of the MEPT:

- **Dielectric tube** inside which the gas is ionized
- **RF antenna** which creates the plasma
- **Permanent magnets** radially polarized which generate the magnetostatic field for plasma confinement and acceleration





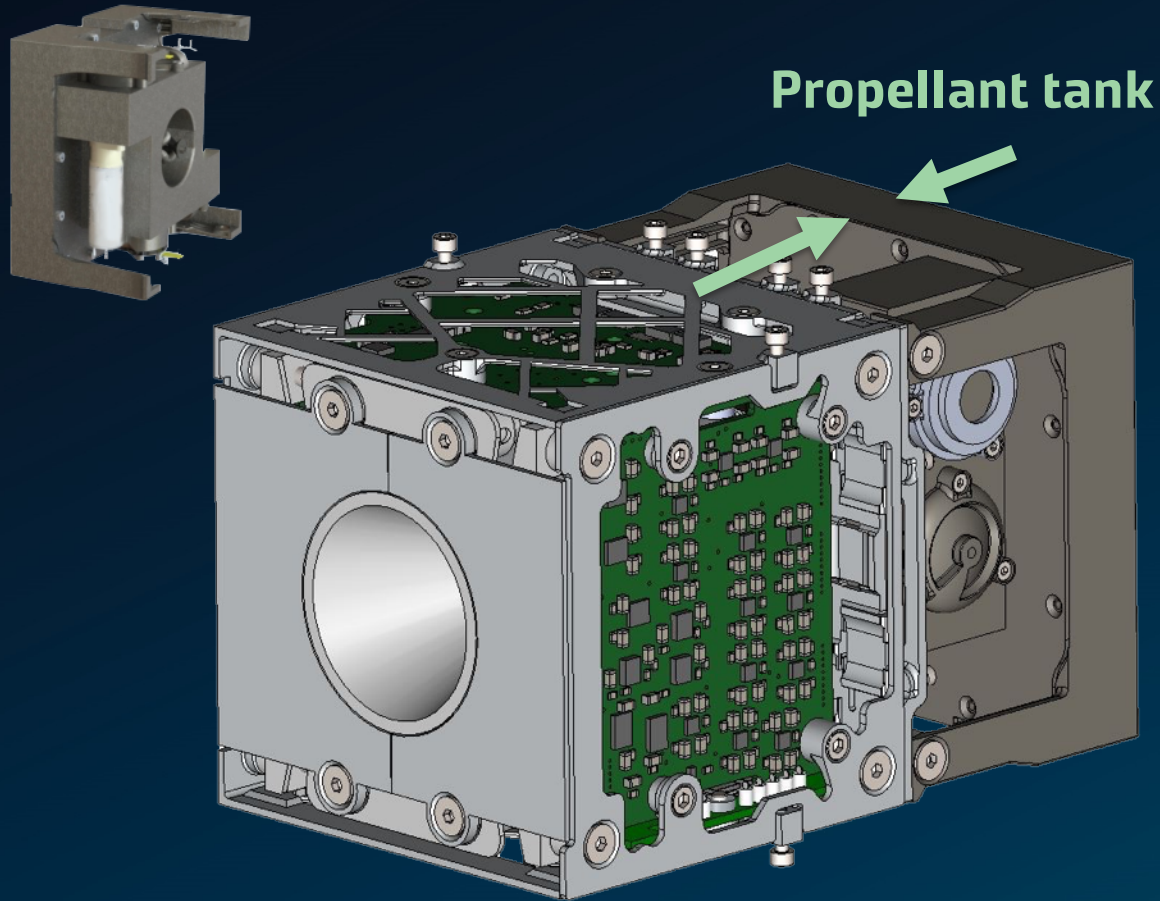
## 8. REGULUS MAGNETICALLY ENHANCED PLASMA THRUSTER



- No electrodes in contact with the plasma
- No neutralizers
- No erosion
- Highly versatile
- Simple geometry
- Multiple gases
- Patented technology

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## 9. REGULUS IODINE FEED LINE



Iodine propellant offers many **advantages**:

- Iodine stored at solid state
- Higher total impulse achievable
- 2x Volume reduction with respect to Xenon
- No pressurized tank (Xenon supercritical state @ 150 bar)
- FM integration on the satellite platform with propellant onboard
- Transportation of the satellite to the launch site with propellant onboard
- Entire system shipped to the launcher ready for use
- 90% less expensive than Xenon

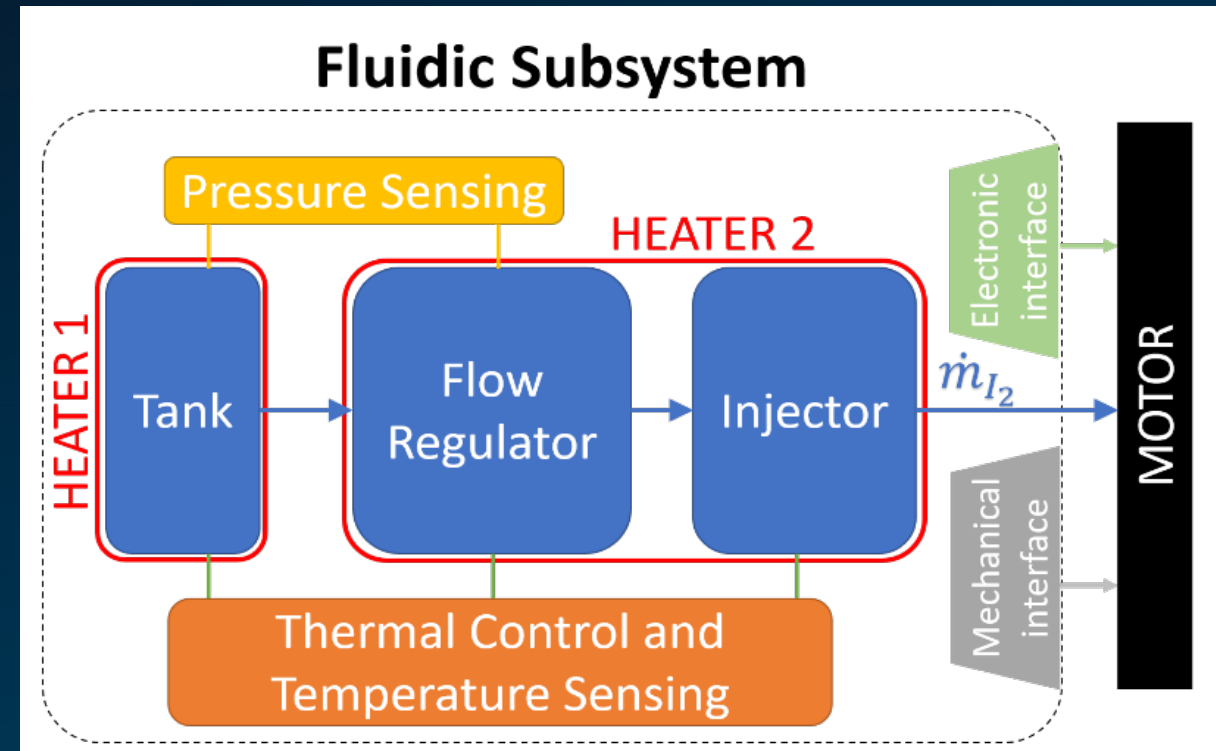
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# 10. REGULUS IODINE FEED LINE

Principal features of the fluidic line:

- Iodine mass flow rate delivered to MEPT equal to **0.1 mg/s,  $\pm$  5%**
- Size of the **tank** can be **varied** without changing the rest of the fluidic line



# 11. REGULUS DEVELOPMENT HISTORY

**80.000 HOURS OF DEVELOPMENTS, 20.000 HOURS OF TESTING, 7 DIFFERENT MODELS**



2006  
2008

First  
Experiment



2008  
2012

First  
Prototype



2012  
2015

Go to High  
Power



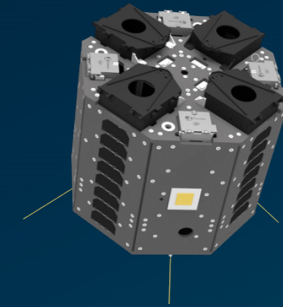
2015  
2019

REGULUS  
complete EP system  
development



2020

REGULUS  
Flight



New REGULUS  
Developments!

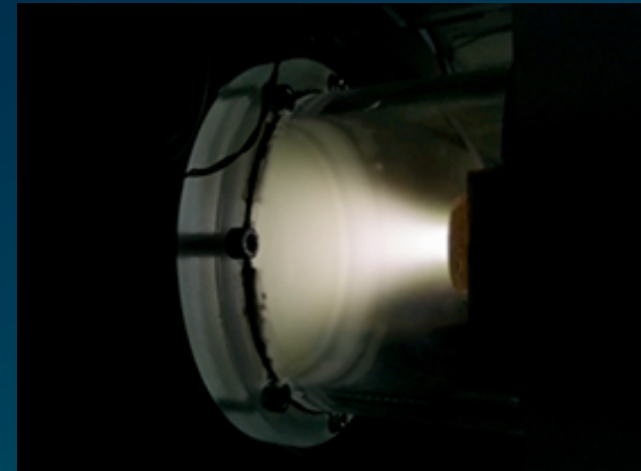
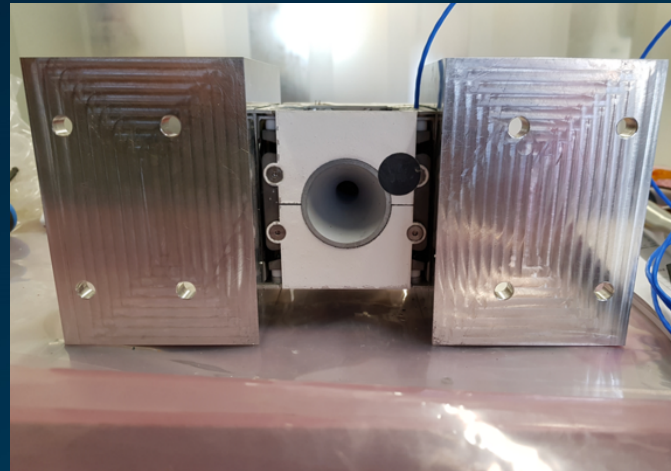
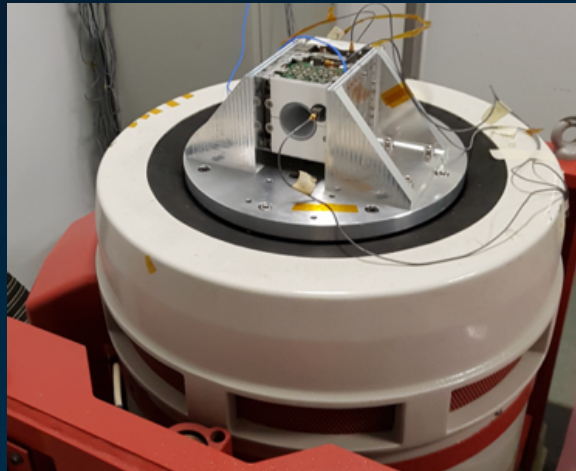
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## 12. WHAT WE ARE DOING NOW

REGULUS ended in 2019 an intensive and extended test campaign. QM was successfully tested:

- Vibrations with qualification levels at the facilities of University of Padua
- Thermal Vacuum in the T-VAC chamber designed and manufactured by T4i
- Fluidics is undergoing a test campaign both in warm and cold conditions inside our T-VAC chamber

**REGULUS will be also qualified at the facilities of the European Space Agency in 2020, integrated in a 6U Cubesat satellite.**

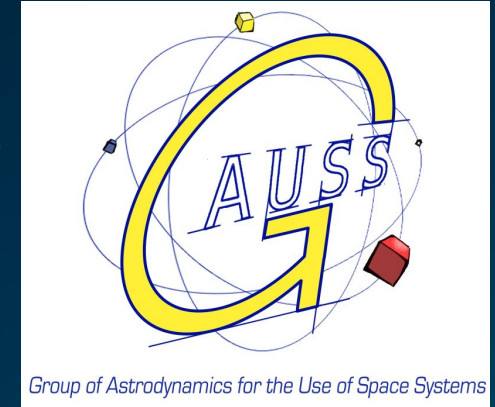
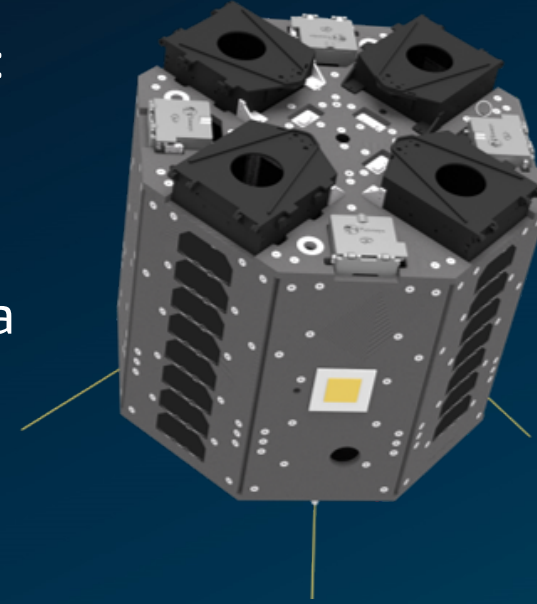


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# 13. WHAT WE ARE DOING NOW

REGULUS will perform an **In-Orbit Demonstration soon:**

- Onboard UniSat-7 cubesat carrier of GAUSS
- The launch will take place during Q2/Q3 2020 using a Soyuz-2 launch vehicle
- Orbital manoeuvres (orbit change, decommissioning, drag compensation, etc) will be performed starting from a Sun Sincronous Orbit at 500 km of height



**Moreover:** It is one of the 14 experiments selected by the European Commission for an IOD/IOV project to be launched by end 2021



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