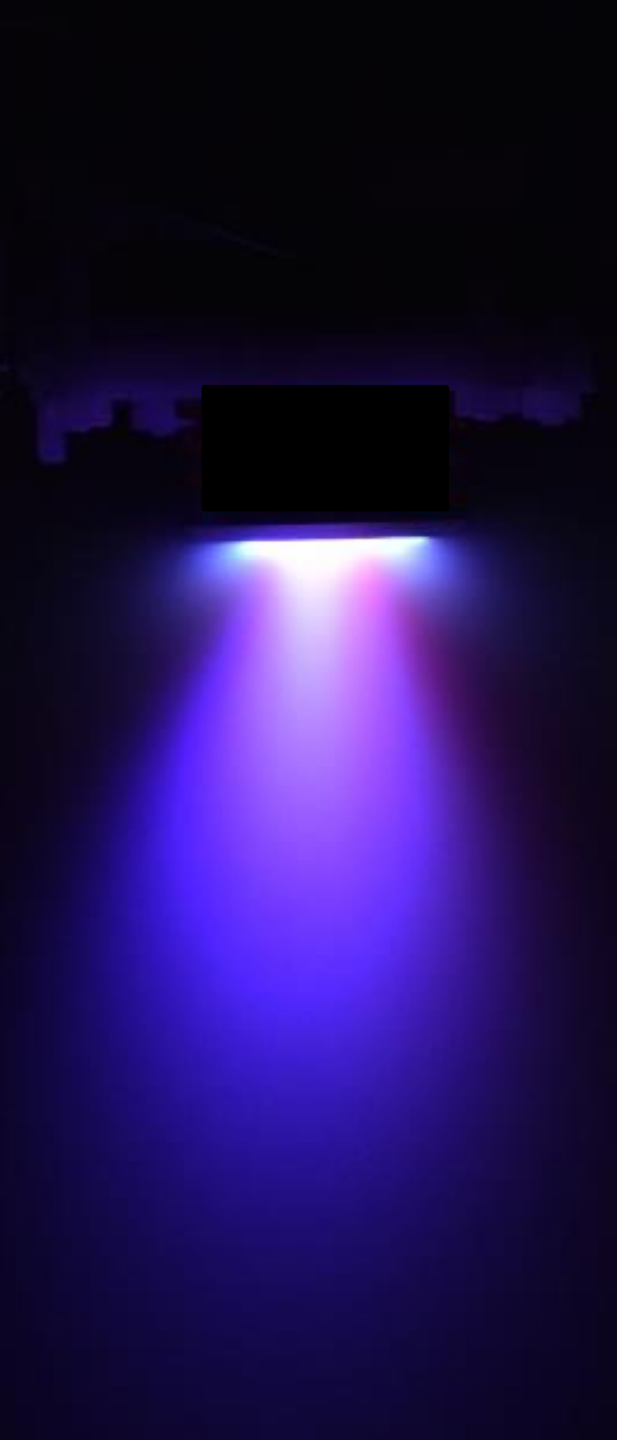
comat
GROUPE AGORA INDUSTRIES

Designer and Provider of Equipment for Space and Industry

www.comat-agora.com



Plasma Jet Pack Technology Overview

L. Herrero

25/10/2017

Our missions :

COMAT designs, manufactures, qualifies and commercializes equipment for space industry **since 1977**.

Our company initially developed its activity in the microgravity field, in particular in designing and building science equipment for manned flight. Some years ago, COMAT enlarged its know how to satellite market and particularly to space equipment such as : mechanism, propulsion, and GSE.

Our integrated offer :

COMAT is an integrated company with the ability to deliver a global offer for **yours space equipment**. The 85 high skills COMAT's employees are dedicated to space activity. This organization allows us reactivity, quality (EN9100/ISO9001) and cost efficiency for equipment development. This organization laid on 3 Business Units:

- BU Space Equipment
- BU Manufacturing
- BU Integration & Services

▶ *Summary*

Summary :

- Issues/motivations
- Existing solutions
- Our proposition : Plasma Jet Pack based on vacuum arc
- Benefits
- Performances comparison
- Missions
- Conclusions

Issues/motivations :

The production cost of small satellites decreases and their performances increases => due to the miniaturization of electronics.

So more and more missions are available on small satellites :

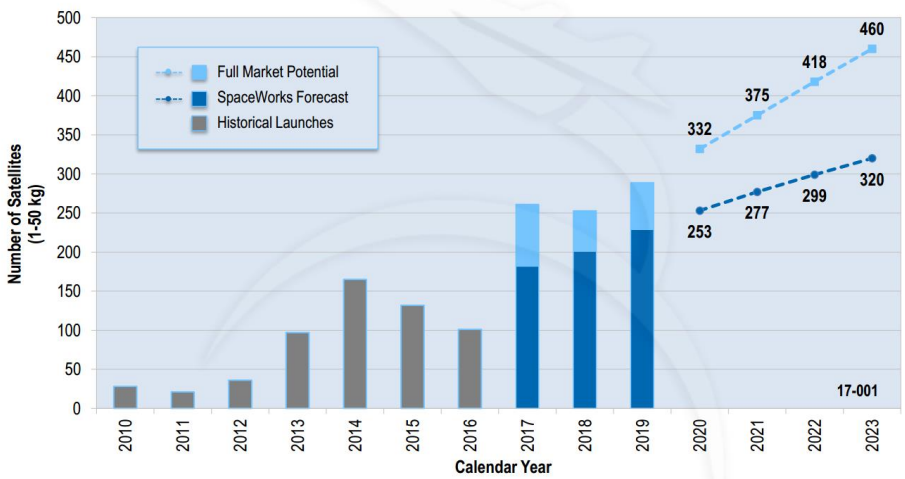
- Earth observation : planet (3U),…
- Telecommunication : OneWeb, spaceX,…

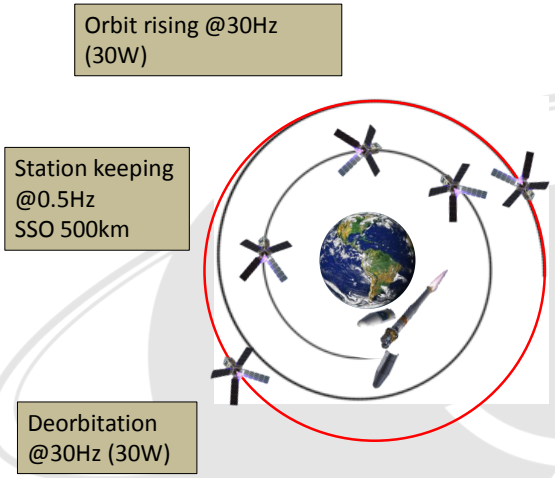
Issues/motivations :

BUT the launch cost is still important versus the cost of nanosatellite & small satellite

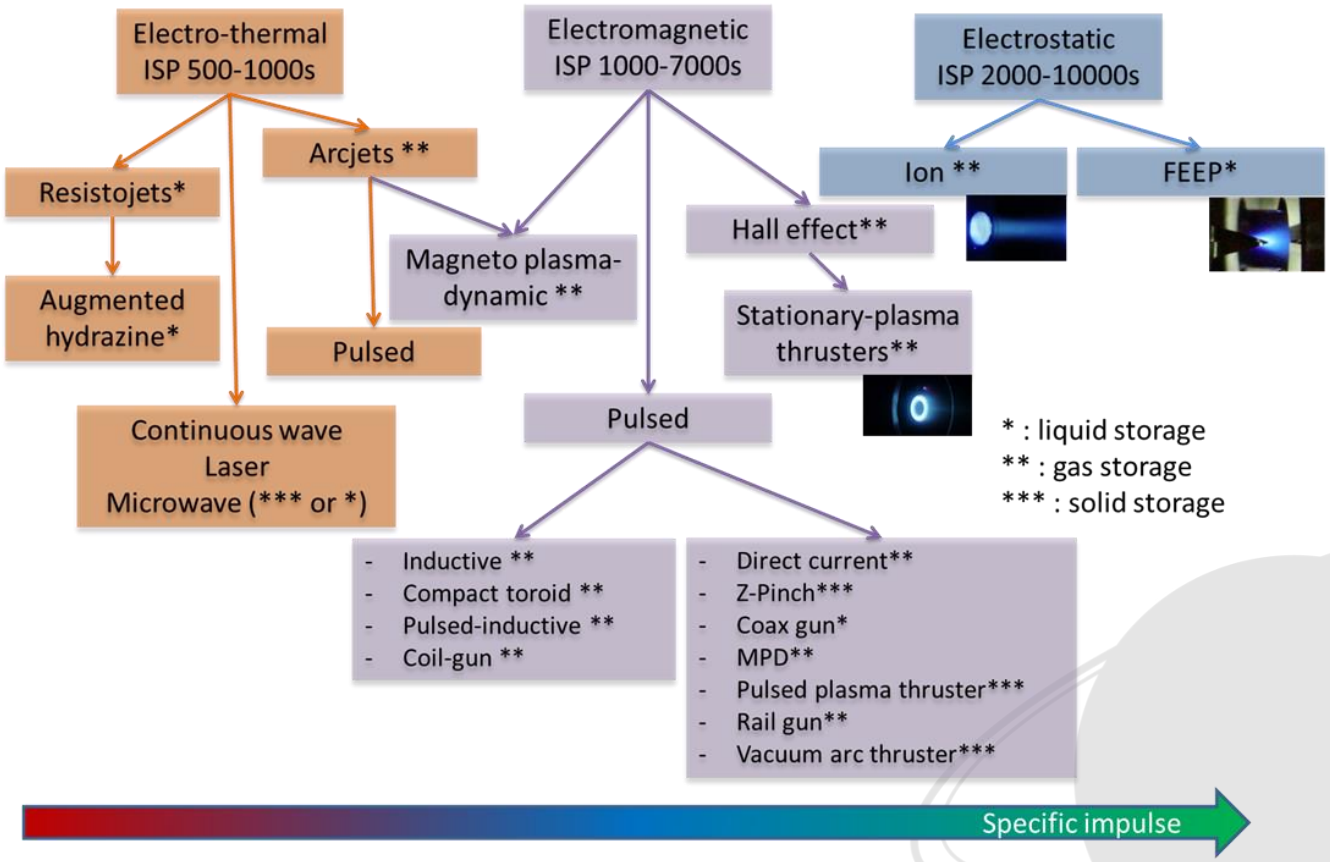
EP could bring :

- Lower mass for propulsion module and so for satellite (lower launch cost)
- Launcher flexibility for small satellite (more choice in launcher)
- Extended spacecraft lifetime (you need less satellites)





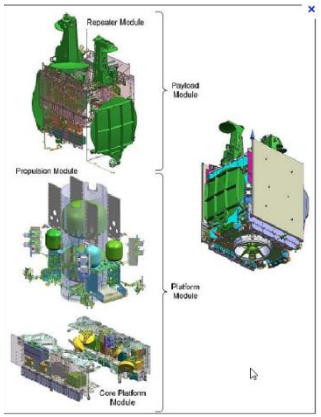
Existing solutions :

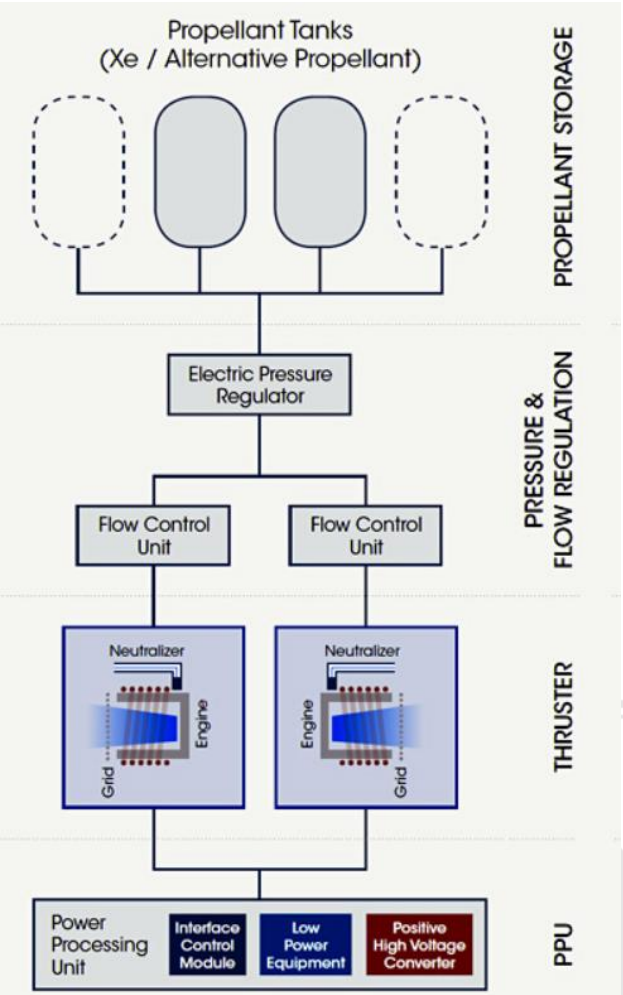


Existing solutions :

Almost all solutions are based on gas feed thruster :

- Gridded Ion Thruster
- Hall Effect Thruster
- Magnetoplasmadynamic thrusters
- ….





Our proposition for less than 300W propulsion module :

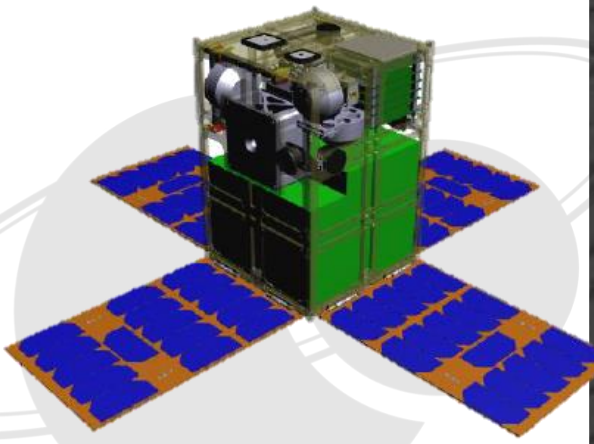
Plamsa Jet Pack® technology is an electric propulsion module family. This technology is an alternative to gas feed system for smallsatellites (<150kg), it uses the vacuum arc physics.

The objectives of COMAT are to commercialize space equipment's :

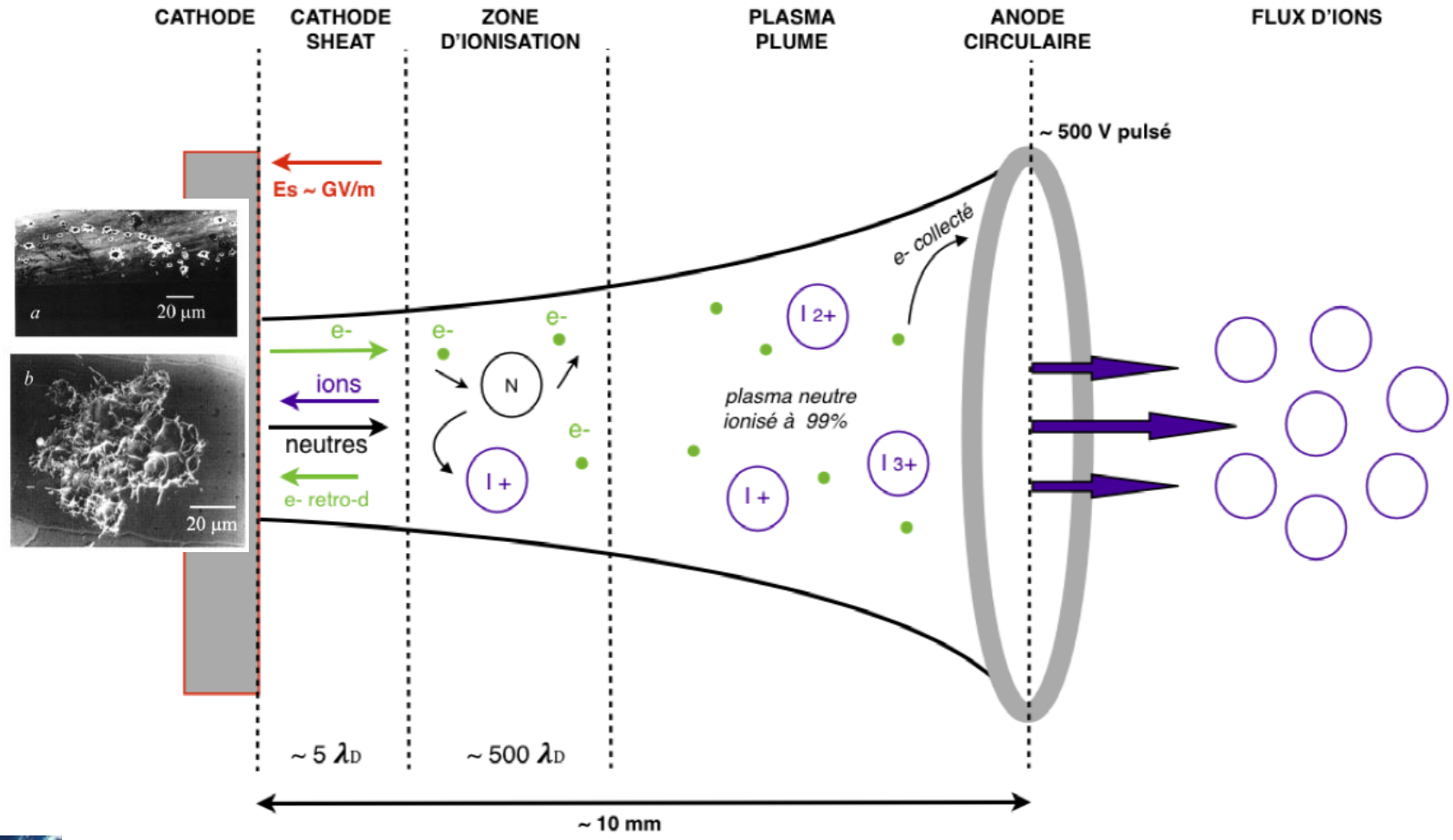
- Plasma Jet Pack 0-30W for nanosatellites available for IOD in 2018
- Plasma Jet Pack 0-150W for small satellites

The Plasma Jet Pack is designed for large range of missions:

- Orbit rising
- Station keeping
- De-orbitation
- Drag compensation
- Attitude control

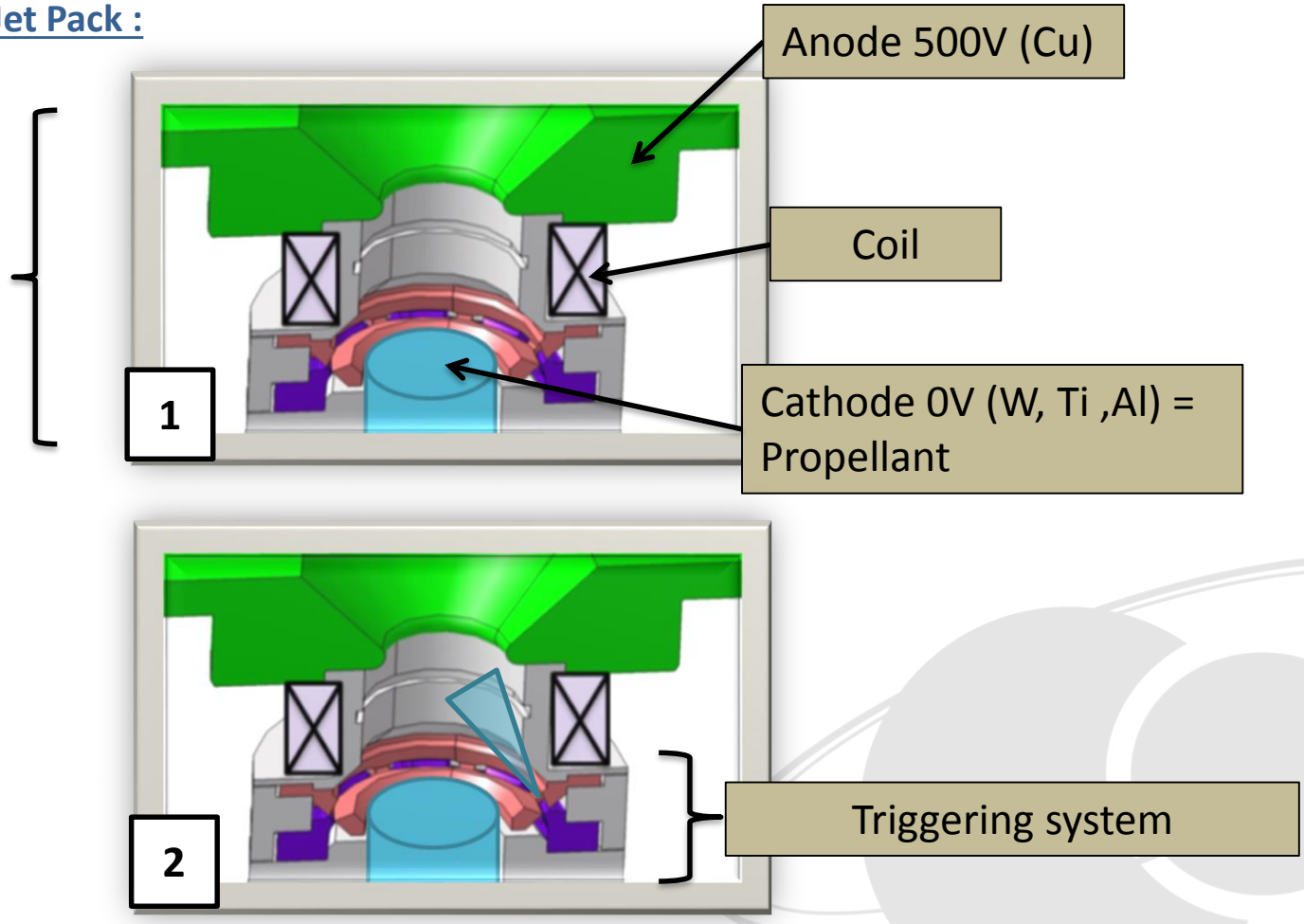


Physics of vacuum arc :



▶ *Our proposition*

Concept Plasma Jet Pack :



▶ *Our proposition*

Plasma Jet Pack 0-30W characteristics :

Average Thrust: 450µN@30Hz

Impulse bit: 15µNs

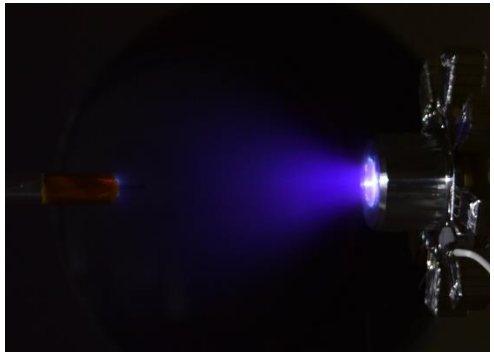
Specific impulse: >5000s

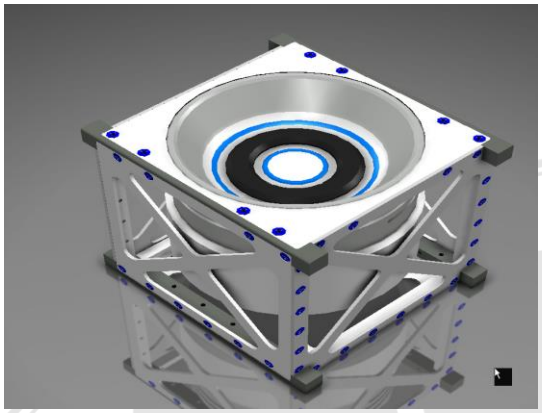
Overall mass with propellant <800gr

Total impulse: 4000N.s (~100Jours@30Hz)

Volume: 1U = 10cm*10cm*10cm

Efficiency >20%





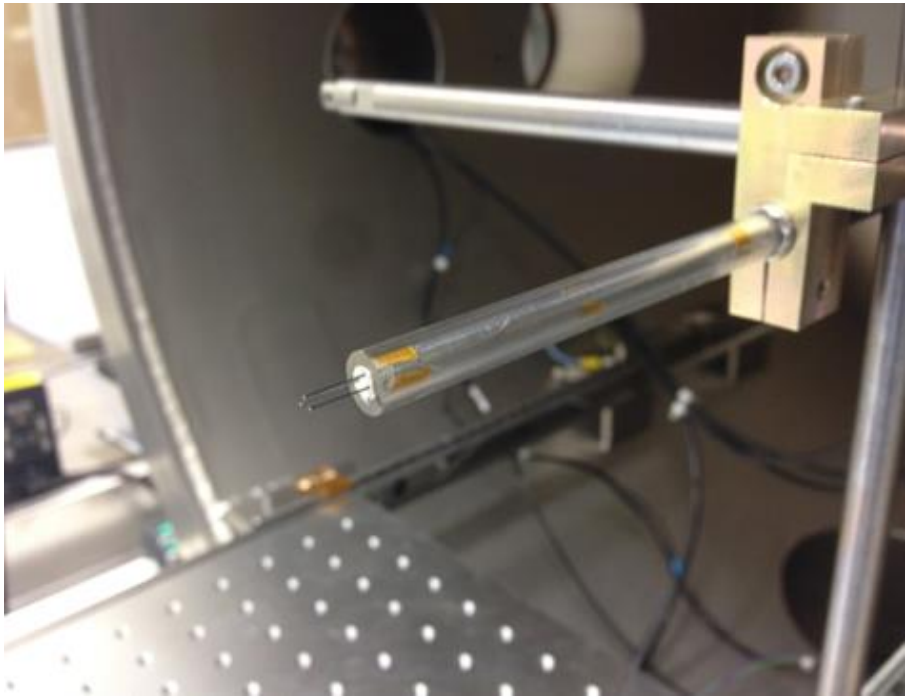
► Facilties : COMAT Propulsion Lab

COMAT Propulsion Lab :

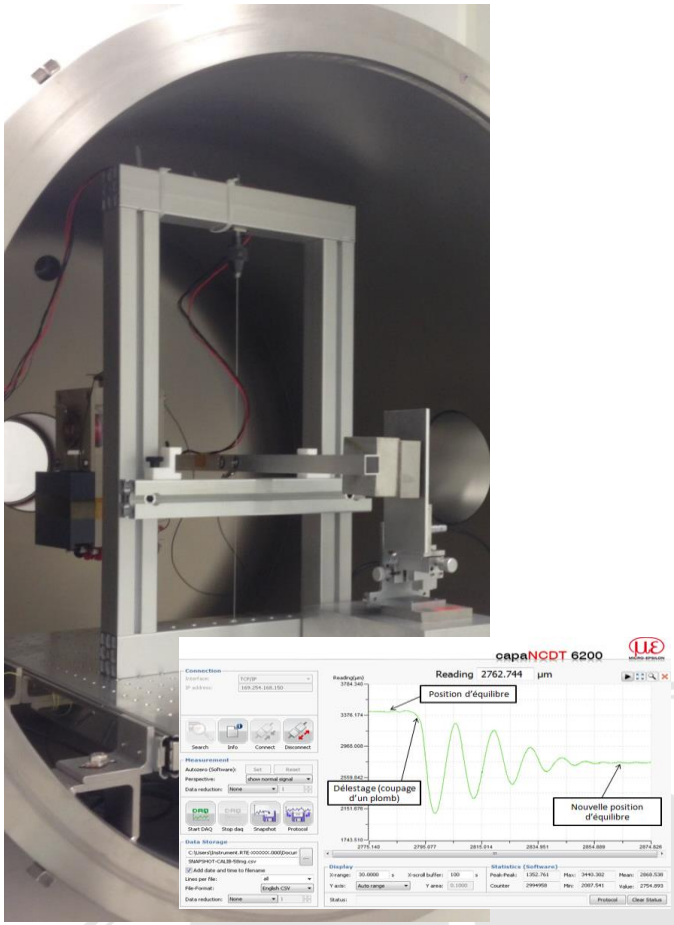
COMAT propulsion lab - Iso 7 clean room

► Facilties : COMAT Propulsion Lab

COMAT Propulsion Lab :



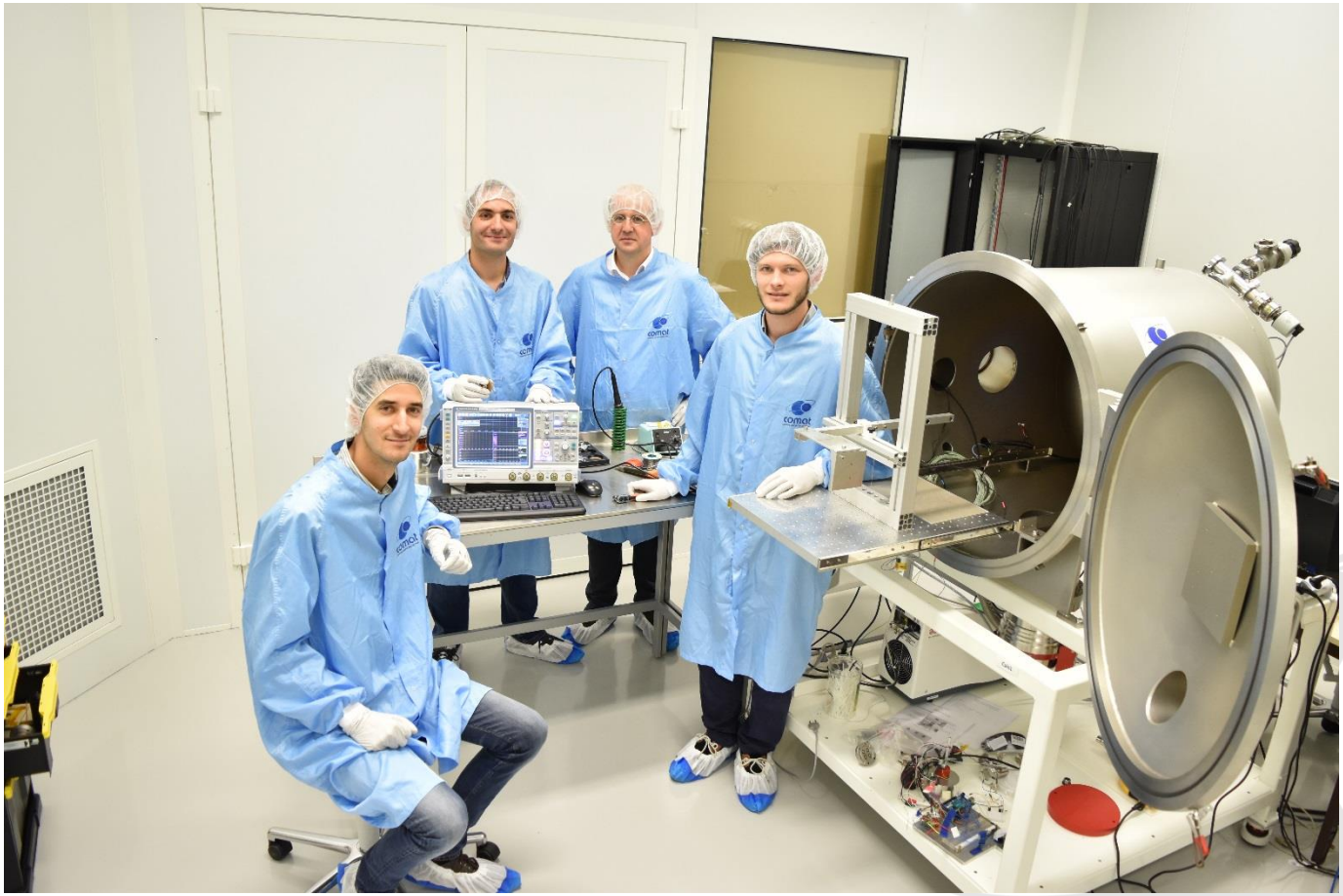
« Home-made » TLP Langmuir probes



µN Thrust bench

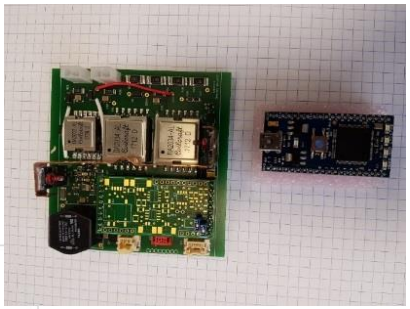
► Facilties : COMAT Propulsion Lab

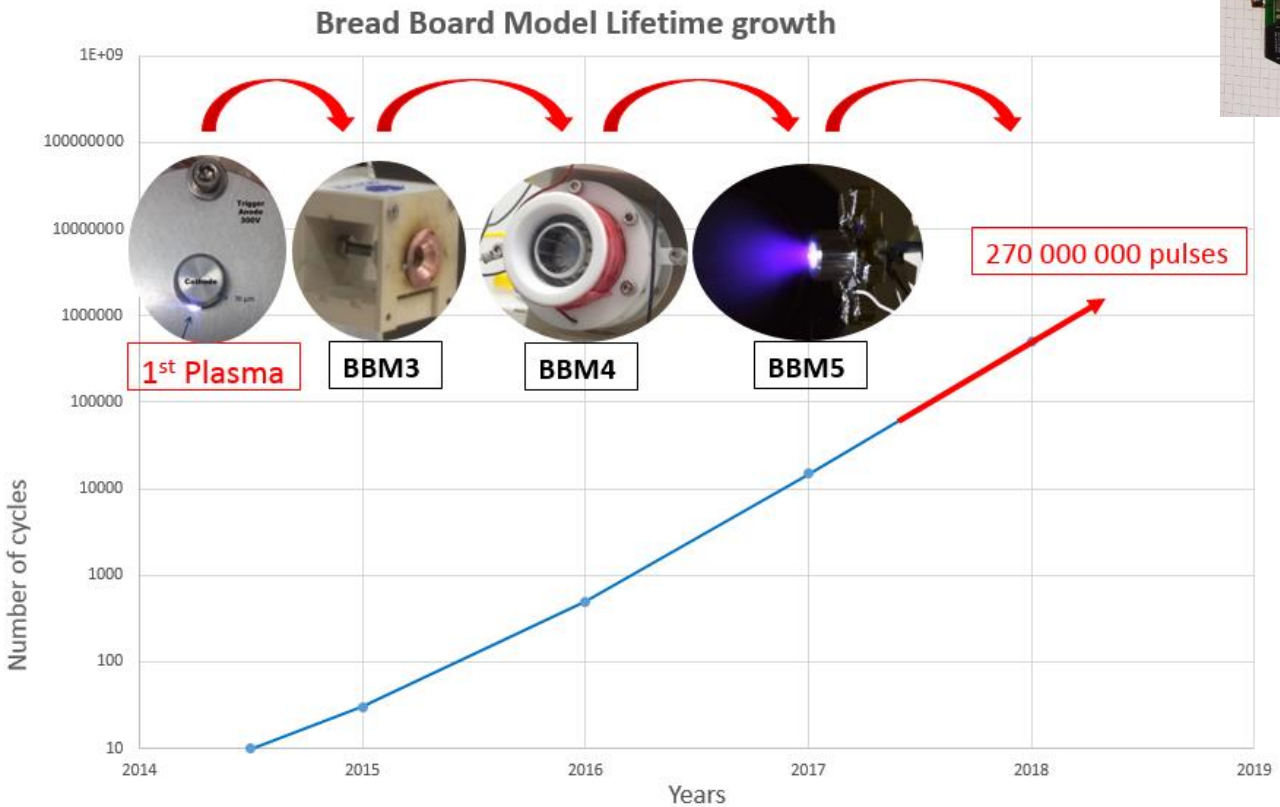
COMAT Propulsion Lab :



Progress:

Plasma Jet Pack 0-30W is TRL 4 and over 100 000 continuous firings .





▶ Benefits *advantages*

Plasma Jet Pack advantage:

- No fluid => simpler propulsion module
  - ⇒ More reliable
  - ⇒ Cheaper
  - ⇒ No filling operation

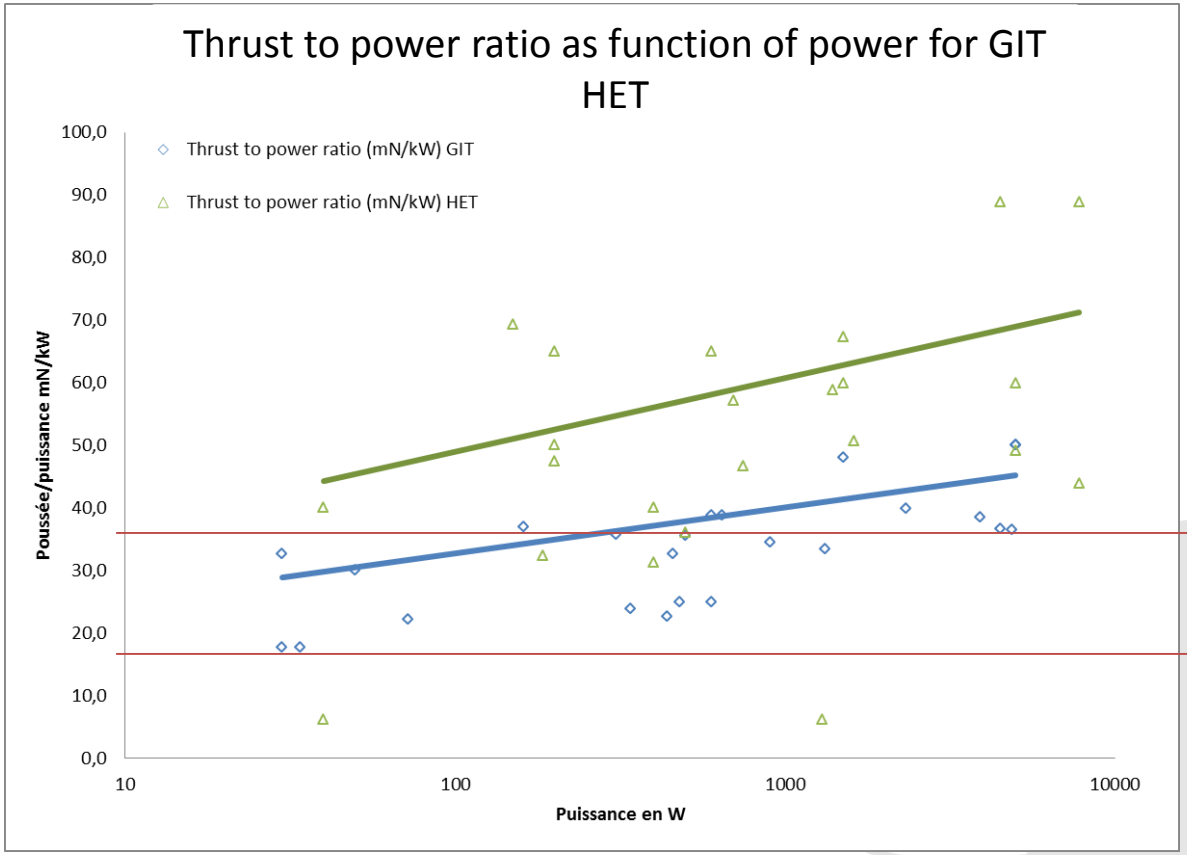
- High specific impulse (5000s)
  - ⇒ Lower mass of propulsion module for same mission
  - ⇒ More payload mass (for example)

▶ Benefits *advantages*

Plasma Jet Pack advantage:

- Solid metal propellant
  - ⇒ Smaller propulsion module
  - ⇒ Environment-friendly
- Neutral and focus plasma plume
  - ⇒ No neutralizer
  - ⇒ Easier integration
- Mean thrust function of frequency without efficiency change
- Ibit flexibility from nNs to mNs as function of design
- Robust power electronics

Performances comparison: thrust to power ratio

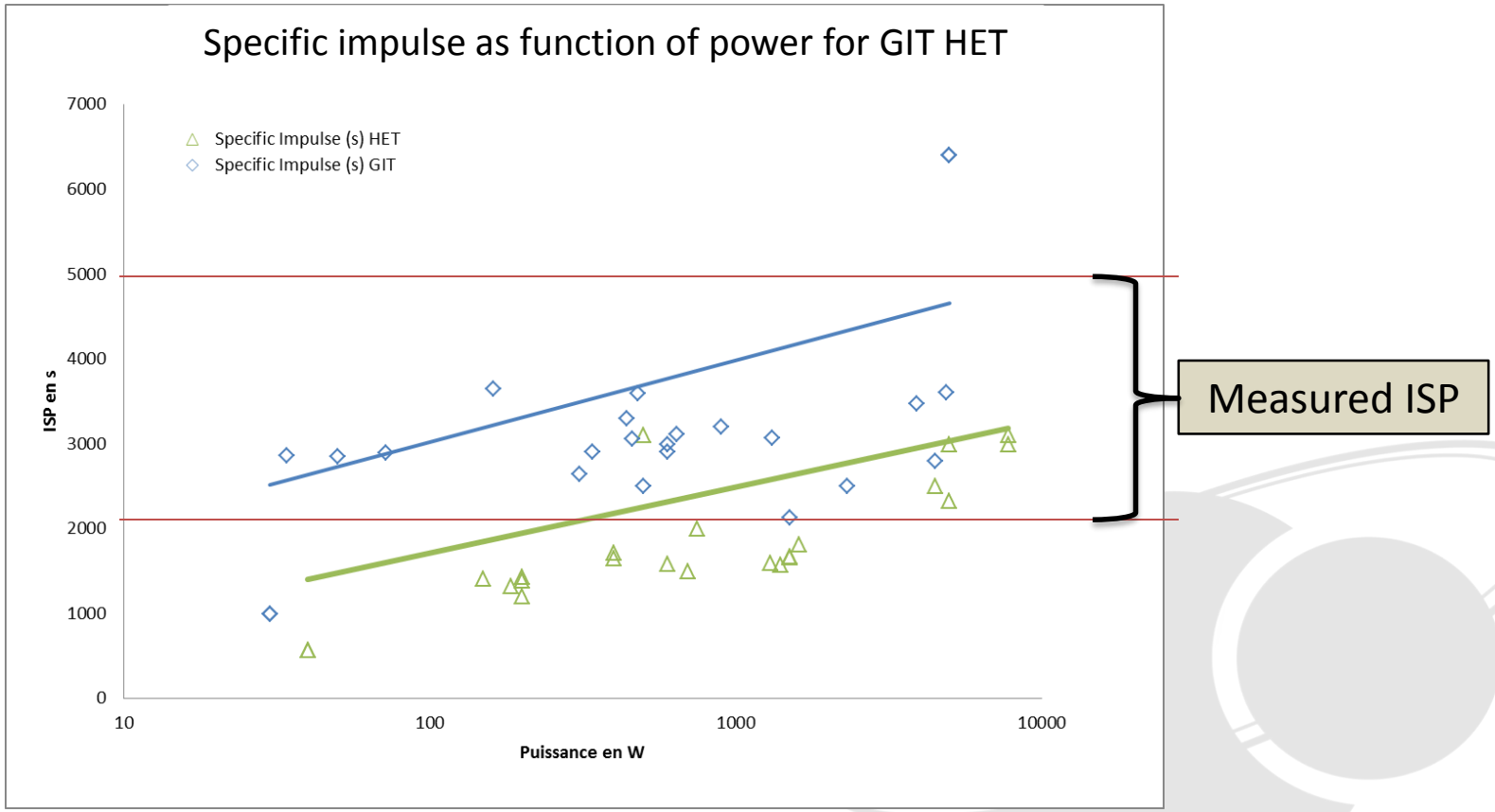


Publication T/P >80µN.W^{-1} ?

Targeted T/P 35µN.W^{-1}

Measured T/P 15µN.W^{-1}

Performances comparison: specific impulse

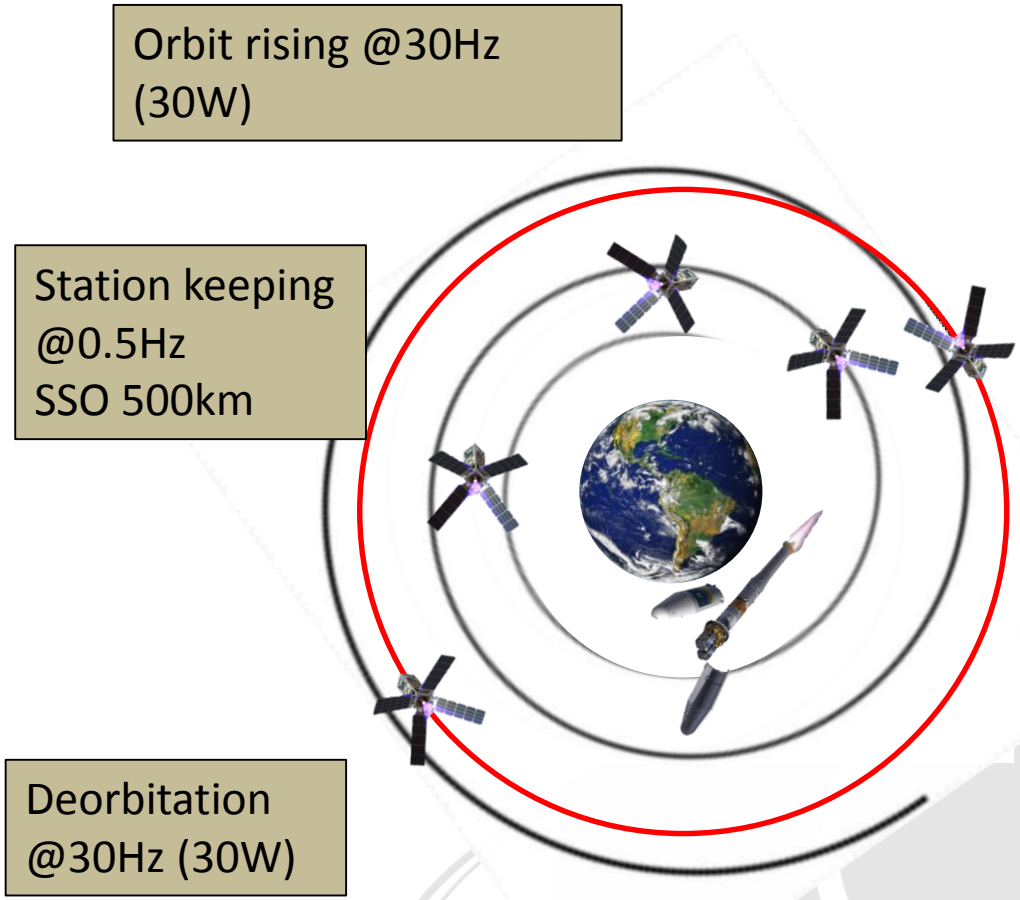


Plasma Jet Pack 0-30W missions :

Add value for nanosatellites missions :

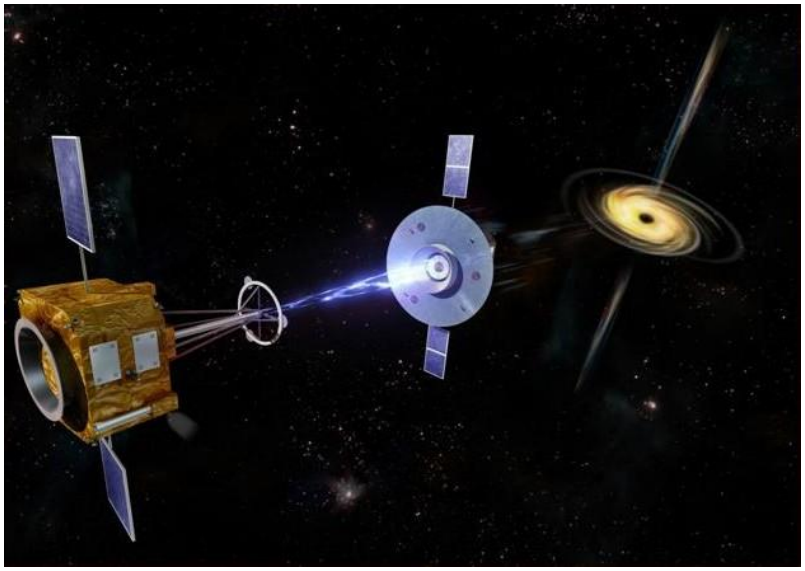
Example : Nanosatellite 30 kg class orbit SSO 500km mission

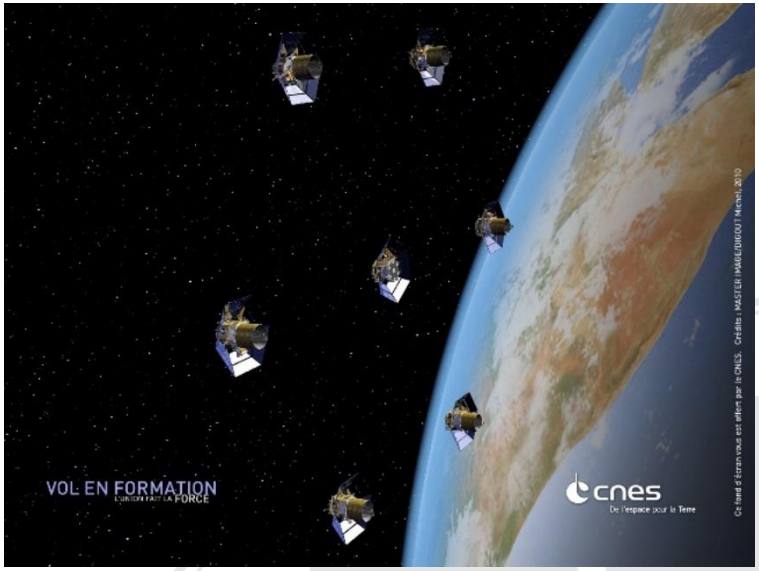
- Speed increment : 130m.s^{-1}
- 100 days of thrust 450µN@30Hz
- Extending life duration up to 5 years



Plasma Jet Pack 0-30W missions :

From mNs to 10nNs for in-flight formation mission.
The ibit is largely scalable as function of materials and bank energy.





Conclusions :

- Vacuum arc physics: complex
  - Solid metal propellant
  - High power and current density(100kW, impulse thrust up to 2N)
  - Efficient conversion
    - Publication efficiency >50%
    - Thrust to power ratio > 35µN.W^{-1}

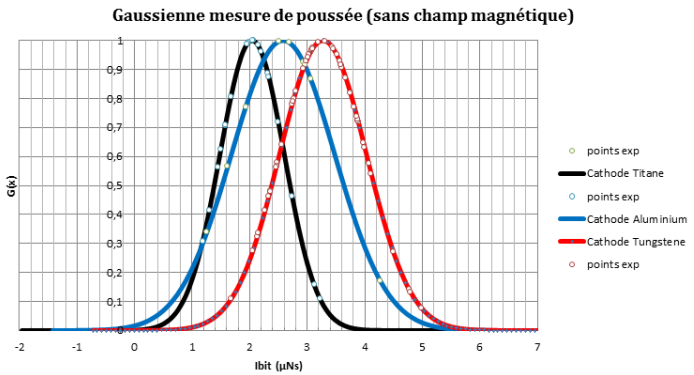
- PJP technology: simple
  - PPU basic
  - Standard manufacturing process

- Progress :
  - PJP0-30W : TRL 4 and 6 bread boards designed and characterized
  - PJP0-150W : begin in January 2018

Conclusions :

Plasma Jet Pack is designed to open the missions field to small satellites.

- Performances are function of cathode material : T/P, ISP, efficiency
- Ibit is function of energy storage from nNs to mNs

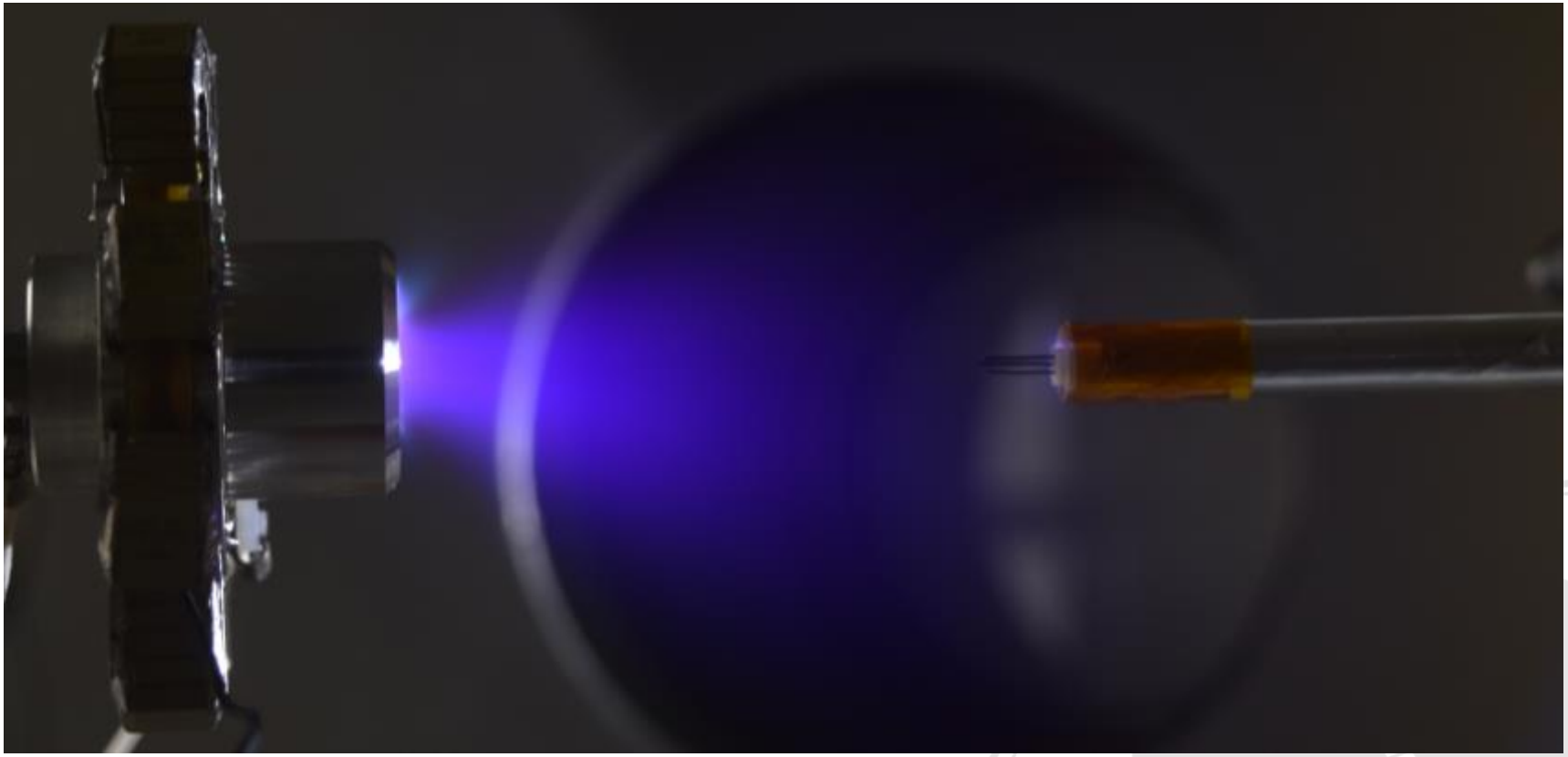


Plasma Jet Pack is designed to improve small satellites capabilities in term of missions and then accessible market.

Perspectives :

- PJP0-30W will be ready for an IOD in 2018 & commercialization is planned in 2019.
  - A first PDR was held in January 2016
  - More than 15khours spent on PJP technology for TRL 0->4

- PJP0-150W development will begin in January 2018.



► Company overview

Key figures :

- 016-2017 turn over : 8M €
- Share capital : 600kEuros
- 85 employees dedicated to space industry
- Holding AGORA Industries
- Quality Agreement : EN9100-V2009 and IS09001

Part of the **AGORA Industries Group (16M€) :**

200

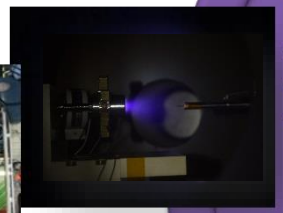
PEOPLE

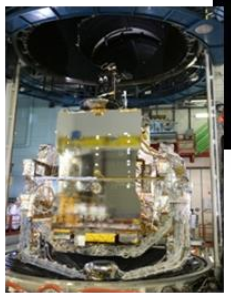
16 M€

TURNOVER

► Company overview

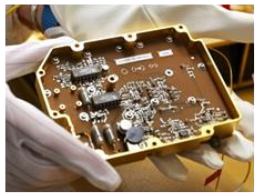
Overview:





BU Space Equipment

- Market and customer needs analysis
- Project management
- System development
- Technical authority



BU Manufacturing

- Parts machining
- Dimensioning control

Added value for customer

BU Integration & services

- Assembly
- Subassembly check
- Tests campaigns

► Company overview

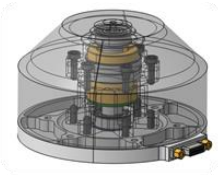
Overview:

Science & exploration (Since 1977)

- Science µG
- Stratospheric balloons
- Space particles detector

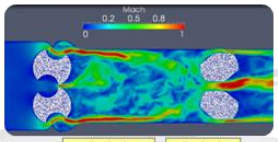
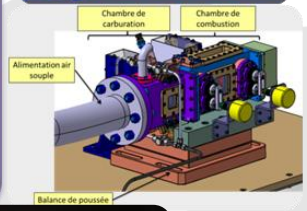
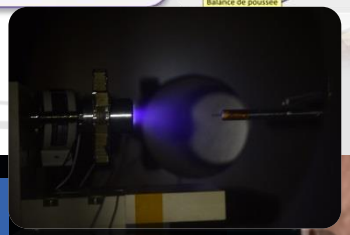
Space Mechanism (Since 2006)

- Antenna positioning system
- Customers mechanisms
- Actuators



MGSE (Since 1985)

- Mechanical and automated GSE

Propulsion system (Since 2004)

- Plasma thrusters
- High efficiency gas turbine