3GPP TSG-RAN WG1 #84
St Julian's, Malta, February 15 –19, 2016

R1-160847

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Document for: Discussion and decision

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PATH LOSS MEASUREMENTS FOR MACROCELL AT 28 GHZ

-INCLUDING DIRECTIONAL CHARACTERISTICS

INTRODUCTION

- Urban macrocell measurements at 28 GHz have been performed to support the development of a new channel model for higher frequencies
- Path loss and directional characteristics have been recorded

MEASUREMENT EQUIPMENT

- Base station
  - Transmitter: MINI-LINK PT2010
  - Roof-top deployment
  - Wide beam antenna (10dBi)
  - Tx power: maximum 22 dBm
  - Frequency: 28.4 GHz
- UE
  - Receiver: MINI-LINK PT2010 (with hardware modifications)
  - Street level 1.6 m
  - Narrow beam antenna (34dBi) on rotating table
  - Scanning angles:
    - 360 degrees (azimuth)
    - -10 +40 degrees (elevation)
    - significant oversampling in relation to HPBW, no peaks missed
- Maximum measureable path loss: 173 dB

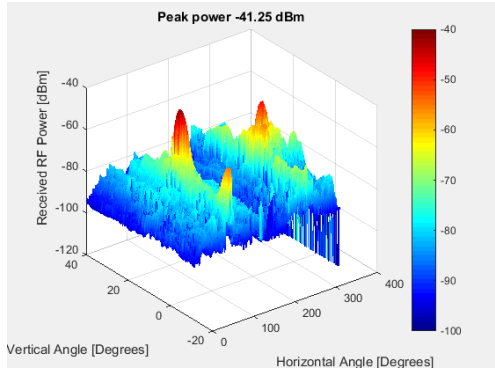
URBAN MEASUREMENT AREAS

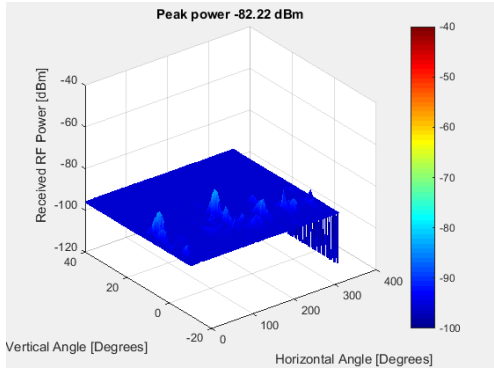
- Lindholmen
  - Base station height 25 m
    - At average rooftop level
    - 4-6 storey buildings
  - Measurements on street level out to 320 m
  - LOS and NLOS

- Mölndal
  - Base station height 46 m
    - Above average rooftop level
    - 3-4 storey buildings
  - Measurements on street level out to 340 m
  - LOS and NLOS

CALIBRATION PROCEDURE

1. Perform angular sweeps in many locations and record received power vs θ, φ
2. Sum power over all sweeps, weighted by sine of zenith angle:
   - $P_{tot} = \sum_m \sum_n P(\theta_n, \varphi_m) sin(\theta_n)$
   - This gives the effective isotropic received power but with an unknown constant offset (average isotropic antenna gain ≠ 1)
   - In low SNR measurements, some nulling of noise samples needed to avoid bias
3. Determine the constant offset by doing the same procedure for a LOS measurement where the expected received power can be calculated
   - The use of very narrow beams allows the direct LOS path to be isolated from any multipath, giving a very accurate calibration with this method
4. Apply this constant offset to all measured P_{tot} samples

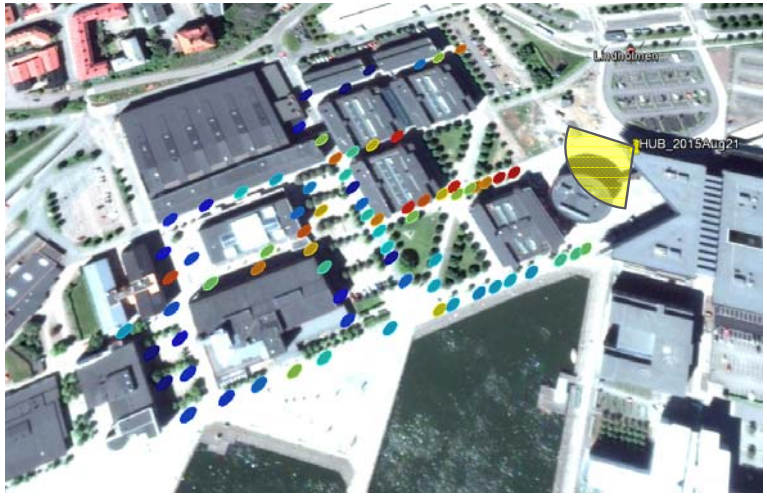


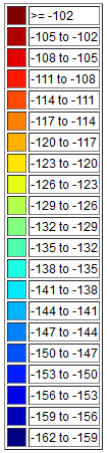


Careful calibration important for getting unbiased path loss estimates!

OVERVIEW OF PATH LOSS RESULTS

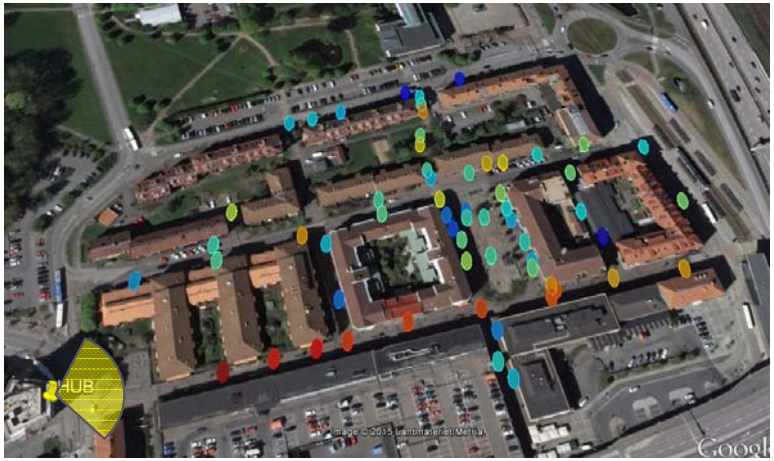
› Lindholmen

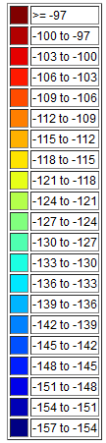




300 m

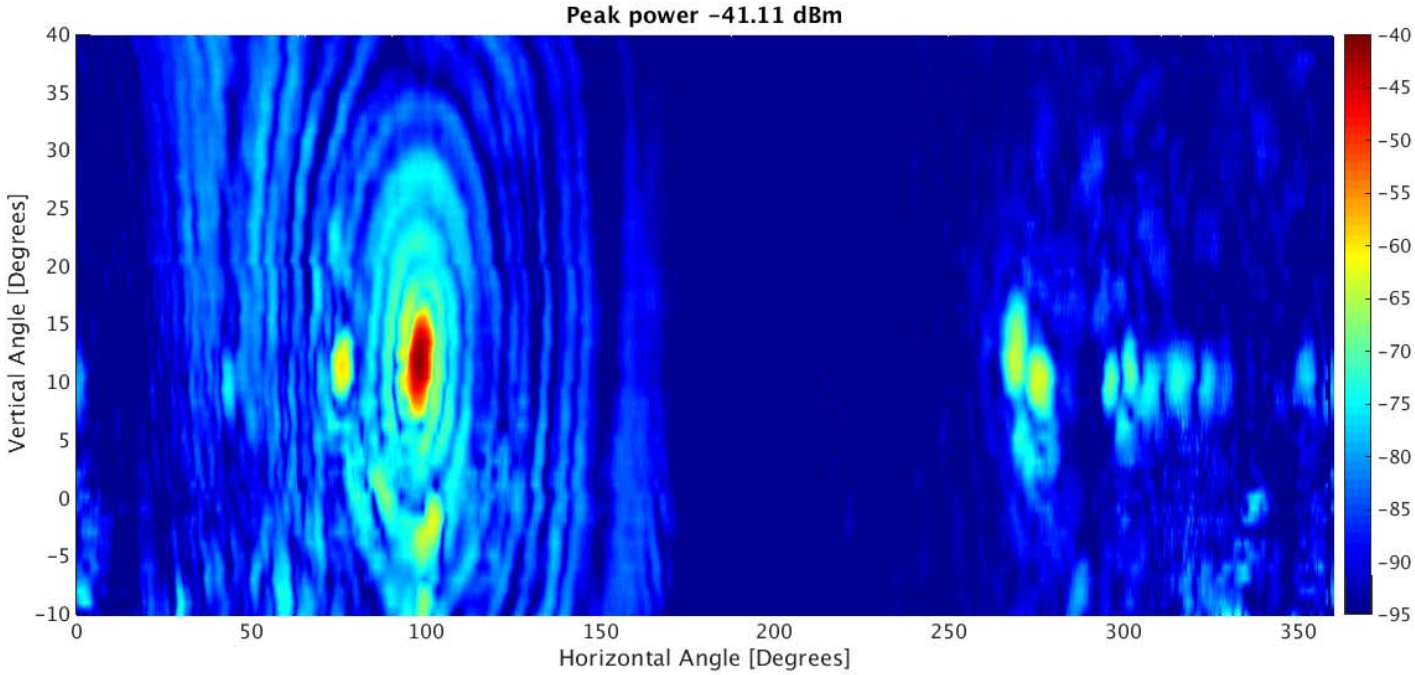
› Mölndal





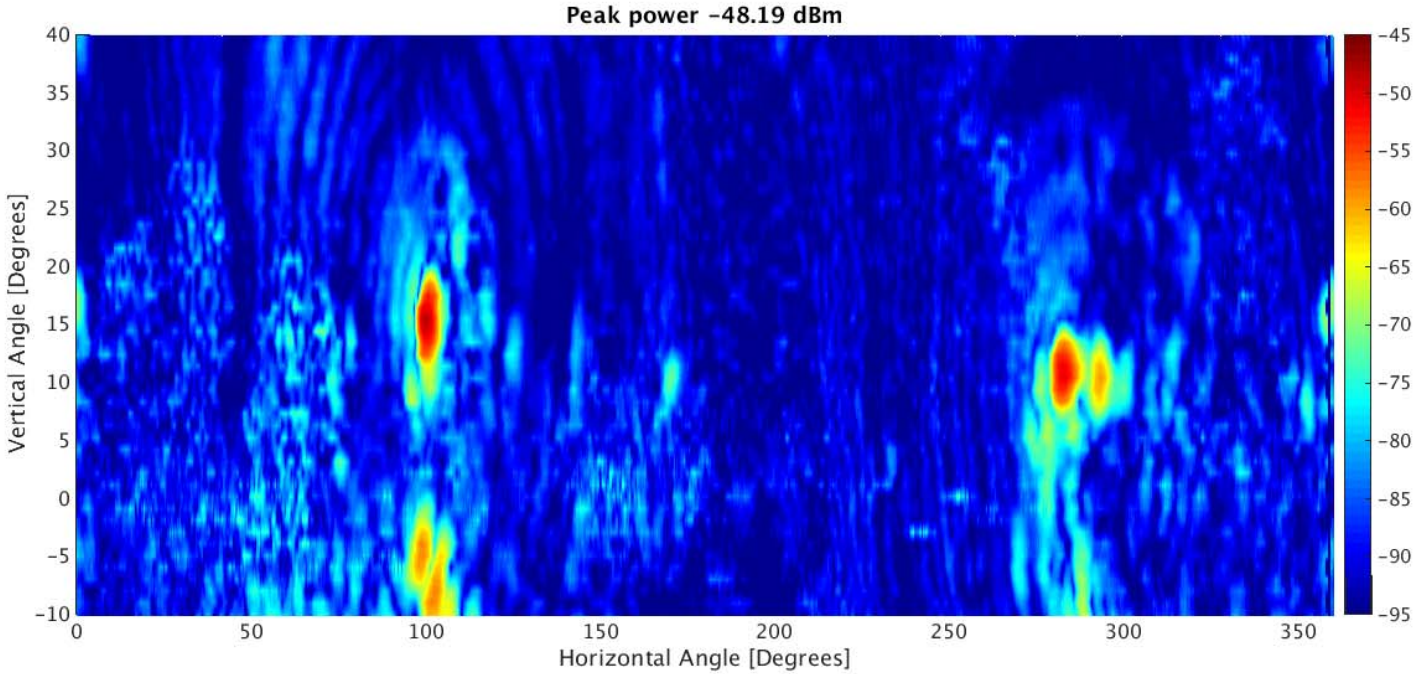
300 m

SOME EXAMPLES



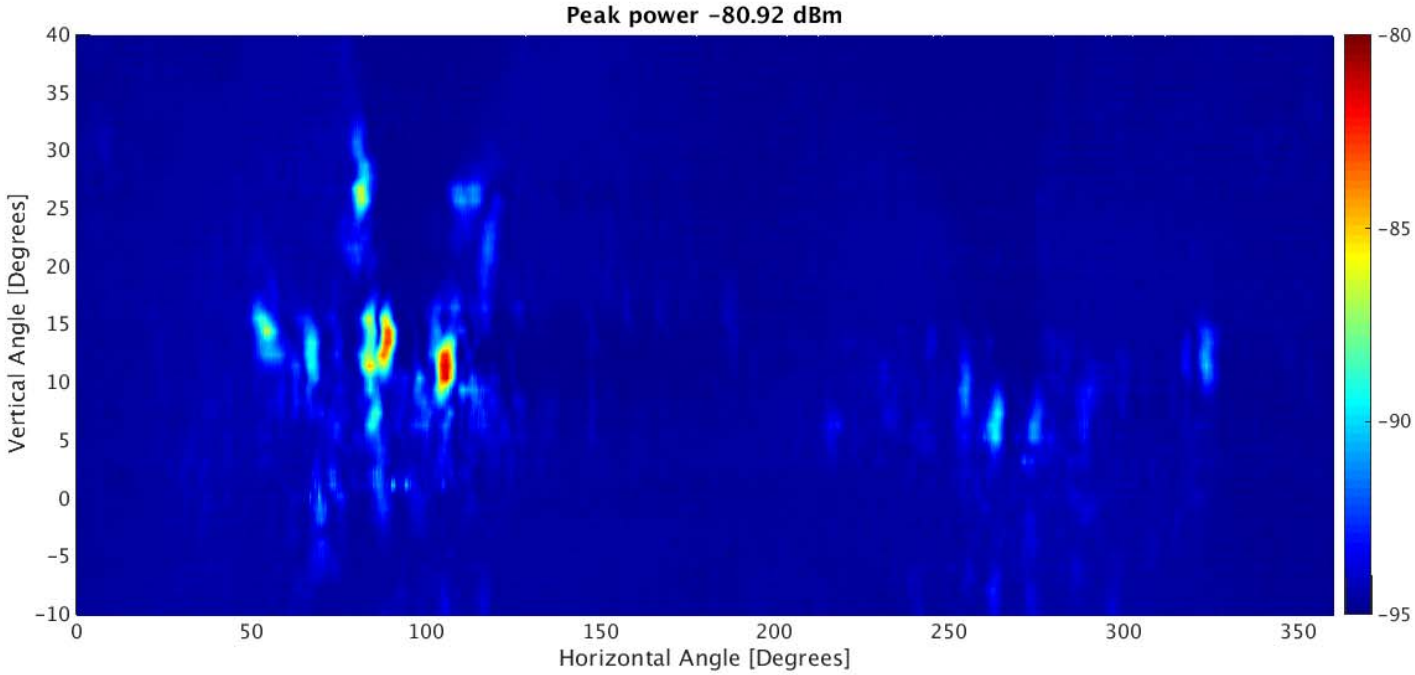
Line of sight

SOME EXAMPLES



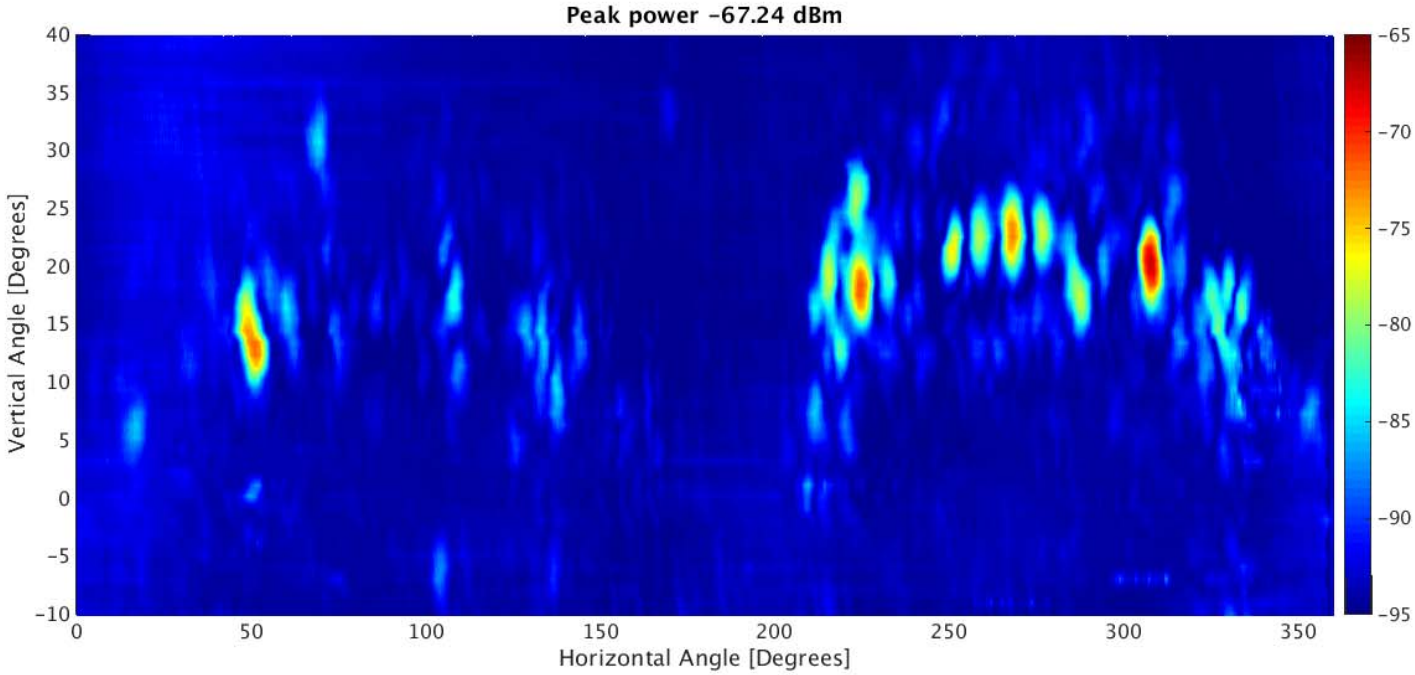
Almost line of sight

SOME EXAMPLES



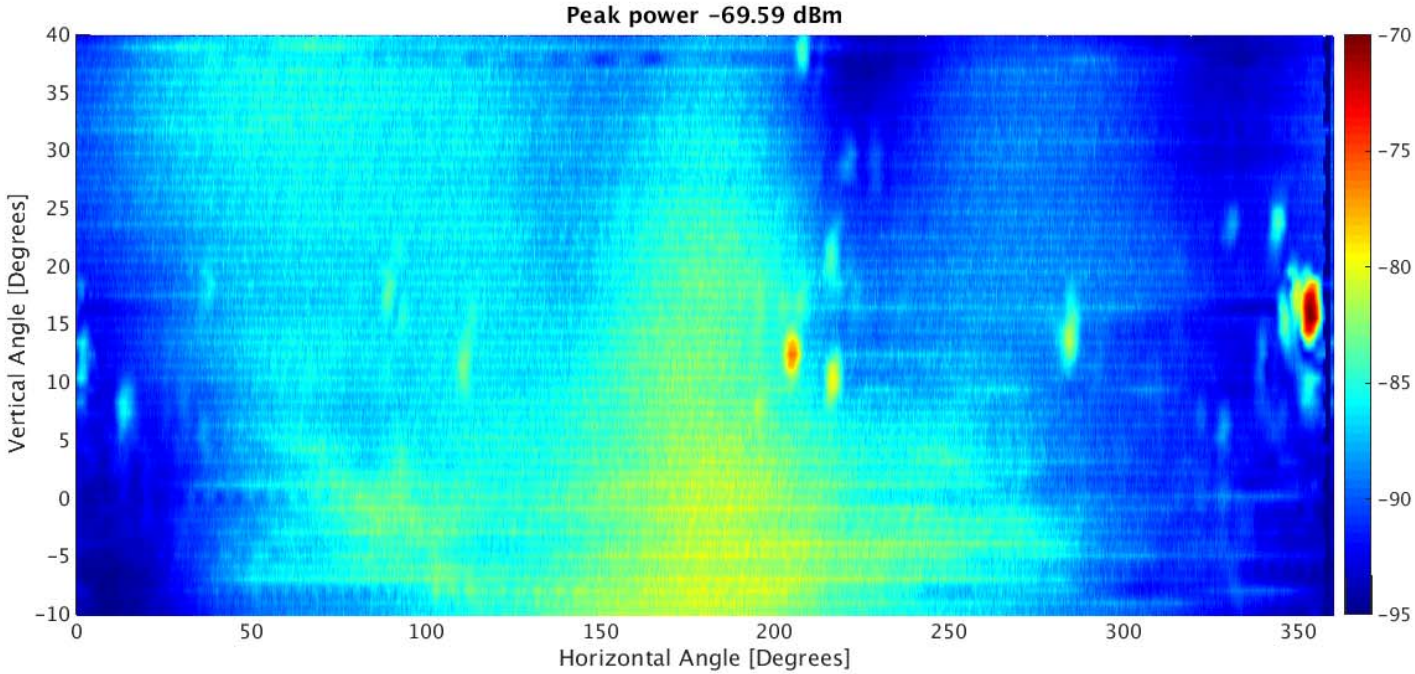
Deep NLOS

SOME EXAMPLES



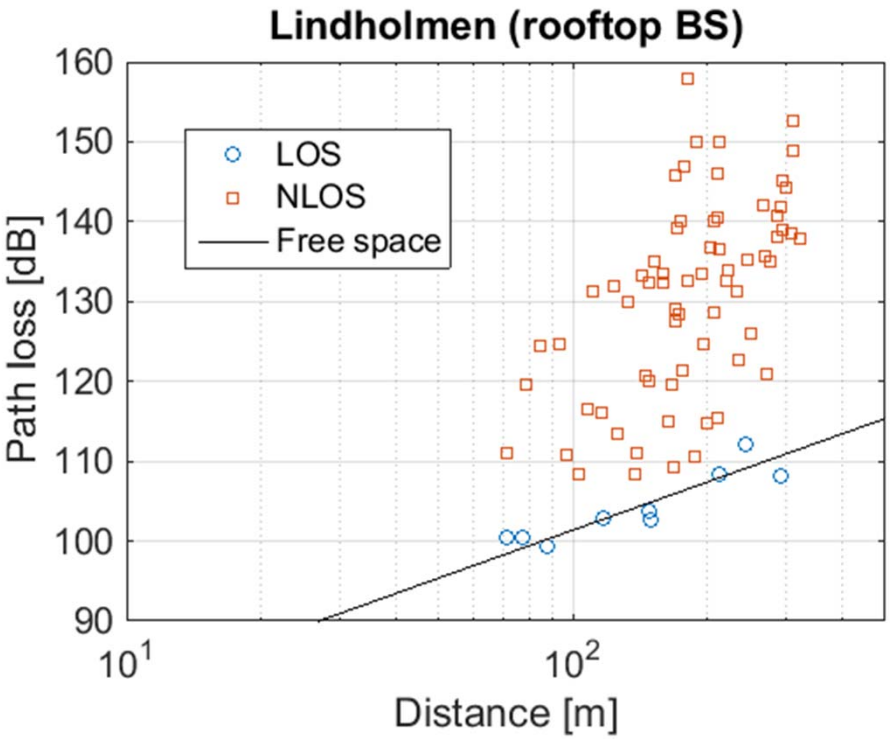
Rich NLOS channel

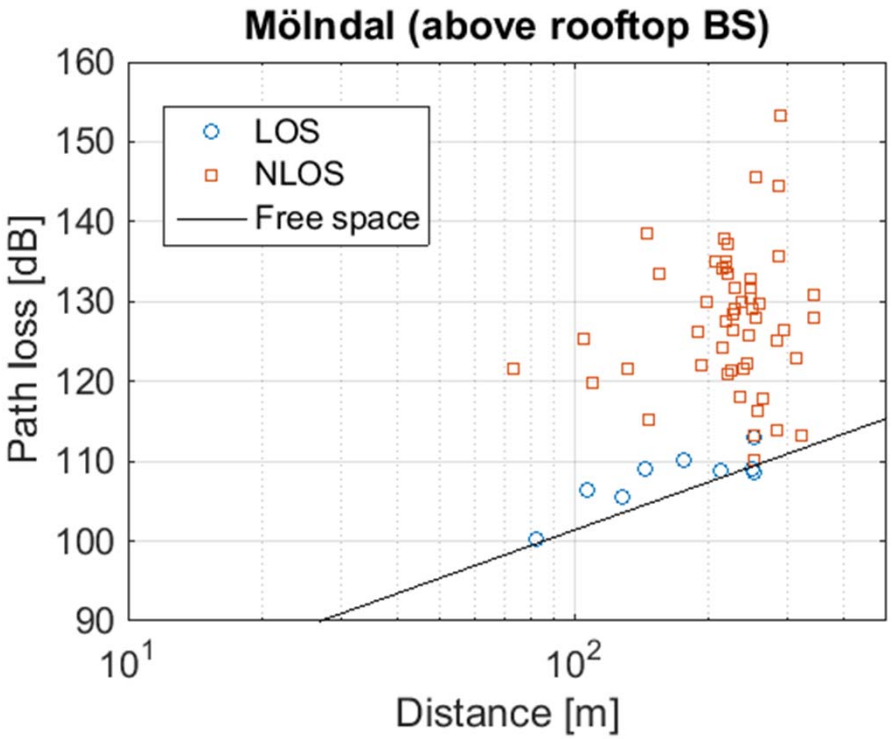
SOME EXAMPLES



Diffuse scattering from a brick wall

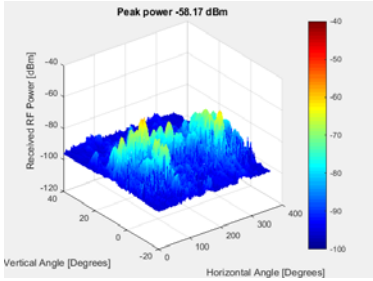
PATH LOSS DATA



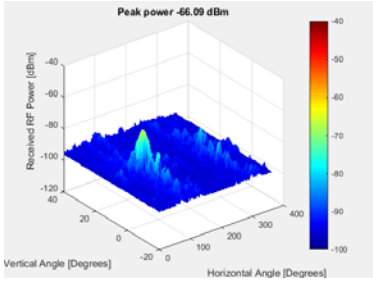


POLARIZATION

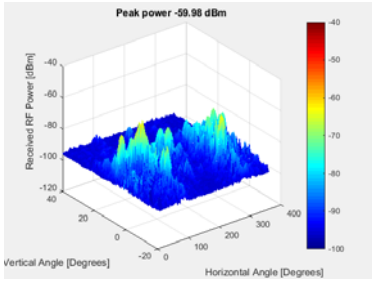
- Measure with all combinations of VP and HP at BS and UE
  - Similar co-polar power for VP and HP
  - 8-14 dB suppressed cross-polar paths



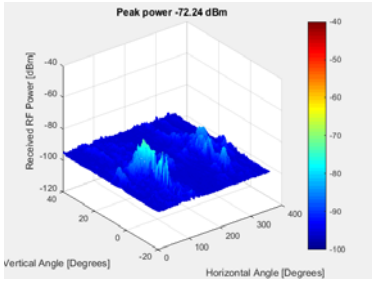
VP-VP



VP-HP



HP-HP



HP-VP

MAIN OBSERVATIONS

- Majority of energy either in LOS path or in specular reflections or reflections off smaller objects
  - E.g. scaffolding, drain pipes, light poles, bikes, balconies and other objects that are typically not available in a building database
- Diffuse scattering from brick wall observed
- Only one location had a clearly identifiable diffraction path as the strongest
- Excess loss above free space path loss up to 55 dB for rooftop BS (Lindholmen), and up to 45 dB for above rooftop BS (Mölndal)
  - Close to free space loss when strong reflection present
  - Multiple paths in deep NLOS
- Similar path loss for vertical and horizontal polarizations
  - Cross-polar paths suppressed by 8-14 dB

RAN1 advised to take these observations into account when developing a channel model for higher frequencies!

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