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PBGUNS v5.2

FAR-TECH, Inc., San Diego, CA 92121

Webinar on PBGUNS v5.2

- **PBGUBS has been serving electron and ion source community for many years, and is a well-regarded simulation code.**

- **With significant upgrades of the functionality in PBGUNS v5.2, we feel it is time for us to offer a free webinar about the upgrades. The webinar will focus on**

❑ **key updates from previous versions. (Present by Dr. Zhao)**

❑ **geometry import feature from CAD drawings. (Present by Dr. Barov)**

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Key Updates in PBGUNS v5.2

L. Zhao, FAR-TECH Inc., San Diego, CA 92121

PBGUNS: Particle Beam Gun Simulation

- **PBGUNS is an interactive program for the simulation of virtually any type of axially symmetric electron or ion beam extraction or transport system. It can also simulate slab geometry.**

  - <u>**Electron beams**</u>**: thermionic, field emission;**

  - <u>**Positive and negative ion beams**</u>**: plasma (with multiple ions when needed), thermionic and sputter ion sources.**
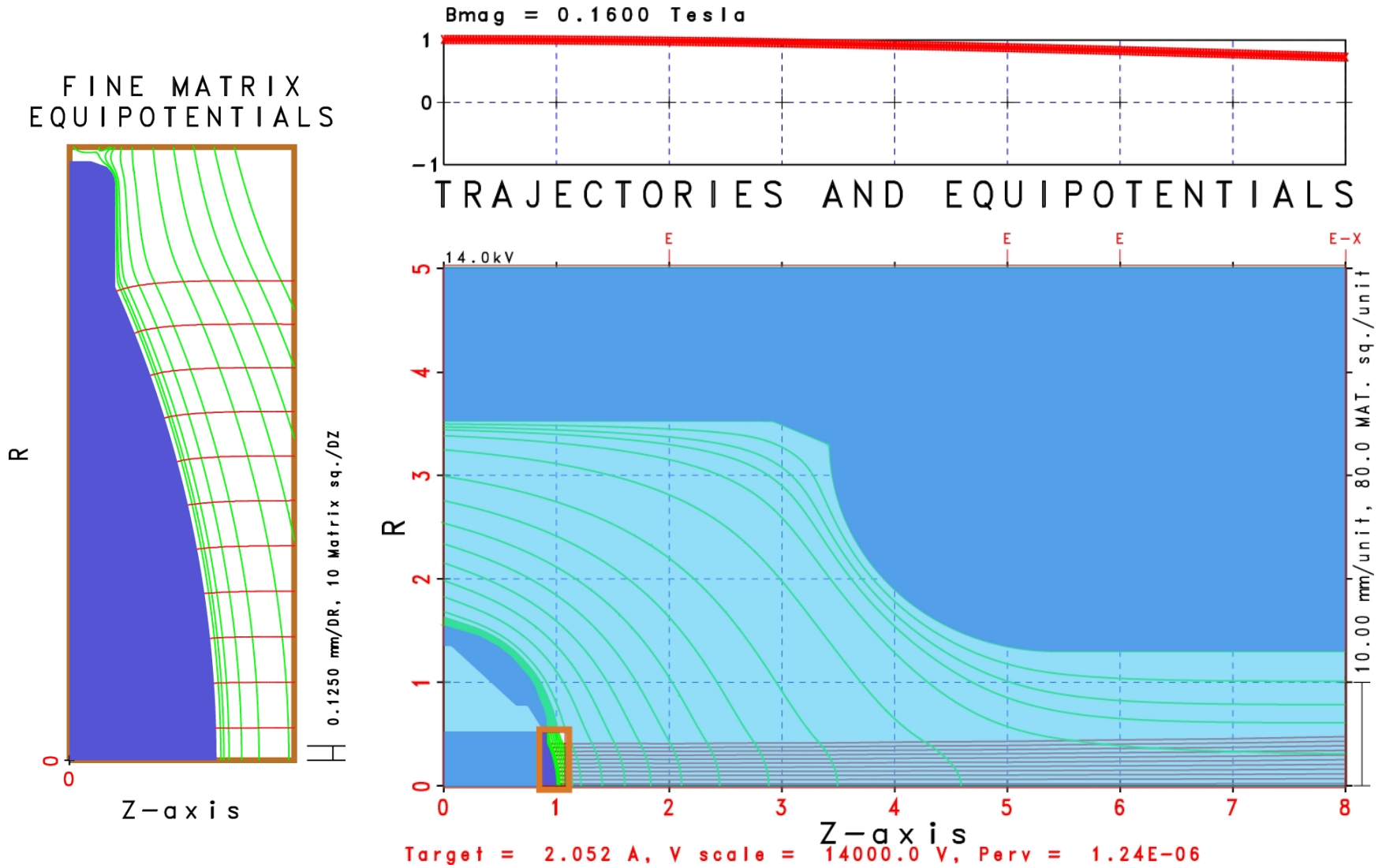
Key Features of PBGUNS

- Models relativistic or non-relativistic beams
- Device can be axially symmetric or 2D rectangular
- Can include axis-symmetric magnetic fields

- The program is interactive.
- The beam can be saved and restarted.

- Uses analytical boundary
- Fine mesh covering the cathode or plasma meniscus (virtual cathode) to improve accuracy and stability.

- Input GUI makes it easy to set up the problem and visualize the geometry.
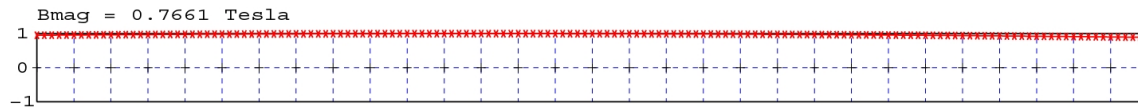
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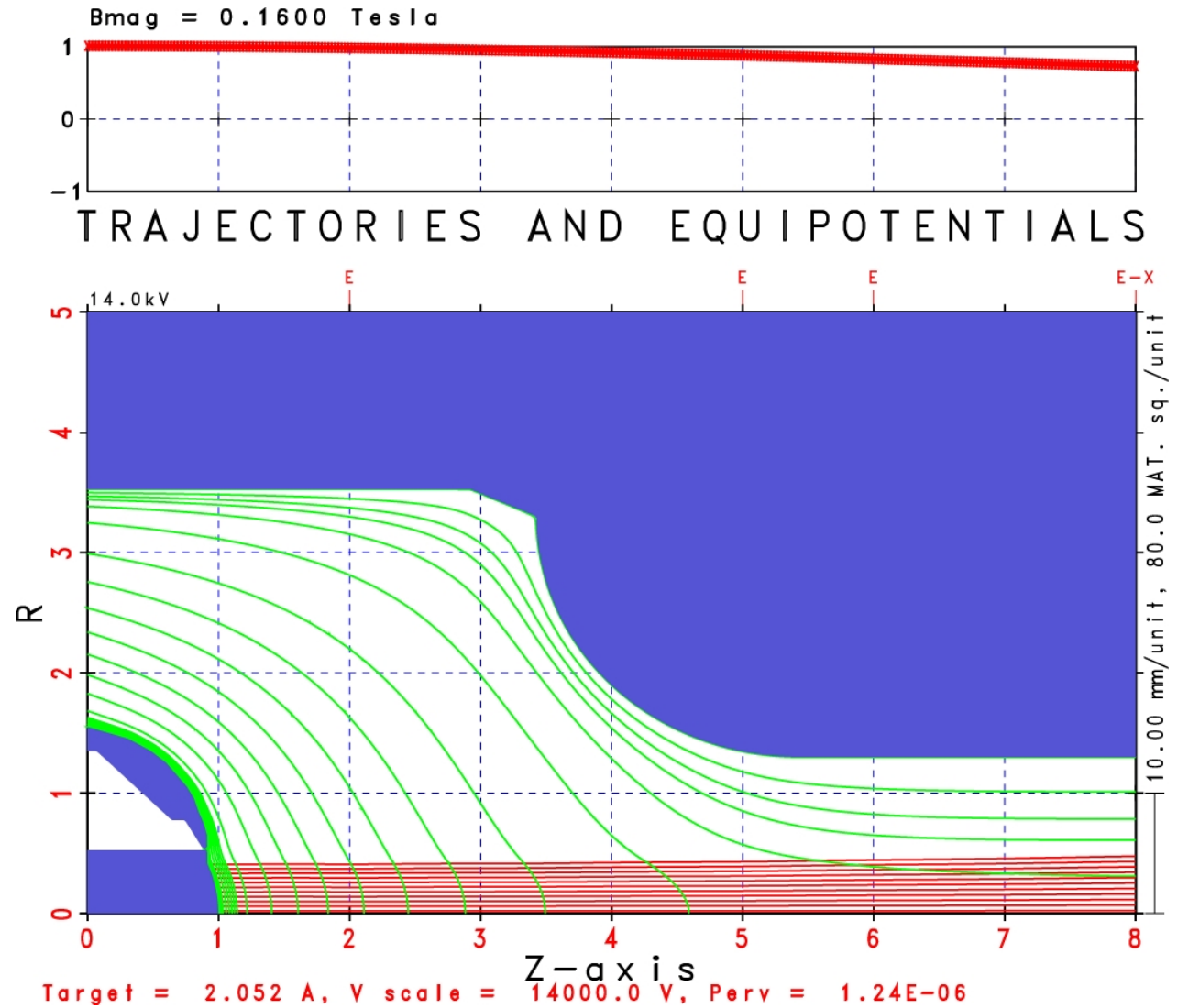
PBGUNS Example: Electron Beam and Fine Mesh
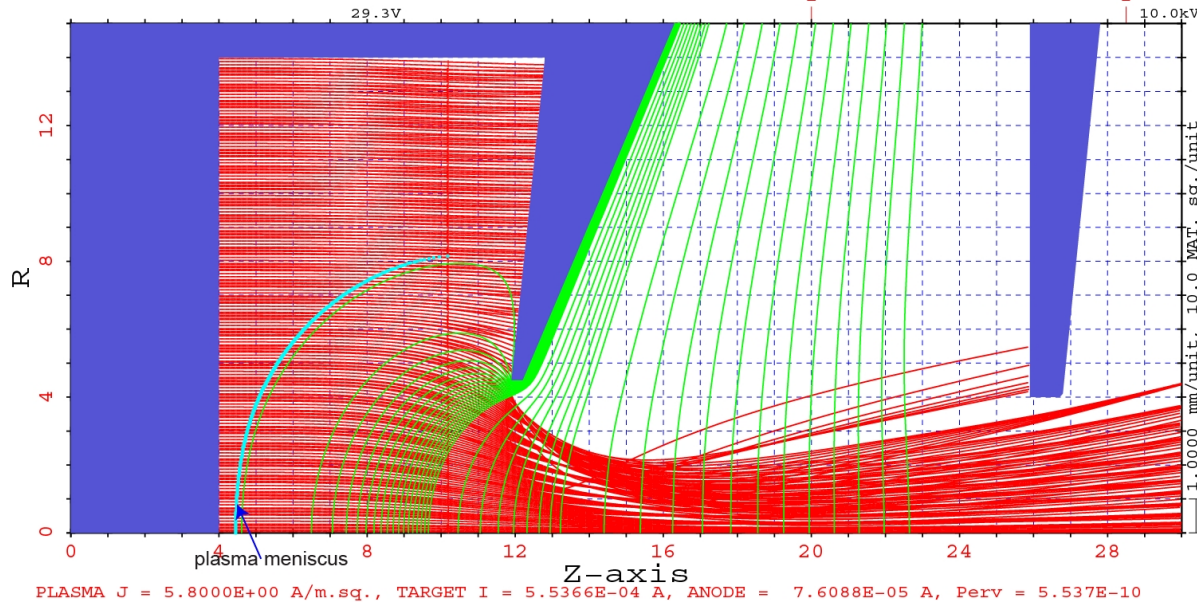
PBGUNS Example: Electron Beam and Fine Mesh

FINE MATRIX EQUIPOTENTIALS

R

Z-axis

0.1250 mm/DR, 10 Matrix sq./DZ

Bmag = 0.1600 Tesla

TRAJECTORIES AND EQUIPOTENTIALS

R

Z-axis

10.00 mm/unit, 80.0 MAT. sq./unit

Target = 2.052 A, V scale = 14000.0 V, Perv = 1.24E-06

PBGUNS Example: Multi-specie Ion Extraction from a Plasma
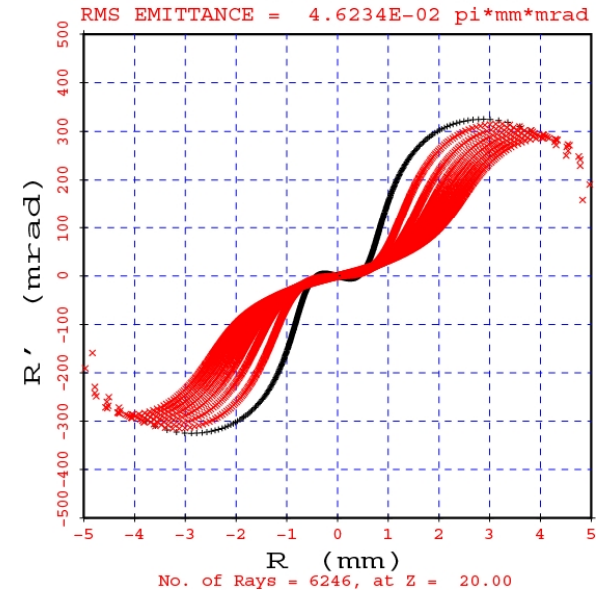
PBGUNS Example: Beam in a Drift Space and Neutralization

TRAJECTORIES AND EQUIPOTENTIALS

Slit Length =1.0000 mT,   % Neutral = 99.9900
Target =0.06540 A, V scale =10000.0 V, Perv = 8.17E-06
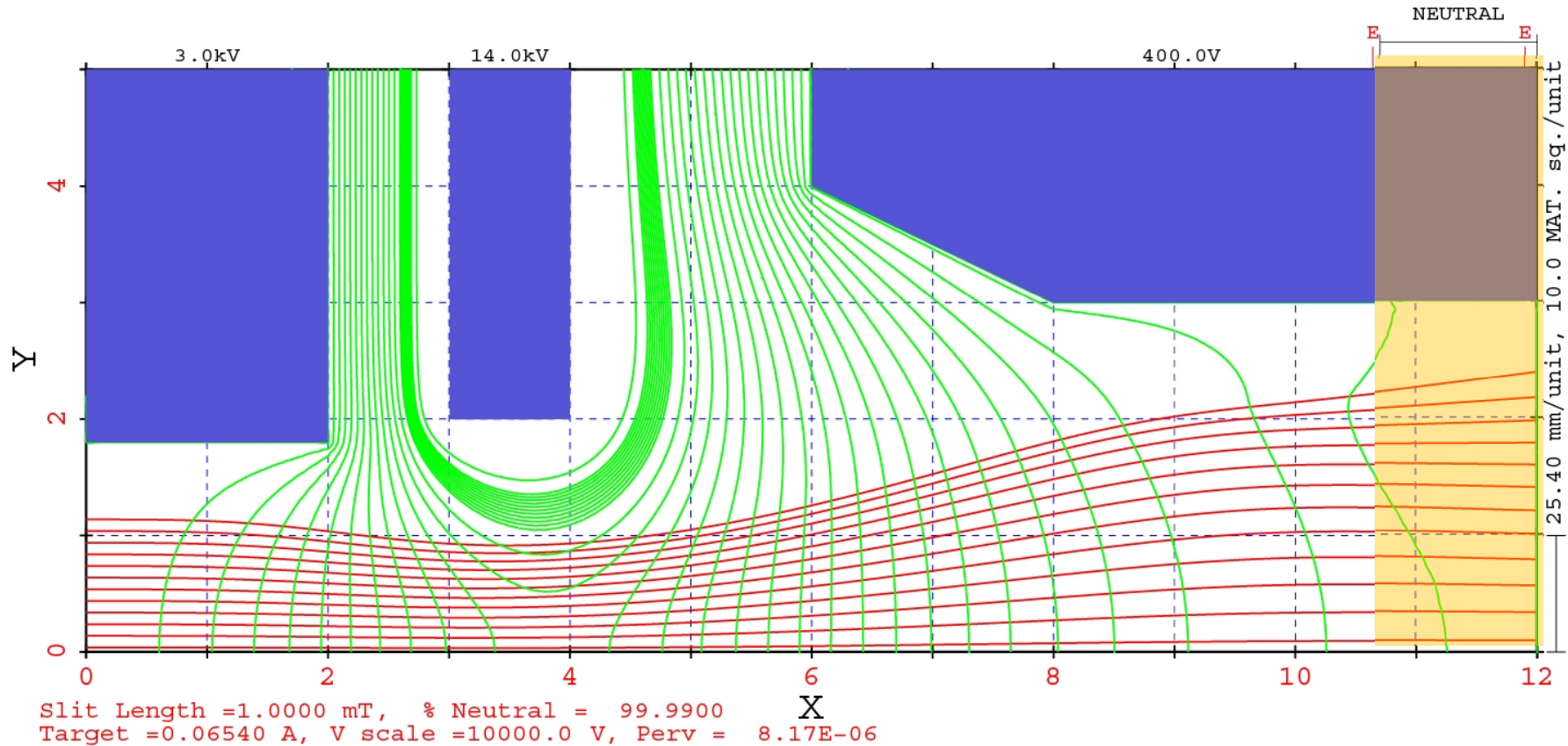
PBGUNS Example: Sheet Beam in Infinite Slab Geometry

TRAJECTORIES AND EQUIPOTENTIALS
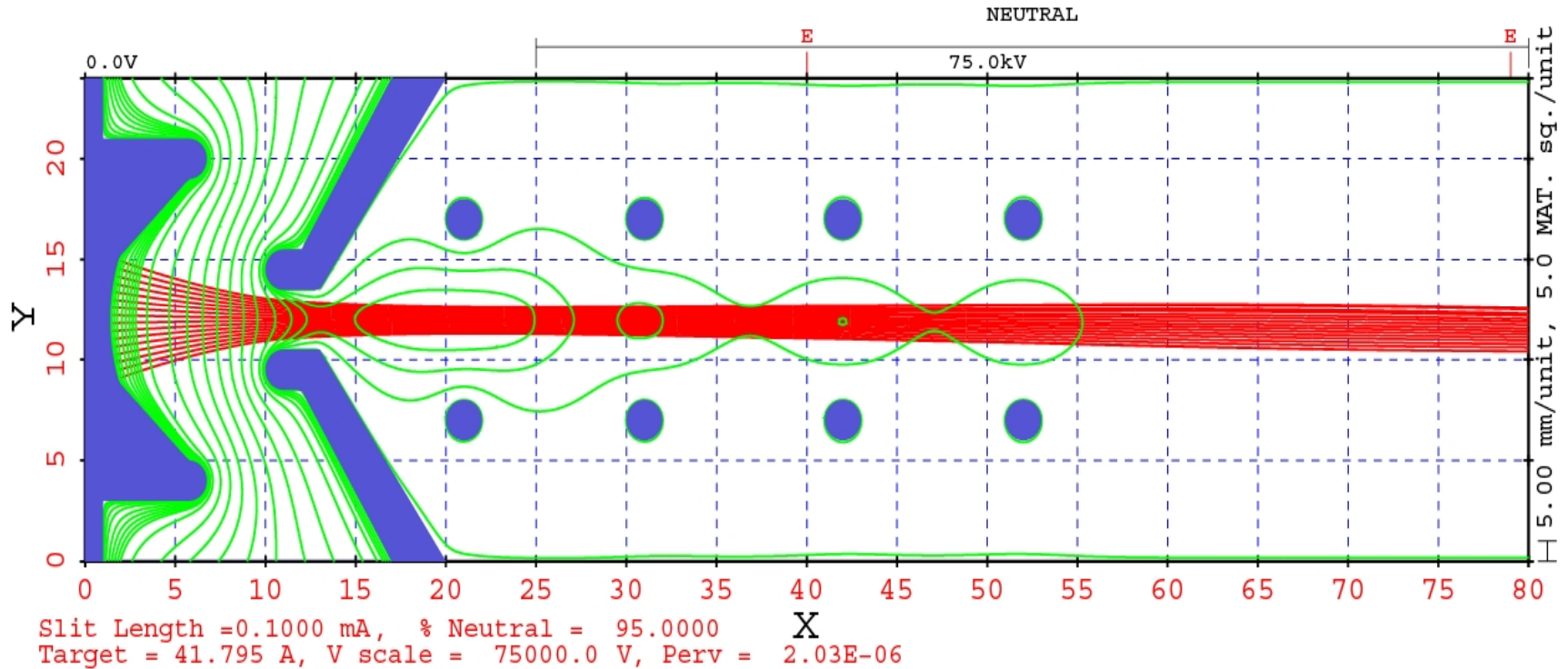
What's new in PBGUNS v5.2

- **A robust the geometry handling algorithm is implemented.**

- **Improved beam save/restore functionality. Simulation can be done in sections for devices with long geometry.**

- **Self-consistent concurrent electron and ion simulation in a drift tube.**

- **Dynamic allocation of the fine mesh, which is no longer limited to 2000x2000 grid points.**

- **A CAD import module for the PBGUNS Input GUI that can interpret STEP format.**
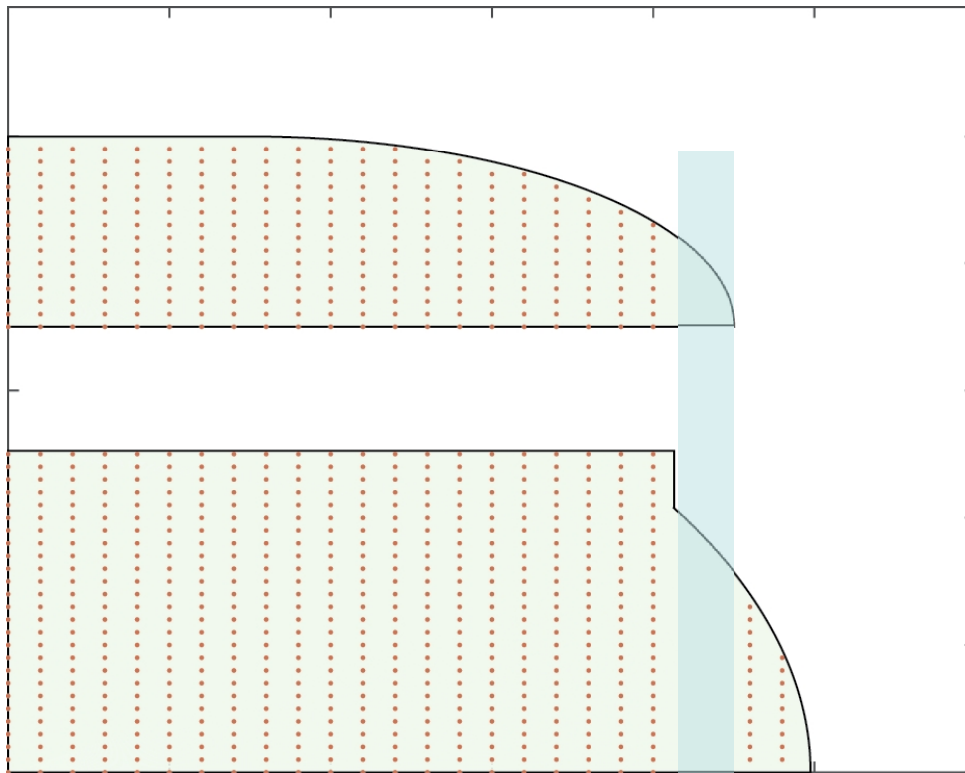
Limited Geometry Handling in pre v5.2 PBGUNS

Prior to Version 5.2, PBGUNS uses preset geometry logic combinations to handle input geometry.

~ 350 combinations are coded but it is not enough to cover all possible geometries.

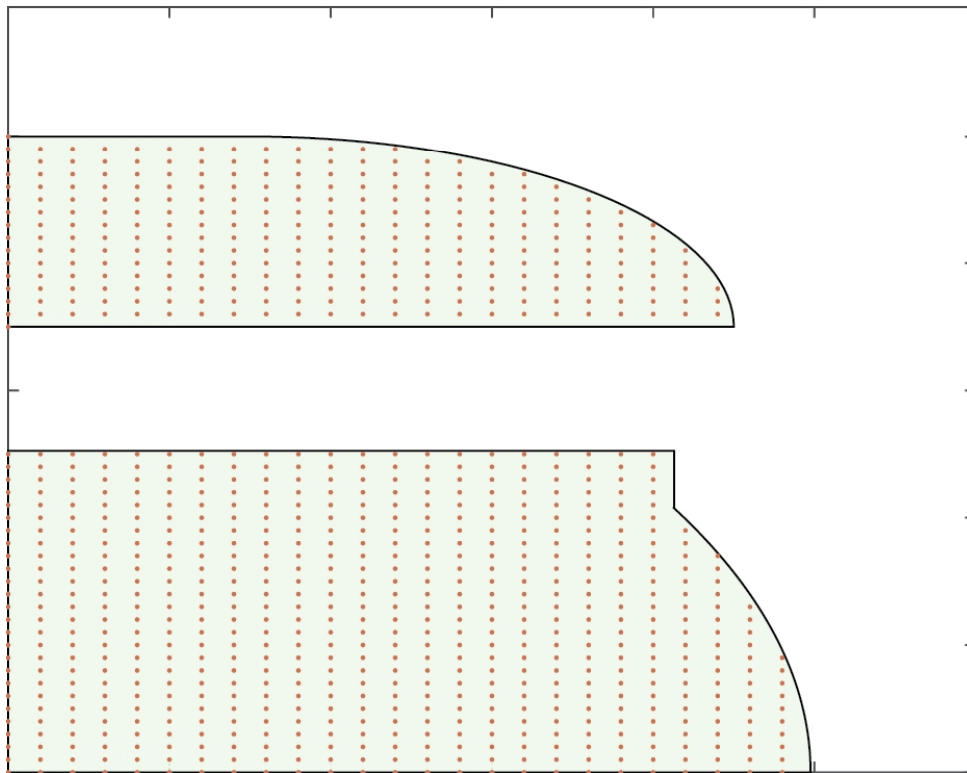As a result, ~ 90% of PBGUNS errors are due to the limitation of geometry logic.

Pre v5.2 PBGUNS did not treat the geometry correctly with complex edges
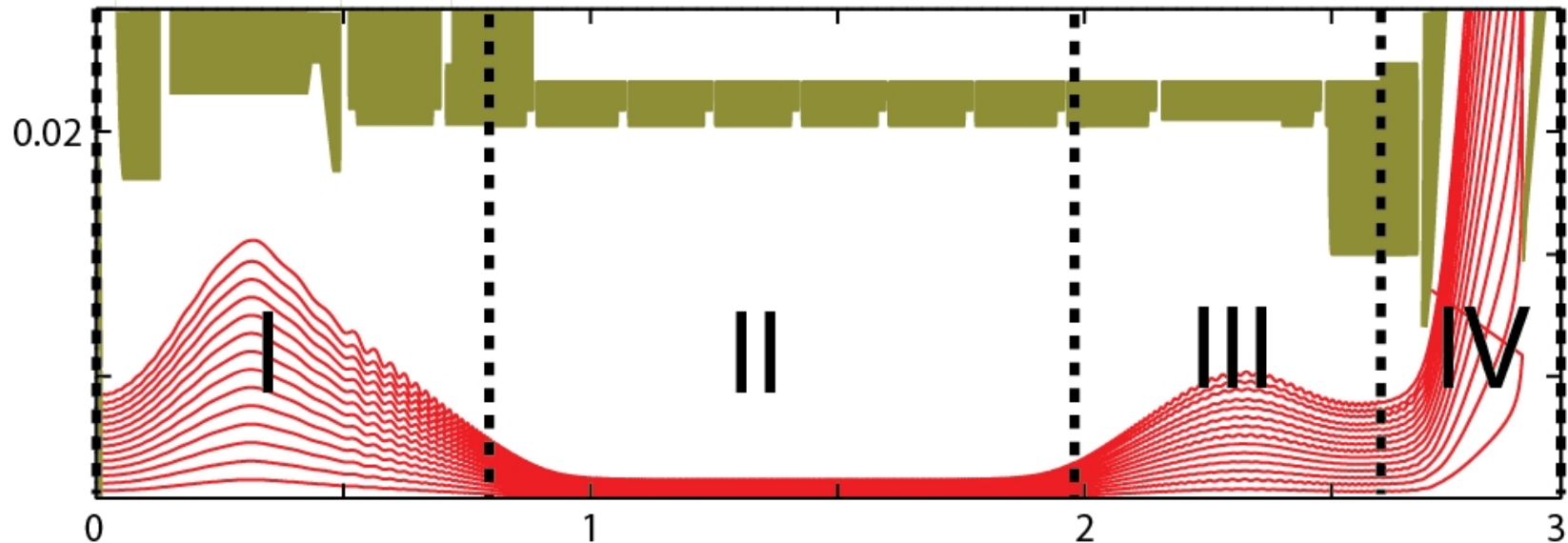
Robust Geometry Handling: Ray-Casting

Ray casting algorithm: starting from a point, a line is extended to the boundary and the number of intersections with electrode boundary is counted.
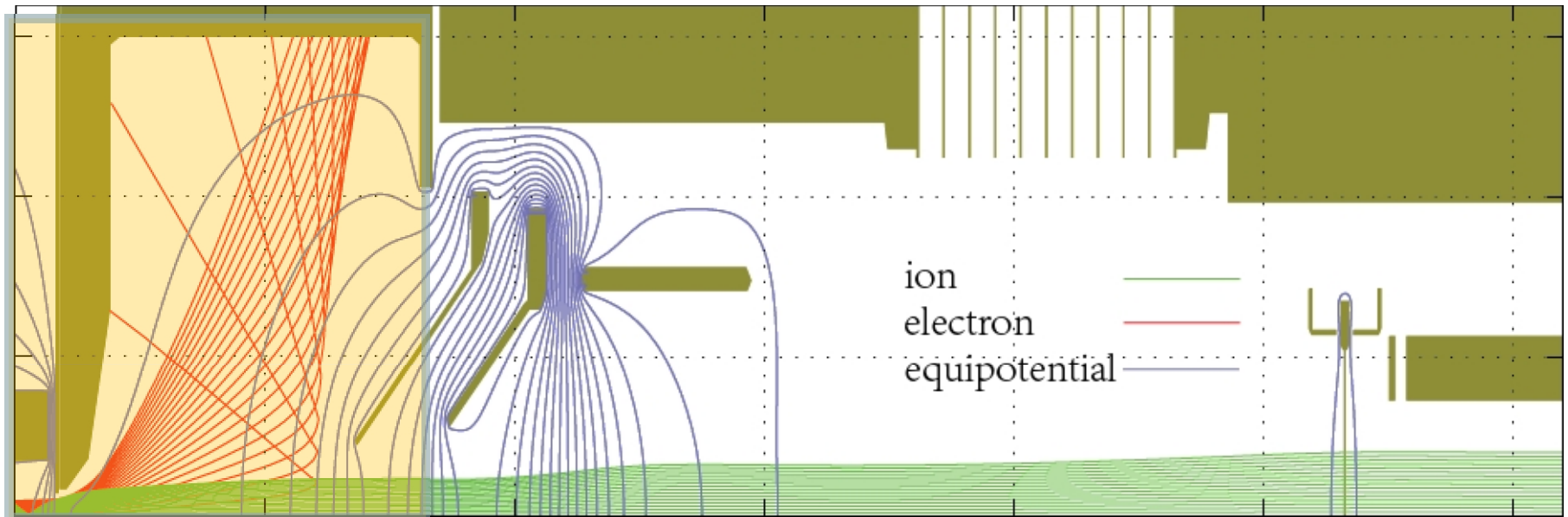
Long Beam Simulation in Sections

With improved restart function, beam can be saved and restarted for simulation continuing in a new section.

Different grid setting can be used in different simulation sections to improve the resolution.

Self-consistent Simulation with Both Electron and Ion Beam

The capability of simulating two beams concurrently has been extended to electron and ion beam.

Each beam transport is simulated with the presence of saved space charge from the other beam. Several loops are needed for convergence.

Plans for Future PBGUNS Versions

- **Improve GUI by adding more visual diagnostics:**

    Check geometry logic;

    Show magnetic field profile;

    Show fine mesh region and cathode location.

- **Output data in HDF5 format to give users flexibility with plots.**

- **Built in graphical output in common vector format, such as eps.**

PBGUNS v5.2 CAD Import Module

N. Barov, FAR-TECH, Inc., San Diego, CA 92121
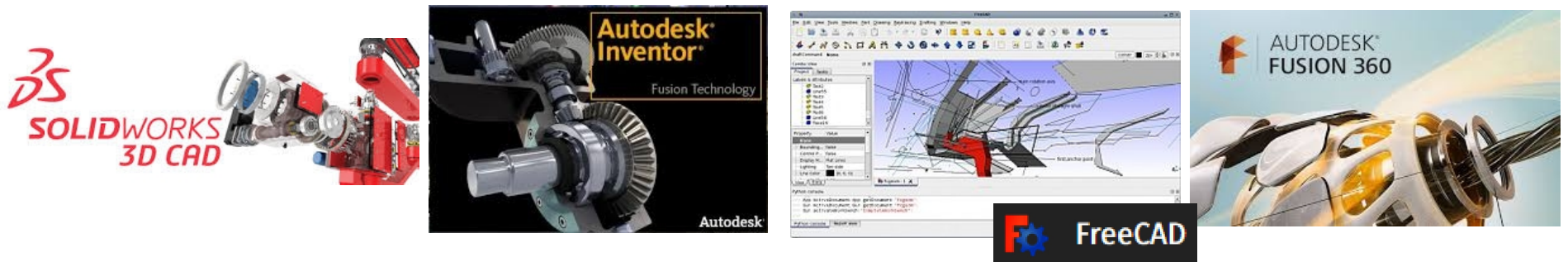
Motivation and Advantages of the CAD Import

CAD experts can generate geometry very quickly.

Can make use of parametric design.

STEP format is "vendor neutral", so it is possible to use many different CAD

programs, such as SolidWorks, Inventor, Fusion 360, and FreeCAD.

Fusion 360 is free to "enthusiasts and startups; educational", and FreeCAD is

free for all.

Outline of the Import Process

The import process proceeds in the following steps:

1) Build and export the CAD model in STEP format.

2) In PBGUNS Input GUI, set mesh parameters and import.

3) Check the geometry in the preview window.

4) Enter additional conductor parameters.

5) Save as a PBGUNS .DAT file.

6) Run PBGUNS.

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Step 1: Build and Export the CAD Model in STEP Format

Example of device we want to simulate, an electron gun.
The device is modeled as a ¼-model surface of revolution.
- **The gray area is the vacuum space inside the device.**
- **Need a bounding rectangle as expected by PBGUNS.**
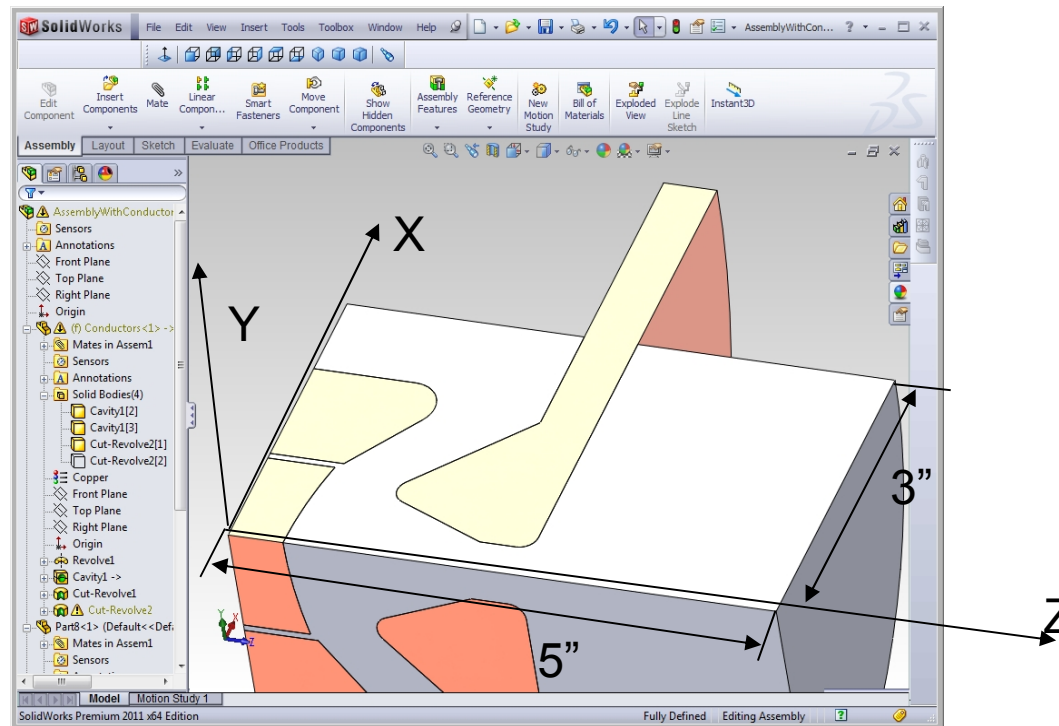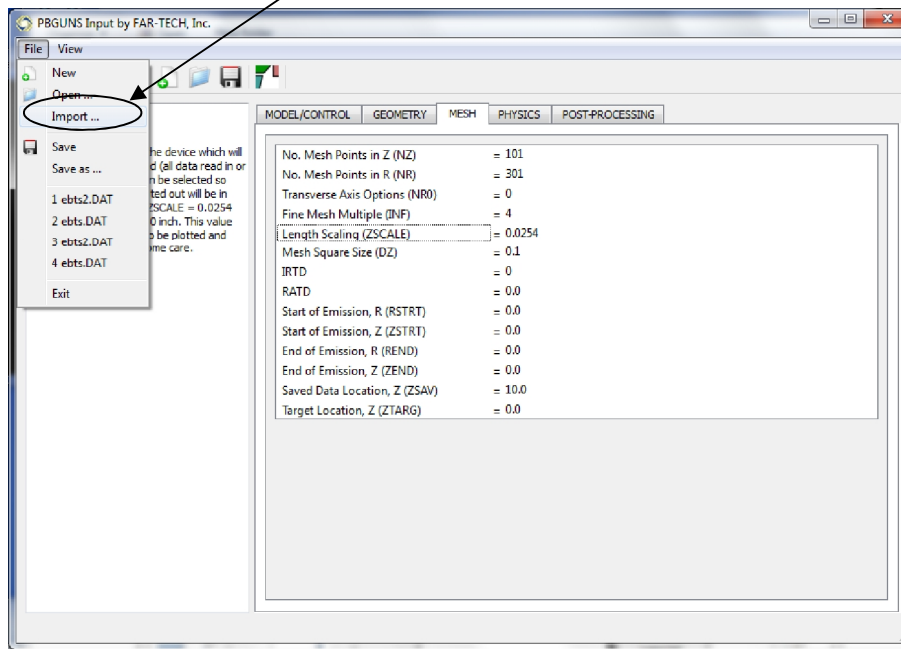
Step 2: Set Mesh Parameters and Import

First set some mesh parameters.
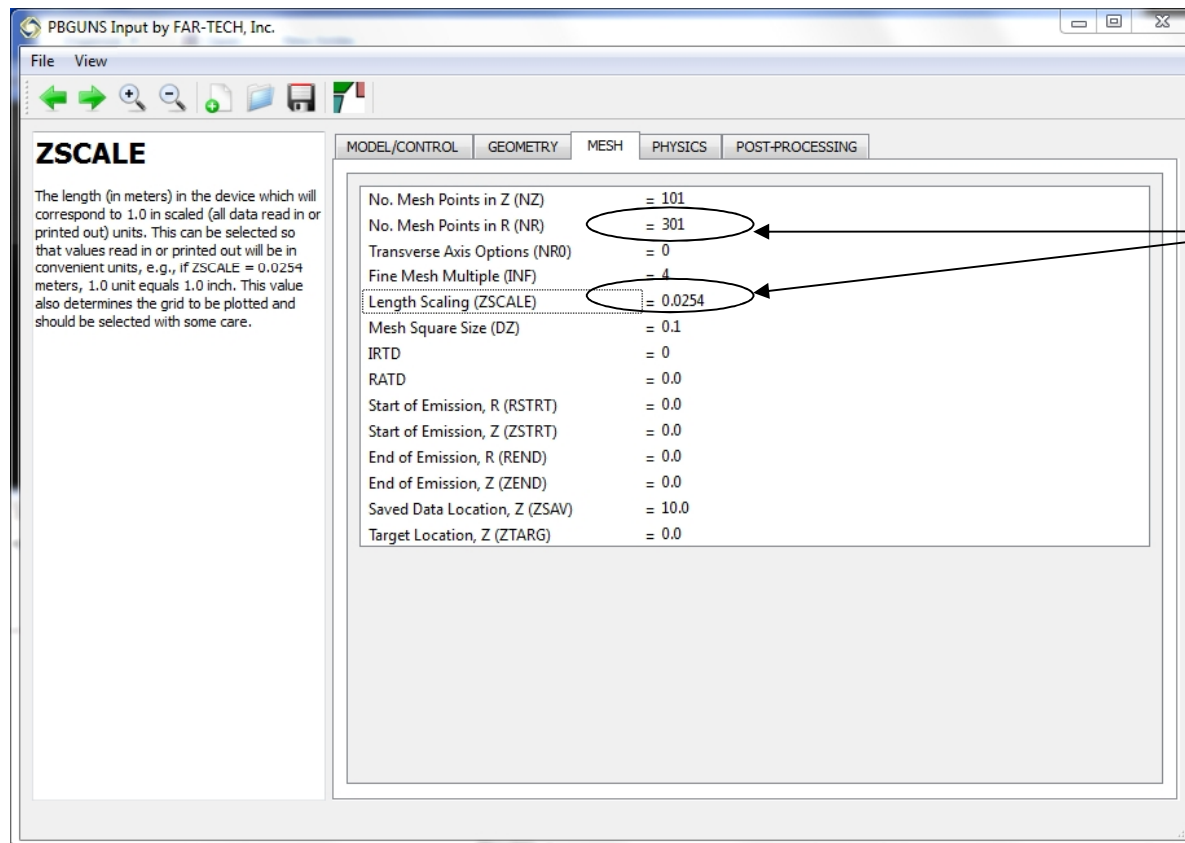
Set NR and ZSCALE

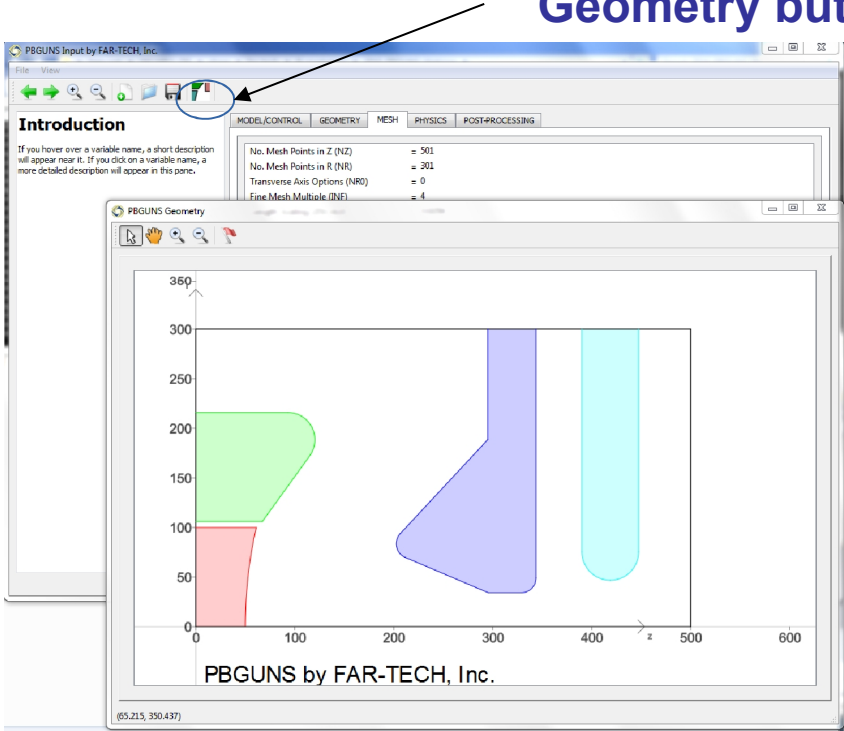# Step 2: Set Mesh Parameters and Import
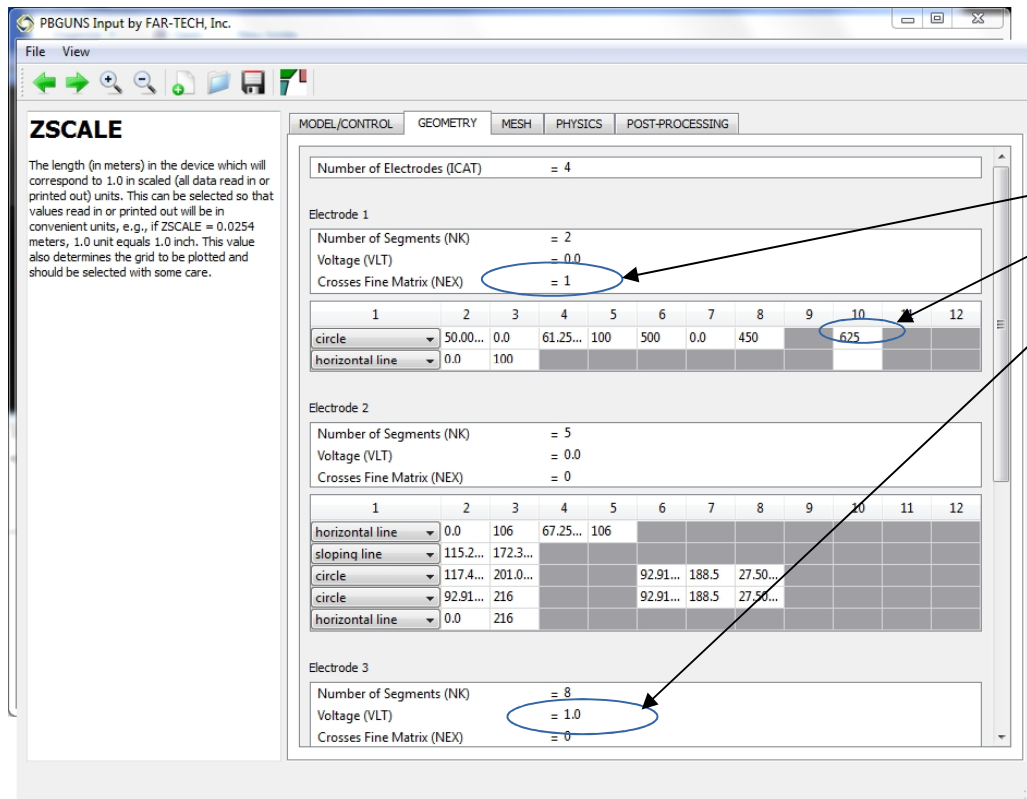
File → Import... and specify the filename.

Step 3: Check the Imported Geometry

This window can be brought up with the geometry viewer button on the toolbar.

Geometry button.
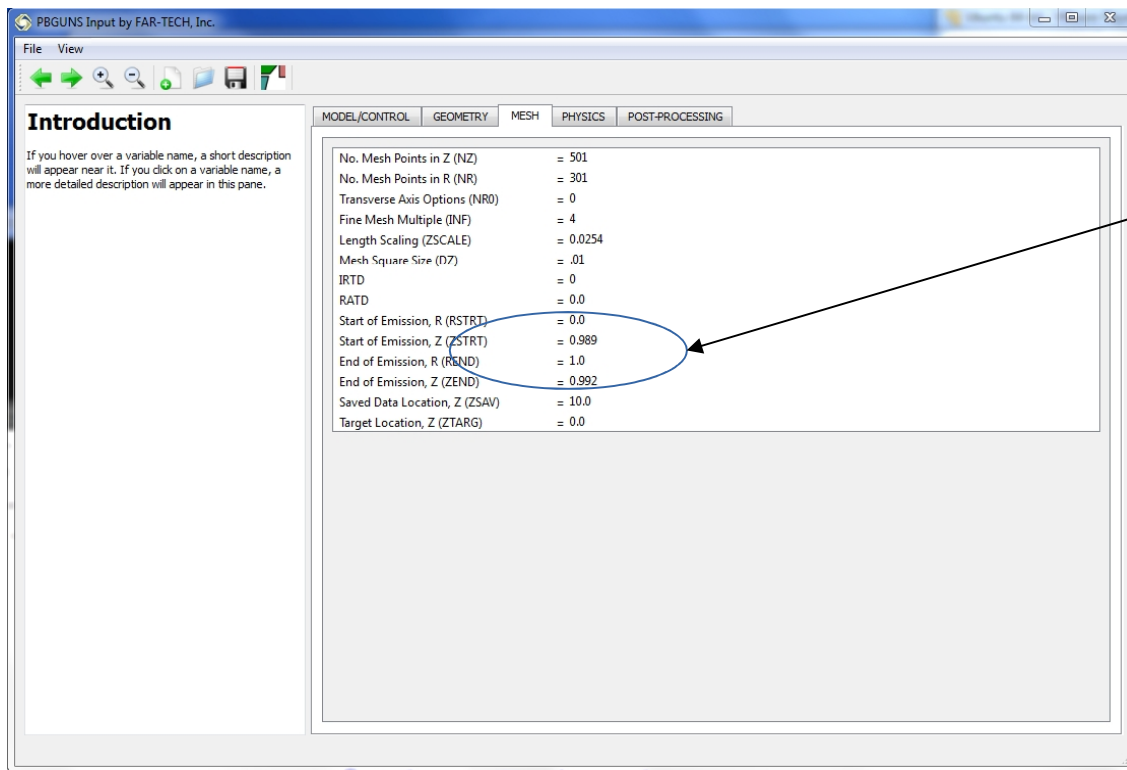
Step 4: Enter Additional Conductor Parameters

Adjust:
NEX: crosses fine matrix
CX: spacing of tracks
VLT: scaled voltages
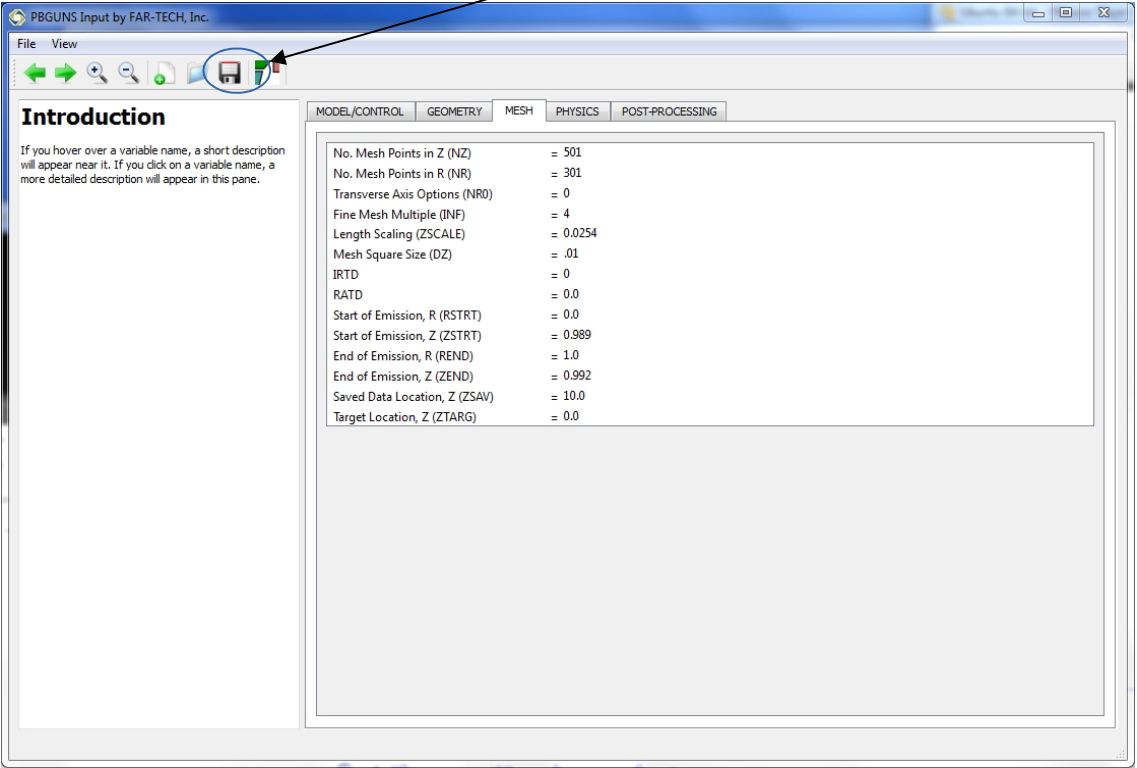
Step 4: Enter Additional Conductor Parameters

Under the Mesh tab:
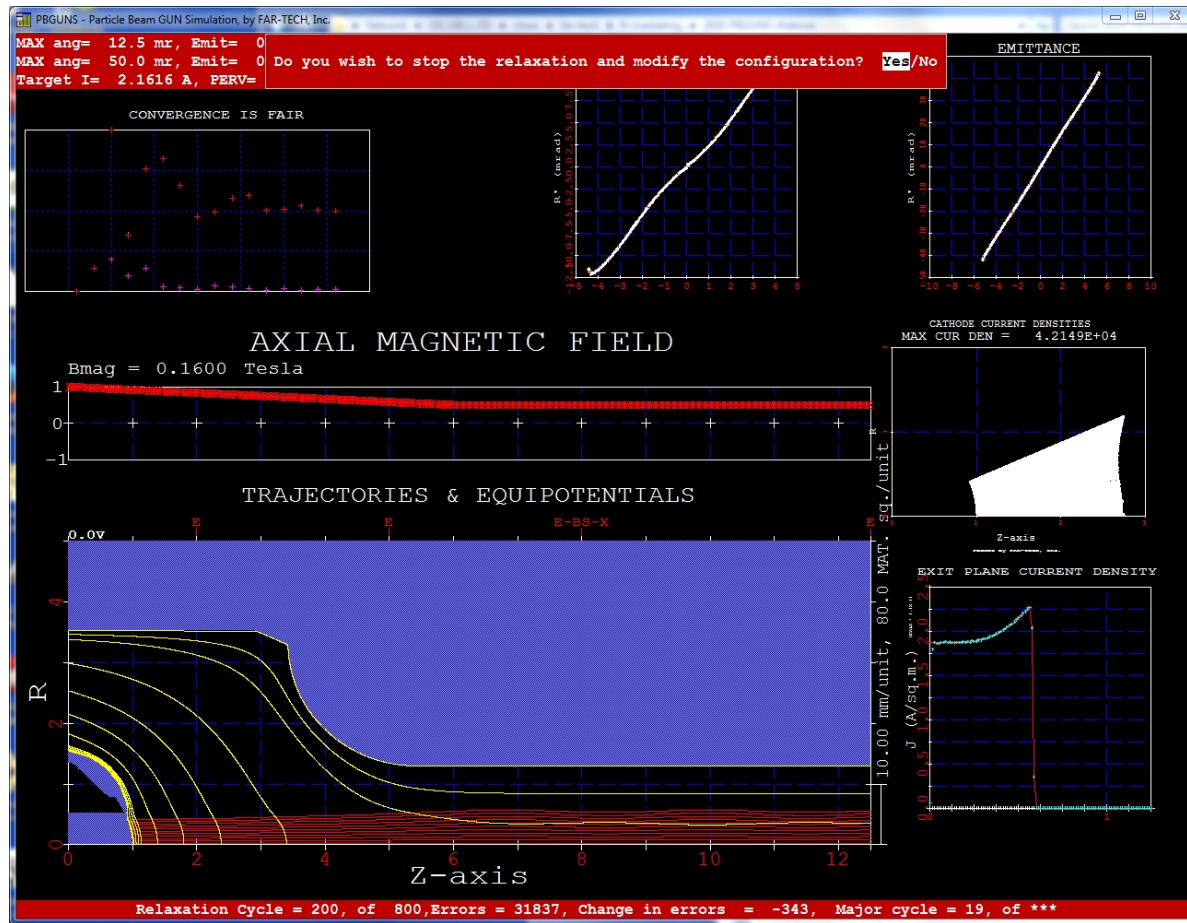**Set the emitter boundaries.**

Set RSTRT, ZSTRT, REND, and ZEND.

Step 5: Save the PBGUNS .DAT Input File

Press the save key and specify the filename.

Step 6: Run PBGUNS

The CAD Import Module…

-   is a powerful method of setting the geometry of a PBGUNS problem

- allows geometry to be manipulated with external CAD tools, as well as the interactive features within PBGUNS such as moving points or entire conductors.

To Conclude

- **Submit your PBGUNS questions to pbguns@far-tech.com**

- **The presentation will be available from our web site www.far-tech.com/pbguns**

- **Promotion period ends Jan 7, 2017**

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