2025

IAF SPACE PROPULSION COMMITTEE

Introduction

The International Astronautical Federation (IAF) Space Propulsion Technical Committee addresses sub-orbital, Earth-to-orbit, and in-space propulsion. All types of propulsion are of interest to the committee: chemical rockets, electric propulsion, including conventional technologies such as Hall-effect, ion, pulsed plasma, electrodeless plasma, and electrospray thrusters as well as the advanced and newly emerged technologies such as the air-breathing propulsion and the propellantless technologies. The particular interest is given to nuclear and nuclear-powered propulsion as well as to the systems that are dedicated to the use aboard the small form-factor satellites. The symposium sessions organized by the Committee during the yearly International Astronautical Congress (IAC) include: liquid systems (2 sessions); solid and hybrid systems (2 sessions); electric propulsion (2 sessions); small satellite propulsion; nuclear propulsion and power systems; air-breathing rocket propulsion; disruptive propulsion systems enabling new missions. In the year 2025, the new session is added to the Space Propulsion symposium that covers future trends in space propulsion.

The Committee deals with component technologies and testing facilities as well as complete propulsion systems, including their implementation in missions and satellites of different form-factors, discussions on in-orbit operations of propulsion systems of different types. Special attention is given to New Space developments, including miniaturized propulsion systems for small spacecraft/launchers and hybrid/multi-mode propulsion technologies.

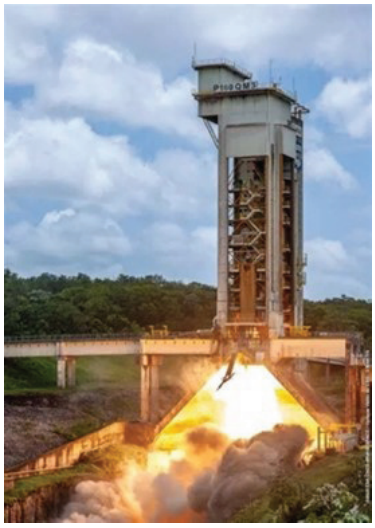
Summary

In **North America**, SpaceX (USA) **Dragon** cargo spacecraft launched in August 2025 have not only delivered supplies and experiments to the International Space Station, but also will help the station maintain its orbit. Venus Aerospace (USA) conducted a successful flight test of a **rotating detonation rocket engine (RDRE)** integrated with an aerospike nozzle. While a first in-flight demonstration of such type of propulsion was done in 2022 in Japan by JAXA and Nagoya University using a solid rocket booster to launch the experimental platform, this flight used no other propulsion system, similarly as the late 2022 flight of Poland's Łukasiewicz Institute of Aviation detonative rocket engine. Venus Aerospace, unlike the previous in-flight demonstrations in Japan and Poland utilized a bi-propellant rocket engine using hydrogen peroxide as oxidizer. The test demonstrated sustained detonation combustion and effective adaptation to varying altitude conditions, laying the foundation for future high-efficiency propulsion systems and potential single-stage-to-orbit (SSTO) applications.

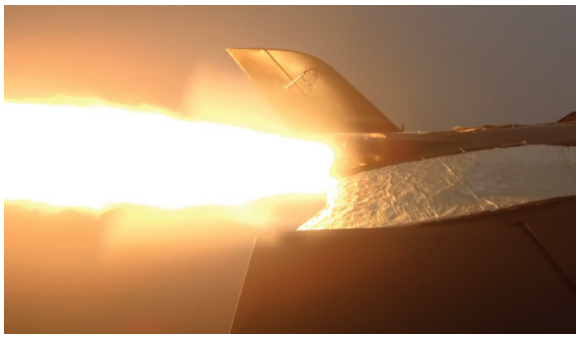
In **South America**, The Brazilian Space Program involves various public and private entities focused on developing launch vehicles and satellites. Efforts are centered on propulsion technologies, both chemical and electric, with significant contributions from DCTA, INPE, and UnB. Private firms are also advancing in solid, hybrid, and liquid propulsion. Notably, UnB recently created an additive manufacturing-based hybrid rocket engine, and the first commercial orbital launch from Brazil's Alcantara Launch Center is set to occur using a foreign company's hybrid-propulsion vehicle soon.

In **Europe**, in 2025, ARIANE 6 has confirmed the good results of its maiden flight of July 2024 with its 2 first successful commercial flights. The propulsion systems of the different stages worked nominally: the **P120C solid rocket motors** of the boosters, the **VULCAIN 2.1 LOX/LH2 engine** of the Lower Liquid Propulsion Module, the **VINCI LOX/LH2** engine and the **LOX/LH2 Auxiliary Power Unit (APU)** of the Upper Liquid Propulsion Module, giving Europe, together with VEGA-C, a return to full Space access capacity. The **P160 solid rocket motor** firing test, an upgrade of the P120C solid rocket motor that propels both Vega-C and Ariane 6 launchers, was tested in French Guyana 'Kourou' on 24 April 2025. The P160 motor firing test, close to 2 minutes, went well and according to initial recorded data, the performance met expectations.

The P160C will allow Ariane 6 Block 2 and Vega-C to launch heavier payloads. The New Space is very active, with a lot of sub-system tests and engine tests all over Europe, e.g. in PLD Space, ISAR Aerospace, RFA, SIRIUS Space Services, LATITUDE, MAIA Space, HyPrSpace, Orbex, Pangea, The Exploration Company. In October 2024, POLARIS Spaceplanes (Germany) successfully achieved the first in-flight ignition of its **Linear Aerospike Engine (LAS)**. The vehicle, with a take-off mass of 229 kg and equipped with an integrated LAS, was ignited in flight and achieved an acceleration of 4 m/s² under rocket propulsion. The engine has accumulated 118 seconds of burn time operating with a LOX/kerosene propellant combination, and delivered a peak thrust of 943 N. In early 2025, Isar Aerospace (Germany) successfully completed integrated hot-fire testing of the first stage of its Spectrum rocket. The stage is powered by nine **Aquila engines** using liquid oxygen and propane. With over 120 hot-fire tests conducted, the campaign demonstrated mature, fully in-house propulsion architecture. The company MaiaSpace (France) conducted successful tests of several technologies for its Colibri kick-stage. This includes simultaneous firings of engines and reaching steady-state thermal conditions, using the **green propellant engine technology** under development at Łukasiewicz Institute of Aviation and supplied by Thaliana Space. The German Aerospace Center (DLR) continued its work on **rotating detonation combustion for RDRE applications** and successfully captured the first published visualization of rotating detonation combustion using oxygen and hydrogen in a small-scale **Rotating Detonation Combustor (RDC)** at the DLR in Lampoldshausen. Using a high-speed camera with a frame rate of 180,000 frames per second, the team obtained images of the detonation wave structure, allowing key wave characteristics such as fill height and shock angle. The fill height, or detonation wave height, was found to be around 9 ± 2 λ, consistent with a well-known correlation by Bykovskii et al., but allowed the uncertainty for this configuration to be reduced. In the field of electric propulsion, The BepiColombo (joint ESA/JAXA mission to Mercury) equipped of four **QinetiQ-T6 Gridded ion thrusters**, has been able to cope with trajectory and propulsion adjustment over 2025. Coming back to LEO orbits, with more than 250 Field-emission electric propulsion (FEEP) thrusters in space in 2025, **ENPULSION** has become a global reference in electric propulsion for CubeSats and small satellites. The **ESA Electric Propulsion Lab** has accelerated its role of Enabler in 2025, increasing its support to various electric propulsion providers and ESA missions in the domain of small and green propulsion. Various tests have been conducted in 2025 with Hall effect (xenon, krypton, iodine), gridded ion, and water electrolysis propulsion thrusters. The ESA propulsion lab is now extending its capability to green chemical propulsion for R&D, supporting new companies and training with a **new ESA Chemical Propulsion Lab** to be inaugurated in February 2026 in **Netherlands Aerospace Centre.**



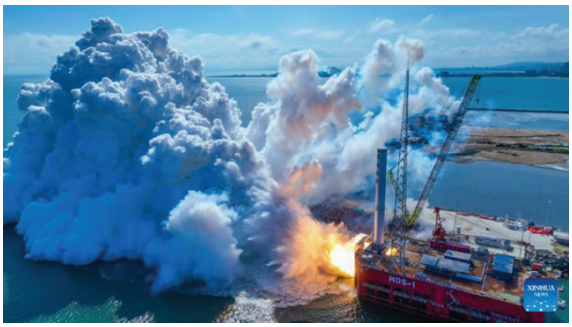
P160 solid rocket motor firing test at Kourou, French Guiana



POLARIS Spaceplanes' Linear Aerospike Engine (LAS) flight test firing

In **Asia**, Beijing-based start-up company Tianbing Technology - Space Pioneer (China) successfully completed a 30-second full scale static fire test of its **Tianlong-3 rocket's first stage propulsion** on 15 September 2025. The 72-meter-tall Tianlong-3 is a partially reusable, medium-lift vehicle capable of carrying 17 to 18 tons to low Earth orbit - comparable to SpaceX's Falcon 9. This test is a step forward to reusable rockets. It was conducted on a sea launch platform to enhance safety. This was a crucial step after a structural failure caused an unintentional launch during a static fire test in June 2024. Over 100 corrective measures were implemented since the June 2024 test, including strengthening the engine mounting section, adding new safety systems, and doubling the number of hold-down arms. The company is targeting the maiden launch of the Tianlong-3 for late 2025, possibly November or December. TiSPACE (Taiwan, China?) conducted a suborbital launch attempt of its **VP01 vehicle** from Hokkaido Spaceport in Japan on July 6. Although the rocket did not reach its target altitude of 100 km due to fin separation issues during ascent, the mission represented a significant step forward in international launch cooperation and highlighted TiSPACE's

hybrid/solid propulsion capabilities. In Japan, the last flight of **H-IIA launch vehicle (No. 50)** took place in June 2025. JAXA has launched one H3 launch vehicle in 2025 so far. This version of the launcher is H3-22S, which features two LE-9 engines and two SRB-3 boosters. H3-24W, the new version of H3 rocket with two LE-9 engines and four **SRB-3 boosters**, will be launched in October 2025. Honda (Japan) has successfully conducted its first takeoff and landing test at an altitude of 300 meters using a prototype of its in-house reusable rocket. The test vehicle is a cluster-type rocket, powered by two engines **(LOX-Methane, 6.5kN thrust)** with a total height of 6.3 meters, a diameter of 85 centimeters.



Tianlong-3 rocket first stage propulsion test

In **Australia and Oceania,** in July 2025, Gilmour Space Technologies (Australia) performed the first test flight of the Eris orbital rocket from North Queensland with the engine firing duration of about 14 seconds.

Highlights

The International Astronautical Congress (IAC 2025) in Sydney (Australia) has been an unforgettable experience, having participants in the Propulsion symposium from all the continents, including presenters from many Oceania region countries. The main highlights of the Space Propulsion symposium of the IAC 2025 include:

- For **chemical propulsion**, University of Naples Federico II (Italy) has presented updates on experi-mental and numerical activities in support of the design of **CubeSat-scale hybrid rockets**, to be hosted on future ASI missions. Moreover, a novel test bench is being developed, for small-scale testing of gas-gas and gas-liquid bipropellants.
- For **electric propulsion**, SAFRAN (France) delivered an extensive review focusing on **Hall-effect thrusters with elevated specific impulses functioning under high voltages**. They emphasized that advancing these systems necessitates identifying innovative high-voltage resistant ceramic materials, developing methods to generate intense magnetic fields, and implementing improved thermal management strategies. Meanwhile, Magdrive (United Kingdom) shared updates regarding preparations for demonstrating the performance of their ***Rogue Pulsed Plasma Thruster*** in orbit.

Outlook

In the field of **electric propulsion**, the Advanced Propulsion Systems (Russia) successfully tested in space the capability of the **MTVEPT** thruster to control the thrust vector direction by means of the magnetic field lines alterations aboard 6UXL-sized CubeSat HORS 3 launched from cosmodrome Vostochny on 5 November 2024. The angle in which the thruster vector direction is shown to be changed in space is 10 deg.

In the field of **micro-propulsion**, NeumannSpace (Australia) revealed the initial flight test results for the **center-triggered pulsed cathodic arc thruster.**

In the field of **space nuclear propulsion**, Space nuclear propulsion continues to advance as a strategic capability for deep space missions. The policy report “Weighing the Future: Strategic Options for U.S. Space Nuclear Leadership” (INL) published in July 2025 urges accelerated investment in nuclear power and propulsion systems to maintain U.S. leadership in cislunar and interplanetary space. On the technical front, the Centrifugal Nuclear Thermal Rocket (CNTR) concept proposes using centrifugal force to stabilize molten nuclear fuel, potentially overcoming key engineering challenges in NTP systems. The paper drew widespread attention, with coverage from outlets including Popular Mechanics, highlighting its potential to reshape crewed Mars mission architectures. In a major shift, DARPA canceled the DRACO program, citing declining return on investment. The joint DARPA-NASA initiative was deprioritized due to reduced launch costs from commercial providers like SpaceX, making NTP less cost-effective for cislunar operations. China and Russia have also reaffirmed plans for a lunar nuclear reactor. Chinese researchers also unveiled a 1.5 MW shrinkable fission reactor prototype, designed to deploy post-launch and propel spacecraft to destinations such as Mars, with initial ground tests successfully completed.

Committee Activities

The Committee is currently made of 49 members from 16 countries, including 9 female members and 12 young professionals, with good distribution among geographical areas and categories (industry, Academia, agencies). In 2025, several new regular Committee members have been welcomed in the Committee: Bhavyashree Janardhana (POLARIS Raumflugzeuge GmbH, Germany), Jamal Darfilal (Khalifa University, UAE), Jouke Hijlkema (ONERA, France).

The Committee is not only active in the organization of the International Astronautical Congress (IAC), but also fosters synergies with other relevant space propulsion conferences, such as the International Symposium on the Peaceful Use of Space Technology – Health (IPSPACE 2025) in December 2025 (Hainan, China), Joint 2nd Brazilian/Inter-American School and Workshop on Electric Space Propulsion in March-April 2026 (TBD) (Brasília, Brazil), Space Propulsion 2026 in May 2026 (Bari, Italy), 4S symposium in May 2026 (Sardinia, Italy), 27th AIAA International Space Planes and Hypersonic Systems and Technologies Conference in July 2026 (Naples, Italy). The Committee members are also active in knowledge dissemination to the space propulsion scientific community through the publication of papers and books.