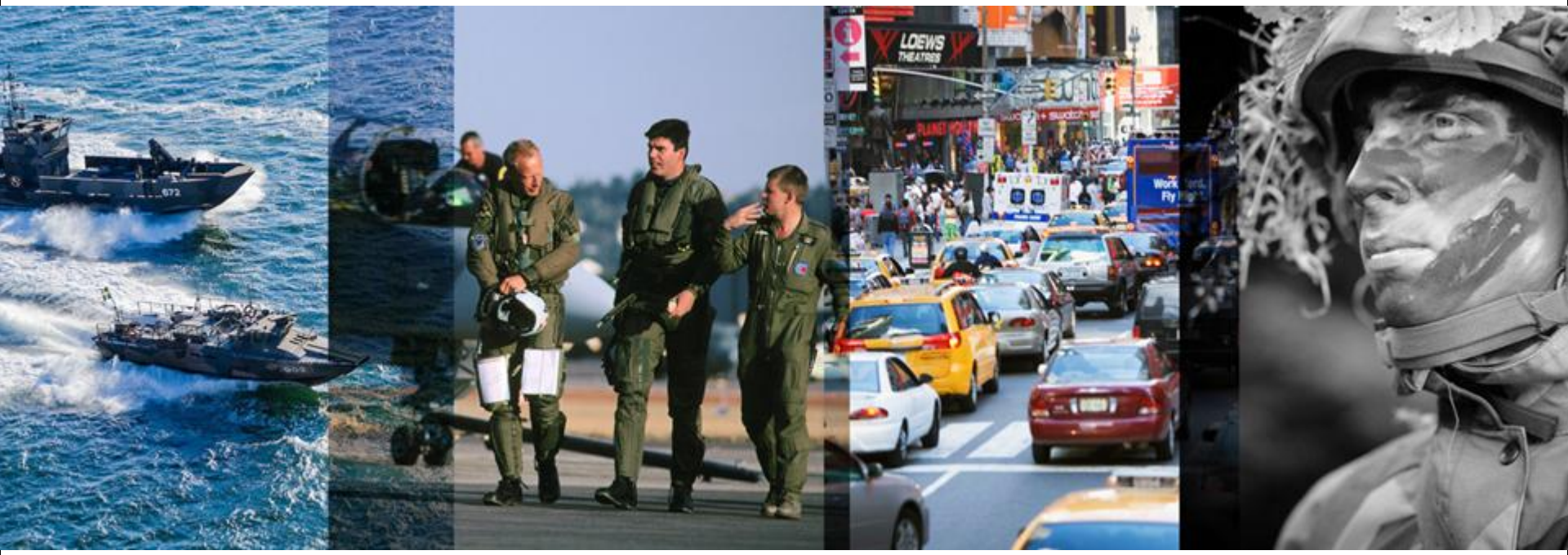
A HIGH PERFORMANCE TAPERED ANECHOIC CHAMBER FOR 0.5 TO 40 GHz



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SAIEEE AP/MTT/EMC Conference

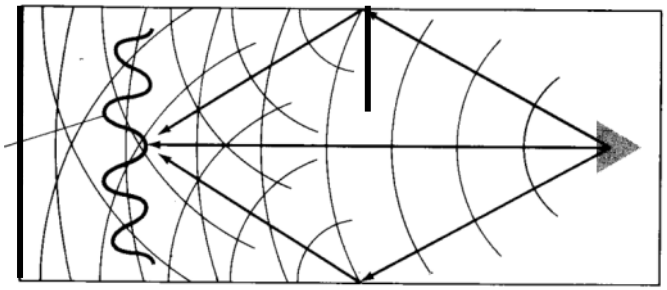
Stellenbosch, 14 and 15 April 2011

THE REQUIREMENT

- Design, install and test a fully equipped anechoic chamber with the longest feasible test distance in a space 5 m x 5m x 20 m.
- Primary use is for antenna testing in the frequency range from 0.5 to 40 GHz, with degraded performance down to 200 MHz.
- Review anechoic chamber options (rectangular and tapered) which will provide the largest quiet zone.
- Broad band operation is required in sub-bands no smaller than 0.5 to 2, 2 to 18 and 18 to 40 GHz.
- Anechoic chamber should provide at least 30 dB of linear cross polarization.
- Determine the maximum sizes and nominal gains of antennas that can be tested.
- Anechoic chamber shall be supplied in a knock-down kit for assembly on site. No cutting of absorbers to be done on site. This requires careful design of the taper section.

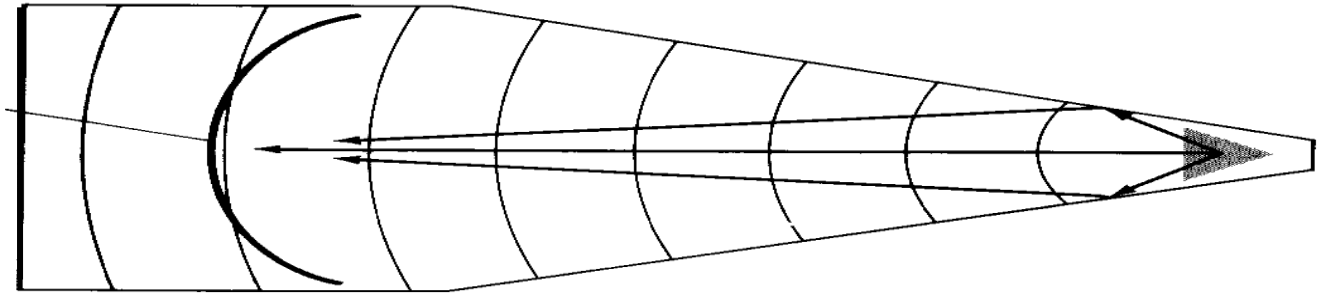
THE OPTONS

1. THE RECTANGUAL ANECHOIC CHAMBER



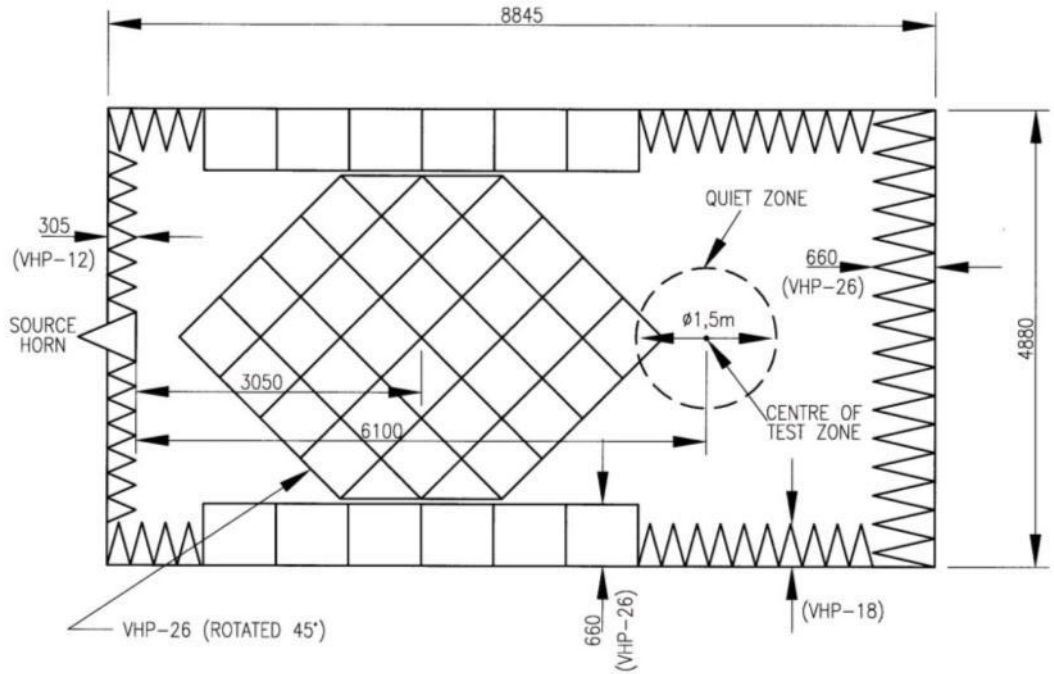
• Note ripples in test zone caused by multiple reflections from side walls.
• Angle of incidence on side walls must be less than about 50 to maintain absorber performance.
• Angle of incidence fixes the test distance.

2. THE TAPERED ANECHOIC CHAMBER



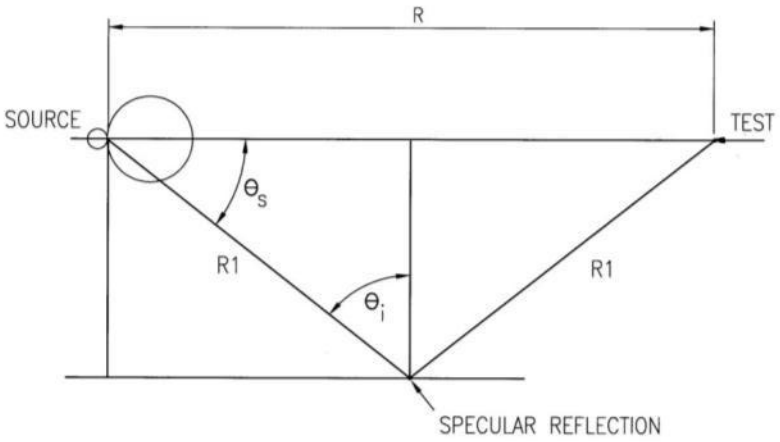
• Wave launched down taper like in a large lossy horn antenna, smooth test field.
• Main reflections are off back wall.
• Longer test distance for same height and width.

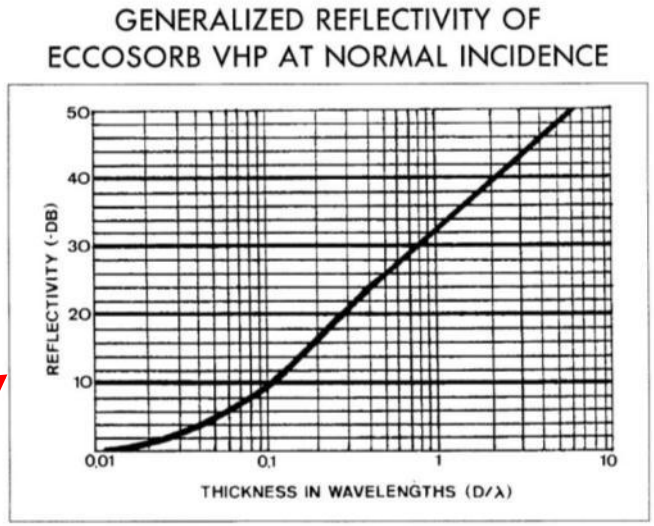
1. THE RECTANGULAR ANECHOIC CHAMBER



- Even when using 5 m height cannot use full 20 m length.
- Low-frequency performance of fixed height absorbers degrades.
- Test distance is only 6.1 m for 4.9 m height.

• ABSORBER PERFORMANCE LIMITS LOW-FREQUENCY OPERATION OF RECTANGUALAR CHAMBER (BELOW 1 TO 2 GHz) .

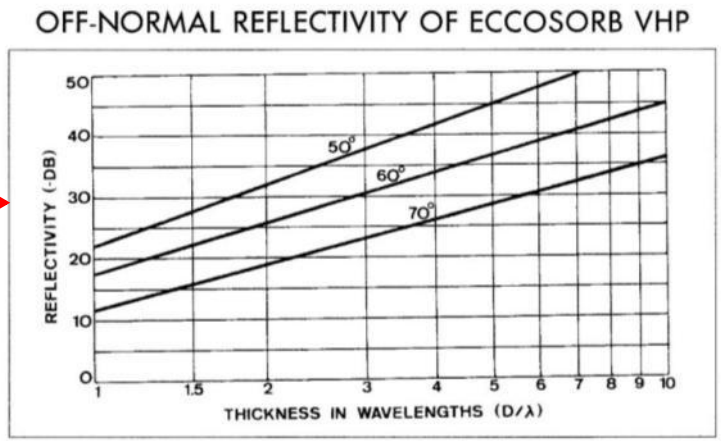




• As frequency decreases, need longer absorbers.

• As angle of incidence increases, absorber reflectivity degrades. This implies even longer absorbers on side walls.

• To double the test distance one must also almost double the height and the width to maintain angle of incidence at about 50 .



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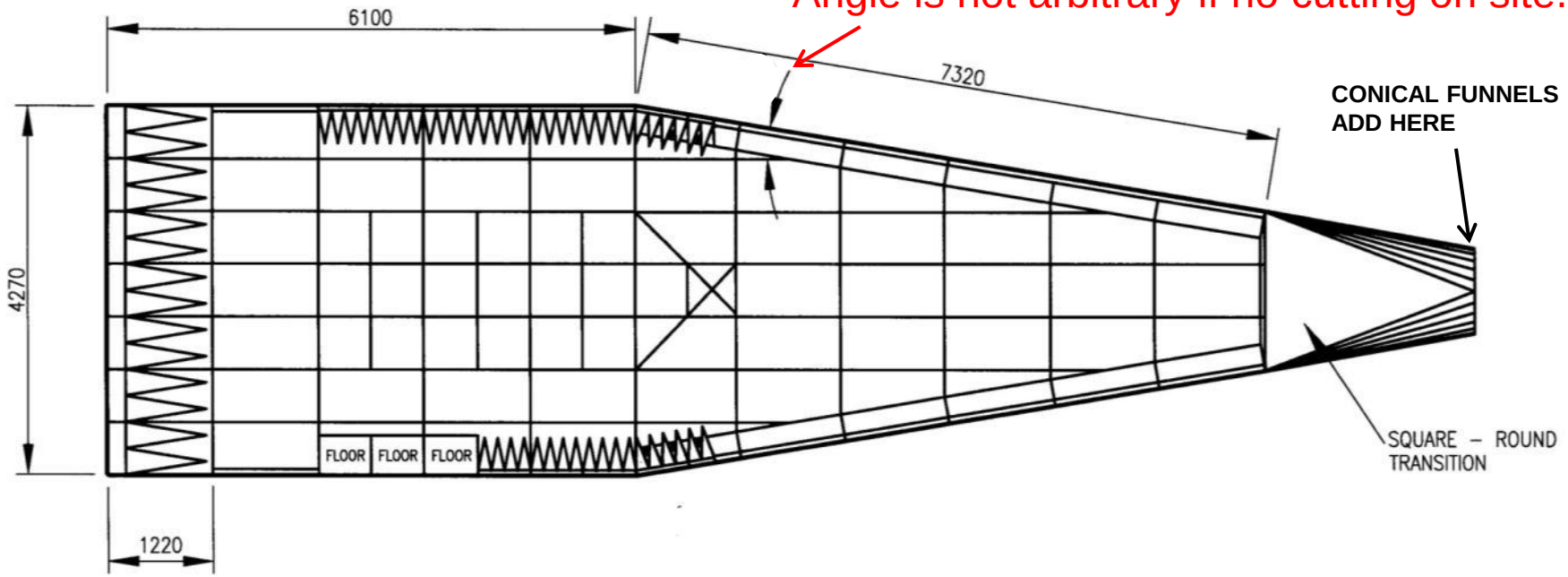
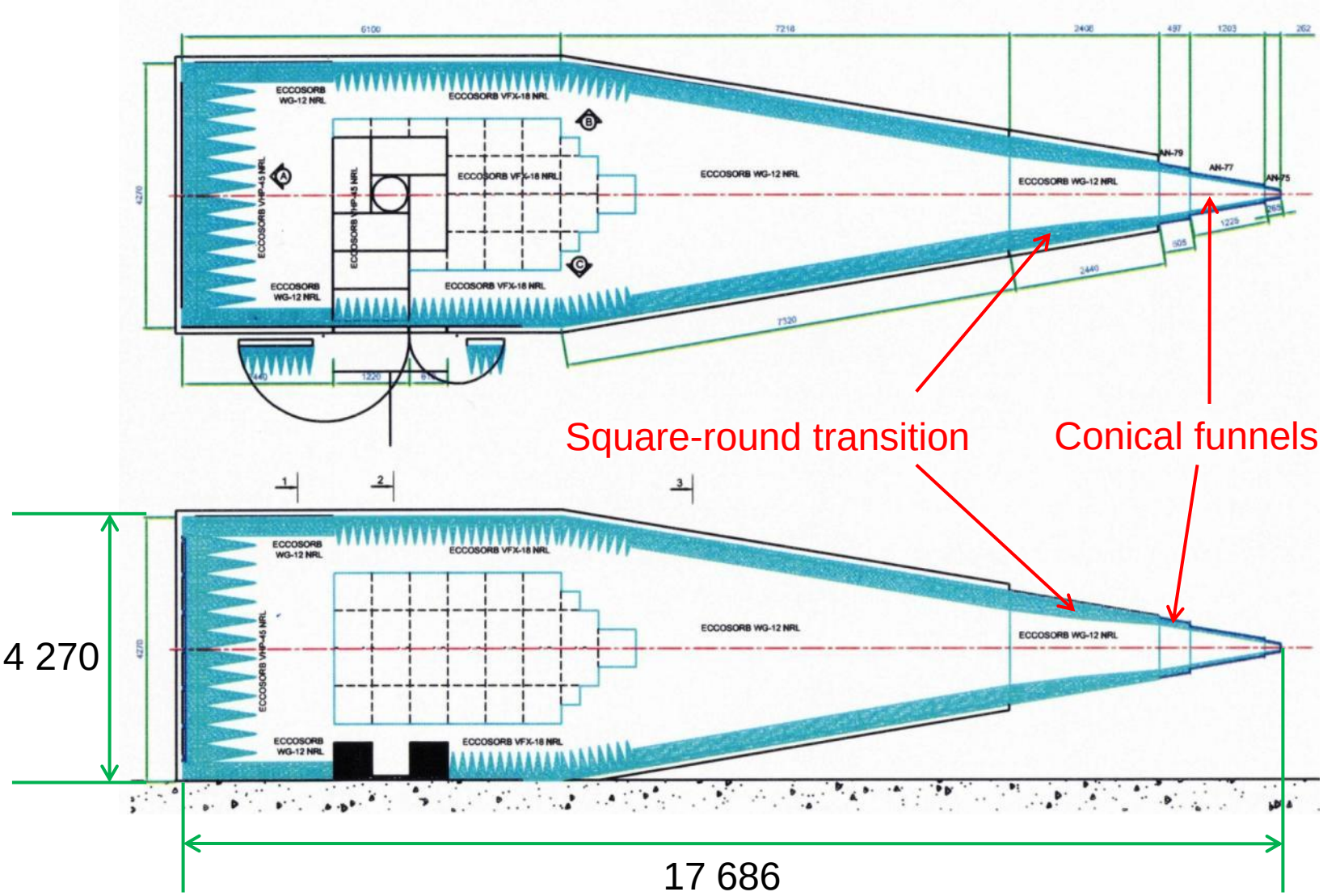
2. THE TAPERED ANECHOIC CHAMBER

- Taper angle is typically 8º - 15º.
- Angle is not arbitrary if no cutting on site.



- With 4.3 m height and width can achieve 14 m test distance, *cf.* 6.1 m above.
- Main reflection is off back wall.
- Use Eccosorb VHP-45 (1.14 m long) on back wall.
- Reflectivity is – 25 dB at 200 MHz and – 50 dB from 3 GHz up.
- There is 1 dB or better field taper over a 1.4 m quiet zone without the ripples as found in a rectangular chamber.

DETAIL OF TAPERED CHAMBER



ASSEMBLY OF FRAMES IN KIT

- Welded steel frames, bolt together, then cladded with 16 mm supa wood.
- Largest frame is 1.2 m x 4.3 m.
- Note location of final square section of the taper.

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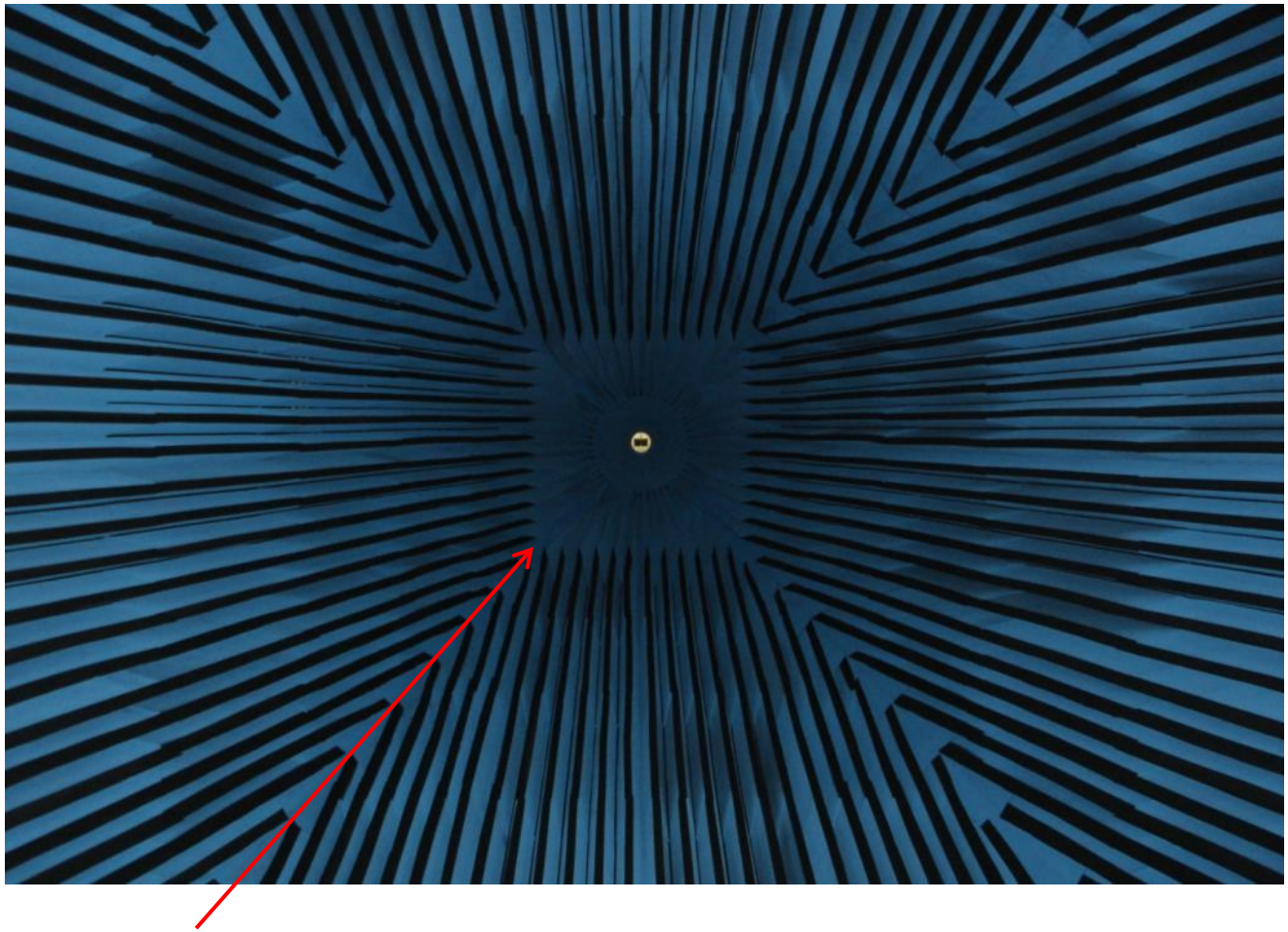
ASSEMBLY OF KNOCK-DOWN KIT

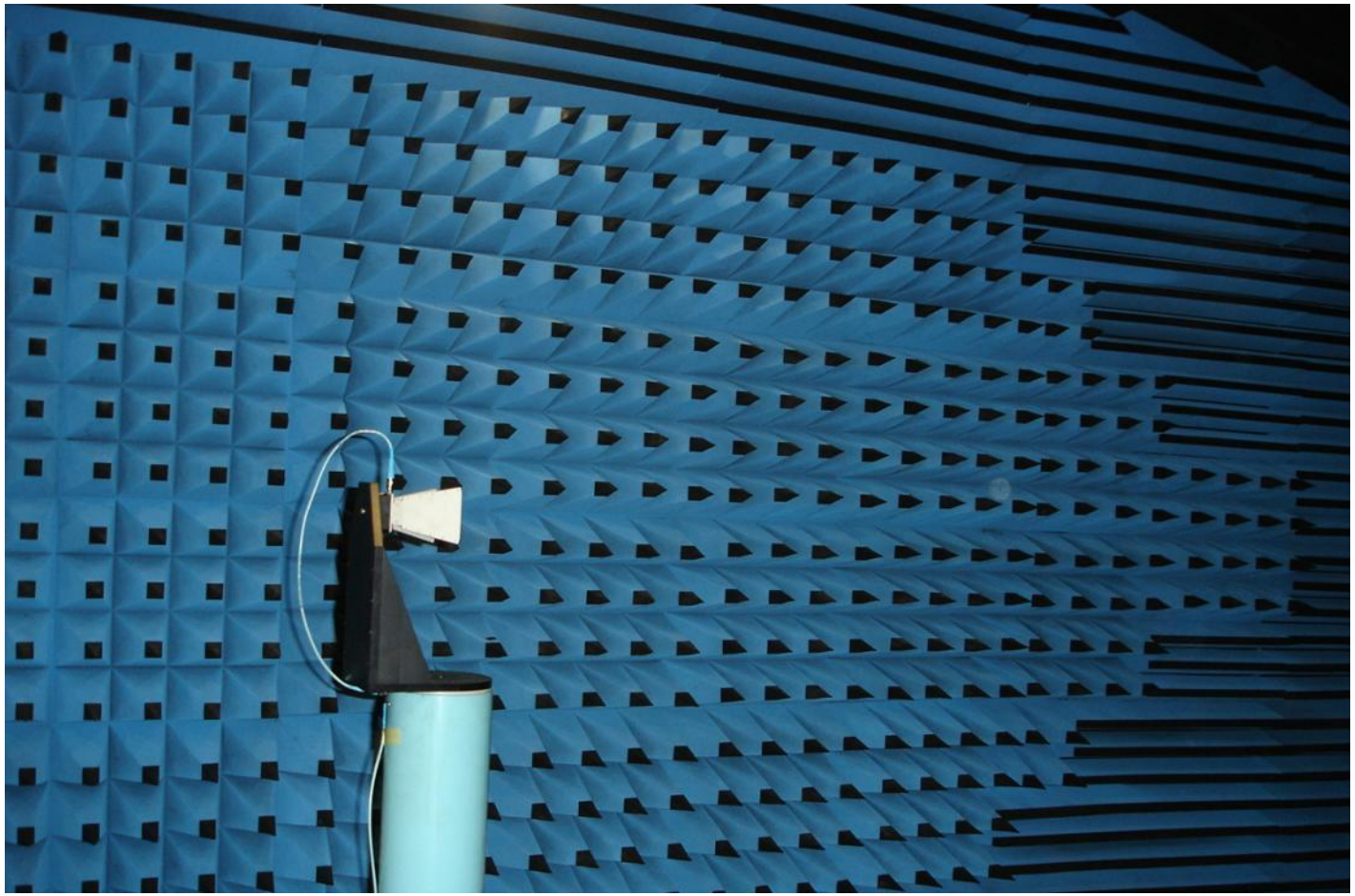
INSTALLATION OF AZIMUTH-OVER-ELEVATION TEST POSITIONER

VIEW FROM TEST POSITIONER TO SOURCE



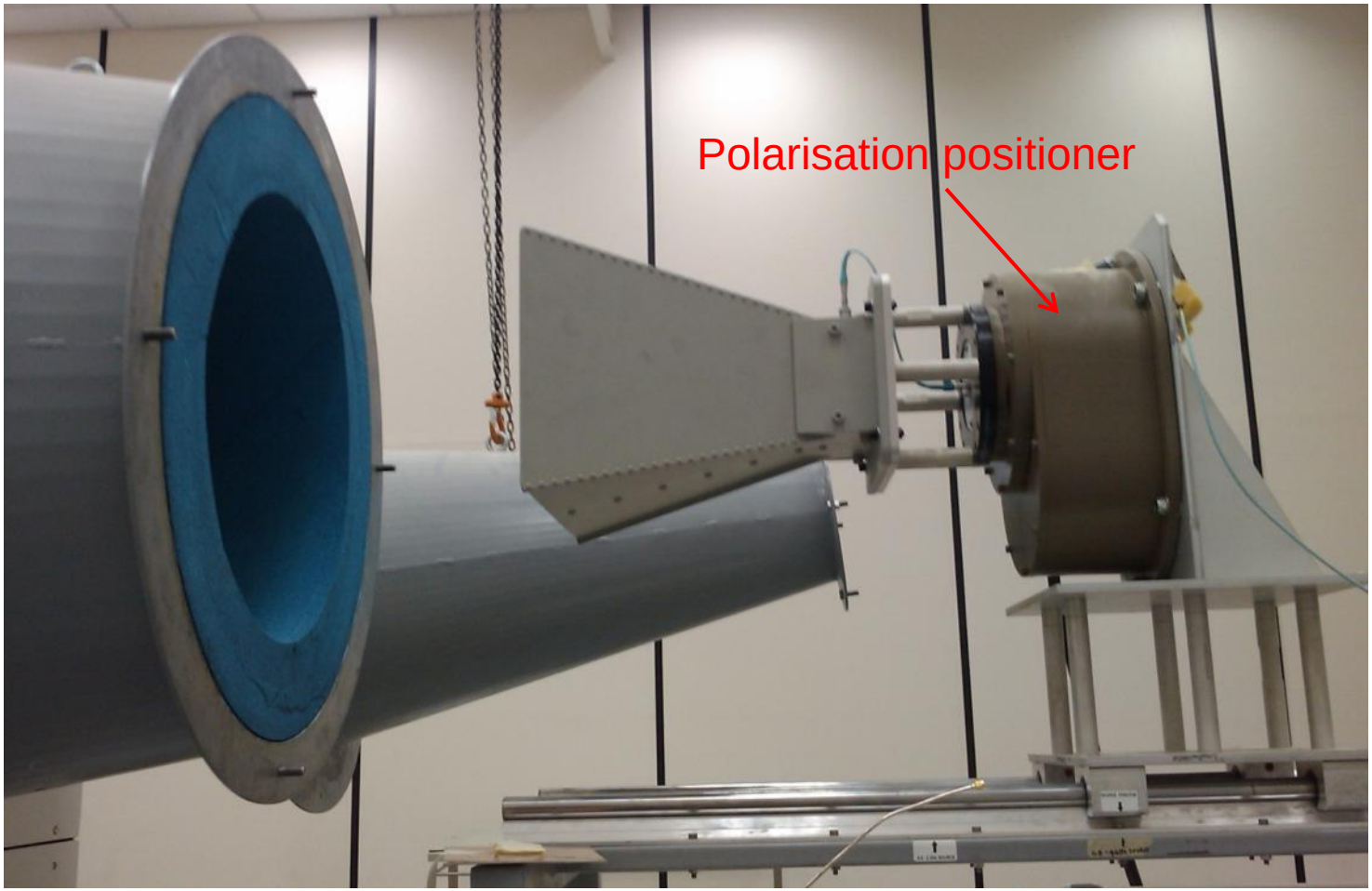
- Nearly perfect alignment of wedge absorbers in taper section.
- The chamber and test positioner axes are aligned using a bore-sighting laser.
- Note the smooth square-to-round transition.

2 – 18 GHz HORN WITH SIDE WALL



0.5 – 2 GHz GHz SOURCE CONFIGURATION

(NOTE THE 2 – 18 GHz FUNNEL IN BACKGROUND)



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GAIN AND 3 dB BEAMWIDTH FOR FAR-FIELD DIAMETER, D, AT 14 m TEST RANGE

Frequency GHz	Diameter D mm	Gain dBi	3 dB BW
0.5	2 049	18.7	20.5°
1.0	1 449	21.8	14.5°
2	1 025	24.8	10.2°
3	837	26.5	8.4°
5	648	28.7	6.5°
10	458	31.8	4.6°
18	342	34.3	3.4°
26	284	35.9	2.8°
40	229	37.8	2.3°

$R \geq 2D^2 / \lambda$

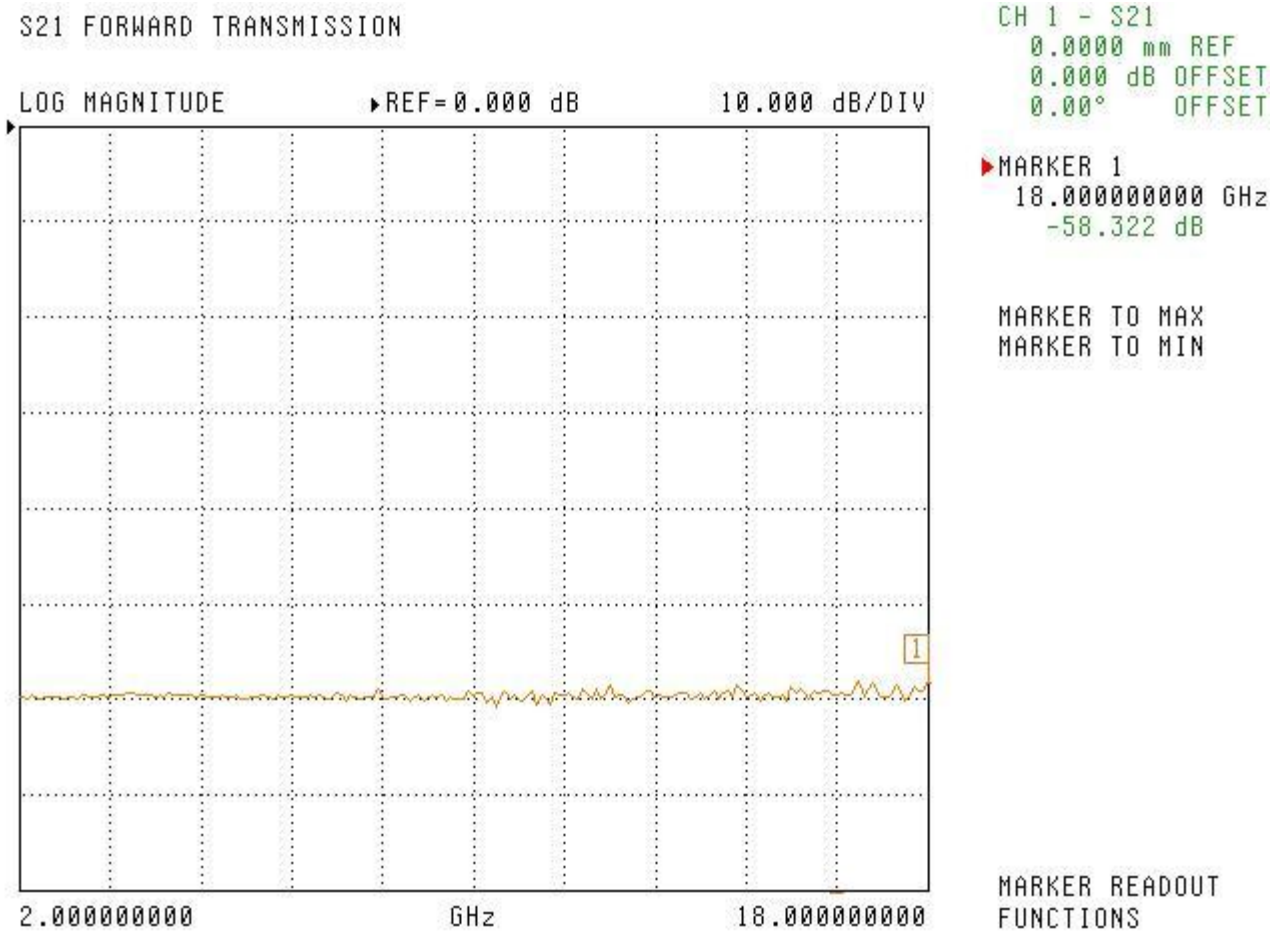
$R = 14$ m

COME INTO THE LAB AND SEE WHAT'S ON THE SLAB

To get he first signal through the full system is always stressful!

DYNAMIC RANGE FOR 2 – 18 GHz

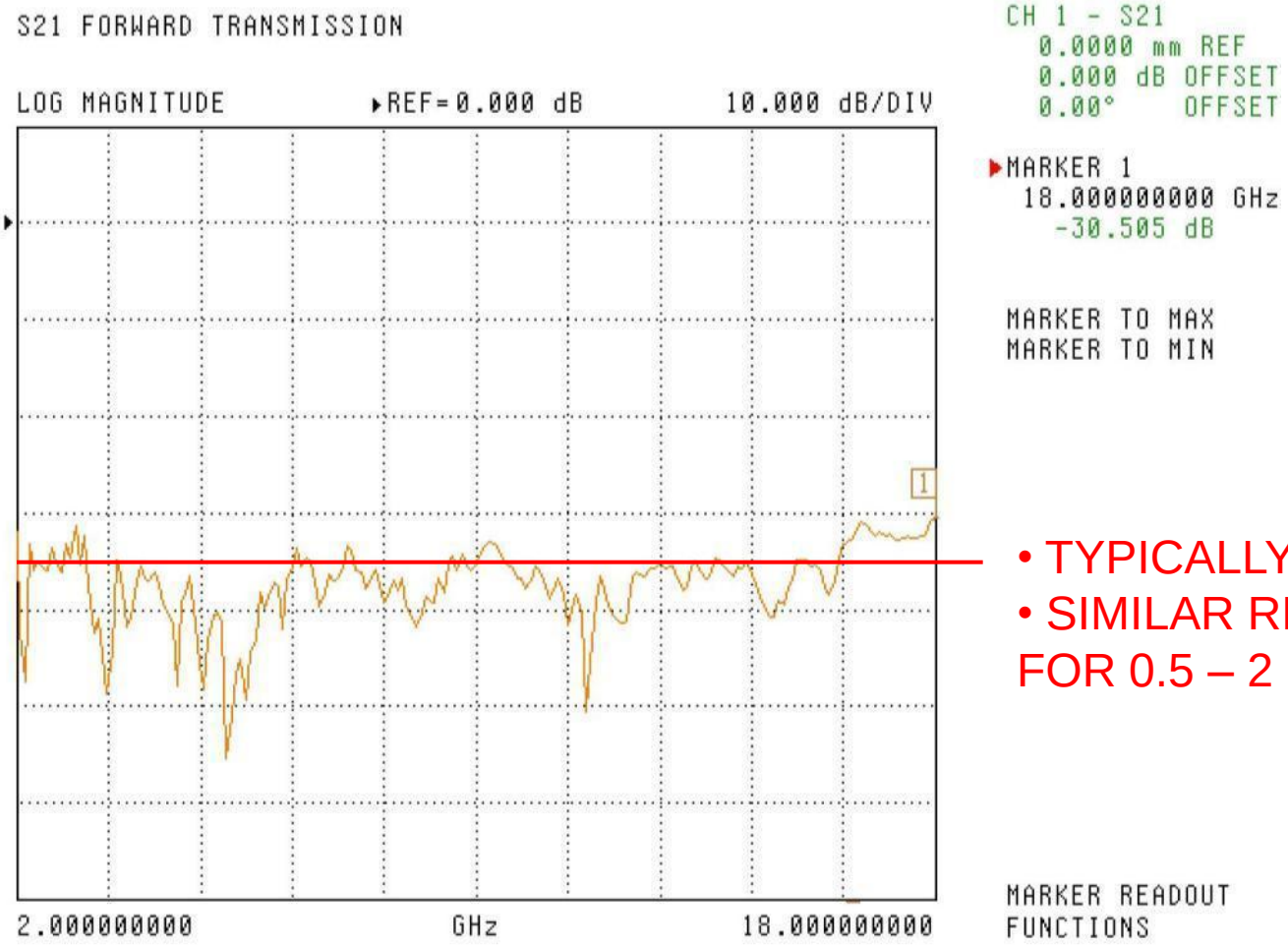
(60 dB ATTENNUATOR IN RECEIVE LINE, NO AMPLIFIERS)



DYNAMIC RANGE FOR 18 – 40 GHz

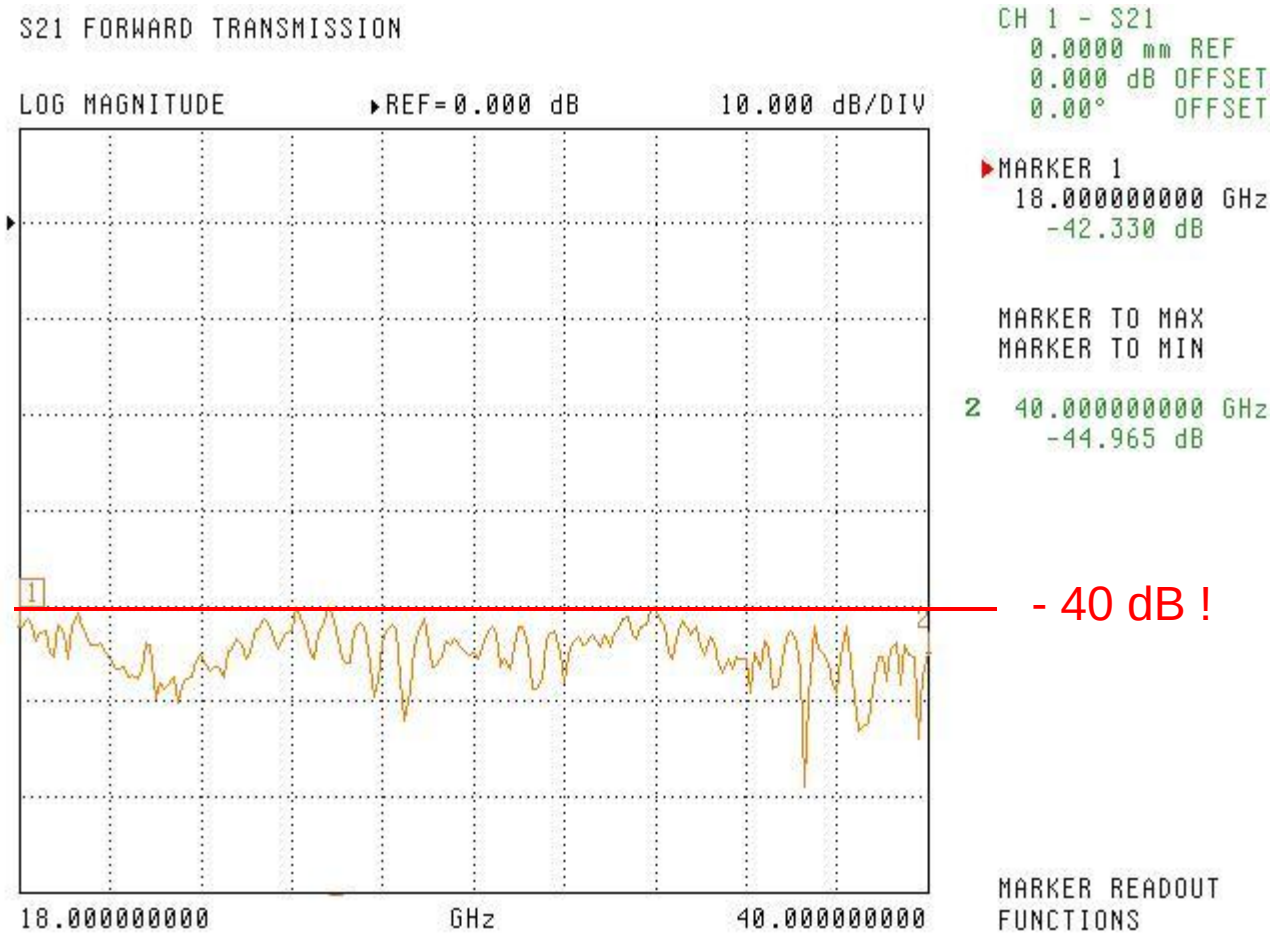
(50 dB ATTENNUATOR IN RECEIVE LINE, NO AMPLIFIERS)

CROSS POLARIZATION 2 – 18 GHz



- TYPICALLY - 35 dB
- SIMILAR RESULT FOR 0.5 – 2 GHz

CROSS POLARIZATION 18 – 40 GHz



CONCLUSIONS

- The background to the design, manufacture and test of a high performance tapered anechoic chamber has been presented.
- The 1 dB field taper region is about 1.4 m in diameter. This exceeds the conventional far-field criterion, i.e. the phase taper dominates for frequencies above 1 GHz.
- Outstanding dynamic range is achieved over the full 0.5 – 40 GHz frequency range without the need for external amplifiers.
- Careful design of the square-to-round transition and the conical funnels yields outstanding cross-polarization performance (typically better than 35 dB down and 30 dB max.).
- Axial ratio and gain of circularly polarized antennas can be measured accurately because of the very good cross-polarization performance.
- Operation of a tapered anechoic chamber requires somewhat more care and skill than that for a conventional rectangular chamber but the increase in test distance far outweighs this.

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