REX Radiometry At 4.2 cm During The New Horizons Encounter Of Ultima Thule. I. R. Linscott[1,4], M. K. Bird[2,3], S. A. Stern[4], R. L. H. Sepan[5], M. A. Vincent[4], C. C. Deboy[5], H. A. Weaver[5], C. B. Olkin[4], J. R. Spencer[4], The New Horizons PATM, COMP and GGI Teams, [1]Department of Electrical Engineering (ret), Stanford University, Stanford, CA 94305, USA, linscott@Stanford.edu, [2]Rheinisches Institut für Umweltforschung, Universität Köln, 50931 Cologne, Germany, [3]Argelander Institut für Astronomie, Universität Bonn, 53121 Bonn, Germany, [4]Southwest Research Institute, Boulder, CO 80302, USA, [5]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA

Introduction: During the Ultima Thule encounter the REX instrument in the New Horizons X-band receiver performed radiometric measurements of thermal emission and a bistatic radar experiment. These operations were similar to those performed during the Pluto Encounter [1], but with significant differences owing much smaller size of Ultima Thule (UT) than Pluto. Chief among these was the much smaller thermal emission together with the inability to resolve UT, as well as the need to substantially increase the power of ground-based transmissions used to illuminate UT for the bistatic experiment. A thermal measurement of radio brightness temperature was made on approach of UT's dayside, at a distance of 52,000 km, where the angular size of UT was ~0.550 mrad, filling just 0.72×10^{-3} of the 'beam' of New Horizons High Gain Antenna (HGA). A second, unresolved thermal measurement was made on departure of UT's night side at a mean distance of 15,100 km, with UT's angular size ~2.0 mrad, and filling 1% of the HGA's beam.

On approach, the uncertainty in the position to UT was much smaller than the HGA's beamwidth, hence the dayside observation was a 'stare', keeping the HGA pointed in a constant direction. However, for the nighttime radiometry, the uncertainty in UT's position was much larger and the observation was a scan along the long axis of the UT error ellipse, from a downstream direction of 180 time-of-flight seconds, to an upstream direction of 180 time-of-flight seconds (corresponding to scanning from -2 degrees to +2 degrees from UT's expected position). The bistatic radar experiment occurred during the nighttime thermal scan, when the HGA intercepted UT somewhere along the scan.

During the nighttime scan a squadron of electromagnetic waves in the form of uplink signals arrived to illuminate UT. These uplinks were radiated six hours and eight minutes earlier by six ground antennas within JPL's Deep Space Network. Four of the transmitting antennas were in Canberra, Australia, and two in Goldstone, California. Collectively, had they been received by the spacecraft directly, they would have each delivered detectable signals with signal to noise ratios in excess of 55 dB/Hz. The echoes from this ensemble of signals illuminating UT, having been scattered from its surface and sub-surface were received by REX and New Horizons and recorded by the spacecraft.

Some but not all of this data has been played back from the spacecraft to earth. Based on the data in hand, the radiometry and bistatic radar experiment results are previewed.

[1] S. A. Stern, et. al. (2015) Science, 350, no. 6258, aad1815.