Instrumentation and methodology of Scanning Photoemission Microscopy, analyzers and multichannel detection

Luca Gregoratti

Sincrotrone Trieste SCpA, Area Science Park, SS14-Km163.5, 34012 Trieste, Italy

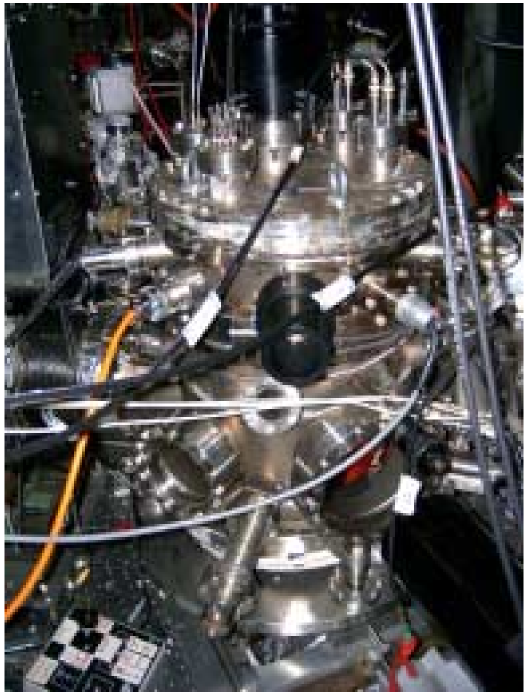
email: luca.gregoratti@elettra.trieste.it

Outline:
ingredients of a Scanning Photoemission Microscope (SPEM) based on Zone Plates

- Vacuum chambers
- Sample and optics manipulators
- Sample holders
- Electron analyzers
- Electron detectors

Vacuum chambers

- No standard geometry
- Dimensions depends mainly from the size of the manipulators
- Large flanges for the manipulators (>CF200)
- Geometry limits the possibility of in-situ experiments



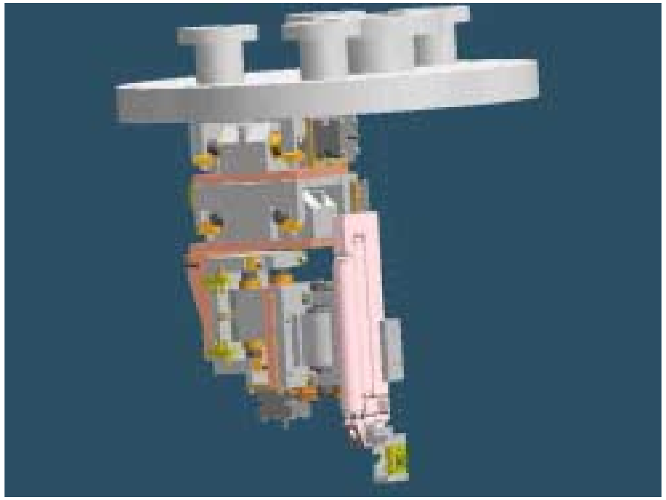
Manipulators

Sample

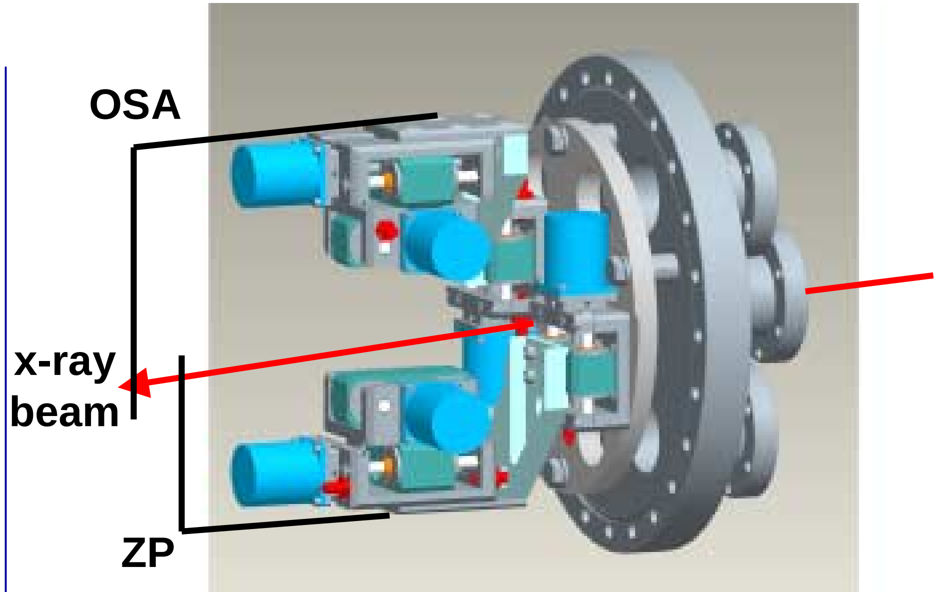
- Large scanning range (>1mm) with large steps (1-100 μm)
- Small scanning range (<3mm) with small steps (10-50 nm)
- The most common choice is to use two kind of motors: stepper (for large scans) and piezo (for small scans)
- Compact design to improve the stability

Optics (ZP+OSA)

- 6-axis needed: 3 for the ZP and 3 for the OSA
- Typical range: 10 - 15 mm
- Movement resolution of 1-3 μm
- Only one type of motors needed (stepper or inchworm)
- Compact design to improve the stability



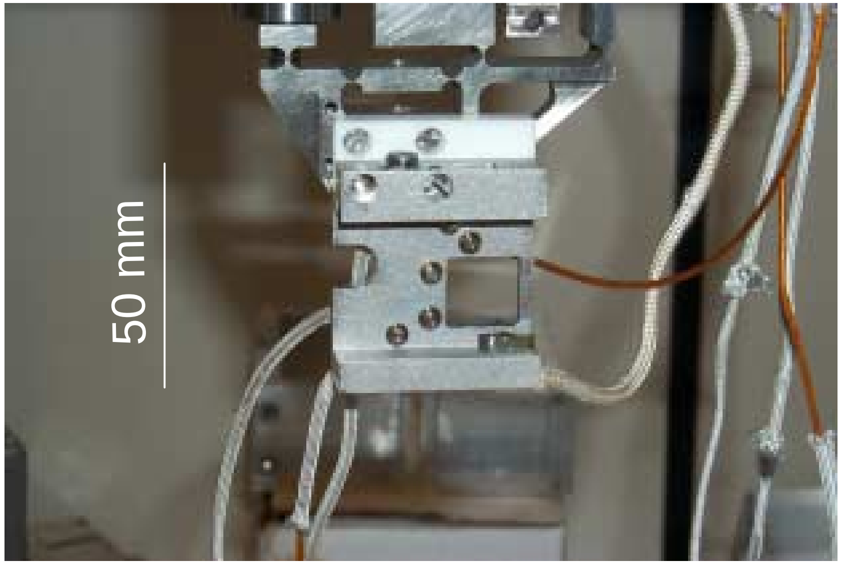
x-y piezo stages

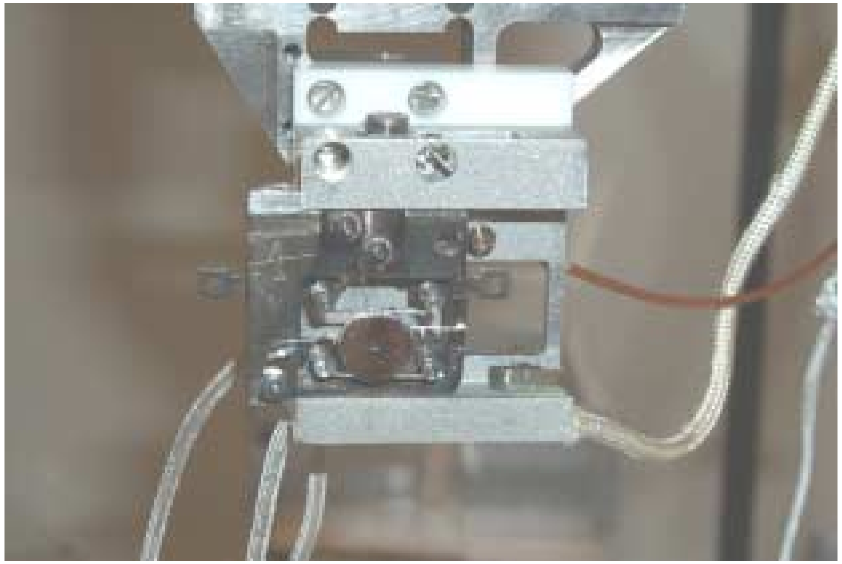


1 axis coarse translation stage

Sample holders

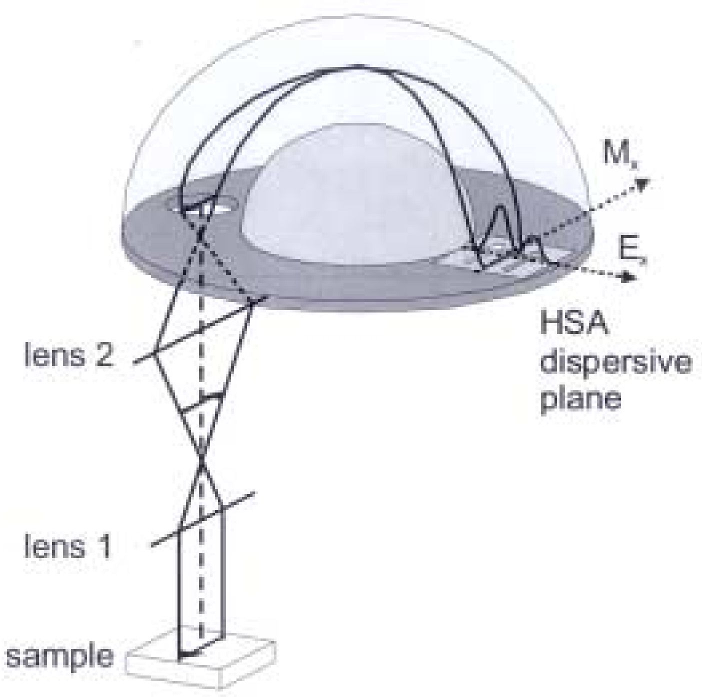
- Cabling used for the contacts (heating, grounding, potentials, etc.) must not interfere with the scanning motion.
- Cooling needs special design
- In most of the cases sample holders are home designed (or modified from standard designs)



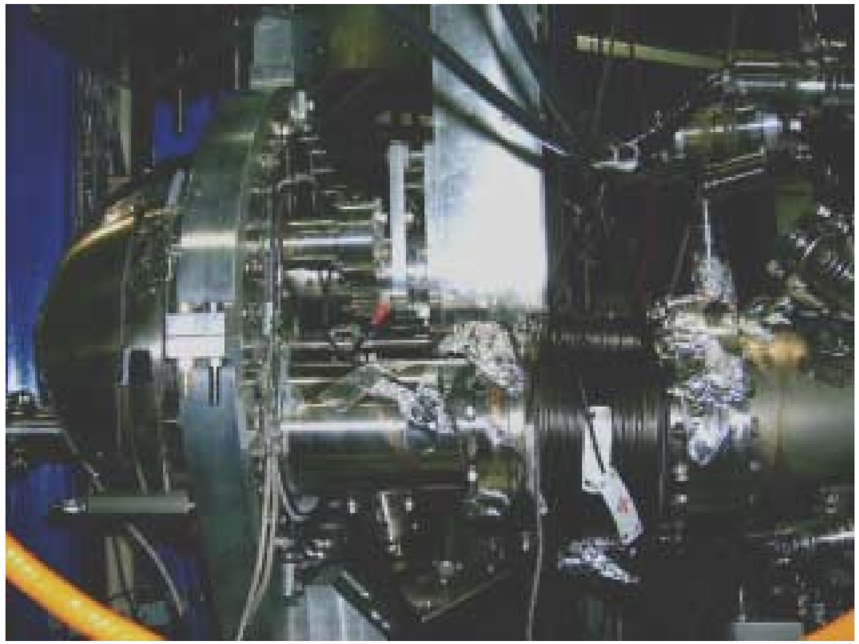


Electron analyzers

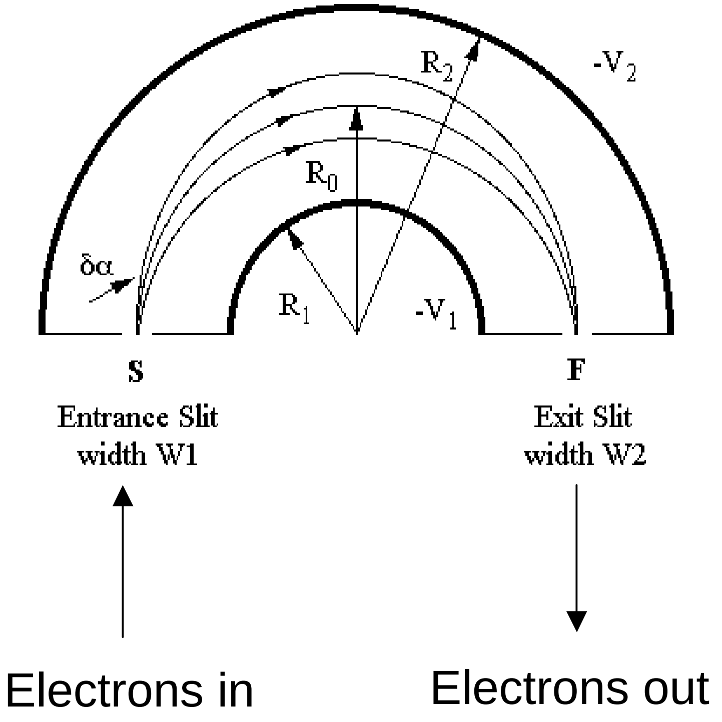
- The most used type of electron analyzer is the Hemispherical Electron Analyzer (HEA)
- Due to geometrical constrains the detection in mainly grazing



Electron analyzer of the SPEM



Potential along the median surface: $V_0 = \frac{V_1 R_1 + V_2 R_2}{2R_0}$



Tangential injection

$$V_1 = V_0 \frac{R_2}{R_1} \qquad V_2 = V_0 \frac{R_1}{R_2}$$

$$E_0 = eV_0$$

Angled injection

$$\Delta R = 2 R_0 \left[\frac{\Delta E}{E} - (\delta\alpha)^2 \right]$$

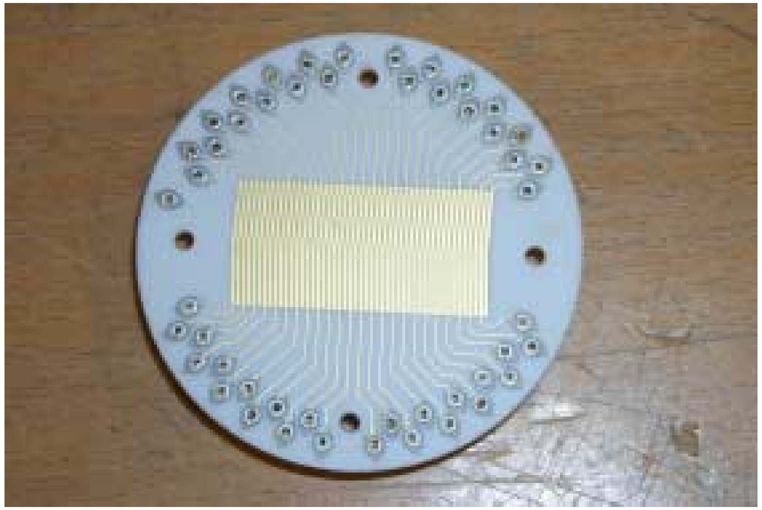
Electron detectors

Single channel

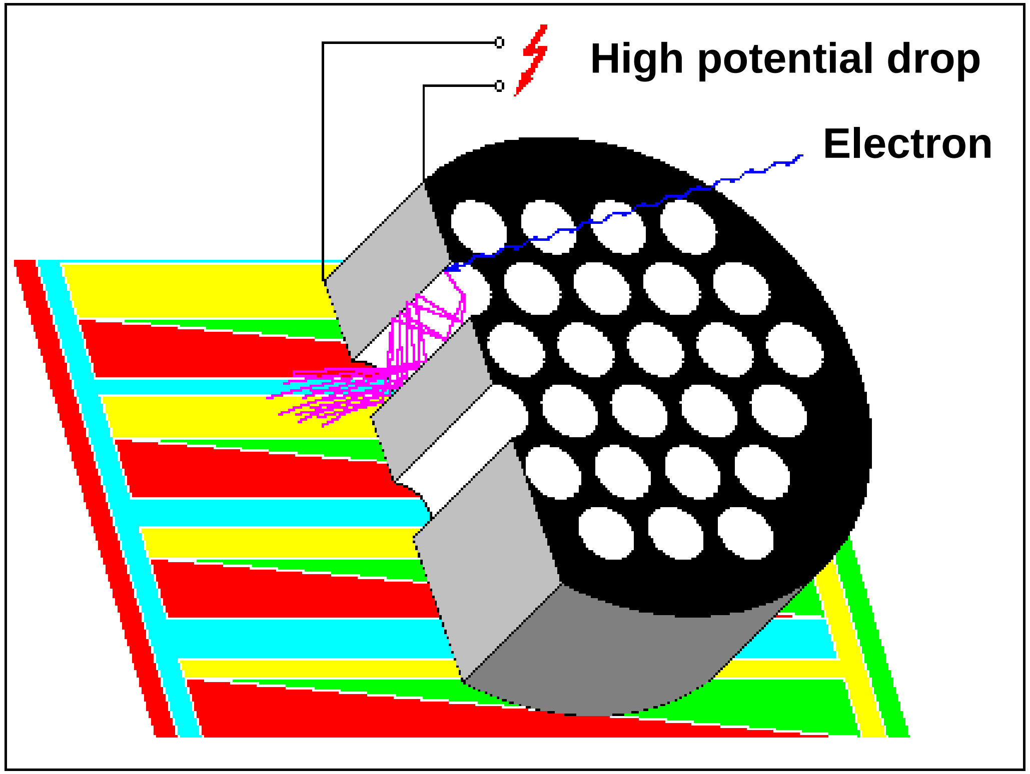
- Single channeltron
- Single Au plated anode
- Not very diffused

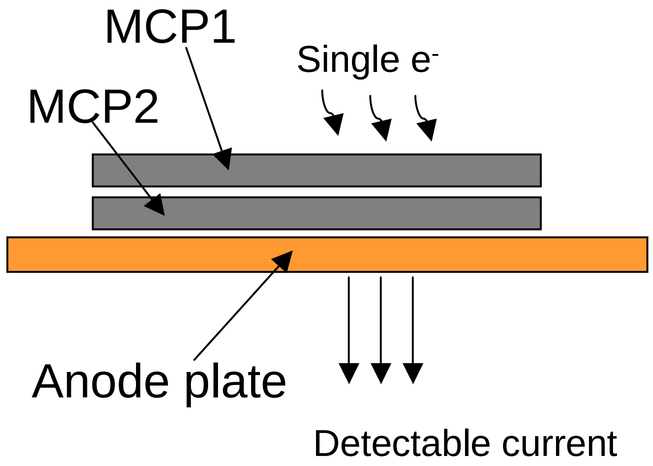
Multi channel

- Array of channeltron (low number of channels)
- Multi Au plated anodes (100 channels)
- 2D-CCD detectors



Electron detectors based on micro channel plates





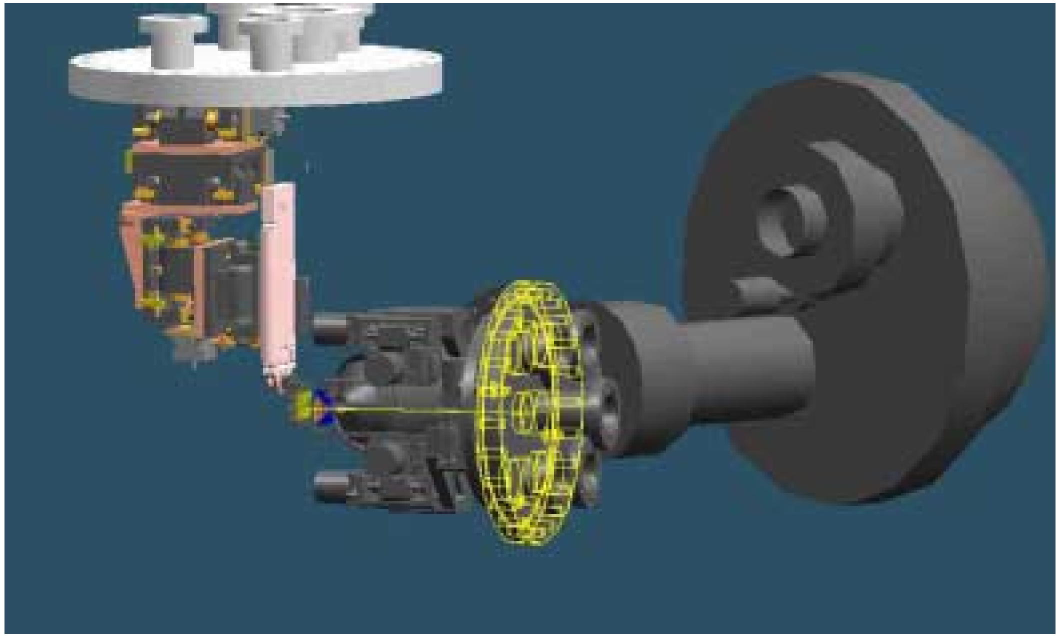
The Microchannel Plate (MCP) consists of millions of very-thin, conductive glass capillaries (4 to 25 micro meters in diameter) fused together and sliced into a thin plate. Each capillary or channel works as an independent secondary-electron multiplier to form a two-dimensional secondary-electron multiplier.

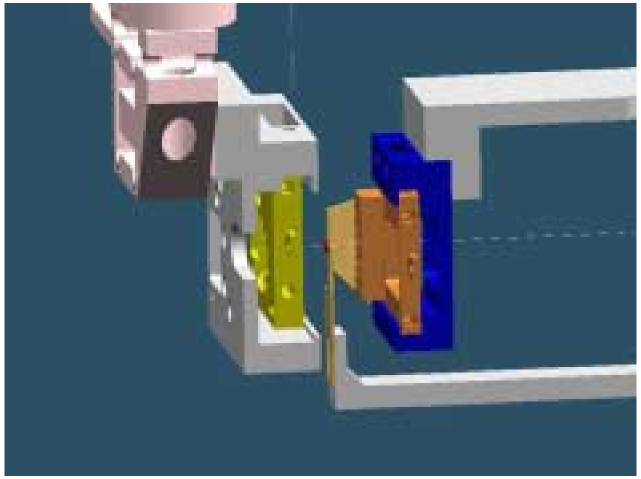
Vacuum compatible condensor

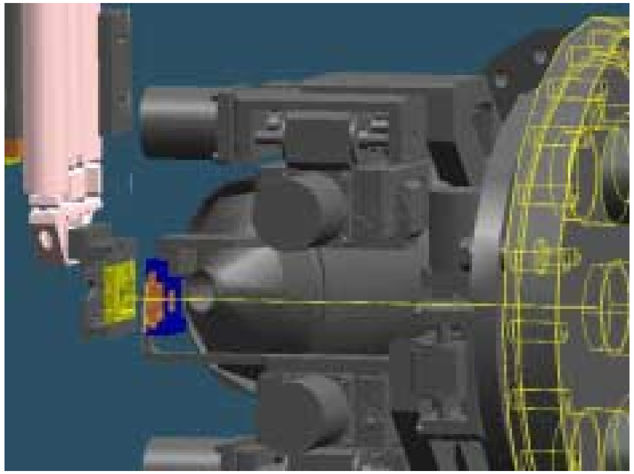
Electron Detector Electronics

- Discriminators
- Preamplifiers
- Counters

Final layout of the experimental chamber

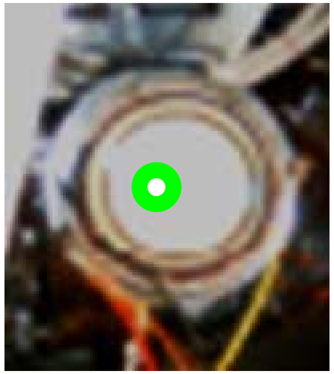


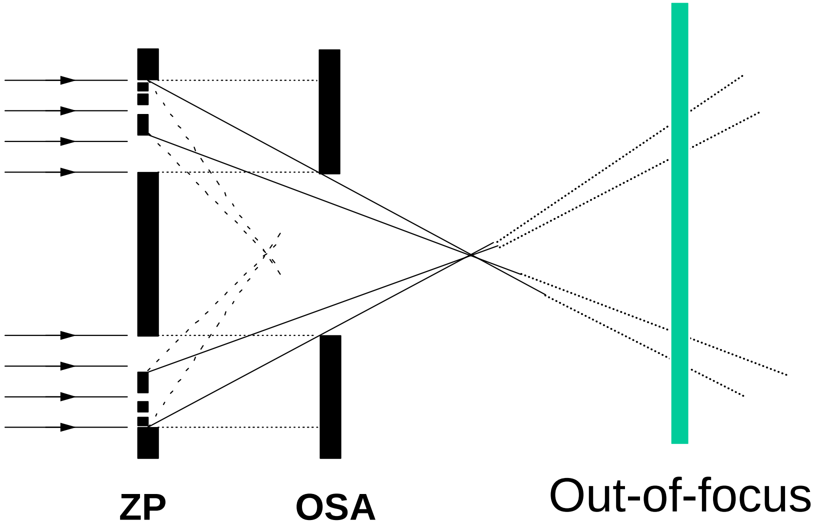




Start-up of an experiment

1. Optics alignment

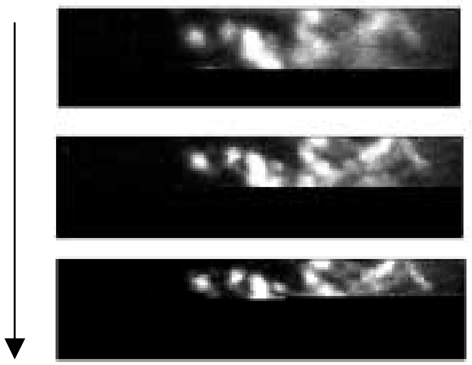


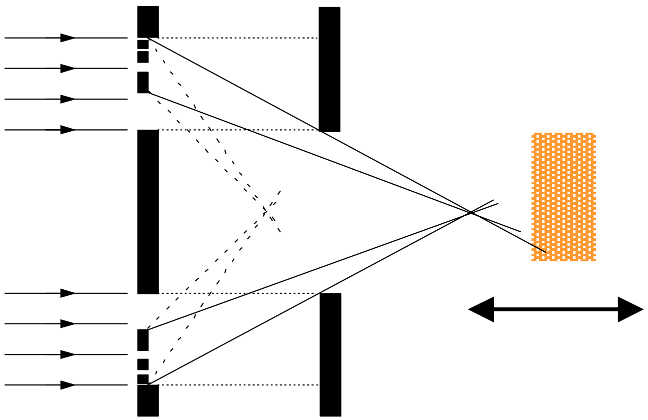


2. Sample on the x-ray focus

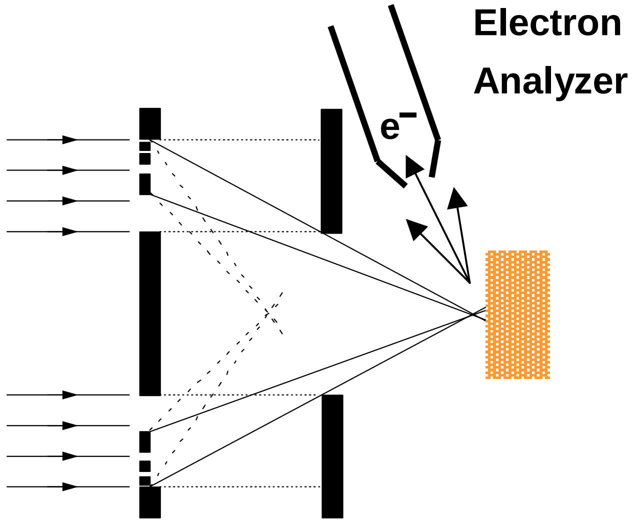
$$DOF = \frac{\delta r}{D} f_m$$

Typical: 5-15μm





3. Analyzer adjustment



4. Data acquisition

- Images: electron analyzer set to a fixed energy and sample rastered
- Photoemission Spectra: sample fixed and energies scanned

References

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