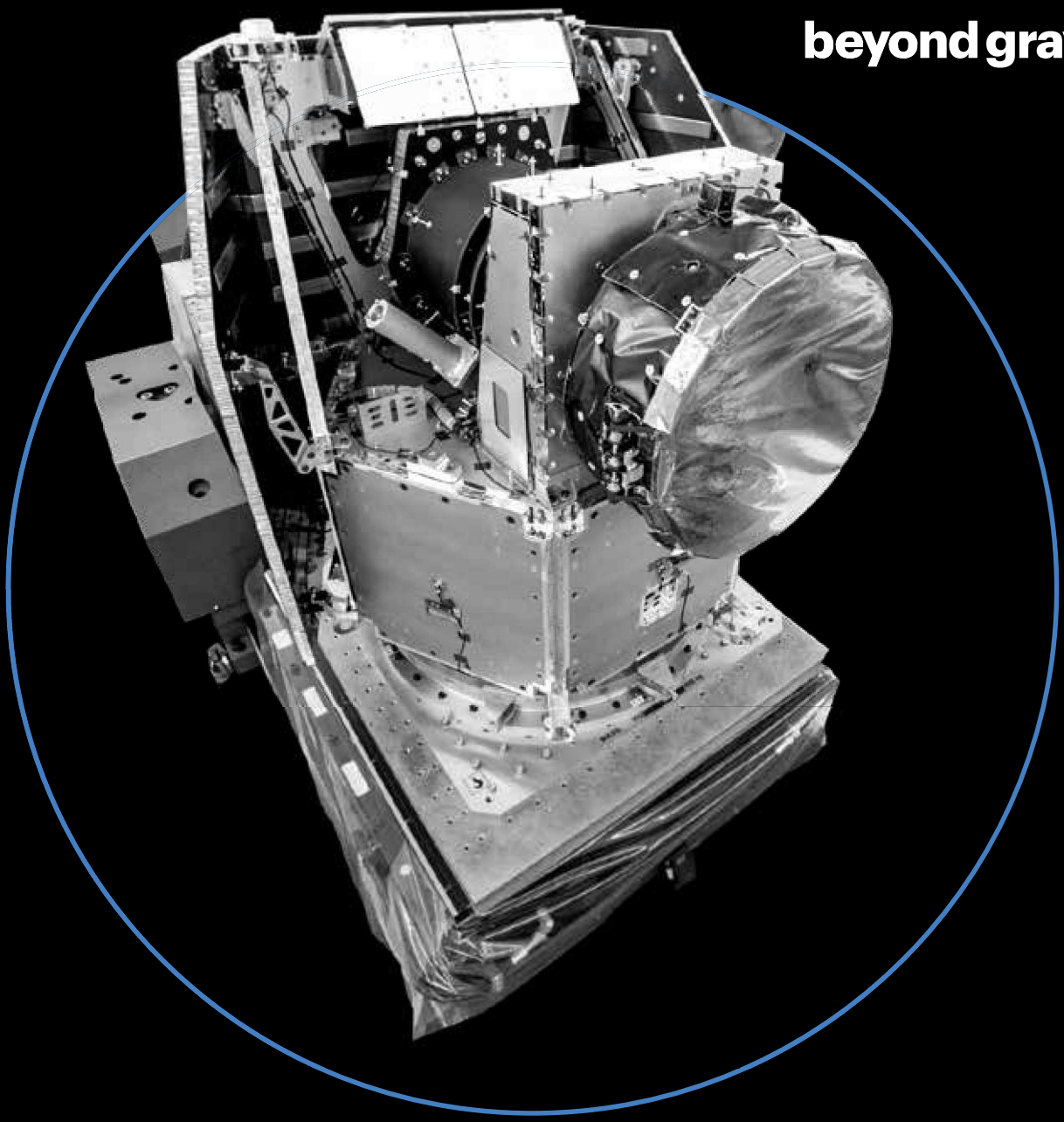
beyond gravity



Global Testing Services

Proven reliability, safety and durability.
Beyond Gravity Testing Services.

Certified by the Swiss Accreditations Service SAS
SN EN ISO/IEC 17025-2018 Certified Testing Laboratory

Certificated by the Swiss Association for non-destructive testing for:
EN 473 / ISO 9712
Pre-and in service testing of equipment, plant and structure, Aerospace

Certificated by the German Association for non-destructive testing for:
Ultrasonic Phased Array Technique

Scope of accreditation
STS Verzeichnis STS 0193

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Over four decades of experience

Beyond Gravity has been involved in space missions since the first space missions in the early 1970s. For us, reliability, meticulous planning and, not least, rigorous testing are important and vital parts in the development of components, electronics and structures for use in space. With our long-standing experience and extensive knowledge we are able to test a wide range of materials and products in our test facilities in Switzerland, Sweden, Germany, Austria, Finland and the US. The testing for qualification and testing of flight hardware and industrial products is one of our core competences. This includes destructive as well as non-destructive testing.

Wide range of testing services for space and non-space applications

Beyond Gravity offers extensive problem solving including, if necessary, model simulation, suggestions for improvement as well as crosschecking of the measures taken. Many methods and various types of equipment are available for non-destructive testing of materials, components and electronics: measurement of hardness, x-ray florescence, electrical conductivity, friction, optical microscopy, standard ultrasonic as well as phased array technique, an automatic air-coupled ultrasonic transmission test facility for large test articles, acoustic composite material testing as well as penetration tests using fluorescing class III fluids give us the possibility to not only characterize material under test, but also detect defects such as cracks, pores or delamination. For mechanical and static load testing our labs are well equipped with tensile testing machines and static load test rigs for unit and component level tests as well as testing of large structures. Shock machines and the possibility to test for pyro shock complete our mechanical testing facilities.

The Beyond Gravity Test Centers are also able to perform environmental simulation testing, utilizing a variety of shakers, climatic chambers and thermal vacuum chambers as well as a centrifuge in order to test components and electronics under temperature, humidity and pressure conditions as well as vibration arising for example during space missions or other types of harsh environments. Our test facility for testing of components, printed circuit boards and electronics can handle the most relevant types of tests for evaluation and investigation including X-ray, PIND testing, Seal test, thermal dissipation tests as well as tests to determine solder bonding and PCB quality.

Consultation included

Beyond Gravity does not only provide the testing services but also offers consulting services with regards to the selection of materials, machining processes and heat treatments for an optimization of the microstructure of components. With our skills, we also assist in the investigation of the root cause of damages and, thus, help to optimize future test procedures and manufacturing processes. All Tests will be performed according to well established standards such as DIN, ISO, MIL, EN, IEC, etc. However, Beyond Gravity has also the possibilities to test according to other standards after consultation. All our equipment is calibrated according to national and international standards.

Hardness test device / Härteprüfgerät

Material Testing & Non-Destructive Inspection

The Beyond Gravity Materials Test Lab is certified for non-destructive testing of composite structures and equipped to measure physical properties of materials. X-ray analysis, microscopy, friction and dye penetrant testing are also part of the expertise that our specialists can offer as a service to external customers and for our own projects.

Hardness

Equipped with multipurpose and micro hardness measurement devices from Leica and Gnehm, Beyond Gravity can determine the Vickers, Brinell as well as the Rockwell Hardness of materials.

The degree of hardness is often determined in addition to the tensile test, since the hardness value is proportional to the tensile strength.

With our portable test equipment, it's also possible to perform on-site measurements to determine hardness.

- Vickers Hardness
- Brinell Hardness
- Rockwell Hardness
- Shore Hardness
- Leeb Hardness
- Hardness Gradient in Materials

X-Ray Fluorescence

With our XRF Analyzers, Fisherscope and Delta X the alloy composition of a sample can be determined in a matter of seconds. This device uses X-rays and measures the fluorescent X-rays which are specific for each element. Almost all metals and other trace elements can be detected. We can perform this test in our facilities or on-site.

- Determination of Alloy Composition
- Detection of Trace Elements

Optical and Scanning Electron Microscopy

To investigate micro sectioned parts but also to investigate other samples more closely, optical microscopes, stereoscopes and Scanning Electron microscopes are available and can provide a resolution of 2nm and up to 2,4 million times magnification. Grain structures of etched metal surfaces can be made visible using polarized light, for which a range of polarizing filters is available. The microscopy is also used for many more purposes, such as fiber, volume content, micro-structures, pore content, coating thickness and detection of non-metallic inclusions in stainless steels.

- Microstructure
- Texture Gradient
- Fiber Volume Content
- Porosity Content
- Coating Thickness

XRF Analyzer / Röntgenfoureszenz-Analysator

Microscopy equipment / Mikroskopie-Ausrüstung

Electrical Conductivity (SIGMATEST)
To determine the layer thickness of organic coatings on non-ferromagnetic substrates the Olympus NORTEC 600 is used.

This is a portable device utilizing the eddy-current technology. The method is mainly used to determine the thickness of “Ematal” coatings, a mineral-based coating to protect metals in harsh environments.

- Coating Thickness
- Mostly used for “Ematal” coatings

With the Olympus NORTEC 600 device it is also possible to determine the specific electrical conductivity of non-ferromagnetic electrical conductors. In combination with hardness measurements or XRF testing it is therefore possible to not only determine the alloy composition of a sample but also its condition.

- Conductivity measurement
- Determination of the heat treatment conditions of aluminum

Dye Penetration Test
With a stationary facility for dye penetration testing, we can visually determine irregularities and cracks on parts. Using a fluorescent dye, it is possible to make pores and cracks visible in the UV light. Next to plunging of small parts, brushing and spraying are used for larger parts to apply the penetrant.

As equipment, Test Fluid System with highly sensitive class III is used.

- Detection of surface and subsurface defects
- Highly Sensitive Class III
- High level of flexibility

Ultrasonic and Acoustic Testing
For composites, it is crucial that the CFRP panels are free of delamination. That is why we invest considerable effort in non-destructive testing (NDI) using ultrasonic and acoustic testing methods. In acoustic testing, the interference pattern of reflected sound waves provides information on the bonding properties of laminates and sandwich structures. The portable equipment offers a high degree of flexibility and can be used for both large and small structures.

Equipped with BondMaster 600 and 1’000e+ it is possible to test components for delamination in the ultrasonic and acoustic frequency range.

Automatic air-coupled ultrasonic transmission test facilities are used to test large sandwich-panels and carbon fiber tubes for failures and delaminations. The measurement data sampled during the test are recorded and converted into C-scan pictures for post processing.

With the Olympus OmniScan MX and OmniScan SX roll form, we can perform both phased array and standard ultrasonic inspections to quickly scan large volumes of test items.

- Detection of delamination
- Phased Array Ultrasonic Tests
- Standard Ultrasonic Tests
- Image tube scanner

Ultrasonic NDI test on VEGA fairing

Test Fluid System for Penetration Testing

NDI test machine scan range

NDI-Equipment

Tensile Testing

Our tensile test machines can deliver results for tensile, compression, bending and shear force tests.

The tensile testing machines from Zwick, Shimadzu and Instron are the most often used ones for tensile and compression tests. Strain gauges and displacement transducers provide a tool for very exact displacement determination. Forces up to 250 kN can be applied.

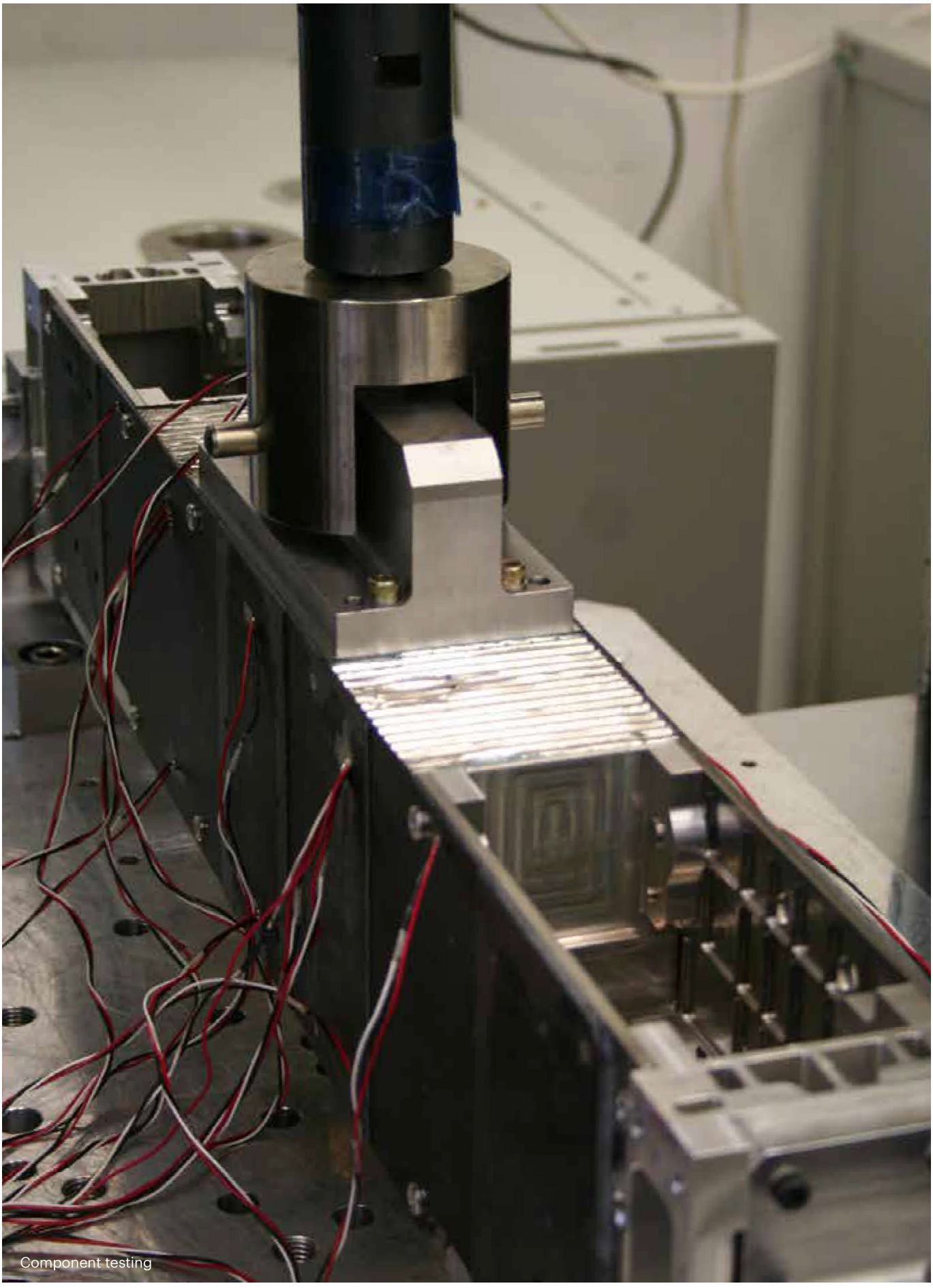
Ovens mounted to the tensile testing machines enable testing between -160°C and 350°C. Specialized devices also allow for evaluation of bending and shear properties.

A broad variety of adapters enable testing of different geometries. In particular, the testing of components requires special equipment. The obtained properties include but are not limited to stiffness under compression, spring constants, force-displacement diagrams, etc., to characterize brackets, hinges, fittings and similar components.

Measurable Properties for metallic and/or composite Materials:

- Young ‘s Modulus E
- Proof Stress Rp0.2
- Yield Strength ReH, ReL
- Tensile Strength Rm
- Elongation at break A
- Compressive Strength at Break RbB
- Flexural Strength B
- Shear Modulus G for composites

Model	Maximal Load	Electrical Strain Gauges	Temperature Range
Zwick 250	250 kN	6 Channels	from -160 °C to +350 °C
Instron 5985	250 kN	-	Ambient
Shimadzu AG-X plus	100 kN	8 Channels	from -70 °C to +280 °C
Shimadzu AG-X	20 kN	-	from +25 °C to +280 °C
Instron 5966	10 kN	-	Ambient
Instron SF1240	5 kN	-	Ambient



Component testing

Bolt testing

Friction testing

Bolt Testing

Our bolt testing equipment can test and evaluate thread torque, screw head torque and bolt tension. Using our wide range of standard or bespoke adapters we can give truly representative conditions for the bolted joint all the way down to the correct surface treatment.

	Equipment	Maximum Load
Thread torque	M-2230	±100 Nm
Screw head torque	M-2230	±100 Nm
Bolt tension	M-2230	100 kN

Friction Testing

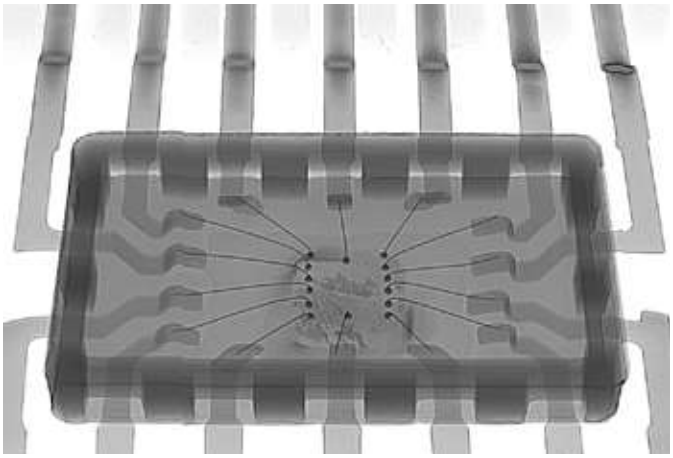
With our friction test rig we can provide the resulting friction and wear when combining different surface treatments. Our test rig consists of a stiff frame with two hydraulic cylinders and load cells, one for each of the force to provide the normal pressure and the force for pushing the test sample. The coefficient of friction is calculated from the reading of both pressure forces.

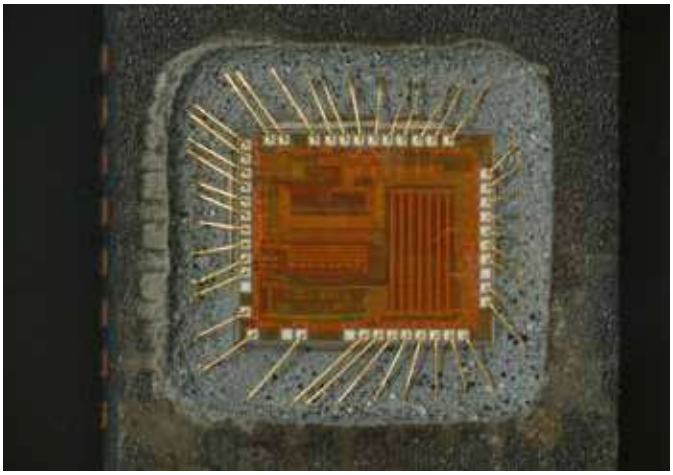
Normal load: 100 kN
Shear load: 10 kN

Electronic Components

The Beyond Gravity Test Center has the equipment and the technical know-how when it comes to testing electrical components and PCBs. We are able to evaluate the performance, function and the quality of both surface mounted components as well as hole mounted components. We can determine and evaluate bonding properties of soldering and use X-Ray equipment to see the properties of multi-layer PCBs and the inside of most types of passive or active electrical components as well as smaller structures.

- Low vacuum Scanning Electron Microscope
- Energy Dispersive X-ray Fluorescence spectroscopy
- Real time X-ray microscope
- Differential Scanning Calorimetry
- Fourier Transform Infrared Spectroscopy
- Thermal Mechanical Analysis
- De-capsulation system
- Single event effect testing
- Seal test, fine and gross leak equipment
- Particle Impact Noise Detection testing (PIND)
- Wet chemical etching
- Single event effect latch-up protection & detection modules
- High resolution optical microscopes with photo facilities
- Exact measurement of currents from 1nA to 10A
- Micromanipulation components
- Liquid crystal microscopy
- Thermal camera filming
- Semi-automatic component grinding & polishing equipment
- Thermal Gravimetric Analysis





Mechanical & Structural Testing

Beyond Gravity has a long-standing history in the management and execution of mechanical and structural testing. The extensive experience and expertise gained over many years of testing internal projects, combined with the specialized testing equipment developed during this time, ensures that a reliable partner is also available to external customers for all testing services.

Static Load Testing

Different test rigs in different sizes are available for large scale structural testing under static load. The 10-meter static load test rig is the largest test rig for spaceflight structures in frame design in Europe. Structures up to 10 meters in height and 6 meters in diameter can be tested with axial and lateral loads of 2'200 kN and bending moments of 6'600 kNm.
All of the test rigs are modular in their assembly and, thus, can be adapted to any structure being tested. Through the use of hydraulic control systems, it is possible to apply axial and lateral loads as well as bending moments, while the data are collected with up to 1085 channels data acquisition systems.

Specifications of test equipment

- Load cells to monitor and control the load application
- Hydraulic actuators up to 500 kN
- Independent reference frames on which displacement transducers can be mounted
- Computer controlled hydraulic benches
- Independent hydraulic pressure monitoring system
- The test item can be equipped to monitor its behavior in real time during the test with:
- Heater blankets
- Load cells
- Strain gauges
- Displacement transducers
- Pressure transducers
- Thermocouples
- Angular inclination Sensors

Interferometric measurements

- Pointing Performance Testing at Cryogenic Environment
- Full 6 DoF Displacement Measurement
- Accuracy -> 1nm
- Resolution -> 1pm
- Down to 15K
- Inside Liquid Helium Cooled Cryostat
- Operation under high vacuum

Static Load Test Rig

Facility	Working Area	Max. Axial Loads	Max. Lateral Loads	Max. Bending Moment	Hydraulic Control System	Overhead Cranes	Data Acquisition
Large Static Load Test Rig	10 × 10 × 13 m	2'200 kN	1'600 kN	6'600 kNm	32 Channels	6.3 T and 10 T at heights of 6.5 m and 12 m	max. 1'085 channels
Static Load Test Rig	6 × 6 × 6 m	120 kN	50 kN	-	32 Channels	6.3 T at height of 6 m	max. 1'085 channels
Static Load Test Rig	3,5 x 3,5 x 5 m	1`477 kN	960 kN		11 Channels	10 T at height of 8,5 m	max. 464 channels
Static Load Test Rig	2 x 2 x 3 m	945 kN	960 kN		11 Channels	10 T at height of 8,5 m	max. 464 channels

Modal Survey – Structural Dynamic Characterization of Components

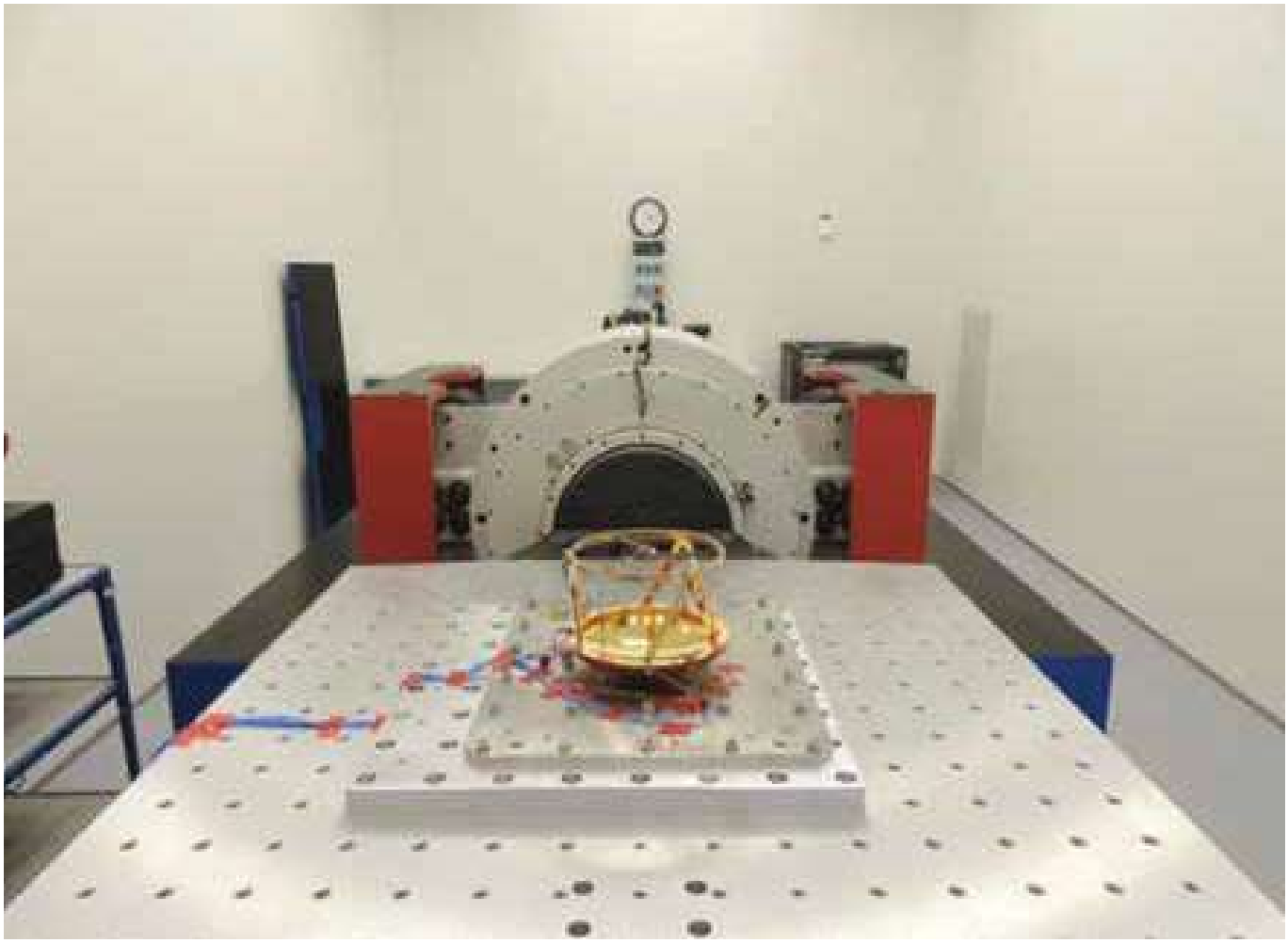
Investigate the structure dynamic response of your product to verify and optimize your design – with Beyond Gravity modal survey solutions.

Beyond Gravity performs modal testing services for several industrial applications:

- To understand the dynamic behavior of structures by physically testing and measuring fundamental mode shapes, damping and frequencies.
- To understand the root cause of noise and vibration problems.
- For diagnostics and health monitoring to confirm product quality from the production line and in the field.

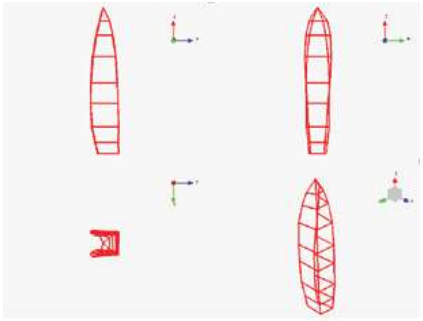
Our Services

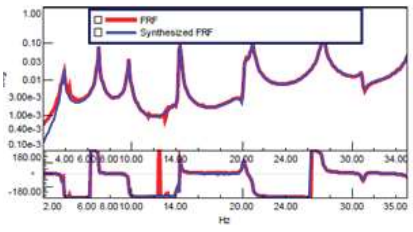
Beyond Gravity uses industry-leading software and hardware for all phases of modal survey and operational modal analysis.
Our engineers perform pre-test analysis, create modal survey test plans, supply all test equipment for data acquisition, and perform data reduction for mode shape extraction.



Specification of Test Equipment

- Calibrated modal hammers up to 2’000 N force and DC - 6’000 Hz bandwidth
- Modal shakers up to 450 N force, sine and random excitation
- Modal accelerometers and acquisition system for dynamic measurements
- Rigid test rigs for fixed boundary conditions
- Electro-dynamic shakers up to 180 kN force and 2’000 Hz bandwidth for operational modal analysis
- High speed data aquistion 64+ channels





Environmental Testing

The Beyond Gravity Test Centers specialize in the performance of mechanical and climatic environmental testing. Not only the execution of development and qualification tests is an essential part of our expertise, but also the consulting, organization, coordination and management of test programs in internal and external facilities on behalf of our customers.

Vibration and Shock Testing

The Beyond Gravity Test Centers are equipped with electro dynamic shakers allowing the testing of test articles of different sizes and weights in horizontal and vertical axes. Latest control and measurement technique guarantee exact testing and detailed data acquisition. For all the shakers a large variety of different adapters and angle support structures are available to support all kind of test configurations. The majority of our vibration test equipment are installed in clean room environments.

The strongest shaker in Switzerland

With 178 kN vibration- and 534 kN shock force, the Unholtz-Dickie T4000 is the strongest shaker in Switzerland. Thanks to the pneumatic auto-centering system, loads of up to 1800 kg can be tested in the vertical axis. Even more in the horizontal axis.

Unholtz-Dickie T4000

The LDS V964 Shaker is capable to test articles up to 900 kg due to its maximum sine force of 89 kN. The shaker is located in a clean-room environment, which can be equipped with a particle measurement system on request.

For the LDS V850 shaker a thermal chamber is available, enabling testing in the temperature range of -60 °C to +100 °C. The LDS V850 is designed for the vibration testing of medium-sized payloads up to 350 kg with a maximum sine force of 22 kN inside as well as outside of the thermal chamber.

The Tira TVS51120 our smallest shaker is capable to test components and smaller test articles up to 3 kg. The shaker is located in a clean-room environment and offer testing in the range 2 – 7'000Hz.

Technical Details of Vibration Equipment:

	UD T4000			LDS V964			LDS V850		
Mode	Sine	Random	Shock	Sine	Random	Shock	Sine	Random	Shock
Max. Thrust	178 kN	178 kN	534 kN	89 kN	89 kN	267 kN	22 kN	22 kN	67 kN
Max. Acceleration*	130 g	80 g	250 g	250 g	70 g	210 g	60 g	50 g	180 g
Max. Velocity*	2.1 m/s			2.0 m/s			2.0 m/s		
Max. Displacement	50.8 mm			38.0 mm			50.8 mm		
Frequency Range	5 – 2'000 Hz			5 – 2'500 Hz			5 – 3'000 Hz		
Max. Load (vertical)	1'800 kg			900 kg			350 kg		
Max. Table Size*	148 cm × 148 cm			121 cm × 135 cm			Ø 65 cm		
Temperature Range	Ambient			Ambient			-60 °C to +100 °C		
Controller	LMS SCADAS III (100 Channels), LMS SCADAS Lab (104 Channels) and LMS SCADAS Mobile (24 Channels)								
Data Acquisition	LMS SCADAS III (100 Channels), LMS SCADAS Lab (104 Channels) and LMS SCADAS Mobile (24 Channels)								

	LDS 894			LDS 826			TIRA TV59410		
Mode	Sine	Random	Shock	Sine	Random	Shock	Sine	Random	Shock
Max. Thrust	55 kN	55 kN	167 kN	26 kN	26 kN	50 kN	100 kN	89 kN	300 kN
Max. Acceleration*	100 g	50 g	80 g	100 g	40 g	80 g	100 g	90 g	300 g
Max. Velocity*	1.6 m/s			1.4 m/s			2.0 m/s		
Max. Displacement	38 mm			25 mm			63.5 mm		
Frequency Range	2 – 2'000 Hz			2 – 2'000 Hz			5 – 3'000 Hz		
Max. Load (vertical)	700 kg			400 kg			910 kg		
Max. Table Size*	77cm x 66 cm			63 cm × 60 cm			650 cm x 620 cm		
Temperature Range	Ambient			Ambient			Ambient		
Controller	m+p Vibrunner hardware, m+p VibControl software & 2 x 16 A/D input channels								
Data Acquisition	m+p Vibrunner hardware, m+p VibControl software & 2 x 16 A/D input channels								

Shaker Technical Details:

	TIRA TV51120		
Mode	Sine	Random	Shock
Max. Thrust	200 N	140 N	N/A
Max. Acceleration*	89 g	62 g	250 g
Max. Velocity*	1.5 m/s		
Max. Displacement	13 mm		
Frequency Range	2 – 7'000 Hz		
Max. Load (vertical)	3 kg		
Max. Table Size*	60 mm		
Temperature Range	Ambient		
Controller	LMS SCADAS III (100 Channels), LMS SCADAS Lab (104 Channels) and LMS SCADAS Mobile (24 Channels)		
Data Acquisition	LMS SCADAS III (100 Channels), LMS SCADAS Lab (104 Channels) and LMS SCADAS Mobile (24 Channels)		

* Maximum values may depend on the specifications of the test and may vary.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Shock Testing

With our MTS Shock machine, it is possible to conduct half-sine shock tests under more extreme conditions than the shakers are capable of. Loads of up to 150 kg can be tested horizontally and vertically with an acceleration of up to 2'000 g* and pulse duration between 50 and 0.25 ms. The maximum table size is 69 × 65 cm.

Pyroshock Testing

Pyroshock is the response of a structure to a high frequency and high amplitude mechanical excitation. The frequencies of the response can rise to 20 kHz. They consist of resonant frequencies of the sample being tested. The peak acceleration can be more than 10,000 g. We also offer pyro shock testing in clean room environment.

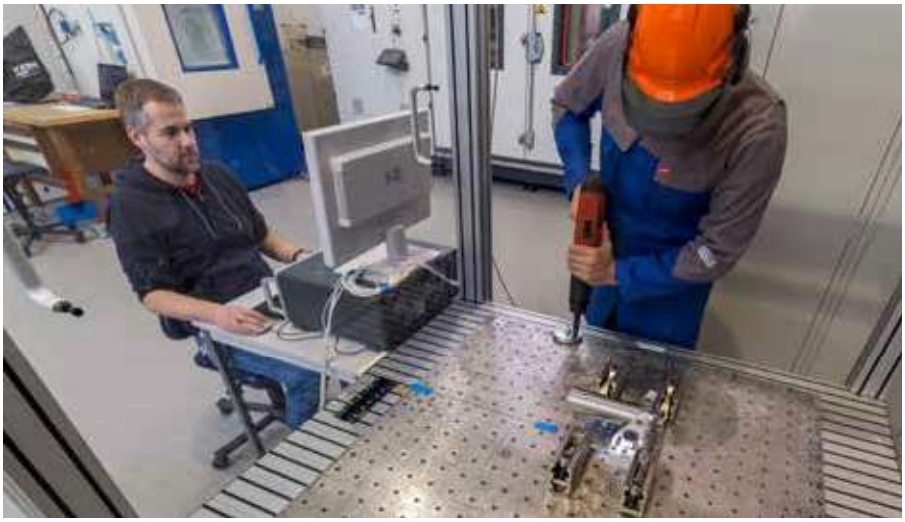
The Beyond Gravity Test Centers are equipped to test mechanisms for pyro shock in a broad spectrum of frequency and amplitude.

Shock Machine MTS

Acceleration	2 – 2'000 g*
Pulse Duration	50 and 0.25 ms*
Max. Load	150 kg*
Orientation	Horizontal & vertical
Table size	69 cm × 65 cm

Pyroshock

Acceleration	> 10´000 g*
Type of excitation	Pyrogun, fall tower pendullum, linear guided hammer, pneumatic actuator
Max. Load	50 kg*
Orientation	Up to 3 axes
Max. test item size	600 mm × 600 mm*



Centrifuge Testing

The Beyond Gravity Test Center in Switzerland is equipped with a large-scale centrifuge that allows test specimens weighing up to 30 kg and measuring 50 × 50 × 50 cm to be tested with very high g-forces. Rotational speeds of up to 215 rpm can be achieved, causing acceleration of up to 80 g.

Centrifuge	
Acceleration	4 – 80 g*
Max. Load	30 kg*
Orientation	Up to 3 axes
Max. test item size	50 x 50 x 50 cm

* Maximum values may depend on the specifications of the test and may vary.

Climatic Testing

The Beyond Gravity Test Centers are equipped with various climatic test chambers, temperature chambers, thermal shock chambers and altitude chambers allowing to regulate humidity from 10% RH up to 98% RH and temperature between a minimum -75 °C up to a maximum of +300 °C.

Our biggest climatic chamber has a usable inner space for 2'000 x 2'000 x 1'350 mm. One of our temperature chambers can also be used with the LDS V850 shaker to operate vibration tests under special temperature conditions between -60 and +100 °C.

Our temperature shock chambers are able to generate thermal shocks in the temperature range from -190 °C to +200 °C. With an altitude chamber, it is possible to simulate altitudes up to 30,000 meters (down to 4 mbar).

Large Vötsch climatic chamber VCS³ 7540-8-S

Equipment	Test Space Dimensions	Max. Mass	Temp. Range	Hum. Range	Temp. change rate w
Weiss ClimeEvent C-340-70a-5-R450	765 x 580 x 860 mm	60 kg	-72 °C to +180 °C	10 RH [%] to 98 RH [%]	± 5 K/min
Vötsch VC^3 7034 R300	765 x 580 x 860 mm	60 kg	-72 °C to +180 °C	10 RH [%] to 98 RH [%]	± 3 K/min
Vötsch VCS³ 7060-5-M	800 x 800 x 950 mm	80 kg	-72 °C to +180 °C	10 RH [%] to 98 RH [%]	± 6 K/min
Vötsch VCS³ 7540-8-S	1'350 x 2'000 x 2'000 mm	500 kg	-72 °C to +180 °C	10 RH [%] to 98 RH [%]	± 8-10 K/min
Vötsch VMC³ 06/500/S	850 x 850 x 700 mm	50 kg	-60 °C to +100 °C		± 6 K/min
Thermotron SC1.2	280 x 390 x 310 mm	20 kg	-73 °C to +177 °C		± 3 K/min
Eliog TRU 300/15	700 x 1500 x 600 mm	80 kg	+70 °C to +300 °C		+5 K/min
Vötsch Temp. Shock VMS³ 2/08/20/64	400 x 400 x 600 mm	20 kg	-75 °C to +200 °C		Immediately
Heraeus VT 6060 M	345 x 415 x 370 mm	20 kg	+25 °C to +200 °C		+< 2 K/m
2 x Vötsch VTS 7027	750 x 580 x 615 mm	60 kg	-72 °C to +180 °C		5 K/min
5 x CTS	750 x 650 x 400 mm	40 kg	-40 °C to +180 °C		5 K/min
Weiss Technik LT 1000	1'000 x 1'000 x 1'000 mm	60 kg	-180 °C to +200 °C		10 K/min (Liquid Nitrogen cooled)
ACS CH125 LN2 ESS	500 x 500 x 500 mm	30 kg	-180 °C to +200 °C		10 K/min (Liquid Nitrogen cooled)
Vötsch VTS 7034	750 x 760 x 580 mm	60 kg	-70 °C to +180 °C		5 K/min
Vötsch VT 7021	630 x 570 x 560 mm	60 kg	-70 °C to +180 °C		2,5 K/min
Heraeus VTM04	15 L	20 kg	-30 °C to +120 °C		3 K/min
Heraeus VLK07/90	430 x 450 x 435 mm	40 kg	-70 °C to +180 °C	10 RH [%] to 95 RH [%]:	5 K/min
Weiss ClimeEvent C-340-70-5	750 x 580 x 765 mm	60 kg	-72 °C to +180 °C	10 RH [%] to 98 RH [%]	7 K/min
Heraeus/HTS7090S	1'000 x 1'150 x 900 mm	30 kg	-70 °C to 180 °C		3 K/min
Espec/EGNZ12-7.5CWL	600 x 743 x 850 mm	60 kg	-70 °C to +180 °C		15 K/min
SCS MHX 612 ZK	600 x 800 x 850 mm	40 kg	-70 °C to +180 °C	10 RH [%] to 95 RH [%]	heat 5 °C/min, cool 2 °C/min
SCS MHX 408 ZK	800 x 850 x 900 mm	40 kg	-70 °C to +180 °C	10 RH [%] to 95 RH [%]	heat 5 °C/min, cool 2 °C/min
VÖTSCH VT 7018	570 x 750 x 450 mm	40 kg	-70 °C to +180 °C		heat 5 °C/min, cool 2 °C/min
VÖTSCH VT 7018	570 x 750 x 450 mm	40 kg	-70 °C to +180 °C		heat 5 °C/min, cool 2 °C/min

Thermal Vacuum Testing

Testing in a thermal vacuum chamber is an essential part of testing equipment for use in space to predict behavior in space-like conditions. Beyond Gravity Test Centers offer testing in a variety of different chamber sizes up to 800 x 900 mm and temperatures from -190°C to +200°C.

Our vacuum chambers can be equipped with various electrical feed through for connecting the test specimen during test to ensure the correct functioning and to monitor the behavior of the test object.

Vacuum Chamber	Maximum Test Dimensions	Temperature Range	Remarks
TVC L1	600 x 600 x 600 mm	-185 °C to +185 °C	
TVC L2	800 x 800 x 600 mm	-70 °C to +120 °C	
TVC M1	Ø 670 x 370 mm	-70 °C to +120 °C	
TVC M2	Ø 630 x 300 mm	-70 °C to +120 °C	
TVC M3	Ø 630 x 300 mm	-70 °C to +120 °C	
TVC M4	Ø 630 x 300 mm	-70 °C to +120 °C	
TVC M5	Ø 630 x 300 mm	-70 °C to +120 °C	
TVC M6	Ø 580 x 250 mm	-70 °C to +120 °C	
TV VA1	800 x 900 x 800 mm	-70 °C to +200 °C *	* Optional -170 °C with nitrogen
TV VA2	600 x 800 x 600 mm	-70 °C to +200 °C *	* Optional -170 °C with nitrogen
TV DN1	Ø 1'200 x 1'200 mm	-65 °C to +100 °C	
Pfeiffer Classic 590	900 x 1'100 x 800 mm	-70 °C to +165 °C	
Pfeiffer Classic 590	900 x 1'100 x 800 mm	-70 °C to +165 °C	
TVC2	300 x 450 x 450 mm	-70 °C to +165 °C	

EMC Tests

Beyond Gravity can provide EMC testing in shielded chambers at multiple locations and has the capability to perform reverberation measurements as well.

EMC Tests	
Conducted Emission	30 Hz – 1'000 Hz
Conducted Susceptibility	30 Hz – 1'000 Hz
Radiated Emission and Susceptibility	H-Field
Reverb Measurements	40 Hz – 40 GHz
ESD Contact	Up to 30 kV
ESD Air	Up to 30 kV
ESD Contact	Up to 30 kV
Other	Selected transient tests

Antenna Testing

Beyond Gravity offers antenna testing in its own RF lab and 6-meter antenna measurement range. We can perform near and far field measurements from 900MHz up to 40 GHz. The test facilities are set up with the latest available test equipment and has automatic roll tables for fast and accurate measurements.

Antenna Testing	
Telemetry and Telecommand Antennas	S-band, C-band, X-band, Ku-band, Ka-band
Link Antennas	L-band, S-band, K-band, X-band, Ka-band
Global Navigation Satellite System Antennas	GNSS RX, GNSS TX, Satellite Based Augmentation, System Antennas
Earth Observation Antennas	Scatterometer, C-band Radio Occultation, L-band
User Antennas	S and L-band Patch Excited Cup Array Elementys
	Feed Array
	X-band SAR and Intersatellite link Antennas
	Custom made Antennas....

Space Mechanism Testing
Beyond Gravity has developed its own methods of tracking and evaluating mechanical movements.

EGSE Development
- Function & Performance Testing
- High Level Test Automation
- TV Test Control
- Calibrated Data Acquisition

Photogrammetry – Motion Tracking
- Mono camera system, measurement of rotation of mechanism
- Accuracy 0.02°, Resolution 0.005°(Mono)
- Multi camera system, Measurements of 6 DoF mechanisms
- Accuracy 50 m/0.02°, Resolution 10 m/0.005°(Multi)

Separation Test
Beyond Gravity has the capability to perform various types of separation tests and also make precise measurements of the forces and movements involved during the testing. Laser trackers, strain gauges, accelerometers, thermocouples, high-speed cameras and the latest state of the art tracking software are used to measure, detect and document those movements and forces.

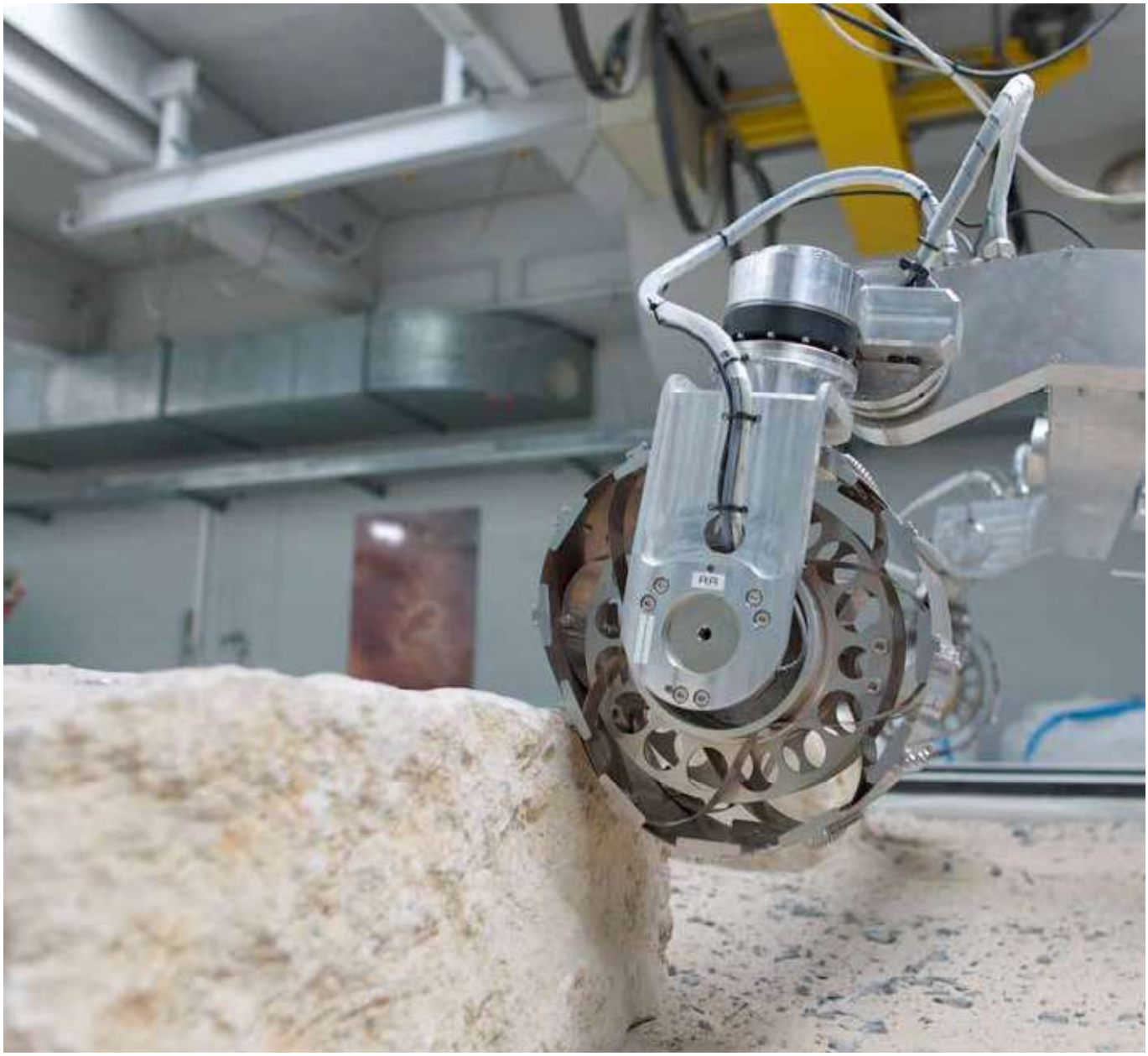
We offer the following separation tests:
- Pyrotechnical Separation test
- Mechanically spring-loaded separation test
- Gas spring loaded separation test
- Explosive bolts separation test
- CBOD (Clamp Band Opening Device)
- PIN-puller test
- Separation nut test

Planetary Surface Simulation

As the only company in Europe, equivalent Lunar and Martian soil test beds are available. Beyond Gravity offers testing and verification of wheels and locomotion including deployment and egress. The test bed can be adapted to simulate the real surface conditions. High-speed cameras, accelerometers and potentiometers, visualization and processing tool are used to record and document the results. The test bed can also be used bulk density measurements. Packing density determines much of the behavior and can be used to simulate other influences on behavior for example influence of ageing.

Planetary Surface Test Bed

Size	6 x 6 Meters
Tilting	Tiltable up to 30 Degrees
Surfaces	4 types of dust/sand to simulate the surface and landscape on the Moon and Mars
Observation/Documentation	• High speed film • Synchronized video • Recording of up to 30 analog signals • Real time tracking



Drop Test
As a part of environmental testing, we can also perform drop tests. These tests are used to simulate typical handling errors in the loading and unloading process of cargo. For drop tests with large test samples, an overhead crane mounted to the ceiling is used. With this crane the drop height can be set up to 3 meters. We can perform drop tests on following surfaces: Concrete, sand, gravel and wood. For safety reason the drop test is released remote controlled.

Highspeed Imaging
With up to 1´000 frames per seconds (up to 100´000 with reduced resolution), we are capable to record high dynamic processes. The newest tracking software and up to 8 syncronized simultaneous recording cameras can track and measure objects in 3 dimensions.

Precision on earth. Reliability in space.

Beyond Gravity (formerly known as RUAG Space), headquartered in Zurich (Switzerland) and part of the aerospace group RUAG International, is the first space company to combine a start-up mindset, agility, speed and innovation with decades of experience and proven quality.

Our vision: Number one independent space product supplier

At Beyond Gravity, approximately 1'600 employees at 12 locations in six countries (Switzerland, Sweden, Austria, Germany, USA and Finland) develop and manufacture products for satellites and launch vehicles with the goal of advancing humankind and enabling the exploration of the world and beyond. Beyond Gravity is the preferred supplier of structures for all types of launch vehicles and a leader in selected satellite products and for constellations in the New Space sector. We have been involved in space missions ever since the first endeavors – and we have always overcome the boundaries. The boundaries of our innovative home country, the boundaries between European and American partners, the boundaries of our atmosphere, the boundaries of what is technically possible.

Pushing boundaries to realize what's next

Our customers can rely on us to turn their mission into a success. Anyone who flies customers into orbit and sets their sights beyond the horizon needs to be passionate, curious and have the will to innovate in order to meet the challenges that new worlds present. At the same time, we are not daredevils, but have a down-to earth attitude. A contradiction? No: because reliability, meticulous planning and a rigorous testing regime are mission critical.

Beyond Gravity has delivered products for hundreds of different missions in over 40 years. We are currently working on around 400 projects. What they all have in common? They all ultimately serve an important purpose that advances humankind. Our activities encompass weather forecasting, satellite-based positioning and communications in even the most remote corners of the globe, satellite data to manage natural hazards, new discoveries revealing the mysteries of our universe, scientific experiments in space and exciting new developments like self-driving cars – everything depends on space technology. With endless opportunities, we help our customers around the world make the impossible possible.

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Realizing what’s next.