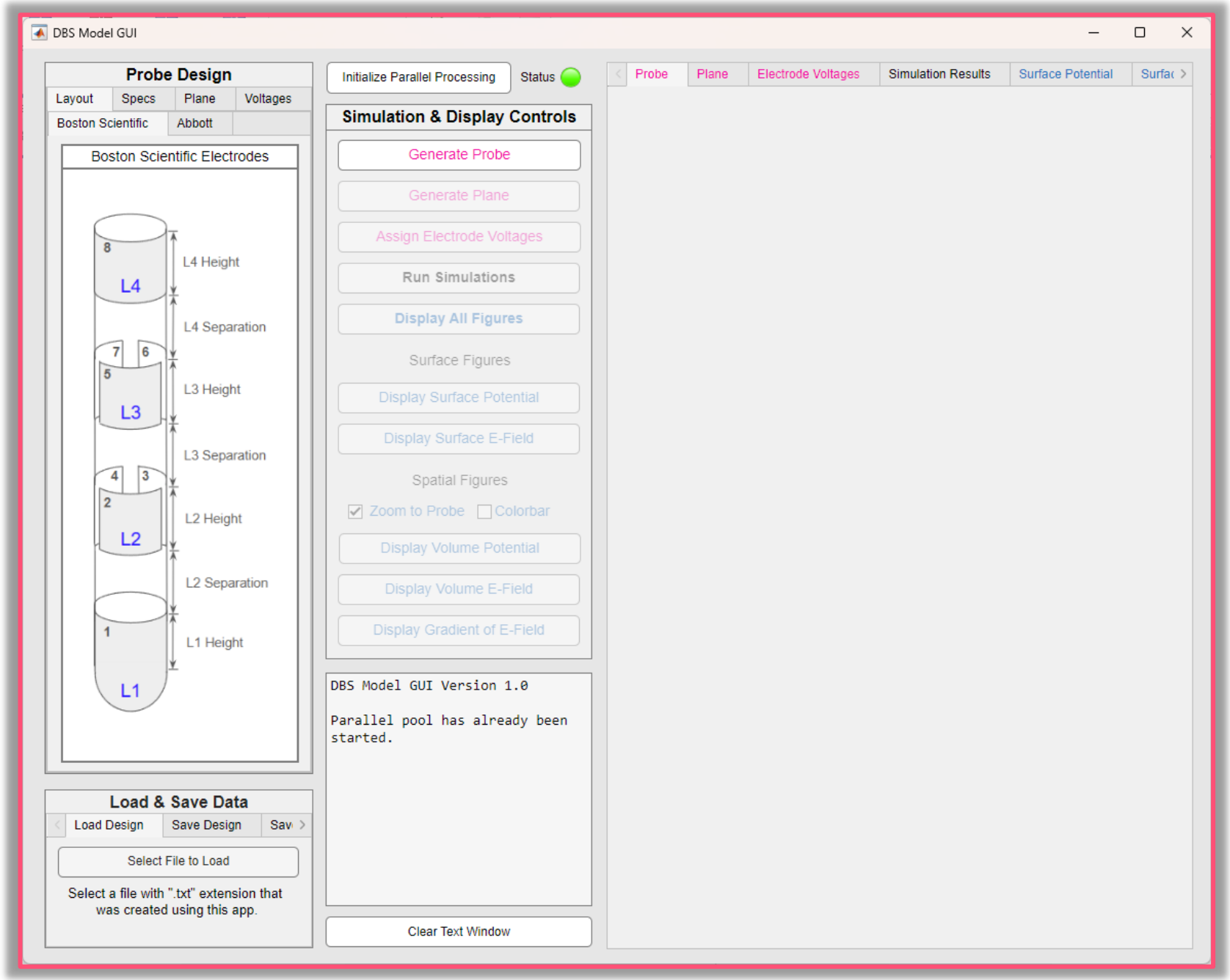
DBS MODEL GUI

USER GUIDE



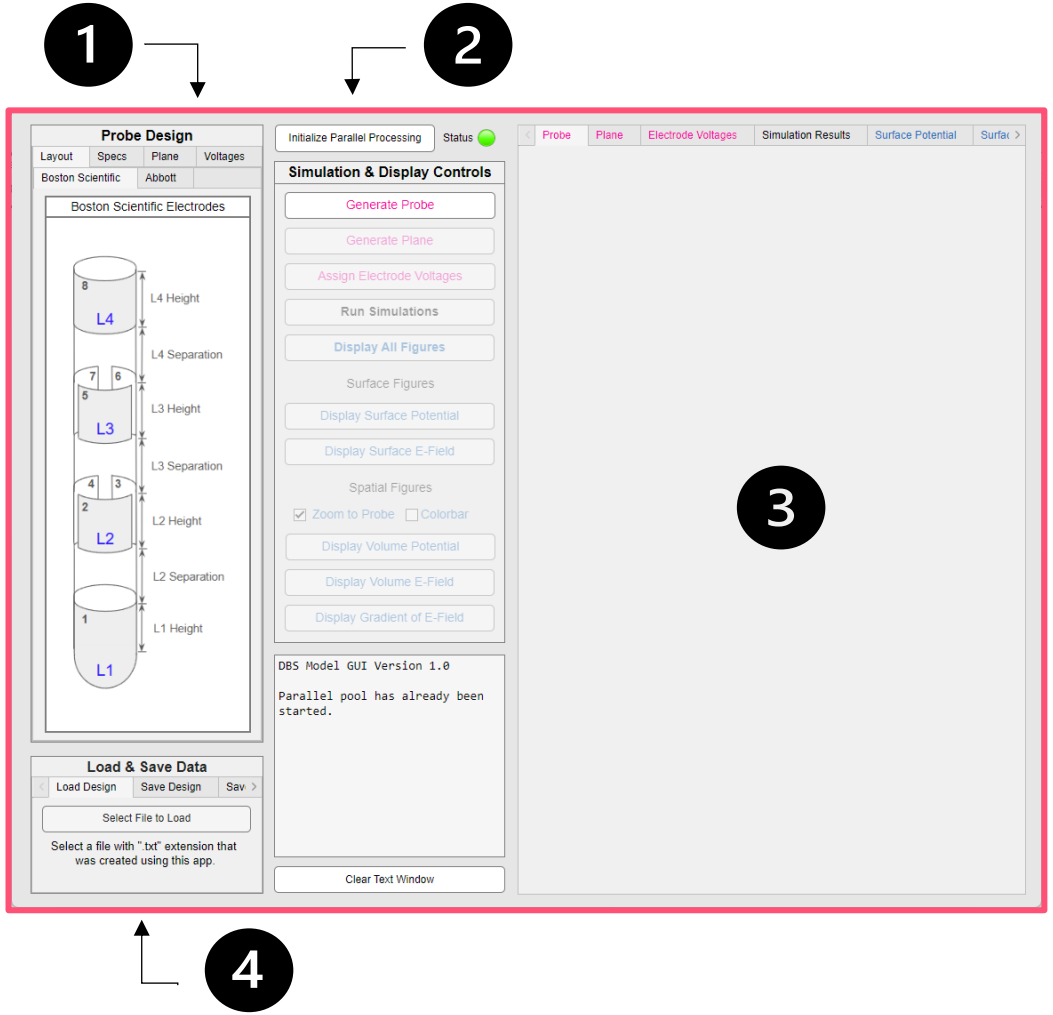
MATLAB REQUIREMENTS

Version

DBS Model GUI was created in **MATLAB 2023b.** It is recommended to use this version (or newer) to avoid incompatibility.

Necessary Toolboxes

- Deep Learning Toolbox
- Parallel Computing Toolbox
- Statistics and Machine Learning Toolbox



1. **Probe Design** panel – Enter probe, observation plane, volume conductivity, and electrode voltage parameters, or use the default values. Use diagrams for reference.

2. **Simulation & Display Controls** panel – First, click the pink buttons sequentially (top to bottom) to display the probe, plane, and electrode voltages specified in the **Probe Design** panel. Next, click the "*Initialize Parallel Processing*" button and wait for the "*Status*" indicator to turn green. Then, click "*Run Simulations*" and wait a few seconds for computations to complete. Click the blue buttons to display figures.

3. **Display** tab group – View generated models and figures, navigating through them using the tabs at the top. Simulation results (electrode currents and impedances) are tabulated here as well.

4. **Save & Load Data** panel – Save your current **Probe Design** panel data, **Display** tab group figures, and 3D E-field data. Previously saved probe designs can be loaded and used.

QUICK START GUIDE

Make sure all necessary MATLAB toolboxes are installed. These are listed on the previous page.

EXTENDED GUIDE

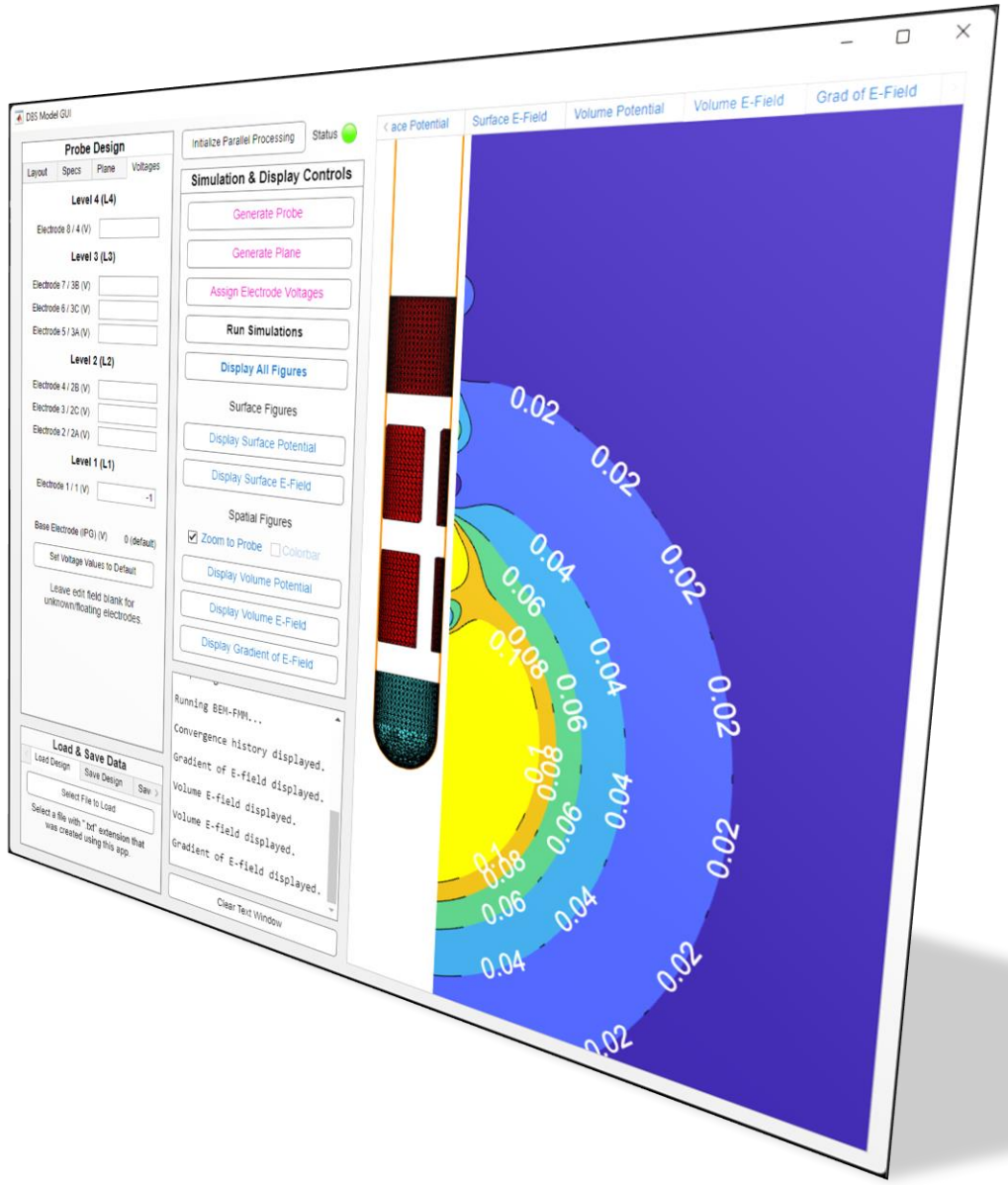
[1] **Probe Design** panel p.5-7
- Layout tab
- Probe tab
- Plane tab
- Voltages tab

[2] **Load & Save Data** panel p.8-11
- Load Design tab
- Save Design tab
- Save Figures tab
- Save 3D Data tab

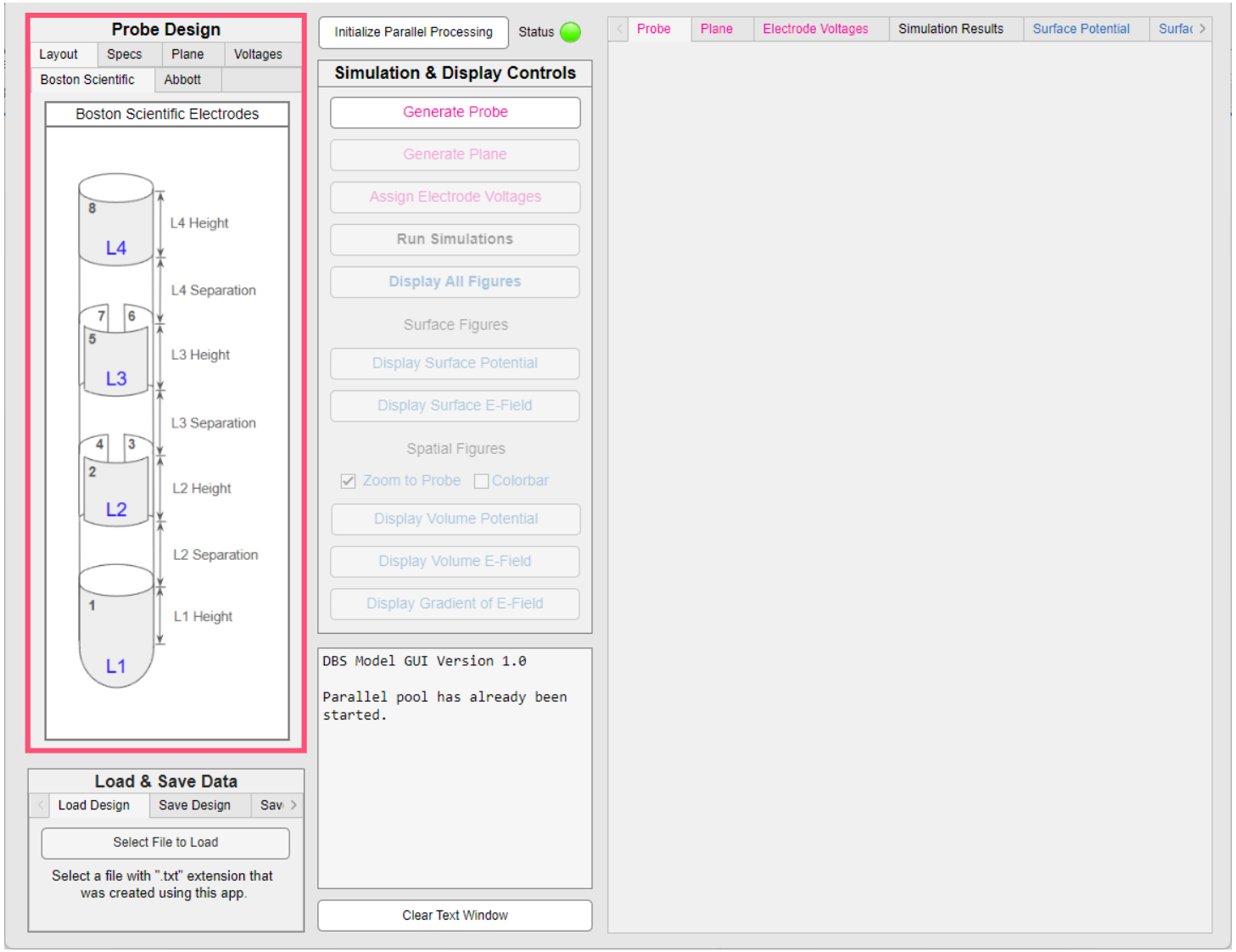
[3] **Simulation & Display Controls** panel p.12-14

[4] **Output Text Window** p.15

[5] **Display** tab group p.16-17



[1] PROBE DESIGN PANEL



Use the **Probe Design** panel to view and change probe dimensions, plane dimensions, volume conductivity, and electrode voltages.

Diagrams for the Boston Scientific and Abbott electrode configurations are shown for reference under the **Layout** tab.

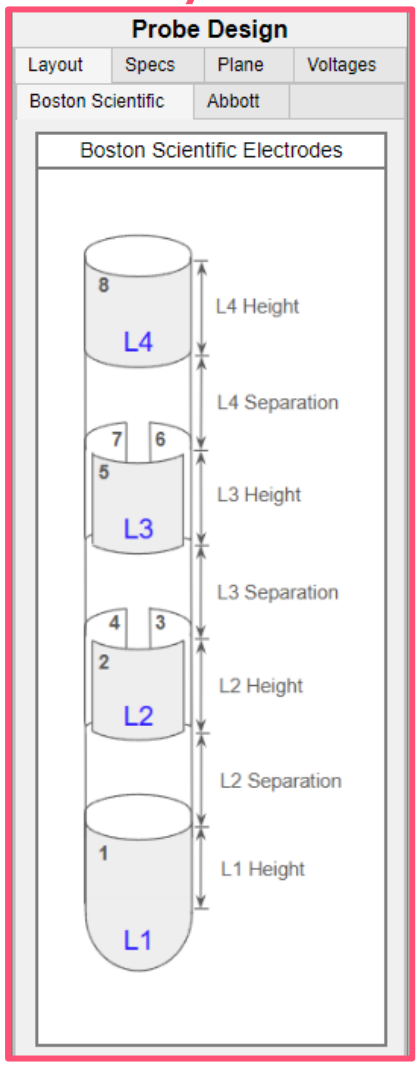
Changes made to all **Probe Design** panel tabs can be saved using the **Load & Save Data** panel below; previously saved data can be loaded here as well.

Units for quantities here are as follows:

- Lengths: [mm]
- Angles: [degrees]
- Voltages: [V]
- Electrical conductivity: [S/mm]

[1] PROBE DESIGN PANEL TABS (1)

Layout

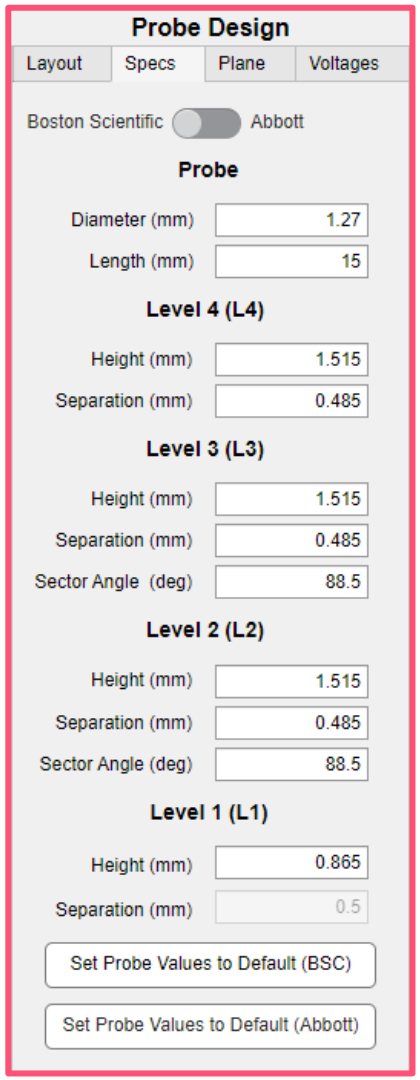


The **Layout** tab contains two sub-tabs: **Boston Scientific** and **Abbott.**

Each sub-tab contains the electrode configuration of the respective model type.

This information can be referenced when entering parameters for the probe specifications and electrode voltages.

Specs



The switch at the top of the **Specs** tab is used to select the desired base model configuration.

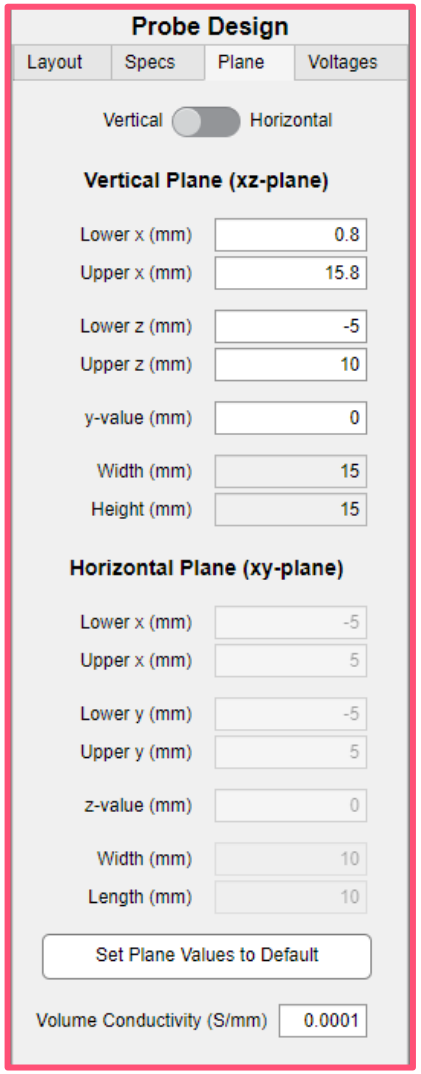
Enter numbers for the probe specifications in the white edit fields or use the "*Set Probe Values to Default*" buttons at the bottom.

The *L1 Separation* edit field near the bottom only applies to Abbott models and will only be editable if "Abbott" is selected using the switch at the top.

The *Sector Angle* for *L2* and *L3* must be the same. Editing one of the values will automatically change the other.

[1] MODIFIERS PANEL TABS (2)

Plane



The **Plane** tab is where the parameters of the vertical or horizontal observation plane ("2D slice") are entered.

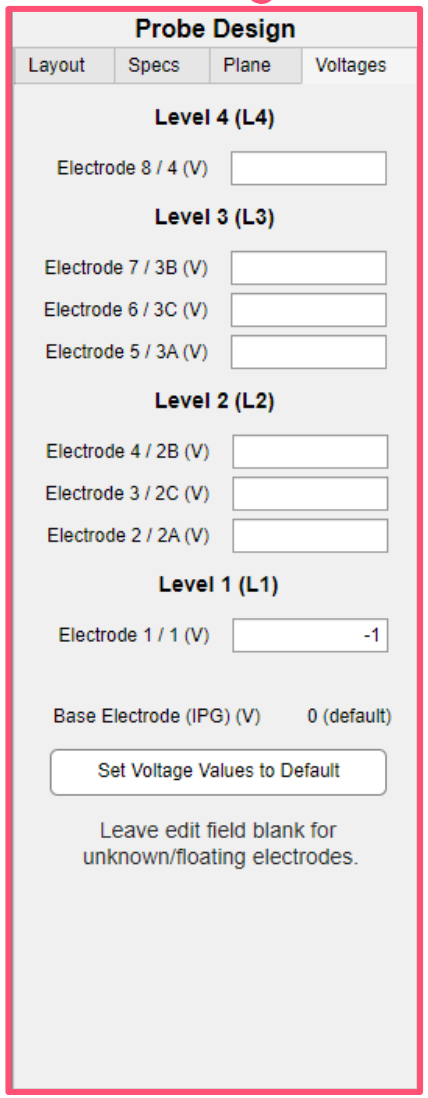
Use the switch at the top to select the desired plane type.

Enter values for the plane parameters in the white edit fields or use the "*Set Plane Values to Default*" button at the bottom.

The *Width*, *Length*, and *Height* fields are not editable; they only display the current dimensions of the plane.

Enter the surrounding volume conductivity using the white edit field at the bottom.

Voltages



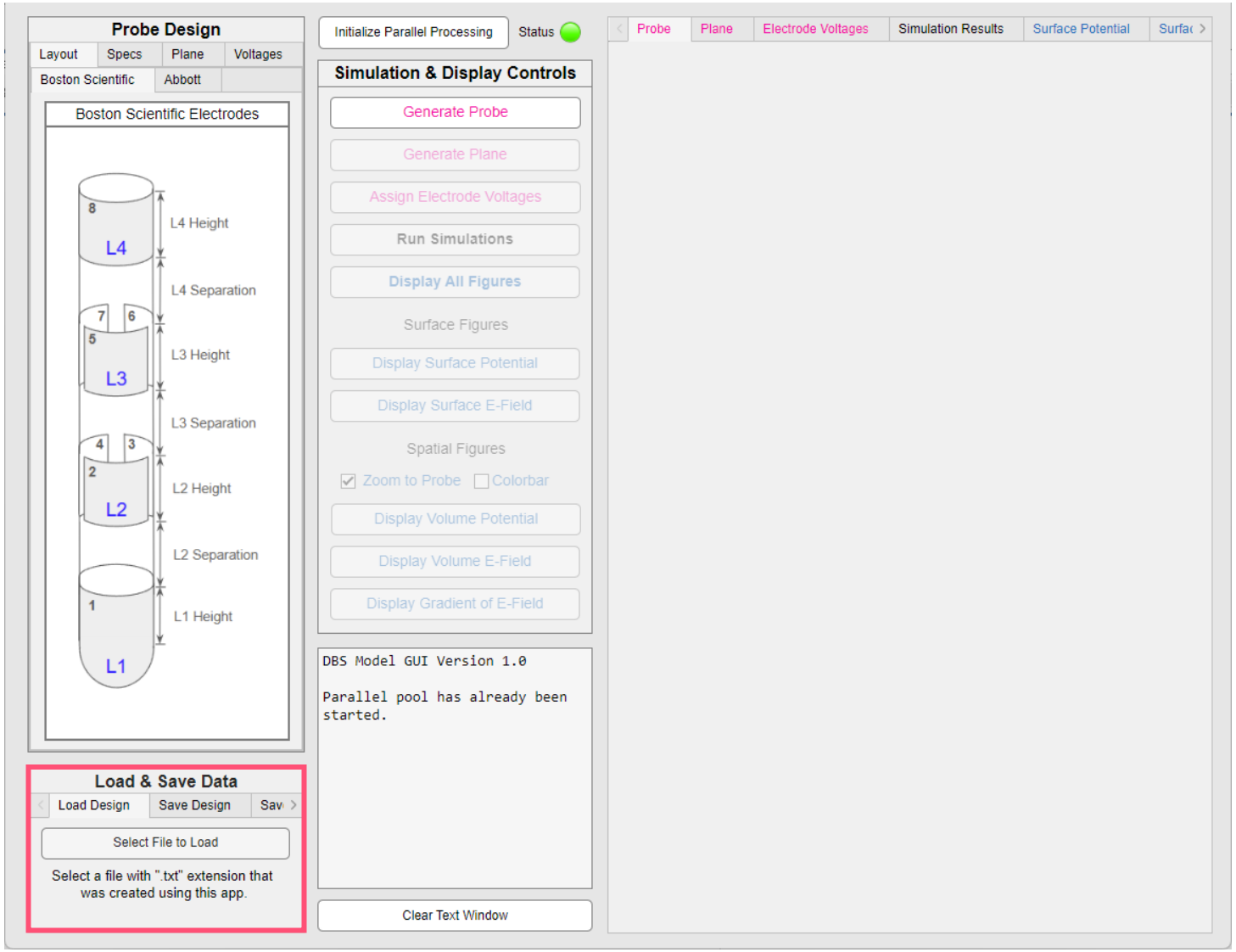
Because the electrodes of the Boston Scientific and Abbott models are numbered differently, the **Voltages** tab edit fields are labeled in this manner:

Electrode [BSC #] / [Abbott #] (V) …

Enter values for known electrode voltages in the white edit fields or use the "*Set Voltage Values to Default*" button at the bottom.

If certain electrodes are floating (also referred to as "high-impedance"), leave the respective edit fields blank.

[2] LOAD & SAVE DATA PANEL



Use the **Load & Save Data** panel to access previously saved **Probe Design** panel data (probe geometry, plane geometry, volume conductivity, and electrode voltages), save the current **Probe Design** panel data for future use, and save the 3D E-field.

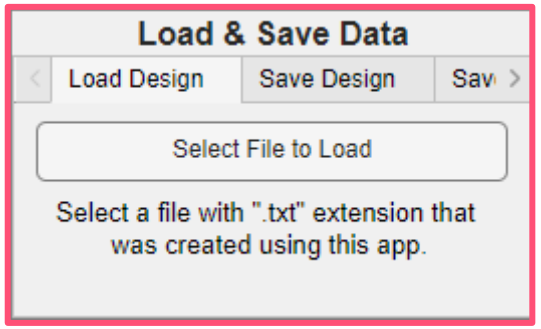
Figures can be saved but cannot be loaded into the GUI.

Files can be named as desired and will use the following file extensions:

- “.txt” for **Probe Design** panel data.
- “.fig”, “.jpg”, “.png”, or “.pdf” for displayed figures.

Files are saved to the current MATLAB directory.

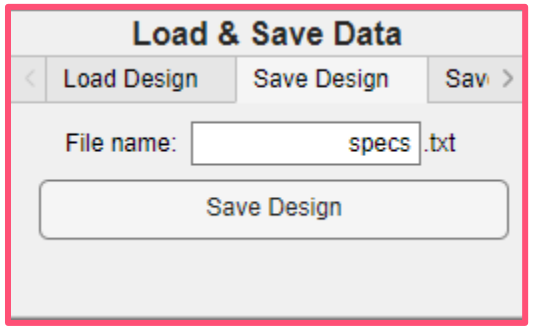
[2] LOAD & SAVE DATA PANEL TABS (1)



Load Design tab

If a model has been saved previously, you can load its corresponding ".txt" file into the GUI to reuse the data by clicking "*Select File to Load*". This will open a file explorer window.

Make sure the file you select is one generated by the GUI.



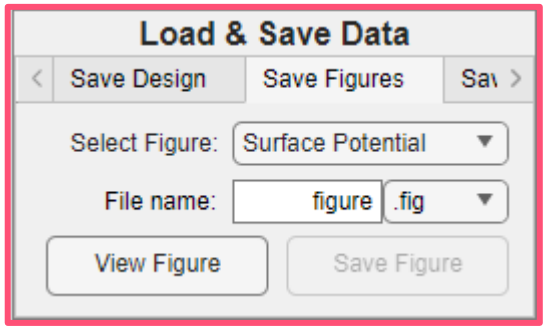
Save Design tab

To save the current **Probe Design** panel data for future use, first enter the name of the file to be generated in the white edit field.

Next, click the "*Save Design*" *button*.

Output Text Window text and MATLAB command window text will not be saved in this file.

[2] LOAD & SAVE DATA PANEL TABS (2)



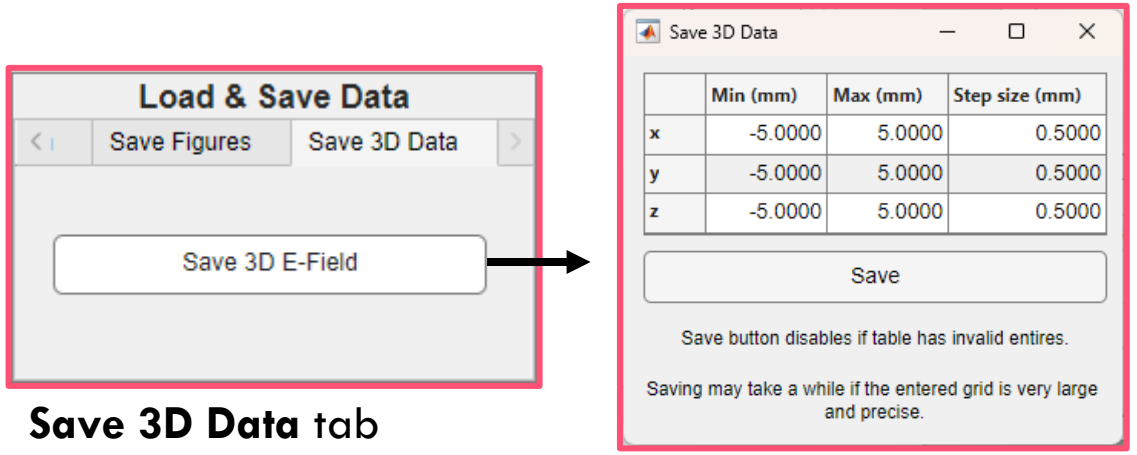
Save Figures tab

To save any generated figure, first select the desired figure using the dropdown menu.

Enter the name of the file to be generated in the white edit field.

Click "*View Figure*" to open a window with the selected figure. Resize and move the plot to view the portion of the figure to be saved.

Click "*Save Figure*" to save as-is and close the figure window.



Save 3D Data tab

To save the complete spatial electric field, click the "*Save 3D E-Field*" button. It is only available after the simulations have been run.

The **Save 3D Data** window will open, where lower bounds, upper bounds, and step sizes (in mm) can be entered for x, y, and z to form a 3D grid.

Click "*Save*" when done; it may take some time to finish. This data will be in the file "EField3D.txt".

See next page for more information.

[2] LOAD & SAVE DATA PANEL TABS (3)

Save 3D Data tab – generated "EField3D.txt" file

```
1   -5,-5,-5,0.00497146520186996,0.0049750954246351 9,0.00563748690540032
2   -5,-4.5,-5,0.00547926109886338,0.0049366300788513 1,0.00614202796511958
3   -5,-4,-5,0.00600945624402264,0.0048161301415915 3,0.00668004105297009
4   -5,-3.5,-5,0.00655492786096654,0.0045966465233081 8,0.00723041437620383
5   -5,-3,-5,0.00709828594220366,0.0042640547734566 5,0.00777820833197214
6   -5,-2.5,-5,0.00761791238743342,0.0038096226340639 2,0.00830417701593187
7   -5,-2,-5,0.00809158886378422,0.0032313111481526 2,0.00879062488143573
8   -5,-1.5,-5,0.00848890386353354,0.0025385803927417 5,0.0092010293560652
9   -5,-1,-5,0.00878913215495519,0.001749299456159 9,0.00951593950048667
10  -5,-0.5,-5,0.00897432116546215,0.0008918188054941 56,0.00971362540723673
11  -5,0,-5,0.00903443540250071,1.51655458741854e-06,0.00977840646978658
12  -5,0.5,-5,0.00899356525705382,-0.0008989224013802 4,0.00971091868132 79
13  -5,1,-5,0.00880012009151073,-0.0017595168700140 7,0.00951222861085823
14  -5,1.5,-5,0.00849163800170458,-0.00254824896498,0.00919813297679936
15  -5,2,-5,0.00808792826520135,-0.0032383573569541 7,0.00878895571648728
16  -5,2.5,-5,0.00761561399480879,-0.0038129242461092 6,0.00831523340760564
```

Each line is formatted as follows:

$x_1, y_1, z_1, E_{x1}, E_{y1}, E_{z1}$

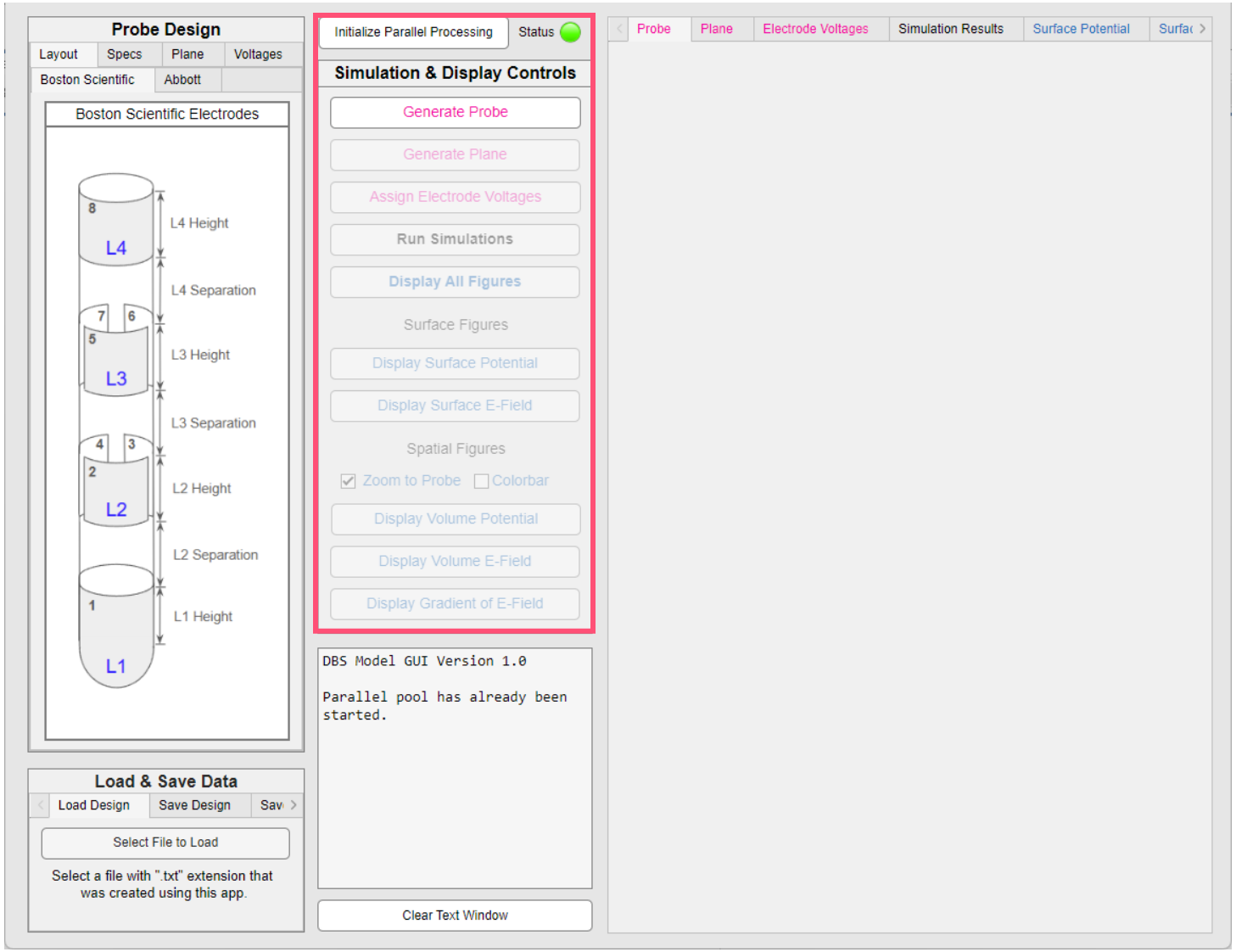
Point in grid (mm)

Electric field corresponding to point (V/mm)

Note: The electric field inside of the probe model is zero.

The first 16 lines of "EField3D.txt" are shown, having been saved using all default settings.

[3] SIMULATION & DISPLAY CONTROLS PANEL



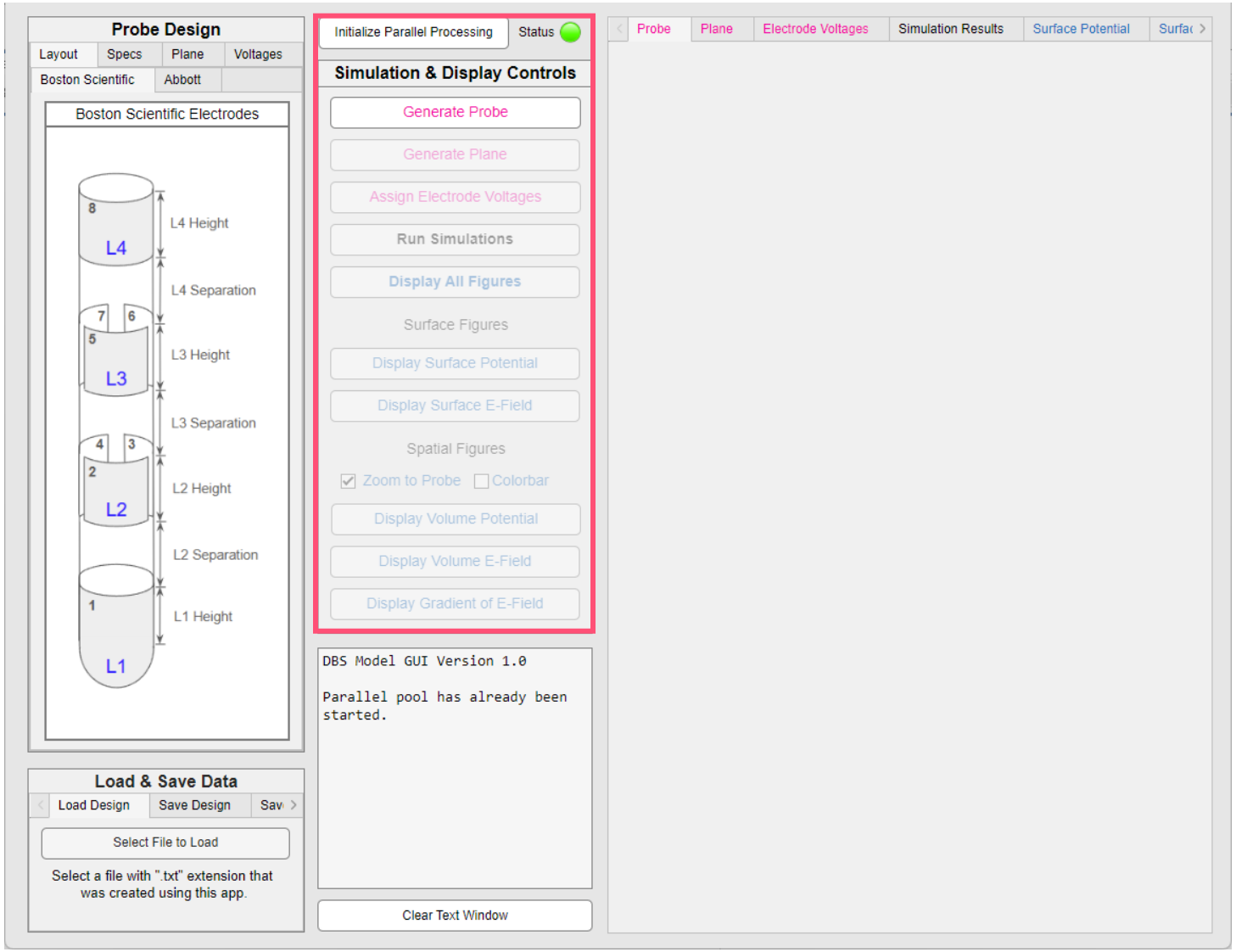
Use the **Simulation & Display Controls** panel to generate & display figures and run model simulations.

Make sure to click the "*Initialize Parallel Processing*" button above the panel before running simulations. The "*Status*" indicator will turn yellow when parallel processing is preparing, then green when it is ready.

Changes made in the **Probe Specs** panel do not automatically update the displayed figures. If a change is made after figures have been generated or simulations have been run, it will require updating the relevant figures and simulation results.

See next page for more information.

[3] SIMULATION & DISPLAY CONTROLS PANEL



The pink buttons are for displaying the model specified by the **Probe Design** panel. Click them sequentially (top to bottom) to generate all necessary information for the simulations. Once all three are clicked, the "*Run Simulations*" button will be enabled.

Click the "*Run Simulations*" button next; it may take a few seconds to complete. Then, use the blue buttons to display the output figures. The "*Display All Figures*" button will generate all figures at once, rather than individually.

The "*Zoom to Probe*" checkbox ensures the display figure automatically zooms to the default relevant area rather than the whole observation plane (recommended). This setting is available for vertical planes only.

The "*Colorbar*" checkbox removes numbers from the contour figure itself and enables a color bar for reference to the right of the figure. Available for horizontal planes only.

See next page for more information.

[3] SIMULATION & DISPLAY CONTROLS PANEL

"*Run Simulations*" button – generated "probecurrents.txt" file

```
1   0,Inf
2   0,Inf
3   0,Inf
4   0,Inf
5   0,Inf
6   0,Inf
7   0,Inf
8   -0.000832283140678509,1201.51418564692
9   0.00083215743736071 1,0
```

All 9 lines of "probecurrents.txt" are shown, having been saved using all default settings.

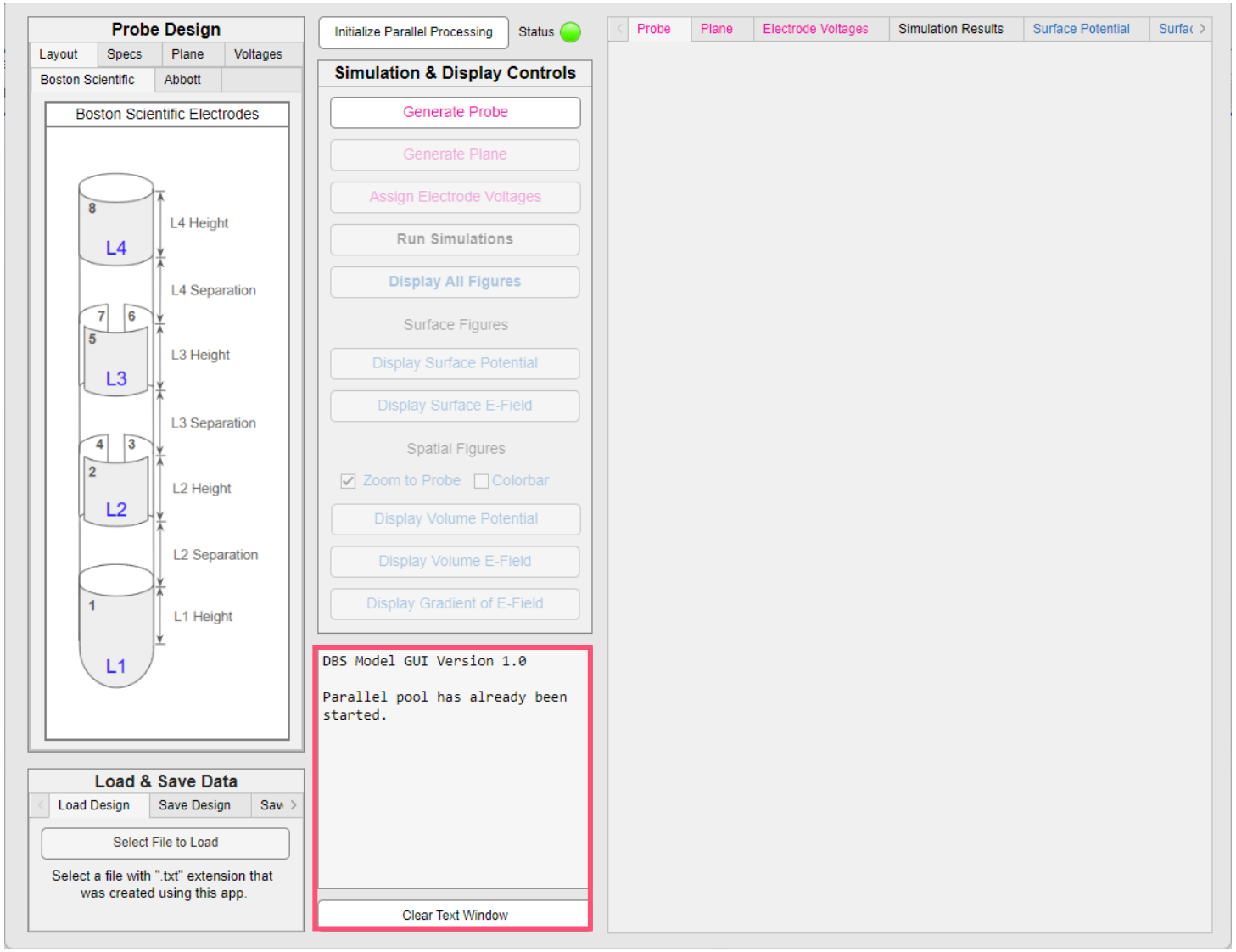
The file is formatted as follows:

Current,Impedance	← Electrode 8 /4
Current,Impedance	← Electrode 7 / 3B
Current,Impedance	← Electrode 6 / 3C
Current,Impedance	← Electrode 5 / 3A
Current,Impedance	← Electrode 4 / 2B
Current,Impedance	← Electrode 3 / 2C
Current,Impedance	← Electrode 2 / 2A
Current,Impedance	← Electrode 1 / 1
Current,Impedance	← IPG

Note: The units for these quantities are

- Current: [A]
- Impedance: [Ohms]

[4] OUTPUT TEXT WINDOW

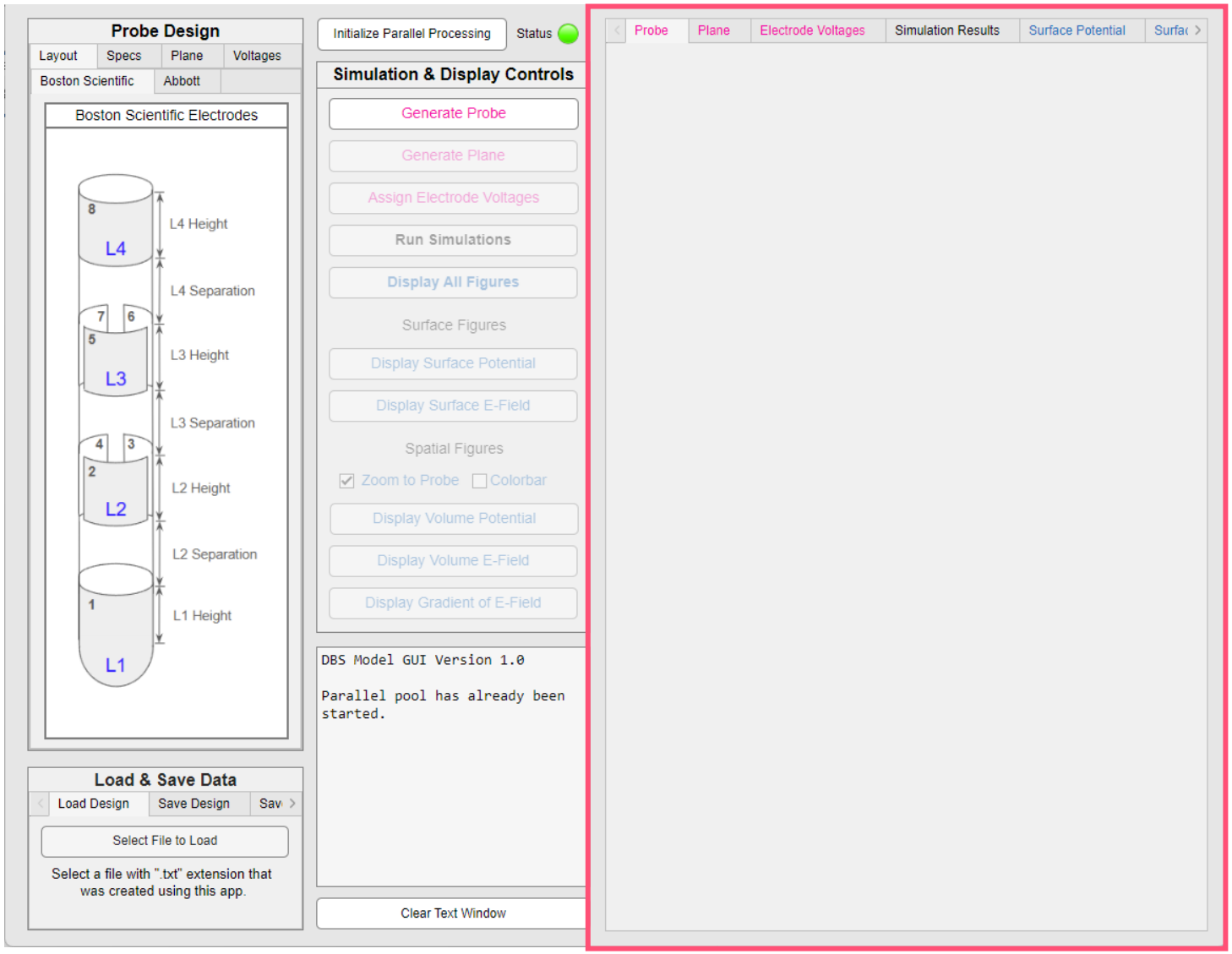


The **Output Text Window** is for viewing information about ongoing and completed processes.

The window can be cleared at any time by clicking the "*Clear Text Window*" button below.

For more extensive outputs, view the MATLAB command window.

[5] DISPLAY



The **Display** tab group is for viewing generated figures. The tabs will be empty until their respective figure is generated using the **Simulation & Display Controls** panel.

Previously generated figures can be accessed by navigating through the tabs at the top.

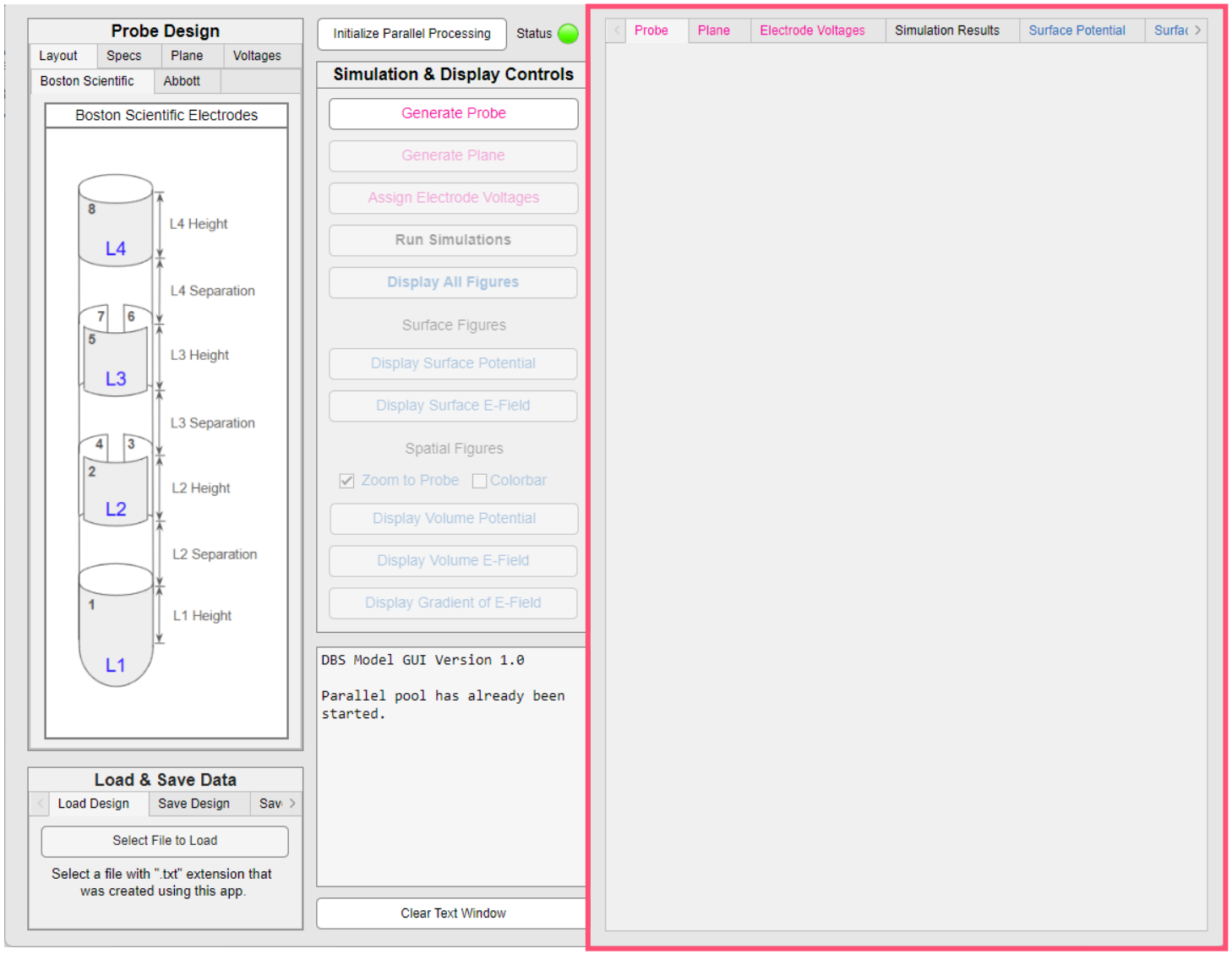
Figures do not automatically update when the parameters in the **Probe Specs** panel are changed. They must be updated using the **Simulation & Display Controls** panel.

Figures can be interacted with using the standard MATLAB toolbar at the top of each figure.

Figures can be saved using the rightmost tab of the **Load & Save Data** panel.

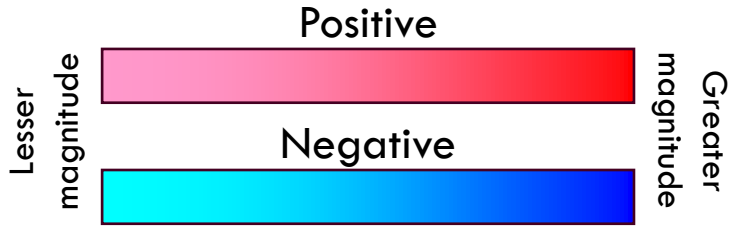
See next page for more information.

[5] DISPLAY



Units for each figure are as follows:

- Probe: [mm]
- Plane: [mm]
- Electrode Voltages:



0V depicted as black

Floating electrodes depicted as yellow

- Simulation results:
  - Convergence history: N/A
  - Voltage: [V]
  - Current: [A]
  - Impedance: [Ohms]
- Surface Potential: [V]
- Surface E-Field: [V/mm]
- Volume E-Field: [V/mm]
- Gradient of E-Field: [V/mm^2]
- Volume Potential: [V]