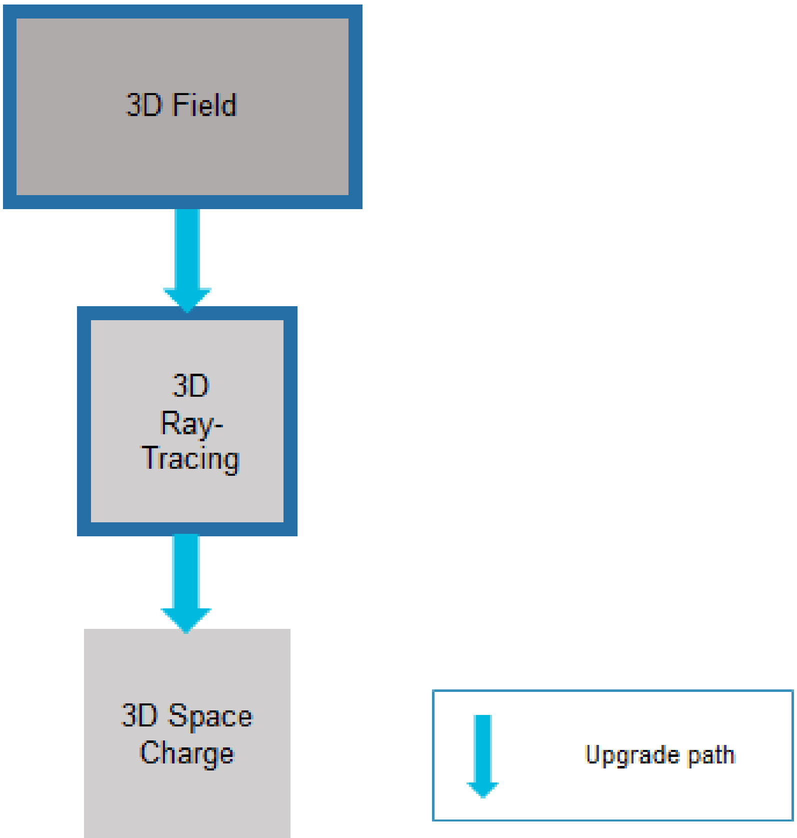
3D Field & 3D Ray Tracing

3D Field Computation, Direct Ray Tracing



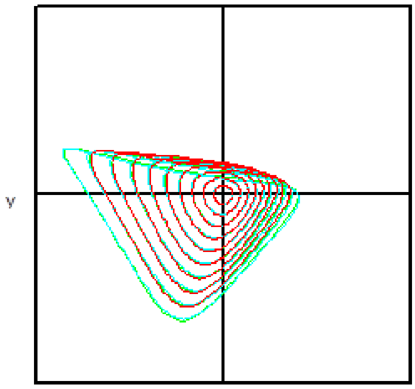
Overview

3D Field uses the finite difference method (FDM) to compute the potential distribution of the elements. The surfaces of the electrodes do not have to conform to the grid lines and thus, 3D objects of varied shape can be analysed without the need for the user to define a complicated mesh to fit around the objects. 3D Field is used by several MEBS packages for field computation.

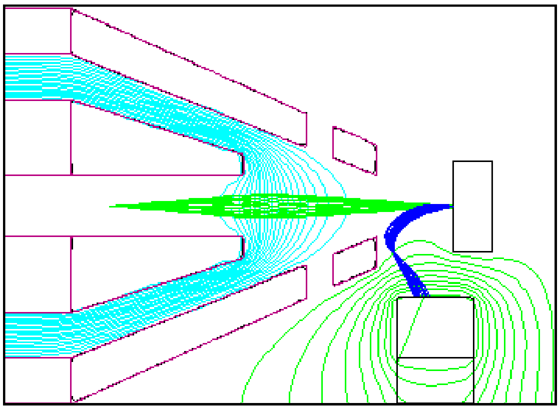
3D Ray-Tracing, which is available as an upgrade to 3D Field, calculates trajectories using the initial positions, energies and emission angles of each charged particle .

3D Field and 3D Ray Tracing compute the properties of electrostatic and magnetic electron optical systems, using a fully three dimensional potential computation and direct electron ray-tracing around 3D electrode and polepiece structures. Equipotentials in 2D sections of the structure in any *(x,y)*, *(y,z)* or *(z,x)* plane can also be plotted. In cases where the structure has a straight optical axis but a departure from rotational symmetry (e.g. an off-axis electrostatic secondary electron collector in a SEM column or a magnetic matrix lens), the axial field functions can be extracted and plotted. These axial field functions can then be used to compute the optical properties of the system, taking the 3D deflection and quadrupole fields into account. The spot shape at the image plane can then be plotted, including the beam shift, coma and astigmatism caused by the 3D fields.

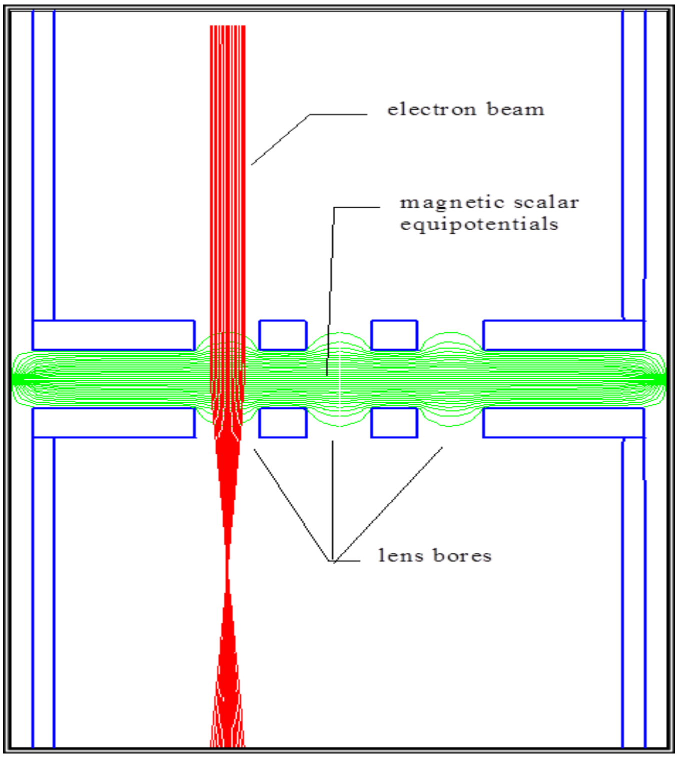
The finite difference method (FDM) is used to compute the potential distribution, wherein the potentials are obtained at points on a 3D rectangular grid. However, the surfaces of the electrodes do not have to conform to the grid lines and thus, 3D objects of varied shape can be analysed without the need for the user to define a complicated mesh to fit around the objects. The regular mesh topology afforded by the FDM and use of a point relaxation method to solve the equations enormously reduces the storage requirements compared with other methods (eg. finite element).



Spot for optic axis through side bore of matrix lens



Rays and equipotentials in a combined field system



Rays and equipotentials in magnetic matrix lens

For the calculation of trajectories, the initial positions, energies and emission angles of each charged particle are specified. The path of the particle (whose mass and charge can be specified) through the 3D fields is computed using a Runge-Kutta algorithm, and the data at the initial and final point on the ray are output, as is the position and velocity at each step of the ray-trace, if required.

To compute the optical properties, the program reads the object and image planes, and the beam half-angle. The beam can be interactively focused at the selected image plane by adjusting any of the electrode potentials or the magnetic field either manually or automatically in an autofocus mode. The first-order optical roperties and the normal and 3D aberration coefficients are output.