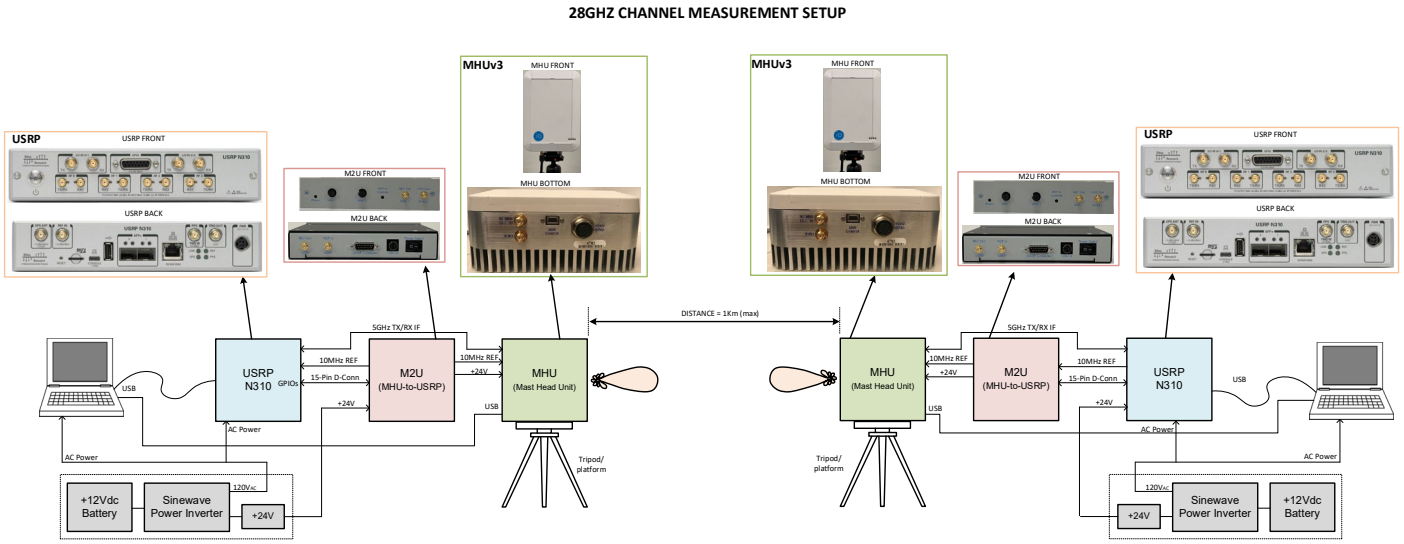
Objective and Description of 28GHz Radio Link Performance Setup

As part of a larger study and characterization of 5G signals performance in the mmWave band, our goal for this measurement campaign is to study mmWave waveform enhancements to tradeoff data rate to extend range using 28GHz Phased Array over-the-air signals.



As shown in the above figure, our measurement setup consists of a pair of 28GHz Mast Head Units (MHUs) separated by up to 1km of distance. The two transceivers, each equipped with a built-in 64-element (8x8 array) analog phased-array antenna (PAA), can use electronically controlled beam-steering as a search and alignment mechanism. The MHU is rated for a transmit power of +38dBm RMS EIRP. Out-of-band emissions are limited to less than -30dBc and EVM is rated at less than 3%. The device is housed in a IP67 weather-proof enclosure rated for outdoor operation. The device complies to 3GPP 38.104 ACLR requirements as shown below

Table 9.7.3.3-1: *BS type 2-O* ACLR limit

***BS channel bandwidth* of lowest/highest NR carrier transmitted $BW_{Channel}$ [MHz]**	**BS adjacent channel centre frequency offset below the lowest or above the highest carrier centre frequency transmitted**	**Assumed adjacent channel carrier**	**Filter on the adjacent channel frequency and corresponding filter bandwidth**	**ACLR limit [dB]**
50, 100, 200, 400	$BW_{Channel}$	NR of same BW (Note 2)	Square (BW_{Config})	28 (Note 3) 26 (Note 4)
NOTE 1: $BW_{Channel}$ and BW_{Config} are the *BS channel bandwidth* and transmission bandwidth configuration of the lowest/highest NR carrier transmitted on the assigned channel frequency. NOTE 2: With SCS that provides largest transmission bandwidth configuration (BW_{Config}). NOTE 3: Applicable to bands defined within the frequency spectrum range of 24.25 – 33.4 GHz NOTE 4: Applicable to bands defined within the frequency spectrum range of 37 – 52.6 GHz				

Table 9.7.3.3-2: *BS type 2-O* ACLR absolute limit

BS class	ACLR absolute limit
Wide-area BS	-13 dBm/MHz
Medium-range BS	-20 dBm/MHz
Local-area BS	-20 dBm/MHz

Initially, a standard 5G baseband test waveform is generated and loaded from a laptop into the USRP device. The 5GHz IF output signal out of the USRP is then fed to the transmitting MHU-1 via an MHU-to-USRP (M2U) interface enclosure.

The radiated mmWave signal from MHU-1 (transmitter) is received by MHU-2 (receiver) and down-converted to IF. After demodulation to complex I/Q baseband, the received signals is analyzed and statistical data are collected to generate Bit-Error-Rate (BER) and received signal strength (RSSI) reports.

Our outdoor mobile setup is powered from sinewave power inverters connected to a 12V DC lead-acid batteries.

This platform supports FR2, 120 kHz sub-carrier spacing and up to 400 MHz bandwidth. The MHU operates within the 3GPP band n257 (26.50 GHZ to 29.50GHz) and uses TDD. It requires 24V DC and consumes 30 W (typical).

The antenna gain is approximately 20dBi peak (array gain plus element gain) with a typical beamwidth of 15 degrees. The array can be steered in horizontal and vertical directions. A power control range of 30dB is available.

The MHU receiver has a rated noise figure of less than 7dB and the integrated phase noise is below 1 deg rms. QPSK, 16 QAM, 64 QAM and 256 QAM modulations are supported.

Through the course of the experiment, standard and modified 5G waveforms stored in the USRP and laptop are transmitted by the Tx MHU, which is located in the parking lot shown in fig XX. The beam is pointed near the horizon in the general azimuthal direction of the Rx MHU. The Rx MHU is located within the boundaries shown in fig XX. The maximum envisioned distance is about 1km. Low spectral efficiency signals requiring low Rx power are used. The channel BWs used in the experiment will be from {200, 100, 50} MHz. Any 200MHz portion of the 26.50 GHZ to 29.50GHz is suitable. It is anticipated that the transmitter will only be ON for a few hr per day of testing.

The data performance measurements collected above will be repeated a regular distance interval starting from 100m separation between transmitter and receiver at up to a maximum of 1km.

SUMMARY OF KEY SPECIFICATIONS

Operating Frequency	26.50 GHZ to 29.50GHz (3GPP band n257)
Transmit Power	+38dBm RMS EIRP
Max Channel Bandwidth	200MHz
Largest channel BW used in experiment	
Phase-array Antenna 3dB Beamwidth	15 degrees
Receiver Noise Figure	7dB
Integrated Phase Noise	< 1deg rms


MHU-Tx
MHU-Rx
Klenzoid Water Treatment
E 10th Ave
Spring Mill Ave
Lime St
Sandy St
East West Label
Industrial Park
Lee St
E Hector St
Spring Mill Fire Company Social Rooms
The Courts at Spring Mill Station
Jornaya
Quaker Park
Quaker Houghton
E Elm St
Schuylkill River Trail
Spring Mill
E North Ln
Washington St
UPS Drop Box
David's Bridal
Measure distance
Click on the map to add to your path
Total distance: 329.16 ft (100.33 m)