Bistatic Radar Observations Of The Moon Using The Arecibo Observatory & Mini-RF On LRO. D. B. J. Bussey[1], R. Schulze[1], D. E. Wahl[2], G. W. Patterson[1], M. Nolan[3], J. R. Jensen[1], F. S. Turner[1], D. A. Yocky[2], J. T. S. Cahill[1], C. V. Jakowatz[2], R. K. Raney[1], and the Mini-RF Team, [1]Applied Physics Laboratory, Laurel MD 20723, [2]Sandia National Laboratory, Albuquerque NM, [3]Arecibo Observatory, Arecibo PR.

Introduction: The Mini-RF team is acquiring bistatic radar measurements that will test the hypothesis that permanently shadowed areas near the lunar poles contain water ice. Additionally these measurements can be used for studies of the composition and structure of pyroclastic deposits, impact ejecta and melts, and the lunar regolith. These bistatic observations (where the Arecibo Observatory Planetary Radar (AO) transmits a 12.6 cm wavelength signal, which is reflected off of the lunar surface and received by the Mini-RF instrument on LRO) have produced the first lunar non beta-zero radar images ever collected.

Rationale: Typically, orbital radar observations use the same antenna to both transmit and receive a signal. The angle between the transmitted and received signals (the bistatic, or beta angle) for these observations is therefore zero, and they are referred to as monostatic observations. By using the AO radar as the transmitter and Mini-RF as the receiver, we have the opportunity to collect data for the Moon with beta angles other than zero. These measurements provide a

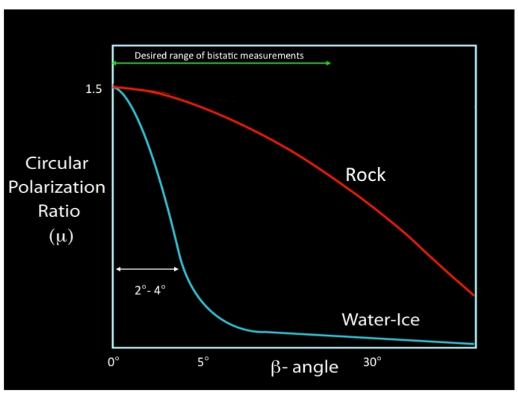

Figure 1. Predicted behavior of CPR versus beta angle for both rock terrains and an ice/regolith mixture.

new and unique test of the water ice hypothesis for the Moon.

A common science product produced using planetary radar is the Circular Polarization Ratio [1] (CPR). CPR is the ratio of the powers of received signal in the same sense transmitted divided by the opposite sense. Typical dry lunar surface has a CPR value less than unity [2]. Higher CPR signals can result from multiple-bounce backscatter from rocky surfaces or from the combined volume scattering and coherent backscatter opposition effects (CBOE) from an ice/regolith mixture [2]. The physics of radar scattering

Figure2. Bistatic image of a portion of the south polar region. Shackleton crater is visible in the top right.

predict that high CPR caused by a rocky surface will be relatively insensitive to the beta angle, whilst high CPR caused by ice will be very sensitive to beta, with elevated CPR values dropping off abruptly at beta angles greater than about 1-2° (figure 1).

Mini-RF monostatic data shows many craters with high CPR values. Most of these features are associated with fresh, young craters and display elevated CPR both inside and outside their rims. Some permanently shadowed craters near both poles show elevated CPR inside the crater rims but low CPR outside the crater rim. This has been interpreted as being consistent with RF backscatter caused by surface roughness in the former case and water ice in the latter [2].

Planned Observations: We are imaging both polar, and non-polar targets that have high monostatic CPR values (figure 2). By acquiring non beta zero data of equatorial high-CPR regions (which we can safely assume have high CPR due to the presence of surface rocks) we can confirm the hypothesis that high CPR caused by rocks is reasonably invariant to the beta angle (red curve in Figure 1). We are looking to see if monostatic high-CPR polar craters have high or low values in the bistatic data. If we find areas that become low only in the bistatic data then this provides strong supporting evidence that these are ice deposits.

Conclusions: Using Arecibo and Mini-RF we are acquiring the first ever planetary bistatic radar images at non β=0 angles. These data provide a unique new piece of evidence to determine if the Moon's polar craters contain ice.

References: [1] Campbell B. et al., Nature, 2006 [2] Spudis P. D. et al., GRL 2010.