

NanoSpace
Swedish Space Corporation Group





MEMS for Space

MEMS technology to open new frontiers in space

MEMS (Micro Electro-Mechanical Systems) is an enabling technology that allows us to perform new types of missions in space.

- Missions that will bring new knowledge about other planets.
- Missions that will increase our understanding of life on earth.
- Missions that will improve life on earth.

Reduced size is the main advantage with MEMS

Miniaturization of components and systems is desirable in many different areas. But in no other field is it as crucial to reduce size and mass as in space applications.

- Reduced size allows more functionality and increased redundancy
- Reduced size translates to reduced cost
- Reduced costs increases access to space

MEMS technology is ready to enter space

MEMS technology has changed the landscape in other areas such as biotech, life science and the automotive industry. Components and subsystems based on MEMS technology are currently being introduced in the space sector. The Prisma mission in 2009 will take a number of new MEMS components to space for the first time, and thereby becoming an important stepping stone in this process.

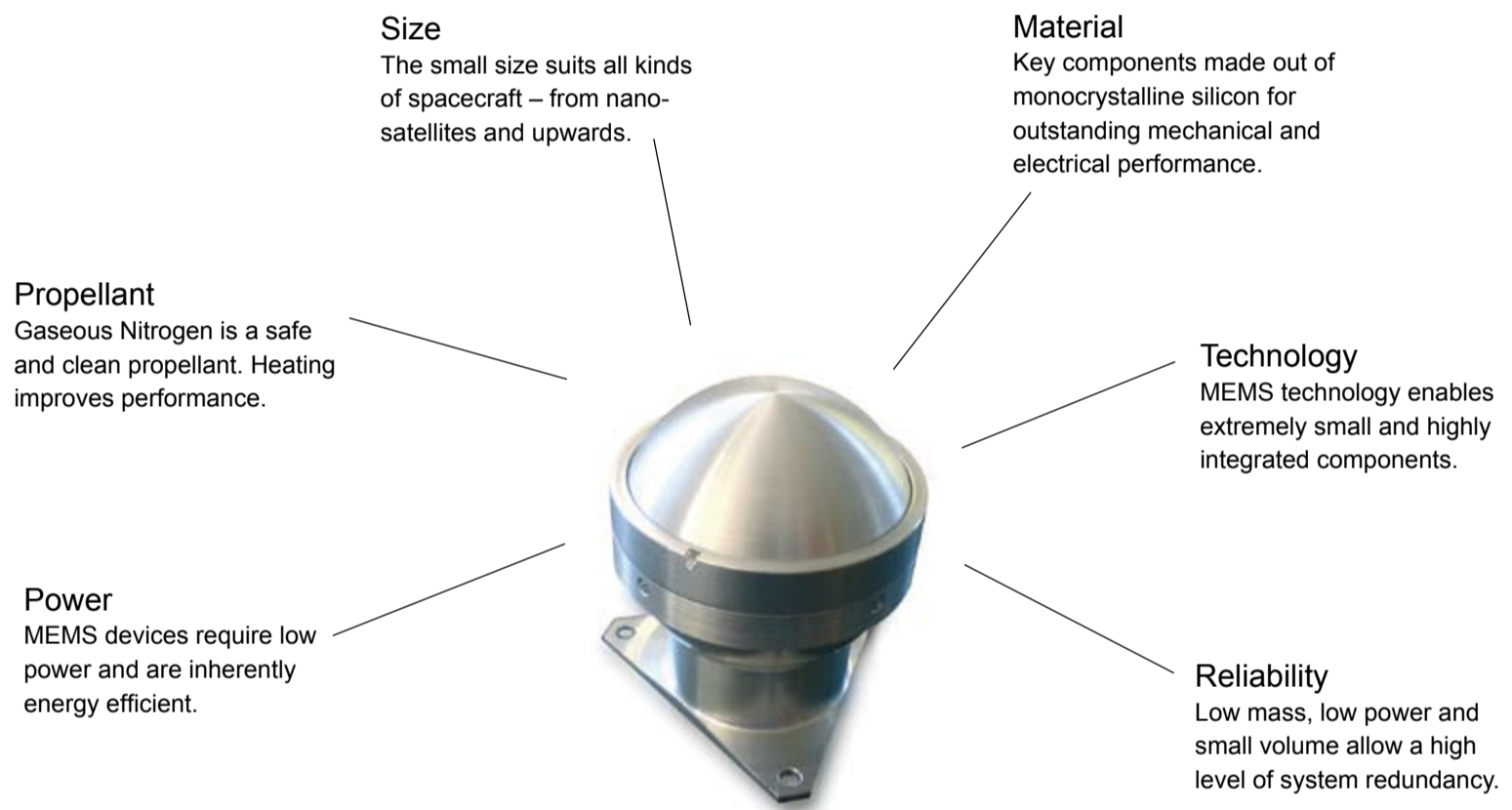
NanoSpace will take MEMS into space

NanoSpace is one of very few companies devoted to development of MEMS products for space applications. NanoSpace has the skills, dedication, experience and support to achieve this.



Smallest on earth

The micropropulsion system developed by NanoSpace is designed to meet the highest requirements on low thrust with low noise and proportional control. "Low thrust" means micro- to milli-Newton levels. The micropropulsion system is not only suited for precision control of advanced space systems but also as primary propulsion for miniaturized satellites where low mass, volume and power consumption are driving criteria.



Scale 1:1
(Diameter: 43.5 mm, Height: 51 mm)

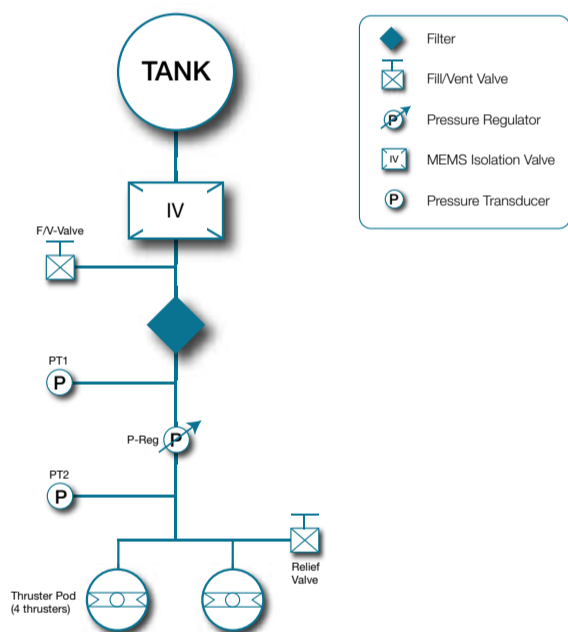
Products

Micropropulsion System

NanoSpace's miniaturized propulsion system provides extremely small and precise thrust for a variety of satellite missions. Formation flying and precise attitude control are examples where thrust levels in the micro- to milli-Newton range are required.

The NanoSpace micropropulsion system contains several novel and patented innovations. The key component is the thruster module containing unique technology. The thruster module contains a silicon wafer stack with four complete rocket engines with integrated flow control valves, filters, and heaters. Extremely small heaters are located inside the thrust chamber to improve the specific impulse and hence efficient use of the propellant.

NanoSpace's miniaturized propulsion system will be flight demonstrated on Prisma – a European mission to demonstrate autonomous formation flying and rendezvous. The NanoSpace micropropulsion system is also being evaluated for a number of other missions.



Micropropulsion Schema: Schematic system layout of a micropropulsion system.

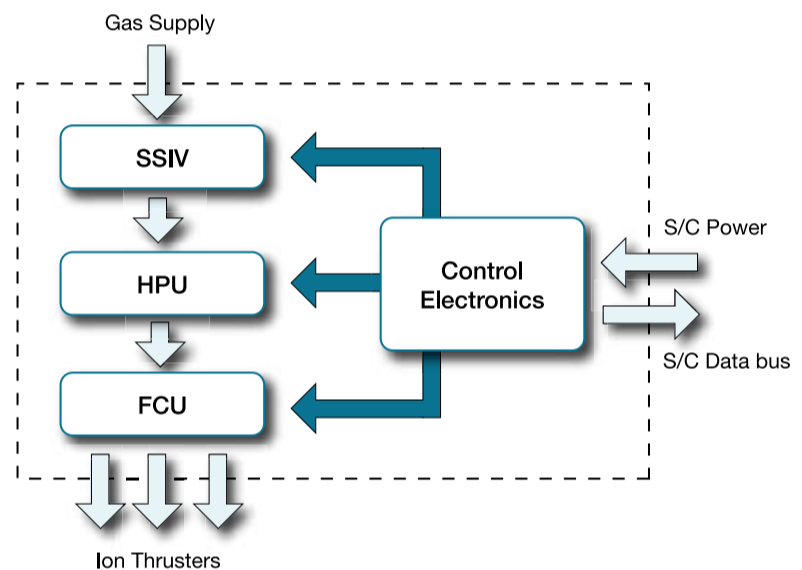
Key requirements	NanoSpace
Thrust range:	10 μ N to 1 mN
Specific Impulse:	50 - 100 sec (higher with heated gas)
Power consumption:	< 1W (per thruster)
Mass:	< 100 g (thruster pod)
Dimensions:	43.5 mm (diameter), 51 mm (height)

Xenon feed system

A Xenon feed system for electric propulsion systems onboard telecom satellites is presently being developed. The system will be placed between the tank and the engine and will regulate/control the propellant to the ion engines.

A modular building concept is applied where miniaturisation is achieved by stacking processed silicon wafers. This concept results in a multi-functional system in a single mechanical housing. The different wafer stacks contain several components and functions such as isolation valve, filters, flow control valves, pressure- and temperature sensors and thermal flow restrictors.

The resulting Xenon feed system offers an order of magnitude mass savings compared with a conventional system.



Xenon Feed Schema: Schematic Xenon Feed System consisting of: MEMS Isolation Valve (MIV), High Pressure Unit (HPU), and a Flow Control Unit (FCU).

Key requirements	NanoSpace
Supply pressure:	MEOP 200 bar, min pressure 10 bar
Operating pressure:	0 -5 bar
Mass flow range:	0 - 4 mg/s
Stability:	\pm 1 %
Mass:	< 200 g

Components



NanoSpace MEMS Isolation Valve

NanoSpace offers a number of MEMS-based components for the space industry, e.g. pressure and temperature sensors, filters, proportional valves for fluid control, flow restrictors and single use isolation valves. The latter is an essentially leakage-proof valve that replaces conventional pyro valves commonly used in space applications.

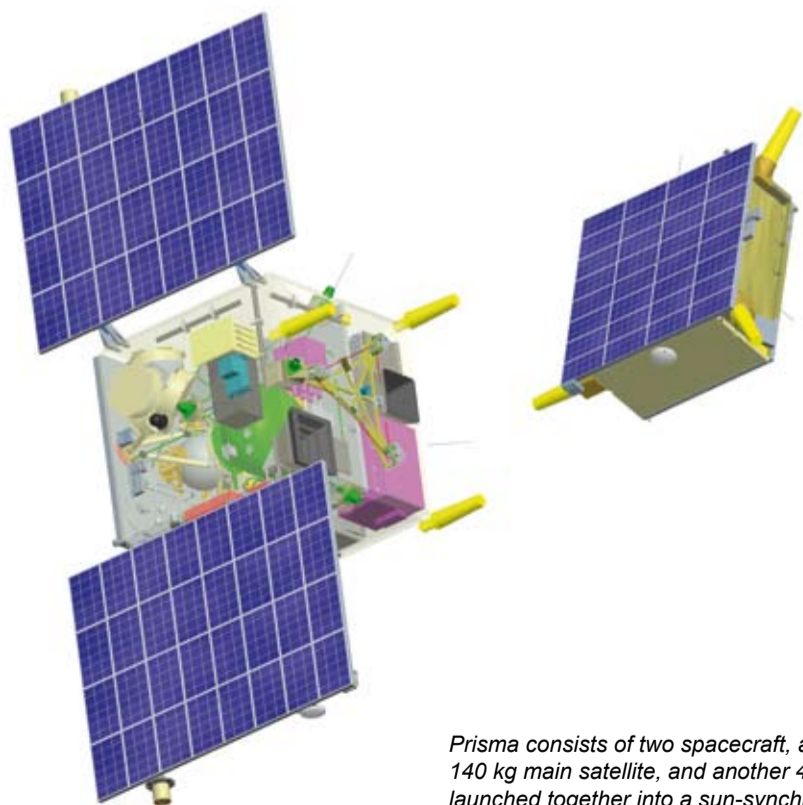
MEMS – The breakthrough technology for space

Miniaturization has always been an issue in space technology, since weight reduction is in constant demand. This demand has always been met by introducing new materials, new tools and new fabrication methods. MEMS technology offers the possibility of a quantum leap - it is truly a breakthrough technology.

Micro-Electro-Mechanical Systems (MEMS) is the integration of electronics and mechanical structures at the micrometer scale ($1\ \mu\text{m} = 0.001$ millimeter) through advanced micro fabrication technology. While the electronics are fabricated using integrated circuit (IC) processes, the micromechanical components are fabricated using compatible micromachining processes that selectively etch away parts of the silicon wafer or add new structural layers to form the mechanical and electromechanical devices.

MEMS offer the benefits of significantly reduced mass and power consumption translating directly into decreased costs and allows for higher system redundancy.

The ability to perform and enhance tasks in the micro world, in ways that are impossible using conventional technologies in the macro world, makes it a genuine breakthrough technology for space. MEMS is an enabling technology for advanced missions such as formation flying, rendezvous and inspections.



Prisma consists of two spacecraft, an advanced and highly maneuverable 140 kg main satellite, and another 40 kg target spacecraft. Both shall be launched together into a sun-synchronous orbit at around 700 km altitude.

PRISMA – The Technology Demonstrator

The Prisma satellites will carry several new MEMS components into space for the first time in 2009. Achieving the first successful flight of a new product is absolutely essential in the conservative space business. For NanoSpace, the flight onboard Prisma is the moment of truth for our micropropulsion technology and all the individual MEMS components that it contains. The flight demonstration on Prisma will pave the way for successive missions in particular and MEMS technology in space in general.



a NanoSpace engineer, working in the clean room.

Innovations and dedication - the heart of NanoSpace

NanoSpace is an innovative company with focus on MEMS-based products for space applications. The key resource of NanoSpace is our highly skilled engineers and researchers with a proven track record to develop, manufacture and deliver MEMS components.

NanoSpace has access to the Ångström Laboratory and their 2000 square meter clean room facility containing the equipment to manufacture a large range of MEMS devices.

NanoSpace is part of the Swedish Space Corporation group. The track record of Swedish Space includes 30 years of space activities including development, manufacturing and operation of six satellites, in earth orbit, the lunar probe SMART-1, more than 500 sounding rocket launches and much more.

Swedish Space gives NanoSpace a solid foundation in terms of technical and financial support relevant experience and connection to the space industry. NanoSpace holds a number of patents and novel innovations within the field of MEMS for space applications.

To space through
reduced size
and cost





NanoSpace

Swedish Space Corporation Group

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