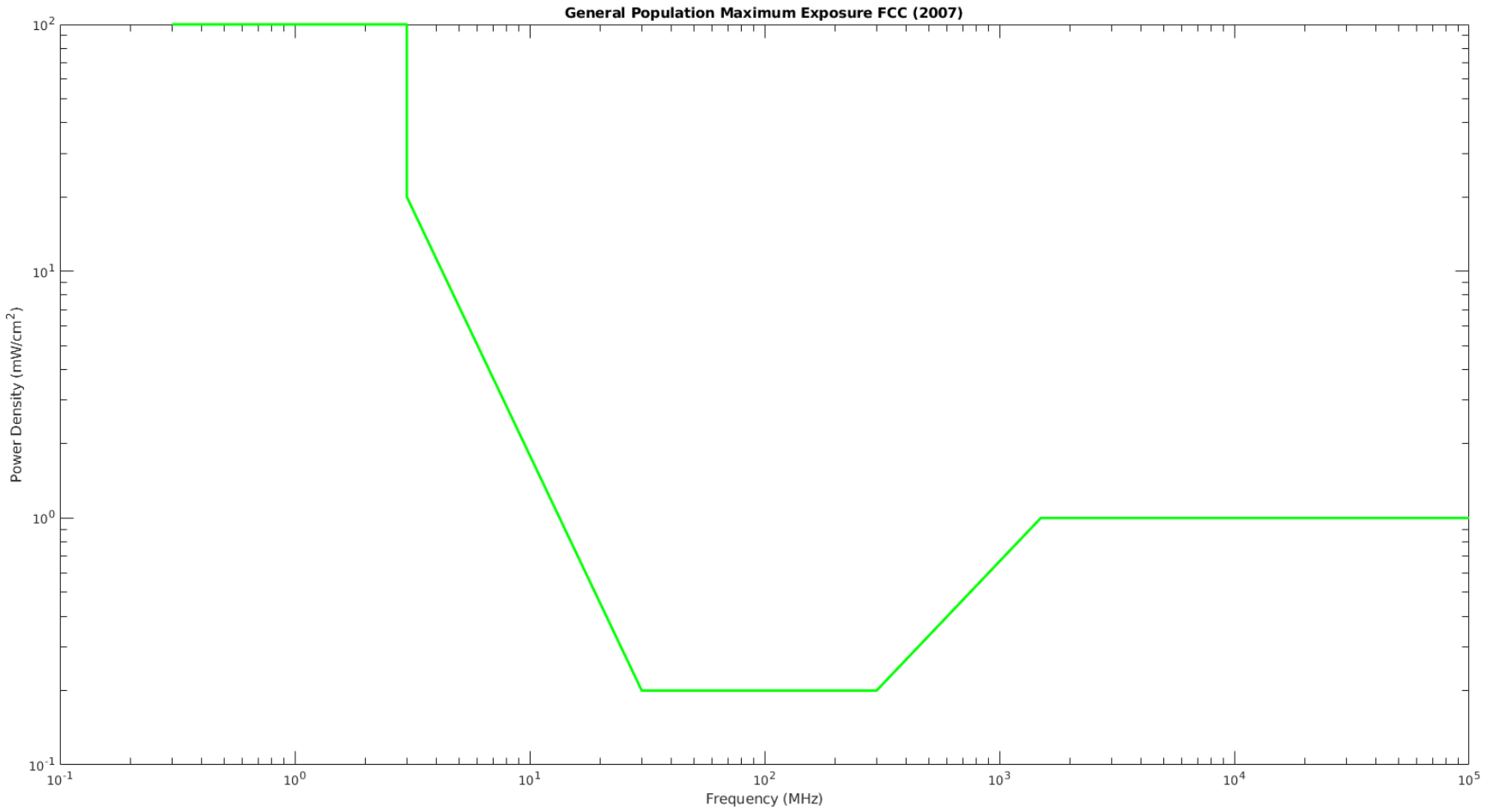
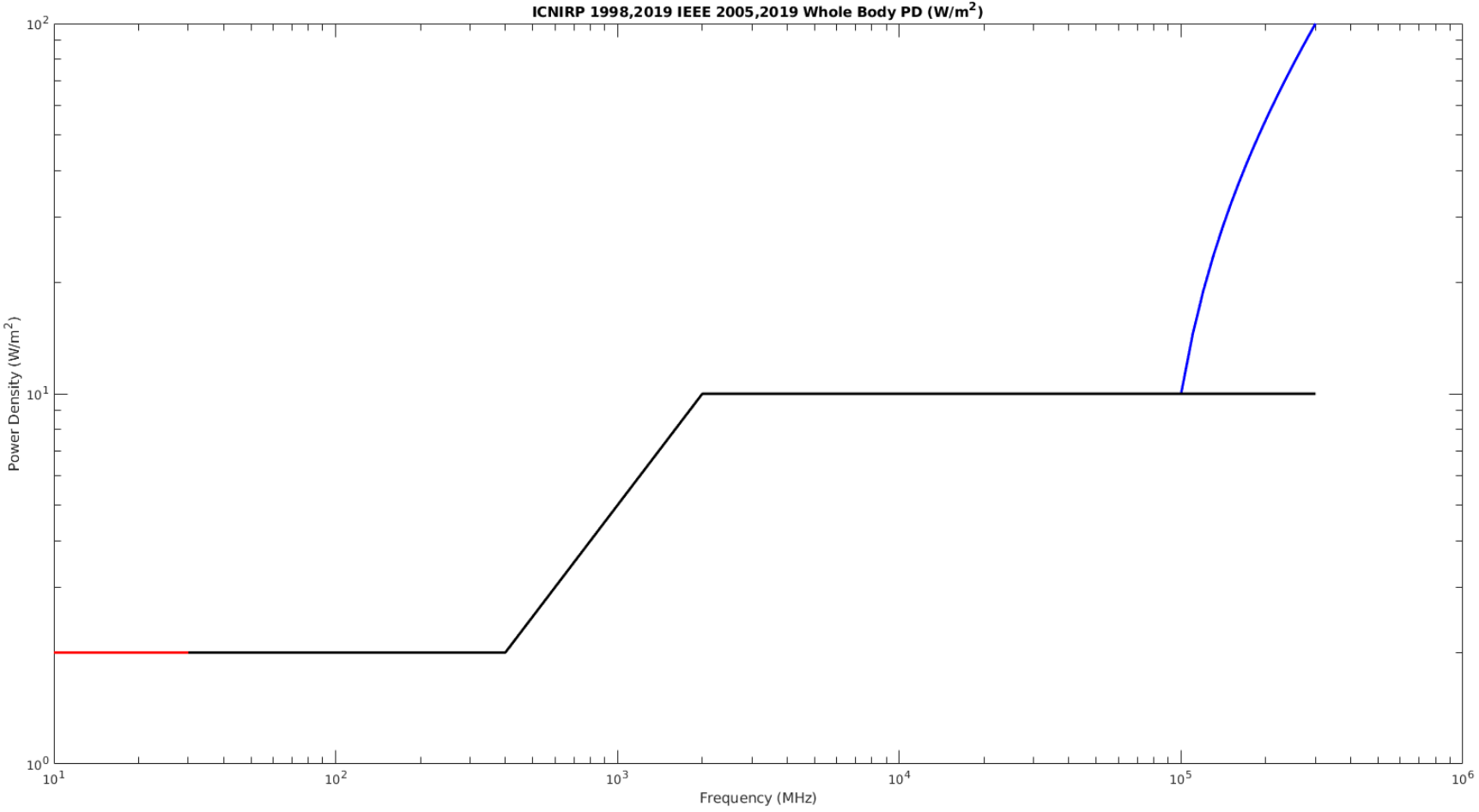
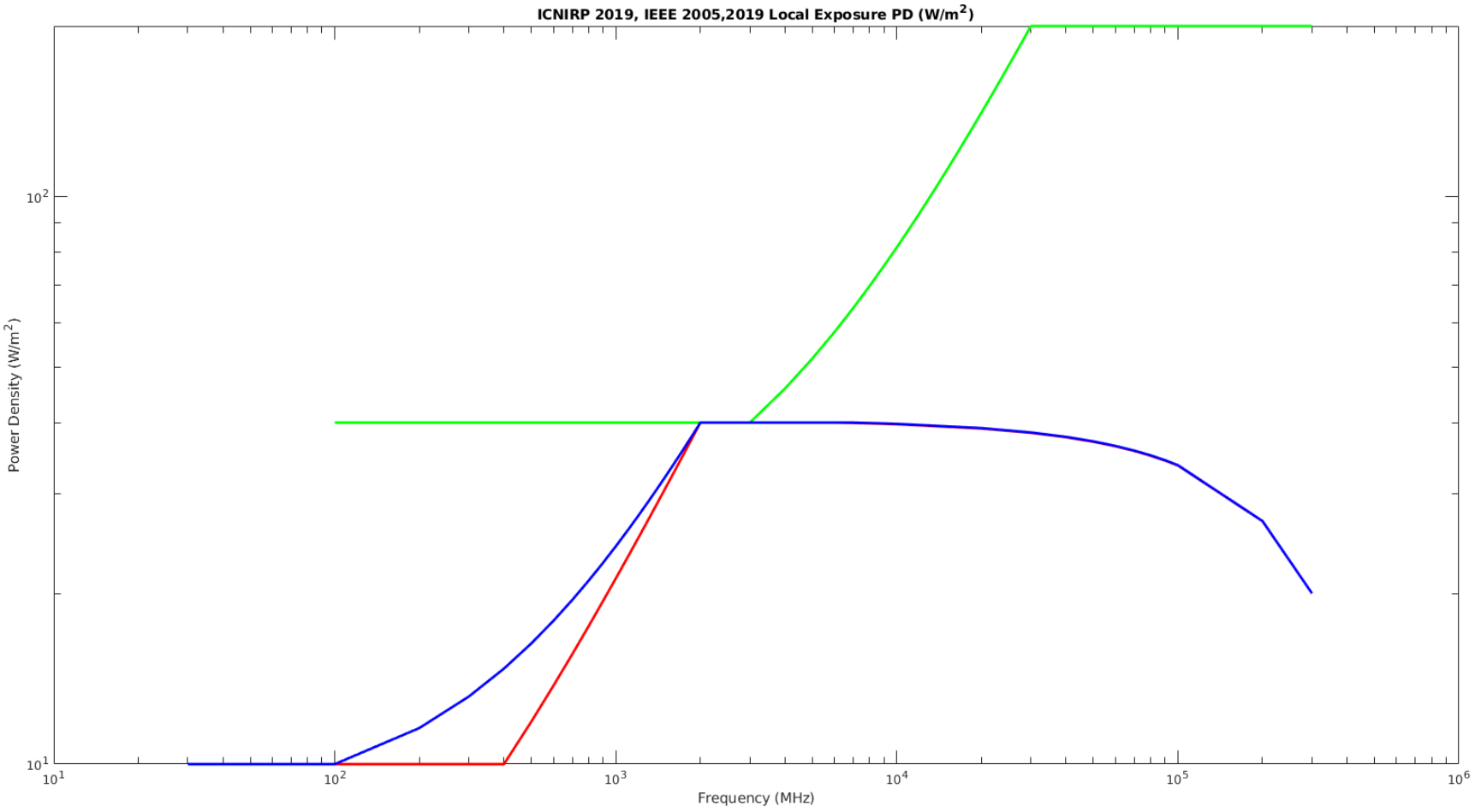
Radiation Hazard 5G

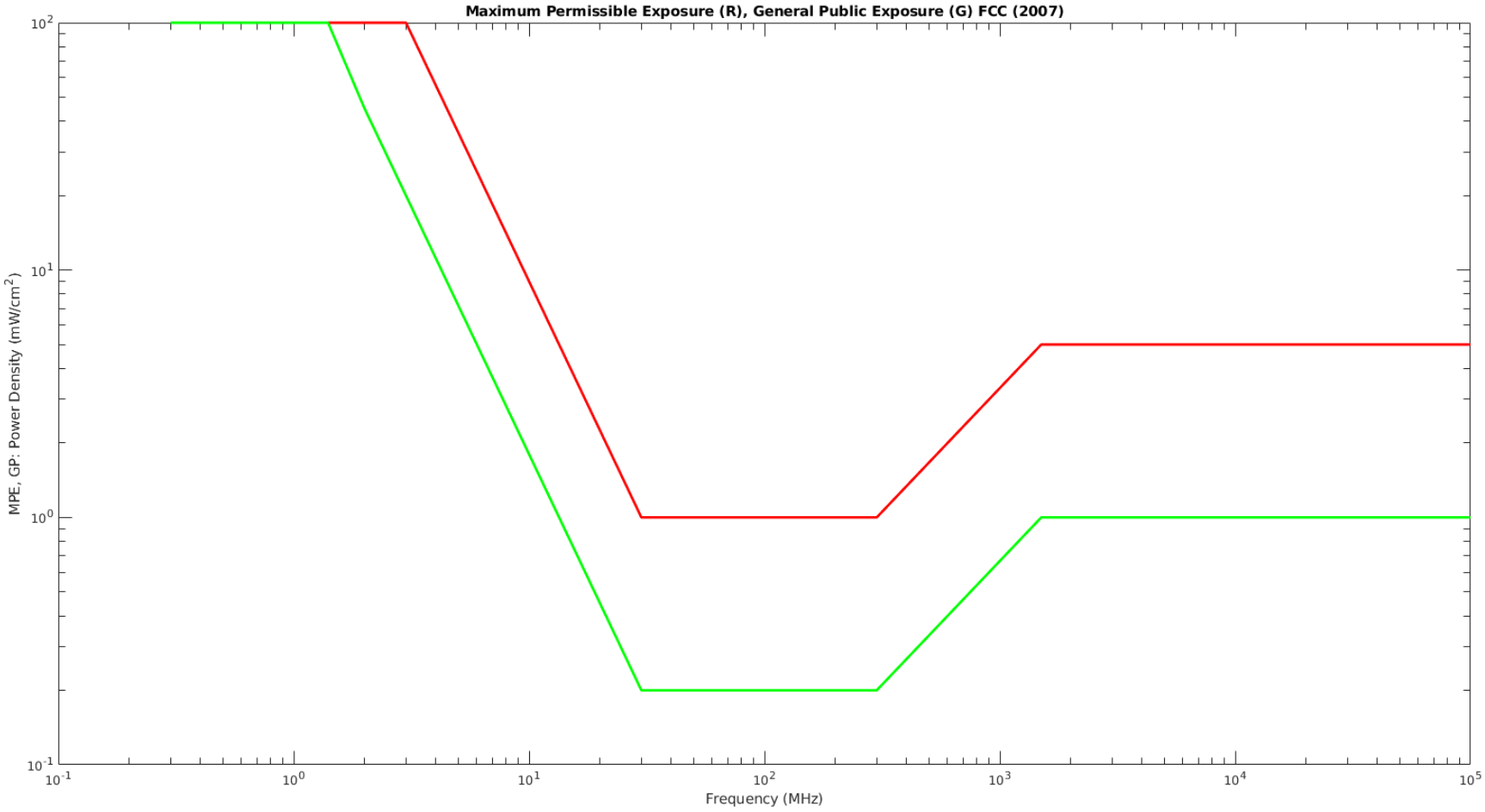
ICNIRP 1998/2019 & IEEE 2005/2019
Whole Body & Local Exposure
Sub 6 GHz Bands, 28 GHz Band: USA
FCC, ICNIRP, IEEE and International Standards
Specific Absorption Rate Case: 850 MHz

FCC 2007 General Public




ICNIRP 1998,2019 IEEE 2005,2019 Whole Body PD (W/m2)
Power Density (W/m2)
Frequency (MHz)
10^2
10^1
10^0
10^1
10^2
10^3
10^4
10^5
10^6

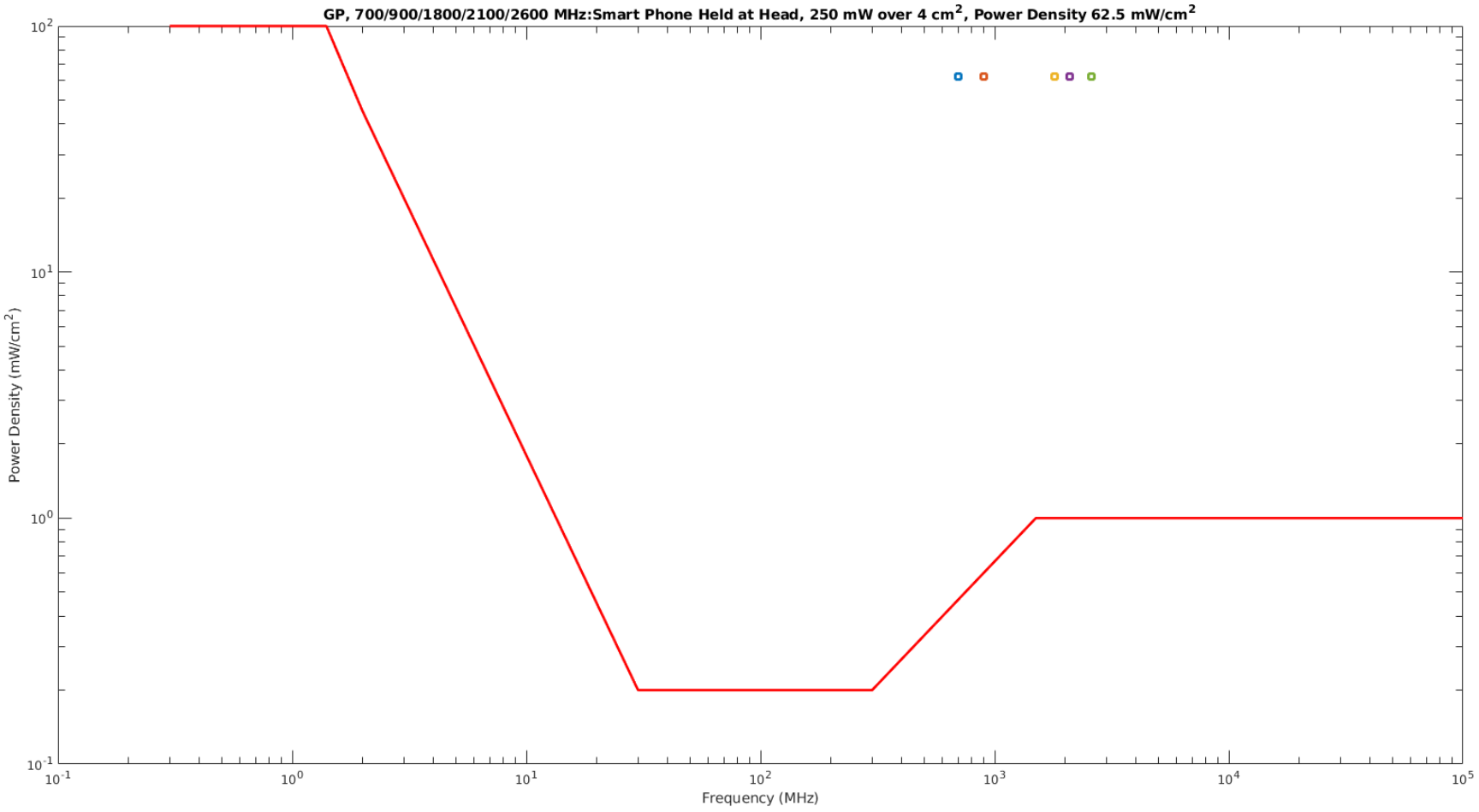

ICNIRP 2019, IEEE 2005,2019 Local Exposure PD (W/m^2)
Power Density (W/m^2)
10^2
10^1
10^1
10^2
10^3
10^4
10^5
10^6
Frequency (MHz)


Maximum Permissible Exposure (R), General Public Exposure (G) FCC (2007)
MPE, GP: Power Density (mW/cm^2)
Frequency (MHz)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}

Use case of cell phone zero distance to head has power density 62.5 mW/cm^2 and exceeds maximum recommended safe level of 5 mW/cm^2 for home microwave

when smart phone held at head (near field)

- **so...DON’T HOLD IT TO YOUR HEAD!!!!!**


GP, 700/900/1800/2100/2600 MHz:Smart Phone Held at Head, 250 mW over 4 cm2, Power Density 62.5 mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
10^2
10^1
10^0
10^-1
10^-1
10^0
10^1
10^2
10^3
10^4
10^5

5G Sub 6 GHz links USA (700, 900, 1800, 2100, and 2600 MHz)

All numbers are contrived to just kiss the limit level at 1 meter distance from user

Figure 1 700 MHz 28 dBm Transmit Power, 18 dBi Antenna Array **Gain**, **1,5,10,25,50,75 & 100** meter distance from Antenna shown vs power density, all contrived to just kiss the maximum permissible exposure limit level, arbitrary numbers chosen on my part, with some basis of belief of use. 700 MHz is **Most powerful, longest reach, most dense** sub 6 GHz band in USA

Figure 2 **900 MHz** Band, **29 dBm** Transmit **Power**, **18 dBi** Antenna Array **Gain**, **1,5,10,25,50,75 & 100** meter distances

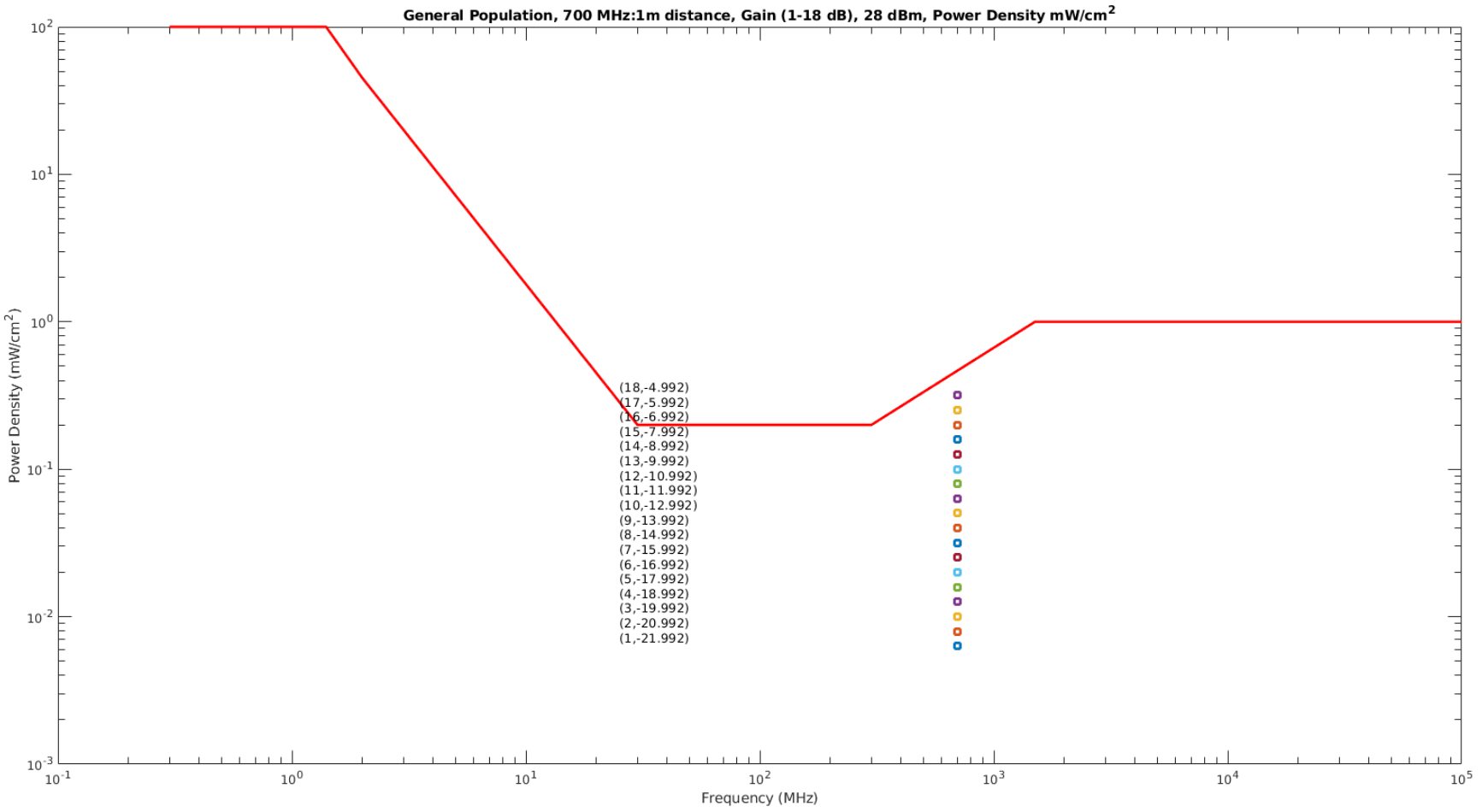
Figure 3 **1800 MHz** Band, 32 **dBm** Transmit **Power**, **18 dBi** Antenna Array **Gain**, **1,5,10,25,50,75 & 100** meter distances

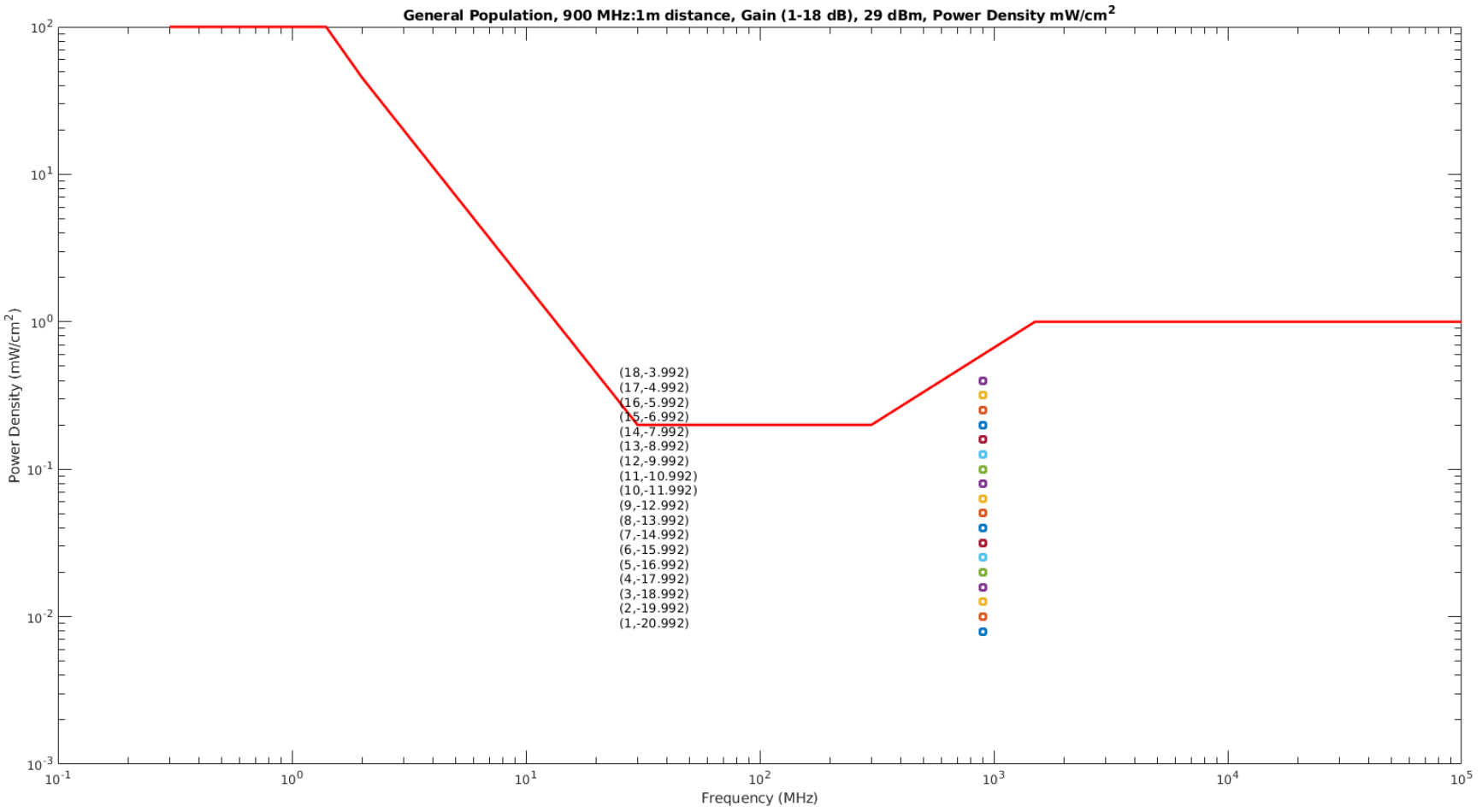
Figure 4 **2100 MHz** Band, 32 **dBm** Transmit **Power**, **18 dBi** Antenna Array **Gain**, **1,5,10,25,50,75 & 100** meter distances

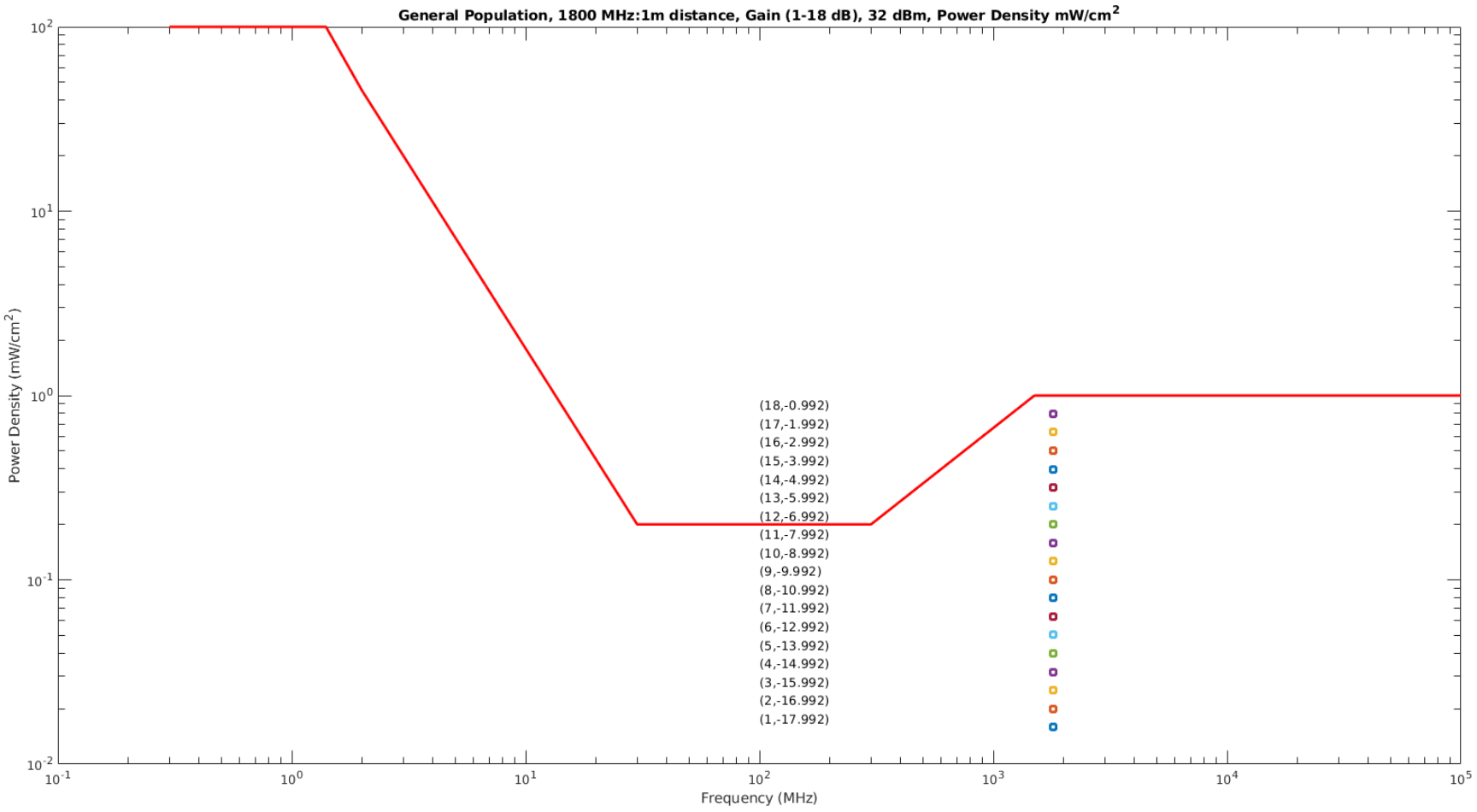
Figure 5 **2600 MHz** Band, 32 **dBm** Transmit **Power**, **18 dBi** Antenna Array **Gain**, **1,5,10,25,50,75 & 100** meter distances

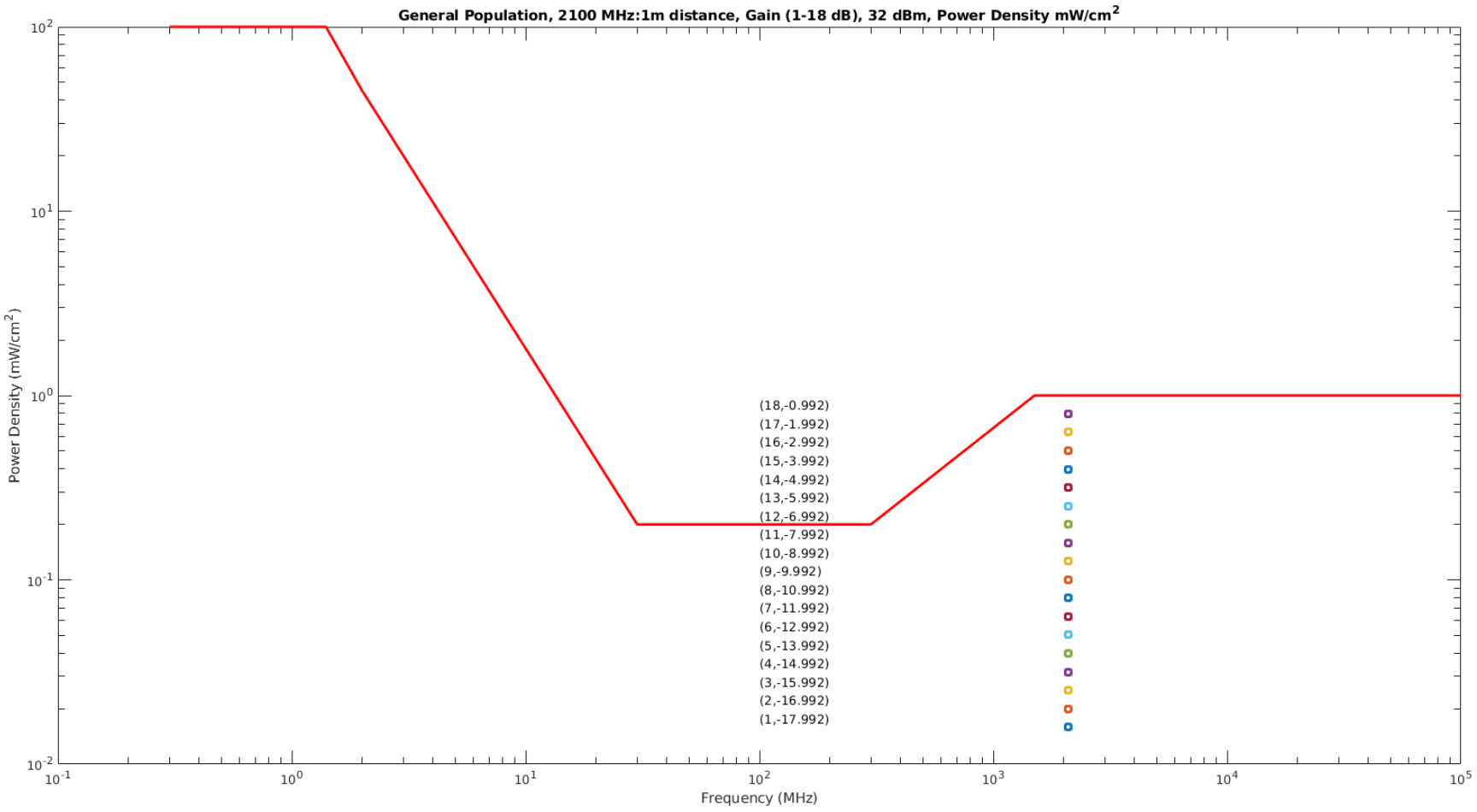
All levels contrived to just kiss the limit levels at higher than 5G Standard Levels.

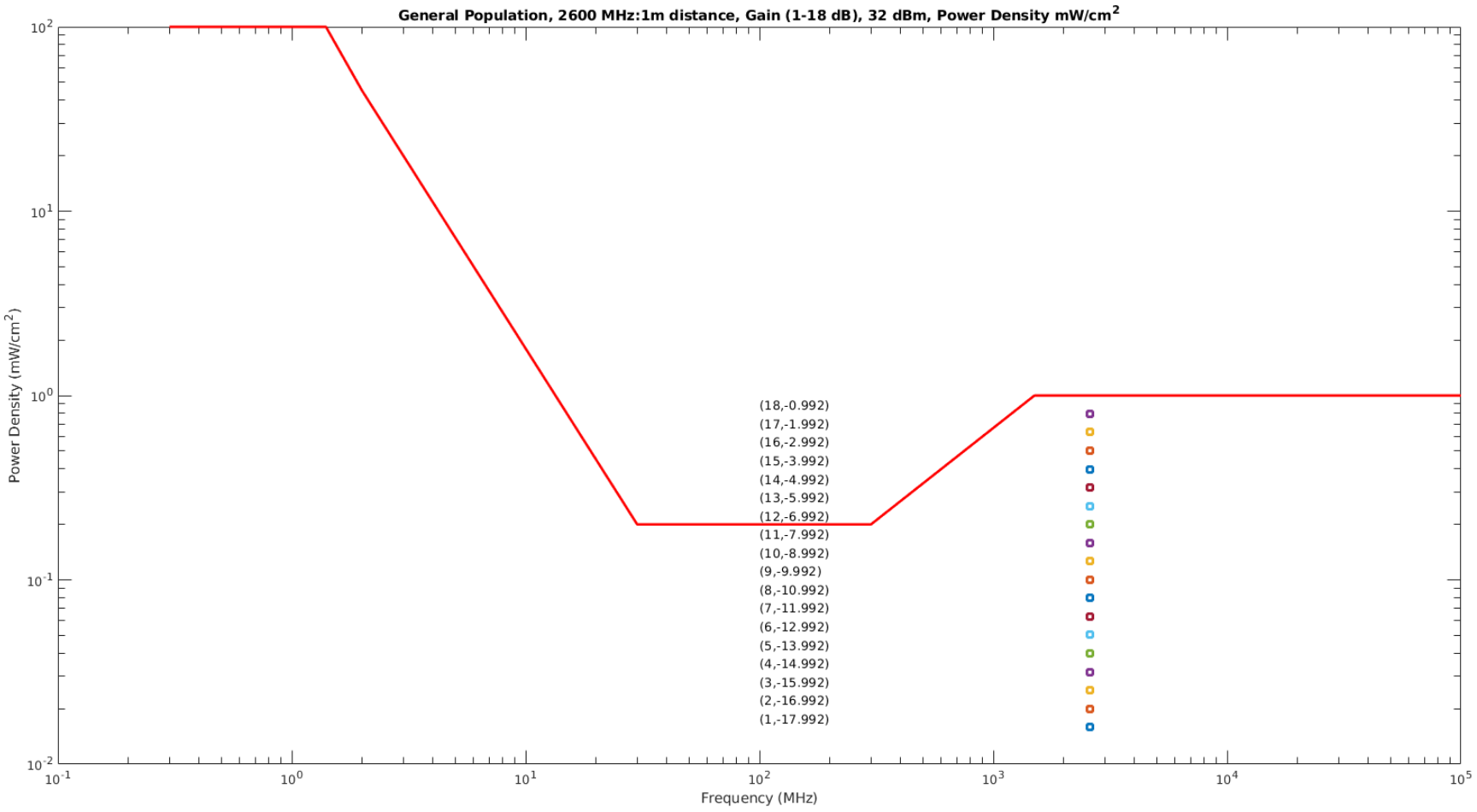
Conclusion: The standard for sub 6 GHz phones is safe. It is likely the standard from 28-32 GHz is also safe, as the reach of those frequencies is less, as is the penetration of the mm wave radiation into human skin at those frequencies.


General Population, 700 MHz:1m distance, Gain (1-18 dB), 28 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
(18,-4.992)
(17,-5.992)
(16,-6.992)
(15,-7.992)
(14,-8.992)
(13,-9.992)
(12,-10.992)
(11,-11.992)
(10,-12.992)
(9,-13.992)
(8,-14.992)
(7,-15.992)
(6,-16.992)
(5,-17.992)
(4,-18.992)
(3,-19.992)
(2,-20.992)
(1,-21.992)


General Population, 900 MHz:1m distance, Gain (1-18 dB), 29 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
(18,-3.992)
(17,-4.992)
(16,-5.992)
(15,-6.992)
(14,-7.992)
(13,-8.992)
(12,-9.992)
(11,-10.992)
(10,-11.992)
(9,-12.992)
(8,-13.992)
(7,-14.992)
(6,-15.992)
(5,-16.992)
(4,-17.992)
(3,-18.992)
(2,-19.992)
(1,-20.992)


General Population, 1800 MHz:1m distance, Gain (1-18 dB), 32 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
(18,-0.992)
(17,-1.992)
(16,-2.992)
(15,-3.992)
(14,-4.992)
(13,-5.992)
(12,-6.992)
(11,-7.992)
(10,-8.992)
(9,-9.992)
(8,-10.992)
(7,-11.992)
(6,-12.992)
(5,-13.992)
(4,-14.992)
(3,-15.992)
(2,-16.992)
(1,-17.992)


General Population, 2100 MHz:1m distance, Gain (1-18 dB), 32 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
(18,-0.992)
(17,-1.992)
(16,-2.992)
(15,-3.992)
(14,-4.992)
(13,-5.992)
(12,-6.992)
(11,-7.992)
(10,-8.992)
(9,-9.992)
(8,-10.992)
(7,-11.992)
(6,-12.992)
(5,-13.992)
(4,-14.992)
(3,-15.992)
(2,-16.992)
(1,-17.992)

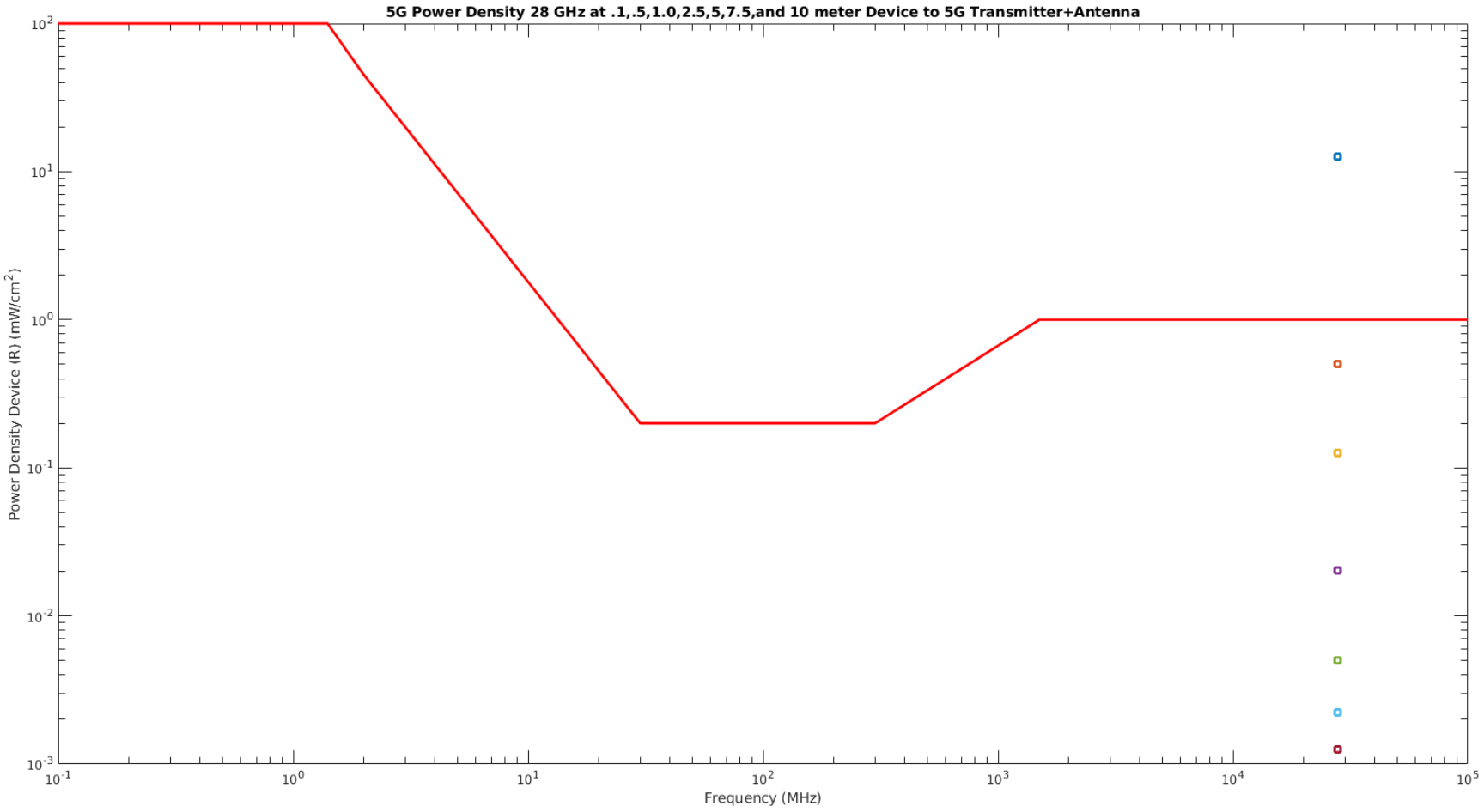

General Population, 2600 MHz:1m distance, Gain (1-18 dB), 32 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
(18,-0.992)
(17,-1.992)
(16,-2.992)
(15,-3.992)
(14,-4.992)
(13,-5.992)
(12,-6.992)
(11,-7.992)
(10,-8.992)
(9,-9.992)
(8,-10.992)
(7,-11.992)
(6,-12.992)
(5,-13.992)
(4,-14.992)
(3,-15.992)
(2,-16.992)
(1,-17.992)

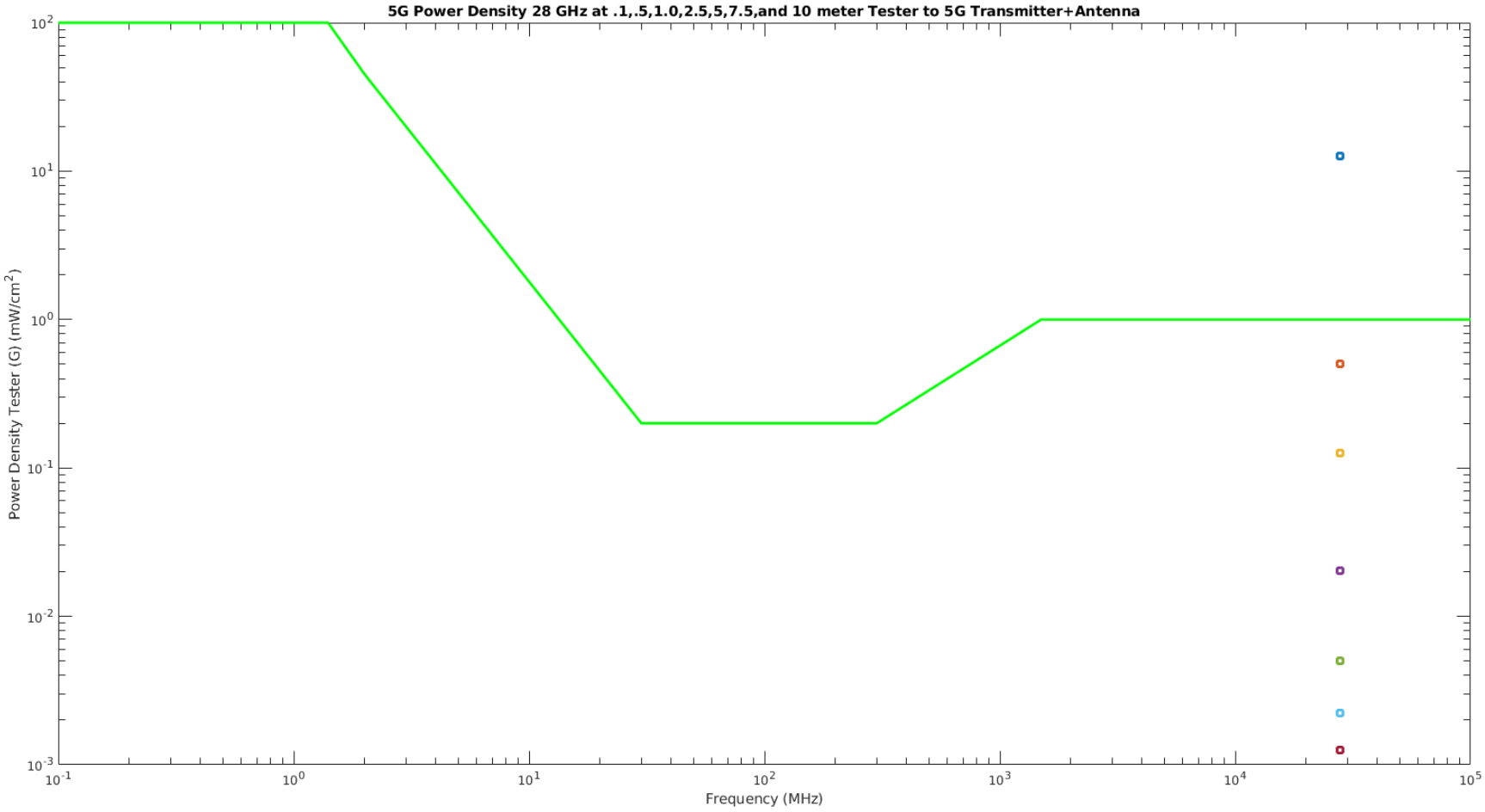
5G 28 GHz link USA; Tester: 24 dBm Tx Pwr; Device: 24 dBm Tx Pwr; 18 dBi Tx Ant Gain; 15 dBi Rx Ant Gain; 4.1 dB Cable Loss

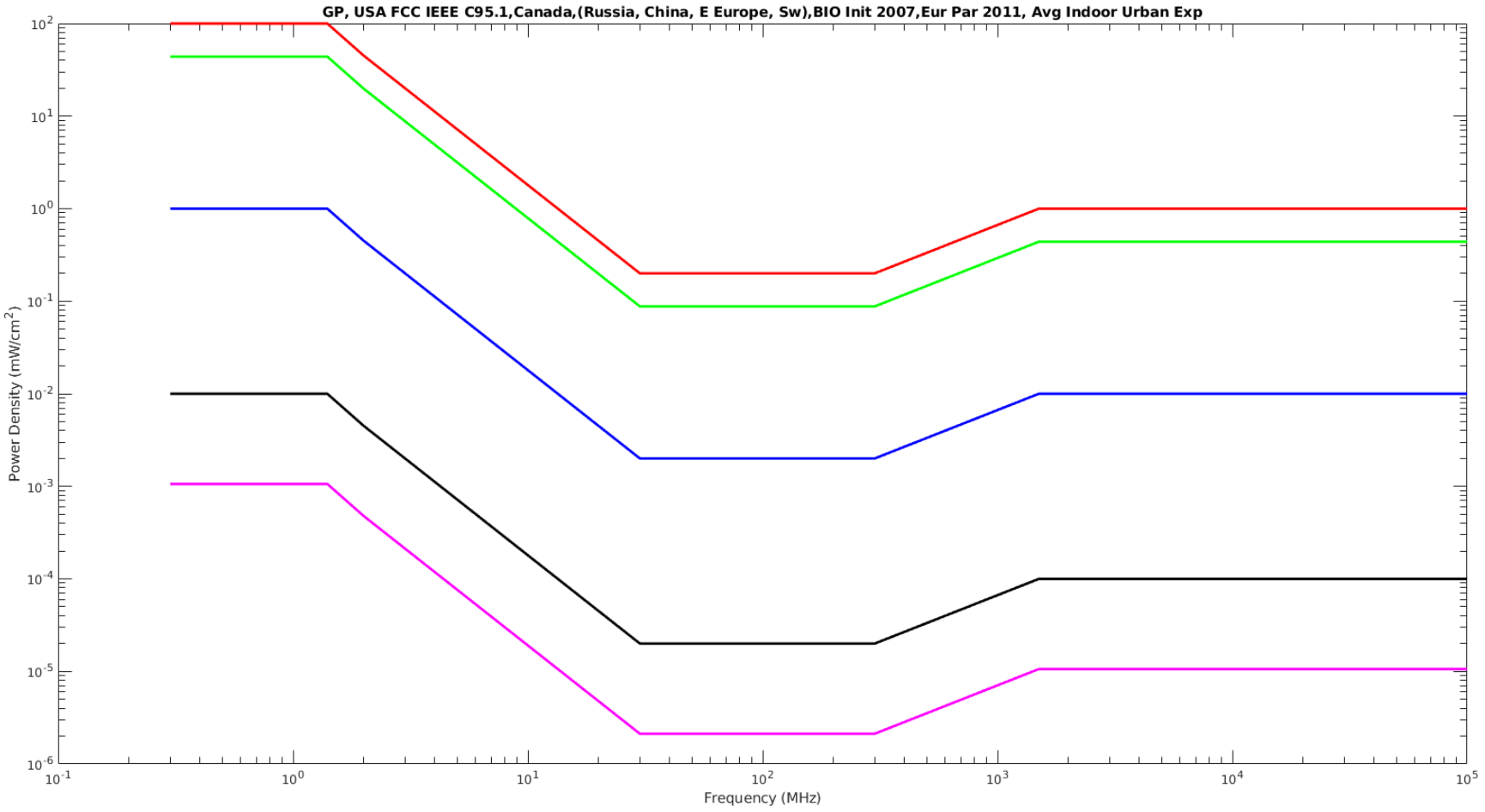
Figure 1 28 GHz Power Density Device; .1,.5,1.0,2.5,5.0,7.5 & 10 meter distance from Antenna

Figure 2 28 GHz Power Density Tester; .1,.5,1.0,2.5,5.0,7.5 & 10 meter distance from Antenna

Conclusion: The standard for 28 GHz phones is safe at a certain distance of user from transmit antenna. We specifiy typical numbers which are safe at a distance of 0.5 meter and greater, user from transmit antenna. It is likely the 5G standard in use for mm wave is safe, as the reach of mm wave frequencies is less, as is the penetration of the mm wave radiation into human skin at those frequencies.


5G Power Density 28 GHz at .1,.5,1.0,2.5,5,7.5,and 10 meter Device to 5G Transmitter+Antenna
Power Density Device (R) (mW/cm2)
Frequency (MHz)
10-3
10-2
10-1
100
101
102
10-1
100
101
102
103
104
105


5G Power Density 28 GHz at .1,.5,1.0,2.5,5,7.5,and 10 meter Tester to 5G Transmitter+Antenna
Power Density Tester (G) (mW/cm^2)
Frequency (MHz)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}


GP, USA FCC IEEE C95.1,Canada,(Russia, China, E Europe, Sw),BIO Init 2007,Eur Par 2011, Avg Indoor Urban Exp
Power Density (mW/cm^2)
Frequency (MHz)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}

IEEE C95.1 (USA); Canada; (Russia, China, E Europe, Sw); BIO Init 2007; Eur Par 2011; Avg Indoor Urban Exposure Standards shown shades of Magenta

Figure 1 **700 MHz** Band, -5.7 **dBm** Transit **Power**, 3 **dBi** Antenna **Gain**, **1** meter distance

Figure 2 **900 MHz** Band, -4.7 **dBm** Transmit **Power**, 3 **dBi** Antenna **Gain**, **1** meter distance

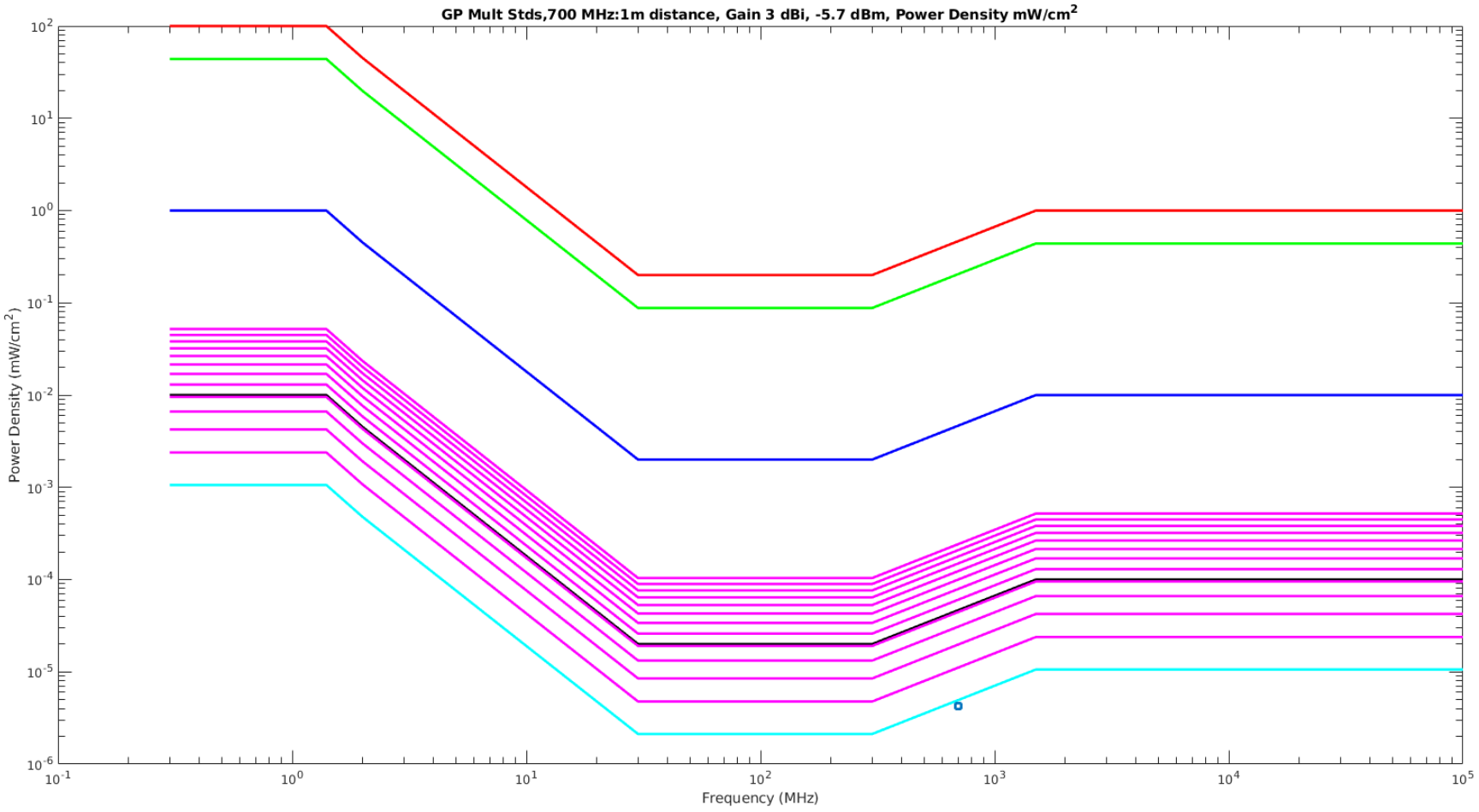
Figure 3 **1800 MHz** Band, -3 **dBm** Transmit **Power**, 3 **dBi** Antenna **Gain**, **1** meter distance

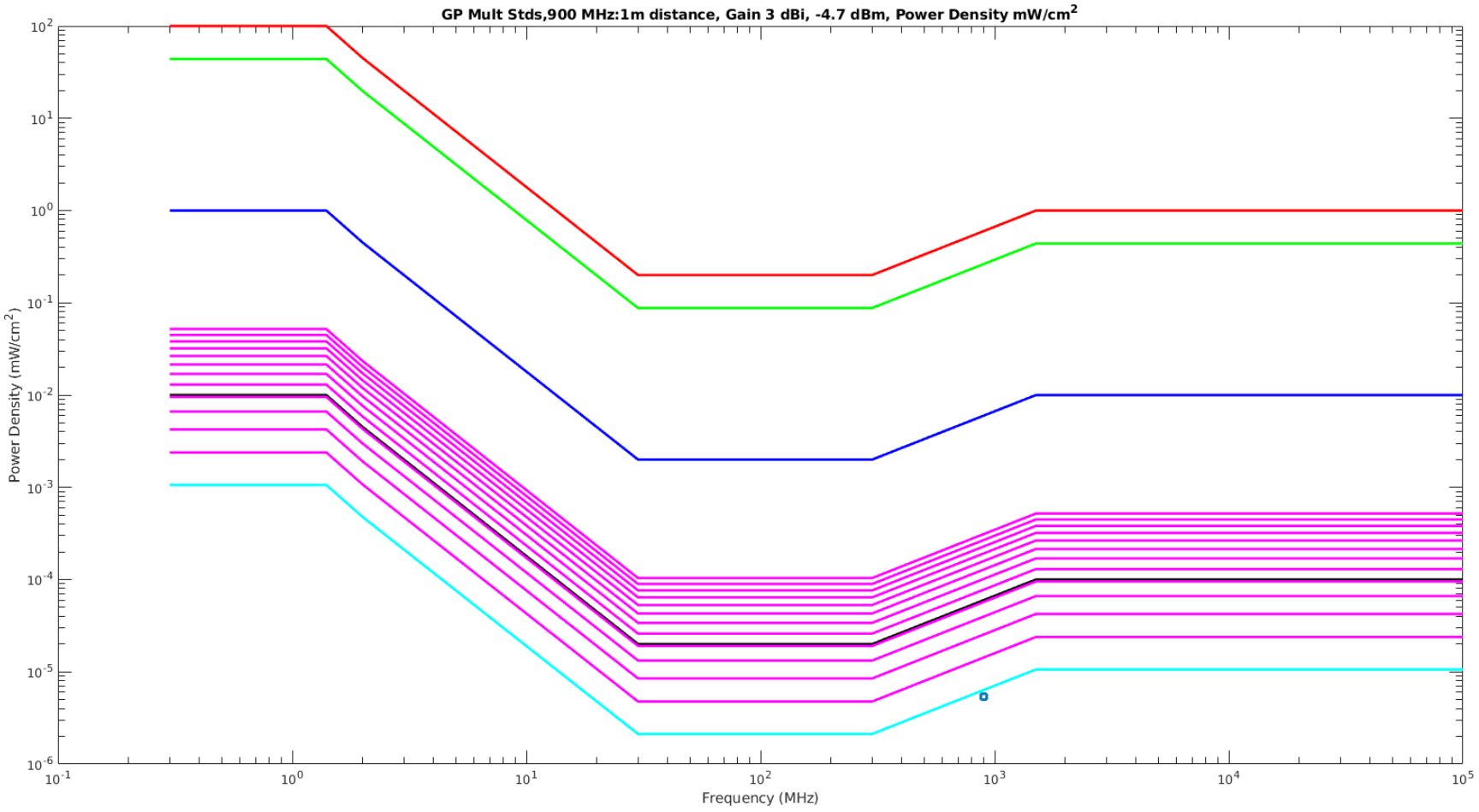
Figure 4 **2100 MHz** Band, -3 **dBm** Transmit **Power**, 3 **dBi** Antenna **Gain**, **1** meter distance

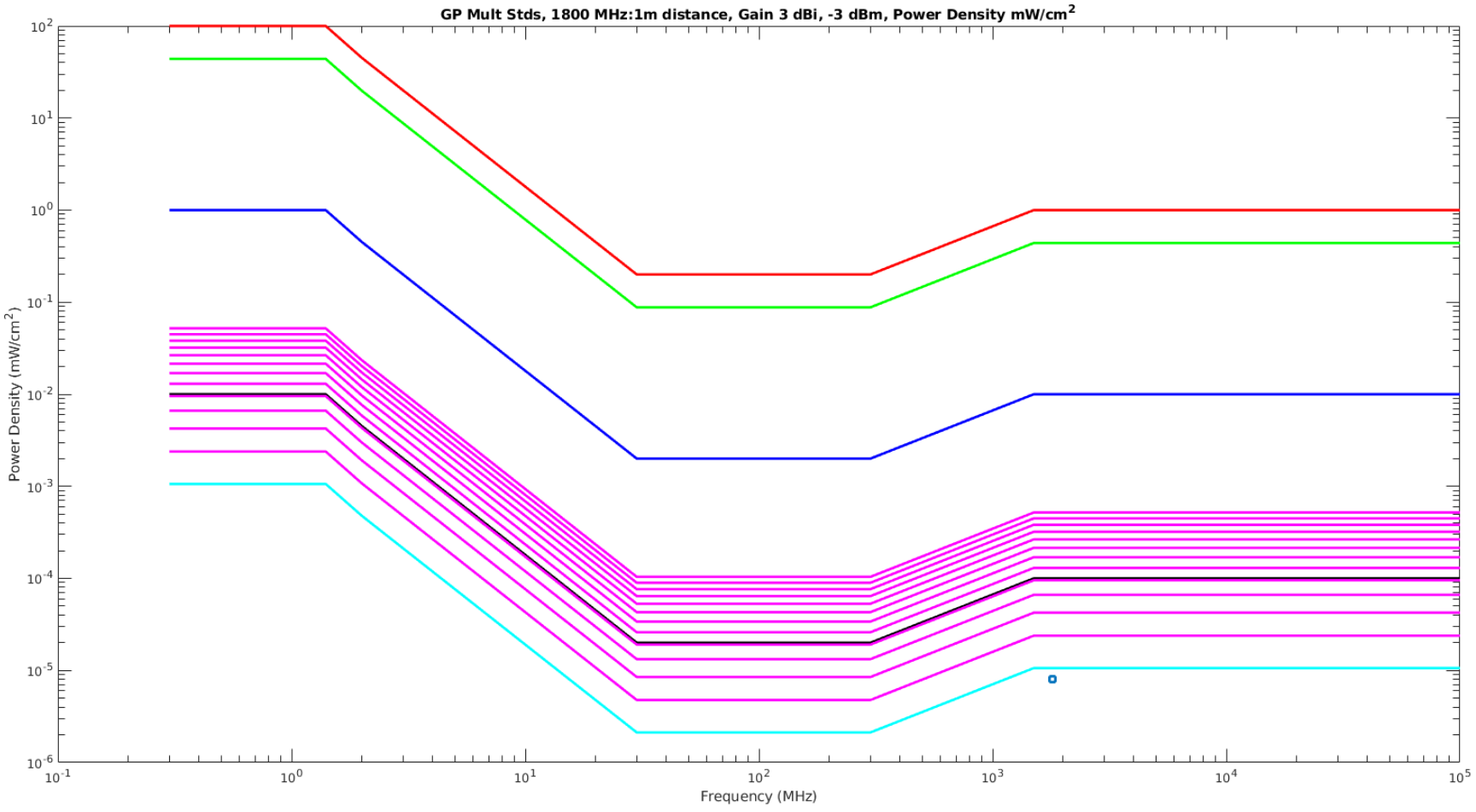
Figure 5 **2600 MHz** Band, -3 **dBm** Transmit **Power**, 3 **dBi** Antenna **Gain**, **1** meter distance

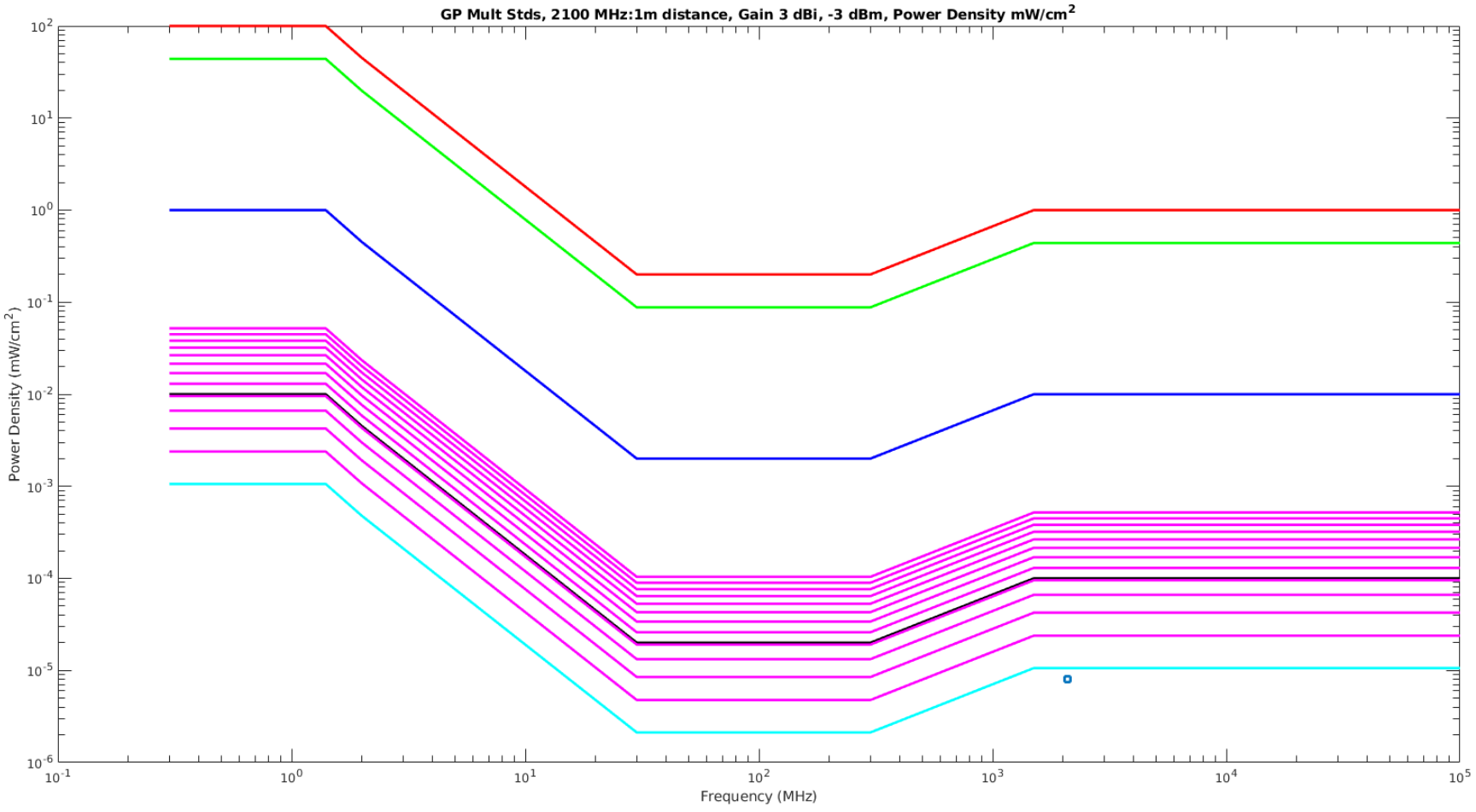
All levels contrived to just touch all Safe limit levels, however, all levels are highly impractical (~500 microwatts and lower, 3dBi Gain) Phone cannot communicate to anywhere at these low levels.

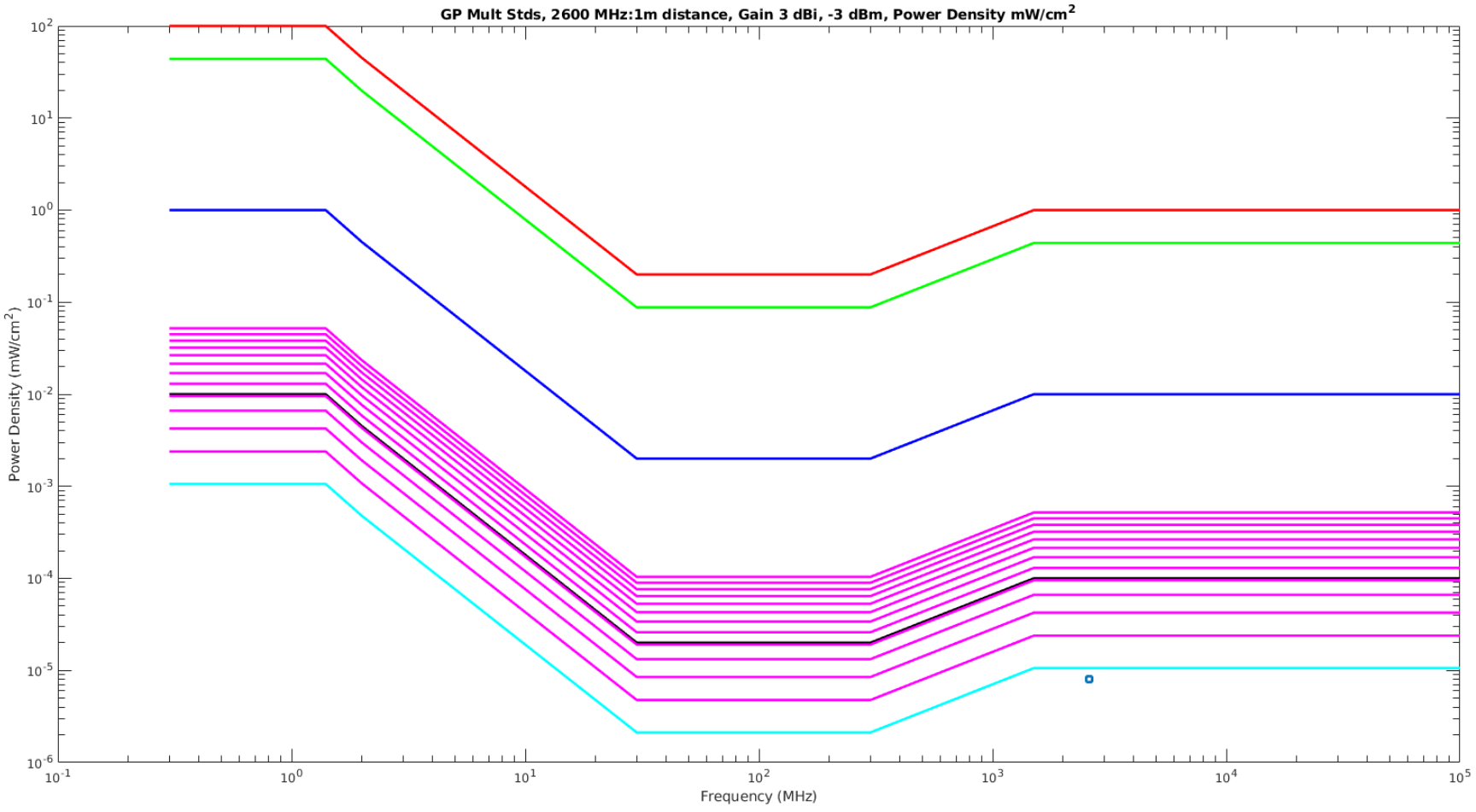
Solution: Change the standards, not the technology which works fine.


GP Mult Stds,700 MHz:1m distance, Gain 3 dBi, -5.7 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
10-1
100
101
102
103
104
105
10-6
10-5
10-4
10-3
10-2
10-1
100
101
102

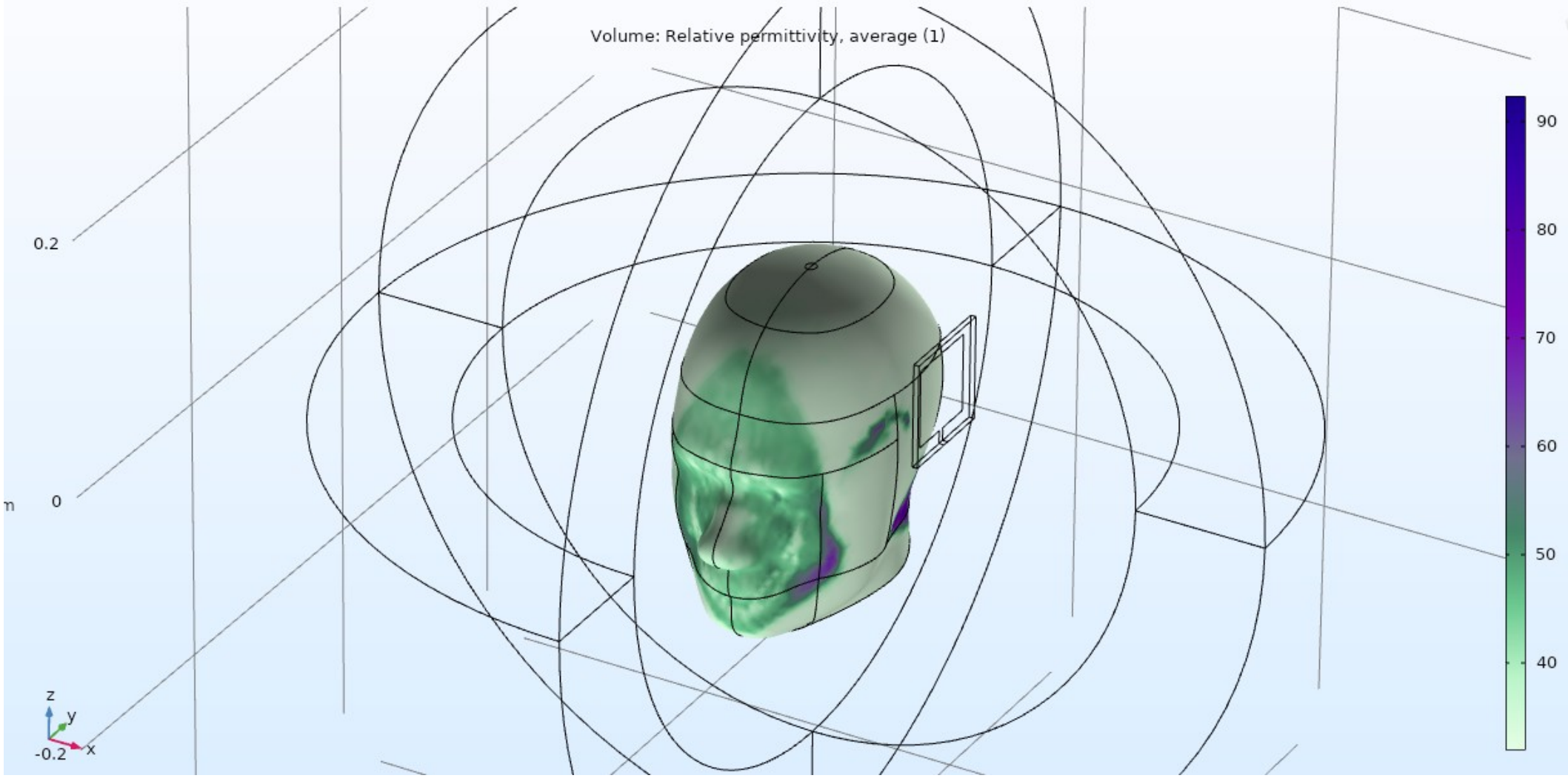

GP Mult Stds,900 MHz:1m distance, Gain 3 dBi, -4.7 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
10-1
100
101
102
103
104
105
10-6
10-5
10-4
10-3
10-2
10-1
100
101
102

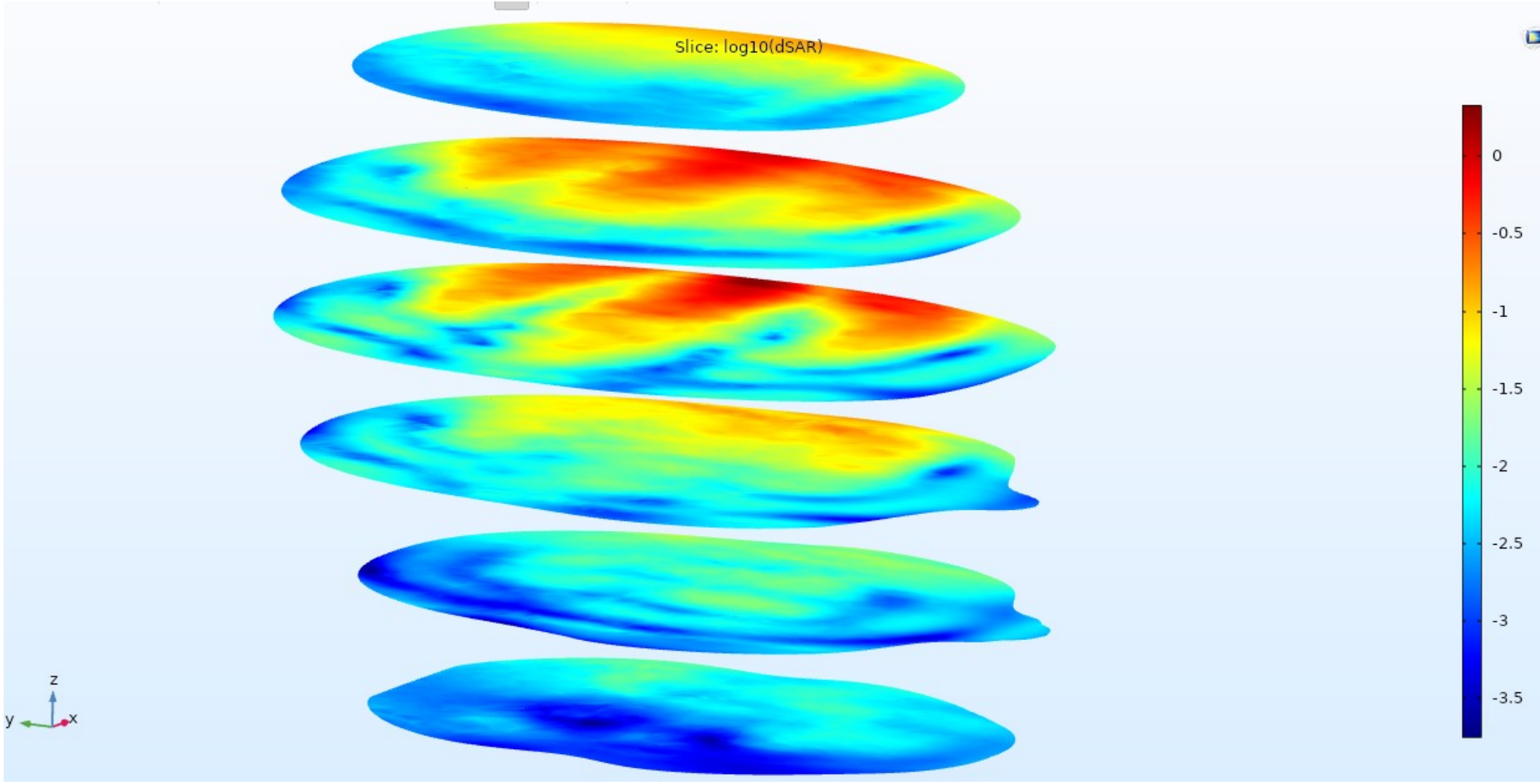

GP Mult Stds, 1800 MHz:1m distance, Gain 3 dBi, -3 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
10-1
100
101
102
103
104
105
10-6
10-5
10-4
10-3
10-2
10-1
100
101
102


GP Mult Stds, 2100 MHz:1m distance, Gain 3 dBi, -3 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
10-1
100
101
102
103
104
105
10-6
10-5
10-4
10-3
10-2
10-1
100
101
102


GP Mult Stds, 2600 MHz:1m distance, Gain 3 dBi, -3 dBm, Power Density mW/cm2
Power Density (mW/cm2)
Frequency (MHz)
10-1
100
101
102
103
104
105
10-6
10-5
10-4
10-3
10-2
10-1
100
101
102

- Specific Absorption Rate-Heating Model of Human Head
- Frequency: 835 MHz
- Conductivity: 1.15 S/m
- Relative Permittivity: 58.13
- Temperature variance-head shown from top to bottom


Volume: Relative permittivity, average (1)
0.2
0
m
-0.2
z
y
x
90
80
70
60
50
40


Slice: log10(dSAR)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
z
y
x

References

1. ICNIRP, “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz),” Health Phys., vol. 75, no. 5, pp. 494–522, 1998.

2. IEEE C95.1, “IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz,” 2005.

3. ICNIRP, “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz),” Health Phys., pp. 1–25, 2019.

4. IEEE C95.1, IEEE Approved draft standard for safety levels with respect to human exposure to electric, magnetic and electromagnetic fields, 0 Hz to 300 GHz, no. 2. 2019.