L.E.R.C.I.P. Internship Summary

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I am currently working towards a double major in Computer Science and Electrical and Computer Engineering. My summer internship at NASA Glenn Research Center has allowed me to apply and further my knowledge of both of these fields. This summer is my second L.E.R.C.I.P. experience, and has worked out equally well as the first. I haven't been working on one single project this year, but instead have had a good variety of things to work on. Thus far I have spent time on the following tasks: antenna measurements, high-temperature reliability testing, and left-handed metamaterials.

The first two weeks of my summer were put toward testing planar antennas that operate at either 14 GHz or 35 GHz. It is hoped that after some fine-tuning, these two types of antennas can be combined, producing a single antenna that operates at both frequencies. The antennas are tested in an antenna range, which is essentially a Plexiglas box lined with foam absorber. A signal at a specific frequency enters the range via a horn mounted on one side of the Plexiglas box. The antenna under test is mounted on a rotating stage directly in the path of the input signal. During testing, the antenna is rotated from a -90° position to a 90° position, relative to the input signal. Effectively, this measures the antenna's ability to receive waves coming from any practical angle. Meanwhile, the power of the signal received by the antenna is monitored. This entire testing procedure is performed automatically by software written in a graphical programming language called LabVIEW. In addition to using this software to measure a number of antennas, I was able to tweak the program, allowing it to run three times faster.

Reliability testing has consumed more of my time this summer than any other topic. Reliability testing occurs over an extended period of time, up to 1000 hours in this case. The devices to be tested are simple, on-wafer circuit components such as resistors, transmission lines, and capacitors. During the entire test, the devices must be kept at a temperature of 500° C. In addition, the devices must be biased to a certain current/voltage level throughout the testing period. I am currently working on the software and hardware for this reliability test setup. The software is again written in LabVIEW. This software will periodically measure the current through and voltage across each device, making it possible to determine when the devices fail, and how their parameters change over time. Due to the extremely high temperatures required by the test, the software will also routinely perform safety checks.

The subject that has filled my spare moments this summer is left-handed metamaterials (LHM's). A metamaterial is a block constructed from more than one type of material. The block is composed in such a way that artificial "cells" are created. The composite behaves like a continuous material because its elements are much smaller than the wavelength of the electromagnetic radiation incident upon it. One way to create a LHM is to start with dielectric sheets that have a thin layer of metal on each side. The sheets are etched so that there are straight, parallel copper lines on one side and split-ring resonators on the other side. Numerous such sheets are interlaced to form a rectangular grid.

Prior to this summer, engineers in my branch had already built one such LHM (See Figure 1 below), using a 20x20 grid.

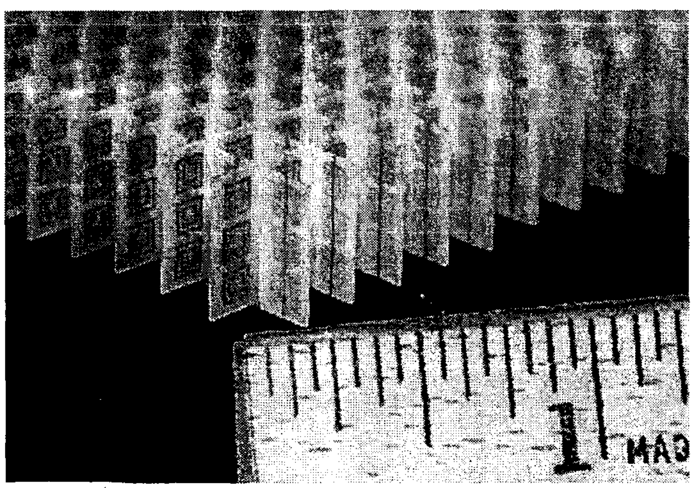

Figure 1: Left-handed metamaterial

My job was to help devise a way to measure the signal inside each cell of the LHM. The signal transmitted through the LHM had previously been measured by sandwiching the material between 2 solid sheets of metal, placing a signal source on one side of the block, and measuring the signal on the opposite side. I worked with another engineer to determine how to test each cell without adding too many additional variables. We built a new fixture to detect the signal. First, we mounted a coaxial connector on the corner of a thin metal sheet. The center conductor of the coax cable was extended out from the metal sheet so that it could be inserted in each cell of the LHM. We chose to attach the connector near the corner of the sheet so that it would be more visible, and hence easier to move quickly from one LHM cell to another. This was especially important because there are hundreds of cells, each of which is relatively small (5mm x 5mm). We used spare metal sheets to cover the parts of the LHM that were left exposed by our new test fixture. With the hardware setup finished, we wrote a simple LabVIEW program to read the power traveling into the block and out through the coax connector. The test setup is now complete and measurements are in progress.

Overall, I have been very pleased with both of my summers at NASA. For me, the experience has been interesting as well as practical. I learned how to use LabVIEW last summer, and was able to apply that skill in a year-long independent study during the past school year. In fact, I would not have been accepted for that position, had it not been for the experience I gained at NASA. Furthermore, the proficiency I gained during my independent study has made me a better programmer back at NASA this summer.