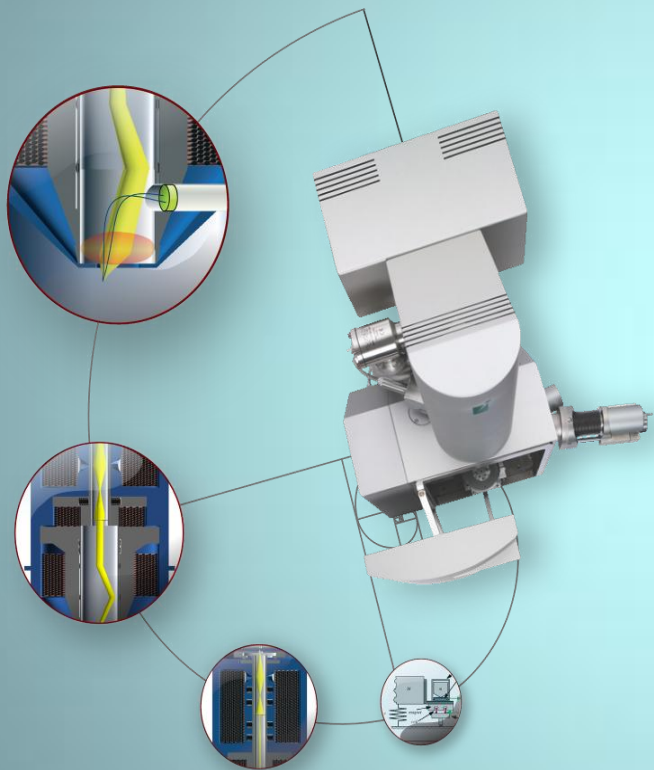




# TESCAN MIRA FESEM Presentation

**Global Supplier of Scanning Electron Microscopes**

TESCAN USA  
508 Thomson Park Drive  
Cranberry TWP, PA 16066



- **About TESCOAN**
- **Product Portfolio**
- **MIRA FESEM Overview**
  - **Electron Optics**
  - **Various Models**
  - **Features**
  - **EDS Analysis**
  - **Imaging Results**



**Established:** 1991

**Location:** Brno, Czech Republic

**Field of Activity:**

Research, development, manufacturing and worldwide supply of scanning electron microscopes and related products

**Main Products:**

- Scanning electron microscopes
- High resolution Schottky FE-SEMs
- Focused ion beam SEMs
- Detectors and accessories for SEMs
- Nanotechnology Instrumentation



Over **1100 SEMs** all over the world





Fig. Brno International Trade Fair Center



Fig. First Czechoslovak electron microscope  
Tesla BS241 (1951), Tesla BS242 (1954)

## Historical Background

### Brno, Czech Republic

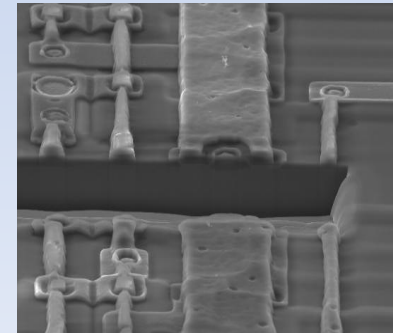
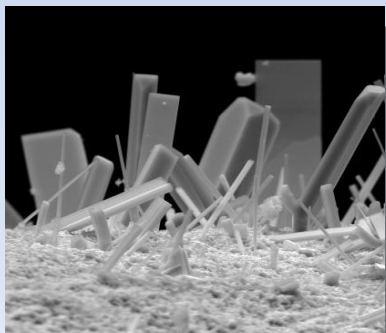
- The second largest city in the Czech Republic
- Traditional center of industry and commerce and Central European trade fairs
- 6 Universities with 27 faculties and about 80,000 students
- Origin of world-famous researchers
- 15 Institutes of Academy of Science

### Electron Microscopy in Brno

- **Over 60 years tradition of electron microscopy in Brno**
- Former leading supplier of EM for Eastern Europe
- Location of other SEM manufacturers

## Historical Facts

- The first TEM assembled at the Technical University of Brno at the end of the 1940's
- TESLA Brno - introduced the first commercial TEM in 1953
  - the leading manufacturer of Electron-Optical Devices in Eastern Europe in the 2<sup>nd</sup> half of the 20<sup>th</sup> century
- The Institute of Scientific Instruments of the Academy of Science of the Czech Republic was founded in 1956
- The Tesla BS-242 TEM was awarded the gold medal at the World Exhibition in Brussels in 1958
- Tesla Brno manufactured over 4,000 devices (TEM + SEM) during four decades of its existence
- TESCOAN founded by former engineers and managers of Tesla Brno (Jaroslav Klima, former head of Tesla's SEM Division)
- TESCOAN, a.s. is one of the companies successfully continuing the electron microscopy tradition in Brno







**TESCAN Team: more than 160 employees**

## **TESCAN are total about 4500 m<sup>2</sup>**

Mechanical Workshops		<b>480 m<sup>2</sup></b>
Electrical Workshops		<b>265 m<sup>2</sup></b>
Assembling		<b>200 m<sup>2</sup></b>
Stores		<b>160 m<sup>2</sup></b>
Final Assembling (clean rooms)		<b>350 m<sup>2</sup></b>
Packaging		<b>300 m<sup>2</sup></b>
Clean R&D laboratories		<b>70 m<sup>2</sup></b>
Demonstration laboratories	Standard	<b>30 m<sup>2</sup></b>
	Clean	<b>40 m<sup>2</sup></b>
R&D offices		<b>150 m<sup>2</sup></b>
Sales, logistics, economics and company management offices		<b>680 m<sup>2</sup></b>
Meeting rooms		<b>395 m<sup>2</sup></b>

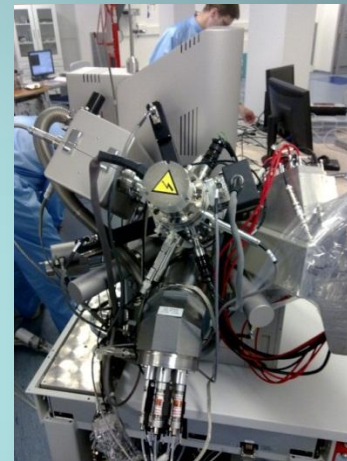






TESCAN, a.s.  
20 Years of Tradition and Excellence  
in Scanning Electron Microscopy

- New premises
- Modern manufacturing facilities
- Strong research and development
- Clean rooms for assembling
- Educated and experienced team
- Worldwide sales and service network





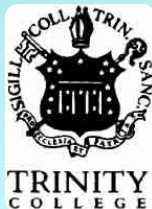
## North America Headquarters

Location: Cranberry Township, PA  
(Pittsburgh, PA)

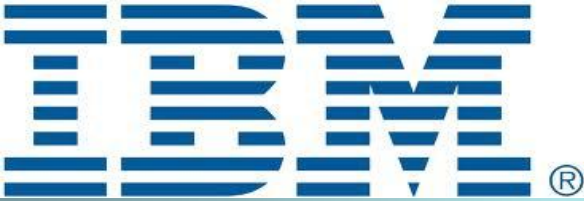


## West Coast Demonstration Lab

Location: Pleasanton, California





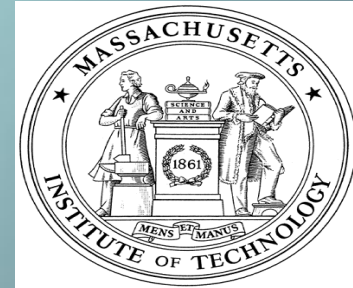


Jacksonville



Orlando

TESCAN provides a guaranteed 48 hour response time  
(Our Goal is 24 hours)  
& guaranteed 95% uptime.







US Steel

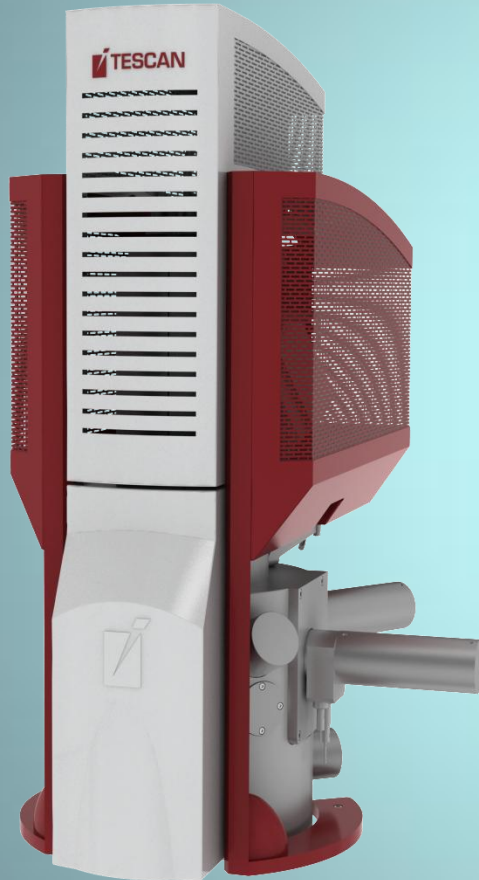


RIO  
TINTO

PPG Industries



TESCAN provides a guaranteed 48 hour response time  
(Our Goal is 24 hours)  
& guaranteed 95% uptime.

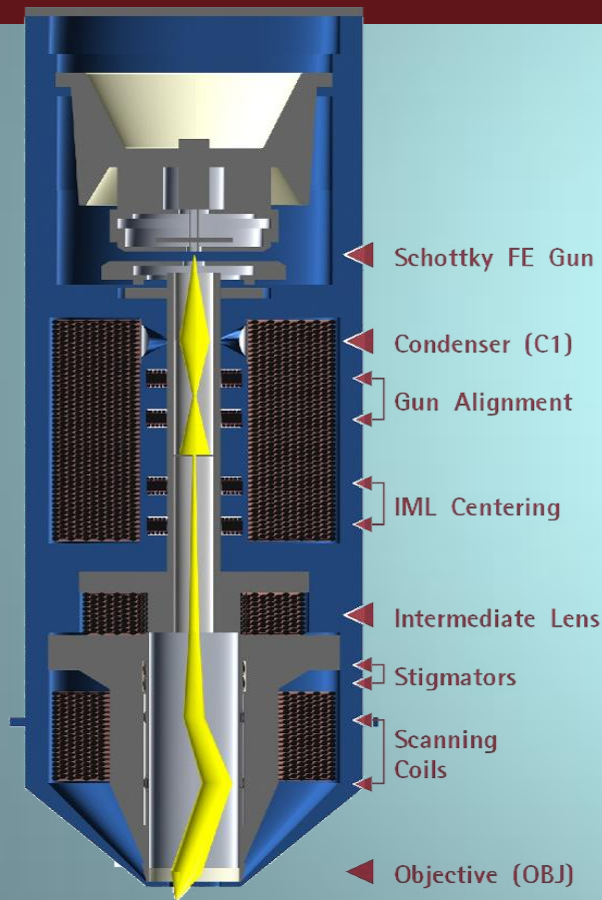


## Specific Features

- High resolution Schottky FEG-SEM
- Unique **Wide Field Optics** SEM optics design
- Intermediate lens (IML) for the beam aperture optimization
- Uniform energy
- **In-Flight Beam Tracing™**
- Stereoscopic imaging 3D Beam Technology
- **UniVac** - variable pressure version
- Beam Deceleration
- Large Chamber and Stage Capability
- Variable Pressure

## Optional / Accessories / Software modules

- **On axis In-Column SE and BSE Detector** for high resolution at lower kV
- STEM Detector
- Low Vacuum Secondary Tescan Detector (LVSTD)
- 16k x 16k Image Store as standard
- Beam Blanker
- Load Lock
- Peltier Cooling Stage
- Nanomanipulators, etc.



## High Resolution Schottky FEG SEM

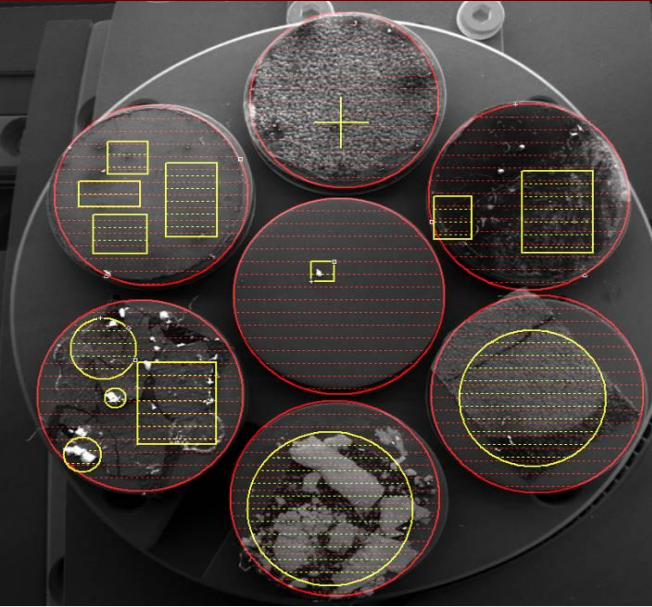
- Point source – high brightness Schottky emitter
- Convergent beam, uniform energy, minimized aberrations

- **Wide Field Optics™**

- Unique Tescan three-lens column design optimized for FE source
- IML - Intermediate lens for beam aperture optimization
- Automated alignment

## In-Flight Beam Tracing™

- Original control of the beam properties



Tescan SEMs = World's Largest Magnification Range

**Benefit** ✓  
for **Application**

## From Centimeters...

- Unique Wide Field Mode (in centimeters)
- Extra-low magnification (down to 1,2x)
- Extra wide scanning angle (up to 45° )

## ...to Nanometers

- High Resolution Shottky FE-SEM (1.2 nm)

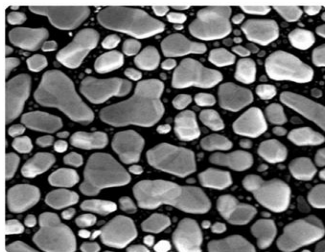
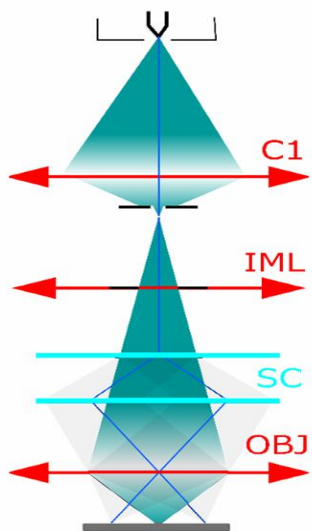
**Fig 1** Magnification up to 1,000,000x

*Top: Defining areas for automated analysis*

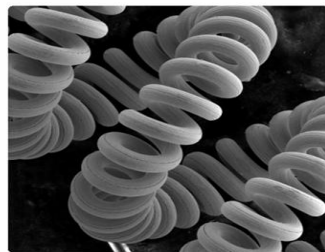
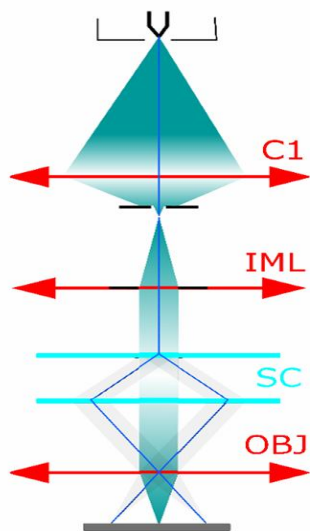
*Bottom: High resolution test*



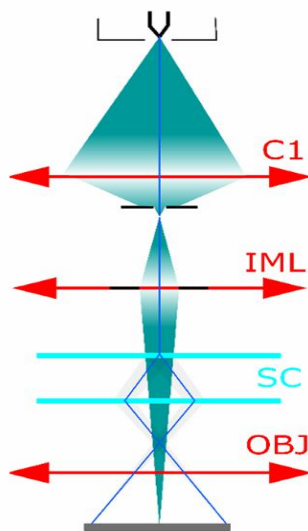
Resolution



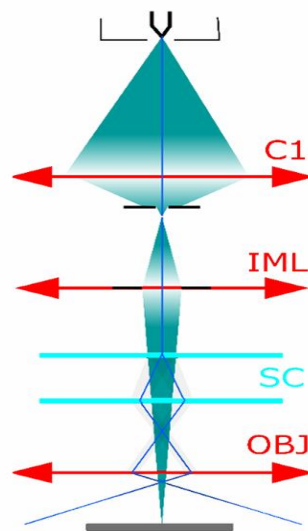
Depth



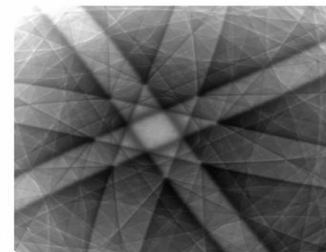
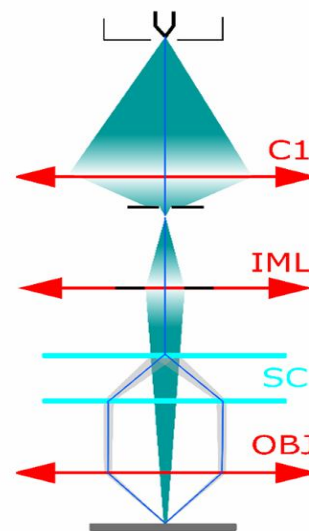
Field



Wide Field



Channelling



### Principles of the beam deceleration:

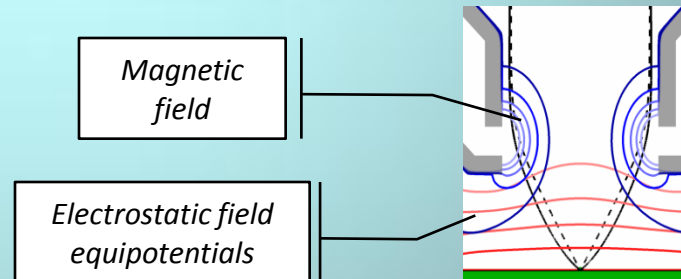
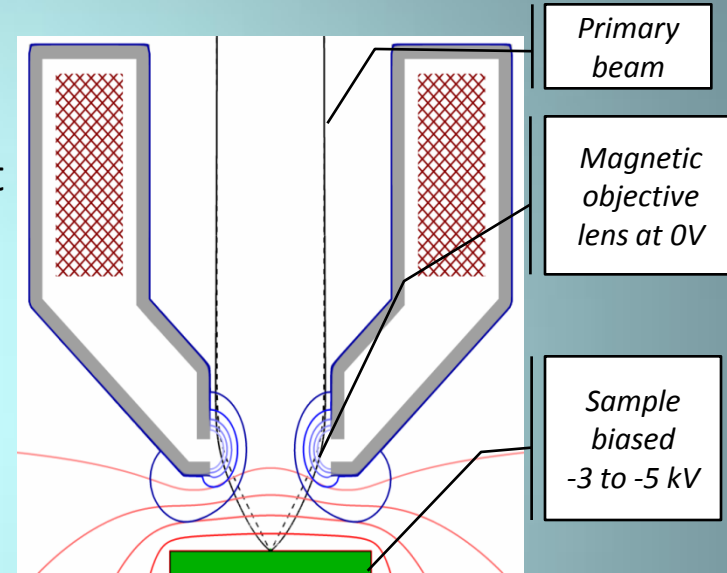
- Applying negative voltage on the specimen
- Using higher accelerating voltage of primary beam that is decelerated just before its landing on the specimen
- Results in smaller chromatic aberration = better resolution

### Example:

- Primary beam energy = 5 keV
- Specimen bias voltage = -4 kV
- Landing energy =  $5 - 4 = 1$  keV

### Special feature:

*In-Flight Beam Tracing™* controls precise focus in DM

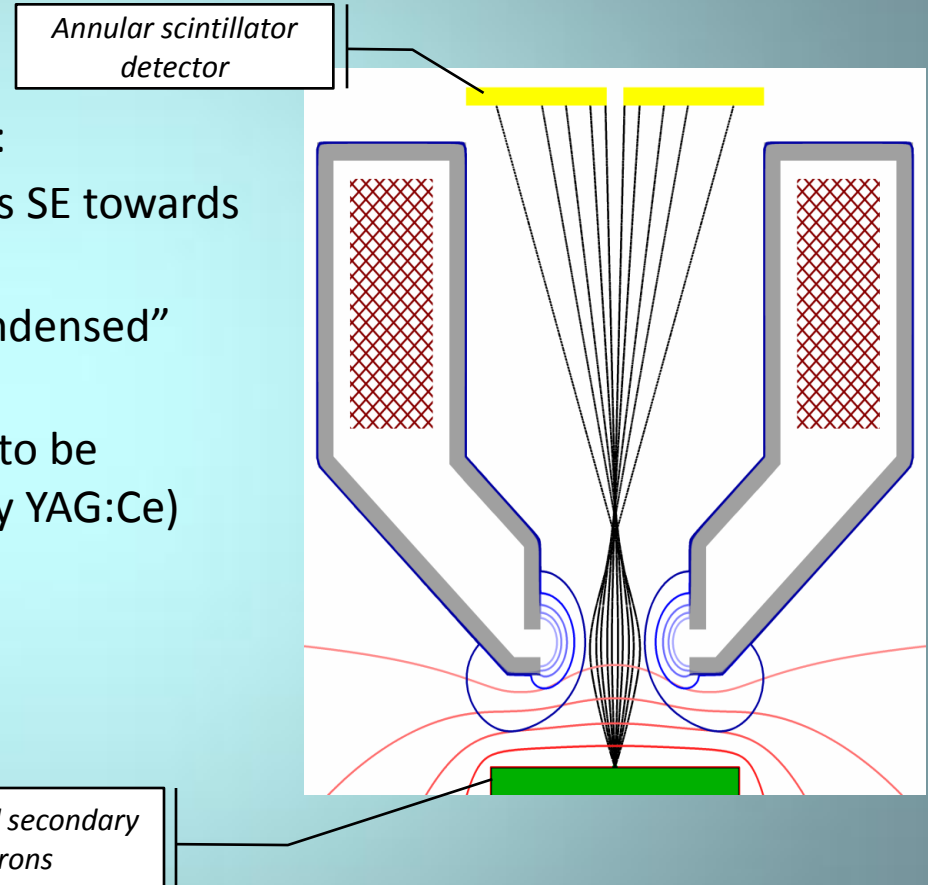


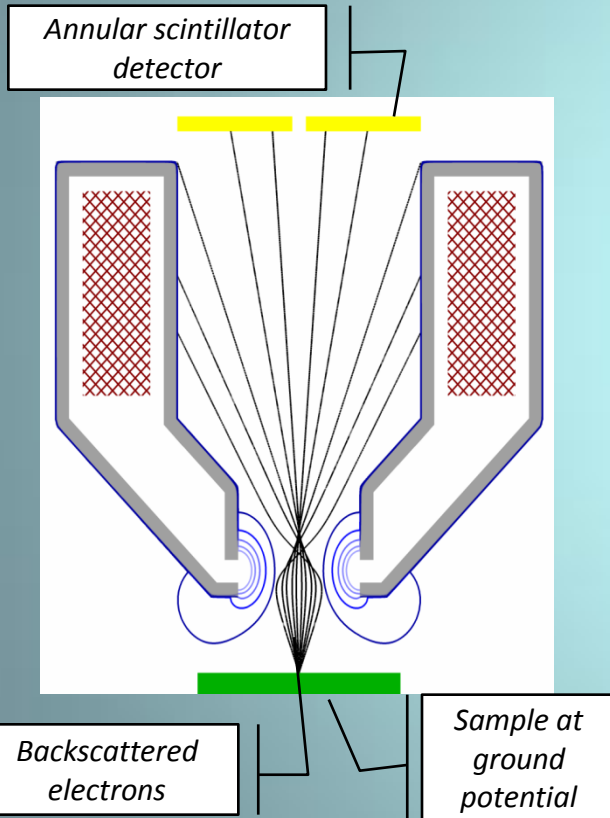
Principles of the secondary electron detection:

- negative voltage on the specimen accelerates SE towards and inside of the column
- The secondary electron are focused and “condensed” close to the optical axis
- acceleration field gives to SE enough energy to be detected by a BSE-like-detector (high efficiency YAG:Ce)

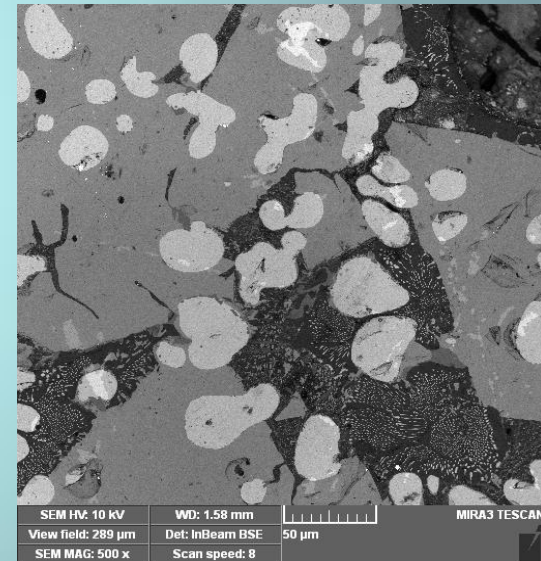
Example:

- Specimen bias voltage = -4 kV
- SE original energy = about 4 eV
- SE detector landing energy = 4+ keV

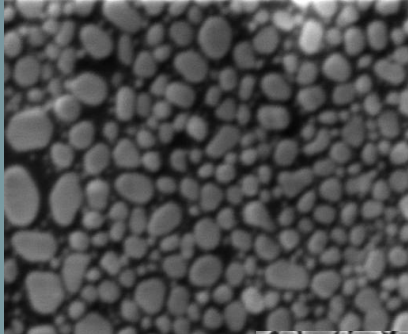




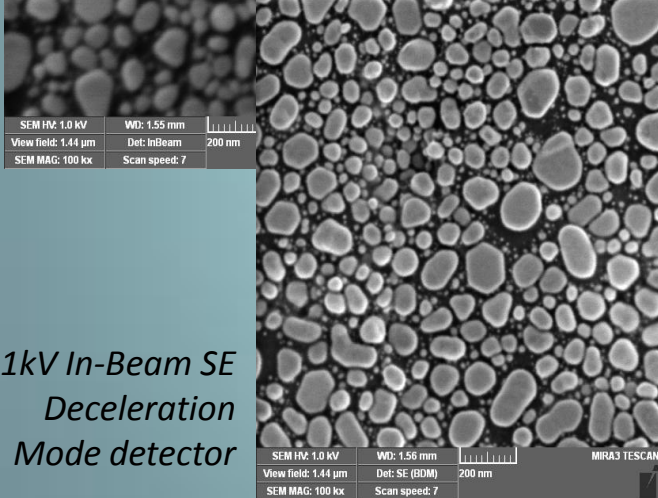
- Sample at the ground potential
- High angle back-scattered electrons detected by in-beam detector (same detector as for the deceleration mode)
- Complementary signal to the standard (below pole piece) BSE detector that detects rather low angle back-scattered electrons
- Enables to use very short WD
- Frees space under objective lens for other detectors







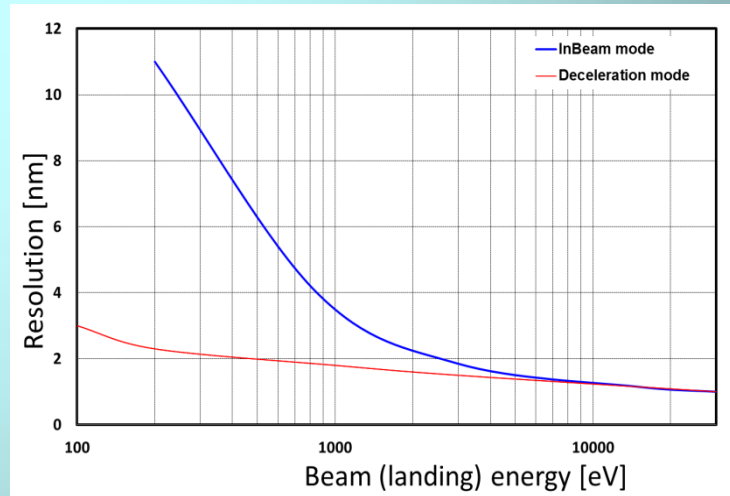
*Resolution  
test Au-C, 1kV  
In-Beam SE  
detector*

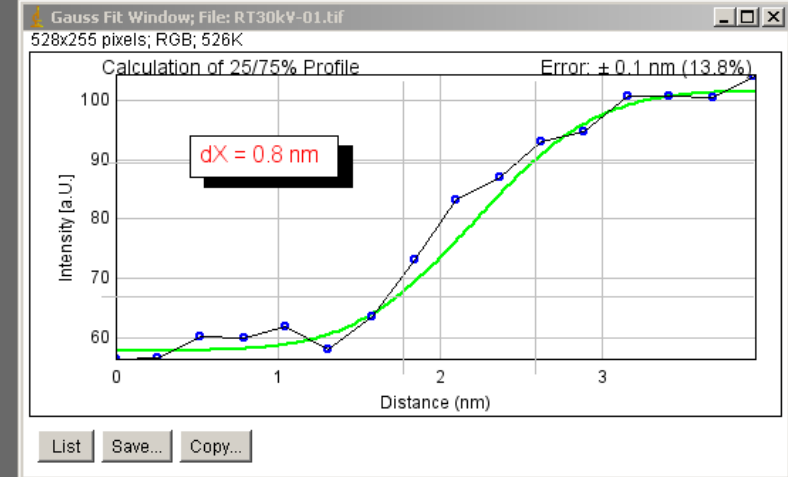
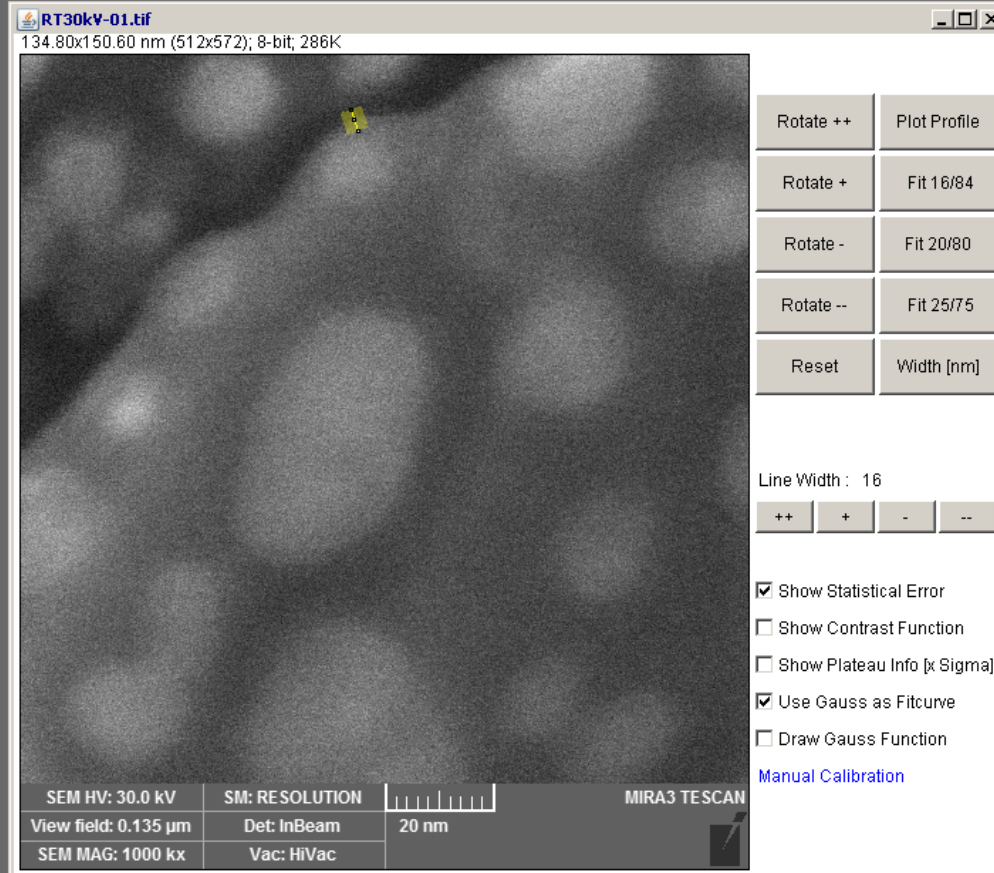


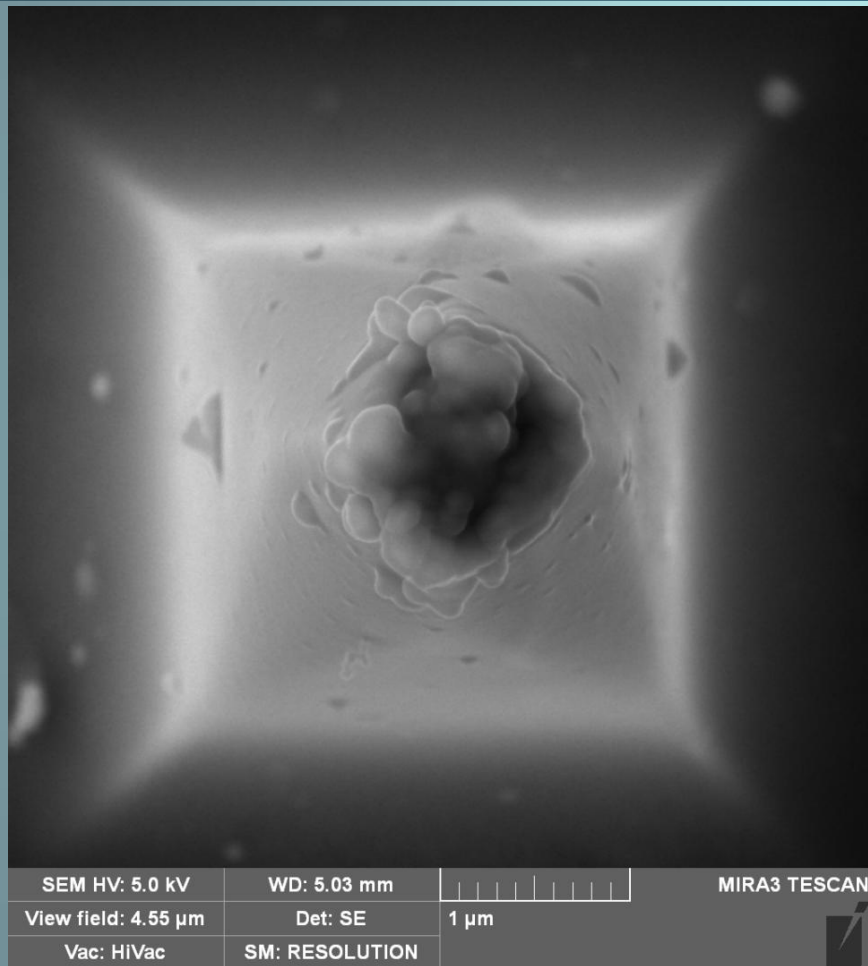
*1kV In-Beam SE  
Deceleration  
Mode detector*

## Advantages of the beam deceleration mode:

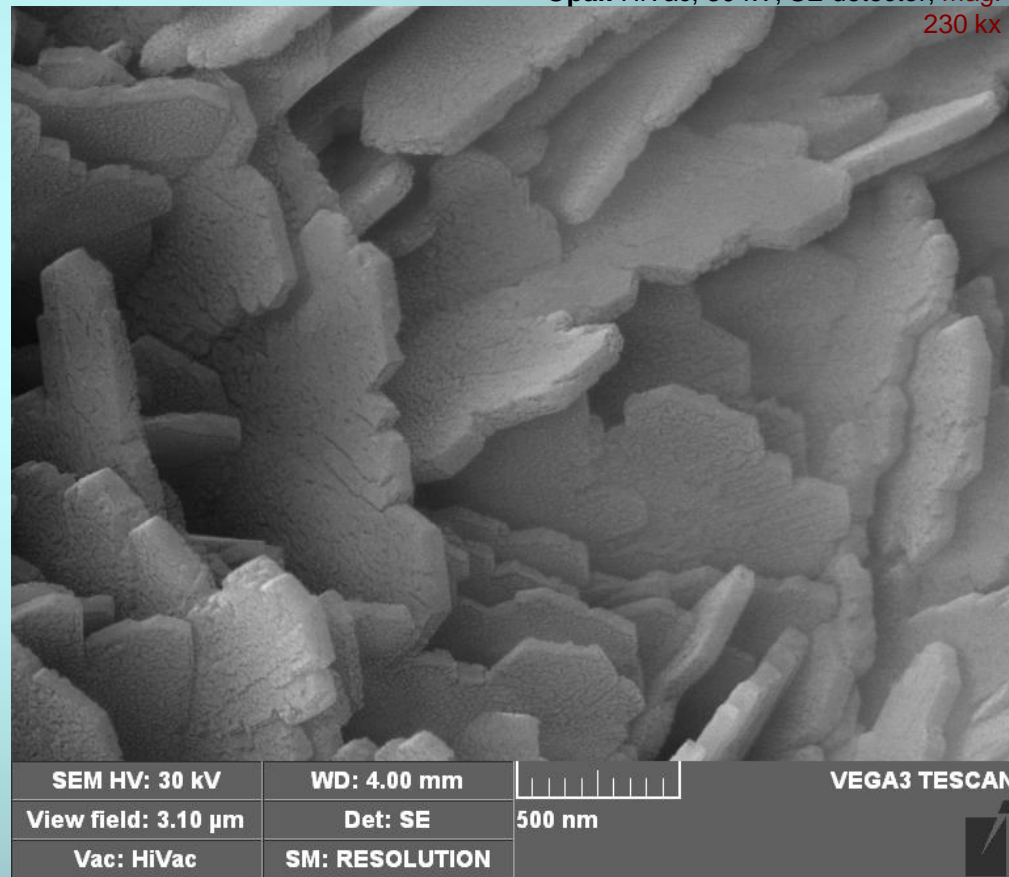
- achieving very low landing voltages down to 100 V
- reduced beam damage of sensitive samples
- much better resolution at low and ultra-low voltages  
1.5 nm @ 3 kV      < 2.0 nm @ 1 kV      2.5 nm @ 200 V



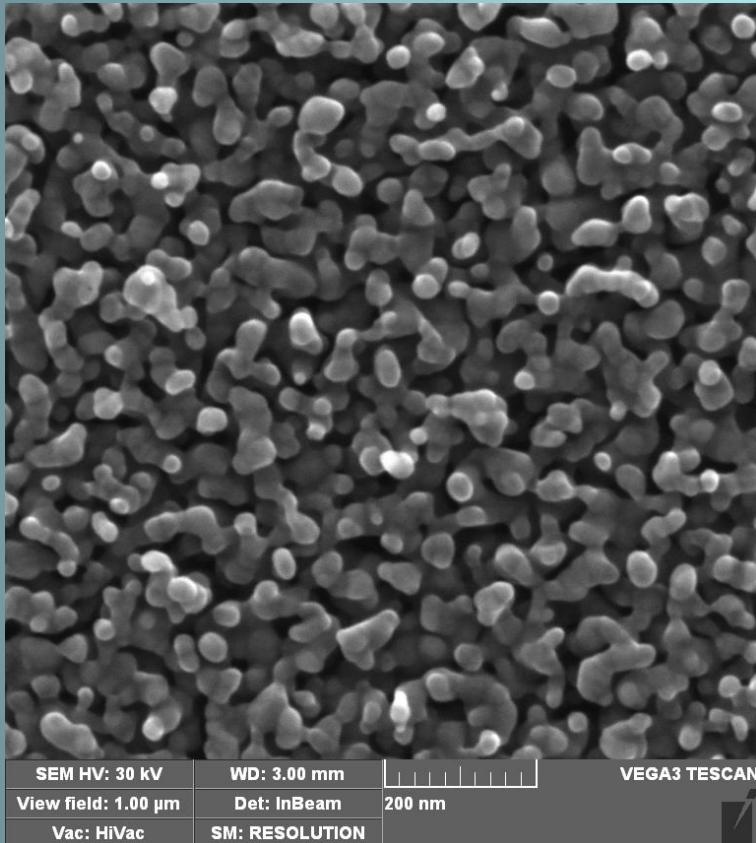
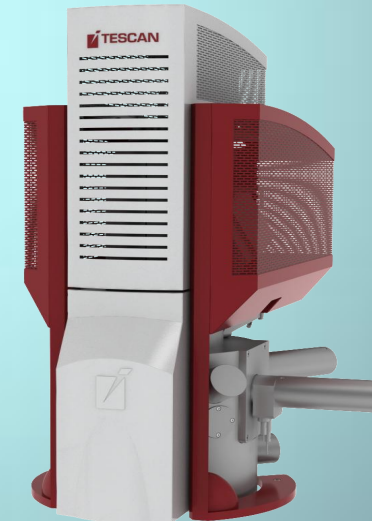




**Used AFM tip:** HiVac, 5 kV, SE detector



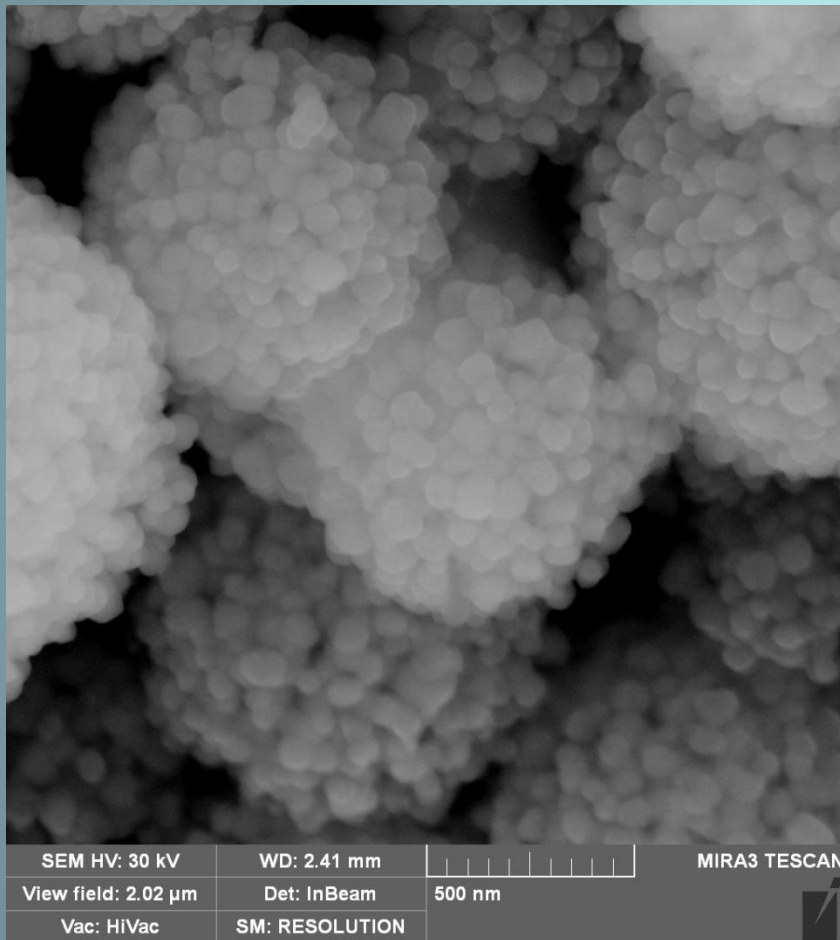
- Special detector position (in lens)
- Detects SE which are emitted back into the objective
- Allows specimen examination at very short working distance
- Outstanding resolution (1 nm at 30 kV, 2 nm at 3 kV)
- Available only for MIRA3 FEG-SEM



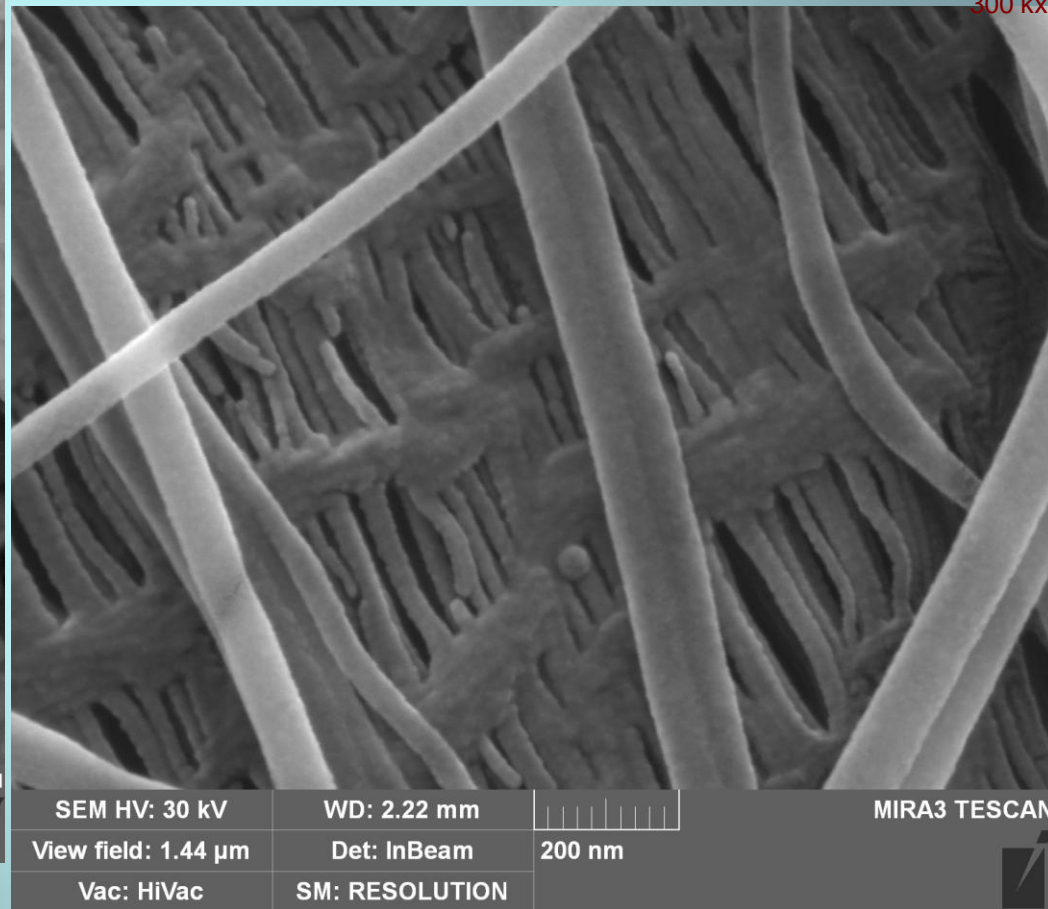
**Ag nanoclusters:** HiVac, 30 kV, In-Beam detector, mag. 217  
kx

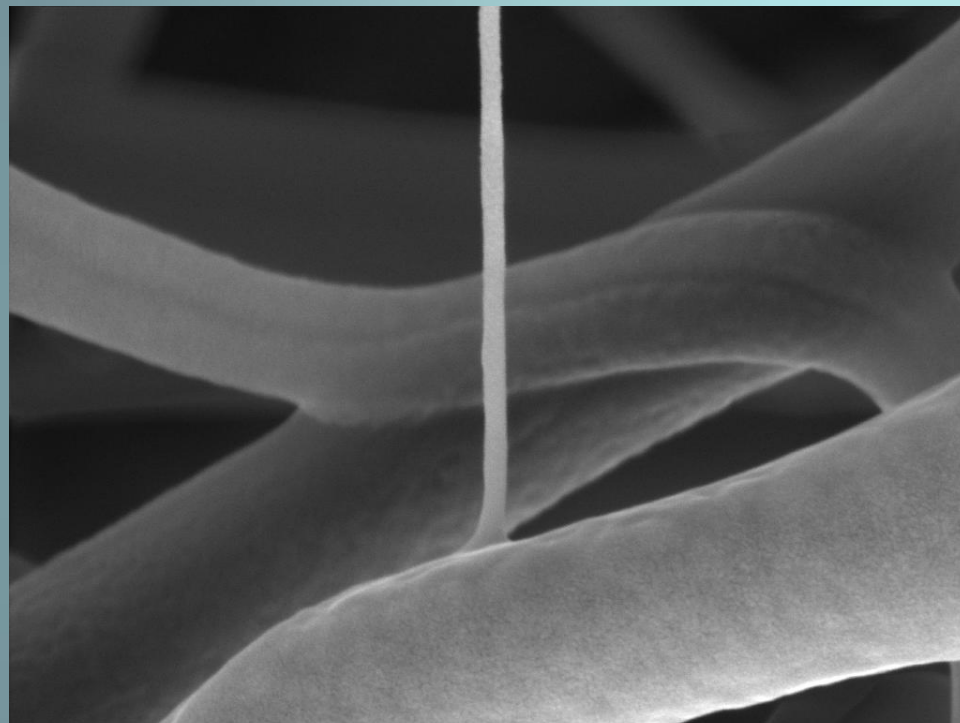


**Nanofibers (gold coated):** HiVac, 30 kV, In-Beam detector, **mag. 300 kx**



**CdTe nanostructures:** HiVac, 30 kV, In-Beam detector

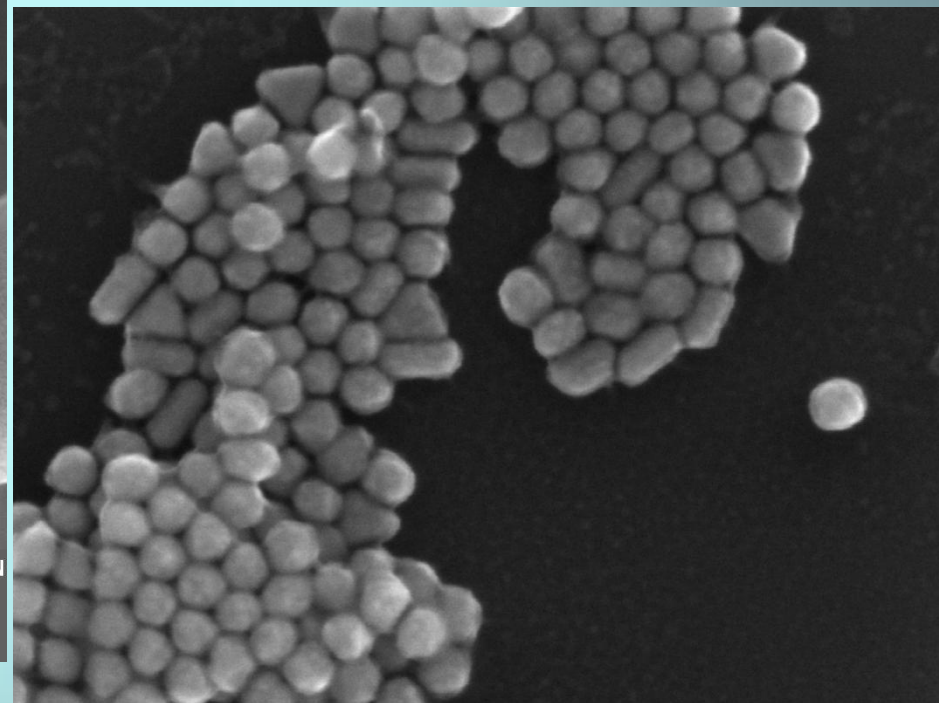




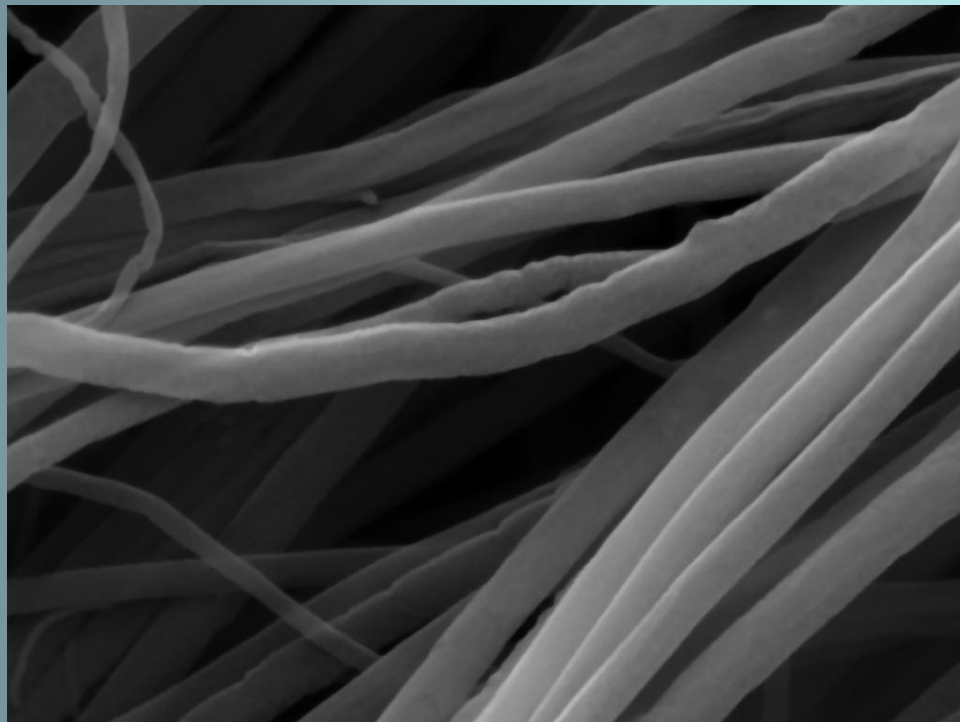
SEM HV: 5.0 kV	WD: 3.48 mm	1 $\mu$ m	MIRA3 TESCAN <b>TESCAN</b> PERFORMANCE IN NANOSPACE
View field: 3.37 $\mu$ m	Det: InBeam		
Vac: HiVac	SM: RESOLUTION		

**Nonwoven textile:** HiVac, 5 kV, In-Beam detector

**Golden nanoparticles:** HiVac, 30 kV, In-Beam detector, mag. 867 kx



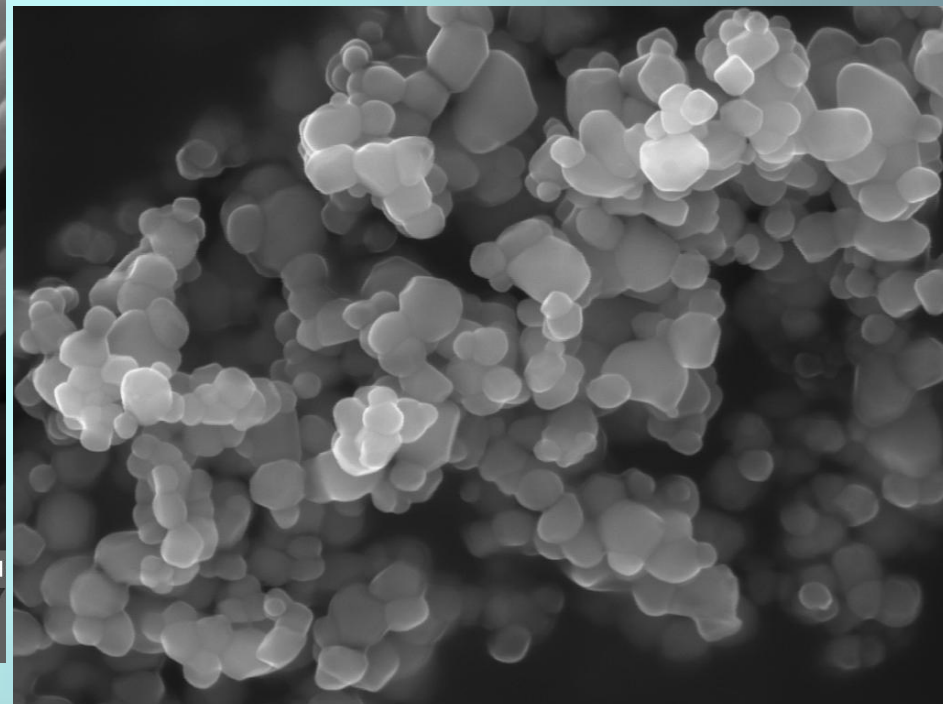
SEM HV: 30 kV	WD: 1.07 mm	200 nm	MIRA3 TESCAN <b>TESCAN</b> PERFORMANCE IN NANOSPACE
View field: 1.000 $\mu$ m	Det: InBeam		
Vac: HiVac	SM: RESOLUTION		



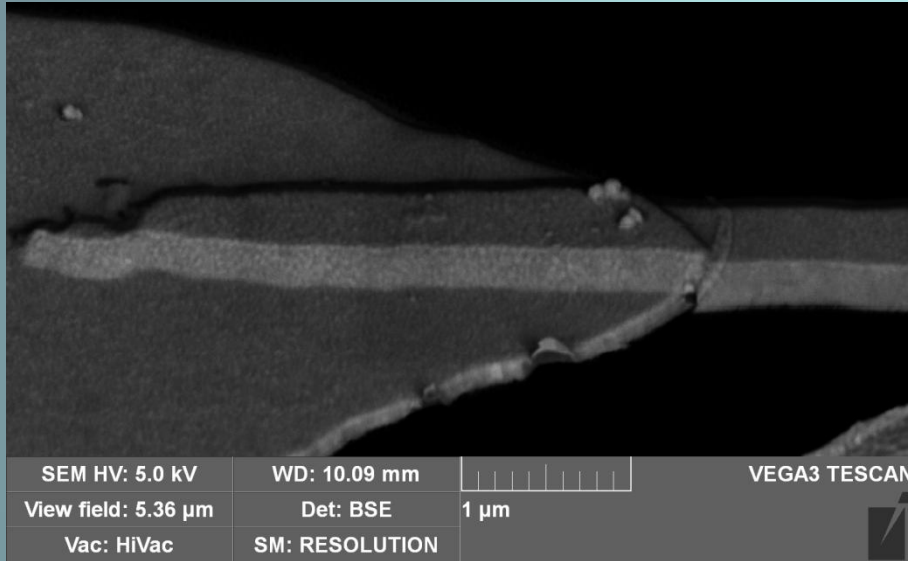
SEM HV: 15 kV	WD: 3.53 mm	 200 nm	MIRA3 TESCAN
View field: 1.53 $\mu$ m	Det: InBeam		
Vac: HiVac	SM: RESOLUTION		

**Carbon nanotubes (Pt coated):** HiVac, 30 kV, In-Beam detector,  
mag. 189 kx

**TiO:** HiVac, 15 kV, In-Beam detector



SEM HV: 15 kV	WD: 5.05 mm	 500 nm	MIRA3 TESCAN
View field: 2.81 $\mu$ m	Det: InBeam		
SEM MAG: 103 kx	SM: RESOLUTION		



**Semiconductor with metallic bridge:** HiVac, 5 kV, BSE detector

### YAG scintillator detector

- Equipped with first-class single-crystal YAG scintillator
- High efficiency – low noise
- Fast imaging rate
- High resolution (2 nm at 30 kV)
- High sensitivity and atomic number resolution (0.1 Z)
- Retractable (manual/motorized) version

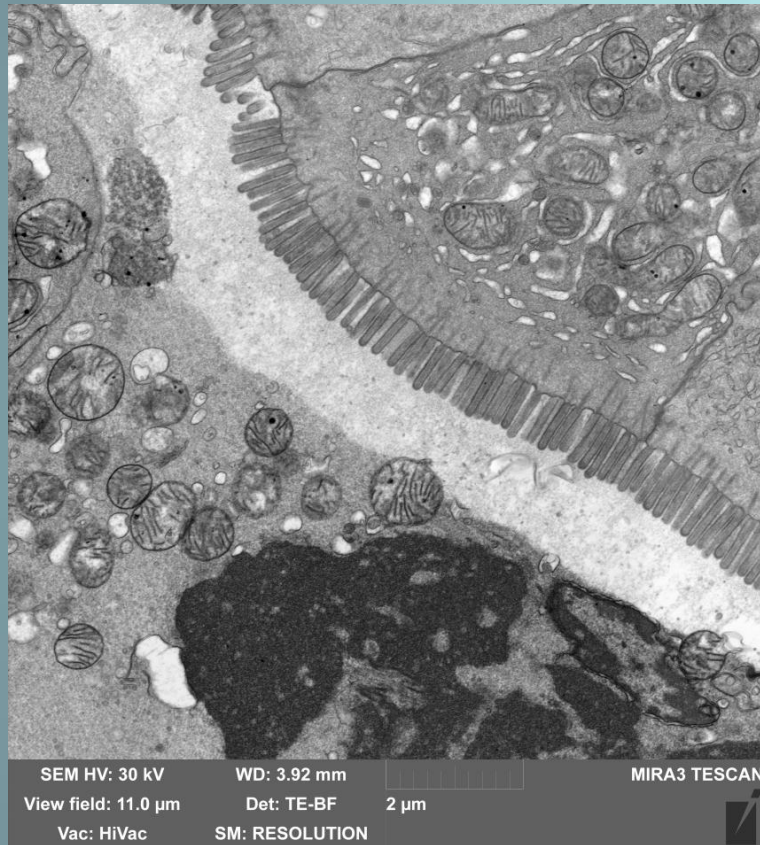


### 4-Quadrant semiconductor detector

- It can achieve signal from 4 quadrants separately and/or mix them
- Used to get both compositional and topographical contrast

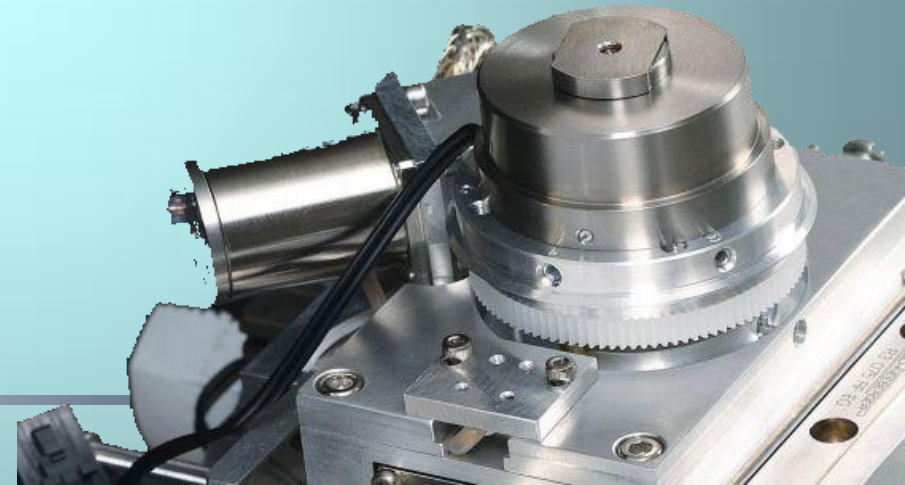


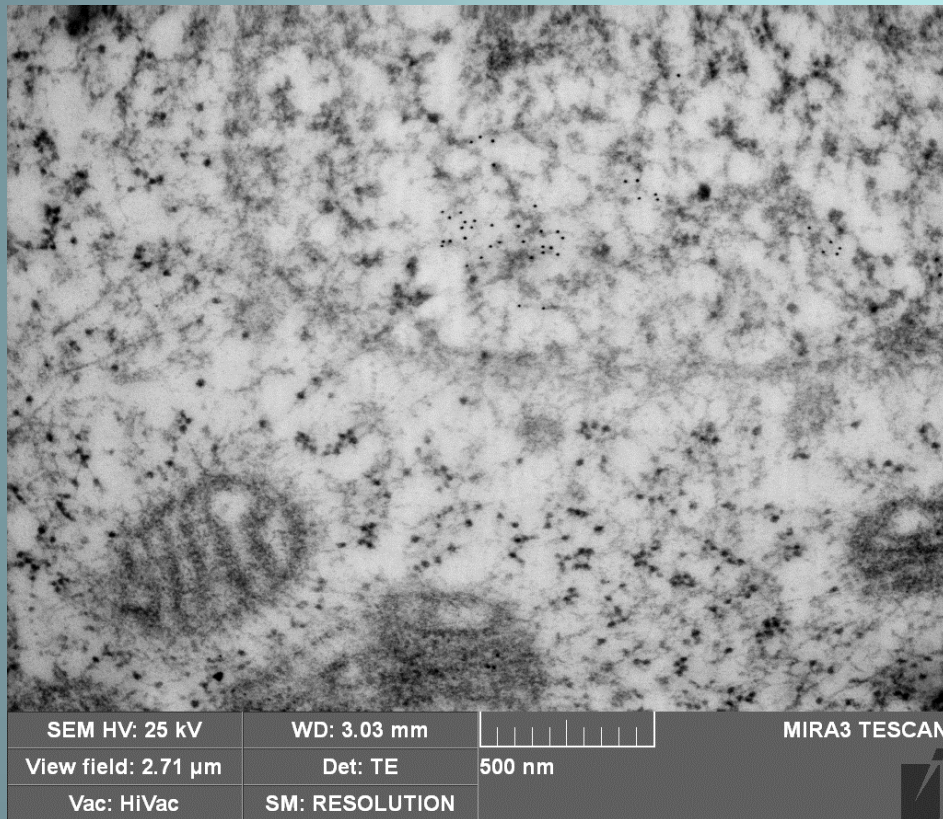




**Cross section of the rat intestine:** HiVac, 30 kV, STEM detector (bright field)

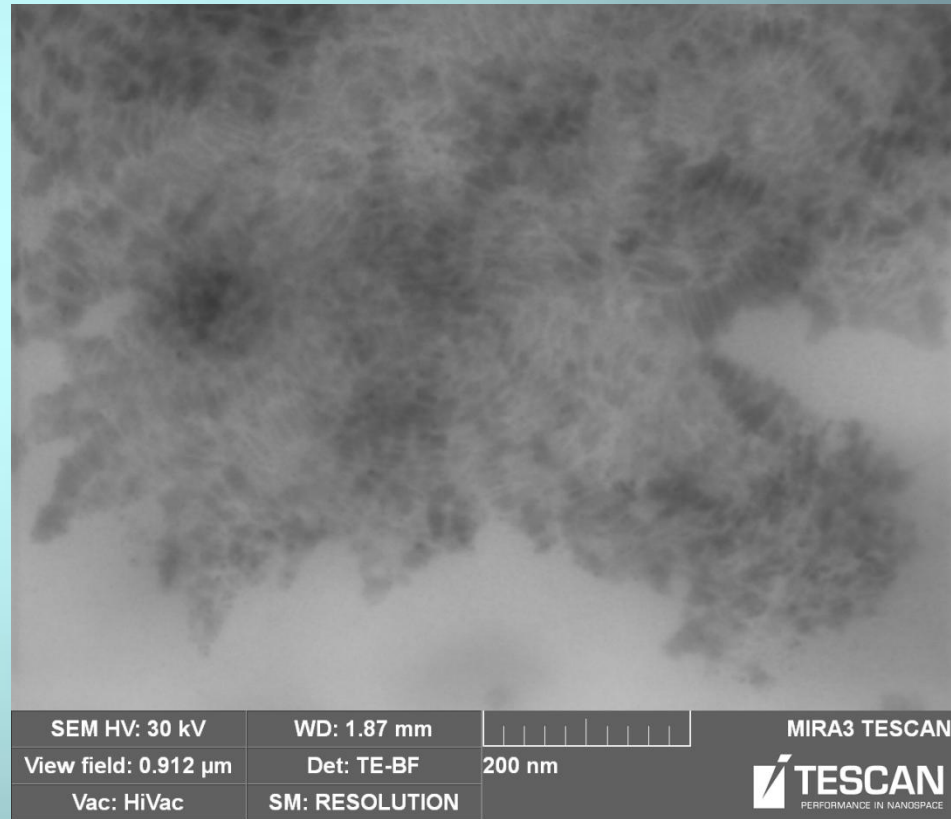
- Ultrastructure of samples observed in SEM
- Suitable for life science, material science, nanotechnology, etc.
- High magnification
- High resolution (0,8 nm at 30 kV)
- Sample preparation techniques same as for TEM
- Good contrast of images achieved without staining
- Simultaneous dark field and bright field imaging

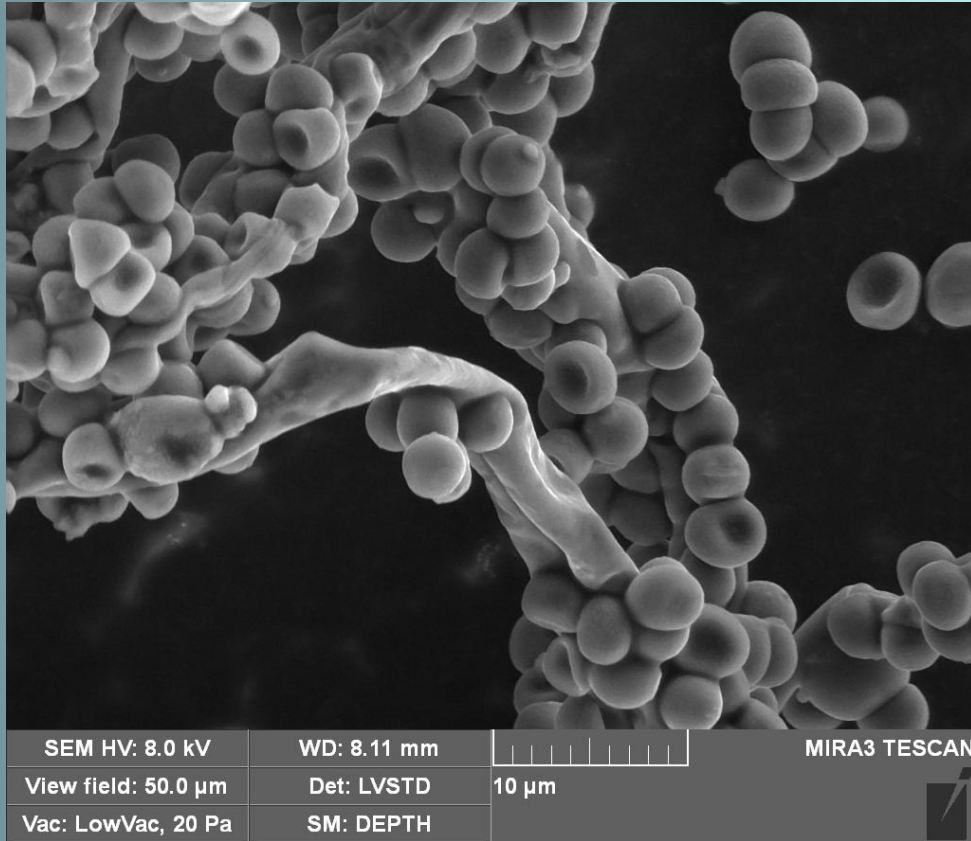




**Immunolabeling (10 nm gold nanoparticles):** HiVac, 25 kV, STEM detector (bright field)

**Ash:** HiVac, 30 kV, STEM detector (bright field), mag. 396 kx





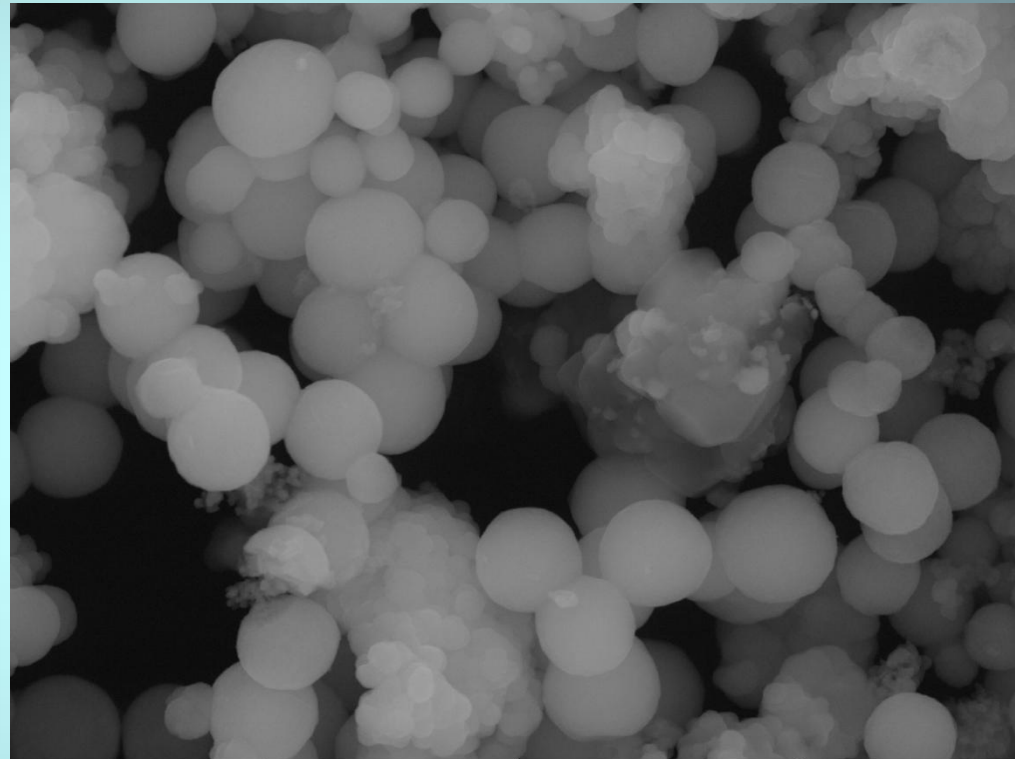
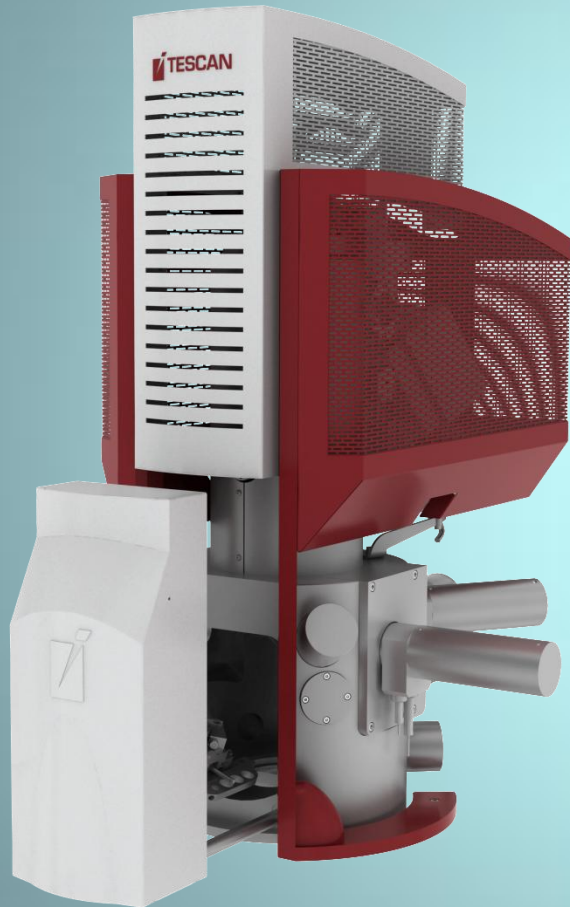
**Blue- green mold (*Penicillium Roqueforti*):** UniVac, 20 Pa, Water Vapor, -36° C,  
20 kV, LVSTD

Value & Excellence in SEMs

- Original design
- Convenient for non-conductive samples investigation
- Modified Everhart-Thornley design  
- patented by TESCAN
- True secondary electron detecting  
in low vacuum condition
- Microlens differential barrier



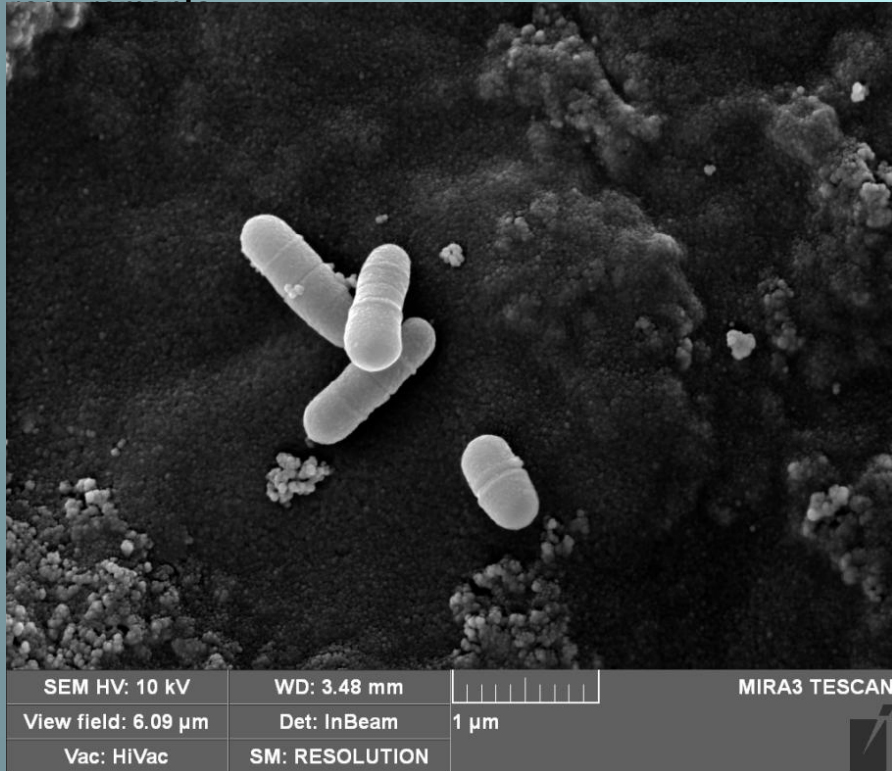




SEM HV: 30 kV	WD: 3.97 mm		MIRA3 TESCAN
View field: 7.20 $\mu\text{m}$	Det: SE		
Vac: HiVac	SM: RESOLUTION		



Please contact us if you have any questions about analyses or further



*Streptococcus mutans* (gold coated): HiVac, 10 kV, In-beam detector



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tel: +420 547 130 414

