# Electromagnetic Express (EM-X)

is a physics modelling package for electromagnetic fields and charged particles. A CAD component allows the definition of mechanical parts and assignment of electric potentials, magnetization and charged particle sources. A time domain, particle-in-cell (PIC) tool then solves the electromagnetic fields and moves the particles within them. The particles' own charges and motions are fed back into the electromagnetic fields allowing the effects of space charge and self-magnetism to be accounted for.

Features

- CAD component with the following:
  - Basic shapes, cuboid, cylinder, code, sphere, toroid.
  - Operations including cut and union.
  - Parameterised reusable sub-assemblies.
  - User definable materials.
- PIC tool with these features:
  - Configurable time and spatial step sizes.
  - Poisson solver for electric and magnetic fields.
  - Absorbing, reflecting or periodic model boundaries.
  - An electron gas model to account for background electrons when modeling ion beams.
  - Uniform and thermionic emission particle sources.
  - User definable particle properties.
- 3D Visualisation tool
  - Displays the mechanical CAD.
  - Can overlay both scalar and vector quantity representations onto the mechanical picture.
  - Arrow glyphs for vectors, cube glyphs for scalars.
  - Glyph size and colour can depend on the quantity magnitude.
  - Vectors available: Electric Field, Magnetic Field, Magnetic Flux Density, Magnetic Vector Potential, Particle Velocity, Current.
  - Scalars available, Electric Potential, Particle Density, Collision Count.
- 2D Visualisation tool
  - Can provide cross-sections of the same set of quantities as the 3D tool in a spectrogram style presentation.
- Chart tool
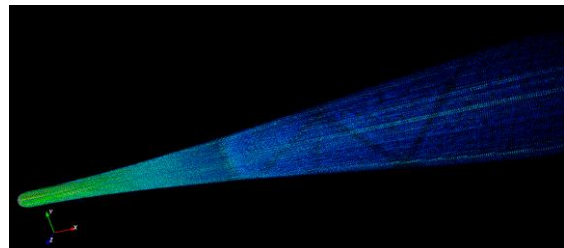 - Various time series data are available for plotting on line graphs.
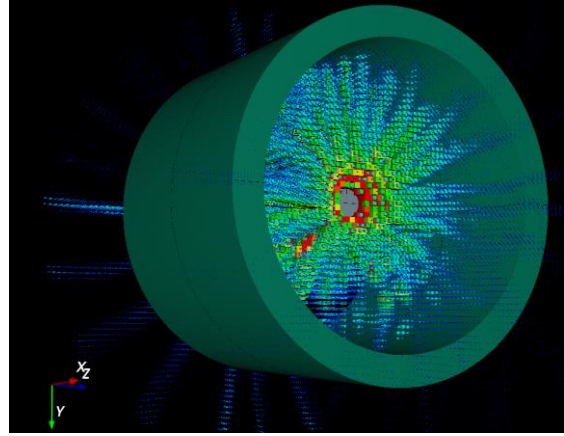
Electron densities of the discharge current in a self-field MPD device.
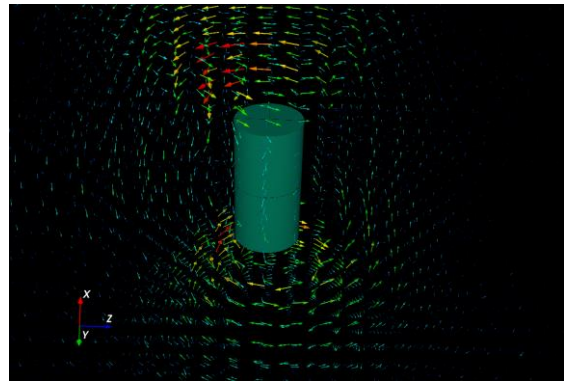
Visualisation of the magnetic flux density around an electric discharge cathode.
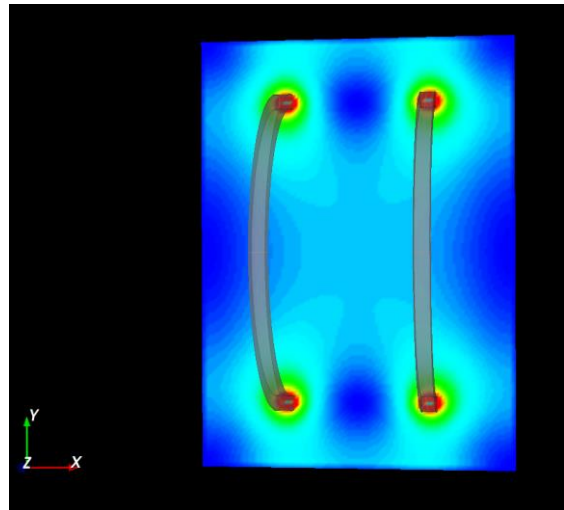
Magnetic flux density cross-section inside a pair of Helmholtz coils.

Particle density picture of an ion beam expanding due to space-charge.

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