HD-Explore™ / tDCS -Explore™

Quick Start Guide

Version 3.1

August 2015

Description:

HD-Explore™/tDCS-Explore™ is a Soterix Medical Neurotargeting software that can be used in conjunction with any Soterix Medical Transcranial Direct Current Stimulation (tDCS) device. It allows researchers and clinicians to investigate brain targeting for their own High Definition (HD) and Conventional Sponge-tDCS configurations in order to rationally plan protocols.

Items included

Two Plug-and-Play USB drives are provided. There is no need to install any software and drivers. One drive holds the Data (Data drive) while the other functions as a key to access it (Unikey drive).

System Requirements

HDExplore™ runs on the following versions of Windows: XP, Vista, 7, and 8 (32 bit and 64 bit). The minimum recommended configuration is Intel Pentium Processor or higher with 2GB RAM.

Instructions

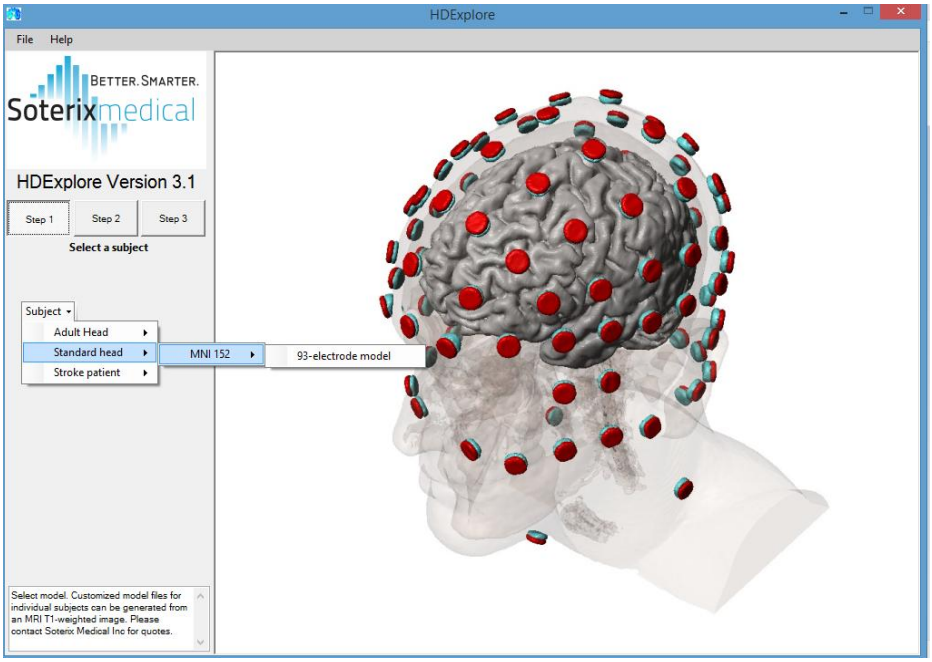
Opening HD-Explore™/tDCS-Explore™

1. Insert the Data drive into your computer's USB-port.
2. Insert the Unikey drive into your computer's USB port.
3. Double-click the Data USB folder icon in My Computer to open the folder named **HDExplore_v3.1**
4. Choose your platform (32 bit or 64 bit). The executable file is under the corresponding folder.
5. Double click the executable file to launch the application

Step 1: Select a Subject

The basic HD-Explore™ version comes preloaded with three neurologically normal adult male heads (**Adult male 1**, **Adult male 2**, and **Adult male 3**), and one standard adult head (**MNI 152**). If more heads are available in your version, choose the model that best approximates the head of your subject.

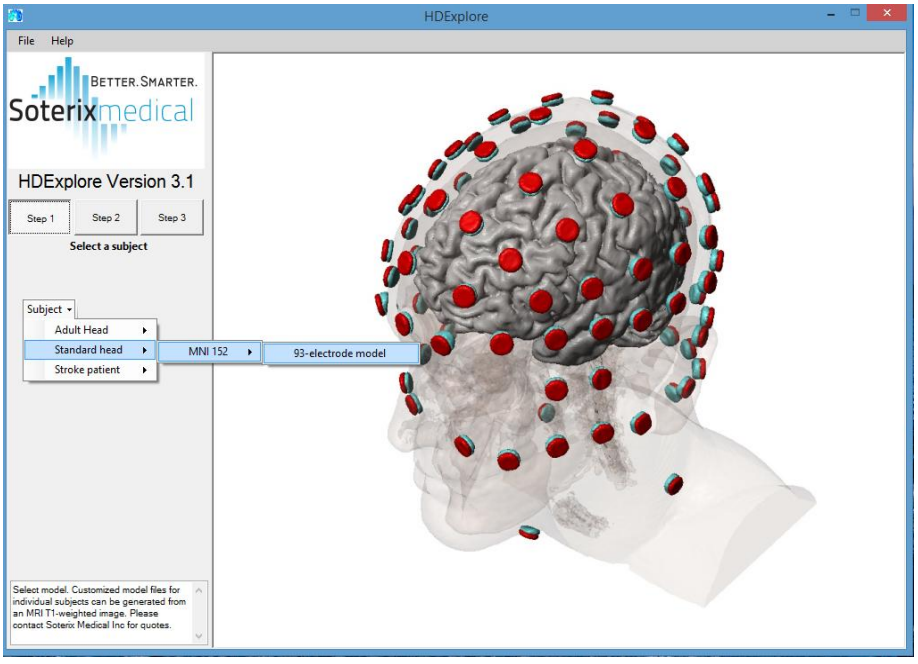
In the figure below, for the basic version, **MNI 152** standard head is selected. Hovering the mouse over the text will choose the respective head.



Choosing Electrode Density

For the **Adult male 1** head model, HD-Explore™ allows stimulation using a **93**- or **332-electrode model**. Higher electrode densities allow for simulation of sponge electrode configurations (*see tDCS-Explore™ starting Page 17*).

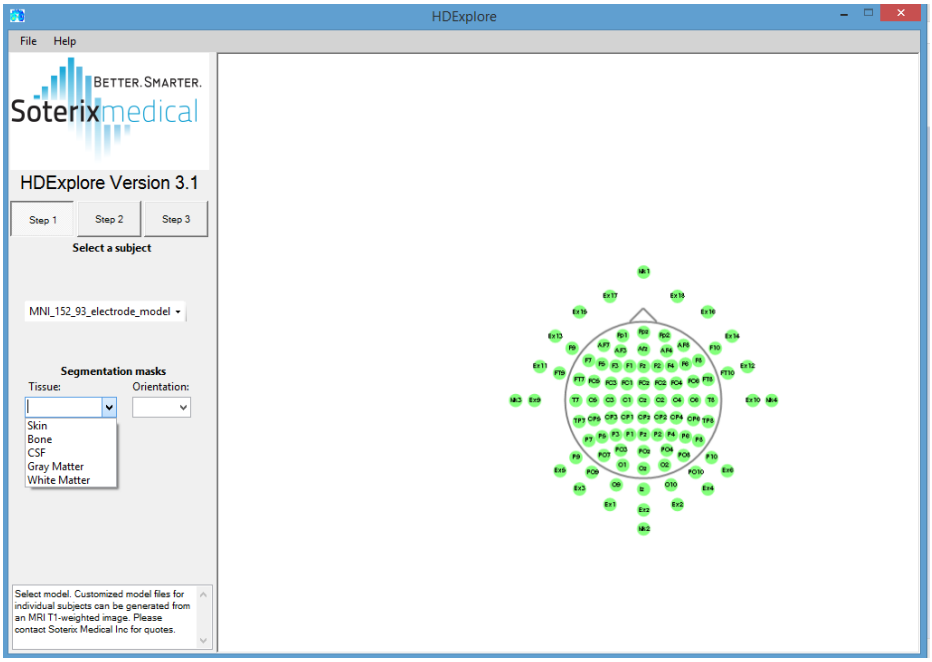
We will begin by choosing the **MNI 152** standard head**,** which is a 93-electrode model.



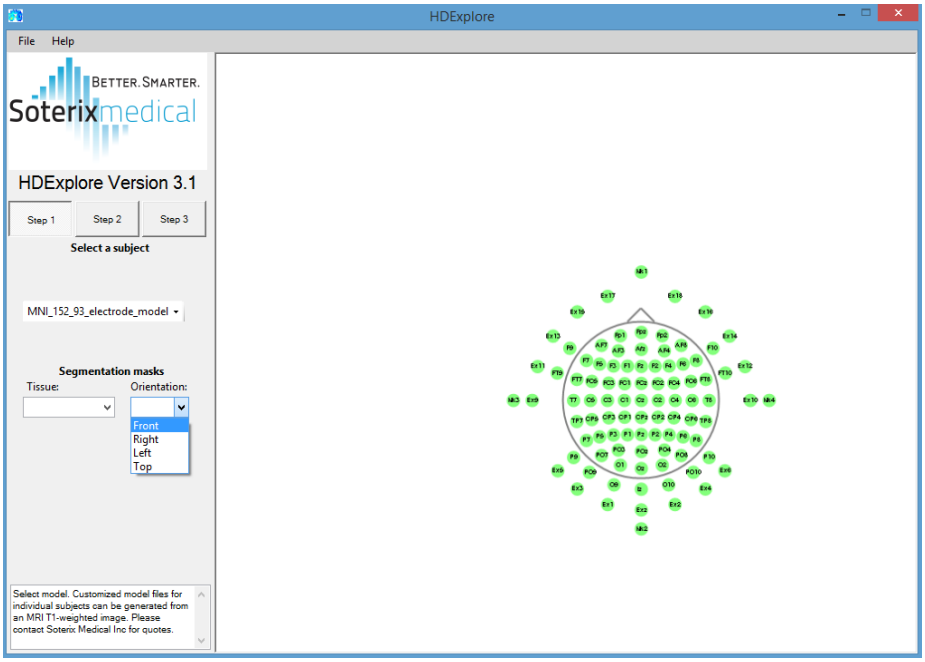
Viewing Segmentation Masks

HD-Explore™ allows the user to view the segmentation masks (Skin, Bone, CSF, Gray Matter, and White Matter) of the selected head through four different orientations.

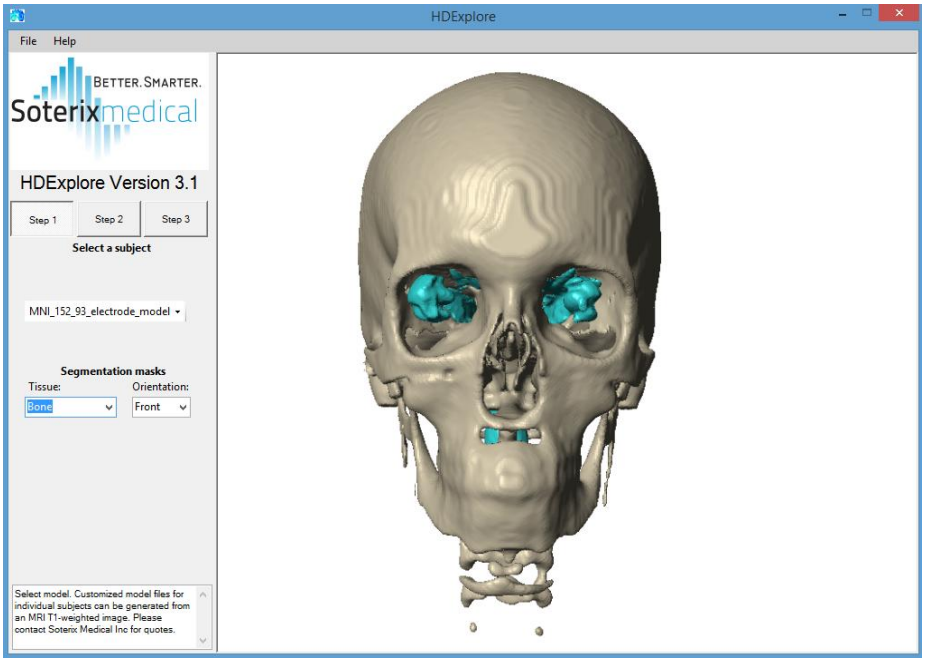
To select a segmentation mask click the downward pointing arrow in the dialog box labeled **Tissue.** Then select the tissue type that you want to view.



Likewise, to select an orientation (Front, Right, Left, and Top) click the downward pointing arrow on the dialog box labeled **Orientation**. Then select the orientation that you want to view.

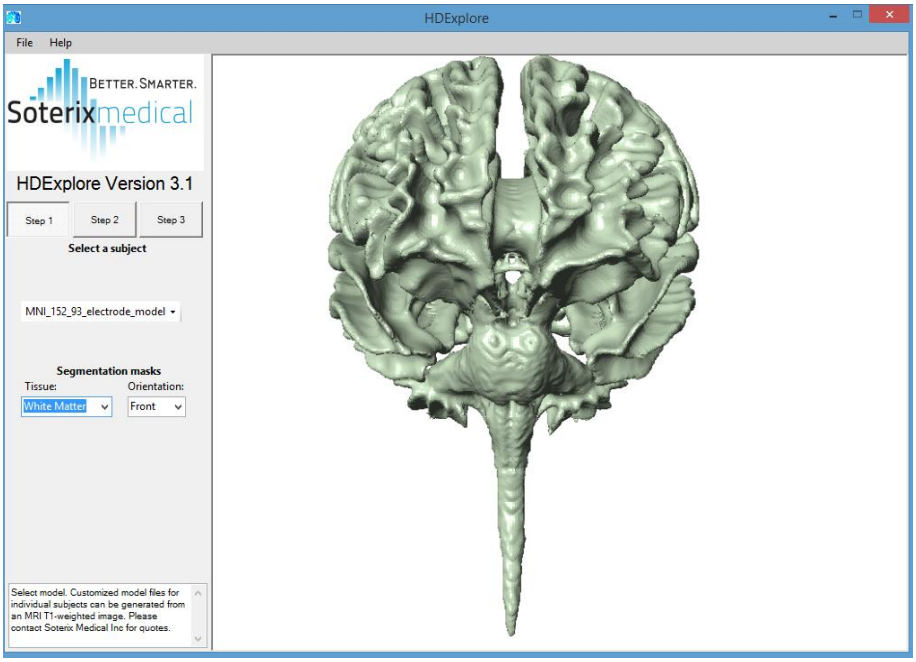


Clicking on a segmentation mask will then load an image of the tissue at the selected orientation. The image below shows the Front view (orientation) of the Bone (tissue) for the **MNI 152** standard head.

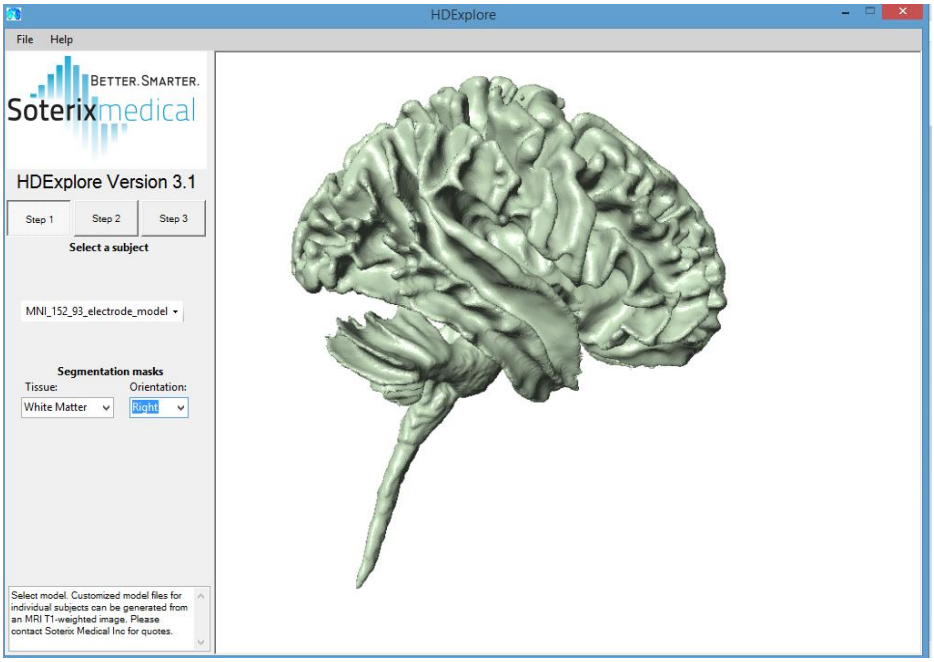


Once you click on the downward pointing arrow or anywhere inside the dialog box, the corresponding box gets selected. This is denoted by an entry highlighted in blue in the box. You can now simply use the direction arrow keys or the mouse scroll wheel to switch between entries. In the figure above, the **Tissue** dialog box is selected indicated by an entry highlighted in blue. You can use the scroll wheel or the direction

key to switch to the White Matter tissue while keeping the **Orientation** fixed at Front (see below).

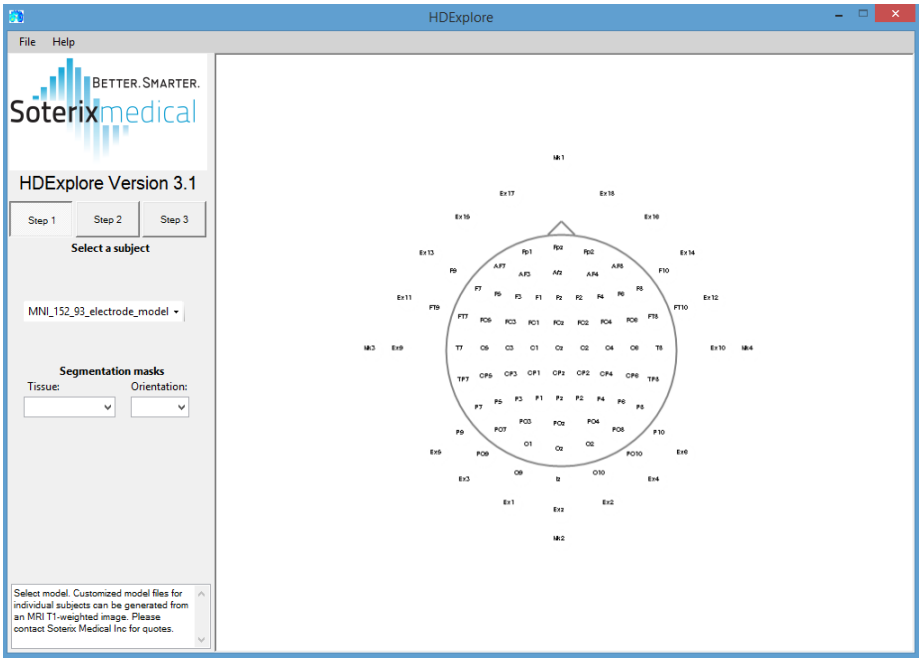


You can now click on the downward pointing arrow of the **Orientation** dialog box or click anywhere inside to select the box (see below). The orientation entries can be simply changed using the direction arrow keys or by the mouse scroll wheel.



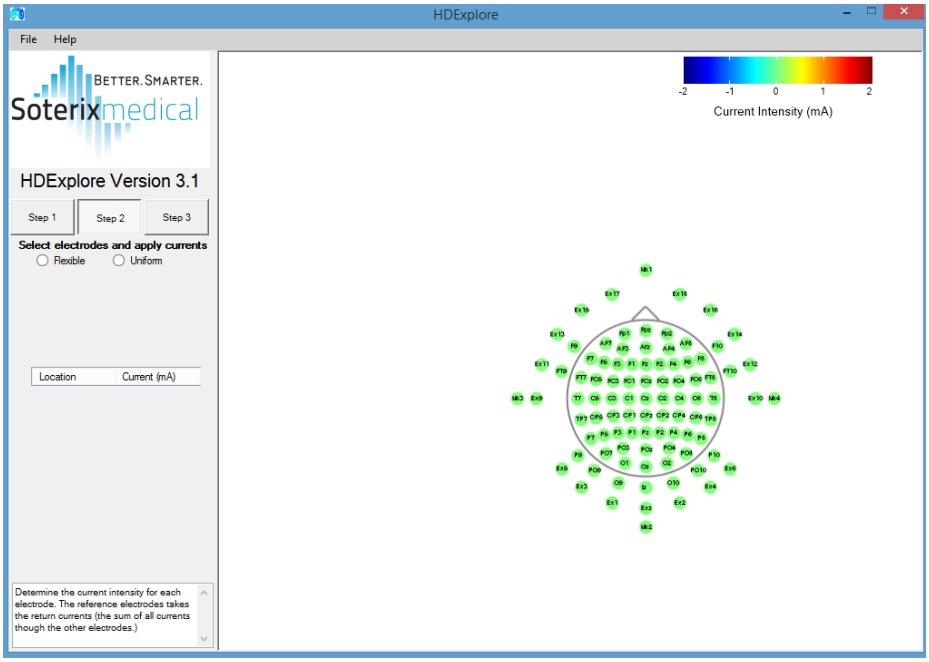
Choosing Electrode Criteria

Once the **93-electrode model** is selected, HD-Explore™ will create a 2D **Electrode Map** denoting the placement of 93 electrodes on the head. If a denser placement is desired, repeat Step 1 to select **Adult male 1** and then select the **332-electrode model** option.

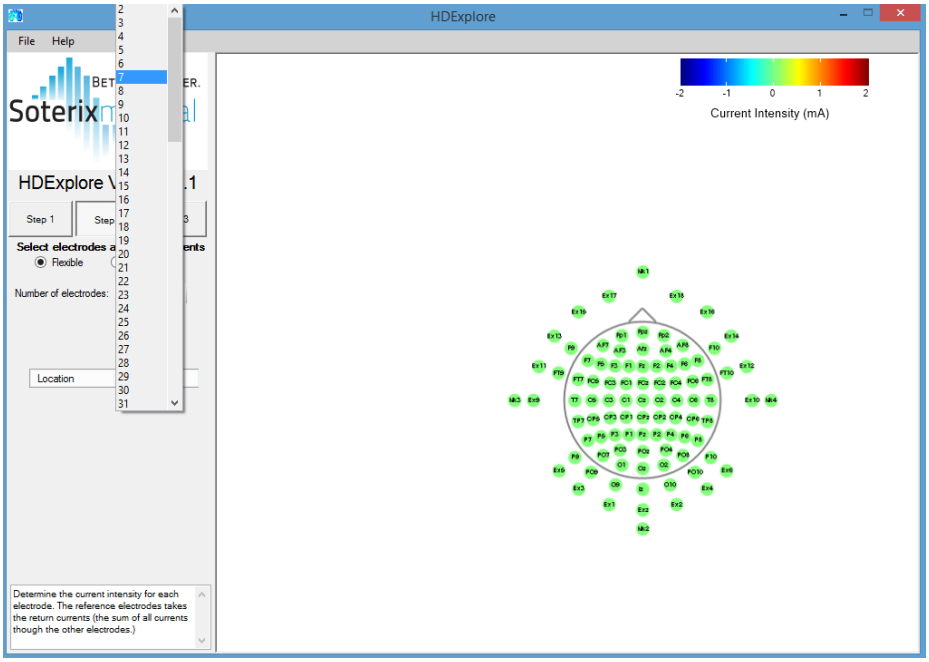


Step 2: Selecting electrodes and apply currents

With selection of Step 2 button, all available electrode locations are shown in a 2D **Scalp Map**. The false color map and corresponding legend indicates that zero current is currently being injected through each electrode. HD-Explore™ allows selection of the configuration of electrodes in either *flexible* or *uniform* manner. Flexible selection allows user to set any current intensity value to be injected through each selected electrode location. Uniform selection automatically distributes the total planned current uniformly across the total number of electrodes.

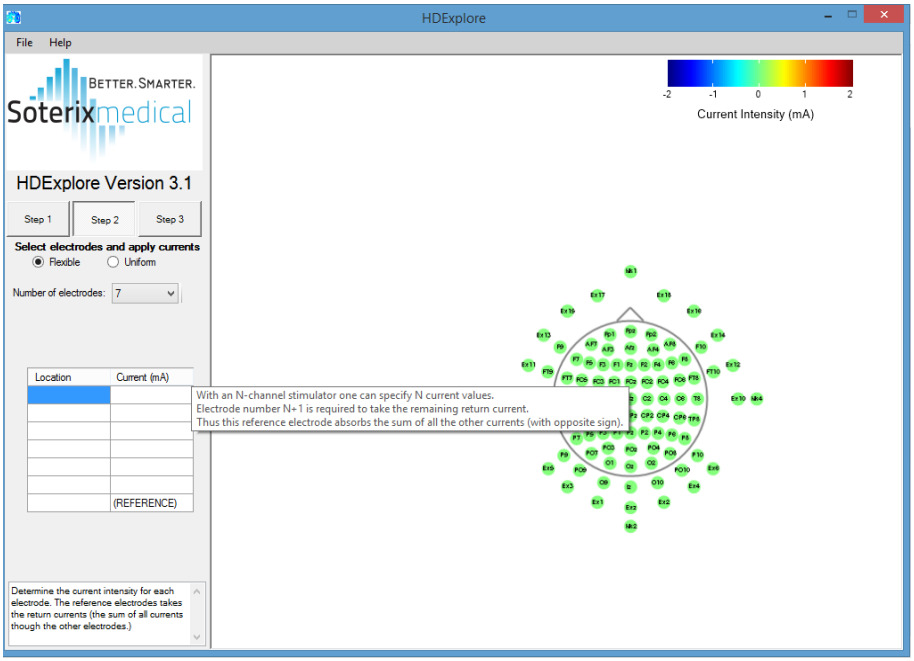


In this example a *flexible* configuration will be used. Once *flexible* is selected, HD-Explore™ will ask for the number of electrodes that are going to be used. For this configuration, **N=7** electrodes were chosen, as seen in the figure below.

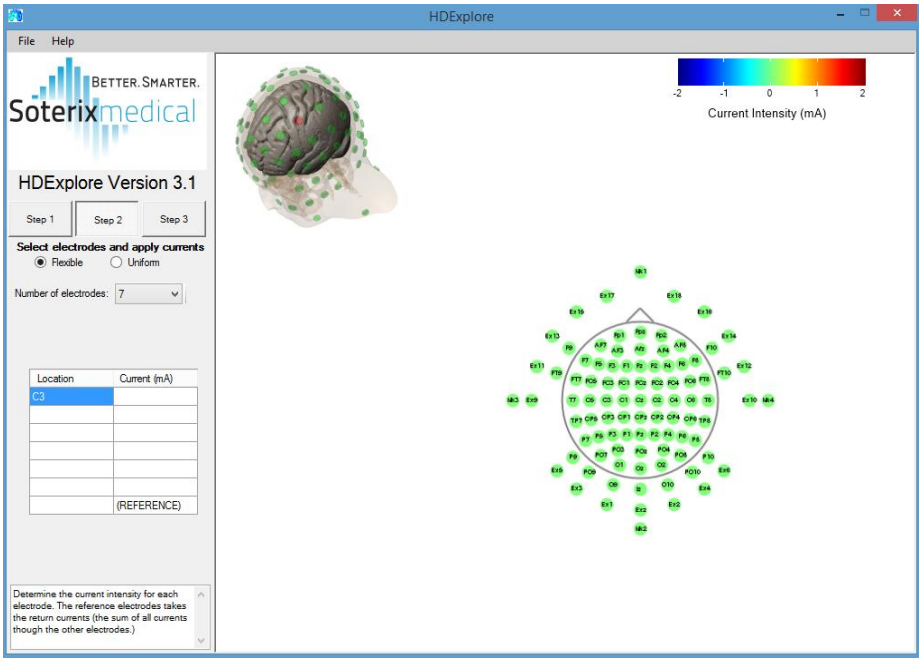


HD-Explore™ will then automatically create a table where the selected electrode **locations** and their **current intensities (mA)** will be stored.

The first electrode and its current intensity will now be set. Ensure that the **Location** entry in table is highlighted in blue before selecting your first electrode. If not, simply click in the entry to enable allowing selected input to be stored.

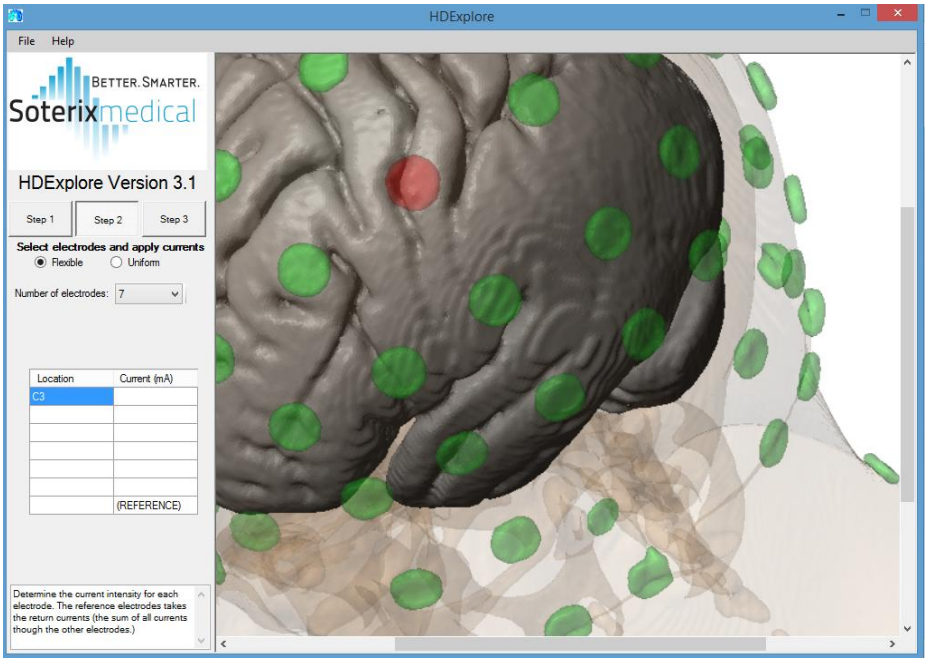


We will begin with electrode C3 as shown in the figure below. Clicking on the electrode icon on the **Scalp Map** will select the electrode.



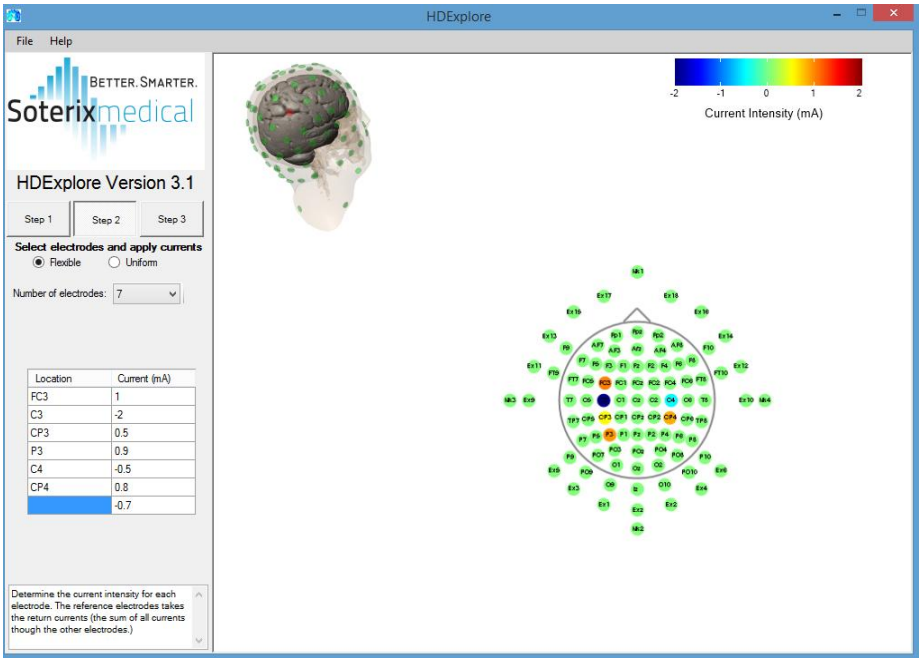
This will not only add the electrode to the list (entry labeled in blue), but also show you where the electrode is on the **3D view** of the **MNI 152** standard head on the top left corner.

Double click on the **3D view** to zoom in. The electrode selected will be either dimmer color than the others or will be red in color.

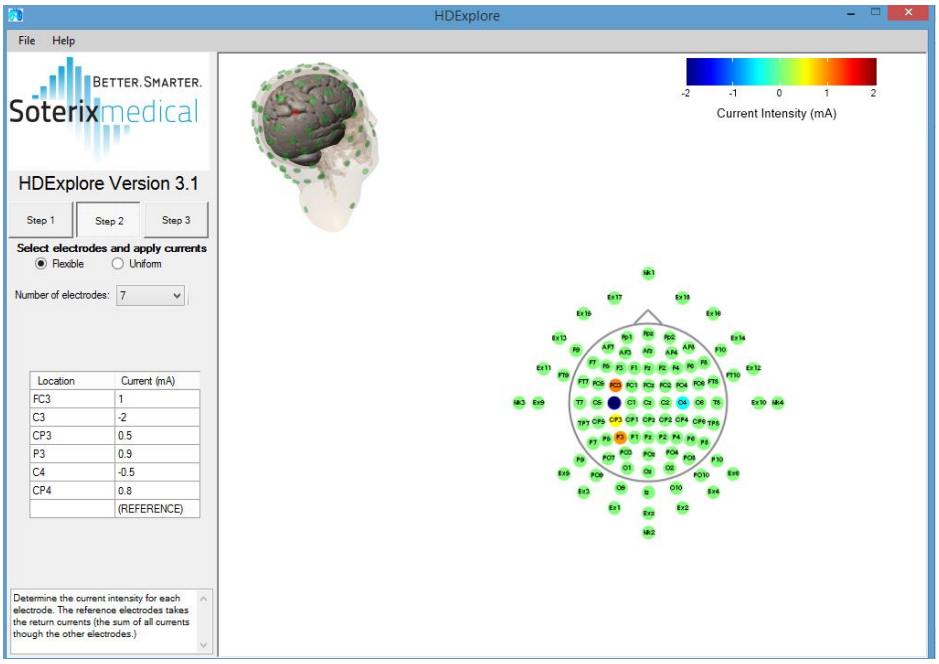


Double Click on the **3D view** again to zoom out. Now enter the desired current to be injected through the chosen electrode (C3). Continue repeating this process until each electrode in your desired configuration is selected and its corresponding **Current (mA)** is set.

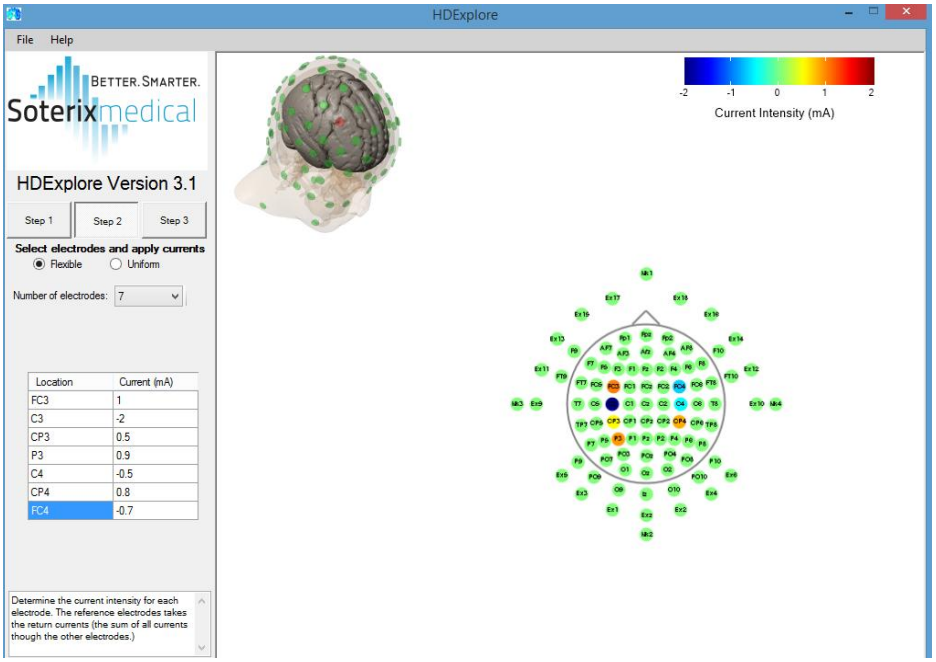
The selected electrodes will change colors on the **Scalp Map** based on the current intended to be injected. The **3D view** will continue to rotate to the position of the current selected electrode as electrodes are selected one by one.



In this particular example, any 7 electrodes on the head of the available 93 locations can be chosen to create your desired configuration. However, you can only set current for the first N-1 electrodes, since the software automatically enters value of the Nth electrode to ensure current conservation. This Nth electrode is referred to as the reference electrode and equals the negative sum of all other currents (N-1) chosen.

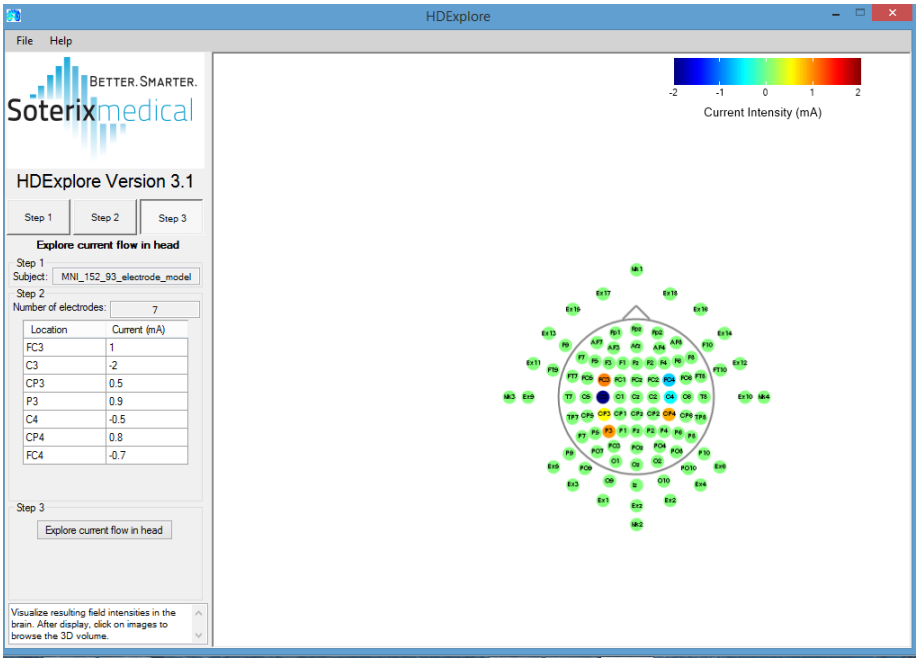


Once the entry to enter the location of the reference electrode is chosen (entry is highlighted in blue), HD-Explore™ will automatically assign it a current. The user can then choose the final electrode location. This process can be seen in figure below.

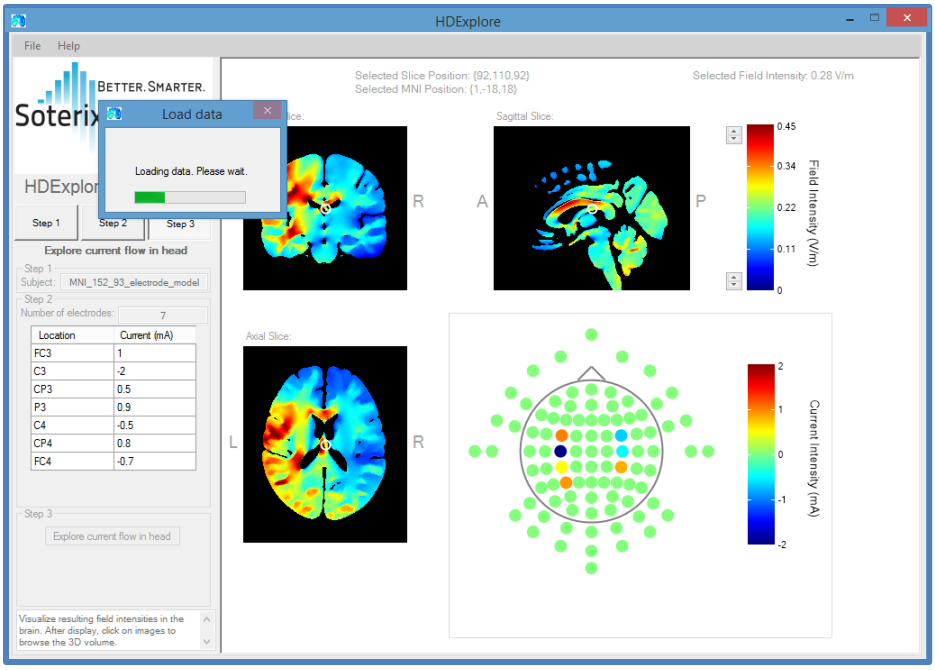


Step 3: Explore Current Flow in Head

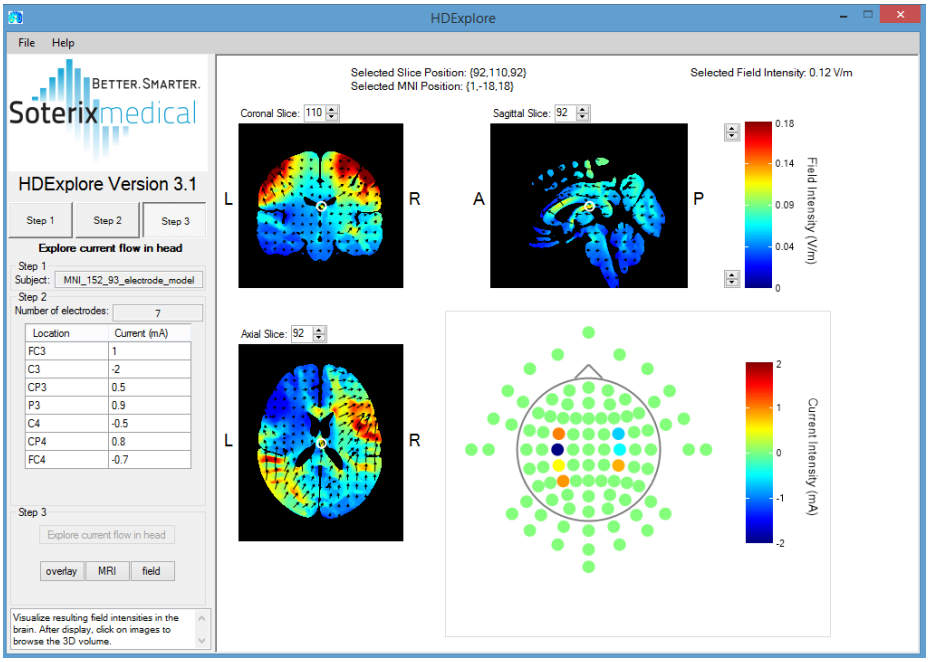
Once all electrodes and current intensities have been selected, proceed to Step 3. With Step 3 button press, a button will appear on the bottom left of the screen **Explore Current Flow in Head.** Clicking this will begin loading the simulation of current



flow through the head. Observe the progress in the **load data** window.

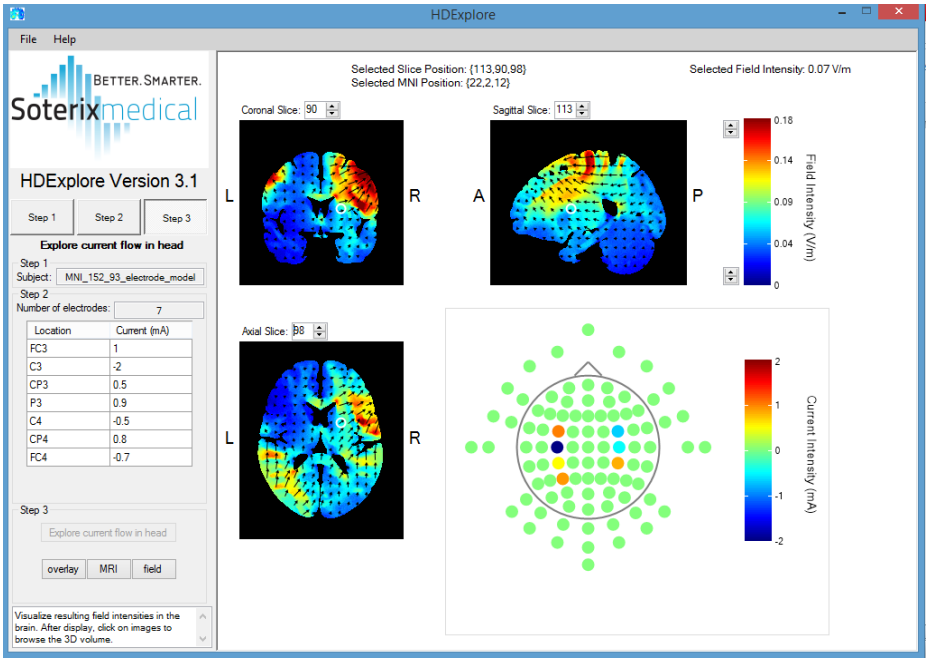


Once the model has loaded, the current flow can be explored in the Coronal, Sagittal, and Axial directions. HD-Explore™ will by default, load solution in a particular slice position depending on the head model chosen. Slice positions can also be compared with MNI positions at the top of the screen. The left (**L**) and right (**R**) labels denote the left and right side of the head model. This is denoted in the coronal and axial views. The anterior (**A**) and posterior (**P**) labels denote the anterior and posterior of the model. This is denoted in the sagittal view.



HD-Explore™ allows the user to analyze current flow through the entire head in 1 mm increments. Clicking the up and down-ward pointing arrows located above the image

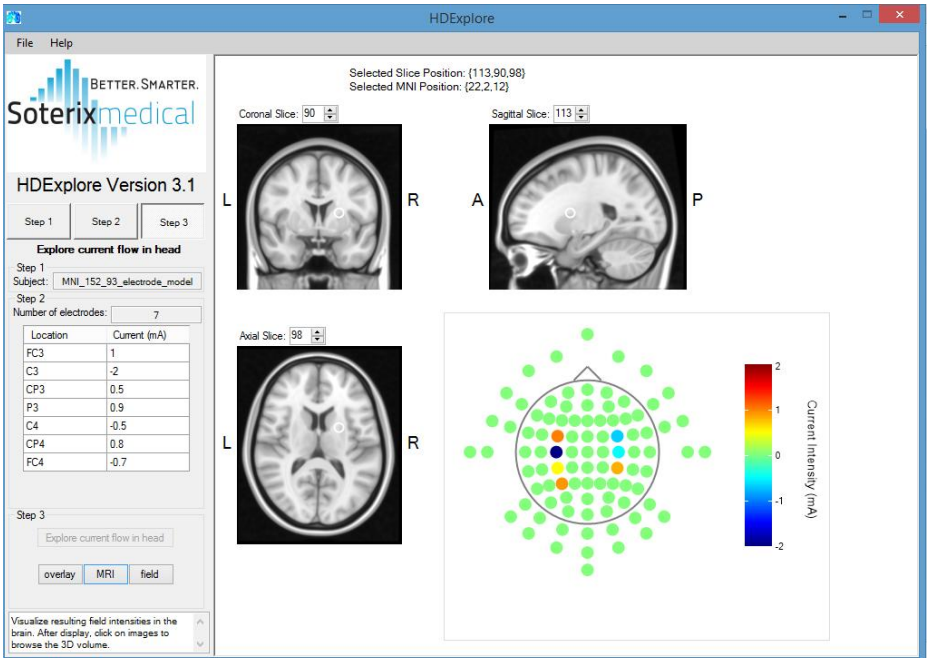
of each slice, allows navigation in any direction. In the image below the slices have been changed to: Coronal- 90, Sagittal- 113, Axial- 98. The color bar on the right denotes the color map and indicates the mapping of the data values (Electric Field Intensity) into the color map.



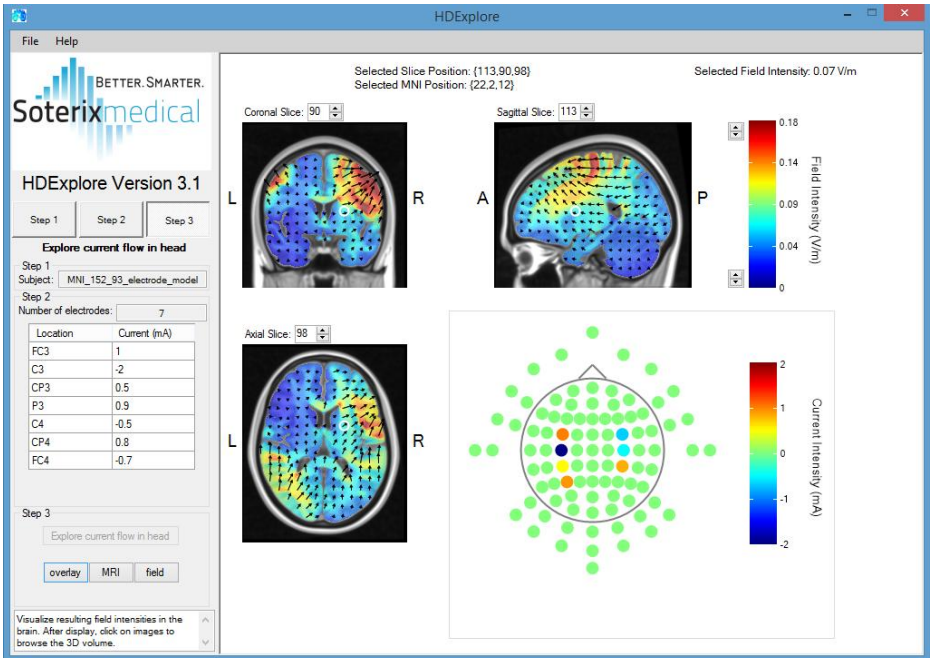
Note that the **Scalp Map** and the corresponding Current Intensity (mA) are still displayed for reference in the bottom-right section of the window.

Any voxel on the slice image can be selected by clicking on the desired section. An *open white circle* on the image denotes the current selected position in the 3D volume. The field intensity in this selected area is displayed in top right hand corner and is denoted as the **Selected Field Intensity**.

HD-Explore™ can display the subject's head by using three different filters. On the bottom left hand corner of the figure in the Step 3 section, the options **overlay**, **MRI**, and **field** can be seen. In the figure above, **field** is shown which displays just the electric field (V/m) in the head. Clicking on **MRI** will display the MRI.

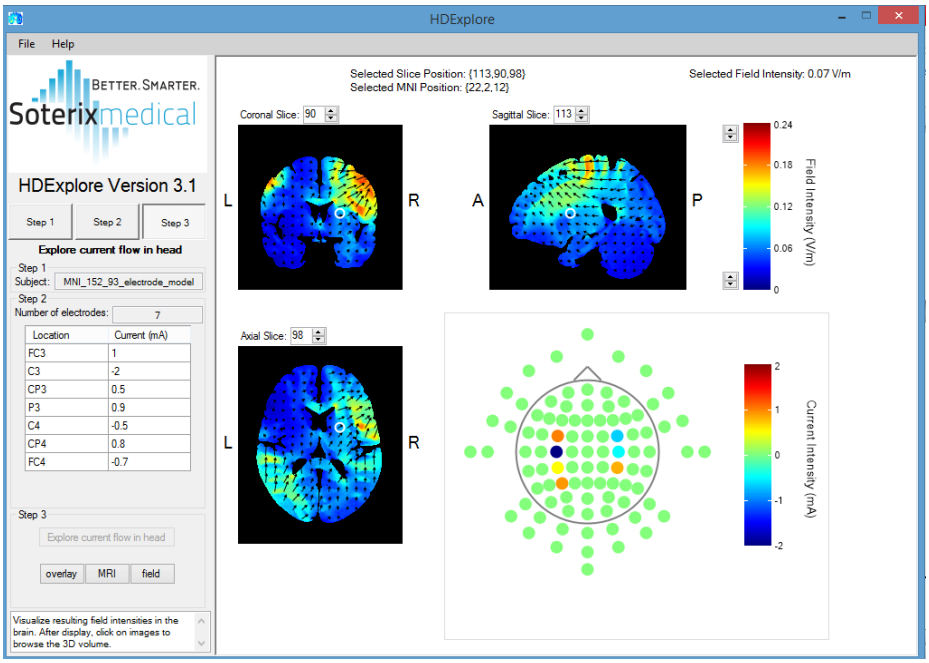


Clicking **Overlay** will display the electric field over the MRI images.



Setting A Range of Field Intensity :

The multicolored scale on the top right hand side displays the *global* field intensity range in the model. Clicking the small up and downward pointing arrows next to the scale allows users to set their own preferred limits. The image below plots field intensity to an increased *global* scale (0 – 0.24 V/m).

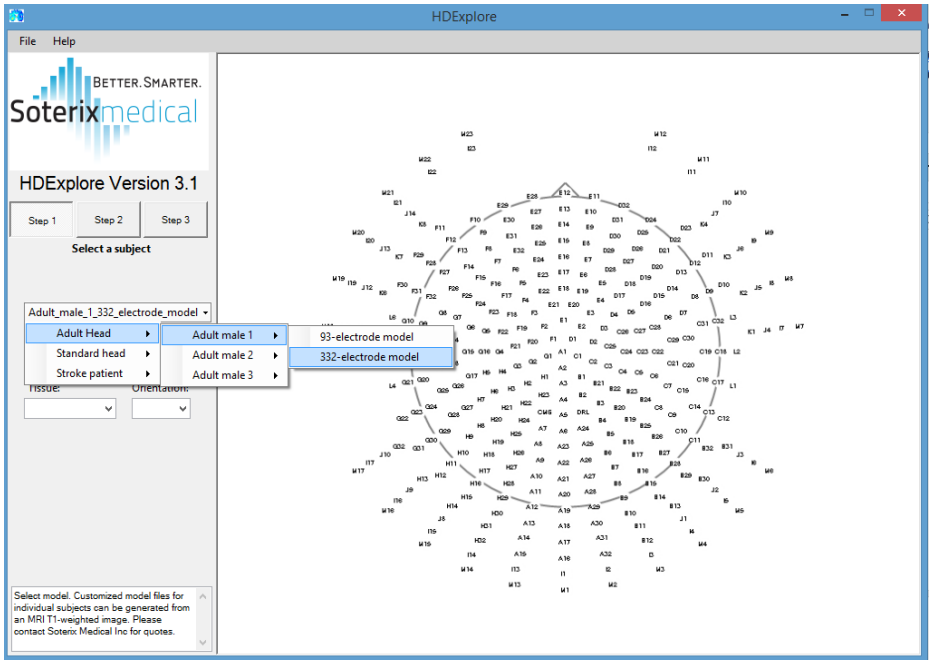


332 Electrode Model:

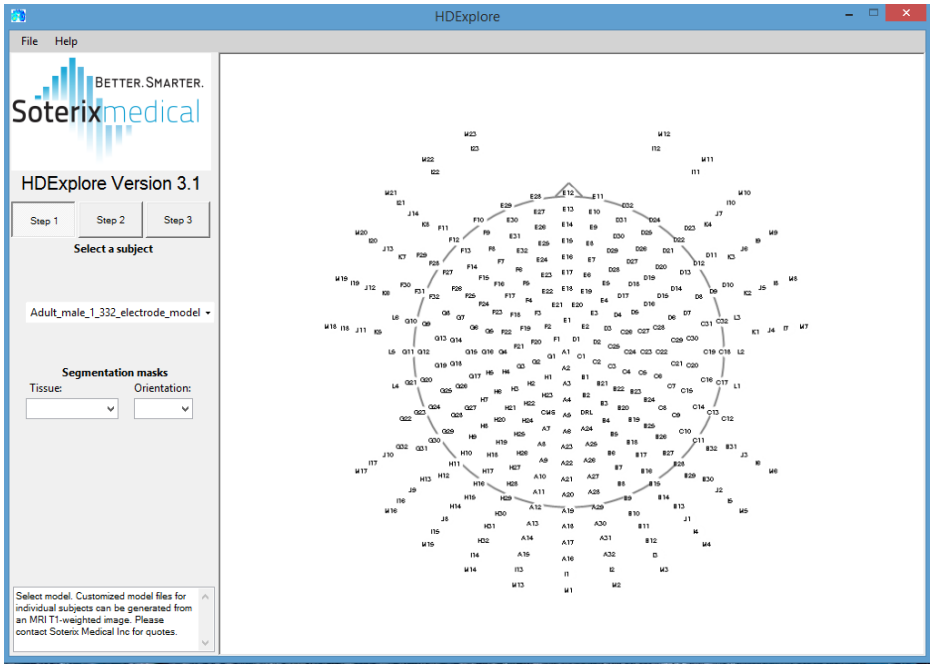
Now the **Adult male 1** head model with 332 electrodes will be covered.

Step 1: Select a Subject

Select the **332-electrode model** as shown below in the figure below.



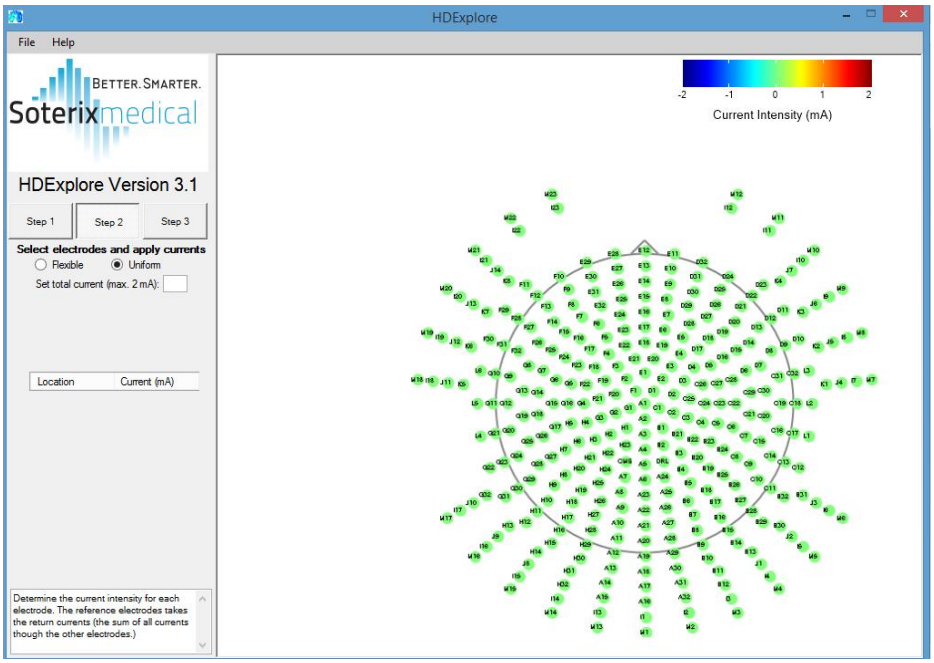
Once the 332-electrode model is selected, HD-Explore™ will create a 2D **Electrode Map** denoting the placement of the 332 electrodes on the head.



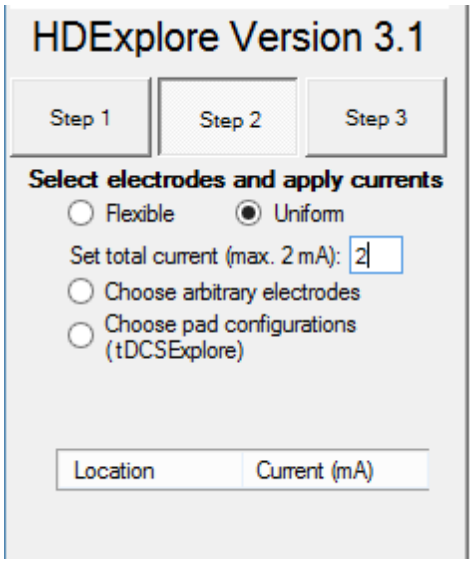
If a less dense placement is desired, repeat Step 1 to select **93-electrode model** option.

Step 2: Selecting electrodes and apply currents

As before, with pressing of Step 2 button, all available electrode locations are shown in a 2D **Scalp Map**. The false color map indicates that zero current is currently being injected through each electrode.



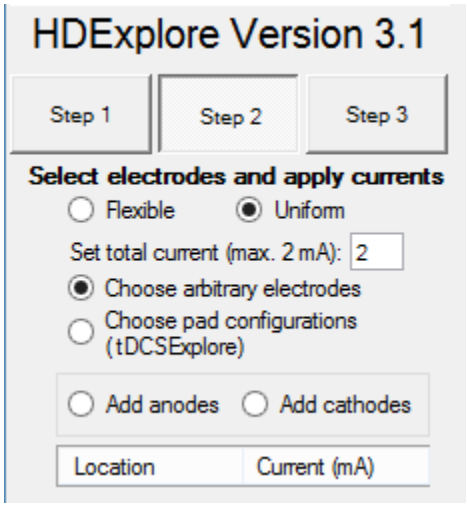
The *flexible* selection works similar to the **93-electrode model**, so only the *uniform* selection will be covered here. Once the *uniform* option is selected, the maximum allowable current to flow through the electrodes is chosen. For this example we will choose 2 mA.



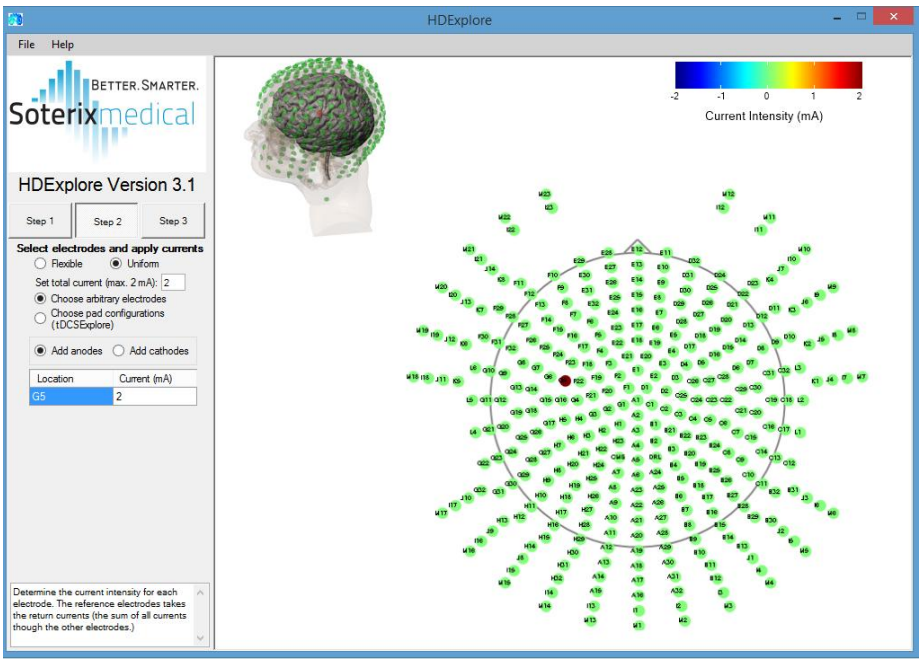
The *Uniform* electrode configurations can either be arbitrarily chosen electrodes enabled by selecting **Choose arbitrary electrodes**. Or they could be arrays of electrodes selected together automatically that simulate sponge pads, enabled by selecting **Choose pad configurations (tDCSExplore™)**.

Choose Arbitrary Electrodes:

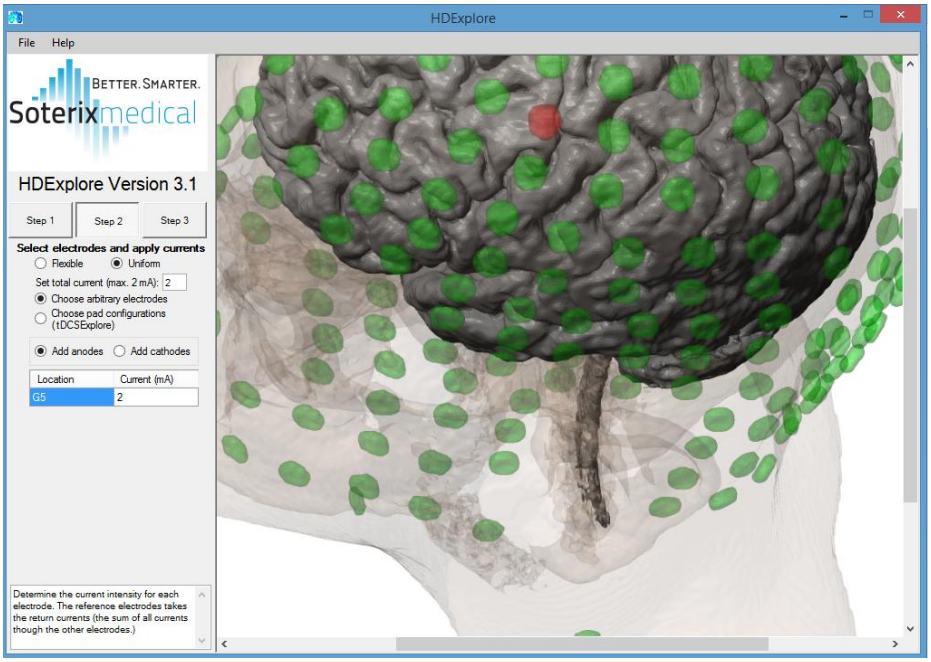
Select **Choose arbitrary electrodes** to select anodes or cathodes one at a time.



The first anode and its current intensity will now be chosen. Click the **Add anode** option seen in the figure below. We will begin by setting electrode G5 to 2 mA. Simply clicking on the electrode's icon on the **Scalp Map** selects the electrode. This will not only add the electrode to the Table summarizing **Location** and **Current (mA)** , but also show you where the electrode is on a **3D view** on the top left corner.

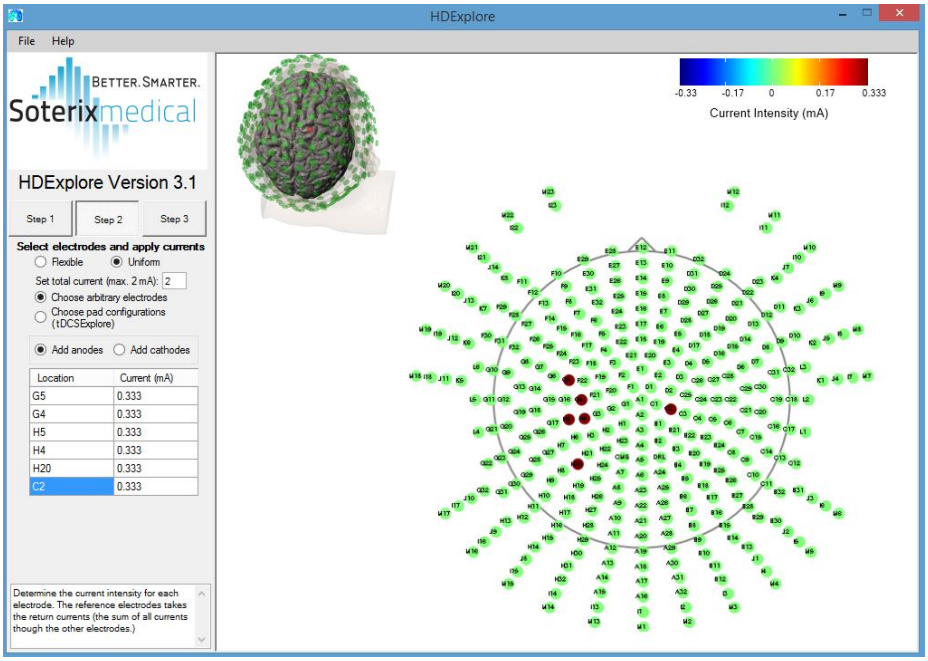


Double click on the **3D view** to zoom in. The selected electrode will be red while the others remain green.

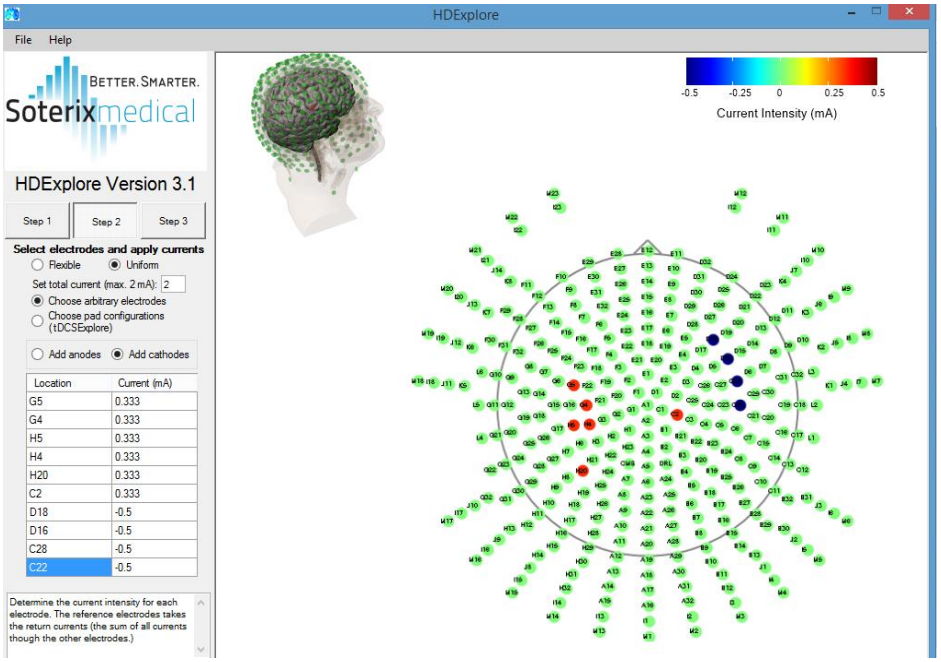


Double Click on **3D view** again to zoom out.

For this example, five more arbitrary electrodes will be used as Anodes; however, any number of the available 332 electrodes can be used. HD-Explore™ will automatically split the total current evenly among all of the selected electrodes. In this case, the 2 mA total current is split amongst six electrodes making each electrode output 0.333 mA.



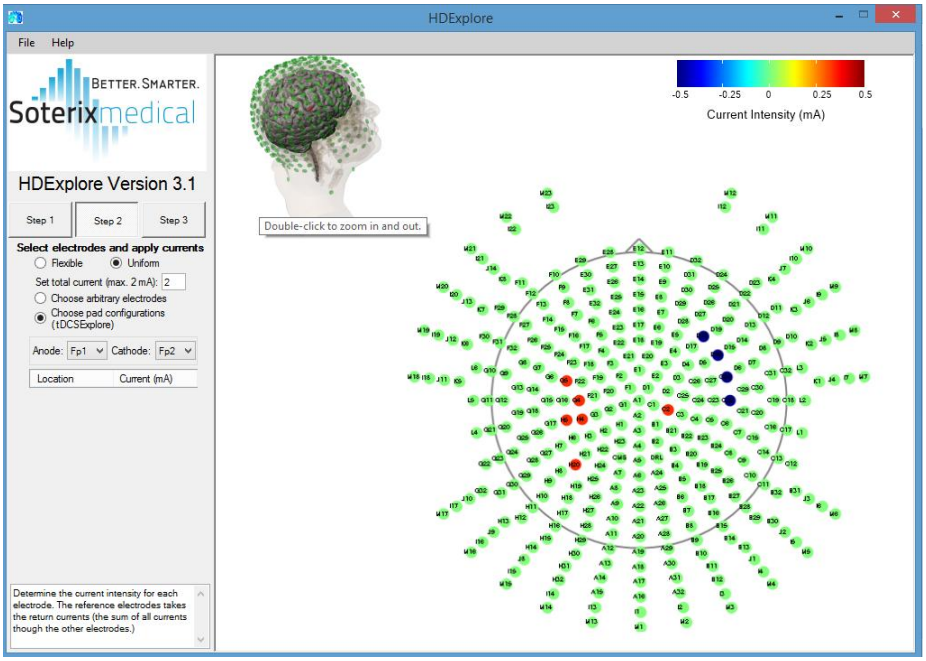
Selecting cathodes can be done by clicking the **Add cathodes** option. Any amount of cathodes can be chosen from the available electrodes as well. For this example, 4 cathodes are used. HD-Explore™ will automatically split the total current across the cathodes as well.



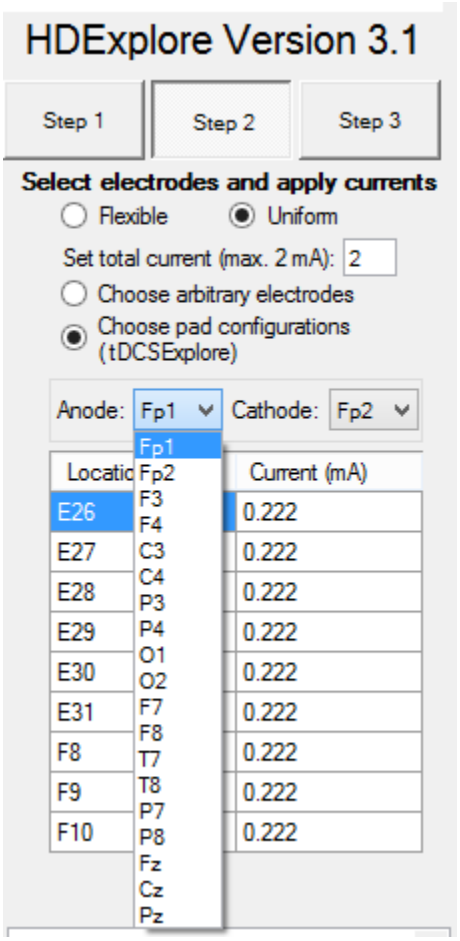
Once all electrodes and current intensities have been selected, proceed to Step 3 (Page 12) as before to explore current flow in the head.

Choose Pad Configuration (tDCSExplore™):

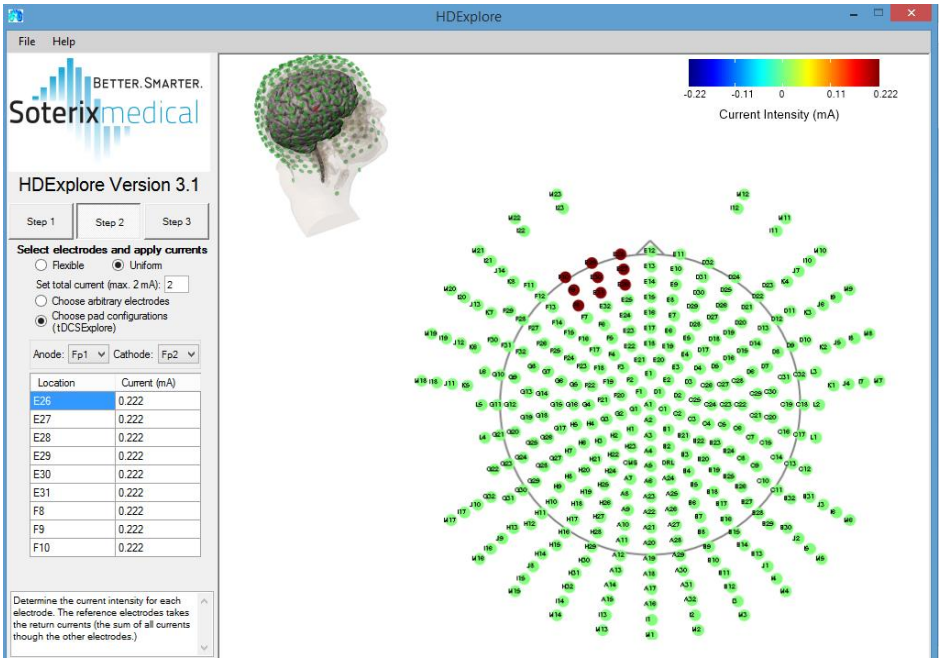
The electrode configuration can be changed easily from arbitrary electrodes to a pad configuration at any time before current flow is simulated. Changing this can be done by selecting the **Choose pad configurations** option on the left of the screen.



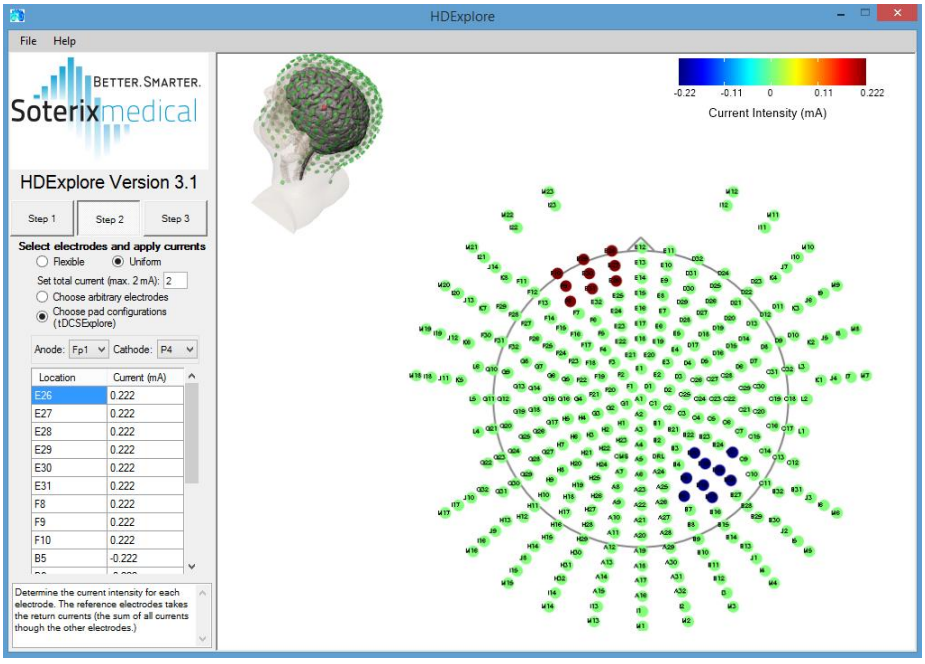
Once this option is selected, **Anodes** and **Cathodes** can be selected through a drop down menu seen in the image below. The menus will allow selection of any one of the available 10-20 EEG electrode locations.



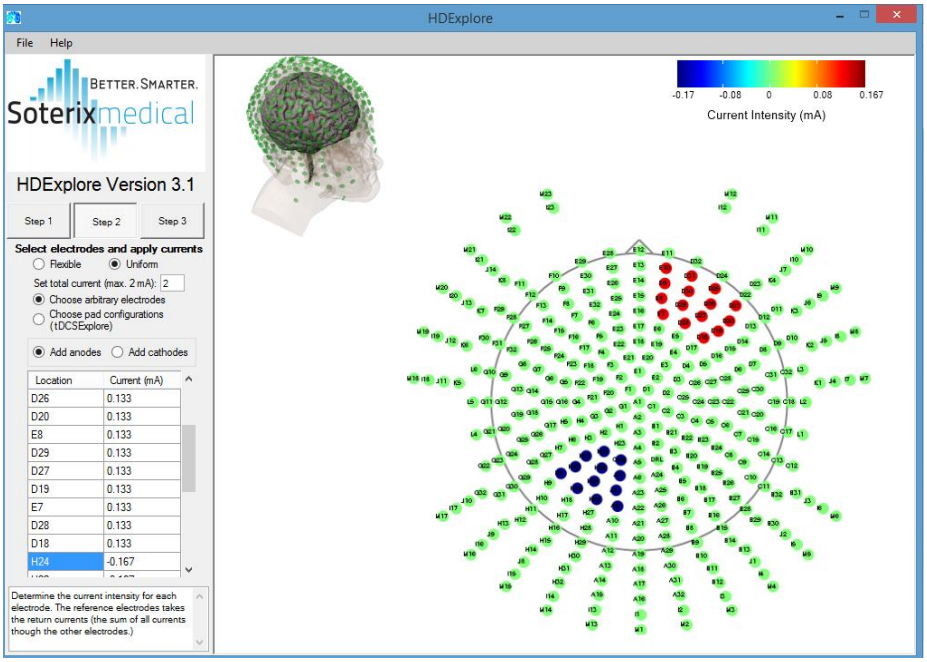
Choosing any one electrode location will automatically populate an array of electrodes centered on the chosen electrode location to simulate a 5x5 cm^2 pad. In this case, 9 electrodes were automatically selected. tDCS-Explore™ will split the total current evenly among all electrodes selected.



Selecting a **Cathode** from the cathode drop down menu will similarly add the cathodal pad to the head using an array of multiple electrodes. tDCS-Explore™ will again split the current evenly.



Clicking on more electrodes around the pads by selecting **Choose arbitrary electrodes** option will allow tDCS-explore to simulate larger pads such as 5x7 cm^2 for both the Anode and Cathode. Note below, how adding 5 more electrodes to the Anode pad automatically splits the total current across 14 electrodes.



Step 3: Explore Current Flow in Head:

To explore current flow for both arbitrary and pad configurations follow the same instructions for the flexible **93-electrode model** (Page 12).

Customizing Your Software

The basic edition of HD-Explore™/tDCS-Explore™ v3.1 comes preloaded with three Adult Male heads and one Standard head. For additional heads (Adult Female, Pediatric, heads with lesion - stroke, TBI) and loading your trial-specific heads, contact Soterix Medical.

Thank you for purchasing Soterix Medical Neurotargeting software **HD-Explore™ / tDCS-Explore™**

If you arrive at a problem,or have any questions,comments,or concerns,please feel free to contact us at SoterixMedical.com