REFLECTION SUPPRESSION TO IMPROVE ANECHOIC CHAMBER PERFORMANCE

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ABSTRACT

Reflections in anechoic chambers can limit the performance and can often dominate all other error sources. This paper will show the results of a new technique developed by NSI to suppress reflections and improve performance in anechoic chambers. The technique, named Mathematical Absorber Reflection Suppression (MARS), is a post-processing technique that involves analysis of the measured data and a special filtering process to suppress the undesirable scattered signals. The technique is a general technique that can be applied to any spherical range. It has also been applied to extend the useful frequency range of microwave absorber in a spherical near-field system. The paper will show typical improvements in pattern performance, and will show validation of the MARS technique using data measured on an antenna in a conventional anechoic chamber.

Keywords: radome, absorber, reflection, spherical near-field, suppression

1. Introduction

This paper describes a proprietary technique developed by NSI to suppress reflections in a spherical near-field test range.

NSI first implemented the MARS technique to support operation in a hemi-spherical automotive near-field test system that NSI recently installed for Nippon Antenna in Itzehoe Germany [1]. NSI has also extended the MARS technique for operation with other spherical near-field test systems with limited or no absorber, as well as for use in improving the reflection performance in a traditional anechoic chamber [2].

Figure 1 – NSI-700S-50 Spherical NF Test Range

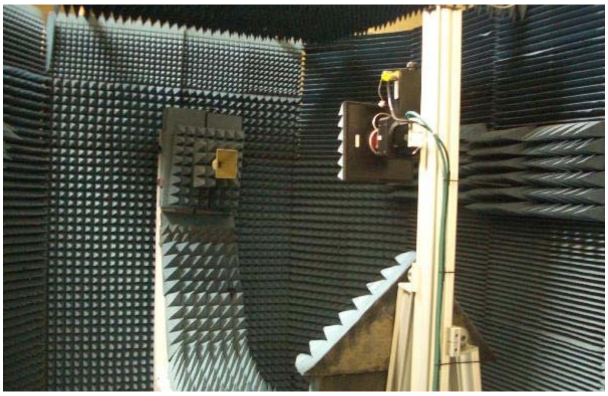

Figure 2 – NSI-700S-60 Spherical NF Test Range

Figure 3 – NSI-700S-90 Spherical NF Test Range

2. MARS Description

The purpose of the MARS approach is to reduce the influence of scattering on far-field pattern results. We use a mathematical post processing technique that requires a minimum amount of detailed information about the AUT, probe and antenna range geometry. The processing is applied during regular near-field to far-field processing. The technique is general enough to apply to different types of spherical measurement geometries and to different antenna types. NSI has developed a mathematical operator that is applied to the measured data that helps to distinguish between the correct antenna properties and scattering. Successful processing requires more measured data than for the AUT without scattering for best performance - typically requires one half the spacing in theta and phi than recommended by sampling criteria. This will usually require about double the test time, compared to normal measurements.

3. Testing antenna in 3 different systems

We will compare test results – patterns, directivity, and beam-widths from measurements of a NSI-RF-SG284 measured on 3 different spherical NF antenna ranges over a frequency range of 2.6 to 3.95 GHz. The range configurations are summarized in the table below:

Figure	Type	Location	NSI Scanner	Absorber
#1	Chamber	Customer	NSI-700S-50	12" pyramid
#2	Chamber	NSI	NSI-700S-60	8" pyramid
#3	Open lab	NSI	NSI-700S-90	NONE!

All the ranges are running NSI2000 Data acquisition and processing software, and we used the Agilent PNA for the RF subsystem. Data in the customer facility was measured using a NSI-RF-WR284 open ended waveguide probe, and the data in the other two ranges was measured using an NSI dual-port probe. Range positioner axis alignment was performed using NSI's electrical alignment technique documented in [3] [4] [5].

Figures 4 shows the near-field measured data of the SGH on the 700S-90 arch range with no absorber or chamber, using NSI's 3-D field viewer. One can easily see the ripple in the 3-D display and pattern cuts at about the -25 dB level due to range reflections. In figure 5, we show the result in NSI-s 700S-60 scanner in the anechoic chamber at NSI, and the reduced reflections are apparent.

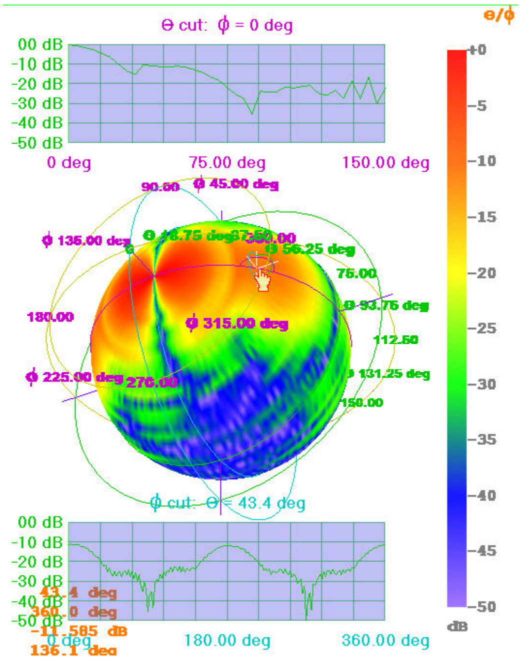

Figure 4 – NSI-RF-SG284 gain horn tested at NSI on NSI-700S-90 ARCH Spherical NF in open environment with NO anechoic chamber – notice ripple in pattern at about -25 dB level due to range reflections

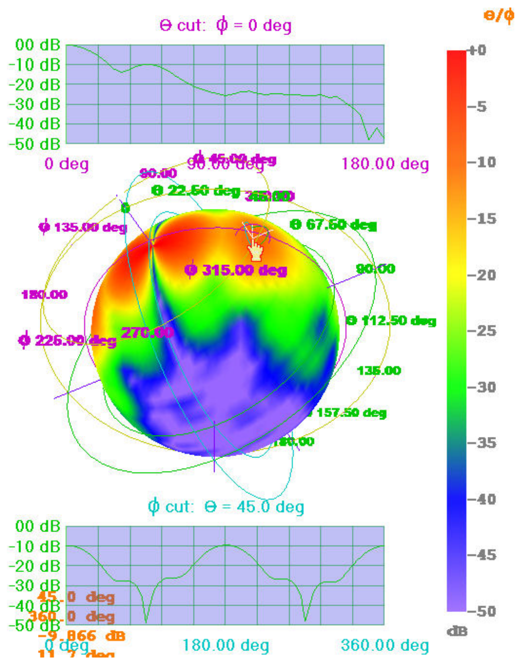

Figure 5 – NSI-RF-SG284 gain horn tested at NSI on NSI-700S-60 Spherical NF in chamber

4. MARS Far-field Pattern Results

Figure 6 shows the far-field calculated pattern of the SGH on the NSI-700S-90 scanner with no absorber or chamber at 3.15 GHz.

MARS processing yields the result in figure 7. Clear improvement in the main beam pattern shape due to reduction of the effects of the reflections is seen.

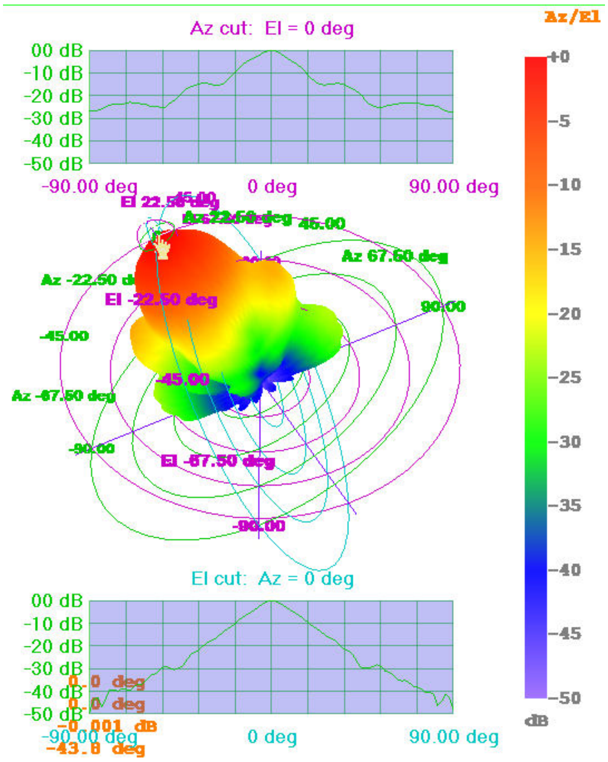

Figure 6 – NSI-RF-SG284 Standard Gain Horn tested on NSI-700S-90 scanner with no absorber or chamber – <u>MARS correction OFF</u>

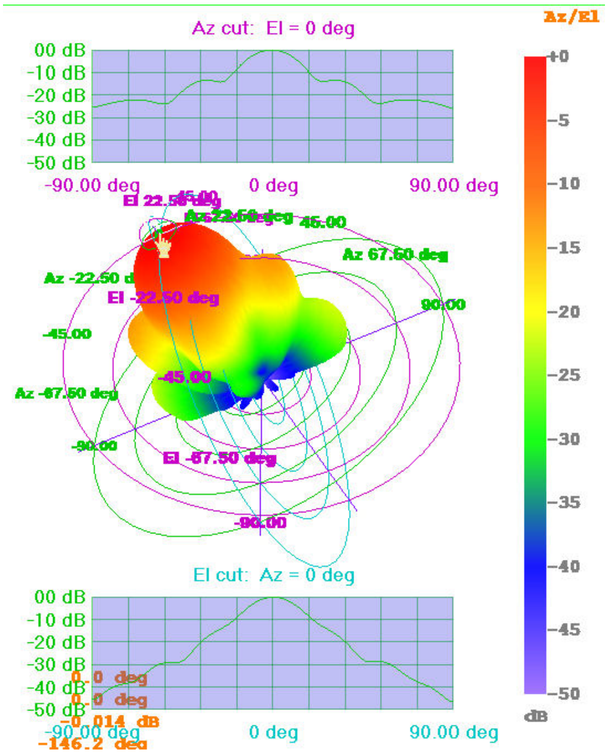

Figure 7 – NSI-RF-SG284 Standard Gain Horn tested on NSI-700S-90 scanner with no absorber or chamber – <u>MARS correction enabled</u>

The same type of SGH was tested with our 700S-50 scanner in a customer chamber with 12” pyramidal absorber, and on the NSI-700S-60 scanner at NSI with 8” pyramidal absorber. A comparison between the results in the two chambers shows a -34 dB error level (figure 8)

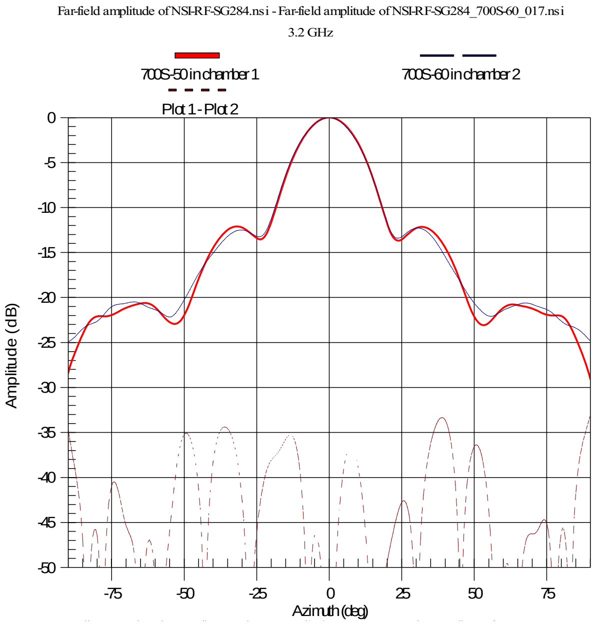

Figure 8 – Far-field comparison at 3.2 GHz of SGH data taken in NSI chamber vs. customer chamber

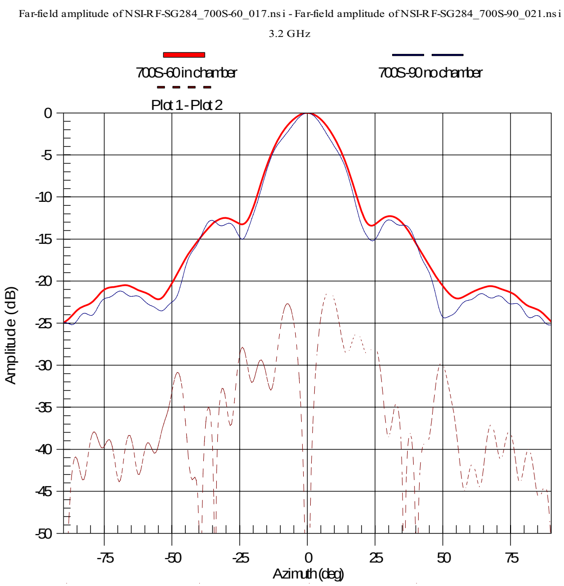

Figure 9 – Far-field comparison at 3.20 GHz of SGH data taken in chamber versus on 700S-90 ARCH range with no absorber or chamber, with <u>no MARS correction</u>

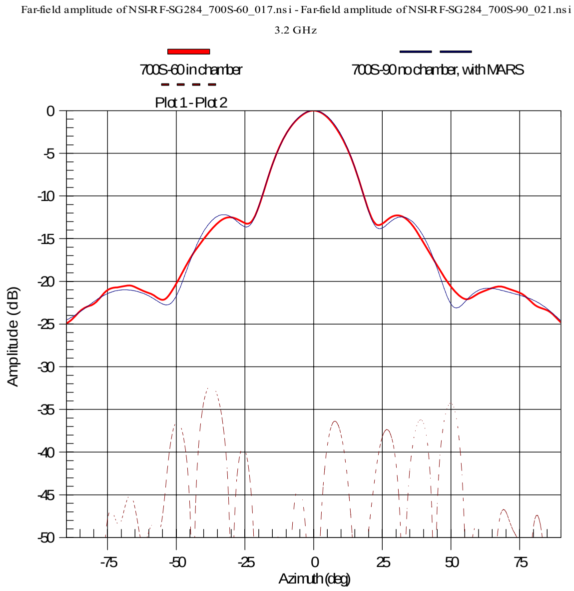

Figure 10 – Far-field comparison at 3.20 GHz of SGH data taken in chamber versus on 700S-90 ARCH range with no absorber or chamber, with <u>MARS correction enabled</u>

Measuring the SGH in the open lab environment of the 700S-90 scanner with no absorber or chamber, yields quite a different result as shown in figure 9. Here the unsuppressed reflections give rise to only about a -21 dB error level from a comparison to the chamber data. However, using the MARS suppression technique shows the result in figure 10, where the error level has been suppressed back to about -33 dB – almost as good as the comparison between the two anechoic chambers. Thus we can conclude that the MARS suppression gives about a 12 dB improvement in chamber performance.

5. MARS Directivity Results

To check the performance over a broader frequency range, we can use the multi-frequency data on the SGH to calculate the directivity performance versus the NRL directivity calculations with and without the MARS processing. Figure 11 and 12 show this result. The maximum difference from the NRL curve with MARS off is about 1.7 dB, whereas when the MARS processing is applied, the large discrepancies disappear and the maximum difference drops to only about 0.5 dB.

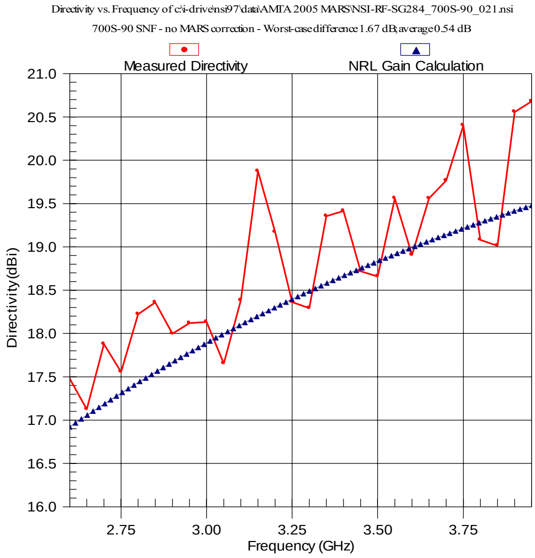

Figure 11 – Directivity vs. frequency on 700S-90 ARCH range with no absorber or chamber, compared to NRL directivity, with no MARS correction

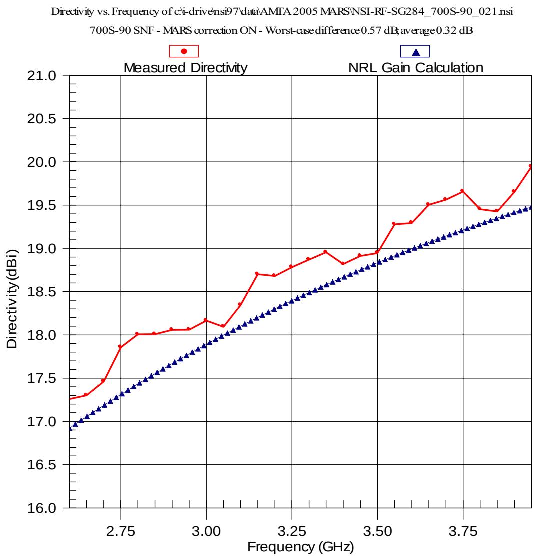

Figure 12 –Directivity versus frequency on 700S-90 ARCH range with no absorber or chamber, compared to NRL directivity, with MARS correction

Figures 13 and 14 show the results in the two anechoic chambers. The table below summarizes the 4 plots.

Scanner	Chamber	Max diff. (dB)	Ave diff. (dB)
700S-90	No - MARS off	1.67	0.54
700S-90	No - MARS ON	0.57	0.32
700S-50	Yes	0.45	0.26
700S-60	Yes	0.37	0.17

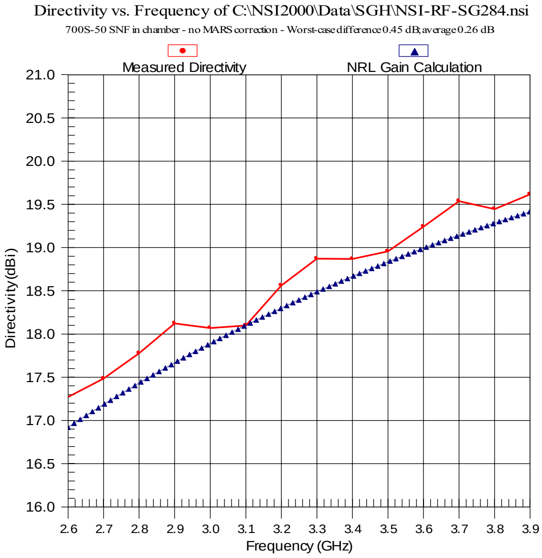

Figure 13 – Directivity vs. frequency on 700S-50 in chamber at customer site, compared to NRL directivity (only 14 frequencies)

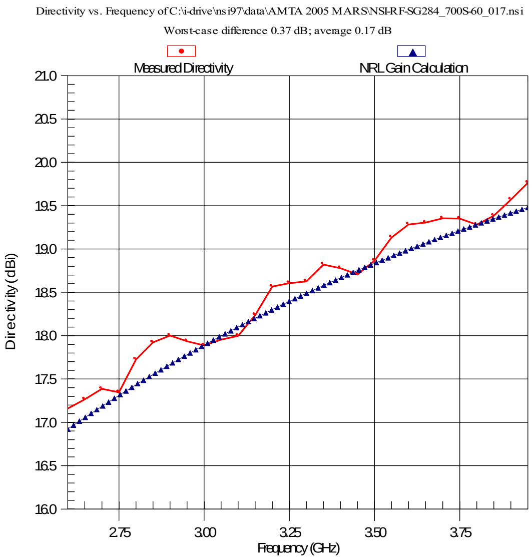

Figure 14 – Directivity vs. frequency on 700S-60 in chamber at NSI, compared to NRL directivity

6. MARS Beamwidth Results

Figures 15 and 16 show the beamwidth result for the two chambers and the results are quite similar as expected. Figure 17 shows the poor results for the 700S-90 range with no absorber or chamber. Figure 18 shows the improved results using the MARS suppression.

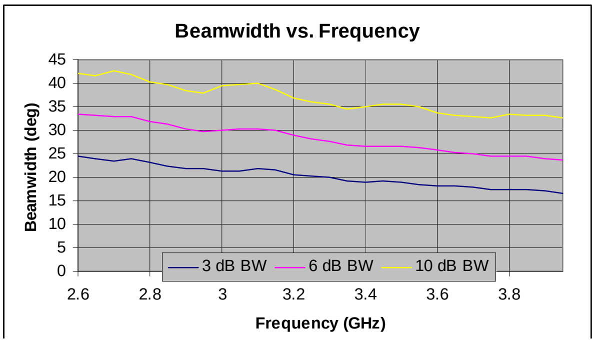

Figure 15 –Beamwidth versus freq - 700S-60 chamber

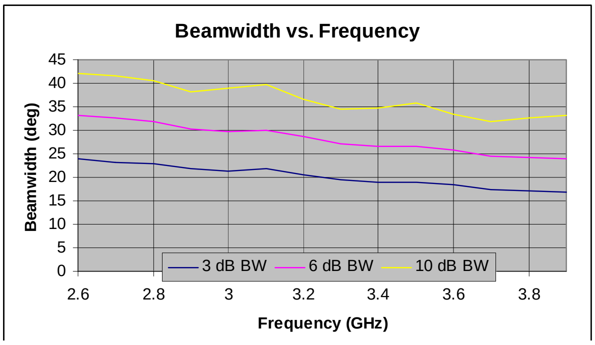

Figure 16 –Beamwidth versus freq - 700S-50 chamber

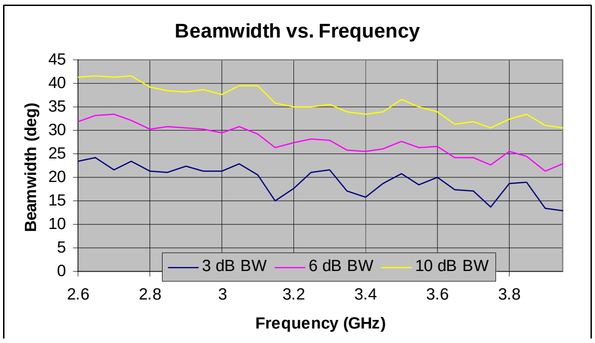

Figure 17 –Beamwidth versus frequency on 700S-90 scanner – no absorber or chamber

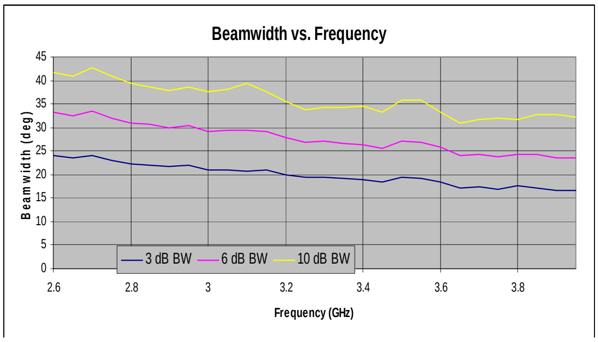

Figure 18 –Beamwidth versus frequency on 700S-90 scanner – no absorber or chamber – WITH MARS

7. Summary

NSI has developed and validated a novel technique to suppress reflections on spherical near-field ranges. The technique is quite general and can be used to achieve acceptable results with use of minimal absorber or even with no anechoic chamber. It can also improve the reflection levels in a traditional anechoic chamber by 10 dB or more, allowing improved accuracy as well as the ability to use existing chambers down to lower frequencies than the absorber used might indicate.

8. REFERENCES

[1] Betjes, P., Pototzki, D., van Rensubrg, D.., " A hemi-spherical near-field system for automotive antenna testing", AMTA 27th Annual Meeting & Symposium, Newport, RI, Oct. 2005.

[2] Hindman, G, Newell, A.C., " Reflection Suppression in a large spherical near-field range", AMTA 27th Annual Meeting & Symposium, Newport, RI, Oct. 2005.

[3] Newell, A. C., Hindman, G., "The alignment of a spherical near-field rotator using electrical measurements" In the proceedings of the 19th annual AMTA Meeting and Symposium, Boston, MA, 1997.

[4] Newell, A. C., Hindman, G., "Quantifying the effect of position errors in spherical near-field measurements", In the proceedings of the 20th annual AMTA Meeting and Symposium, pp 145-149, Montreal, Canada, 1998.

[5] Newell, A.C., "The effect of measurement geometry on alignment errors in spherical near-field measurements", AMTA 21st Annual Meeting & Symposium, Monterey, California, Oct. 1999.