RFI Blocker Testing at GGAO to Enable Space Geodetic Technique Colocation

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Abstract

Goddard Geophysical and Astronomical Observatory, or GGAO, is setting the new standard in research facilities when it comes to connecting space geodetic techniques. The GGAO is one of the few sites in the world where over four space geodesy techniques such as: Satellite Laser Ranging (SLR), Very Long Baseline Interferometry (VLBI), global navigation satellite system (GNSS), and Doppler Orbitography Radiopositioning on Satellite (DORIS) reside. In order for these techniques to function most efficiently, the site needs to be frequently surveyed to determine the exact position and elevation of calibration piers, antennas, and beacons of each technique. The VLBI is one of the most sensitive equipment at GGAO because it operates by timing the difference of the arrival of very faint and distant waves emitted by a quasar at the other end of a long baseline. An issue for developing research facilities is the colocation of the techniques and the interference between equipment. To prevent interference within GGAO, we are creating a Radio Frequency Interference (RFI) Blocker to allow the operation and coexistence of these modern techniques in a single research facility.

Objectives

(Above) Map of GGAO

(Left) VLBI2010 Antenna

(Right) Temporary DORIS Beacon

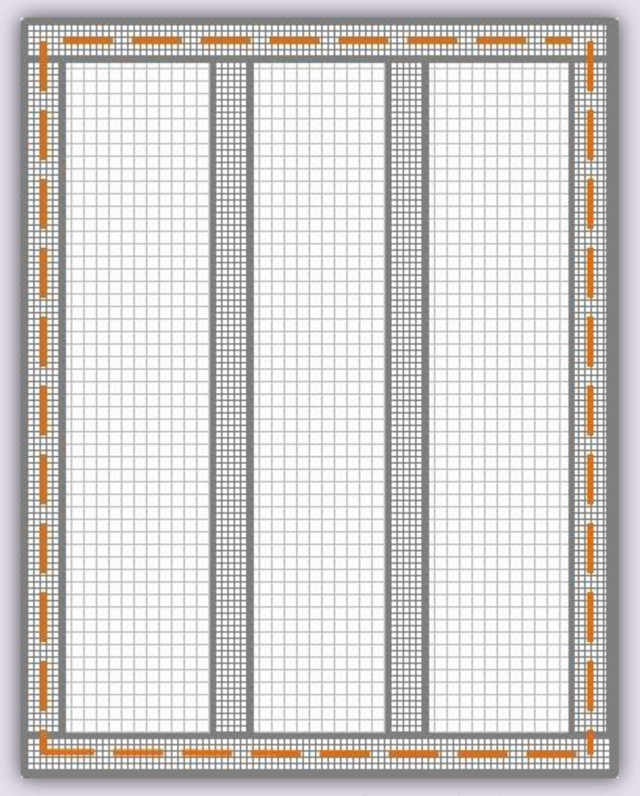
The objectives of my team are twofold: to survey and model GGAO, and to prevent interference between other equipment and the VLBI. A survey of the site is necessary to model GGAO and will allow us to simulate different scenarios of interference at the site without harming any equipment. To prevent interference, we will construct a RFI Blocker between the VLBI antenna and a temporary DORIS beacon set 136 meters away. We must construct the RFI Blocker to withstand all weather while providing enough RFI blockages.

Methods

To survey GGAO Erik Donald from Honeywell and I used a survey rod and laser level to find the difference in elevation between survey piers throughout the site. In total we surveyed from 24 piers to get accurate positions and elevations of the equipment and piers on site.

Survey Pier

Survey Rod



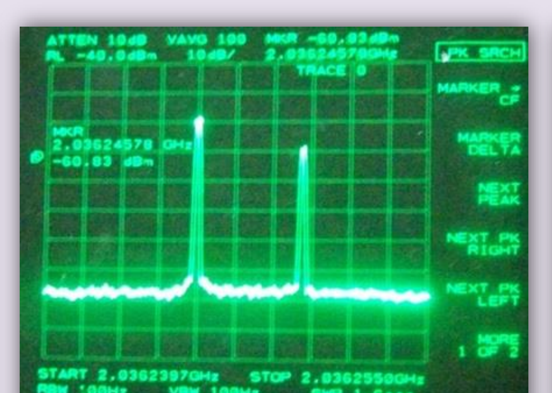
Designed 18 Mesh RFI Blocker

To determine the best material to be used as the RFI Blocker, my team tested the effectiveness of multiple materials in RFI blocking and wind resistance. We concluded that 18 openings per inch (OPI) stainless steel mesh will give the best balance between RFI effectiveness and minimal wind resistance. To make the mesh large enough, we had to sew panels together with metal wire and give the edges sleeves to allow the mesh to hang from scaffolding and eventually flagpoles.

Results

To determine how effective our new blocker is, we conducted a few baseline tests. The first test is had no blocker between the VLBI and temporary DORIS and peaked at -44.5 dBm. With a non-wind resistant, effective blocking material, the Al 100 blocker reduced the interference down to -60.83 dBm. Our home-made RFI Blocker peaked at -56.67 dBm, only about 4 dBm higher than the Al 100 blocker.

-44.50 dBm with no Blocker



-60.83 dBm with Al100 Blocker

-56.67 dBm with 18 Mesh Blocker

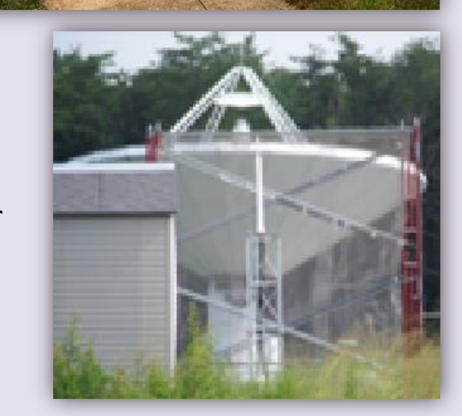
Conclusions

To date the 18 mesh RFI Blocker provided about 12 dBm attenuation to the VLBI and we aim to block even by trying different positions and angles. Another issue we will have to consider moving forward is multipath. We want to dissipate the interference coming from DORIS and other equipment however; we also do not want those signals being reflected into space at a slight delay causing multipath. To account for gusts, we overlapped panels of mesh so that the wind can escape sideways through the panels while maintain a uniform cross section to DORIS. More tests are necessary to attenuate the most energy, however we are confident that we will create an all-weather blocker that will allow new research facilities to place equipment like DORIS and VLBI in the same area and have both techniques function effectively. Our next step is to mount a larger mesh on flagpoles and attempt to block signals coming from SLR equipment effectively. The radar has a much more directed beam than the DORIS beacon so the bigger blocker may allow both SLR and VLBI to view larger portions of the sky than presently allowed.

(Above) Profile of Configuration

(Left) 18 Mesh RFI Blocker

(Right) Along Configuration



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