

## TAO™ - Tip Assisted Optics Module

### 2- or 3- axis sample scanning module for the NanoWizard® AFM

#### Tip scanner meets sample scanner: TAO, the ultimate 5- or 6-axis scanner system

TAO – Tip Assisted Optics – is the answer to cutting edge needs in the NanoOptics. The TAO consists of an electronics module, software and an additional scanner integrated in a special designed AFM sample stage. As a modular component of the NanoWizard® AFM system, it opens up almost unlimited possibilities with its unique combination of sample scanner (TAO Stage) and tip scanner (NanoWizard® AFM). These independently operable scanners provide a maximum of movement in a total of 5 or 6 axes:

**AFM head tip scanner: 100 x 100 x 15 µm in x, y, z AND**

**TAO sample scanner: 100 x 100 µm in x, y, or**

**TAO sample scanner: 100 x 100 x 10 µm in x, y and z**

This comes fully integrated in inverted optical microscopes for techniques such as fluorescence, confocal laser or sample scanning, TIRF, Raman/TERS, SNOM, single photon counting, FRET, FCS, FLIM and many others.

#### Highest precision and resolution

Spatial resolution at the sub-nanometer level, excellent linearity and precise positioning – the power of the scanners in the integrated TAO system comes from piezo elements of PI (Physik Instrumente) that have been custom developed for JPK. The parallel kinematics scanners with friction-free flexure systems guarantee the best results in dynamics, resolution, and reproducibility. All axes are equipped with integrated capacitive sensors – a guarantee for sub-nm positioning accuracy and long-lasting stability during measurements. A positioning stability in the nanometer range and manipulation capabilities at the true nanoscale are the results of this approach. The complete software integration with a multitude of operation modes enables the full capability of the hardware while leaving sufficient room for the user's creativity and self-designed experiments through software scripting.



TAO™ module including controller

#### Key factor for many applications: system stability

There is no room for uncertainty during single molecule AFM experiments and simultaneous near-field optical experiments or single molecule fluorescence. The mechanical design and high performance scanner technology diminishes long term drift and noise that limit experiments in conventional designs. The use of identical flexure scanner designs for tip and sample scanning ensures best values for out-of-plane movement, drift and linearity.

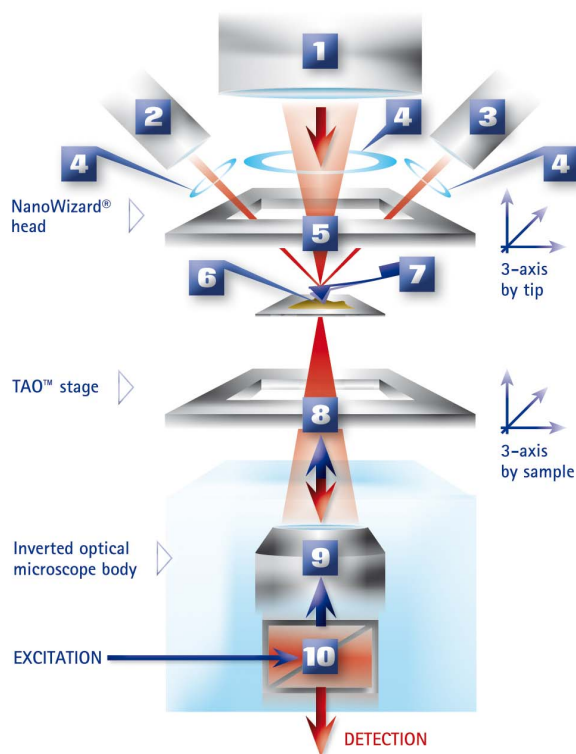
Stability is a prerequisite for the highest possible resolution in AFM. All TAO components are designed that the entire platform – including the inverted optical microscope – will perform optimally, even during long-term experiments and with changing temperatures. The scanning is virtually drift free – especially important to TERS experiments where the laser has to remain precisely focused on the tip for a long time.

#### Powerful and modular concept

A key point of the TAO module is the easy upgradeability of existing JPK AFM's in combination of inverted microscope bases. The module fits to inverted microscopes from Zeiss (Axiovert & Axio Observer series), Leica (DMI), Olympus (IX series) and Nikon (TE & Ti series).

### Application fields

- For all experiments where sample scanning or positioning is needed
- Sample scanning confocal microscopy
- FRET, FLIM and FCS
- Tip-enhanced Raman spectroscopy (TERS) setups
- Scattering-type SNOM and fiber-SNOM setups
- Nanolithography and manipulation in combination with light



- |                                      |                          |
|--------------------------------------|--------------------------|
| 1 Condenser lens from microscope     | 6 Sample                 |
| 2 Detector for cantilever deflection | 7 Cantilever             |
| 3 Laser for beam deflection          | 8 Sample scanner         |
| 4 Filters                            | 9 High-NA objective lens |
| 5 Tip scanner                        | 10 Fluorescence splitter |

### System specifications

#### Key features

- Unique combination of tip and sample scanning AFM
- Ultimate flexibility through simultaneous control of 5 or 6 scan axes with sub-nm closed-loop precision
- Tip scanner by AFM head: 100 x 100 x 15µm
- Sample scanner by TAO: 100 x 100µm OR 100 x 100 x 10µm
- Imaging, force measurement, nanomanipulation, mechanical and electrical characterization **plus** optical applications on the nanoscale in air or liquid
- Works in air and in liquids
- Unmatched AFM and optical performance on cover slip sample substrates also with temperature control

#### TAO hardware

- Stage design
  - Design is symmetric to the head geometry
  - Intelligent material mix for minimized drift
- Scanner design inside the stage
  - Proven NanoWizard® scanner technology
  - Parallel kinematics design
  - Friction-free flexure design scan stage
  - Encapsulated and fluid/humidity protected piezo stacks
  - Extremely flat scanning trajectory - <5 nm bow over full range
- Closed-loop control
  - Linearized with capacitive sensors up to 10kHz bandwidth
  - Position noise level 0,2 nm RMS in xy in closed loop
  - <0.03 % linearity error

#### TAO controller and software

- Scanner controls
  - 2 or 3 channels closed-loop control via capacitive sensors
  - 4th channel optional
  - -20 to +120 V scanner drive
- Signal connection via Signal Access Module (SAM) with the Vortis™ Advanced SPM controller
- Easy-to-use Java based graphical user interface
- Precise compensation of the offset between confocal optical and AFM image through the JPK software

**Compatibility**

- Fits to the following inverted research microscopes
  - Zeiss Axiovert & Axio Observer series
  - Leica DMI series,
  - Olympus IX series
  - Nikon TE & Ti series
- TAO stage is compatible to the following sample holders:
  - Standard sample holder
  - BioCell™

- All CoverslipHolders
- PetriDishHeater™
- Heating Cooling Module
- PIFOC® objective positioner from Physik Instrumente (PI) GmbH & Co.

**Additional information**

- CE compliant
- Weight controller: approximately 10 kg
- Power consumption: 150 W max