iFACT-MP

iodine Fed Advanced Cusp field Thruster for Mid-Power

NEWSLETTER VOL.01

Gerrit Kottke
Project Coordinator

AIRBUS
DEFENCE AND SPACE GMBH

ifact-mp.eu
info@ifact-mp.eu

Dear Readers,

Welcome to the 1st issue of our project newsletter! We are excited to share with you the progress and developments of iFACT-MP, which is focused on enabling iodine electric propulsion for the highly attractive 3-5 kW power class.

To tackle the major challenges in iodine electric propulsion, our project is structured into several work packages and distributed across our highly qualified consortium with their respective fields of expertise, each addressing a specific building block. These work packages include the development of: the thruster and cathode, C12A7 emitters for the cathode, system engineering and iodine fluidics, a power electronics breadboard, an iodine flow sensor and a suitable vacuum test facility.

In this newsletter, we will provide updates on the progress of each work package, highlighting key achievements, challenges, and next steps.

In the past year, every party has worked relentlessly on finalising the specifications, the preliminary and then the detailed designs of each component. Along that development, the SRR, PDR and CDR have been held to review the specifications and designs, ensuring the compatibility between the building blocks. Right now, the procurement and manufacturing phase is on-going, the first parts are arriving and testing of each component will commence once they are ready. Following that, the components will be integrated up to the full subsystem for coupling tests, leading up to the final 500 h endurance test and shaker testing of the thruster unit by end of the year.

We hope you enjoy the read and look forward to keeping you informed and engaged as we continue to advance this exciting project.

Best regards,
Gerrit Kottke

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

PROJECT SCOPE

The iFACT-MP project aims to develop a competitive iodine-fed thruster for the 3-5 kW range, by focusing on key components like the Advanced Cusp Field Thruster (ACFT), the fluid system (including a heated iodine reservoir, an optical flow sensor and control for the thruster), the neutralizer and functionally equivalent PPU breadboard.

The goal is to scale up the ACFT and develop the necessary fluidic components to realize a functional iodine Electric Propulsion (EP) subsystem and enhance its maturity.

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

WP2: System and Fluidics Engineering
by Airbus Defence and Space Toulouse

This work package aims to mature an electric propulsion system, relying on Iodine as propellant and CUSP thruster.
Tricky functions, such as Iodine regulation and fluidic tray, must be defined, manufactured and tested at the end of this development.

Highlights Summary

The Electric Propulsion team in Toulouse is in charge of analyzing the system performance and integration aspects to high-power satellite platforms, and the thermo-fluidics design of the sub-system.
It deals with the tank and a fluidic regulator, capable to manage, in a gaseous state, a large range of flow rate.
The first step of the development was concentrated on state of the art and main engineering constraints. This development takes also benefit of Airbus Friedrichshafen heritage for such functions.

Main Results and significant achievements

The analysis of the fluidic tray has been achieved in temperature and pressure. It leads to technical specification of the tank and the Iodine Fluidic Regulator.
A system analysis highlighted quantitative advantages and drawbacks of iodine applied to Medium Earth Orbit (MEO) and GEostationary Orbit (GEO) missions in a range 3 to 5 kW per thruster.

Next steps

The Iodine Fluidic Regulator will be studied and manufactured by the end of June.
Fluidic simulation and control loop will be studied and plugged in the PPU.
The coupling test plan, associated with Aerospazio, Airbus Friedrichshafen and Airbus Elancourt teams, will be prepared.
The coupling test should occur from July to October.

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

WP3: Thruster and Cathode Development

by Airbus Defence and Space Friedrichshafen

The thruster unit represents the central technical building block and is driving the performance of the 3-5 kW iodine electric propulsion subsystem, that is being developed and tested within the project.

Highlights Summary

The design phase has been concluded and the PDR, CDR and MRR held. A thruster unit consisting of the structural bracket, the iodine thruster and noble gas cathode has been developed as baseline configuration. In parallel, work is on-going on the development of an iodine fed cathode using C12A7 as emitter.

Main results & significant achievements

Starting from the conception, the detailed design of the thruster and the cathode and their integration into one thruster unit has been completed in the previous months. The iodine thruster and the noble gas cathode have been scaled to the desired power range based on previous ACFT developments. An emphasis was put on the thermal design to manage the dissipated heat loads at thruster level using a radiator, and selection of proper materials for iodine compatibility. The fluidic section, which requires pre-heating to avoid iodine condensation, has been designed to enable rapid heat-up times.

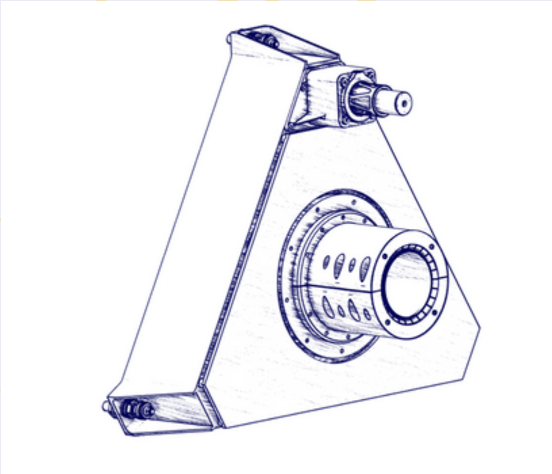

Figure 1. Sketch of the thruster unit, consisting of the iodine ACFT and a noble gas fed cathode.

In parallel to the hybrid propellant baseline design, development and testing of an iodine fed cathode prototype is on-going. As electron emitter, the most critical part of an iodine-fed cathode, C12A7 emitters that are developed and manufactured by Fraunhofer IKTS are used. To enable stable long-term operation, the material is being modified to increase the melting point.

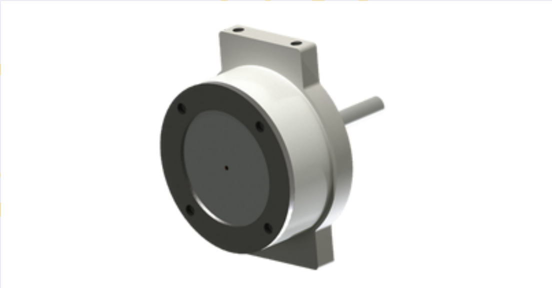

Figure 2. Render of the planar iodine cathode, designed to use C12A7 emitter disks manufactured by Fraunhofer IKTS.

Next steps

The next step is the procurement, manufacturing and integration of the parts and components, followed by testing. The tests will start at component level to then integrate more building blocks up to the full subsystem test foreseen for July.

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

WP4: Electron emitting ceramic
by Fraunhofer IKTS

The improvement of the melting point for the electron emitter is important to optimize the long-term performance. Local melting of the material as degradation of properties have to be avoided, so that a continuous emission is expected.

Highlights Summary

As planned, the improvement of the melting point of the electron emitting ceramic is the aim of this work package. For this, the material C12A7 as electron emitting ceramic is doped with heavier elements. Several material modification are under investigation.

Main Results and significant achievements

We have worked on the improvement of the melting point of the C12A7 ceramic as electron emitting ceramic. For this, the material was doped with other elements to change the properties. We are still characterizing the phase composition of the material. In parallel, the testing samples for Airbus are prepared and delivered. After testing, we are taking a deeper look on the material properties again to determine the changes in composition and microstructure during testing with iodine.

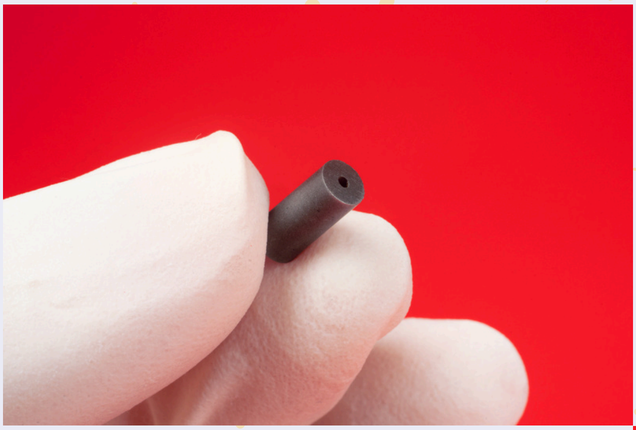

Figure 3. Hollow cathode made of C12A7 ceramic for electron emission

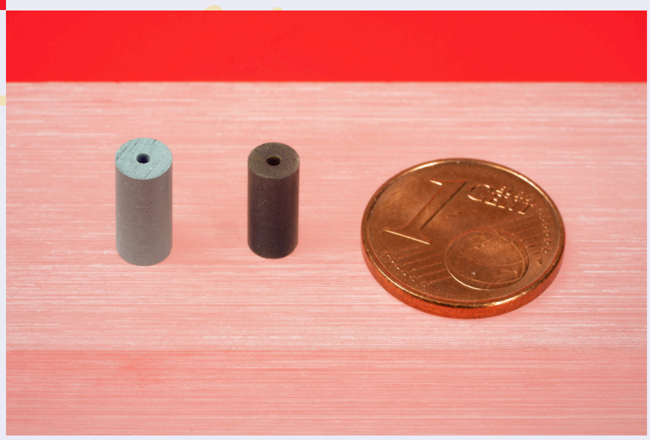

Figure 4. Hollow cathode of C12A7 ceramic before and after sintering

Next steps

The measurement of the material properties such as melting point and phase composition is still on focus. Additionally, the structuring of the cathode surface for increasing the emitting area will be tested.

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

WP5: Breadboard PPU

by Airbus Defence and Space Toulouse & Elancourt

This Work Package aims to design and provide a Breadboard, capable to manage the full Electric Propulsion system and reproducing a thrust sequence in the specified operating range.
Such step is made necessary to explore such technology, and to identify any tuning, from analogic functions (power, drivers, transient) to numerical management (Telemetries, control loop, thresholds).

Highlights Summary

The management of Iodine Electric Propulsion system gathers thruster, iodine & rare gas regulation and heating. Specific and tunable power supplies are necessary to cover thruster range from 3 to 5 kW, up to 800V.
In addition, versatile electronics is needed to explore the whole range of the system. Such approach leads to prefer a PPU breadboard instead of an EM model in this development phase.
Airbus Elancourt is mastering high power and voltage DC supply across flightworthy Eurostar and One Web PPU families and is supported by Airbus Toulouse for system and management topics.

Main Results and significant achievements

The specification of the breadboard has been reviewed.
Architecture has been defined, power supplies and drivers have been tailored.

Hardware design:

- All COTS components have been ordered.
- Several specific electronic racks have been designed to power and to self-test the Breadboard.
- All harnesses have been designed and are being manufactured.
- Some power supplies and boards have been tested, in range and reaction time.

Figure 5. Breadboard PPU

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

WP5: Breadboard PPU

by Airbus Defence and Space Toulouse & Elancourt

Software design:
Human Machine Interface has been defined in coordination with Airbus Toulouse and Friedrichshafen, to cope with requirements and to ease coupling tests.
COTS drivers have already been developed and tested.
The test plan, from individual component validation to Breadboard functioning and protection testing, has been released.

Next steps

- The functional design report.
- The Breadboard will be assembled from March to May.
- The software will be developed and tested with the self-test rack and simulators such as the fluidic box.
- The Breadboard acceptance test shall occur in June.
- The Airbus Elancourt team will support coupling tests for setup, parameters and soft tuning during functional test with iFACT-MP thruster and fluidic regulator(s).

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

WP6: Development of a vacuum test facility for iodine fed thrusters up to 5 kW

by Aerospazio

The new facility will allow the operation of an Iodine fed thruster with a nominal power of up to 5 kW, collecting the expelled propellant on cryogenic surfaces in a total quantity of several kilograms.

Thanks to the previous experience of Aerospazio Tecnologie with this kind of tests, this goal will be achieved with a high level of efficiency and safety.

Highlights Summary

The main vacuum chamber of the new test facility is in our workshop to receive the final machining and surface treatment.

Main Results and significant achievements

The main chamber of the new test facility is now undergoing finishing operations in our mechanical workshop at the Aerospazio Tecnologie main site in Rapolano Terme. The chamber will be equipped with the secondary flanges and the door opening mechanisms. In addition, the cryogenic panels of the pumping system and the arm with electrostatic probes for scanning the thruster plume (not visible in the image) will be installed inside the vessel.

Figure 6. The main vacuum chamber of the new test facility

Next steps

From now on, the work to assemble and set up the test facility will be a huge puzzle, made of commercial components, custom equipment made in-house, construction work, software development, functional tests and last but not least the preparation of a large amount of documentation to ensure the correct functionality and above all the safety of the test system.

Figure 7. Assembly of the new test facility

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

WP7: Iodine Mass Flow Diagnostics

by University of Pisa

Developments pursued within WP7 will permit to have an instrument capable of measuring iodine mass flowrate in realtime during tests of electric propulsion systems.

Highlights Summary

As part of the development activities of the laser absorption mass flowmeter, UniPi team carried out the acceptance tests of the first control electronics prototype, demonstrating correct behavior of all its functionalities.

Main Results and significant achievements

Benchtop tests using dummy components verified all functionalities of the electronics board, including MFM temperature control, laser operation and absorption measurements.

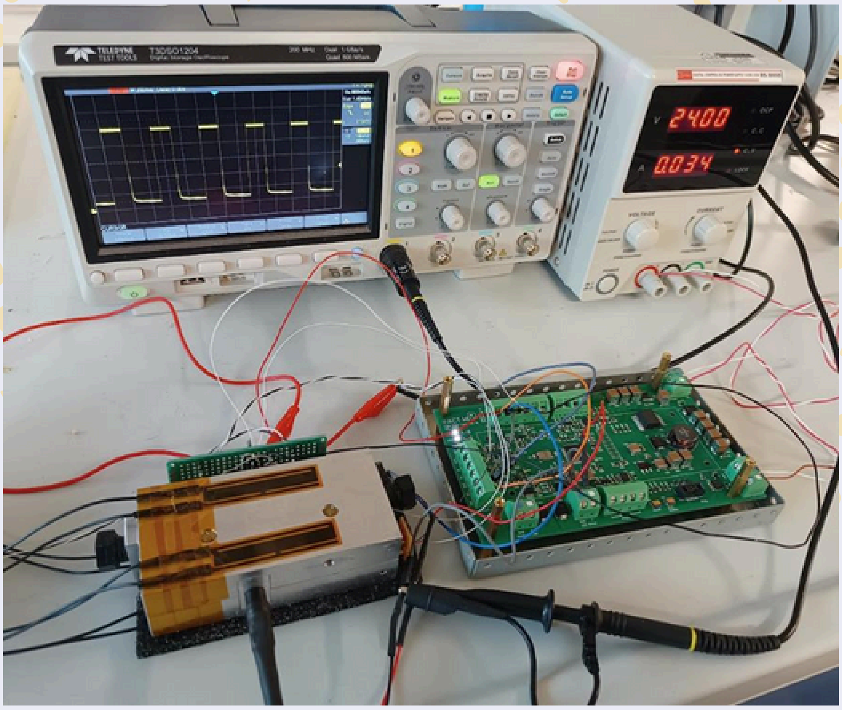

Figure 8. Verification of the laser activation using the MFM electronics board connected to a dummy MFM body.

Next steps

Further functional tests will follow to verify the system operation under the more realistic environment of a vacuum chamber, including measurements of iodine mass flow.

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

Events & Conferences

Engaging Presentations at Two Conferences

Early in 2024, Max Vaupel (Airbus FDH) participated in the 9th Edition of the 3AF International Conference on Space Propulsion, held in Glasgow, Scotland.

He presented on how the iFACT-MP Initiative will pioneer Europe's first iodine-fed propulsion system, highlighting our commitment to innovation in space propulsion.

Figure 9. Max Vaupel (Airbus FDH) in the 3AF International Conference on Space Propulsion,Glasgow, Scotland.

At the IEPC 2024 in Toulouse, our coordinator Gerrit Kottke from Airbus FDH provided an insightful presentation on the iFACT-MP project!

He discussed the innovative advancements of the iodine-fed Advanced Cusp Field Thruster for Mid-Power, marking a significant leap forward in space propulsion technology.

Figure 10. Our coordinator Gerrit Kottke (Airbus FDH) in the IEPC 2024 , Toulouse, France.

Upcoming Events

The iFACT-MP Team will participate in the following events:

- 39th International Electric Propulsion Conference (IEPC), 14 to 19 September 2025, London
- IEEE Conference. Barcelona
- 15th EASN International Conference. 14 to 17 October, Madrid

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.

OUR TEAM

AIRBUS

AIRBUS DEFENCE AND SPACE GMBH
AIRBUS DEFENCE AND SPACE SAS

AEROSPAZIO

IN SUPREMÆ DIGNITATIS 1343
UNIVERSITÀ DI PISA

Fraunhofer

EASN TIS

CONNECT WITH iFACT-MP

101134963 01.01.2024 24 Months

Coordinated by
AIRBUS DEFENCE & SPACE GMBH

ifact-mp.eu

info@ifact-mp.eu

Funded by the European Union

Funded by the European Union under GA No 101134963. Views and opinions expressed are however those of the author(s) only and not necessarily reflect those of the European Union or HADEA. Neither the European Union nor HADEA can be held responsible for them.