The Project

MIPRONS is a Start-up, set-up in 2019, whose vision is to innovate space propulsion by means of systems characterized by miniaturized dimensions, high performance, wide range of thrust, scalability and green/non-hazardous propellant.
In particular, 2 innovative space propulsion systems are under development, covered by four international patents:

- ***"Space propulsion system",*** PCT/IB2018/055595 (already issued in Italy); and,
- ***"Low and high thrust space propulsion system"***, PCT/IB2021/061166.
- ***"Electrochemical device capable of functioning as an electrolyzer and fuel cell"*** *102022000011999*
- Fourth patent pending

They both adopt water as primary propellant ("green, non-hazardous, cheap and high-density").
In the first solution, this is split into hydrogen-oxygen, directly in orbit, through a *water-electrolysis* process. They react inside a miniaturized combustion chamber to deliver high thrust and high Isp (specific impulse), ideal to quickly accomplish maneuvers such as orbit raising, de-orbiting, collision avoidance, etc, with low propellant weight.
In the second solution, a high-thrust and low thrust lines are present to obtain a *multi-mode propulsion system* that adopts only one primary propellant. Beside the *water-electrolysis* system there is a *steam* propulsion system for low thrust, ideal for high-precision maneuvering (attitude & control). In this way, it is possible to reply to all the satellite maneuvers requirements (DV and RCS) with a simplified system (small, light and cheap).
High thrust, in miniaturized dimensions, has been possible thanks to innovative combustion chambers; figure 1 below shows miniaturized thrust chambers, the farthest left delivers up to 5N of thrust in about 6x9mm (DxH).
The third patent, the ownership of which belongs in equal parts to MIPRONS and CNR, is an invention of Eng. Minotti together with Alberto Figoli, John Jansen, of Dutch nationality, Enrica Fontananova, Elisa Esposito, Roberto Jerace, and Mariagiulia Longo of the CNR.
It is an electrochemical device designed to function as an electrolyser and as a fuel cell. It allows you to convert chemicals by breaking them down into simpler substances through the use of electricity.

Figure 1 - Thrust chambers (from 6x9mm, left, to 20x30mm, right)

As of today, the MIPRONS water-electrolysis propulsion system has reached TRL=5 (Technology Readiness Level). The working prototype is expected to be finalized by the second half of 2023 with an IOD (In Orbit Demonstrator) according to the first flying availability.
The company is part of the ESA Bic (Business Incubation Centre) and has operative headquarters in Colleferro (Rome), equipped with High Performing Computing, HydrogenOxygen test bench and a vacuum chamber for tests at space conditions.

Target Market, Future Estimation and Competition

The propulsion systems, characterized by miniaturized dimensions, high performance, scalability and versatility, can be installed on, see fig.2:

- Satellites and/or related carriers;
- Extra-atmospheric drones;
- Last stages of launchers.

Figure 2 – Applications

Then, customers are both institutional and private, national and international entities, such as:

- Space Agencies
- Defence, Interior, Intelligence
- Telecommunication companies, Earth Observation, Data Exchange
- Satellite Suppliers, Satellite service providers, etc.

Independent analyses figure out that the satellite propulsion industry may reach a turnover of the order of **€22.5 Bln in 2027**, with a **CAGR of 3.8%** (Research and Markets.
In fact, being the constellation forming the trend (tens or hundreds of satellites capable of instantly mapping the entire globe), each with a specific technological/commercial objective

(observation, data exchange, internet, etc.), the number of satellites is assumed to exceed several thousands.

The high potential of MIPRONS' technology has been sustained by ESA, which in the last *"R+D days: Propulsion, Aerothermodynamics and Flight Vehicles Engineering Division"* (March 22nd, 2022), stated that water-electrolysis *"is one of the most advanced innovative propulsion systems and features a multitude of advantages in comparison with conventional propulsion systems"*.
In particular, the water-electrolysis system provides very high thrust reducing the time for maneuvering, increasing therefore, the **usability/profitability** of the satellite itself.
Moreover, the water-multimode propulsion system may deliver low and high thrust to reply to all the satellites maneuvers requirements, deeply simplifying the overall system, reducing the cost, the purchasing time and the certification process.
It is evident how both the solutions offer competitive advantage in terms of **income, ROI, strategic applications**.
To date, only two companies in the world, in addition to MIPRONS, are developing water electrolysis propulsion and no company is developing a multi-mode (low-high thrust) system using water.

Figure 3 – Water tank, electrolyzer and thrust chamber

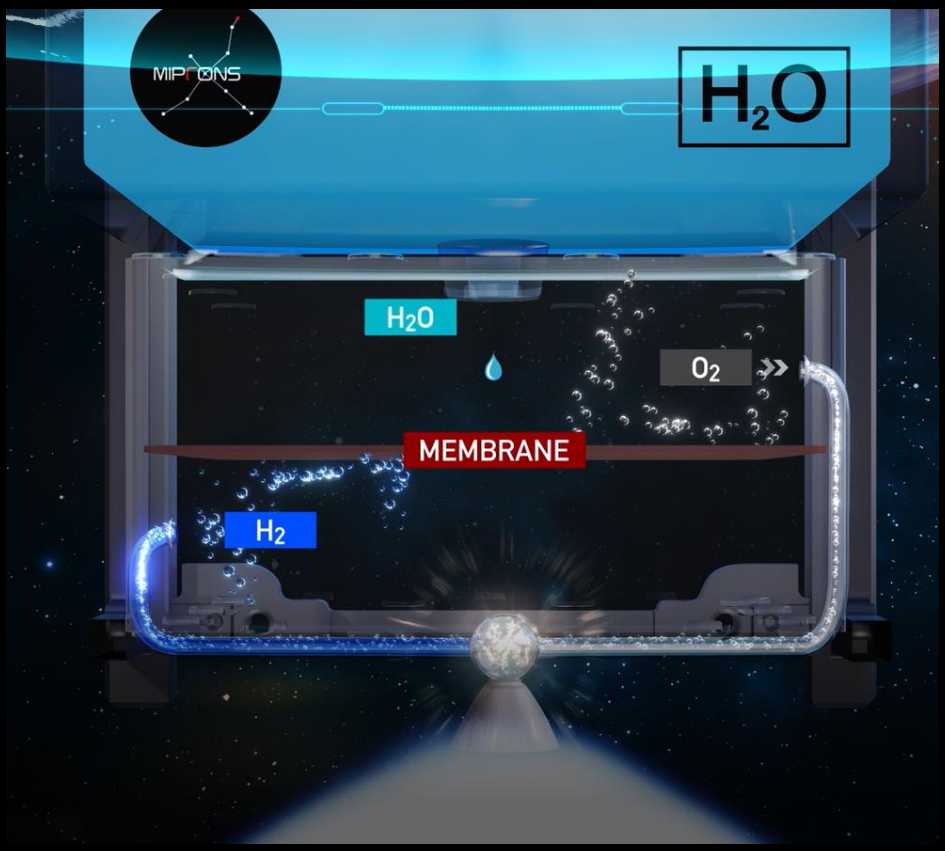

Figure 4 – Water-electrolysis process