Los Alamos NATIONAL LABORATORY ESTABLISHED 1943

2006 R&D 100 Award Winner

Joint entry with Naval Research Laboratory, Science Applications International Corporation, and Simulation Technology & Applied Research, Inc.

MICHELLE: A Software Tool for Three-Dimensional Modeling of Charged-Particle-Beam Devices

Features

MICHELLE simulates the operation of a wide variety of charged-particle-beam devices. To perform a simulation, MICHELLE calculates the electrostatic fields, the magnetostatic fields, and the particle trajectories in the device under steady-state or slowly varying field conditions. MICHELLE can model intense or relativistic particle beams, particle injection into the device volume, and secondary-electron emission produced by particle collisions with the device walls. MICHELLE's calculational space can be decomposed into as many as 9 million volume elements, providing unprecedented spatial resolution for this type of code. MICHELLE can also calculate up to 200,000 particle trajectories, which is also unprecedented. It is the only code that provides accurate simulations of several advanced guns and collectors used in high-power microwave tubes.

Applications

MICHELLE has been used to simulate the operation of

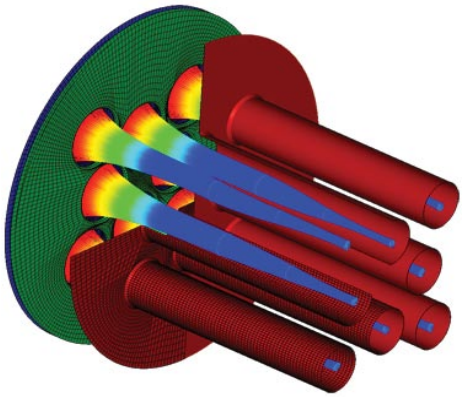
- gridded, multibeam, sheet-beam, and annular-beam electron guns for high-power microwave tubes,
- multibeam and multistage depressed electron collectors for high-power microwave tubes,
- complete (gun-to-collector) high-power microwave tubes,
- ion thrusters for deep-space missions, and
- beam transport in particle accelerators.

Benefits

MICHELLE is the only code that provides accurate simulations of several advanced guns and collectors used in high-power microwave tubes. Physical insight provided by MICHELLE's simulations has saved years of trial and error in the laboratory and led to longer-lasting microwave tubes for defense-radar systems, more cost-effective tubes for satellite-communication systems, and higher-power tubes for particle-accelerator and deep-space communication systems.

For additional information contact:
Eric M. Nelson, 505-665-6350, enelson@lanl.gov
Baruch Levush, 202-404-4513, levush@estd.nrl.navy.mil
John Petillo, 781-221-7615, john.j.petillo@saic.com*
John DeFord, 262-240-0291, john.deford@staarinc.com

**Principal point of contact*



This is a computer rendering of a MICHELLE simulation of an eight-beam electron gun. The beams originate at eight separate cathodes (not shown), pass through eight holes in the focusing electrode (green disk), and then accelerate toward the anode and into the eight drift tubes—the anode/drift-tube structure is red, with a cutaway to show more of the electron beams. The energies of the beams' electrons are indicated by different colors—low-energy electrons are red; high-energy electrons are blue. This gun is part of a high-power multiple-beam klystron for a radar system. This rendering shows MICHELLE's ability to simulate electron guns with very complicated three-dimensional geometries.

Los Alamos 2006 Winners

ENABLE: Energetic Neutral Atom Beam Lithography/Epitaxy

Green Primaries: Enviro-Friendly Energetic Materials

MICHELLE: A Software Tool for Three-Dimensional Modeling of Charged-Particle-Beam Devices

PixelVizion: An NPU-Embedded Visualization Accelerator for Large Data Sets

Trident