5G mmWave Radiation Learning Session —

Field Experience with Safe & Sound mmWave RF Meter

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Introduction

- I acquired the Safe & Sound mmWave 5G RF meter in early June 2023 as a beta tester
- I also had the FM5 mmWave 5G RF meter since late 2022
- This presentation covers field testing in June 2023
- More info on 5G in 57-page online 5G course on Building Biology Institute website, <u>https://</u>

<u>buildingbiologyinstitute.org/course/electromagnetic-</u> <u>radiation/5g/</u>

Also in 5G article on my website, with update and PPT, at <u>www.createhealthyhomes.com/education/5g</u>

5G Coverage by U.S. Cell Carrier

- **Low band 5G** (600 MHz to I GHz) repurposed 4G LTE:
- T-Mobile at 600 MHz for 200 million customers
- AT&T's "5GE" (5G Enhanced) at 850 MHz for majority of customers
- Verizon's "5G Nationwide" at 850 MHz for majority of customers
- Mid band 5G NR (1-6 GHz):
- > T-Mobile at 2.5 GHz (inherited from Sprint with merger in April 2020)
- > 3.4-3.5 GHz CBRS and 3.5-4.2 C-Band four carriers (Ver, AT&T, Dish, U.S. Cellular)
- Verizon's C-band service called "5G Ultra Wideband" (along with mmWave service)
- **High, mmWave band 5G NR** (28 & 39 GHz):
- Verizon's "5G Ultra Wideband" service combined C-band and mmWave, in more than 100 cities covering 175 million people — went nationwide in Q1 2023
- > T-Mobile's "5G Ultra Capacity" service combined 2.5 GHz and mmWave
- > AT&T "5G+" in 19 cities mostly sports arenas, stadiums and airports

- Start with 4G LTE data download speeds
- Varies from roughly 12 to 50 Mbps
- T-Mobile merged with Sprint in April 2020



Data collection August 1 - October 30, 2019. Note: band represents primary band in use.

- mmWave download speeds 10-100 times faster than 4G LTE
- Verizon leads other carriers

Average download speeds on mmWave 5G in the US, by carrier



Data collection period: June 14 - September 11, 2021 | © Opensignal Limited

- However, 5G mmWave service less than 1% of cellular connections
- mmWave 5G service only available in urban and suburban areas

Average time with an active mmWave 5G connection in the US, by carrier



Data collection period: June 14 - September 11, 2021 | © Opensignal Limited

- 5G includes low, mid and mmWave band
- 4G LTE still dominates
- Most 5G is sub-6 GHz (low and mid bands)

Share of US mobile data traffic, by technology







This analysis excludes data consumed on 3G and 2G networks. We also exclude mobile data that could not be confidently assigned to either network technology, for example when the connection moved from a 4G network to 5G, and vice versa. Data collection period: Jul. 1 – Jul. 31, 2021 | © Opensignal Limited

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https://www.opensignal.com/2021/09/22/mmwave-5g-provides-a-big-capacity-boost-to-us-users-in-high-traffic-areas Oram Miller, BBEC, EMRS

History of My mmWave Testing

- I have used the FM5 for over six months and had not found mmWave cellular signals in front of any client's home in suburban residential areas
- I do find low and mid-band 4G LTE and 5G with S&S Pro II
- I had not had the time to look for mmWave signals in urban areas; I only used FM5 when I went to client's homes
- I only took the time to look for mmWave signals in urban areas when I obtained SLT's mmWave RF meter as a beta tester, and found them recently on busy boulevards

Verizon mmWave antennas in Santa Monica, California





Verizon mmWave antennas in Santa Monica, California





Verizon mmWave antennas in Los Angeles, California





What mmWave antennas sound like (click each image to play video)





mmWave RF meter with horn antenna vs. stub antenna (click each image to play video)





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mmWaves blocked by walls; not so much by glass (click each image to play video)





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mmWave signals *much* weaker than 4G LTE at same distance (click each image to play video)





- mmWave cell signals are no longer on-demand as they initially were since early years of 5G starting in 2018
- Currently-measured mmWave antennas are always-on
- mmWave signal is consistent in power flux density (PFD) across full 120 degree-wide transmission pattern side to side, just like 4G LTE and low and mid-band 5G
- Power density of mmWave signal is significantly less strong than 4G LTE at same distance from antenna array
- Generally only 100-1,000 μW/m² vs. 10,000-250,000 μW/m²

- mmWave signals dissipate quickly with distance and were not measurable beyond one city block away from antenna
- Compare that to 4G LTE and low and mid-band 5G that travel at high power densities for one mile or more
- I am not measuring mmWave signals in residential suburban neighborhoods
- mmWave signals are so far confined to main boulevards with foot traffic and commercial and apartment buildings

- mmWave service is primarily an outdoor phenomenon, supplementing low and mid-band 4G LTE and 5G service
- mmWaves do not penetrate building walls well
- Shielding would be highly effective when used
- mmWaves do penetrate Low-E glass roughly 50-70%
- Film, metal mesh screen and RF curtains could be effective on and over windows and need to be tested

- mmWave signals *not* dependent upon presence of cell phone
- Verizon mmWave antenna signal power density unrelated to whether my Verizon iPhone had 5G enabled, disabled, or was in Airplane Mode or off — different than early 5G era since 2018
- But my Verizon iPhone emitted high RF levels, >500,000 μ W/m²
- RF signals from Verizon iPhone not present when my iPhone is not near a Verizon mmWave antenna
- Only phones from same carrier that installed antenna will have
 5G transmissions from cell phone turned on by antenna

- I measured higher mmWave readings on my mmWave RF meter when passersby walked by, presumably with their Verizon cell phone triggered by Verizon mmWave antenna
- These high RF levels from cell phones may be a stronger health threat than actual mmWave signals from antenna
- Granted, mmWave signals from antenna are beam-formed
- I do not know if RF from cell phones triggered by mmWave antenna is beam-formed — needs to be researched

Value of Using mmWave Antenna

- Considering you will likely not see mmWave signals in suburban residential areas, mmWave RF meter is valuable for reassuring clients they do not have "5G" outside their house
- They are greatly relieved!
- Also see where mmWave service does exist in urban areas
- Show how strong and pervasive 4G LTE and low/mid 5G is
- Show how strong RF levels are from all the portable wireless devices within a client's personal space (cell phones, tablets, laptops)

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