Image: ESTEC's new Galileo Payload Laboratory

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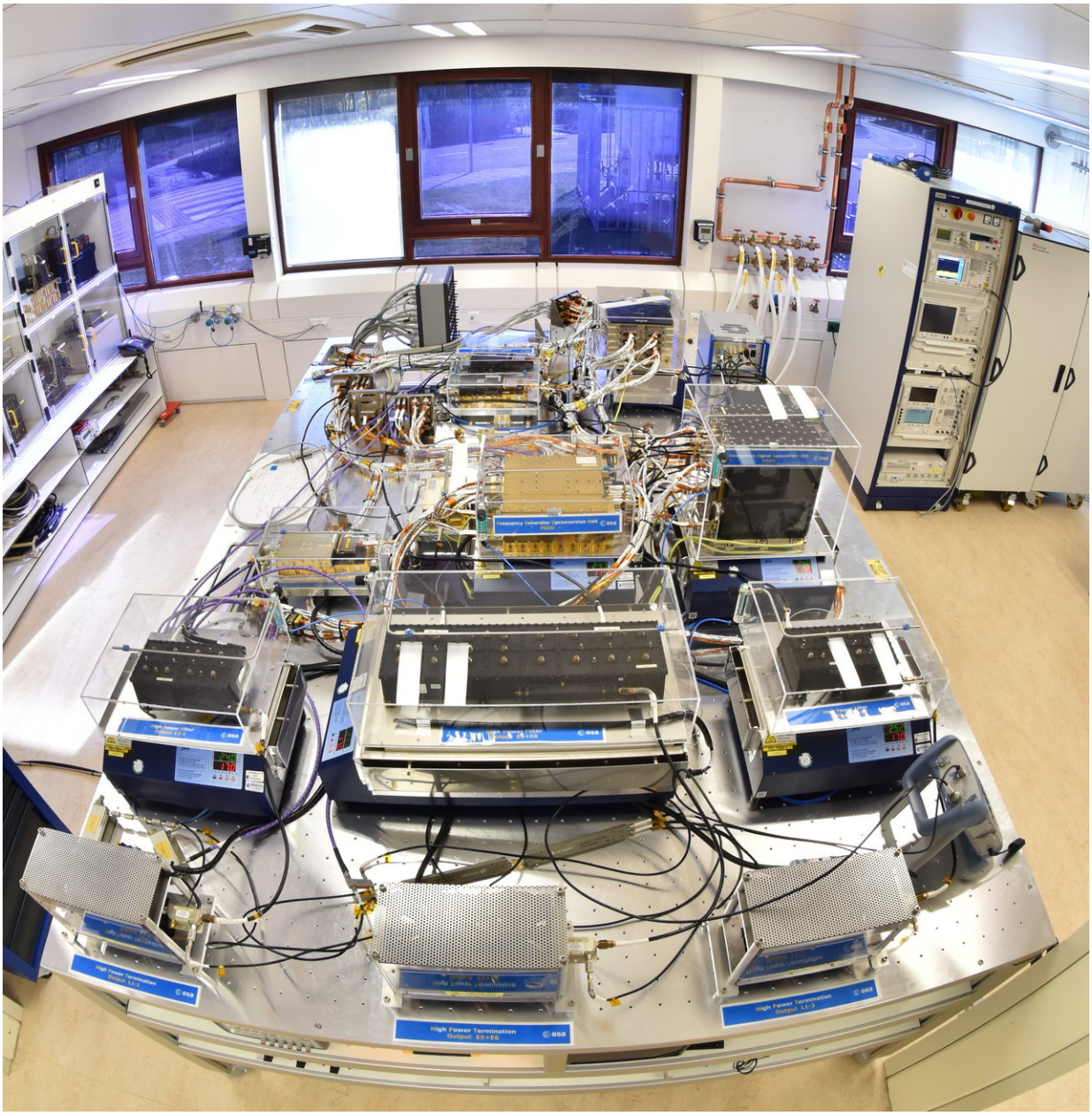

Credit: ESA–Cesar Miquel Espana

ESA microwave engineers took apart an entire Galileo satellite to reassemble its navigation payload on a laboratory test bench to run it as though it were in orbit – available to investigate the lifetime performance of its component parts, recreate satellite anomalies, and test candidate technologies for Galileo's future evolution.

Located in the cleanroom environment of the Galileo Payload Laboratory – part of ESA's Microwave lab based at its ESTEC technical centre in the Netherlands – the new Galileo IOV Testbed Facility was inaugurated this week with a ceremony attended by Paul Verhoef, ESA Director of Navigation and Franco Ongaro, ESA Director of Technology, Engineering and Quality.

Paul Verhoef congratulated the team and underlined the importance of ESA having these capabilities: "Such a navigation payload laboratory does not exist in industry. We foresee the testing and validation a number of very innovative ideas for the next series of Galileo satellites, before entering into discussions with industry in the context of the procurement of the Galileo Transition Satellites that has recently begun. This shows the added value of ESA as the design agent and system engineer of the Galileo system."

"Our lab has always been very responsive to the testing needs of the Navigation Directorate," says microwave engineer César Miquel España.

"Now, this unique facility allows performance of end-to-end testing of a Galileo payload as representatively as possible, using actual Galileo hardware. We can also support investigations of any problems in orbit or

plug in future payload hardware as needed. And because each item of equipment is separately temperature controlled we can see how environmental changes affect their performance."

The Testbed began as an 'engineering model' of a first-generation Galileo In-Orbit Validation (IOV) satellite, built by Thales Alenia Space in Italy for ground-based testing. It was delivered to ESTEC in August 2015, along with four truckloads of ground support equipment and other hardware.

That began a long three-year odyssey to first take the satellite apart, then put it back together – akin at times to space archaeology, since the satellite had been designed more than 15 years ago.

"We found lots of documentation on how to integrate the satellite, but nothing on how to take it apart," adds technician Gearóid Loughnane. "We had to dismantle it very carefully over several weeks to remove the smaller items safely and take out the electrical harness, which ended up as a big spaghetti pile on the floor."

The next step was to extricate the navigation payload from the satellite platform, and then begin to lay it out to connect it up again. A parallel effort tracked down supporting software from the companies involved, to be able to operate the payload once it was complete, as if it is orbiting in space.

Valuable help came from Surrey Satellite Technology Limited in the UK, Dutch aerospace company Terma that developed Galileo software, and Rovsing in Denmark, supplying ground support equipment.

"A big challenge was tailoring the spacecraft control and monitoring system to work only with the payload units while having to emulate the platform equipment," says technician Andrew Allstaff.

Comprising equipment produced by companies in seven separate European companies, the testbed generates navigation signals using actually atomic clocks co-located in the lab, which are then upconverted, amplified and filtered as if for transmission down to Earth.

The idea came from a GIOVE Payload Testbed already in the lab, which simulates the performance of a test satellite that prepared the way for Galileo. As a next step the team hopes they can one day produce a Galileo 'Full Operational Capability' Payload Testbed – the current follow-on to the first-generation IOV satellites.

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