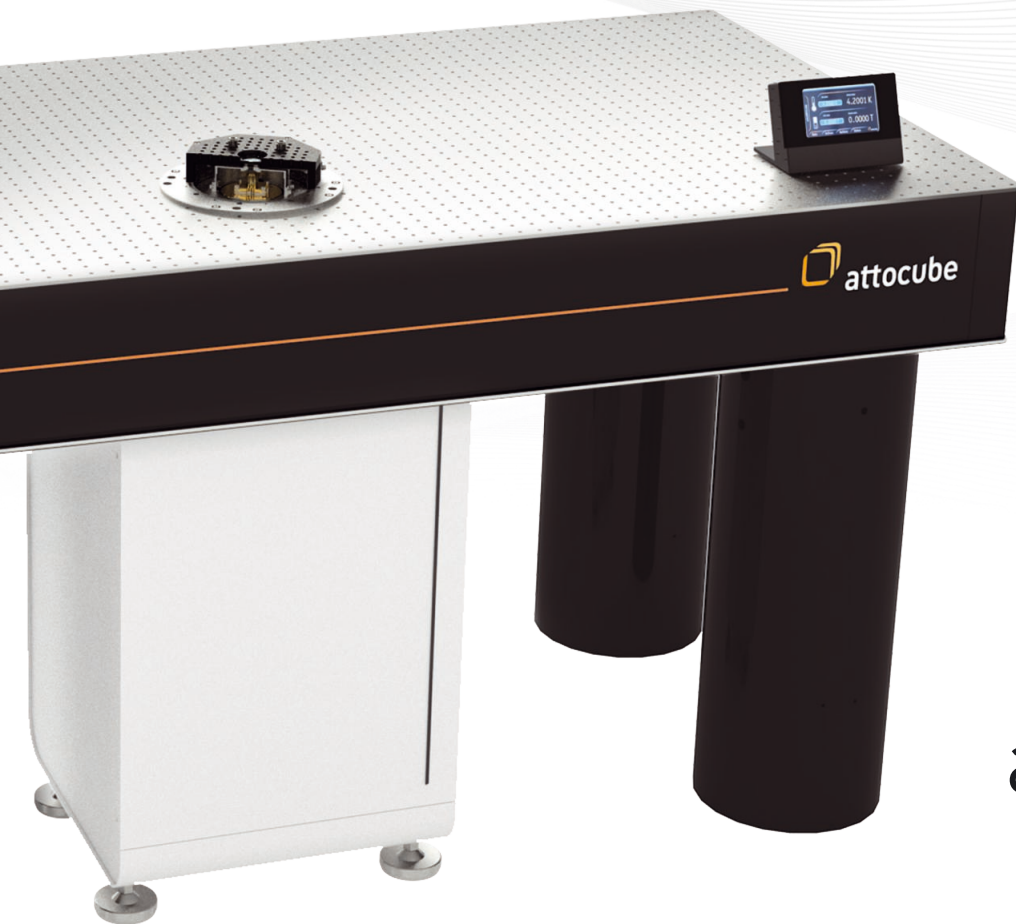




attocube

WITTENSTEIN group



attoDRY800

cryo-optical table

CRYOGENIC INSTRUMENTS

cool tools for cold science

attoDRY800

cryo-optical table (closed-cycle)

Specifications

attoDRY800

NEW

Quantum optics experiments often require cryogenic temperatures in combination with optical access to the sample space. Most experimental setups contain numerous optical elements that need to be precisely arranged on an optical table to shape and prepare the incident light, as well as to efficiently collect and convert the emitted light from the sample. The available space on the optical table in such cases is of paramount importance to many complex setups.

The revolutionary concept and design of the attoDRY800 present the perfect solution to satisfy these demanding requirements: it consists of an ultra low vibration cold breadboard platform which is fully integrated into an optical table. The cryocooler assembly is located in the otherwise unused space underneath. This unique design ensures a free workspace and unobstructed optical access to the cold sample from all directions on the optical table. Apochromatic objectives with high numerical aperture (NA=0.81-0.95) can either be integrated into the cryostat, into the vacuum shield, or put in close working distance next to the optical windows from the outside. This ensures extremely low drifts and optimal collection efficiency.

Being a closed-cycle cryostat, the attoDRY800 is the perfect replacement for all helium flow cryostat setups, adding the huge advantage that it requires no liquid cryogens and thus minimizing running costs. In addition, a fully automated temperature control between 3.8 and 320 K conveniently enables unattended long measurement cycles.

Most other off-the-shelf closed-cycle cryostats suffer from severe vibrations at the sample location, which typically are in the range of many microns. Thanks to our patented vibration isolation technique, the residual vibrations on the cold plate of the attoDRY800 were measured to be around 2.6 nm peak-to-peak (vertical direction) only. Hence, with the attoDRY800 even extremely sensitive measurements are possible. Its cold breadboard sample space is designed to host several of attocube's patented nanopositioners, as well as complete microscope or photonic probe station solutions.



- 01 optical table (included)
- 02 cryocooler
- 03 cold breadboard
- 04 customizable vacuum shroud
- 05 touchscreen user interface
- 06 obstruction free work space

PRODUCT KEY FEATURES

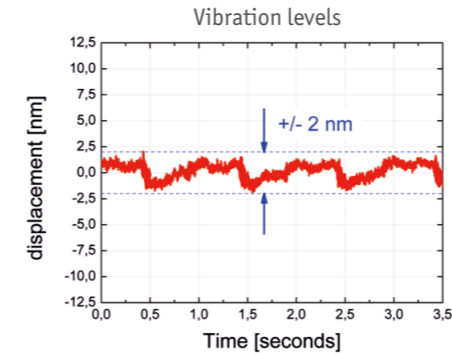
- cold breadboard integrated into optical table
- low vibrations < 5 nm peak-to-peak
- fully automated variable temperature 3.8 .. 320 K
- customizable vacuum shroud

BENEFITS

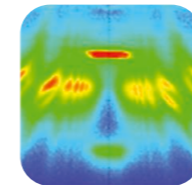
- free workspace & obstruction-free optical access
- high sample throughput due to fast cooldown
- low running costs (no liquid cryogens)
- flexible combination with attocube equipment: patented cryogenic positioning solutions with multi-degrees of freedom

APPLICATION EXAMPLES

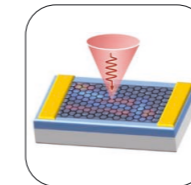
- quantum dot spectroscopy
- photocurrent / photoconductivity
- time-resolved spectroscopy
- reflectance / transmittance measurements
- micro-Raman imaging & spectroscopy
- optical resonators coupled to waveguides
- plasmonics on 2D materials
- resonant fluorescence
- optically detected nuclear magnetic resonance
- quantum information processing
- scanning probe microscopy



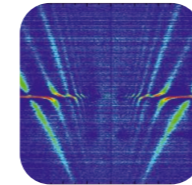
Application examples



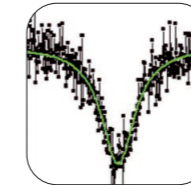
Quantum Dot Spectroscopy



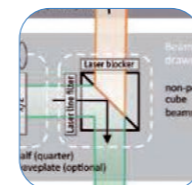
Photocurrent / Photoconductivity Measurements



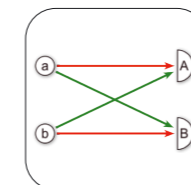
Micro-Raman Imaging / Spectroscopy



Optically Detected Nuclear Magnetic Resonance



Resonant Fluorescence



Quantum Information Processing

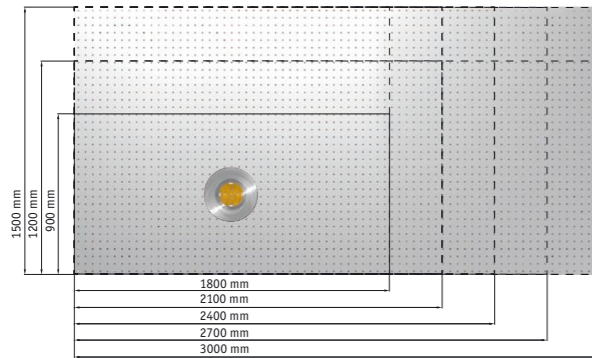


- **Obstruction free** work space
- **Optical table included** (different sizes available)
- 36 customer wires included, **heat sunk @ 4 K**
- Turbo pump incl., **base pressure in sample chamber < 5e-6 mbar**

General Specifications	
technology	ultra low vibration, closed-cycle cryostat intimately integrated into optical table, optical table included
sample environment	cryogenic vacuum, sample cooled via braids (ATC100)
sample space	75 mm (diameter)
sample exchange	easy access via removal of vacuum shroud
usability	fully automated temperature control (vacuum, cooldown, T control, warmup), all pumps integrated, USB interface for remote control
vibration & acoustic noise damping system	proprietary low vibration design
Performance Data	
temperature range	3.8 .. 320 K (depending on configuration)
base pressure (in sample chamber)	< 5e-6 mbar
leak rate of vacuum	< 5e-9 mbar l/s
cool down time (incl. pumping time)	< 4.5 h to 5 K (depending on thermal load)
temperature stability	< 15 mK (peak-to-peak with damped sample mount)
cooling power at sample location	> 170 mW @ 5 K
vibration level (cold plate, vertical)	< 5 nm (peak-to-peak @ 1500 Hz)
Closed-cycle cooler	
power consumption	max. 3 kW
cooling of compressor	water cooling (default; requires local infrastructure), air cooling (optional)
Size and Dimensions	
optical table	standard size 900 mm x 1800 mm x 305 mm (leg height 597 mm); metric or imperial mounting threads (other table sizes available)
Options and Upgrades	
temperature controller	included
pumping kit	included
vacuum shroud	Basic (standard shroud), RT-SWD, RT-USWD upgrade, LT-APO objective, HV objective, Photonic Probe Station, or customized height, diameter, windows & working distance
electrical access	36 customer wires included, heat sunk @ 4 K
feedthroughs	electrical (DC, HF), optical fibers, gas capillary (on request)
sample motion	ANP positioners
cryostat compressor upgrade	air-cooled (grey-room recommended)
flexlines	extension to 13 m or 20 m (instead of 6 m)
air-compressor	for active vibration isolation of optical table
Compatible Equipment	
confocal microscopes	attoCFM
confocal Raman microscopes	attoRAMAN (on request)

attoDRY800 Options

optional items for the cryo-optical table

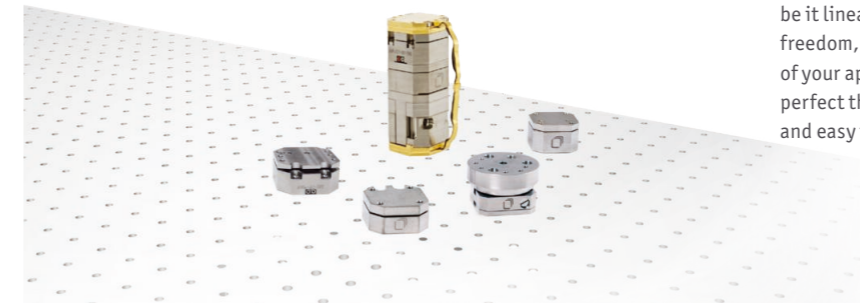


Decide on the table size

Customized Newport optical tables with metric M6 or imperial hole pattern are available with the following dimensions:

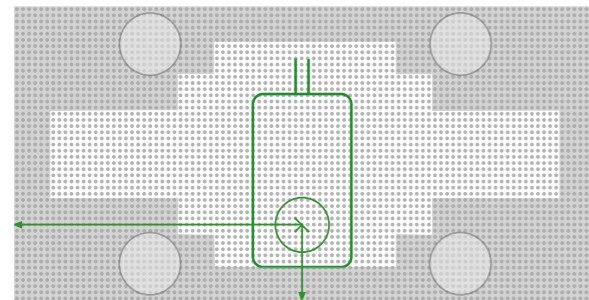
(other table sizes and solutions for integration with existing optical tables available on request)

Default size: 900 mm x 1800 mm Leg height: 597 mm, Table thickness: 305 mm	
1200 mm x 1800 mm	1500 x 1800 mm
1200 mm x 2100 mm	1500 x 2100 mm
1200 mm x 2400 mm	1500 x 2400 mm
1200 mm x 2700 mm	1500 x 2700 mm
1200 mm x 3000 mm	1500 x 3000 mm



Add multiple degrees of freedom for sample motion

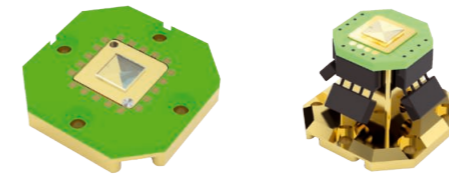
The attoDRY800 is predestined to host your choice of nanopositioners, be it linear, rotary, tilting or scanning stages. Combine many degrees of freedom, or more than one stack of positioners to fulfill all requirements of your application! With our dedicated ATC100 thermal link, we ensure a perfect thermalization of your sample that is straightforward to mount and easy to use.



Choose location of cold breadboard

In order to optimally adapt the system to specific experimental needs, the location of the cold plate of the cryostat can be specified by the customer upon ordering. It can be placed as close as 200 mm to the long edge, as well as off-center with respect to the short edge on wider tables (depending on table size).

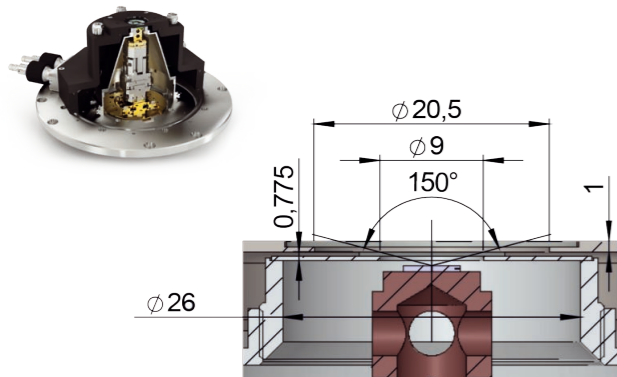
Contact attocube for more details.



Sample holders

For users that require a sample holder with electrical contacts, attocube offers PCB based sample holders with 12 contacts. There are different options available for the respective vacuum shrouds and positioner configurations.

Article	Art.No.
ASH/PCB/12	1005710
ASH/SWD	1012785
ASH/Zvar	1013136
ASH/PCB/12mini	1013138



Ultra-short working distance

A popular option for flow cryostats is to bring the cold sample as close as possible to an ultra-low working distance window. This allows to flexibly use external optics with a very high angle of admittance, maximizing the collection efficiency via high numerical aperture objectives. The ultra-short working distance option (RT-USWD) is compatible with xyz positioners, and features a min. working distance of 2 mm (1 mm) with (without) cold window installed.

Article	Art.No.
RT-SWD option	1011252
RT-USWD upgrade	1013109



Electrical and optical feedthrough options

Additional DC or high-frequency wiring with pre-configured full thermalization and/or fiber feedthroughs can be provided through an adapter ring at the bottom of the sample chamber. Retrofit extra wiring or optical feedthroughs are possible via electrical feedthroughs in an adapter ring at the bottom of the sample chamber.

Article	
Electrical access in vacuum	12 wires, terminated in vacuum
Pre-wired to cold plate	12 wires, low resistance, compatible with nanopositioners
Coaxial feedthroughs	2 or 4 SMA connectors
Fiber feedthroughs	1, 2 or 4 FC/APC or FC/PC connectors

Proven Low Vibrations

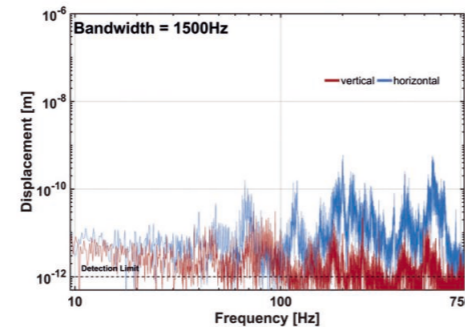
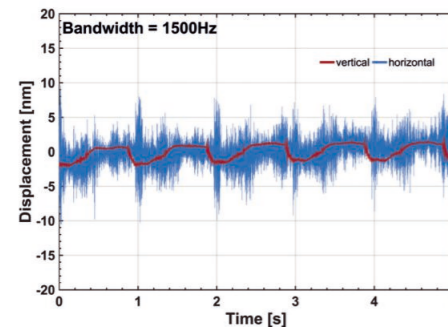
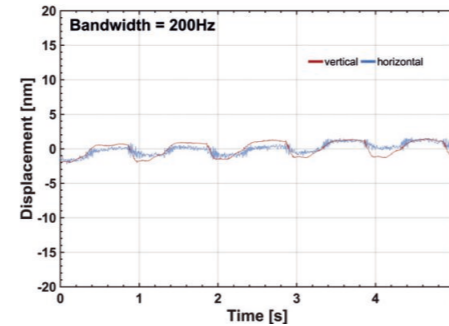
attoDRY800 selected measurements

Selected Application

attoDRY800

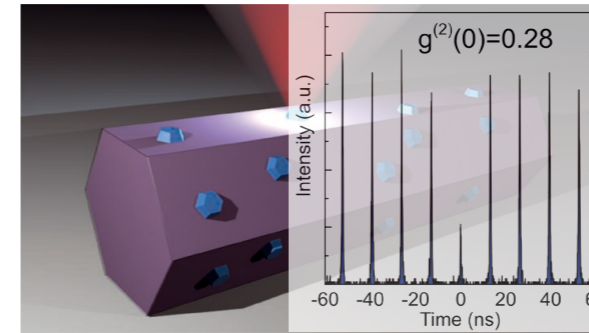
Vibration measurements on cold plate of attoDRY800

The interferometric measurements to the left show vertical & horizontal displacement data measured directly on the cold plate of the attoDRY800. The peak-to-peak vibrations in vertical direction are around 3 nm (4 nm), while in lateral direction they are around 2 nm (17 nm) in a bandwidth of 200 Hz (1500 Hz). This very efficient and unique low vibration design even allows for very sensitive optical measurements such as optical probe stations or high resolution optical spectroscopy on nanostructures.



The FFT of the data above is shown to the left as well for both directions, vertical and horizontal respectively, at a bandwidth of 1500 Hz. The dashed line at 1 pm indicates the noise floor of the interferometer.

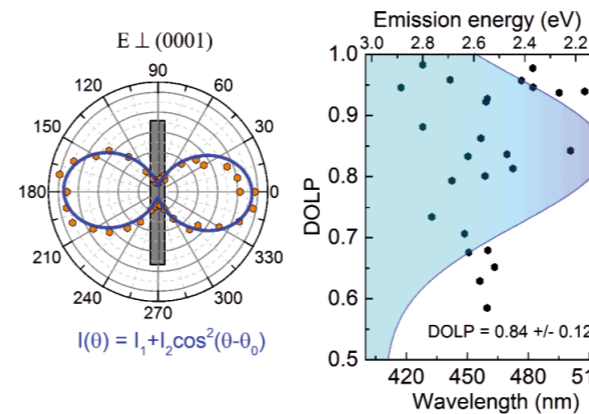
Direction	Peak-to-Peak @200 Hz (1500 Hz)	RMS @200 Hz (1500 Hz)
vertical	3 nm (4 nm)	1.0 nm (1.1 nm)
horizontal	2 nm (17 nm)	0.6 nm (2.1 nm)



Single Photon Generation with Controlled Polarization from InGaN Quantum Dots

The research groups led by Prof. R. Taylor & Dr. R.A. Oliver in the UK have successfully generated single-photons with polarized light emission and predefined polarization axis at temperatures spanning from around 5 K to above 200 K using InGaN quantum dots. These quantum dots offer several advantages, such as high experimental repetition rates in the range of GHz, and for their growth as a planar structure, a single routine without complex geometrical engineering.

The emission spectra of these quantum dots were characterized using micro-photoluminescence techniques, while the samples were kept cool inside an optical cryostat equipped with attocube positioners. This cryostat, the attoDRY800, is able to reach temperatures ranges from below 5 K up to even above 300 K with very good thermal and vibrational stability.



The single-photons generated by these quantum dots are bright enough to allow their optical properties to be measured even above 200 K, a temperature considered to be the Peltier cooling barrier. Hence, this suggests in principle, that these quantum dots could be applied in integrated electronic circuits. And thanks to the achievable polarization control, these quantum dots are good candidates for on-chip polarization encoding in quantum cryptography.

To know more about the work done by Robert Taylor, Rachel Oliver and their research teams, please visit their websites here: and here <http://www.gan.msm.cam.ac.uk/directory/oliver>

[Data courtesy of R. Taylor, Oxford University]

Further reading:

- [1] T. J. Puchler, R. A Taylor, et al. *Nanoscale* 2017, 9, 9421-9427
- [2] T. Wang, T. J. Puchler et al.. *Nanophotonics*. DOI 10.1515/nanoph-2017-0027
- [3] T. Wang, T. J. Puchler *Phys. Status Solidi B*, 1600724 (2017)

CUSTOMER FEEDBACK

Dr. Heindel

Our group is working on quantum optics experiments exploiting deterministic quantum light sources based on semiconductor quantum dots. The two attoDRY800 systems will be used to probe the mutual two-photon interference of remote quantum emitter located in both cryostats. We are keen on the exciting experiments possible with these very stable cryostat systems.

(TU Berlin, Institute of Solid State Physics, Berlin, Germany)

CUSTOMER FEEDBACK

Dr. M. Kroner

The attoDRY800 setup is ideal for phase contrast microscopy as it allows free space optical access to the sample from both sides and makes it easily possible to investigate the transmitted light in momentum and real space excellent!

(Institute for Quantum Electronics, ETH Zurich, Switzerland)

CUSTOMER FEEDBACK


Prof. R. A. Taylor

I have to say we are very pleased with the attoDRY800 and have collected a good deal of data already.

(University of Oxford, Department of Physics, Oxford, Great Britain)

attoDRY800 Vacuum Shrouds

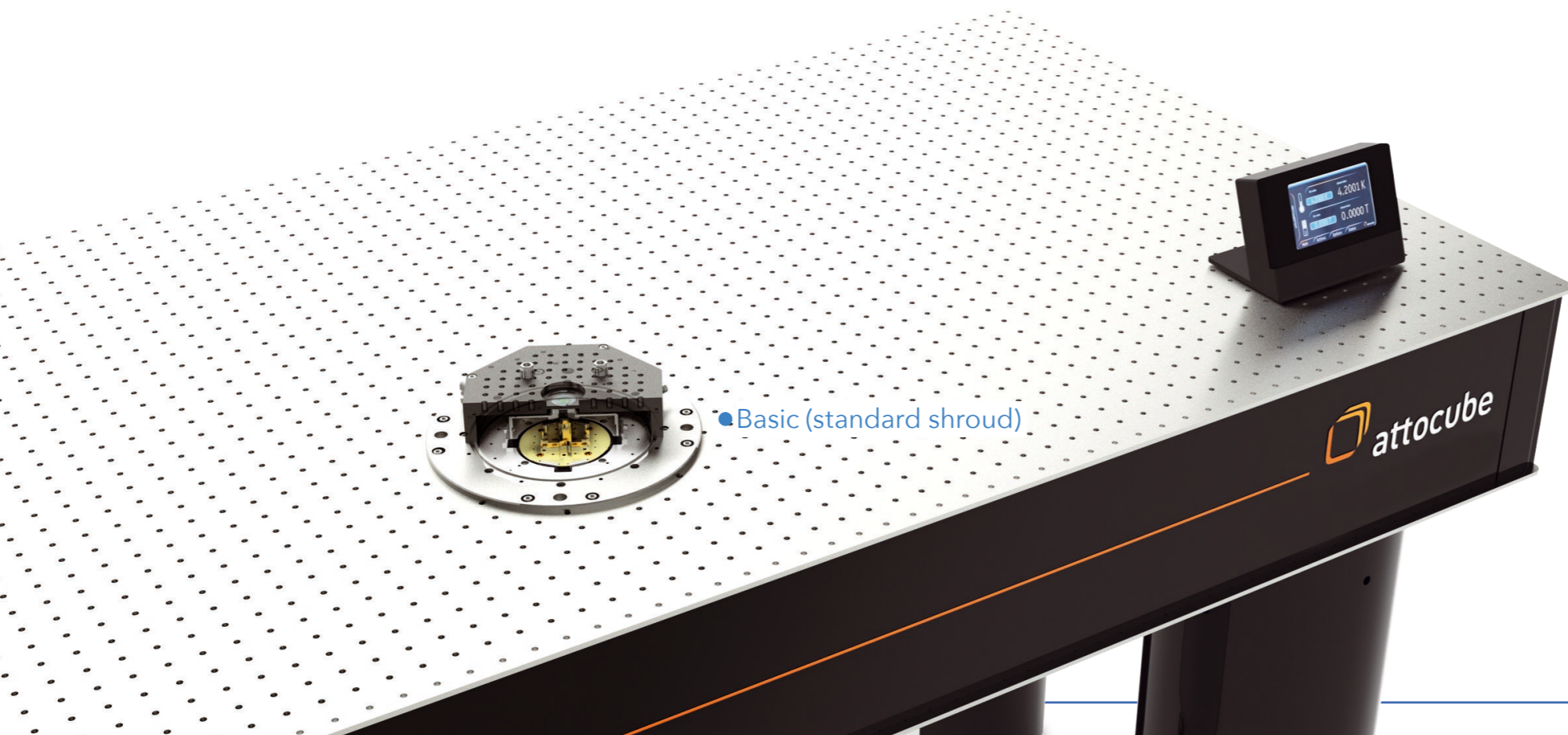
introduction

The idea behind the world's first cryo-optical table is that the user receives a high quality optical table from  Newport of his choice, which has an integrated cold plate of 75 mm in diameter. The cryostat is an integral part of the table, and comes in a standard configuration. The position of this cold plate can be chosen upon order.

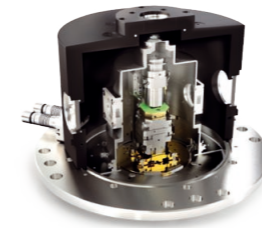
Anything above the table surface can be customized according to the technical requirements and preferences of the user and his/her application. From more than 25 years working at the forefront of cryogenic optics applications, as well as learning from our users, and anticipating typical configurations, we have designed several standard vacuum

shrouds and cold shields, that are intended for certain types of positioners, sample holders, working distances and objectives. These options constitute an economic pre-configured set of components that give the user a head start for his research with optics at low and variable temperatures.

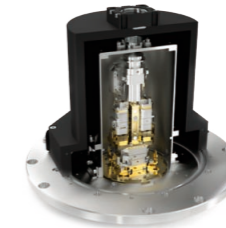
Most of our standard shrouds feature clever extensions by default, such as a feedthrough ring for optional additional DC, SMA and fiber feedthroughs, as well as a 30 mm and 60 mm cage system with quick release adapters centered around the top window.



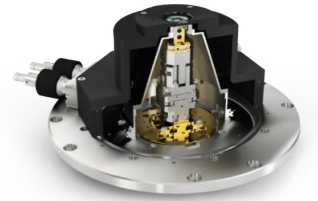
● Basic (standard shroud)



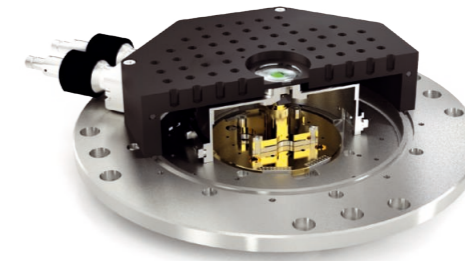
LT-APO objective



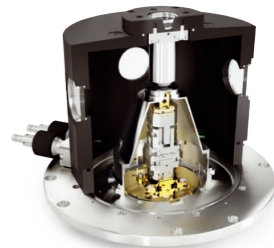
Photonic Probe Station



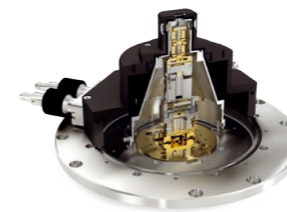
RT-SWD (RT-USWD)



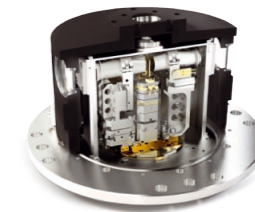
● Basic (standard shroud)
included with basic configuration*



HV objective



Customized
(5 window free-beam access LWD)



Customized
(LT-APO transmission)

*if no other shroud is bought

NEW

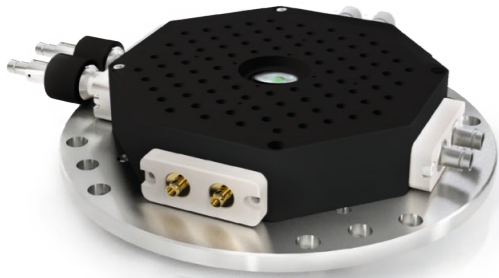
Basic (Standard Shroud)

basic vacuum shroud for use with a room temperature objective



RT-SWD (RT-USWD)

vacuum shroud for use with room temperature objective and positioners



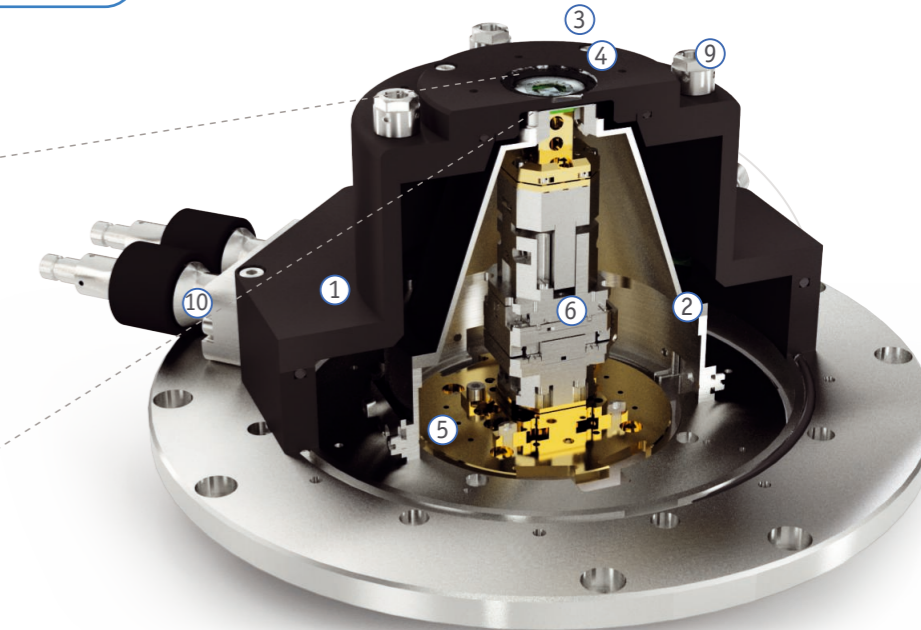
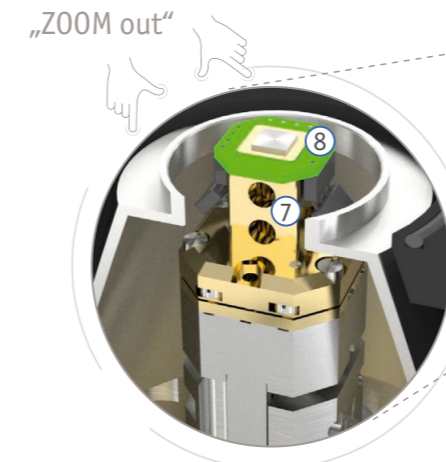
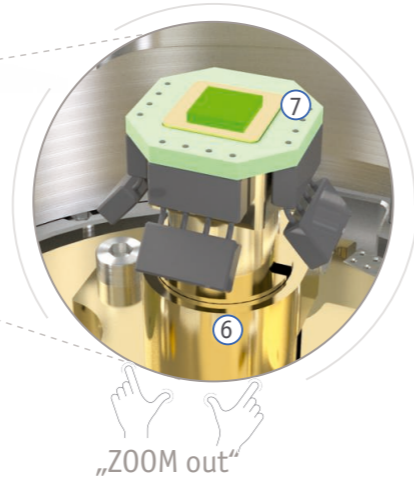
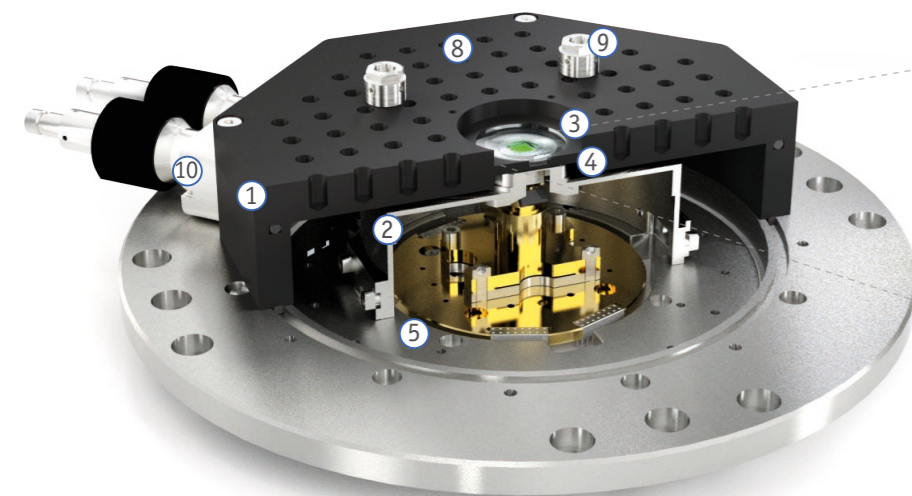
PRODUCT KEY FEATURES

- included with attoDRY800 base configuration at no additional cost!*
- corresponds to the classical flow cryostat configuration
- 88xM6 breadboard mounting holes
- compatible with 30 mm & 60 mm cage system
- optional sample holder with manually adjustable height, and 12 optional electrical contacts
- feedthrough ring with blind flanges included, DC/SMA/fiber feedthroughs optional
- not compatible with positioners, see e.g. RT-SWD or others

*no additional cost only in case no other vacuum shroud is purchased

PRODUCT KEY FEATURES

- standard configuration for use with external RT objective and xyz positioners
- Ultra-short working distance upgrade available (1 mm / 2 mm)
- compatible with 30 mm & 60 mm cage system
- optional sample holder with 12 optional electrical contacts; temp. sensor & heater included
- feedthrough ring with blind flanges included, DC/SMA/fiber feedthroughs optional



- ① attoDRY800 basic vacuum shroud for use with room temperature objective (max. objective outer diameter 36 mm)
- ② cold shield with top lid adjustable for min. working distance
- ③ vacuum top window, 25 mm x 1.5 mm, fused silica (others on request)
- ④ default min. working distance of 3.5 mm (others on request); cold shield top window, 12.7 mm x 0.5 mm, fused silica (others on request); default cold shield clear aperture 9 mm (3, 6, 11, 14 mm on request)
- ⑤ cold plate

- ⑥ ASH/Zvar sample holder with +/-7 mm manual z range
- ⑦ ASH/PCB/12mini for ASH/Zvar with 12 electrical contacts wired to twisted pairs
- ⑧ 88x M6 breadboard mounting holes on lid (12.5 mm grid)
- ⑨ 30 mm x 30 mm & 60 mm x 60 mm cage system mounting threads centered around top window; 4x cage rod mounting adapters for quick removal included
- ⑩ feedthrough ring with blind flanges included, DC/SMA/fiber feedthroughs optional

- ① attoDRY800 RT-SWD vacuum shroud for use with room temperature objective; default min. working distance < 4 mm (others on request, see also USWD option with 2 mm (1 mm))
- ② cold shield with top lid adjustable for min. working distance
- ③ vacuum top window, 25 mm x 1.5 mm, fused silica (others on request)
- ④ cold shield top window, 12.7 mm x 0.375 mm, fused silica (others on request); default cold shield clear aperture 9 mm (3, 6, 11, 14 mm on request)
- ⑤ cold plate

- ⑥ ANPxy311/ANPz102 positioners + ATC100/Si thermal link with integrated Si diode & heater + optional ANSxy100
- ⑦ ASH/SWD sample holder for attoDRY800
- ⑧ ASH/PCB/12mini for ASH/SWD with 12 electrical contacts wired to twisted pairs
- ⑨ 30 mm x 30 mm & 60 mm x 60 mm cage system mounting threads centered around top window; 4x cage rod mounting adapters for quick removal included
- ⑩ feedthrough ring with blind flanges included, DC/SMA/fiber feedthroughs optional

NEW

LT-APO Objective

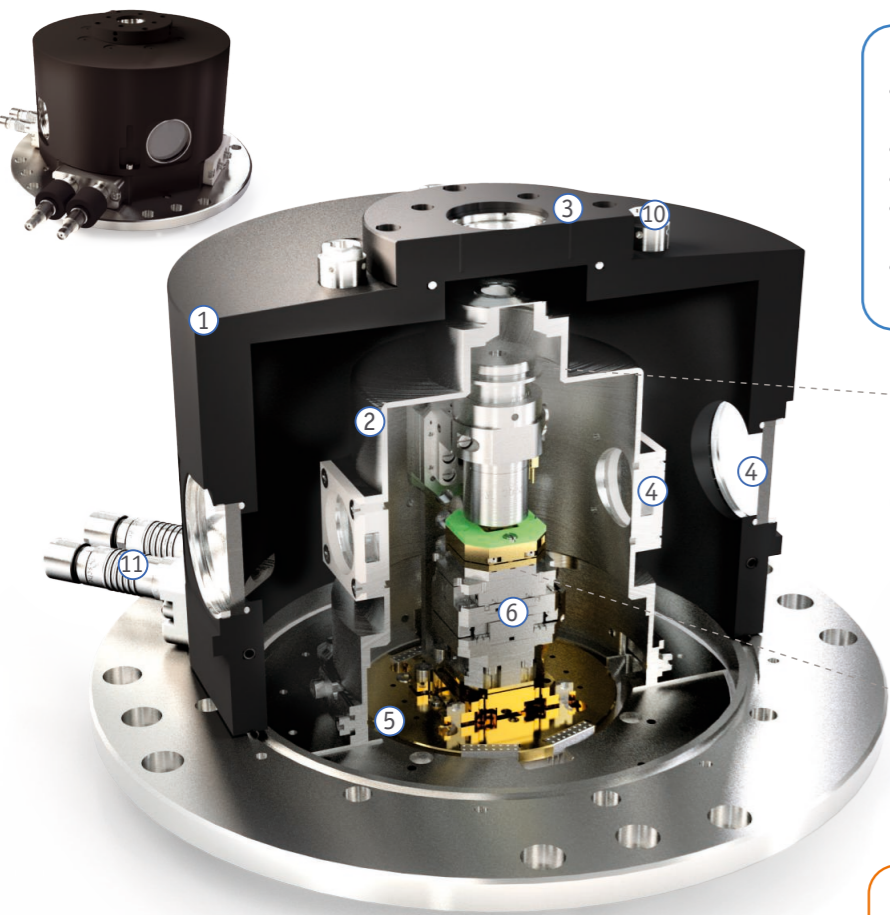
vacuum shroud for use with low temperature objective



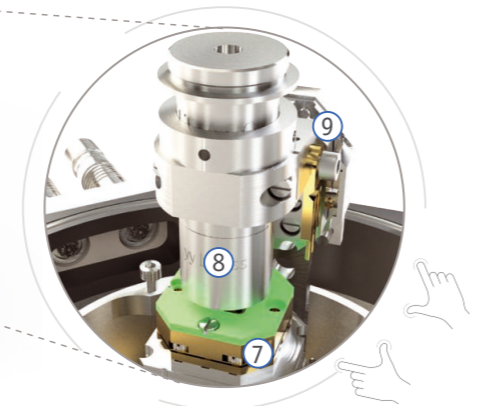
HV Objective

vacuum shroud for use with vacuum objectives

NEW

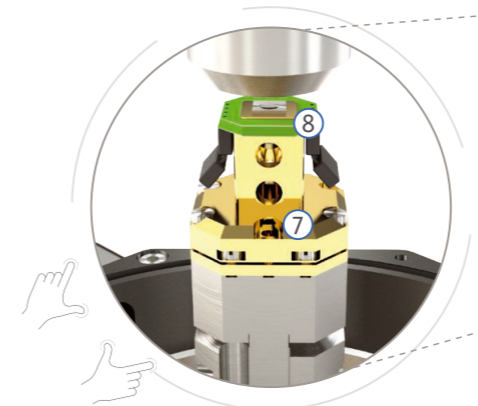


- PRODUCT KEY FEATURES**
- standard configuration for use with internal LT-APO low temperature objective and xyz positioners
 - minimal sample drift, broadband high collection efficiency
 - compatible with 30 mm & 60 mm cage system
 - optional sample holder with 12 optional electrical contacts; temp. sensor & heater included
 - feedthrough ring with blind flanges included, DC/SMA/fiber feedthroughs optional

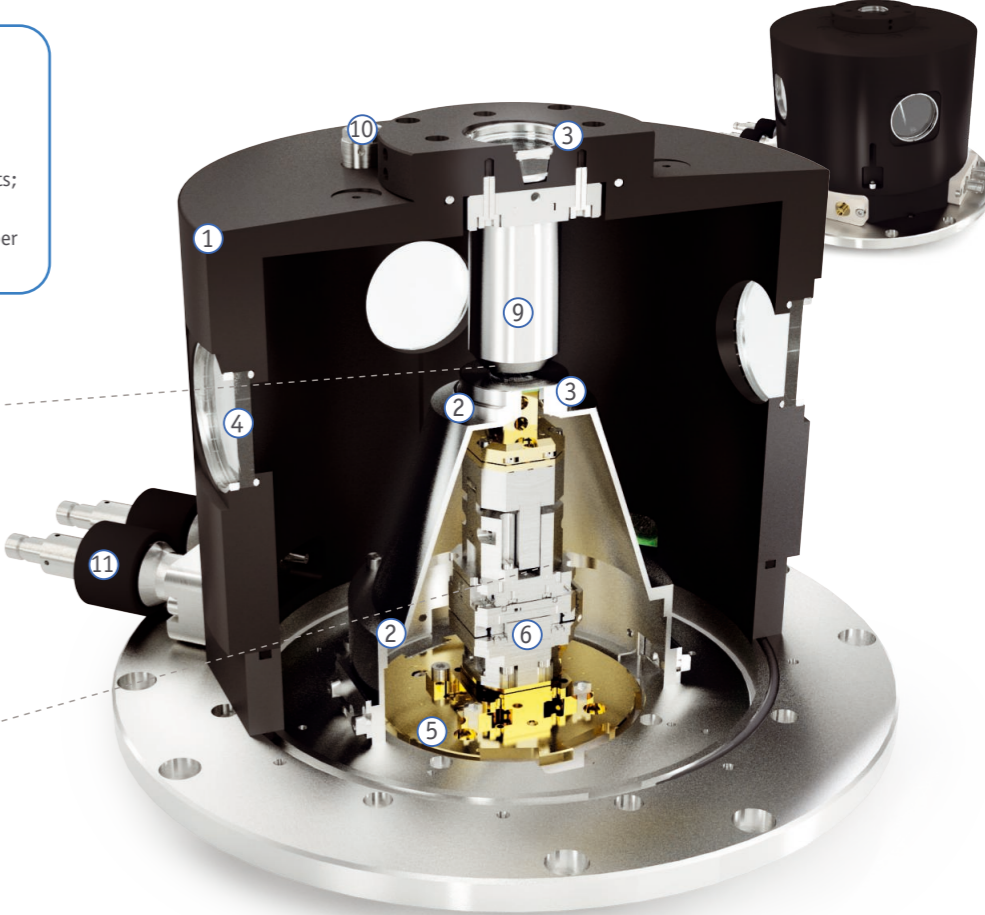


„ZOOM out“

- PRODUCT KEY FEATURES**
- standard configuration for use with internal high vacuum objective and xyz positioners
 - compatible with 30 mm & 60 mm cage system
 - optional sample holder with 12 optional electrical contacts; temp. sensor & heater included
 - feedthrough ring with blind flanges included, DC/SMA/fiber feedthroughs optional



„ZOOM out“



- Cryogenic Apochromatic Objectives**
- negligible chromatic focal shift in working range
 - uniform spot size and intensity within apochromatic range

- ① attoDRY800 LT-APO vacuum shroud for use with low temperature objective
- ② cold shield
- ③ top vacuum window 25 mm x 1.5 mm, cold shield top window 12.7 mm x 0.375
- ④ 4x side vacuum windows 40 mm x 4 mm, 4x cold shield windows 25 mm x 4 mm; window material fused silica (others on request)
- ⑤ cold plate
- ⑥ ANPxy311 positioners + ATC100/Si thermal link with integrated Si diode & heater

- ⑦ ASH/PCB/12 with 12 optional electrical contacts wired to twisted pairs
- ⑧ LT-APO objective n separate mounting post
- ⑨ ANPz311 for z focus of objective with thermal link for objective
- ⑩ 30 mm x 30 mm & 60 mm x 60 mm cage system mounting threads centered around top window; 4x c moval included
- ⑪ feedthrough ring with blind flanges included, DC/SMA/fiber feedthroughs optional

- ① attoDRY800 HV objective vacuum shroud for use with high vacuum compatible objective
- ② cold shield with top lid adjustable for min. working distance
- ③ top vacuum window 25 mm x 1.5 mm, cold shield top window 12.7 mm x 0.375; window material fused silica (others on request)
- ④ 4x side vacuum windows 40 mm x 4 mm
- ⑤ cold plate
- ⑥ ANPxy311/ANPz102 positioners + ATC100/Si thermal link with integrated Si diode & heater

- ⑦ ASH/SWD sample holder for attoDRY800
- ⑧ ASH/PCB/12mini for ASH/SWD with 12 electrical contacts wired to twisted pairs
- ⑨ HV compatible, RMS standard objective with 45 mm length; several objectives available on request (NA = 0.75 .. 0.95)
- ⑩ 30 mm x 30 mm & 60 mm x 60 mm cage system mounting threads centered around top window; 4x cage rod mounting adapters for quick removal included
- ⑪ feedthrough ring with blind flanges included, DC/SMA/fiber feedthroughs optional

NEW

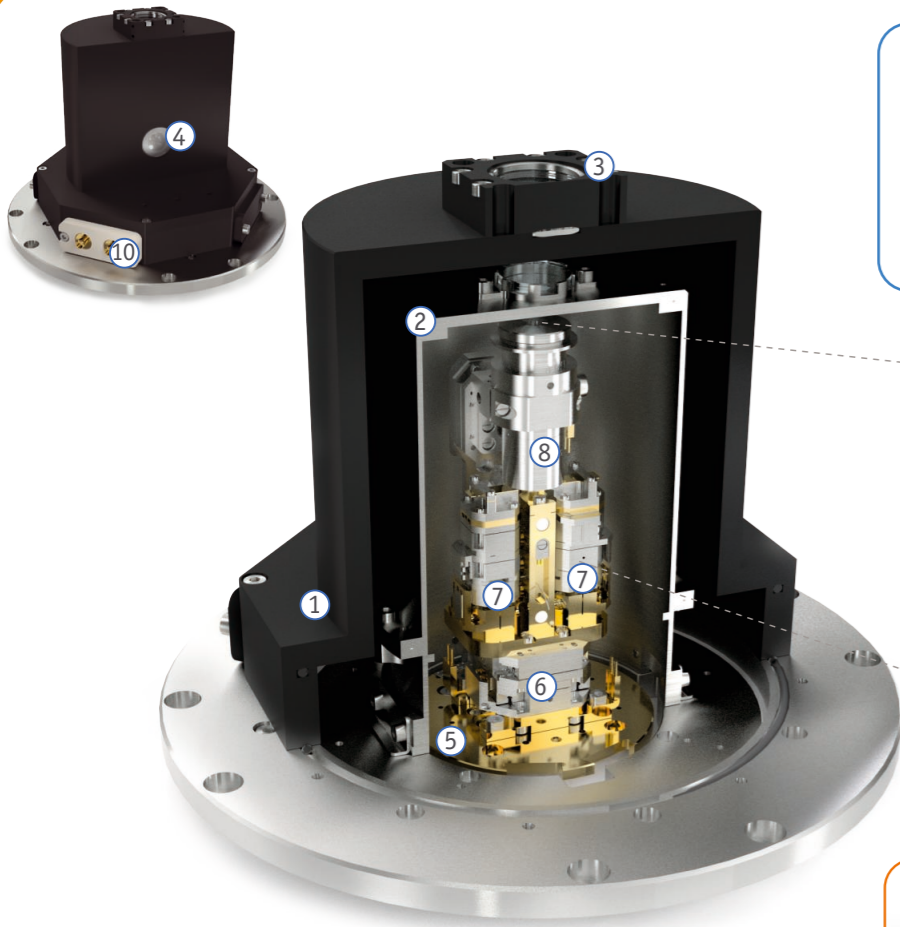
Photonic Probe Station

vacuum shroud for photonic probe station incl. optical side access



Customized Vacuum Shrouds

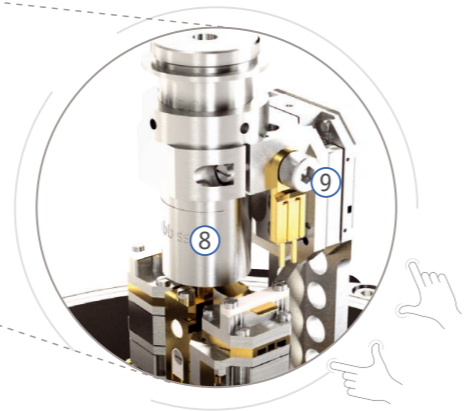
attoDRY800



- ① attoDRY800 vacuum shroud for photonic probe station setup
- ② cold shield
- ③ top vacuum window 25 mm, cold shield top window 20 mm
- ④ additional window for side inspection 25 mm x 1 mm; window material fused silica or N-BK7 (others on request)
- ⑤ cold plate

PRODUCT KEY FEATURES

- Vacuum shroud for use with internal LT-APO low temperature objective and lensed-fiber probes for side illumination & detection of waveguide structures
- minimal sample drift, broadband high collection efficiency
- Sufficient space for 9 degrees of freedom to independently position sample, focus, and 2 fiber probes
- Side access with additional window for RT optics



„ZOOM out“

Cryogenic Apochromatic Objectives

- negligible chromatic focal shift in working range
- uniform spot size and intensity within apochromatic range

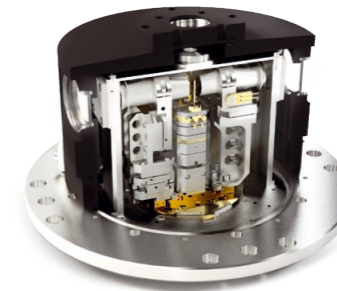
- ⑥ ANPxy311/RES positioners for xy translation of sample and fiber probes
- ⑦ 2x ANPxyz51/RES for xyz translation of fiber probes
- ⑧ LT-APO objective on separate mounting post
- ⑨ ANPz311 for z focus of objective with thermal link for objective
- ⑩ feedthrough ring with blind flanges included, DC/SMA/fiber feedthroughs optional

customized shroud for transmission with two LT-APO objectives



PRODUCT KEY FEATURES

- Vacuum shroud for use with 2 horizontal internal LT-APO low temperature objective
- Sufficient space for 7 degrees of freedom to independently position sample and 2x focal spot
- 8 side windows for scattering and transmission

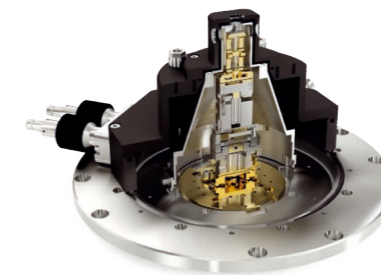


customized shroud for free-beam access from 5 sides with low working distance



PRODUCT KEY FEATURES

- Vacuum shroud for use with up to 5 room temperature objectives
- Low working distance from 5 sides
- Compatible with low temperature positioners (xyz)



i Contact us for other customizations!



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WITTENSTEIN group



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