Radio Frequency Interference (RFI) Blocker

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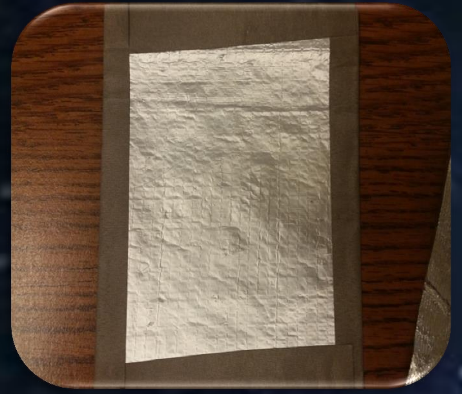
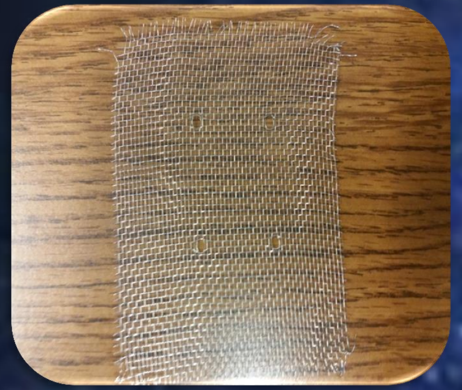
Abstract

Understanding and mitigating Radio Frequency Interference (RFI) is an essential part of the Space Geodesy Project. RFI can interrupt, disturb, or limit the effective performance of electrical equipment. There are four SGP techniques at the Goddard Geophysical and Astronomical Observatory (GGAO); Very Long Baseline Interferometry (VLBI), Doppler Orbitography Radiopositioning on Satellite (DORIS), Satellite Laser Ranging (SLR), and the Global Navigation Satellite System (GNSS). An RFI blocker is being developed to mitigate interference between the equipment in use for the four techniques at the site. In order for these techniques to tie together and operate simultaneously without complications, there needs to be an effective blocker to prevent any unwanted noise. RFI is an issue at many locations that use SGP techniques, not just GGAO, so the question of, "what is an adequate RFI blocker", is definitely one that needs to be answered.

Objective

The primary objective was to figure out what material would have the best RF properties, as well as wind loading properties. Wind loading properties are important because this material would be deployed outside, which means it would need to be able to withstand turbulent winds and any other weather that may occur. The three materials up for testing were AL100, stainless steel mesh with 18 holes per square inch, and stainless steel mesh with 100 holes per square inch.

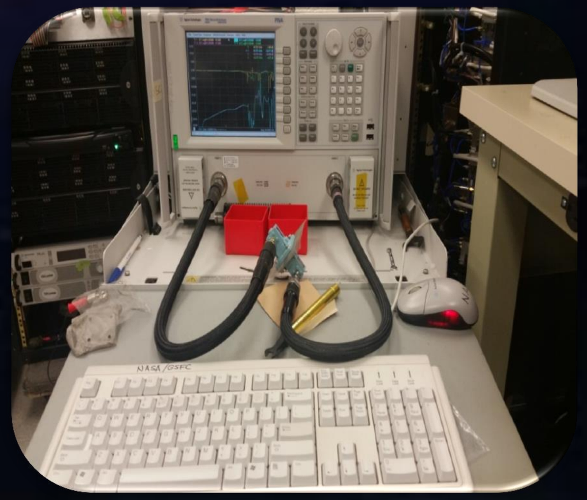




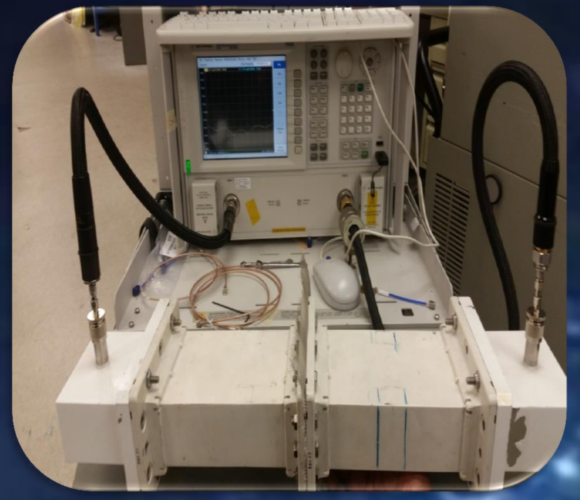
(Above Left): AL100; (Above Right): 18 Mesh; (Bottom): 100 Mesh

Testing

To test the RF properties, each material was placed in a Waveguide Analyzer, which was then hooked up to a PNA Network Analyzer via coax cables. The PNA Network Analyzer measures the S-parameters, or transmission coefficients. The S-parameters that were important for this test were the S11 (return loss) and S21 (insertion loss). The test frequency range was 300MHz-18GHz to include all frequencies of the beacons and radars. This range of frequencies can not be covered with a single waveguide size.



(Above) PNA Network Analyzer test setup
(Below) 18 Mesh inside Waveguide Analyzer



PNA Network Analyzer test setup with S-band Waveguide Analyzer

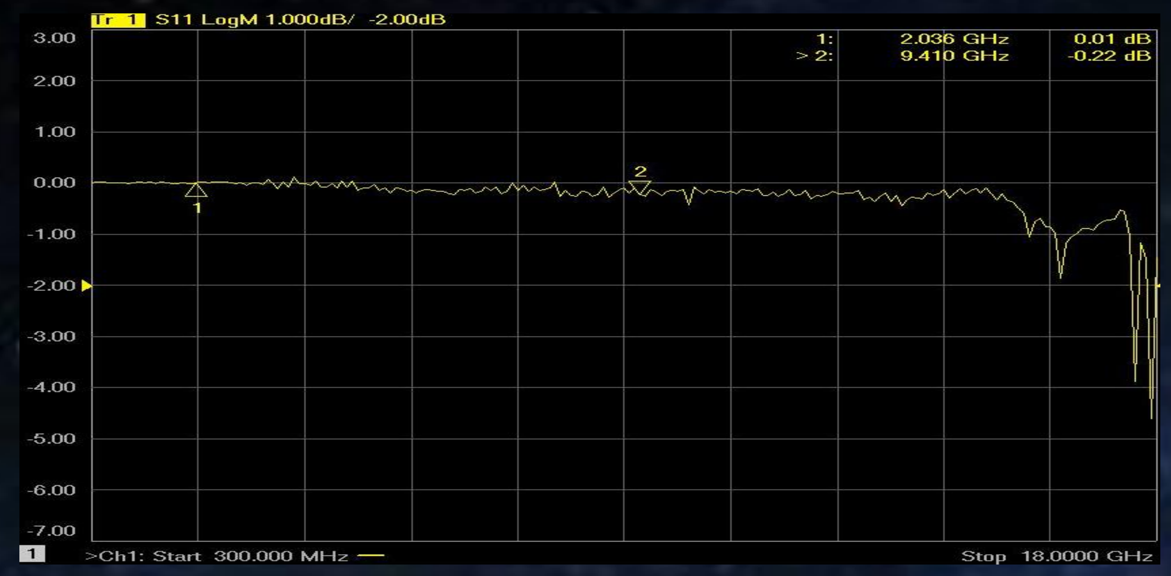
The second RF property test was done with a S-band Waveguide Analyzer. The 100 Mesh and 18 Mesh materials were tested, just in a more specified and condensed frequency range that included the DORIS operating frequency~2035 MHz that interferes in the VLBI frequency range 2-14 GHz.

The wind loading tests were done on a Jet Stream 500 wind tunnel located at my alma mater, South River High School. All three material samples were approximately 3''x3'' and placed inside of a tape and cardboard frame for stability purposes. All of the materials were tested in the wind tunnel at angles ranging 5°-40° from vertical and against wind speeds up to 80 miles per hour.

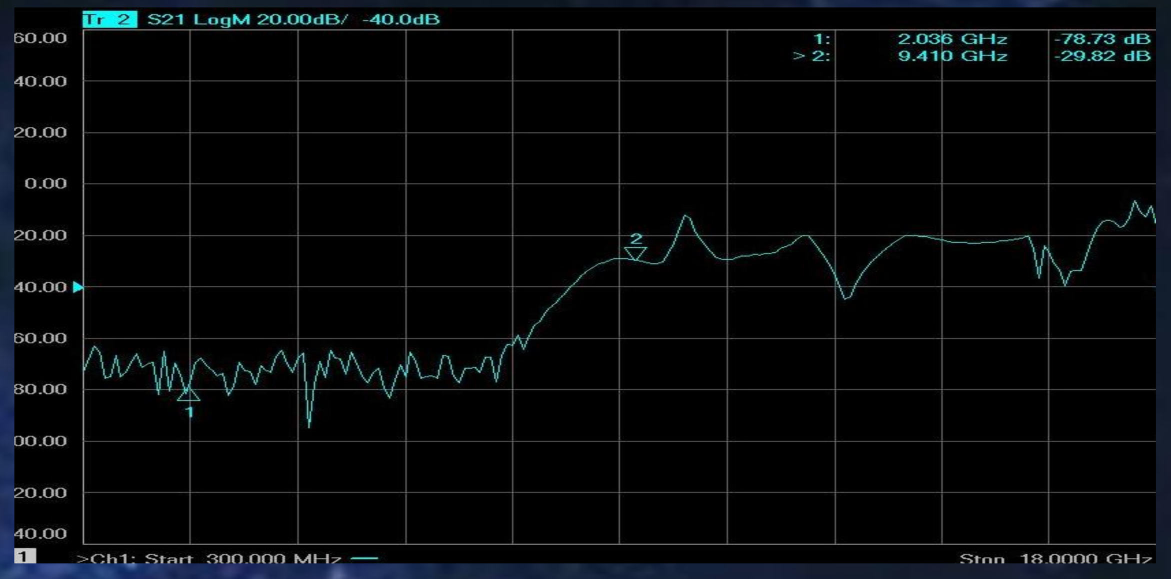
(Top) Greg and I preparing the samples for testing.
(Bottom) Carlos and I conducting the tests.

Results

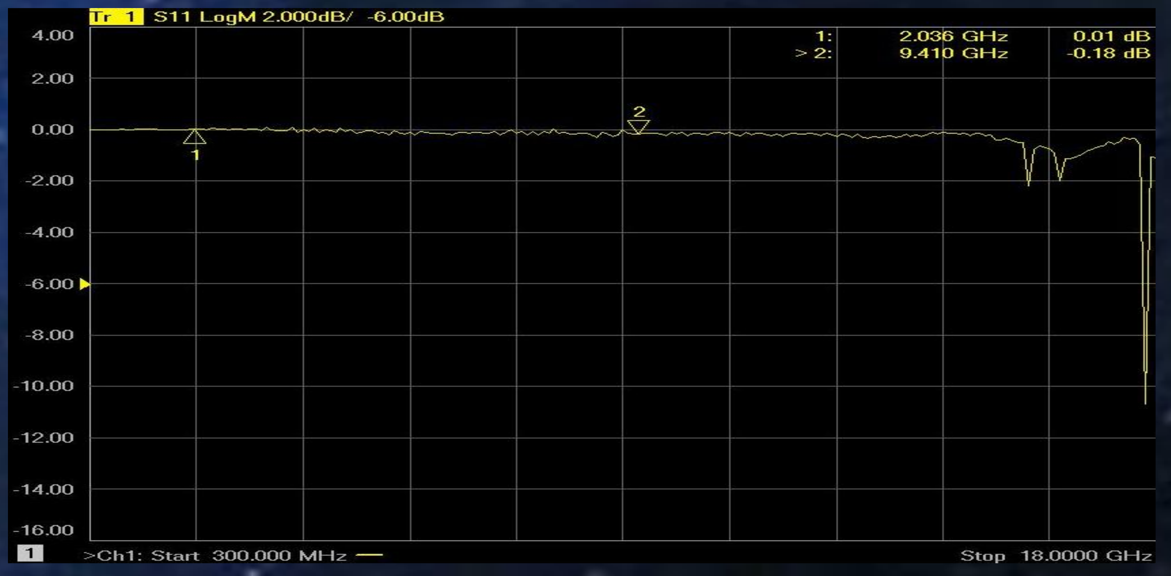
I was responsible for analyzing the RF property data that was produced from the tests done on the PNA Network Analyzer. Carlos was responsible for analyzing the data produced from the wind tunnel tests.



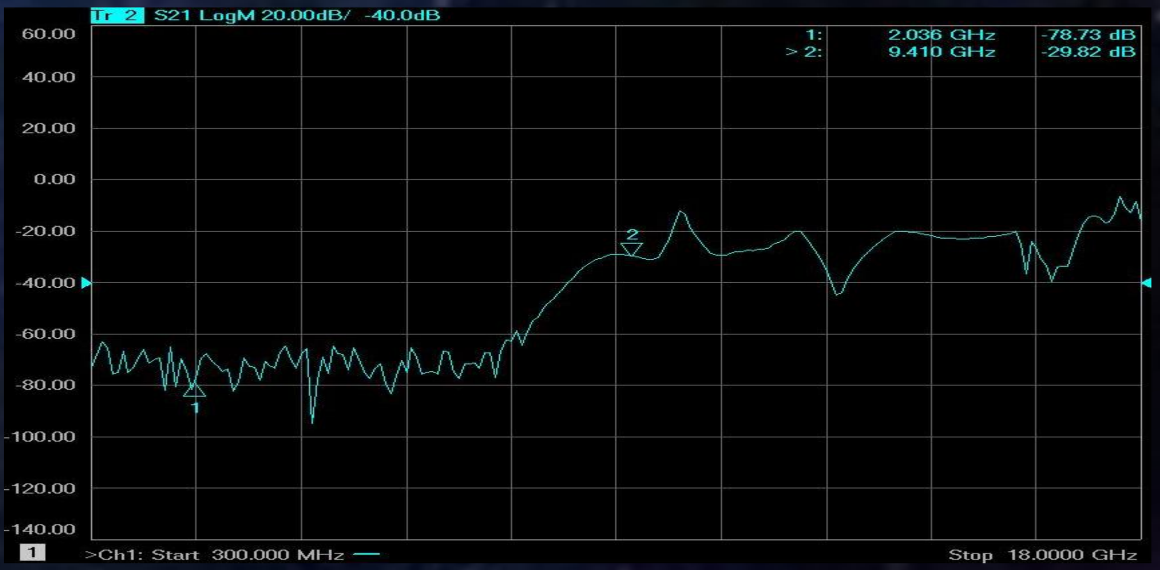
18 Mesh S11



18 Mesh S21

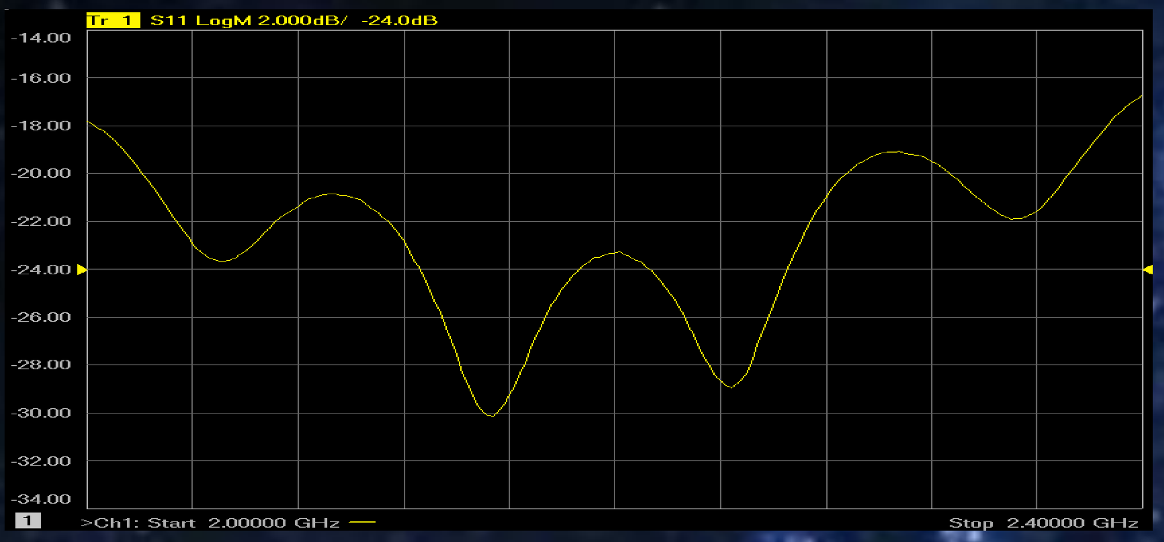


100 Mesh S11

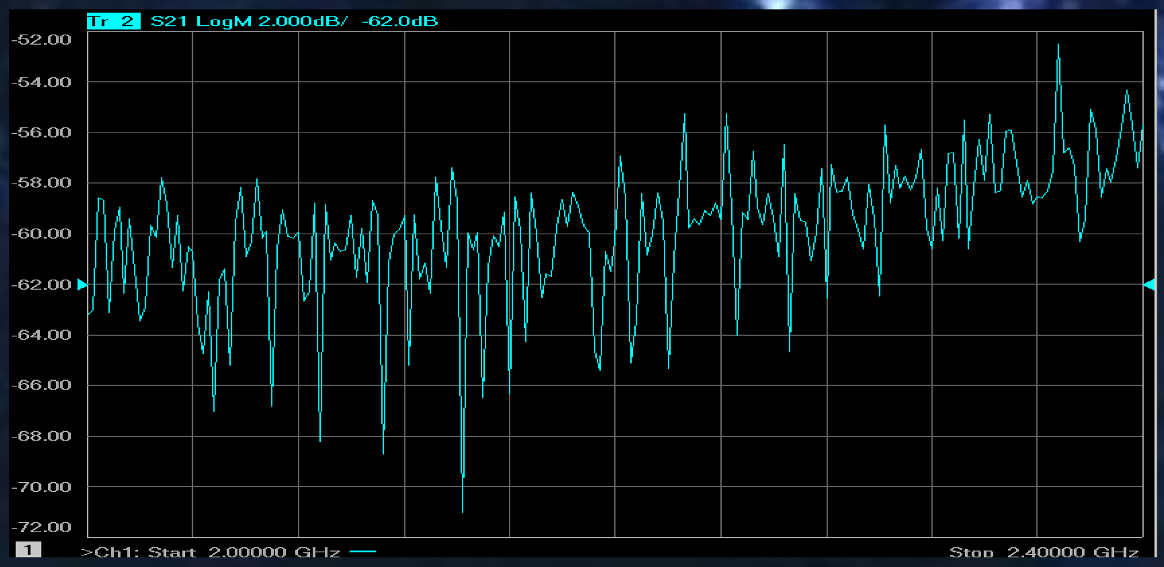


100 Mesh S21

Results (continued)



18 Mesh S11 (S-band Waveguide)



18 Mesh S21 (S-band Waveguide)

Conclusion

Ultimately, the material that was chosen was the 18 Mesh because of its durability, ability to give sufficient blockage, and its cost. We ran into some issues during the testing phase that we have to correct, so we will have to do some of the tests over again to be able to correctly deploy a long term effective blocker. We currently have an 18 Mesh test blocker deployed at GGAO and we are in the process of creating a more effective one. We are optimistic that we will be able to design and create an efficient blocker that can also be used at other facilities. We still have a lot of work to do to achieve this goal.

Acknowledgements

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