

THEMATIC RESEARCH FOCUS

Research area

- Electron and ion optics
- Electron optical design and simulations
- Design of detection systems in electron and ion optical instruments
- Simulations of ion and electron sources

Excellence

- Electron and ion optical simulation of nonstandard systems and aberration corrected systems

Mission

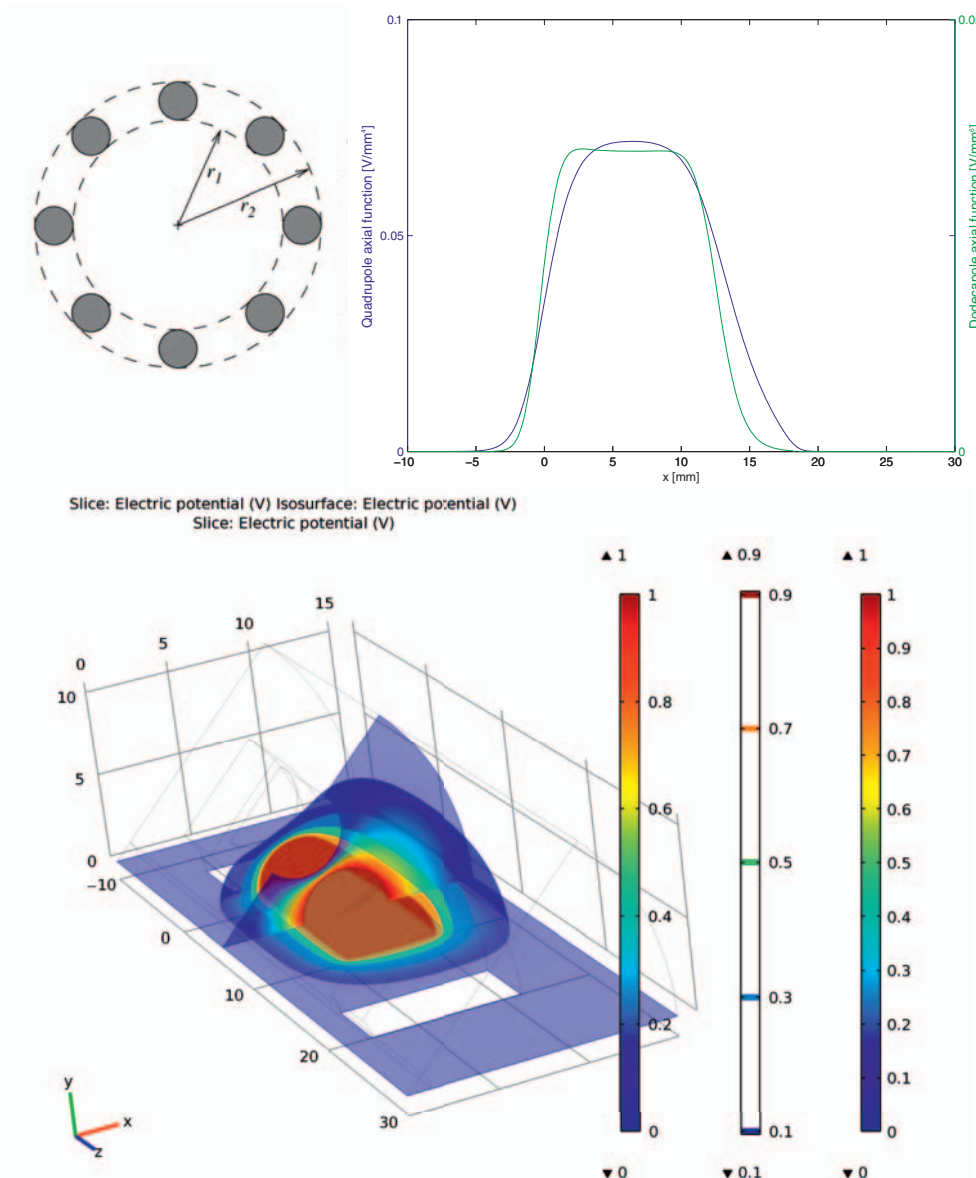
- Development of new computations methods in electron and ion optical systems
- Simulation and design of nonstandard electron and ion optical systems

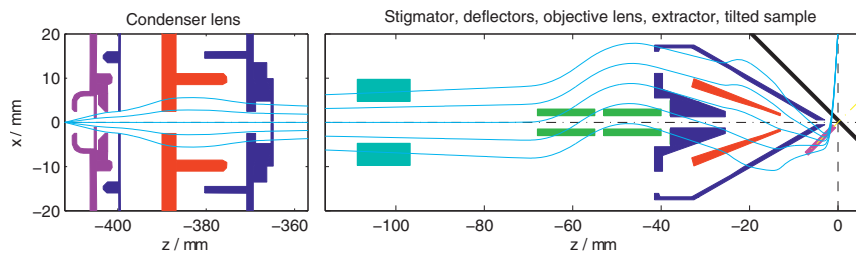
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 of the CAS v.v.i.**

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3D field of a stigmator





UP-TO-DATE ACTIVITIES

Research orientation

- Calculations of high order aberrations by regression or by differential algebraic method
- Current density profiles with and without diffraction
- Space charge and stochastic Coulomb interactions
- Simulation of interaction of electron with gas molecules

Main capabilities

Basic research

- Exploring the resolution limits of electron and ion optical systems due to aberrations, Coulomb interaction and diffraction
- Simulations of the electron and ion source properties
- Analysis and correction of parasitic aberrations in general optical columns including aberration-corrected systems

Applied research

- Design of electron and ion optical instruments
- Development of software for simulation of non-standard electron and ion optical systems

Sub-fields of group activities

- Electron optics and electron microscopy
- Ion mass spectroscopy and electron spectroscopy (ToF, energy-dispersive)
- Signal electron and X-ray detector optimisation

KEY RESEARCH EQUIPMENT

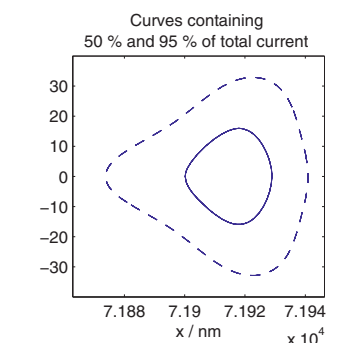
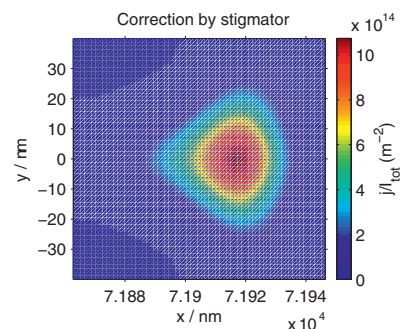
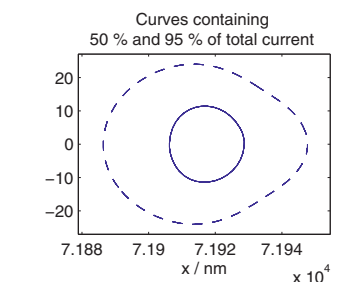
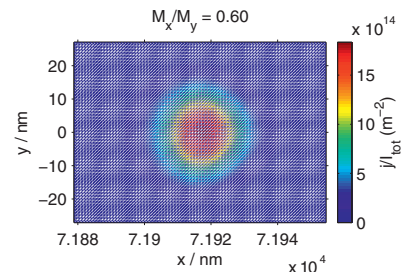
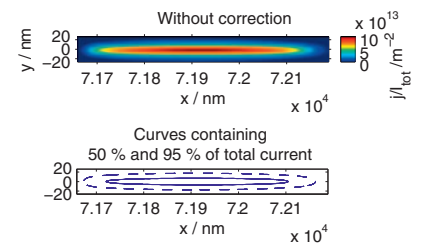
List of devices

Software for simulation of electron and ion optical systems that has been developed at ISI.

ACHIEVEMENTS

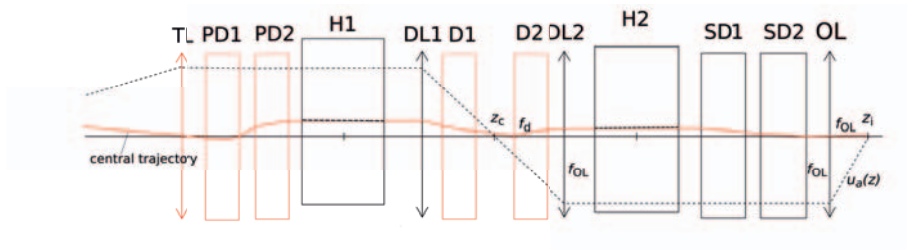
■ Simulation of nonstandard electron and ion optical systems (electron mirror, extraction optics of Time of Flight detectors, Wien Filter with permanent magnets, general 3D optical systems), correctors and misalignment aberrations

- M. Oral, T. Radlička, B. Lencová: "Effect of sample tilt on Photo Emission Electron Microscopy resolution", *Ultramicroscopy* **119**, 45–50, 2012
- M. Oral, B. Lencová: "Correction of sample tilt in FIB instruments", *Nucl Instrum Meth A*. **645**, 130–135, 2011

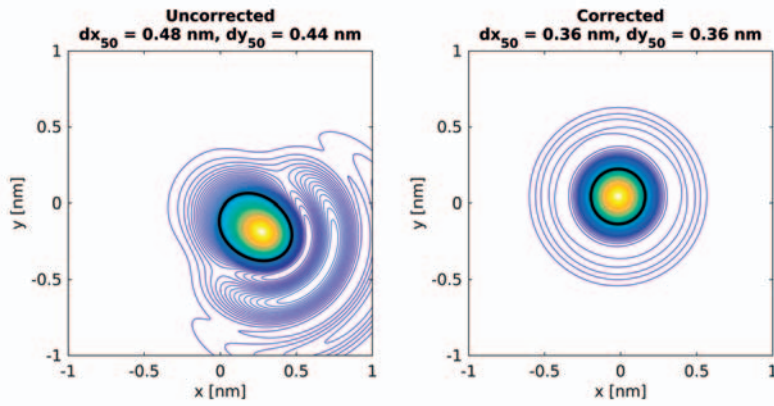


Corrections of sample tilt SIMS

Analysis and correction of parasitic aberrations of a hexapole corrector of spherical aberration

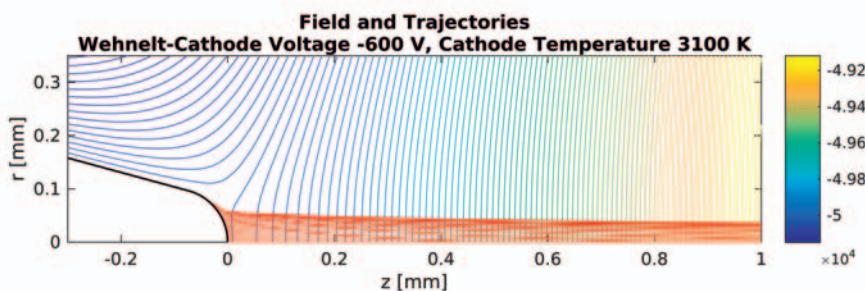
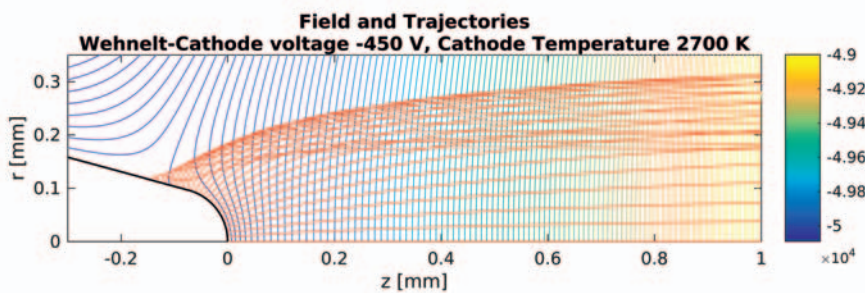
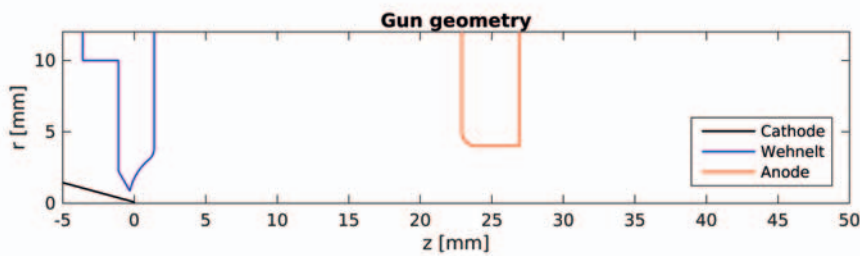


Doublet lenses ellipticity: $1\mu\text{m}, (0.57+0.48i)\mu\text{m}$

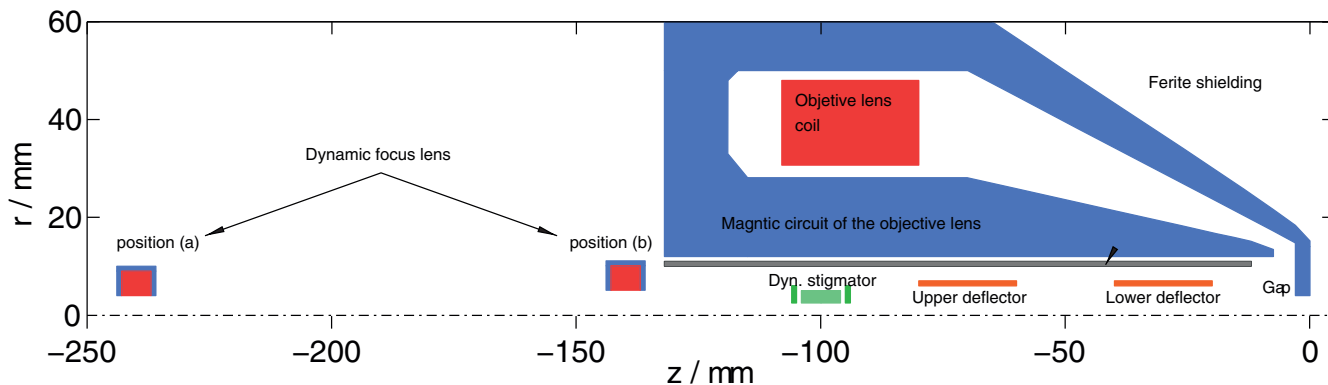


Exploring the resolution limits of low-energy SEM and corrected Transmission SEM including design of correctors and parasitic aberration analysis.

- T. Radlička: "Wave Optical Calculation of Probe Size in Low Energy Scanning Electron Microscope"; *Microscopy and Microanalysis* **21**, S4, 212–217, 2015



Space-charge-limited thermionic emission



■ Design of low-energy environmental SEM with dynamically corrected deflection systems

- M. Oral, V. Neděla, G. Danillatos: "Dynamic Correction of Higher-Order Deflection Aberrations in the Environmental SEM"; *Microscopy and Microanalysis* **21**, S4, 194–199, 2015

■ Simulation of thermionic electron sources with space-charge-limited emission.

- J. Zelinka, M. Oral, T. Radlička: "Simulation of Space Charge Effects in Electron Optical System Based on the Calculations of Current Density"; *Microscopy and Microanalysis* **21**, S4, 246–251, 2015

Design of a low-energy environmental SEM objective lens with a dynamically corrected deflection system

MAIN COLLABORATING PARTNERS

Collaboration with academic partners

Brno University of Technology (Brno, CZ)
Technische Universität Wien (Vienna, A)

Collaboration with companies

FEI CR (Brno, CZ); now Thermo-Fisher Scientific
Delong Instruments, a.s. (Brno, CZ)
Nion Company, (Kirkland, USA)

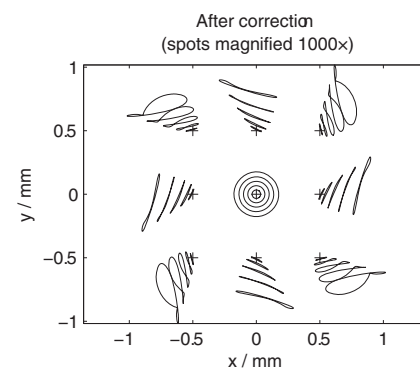
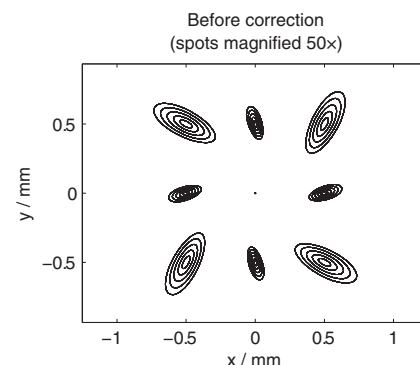
EXPECTATIONS

Offers

- Partnership in international projects
- Design of electron and ion optical systems
- Simulation and design of electron and ion sources
- Computationally intensive calculations of acceptance diagrams for description of contrast mechanism including Monte-Carlo simulation of signal electron emission
- Consulting in the field of charge particle optics

Requirements

Collaboration with industrial partners in projects dedicated to charged particle optics.
Collaboration with academic partners on development of custom instruments using charged particles.



Deflection aberration patterns without and with dynamic corrections