

# Lunar Communications with the ANU Optical Ground Station

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We present the progress towards a transmitter and receiver for lunar communications on the Australian National University (ANU) Optical Communications Ground Station (OCGS). The OCGS is a 0.7 m telescope facility currently under construction at Mt Stromlo Observatory in Canberra, Australia. The transmitter and receiver will be installed at the OCGS to support future lunar missions by adhering to the Consultative Committee for Space Data Systems (CCSDS) High Photon Efficiency (HPE) standard. The location of the OCGS provides site diversity and increased visibility to a spacecraft to allow longer optical uplink time.

Link budget analysis gives an expected uplink data rate to lunar distances (380,000 km) of 20 Mbps and downlink data rate of at least 80 Mbps.

The transmitter is comprised of four 15 cm apertures which are separated by the atmospheric coherence length ( $r_0$ ). This configuration helps to reduce the chance fading at the spacecraft as each of the beams travels through a different column of atmosphere and experiences different aberrations due to atmospheric turbulence. The apertures operate independently with their own steering loops to remain pointed at the spacecraft optical terminal. The transmitter assembly will stack the apertures in a 2 x 2 arrangement which is attached by a piggyback mount to the 0.7 m OCGS telescope.

The receiver is located at the Nasmyth port of the telescope uses the signal collected by the 0.7 m aperture to couple into a fibre. We use a fast steering mirror and quadrant sensor to remove any tip-tilt motion induced by the atmosphere to maximise coupling efficiency into the fibre. A photonic lantern is used to split the signal between several superconducting nanowire single photon detectors (SNSPD).