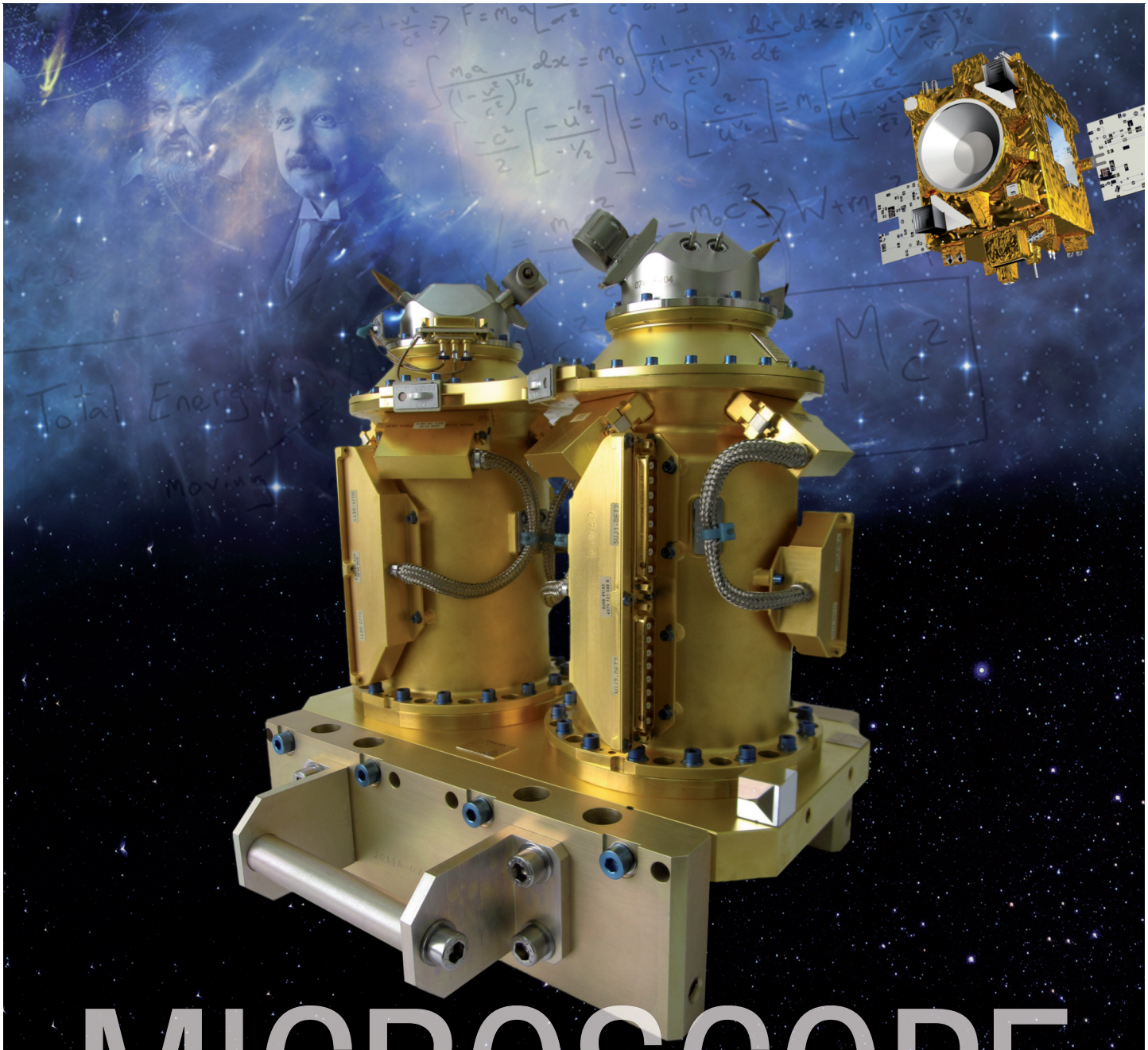

# MICROSCOPE

## Ultra-precise accelerometers for testing the general theory of relativity

ONERA has developed the T-SAGE instrument, which can be used for testing Einstein's general theory of relativity in the framework of the MICROSCOPE space mission (*MICROSatellite à traînée Compensée pour l'Observation du Principe d'Équivalence* - Compensated drag microsatellite for observing the equivalence principle). This dual differential accelerometer will test the equivalence principle, or universality of free-fall, 100 times more precisely than any experiments carried out on Earth. The satellite is operated by CNES, the special partner for this mission.

MICROSCOPE

ONERA
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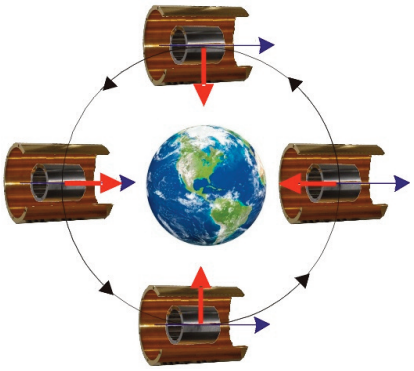


Principle of the EP test experiment

## What does the payload do?

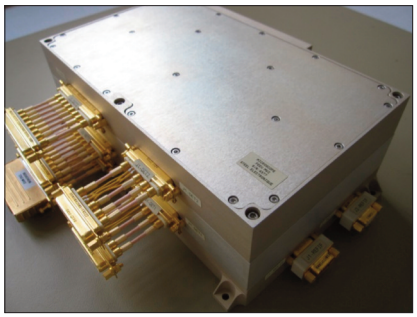
T-SAGE (Twin Space Accelerometer for Gravity Experiment) constitutes the payload of the MICROSCOPE space mission. It is a dual differential accelerometer used for testing the equivalence principle (EP), or universality of free-fall, at $10^{-15}$ or 100 times better than any experiments carried out on Earth.
The principle of the experiment: the proof masses are accelerated in order to be kept concentric on the same trajectory by means of electrostatic forces.
If a difference of control acceleration is detected for the two masses, this would indicate a violation of the EP.

## Exceptional performance

This instrument represents a distillation of 40 years of ONERA know-how in the field of nano and femto accelerometry.
It comprises two accelerometric measurement chains, each consisting of:

- two electrostatic inertial sensors (SU) with two controlled proof masses
- a high-resolution proximity electronic controller (FEEU)
- digital satellite control and interface electronics (ICU)

The total volume is 37 liters, distributed over 4 units, for a mass of 36 kg and 40 W of power.



Onboard FEEU electronics with the position detection functions at $10^{-11}$m/Hz$^{1/2}$, ONERA's core business

## ONERA: world leader in ultra-sensitive space accelerometry

ONERA makes available its know-how in nano/femto accelerometry to major space missions:

- CACTUS (1975) on CASTOR D5B (CNES)
- ASTRE (1996 and 1997) on Columbia (ESA/NASA)
- STAR (2000) on CHAMP (CNES/DLR)
- SuperSTAR (2002) on GRACE (NASA/DLR)
- Gradio (2009) on GOCE (ESA)
- T-SAGE (2016) on MICROSCOPE (CNES/ONERA/OCA)
- SuperSTAR-FO (2017) on GRACE- FO (NASA)

The MICROSCOPE mission center at ONERA

## MICROSCOPE: a scientific mission coordinated and operated by ONERA

Since mission launch in April 2016, the scientific mission center, based at ONERA, has gathered the operating data and defined the scenario for the scientific mission loaded by CNES on the satellite. In collaboration with the Observatory of the Côte d'Azur, ONERA has developed all the operational and scientific software tools for the scientific phases of the mission.

From 2019, once the scientific results have been validated, ONERA will release the data.

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ONERA - May 2017 - Images: © ONERA - satellite: © CNES-July 2012-illus. D. Ducros