MEPS: A Low Power Electric Propulsion System for Small Satellites

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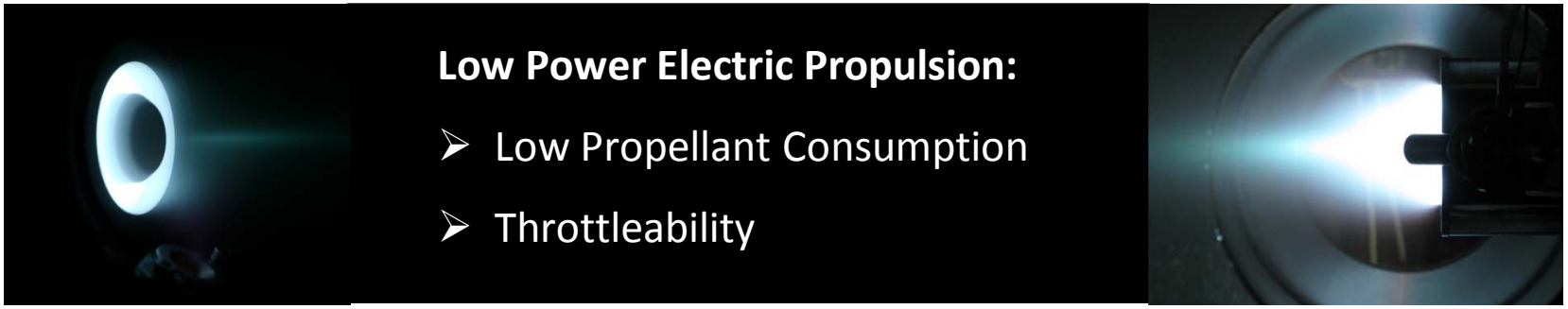
10th IAA Symposium on Small Satellites for Earth Observation
Berlin, Germany, 20-23 April 2015

Introduction

MEPS (Micro-Satellite Electric Propulsion System) is programme aiming at the qualification of a propulsion subsystem based on a **low power Hall Effect Thruster** (*~150-300W*).

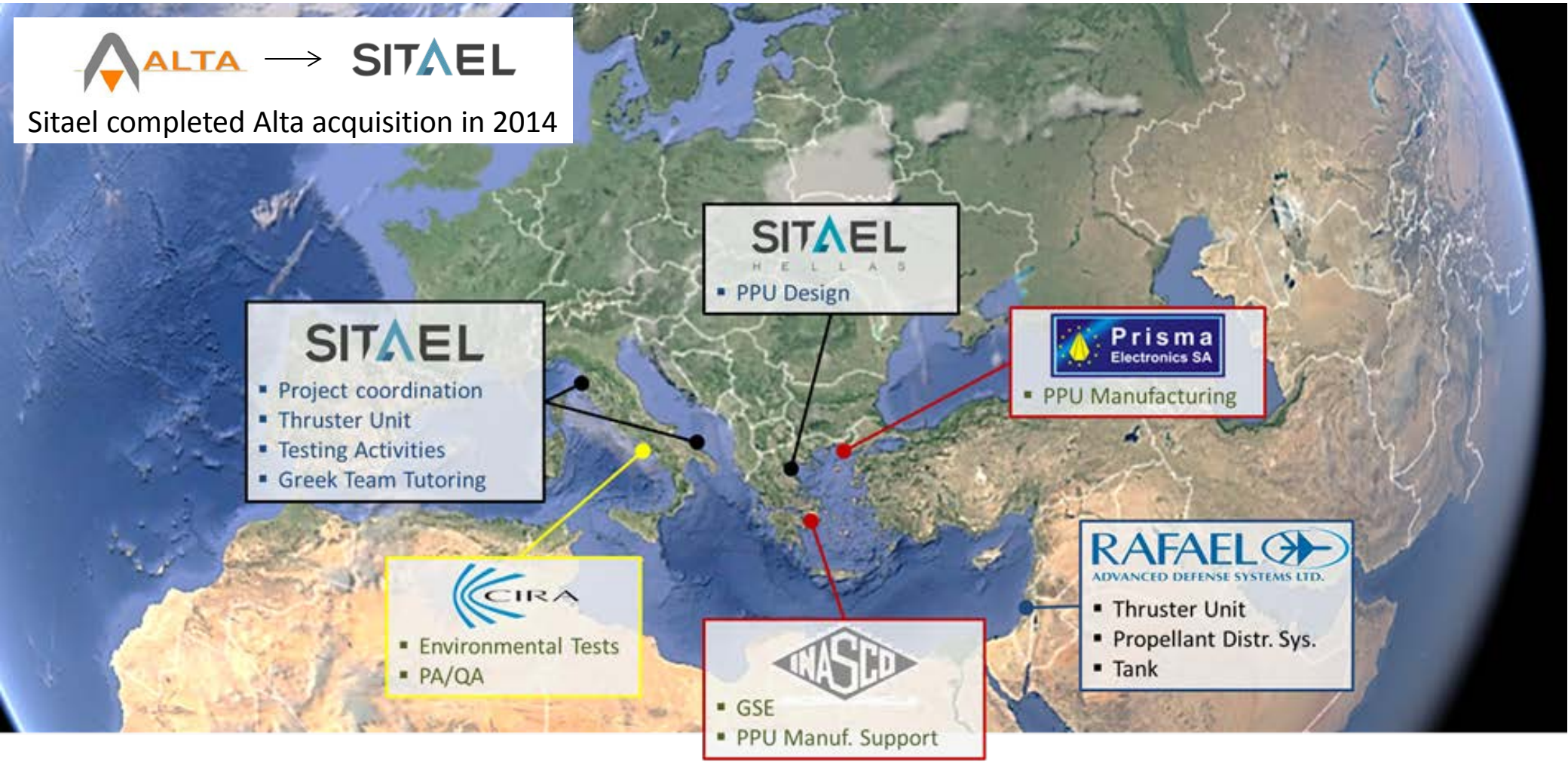
The system has been conceived for being used onboard of a small satellite platform, typically with a total mass at launch of less than 250 kilograms. Possible applications:

- ✓ Orbit maintenance of spacecraft in Low and Very-Low Earth Orbit (LEO and V-LEO)
- ✓ Accurate final orbit insertion after separation from launcher
- ✓ Spacecraft end-of-life disposal



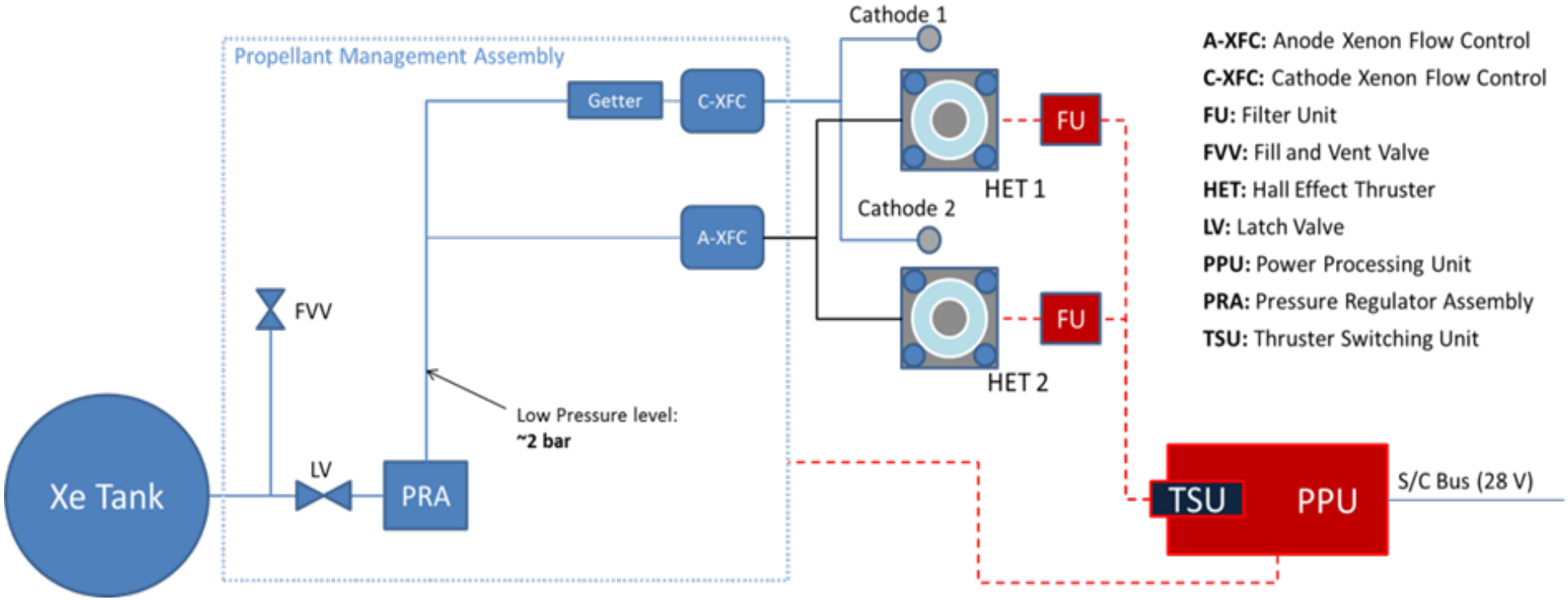
MEPS is jointly financed by the European Space Agency (ESA) and the Israeli Space Agency (ISA)

MEPS Team



Note: part of the testing activities will be performed at **ESTEC (EP Laboratory)**

MEPS Propulsion System Architecture

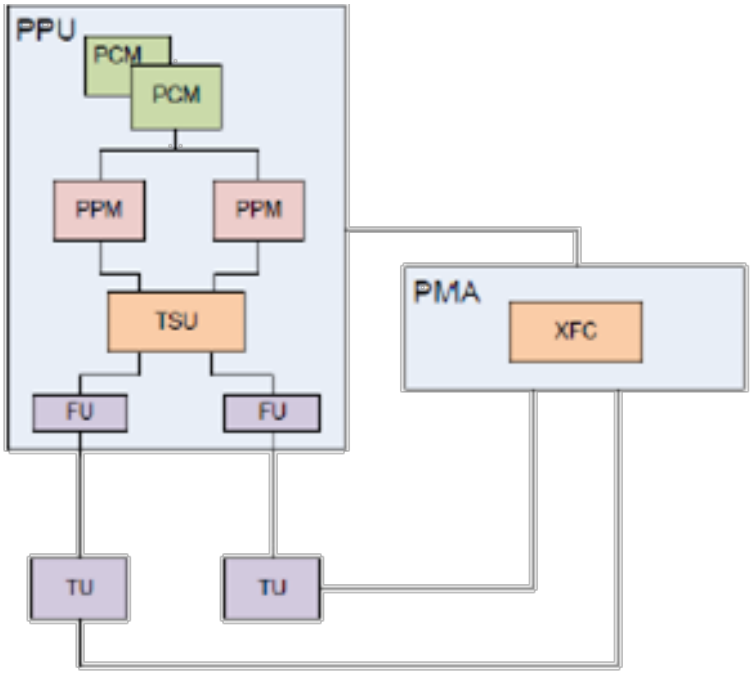


Main System Components (baseline configuration):

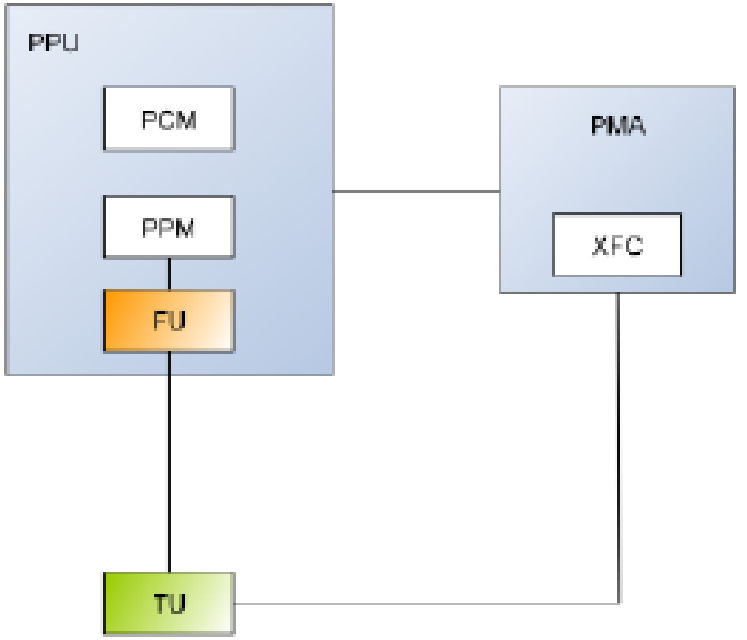
- ✓ *two Thruster Units*
- ✓ *Power Processing Unit (PPU)*
- ✓ *Propellant Management Assembly (PMA)*
- ✓ *Xe Tank*

MEPS Thruster - Target Performance	
Max. Input Power	300 W
Anodic Power	100 - 250 W
Thrust Range	5 - 15 mN
Specific Impulse	800 - 1400 sec
Lifetime	> 3000 h

MEPS Flexibility: Redundant vs. Single Branch Config.



PPU: Power Processing Unit
PCM: Power Control Module
PPM: PPU Power Module
TU: Thruster Unit
FU: Filter Unit
XFC: Xenon Flow Controller
PMA: Prop. Manag. Assembly
TSU: Thruster Switching Unit

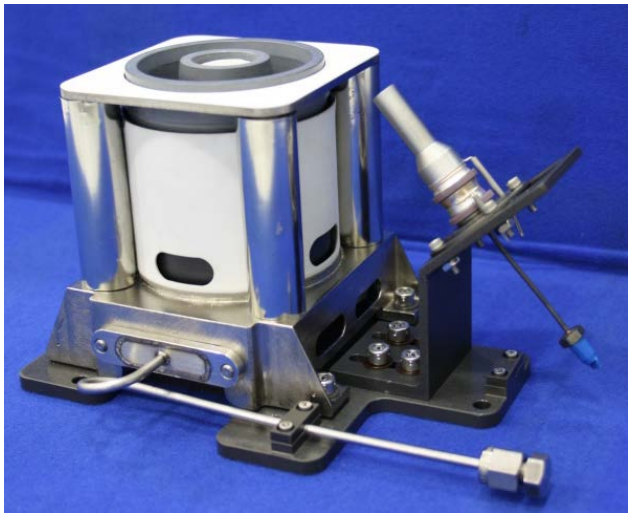


MEPS Thruster - Target System Mass	
Fully Redundant (top left)	< 15 kg
Single Branch (top right)	< 9 kg

Low Power Hall Effect Thruster

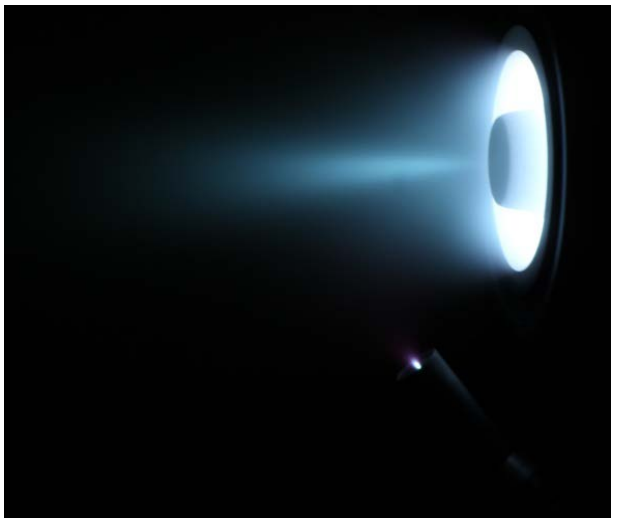
CAM 200 (Rafael)

- **Non conventional magnetic field topology,** to extend thruster lifetime
- Improved ionization efficiency
- More than 700 hrs of cumulated firing time



HT 100 (Sitael)

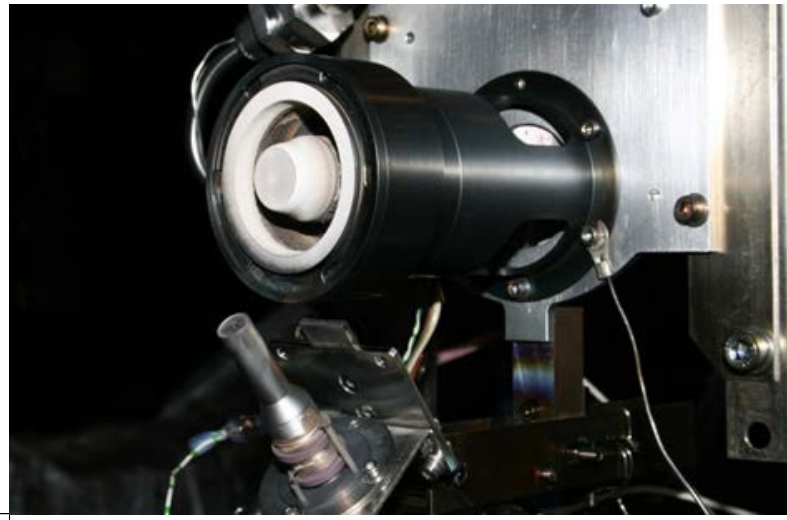
- **Permanent Magnets,** to reduce thruster size and thermal loads
- Max. Efficiency: 35%
- Thruster weight: 436g

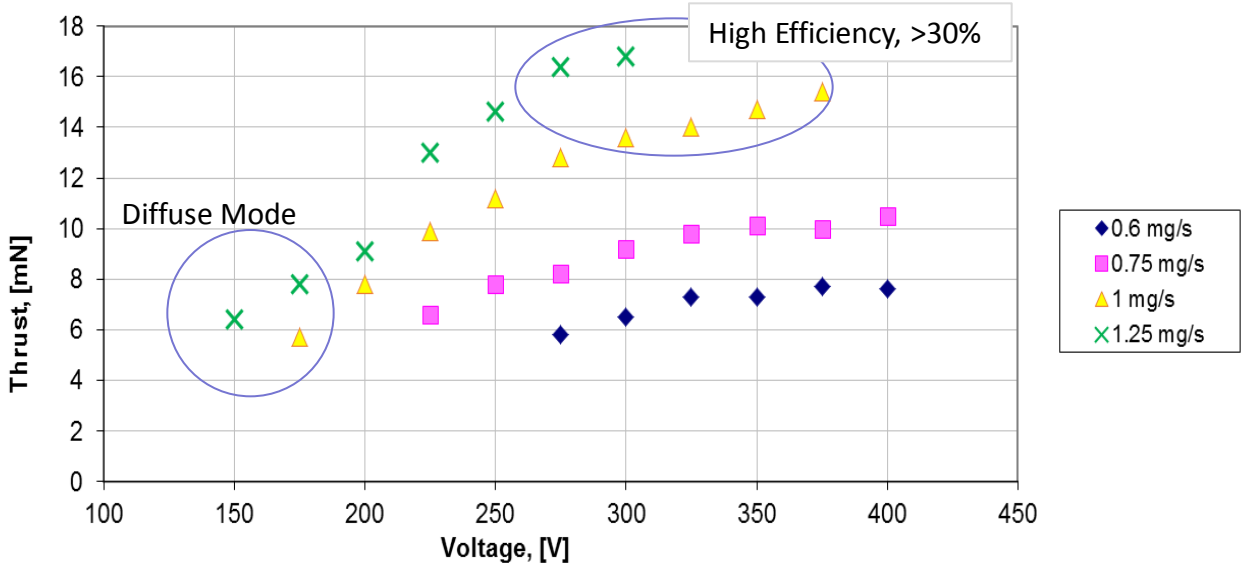


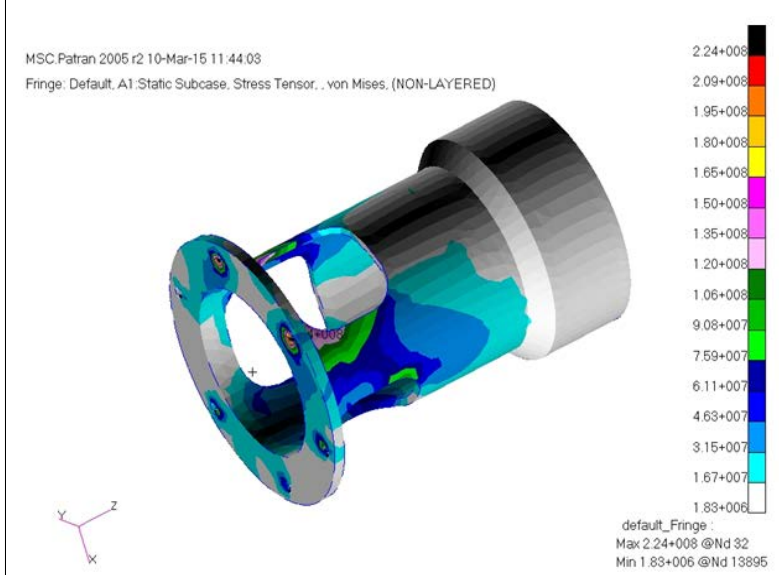
HT100 Thruster Development @ Sitael

In ascending order of importance:

1) Thruster full characterization / thermal-vacuum thrust operation in our large **LN2-shrouded vacuum facility**
2) Structural Analysis ---> Shock & Vibration Tests
3) **Endurance Test** (presently ongoing: cumulated firing time 480h @ 10.5mN, total impulse >18 kNs)







PPU BB Development

- ✓ Thruster Impedance test (Dec 2014) on HT100 and CAM200

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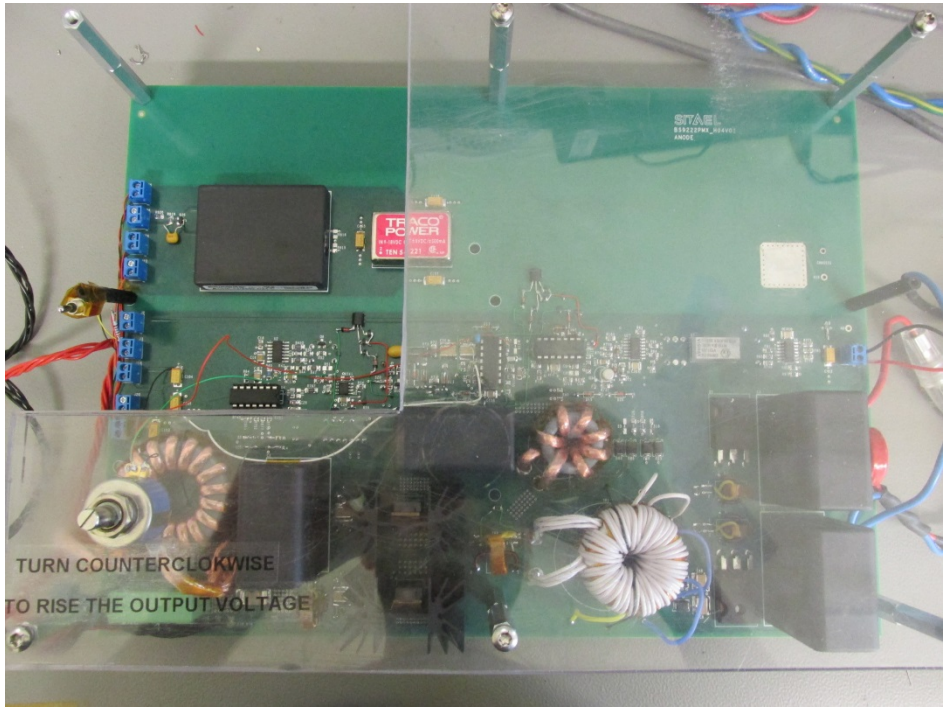
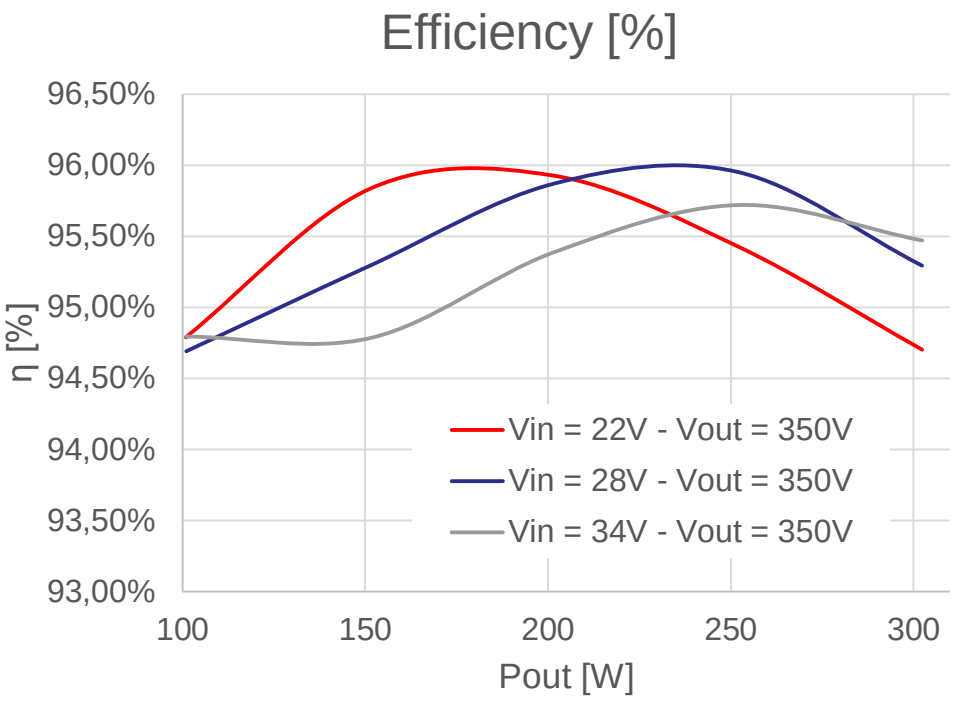
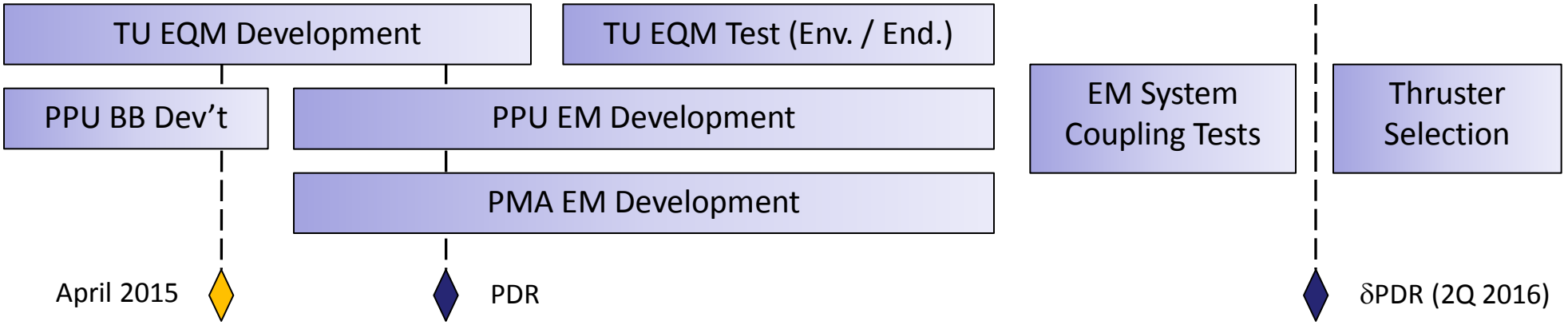
- ✓ PPU BB Manufacturing (Jan/Feb 2015 Anode Power Supply, Mar/Apr 2015 Cathode Power Supply)
- ✓ PPU BB Test, Anode Power Supply (Mar 2015)

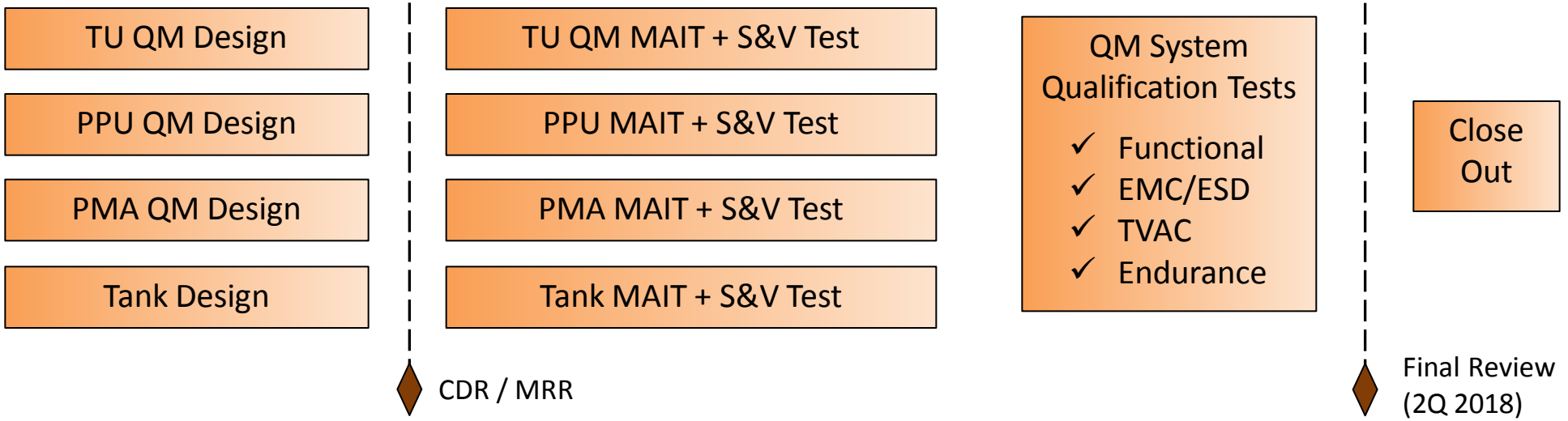




MEPS Roadmap: **Phase 2A, System EM**

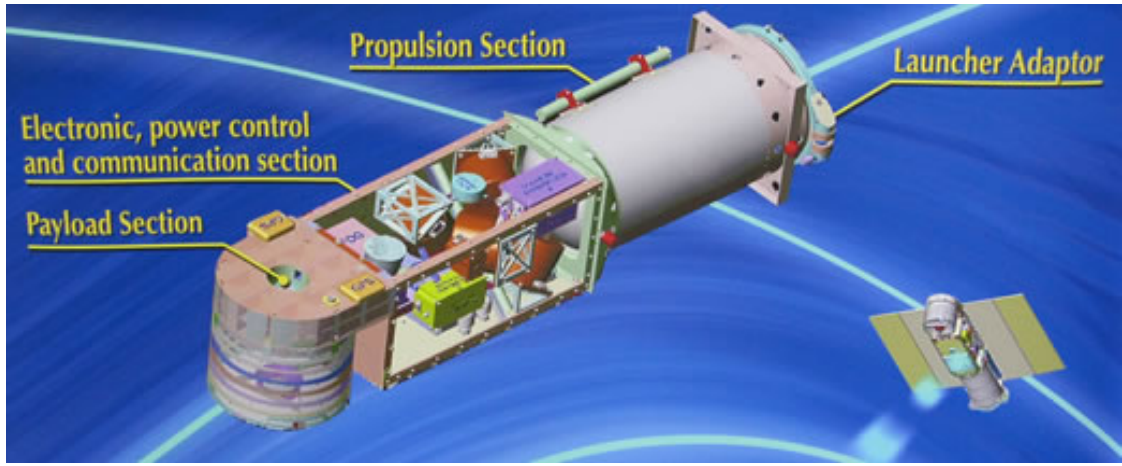


MEPS Roadmap: **Phase 2B, System QM**

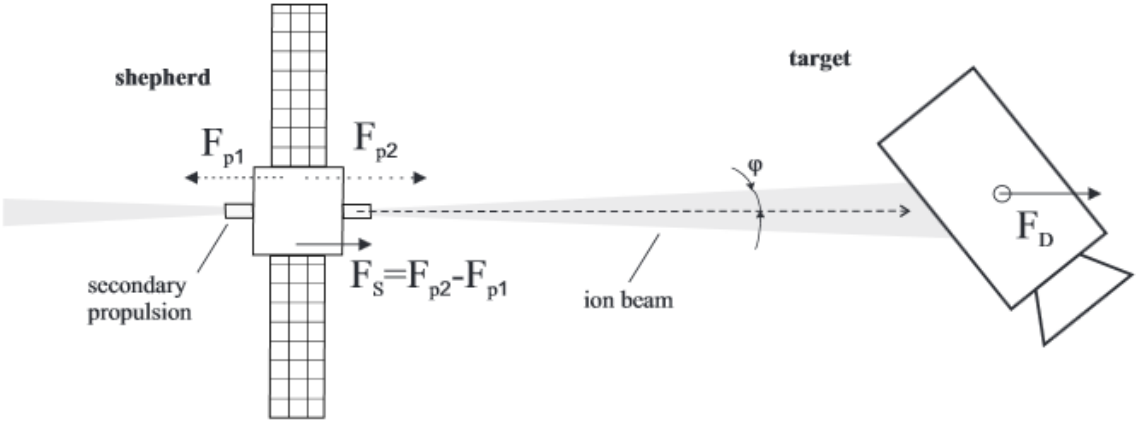


Target Applications

- **Drag compensation:** orbit maintenance of spacecraft in Low and Very-Low Earth Orbit (LEO and VLEO) for observation satellites, i.e. Litesat operated by Rafael/ISA
- **LEO large satellite constellations**: with MEPS in single-branch configuration (trade-off between size and reliability)



- **Deorbiting** / End of life disposal
- **Space debris removal** (ion beam shepherd concept, *ref. Merino, Ahedo, Bombardelli, "Ion Beam Shepherd Satellite for Space Debris Removal"*)



Conclusions

Low power electric propulsion can be a winning option for many missions, sometimes even the only suitable option. Moving quickly towards the qualification and flight demonstration of such a system is thus a high priority.

The aim of MEPS programme is to have a compact, flexible and cheap EP system fully qualified in a three year timeframe.

- **Compact:** the system has to be *lightweight* in order to be appealing for mini- and micro-satellites that can thus take advantage of it, enabling new mission scenarios.

- **Flexible:** both in terms of performance and architecture, MEPS has to fulfill market requirements and demands, *serving a wide variety of missions*.

- **Cheap:** the adoption of a design-to-cost philosophy will allow us to *reduce the selling price*. Controlling system cost is crucial, especially for small satellite market. Large constellations of satellites may open totally new perspectives, trigerring a 'mass production' process that would lead to a dramatic reduction of the item selling price.

MEPS will be the lowest power HET-based propulsion system ever qualified in Europe.


SITAEL