KSW ANTENNAS
Simply Wireless

Product Tested: Apron-C and Apron-W

Applicant: Dr. Finkel Ltd. UK 136-144 Golders Green Road, London NW118HB England

Conducted by: Chief RF Engineer – Mr. Matti Martiskainen
Date: Nov 2020

Test Purpose

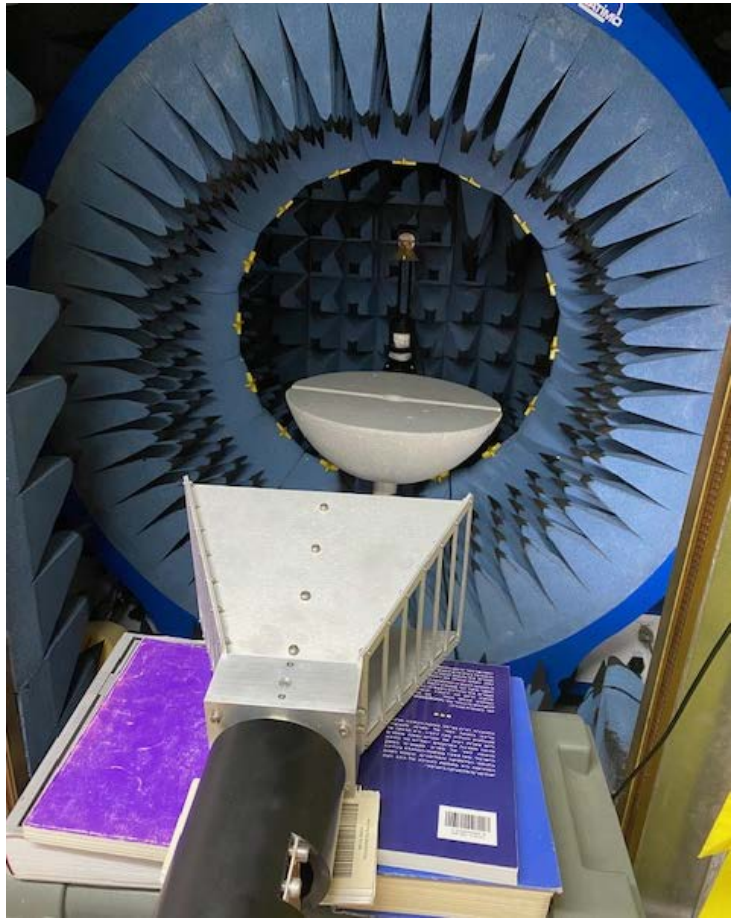
- Test conductive/reflective fabric materials for attenuation level in the frequency range of 600MHz – 18GHz.
- During period moving from 4G to 5G both frequency needs are important for future products as protecting user from RF effects

Selected test Method

- The measurement was done in anechoic chamber in order to avoid

  reflected signal between transmitting and receiving antenna
- The measurement was done in far field. This covers the effect of base stations and similar, but does not necessarily count the handheld devices used next to user body
- The measurement was done on one layer of the material

Apron C and Apron W in range 0.6-17 GHz Far field setup



Directive transmitting antenna pointing towards receiving antenna within an anechoic chamber; Reference measurement without any shielding material setting 0 level. In this setup the probes of the Satimo measurement system are not in use.

Apron C and Apron W in range 0.6-17 GHz Far field setup

Directive transmitting antenna pointing towards receiving antenna within an anechoic chamber; Actual measurement with Apron W material located in middle of transmitting and receiving antennas. Apron W hides the receiving antenna from viewer.

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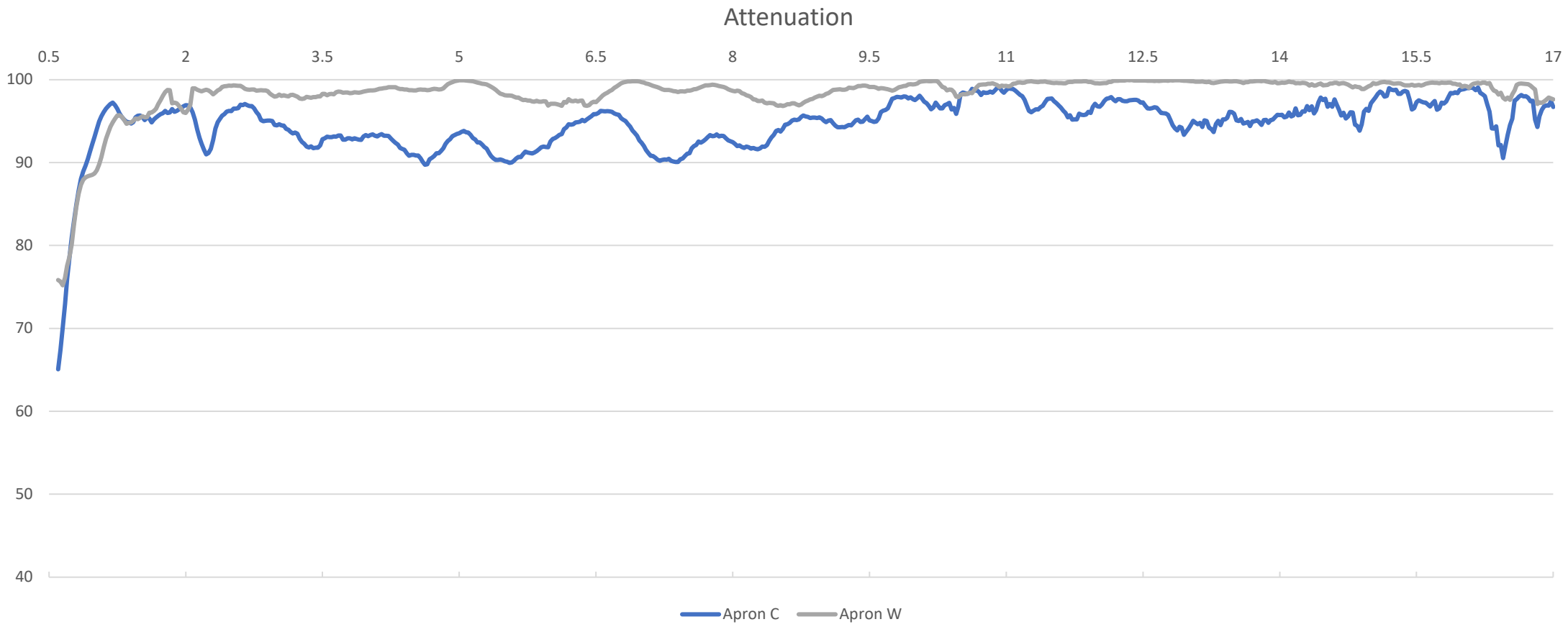
Apron C and Apron W in range 0.6-17 GHz



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Apron C and Apron W Attenuation table

Attenuation			Attenuation			Attenuation			Attenuation			Attenuation			Attenuation			Attenuation			Attenuation			Attenuation		
Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W
0.6	65.1	75.8	1.475	95.7	95.2	2.35	94.9	98.7	3.225	93.5	98.0	4.1	93.2	98.8	4.975	93.5	99.9	5.85	91.4	97.4	6.725	95.8	99.2	7.625	92.5	99.0
0.625	67.4	75.6	1.5	95.7	95.4	2.375	95.3	98.8	3.25	92.9	97.7	4.125	93.3	98.9	5	93.5	99.9	5.875	91.6	97.3	6.75	95.8	99.4	7.65	92.4	99.1
0.65	70.1	75.2	1.525	95.5	95.6	2.4	95.7	99.1	3.275	92.5	97.7	4.15	93.4	98.9	5.025	93.7	99.9	5.9	91.8	97.3	6.775	95.3	99.5	7.675	92.6	99.2
0.675	72.9	76.1	1.55	95.1	95.4	2.425	95.8	99.2	3.3	92.3	97.7	4.175	93.2	99.0	5.05	93.8	99.9	5.925	91.9	97.4	6.8	95.1	99.7	7.7	92.8	99.3
0.7	76.0	77.6	1.575	95.5	95.5	2.45	96.1	99.2	3.325	91.9	97.9	4.2	93.2	99.0	5.075	93.6	99.9	5.95	91.9	97.4	6.825	95.0	99.7	7.725	93.1	99.3
0.725	78.5	78.6	1.6	95.3	96.0	2.475	96.2	99.3	3.35	91.8	97.9	4.225	93.2	99.1	5.1	93.6	99.9	5.975	91.9	96.9	6.85	94.7	99.8	7.75	93.3	99.3
0.75	80.9	80.1	1.625	94.8	96.0	2.5	96.2	99.3	3.375	92.0	97.8	4.25	92.9	99.1	5.125	93.3	99.8	6	92.5	97.1	6.875	94.3	99.8	7.775	93.2	99.4
0.775	83.0	82.6	1.65	95.2	96.2	2.525	96.5	99.3	3.4	91.7	97.9	4.275	92.6	99.1	5.15	93.0	99.8	6.025	92.8	97.1	6.9	93.9	99.8	7.8	93.2	99.4
0.8	84.9	84.7	1.675	95.4	96.5	2.55	96.5	99.3	3.425	91.8	97.9	4.3	92.4	99.1	5.175	92.8	99.7	6.05	93.0	97.1	6.925	93.6	99.8	7.825	93.4	99.3
0.825	86.6	86.2	1.7	95.6	97.1	2.575	96.6	99.2	3.45	91.8	98.0	4.325	92.2	99.0	5.2	92.4	99.7	6.075	93.1	97.0	6.95	93.2	99.8	7.85	93.1	99.2
0.85	88.0	87.3	1.725	95.8	97.5	2.6	97.0	99.2	3.475	92.1	98.0	4.35	91.8	98.9	5.225	92.4	99.6	6.1	93.3	97.0	6.975	92.7	99.8	7.875	93.2	99.2
0.875	88.9	87.9	1.75	96.0	98.1	2.625	96.9	99.1	3.5	92.8	98.3	4.375	91.6	98.9	5.25	92.2	99.5	6.125	93.4	96.9	7	92.4	99.7	7.9	93.2	99.1
0.9	89.6	88.2	1.775	96.2	98.5	2.65	97.1	98.9	3.525	92.9	98.3	4.4	91.5	98.8	5.275	91.9	99.5	6.15	94.0	97.3	7.025	92.0	99.6	7.925	92.9	99.0
0.925	90.4	88.3	1.8	96.0	98.8	2.675	96.9	98.8	3.55	93.1	98.1	4.425	91.1	98.8	5.3	91.7	99.4	6.175	94.2	97.2	7.05	91.5	99.5	7.95	92.7	98.8
0.95	91.3	88.4	1.825	96.0	98.7	2.7	96.8	98.8	3.575	93.1	98.3	4.45	90.8	98.7	5.325	91.2	99.3	6.2	94.6	97.6	7.075	91.1	99.5	7.975	92.6	98.7
0.975	92.2	88.5	1.85	96.5	97.1	2.725	96.8	98.8	3.6	93.1	98.3	4.475	90.9	98.7	5.35	90.8	99.1	6.225	94.6	97.4	7.1	90.8	99.4	8	92.5	98.6
1	93.1	88.7	1.875	96.1	97.2	2.75	96.5	98.8	3.625	93.1	98.2	4.5	90.9	98.7	5.375	90.5	99.0	6.25	94.6	97.4	7.125	90.8	99.2	8.025	92.2	98.6
1.025	94.1	89.1	1.9	96.2	97.1	2.775	96.1	98.7	3.65	93.1	98.5	4.525	90.8	98.7	5.4	90.3	98.8	6.275	94.9	97.5	7.15	90.6	99.2	8.05	92.0	98.7
1.05	95.0	89.8	1.925	96.4	96.9	2.8	95.8	98.7	3.675	93.2	98.6	4.55	90.8	98.8	5.425	90.3	98.5	6.3	94.9	97.4	7.175	90.3	99.1	8.075	92.1	98.6
1.075	95.6	90.7	1.95	96.6	96.5	2.825	95.1	98.7	3.7	93.3	98.5	4.575	90.5	98.8	5.45	90.4	98.3	6.325	94.9	97.4	7.2	90.2	99.0	8.1	91.9	98.4
1.1	96.1	91.9	1.975	96.8	96.1	2.85	95.0	98.7	3.725	92.8	98.4	4.6	90.1	98.8	5.475	90.3	98.2	6.35	95.2	97.5	7.225	90.3	98.9	8.125	91.8	98.3
1.125	96.5	92.9	2	96.9	96.0	2.875	95.0	98.7	3.75	92.8	98.4	4.625	89.7	98.8	5.5	90.1	98.1	6.375	95.0	96.9	7.25	90.4	98.8	8.15	91.9	98.1
1.15	96.8	93.6	2.025	96.9	96.4	2.9	95.1	98.6	3.775	92.9	98.5	4.65	89.8	98.7	5.525	90.1	98.1	6.4	95.2	96.9	7.275	90.3	98.7	8.175	91.9	98.0
1.175	97.1	94.3	2.05	96.7	96.9	2.925	95.1	98.3	3.8	92.9	98.4	4.675	90.4	98.8	5.55	89.9	98.1	6.425	95.4	96.9	7.3	90.5	98.7	8.2	91.7	97.9
1.2	97.2	94.8	2.075	96.1	99.0	2.95	95.0	98.1	3.825	92.8	98.4	4.7	90.6	98.8	5.575	90.0	98.1	6.45	95.6	97.2	7.325	90.2	98.7	8.225	91.8	97.6
1.225	96.9	95.3	2.1	95.2	99.0	2.975	94.5	98.0	3.85	92.9	98.5	4.725	90.8	98.9	5.6	90.2	98.0	6.475	95.9	97.3	7.35	90.1	98.6	8.25	91.7	97.6
1.25	96.5	95.7	2.125	94.0	98.8	3	94.5	98.0	3.875	92.9	98.4	4.75	91.1	98.9	5.625	90.5	97.9	6.5	95.9	97.3	7.375	90.1	98.6	8.275	91.6	97.4
1.275	95.9	95.7	2.15	93.0	98.7	3.025	94.6	98.2	3.9	92.8	98.4	4.775	91.1	98.8	5.65	90.7	97.8	6.525	96.0	97.6	7.4	90.1	98.5	8.3	91.7	97.4
1.3	95.5	95.5	2.175	92.2	98.6	3.05	94.5	98.0	3.925	92.7	98.5	4.8	91.4	98.8	5.675	90.7	97.7	6.55	96.2	97.8	7.425	90.4	98.6	8.325	91.9	97.5
1.325	95.2	95.1	2.2	91.6	98.7	3.075	94.4	98.1	3.95	93.1	98.6	4.825	91.7	98.9	5.7	91.0	97.5	6.575	96.2	98.1	7.45	90.5	98.6	8.35	91.9	97.2
1.35	94.9	94.7	2.225	91.0	98.8	3.1	94.1	98.0	3.975	93.3	98.6	4.85	92.2	99.2	5.725	91.3	97.6	6.6	96.2	98.3	7.475	90.8	98.6	8.375	92.1	97.2
1.375	94.9	94.8	2.25	91.1	98.7	3.125	94.0	98.0	4	93.2	98.7	4.875	92.6	99.4	5.75	91.2	97.5	6.625	96.2	98.4	7.5	91.1	98.7	8.4	92.6	97.2
1.4	94.7	94.8	2.275	91.6	98.5	3.15	93.7	98.1	4.025	93.3	98.7	4.9	92.8	99.6	5.775	91.2	97.5	6.65	96.2	98.6	7.525	91.1	98.7	8.425	93.0	97.2
1.425	94.9	95.0	2.3	92.7	98.2	3.175	93.5	98.2	4.05	93.4	98.7	4.925	93.2	99.7	5.8	91.1	97.4	6.675	96.1	98.8	7.55	91.7	98.7	8.45	93.3	97.1
1.45	95.5	95.3	2.325	94.1	98.4	3.2	93.6	98.1	4.075	93.2	98.7	4.95	93.3	99.8	5.825	91.2	97.3	6.7	95.9	99.0	7.575	92.0	98.8	8.475	93.8	96.9

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Apron C and Apron W Attenuation table

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Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W	Frequency	Apron C	Apron W
8.5	93.9	96.8	9.375	95.2	99.2	10.25	96.9	99.8	11.125	98.4	99.6	12	96.8	99.6	12.875	93.9	99.9	13.75	95.1	99.8	14.625	97.0	99.6	15.5	97.3	99.3	16.375	94.4	98.6
8.525	93.7	96.9	9.4	94.9	99.2	10.275	96.5	99.5	11.15	98.2	99.7	12.025	96.7	99.5	12.9	94.3	99.9	13.775	94.9	99.8	14.65	96.4	99.5	15.525	97.5	99.4	16.4	92.1	98.2
8.55	94.1	96.8	9.425	94.9	99.3	10.3	96.5	99.1	11.175	98.0	99.6	12.05	97.0	99.6	12.925	94.2	99.9	13.8	94.5	99.8	14.675	95.7	99.6	15.55	97.4	99.3	16.425	92.1	98.4
8.575	94.6	96.9	9.45	95.2	99.3	10.325	96.9	99.0	11.2	97.6	99.6	12.075	97.4	99.6	12.95	93.3	99.9	13.825	95.1	99.9	14.7	96.0	99.6	15.575	97.3	99.4	16.45	90.5	97.8
8.6	94.6	97.0	9.475	95.5	99.2	10.35	97.0	98.7	11.225	96.9	99.8	12.1	97.7	99.6	12.975	93.7	99.9	13.85	95.1	99.8	14.725	95.3	99.5	15.6	97.2	99.5	16.475	92.0	97.6
8.625	94.8	97.0	9.5	95.1	99.1	10.375	97.2	98.8	11.25	96.2	99.8	12.125	97.8	99.7	13	94.1	99.8	13.875	94.8	99.7	14.75	95.6	99.4	15.625	97.0	99.6	16.5	93.3	97.8
8.65	95.1	97.2	9.525	95.0	99.1	10.4	96.4	98.8	11.275	96.1	99.8	12.15	97.9	99.7	13.025	94.5	99.8	13.9	95.1	99.7	14.775	96.1	99.2	15.65	96.7	99.6	16.525	94.5	97.6
8.675	95.2	97.1	9.55	94.9	99.1	10.425	96.6	98.5	11.3	96.3	99.7	12.175	97.6	99.9	13.05	95.0	99.8	13.925	95.2	99.6	14.8	96.0	99.1	15.675	97.1	99.7	16.55	95.3	98.2
8.7	95.1	97.0	9.575	94.9	99.0	10.45	95.9	97.9	11.325	96.4	99.7	12.2	97.4	99.9	13.075	94.8	99.8	13.95	95.5	99.7	14.825	94.6	99.2	15.7	97.4	99.6	16.575	97.5	98.7
8.725	95.2	96.9	9.6	95.3	98.9	10.475	96.7	97.9	11.35	96.4	99.7	12.225	97.7	99.9	13.1	94.6	99.8	13.975	95.8	99.6	14.85	94.4	99.1	15.725	96.4	99.6	16.6	97.7	99.4
8.75	95.5	97.0	9.625	96.1	99.0	10.5	98.2	98.1	11.375	96.7	99.8	12.25	97.6	99.9	13.125	94.8	99.8	14	95.7	99.6	14.875	93.8	99.1	15.75	96.5	99.5	16.625	97.9	99.5
8.775	95.7	97.2	9.65	96.3	99.0	10.525	98.4	98.2	11.4	96.8	99.8	12.275	97.5	99.9	13.15	94.3	99.8	14.025	95.8	99.6	14.9	94.6	98.9	15.775	97.2	99.7	16.65	98.1	99.5
8.8	95.6	97.4	9.675	96.3	98.9	10.55	98.4	98.2	11.425	97.3	99.8	12.3	97.4	99.9	13.175	95.1	99.7	14.05	95.4	99.6	14.925	96.1	98.9	15.8	97.1	99.6	16.675	98.0	99.5
8.825	95.5	97.5	9.7	96.5	98.8	10.575	98.3	98.3	11.45	97.7	99.7	12.325	97.4	99.9	13.2	95.0	99.7	14.075	95.5	99.7	14.95	96.5	99.0	15.825	97.4	99.6	16.7	98.0	99.5
8.85	95.4	97.6	9.725	97.2	98.7	10.6	98.4	98.4	11.475	97.7	99.7	12.35	97.5	99.9	13.225	94.2	99.7	14.1	96.0	99.8	14.975	96.2	99.2	15.85	97.9	99.6	16.725	97.8	99.4
8.875	95.4	97.7	9.75	97.7	98.7	10.625	98.9	98.4	11.5	97.7	99.6	12.375	97.5	99.9	13.25	94.0	99.6	14.125	95.6	99.7	15	97.1	99.3	15.875	98.4	99.6	16.75	97.4	99.3
8.9	95.4	97.8	9.775	97.8	98.7	10.65	98.7	98.8	11.525	97.4	99.6	12.4	97.6	99.9	13.275	93.7	99.6	14.15	95.7	99.7	15.025	97.5	99.6	15.9	98.3	99.5	16.775	97.5	99.0
8.925	95.4	97.9	9.8	97.9	98.9	10.675	98.7	99.1	11.55	97.2	99.6	12.425	97.6	99.9	13.3	94.7	99.6	14.175	96.5	99.6	15.05	97.9	99.5	15.925	98.5	99.5	16.8	95.2	98.8
8.95	95.4	98.0	9.825	97.9	99.1	10.7	98.5	99.4	11.575	96.9	99.6	12.45	97.5	99.9	13.325	95.0	99.7	14.2	95.7	99.6	15.075	98.3	99.5	15.95	98.4	99.4	16.825	94.3	97.1
8.975	95.3	98.0	9.85	97.8	99.2	10.725	98.1	99.4	11.6	96.6	99.6	12.475	97.2	99.9	13.35	94.5	99.8	14.225	95.8	99.6	15.1	98.6	99.7	15.975	98.8	99.4	16.85	95.6	97.3
9	95.0	98.1	9.875	98.0	99.2	10.75	98.5	99.4	11.625	96.3	99.6	12.5	97.2	99.9	13.375	95.2	99.8	14.25	96.2	99.6	15.125	98.4	99.7	16	98.8	99.1	16.875	96.3	97.2
9.025	94.9	98.3	9.9	98.0	99.3	10.775	98.4	99.4	11.65	96.0	99.6	12.525	96.9	99.9	13.4	95.2	99.8	14.275	96.2	99.6	15.15	98.0	99.7	16.025	98.9	99.2	16.9	96.8	97.4
9.05	95.1	98.4	9.925	97.7	99.4	10.8	98.4	99.5	11.675	95.5	99.7	12.55	96.5	99.9	13.425	95.4	99.8	14.3	96.8	99.5	15.175	98.0	99.7	16.05	99.0	99.2	16.925	96.9	97.6
9.075	95.1	98.6	9.95	97.9	99.4	10.825	98.6	99.5	11.7	95.7	99.7	12.575	96.5	99.9	13.45	96.1	99.8	14.325	96.3	99.3	15.2	99.0	99.7	16.075	99.0	99.0	16.95	96.9	97.8
9.1	94.8	98.8	9.975	97.7	99.4	10.85	98.4	99.6	11.725	95.2	99.7	12.6	96.6	99.9	13.475	96.1	99.8	14.35	96.8	99.4	15.225	98.8	99.6	16.1	99.1	99.3	16.975	97.4	97.7
9.125	94.4	98.8	10	97.5	99.5	10.875	98.7	99.5	11.75	95.2	99.8	12.625	96.7	99.8	13.5	95.9	99.8	14.375	95.9	99.3	15.25	98.7	99.5	16.125	99.0	99.5	17	96.7	97.6
9.15	94.3	98.8	10.025	97.8	99.5	10.9	99.0	99.3	11.775	95.2	99.8	12.65	96.6	99.9	13.525	95.1	99.8	14.4	96.3	99.3	15.275	98.8	99.5	16.15	98.7	99.6			
9.175	94.3	98.8	10.05	98.0	99.7	10.925	99.1	99.1	11.8	95.9	99.8	12.675	96.3	99.8	13.55	95.0	99.8	14.425	97.3	99.5	15.3	98.3	99.6	16.175	99.1	99.6			
9.2	94.3	98.8	10.075	97.7	99.8	10.95	98.7	99.3	11.825	95.8	99.8	12.7	96.0	99.9	13.575	95.3	99.7	14.45	97.8	99.5	15.325	98.3	99.5	16.2	98.4	99.5			
9.225	94.3	98.8	10.1	97.3	99.8	10.975	98.4	99.2	11.85	95.7	99.8	12.725	95.9	99.9	13.6	94.7	99.6	14.475	97.5	99.3	15.35	98.6	99.4	16.225	98.2	99.6			
9.25	94.4	98.8	10.125	97.2	99.8	11	98.7	99.3	11.875	95.8	99.8	12.75	95.9	99.9	13.625	94.8	99.7	14.5	97.7	99.3	15.375	98.6	99.3	16.25	98.0	99.6			
9.275	94.5	99.0	10.15	96.8	99.8	11.025	98.9	99.2	11.9	96.1	99.7	12.775	95.8	99.9	13.65	94.9	99.7	14.525	96.7	99.4	15.4	98.5	99.3	16.275	97.0	99.5			
9.3	94.5	99.0	10.175	96.4	99.8	11.05	98.9	99.3	11.925	96.0	99.7	12.8	95.2	99.9	13.675	94.4	99.8	14.55	97.1	99.5	15.425	97.6	99.3	16.3	96.1	99.6			
9.325	94.8	99.0	10.2	96.7	99.8	11.075	98.9	99.5	11.95	96.7	99.7	12.825	94.5	99.9	13.7	95.0	99.8	14.575	96.7	99.5	15.45	96.4	99.4	16.325	94.1	99.0			
9.35	95.1	99.1	10.225	97.2	99.8	11.1	98.7	99.5	11.975	97.1	99.6	12.85	94.1	99.9	13.725	95.0	99.8	14.6	97.6	99.6	15.475	96.6	99.3	16.35	94.1	98.7			

Apron C and Apron W in range 17-18 GHz

- Relative long cables in the measurement setup together with the path loss and effective shielding make the signal very weak in the high end 17-18 GHz
- Measurement result looks very noisy even with averaging of the data
- We don’t have an amplifier suitable for this frequency range
- Most likely the attenuation is stable also in these frequencies; the weakness of the signal builds up error
- Therefore the result is shown only over 0.6 – 17 GHz range

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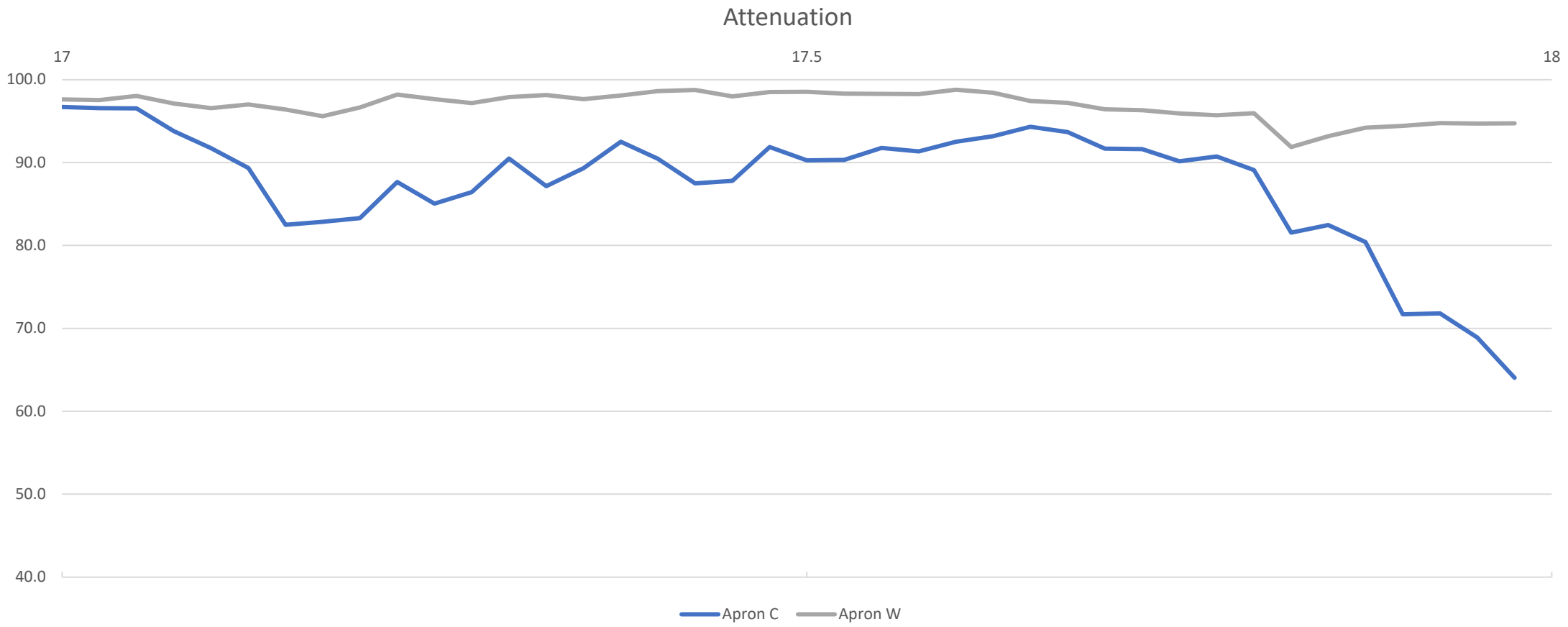
Apron C and Apron W in range 17-18 GHz



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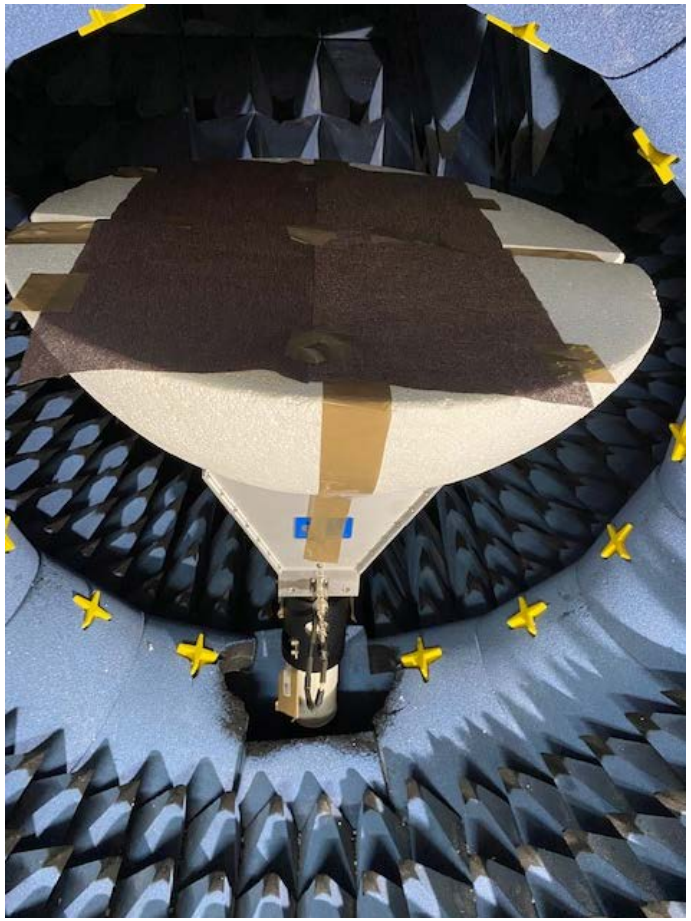
Apron C

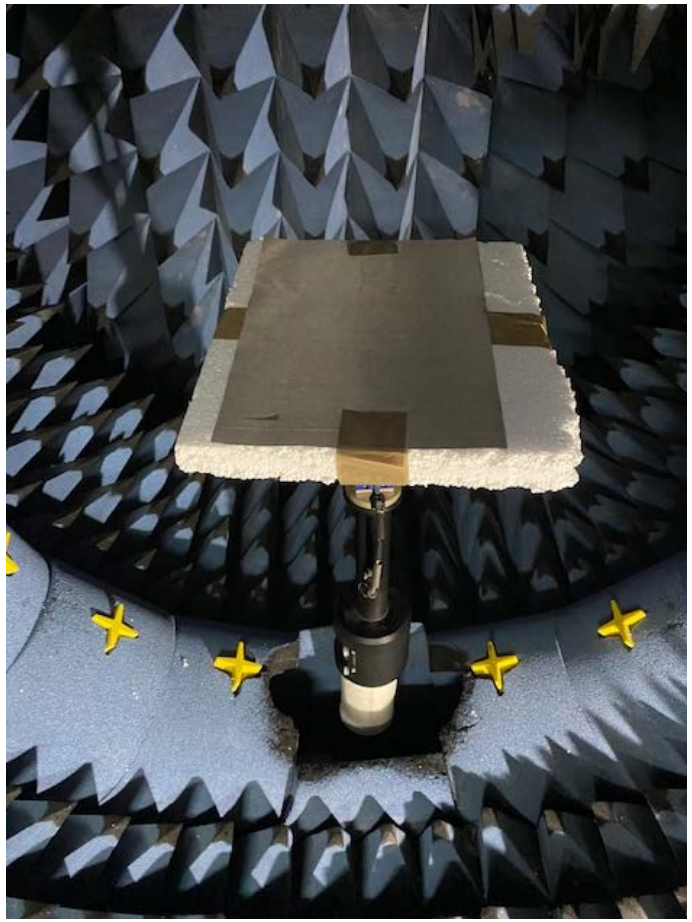
- Relatively weak attenuation in low frequencies raises question if measurement result has an error?
- Totally different setup with Apron C provides the same result as shown in the radiation patterns
- The peak gain of horn antenna in zenith at 650 MHz drops about 4.4 dB. This equals to 64 % attenuation
- If some conflict between results in different setups are found the result of radiation pattern difference is selected

2nd Setup

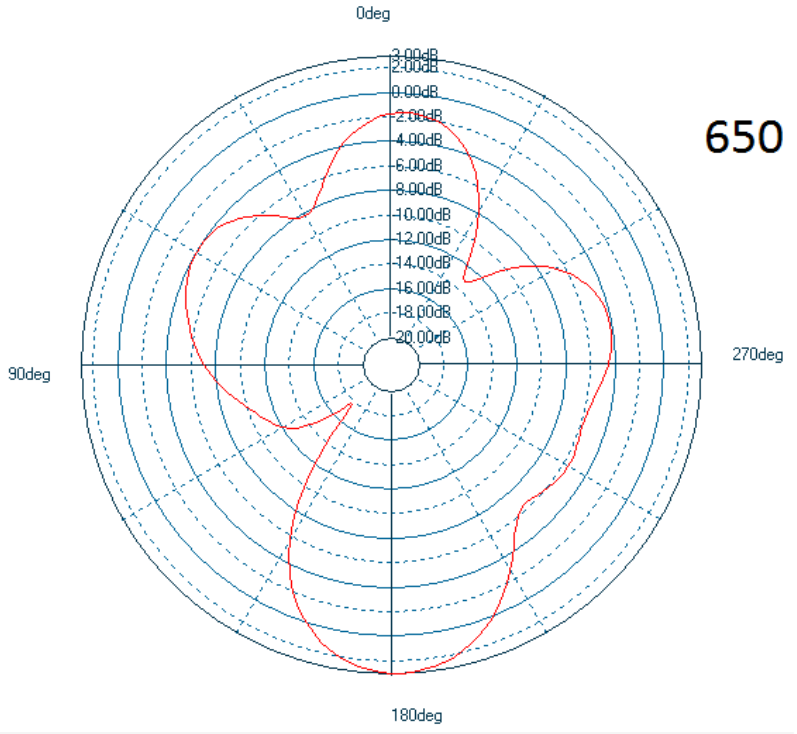
0.6-8 GHz Horn antenna points to the zenith. A polystyrene support holds the material under test on the top of horn antenna. A measurement without shielding material provides 0 level. The difference of measurements without and with shielding material provides information about attenuation. Alternative is a 2-18 GHz horn antenna having smaller polystyrene support for shielding material.

2nd Setup

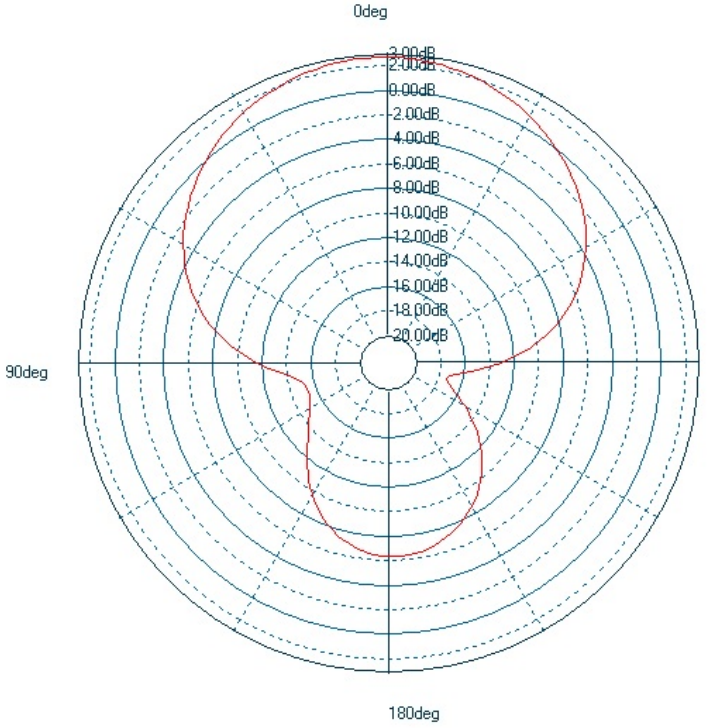




Apron C



650 MHz

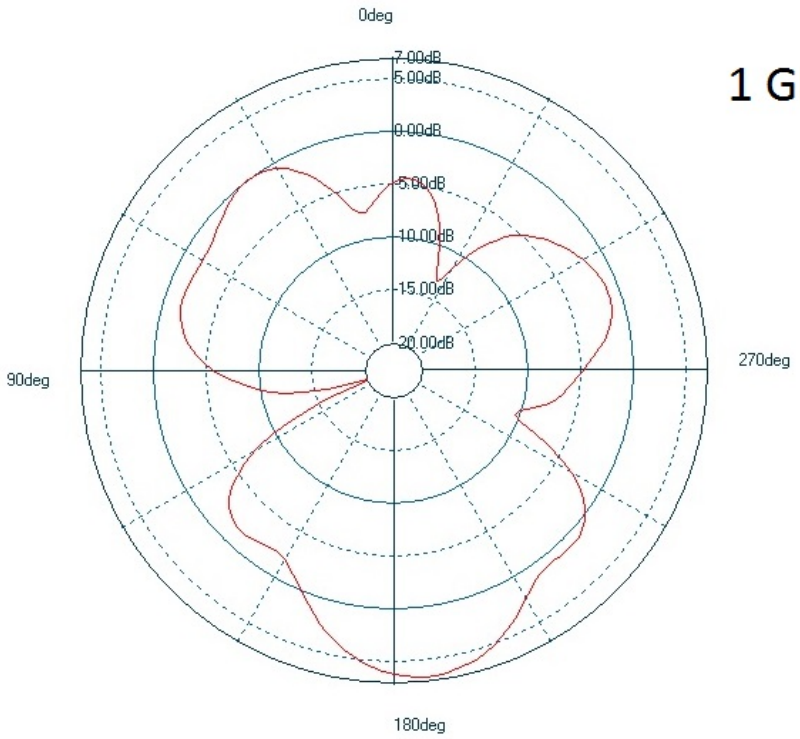


Signal towards Zenith drops about 4.4 dB at 650 MHz when Apron C is located on top of the 0.6-8 GHz horn

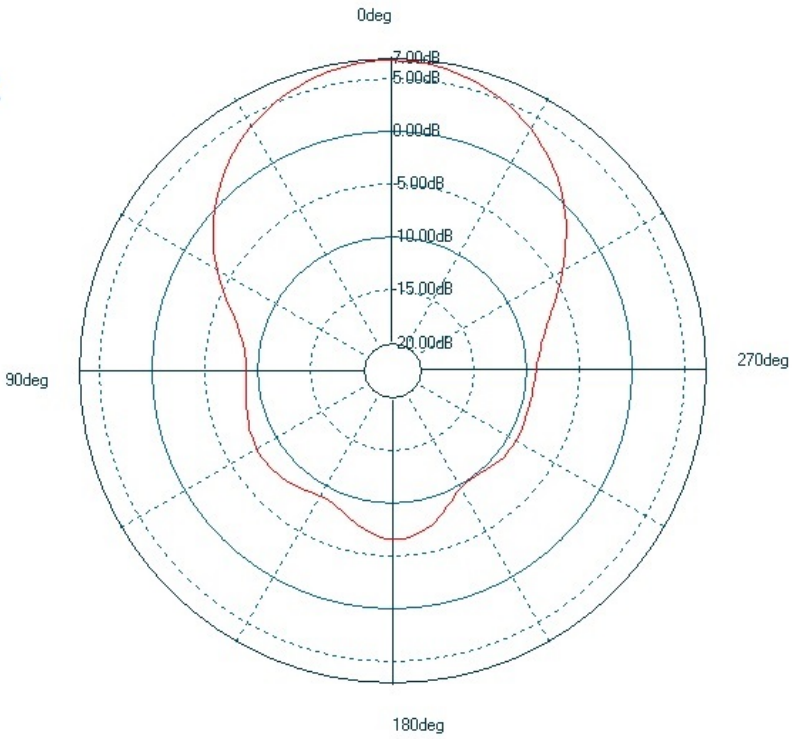
Horn antenna Elevation pattern Phi=0 with Apron C sheet over it

Horn antenna Elevation pattern Phi=0

Apron C



1 GHz

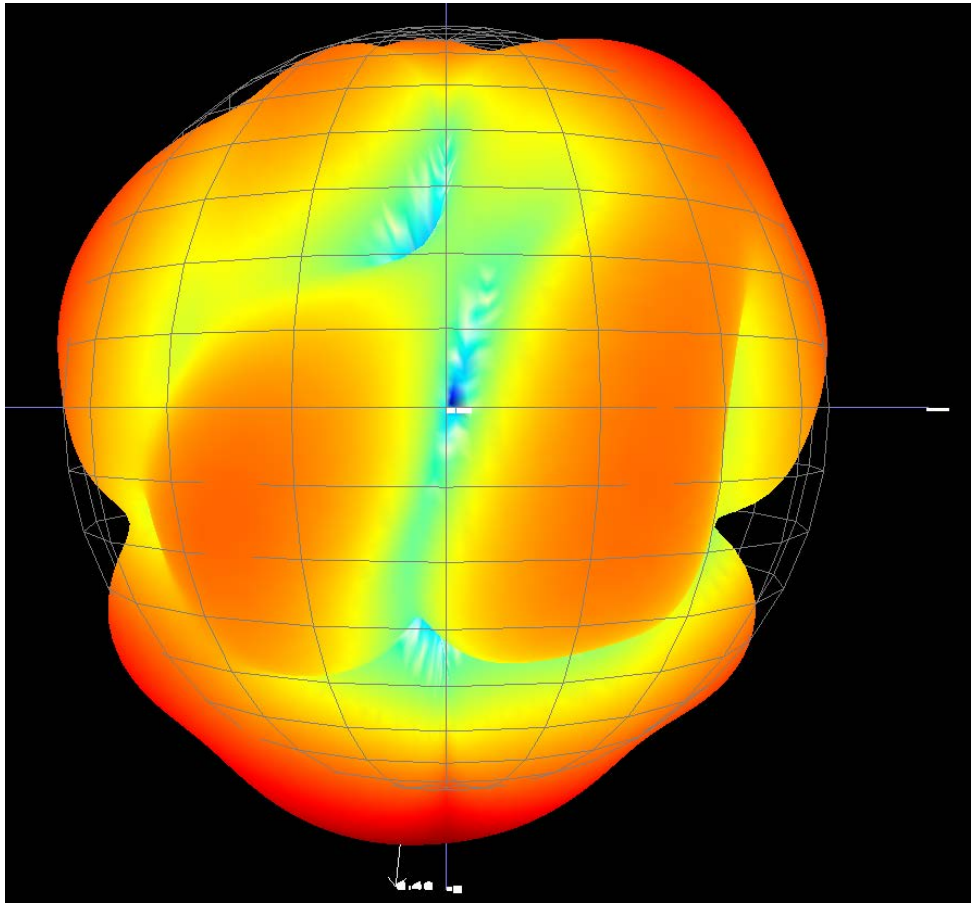


Horn antenna Elevation pattern Phi=0 with Apron C sheet over it

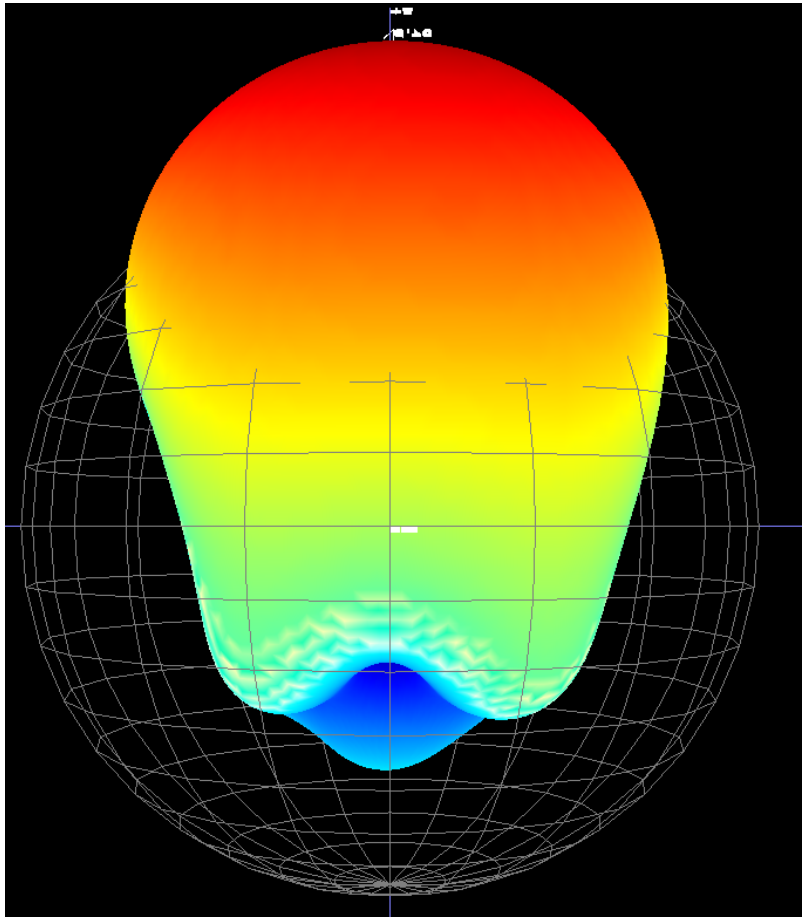
Horn antenna Elevation pattern Phi=0

Signal towards Zenith drops about 11 dB at 1 GHz when Apron C is located on top of the 0.6-8 GHz horn

3D Pattern of 0.6-8 GHz Horn at 1 GHz



Reference -5dBi



Reference 0 dBi

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Conclusions

- The overall tendency of both Apron C and Apron W is to provide increased attenuation when frequency increases
- Apron W provides higher attenuation basically at the whole 0.6 – 17 GHz range
- The results of both, Apron C and Apron W show that there is 65% - 90% attenuation in the range 600-900MHz
- The results of both , Apron c and Apron W show that there is over 90% attenuation in the range of 900MHz - 17GHz.
- this measurement cover the Low and High 5G frequencies and part of the Very High 5G frequencies.