ND*nano* Undergraduate Research Fellowship (NURF)
2012 Project Summary

1) Student name: Joshua Donati
2) Faculty mentor name: Patrick Fay
3) Project title: High Speed Transistor Testing

4) Briefly describe any new skills you acquired during your summer research:

Use Agilent ICCAP modeling software.
Configure and Operate a Vector Network Analyzer.

5) Please briefly share a practical application/end use of your research:

With this computer model of the GaN HEMT, engineers will be able to design and test new circuits. By using the computer model it will also save money and time during the prototyping of these new designs.

Project summary:

GaN HEMTs (High Electron Mobility Transistor) show great promise for future use in high power and high bandwidth applications. Because of the great promise of this technology, engineers need reliable computer models to use in the design of a wide variety of devices. For this project, I will be characterizing a 30 nm gate length GaN HEMT with 2 gate fingers and total gate width of 50 um AC and DC performance. From these measurements I will be able to complete a large and small signal model of the transistor using Agilent's EEHEMT equivalent circuit model. This model then can be implemented into CAD software for designers use.

The first step of my project was spent reading on extraction techniques that I will need to use during the characterization of the device. Most important from this reading was about how to extract the equivalent circuit from S-parameter measurements. The choice of using the EEHEMT equivalent circuit model allowed for a flexible model to be created. Using the model equations in the ICCAP software, the IV curves for the DC parameters where fitted. A perfect fit for all the IV curves could not be obtained. This was expected due to the model is customized for HEMTs not designed for specifically for them. Knowing this, the effort was made to make the best fit in the ranges where the transistor would be used the most. AC curves were fitted next due to their reliance on the DC family IV curves and characteristics. These curves did not fit nearly as well due to the large range of frequencies, Vgs, and Vds that the measurements were taken over. With the large amount of variables to work with, the equivalent circuit model was created and found to have a good fit.

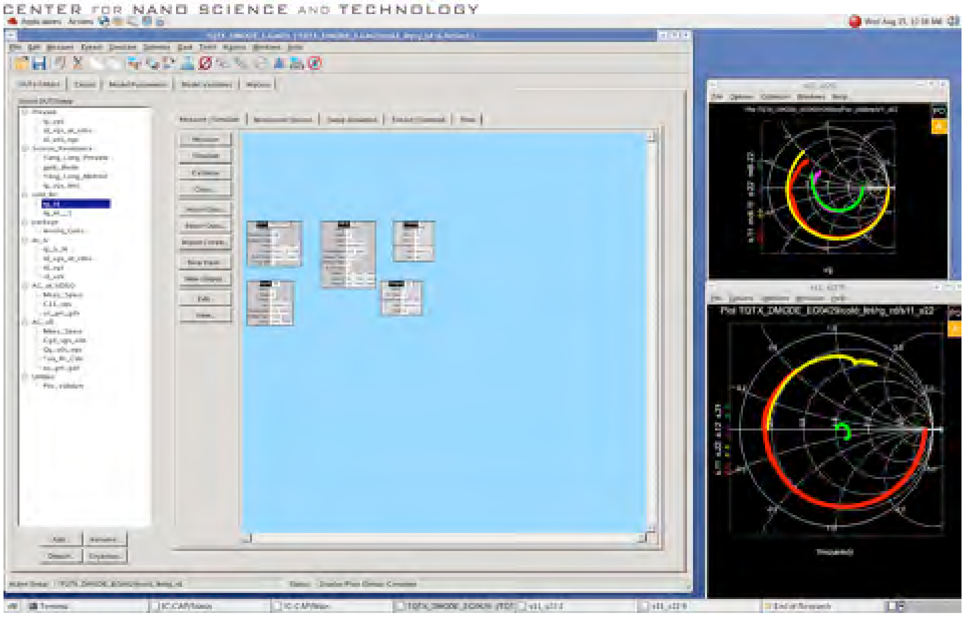
Figure 1: Agilent ICCAP enviroment

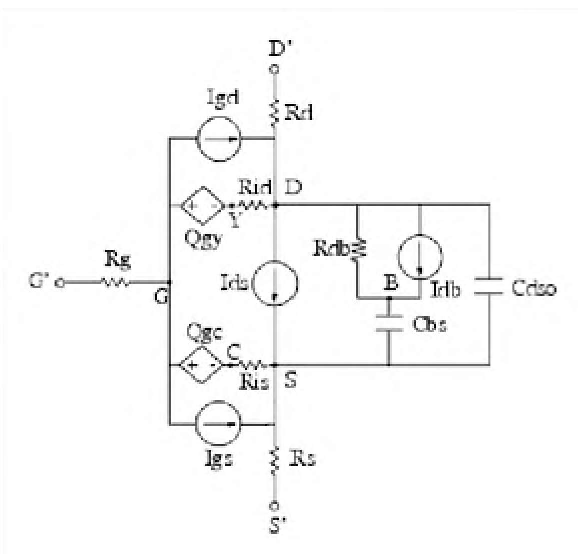

Figure 2: EEHEMT Equivalent Circuit

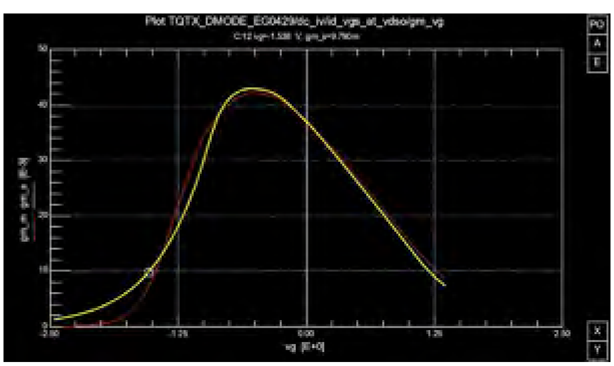
Figure 3: Id vs Vgs at Vdso

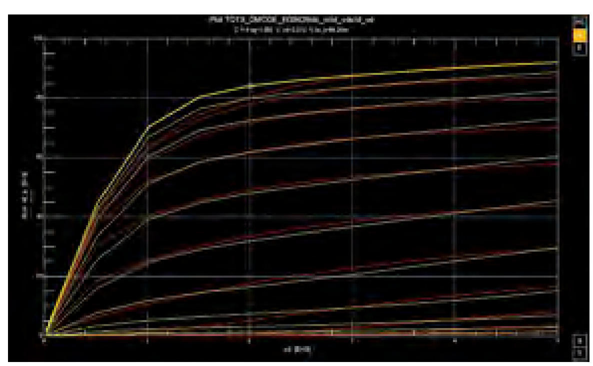
Figure 4: Id vs Vds vs Vgs

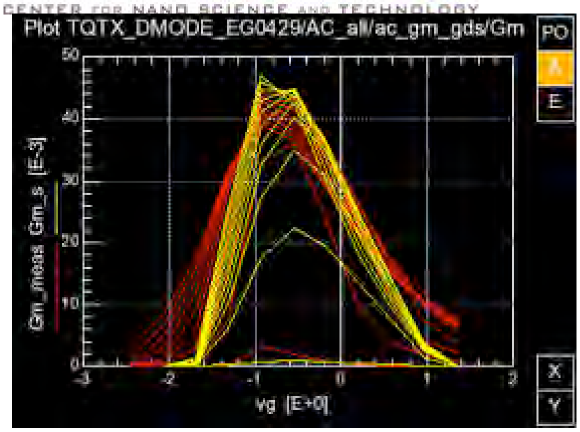

Figure 5: AC Gm vs Vgs

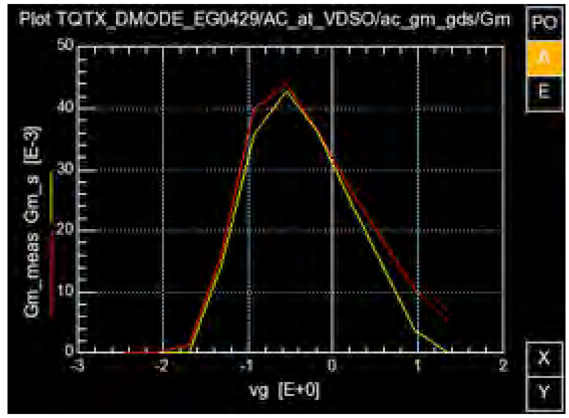

Figure 6: AC Gm vs Vgs at Vdso