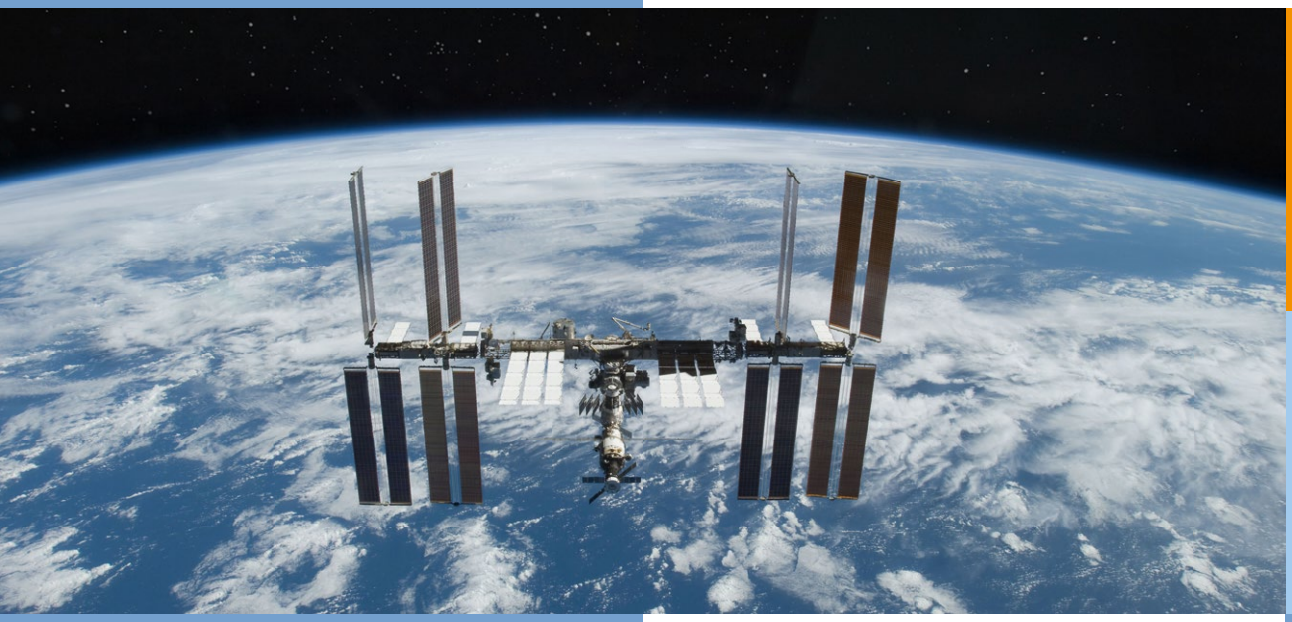
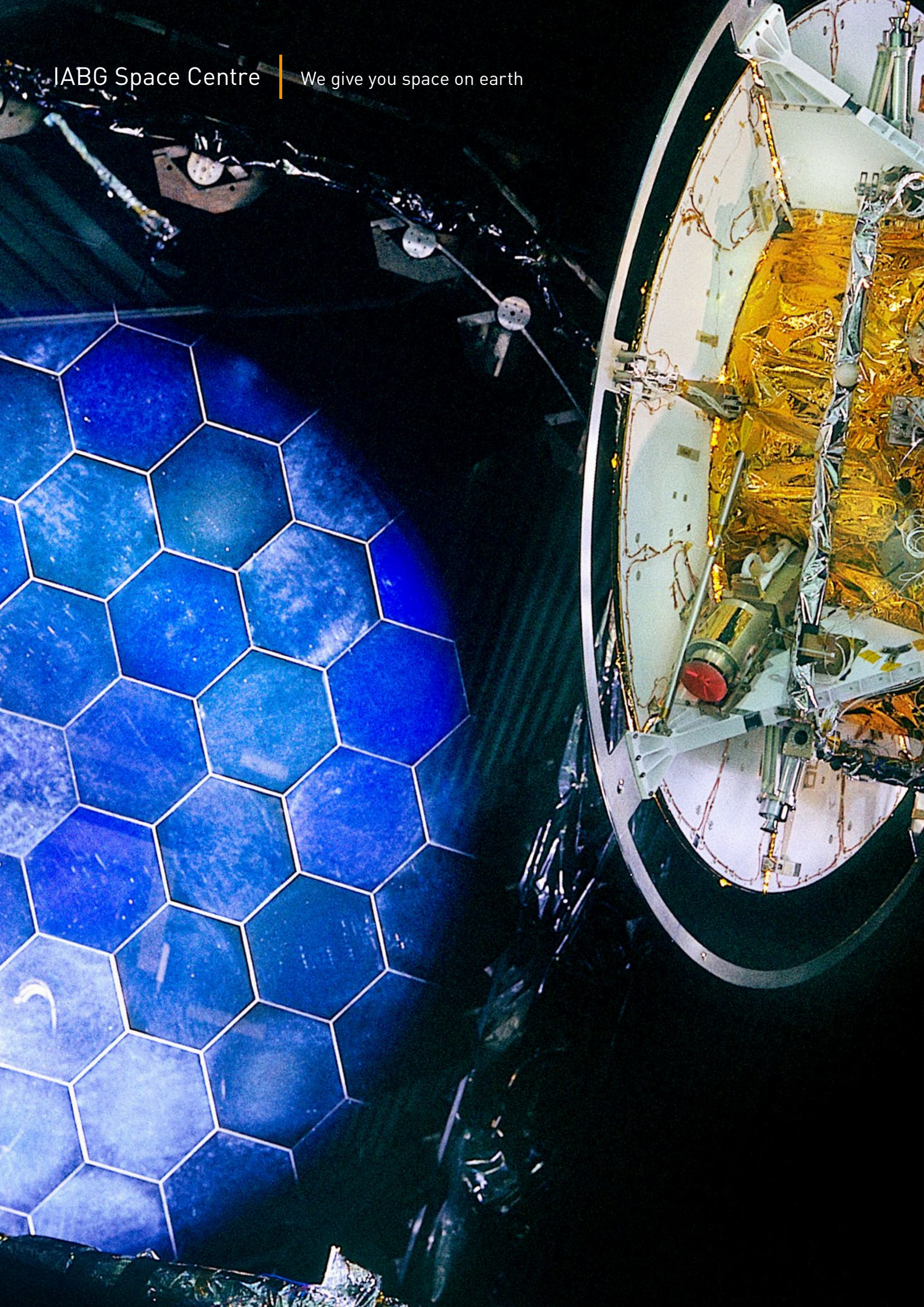
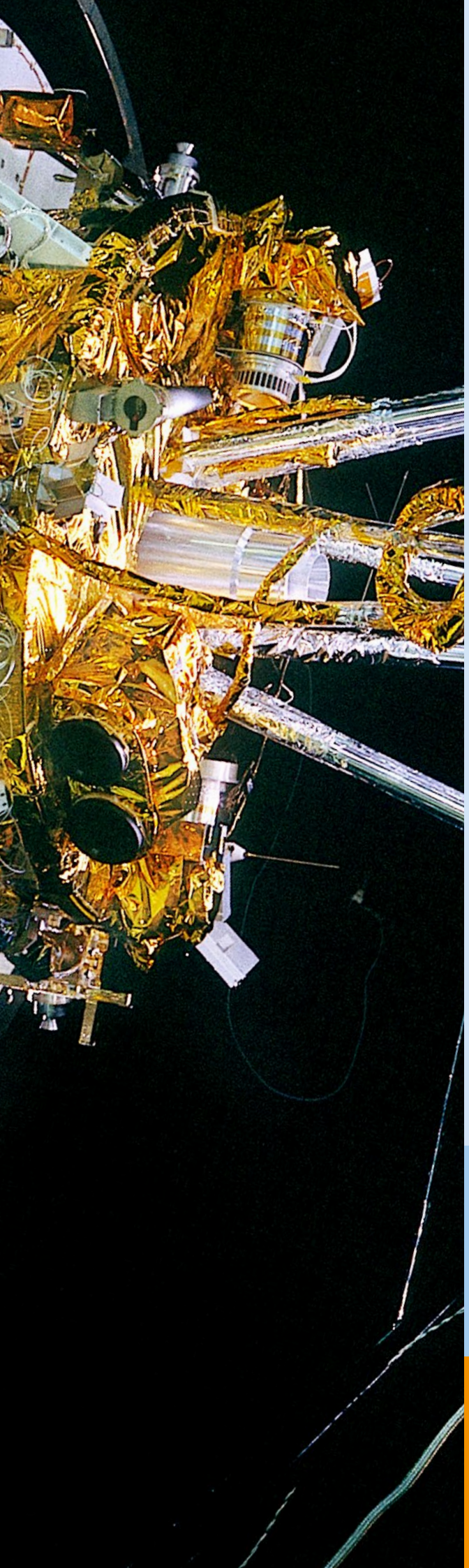
IABG Space Centre
We give you space on earth



SPACE

IABG Space Centre | We give you space on earth





IABG Space Centre – International technical and scientific services to ensure the success of your space projects

The IABG Space Centre operates the national space test centres at Ottobrunn, near Munich, Germany. IABG provides engineering tests and analyses using state-of-the-art technology. We offer customised support to various clients in the commercial, industrial and research sectors – on large and small-scale projects alike, goal-oriented and cost-effective.

We perform

- Extensive testing
- Project and test management
- Support in AIT and QA tasks
- Design of test systems
- Consultancy on methods, procedures, products
- Analyses and computational simulations
- Calculations
- Special measurements

Our more than 50 years' experience and well-founded know-how on topics of both technical and scientific nature have played a major role in the success of many national and international space projects.

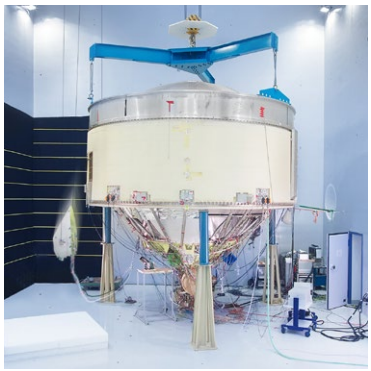
This expertise makes us an ideal partner in the fields of engineering and technology. The standards applied in space technology with regard to scientific quality and technical precision provide the basis for our work in all sectors, right through to quality assurance and product monitoring.

IABG

Acoustic noise test on Swarm satellites in stack configuration

Control room of the vibration lab

Separation shock test on ARIANE 5 ESC-A upper stage



Comprehensive testing services and analyses

We combine theory with practice

The IABG Space Centre offers its customers extensive test facilities and know-how in performing all types of environmental tests related to space applications and other technical sectors. On this basis we provide acceptance and qualification tests to prove spaceworthiness and to identify hidden weak points in technical components and complex systems, making a major contribution to minimise failures and to increase operational efficiency. Results are verified in-house and form the basis for further technical optimisation.

We offer the whole spectrum of test services, combined under one roof:

- Thermal vacuum tests
- Space simulation tests
- High-temperature stress tests
- Thermal distortion tests (videogrammetry, ESPI, laser)
- Cryogenic testing at helium temperature
- Magnetic tests
- Electromagnetic compatibility tests
- Vibration and shock tests
- Modal survey and operational vibration analyses
- Acoustic tests
- Static strength and stiffness tests
- Mass property measurements
- Design and construction of test related MGSE
- Mobile ISO class 5 clean room

All these test activities are accompanied by dedicated quality assurance measures.

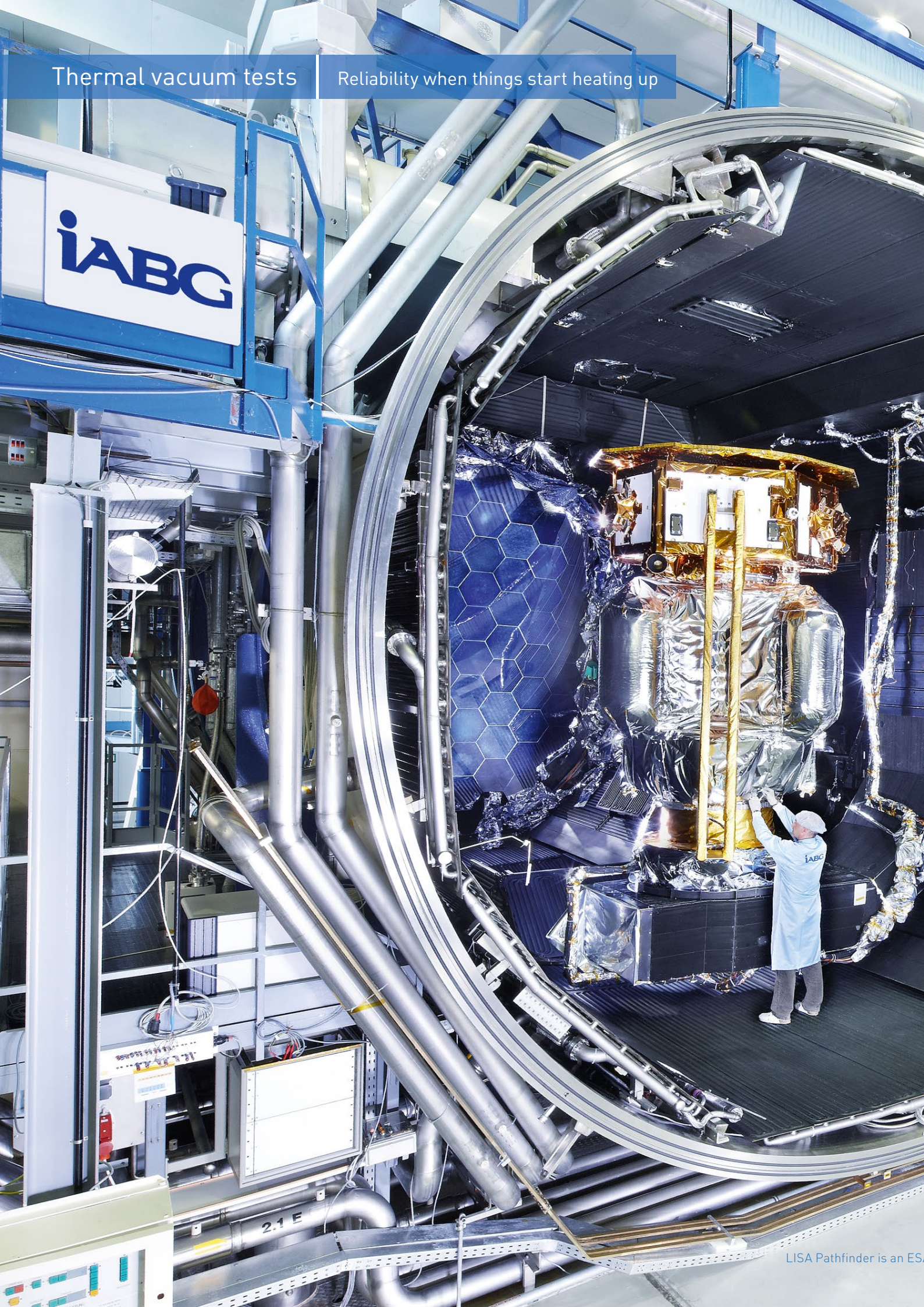
We are active and experienced on an international level and have proved both our efficiency and expertise many times in national and international projects. We have been responsible for comprehensive testing of a variety of systems including

- Satellites
- Space probes
- Orbital platforms
- Launchers
- Optical instruments
- Components and sub-systems

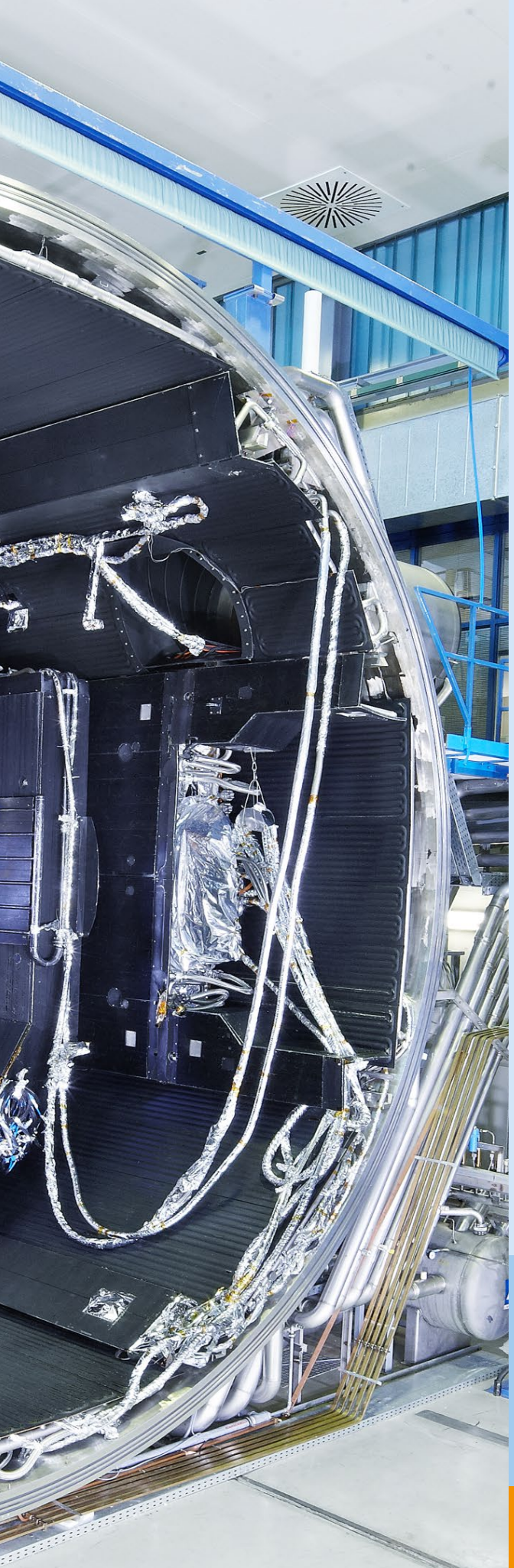
In the space sector, IABG simulates real operational conditions such as the mechanical and thermal loading at lift-off and in orbit, operation in vacuum and stressing during re-entry into earth's atmosphere. On the basis of our results, space systems were qualified, or rather improved to assure the technical and financial success of the missions. Increasingly, many other technical sectors not related to space applications are demanding our expertise and environmental testing services for product development and qualification as well.

Thermal vacuum tests

Reliability when things start heating up



LISA Pathfinder is an ES



LISA Pathfinder LCM satellite
in space simulation chamber WSA/TVA
A project with Airbus Defence and Space Ltd. as prime contractor

Reliability when things start heating up

The extreme ambient environment to which items of avionic and space equipment are exposed demands the highest standards when it comes to materials and overall system reliability. We can pinpoint inaccuracies in the theoretical models with our thermal vacuum test systems permitting their optimisation, and we test the reliable operation of components and systems under simulated space conditions. By simulating temperature profiles and thermo-mechanical load conditions, we can prove the suitability of new materials, components and systems for implementation under extreme conditions.

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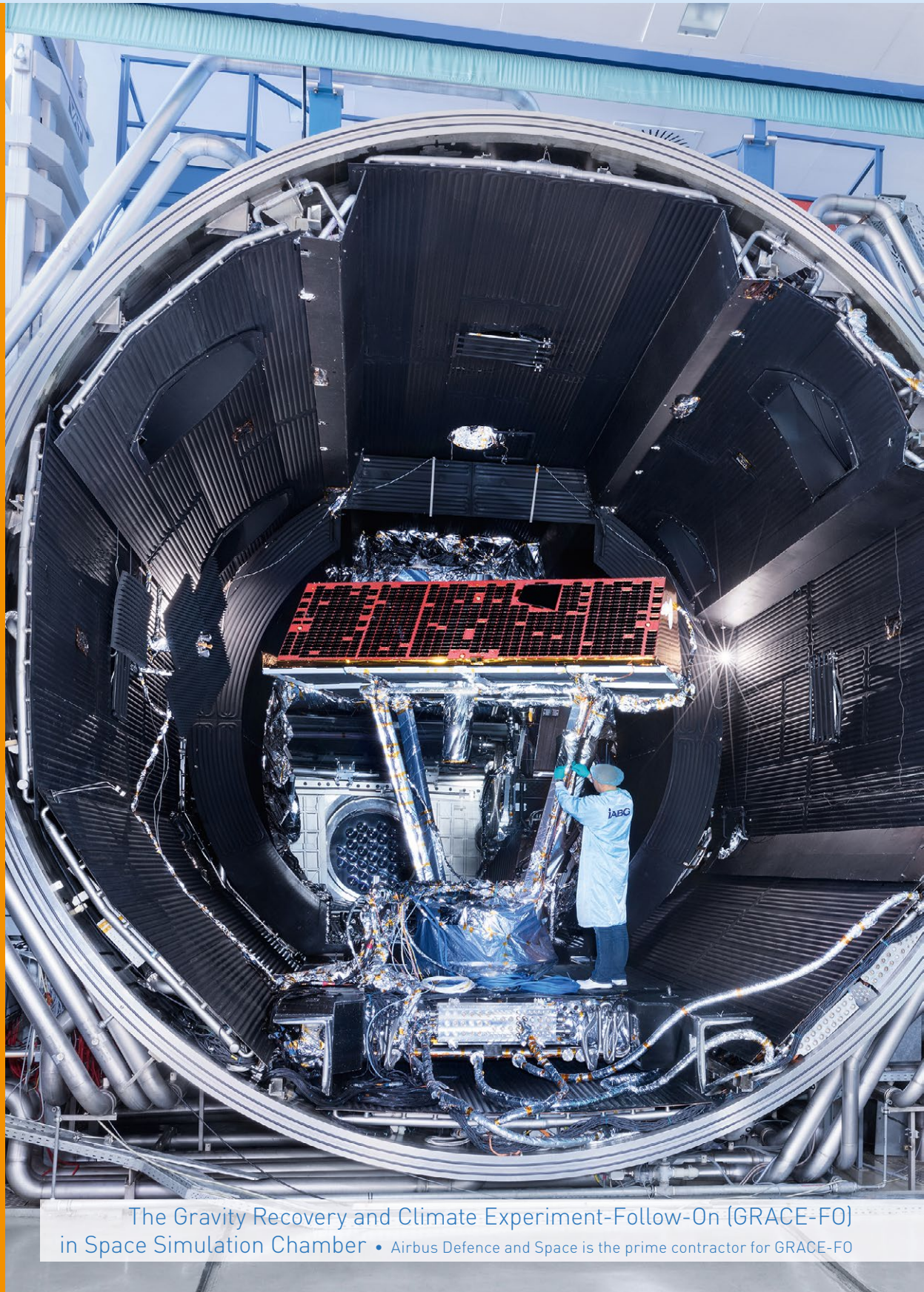
Thermal vacuum tests | Reliability when things start heating up



The Gravity Recovery and Climate Experiment-Follow-On (GRACE-FO) in Space Simulation Chamber • Airbus Defence and Space is the prime contractor for GRACE-FO

Cryogenic test facility
2.5 m HeTVA with ISO 5 tent

Sentinel 3 SLOSU Instrument
in 2m-TVA

Sentinel 3 is one of the five Sentinel S/C that form the Global Monitoring for Environment and Security (GMES) program funded by the European Space Agency and the European Union.

Thermal vacuum tests

Under the sun with IABG

In our solar simulation/thermal vacuum chambers flight systems are tested to their extreme. The biggest chamber with 6.8 m in diameter creates space conditions such as vacuum, extreme heat and cold, as well as solar radiation with its artificial sun simulator in order to qualify the specimen. With this procedure, we are able to discover any weak points to validate thermal mathematical models and re-entry technology into the earth's atmosphere.

The ideal test chamber for each test object

The IABG Space Centre provides a wide spectrum of facilities and test chambers of various sizes and technical characteristics in the space simulation and thermal vacuum sectors. Our clients can test nearly everything, from entire satellite systems to subsystems such as antennas and solar generators down to simple components. We keep optimum technical and economic aspects in mind. In our facilities we can simulate the thermal ambient conditions in space. We are experts in the application of sun simulation methods, as well as infrared and thermal vacuum test processes.

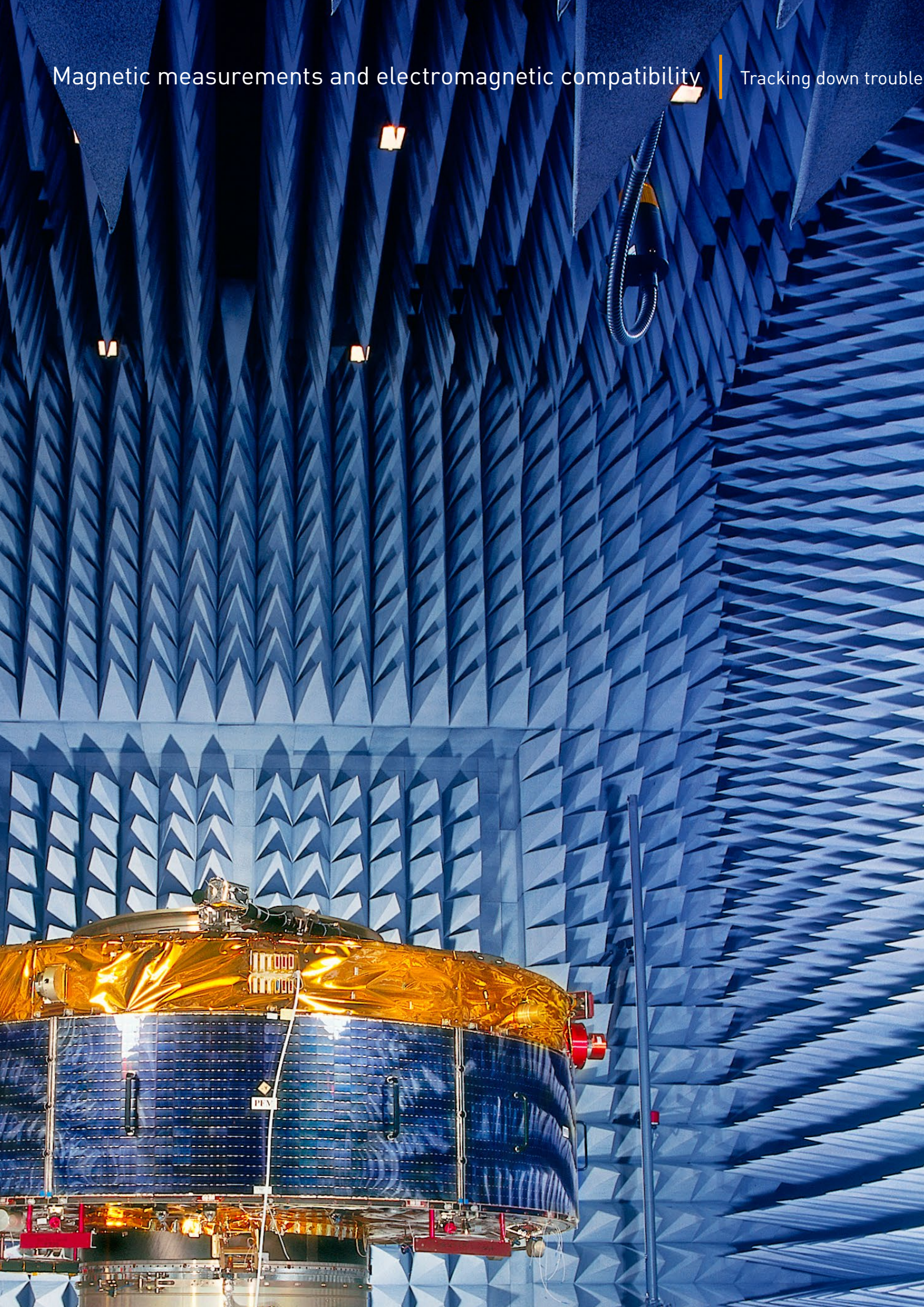
You ask for more – IABG gives you more

Complementary measuring capabilities in the vacuum and radiation measuring sectors round off our service package. Furthermore, we have extensive experience in the fields of residual gas analysis, establishing leakage rates, contamination measurements and measuring local and spectral radiation intensity distribution. By using our IABG developed software *TeleDisplay* our customers are able to track and evaluate the test data gained during the Thermal Vacuum Tests via internet all over the world. We also advise our customers on the development of test procedures. And it goes without saying that quality assurance methods are standard features at IABG.

Really cool services for burning questions

To ensure that no problems arise when things start heating up, we are at hand with a full service package:

- Simulation of temperature profiles down to -263 °C
- Validation of thermal models (thermal balance test)
- Thermal distortion test using videogrammetry, ESPI or laser
- Tests under thermo-mechanical load conditions
- High-temperature technology including re-entry simulation
- Proof of new materials' suitability for thermal protection systems
- Tests and optimisation of propulsion units
- Non-destructive material tests
- Damage analyses



Tracking down troublemakers

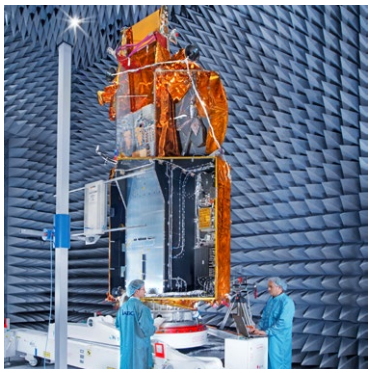
Measuring magnetic fields and ensuring electromagnetic compatibility is essential to the reliable operation of electrical and electronic components and systems.

IABG operates a magnetic field simulation facility that is unique in Europe and, at the same time, one of the most accurate in the world. In our EMC test centre, we apply electromagnetic test techniques with the most advanced measuring systems on a wide variety of electric and electronic components as well as on complete systems.

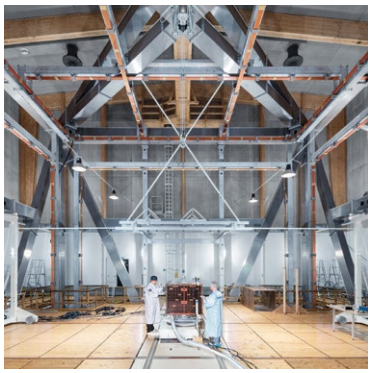
Moreover, our know-how and years of experience in performing magnetic measurements and EMC tests make us an efficient and competent partner for all measuring and engineering tasks in the magnetic and EMC sectors, not just in the avionics and space sector. Magnetic and EMC tests represent a permanent feature of consistent quality assurance in all branches of industry, thus also guaranteeing the international competitiveness of products.

IABG

Swarm satellite in magnetic test facility MFSA



CryoSat spacecraft during EMC measurements



EU:CROPIS in magnetic test facility MFSA

Picture: With the kind approval of DLR

Magnetic measurements and electromagnetic compatibility

Electromagnetic compatibility – yes or no?

How do electronic and technical products react to electro-magnetic fields? How high is the electromagnetic emission of electrical equipment and systems? These and similar questions can be answered quickly and reliably by the accredited EMC test department. We measure electromagnetic susceptibility and emissions as these might occur both in aircraft and space systems and in civil or military appliances.

Magnetic tests

The IABG magnetic test facility MFSA is built to state-of-the-art standards and permits the precise measuring of DC and AC magnetic fields. Our laboratory accommodates testing of individual components as well as large, complex systems. This facility offers a wide range of testing options. For instance, we can practically "switch off" the earth's magnetic field to simulate conditions in space or, depending on the specific requirements, vary the magnitude, intensity and frequency of fields.

Specialised hardware and software

Our most advanced test equipment permits the efficient, cost effective execution of demanding tests spanning all sectors of electromagnetic compatibility. We also develop – on demand or as required – specialised hardware and software for particular tasks.

Teaming engineering expertise

Besides EMC and magnetic measuring systems, we are also equipped with first-class engineering expertise in the computer-aided simulation of electromagnetic phenomena.

Our experience in measurement and simulation technologies also benefits our customers when it comes to answering "non-routine" technical EMC questions, for example in the aeronautical or military technology branches.

Vinci engine for Ariane 6 on IABG's 320 kN Multi-Shaker

Ensuring safety comes first

During phases of mechanical loading, nothing must fail: lift-off and landing, turbulence and in-flight separation processes make the highest demands on the materials and structures of space systems.

On specialised test stands, IABG pinpoints structurally critical spots. We supply engineers and designers with test results for optimisation and correlation work and also help with ongoing product development.

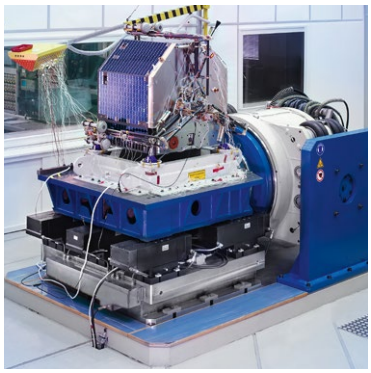
Besides sound knowledge of the scientific and technical background to the wide spectrum of real world mechanical loading, extensive testing systems are available in the following sectors:

- Vibration and (pyro)shock
- Long stroke shaker
- Acoustic loading
- Modal testing and analysis
- Static and dynamic characterisation
- Constant acceleration
- Thermo-mechanical loading and stressing
- Fatigue testing
- Mass properties
- Micro-vibration testing

IABG

TerraSAR-X spacecraft during acoustic noise test

This project has been funded on behalf of the German Aerospace Centre (DLR) by the German Federal Ministry of Education and Research (promotional reference 50 EP0104). The result has not been influenced by the German Aerospace Centre



Philae on the 200 kN shaker

Thermal Vacuum Facility 2,5 m-HeTVA including high temperature subsystem with ESA's Solar Orbiter Antenna Reflector built by Airbus Defence and Space

Mechanical tests

Our aim: materials and structures without risk of failure

Material fatigue, inadequate design and manufacturing deficiencies are well-known causes of failure in the history of spaceflight. Besides the minor malfunctions that may "only" cost time and money, serious faults that are not recovered in time can jeopardise entire missions. To ensure that this does not happen, IABG examines the effects of the mechanical loading by means of extensive hardware testing.

Vibration and shock tests

During its service life, whole space hardware such as technical equipment may be exposed to severe dynamic loads of a random, sinusoidal or shock-type nature. Electrodynamic vibration systems with graduated force ratings from 36 to 320 kN, as well as drop shock, pyroshock, centrifuge and transport test facilities are available to realise a wide spectrum of dynamic loads on mechanical systems and components. Furthermore, combined vibration and temperature tests can be carried out. The dynamic responses of the item under test can be acquired to determine local loadings and to analyse the dynamic behaviour of the test article as a whole.

Acoustic noise tests

In order to simulate the acoustic environment during the lift-off and the atmospheric flight of a rocket, dedicated acoustic tests are carried out in a large reverberation chamber. IABG is also equipped with a special progressive wave tube to investigate acoustic fatigue problems in the regime up to 170 dB acoustic noise level.

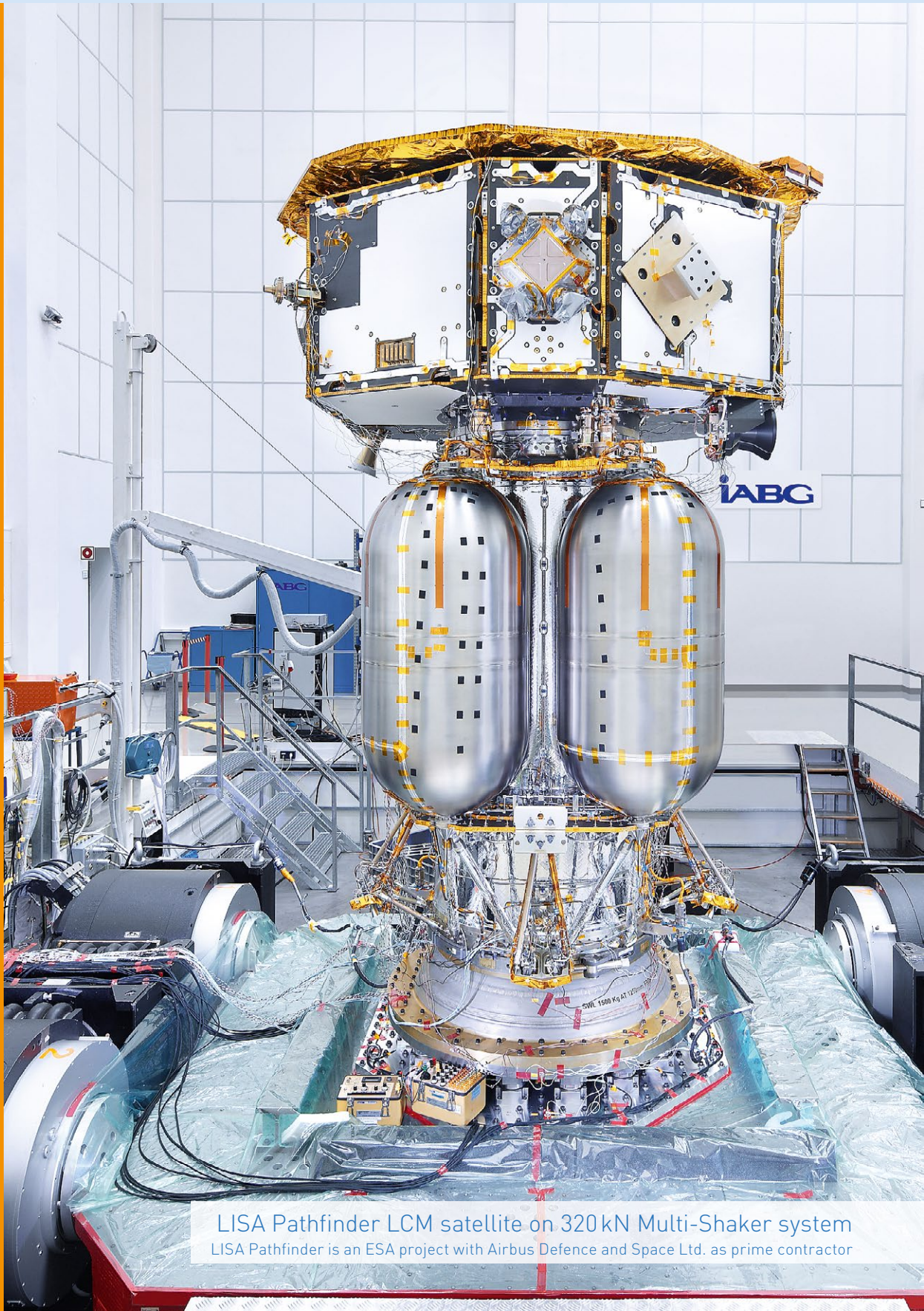
Static strength and stiffness tests

On full scale structures and space structure components, we carry out

- Simulation of static load conditions in the launch and flight phases
- Determination of structural stresses and stiffness
- Proof of static strength
- Functional tests (e.g. booster separation, pressure tests, leakage tests)

Thermo-mechanical tests

For the development and qualification of structures, materials and thermal protection systems of re-entry systems, we have developed suitable test technologies and established various high-temperature test facilities. Corresponding to the specific mission or application profile, temperatures of over 1,700 °C have already been applied to test items. Simultaneously, mechanical forces can be superimposed on thermal loading.



LISA Pathfinder LCM satellite on 320 kN Multi-Shaker system

LISA Pathfinder is an ESA project with Airbus Defence and Space Ltd. as prime contractor

Mass property measurements on GRACE-FO

Modal survey test on VEGA launcher

Mass property measurements

The reliable determination of mass, the centre of gravity and the moments of inertia is a prerequisite for correctly characterising and steering satellites. IABG has the suitable test equipment and appropriate analysis methods for this job on system and on subsystem level. Furthermore, in our laboratories we perform static and dynamic balancing tests.

Modal tests and analyses

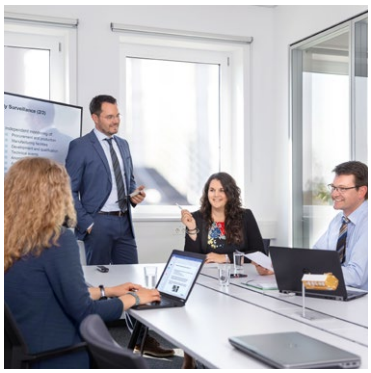
Up-to-date test facilities and analysis software form our basis for an extensive range of test and analysis services. We determine the dynamic properties of mechanical structures and systems, analyse their vibrational behaviour and pinpoint critical structural areas with respect to dynamic loads and deformations.

Moreover, we develop strategies for improving vibrational behaviour and advise our customers in all areas of structural dynamics. With our fully mobile and modular test equipment, we are able to support projects all over the world. Impressive evidence of its value is furnished by numerous large-scale structural tests on the ARIANE 4 and ARIANE 5 launcher family as well as on the VEGA rocket.

Mathematical modelling

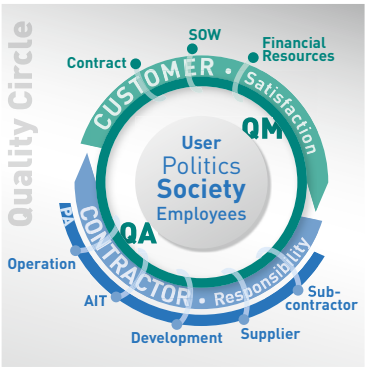
The creation of mathematical models is an important tool in the design and simulation of mechanical structures. We develop our own computer-based models of the test equipment and implement our customers' models to support our testing activities. The visualisation of results, depicted by graphics and computer animation, is both fast and efficient. Testing and calculation are the perfect couple to provide precise and reliable computational simulations using realistic mechanical properties.

IABG Space Centre, Munich, Germany, since 1965



Consultancy – planning, realisation and operation

Quality circle



Consultancy

Decades of heritage

Our main objective is to support our customers achieving their mission goals in a most efficient, suitable, and transparent way. Technical and programmatic competences are our focus to assist implementing project and quality management systems and methods for an effective control of their program.

Hereby we provide independent consultancy related to project and quality management aspects in conjunction with specific technical expertise in

- System engineering
- Product and quality assurance
- Project and quality management
- Assembly, integration and testing
- Certification process against international standards
- Quality management systems according to ISO 9100, ISO 9001
- Audit management and performance

With this background, we support our customers in the life cycle of a space program; between definition, development, qualification, production, acceptance, integration, testing and verification.

Our business competence covers the procurement and development of space hardware as well as test infrastructures.

We follow our **quality circle** for support covering

- Analysis, review and evaluation of program status
- Controlling and surveillance of space hardware development, manufacturing and qualification
- Development of improvement strategies and recommendations
- Documentation and reporting processes

Proven experience: the National Surveillance Organisation

The National Surveillance Organisation (NSO) is an independent Organisation that provides continuous quality monitoring and assistance of

- Procurement and production
- Manufacturing facilities
- Development and qualification
- Technical events
- Anomalies
- Activities of contractors and suppliers
- Configuration management
- Internal and external audits

The NSO team is directly mandated by ESA to accompany the German contribution to the Ariane & Vega European Launcher Systems. It operates at all relevant supplier sites of the Ariane and Vega programs in Germany.

Customer benefit

Independent consultancy and one-stop service with specific expertise of complex space programs and wide knowledge on

- Space missions and systems, satellite and payload technologies
- Test infrastructure
- System engineering, project, quality management, and product assurance management
- Verification, AIT and acceptance processes
- Multi-cultural aspects

We give you space on earth | Services on an international level

European Space Research and Technology Centre (ESTEC) in Noordwijk, The Netherlands
(Picture: ESA)

Services on an international level

One of the keys to IABG's international reputation as a professional and reliable partner is the company's traditional commitment to high-quality performance.

Diversity is our strength. Our service package covers a wide range of technical and scientific activities: from consultancy and general planning to establishing tailored tests and designing dedicated test facilities, developing customised hardware and software solutions and performing and evaluating the required tests. Our comprehensive work leads to new procedures and technologies that form the basis for advanced technical applications.

We serve clients from all over the world. On demand, we provide the full scale of technical services, testing and monitoring on-the-spot. For example, structural system tests of the European launcher ARIANE 5 were also performed in Paris, France, and Kourou, French Guyana (South America).

In cooperation with a European partner we established the European Test Services (ETS) in order to manage the ESTEC space test centre located in Noordwijk, The Netherlands. As a team of specialists we operate and maintain the test facilities of ESA and perform all environmental tests on satellites and components. All major ESA projects such as Galileo, BepiColombo, METOP, ATV, HERSCHEL or PLANCK have been tested by ETS. The ETS enterprise is a further example of our leading role for technical services on the international market.

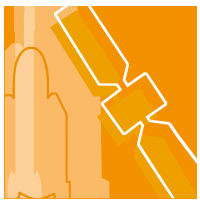
Cover picture: NASA

AUTOMOTIVE

INFOCOM

MOBILITY, ENERGY & ENVIRONMENT

AERONAUTICS



SPACE

DEFENCE & SECURITY

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