Customer Feedback

Nicolas Stübe, Dr. Alke Meents
DESY/suna-precision GmbH, Hamburg, Germany

Due to the fast adjustment and precise sub-nanometer resolution of the sensor, we are able to easily identify trajectories and eigen frequencies for the optimization of flexure based components. The combination of the digital interfaces with our motion control system allows most accurate closed-loop control for scanning applications. With the closed-loop integration of the IDS3010 in our X-ray microscope by the end of this year, we feel confident to get the first 3-D tomographic pictures of biological samples with a resolution of 20 nm within the beginning of 2016.

Dr. Paolo Imperia
Sample Environment Group Leader,
ANSTO, Lucas Heights, Australia

We use the attoMOTION Nano Drives in our standard cryostats typically for non-standard experiments. It provides a precise, compact and reliable tool for in-situ sample alignment which is perfectly suited to a variety of situation within the neutron scattering experiments. The accompanying attoCONTROL unit integrates well with our instrument control system to allow for a seamless beamline user experience. Additionally, the attention given to providing excellent customer service and meaningful collaboration with clients has and will continue to lead to great advancements in the required capabilities.

Dr. Thomas Zickler
CERN / Magnetic Measurement Section, Geneva, Switzerland

Before purchasing a laser interferometer, we were not sure about the applicability of the interferometer for our requirements. During the short testing phase, we became familiar with the interferometer and its operation. While using the sensor for the intended application, we verified the advantages of the device and decided for purchasing it.

Dr. Stefan Kubsky
Synchrotron SOLEIL, St. Aubin, France

An intense and ongoing scientific exchange with the attocube-development team permitted us to obtain new functionalities and highest precision. Our system, being inherently non-standard, profits greatly from the compactness and modularity of the sensorheads. We rapidly managed to file a patent application implying interferometric metrology.

Dr. Hendrik Ohldag
SSRL - Stanford Synchrotron Radiation Lightsource,
SLAC National Accelerator Laboratory, USA

We use attocube linear stages with optical and resistive encoders for positioning of samples relative to high resolution x-ray optics in a Scanning Transmission X-Ray Microscope (STXM). The microscope operates in ultra high vacuum, in magnetic fields and at variable temperature. attocube stages provide the unique capability of high precision long term stability positioning under such conditions, which is crucial for the successful operation of a STXM microscope that serves a broad community of researchers. In addition, we appreciate the excellent customer service and friendly personnel at attocube, always willing to find the solution allowing the client to successfully address a challenge.

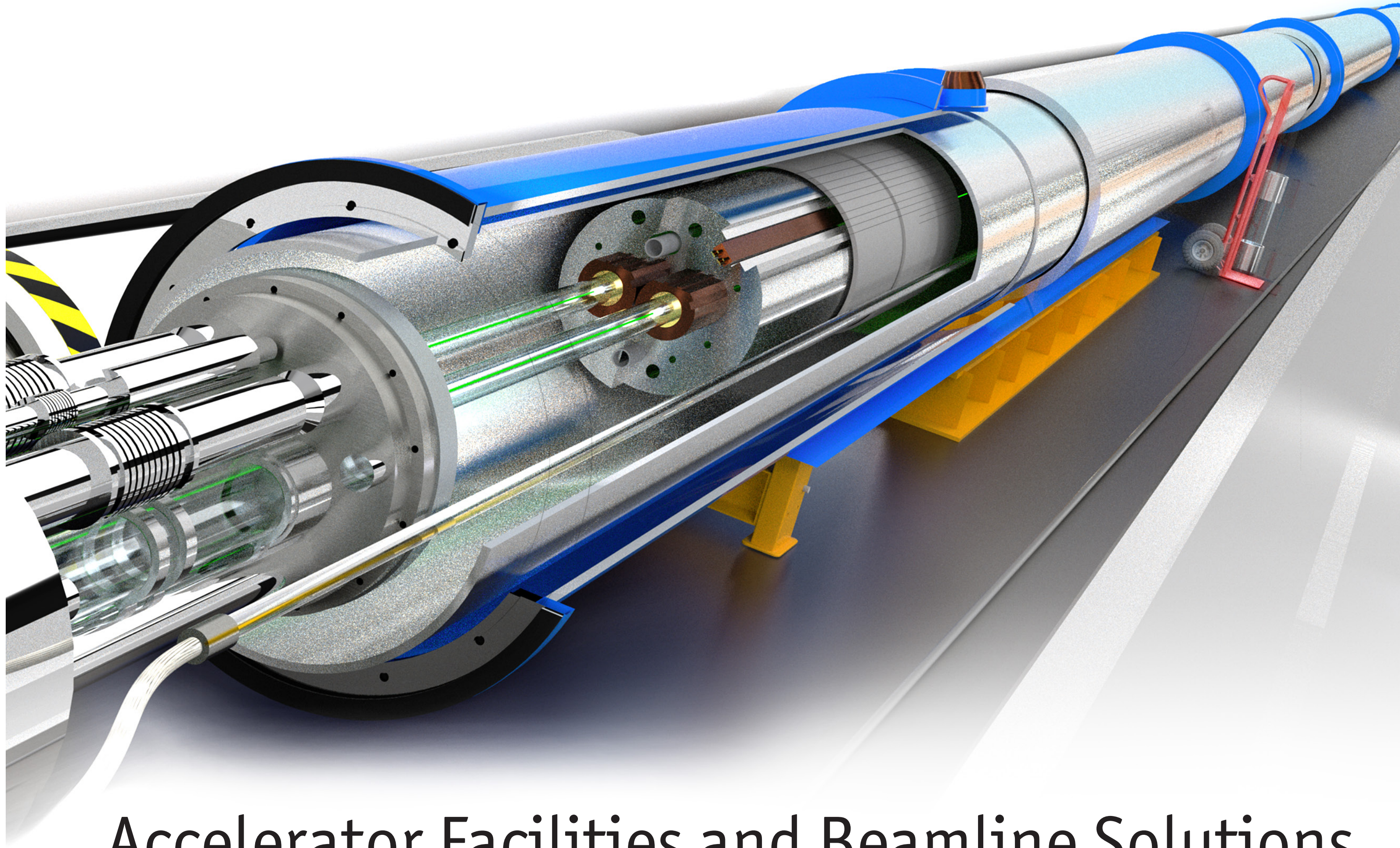
Prof. Tim Salditt
Institute for X-Ray Physics,
Georg-August-Universität Göttingen, Germany

Due to very limited space in our setup, the compact nanopositioning solutions of attocube were ideally suited for our X-ray experiments; highest positioning resolution and stability were essential for a precise alignment of our waveguide with respect to the sample. A special thanks goes to the fast, elaborate and highly knowledgeable customer support attocube provides.

attocube systems AG | Eglfinger Weg 2 | 85540 Haar | Germany
Tel.: +49 89 420 797 - 0 | info@attocube.com
www.attocube.com

Brochure version: 2018 - 01

attocube
WITTENSTEIN Group



Accelerator Facilities and Beamline Solutions

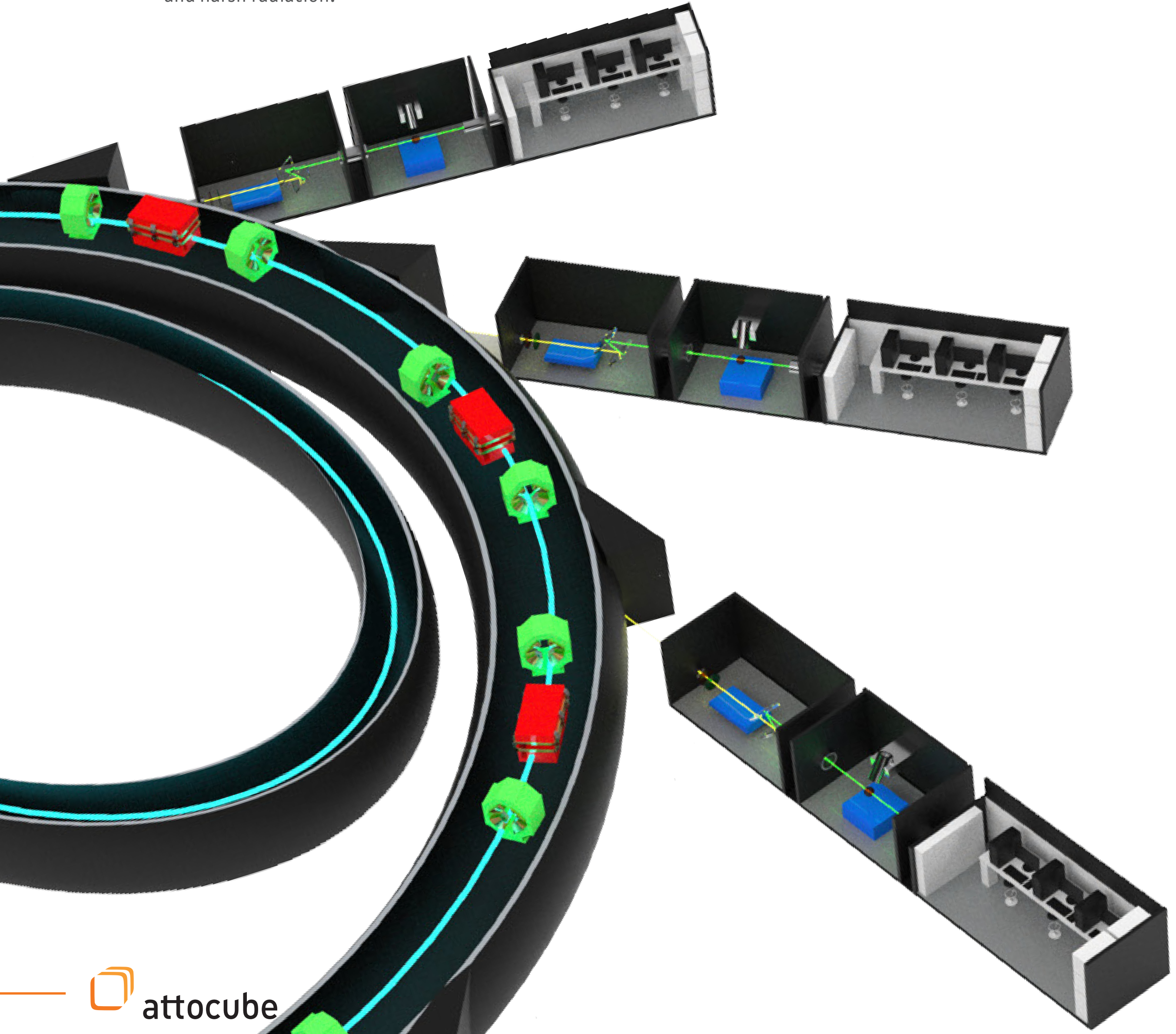
Nanoprecise Motion and Measurement Solutions by attocube

Infrastructure

nanoprecise motion control in the heart of the facility

The infrastructure for all large scale facilities, whether they are particle accelerators or spallation sources, needs position control of a wide variety of devices often operating under challenging conditions such as vacuum, extreme temperatures, and harsh radiation.

For optimal beam transport and characterization, nanometer precise measurement solutions are increasingly important due to higher demands on the stability of the position and wavelength of the radiation.

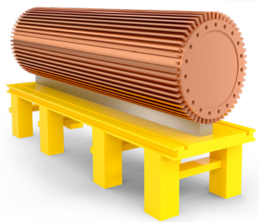


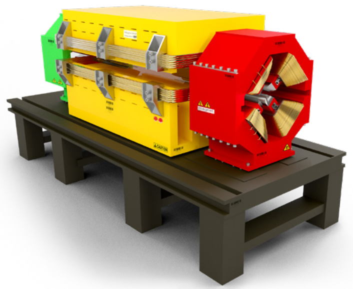
Particle accelerators

Cyclic particle accelerators generate and direct beams with high flux. Vibration and displacement monitoring of equipment which undergo constant beam impact plays a critical role in the stability and quality of the beam.

- Mechanical stability and vibration measurements

From mirror mounts to beam dumps, many surfaces are in contact with a high dose of radiation. The tilt and vibration of these surfaces needs to be measured with contactless technology down to nm-precision to not degrade the beam damage threshold.





- Position detection of bending magnets

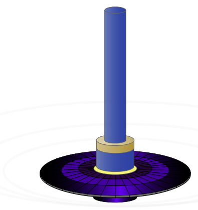
Bending magnets steer the particles in the storage ring, and ever increasing demands on homogenity of the fields requires precision characterization of these magnets. Often the measurement transposes magnetic inhomogenity into angular deflection.

FELs and spallation sources

Round-the clock monitoring of vibration and displacement of all safety features in a facility is necessary to protect the health and well being of the members of the work force.

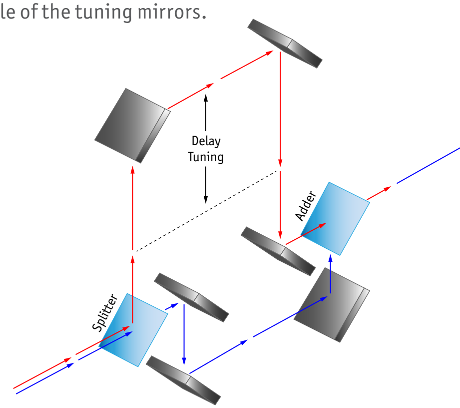
- Target wheel position & safety control

The vibrational stability and the position of a target wheel must be extensively characterized for the safety of the whole facility. This requires a radiation compatible and contactless technique for measuring displacement.



- Split and delay unit - precise position control of mirrors

The split-and-delay unit at XFEL sources creates two beam pulses that are delayed in time by a variable amount for pump-probe and temporal coherence measurements among others techniques. The tuning delay depends on the position and the angle of the tuning mirrors.



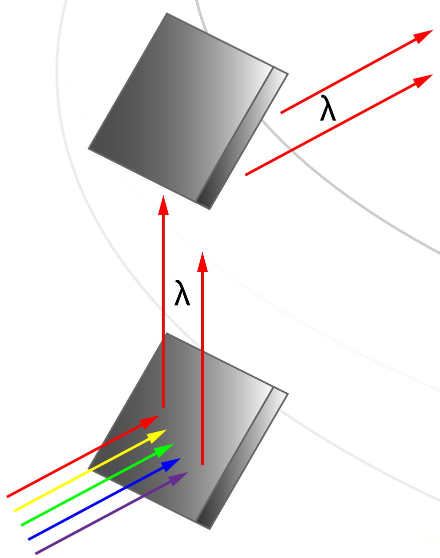
Beamlines and End Stations

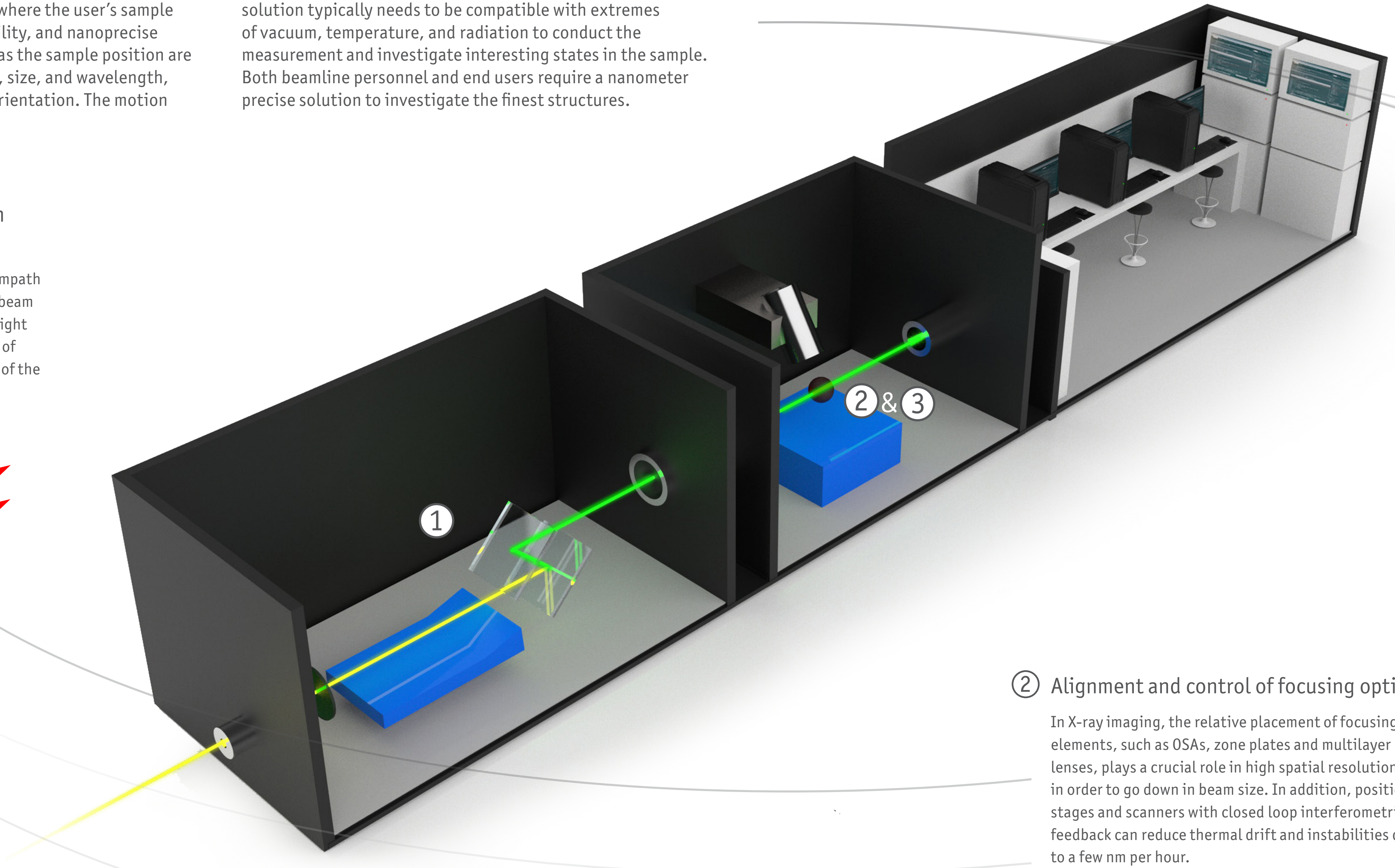
nanoprecise motion control at the interface with the user

The end stations at the beamlines are where the user's sample interacts with the radiation of the facility, and nanoprecise motion control of beam optics as well as the sample position are necessary to optimize the beam shape, size, and wavelength, and to guide it to the correct sample orientation. The motion solution typically needs to be compatible with extremes of vacuum, temperature, and radiation to conduct the measurement and investigate interesting states in the sample. Both beamline personnel and end users require a nanometer precise solution to investigate the finest structures.

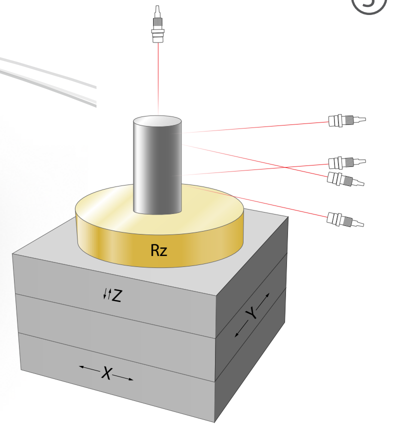
① Tilts and vibrations of crystals in monochromators

Double crystal monochromators in the beampath serve to filter the incoming polychromatic beam and select the relevant wavelength of the light for the experiment. The angular alignment of the crystals directly influences the quality of the monochromatic beam.





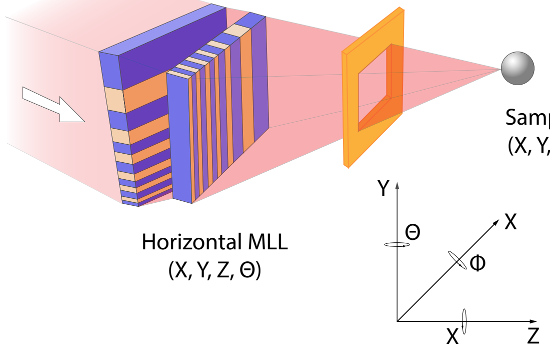
③ Sample positioning



Beam sizes are constantly shrinking in a effort to resolve on even finer structures in the user's sample. Triggering, detection, and feedback of the sample position therefore needs to be reliable, well documented, and highly precise. Sample stages based on piezo motors are usually the optimal choice, as well as interferometers for a contactless displacement sensing with picometer resolution, to be able to detect and correct any non-orthogonality, parasitic movements, or run-outs.

② Alignment and control of focusing optics

In X-ray imaging, the relative placement of focusing optic elements, such as OSAs, zone plates and multilayer Laue lenses, plays a crucial role in high spatial resolution setups in order to go down in beam size. In addition, positioning stages and scanners with closed loop interferometric feedback can reduce thermal drift and instabilities down to a few nm per hour.



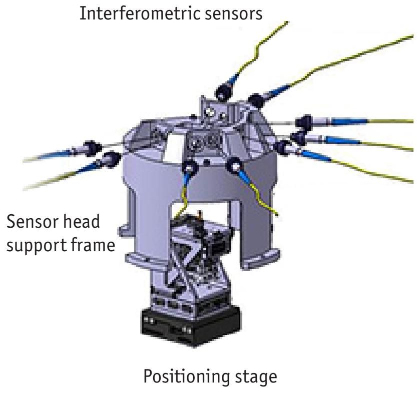
Applications for Light and Neutron Sources

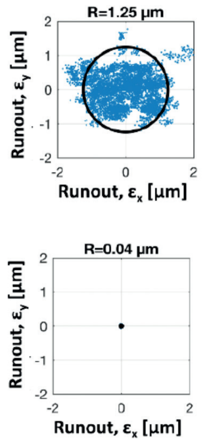
endstation applications

Rotation motion error compensation for stable probe positioning

The challenge of rotatory probe positioning for x-ray nanotomography is the limited tolerance of the runout. The smaller the runout – the better the resolution of experiments. The closed loop system at the synchrotron SOLEIL consists of a positioning stage for rotating the probe and attocube's interferometer focusing directly on the rotating cylinder. The positioning stage is equipped with three linear drives, two piezo driven positioners for compensation of error motions, and one rotational stage. Based on a reduction algorithm for error motions, the initial runout of 1250 nm is reduced to 42 nm – a decrease of 97%.

Christer Engblom, Synchrotron Soleil, St Aubin, France





Lensless Imaging with X-Ray Waveguides

A synchrotron generated X-Ray beam was coupled into an X-Ray waveguide located in the focus of Kirkpatrick-Baez mirrors. The resulting filtered wave was then used to illuminate a sample coherently, yielding a magnified hologram of the sample recorded by a pixel detector. Several linear positioners, goniometers, and rotators were applied for precision alignment of the waveguide with respect to the sample, which in turn was mounted on a high-precision tomographic rotation stage.

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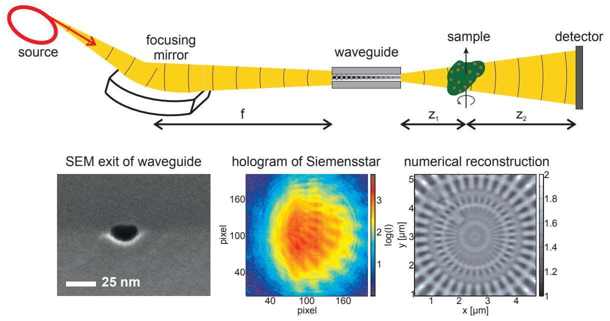
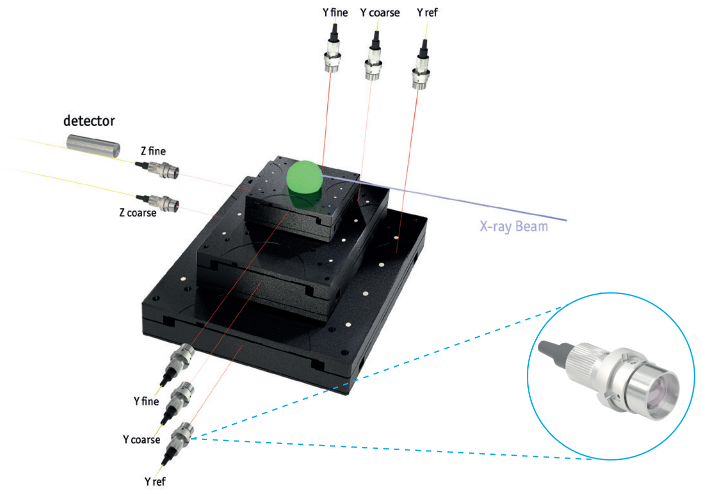


Detecting vibration propagation and parasitic motions with picometer resolution

Exact sample positioning in synchrotron beamlines requires position detection with highest resolution. A group at the Diamond Light Source designed a sample positioning system with three positioners for x, y, z movements. To determine the error motions, eight axes of three IDS3010 devices were triggered for synchronous data acquisition, controlling the movement with BiSS-C interface. They identified parasitic motions of only 100 pm that were caused in the non orthogonal fixing of the positioners. These smallest amount of deviation can be detected in Ultra-high vacuum only - and with the IDS3010.

Trevor Bates, Brian Nutter, Diamond Light Source Limited, Oxfordshire, England



Characterizing a high resolution, scanning fluorescence X-ray microscope with attocube interferometer

When developing an X-Ray microscope capable of nm resolution, careful design is a must. Thermal and mechanical stability of the components and assemblies has to be followed throughout the process. The FPS shows superior performance regarding its outstanding stability and its capability of measuring sub-nm displacements. The senor has a better than 1.25 nm stability over 40 hours, and a better then 300 pm resolution at 100 Hz bandwidth in a controlled environment. The FPS is therefore the ideal supplement for the mechanical control of all components used in the described X-Ray microscope setup achieving a resolution in the order of 40 nm, while the stability is below 45 nm over the entire time needed for data collection.

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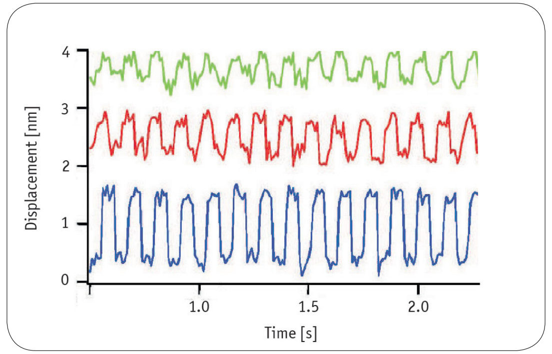
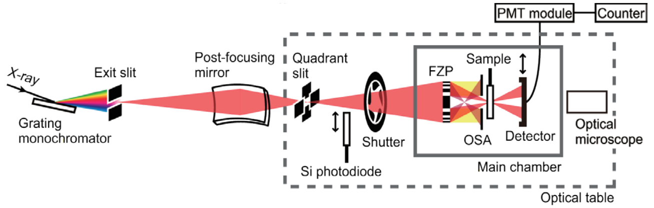
© 2013, American Institute of Physics.



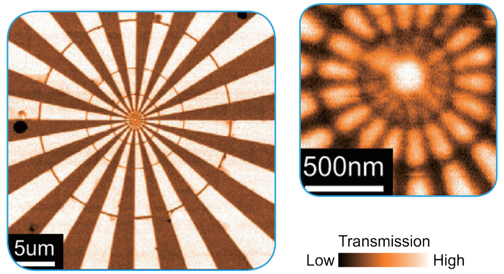
Applications for Light and Neutron Sources

beamline and infrastructure applications

New stable and portable x-ray microspectroscope at photon factory KEK



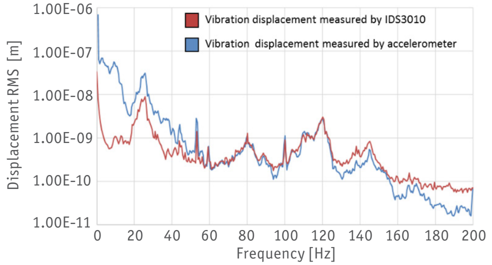
At the high energy research accelerator KEK in Japan, Dr. Takeichi et al. designed a novel X-Ray microspectroscope for high resolution composition analysis. The setup is comprised of 11 attocube ECS stepping positioners and a dedicated scanner for sample imaging. All the positioners are equipped with optoelectronic sensors and can be digitally controlled. The sample stage is stabilized via attocube's interferometric FPS3010 sensor with a resolution of 25 pm. The whole four-stack-setup is compact enough to fit into a vacuum chamber of only 220×310×200 mm³. First measurements show the resolution of the new instrument to be approximately 40 nm.

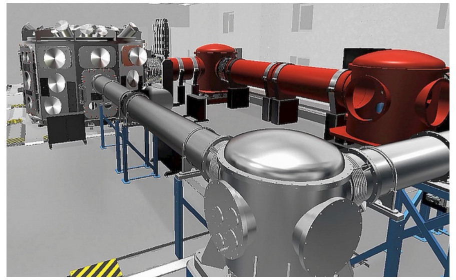


Y. Takeichi, et al; Rev.Sci.Instr. 87, 013704 (2016); doi: 10.1063/1.4940409

Vibration of high-power precision laser mirror

At the "ELI Beamlines facility", currently under construction in Dolní Brežany close to Prague in the Czech Republic, we have developed an ultra-high pointing stability laser mirror mount for guiding the world's highest repetition rate HAPLS Petawatt laser over up to 107 meters onto the target. The attocube IDS3010 offers major advantages compared to standard sensors like capacitive probes and accelerators when measuring 5 – 100 nrad RMS pointing stability of a mounted high-power precision laser mirror. While accelerometers may be used to measure mirror dummies for frequencies > ~12 Hz, the IDS3010 interferometer may diagnose contactless sub-nm displacements up to 10 MHz of mounted mirrors without risking the degradation of its laser damage threshold. In addition the IDS3010 sensor allows working distances up to a few meters. The software WAVE has proved to be convenient for visualizing in real-time the displacement data and for identifying resonant frequencies.



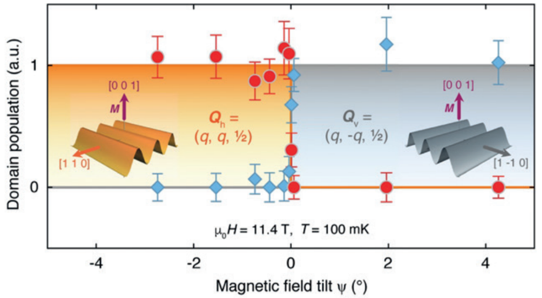


Dr. Tomas Laštovicka, Dr. Martin Sokol, Dr. Michael Morrissey, Ing. Antonin Fajstavr,
Dr. Stefan Borneis ELI-Beamlines, Dolní Brežany, CZ

Hypersensitive macroscopic manipulation of quantum many-body states

M. Bartkowiak, S. Gerber and M. Kenzelmann from the Paul Scherrer Institut, Switzerland, have developed a goniometer sample holder for neutron scattering, which permits in-situ tuning of complex quantum states at low temperatures (100 mK) and high magnetic fields (up to 12 T) [1]. The device is based on a purpose-built, non-magnetic ANGt50/LT goniometer of attocube's open loop positioners. It has an angular range of ±3.6° and is sufficiently compact to fit a dilution refrigerator – cryomagnet environment.

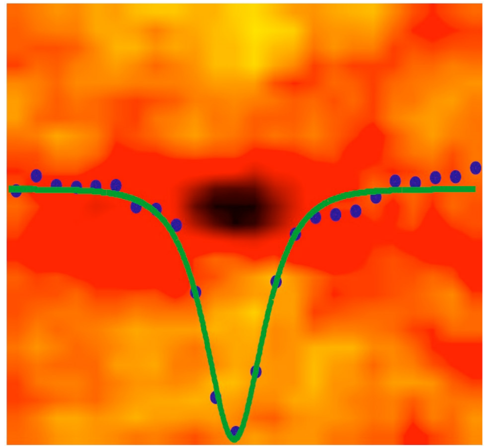
With this device, the magnetic domain population in so-called Ce-115 superconductors could be controlled by altering the alignment of the sample to the magnetic field direction [1,2]. Therewith a binary switching behavior has been found which provides strong evidence for a direct coupling of magnetism and unconventional superconductivity in the vicinity of quantum criticality. Population of the Q_h (orange) and Q_v (grey) magnetic domains in the so-called Q-phase of the compound $CeCoIn_5$ is shown as a function of the tilt angle with respect to the external magnetic field. For $|\Psi| \geq 0.05°$ a mono-domain population is found, which can be macroscopically switched (modified from [1]).



[1] S. Gerber et al., Nature Physics 10, 126 (2014).
[2] D. G. Mazzone et al., Scientific Reports 8, 1295 (2018).

Sample positioning in scanning transmission x-ray microscope at SLAC

We use attocube linear stages with optical and resistive encoders for positioning of samples relative to high resolution x-ray optics in a scanning transmission x-ray microscope.
The picture shows a magnetic excitation called "soliton" that is the result of a spin polarized current injected into a thin ferromagnetic Co/Pt multilayer. The injected spin causes a localized oscillation of the magnetization at the spot where the current is injected, here a nano contact with a 150 nm diameter in the center of the picture. Time resolved scanning transmission x-ray microscopy using magnetic circular dichroism as a contrast mechanism is used to obtain an image of the magnetic soliton.



Dr. Hendrik Ohldag, Stanford Synchrotron Radiation Laboratory, SLAC National Accelerator Laboratory.

Worldwide X-Ray and Neutron Sources

using attocube's products

China

- BSRF - Beijing Synchrotron Radiation Facility (Beijing)
- NSRL - National Synchrotron Radiation Laboratory (Hefei)
- SSRF - Shanghai Synchrotron Radiation Facility (Shanghai)

Canada

- CLS - Canadian Light Source (Saskatoon)

Japan

- Photon Factory KEK - High Energy Accelerator Research Organization (Ibaraki Prefecture)
- J-PARC - Japan Proton Accelerator Research Complex (Ibaraki Prefecture)
- SPring-8 - Super Photon ring 8 GeV (Hyōgo Prefecture)
- SACLA - SPring-8 Angstrom Compact Free Electron Laser (Hyōgo Prefecture)

United States

- SSRL - Stanford Synchrotron Radiation Lightsource at SLAC National Accelerator Laboratory (Menlo Park)
- LCLS - Linac Coherent Light Source at SLAC National Accelerator Laboratory (Menlo Park)
- ALS - Advanced Light Source, Lawrence Berkeley National Laboratory (Berkeley)
- APS - Advanced Photon Source, Argonne National Laboratory (Argonne)
- NSLS-II - National Synchrotron Light Source II at Brookhaven National Laboratory (Upton)
- Jefferson Lab FEL - Thomas Jefferson National Accelerator Facility (Newport News)
- SNS at ORNL - Spallation Neutron Source at Oak Ridge National Laboratory (Oak Ridge)

Taiwan

- NSRRC - National Synchrotron Radiation Research Center (Hsinchu)

Korea

- PAL-II - Pohang Light Source-II (Pohang)
- PAL XFEL - Pohang Free Electron Laser (Pohang)

Brazil

- LNLS - Laboratório Nacional de Luz Síncrotron, Brazilian Synchrotron Light Laboratory (Campinas)

Australia

- Australian Synchrotron (Melbourne)
- ANSTO - Australian Nuclear Science and Technology Organisation (Lucas Heights)

Germany

- PETRA III at DESY - Deutsches Elektronen-Synchrotron (Hamburg)
- FLASH at DESY - Free-Electron Laser Hamburg (Hamburg)
- European XFEL - European X-ray Free Electron Laser (Hamburg)
- BESSY II at HZB - Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung at Helmholtz-Zentrum Berlin (Berlin)
- MLZ - Heinz Maier-Leibnitz Zentrum neutron source (Garching)

France

- ESRF - European Synchrotron Radiation Facility (Grenoble)
- ILL - Institut Laue-Langevin (Grenoble)
- Synchrotron SOLEIL (Saint-Aubin)
- LLB - Laboratoire Leon Brillouin (Gif sur Yvette)

United Kingdom

- DLS - Diamond Light Source (Didcot)
- STFC ISIS - Science & Technology Facilities Council, ISIS Neutron and Muon Source (Didcot)

Czech Republic

- ELI Beamlines - Extreme Light Infrastructure, International Laser Reserach Centre (Dolní Břežany)

Italy

- Elettra Sincrotron Trieste (Basovizza)

Switzerland

- CERN - European Organization for Nuclear Research (Geneva)
- SLS at PSI - Swiss Light Source at Paul Scherrer Institut (Villigen)
- SwissFEL - Swiss Free Electron laser at Paul Scherrer Institut (Villigen)
- SINQ - Swiss Spallation Neutron Source at Paul Scherrer Institut (Villigen)

Sweden

- MAX IV Laboratory (Lund)
- ESS - European Spallation Source (Lund)

Denmark

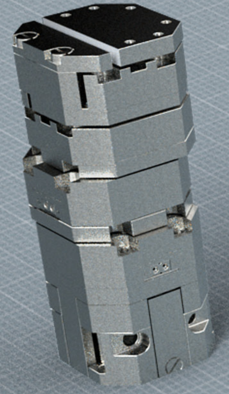
- ISA - Institute for Storage Ring Facilities, Aarhus university (Aarhus)

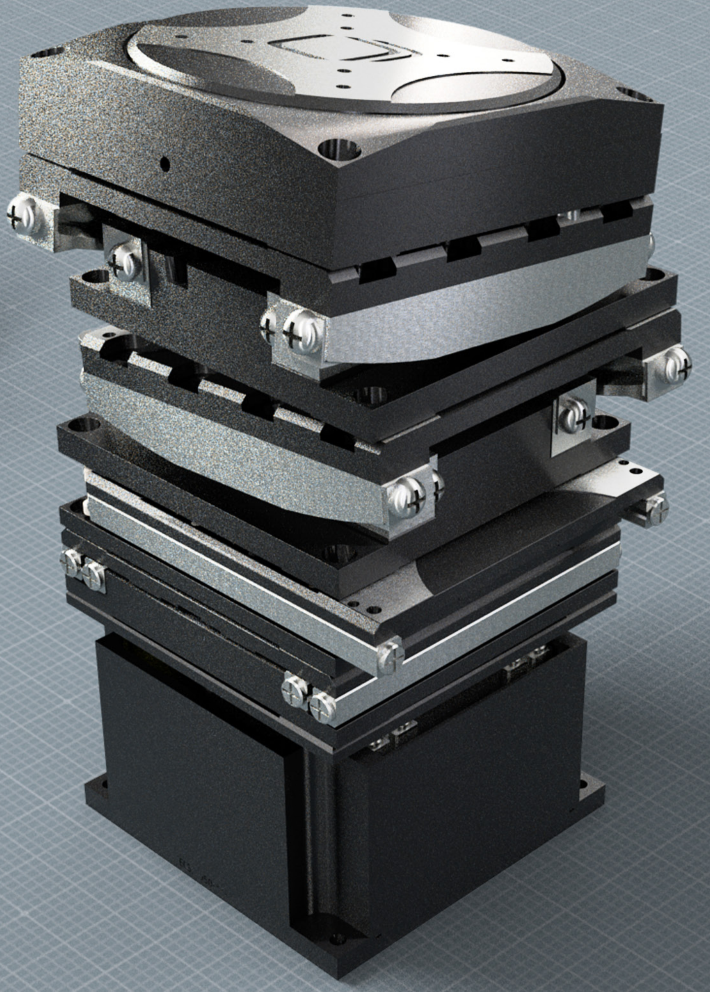
attocube

Nanopositioning Solutions

versatile piezo based nanopositioners for extreme environments

With beam size down to the nanometer for the highest resolution microscopy or tomography application, attocube's nanopositioners offer flexible stacking for motion with multiple degrees of freedom in a wide range of sample environments.

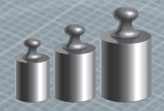




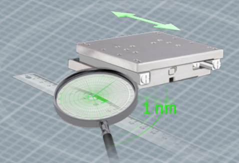
• footprint: starting from 15 x 15 mm²

Compact, precise, and powerful.

attocube positioners employ a powerful and precise nanodrive in a compact frame for easy integration into customer setups



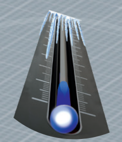
• dynamic force: up to 5 N



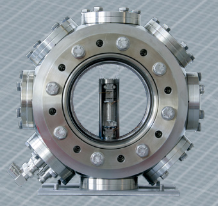
• resolution: down to 1 nm

Extreme Environments

The attocube nano drives meet the challenge of nanoprecise positioning systems working reliable under extreme environmental conditions. Suitable models are available for cryogenic temperatures, high and ultra high vacuum, as well as high magnetic fields.



• low temperatures down to 10 mK



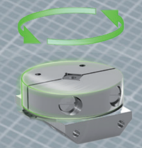
• UHV pressure down to 5 x 10^{-11} mbar

• magnetic fields up to 31T

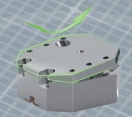
Flexible positioning

attocubes positioners can be stacked to multi-axis devices with up to 6 degrees of freedom

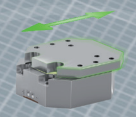
• all in one - hexacube



• rotation



• goniometer



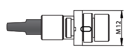
• linear

IDS3010: Modular Laser Interferometer

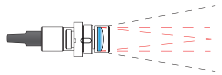
fiber-based displacement sensor adaptable to your application

The Fabry-Perot interferometer IDS3010 is capable of measuring displacements in nanometer range in extreme environments. Its modular and miniaturized design makes the IDS3010 easy to integrate into space-confined applications. The fiber-based interferometer and sensor heads can be easily assembled and adapted to new measurement setups.

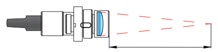
- Pluggable or clamped sensor heads



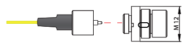
Mounting:
cylinder or metric thread
from 1.2 mm diameter to
M15.5 x0.5 metric thread



Optics type:
focusing, divergent
or collimating

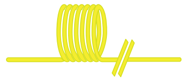


Focal length:
7 mm - 250 mm



Fiber connection:
clamped on fiber
or pluggable FC/PC

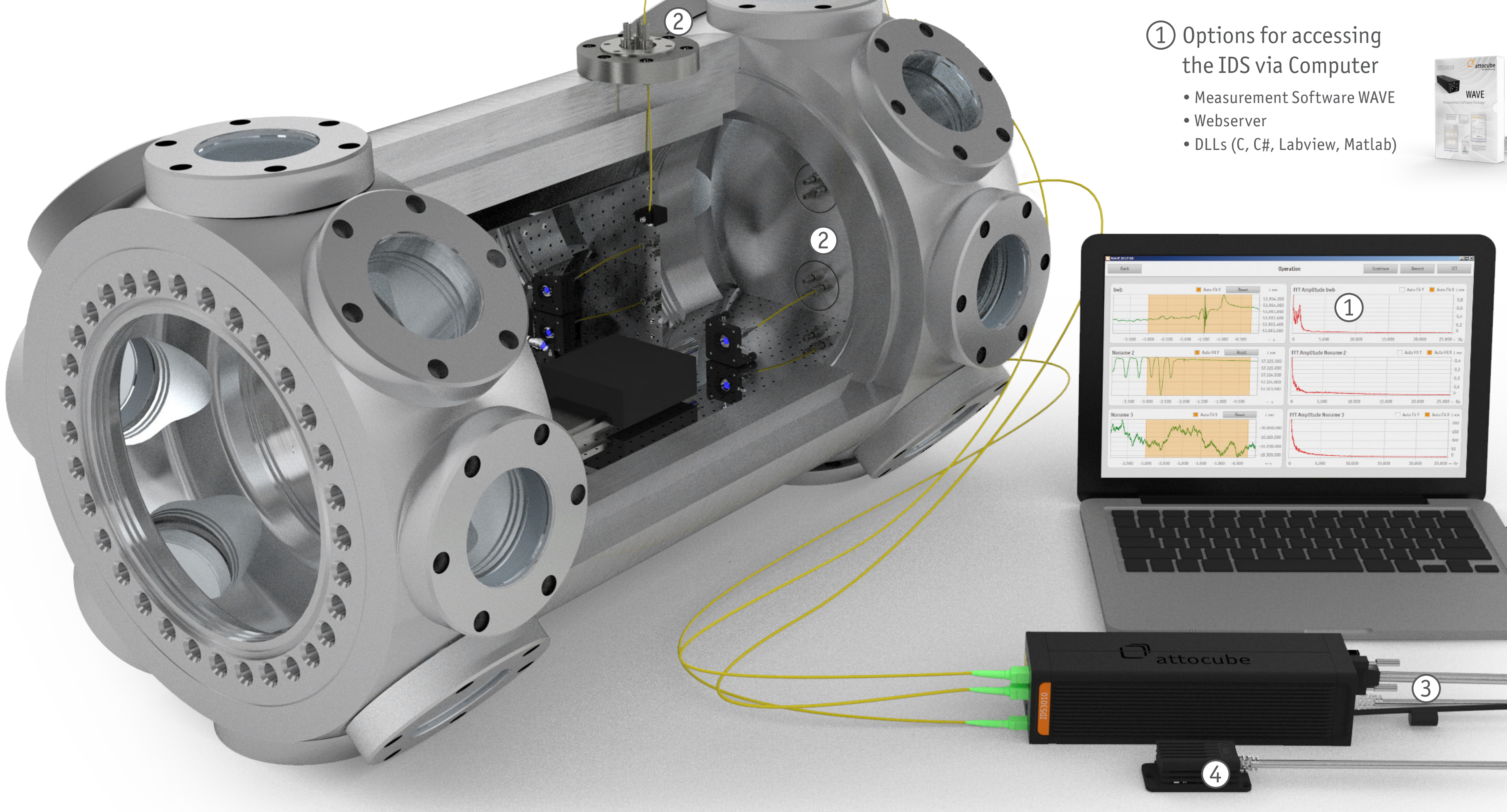
- Connected fiber



customized length, bending radius,metal tubing

- Optical target

customized targets are available such as unmounted corner cube retroreflectors, mirrors, or glass targets



Adaptable modules and components

① Options for accessing the IDS via Computer

- Measurement Software WAVE
- Webserver
- DLLs (C, C#, Labview, Matlab)

② Vacuum Feedthroughs (optional)

- KF or CF flanges
- One or three fibers
- Customized options available

③ Realtime Output-Signals:

- Sin/cos
- HSSL
- Linear analog
- AquadB
- BiSS-C

④ Environmental Compensation Unit (ECU)

- Sensor heads compatible to extreme environments (HV, UHV, LT, RAD)
- Only for ambient conditions: ECU to compensate environmental influences

Compact sensor heads

The controller unit has a volume of around 0.5 l, while the smallest sensor head has a diameter of 1.2 mm

Data capturing rate of 10 MHz

The high bandwidth of 10MHz enables even vibration measurements with target velocities of up to 2m/s

Working distance up to 5 m

The three axes of the IDS3010 allow displacement measurements at long distances until 5 m.

1 pm-resolution & certified accuracy

The digital resolution of the IDS3010 is 1pm, while the PTB has quantified the systematic error of measurement to 0.0ppm between 0 and 3m*

attocube

* total expanded measurement uncertainty: $U_l = \sqrt{(0.084\mu m)^2 + (2.8 \cdot 10^{-7} \cdot l)^2}$