



Deposited via The University of York.

White Rose Research Online URL for this paper:

<https://eprints.whiterose.ac.uk/id/eprint/146305/>

Version: Other

---

**Proceedings Paper:**

Dawson, John and Pisssoort, Davy (2019) Overview of the P2715 WG - IEEE Guide for the Characterization of the shielding effectiveness of planar material::Free Space and Absorber Box Methods of Planar Shielding Measurement. In: Electromagnetic Compatibility (EMC), 2019 IEEE International Symposium on. IEEE Symposium on Electromagnetic Compatibility, Signal Integrity and Power Integrity.

---

**Reuse**

Other licence.

**Takedown**

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing [eprints@whiterose.ac.uk](mailto:eprints@whiterose.ac.uk) including the URL of the record and the reason for the withdrawal request.

# Free Space and Absorber Box Methods of Planar Shielding Measurement

Dawson, J. & Pissort, D. , "Overview of the P2715 WG - IEEE Guide for the Characterization of the shielding effectiveness of planar material: Double Horn Set-up/Absorber Box" , Electromagnetic Compatibility (EMC), 2019 IEEE International Symposium on , 2019

© 2019 IEEE. Personal use of this material is permitted. Permission from IEEE must be obtained for all other uses, in any current or future media, including reprinting/republishing this material for advertising or promotional purposes, creating new collective works, for resale or redistribution to servers or lists, or reuse of any copyrighted component of this work in other works.

John F Dawson, University of York, UK

Davy Pissort, KU Leuven, BE

With results from:

C Stott, BAE Systems, UK

F Moglie & V M Primiani, Universita Politecnica delle Marche, IT

A Bohbe, CISCO Systems, US

F Leferink, Thales, NL

J Janukiewicz, & Z Joskiewicz, Wrocław University of Science and Technology, PL

D Inman, Parker Chomerics, US

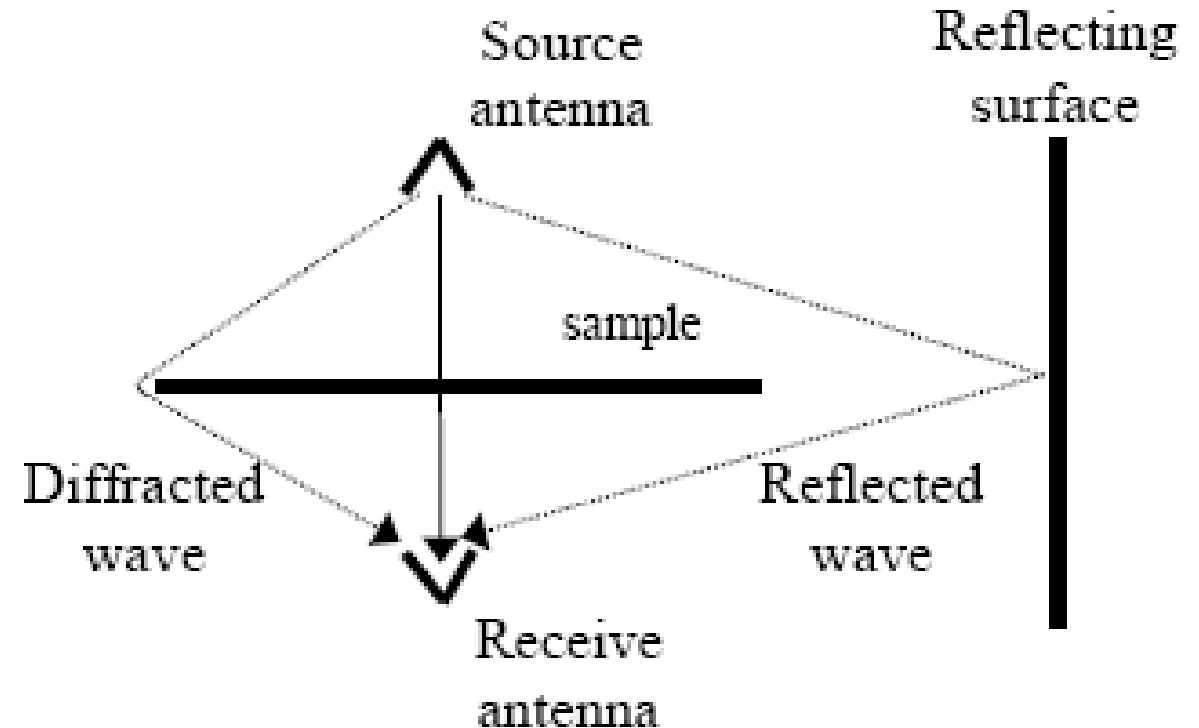
V Gkatsi & E Tourounoglou, Aristotle University of Thessaloniki; A Roc'h, Eindhoven University of Technology; and

Frank Leferink, University of Twente

M Mirhoseini & A C Marvin, University of York, UK

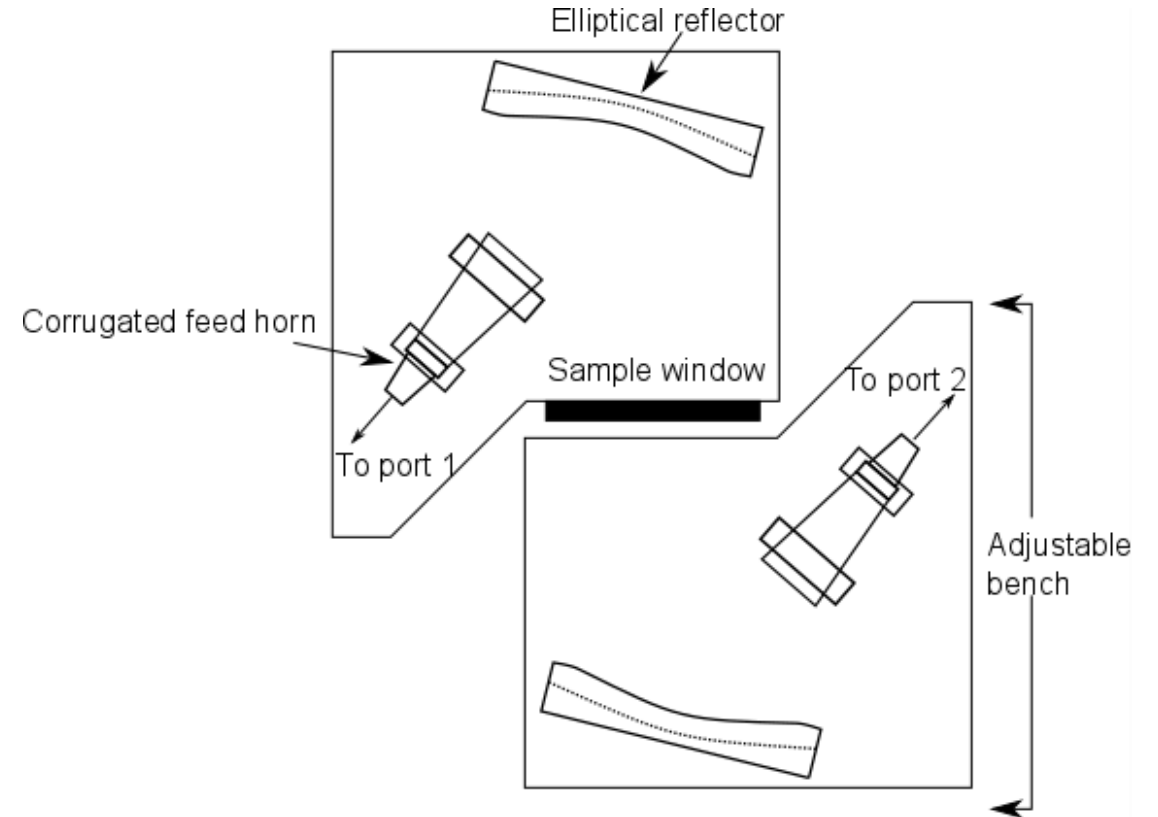
# The free space method - concept

- Why not just shine a beam at the sample ?
- Edge diffraction and reflections make this difficult
- Need a focussed (Gaussian Beam)
- Sample must be large in wavelengths



# The free space method - reality

- Need to focus beam (Gaussian beam)
- Minimise edge diffraction
- Sample must be large in wavelengths
  - 600mm x 600mm sample for 8.2GHz to 12.4GHz.
- May need absorber on and around jig to minimise reflections
- May be able to time gate reflections



Images Courtesy of BAE Systems

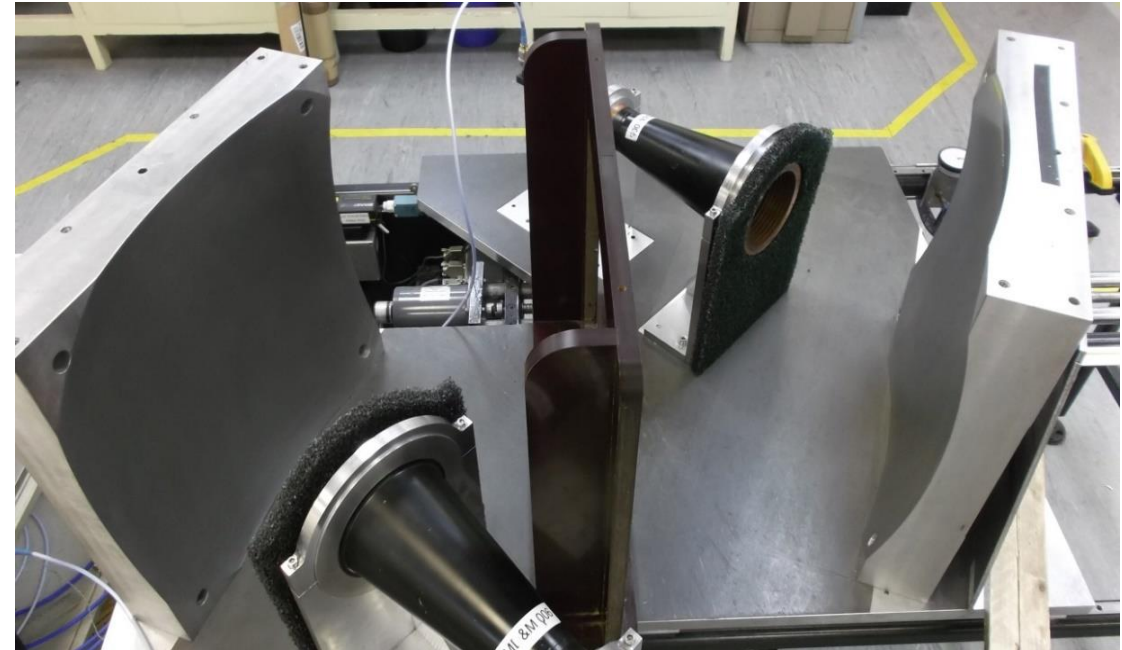
See also: Clarke, B., Gregory, A., Cannel, D., Patrick, M., Wylie, S., Youngs, I., & Hill, H. (2003). *A guide to characterisation of dielectric materials at RF and microwave frequencies*. London: NPL

# The free space method - SE

- Thru, Reflect, Line calibration of A
- Simple calculation of SE used here:

$$SE = -20 \log_{10} S_{12,\text{sample}} \text{ dB}$$

- $S_{12,\text{sample}}$  is the transmission between antennas for the jig with sample in place
- Can measure two polarisations by rotating sample and cross polar also if antenna is rotated.

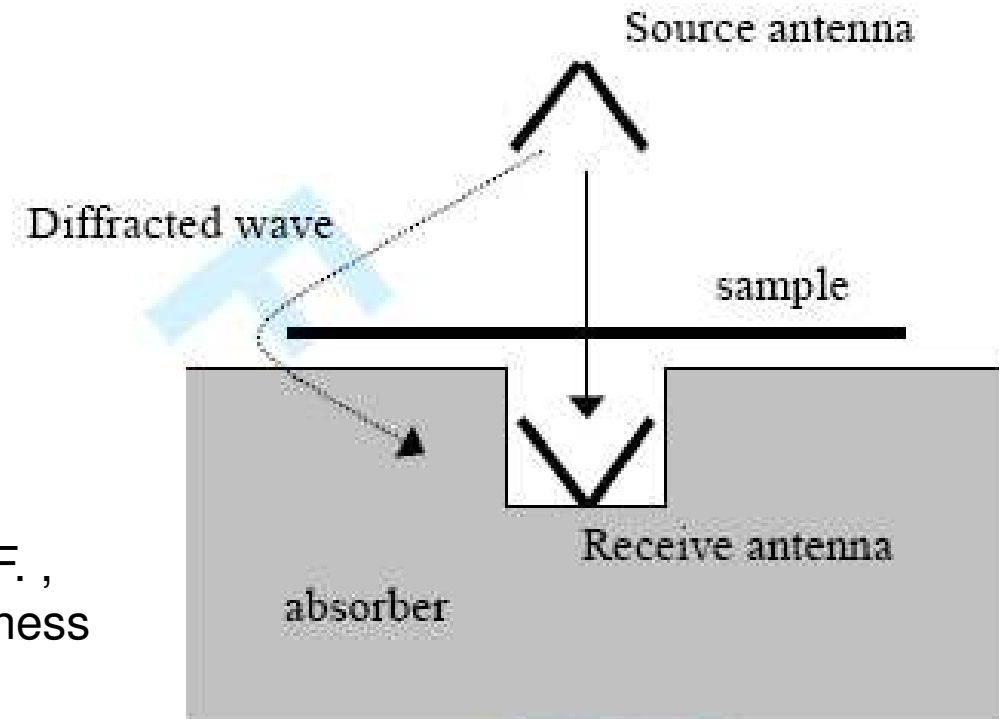


Images Courtesy of BAE Systems

# Absorber box method – concept

- Surround one (or both) Antenna(s) with radio absorptive material
- Prevent diffraction and reflections
- No sample edge preparation – just overlap
- Works 1-10GHz (current system)

Marvin, A. C.; Dawson, L.; Flintoft, I. D. & Dawson, J. F. ,  
"A Method for the Measurement of Shielding Effectiveness  
of Planar Samples Requiring No Sample Edge  
Preparation or Contact" , *IEEE Transactions on  
Electromagnetic Compatibility* , vol. 51, no. 2 , 255-262 ,  
May, 2009

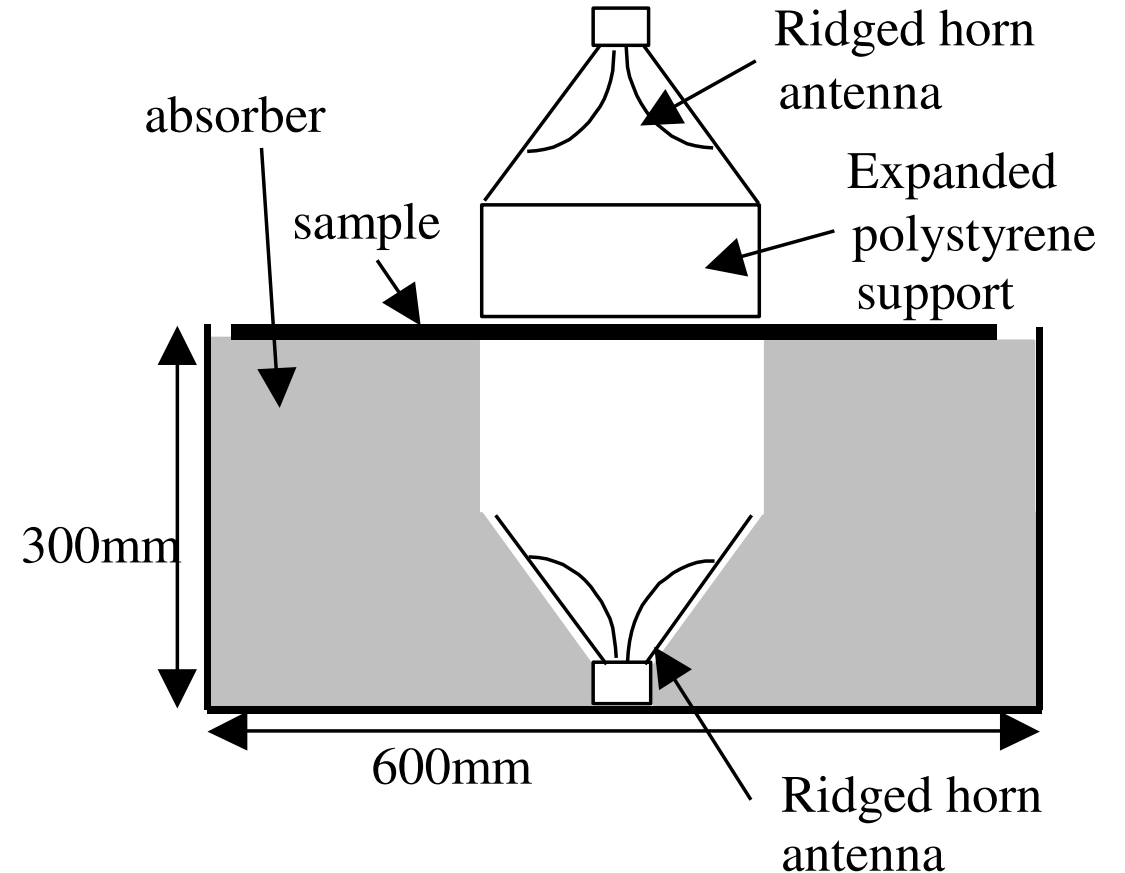


# Absorber box method - SE

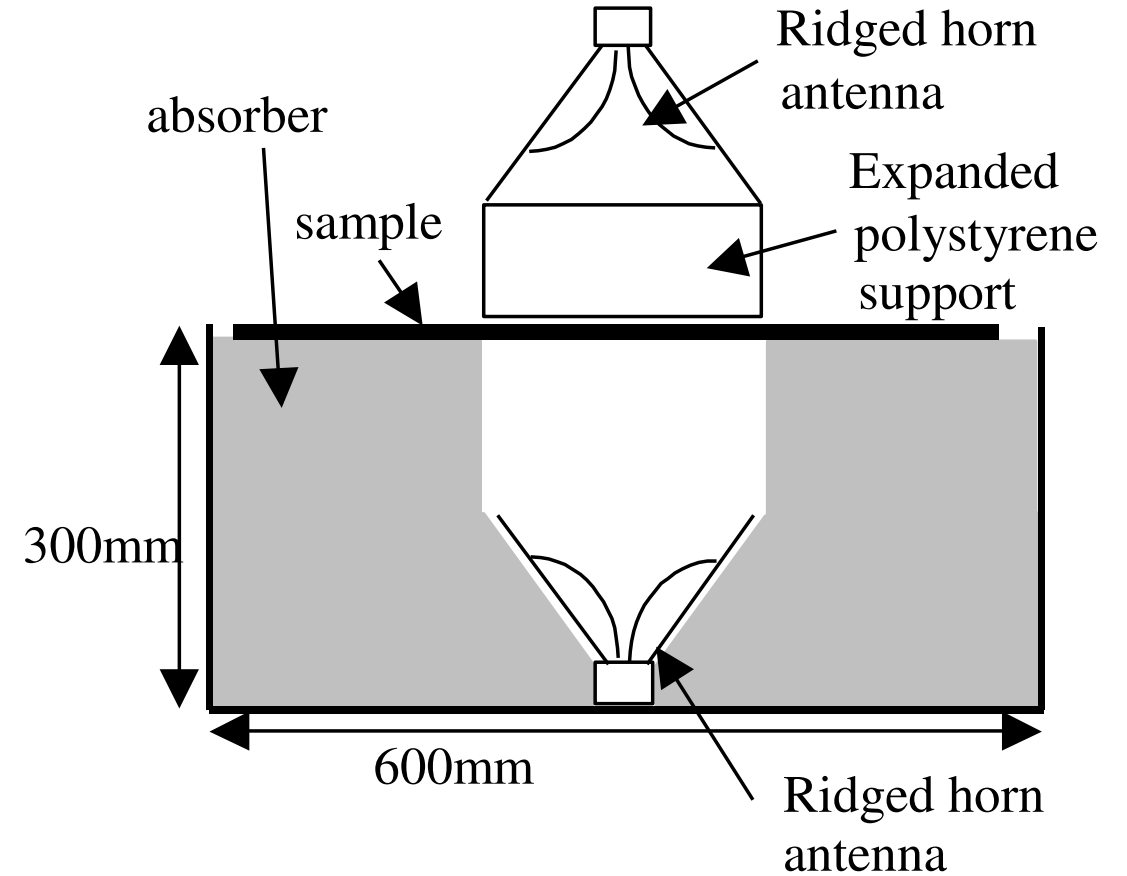
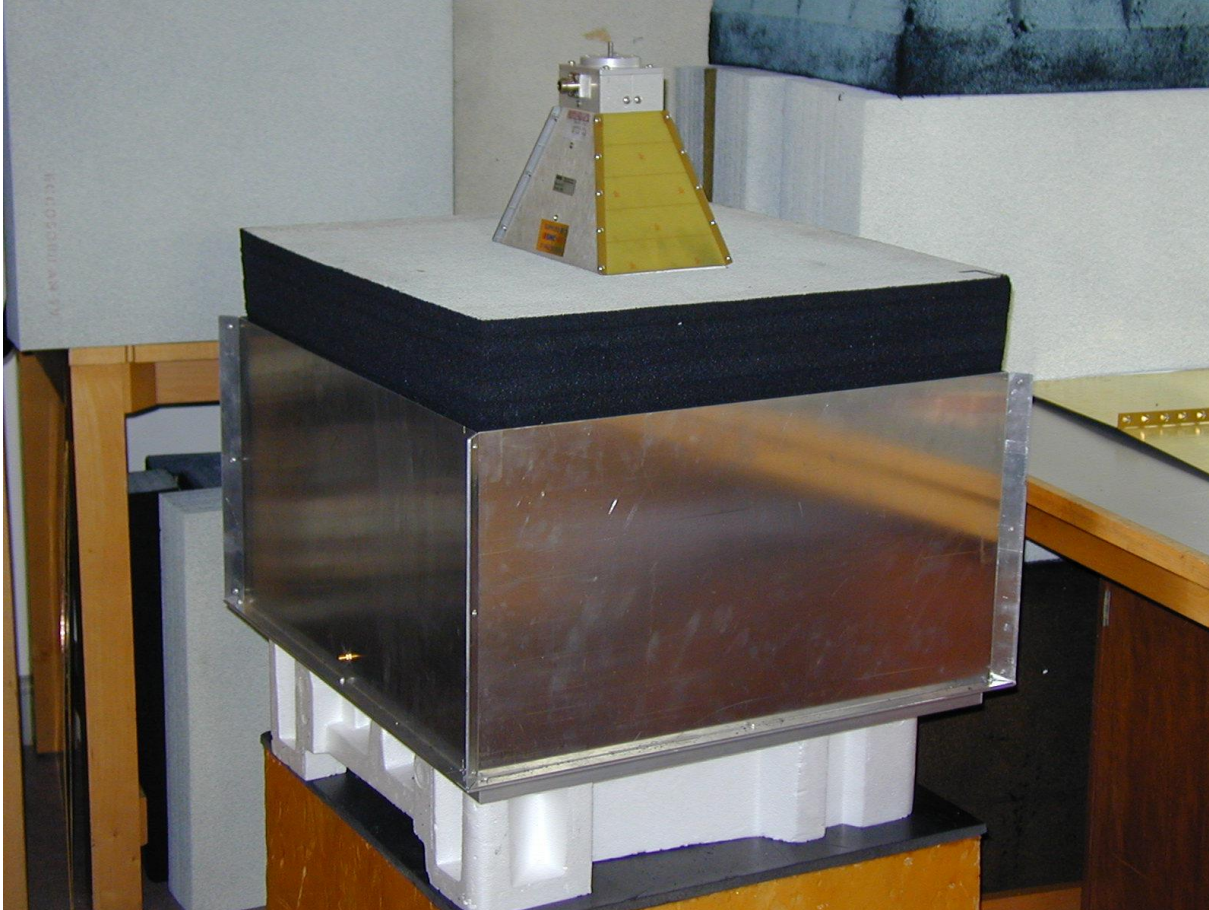
- SE using known reference:

$$SE = SE_{\text{ref}} + 20 \log_{10} \frac{S_{21,\text{ref}}}{S_{21,\text{sample}}} \text{ dB}$$

- $S_{21,\text{ref}}$  is the transmission between antennas with known sample having  $SE_{\text{ref}}$  (in dB)
- $S_{21,\text{sample}}$  is the between antennas with unknown sample in place
- Can measure two polarisations by rotating sample

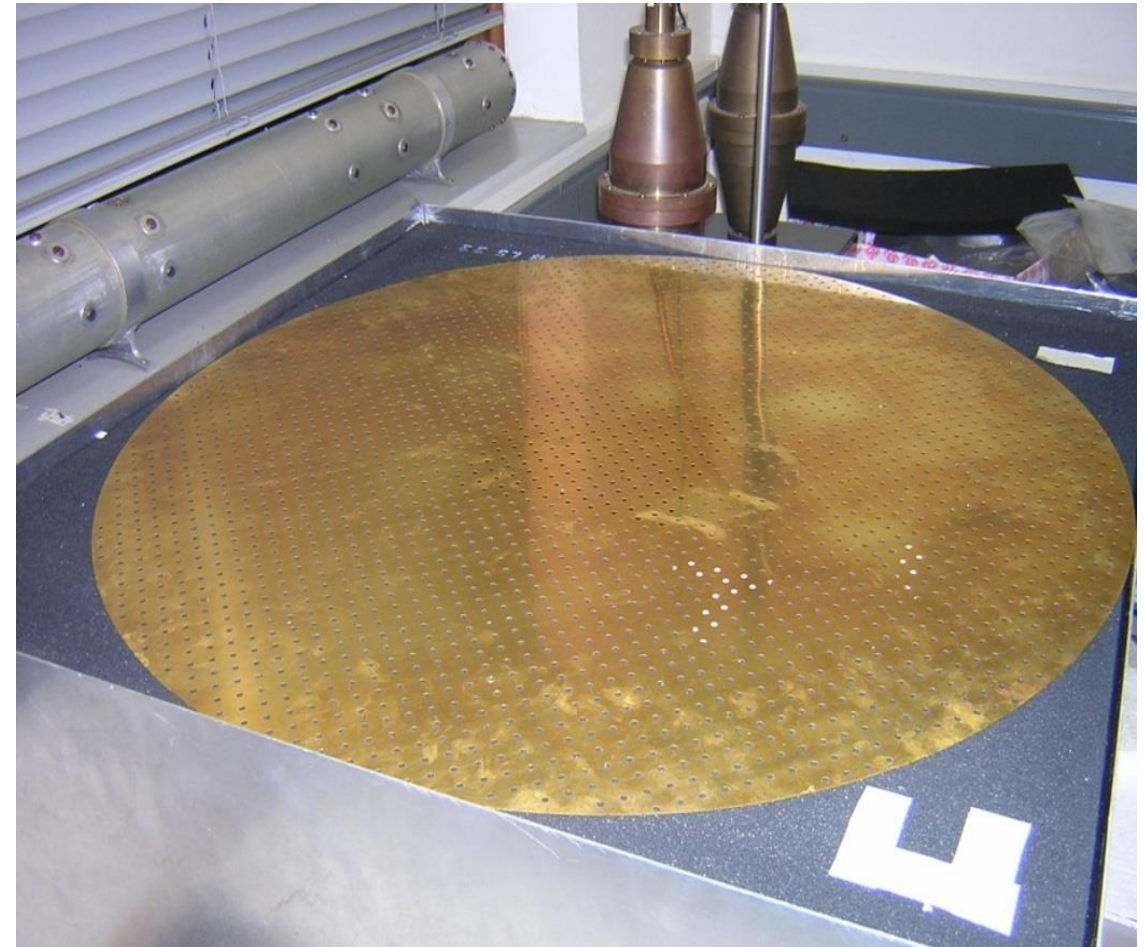


# Absorber box method - reality



# Absorber box method - reality

- In practice we use a known reference sample for calibration
- Proximity of the absorber to RAM means simple free-space assumptions no longer apply
- As sample just sits on absorber no special preparation is required
- Anisotropic materials can be measured easily

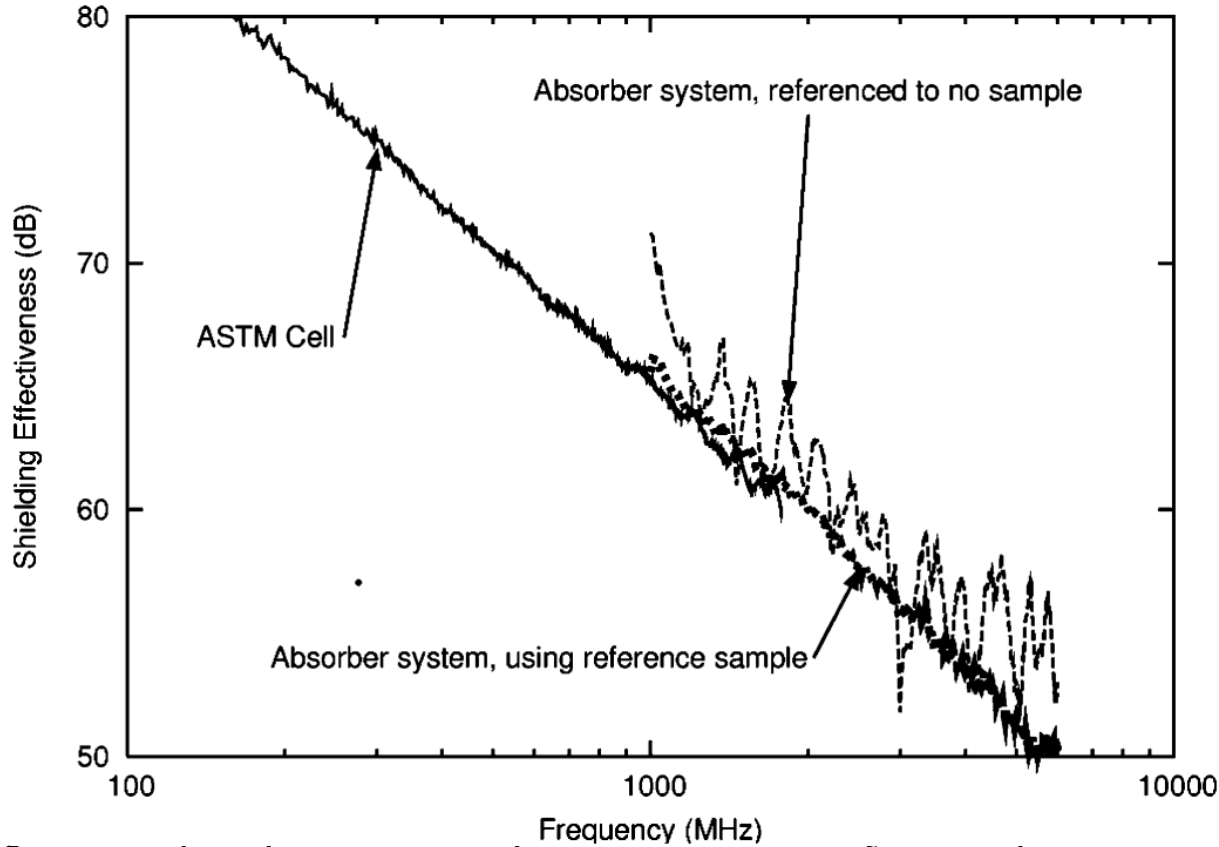


# Measurement video



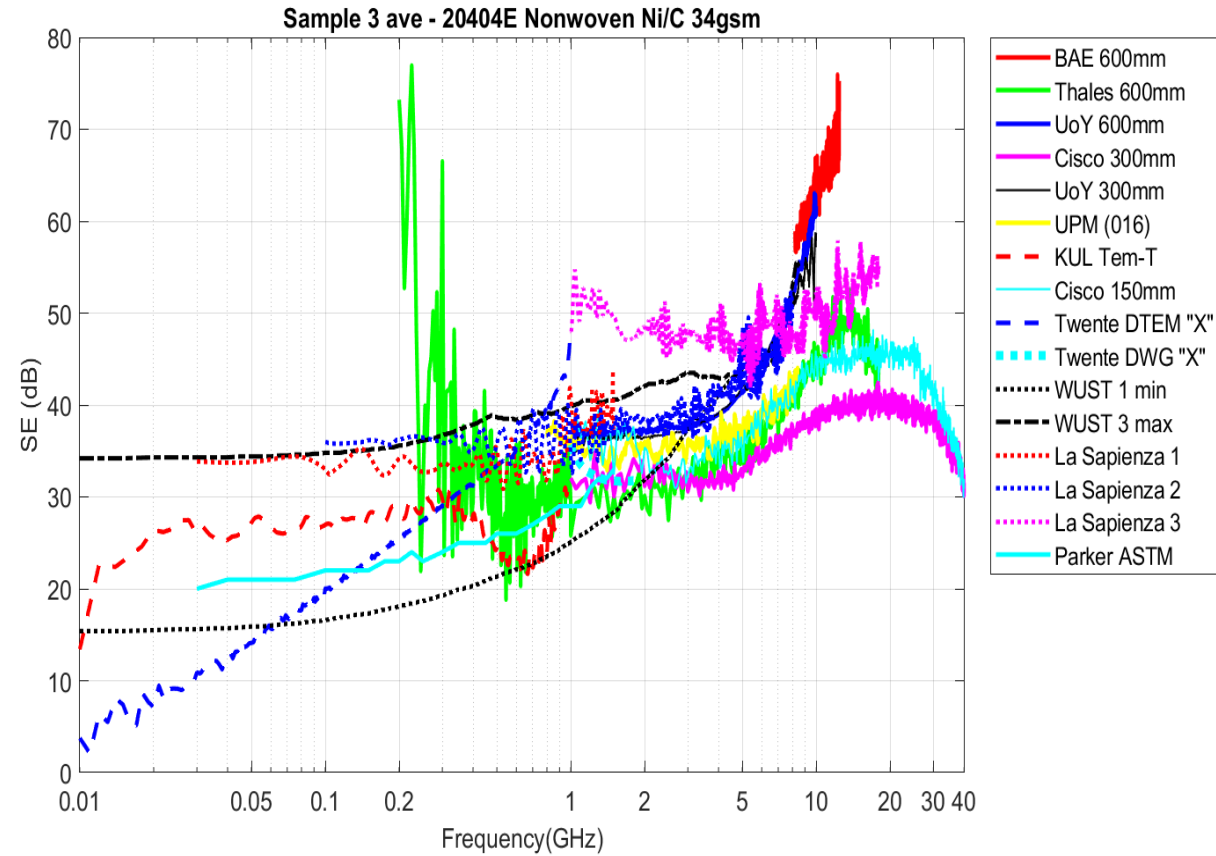
Video showing measurement of reference sheet and sample takes about 90s. The sample edge is prepared with plastic tape to avoid fraying and to protect hands from fibres

# Some results compared to other methods



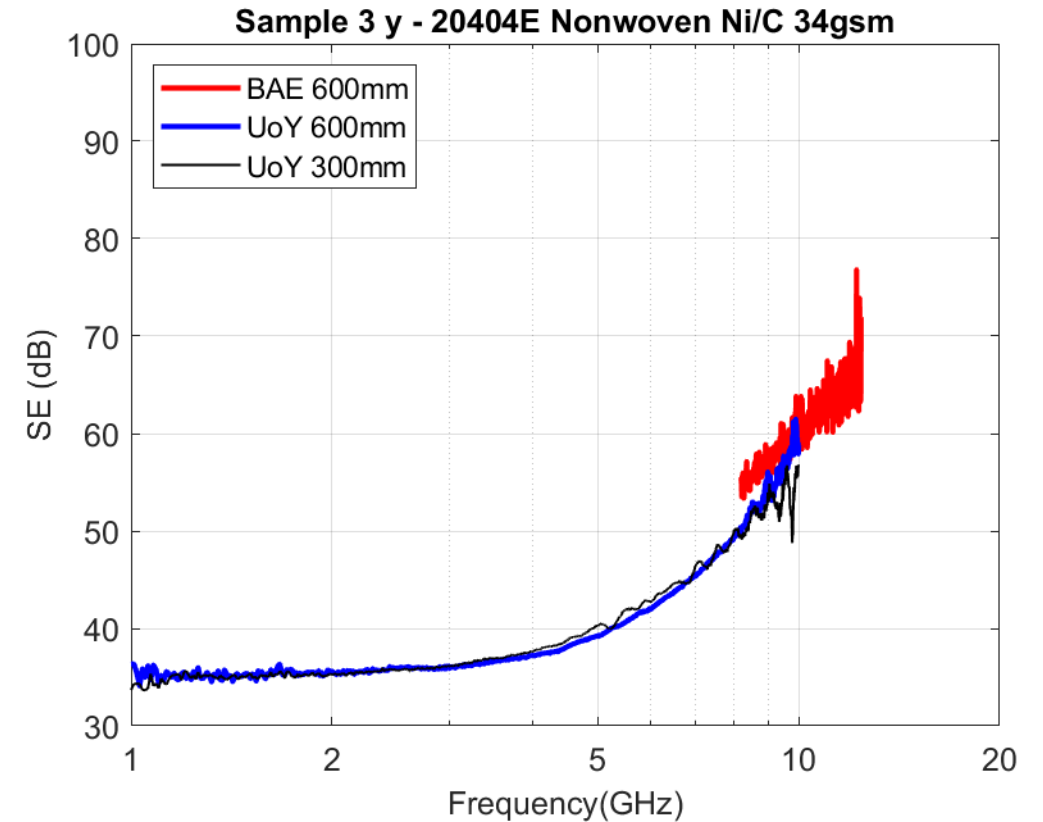
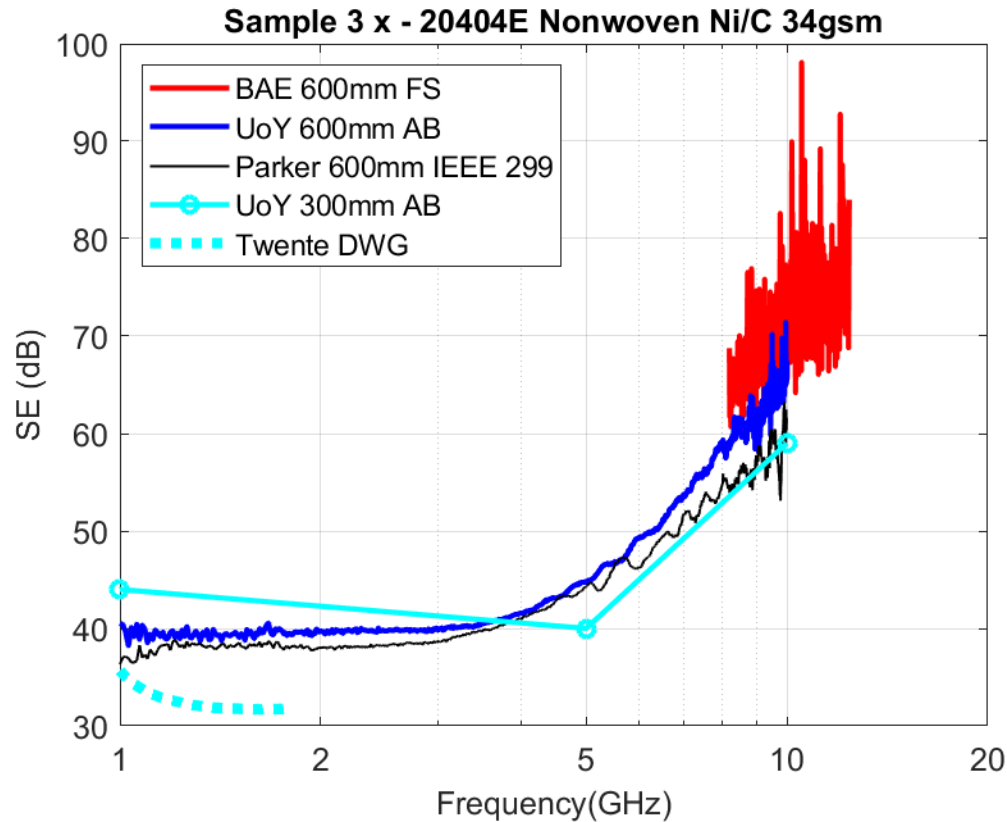
Corrected and uncorrected measurements of second-perforated brass plate (in absorber system) and ASTM cell measurement.

Marvin, A. C.; Dawson, L.; Flintoft, I. D. & Dawson, J. F. , "A Method for the Measurement of Shielding Effectiveness of Planar Samples Requiring No Sample Edge Preparation or Contact" , *IEEE Transactions on Electromagnetic Compatibility* , vol. 51, no. 2 , 255-262 , May, 2009



Comparing the free space (BAE), and Absorber box (UoY) average SE with Coaxial (WUST/La Sapienza) and Reverberation chamber measurements for anisotropic material.

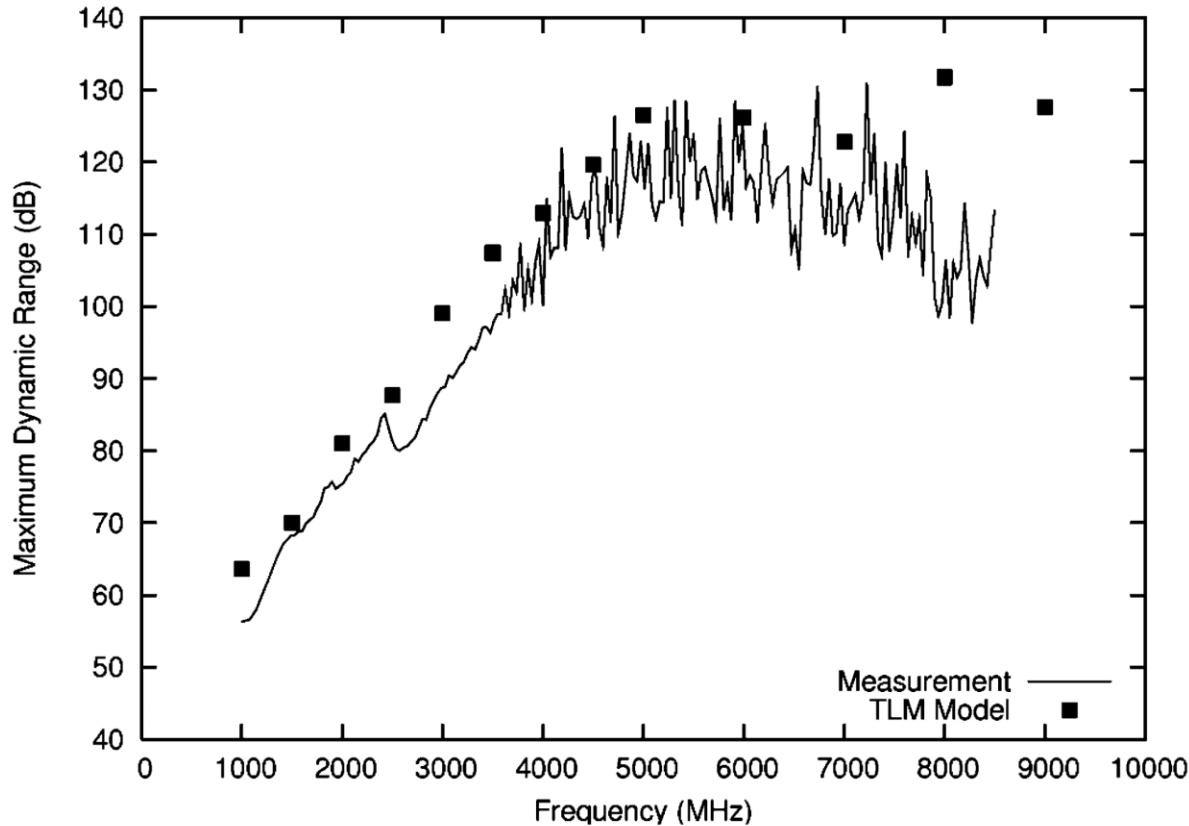
# Anisotropic materials – sample #3



Comparing two orientations for a anisotropic non woven material

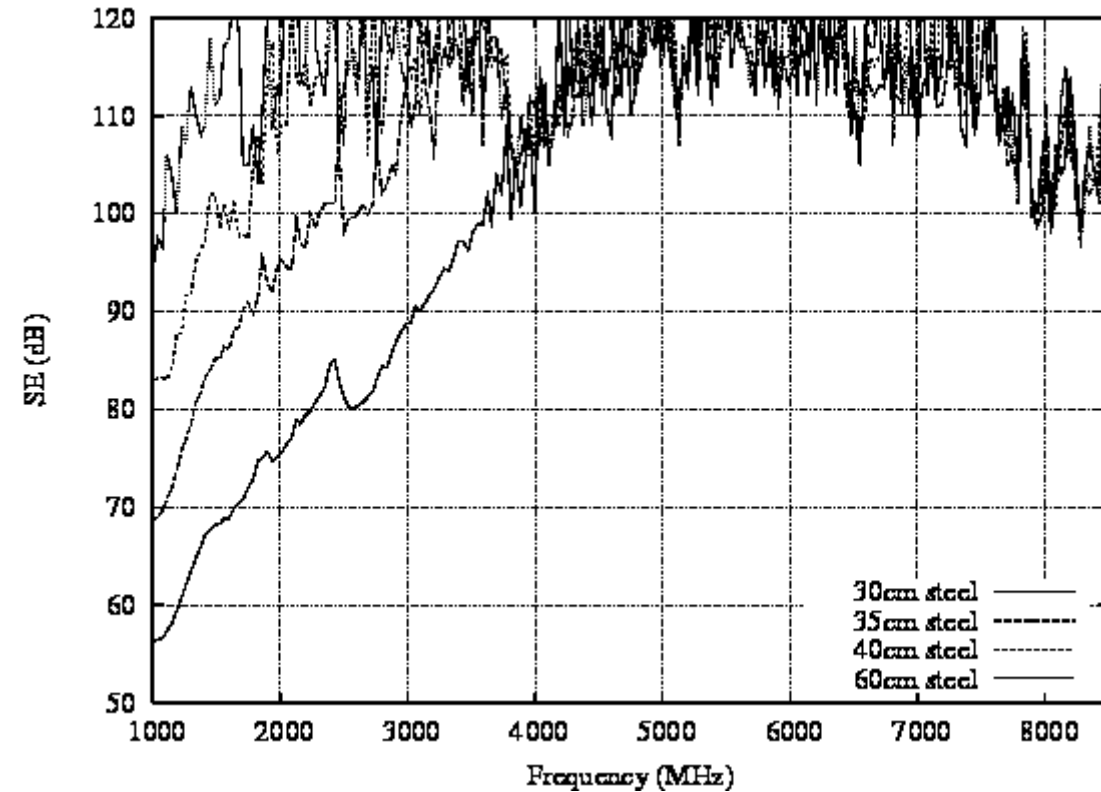
See also: Dawson, J. F.; Austin, A. N.; Flintoft, I. D. & Marvin, A. C. , "Shielding Effectiveness and Sheet Conductance of Nonwoven Carbon-fibre Sheets" , *Electromagnetic Compatibility, IEEE Transactions on* , vol. 59, no. 1 , 84-92 , Feb, 2017 , DOI: 10.1109/TEM.2016.2601658 , Available: <http://eprints.whiterose.ac.uk/104001/>

# Dynamic range



Modeled and measured dynamic range of the absorber system with a 300-mm square sample.

Marvin, A. C.; Dawson, L.; Flintoft, I. D. & Dawson, J. F., "A Method for the Measurement of Shielding Effectiveness of Planar Samples Requiring No Sample Edge Preparation or Contact", *IEEE Transactions on Electromagnetic Compatibility*, vol. 51, no. 2, 255-262, May, 2009



Ultimate Shielding Effectiveness (SE) dynamic range for sample sizes (300mm, 350mm, 400mm and 600mm square).

# Conclusions: Free-space and Absorber box



- Pro
  - Simple method with no surface preparation of sample required
  - Extended low frequency range compared with Free space for given sample size (AB)
    - Low frequency limit is that of antenna
  - Good dynamic range
  - No need to machine sample to fit jig, a range of shapes and sizes possible
  - Fast measurement
  - Can measure anisotropic materials
  - Can measure features such as joints and seams
- Con
  - Needs relatively large sample compared to some methods
    - Sample size must be a number of wavelengths in size (FS only)
    - Sample must overlap absorber sufficiently to achieve isolation (AB only)
  - Needs reference sample (AB only)
  - Upper frequency limit due to higher order modes in absorber waveguide cavity (AB only)