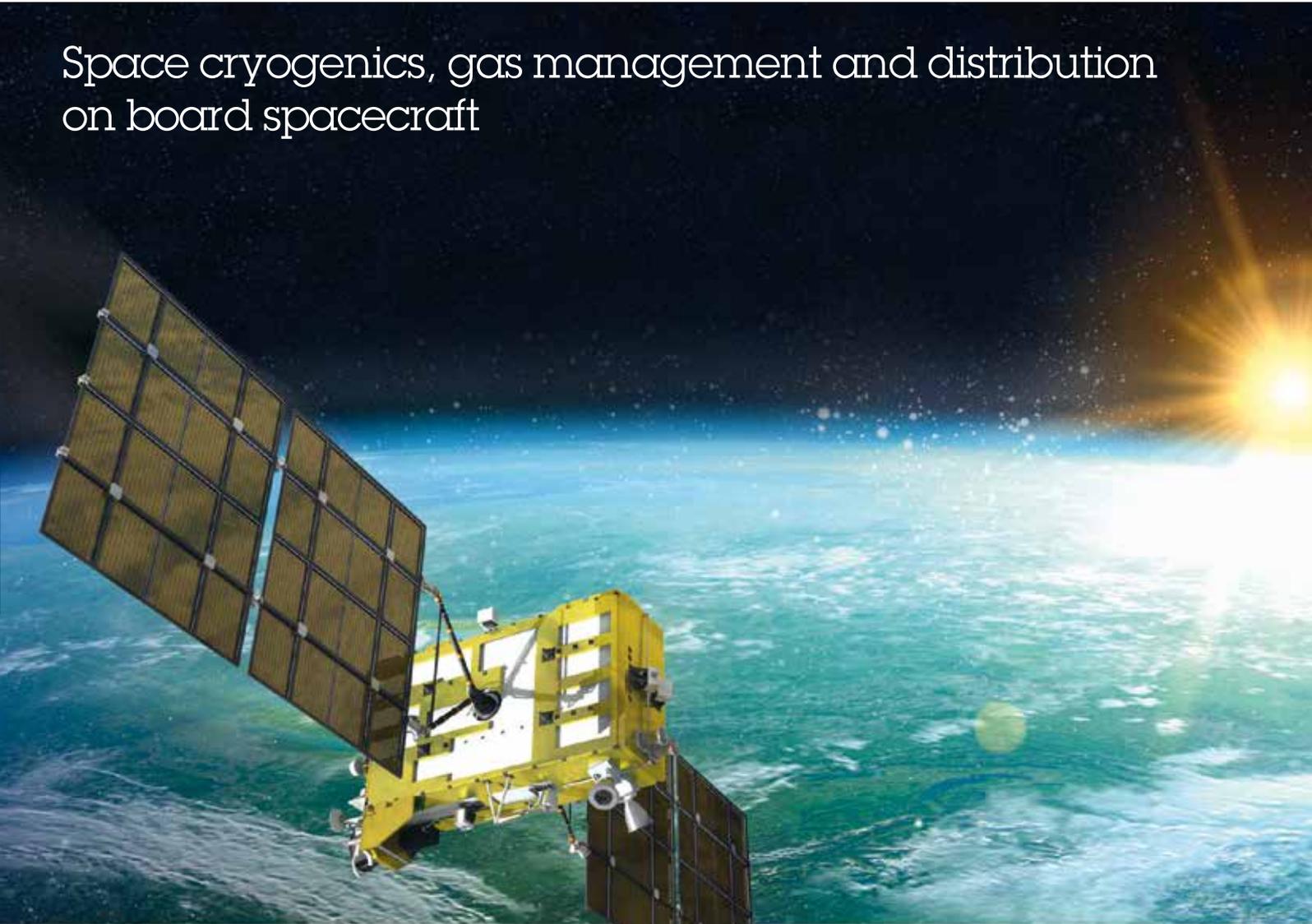


Satellites

Space cryogenics, gas management and distribution on board spacecraft



Air Liquide's teams ensure design, development, manufacturing and testing of satellites' sub systems.

Space cryogenics

Thanks to our expertise in very low temperatures, we provide customized solutions to produce, manage and distribute cold to meet a wide range of requirements in the field of satellites: observing the thermal radiation of the universe, cooling the infrared sensors on earth observation satellites or preserving biological samples taken on the International Space Station (ISS)...



Cold production from 0.1K to 200K

Developing, qualifying and delivering coolers and cryogenic equipment with a wide temperature range for satellites requiring cooling power:

• Pulse tube cryocoolers

- Miniature Pulse Tube Cooler
- Large Pulse Tube Cooler
- Heat intercepted Pulse Tube Cooler

• Large and specific cryogenic equipment

Extremely low temperature systems:

- Dilution
- Cryostats

High power cooling:

- Stirling
- Turbo-Brayton

Cold management and distribution

Designing, manufacturing and testing of complete systems:

- Controlling and monitoring the cooling power or temperature
- Adjusting pressure and flow rate
- Management of induced vibrations

Conceiving, producing and checking critical cryostats elements:

- Hydrogen and helium tanks
- Vacuum vessels
- Thermal shields
- All fluid lines and thermal links providing the cooling power to the instrument

Our major achievements

Air Liquide provided the cryogenic systems for most of the European scientific and Earth observation missions for the last 15 years:

• Pulse tube coolers (from 10K to 200K)

References: MTG & IASI-NG



• Cryogenic storage system

Reference: ISS



• Dilution cooler (from 0.1K to 1.6K)

Reference: Planck



• Turbo-Brayton cooler (from 20K to 200K)

Reference: MELFI on ISS



• Cryostats

Reference: Herschel



Gas management

By 2022, a quarter of satellites in geostationary orbit will use electric propulsion. By using xenon as fuel, satellites' weight can be cut by two.

In that context, Air Liquide teams have developed a global solution for electric propulsion for satellites, including flow control system, xenon supply and filling service. Air Liquide can also provide gas management devices, supply and services related to other gases such as krypton, helium...



Ground support equipment

Providing ground support equipment and associated services for satellites

- **Loading carts (xenon, krypton, helium...)**

For filling of small and large satellites



- **Gas production and supply (xenon, krypton, helium...)**

- **Large range of tests**

Fonctionnal, mechanical, thermal, components tests and under representative space conditions

- **Associated services**

Filling on launch pads, maintenance, training...

Onboard gas management devices

Satellites propulsion and planetary exploration

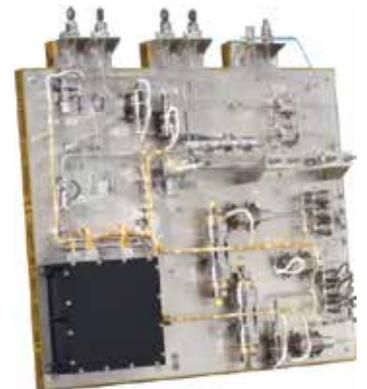
- **Valves (xenon, krypton, helium...)**

- Micro latch valve
- Pressure control valve

- **Propellant storage and regulation**

Air Liquide's electronic units keep in line gaseous mass flows and pressures for satellites through the control and monitoring of components.

Reference: Planck





A system-level approach of your project

Air Liquide teams get involved very early in the cycle of projects, approaching each solution globally, using a procedure that combines advice, solution design, risk and cost control. We take into account fluidic, thermal, mechanical and interface aspects to propose you the most appropriate solution:

- Control of fluids
- Mechanical environment
- Air Liquide project support
- Temperature management
- Interface

Our strenghts

- Recognized experience in the space adventure
- Solid expertise in space cryogenics and in gas production and storage (Air Liquide core business)
- Dedicated teams providing support
- A large scale cryogenic test center simulating space environment
- Resources of an international group

Air Liquide and Space

Since the beginning of cryogenic launchers in Europe more than 50 years ago, Air Liquide has been a major partner, bringing to the space community its pioneering spirit, its innovation capacity, its expertise and its technical excellence.

Air Liquide is a key partner for launchers, satellites and space exploration.

Contacts

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The world leader in gases, technologies and services for Industry and Health, Air Liquide is present in 80 countries with approximately 65,000 employees and serves more than 3.5 million customers and patients.