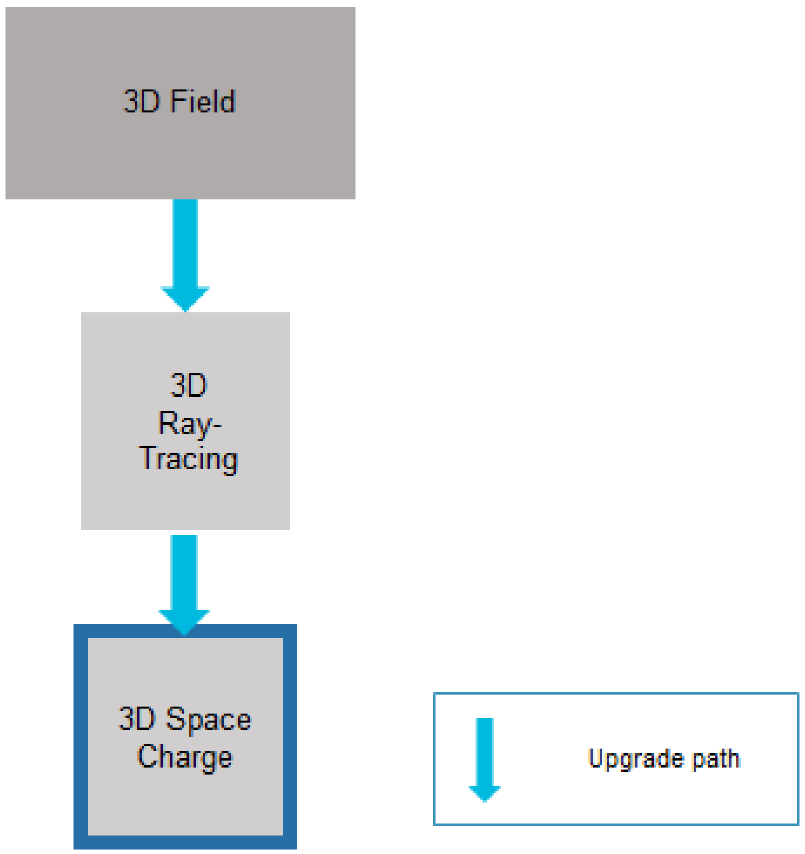
3D Space Charge

3D Field Computation, Direct Ray Tracing and Space Charge



Overview

The 3D Space Charge software extends the functionality of 3D Field and 3D Ray-Tracing to take into account space charge effects.

To compute the effects of volume space charge, the potential distribution, φ should be a solution of Poisson's equation,

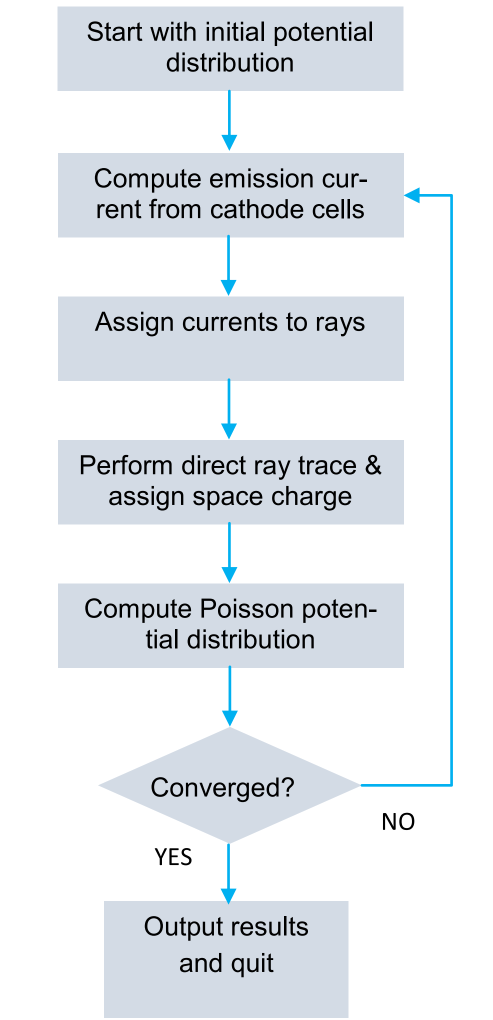
$$\nabla^2\phi = {}^{-\rho}/_{\varepsilon_0}$$

At the outset of the solution, neither the potential distribution nor the space charge distribution, *ρ*, are known.

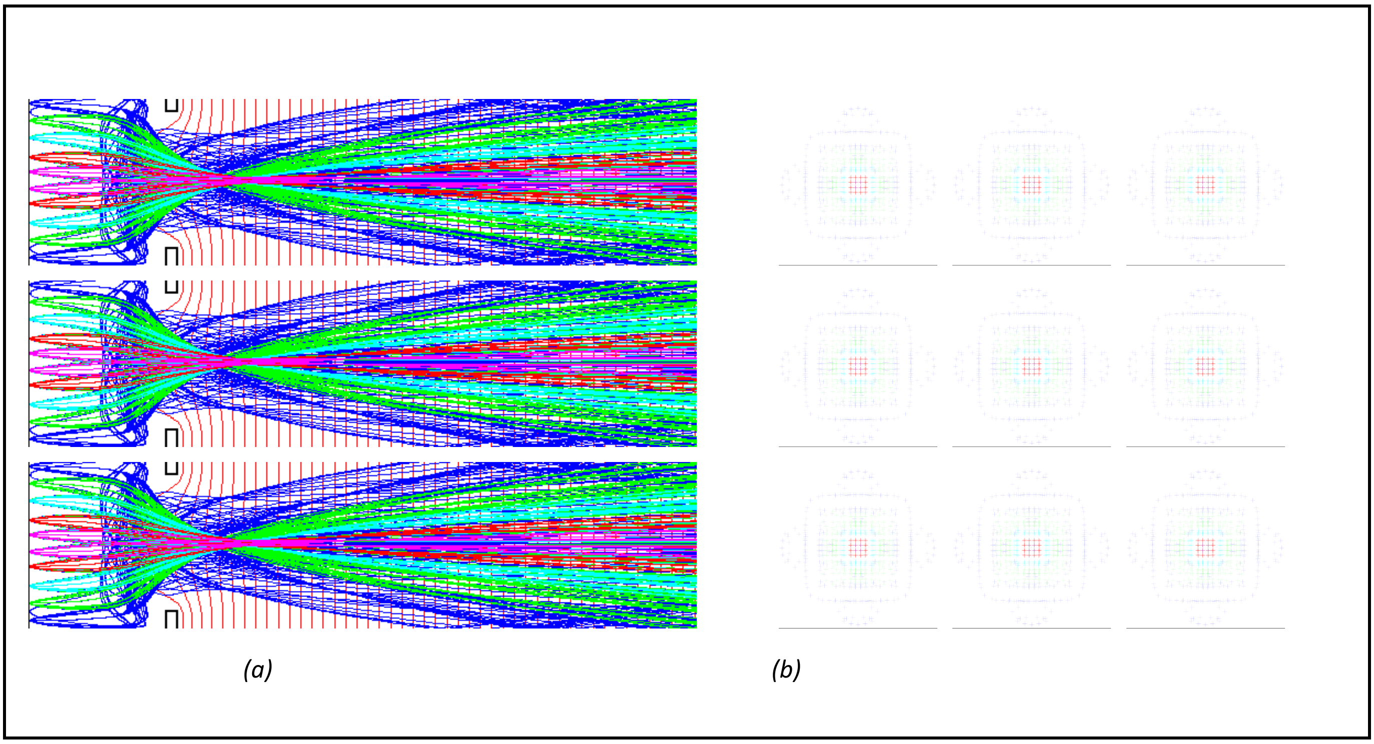
Poisson's equation is solved by an iterative scheme, which involves successively computing the 3D electrostatic potentials, cathode emission current (if a flat cathode is present) and space charge density distribution, until a self-consistent solution is obtained.

If the cathode region is not analysed, the user can assign a specified current to each of the electron rays defined in the ray-trace initial conditions. Alternatively, 3D Space Charge will interface with the SOURCE software and read the output data from a 2D cathode region analysed using SOURCE, and compute the space charge effects in the subsequent 3D electric and magnetic field regions.

The space charge distribution is computed by tracing the current-carrying rays through the system. As a ray carrying current Δ*I* passes through each cell of the mesh it deposits a charge , ΔQ = ΔI.Δt where Δ*t* is the transit time of the ray through the cell. The space charge density in the cell is increased by Δρ = ΔQ/*vol* where *vol* is the cell volume. An incremental charge density, δρ = Δρ/8, is then assigned to each node bounding the cell.



Flowchart for 3D Space Charge Software for analysis of cathode region



Equipotentials and rays for Poisson solution of SCALPEL-type gun. (a) cross-section through the gun, along the optical axis. (b) cross-section through the grid, normal to the optical axis