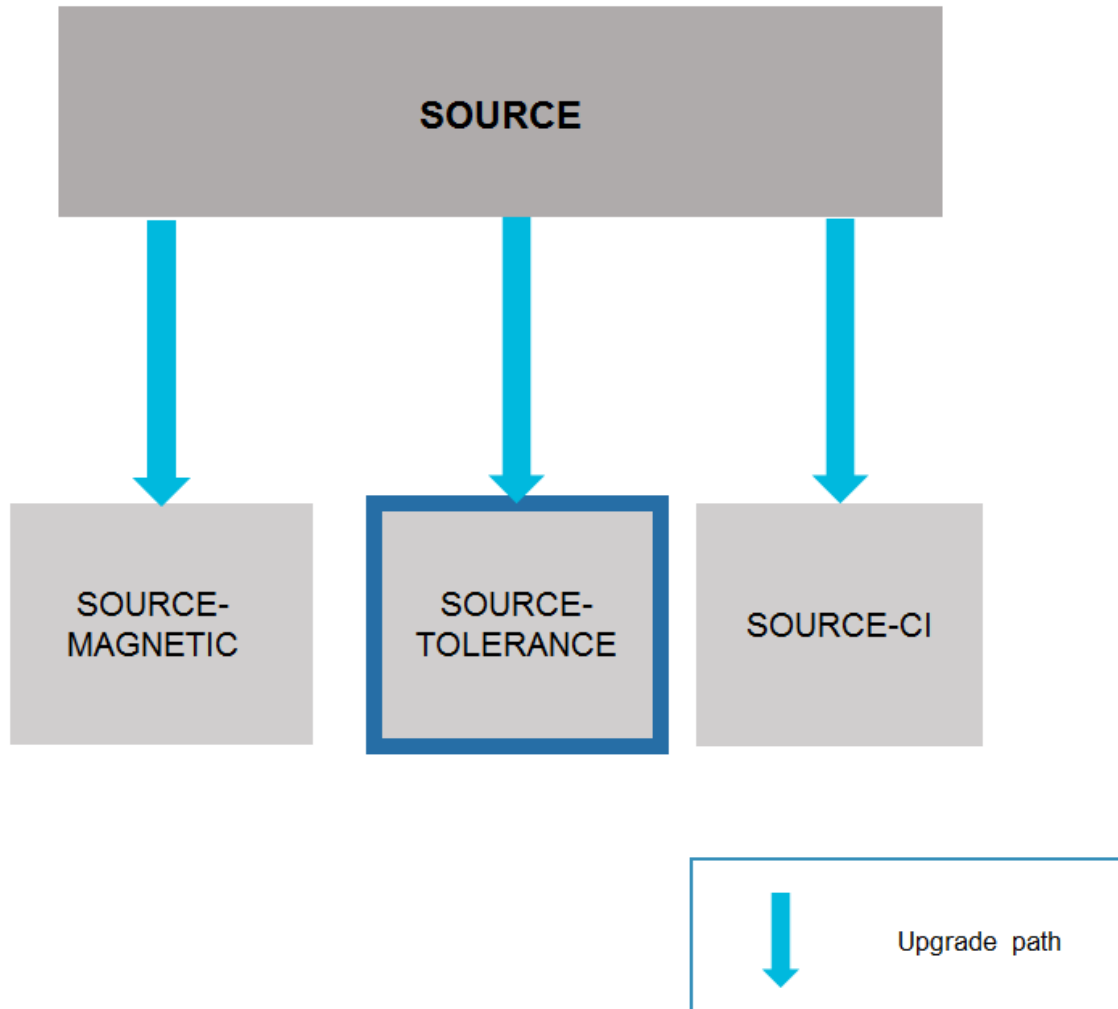


SOURCE-TOLERANCE

Electron Source Tolerancing



Overview

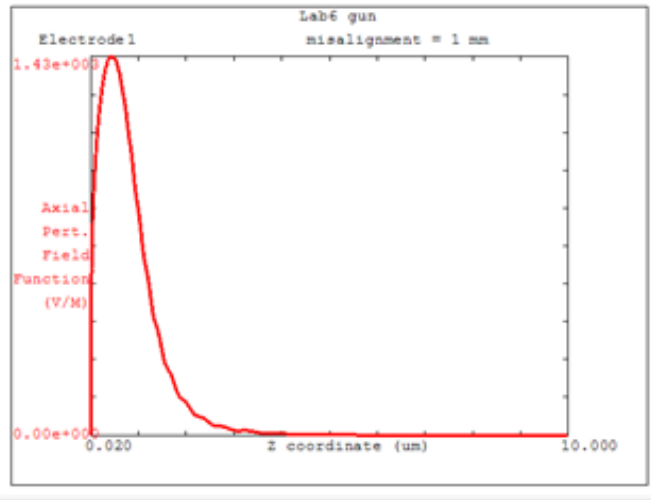
Real columns suffer from asymmetry errors caused by small mechanical imperfections during construction and alignment. Using the SOURCE-TOLERANCE software, the user can compute the perturbation field distributions due to tilts, misalignments and ellipticities in the electrodes or cathodes, to ensure that the system will perform in accordance with its design specifications. The corresponding beam displacements and asymmetry aberrations can also be computed.

The SOURCE-TOLERANCE module can only be used for systems which contain electron or ion sources with rotationally symmetrical electrostatic structures, not with planar symmetrical structures or magnetic lenses.

The potential field distribution of the source must first be computed using the SOURCE software, before computing the perturbation field functions using the SOURCE-TOLERANCE software.

The tilt centres of each electrode can then be set and then the SOURCE-TOLERANCE module can be used to compute the perturbation field functions of the source.

SOURCE-TOLERANCE uses the first-order FEM, rather than the second-order FEM, to compute the perturbation fields. It is accurate enough to use the first-order FEM for computing the perturbation fields, even though the rotationally symmetrical potentials are computed with the second-order FEM.



Graph of perturbation field

After the normal potential distributions and the perturbation field functions are computed, the user can then compute the asymmetry aberrations.

The program computes the beam displacement and aberrations due to misalignment, tilt and ellipticity errors by solving the equations of motion, with the asymmetric perturbation fields as well as the rotationally symmetric electrostatic axial potential distribution.

A bunch of rays are computed from the cathode to the exit plane of the source, which should be in a field-free region; then all these rays are projected back to the virtual crossover plane. This is similar to the computation of the chromatic aberration in the SOURCE software. The position and slope of the central ray at the virtual crossover give the shift and slope of the displacement. The beam confusion disc at the virtual crossover gives the aberration due to the asymmetry error. In this program, only the third-order aberrations are taken into account.

The screenshot displays the MEBS SOURCE GUI Version 2.0 interface. The 'Source Physical Conditions' panel on the left includes settings for Units (millimetre), Symmetry (Rotational), Relativistic Effect (On), Cathode (Emission Region 1, Temperature 1770 K, Work Function 2.70 eV, Richardson Constant 70), Emission Edge Definition (default), Energy Spread (default), Space Charge (checked, Number of Bundles 2, Number of Energies/Bundle 6, Number of Angles/Energy 6, Max. Number of Iteration Cycles 30, Ray Accuracy 1.0e-12, Convergence Error 0.002), and Ion Emission (unchecked).

The 'Source Mesh Data' table at the bottom left shows z coordinates for various points:

z Coordinates	Coordinates	Curvatures	Curvatures	Electrodes & Boundaries
1	12	18	24	27 38 43 50
-2.000000	-2.000000	-2.000000	-1.0000	-50000 3.2500 6.0000 10.0000
-919822	-919822	-90366	-10000	50000 3.2500 6.0000 10.0000
-271716	-271716	-108586	-10000	50000 3.2500 6.7500 10.0000
-129893	-112732	00581	19979	43896 3.2500 6.7500 10.0000
-057817	-031935	05240	25051	40794 3.2500 6.7500 10.0000
-021186	009127	07607	27628	39218 3.2500 6.7500 10.0000
-002571	029996	08811	28938	38417 3.2500 6.7500 10.0000
006890	040602	09422	29694	38010 3.2500 6.7500 10.0000
011699	045992	09733	29942	37803 3.2500 6.7500 10.0000
014142	048731	09891	30114	37698 3.2500 6.7500 10.0000
020000	068916	13988	42588	53312 3.2718 6.7500 10.0000

The 'FEM Mesh' panel shows a schematic of the Lab6 gun structure with a 3.500 mm scale bar.

The 'Computed Results' panel displays the following table for Electrode 1:

Electrode:	Group	Axial Mesh No.	Radial Mesh No.
ID	JA	JB	IA IB
1	24	27	1 9
2	43	50	1 9

Below the table, it states: '(JA, JB, IA and IB are specified in File c:\source_tolerance_data\lab6gun.dat)'. The section 'Perturbation fields due to asymmetries in ELECTRODE 1' is followed by a table for 1 micron of misalignment:

z (mm)	A1 (Volts/m)
0.02000000	0.0000000e+000
0.02119037	1.0041916e+002
0.02238075	1.7903872e+002

Electron source simulation with the computed beam displacement and asymmetry aberrations displayed numerically in the lower part of the screen