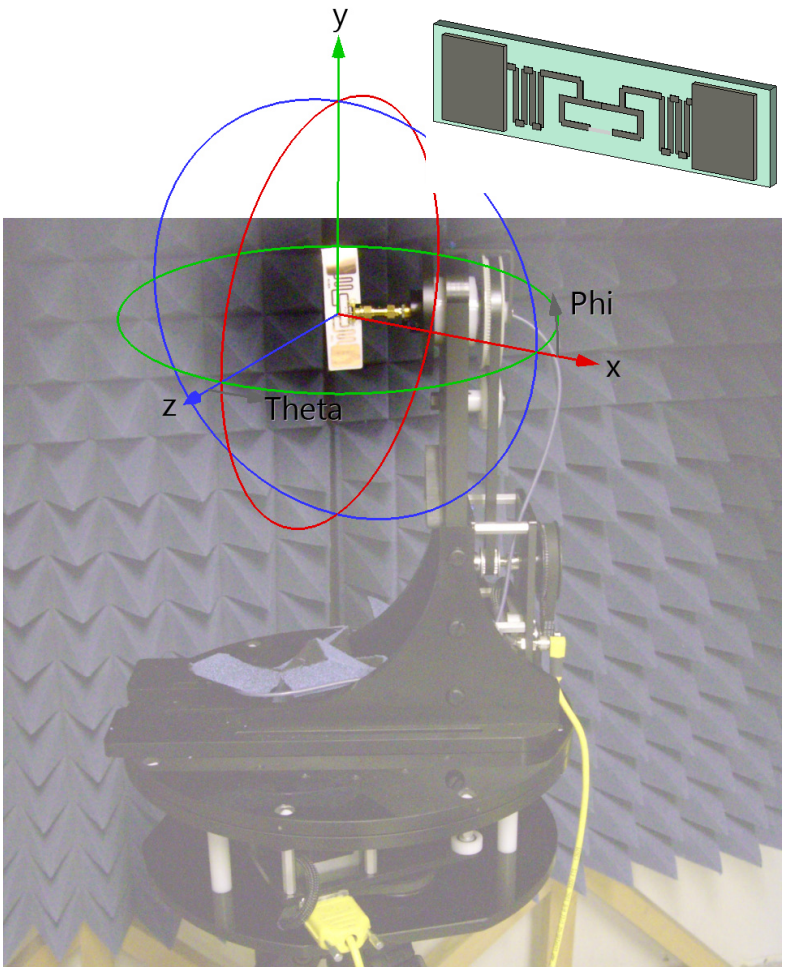
Diamond Engineering
Automated Measurement Systems

Application Note #0421
February 2010
Revised: January 2011

RFID Antenna Measurement



This example demonstrates the basic measurement technique and utilizes most (but not all) of the DAMS Software capabilities.

This example will determine:

- Gain (Phi and Theta)
- Match
- Efficiency
- 10dB spherical compliance
- Antenna range (assuming 10 Watts Tx, RFID Retransmit efficiency=.001% 920MHz)

Test System Specifications

System: DAMS6000 with FSM-5

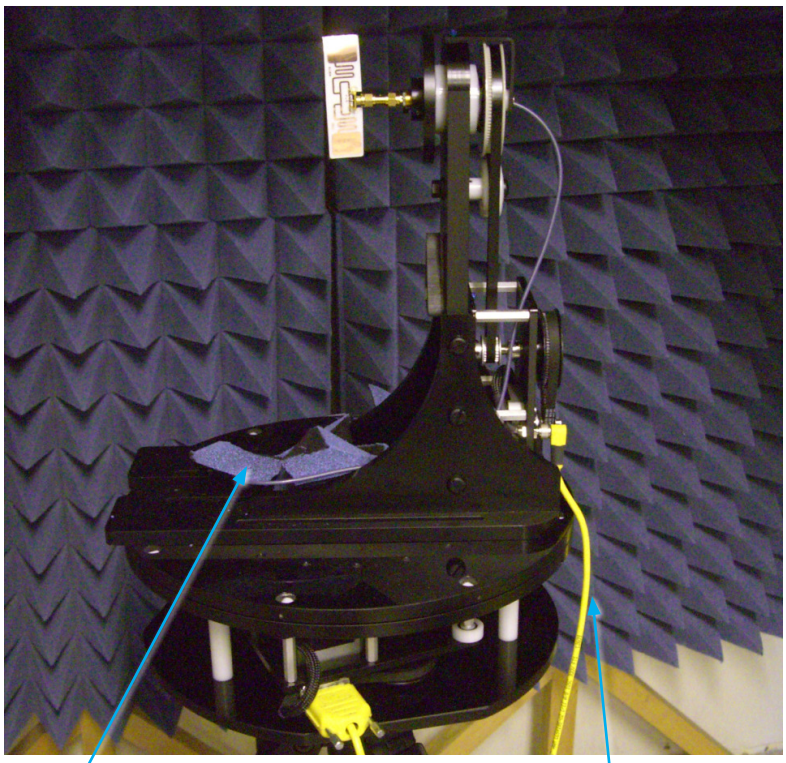
Frequencies: 800MHz to 1GHz with 101 points

Azimuth: 0 to 360 (Step 5)

Elevation: -90 to +90 (Step 10)

Method: Gain Transfer calibrated Yagi Ref.

Apply Sampling 8th order to correct errors Ignore the absence of the Balun choke normally supplied by the RFID chip.



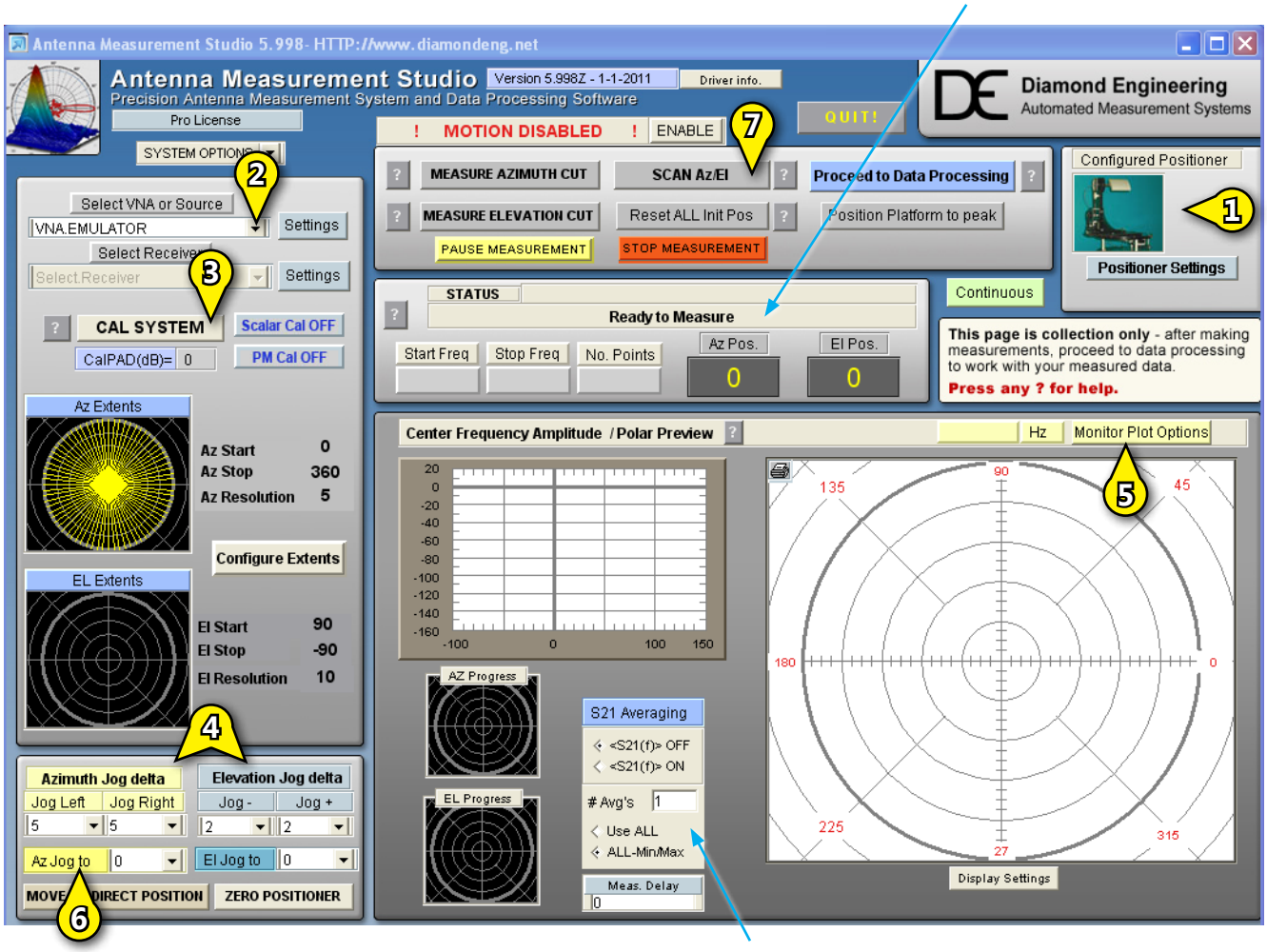
Absorber over rotary joint

⚠ ***NOTE:*** Be sure to switch the Azimuth and Elevation cables when using the FSM attachment.

System Calibration

1. Ensure the picture in Configured Positioner is your platform.
2. Select your test equipment.
3. Perform a VNA calibration from the reference to the DAMs rotary joint. (DAMS provides scalar cal for non-vector measurements.) In settings menu check Additional Parameter S11 or S22.
4. Configure the Az-EL movement
5. Set the default monitor plot items
6. Make sure the AUT is properly positioned. Use the jog and Zero Positioner.
7. Initiate SCAN Az/El and begin the measurement. Button will turn grey until finished.

Measurement time remaining will update here.



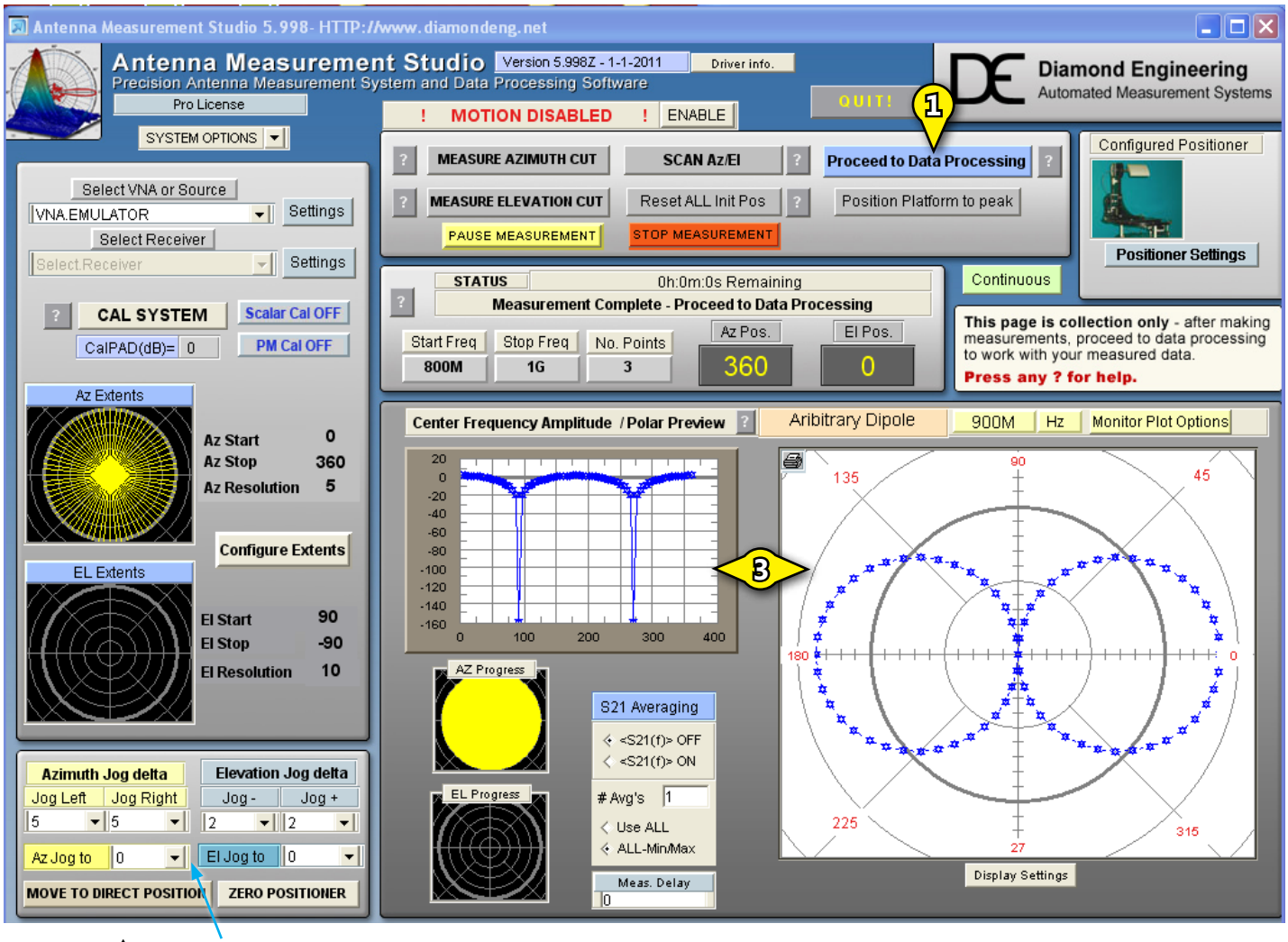
TIP: You can make multiple measurements for averaging and min/max delete.

Monitor Plots

1. After the measurement is complete proceed to Data Processing to save the data. (See next page)

2. Return and rotate Reference Antenna 90 degrees. Repeat measurement and save data. (See next page) Where? How?

3. The monitor plots display the link data by default. They can also be set to gain data in the Monitor Plots menu. Additionally, real time gain can be invoked for pre-test or experimentation.



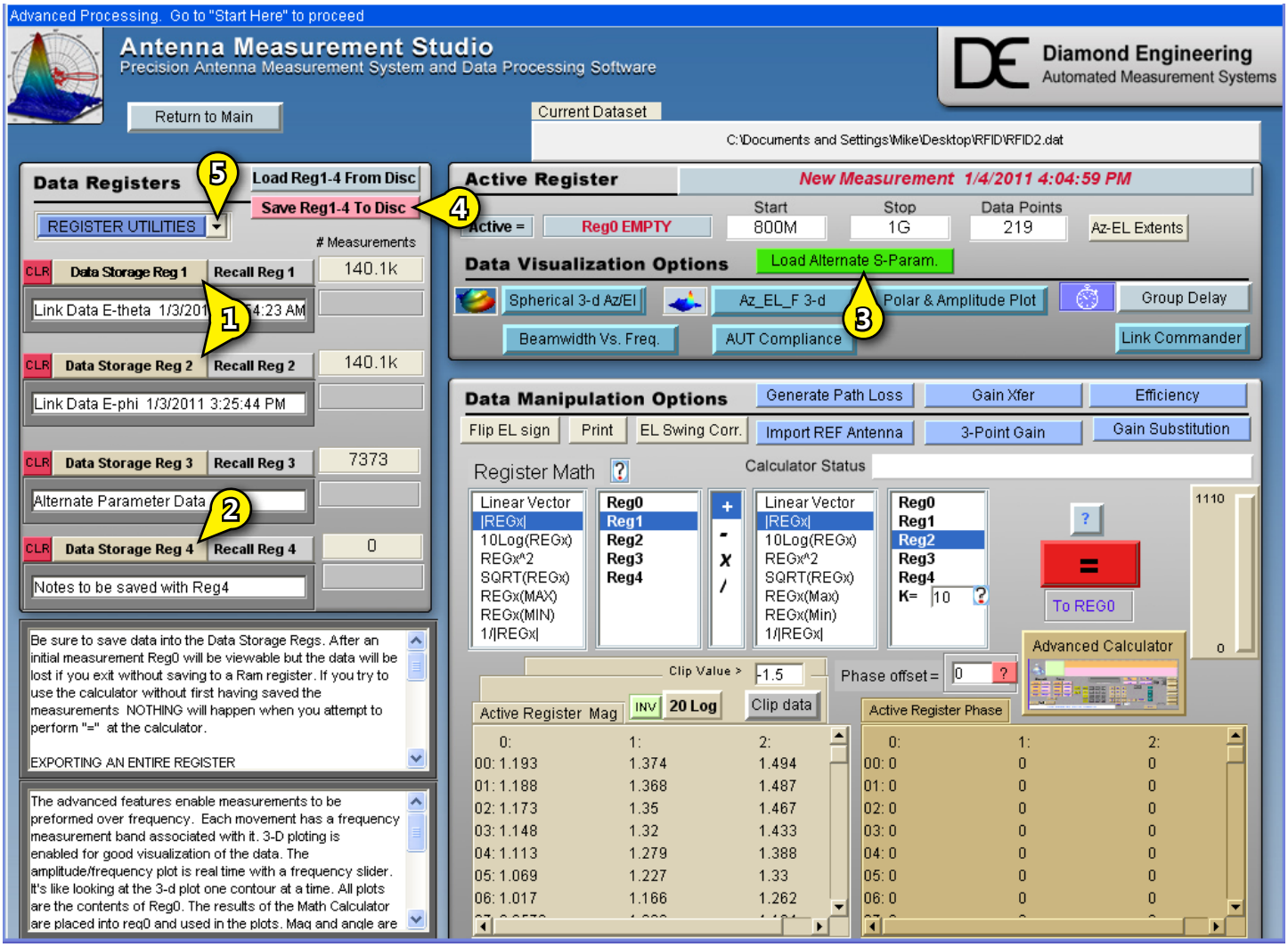
TIP: When utilizing the real-time gain plot, you can jog or zero the position.

Saving Your Data

To save your data to a REG and then save REGs to your drive:

1. Save each data set to a register(REG1& 2). Label the Registers
2. Load the Alternate Parameter (Sxx match) to the display Register.
3. Save Alternative Parameter to unused Reg4.
4. Save the data to the disk
5. In the event of data loss go to RECOVERY in the Register Utilities

The data is now secure. Next the data can be processed into Gain data. While the math can be done in the array calculator the Gain Transfer is set up for this. It requires knowledge of the path and the reference antenna.



TIP: Register Utilities can be used to load multiple files. See "Load single Register".

Path Loss Generator

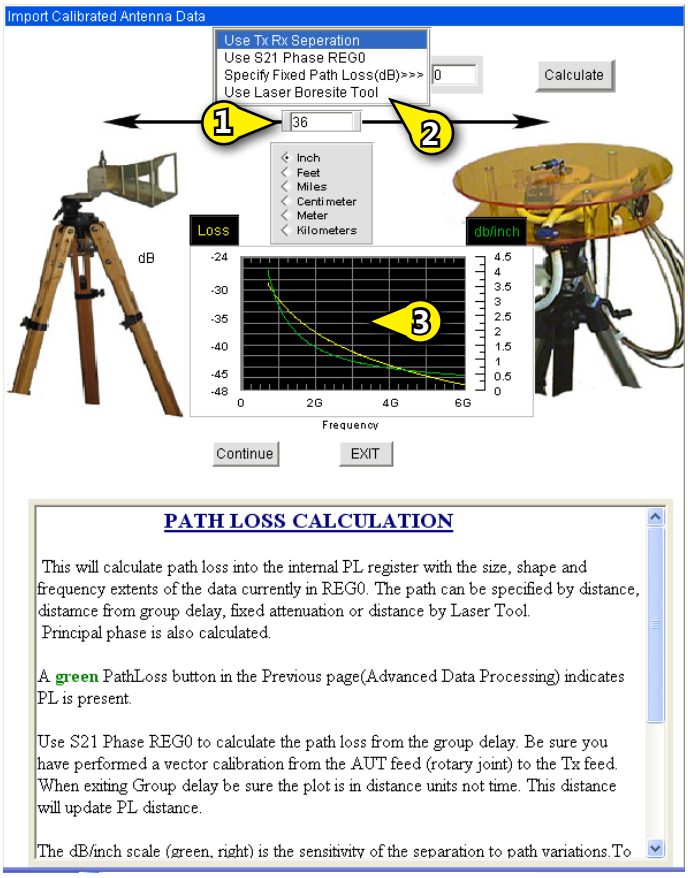
1. Enter the Separation Distance and select the appropriate unit of measurement and click "Continue".

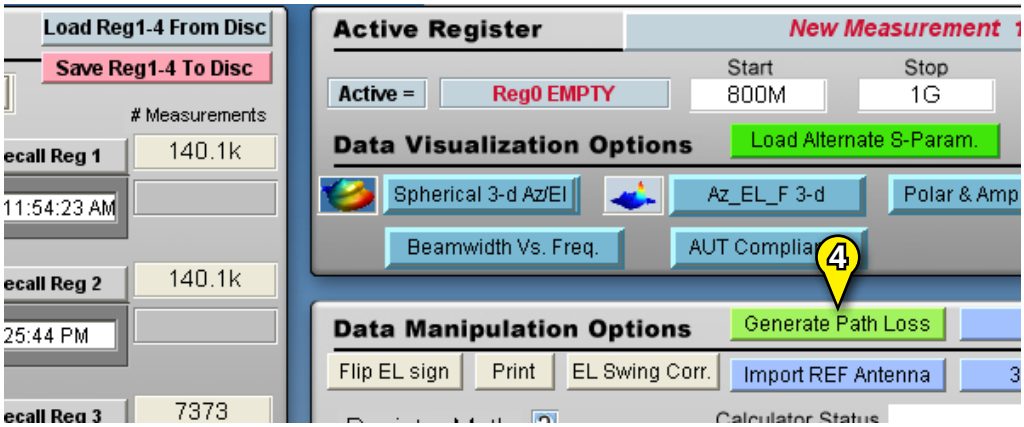
2. Additionally, besides TxRx separation, you can use the group delay, specify a fixed path loss, or use the Laser Borsite tool to determine distance, pointing angle and path loss.

3. Left scale (yellow) is path loss. Right scale is path loss sensitivity to length (dB/in)

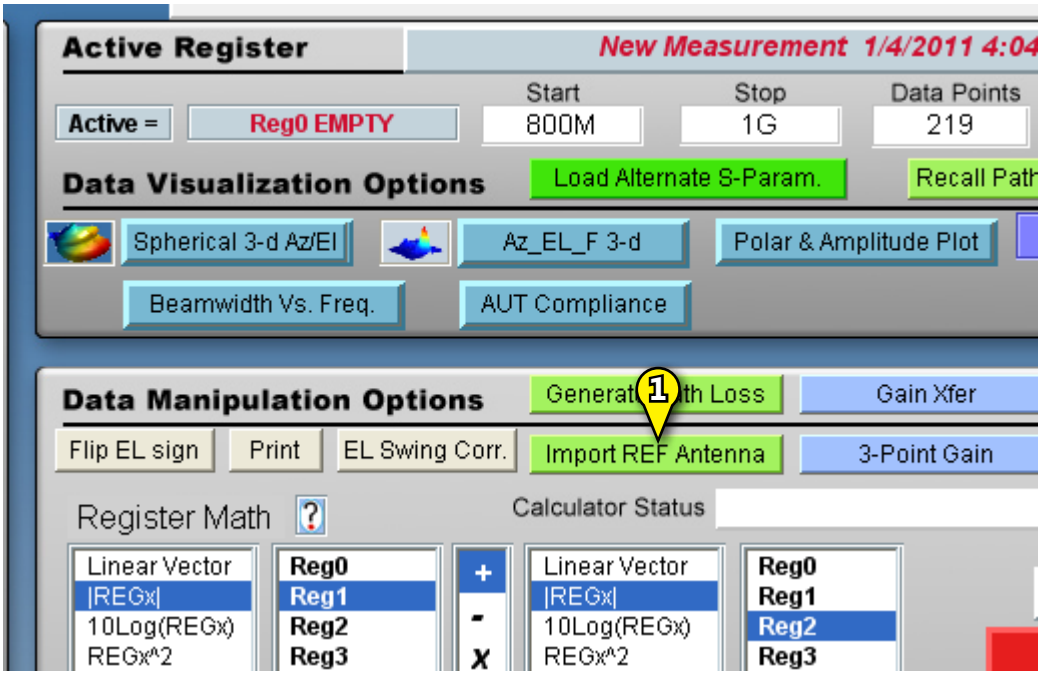
4. Invoke Generate Path Loss. Once done, button will turn green.

(Continues next page...)

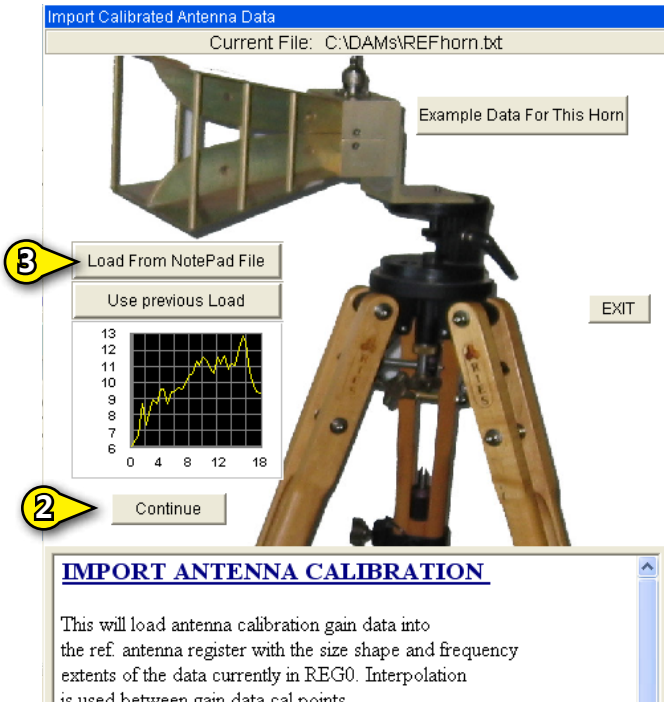




1. Invoke Reference Antenna. Once done, button will turn Green
2. Follow instructions to create reference antenna file. Press Continue when done.
3. You can import arbitrary losses by adding them to the Ref Horn file.



(Data in REG1 is used for Gain Transfer. REG1 was EQ.)



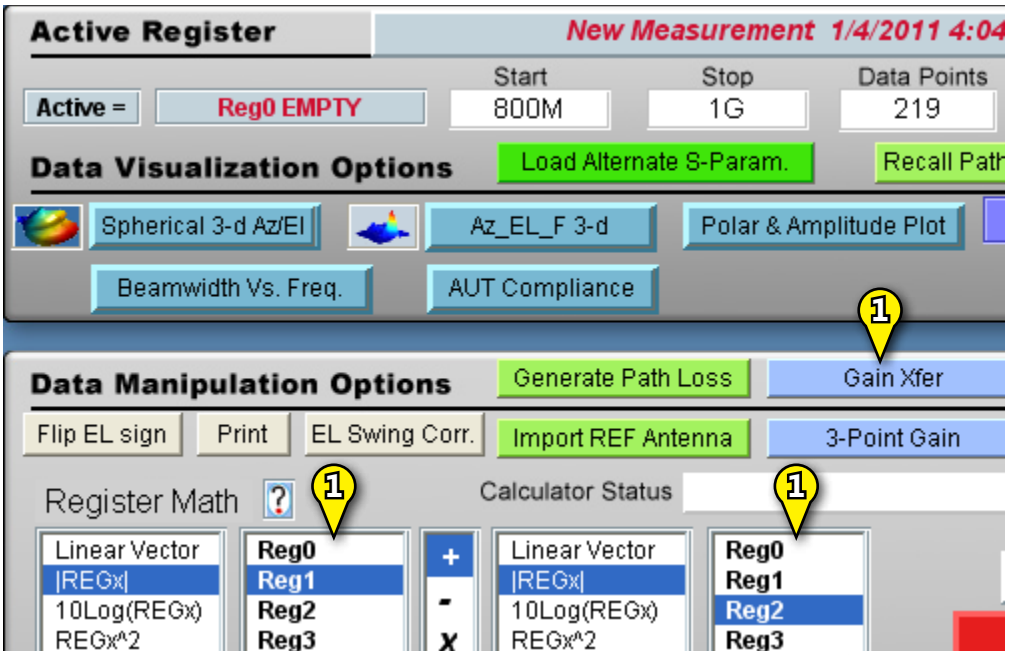
(Continues next page...) [?]

1. Invoke Gain Xfer for REG1 (EQ) and REG2(EF)
2. Calculate ABS AUT Gain=REG4&0 "Total Power Factor"
3. Re-save ABSgain to REG3 so REG4 can be used for other things

Click Gain Xfer again?

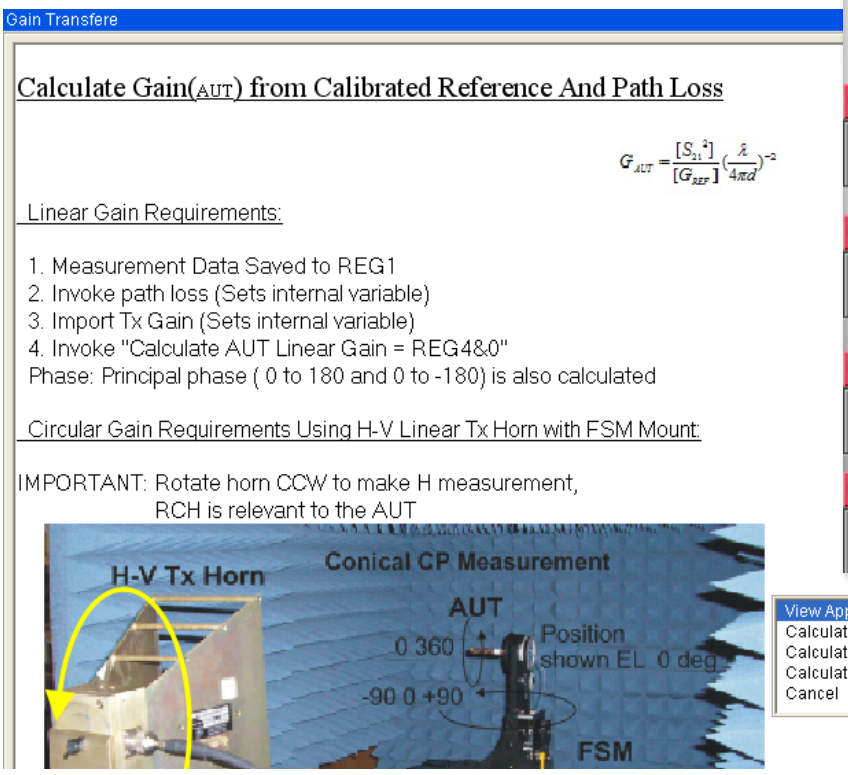
4. "Calculate Total Power factor" will convert REG1 and REG2 to Gain and calculate the ABS gain and store to REG4&0

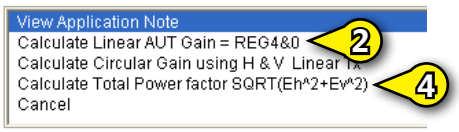
TIP: You can perform circular, 3-point or substitution measurements in the Data Transfer window.



(REG0 is the display REG used for plotting)

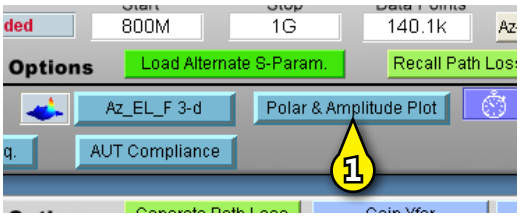
After step 4 we have:





Compare the PeakEQ,EF Gains to Absolute Gain

1. Enter Polar & Amplitude Plot, then recall REG3(ABS(G))



2. Check dB and 3dB/div **with 20 Log (?)**

...as indicated in img?

3. Click Goto Max Signal

4. Read peak gain ***and*** associated F,Az-EL positions, and note all three sets of[?] parameters

...as indicated in img?

5. Click "Normalize"

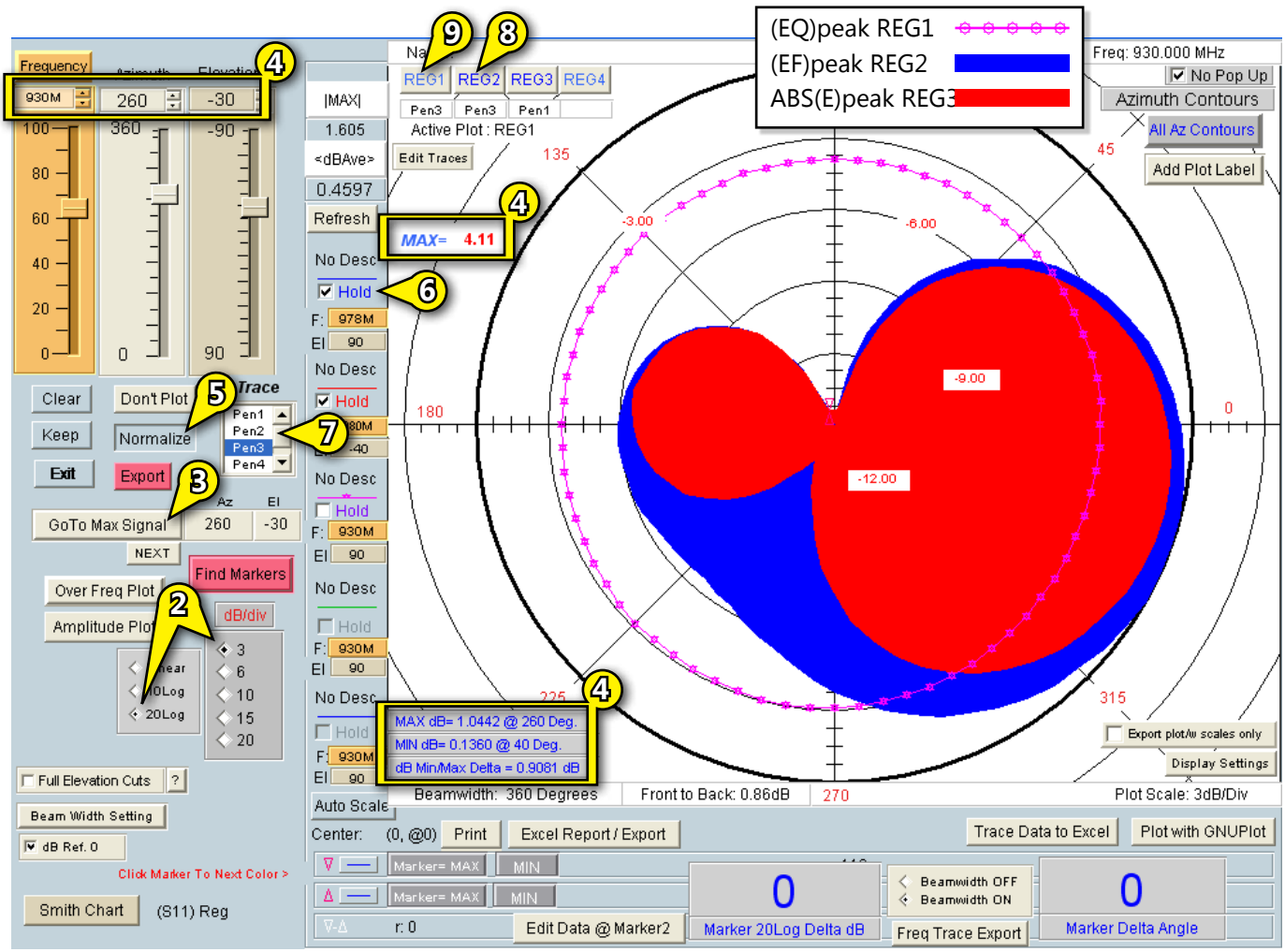
6. Check Hold

7. Switch to Pen2

8. Recall REG2 and repeat steps 3-7

9. Recall REG1 and repeat steps 3-7

⚠ **TIPS:** - You can set the linetype, point type and label by clicking on "No Desc"
- You can export any contour to Excel.



(Color shading shown is for illustrative purposes only.)

Plot Peak Abs(E) Gain and Associated Ef,Eq Gains

1. Recall ABS(E) REG3
2. Click Goto Max Signal
3. Note the Az,EL,f on top of sliders
4. Click "Normalize"
5. Check Hold
6. Switch to Pen2
7. Recall REG2 (See 1)
8. Reset sliders (See 3)
9. Check Hold (See 5)
10. Switch to Pen3 (See 6)
11. Recall REG1 (See 6)
12. Reset sliders (See 3)

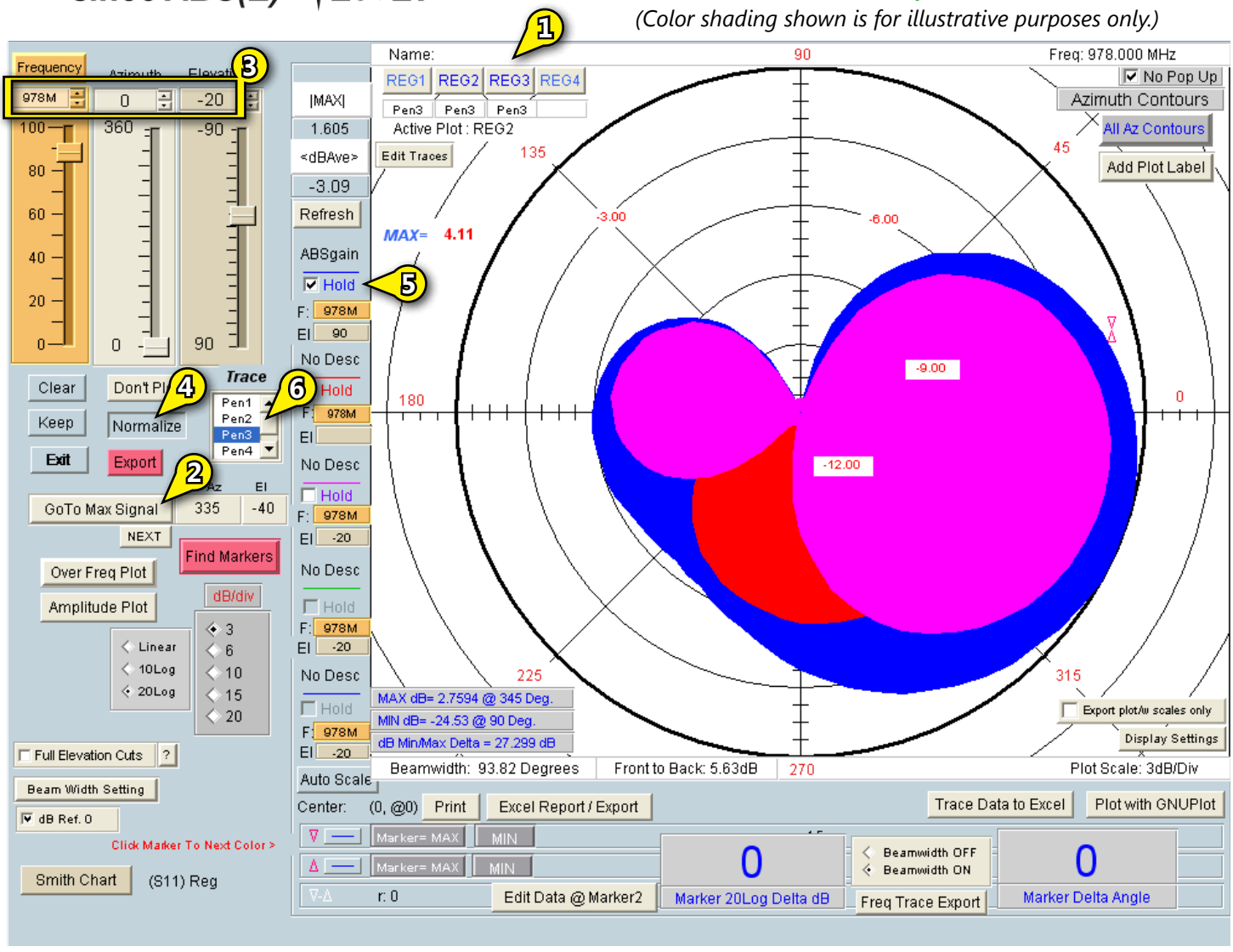
⚠ **TIP:** You can set the linetype, point type and label by clicking on "No Desc"

The ABS(E)<= E_Θ, E_Φ

since ABS(E)= $\sqrt{E_\Theta^2 + E_\Phi^2}$

Need color code key like on page 9...?

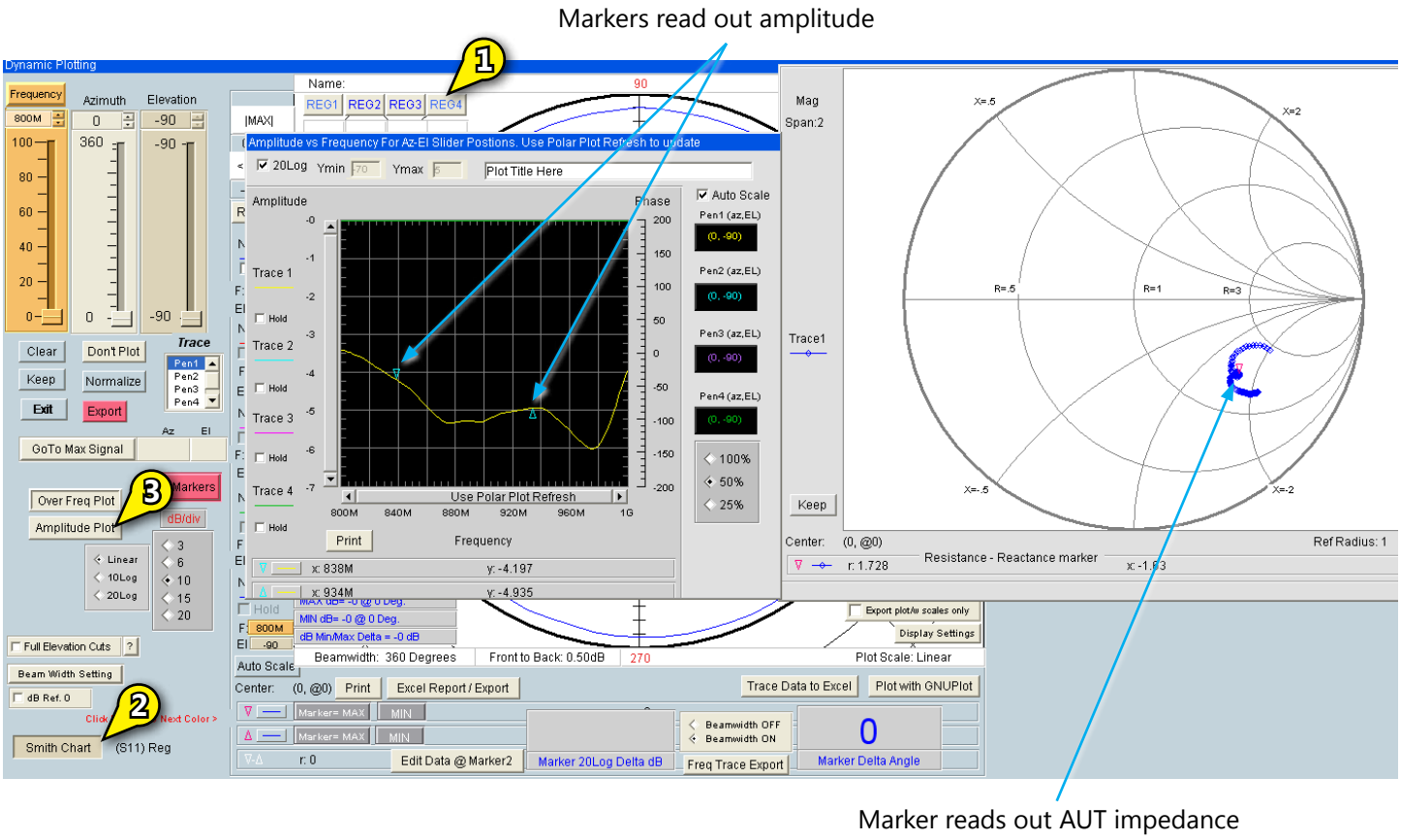
(Color shading shown is for illustrative purposes only.)



Plot the AUT Reflection Coeficient

1. Recall the previously loaded S11 data REG4
2. Invoke the Smith chart
3. Invoke the Amplitude plot

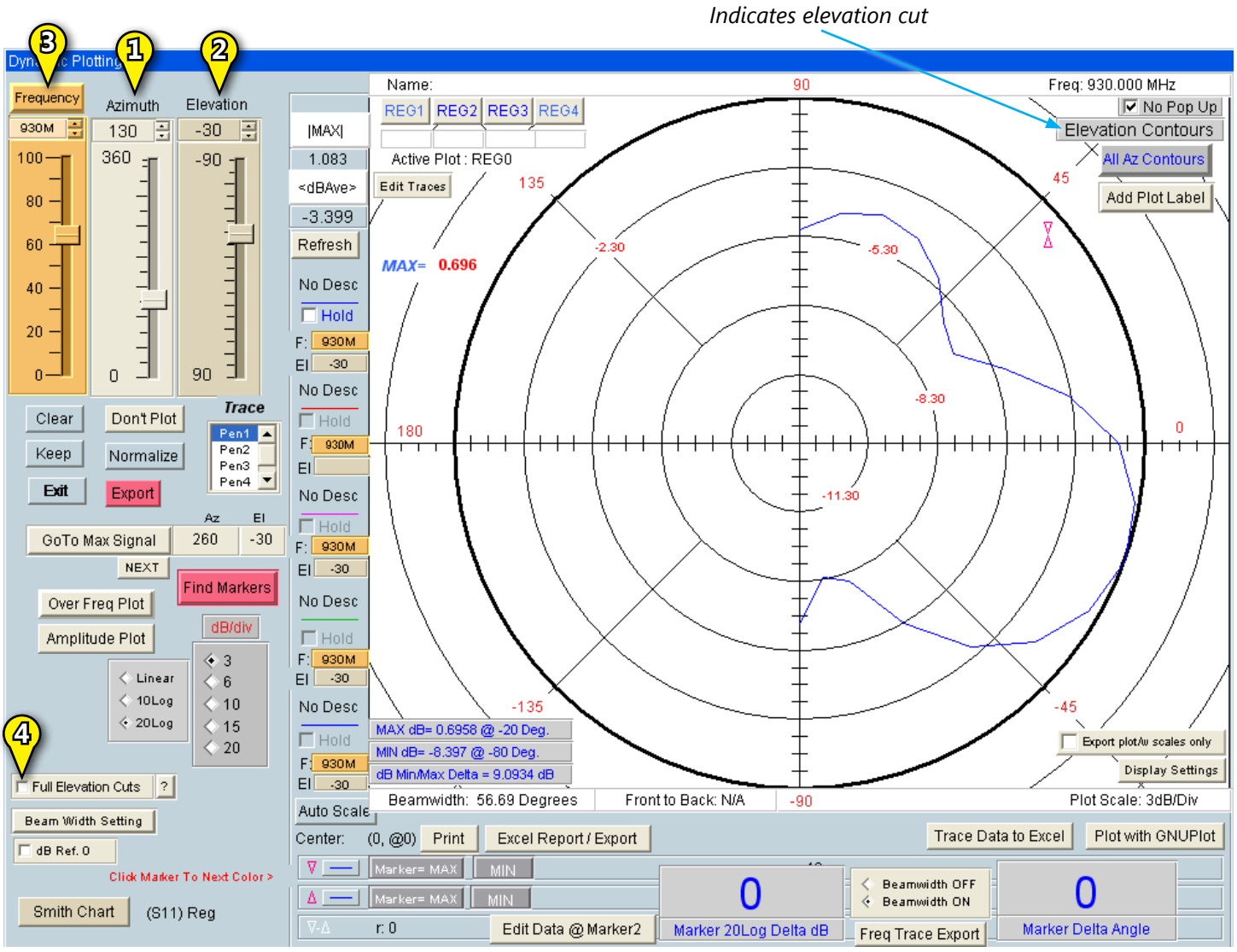
   This enables the AUT match amplitude and phase to be plot.



Full Elevation for Full-Circle Azimuth Cuts

1. Move Azimuth slider to see elevation cuts
2. Move Elevation slider to see azimuth cuts
3. The "Frequency" button can be used to enter frequency.
   (M,G and k are valid multipliers.)
4. Check for full 360 deg Elevation cut. Only valid for full scan data

TIP: You can export this data to Excel.

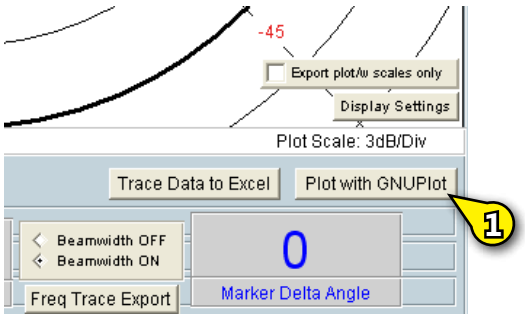


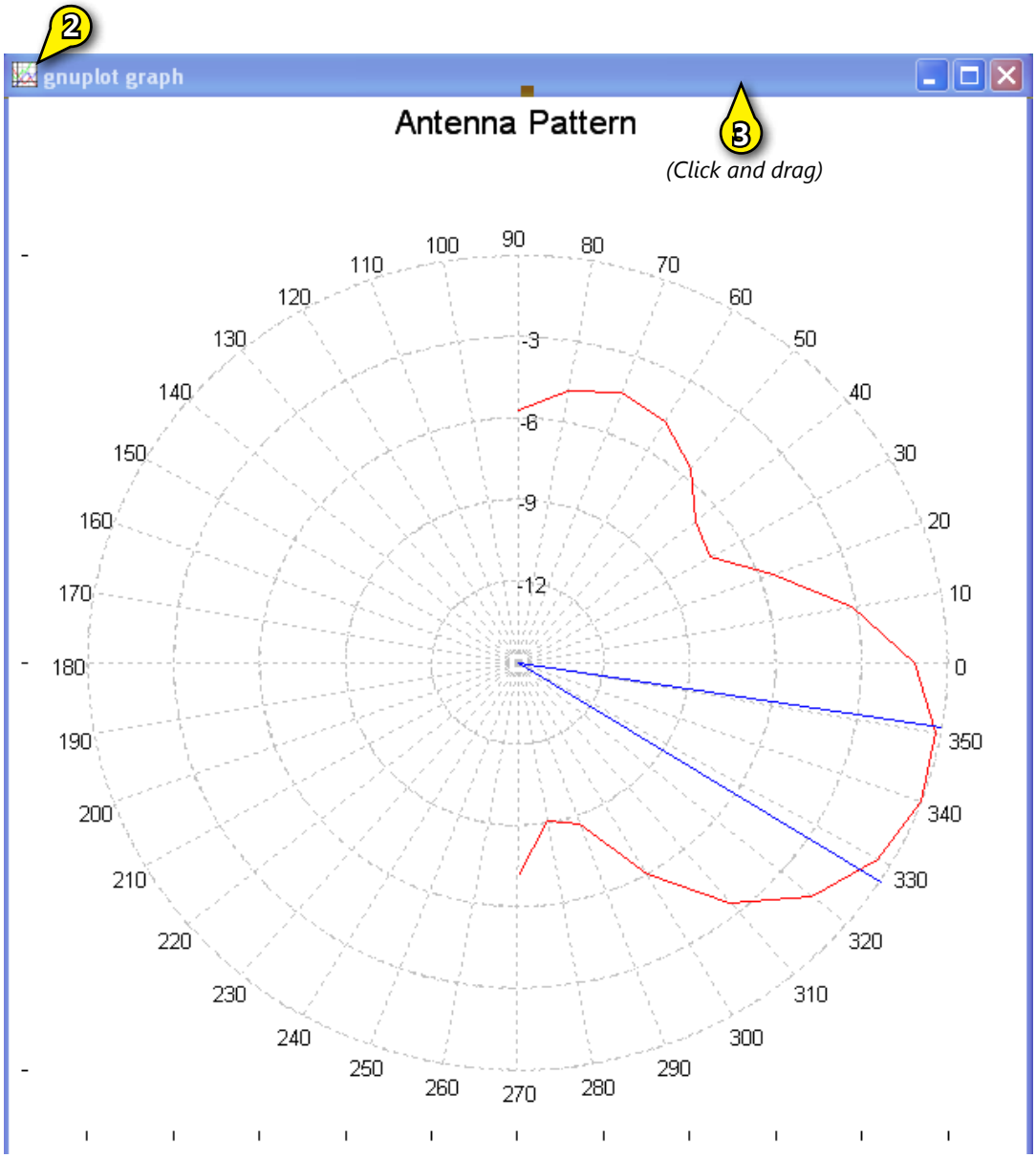
GNU Plotting

GNU plotting provides more marketable plots. To utilize GNU, follow these steps:

1. Click "Plot with GNUPlot".
2. Click here to reveal more options
3. Move the polar plot aside. It's best to have DAMS full screen so more plots can be run simultaneously.

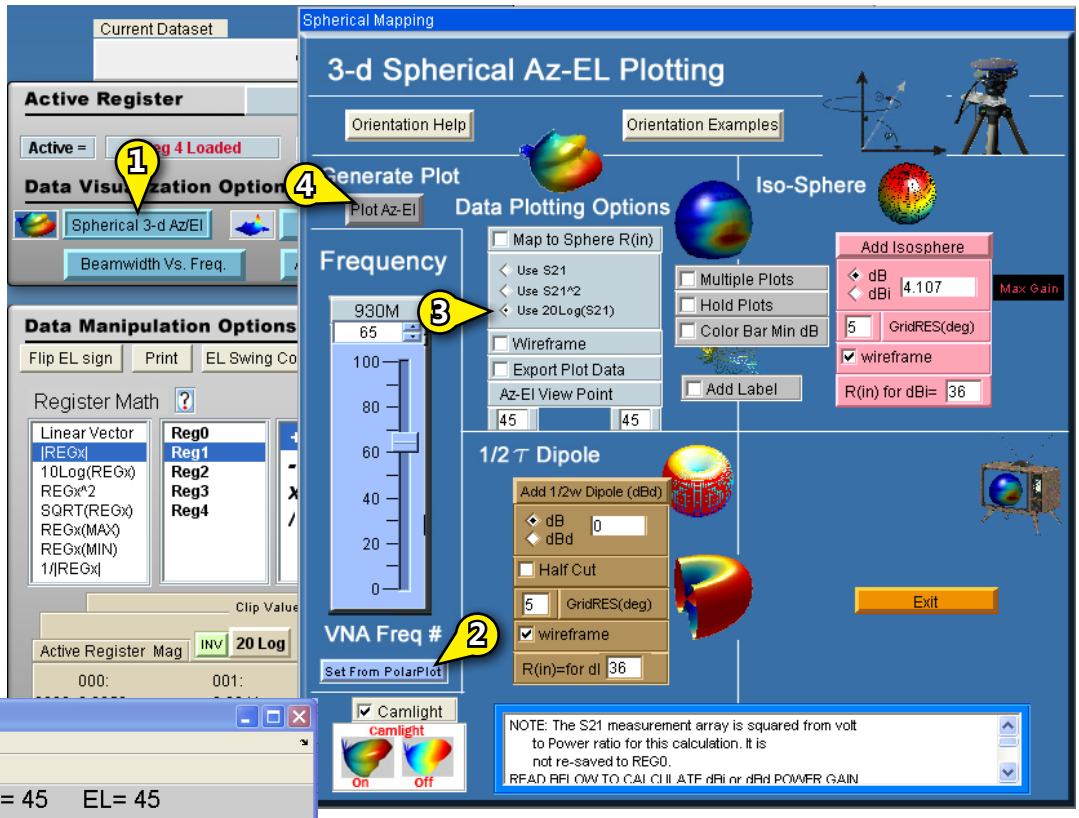
TIP: The amplitude plot may also be used to plot with GNU.



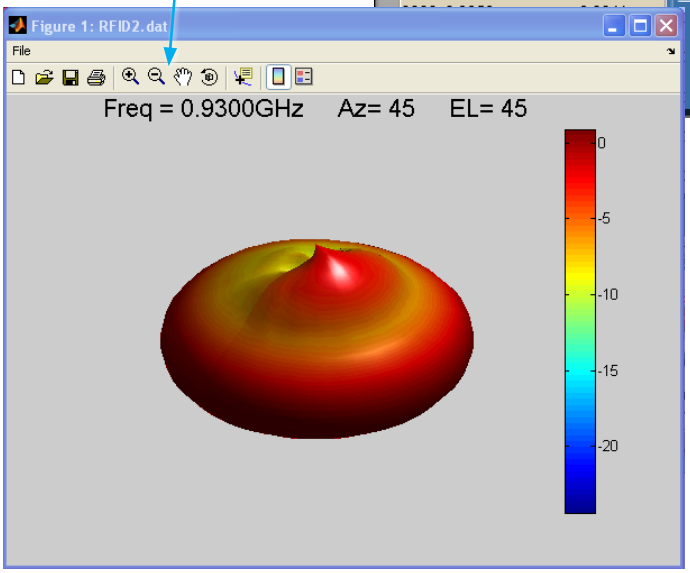


Plotting Peak Spherical Gain

1. Invoke the spherical 3-d Az/EL
2. Set the frequency slider to peak gain by invoking “Set From Polar Plot”
3. Check Use 20Log(S21)
4. Invoke Plot Az-EL, which opens the 3D rendition as seen below[?]



TIP: Processing toolbar offers a host of plot tools.



TIP: Generally the polar plot is used to identify a desired (Az,EL,f) contour. The Spherical frequency can be set “2” from the polar frequency slider in another window[?].

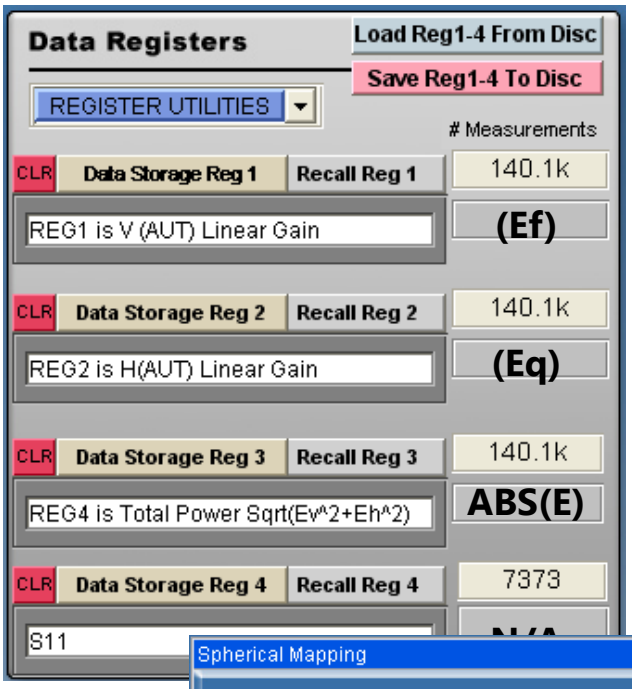
Where is said slider? Isn't the visible blue slider for the "VNA Freq #" as it says below it?

Spherical Plot of Gains (EQ),(EF),ABS(E)

⚠ **IMPORTANT**: See note in spherical regarding multiple dB spherical plotting for exceptions.

Where is this?

1. Be sure the REGs are as follows (from Gain Xfer Total Power)

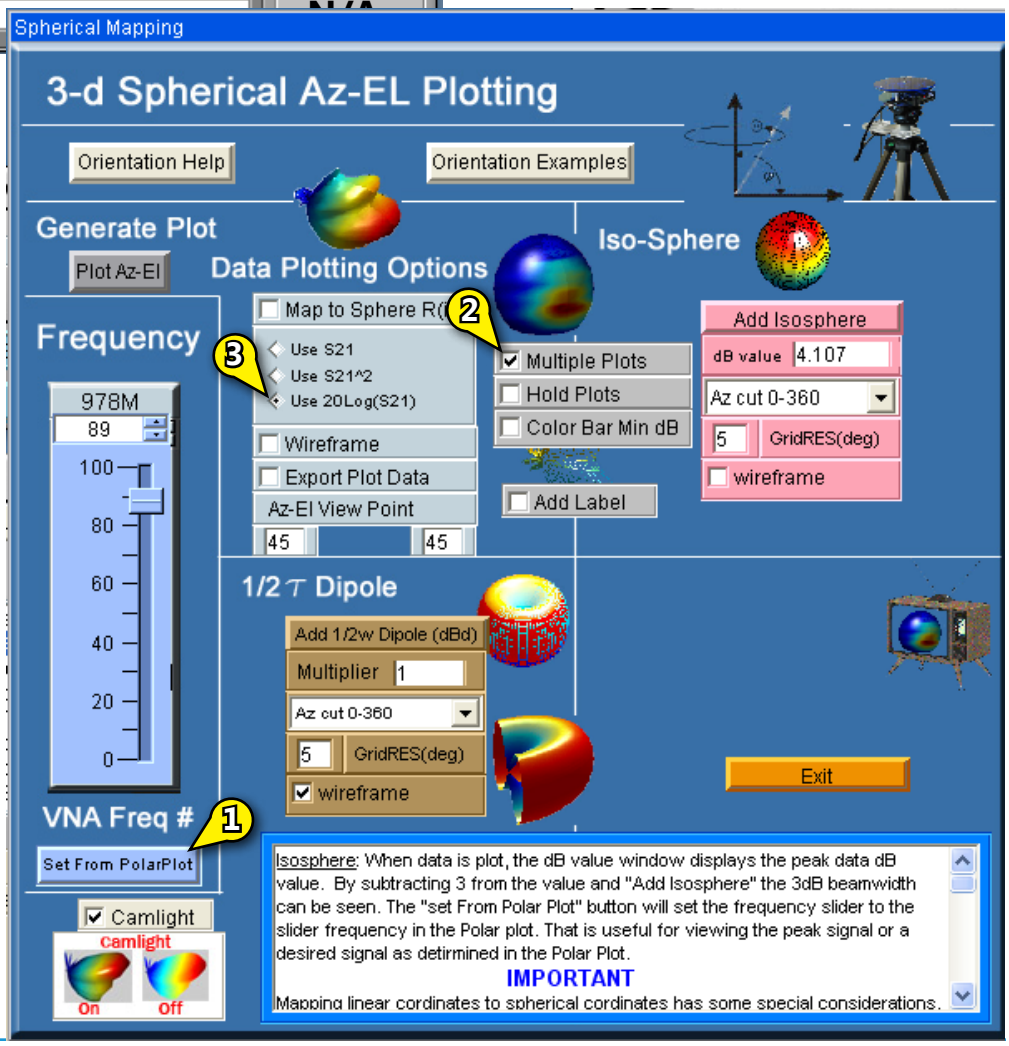


Where?

2. In the Polar Plot recall ABS(E) and invoke "Go To Max" to set the frequency slider to the frequency associated with max ABS(E)

1. Set the freq slider to polar plot (max)
2. Check Multipal Plots
3. Check 20Log(S21)

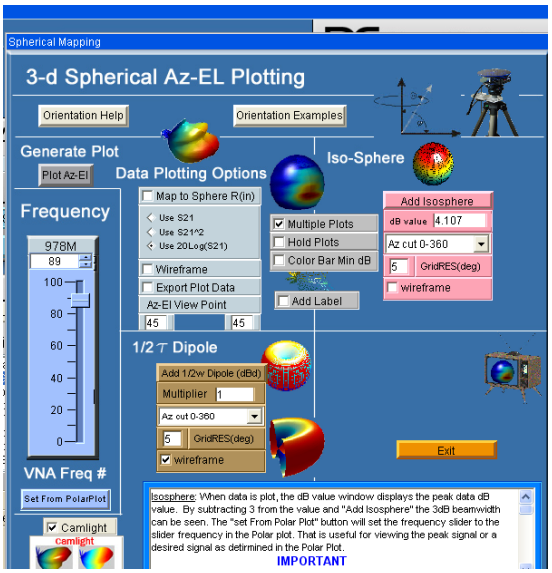
(Continues next page...) [?]



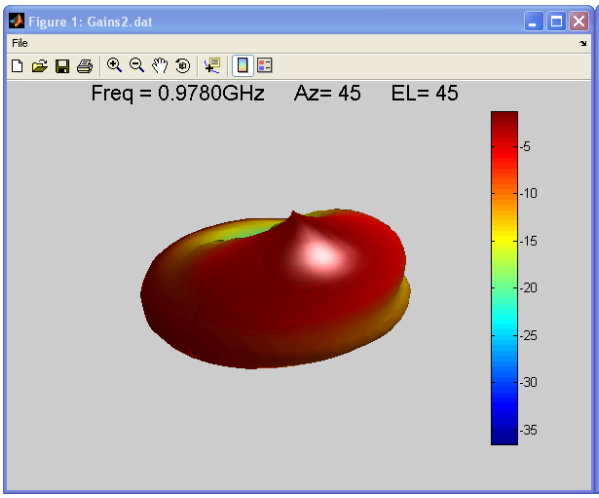
1. Recall REG1, Plot (EF)
2. Recall REG2, Plot (EQ)
3. Recall REG3, Plot ABS(E)

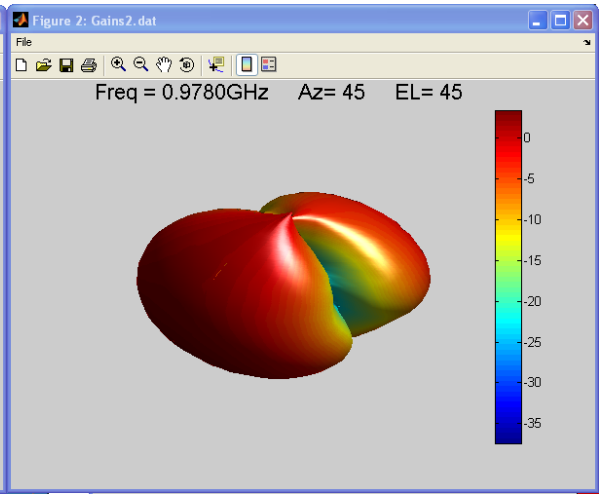
TIP: Plots can also be over laid by checking “Hold”. “Wire” can be used to delineate plots.

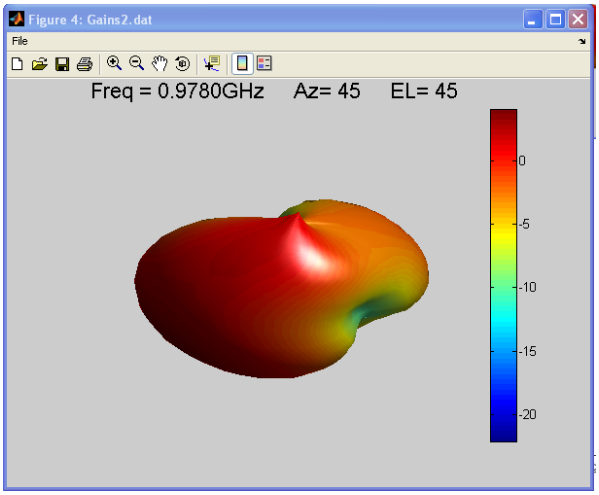
TIP: By clicking wire or no wire multiple plots can be made more visible.



What is this entire page?????

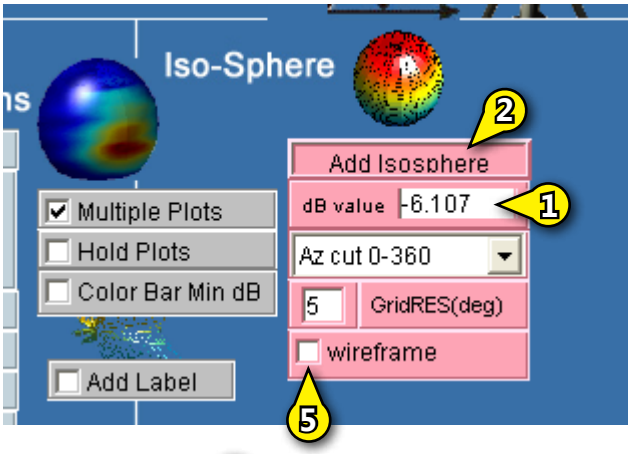


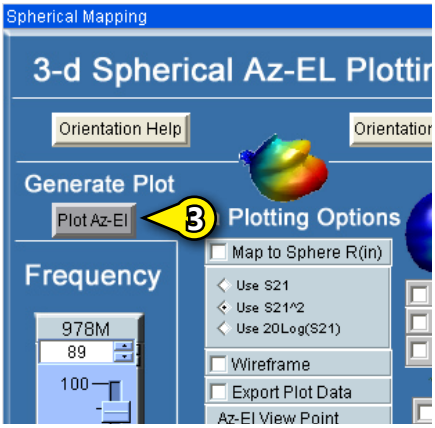


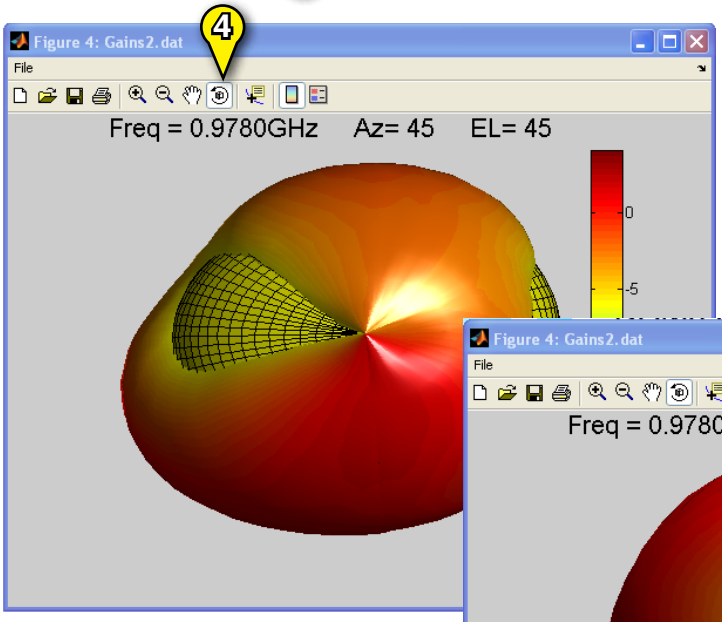


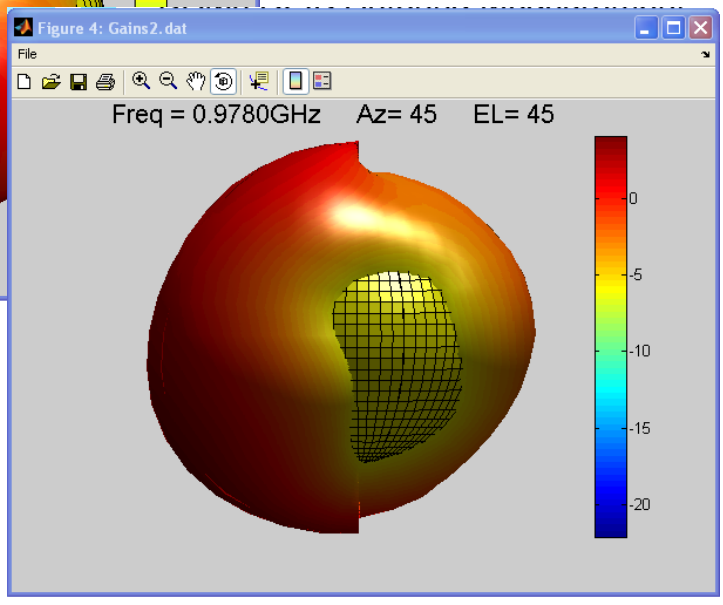
Determine Spherical Areas Less Than 10db Down From Peak

1. Spherical plotting displays the Max in the isotropic dB value. Subtract 10 and enter into window.
2. Depress "Add Isosphere"
3. Click "Plot Az-EL"
4. Use rotation to view data
5. By clicking wire or no wire multiple plots can be made more visible





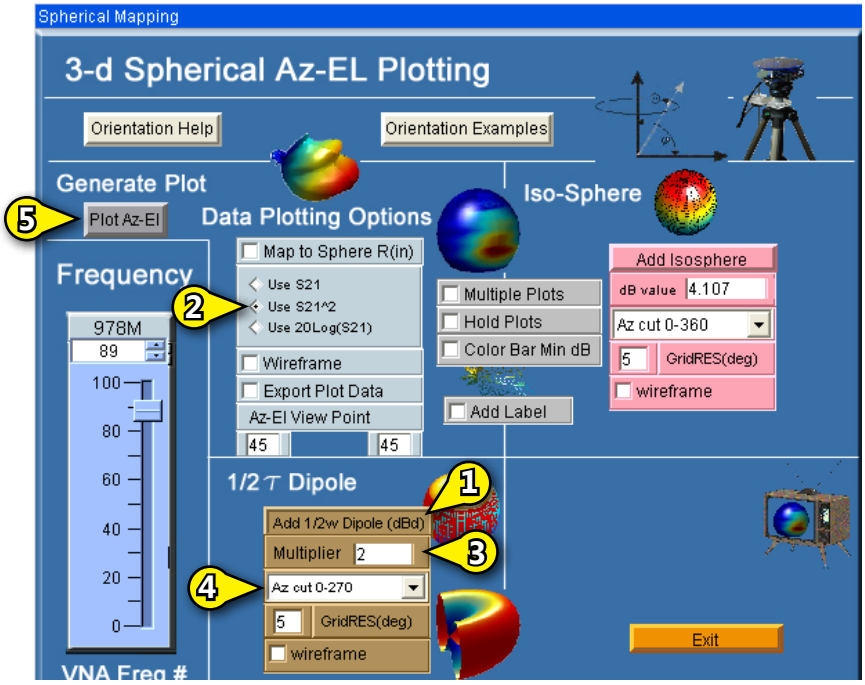


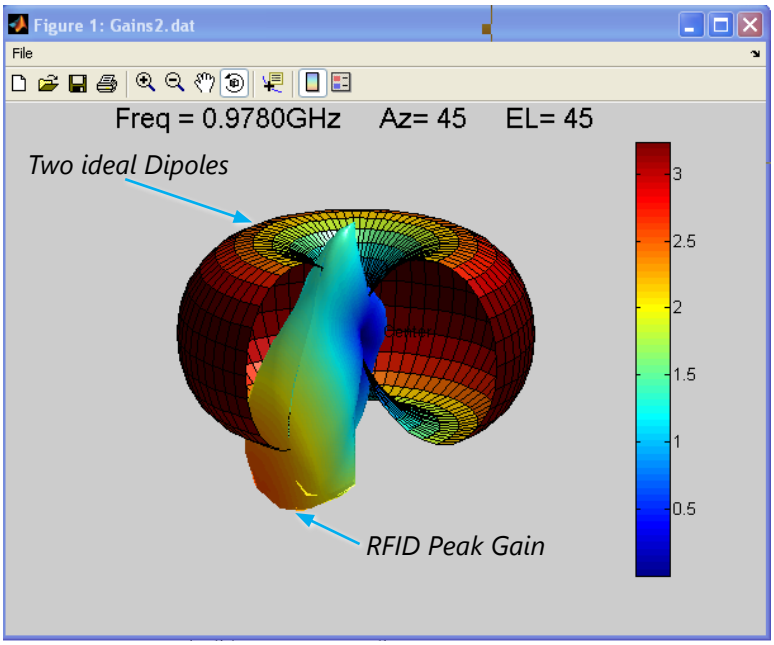


Determine the Equivalent Number of Dipoles

1. Depress "Add 1/2w Dipole"
2. Check S21^2
3. Increase multiplier until dipole gain ~ ABS(Gmax)
4. Select 3/4 dipole (with no wireframe)
5. Click "Plot Az-El"

TIP: By clicking wire or no wire multiple plots can be made more visible



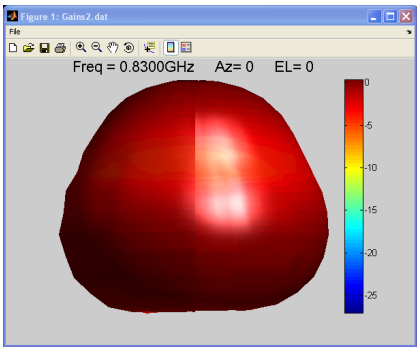


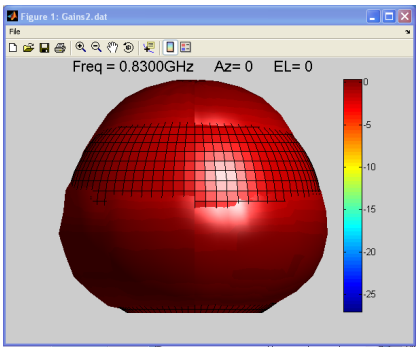
Determine the ABS(E)-3dB Compliance at 830MHz

1. Recall the ABS(E) data REG3 How?
2. Check "Use 20Log(s21)
3. Check "Multiple Plots"
4. Set slider to 830MHz
5. Click "Plot Az-El" to plot spherical. (Peak gain should appear in the "Add Isosphere" window, as shown to right.[?])
6. Press "Add Isosphere"
7. Subtract 3 from peak gain. May be performed in Add Isophere window, (see 5)

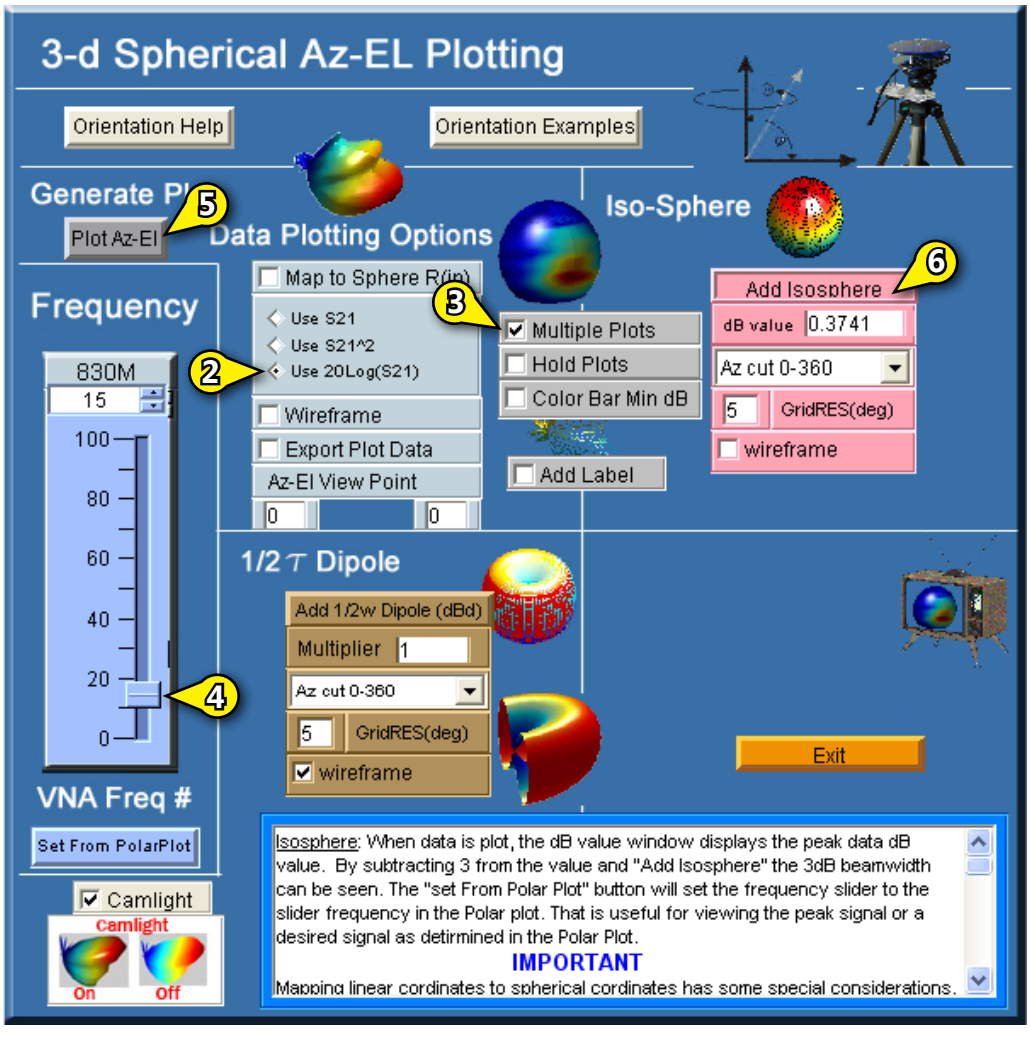
What?? Wrong number???

8. Click "Plot Az-El" (see 5)



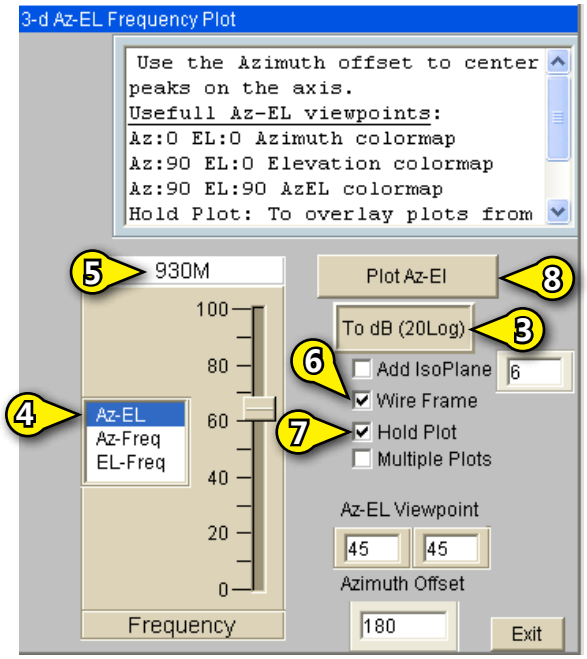


⚠ **TIP:** Every spherical max is set in Isosphere window

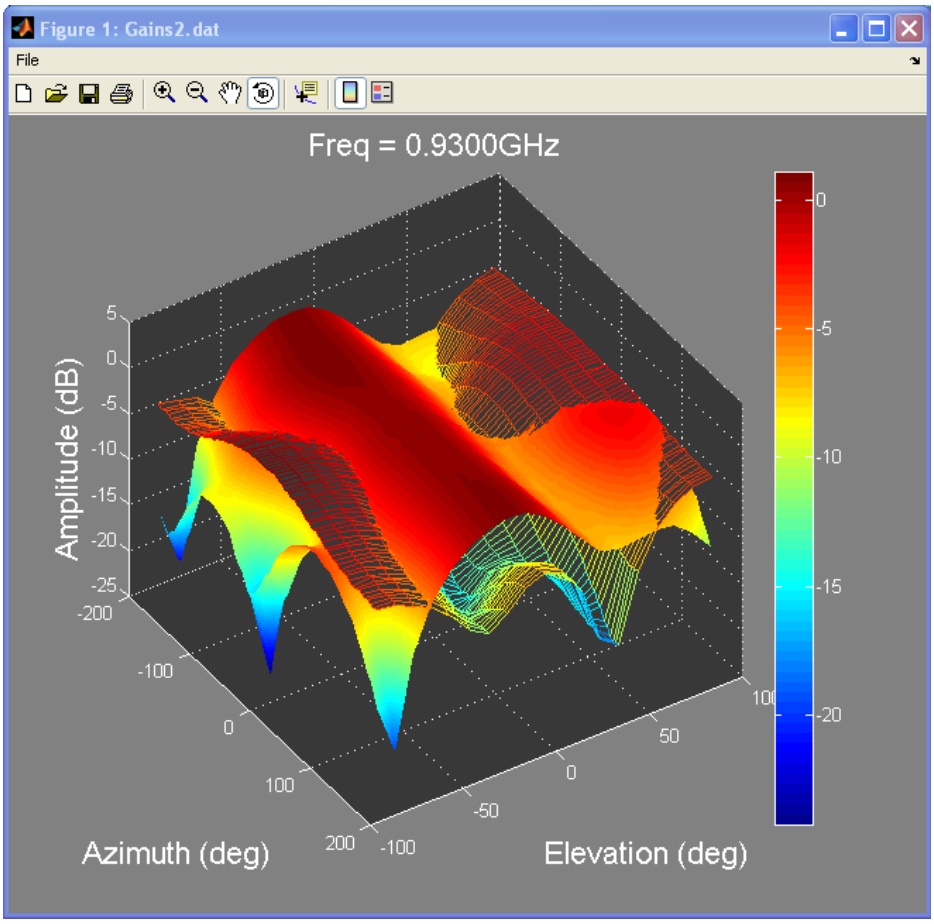


Overlay G(theta) and G(phi) AzEL Gain at 930MHz

1. Recall the GQ data from REG1 How?
2. Invoke the AzEL 3d plot How?
3. Click "To dB (20Log)"
4. Select "Az-EL"
5. Set frequency to 930MHz
6. Check "Wire Frame"
7. Check "Hold Plot"
8. Plot the data
9. Recall the GF data (REG2) How?
10. Uncheck "Wire Frame" and plot the data once again, (see 8).



TIP: You can use "Add Isoplane" to determine spec limits and beam widths



Color Plot of Az vs EL at 930MHz

1. Make a color graph of the AzEL plane. **How?**

2. Select Az-EL

3. With the previous plot present, change the Viewpoint angle to Az=90 EL=90

4. Re-plot the data

5. Use the data reader to click on data values

TIP: The slider will change depending on which plot is selected.