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Space Debris Detection, Tracking and Characterization - SST (1)

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THE GOLDSTONE ORBITAL DEBRIS RADAR OBSERVATIONS

Abstract

Orbital debris consists of man-made objects in Earth orbit that no longer serve a useful purpose. There are currently over 100 million objects less than 1 cm in size that pose a serious risk to space assets, including astronauts at the International Space Station. With the increase in human space activities, the number of space debris is expected to increase dramatically year by year.

The Goldstone orbital debris radar (GODR) program has been in operation for over two decades at NASA's Goldstone Deep Space Communications Complex in California. These observations, now carried out at 2-4 times per month, provide important information on orbital debris objects, including estimates of their size, relative velocity, range, and orbit inclination angle. These measurements provide key information on debris objects from 10 mm down to 2 mm in size to NASA's orbital debris model.

Goldstone's ODR experiments are configured as bistatic radar tracks, which involve transmitting alternate up and down chirps from DSS-14, a 70-m diameter antenna equipped with a 450 KW transmitter, and receiving echoes with a nearby antenna, typically a 34-m diameter tracking dish. The roughly 10 km baseline distance between the transmit and receive antennas determines the slant detection distance of the covered area between 600 km and 1000 km in altitude.

We are investigating alternative transmit/receive configurations as well as continuous chirp waveforms to improve the sensitivity and coverage of GSSR ODR measurements. We have recently designed a continuous sawtooth waveform, consisting of consecutive up and down chirps over a relatively large bandwidth to cover Doppler shifting of debris objects in Low Earth Orbit, improving the sensitivity of the system by at least a factor 5 compared to pulsing radar configurations used previously. We have also developed methods to remove the deleterious effects of multipath scattering since blanking of transmit signal is no longer feasible in continuous mode transmission.

In this talk, we will describe the overall GODR program and will present recent results from newly implemented configurations demonstrating the expected improvements over pulsing radar configurations. We will also discuss planned enhancements to the GODR program over the next few years.