Premium Line

Nano Drives for Research

attoMOTION
Piezo-based Nano Drives

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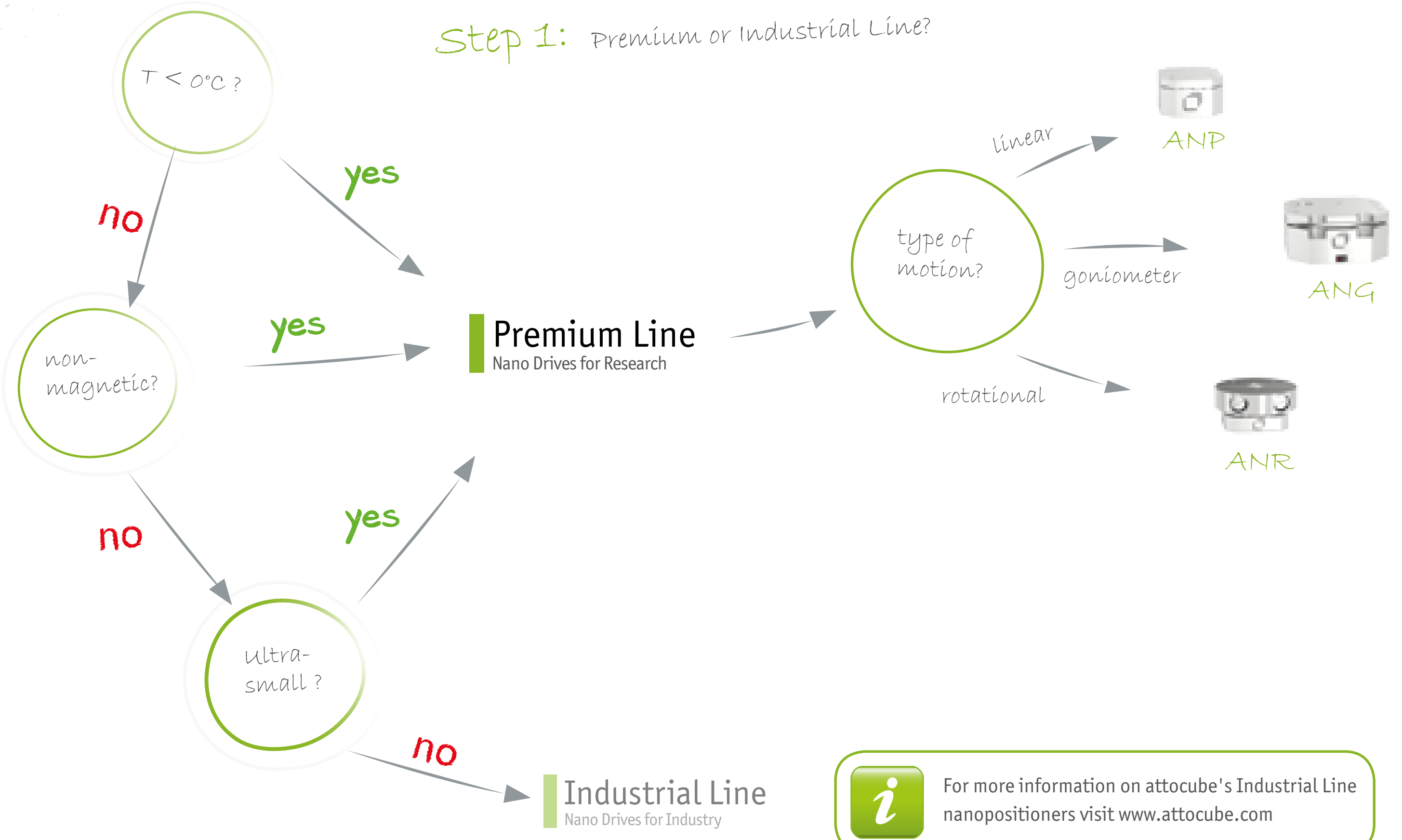
attocube
WITTENSTEIN Group

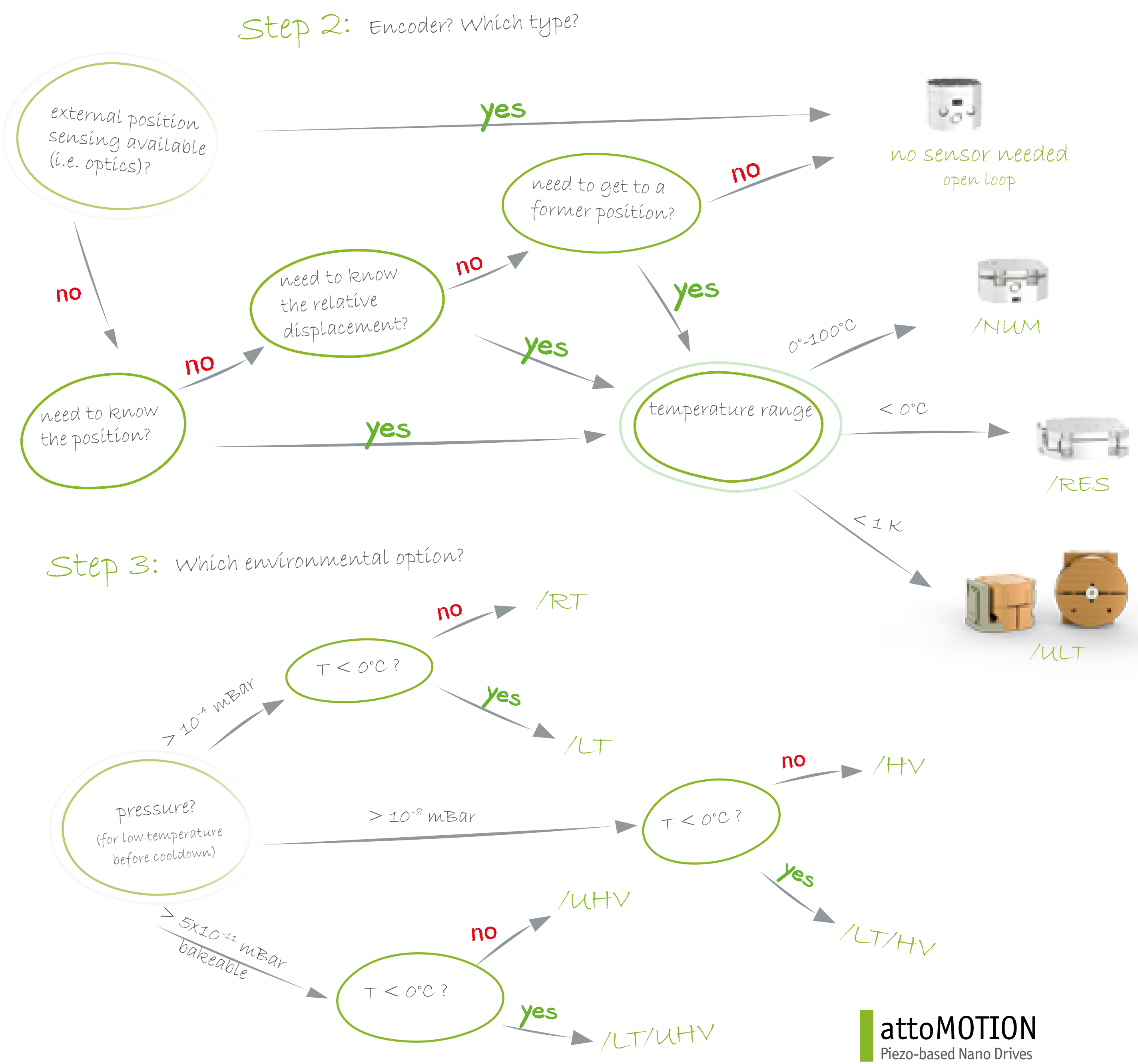
attoMOTION

product finder

Our positioners are named by the base modell (i.e. ANPx101) followed by several extensions describing the type of position sensor and suitable environment. You can determine in just three steps which attocube product line fits your needs best (step 1), if you need a position encoder and what is the ideal version for you (step 2) and what environmental options you require to get the most suited positioner for your application. In the end you will end up with something like ANP/RES/LT/UHV. To choose the exact positioner go to the corresponding section in the catalogue and check the required travel range and size. Scanners (for definition see Glossery) come without integrated encoder, so only step 3 applies.



For more information on attocube's Industrial Line nanopositioners visit www.attocube.com



Premium Line

Nano Drives for Research

The great success of attocube's Premium Line positioners is based on the unique combination of a patented driving technology, the powerful design, the selection of high quality materials, and the long experience of the attocube staff. Premium Line positioners allow for reliable motion over centimeter ranges with the highest precision under extreme environmental conditions such as cryogenic temperatures, high magnetic fields, and ultra high vacuum.

The Premium Line portfolio comprises linear, rotary, and goniometric positioners and scanners – many of them with integrated position sensors for closed loop operation. Depending on the requirements, different sizes, travel ranges, and encoder options are available. The innovative design enables the assembling of several stages to positioning units with up to six degrees of freedom.

Extreme Environments

The non-magnetic Premium Line 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.

Large Travel Ranges in Extreme Environments

Positioners of the Premium Line take advantage of attocube's patented inertial drive technology which is dedicated for the use in extreme working environments. Controllable motion over centimeter ranges with small and reproducible steps of a few tens of nanometers can also be achieved in cryogenic environments, where PZT piezo ceramics are usually limited to scanning ranges of only a few microns.

Closed Loop Control

Exact and repeatable positioning in absolute and relative terms is an easy task for all Premium Line positioners with implemented encoders. Depending on the positioner type and model, up to two different encoder options are available: a resistive encoder optimized for cryogenic applications and an optoelectronic encoder adjusted for applications at ambient temperatures.

Multi Axis Operation

attocube's Premium Line positioners are available in a large variety of designs, sizes, and travel ranges. They can be stacked directly on top of each other thus offering highest flexibility for multi-axis operation.

Premium Line

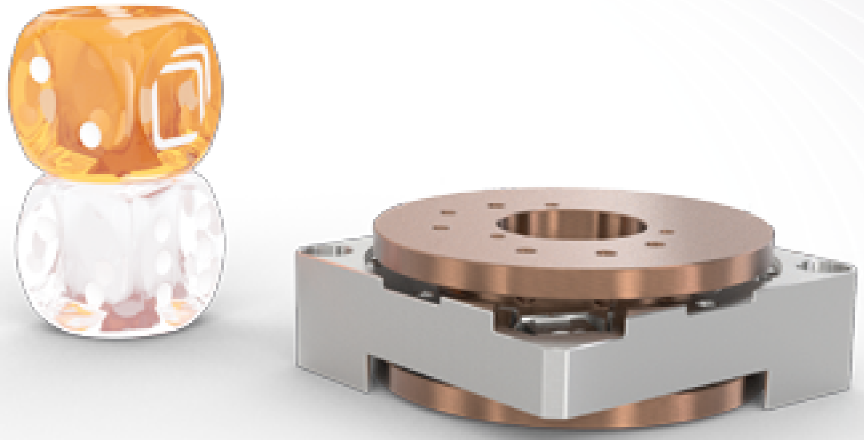
portfolio overview

Linear Positioners

- travel range: up to 20 mm
- maximum load: up to 2 kg
- footprint: starting from 11 mm Ø

Linear Positioners Linear Positioners Linear Positioners

Rotators Rotators Rotators



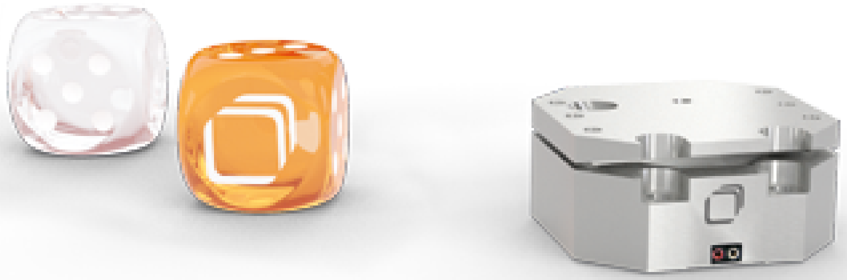
Rotators

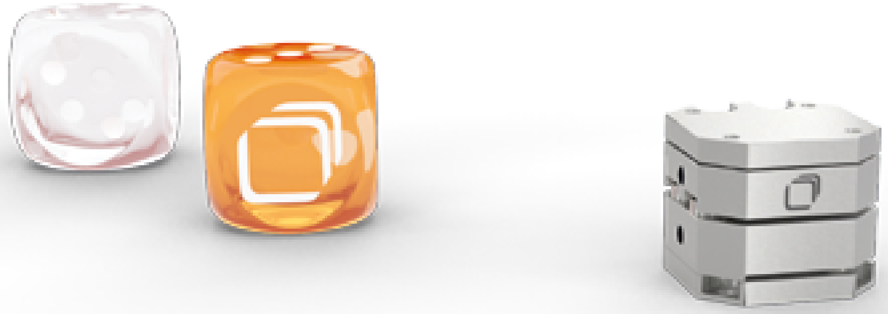
- travel range: 360° endless
- maximum load: up to 200 g
- footprint: starting from 10 mm Ø

Goniometers

- travel range: up to 7.2°
- maximum load: up to 100 g
- footprint: starting from 15 x15 mm²

Goniometers Goniometers Goniometers





Scanners

- travel range: up to 125 µm
- maximum load: up to 100 g
- footprint: starting from 15 x15 mm²

Scanners Scanners Scanners

for detailed specifications refer to the product overview

All attocube stepping positioners and scanners are driven via piezoceramics made from lead zirconite titanate (PZT) for voltages <150V. The PZT for cryogenic scanners and steppers is optimized for maximal performance under these conditions.

The stepping positioners and scanners of each product line can be combined with one another to fit even the most sophisticated multi-axis applications.

Scanners

attocube's scanners are available for extremely smooth motion as part of the Premium Line. They feature up to three linear axes.

• travel range up to 125 µm
• driven via DC voltage (mainly unipolar)
• continuous motion
• motion almost linear to voltage (limited by piezo hysteresis and piezo creep)
• movement of piezo amplified via solid state flexures

Stepping positioners:

The piezosteppers of attocube can perform linear or goniometric movements as well as 360° rotations.

• travel range up to 50 mm (linear), 10° (goniometric) 360° endless (rotational)
• slip stick principle (see next page),driven via sawtooth voltage
• minimum step size: down to 10 nm
• speed up to several mm/s
• can be used in fine positioning (=scan) mode by applying a DC voltage to obtain sub-step-size resolution (with selected controllers, i.e. ANC350, ANM300, ECC100/Pro)

Premium Line
Nano Drives for Research

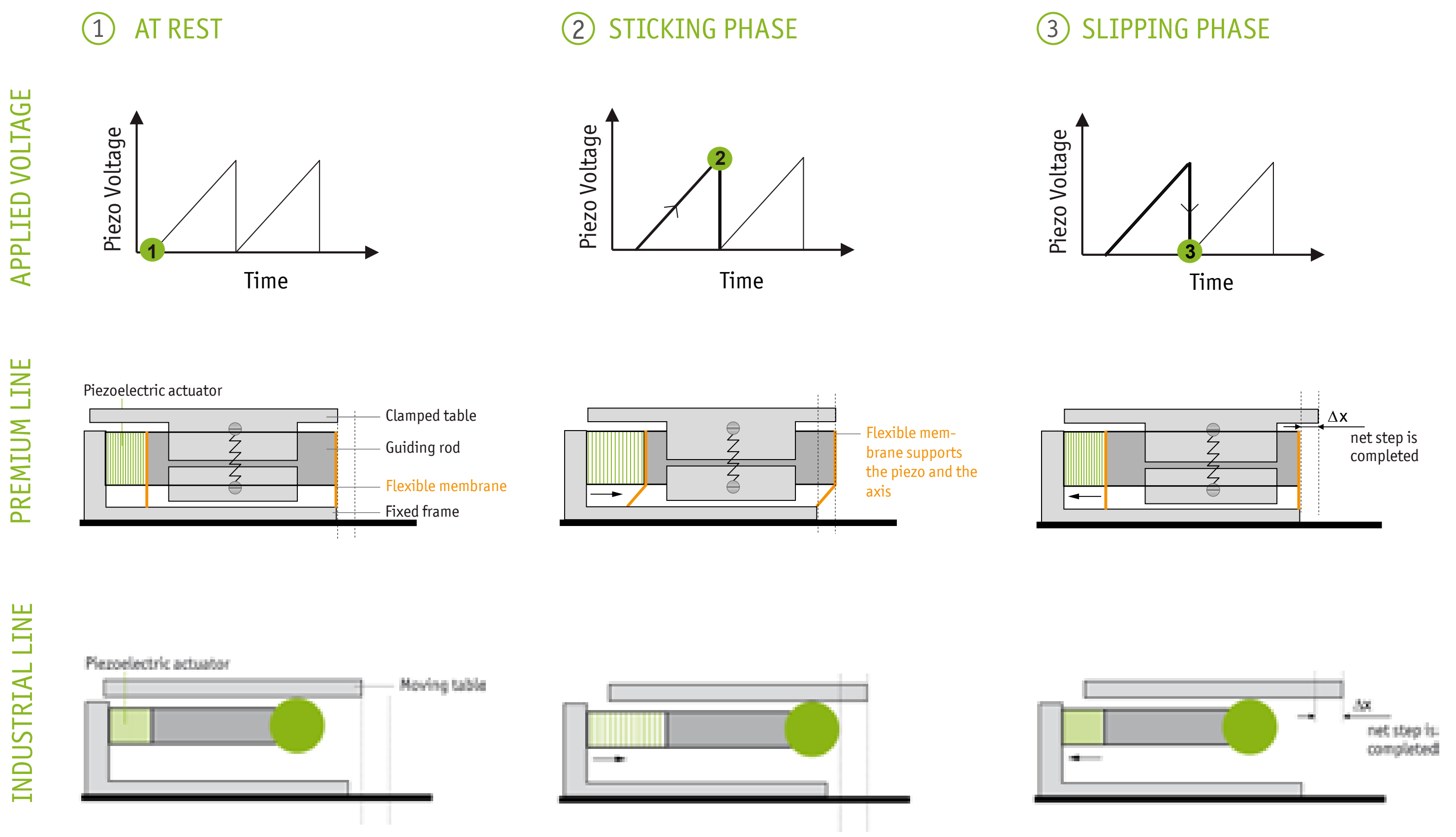

ANS


ANG


ANP


ANR

To acquire microscope images we recommend using (stepping) positioners for course positioning and dedicated scanners for the image acquisition.
It is not recommended to use steppers for image acquisition as open loop positioners show non-linearities while closed loop positioners are slowed down by the settling time required to reach a position.



1. The moving table is spring-clamped to the driving element moved by a piezoelectric ceramic. The clamping force and the coating on both sides of the frictional contact have been carefully chosen for the respective environment. There is no voltage applied to the piezo, the table is held in place by the friction with the driving element.

2. A sawtooth shaped pulse is applied to the piezo. During the phase of the slow flank the movable table sticks to the drive element and is moved over a distance Δx. The achieved expansion Δx is proportional to the applied maximum voltage. The typical minimum step size for positioners is 50 nm at room temperature and about 10 nm at cryogenic temperatures.

3. By applying the steep flank of the voltage pulse to the piezo, the drive element is accelerated very rapidly over a short period of time, so that the inertia of the movable table overcomes friction. This way, the table disengages from the accelerated drive element and remains nearly non-displaced. The net step Δx is now completed and the table remains fixed again at zero voltage.

By repeating this procedure the table can be moved over large distances with nanometer precision.

Temperature Range	Minimum Pressure at Room Temperature		
	ambient	1e-8 mbar	5e-11 mbar
0 .. 100 °C	/RT	/HV	/UHV
1 K - 300 K	/LT	/LT/HV	/LT/UHV
< 1 K	/ULT	/ULT/HV	/ULT/UHV

Temperature

All attocube positioners can be used in a temperature range of 0°C to 100°C in a non-condensing environment. For temperatures lower than this range special versions (/LT, /ULT) are available, see below. Due to the intrinsic nature of the semiconductors used in our precise optoelectronic encoder the /NUM sensor readout will only work up to an encoder temperature of 55°C.

Low Temperature /LT

As a standard, all Premium Line positioners are manufactured from non-magnetic materials such as highly pure titanium (grade 2) and ceramics. /LT means that the materials used are suitable for repeated cooling and operation in cryogenic temperatures of less than 10 mK. Before shipping, they are tested at 4 K. They can work in a vacuum that is generated due to cryopumping. The vacuum before cooling down should not be lower than 1E-4 mbar. Otherwise combined versions (/LT/HV and /LT/UHV) are available.

Ultra Low Temperature /ULT

Titanium which is used with the Premium Line positioners gets superconducting at about 400 mK. For highly sophisticated measurements going beyond this temperature attocube offers the /ULT version of Premium Line positioners. These positioners come with a special resistive sensor and are made from copper beryllium (CuBe) instead of titanium.

Room Temperature /RT

/RT positioners are manufactured for use at ambient conditions (room temperature, dry atmosphere, ambient pressure). If not stated otherwise specifications listed are measured under ambient conditions.

All attocube positioners are tested at room temperature before delivery. Depending on the ordered version additional tests at 4K or inside our vacuum chamber will be performed prior to shipment.

High Vacuum /HV

At attocube the high vacuum range is specified down to 1E-8 mBar. The materials used are stainless steel in case of the Industrial Line positioners and titanium for the Premium Line positioners. All /HV positioners will be tested prior to shipping to provide most reliable motion in high vacuum.

Ultra High Vacuum /UHV

/UHV means that the materials used are compatible with UHV specifications. These positioners can be baked out up to 150 °C. A test in a baked UHV environment is performed to guarantee full functionality usually down to 5E-11 mBar. A few rotators and goniometers use UHV compatible grease. Due to the increased outgassing of these types at elevated temperatures we specify them for 10E-9 mBar as a precaution (noted in specification sheets).

Magnetic Field

All of attocube's Premium Line positioners are built of completely non-magnetic materials such as titanium and ceramics. They can therefore be used in environments sensitive to magnetic materials, close to electron or other charged particle beams. They are especially dedicated for the use in high magnetic fields (currently maximum tested field: 31 T). /NUM(+) encoded positioners are specified for a maximum outer magnetic field of 7 T. Industrial Line positioners are not suitable for experimentation in magnetic fields due to their stainless steel bearings.

Open Loop Positioning

In this mode, the positioner is simply driven forward or backward, without an encoder to read back the actual position or a feedback loop to control the desired target position. Many applications don't require either of the latter or provide inherent external means of controlling the position. Still, at least a rough estimate of the actual position can be deduced by counting the number of steps (if the step size can be determined from an external measurement). The step size itself is relatively uniform under fixed conditions (temperature, humidity, pressure, load, etc) and typically within 5% over the full range but depends strongly on the applied force along the axis. The forward/ backward asymmetry is also typically 5% (no external force assumed).

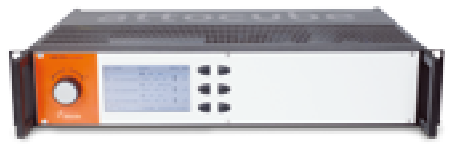
Closed Loop Positioning

Positioners with an integrated or external encoder (/RES, /NUM(+), /FPS) can be used for closed loop position control. A feedback loop integrated into the control electronics minimizes the difference between target position and actual position. Setpoints can either be defined in a software interface (ANC350, ECC100) or on the front panel of the closed loop electronics (ANC350). Settling time depends on the resonance frequency of the setup, speed of the feedback loop and measurement bandwidth.

Suitable Controllers

ANC300 (open loop)

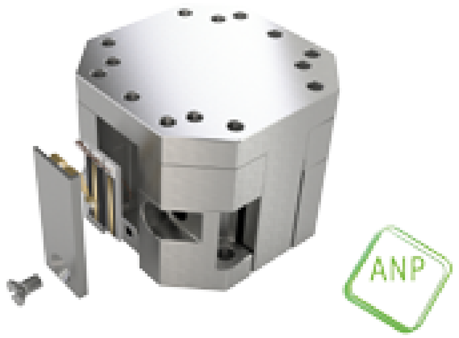
- modular, up to 7 axes
- suited for scanners and positioners
- USB and Ethernet
- controllable via:
  LabVIEW | text-based LUA-console | touchscreen



ANC350 (closed loop)

- three axes (/RES, /NUM, /FPS)
- USB and (optionally) Ethernet
- controllable via:
  LabVIEW | DLL | EPICS
  Windows Software | touchscreen

Glossary
encoder options



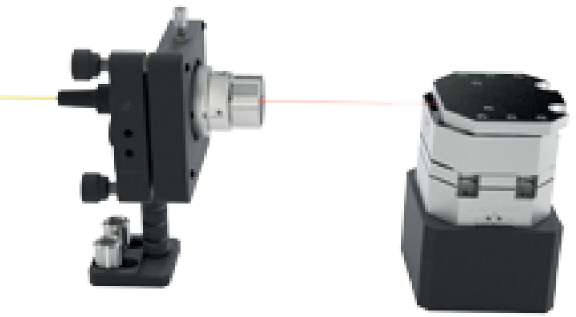
Most of our positioners are available with optional encoders for closed loop control. The encoder allows to read back the actual position, while a feedback loop integrated into the corresponding electronics is used to minimize the difference between target position and actual position. Setpoints can either be defined in a software interface (ANC350, ECC100) or on the front panel of the closed loop electronics (ANC350). The available encoder types are described below.

/RES: Resistive Encoder

The working principle of this encoder type is based on a potentiometer. It is the method of choice for applications at cryogenic temperatures, ultra high vacuum and highest magnetic fields (current maximum tested field: 31 T). The /RES encoder measurement refers to the absolute sample position with a position resolution of 200 nm and a repeatability of 1 µm for most linear steppers. For ultra low temperatures (T < 1 K) a special /RES+ sensor is available which is included in all our /ULT models.

/NUM, /NUM+: Optoelectronic Encoder

The usage of a glass grating and the interpretation of the generated Moiré pattern characterizes the working principle of the /NUM and /NUM+ encoder. The measurement refers to the relative sample position with a position resolution of 1 nm and a repeatability of typically 50 nm for most linear stepping positioners. An absolute position information is also available via a reference mark. This encoder is available for room temperature conditions including /HV and /UHV positioners. The +-version /NUM+ features a reduced thermal dissipation of only 50 mW making it especially suited for /HV and /UHV positioners. The necessary amplifier has been detached from the sensor itself and placed in the connector of the cable outside of the vacuum chamber. The Premium Line/NUM(+)models can also be used in high magnetic fields up to 7 T.



/FPS: Combination with Interferometer

Outstanding precision is achieved by combining attocube's innovative, fiber-based interferometers (FPS or IDS) with standard open loop positioning stages. A 25 pm position resolution and 2 nm repeatability even at cryogenic temperatures (/LT, /ULT), UHV conditions and high magnetic fields outrivals the specifications of any other encoder type. To achive maximal reproducability the position should be measured as close to the point of interest as possible. For detailed information on the interferometers, please refer to http://www.attocube.com/attosensorics/

Glossary
sensor terminology

Sensor Resolution

The term sensor resolution or sensitivity indicates the smallest incremental position change detectable by a sensor. If the sensitivity is not fundamentally limited due to mechanical properties such as friction, the sensitivity is almost always bandwidth dependent. attocube specifies the resolution of optoelectronic /NUM(+) sensors at a measurement bandwidth of 1 kHz.

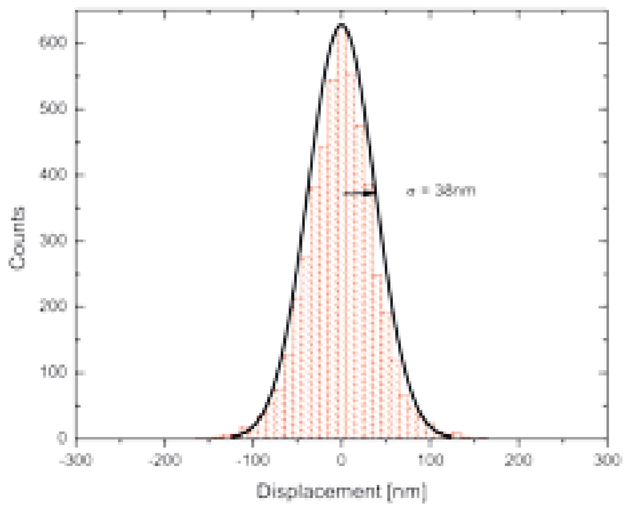
Sensor Accuracy

The term sensor accuracy represents the absolute deviation of any measurement from a calibrated, metrologically traceable standard. Best accuracy is often obtained by interferometric sensors, using well-known laser lines from thermally stabilized single mode gas lasers. Sensor accuracy does not necessarily relate to sensor sensitivity and repeatability, i.e. a sensor may provide a very high sensitivity and repeatability, yet lack a high accuracy and vice versa. attocube's FPS and IDS interferometric displacement sensors were tested by Germany's national metrology institute PTB. The accuracy of both sensors was measured to be smaller than 0.2 ppm. They can be combined with the attoMOTION piezostages for the ultimate accuracy and resolution.

Sensor Repeatability

The sensor repeatability represents the position error when repeatedly approaching a certain sensor value from both sides (bi-directional repeatability, e.g. /NUM, /NUM+), respectively one side (uni-directional repeatability, e.g. /RES).

At attocube, the sensor repeatability is measured in conjunction with an actual positioner, i.e. parameters such as minimum step size, thermal expansion, and resolution all contribute to the sensor repeatability. The repeatability for each closed loop positioner is determined by the value of the standard deviation (σ). An example of a repeatability measurement is given in the figure below.



Merge nanopositioning stages to multi-dimensional sytems

The innovative design of attocube's positioners in combination with a consequent use of similar mounting patterns enables the assembly of multi axis positioning units composed of several nanopositioning stages.

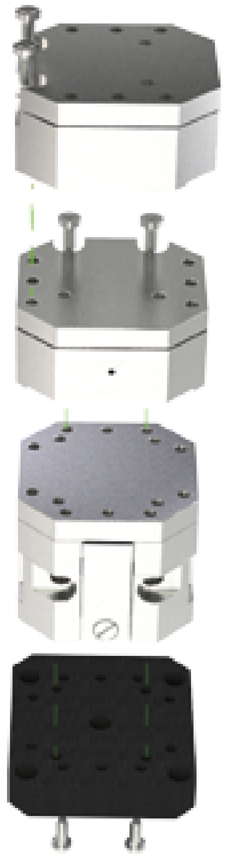
Different types of positioners (linear stages, rotators, goniometers and scanners) may be combined to form a dazzling variety of setups reflecting the diverse applications. The modular concept offers the user highest flexibility in the current setup as well as for future projects. Merging several positioning units with distinct travel ranges and motion options, motor assemblies with up to six degrees of freedom can be built.

Cross mounting rules:

Following general rules apply for building multi-dimensional setups:

- A positioner with a lower number should not be used to support one with a larger number, e.g. an ANPx51 should not carry an ANPz101.
- Cross-mounting between two differently sized models (e.g. a 51 series positioner on top of a 101 positioner) may necessitate an adapter plate (see adapter plates overview in accessories section)
- All bearing-based positioners (ANPx3*1 series) can be mounted on a L-bracket which enables vertical positioning with loads corresponding to the specified dynamic force for the respective positioner.

For more information on adapter plates please refer to our webpage: http://www.attocube.com/attomotion/accessories/adapter-plates-aap/



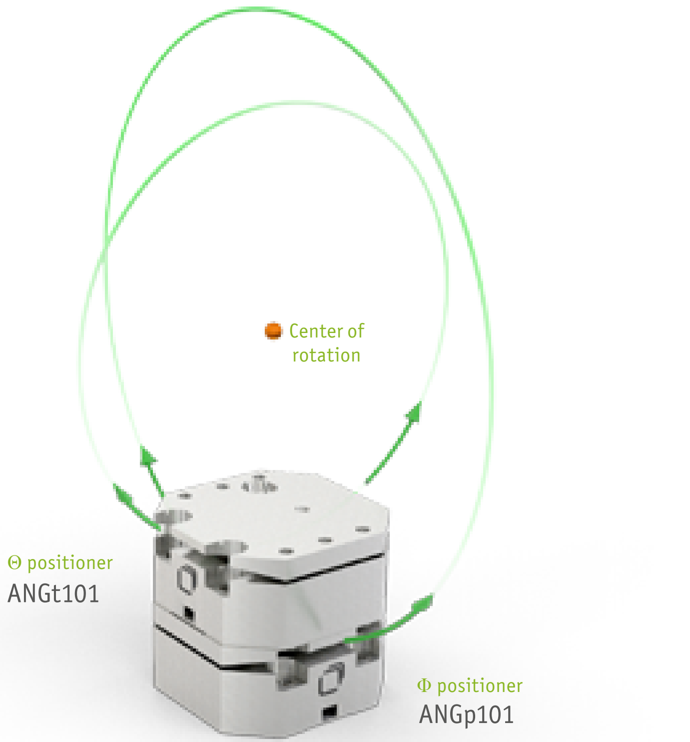
For a standard ANPxyz-configuration, two x-positioners (one rotated by 90°) are mounted on top of a z-positioner.

Combining Goniometers

attocube's goniometers are much more compact than tripod setups starting from just over 15x15x20 mm³ of space.

Each size of goniometer is available in two versions which are usually used as a pair for theta (Θ) and phi (Φ) motion. The theta positioner mounted on top of the phi positioner they form a tip-tilt stage with a common center of rotation (see sketches below). Mounting is directly done via two or four screws.

There are three different pairs of goniometers available: ANGp/and two ANGp/t101. The latter ones can also be equipped with integrated encoders.
Combinations with other positioners are explained on the page to the left respectively in the accessories sections on our webpage: http://www.attocube.com/attomotion/accessories/adapter-plates-aap/



Combination of two ANG-goniometers for 2-angle alignment with one center of rotation

Overview Linear Positioners

choose your type of attocube's ANP linear nanopositioners

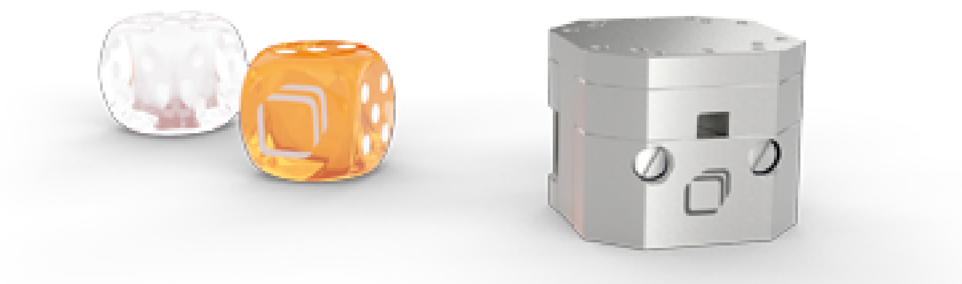
Linear Positioners												
product name	ANPz30	ANPx51	ANPz51	ANPz51eXT	ANPx101	ANPz101	ANPz102	ANPz101eXT12	ANPx311	ANPx312	ANPx321	ANPx341
Options												
environment		/RT, /HV, /UHV, /LT, /LT/HV, /LT/UHV						/RT, /HV, /UHV, /LT, /LT/HV, /LT/UHV				
encoder	---	/RES, /ULT, /NUM+	/RES, /ULT, /NUM+	/RES, /ULT, /NUM+	/RES, /ULT, /NUM(+)	/RES, /ULT, /NUM(+)	/RES, /ULT	/RES, /ULT, /NUM(+)	/RES	/RES	/RES, /NUM(+)	/RES, /NUM(+)
high load	---	---	---	---	---	/HL	---	---	/HL	---	/HL	/HL
Dimensions												
footprint; height	ø 11; 12 mm	15 x 15; 9.2 mm	15 x 15; 13.5 mm	15 x 15; 17 mm	24 x 24; 11 mm	24 x 24; 20 mm	24 x 24; 27 mm	24 x 24; 32 mm	30 x 30; 10 mm	30 x 30; 12 mm	40 x 41.6; 11.5 mm	40 x 45; 11.5 mm
Positioning Mode @ Ambient Conditions												
travel range	2.5 mm	3 mm	2.5 mm	6 mm	5 mm	5 mm	5 mm	12 mm	6 mm	6 mm	15 mm	20 mm
drive velocity	1 mm/s	1 mm/s	1 mm/s	1 mm/s	3 mm/s	3 mm/s	3 mm/s	3 mm/s	3 mm/s	3 mm/s	3 mm/s	3 mm/s
maximum load	0.1 N	0.25 N	0.5 N	0.5 N	1 N	2 N	2 N	2 N	20 N	20 N	20 N	20 N
dynamic drive force	0.2 N	1 N	1 N	1 N	2 N	5 N	5 N	5 N	2 N	2 N	2 N	2 N
Closed Loop Features												
resolution /RES	---	200 nm	200 nm	200 nm	200 nm	200 nm	200 nm	200 nm	200 nm	200 nm	200 nm	200 nm
repeatability /RES	---	1..2 µm	1..2 µm	1..2 µm	1..2 µm	1..2 µm	1..2 µm	1..2 µm	1..2 µm	1..2 µm	1..2 µm	1..2 µm
resolution /NUM	---	1 nm	1 nm	---	1 nm	1 nm	---	1 nm	---	---	1 nm	1 nm
repeatability /NUM	---	50 nm	50 nm	---	50 nm	50 nm	---	50 nm	---	---	50 nm	50 nm

Naming Scheme

- ANP — Premium Line linear nanopositioner
- x — enabling movement in x or y direction
- z — enabling movement in z direction
- 30 — positioner series with smallest available footprint
- 51 — positioners designed for a 1"clear bore size (25.4 mm)
- 101 — positioners designed for a 2" clear bore size (50.8 mm)

- eXT — extended travel range
- 300 — linear positioners with integrated bearings
- /NUM — closed loop control based on an optoelectronic encoder
- /NUM+ — closed loop control based on an optoelectronic encoder with reduced heat load
- /RES — closed loop control based on a resistive encoder
- /ULT — closed loop control based on a resistive encoder for mK temperatures

All open loop and /RES encoded positioners are compatible with ambient temperature, /(U)HV conditions and/or cryogenic environments.
/NUM(+) encoded positioners are suitable for ambient temperatures and /(U)HV conditions.



ANPz101

Overview Goniometers

choose your type of attocube's ANG goniometers

Goniometers				
product name	ANGt50	ANGp50	ANGt101	ANGp101
Options				
environment	/RT, /HV, /UHV, /LT, /LT/HV, /LT/UHV			
encoder	---	---	/RES, /ULT, /NUM (+)	/RES, /ULT, /NUM (+)
high load	---	---	---	---
Dimensions				
footprint; height	15 x 15; 10 mm	15 x 15; 10 mm	24 x 24; 11 mm	24 x 24; 11 mm
distance center of rotation to top	30 mm	40 mm	40 mm	51 mm
Positioning Mode @ Ambient Conditions				
travel range	7.2 °	5.8 °	6.6 °	5.4 °
drive velocity	1 °/s	1 °/s	1 °/s	1 °/s
maximum load	0.25 N	0.25 N	1 N	1 N
dynamic drive torque	3 Ncm	3 Ncm	10 Ncm	10 Ncm
Closed Loop Features				
resolution /RES	---	---	0.1 m°	0.1 m°
repeatability /RES	---	---	2 m°	2 m°
resolution /NUM	---	---	1 µ°	1 µ°
repeatability /NUM	---	---	400 µ°	400 µ°
				

Naming Scheme

- ANG Premium Line goniometer
- p enabling angular movement in „phi"
- t enabling angular movement in „theta"
- 50 goniometers designed for a 1"clear bore size (25.4 mm)
- 101 goniometers designed for a 2" clear bore size (50.8 mm)

- /NUM closed loop control based on an optoelectronic encoder
- /NUM+ closed loop control based on an optoelectronic encoder with reduced heat load
- /RES closed loop control based on a resistive encoder
- /ULT closed loop control based on a resistive encoder for mK temperatures

All open loop and /RES encoded positioners are compatible with ambient temperature, (U)HV conditions and/or cryogenic environments.
/NUM(+) encoded positioners are suitable for ambient temperatures and /(U)HV conditions.

Overview Rotators

choose your type of attocube's ANR rotators

Rotators						
product name	ANR31	ANR51	ANRv51	ANR101	ANRv220	ANR240
Options						
environment	/RT, /HV, /UHV, /LT, /LT/HV, /LT/UHV					
encoder	---	/RES, /ULT	/RES, /ULT	/RES, /ULT, /NUM(+)	/RES, /ULT	/RES, /ULT
Dimensions						
footprint; height	ø 10; 7.5 mm	15 x 15; 9.5 mm	10 x 20; 21 mm	24 x 24; 15.2 mm	27 x 12; 27 mm	35 x 35; 13.5 mm
Positioning Mode @ Ambient Conditions						
travel range	360 °	360 °	360 °	360 °	360 °	360 °
drive velocity	3 °/s	10 °/s	10 °/s	30 °/s	30 °/s	30 °/s
maximum load	0.05 N	0.3 N	0.2 N	1 N	1 N	2 N
dynamic drive torque	0.03 Ncm	0.2 Ncm	0.2 Ncm	0.8 Ncm	1 Ncm	2 Ncm
Closed Loop Features						
resolution /RES	---	6 m°	6 m°	6 m°	6 m°	6 m°
repeatability /RES	---	50 m°	50 m°	50 m°	50 m°	50 m°
resolution /NUM	---	---	---	0.01 m°	---	---
repeatability /NUM	---	---	---	1 m°	---	---
						

Naming Scheme

- ANR Premium Line rotator
- 31 rotator series with smallest available footprint
- 51 rotators designed for a 1" clear bore size (25.4 mm)
- 101 rotators designed for a 2" clear bore size (50.8 mm)

- 220 rotator with ultra low wobble
- 240 rotator with 1/2" aperture and ultra low wobble
- /NUM closed loop control based on an optoelectronic encoder
- /NUM+ closed loop control based on an optoelectronic encoder with reduced heat load
- /RES closed loop control based on a resistive encoder
- /ULT closed loop control based on a resistive encoder for mK temperatures

All open loop and /RES encoded positioners are compatible with ambient temperature, (U)HV conditions and/or cryogenic environments.
/NUM(+) encoded positioners are suitable for ambient temperatures and /(U)HV conditions.

Overview Scanners

choose your type of attocube's ANS scanners

Scanners											
product name	ANSxy50	ANSz50	ANSxyz50	ANSxy100/std	ANSxy100/lr	ANSz100/hs	ANSz100/std	ANSz100/lr	ANSxyz100/hs	ANSxyz100/std	ANSx150
Options											
environment		/RT, /HV, /UHV, /LT, /LT/HV, /LT/UHV					/RT, /HV, /UHV, /LT, /LT/HV, /LT/UHV				
Dimensions											
footprint; height	15 x 15; 7 mm	15 x 15; 6 mm	15 x 15; 13 mm	24 x 24; 10 mm	24 x 24;10 mm	24 x 24; 10 mm	24 x 24; 10 mm	24 x 24; 10 mm	24 x 24; 10 mm	24 x 24; 10 mm	24 x 24; 9 mm
Scan Mode											
fine positioning range @ 300 K	30 x 30 µm²	4.3 µm	30 x 30 x 4.3 µm³	40 x 40 µm²	50 x 50 µm²	4.3 µm	24 µm	50 µm	40 x 40 x 4.3 µm³	50 x 50 x 24 µm³	80 µm
fine positioning range @ 4 K	15 x 15 µm²	2 µm	15 x 15 x 2 µm³	9 x 9 µm²	30 x 30 µm²	2 µm	15 µm	30 µm	9 x 9 x 2 µm³	30 x 30 x 15 µm³	125 µm
maximum load	0.5 N	0.5 N	1 N	1 N	1 N	1 N	1 N	1 N	1 N	1 N	1 N
											

Naming Scheme

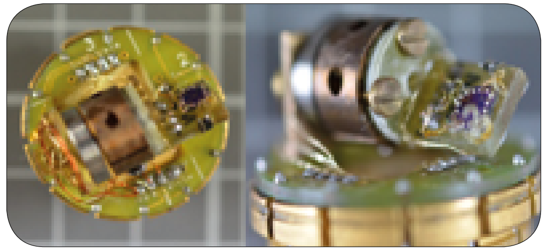
ANS	Premium Line scanner
50	scanner designed for a 1" clear bore size (25.4 mm)
100	scanner designed for a 2" clear bore size (50.8 mm)
150	scanner with extended scan range at cryogenic temperatures

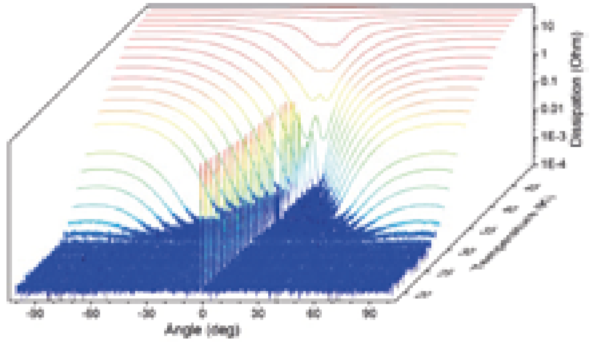
x	scanning in x or y direction
z	scanning in z direction
xy	scanning in x and y direction
xyz	scanning in x,y and z direction

All scanners are open loop scanners and are compatible with ambient temperature, (U)HV conditions and/or cryogenic environments.
In combination with attocube's microscopes or attocube's FPS3010 interferometric sensor and ANC350/FPS controller, a cutting edge closed loop solution can be offered.

ANSxyz50

Selected Applications
Premium Line - transport measurements



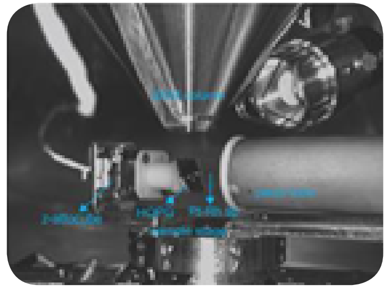


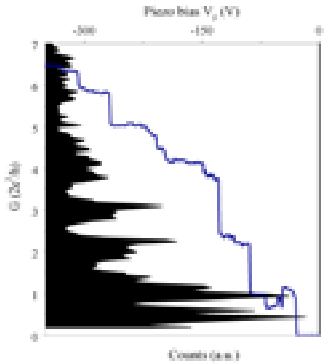
Slow & Fast Vortices in Iron Pnictide Superconductors

Using the attocube ANR31 rotator, a precise nano-rotator setup was designed to fit on a small (25 mm diameter) standard sample carrier. We have investigated the vortex matter of the iron-pnictide high temperature superconductors [1]. We studied the mobility of magnetic vortices in the layered superconductor SmFeAs(O,F) and could show an enormous enhancement of vortex mobility associated with a transition of the vortex nature itself, changing from Abrikosov to Josephson-type. A perfectly in-plane Josephson vortex, centered in a "non-superconducting" Sm(O,F) layer, can only be weakly pinned and thus experiences the mentioned enhancement in mobility.

This feature, however, is immediately lost if the field is tilted out of the FeAs planes and even the smallest misalignment (<0.1°) completely destroys the effect as the misaligned vortex is not parallel to the crystallographic layers anymore. As mobile vortices cause dissipation, their mobility is observed as a very sharp spike in voltage as shown in Fig. 1 (see also [1]). Therefore angular precision and stability is the key to observing this effect. The discovered Abrikosov to Josephson transition was unexpected, as the materials' electronic anisotropy is low. Moreover, Josephson vortices are believed to be a feature of highly anisotropic superconductors. This finding challenges our "global" understanding of superconducting anisotropies and their relevance for the microscopic, intra-unit cell modulation of the order parameter.

[1] P.J.W. Moll, L. Balicas, V. Geshkenbein, G. Blatter, J. Karpinski, N.D. Zhigadlo, and B. Batlogg, Nature Materials 12, 134 (2013) (Data and Images courtesy of Philip Moll,et al. Laboratory of Solid State Physics, ETH Zurich, Switzerland)

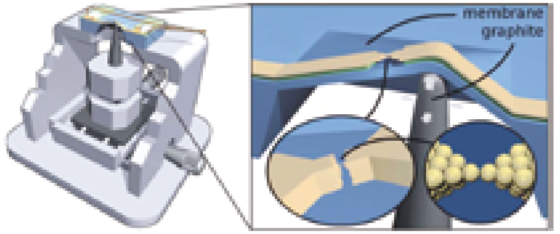




Piezo-Controlled Exfoliation of Graphene

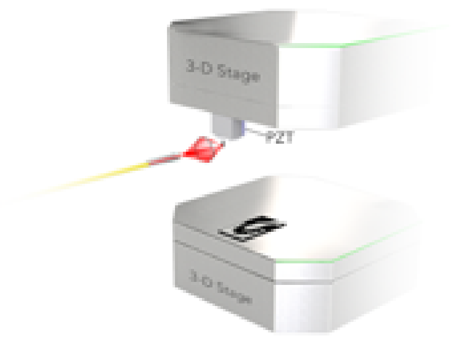
In the group of Prof. Gosh at the IIS in Bangalore, researcher Kinikar and his coworkers managed to measure the conductance of narrow stripes of graphene during their exfoliation. A metal tip is crashed into a graphite HOPG crystal using an attocube ANPz101 and slowly retracted via a piezo tube. Conductance is measured from the tip through the HOPG crystal. The setup situated inside a SEM is shown in picture 1. The graphite piece sticking on the tip will thereby be torn to a single layer of graphene. Mechanically torn graphene has highly crystalline edges, leading to quantized conductance. This is due to one-dimensional channels forming at the edges each with a conductance of 2e^2/h (graph 2). A similar setup was used in a cryostat for high magnetic field measurements (picture 3). Kinikar: "The attocubes have been with us for over a decade, and they still work perfectly!"

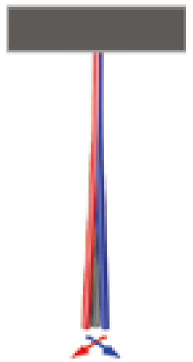
A Kinikar, T P Sai, S Bhattacharyya, A Agarwala, T Biswas, S K Sarker, H R Krishnamurthy, M Jain, V B Shenoy, A Ghosh ; Nature Nanotechnology 12, 564–568 (2017).



Mechanically Controlled Multi-Contact Break Junctions

In this application, small tips made from either glass or graphite were used to locally deform a silicon membrane, creating break junctions in a very controlled fashion. The tips with a typical radius between 50 and 200 microns were precisely controlled using attocube's nanopositioning technology. The approach of locally creating and controlling individual break junctions can be used to study the influence of optical excitations on the conductance of individual molecules and for controllable metallic single-electron transistors.

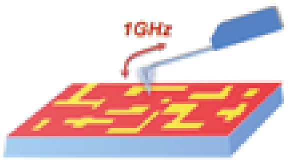


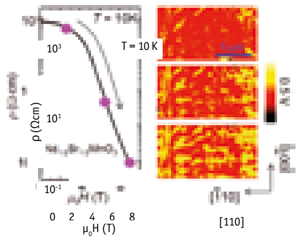


Vectorial Scanning Force Microscopy Using a Nanowire Sensor

Using a GaAs/AlGaAs nanowire and its two distinct flexural modes the group of Martino Poggio in Basel was able to detect lateral 2D forces in a novel type of AFM system. An XYZ set of attocube's ultra stable ANPx311/HL/LT/UHV positioners helped in positioning the nanowire in the focus point of an interferometer detecting its motion. A second 3D set of attocube positioners was used to position and image the sample. Detection of both eigenmodes is possible due to their distinct resonance frequency. Interaction with an in-plane field lead to a rotation of the eigenmodes the angle of which yields the force field.

N. Rossi, F. R. Braakman, D. Cadeddu, D. Vasyukov, G. Tütüncüoglu, A. Fontcuberta i Morral & M. Poggio; Nature Nanotechnology 12, 150–155 (2017).



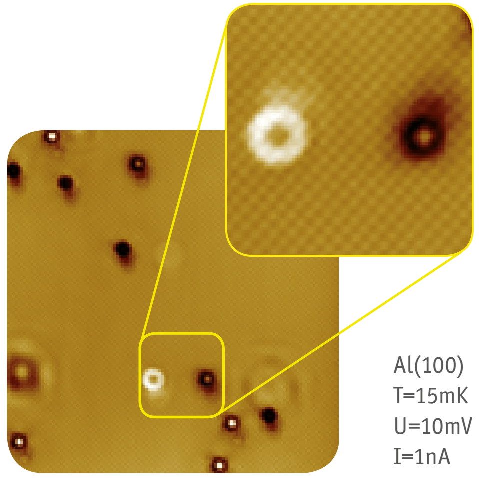


Scanning Microwave Impedance Microscopy at 4 K and 9 T

A set of linear positioners and scanners was implemented into a microwave impedance microscope located inside a liquid Helium flow cryostat equipped with a 9 T superconducting magnet [1]. The 1 GHz microwave signal was guided to the cantilever probe, which detected the dielectric constant and conductivity contrast of the sample during scanning. The system is a versatile tool för fundamental research on complex materials and phase transitions under various conditions.

[1] K. Lai, M. Nakamura, W. Kundhikanjana, M. Kawasaki, Y. Tokura, M. A. Kelly, and Z.-X. Shen, Science 329, 190 (2010).

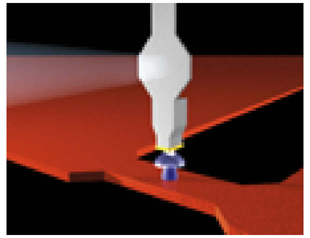
Selected Applications
Premium Line - SPM measurements

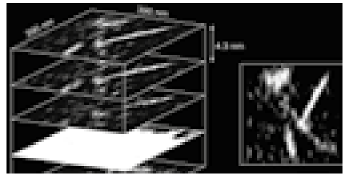


mK STM Image with Atomic Resolution

STM image of an aluminum (100) surface with atomic resolution. The image size is about 29 x 20 nm². The corrugation is between 300fm and 800fm, depending on the direction of the line profile. Defects show up as ring-like structures with different radii depending of their depth. The image was measured in a homebuilt mK-STM at the Max-Planck Institute for Solid State Research in Stuttgart, which uses an attocube ANPz51 positioner for coarse approach.

(Image courtesy of Department of K. Kern, Max-Planck Institute for Solid State Research, Stuttgart, Germany)

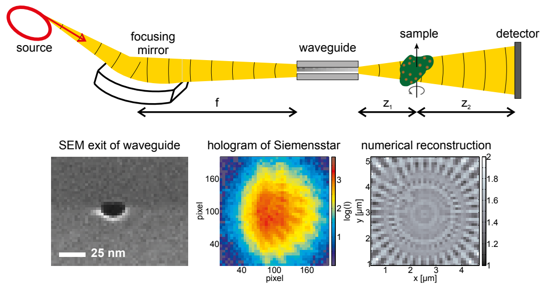




Magnetic Resonance Imaging of Nanoscale Tobacco Mosaic Virus at 300 mK

attocube's ANPx51 positioners were used in an MRFM setup with the task to precisely and reliably position a magnetic tip and a copper nanowire to close proximity of an ultra-sensitive cantilever. The MRFM setup was applied to investigate and reconstruct the 1H spin distribution of Tobacco Mosaic Virus particles, representing a 100-million fold improvement in volume resolution over conventional MRI.

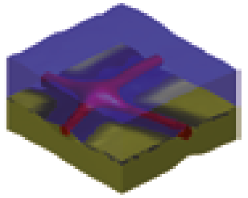
C. L. Degen, M. Poggio, H. J. Mamin, C. T. Rettner, and D. Rugar, PNAS 106, 1313 (2009).



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.

Reprinted with permission from S. Kalbfleisch et al., AIP. Conf. Proc., 1234, 433-436 (2010). © 2010, American Institute of Physics.

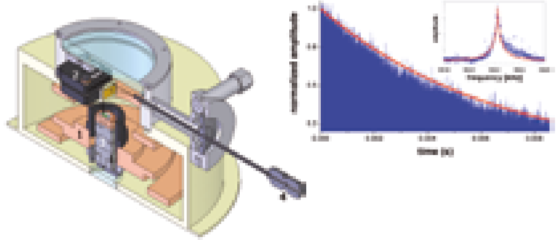


Special Micro X-Ray Fluorescence Analysis (micro-XRF) Spectrometer

Confocal micro-XRF is a method to determine the spatial distribution of major, minor and trace elements within a sample in three dimensions. The employed polycapillary X-Ray optics need to be aligned precisely to get optimal results. Very compact positioners had to be used inside the vacuum chamber for this purpose. Long time stability of the alignment is also a major requisite. ANPxyz101 nanopositioners fulfill these requirements very well.

The figure to the left shows a 3D sample measurement of a cross made from 10 µm copper wire which is placed on an X-Ray screen and fixed using adhesive tape [1].

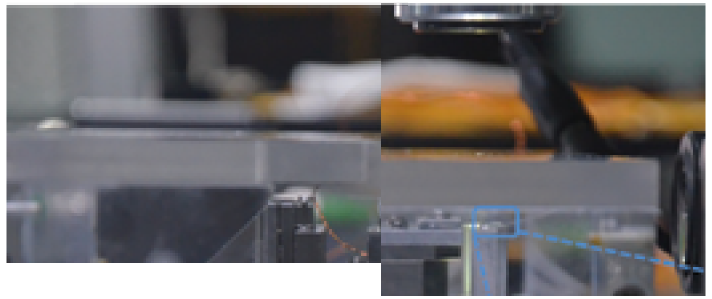
[1] S. Smolek, C. Streli, N. Zoeger, and P. Wobrauschek, Rev. Sci. Instr. 81, 053707 (2010).
(The data was kindly provided by S. Smolek and C. Streli, Atominstitut of the TU Wien.)



Dissipation in Optomechanical Resonators

The acoustic dissipation of microresonators was analyzed via a cryogenic interferometry setup. Hereby, a continuous flow 4He cryostat was utilized as sample chamber, which in turn was equipped with a stack of attocube's ANPxyz51 positioners for the alignment of the sample with respect to an optical fiber. The fiber was part of a homodyne interferometer, allowing high signal-to-noise measurements of the eigenmodes of the resonator while keeping disturbances due to radiation pressure and optical fluctuations at a minimum. The turbo-pumped cryostat enabled interrogation from room temperature to 20 K, and from atmospheric pressure to vacuum levels of 2.5×10-7 millibar.

G. D. Cole, et al., 23rd IEEE International Conference on Microelectromechanical Systems, Hong Kong SAR, China, 24–28 January 2010, TP133.



Realization of Optomechanically induced Non-Reciprocity

Non-reciprocal photonic devices, like circulators and isolators, have attracted the attention of researchers in the field of quantum information. Recently, Prof Chunhua Dong from University of Science and Technology of China successfully demonstrated unambiguously non-reciprocity in an optomechanical system. The optomechanical system (schematic shown in the figure) includes a whispering gallery microresonator and a tapered fiber. The driving field can be clockwise or counter-clockwise. The breaking of the time reversal symmetry leads to the non-reciprocal transmittance of the signal light.

To carry out the non-reciprocal optical experiment, a set of attocube ECS and ANP positioners are used for approaching the microsphere with the fiber. The distance of the fiber to sphere can be finely adjusted for better optical signal detection.

Z. Shen, G.C. Guo and C.H. Dong et al., Nature Photonics, 10, 657-661, 2016.