Beam Optics Analyzer
Beam Optics Analyzer (BOA) is an advanced computer program to simulate electron trajectories and electromagnetic fields in 2D and 3D geometries. The code imports solid model geometries from commercial computer aided design (CAD) programs and includes integral electrostatic and magnetostatic field solvers. The code simulates emission from thermionic cathodes, including temperature and work function effects. One also can inject beams using a variety of formats. The code models secondary electron emission, and the graphical user interface (GUI) allows rapid setup and analysis. The integral, finite element, mesh generator supports adaptive and user-defined meshing, ensuring high accuracy and rapid analysis.

Features include:
» Finite element analysis using unstructured, tetrahedral elements
» Automatic meshing supporting user-defined region resolution and adaptive meshing
» Support of space charge and self-magnetic fields
» Built-in materials database
» Optimizer for maximizing performance of electron guns and collectors
» Support of symmetry to reduce computational resources and analysis time
» Parallel processing for adaptive meshing, field solutions, and particle pushing
» Time dependent analysis of low frequency structures, such as grided electron guns
» Support of ACIS and Parasolid formatted geometry files
The extremely robust meshing routines in BOA define the problem domain resolution with high accuracy using minimal computational resources. The GUI allows the user to define mesh density in selected regions, which can be further refined with adaptive meshing. The mesh density can be more accurately defined as the design matures, providing high user efficiency with improved simulation precision.

Adaptive meshing automatically refines mesh resolution where required to achieve user-defined accuracy criteria. This is particularly useful in regions with high field gradients where values are rapidly changing, as occurs near complex electrode structures. BOA’s adaptivity routines also refine mesh density in regions where charged particles are present to more accurately determine trajectories and calculate space charge and self-magnetic fields.
BOA’s integral electrostatic and magnetostatic solvers provide rapid, accurate analysis of fields in 3D geometries. When charged particles are present, the space-charge fields are included in the electrostatic analysis. The solver also models dielectrics, and BOA includes a built-in library of materials and their properties. Customized material libraries can be added.

BOA’s magnetic solver models permanent magnets and solenoids, including contributions from self magnetic fields. The solver includes non-linear effects, and users can import B-H curves to supplement the materials provided in the built-in database. Both field solvers are parallelized with OpenMP.
BOA propagates electrons through complex geometries as determined by the electromagnetic fields in the problem domain. The code uses particle space charge and beam current information to update the electric and magnetic fields respectively. Step sizes are adaptive, and self-consistent algorithms ensure that field errors and emitting current simultaneously satisfy preset criteria. BOA supports thermionic emission, including the Longo-Vaughn formulation, and injected beams in a variety of formats. Secondary emission using the Monte Carlo method is supported. Magnetic focusing can be accomplished by importing an external magnetic field or using the built-in magnetostatic solver. The magnetostatic solver uses the same CAD model as the beam optics simulation. To simulate ionization, users can specify regions as optically transparent and define a specific charge neutralization to each region. All calculations are fully relativistic and fully parallelized.

Particles in BOA’s beam optic simulation dissipate their energies on terminal surfaces. One can use this information to analyze heat transfer within BOA. The 3D heat transfer solver determines the deposited beam power and calculates temperatures in device components. By including convective heat transfer information, one can also estimate the cooling requirements. The analysis uses the same CAD geometry as the beam optics analysis, and material properties and boundary conditions are automatically incorporated. The mesh density can be automatically adapted to achieve high accuracy. The solver is parallelized using OpenMP.
BOA can simulate time-dependent behavior in electron beams where particles are pushed synchronically in time. Particles can be modulated by a temporal potential prescribed to an electrode or by a series RLC external circuit with a driving potential. A formula parser permits input of potentials as a combination of intrinsic functions. Particles moving in time can be animated.

BOA’s built-in optimization routines can dramatically reduce design time and achieve performance levels not practical with manual techniques. This optimization capability led to the world’s first double convergence multiple beam gun design. Users can optimize the geometry (lengths, diameters, etc.) or operational parameters (voltages, currents, etc.) to achieve specified performance requirements, including beam current, ripple, compression, and field gradients.

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Contact Information

Beam Optics Analyzer can be downloaded from www.calcreek.com. A demo license is available for evaluating the program. Users must provide geometry files in ACIS or Parasolid format. Calabazas Creek Research, Inc. can recommend appropriate commercial CAD programs compatible with BOA’s extensive features.

Beam Optics Analyzer is available for export.

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