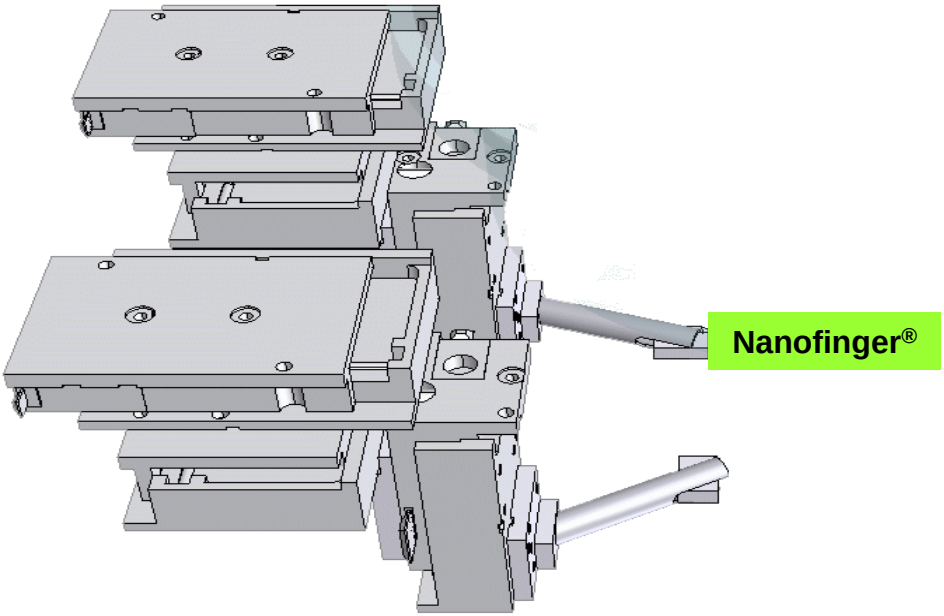
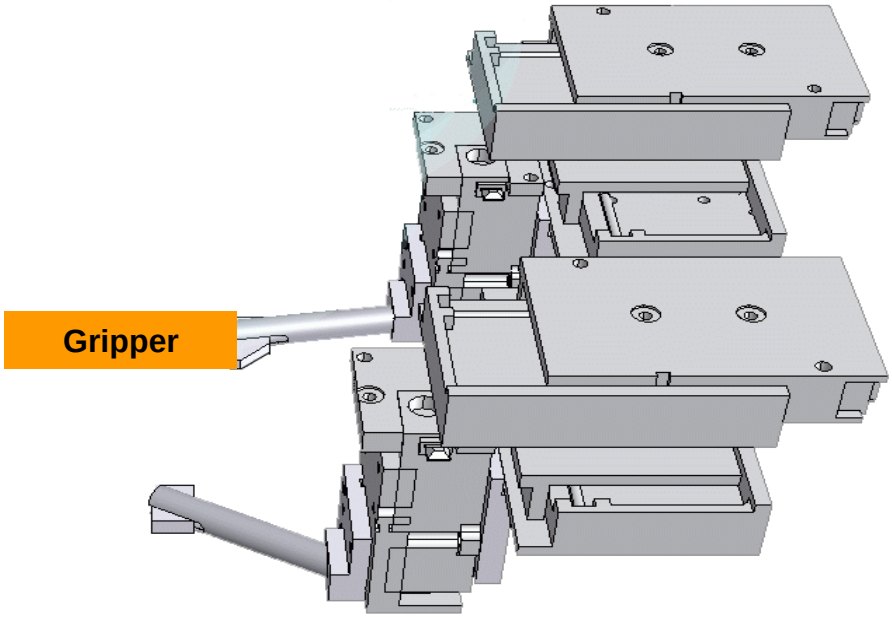
Particle Sorting:

Sorting of micro/nano-particles inside SEM/FIB systems with the Nanoworkbench from Klocke Nanotechnik

Particle Sorting

Nanoworkbench Configuration





1. Nanomanipulator equipped with: 1D-Nanofinger® as Scout
plus tip for particle releasing

2. Nanomanipulator equipped with: Gripper tool

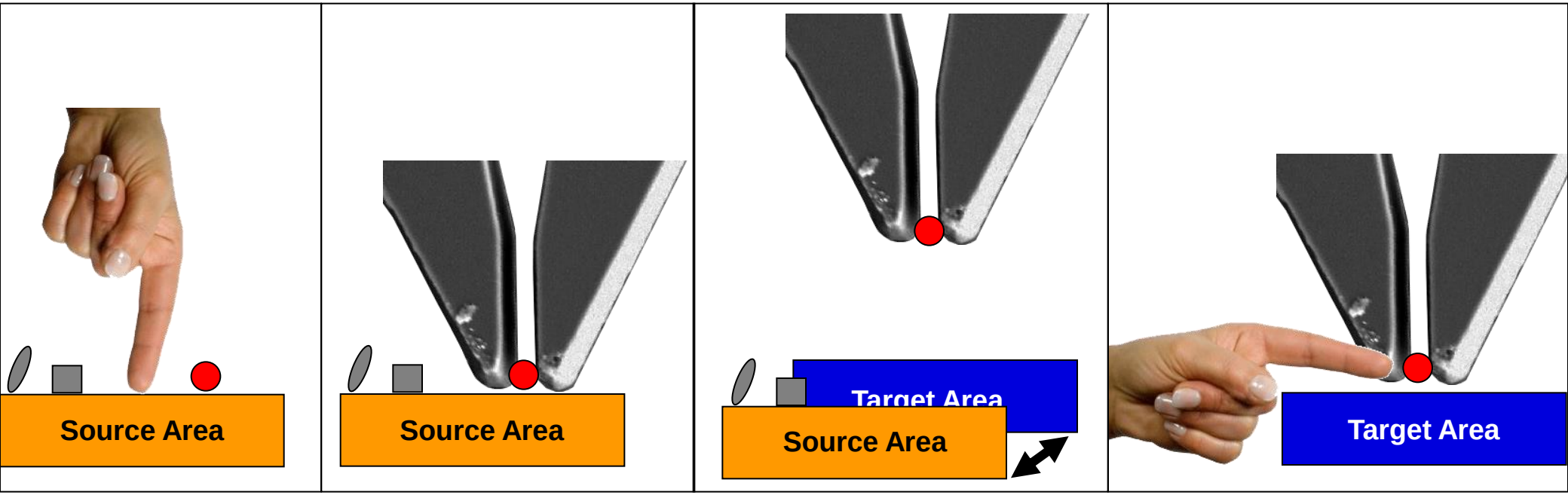
- Standard Software Package: Macro Executor, Live Image Positioning, Assistants, Sequencer

Particle Sorting

Handling sequence

Pre-Condition:

- Sample stage moves independent from manipulators
  - Realized by stationary manipulators



Only gripping and releasing are done manually!

Particle Sorting

Handling steps

Pre-Condition:

- Sample stage movement independent from Nanomanipulator movements
  
  realized by stationary manipulator installation

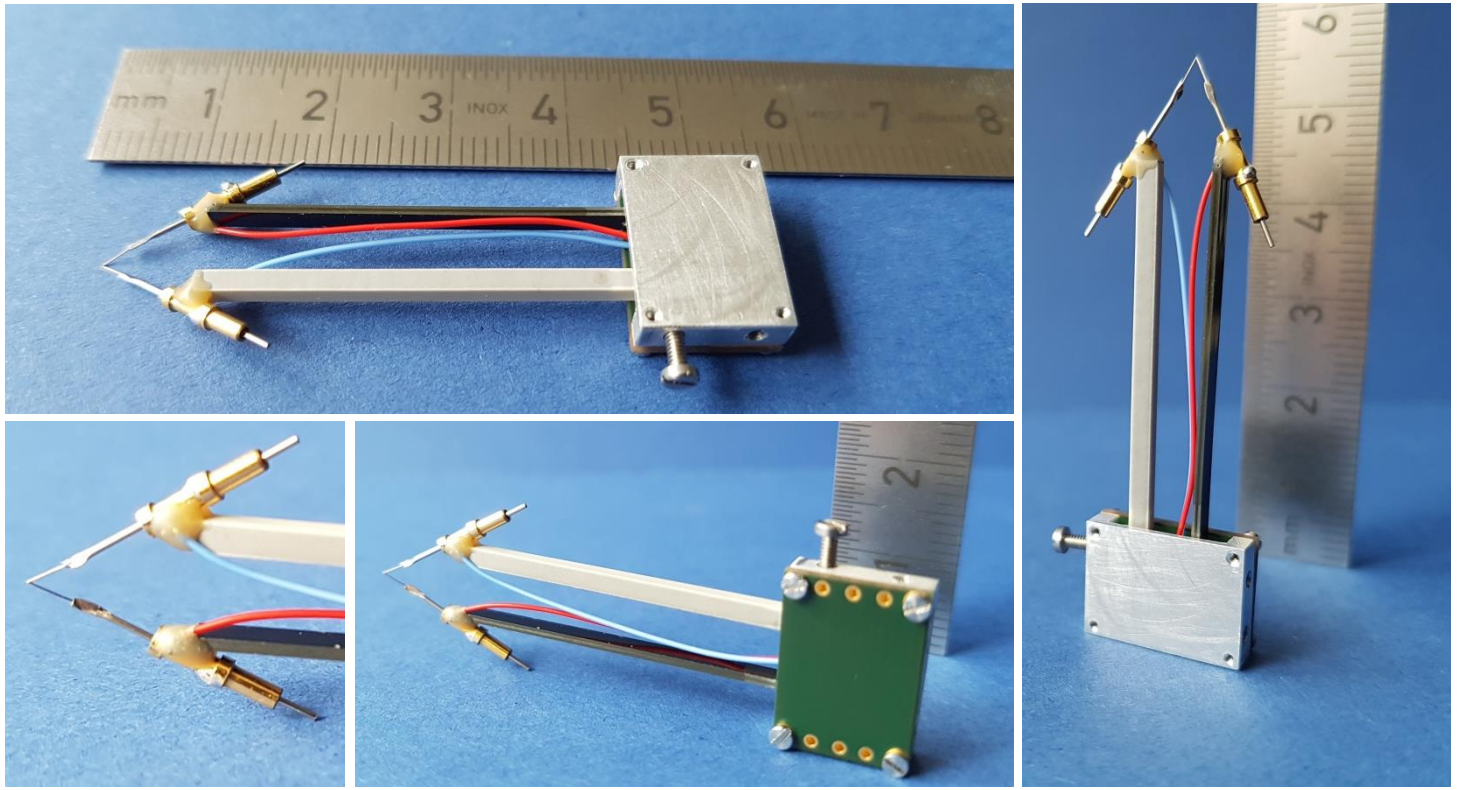
Semi-automatic process with the following steps:

- Find the source area:
  - in XY by “Live Image Positioning” of the gripper
  - in Z by automatic approach using the Nanofinger® as Scout
- Grip and lift the particle with a microgripper at Manipulator 2
- Automatic sample stage movement to target area
- Lower gripper and release the particle, assisted by the Nanofinger® - tip at Manipulator 1

Only gripping and releasing are done manually!

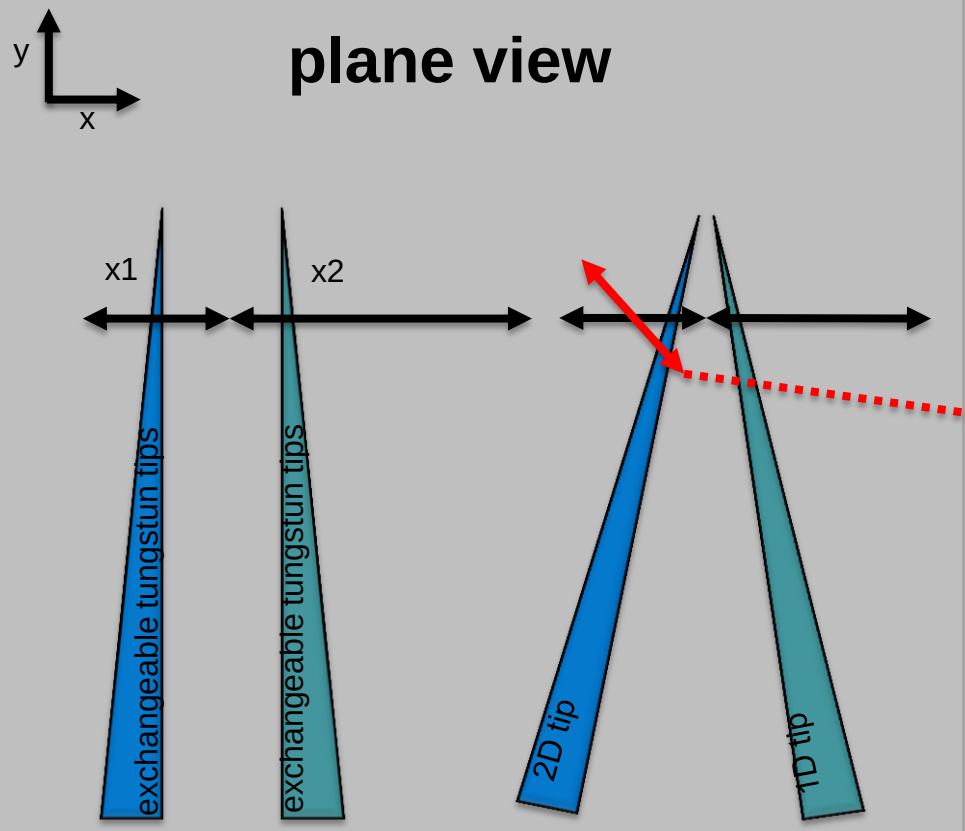
Particle Sorting

High precision within small dimensions

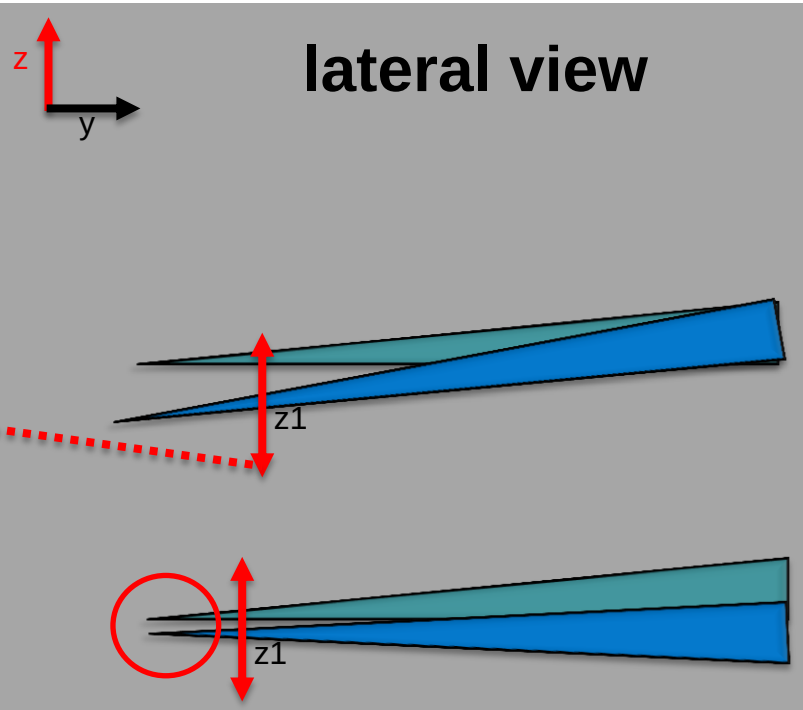


Particle Sorting

3 dimensional movement of the tips for easy alignment



movement in x axis for both tips to open and close tips (x1+x2)

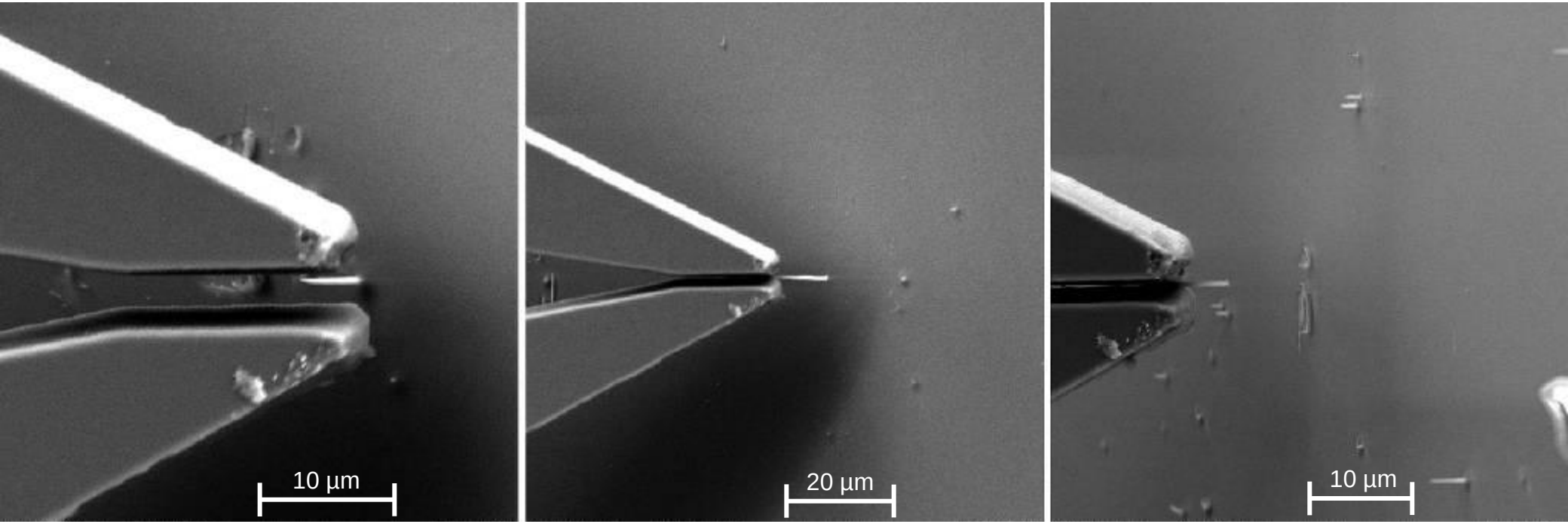


movement in z axis to align gripper tips

Particle Sorting

Gripping of CNT

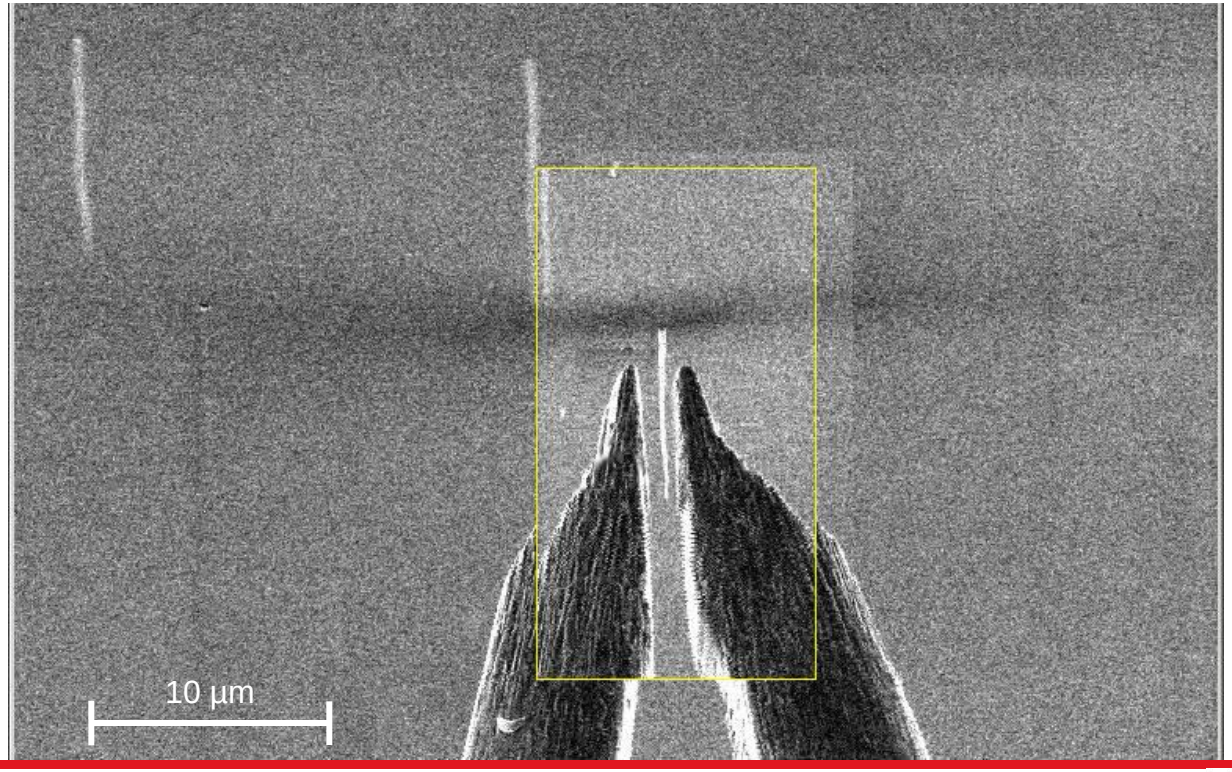
Multiwall Carbon Nanotube gripped with an electrostatic gripper



Particle Sorting

Gripping of CNT

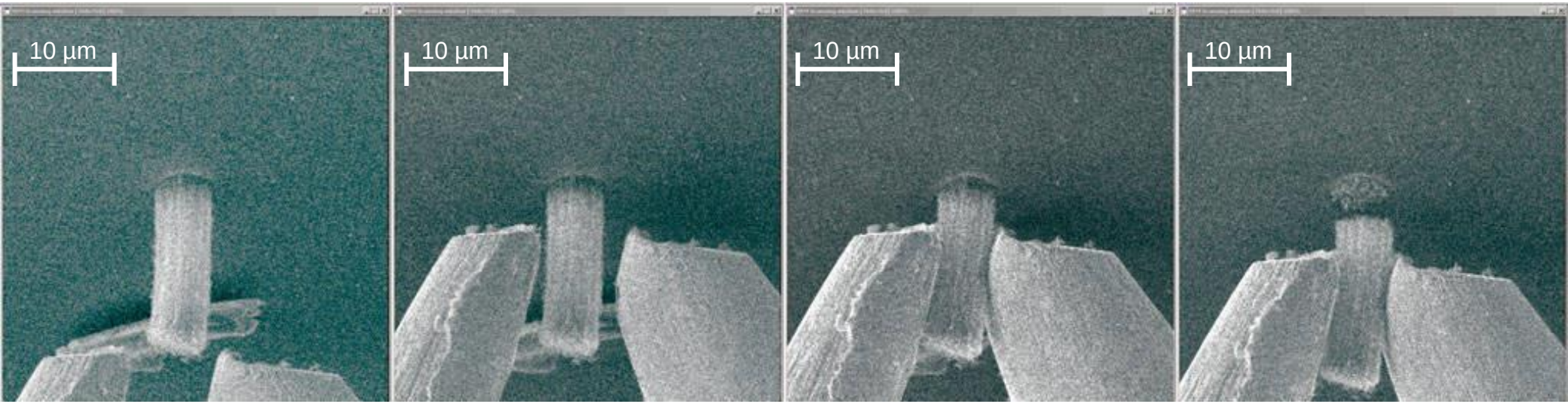
Multiwall Carbon Nanotube gripped with a piezo-driven gripper



Particle Sorting

Gripping of CNT

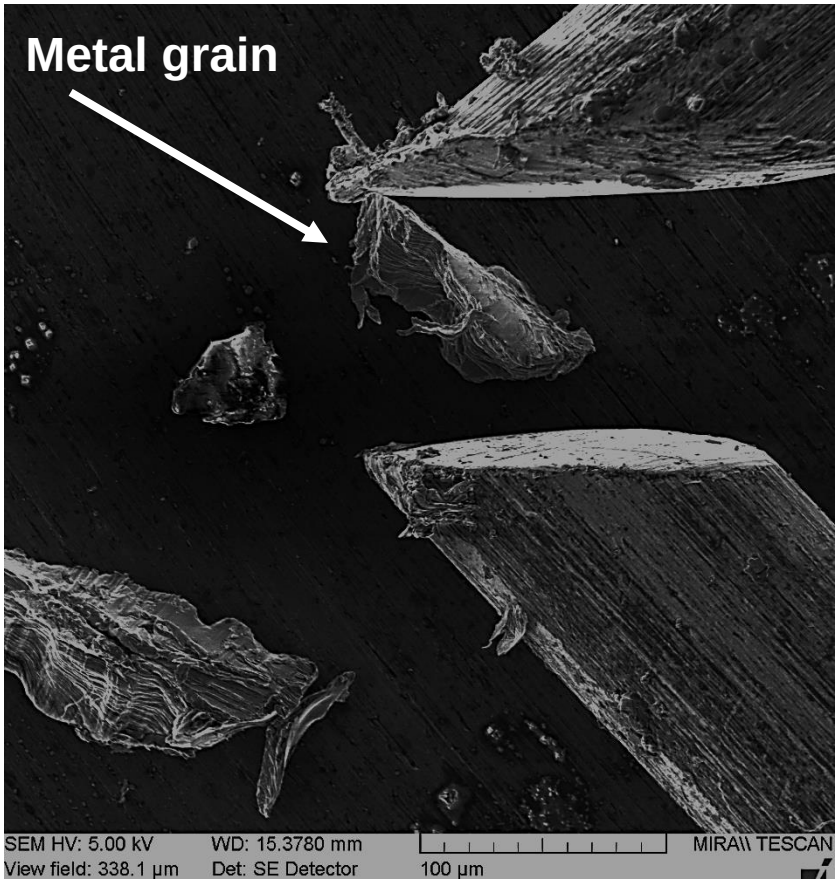
A bundle of CNTs gripped and sheared off with a piezo-driven gripper

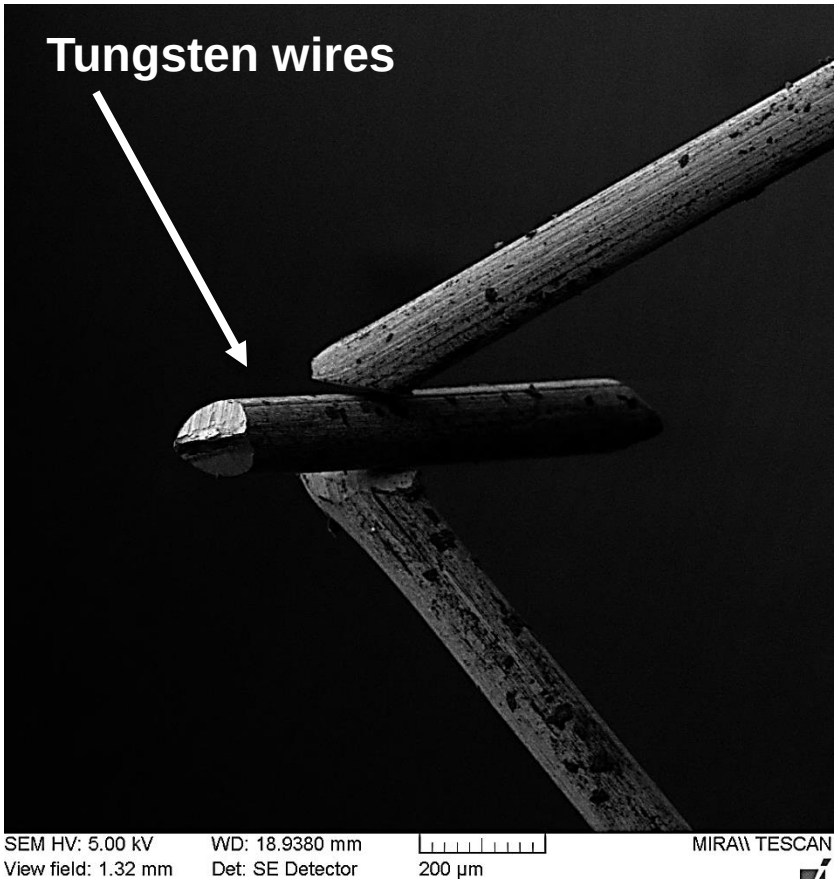


Particle Sorting

Handling of bigger particles

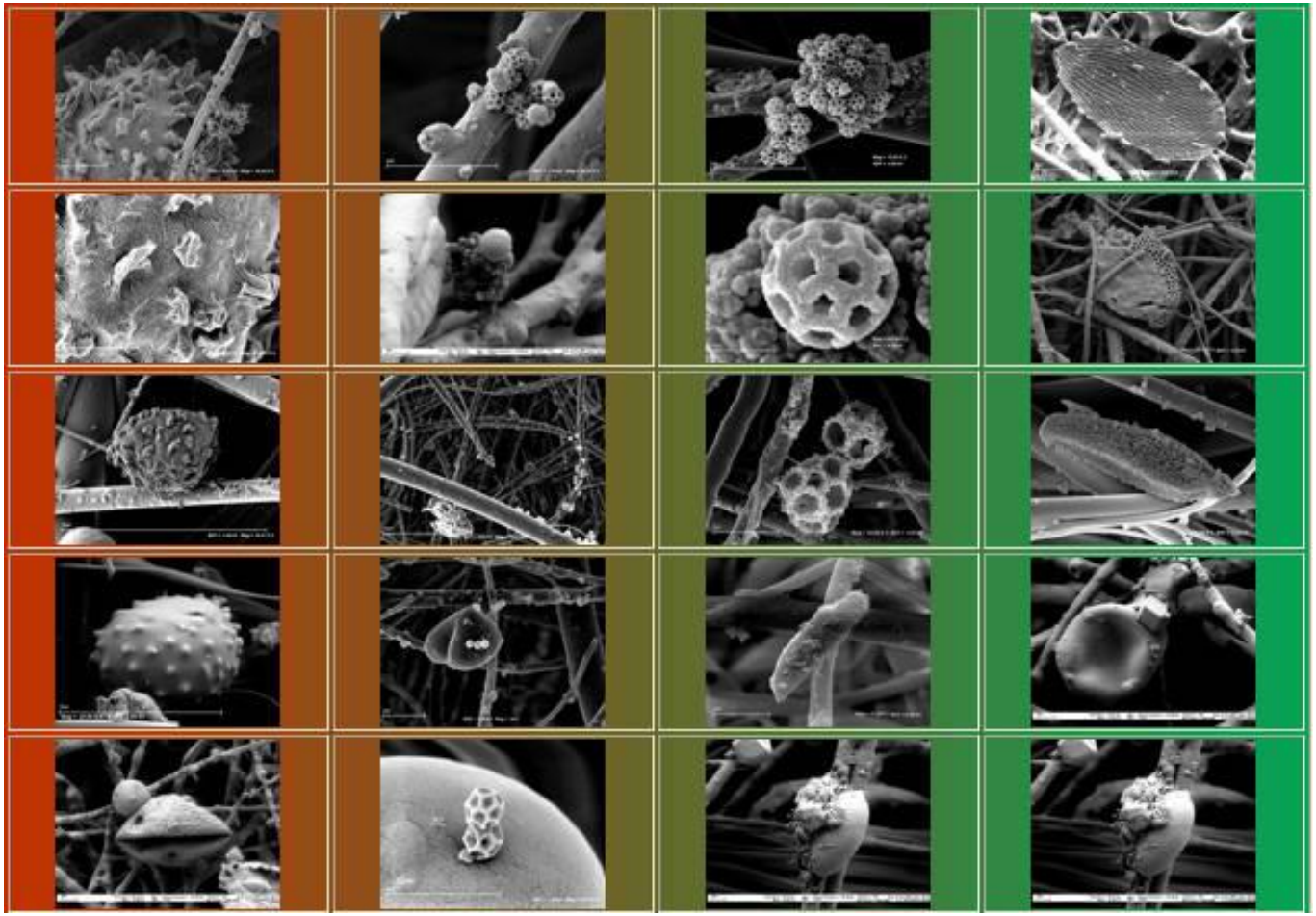
Depending on the chosen shape of the particles, many different kinds of particles can be handelt





Particle Sorting

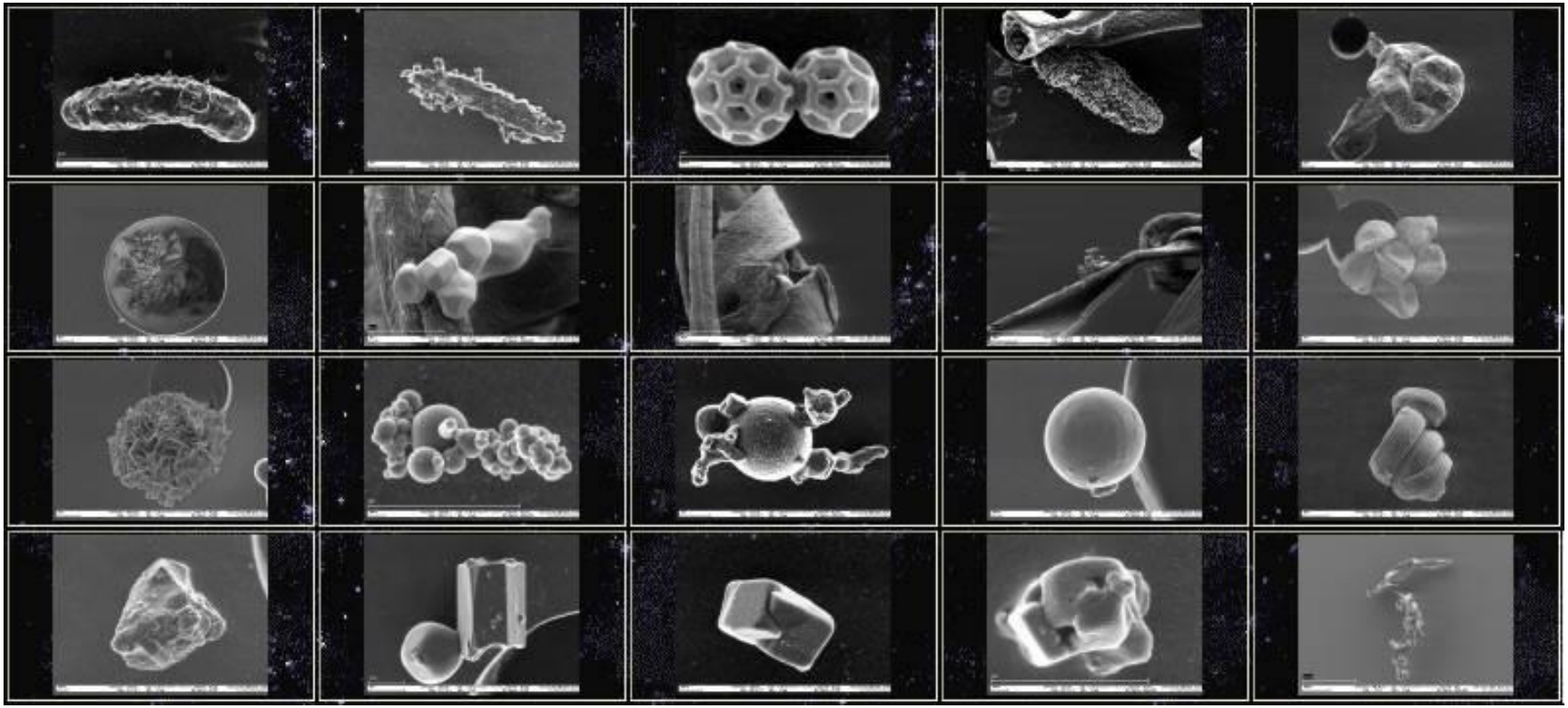
Before sorting



SEM - Images of Aerosol particles embedded “in the dust”

Particle Sorting

After sorting

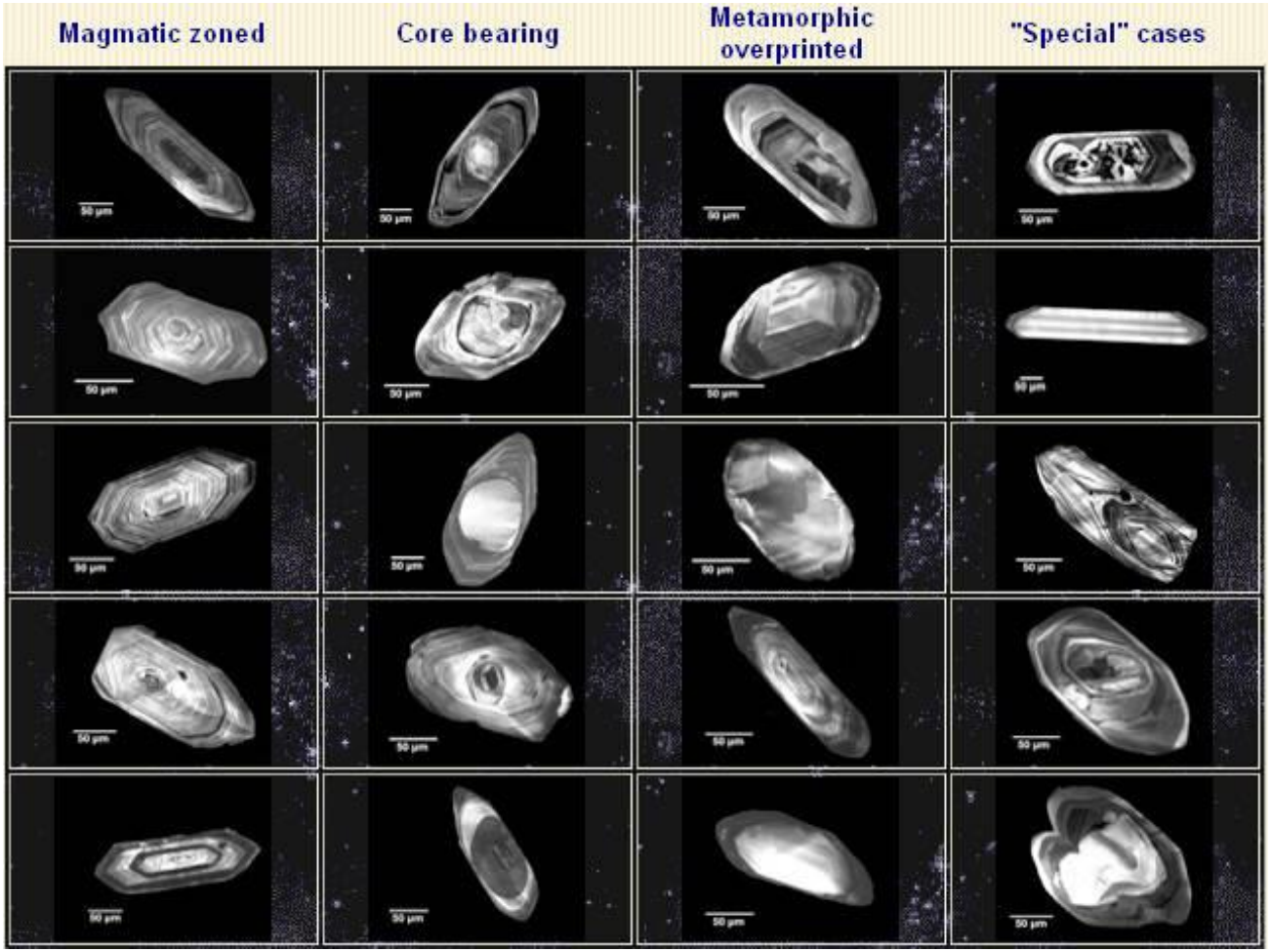


Separated Aerosol particles

Particle Sorting

After sorting

Other examples:

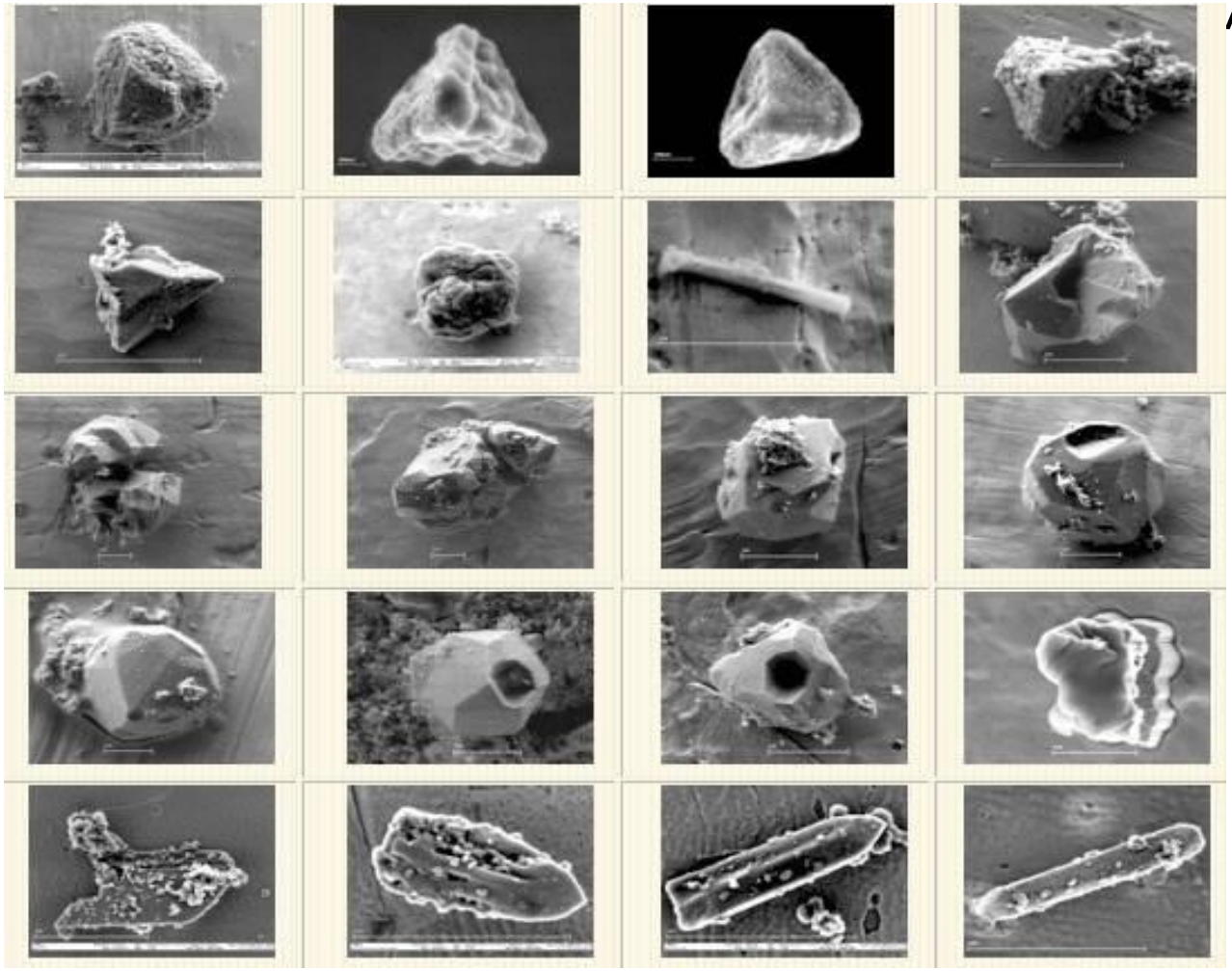


Separated zircons from crustal rocks

Particle Sorting

After sorting

Further examples:



Separated stardust particles

Particle Sorting

Further examples

One process for plenty of applications:

- The mostly automated handling procedure is always nearly the same
- Huge variety of applications in different disciplines can be done with one process
- Further examples are e.g.:
  - Forensic/Crime research (trace analysis)
  - Pollution analysis of arctic ice
  - Failure analysis in material research
  - Nano-Keyhole surgery
- Similar application: Micro/Nano-Assembly like in our “NanoFab”

Particle Sorting

Plus sample preparation

Sometimes particles are hidden within the bulk material:

- Preparation of the sample with **NanoCutting** and **NanoCleaning**

  → see related leaflets of these Nanoworkbench standard application packages.

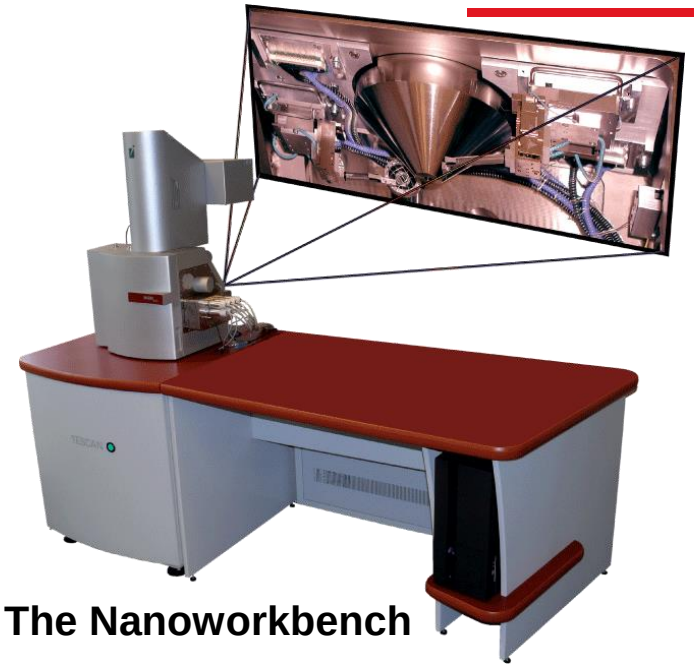
Particle Sorting

… part of the Nanoworkbench

- With the Nanoworkbench from Klocke Nanotechnik Particle Sorting in a SEM/FIB is very fast, safe and easy.
- The Live Image Positioning module allows to direct the gripper in XY to the target area just by mouse-click into the SEM image.
- The automatic approach sensor Nanofinger® operates as Scout for the gripper and assists when particles shall be released.
- Automatic macros and absolute positioning in superior precision allow to program processes in combination with manual interactions.

The Nanoworkbench

and its Application Packages



The Nanoworkbench

Particle Sorting …

is one out of several “Standard Application Packages”

of our Nanoworkbench.

The Nanoworkbench enables the **hand-eye coordination**

as used at Light Microscopes now in any SEM/FIB,

together with automation of the SEM/FIB **(@ZEISS, FEI, TESCAN)**





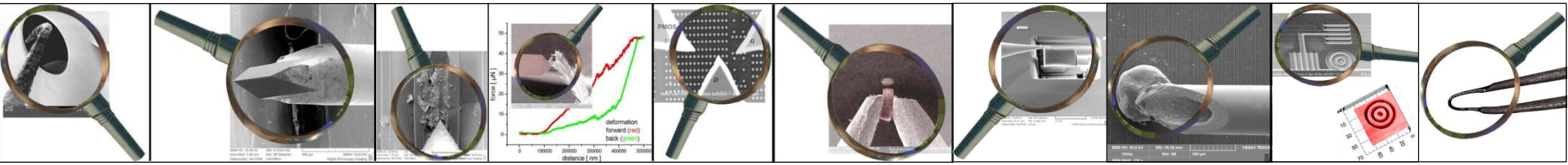
At Light Microscopes it is natural for everybody to use tool sets like tweezers, knives, hooks, probes and several different measurement tools, so it is with the Nanoworkbench.

The Nanoworkbench

One Product for all applications

The Nanoworkbench Standard Packet includes:

- The basic application package “Nanomanipulation” and
- one additional “Application Package” out of:

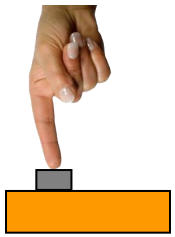


Manipulation, NanoCleaning, NanoProbing, TEM-Lamella, 3D-Nanofinger
NanoCutting, Force-Distance, Particle sorting, NanoFriction Spot-Heating

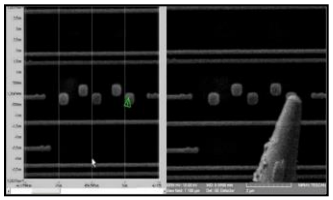
Each application package includes a standard tool, a standard sample and pre-defined processes as source-code and origin for own projects.

- **The following set of modules for easy usage an application control:**

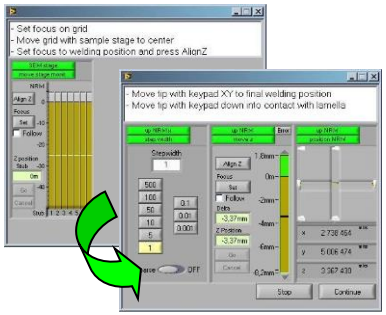
The Standard Packet



Nanofinger® as Scout, guiding the Nanoworkbench Tools,



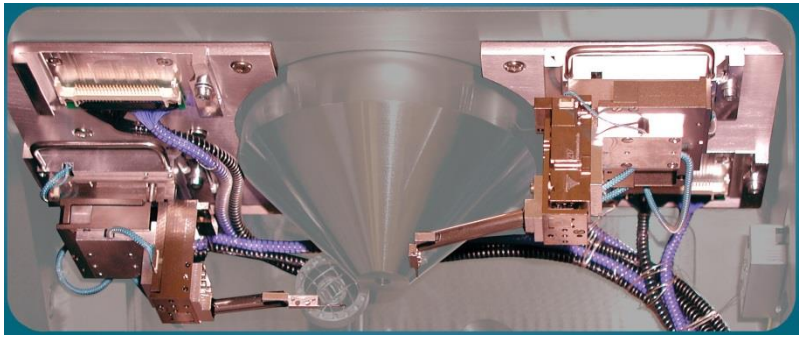
Live Image Positioning,



Assistants (Wizards),

Hand-eye coordination:

Sequencer for automation,
Macro Executor,
Remote Control,
…



2 Nanorobotics Manipulators with docking stations

More information?

Please ask for the leaflet “Nanoworkbench”