Size of devices to be measured at 3m

Andy Griffin, Cisco Systems, Jan 2014, Rev 2

Problem statement

3m measurements	Standards define the size of EUT that can be measured at 3m differently. Hence a common approach is required to give consistency across EMC standards.

CISPR 16 Issues

NSA	The NSA requirements for chambers does not adequately assess the impact of large equipment, the transmit and receive antennas are aligned and hence a chamber could satisfy the requirements but ‘miss’ deviations. In addition, very wide equipment could be measured at 3m, which was never the intended.
Antenna width	For horizontal polarizations (based upon limitations) the wide of the validation volume could be increased based upon using larger antennas.
Test Method	At a 3m measurement distance it is claimed that to improve correlation to 10m measurements that antenna should be pointed (or bore-sighted) at the EUT.

CISPR 11 Issues

CISPR 11	CISPR 11 limits the size of the EUT Small 1.2m (w) x 1.5m (h) Medium 3m (w) x 1.8m (h) *with a 2dB tightening of the limits* Medium is defined in CIS/B/601/CD
Rationale	These are loosely based on the 3dB beamwidth of the Log Periodic (LPDA) antenna at 1GHz and the limitation of not bore-sighting the rec antenna.
Comments	Based upon the frequency, emissions are not cable related (because they are not very effective at these frequencies). Hence for most products it will be a spot frequency source. Based upon this, the size of the EUT should not include cables.

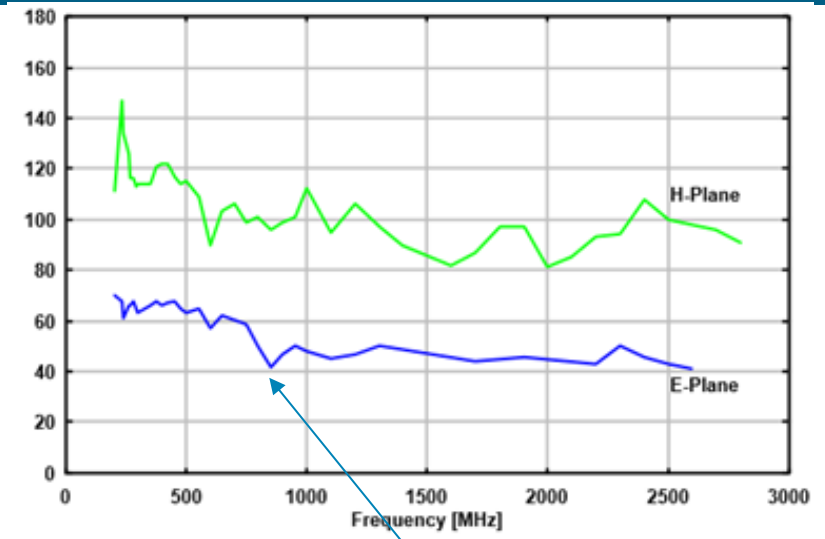
CISPR 32 Issues

CISPR 32	CISPR 32 defines the width of the EUT that can be measured @3m to be based upon NSA verification.
NSA	The problem with NSA requirements under CISPR 16, this width could be up to 6m. Whilst 6m is the largest, in reality 2m to 3m is typical.

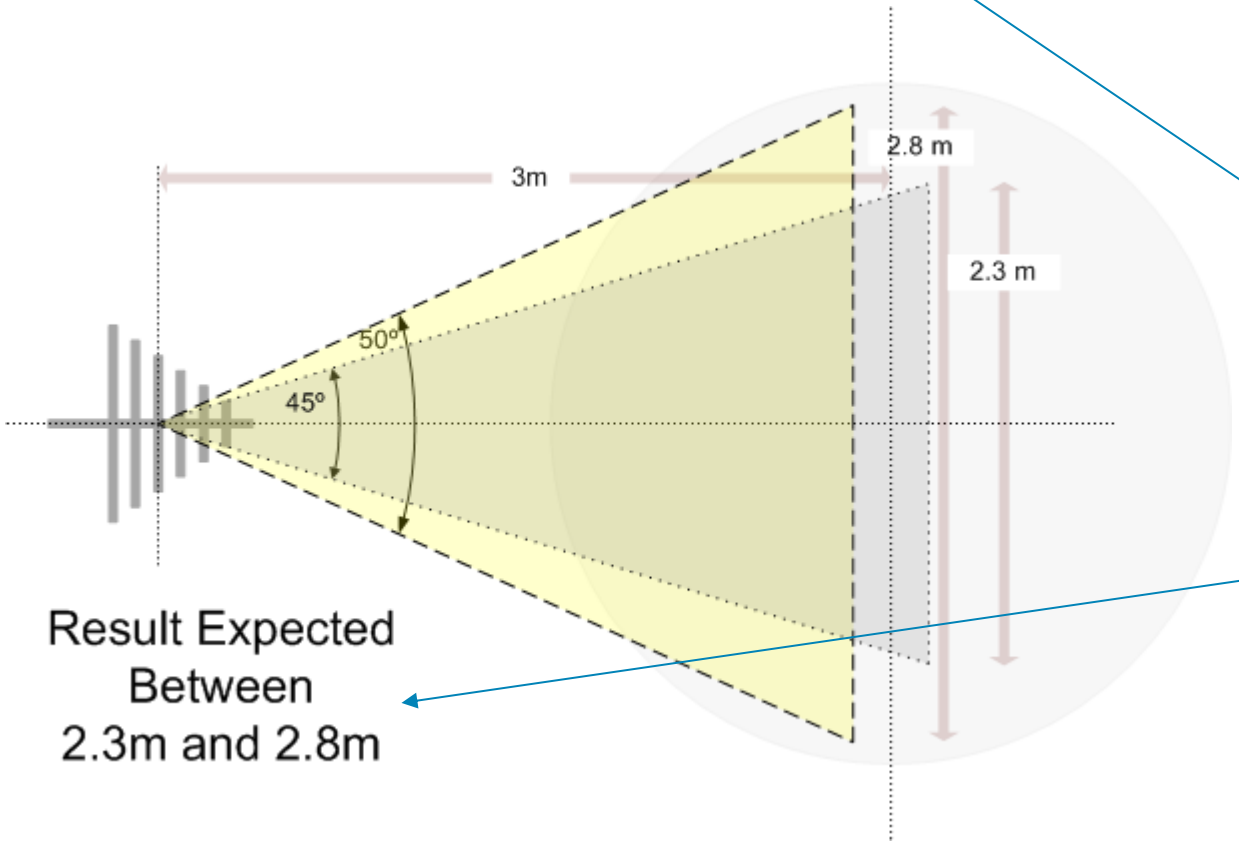
Antenna beamwidth

CISPR16-1-4, 60 degs @ 1GHz

Frequency GHz	LPDA or LPDA-V [a]			
	$\theta_{3\ dB}$ °	d = 1 m	d = 3 m	d = 10 m
		w m	w m	w m
1,00	60	1,15	3,46	11,55



w/c @800MHz
42 degs (2.3m)
Manufacturer Data

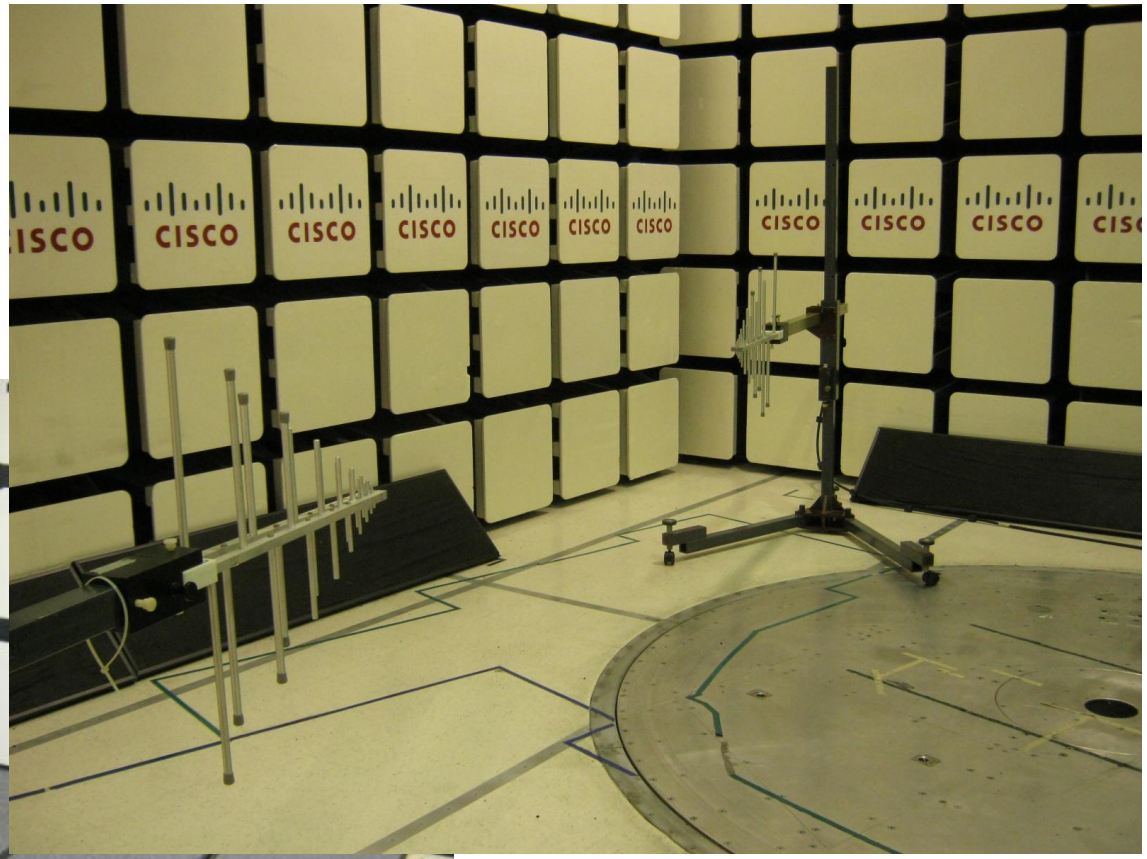


Result Expected
Between
2.3m and 2.8m

beamwidth defined in CISPR16, this could be wider

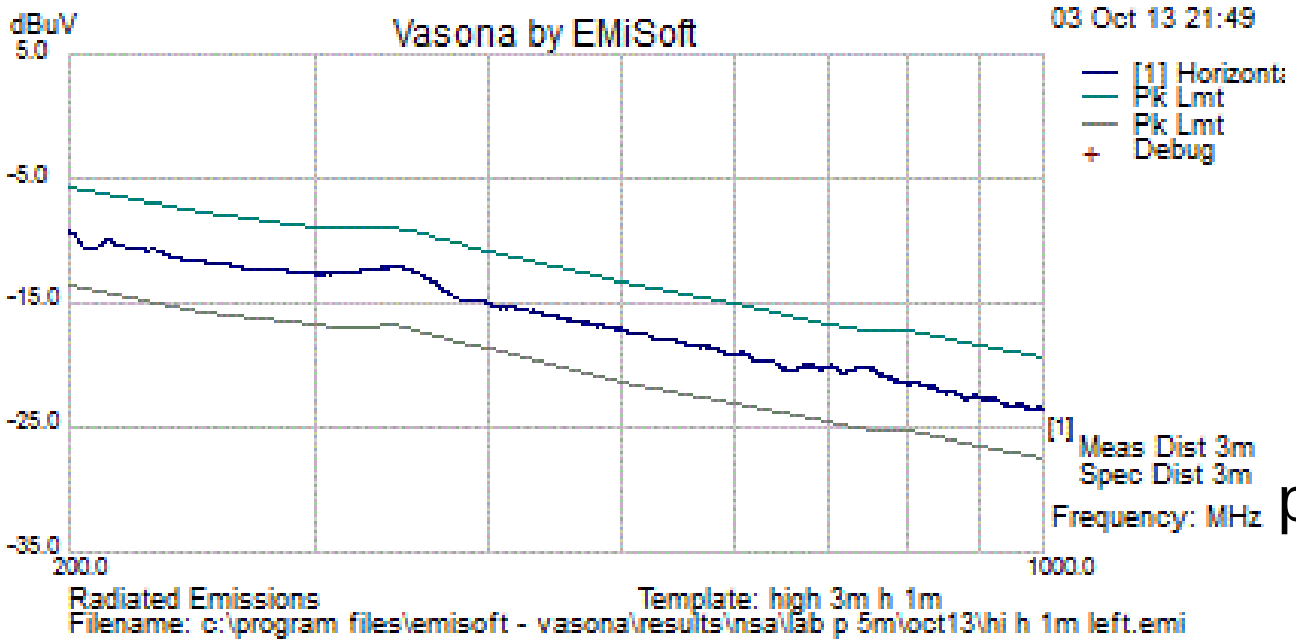
5m Semi Anechoic Chamber

Storage of RI tiles
In the corner



Typical NSA Setup

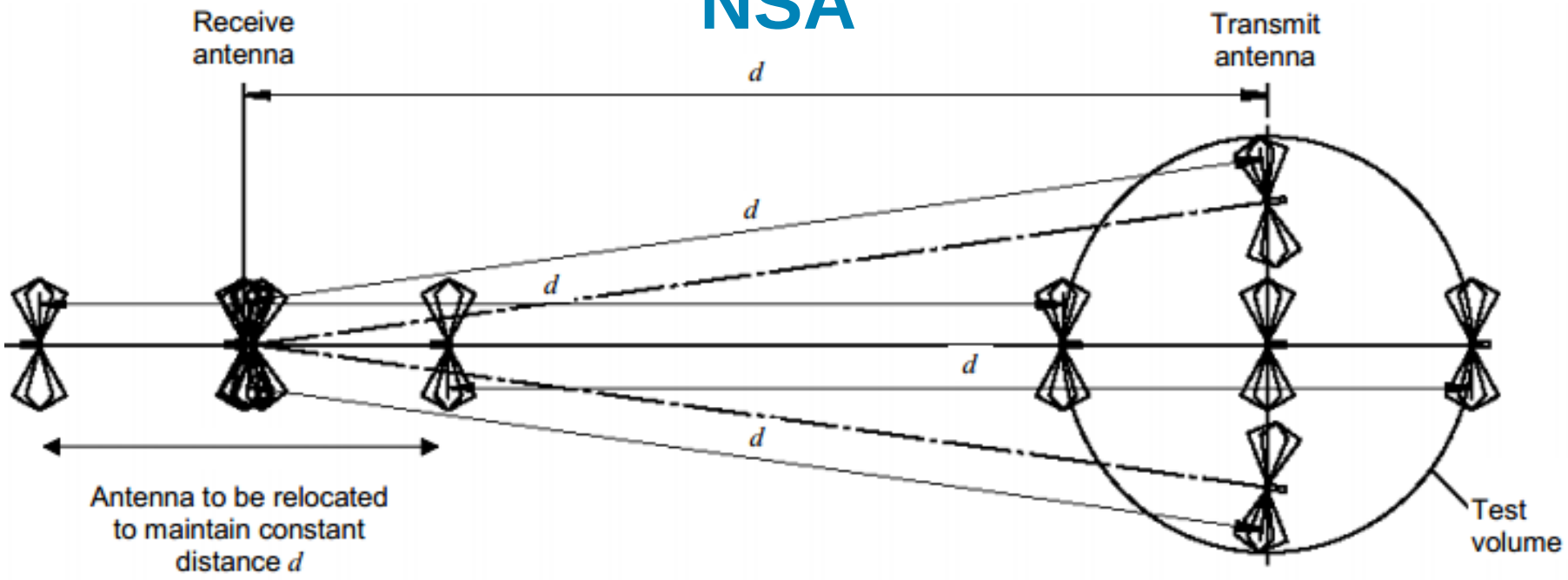
Equipment /Chamber



Typical NSA performance above 200 MHz

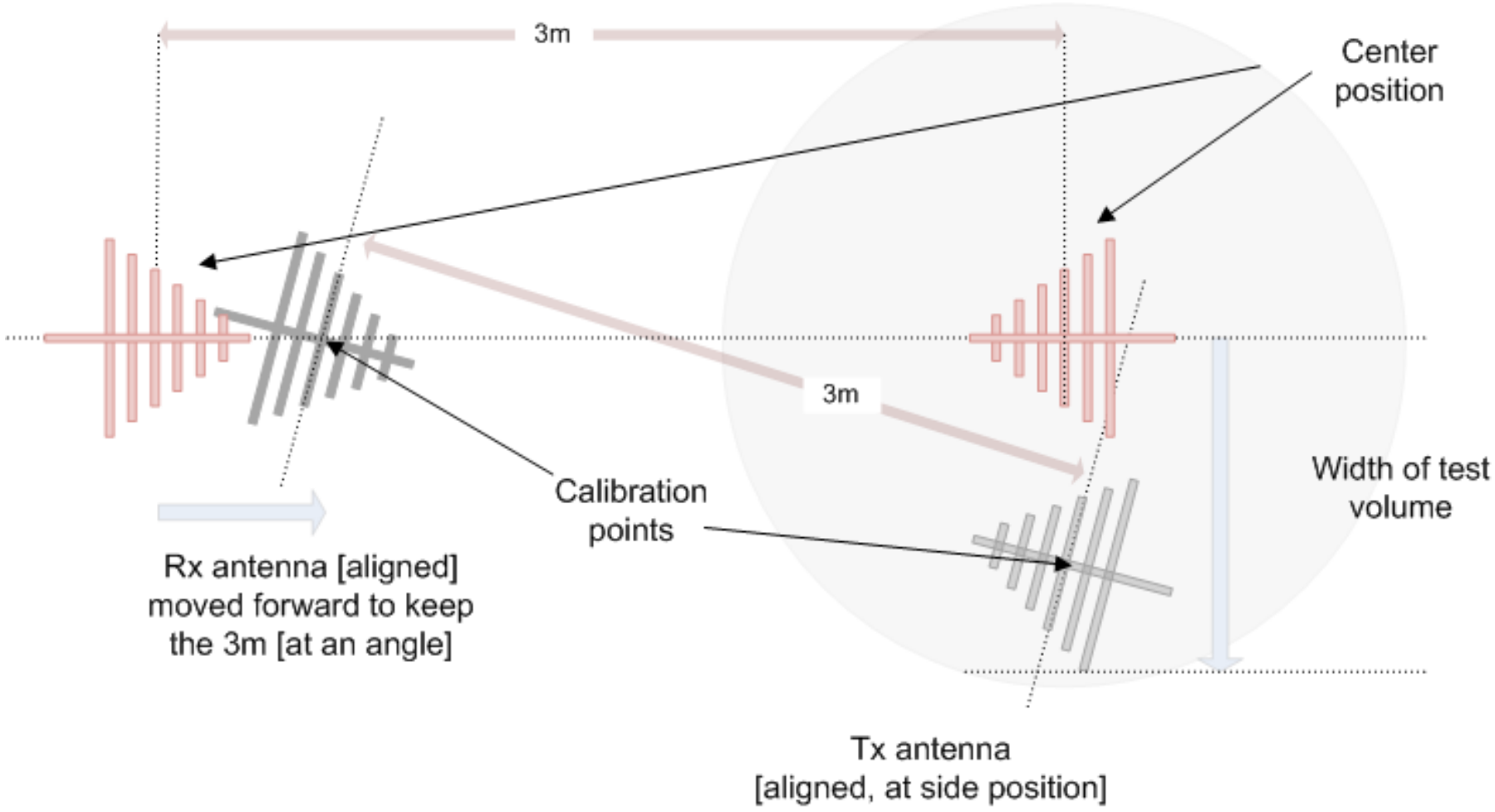
Details	Chamber: 3m/5m, Built : 1999, Size: 23ft x35ft x 21ft Absorber (331) over ferrite tile (30000) with YB boards. Cal: Meets NSA, Svswr, RI Uniform Field
NSA Equip	Spectrum Analyser : Rohde & Schwarz : ECSI Antennas: Schwarzbeck (VUSLP 9111) Attenuators : Agilent
EUT Equip	Spectrum Analyser : Rohde & Schwarz : ESU [EUT1] Spectrum Analyser : Agilent : MXE [EUT2] Antennas: Sunol: JB1

NSA



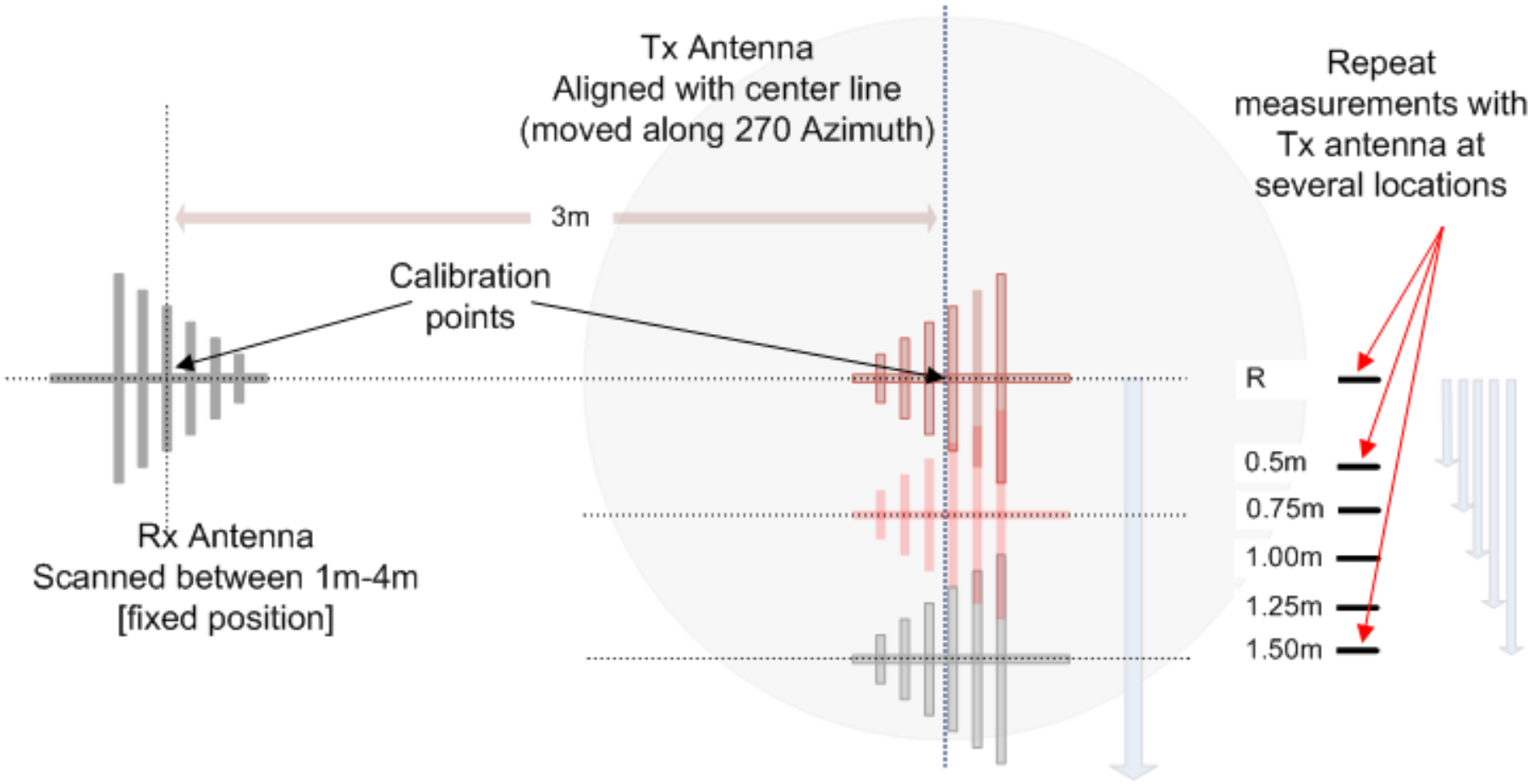
Alignment	It is clear from the wider positions that both the Tx/Rx antennas are aligned. To get an improved verification the alignment of the rx antenna should not be changed. In addition, the actual position of the Rx antenna should not change either because during the test, the antenna is not moved.

NSA, specific example



Example	Example of two different positions (within a SAC)

NSA1, alignment parallel with center line

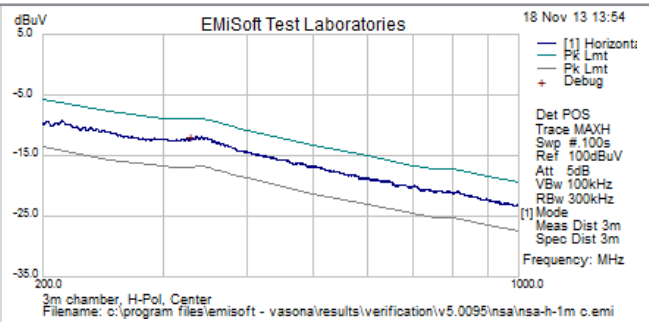


EUT Width	(Dist from R) * 2 + Width of the Antenna For example, (0.5m x 2) + 0.6m = 1.6m

Tx Ant Posn	Along 270 deg azimuth	R+.9m (EUT 2.4m width) meets the 4dB
Tx Align	No	
Meas Dist	3m (at ref) then larger	
Polarity	Horizontal	

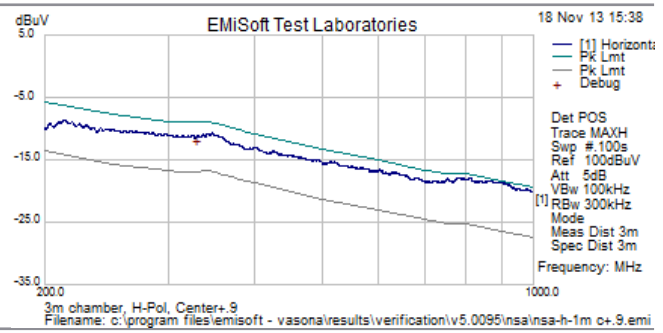
R

EUT Width 0.6m



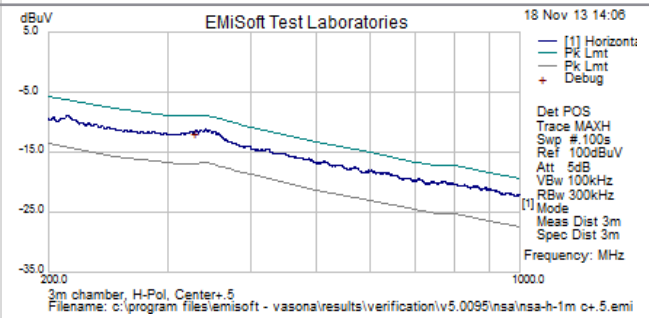
R+.9

EUT Width 2.4m



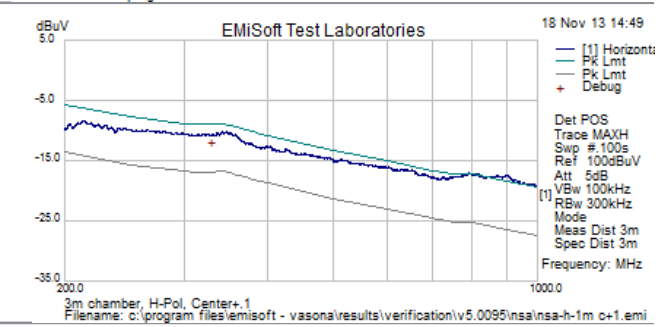
R+.5

EUT Width 1.6m



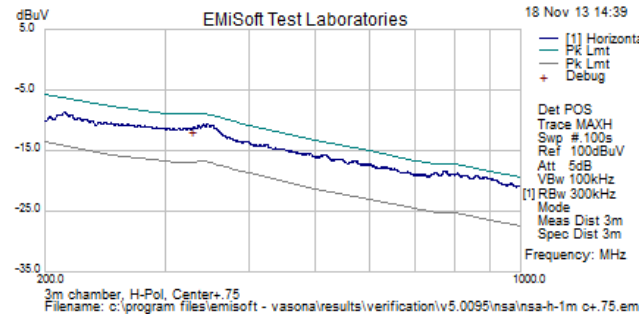
R+1

EUT Width 2.6m



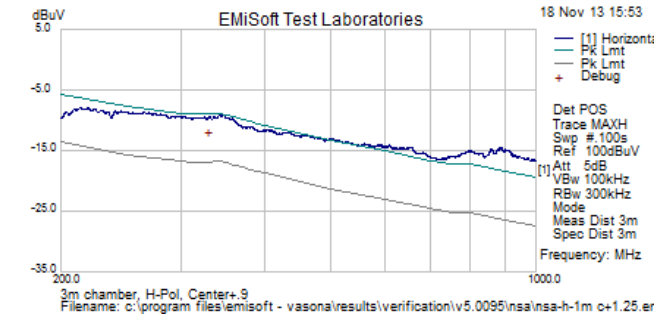
R+.75

EUT Width 2.1m



R+1.25

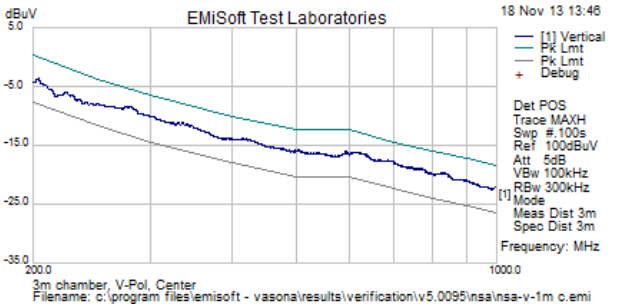
EUT Width 3.1m



Tx Ant Posn **Tx Align** **Meas Dist** **Polarity**	Along 270 deg azimuth No 3m (at ref) then larger Vertical	Weak performance at 200-230MHz caused by small size of Log Periodic. EUT width at 3m is ok !

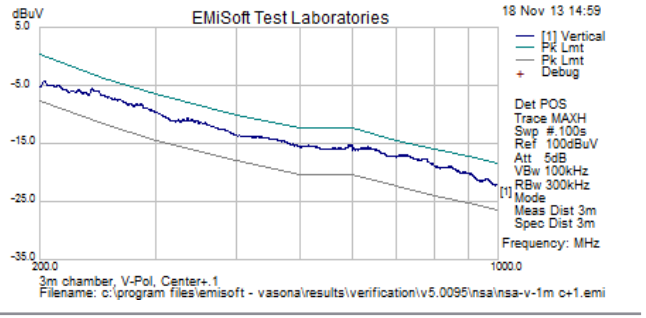
R

EUT Width 0.1m



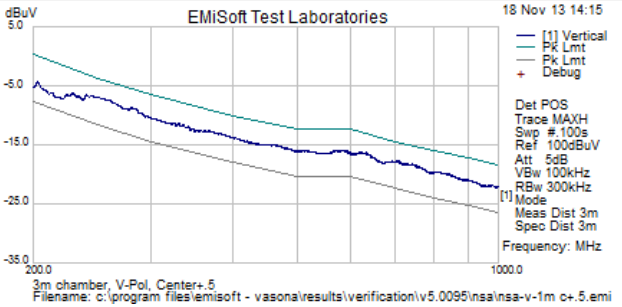
R+1

EUT Width 2.0m



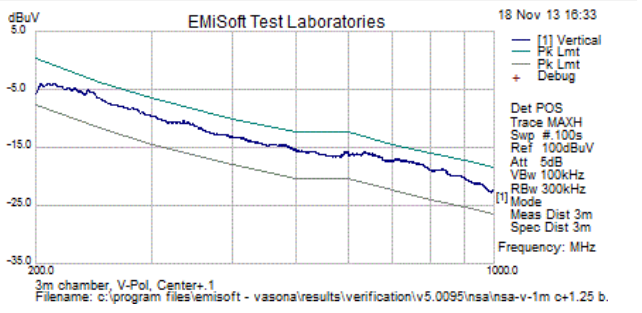
R+.5

EUT Width 1.0m



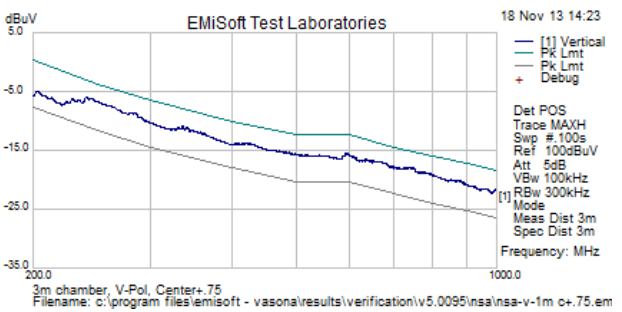
R+1.25

EUT Width 2.5m



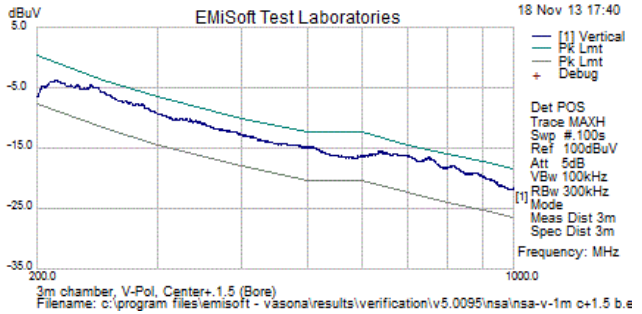
R+.75

EUT Width 1.5m

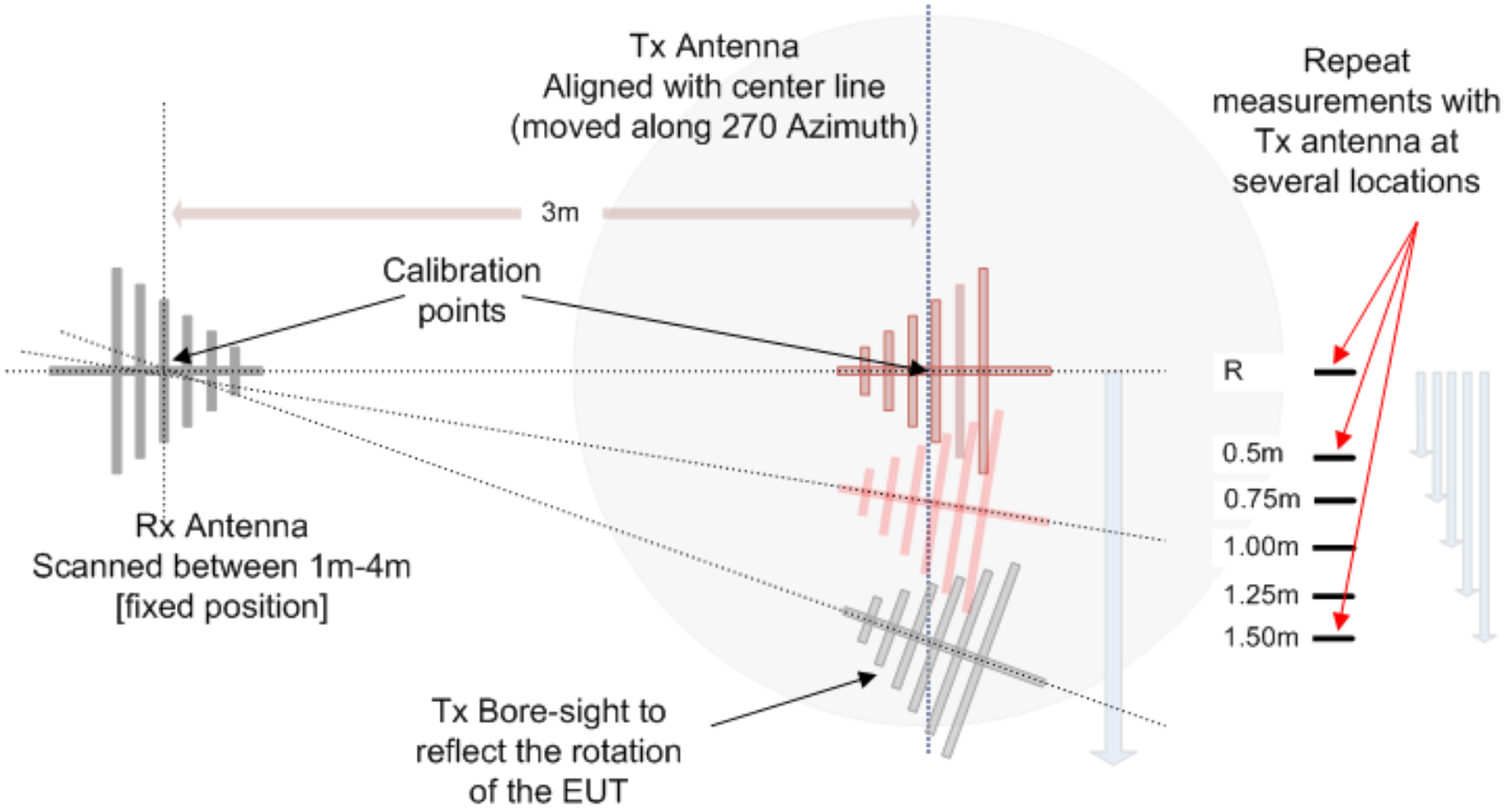


R+1.5

EUT Width 3.0m



NSA2, Bore-sight TX antenna

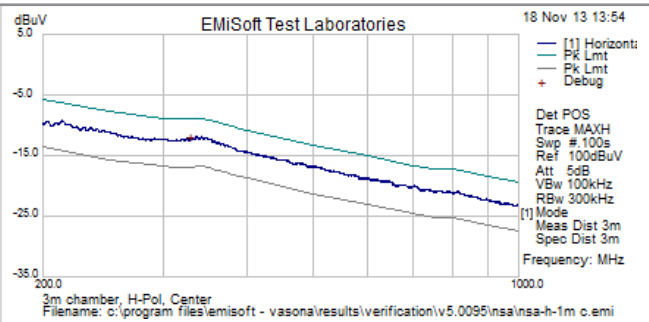


Bore-Sight Tx	During the actual test, the EUT is rotated, hence the Tx antenna should be bore-sighted to better reflect the response of the test volume.

Tx Ant Posn **Tx Align** **Meas Dist** **Polarity**	Along 270 deg azimuth Bore-sight 3m (at ref) then larger Horizontal	R+1.25 m (EUT 3.1m width) meets the 4dB

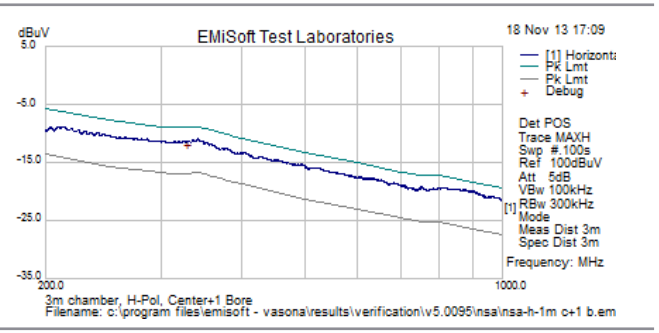
R

EUT Width 0.6m



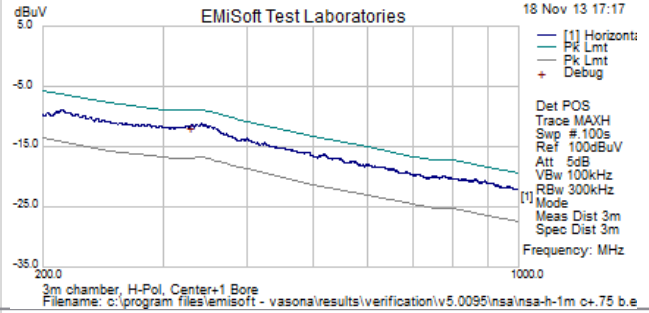
R+1

EUT Width 2.6m



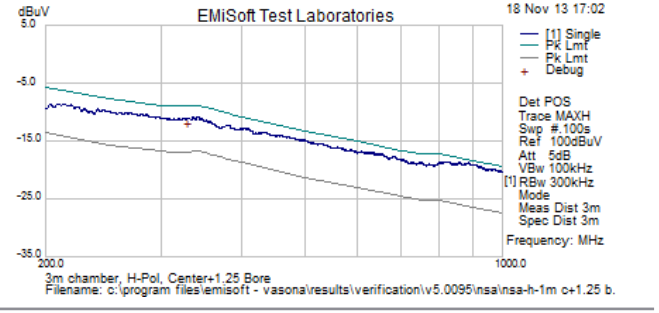
R+.75

EUT Width 2.1m



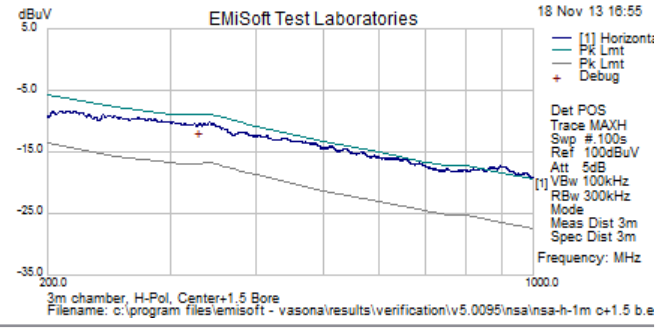
R+1.25

EUT Width 3.1m

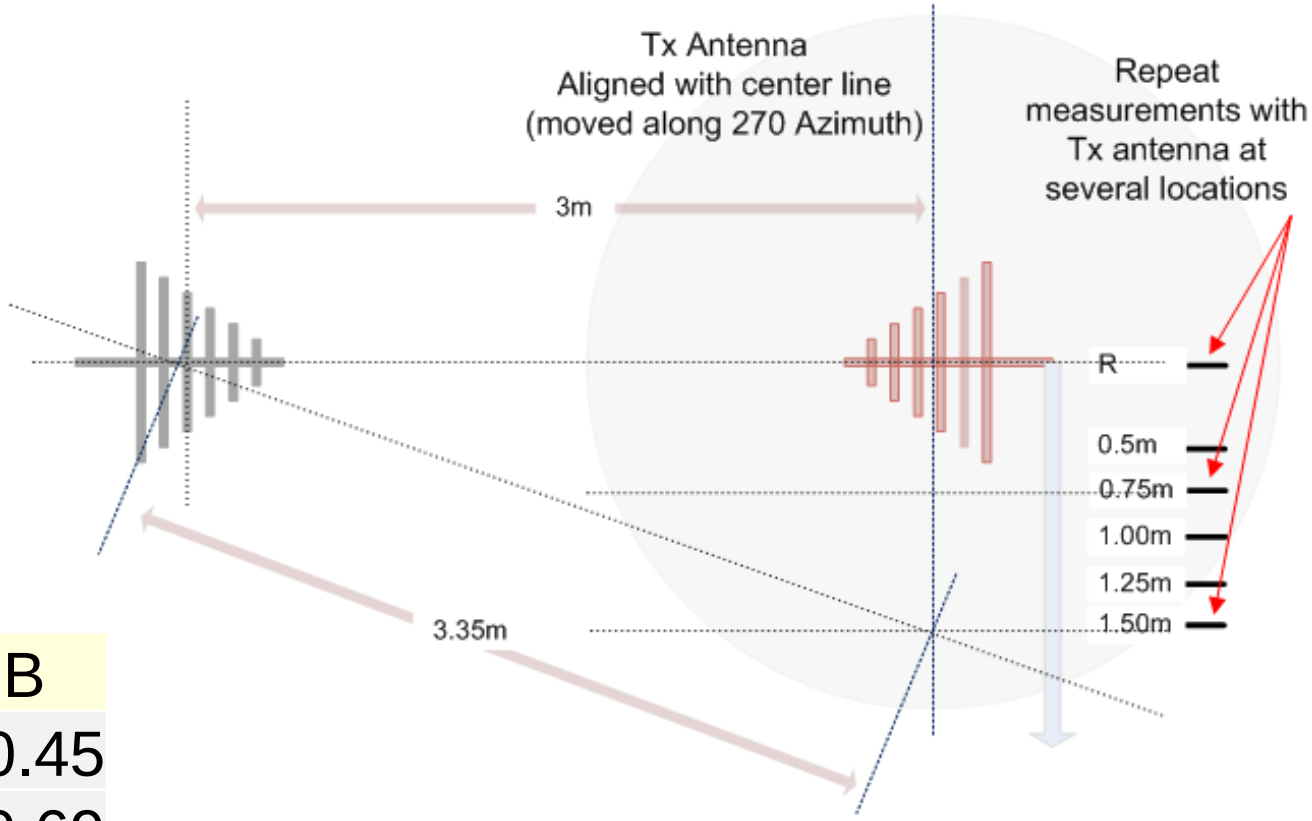


R+1.5

EUT Width 3.6m



NSA3, offset with respect to distance



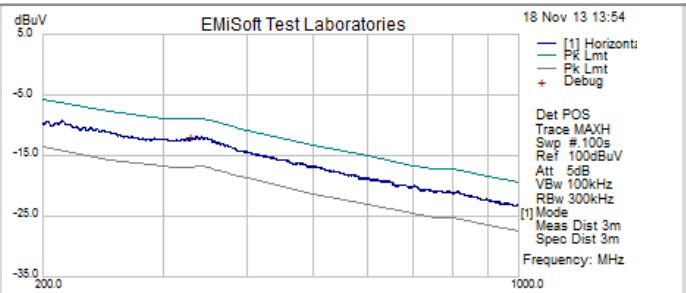
R+X	Actual	dB
1	3.16	0.45
1.25	3.25	0.69
1.5	3.35	0.97

Meas Dist	Error with NSA1 & NSA2, comparing response with 3m limits but the measurement distance is increased. Hence results need offsetting by 20 Log (actual distance / 3)

Tx Ant Posn **Tx Align** **Meas Dist** **Polarity**	Along 270 deg azimuth Bore-sight Corrected to 3m Horizontal	EUT Width of 3.1m passes easily (w/c 2.85dB) EUT Width of 3.6m only just fails (4.07dB, w/c 4.24dB)

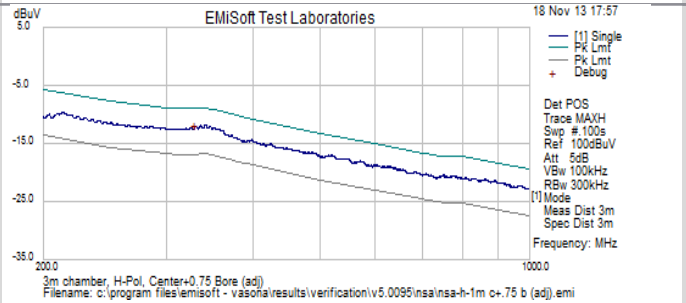
R

EUT Width 0.6m



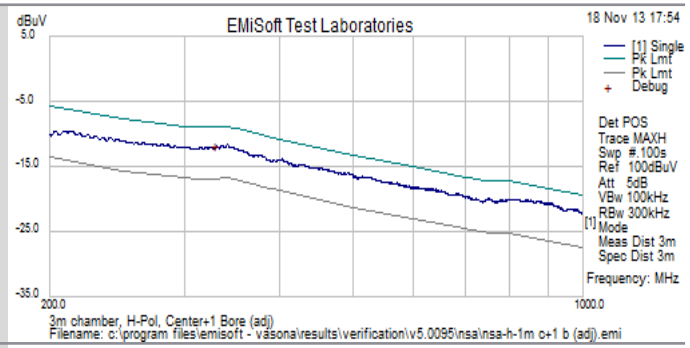
R+.75

EUT Width 1.6m



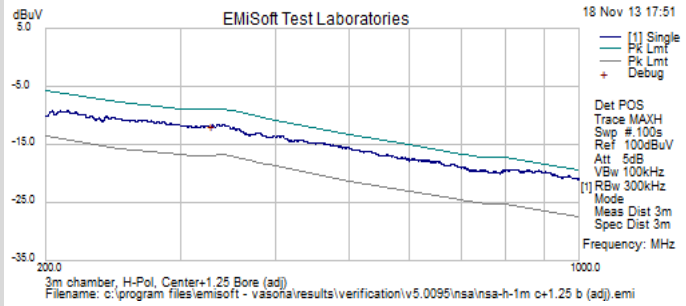
R+1

EUT Width 2.6m



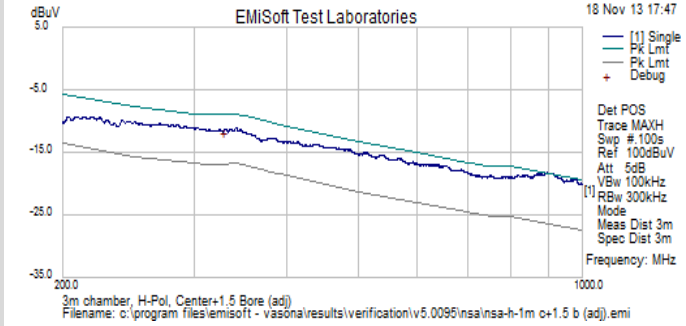
R+1.25

EUT Width 3.1m

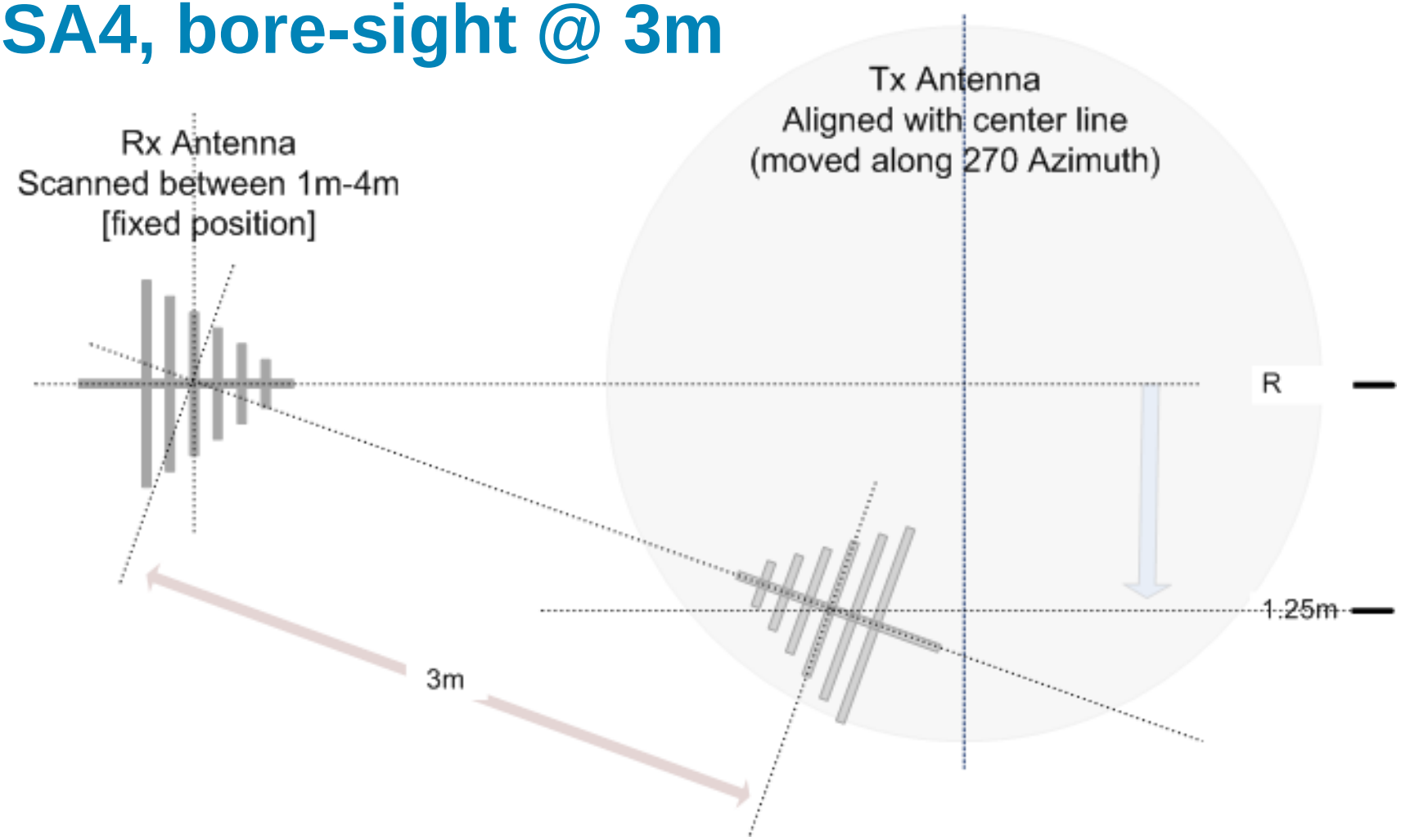


R+1.5

EUT Width 3.6m



NSA4, bore-sight @ 3m

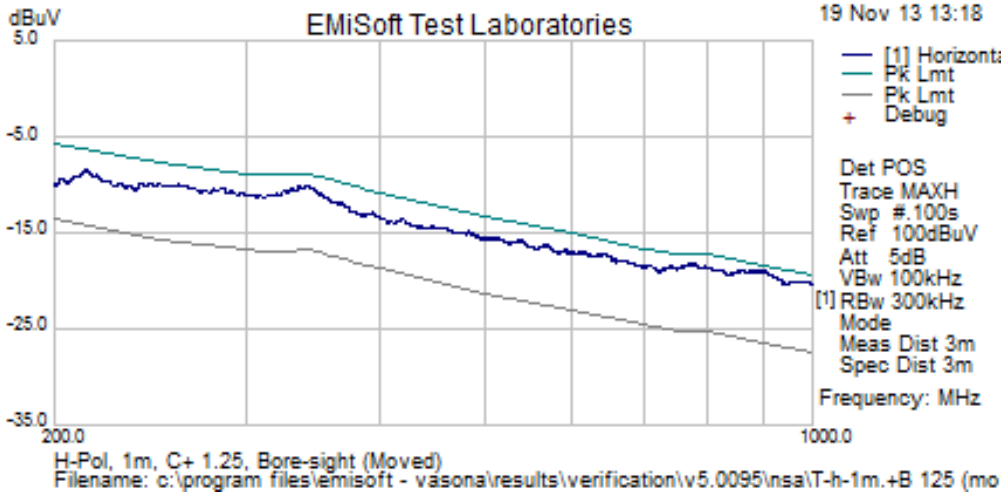


Single Point	In order to verify NSA3, a measurement was repeated at 3m distance with the tx antenna, taking a 1.25m offset from the center line.

Tx Ant Posn **Tx Align** **Meas Dist** **Polarity**	Along 270 deg azimuth Bore-sight 3m Horizontal	Calculated result was 2.9dB, measured was 3.57dB, but it is using a different part of the chamber

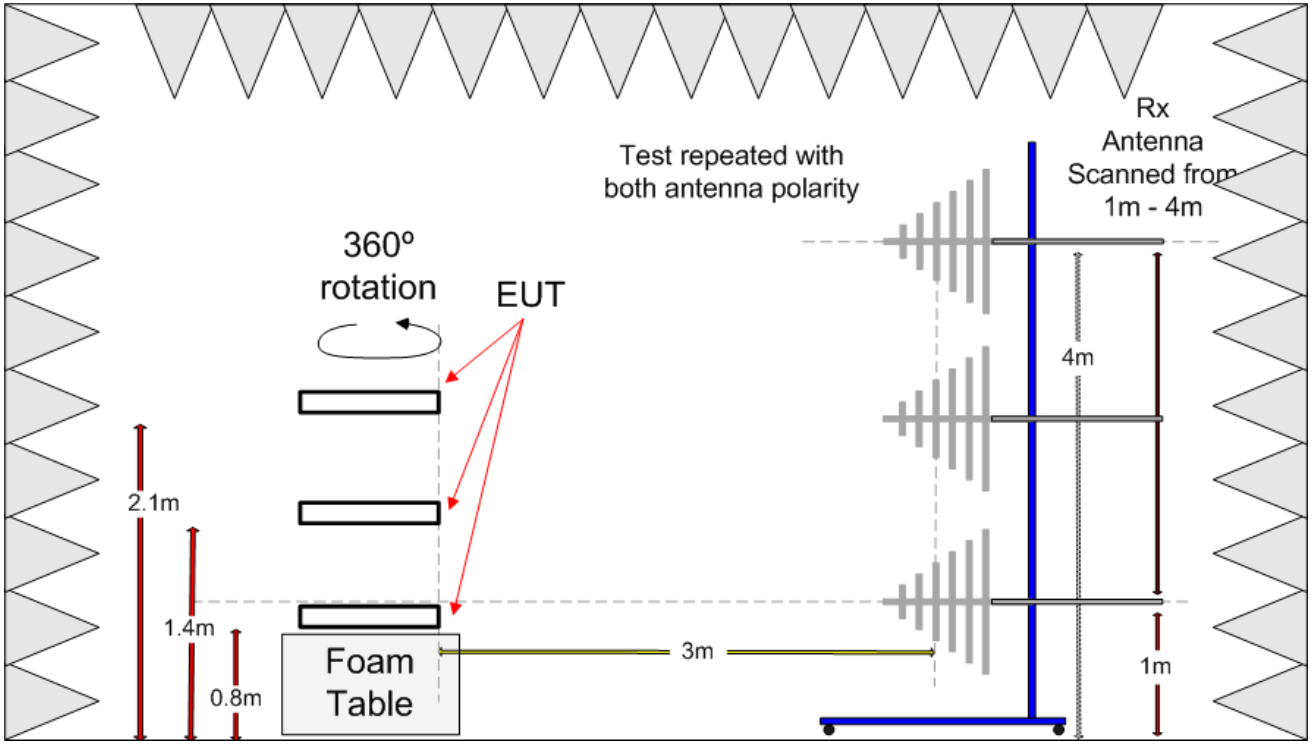
R+1.25

EUT Width 3.1m



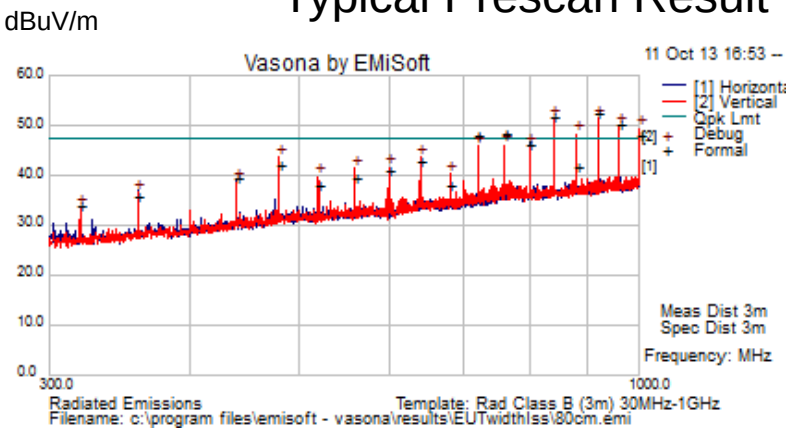
Freq MHz	Vdirect	Af1, Tx	Af2, Rx	VSite	Path Loss	NSA	Margin
902.8	93.61	22.09	22.09	68.39	-18.96	-22.53	-3.57
770	94.15	21.23	21.23	69.98	-18.29	-21.33	-3.04
780	94.08	21.31	21.31	69.71	-18.25	-21.33	-3.08
790	93.97	21.36	21.36	69.84	-18.59	-21.30	-2.71
800	93.93	21.32	21.32	70.00	-18.71	-21.30	-2.59
900	93.63	22.07	22.07	68.61	-19.12	-22.50	-3.38
1000	93.21	23.10	23.10	67.54	-20.53	-23.50	-2.97

EUT Height Test 1

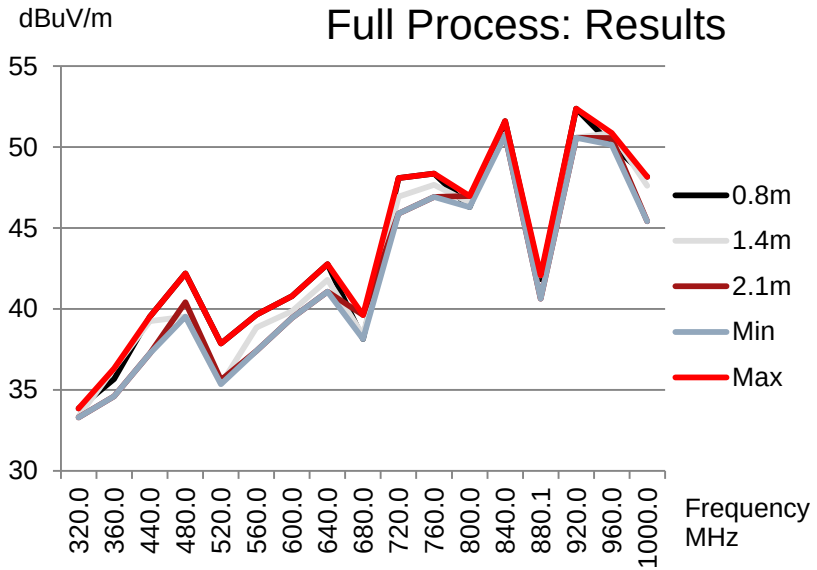


3 Heights	Stable 1U EUT (w/o cover) tested at different heights.
Prescan Process	Maximised analyser scan during full rotation. Results worse case, from antenna heights of 1m, 2m, 3m and 4m
Full Process	Individual emissions measured at worst case polarity, during antenna scan (1m-4m) & turntable rotation (0-360)

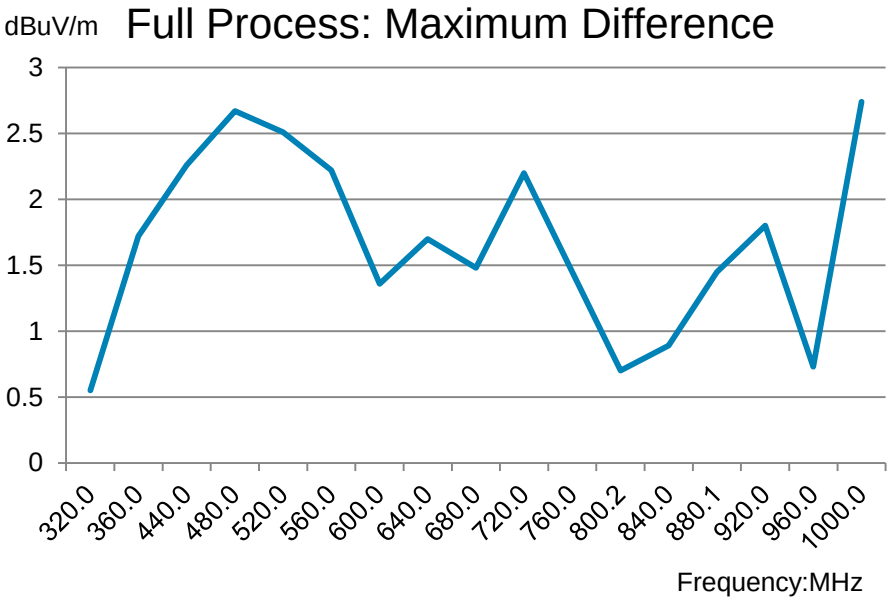
Typical Prescan Result



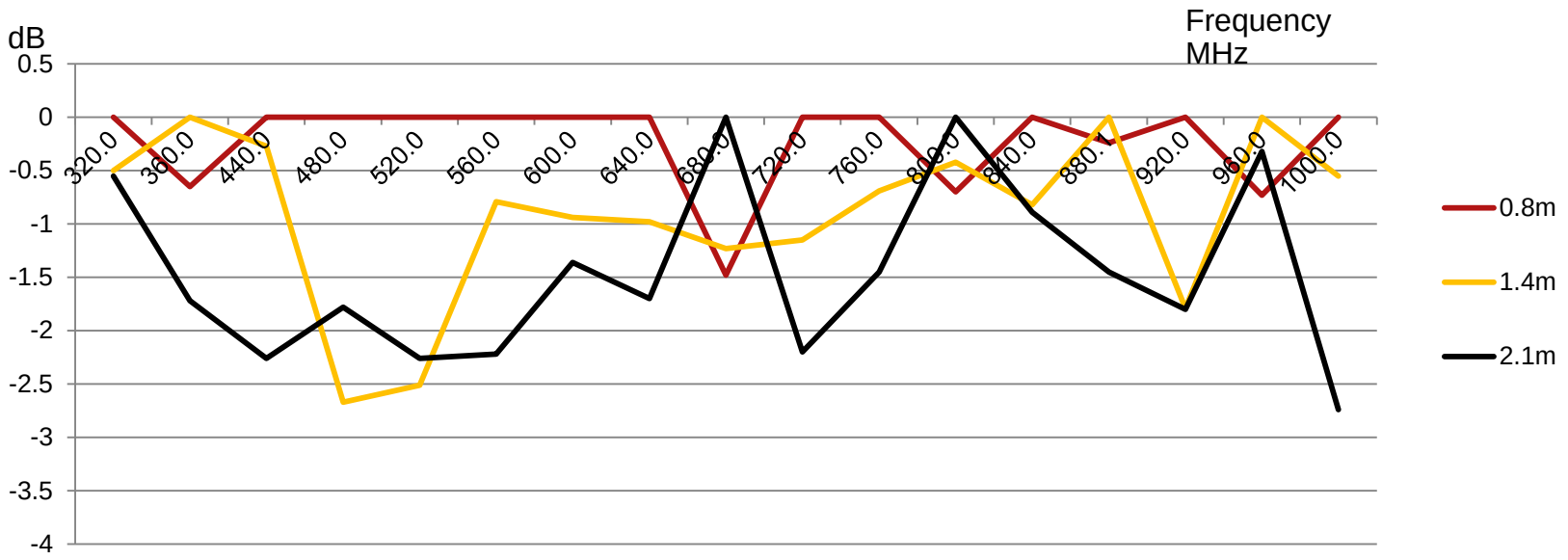
Full Process: Results



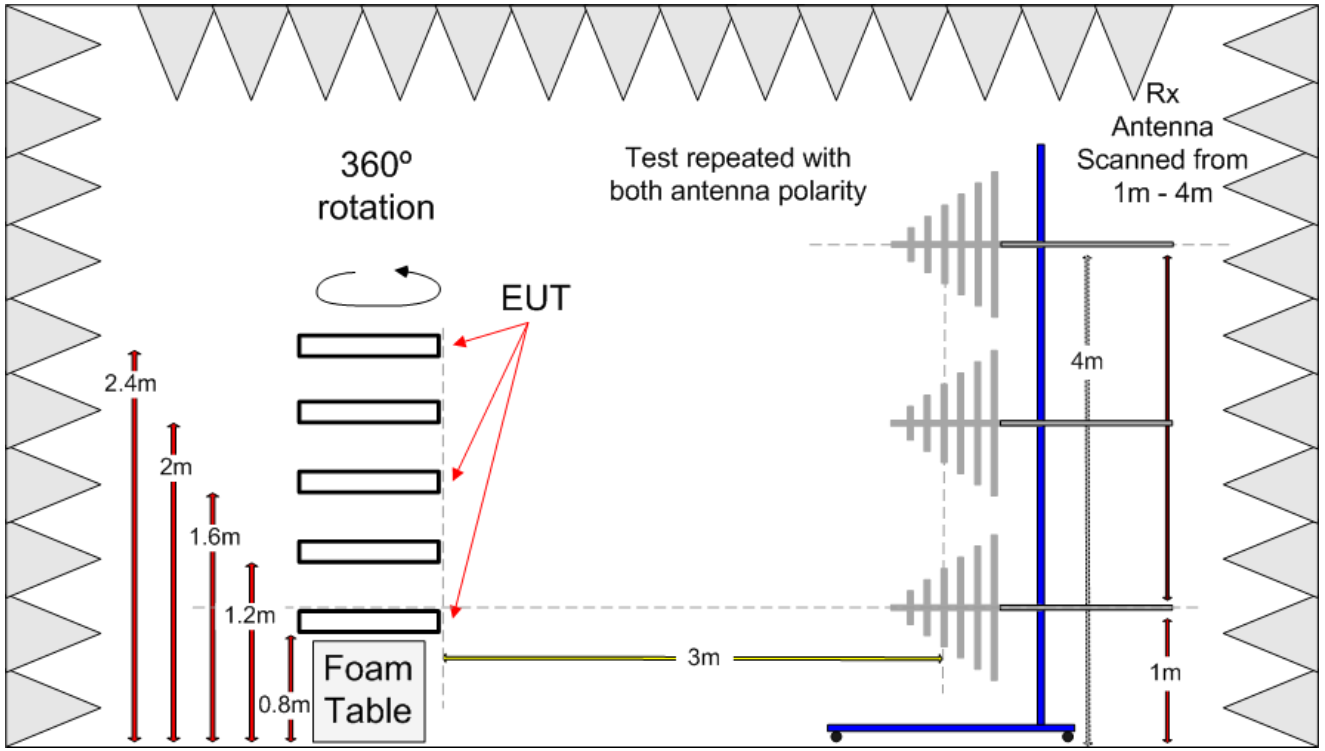
Full Process: Maximum Difference



Full process normalized to the maximum result (worst case polarity)

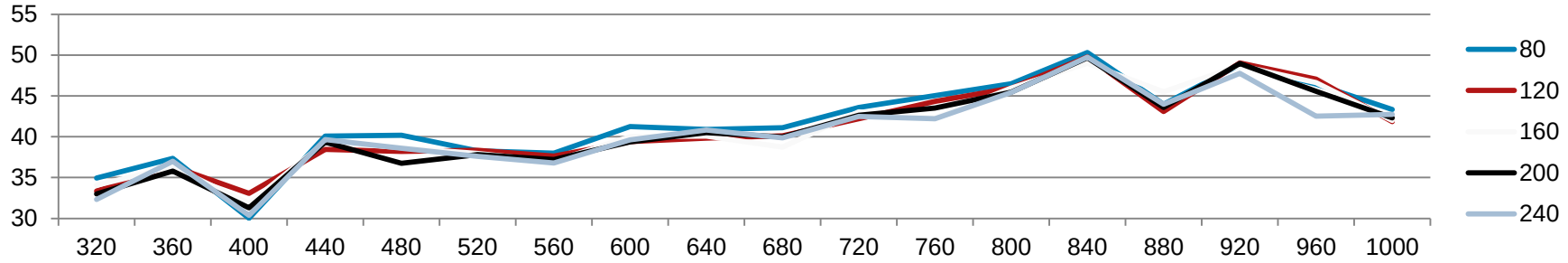


EUT Height Test 2

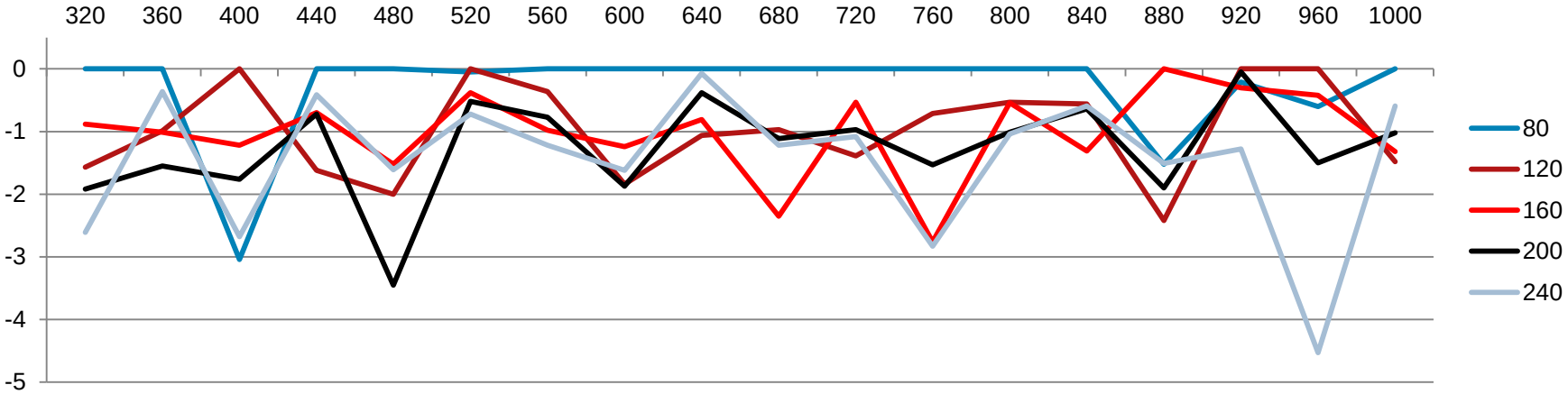


3 Heights	Stable 1U EUT (w/o cover) tested at different heights.
Prescan Process	Maximised analyser scan during full rotation. Results worse case, from antenna heights of 1m, 2m, 3m and 4m
Full Process	Individual emissions measured at worst case polarity, during antenna scan (1m-4m) & turntable rotation (0-360)

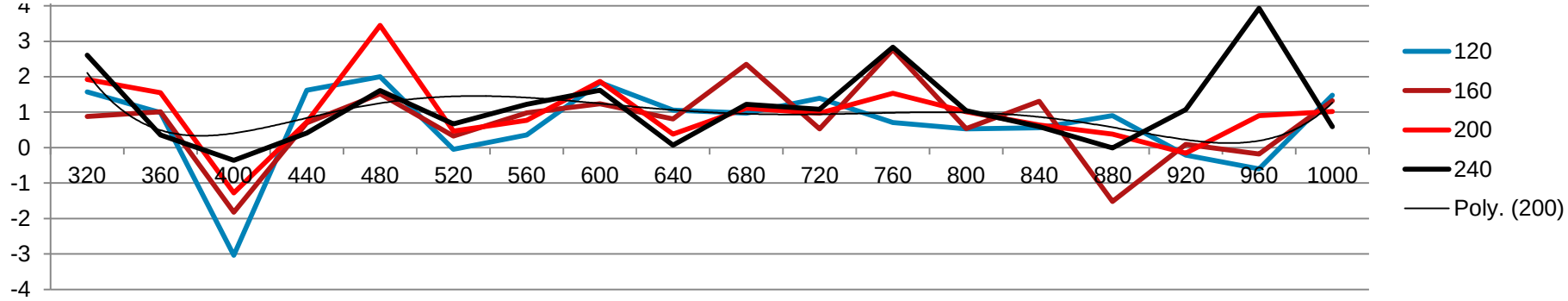
Horizontal



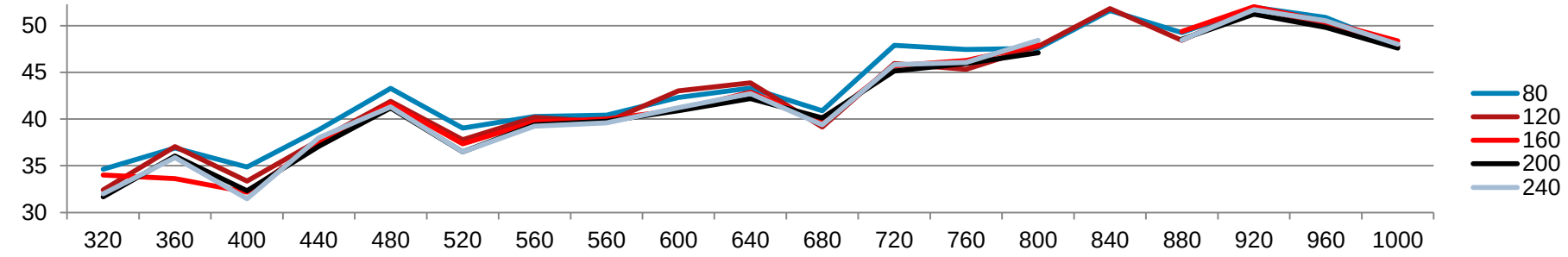
Normalized to the maximum response



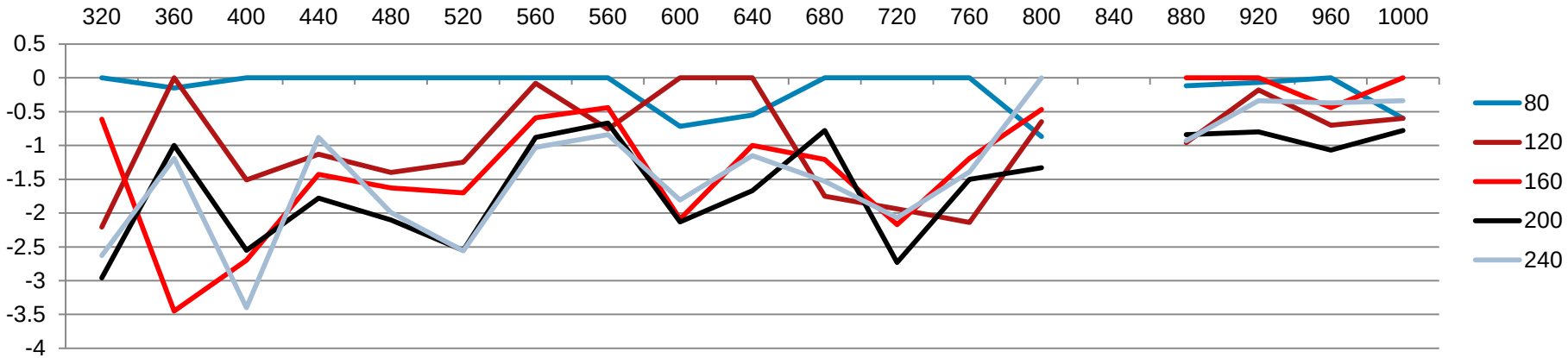
Normalized to the results at 80cm



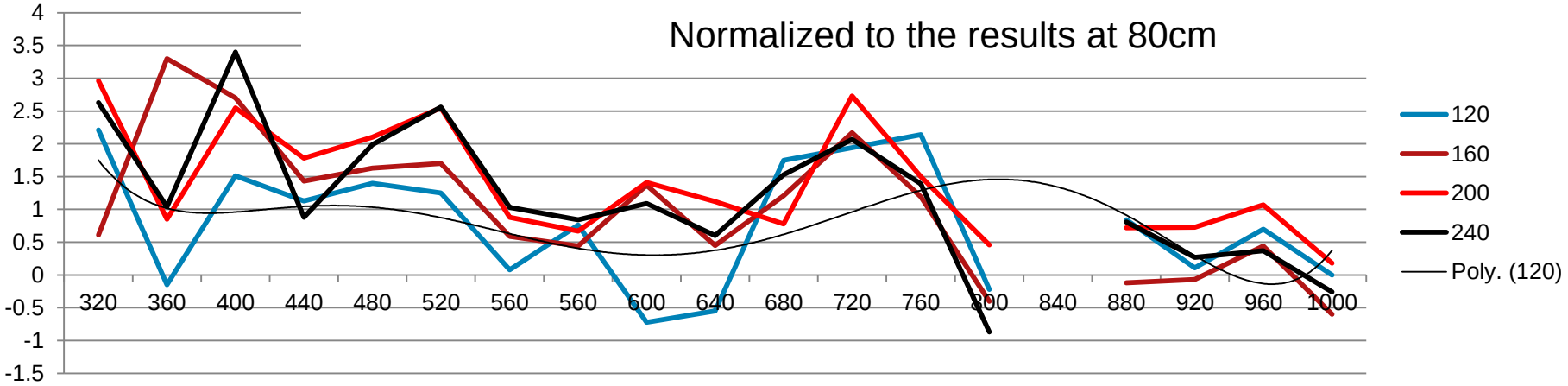
Vertical



Normalized to the maximum response



Normalized to the results at 80cm



Summary Of EUT results

STD Deviation	The standard deviation for normalised results to 80cm for both Horizontal and Vertical is approximately 1.
Trendline	The polynomial trend line also indicates a value around 1 to 1.5.
Variation	Based upon the results and knowledge of the NSA, it is clear that the height of the EUT should not be limited based upon the beamwidth of the LPDA antenna.
Chamber	EUT Test2 results were carried out within a different chamber but the processes were the same. With EUT Test2, both complete sets of data were shown, rather than just the worst case.

Summary

Summary	It is clear from either the measurements or the beamwidth of the Log Periodic Antenna (LPDA) that the EUT width should not be limited to 1.5m but should be in the order of 3m. A similar statement can be made with respect to EUT height with a limitation above 2m.
CISPR 16	Based upon the EUT results, there in no need to bore-sight the Log Periodic antenna @ 3m. The complexity of the test method would not bring sufficient benefit.
CISPR 11	The definitions in CISPR11 clearly need reviewing to ensure that they reflect the actual measurement process.
CISPR 32	Because changing CISPR 16 could be problematic, it is recommended that EUT should be limited to a 3m width in CISPR 32.
EUT	Based upon the frequency of the emissions concerned (specifically around 1GHz), the definition of the cabling of the EUT needs to be carefully considered.