SIEMENS

AEROSPACE AND DEFENSE

Thales Alenia Space

Thales Alenia Space partners with Siemens to explore new tools and methods for acoustic testing in the space industry

Product

Simcenter

Business challenges

Performing tests on-site without the need to ship tested items to a dedicated test facility

Lowering the costs of satellite qualification testing

Safeguarding the integrity of specimens and personnel at all times

Keys to success

Demonstrate new control method for direct field acous-tic excitation

Obtained a uniform acoustic field as in an acoustic reverberant testing facility and similar vibration levels on the specimen

Run components and small satellite test campaigns faster and onsite

Results

Flexible setup that does not require an acoustic reverberant room

Reproduced test conditions accurately, comparable to the ones obtained in reverberant room

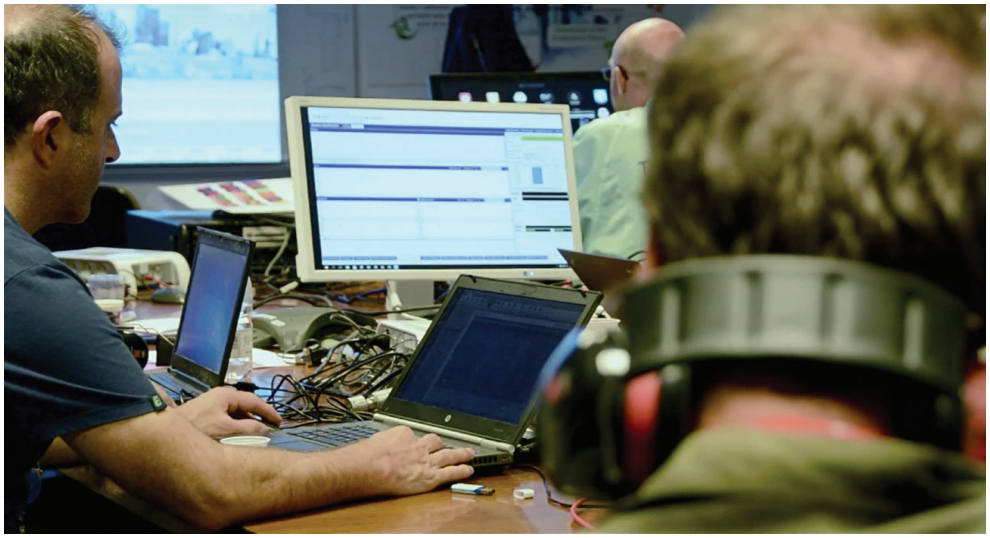
Increased efficiency with up to 25 test runs performed within one day of campaigne

Launch survivors

The launch of a communication satellite into space is a traumatic event for its parts and pieces. Components are heavily exposed to the eventuality of breakdown or damage, yet engineers need to ensure that the satellite reaches its orbit in faultless operating condition.

Satellite qualification testing is the ultimate step of a satellite development process. This step certifies that every single satellite element will survive the traumatic launch conditions. Relying on decades of experience in delivering dedicated solutions for dynamic environmental testing, Siemens Digital Industries Software is the preferred partner of space agencies worldwide for satellite qualification testing. The combined capabilities of Simcenter Testlab™ software and Simcenter SCADAS™ hardware, both part of the Simcenter™ portfolio, ensure safe and efficient qualification testing.

Thales Alenia Space, a leading European space satellite and payloads manufacturer, partners with Siemens to explore new methods for satellite testing. Thales Alenia Space is a joint venture between Thales (67 percent) and Leonardo (33 percent). Combining 40 years of experience with a unique blend of expertise, talents and cultures, Thales Alenia Space architects design and deliver high-technology solutions for telecommunications, navigation, earth observation, environmental management, exploration, science and orbital infrastructures.



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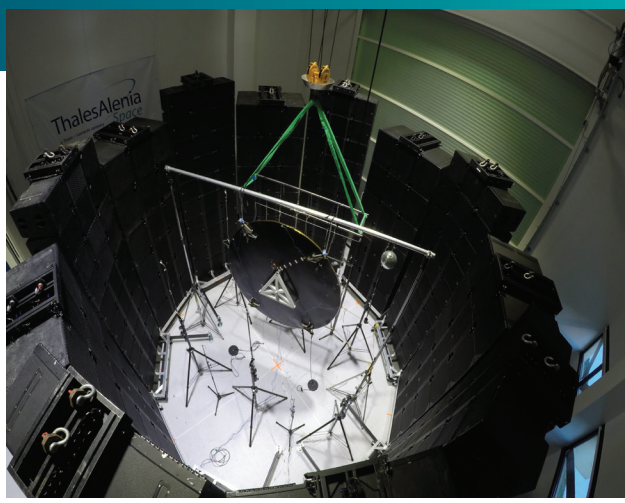
Project Leader – Antenna Mechanical Analysis
Thales Alenia Space

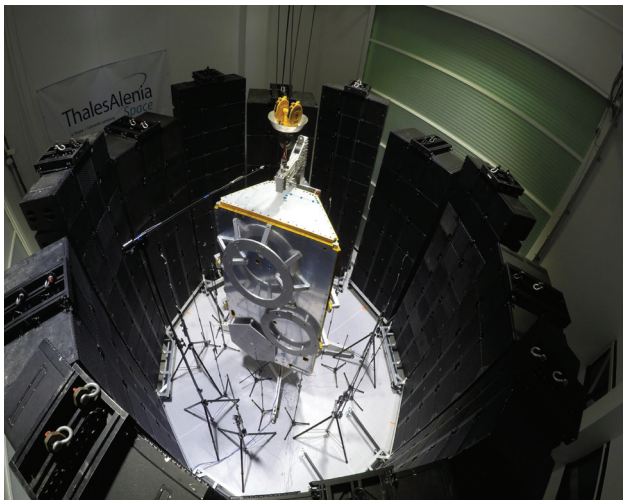
Reforming methods

Dynamic environmental testing encompasses a number of essential tests for qualification of space hardware, and acoustic testing is one of those most crucial steps. It subjects an item to intense noise levels while measuring its vibration response. This test is performed on both component (reflectors, solar panels) and system (full satellite) levels.

Satellite acoustic testing is traditionally performed in acoustic reverberant rooms. In most cases, these large facilities (sometimes over 1,000 cubic meters to accommodate large spacecraft) are filled with gaseous nitrogen which has a lower sound absorption coefficient than air. The noise is generated by modulators connected to horns placed in the chamber; the result is a noise level that can reach over 150 decibels (dB). In these facilities, engineers simulate the noise field that excites the satellite in the fairing of the launcher. In addition to its extensive offering for multichannel data acquisition, Simcenter offers a comprehensive solution to control acoustic signals in the reverberant room.

Acoustic testing in reverberant rooms is a safe, reliable and accurate testing method, while at the same time extremely costly and time-consuming. Satellite subsystems such as antennas or reflectors are also tested according to this method, often in medium-sized reverberant rooms.





Over the past 15 years, the U.S. space industry has been trying alternative testing methods. Research projects evaluate methods that offer a more economical option as well as more flexibility to perform the tests away from sparse and costly-to-operate facilities. A Direct Field Acoustic eXcitation (DFAX) method, also

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named DFAT in the U.S., has been developed and is partly used today for qualification of North American satellites. DFAX has lower running costs and initial investment and offers the technical benefit of considerably shorter ramp-up time to level or better controllability in the lower frequency range of 20 hertz to 60 hertz (Hz). In 2016, the National Aeronautics and Space Agency (NASA) published the NASA Handbook 7010, which is the first handbook that lays out the guidelines for companies wanting to use the new acoustic testing methodology. Like their North American counterparts, leading European industry companies such as Thales Alenia Space are conducting experiments to explore and validate new methods for satellite acoustic testing.

Pump up the volume

What do Werchter, Belgium, Roskilde, Denmark, and Kuru, French Guyana have in common? Werchter and Roskilde are locations of popular open-air rock and pop festivals that bring crowds of passionate music lovers together. Incidentally, in recent years, performances of modern loudspeakers and amplifiers have been pushed to their maximum to better entertain the ever-growing hordes of music fans. The availability of commercial loud-speakers and amplifiers capable of generating the sound field required in a test has made the development of the direct field acoustic excitation method possible. In a DFAX test, the specimen is placed in the middle of a loudspeaker circle and gets excited by a direct acoustic field. Modern loudspeakers and amplifiers deliver the required high decibels to obtain the target overall sound pressure level (OASPL). The vibration levels measured on the specimen during the DFAX test are comparable with those measured with reverberant field acoustic excitation. In the near future, satellites that are placed on the European launch pad of Kuru might have been partially qualified using rock concert loudspeakers.

Clearly, DFAX lowers overall test expenses, can be performed (nearly) everywhere and brings more flexibility with shorter test sequences. However, safety, reliability and accuracy of the tests should not be discounted. The nature of the sound field in a DFAX test differs from that of a reverberant room test. This difference needs to be accounted for in order to produce realistic test conditions. The engineers of Thales Alenia Space are relentlessly working to improve and validate the DFAX method.

Homogenate the sound field

Space in Toulouse, France, develops satellite components that will later be integrated in the full system. The company owns an acoustic reverberant room facility; however, this facility is located in Cannes, some 500 kilometers from Toulouse. In practice, this implies that every newly developed component needs to be shipped to Cannes for acoustic qualification testing, leading to additional costs and delays. With the help of Siemens Digital Industries Software engineers, the team explored a new DFAX method that would permit on-site qualification testing of components. “Thunder” is the name of the project, apropos for a project that generates a 147 dB sound field in an International Organization for Standardization 9 (ISO9) clean room. The performance is unmatched in Europe.

The objective of the test campaign is to reproduce the acoustical environment that a communication satellite is subjected to when placed in the fairing of a satellite launcher. The test setup is designed to generate the high acoustic levels that excite the specimen during takeoff. The setup is comprised of 96 loudspeakers, stacked in 12 columns and adequately positioned in a circular configuration, and 96 amplifiers that deliver the required high power of 4x5 kilowatts (kW). The specimen being tested is placed at the center of the five-meter cylinder of loud-speaker columns. The challenge is to reproduce a

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Solutions/Services

Simcenter Testlab
siemens.com/simcentertestlab

Simcenter SCADAS
siemens.com/simcenterscadas

Customer's primary business

Governments, institutions and companies rely on Thales Alenia Space to design, operate and deliver satellite-based systems that help them position and connect anyone or anything and help optimize our resources.
www.thalesgroup.com

Customer location

Toulouse
France

uniform diffuse acoustic field around the specimen. In the described test, the team evaluates the behavior of the specimen, making sure that it is equivalent to the one specimen placed in an acoustic reverberant room.

Christophe Fabriès, project leader at Thales Alenia Space explains: "Siemens brings its expertise to solve the complex challenge of generating an homogeneous sound field around the test item. The solution uses Simcenter SCADAS hardware fitted with a multiple inputs multiple outputs (MIMO) controller and combined with Simcenter Testlab software. It requires the measure of 16 microphones positioned around the specimen, analyzes their response and corrects drives. The corrected drive values are reinserted in the loudspeakers in order to create an homogeneous acoustic field."

The Simcenter SCADAS hardware provides the adequate voltage output. Using a closed-loop algorithm, the solution ensures that the output matches the reference profile drive. The method allowed the team to successfully qualify the reflector shell of an antenna subsystem demonstrator. In the second phase, the team performed qualification tests on the mid-sized platform of a Global Star second generation (GB2) spacecraft mockup. The full qualification sequence was realized according to multilaunchers requirements.

"This phase helped us validate that the testing method is suited for qualification of spacecraft from constellation production lines," says Fabriès. "With this method, we are able to conduct up to 25 test runs within a test session. It is a very efficient way of testing newly-designed hardware. It will allow us to explore more variants with the possibility of performing immediate validation in the lab."

> "The project delivered the unmatched performance of generating a 147 decibels direct sound field.

Christophe Fabriès
Project Leader – Antenna Mechanical Analysis
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