Laboratory Electrostatic Field Map procedures
Procedure for Full Field Dipole Map

Place conducting electrodes at coordinates 1:(x=1,y=6),2:(x=1,y=12)
(Note: lowermost left hand square has coordinates at cross of 1,1).

Connect negative battery to Com on voltmeter
Connect positive battery to electrode #2.
Connect Com on voltmeter to electrode #1.
Use probe connected to voltmeter on “VΩ” connection.

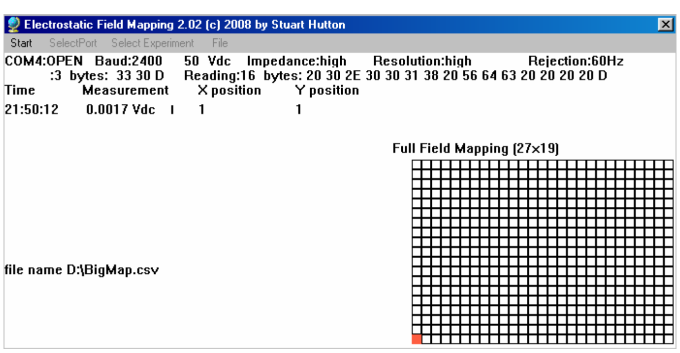
Turn on voltmeter in the following way:
Hold pk+/- and turn switch one notch to Vac. You should observe a double headed arrow that says <RS232>. The interface is now initialized. You may release the pk+/- button.

Turn switch two more notches so that the setting is now on Vdc.
The voltmeter is now ready to read voltage.

Start the program EField Map. You should do this by opening firefox and going to the following url:
http://www.lyon.edu/webdata/users/shutton/Courses/Su08/WorkShop/index.html
Locate on the index page the link that says
Electric Field Mapping Data Acquisition Program

Click on that link. Firefox will download it to your desktop (in the best of circumstances) (you will have to choose to save it) and then it will present you with a download progress box. After the program is downloaded, you can use the download box to open it by clicking on open. Do so now.
Opening the program, the front screen has the following menu options initially available: Start and Select Port. Click on Select Port and choose COM1, which is the port which I should have all the voltmeters connected to.
You will then need to Select Experiment. Choose Full Map (27x19). (For future maps, you will choose one of the other experiments.)

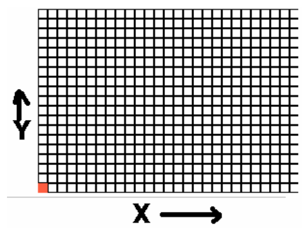
Next Choose File. Please choose a file located on the Idrive which has a name which is unique. We don’t want to be getting the data files confused. After you type in your file name, the “.csv” extension which means “comma separated variables” will be automatically added. Click on “open” to set this as the file name.



Next Choose Start
If you are met with the Red Screen of Death, for some reason, the computer is not talking to the voltmeter. You’ll probably need my help so ask for it if this happens. Otherwise you

should see the following screen: shown except your file name will be different and it should say I:\yourfilename.csv. Your Com port will be Com1 (not Com4 as in my screen). Notice that one square is already colored. The color of the square is an indication of the value of the present measurement. I have calibrated the color scale to coincide with the colors that one would observe from temperatures ranging from 1000K to 40000K. Blue corresponds to a higher voltage away from zero. Orange corresponds to a zero voltage.

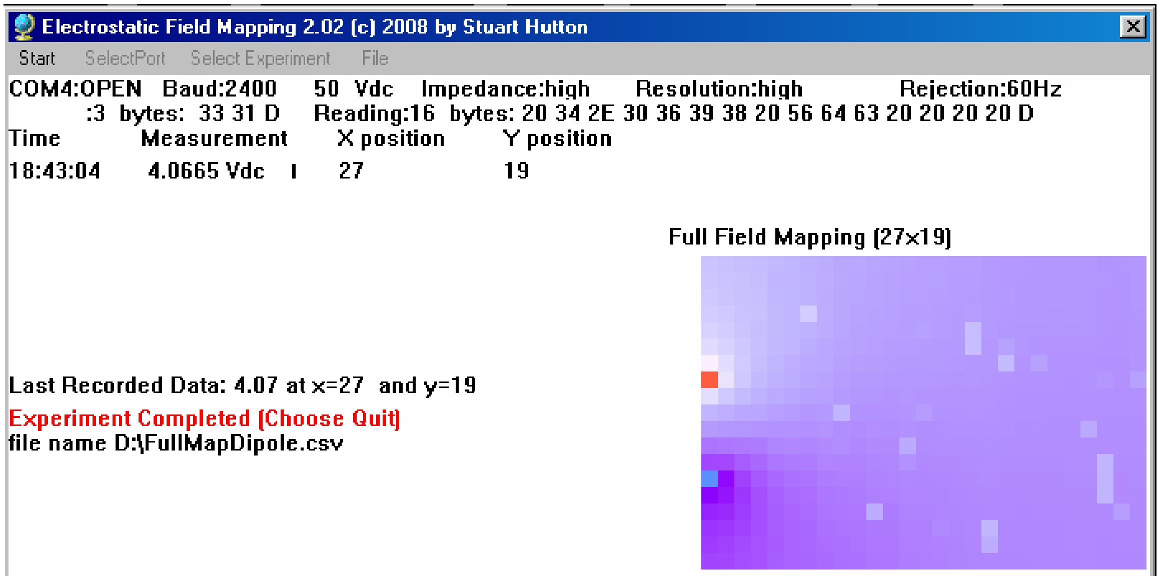
Now place your probe point gently at the first + (which has coordinates 1,1). Hold it there and press the space bar. The program will tell you to hold the probe steady. It will make 3 measurements and then average them. You may hear a beep or your lab partner may say next so that you move to the next + mark. On this grid, I have designated x and y coordinates as shown below:



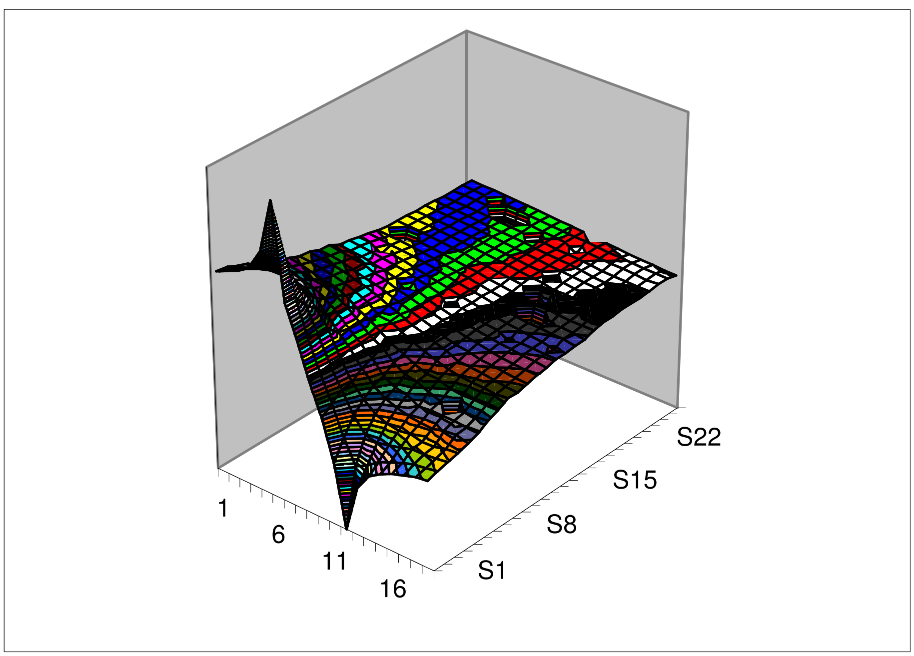
The square which is already filled is the present measurement and this particular one is at coordinates 1,1. Your color may be different.

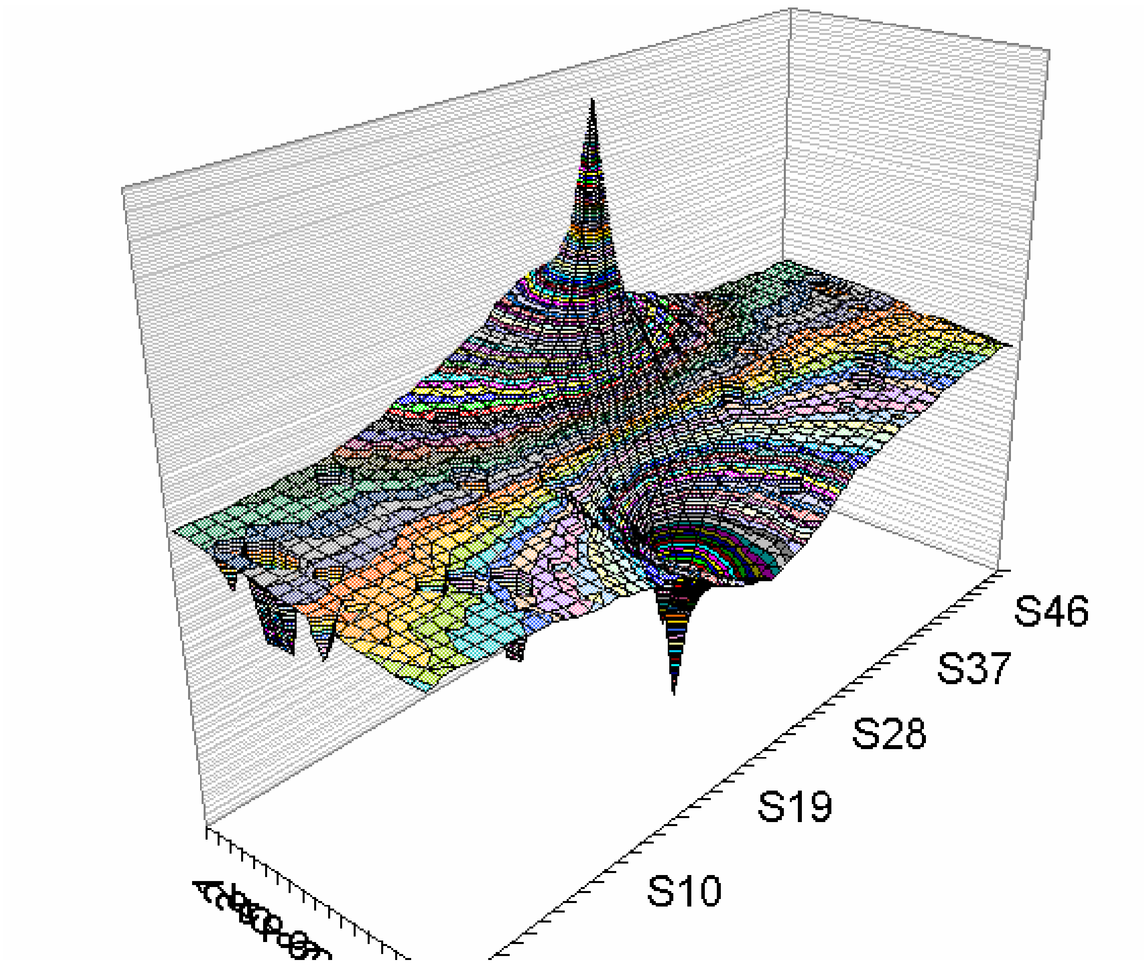
Do the measurements in the following way:
go up the y-axis one by one then shift over to the next x column. (coordinates 2,1).
Fill in all the data, pressing the space bar for each measurement. You will need to do this with concentration and a clear mind. Avoid distractions during this measurement.

If you just can't take all the data, you can quit after a while. I recommend taking all the field data. Also note, if an electrode is at the location you want to measure, touch your probe to the electrode. When you take your last data point, the program will tell you the experiment is completed and you should choose quit. However, with success, your filled in screen should look something like what I am showing below:



Even in this rudimentary picture, it is clearly possible to see the presence of the two electric dipoles and you now even see an indication of how the potential falls off from the dipole. In the analysis portion of the lab, I will show you how to make the beautiful 3-D plot of this data. It is worth taking good data here so that you can make a 3-D plot which looks like what I am showing below:





This shows the dipole with the data mirrored: symmetry dictates that it would look very similar in negative regions as in positive regions.

Procedure for Dipole Symmetry Axis Drop Off

Leave electrode #2 at its present coordinates of (1,12)
Move electrode #2 up one position to have coordinates of (1,7)
The electrical connections are these: connect battery positive to electrode #2 and battery negative to electrode #1. Measure along the symmetry axis with both leads from the voltmeter (so as to measure a differential voltage). This is slightly different from before but provides a quicker and better measurement.

When you run the acquisition program, this time choose the experiment named **Dipole Drop Off (27x1)**. You will be presented with the grid for this experiment which is 27 x-units long and 2 y-units wide. Choose an appropriate file name and then acquire data as before. On the coordinate grid, start measurements at (1,9). Then measure at (1,10) then (2,9) then (2,10), etc. The program will only say positions as (1,1), (1,2), (2,1),(2,2), etc.
For this particular arrangement, we should have (extending slightly the work from class) the following dependence for the electric field along the symmetry axis:

$$\vec{E}_p = k\frac{q}{\left[\sqrt{2.5^2+y_p^2}\right]^3}\left(-2\hat{x}\right)$$

Procedure for Mapping the field inside a capacitor.

Cut two pieces of wire into 10 cm length (this is 10 coordinate positions on the paper). Use the conducting push pins on the ends to make electrical contacts. Place the wires on the paper 8 units apart. This means, where the wire is, we call 1, then there are 6 empty spaces then the second wire. You will need about 5 push pins to hold the wires down well, which is important here. Note: when you must measure where a pin is, just touch the wire since the potential is constant over the wire. Also all electrical connections are as before. Start the program again but this time choose Capacitor map (10x8). Acquire data as before.

Analysis

I have prepared a spreadsheet on the website which will help with all the analysis for today's lab. It will be found at the spreadsheet link at the website: http://www.lyon.edu/webdata/users/shutton/Courses/Su08/WorkShop/index.html. Make sure you use Firefox to access this spreadsheet, otherwise you will have trouble to save the spreadsheet afterwards.

You will copy and paste your data from your "csv" spreadsheets directly into these spreadsheets. For the full field dipole, you may adjust the 3-d viewing position to see the equipotential contures. The electric field is obtained by looking at the potential difference between two neighboring lines and dividing this by the distance between the two lines. The electric field always point at right angles to the lines of equal potential.

For the dipole dropoff, choose tools, then solver. I have set up a "solver" in excel that will provide a fit to the data based upon a least square deviation. In most cases you should observe that the electric field can be modeled closely to what we had in class.

For the parallel plate capacitor data, copy and paste your data into the appropriate spreadsheet. You will see, with a successful experiment, a series of parallel equipotential surfaces which are equally spaced inside the capacitor. This is interpreted in accord with the work in class to provide an electric field which is uniform in both direction and magnitude inside the capacitor.