Group of Electron Optics
Department of Electron Microscopy

Institute of Scientific Instruments AS CR, v.v.i.

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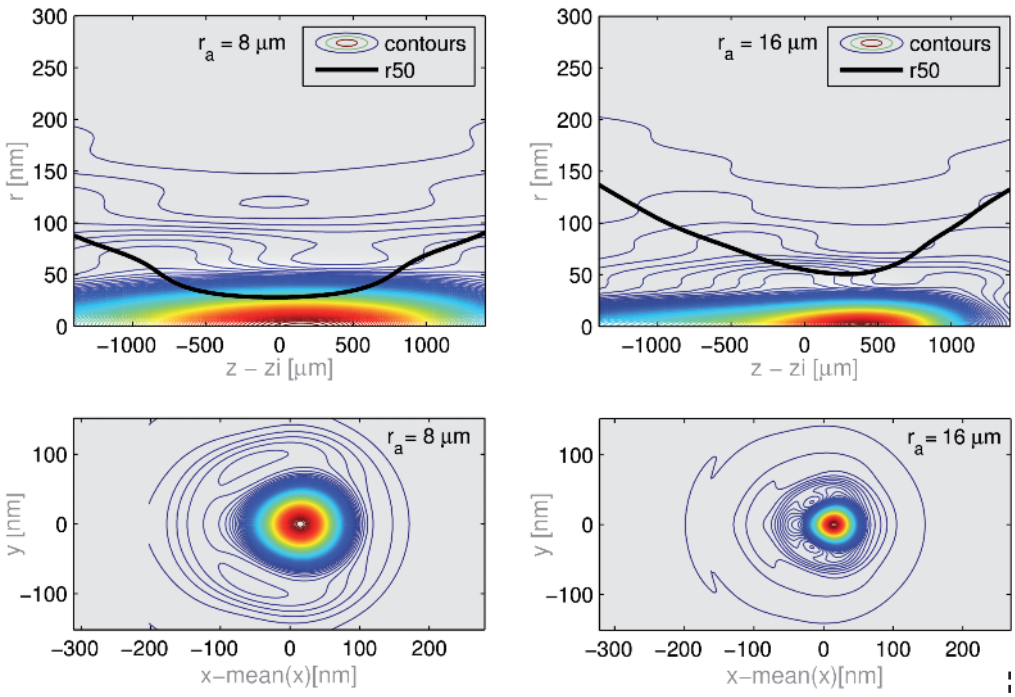
THEMATIC RESEARCH FOCUS

Research area
– Electron and ion optics
– Electron optical design and simulation
– Design of detection systems
– Simulation of ion and electron sources

Excellence
– Electron and ion optical simulation of nonstandard systems

Mission
– Development of new simulation methods in electron and ion optical systems
– Simulation and design of nonstandard electron and ion optical systems



Beam profiles with diffraction

DEVELOPED TECHNOLOGIES

Content of research
– Calculations of higher-order aberrations and current density profiles
– Space charge and stochastic Coulomb interactions
– Simulation of interaction of electrons with gas molecules

Main capabilities

Basic research

– exploring the resolution limits of electron and ion optical systems due to aberrations, Coulomb interactions and diffraction
– simulation of the electron and ion source properties

Applied research

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

Fields of research results application

– Charge particle optics
– Ion mass spectroscopy
– Materials science

KEY RESEARCH EQUIPMENT

Software for simulation of electron and ion optical systems developed at the ISI

ACHIEVEMENTS

Simulation of Coulomb interactions in electron and ion optical systems including the region in the vicinity of emitting surfaces and their influence on beam properties and resolution of the system.

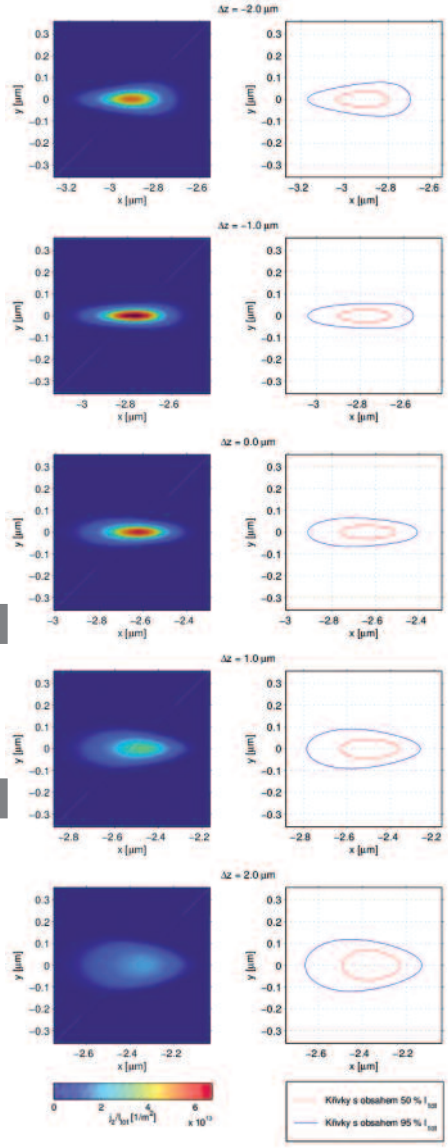
– Radlička, T., Lencová, B., *Coulomb interactions in GaLMIS*. Ultramicroscopy 108, (2008), p. 445–454
– Jansky, P., Zlámal, J., Lencová, B., Zobač, M., Vlček, I., Radlička, T., *Numerical simulations of the thermionic electron gun for electron-beam welding and micromachining*. Vacuum 84, (2009), p. 357–362
– Radlička, T., Lencová, B., *Influence of clusters on BiLMIS properties*. Nucl. Instrum. Meth. A, 645, (2011), p. 124–129

Calculation of higher-order aberrations of electron and ion optical systems, calculation of current density beam profiles

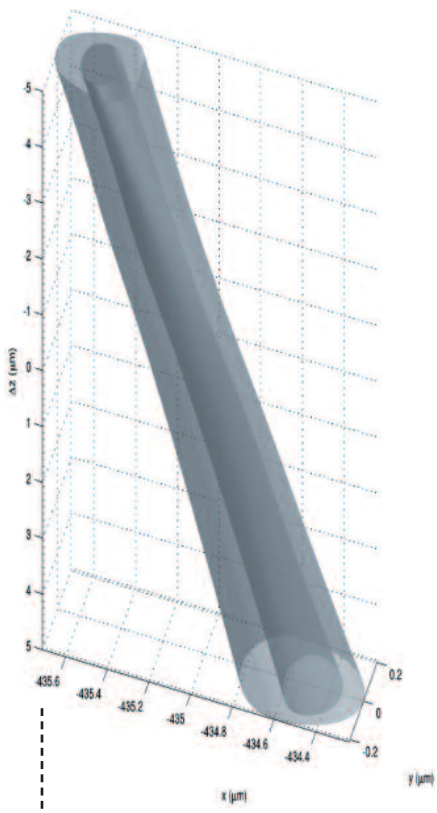
– Radlička, T., *Lie Algebraic Methods in Charged Particle Optics*. Adv. in Imagin. Electr. Phys. 151, (2008), p. 241–362
– Radlička, T., Lencová, B., *Determination of analytical expansion from numerical field data*. Ultramicroscopy 110, (2010), p. 1198–1204
– Oral, M., Lencová, B., *Calculation of aberration coefficients by ray tracing*. Ultramicroscopy 109, (2009), p. 1365–1373

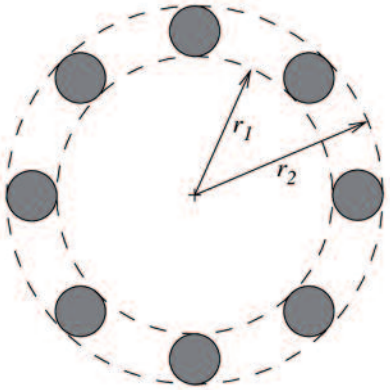
Simulation of nonstandard electron and ion optical systems (electron mirror, extraction optics of Time-of-Flight detectors, Wien Filter with permanent magnets, general 3D optical systems), correctors and misalignment aberrations

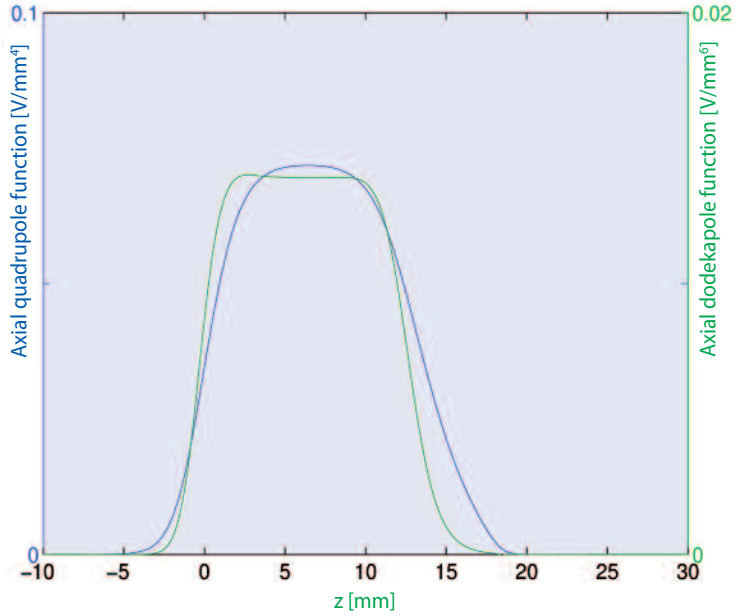
– Oral, M., Radlička, T., Lencová, B., *Effect of sample tilt on Photo Emission Electron Microscopy resolution*. Ultramicroscopy 119, (2012), p. 45–50
– Oral, M., Lencová, B., *Correction of sample tilt in FIB instruments*. Nucl. Instrum. Meth. A 645, (2011), p. 130–135



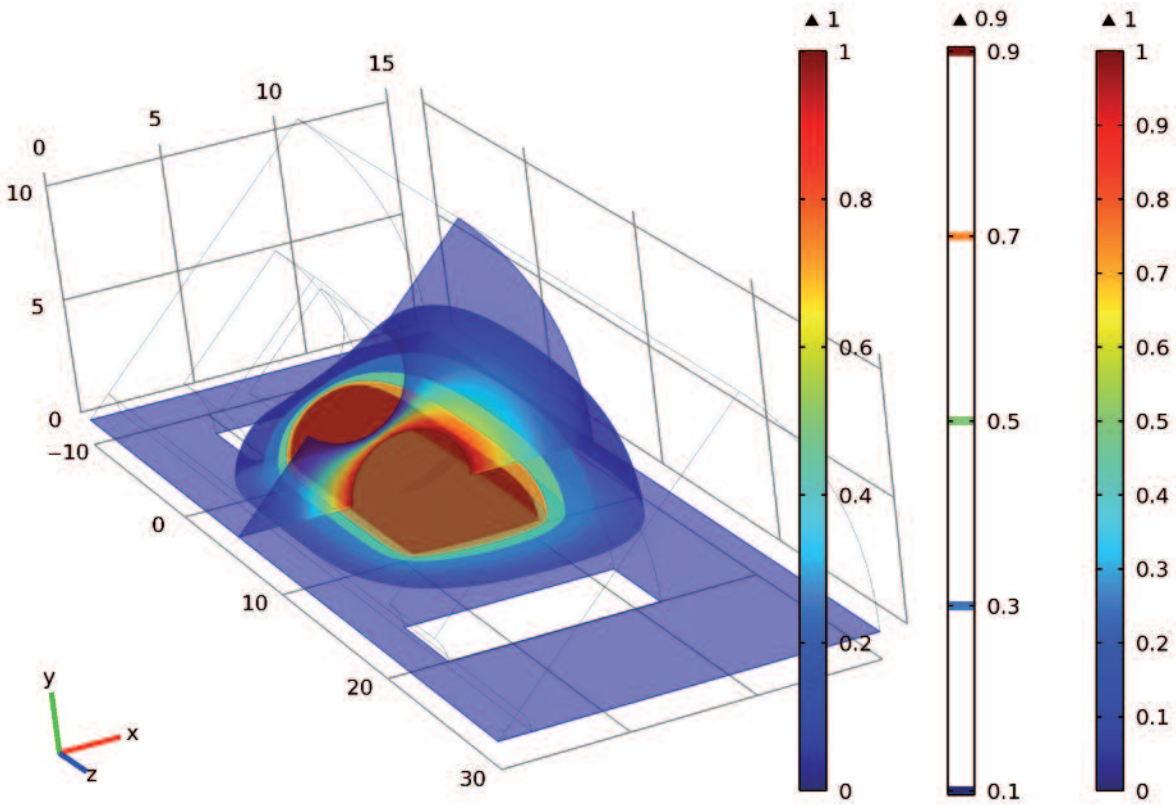
Beam profiles of a deflected beam







Slice: Electric potential (V) Isosurface: Electric potential (V)
Slice: Electric potential (V)



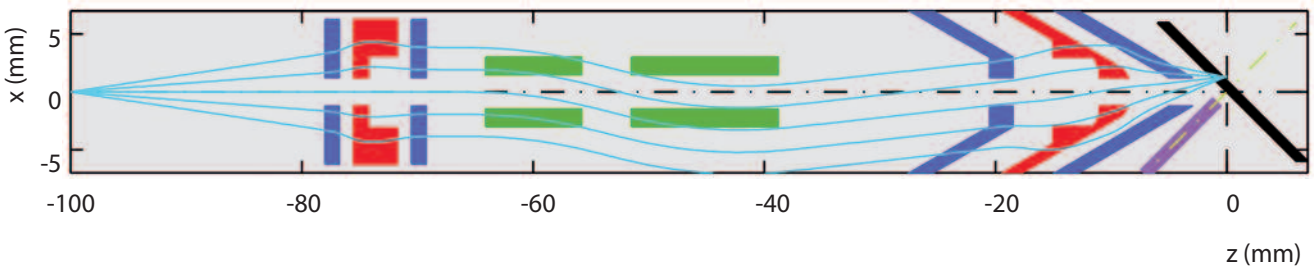
3D field of a stigmator

MAIN COLLABORATING PARTNERS

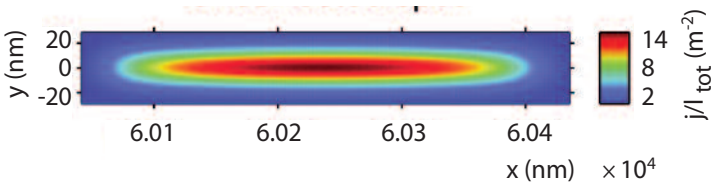
Collaboration with academic partners
Brno University of Technology (Brno, CZ)

Collaboration with companies
ION-TOF, GmbH (Muenster, D)
FEI Czech Republic (Brno, CZ)

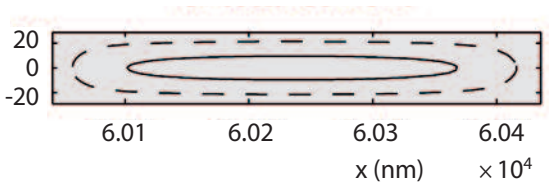
Optical system, selected trajektories (15× vertically magnified)



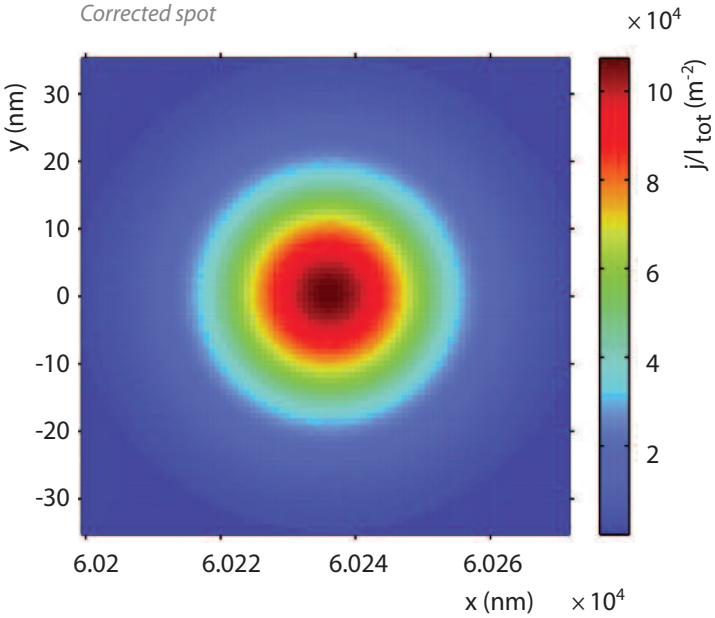
Uncorrected spot



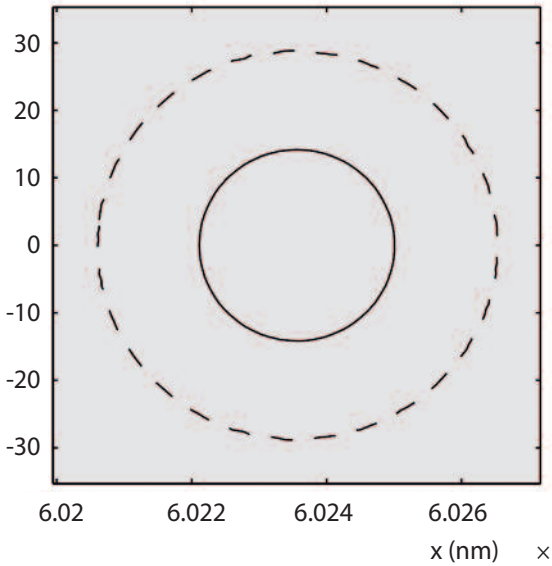
Contours for 50 %, 95 % of total current



Corrected spot



Contours for 50 %, 95 % of total current



Offers

– Partnership in international projects
– Design of electron and ion optical systems
– Simulation and design of electron and ion sources
– Consultation in charged particle optics

Requirements

– Collaboration with industrial partners in projects in applied science
– Collaboration with academic partners in development of custom instruments using charged particles

Correction of sample tilt in a SIMS