An hierarchical Boundary Element Method (BEM) solver for the General Particle Tracer (GPT) code

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Here we present an hierarchical Boundary Element Method (BEM) solver for the computation of electrostatic and magnetostatic fields in very demanding geometries such as lens-arrays and nano-tips. This dense matrix method does not require a volume mesh, is insensitive to scale differences, and it can produce analytical multipole expansions of the resulting fields. The BEM results can be imported in the General Particle Tracer (GPT) code to obtain aberration coefficients from tracking results, or to study for example the effect of stochastic interactions.

The overall GPT-BEM package consists of five individual components:

- A parametric 3D surface modeller.
- A re-mesher that iteratively converts a visualisation mesh into a mesh that is tailor-made for the BEM method (figure 1).
- The hierarchical BEM solver that allows for hundreds of thousands of surface-triangles to be solved with ppm precision.
- Analytical on-axis multipole extraction up to 5th order.
- Relativistic tracking to obtain On-axis, off-axis and chromatic aberration coefficients.

The above five components can work together to track particles through complex geometries such as aperture lens arrays (figure 2) where cross-talk between lenses can be studied in terms of aberration coefficients. GPT-BEM also has support for magnetostatics (figure 3) to study deflection systems. The built-in multi-objective genetic optimiser paves the way to full 3D geometrical optimisation of electron and ion beam optics.

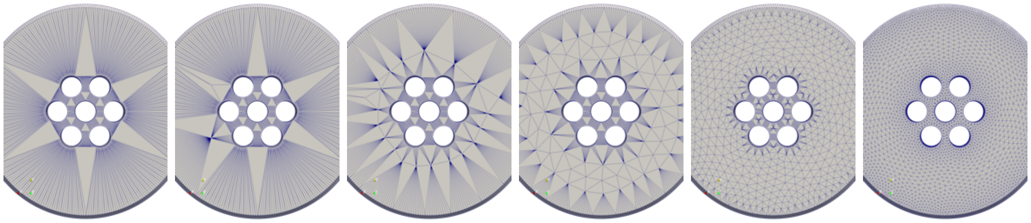

Figure 1: Illustration of the iterative re-meshing component converting a visualisation mesh into a computational mesh.

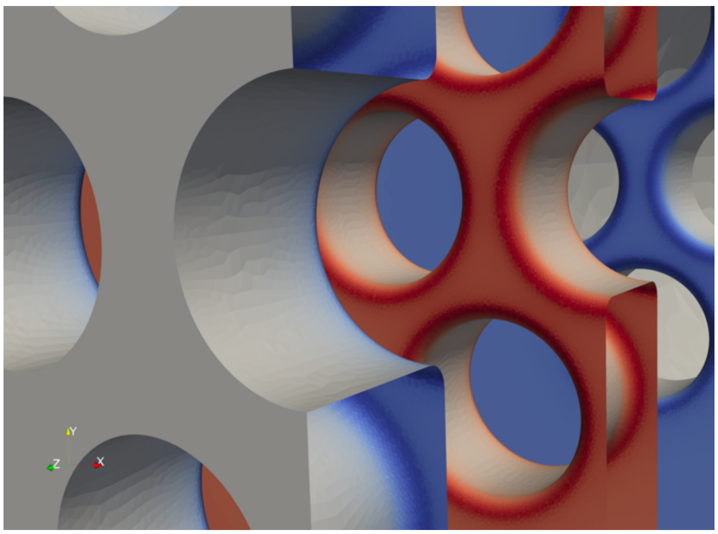

Figure 2: Surface charge density in a hexagonal Einzel lens array.

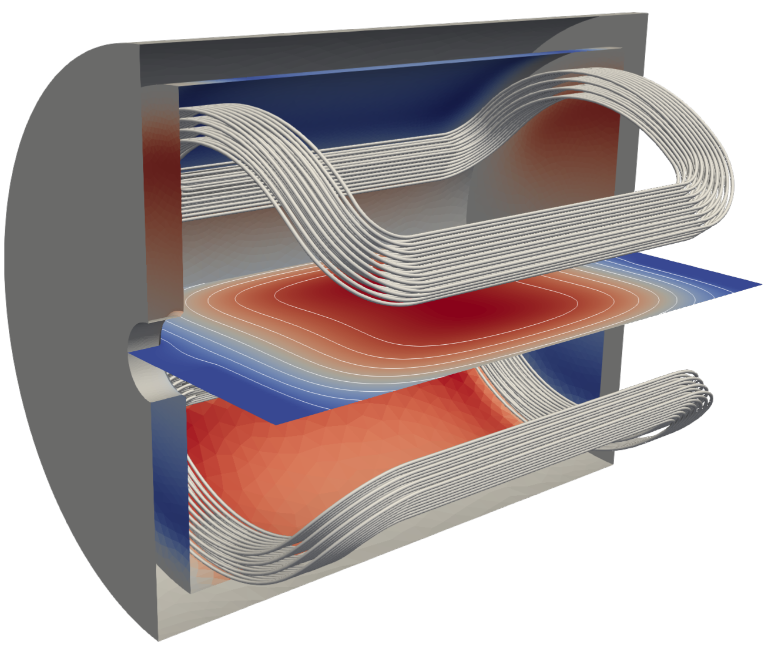

Figure 3: BEM applied to a magnetostatic problem.