EMC TEST SYSTEMS, L.P. – An ESCO Company

May 30, 2000

TEST REPORT OF PERFORMANCE OF THE ARRISTA TECHNOLOGIES, INC. 3M SEMI-ANECHOIC CHAMBER AS TESTED ON MAY 29-30, 2000

Prepared for

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1.0 INTRODUCTION

1.1 Introduction to the Arrista Technologies, Inc. 3m Chamber

In May of 2000, Arrista Technologies, Inc. in Winnipeg, Manitoba, Canada, completed a 3m indoor, shielded, semi-anechoic chamber. The chamber was constructed by Rantec Division of EMC Test Systems, L.P., with the capability of measuring Class B electronic devices that must comply with FCC Rules Part 2 section 2.948. In addition to this report, Arrista Technologies, Inc. has also been provided with all measured data in MS Excel spreadsheet format.

1.2 Location of the Arrista Technologies, Inc. 3m Chamber

The 3m Chamber of Arrista Technologies, Inc. is located at

5-55 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4
Attn: Mr. Roman Wroczynski
Tel: 204-489-3200
Fax: 204-489-8300

2.0 PHYSICAL LAYOUT AND THE SITE DESCRIPTION

2.1 Shielded Enclosures

The EMC radiated test facility consists of a RF-shielded enclosure. The interior shield to shield dimensions of the indoor semi-anechoic chamber are approximately 28 feet long by 20 feet wide by 18 feet high and consist of rigid, steel-clad, wood core modular panels with steel framing. In the shielded enclosure, the faces of the panels are galvanized and the chamber is self-supporting. The framing/joining system channels are made of 1/8 inch zinc plated steel, and have serrations running lengthwise along each side of the contacting surface. Screw fasteners, 4 inches on center, are zinc-plated and fasten the steel framing to the modular panels, thus forming the shielded enclosure. At all corner intersections of walls, floor or ceiling, a specially fabricated one-piece corner section completes the assembly.

Lighting in the semi-anechoic chamber within the shielded enclosure is RF-filtered. In the semi-anechoic chamber, lighting consists of four (4) corner-mounted incandescent floodlight fixtures. A swing type shielded door is provided for personnel and equipment access into the semi-anechoic chamber. Door specifications are:

Chamber door	4' X 7'	Brass Knife 100 dB	Swing (single leaf)
Control room door	3' X 7'	Brass Knife 100 dB	Swing (single leaf)

HVAC is provided by four honeycomb wave-guide air vents mounted in the chamber's ceiling. The semi-anechoic chamber is capable of meeting RF attenuation levels of over 100dB throughout the frequency range of 30 MHz to 10 GHz, so that testing performed within the chamber does not interfere with other testing activities at the facility, and vice-versa.

2.2 Turntable and Ground Plane

The turntable is an electrically driven EMCO Model 2081-2.03 metal top turntable with two-meter diameter and capable of supporting a uniformly distributed load of up to 3300 lb. The turntable is grounded around its circumference with continuous metallic brush to the semi-anechoic chamber floor by a grounding ring. The electrically driven turntable does not introduce conducted or radiated electrical noise above the ambient levels existing with the chamber. The turntable rotation is controlled by an EMCO Model 2090 Multi-device Controller with IEEE-488 data/control for automation.

Interconnecting cables may be routed along an access area through the turntable's center bearing. A sleeve is provided to prevent the cables from rubbing against the main bearing when the turntable is in motion.

The chamber's sixteen inch raised ground plane consists of a continuous metallic surface with vinyl top surface finishing.

2.3 Antenna Mast

An EMCO Model 2075-2 electrically powered, air-polarized, antenna tower mast is used in the chamber. This mast features computerized remote control of both the scanning height and the antenna polarization. It is also controlled by the EMCO Model 2090 Multi-device Controller with IEEE-488 data/control for automation.

2.4 Power Facilities

Power is supplied on separate circuits to the chamber and control area. All power filters provide a minimum of 100 dB attenuation over a frequency range of 14 kHz to 10 GHz when tested per MIL STD 220A. Seven (7) ULW-2x30 amp, 60 Hz, UL-listed power-line filters are provided for the chamber and control room.

2.5 Control Area

The control area is a shielded enclosure made of the same construction as the semi-anechoic chamber with dimensions of 10 feet by 10 feet by 8 feet. Three shielded conduits provide access for RF, fiber optic and control cables to enter the chamber.

2.6 Anechoic Absorbers

Rantec Division of EMC Test Systems provided anechoic treatment for the chamber sufficient to achieve the requirements of ANSI C63.4 1992 at 3 meter distance. The anechoic design consists of broadband hybrid EMC absorber, *FerroSorb™*, designated as *FS-400* by Rantec, covering the endwall behind the turntable and a specular region of the ceiling and *FS-600* covering a specular region of each sidewall. The absorbing material is a combination of dielectric foam absorber and magnetic ferrite tile materials. The remaining wall and ceiling areas are treated with Rantec's *FT-1000 and FT-1500* ferrite tile absorber material.

2.7 Quiet Zone and Test Range Position

The quiet zone for the 3 meter test range is a cylinder two (2) meters in diameter per the volumetric quiet zone testing requirement specified in ANSI C63.4 document. All five test positions of the test volume (i.e. center front, back, left, and right) were measured and included in this report. The axis of the chamber's

primary 3 meter test range is positioned from the turntable's center to a point 8 feet 4 inches from the chamber's wall (door side).

3.0 NORMALIZED SITE ATTENUATION TEST METHOD PER ANSI C63.4-1992

3.1 Test Method

The swept frequency method with broadband antennas was employed to perform site calibration test of the chamber. These measurements were carried out in accordance with ANSI C63.4-1992 requirements. The measurement condition of the swept frequency method and equipment used are listed in Table 1.

The reference signal level is first measured by connecting the coaxial cables before the site attenuation measurement. The reference signal is stored in the vector-network analyzer. The coaxial cables are then connected to the transmit and receive antennas, respectively. A constant projection separation of 3m is kept between the transmit and receive antennas. The distance is measured from the center of biconical and log-periodic, and tip of the horn antennas. The received signal is maximized while the receive antenna is scanning from 1 to 4 meters. The maximum received signal during height scan is used to compute the Normalized Site Attenuation.

$$NSA(dB) = V_{Direct} - V_{\mathrm{Re}\,ceived}^{Max} - AF_{Tx} - AF_{Rx}$$

Where:

V_{Direct} *reference signal level in dBμV/meter with cables connected directly*
$V_{\mathrm{Re}\,ceived}^{Max}$ *maximum received signal level in dBμV/meter during height scan*
AF_{Tx} *antenna factor of the transmitting antenna in dB / meter.*
AF_{Rx} *antenna factor of the receiving antenna in dB / meter.*

In April, 2000, the Biconical and Log-periodic antennas used were calibrated using the swept-frequency method at Liberty Labs Inc. open area test site at Kimballton, Iowa according to ANSI C63.5-1992. In May, 2000, the Quad-ridged Horn Antennas used were calibrated using the swept-frequency method at ETS's OATS in Austin, Texas, according to ANSI C63.5-1992. The antenna factors for these antennas are listed in Figures 17-19. The measured NSA is then compared to the theoretical NSA derived from an ideal open area site to obtain NSA deviations.

3.2 Measured Data

The measured NSA data obtained by using the swept-frequency method is shown in Figures 1 to 16 for each polarization and each transmit antenna height.

Biconical Antennas are used to conduct the test between 30 and 200 MHz with 401 data points measured, Log-periodic Antennas between 200 and 2000 MHz with 801 data points measured, and Quad-ridged Horn Antennas between 2-18 GHz with 801 data points measured. The test results are combined into graphs to cover 30 MHz to 1 GHz and 1-18 Ghz frequency range for each test configuration.

The test data for the primary test range at 3m test distance with two (2) meter diameter test volume showed a better than ±3.2dB normalized site attenuation deviation from the theoretical NSA derived from an ideal open test site.

All normalized site attenuation test data at all test positions derived from the measurements in the semi-anechoic chamber are within ±4 dB deviation from theoretical NSA derived from an ideal open test site.

4.0 TEST EQUIPMENT LIST

Test equipment for conducting normalized site attenuation test is shown in Table 1.

All instrumentation is calibrated on a yearly basis, usually by manufacturers. The antennas are calibrated in accordance with ANSI C63.5-1988. All instrument and antenna calibrations are traceable to NIST. The antenna factors at three (3) meter test distance are shown in Figs.17-19.

Appendix A.1

Table 1.

Test equipment used for measuring Normalized Site Attenuation:

TYPE OF EQUIPMENT	MODEL NUMBER	MANUFACTURER	CALIBRATION DUE DATE
NSA Measurement Software	WinCal™	EMC Test Systems	NA
Laptop Computer with Windows 95	Latitude CPI 300	DELL Computer	NA
Vector Network Analyzer	HP 8753C S/N:3025A01091	Hewlett Packard	March 28, 2001
S-Parameter Test Set	HP 85047A S/N:2936A01401	Hewlett Packard	March 28, 2001
Type-N Calibration Kit	HP 85032B S/N:2541A02095	Hewlett Packard	February 28, 2001
Vector Network Analyzer	HP 8720A S/N: 2749A00347	Hewlett Packard	January 18, 2001
Biconical Antenna 30MHz-200MHz	EMCO 3124 S/N: 0004-1001	EMC Test Systems	April 27, 2003
Biconical Antenna 30MHz-200MHz	EMCO 3124 S/N: 0004-1002	EMC Test Systems	April 27, 2003
Log Periodic Antenna 200MHz-2000MHz	EMCO 3148 S/N: 9907-1071	EMC Test Systems	April 26, 2003
Log Periodic Antenna 200MHz-2000MHz	EMCO 3148 S/N: 0003-1149	EMC Test Systems	April 26, 2003
Quad-ridged Horn Antenna 2-18 GHz	A6100 S/N:C76700	General Instruments	May 16, 2003
Quad-ridged Horn Antenna 2-18 GHz	A6100 S/N:C76800	General Instruments	May 16, 2003
Antenna Positioner Controller **(provided by Arrista Technologies, Inc.)**	EMCO 2090 S/N: 9812-1384	EMC Test Systems	NA
Antenna Positioner **(provided by Arrista Technologies, Inc.)**	EMCO 2075-2 S/N: 9812-2208	EMC Test Systems	NA

Appendix A.2

Normalized Site Attenuation and Combined Antenna Factors

Fig. 1. Primary 3m Range: Measured NSA Horiz. Pol., D=3m, Tx=1m

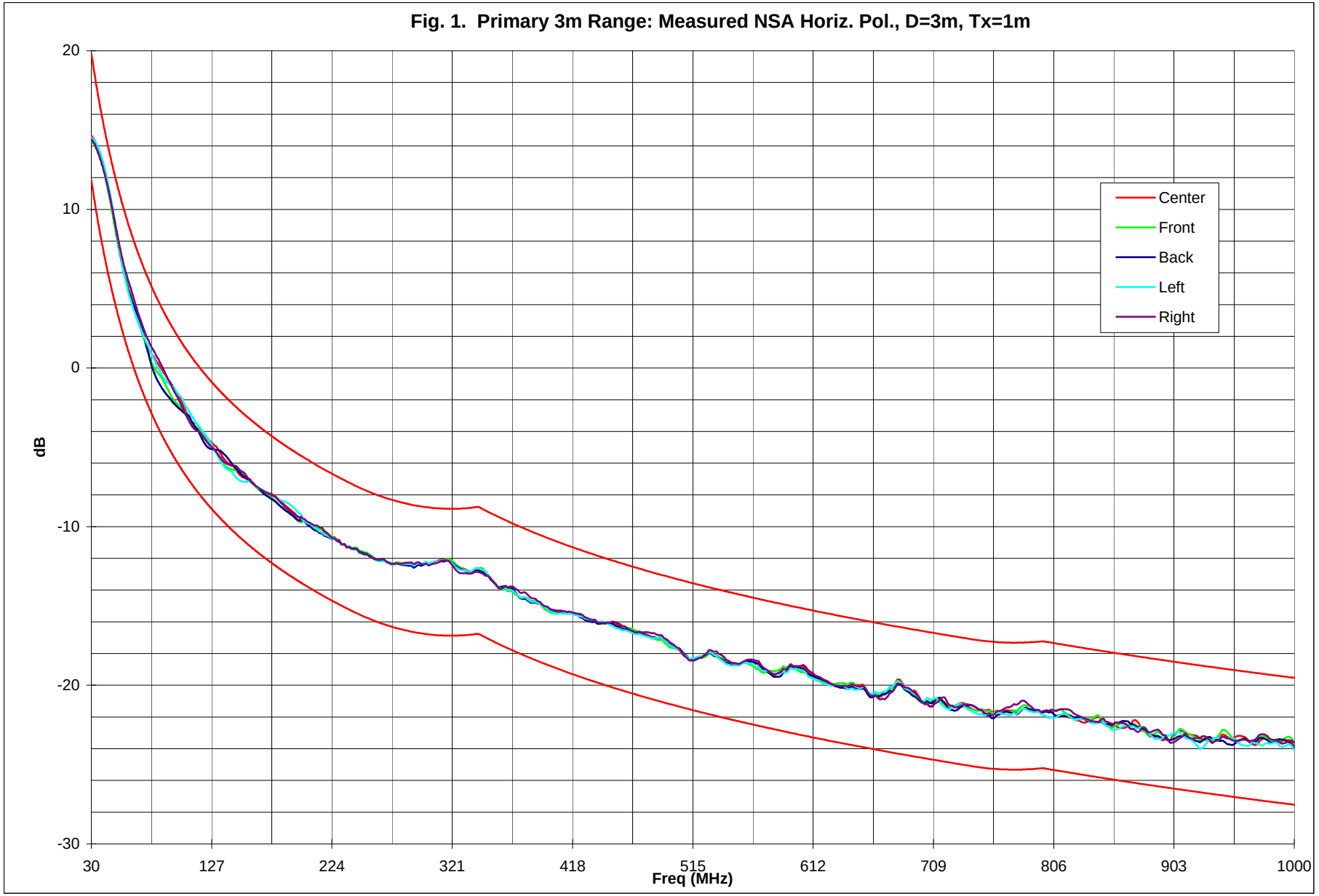

Fig. 2. Primary 3m Range: Delta NSA Horiz. Pol., D=3m, Tx=1m

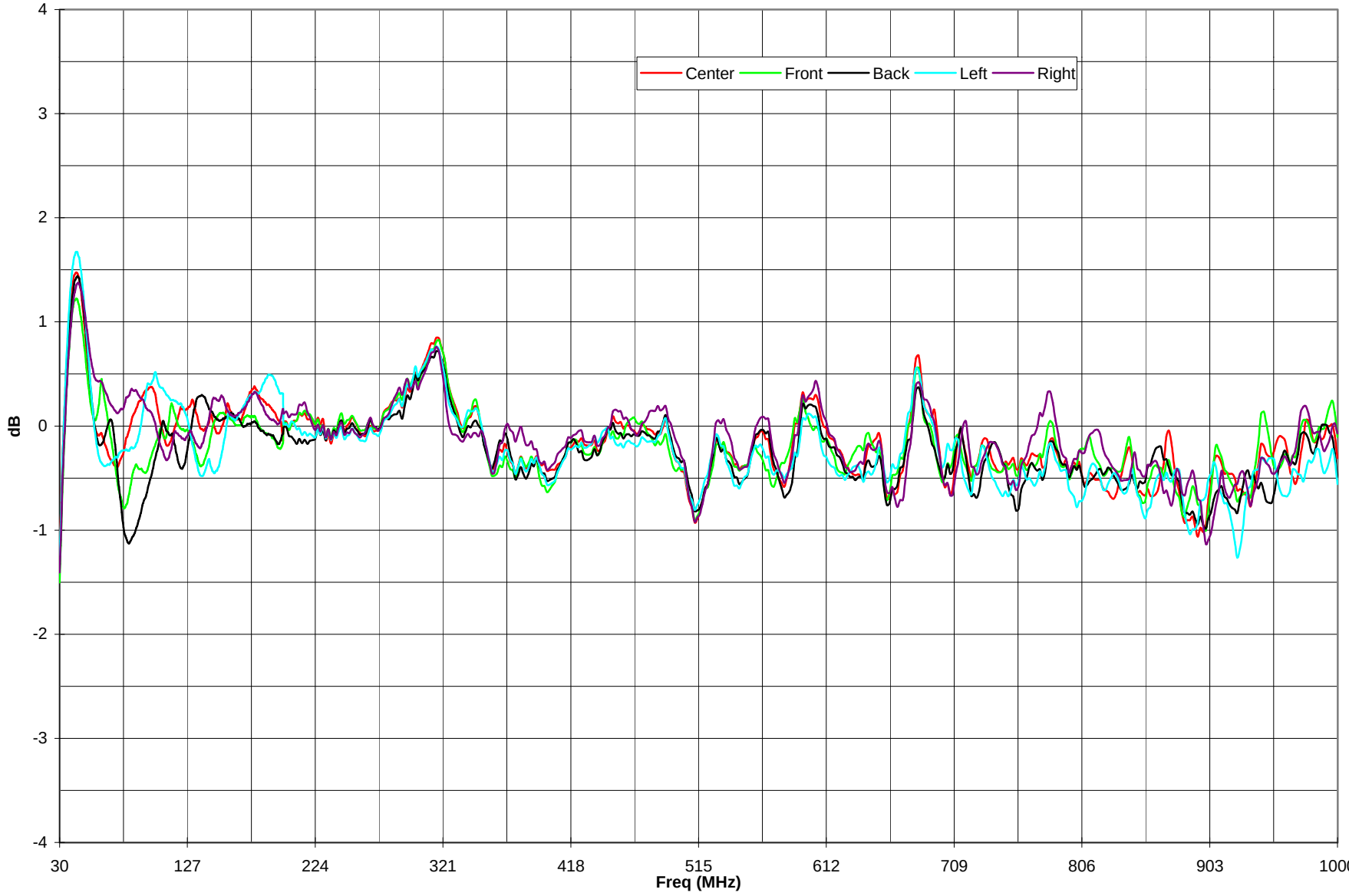

Fig. 3. Primary 3m Range: Measured NSA Vert. Pol., D=3m, Tx=1m

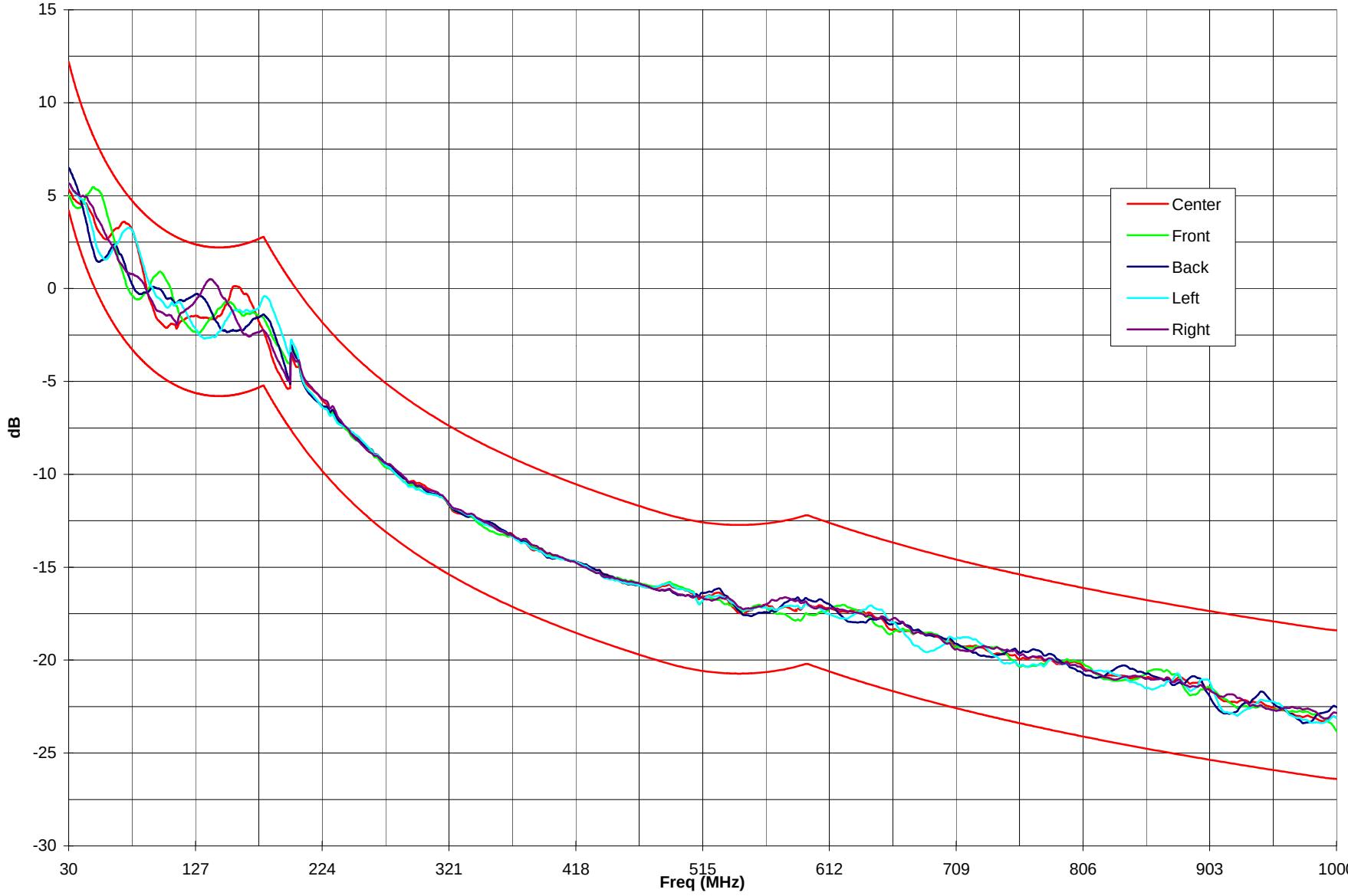

Fig. 4. Primary 3m Range: Delta NSA Vert. Pol., D=3m, Tx=1m

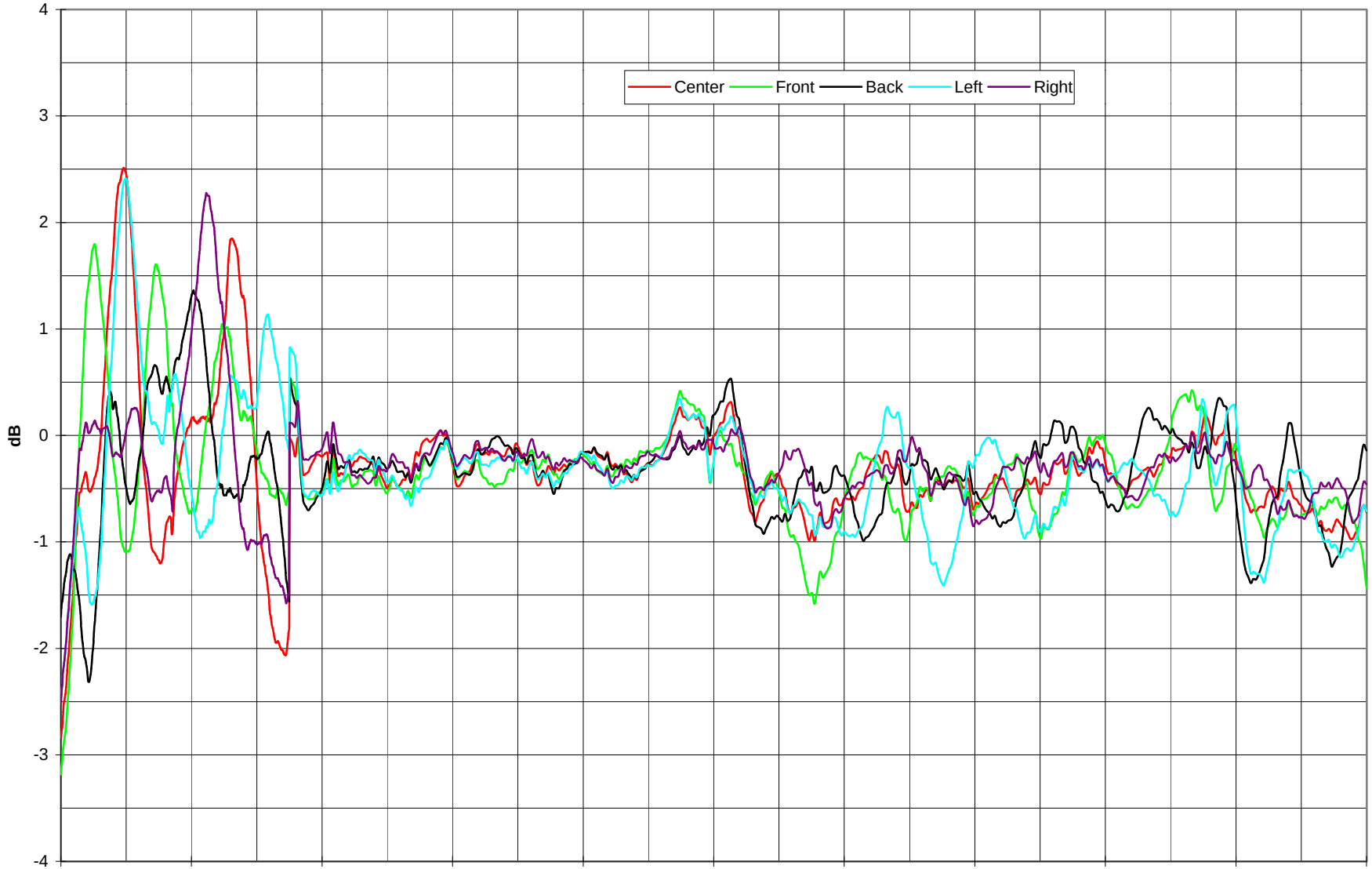

Fig. 5. Primary 3m Range: Measured NSA Vert. Pol., D=3m, Tx=1.5m

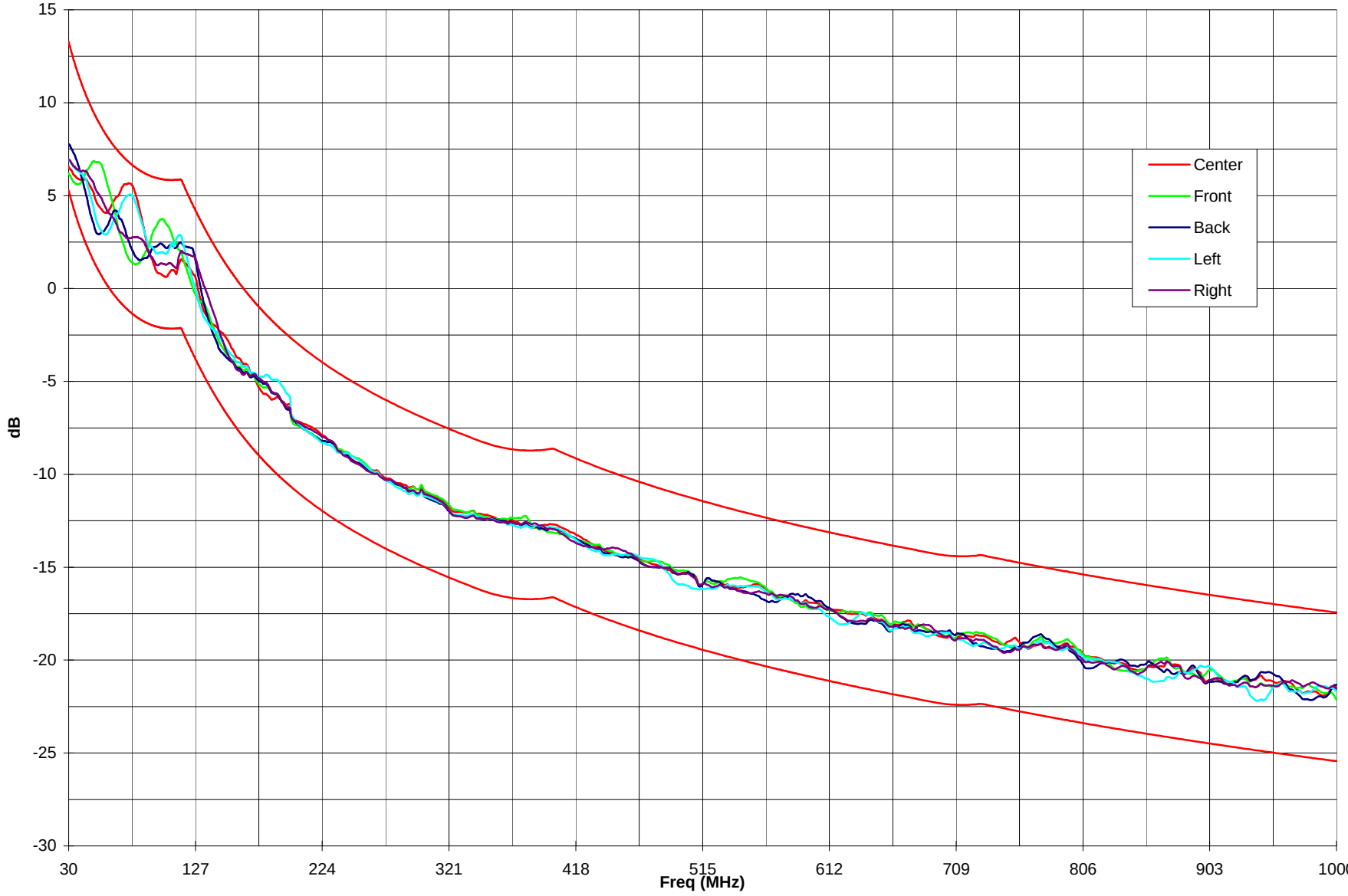

Fig. 6. Primary 3m Range: Delta NSA Vert. Pol., D=3m, Tx=1.5m

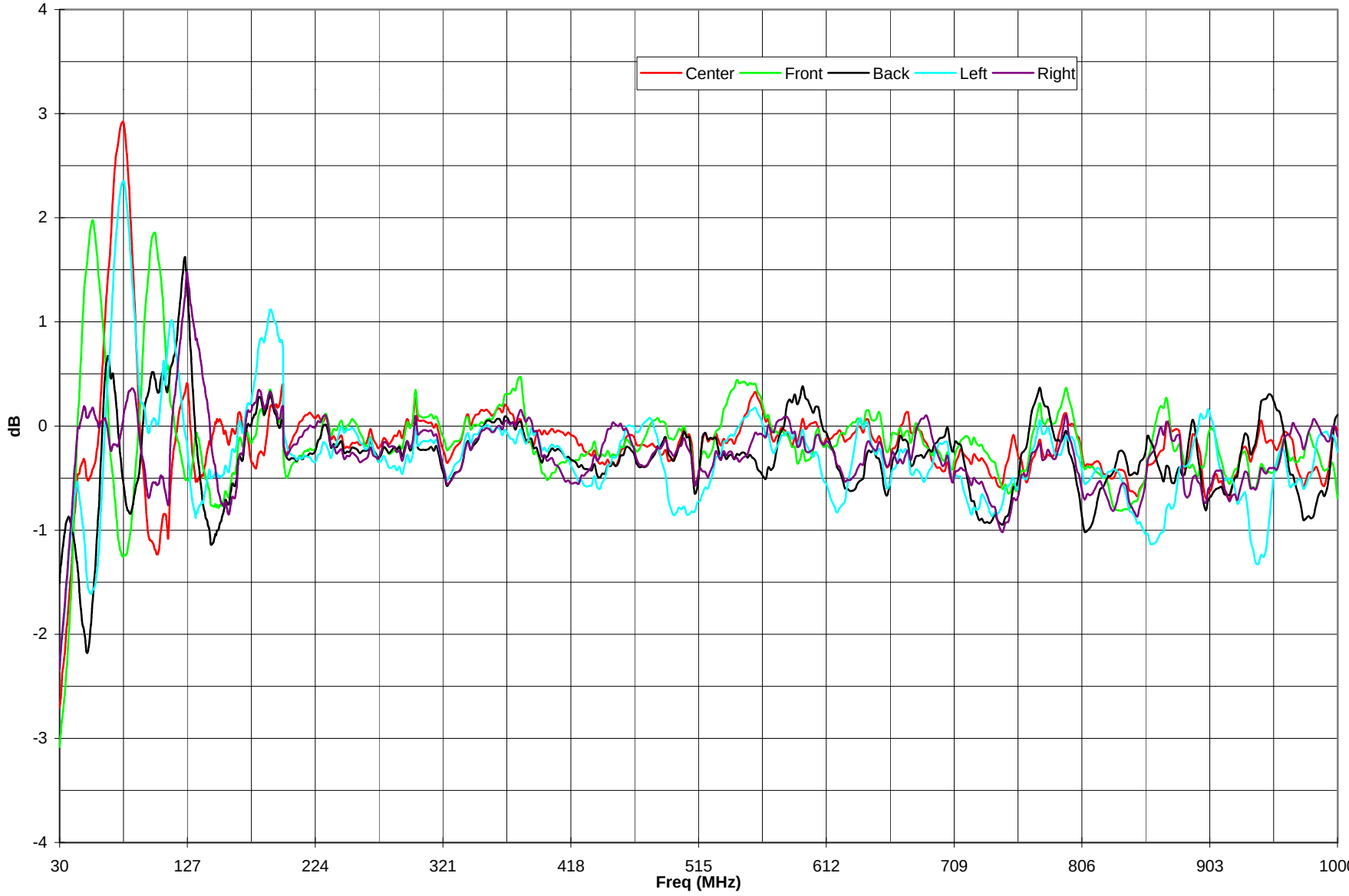

Fig. 7. Primary 3m Range: Measured NSA Horiz. Pol., D=3m, Tx=2m

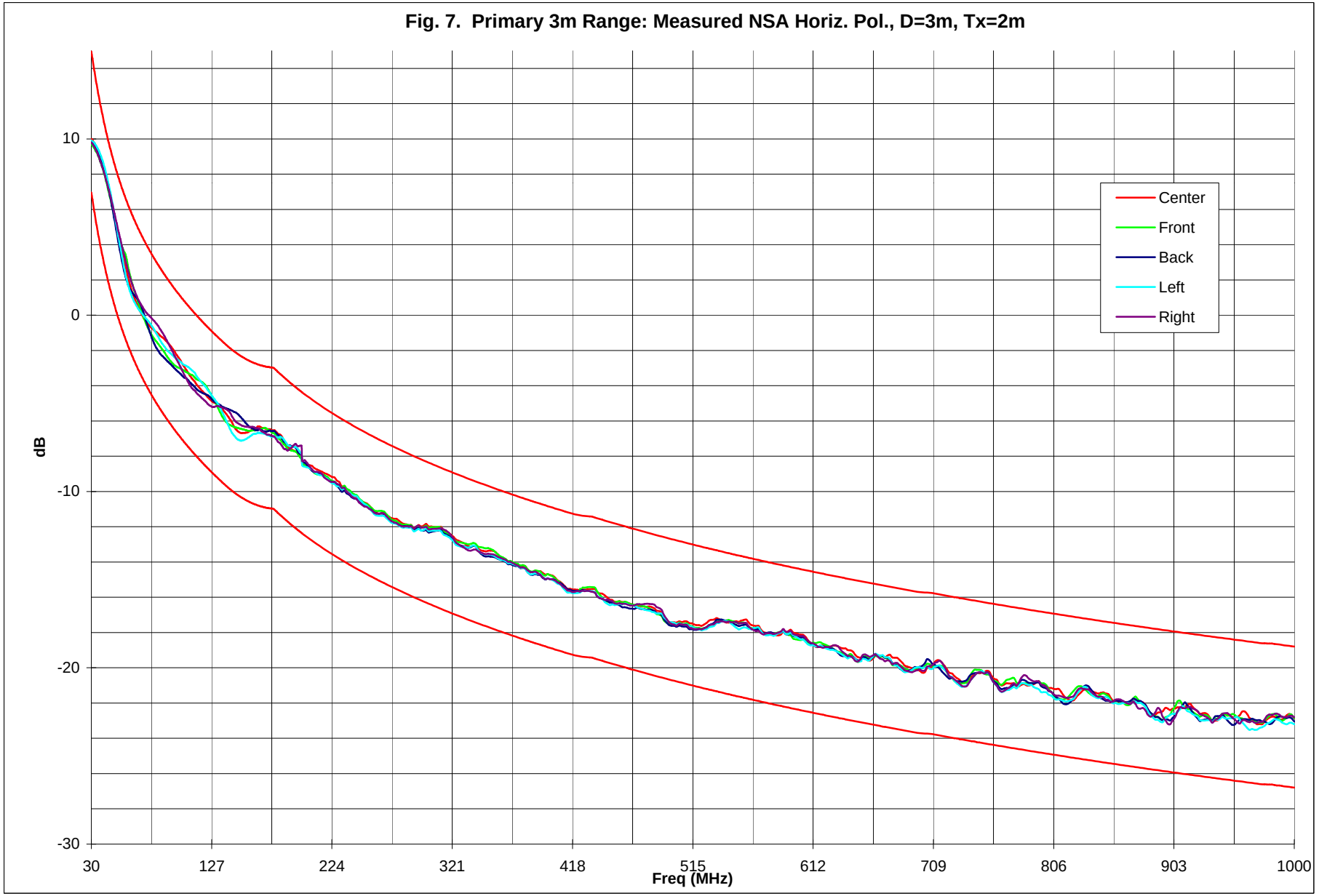

Fig. 8. Primary 3m Range: Delta NSA Horiz. Pol., D=3m, Tx=2m

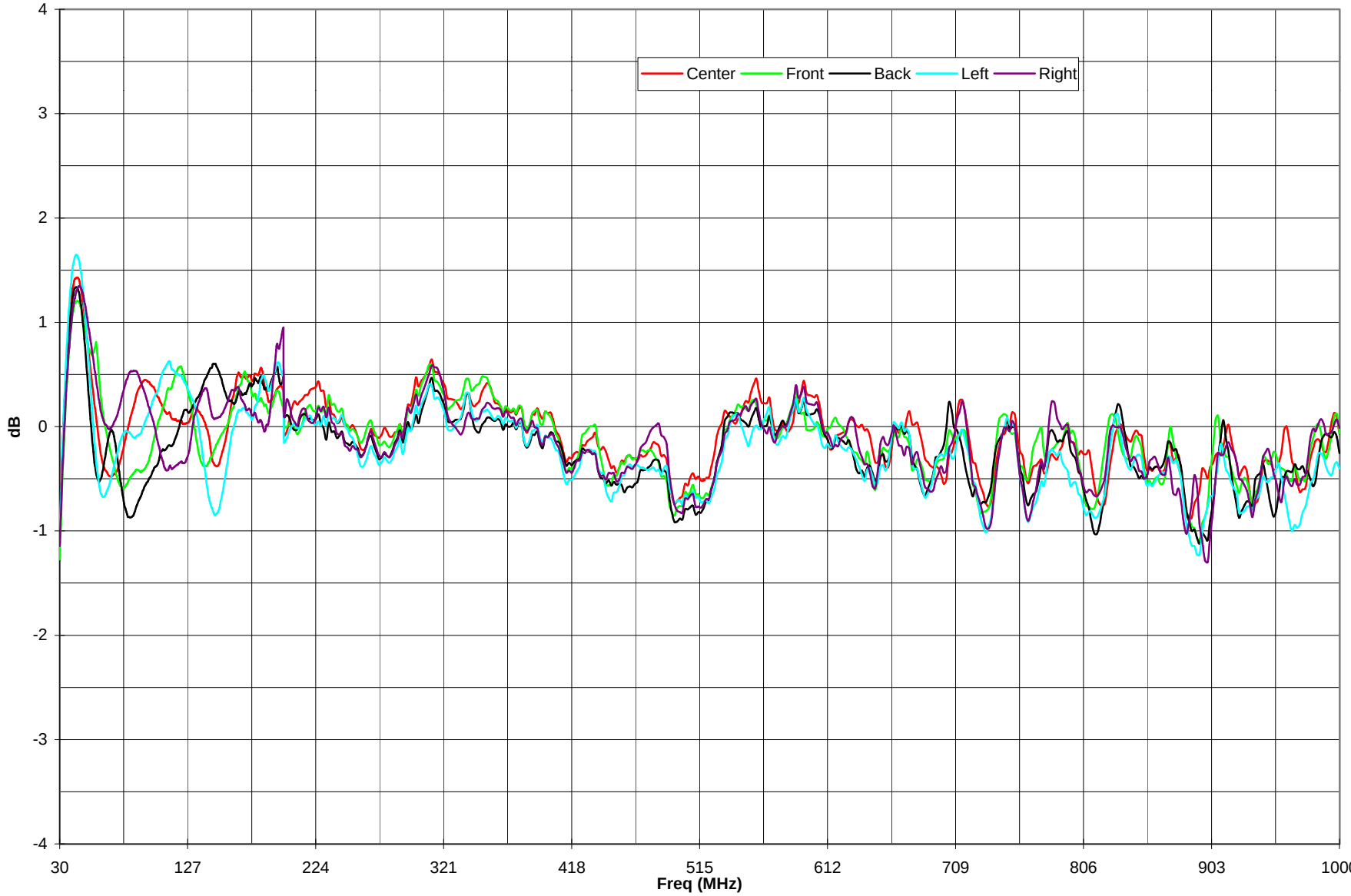

Fig. 9. Primary 3m Range: Measured NSA Horiz. Pol., D=3m, Tx=1m

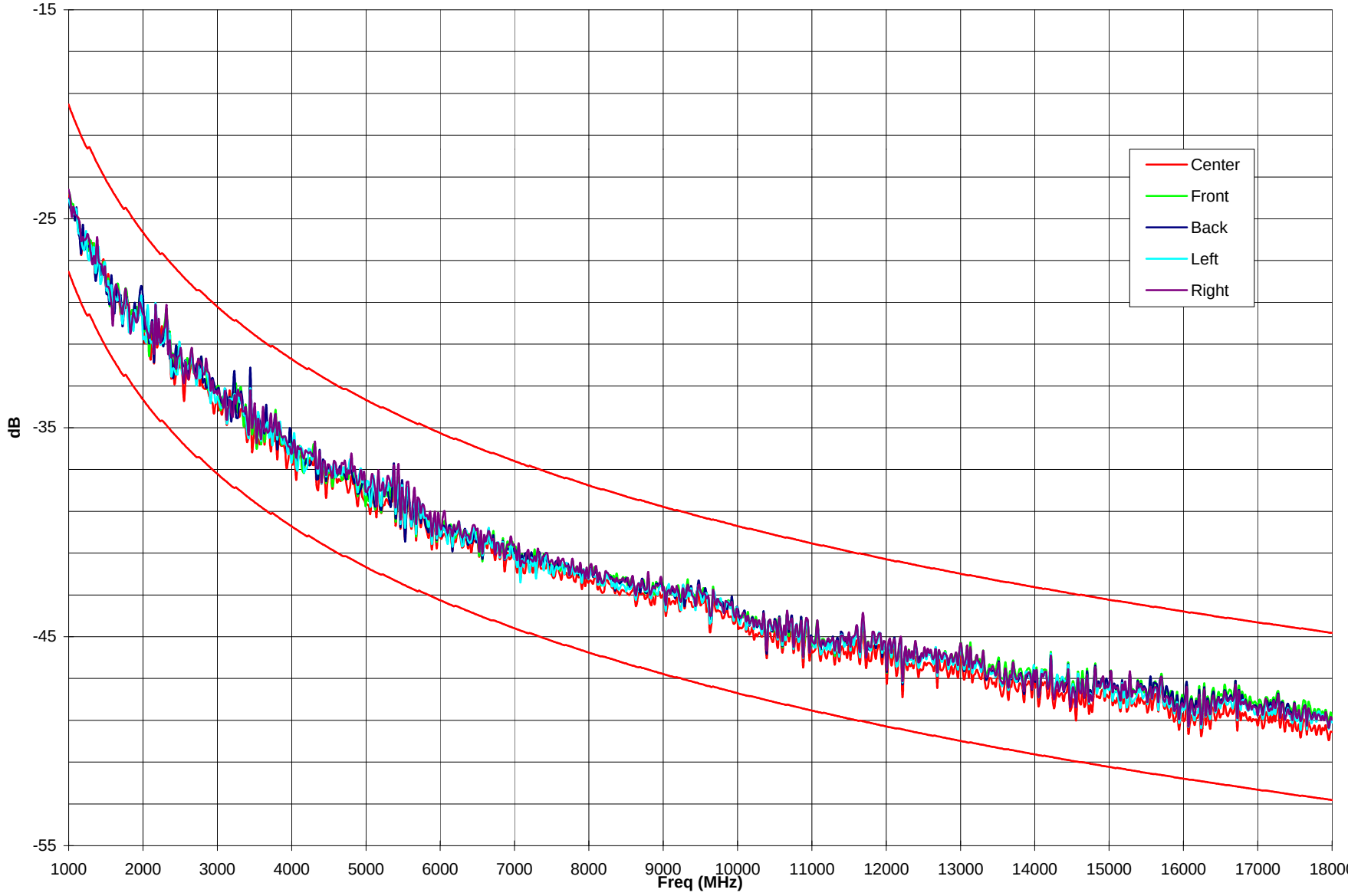

Fig. 10. Primary 3m Range: Delta NSA Horiz. Pol., D=3m, Tx=1m

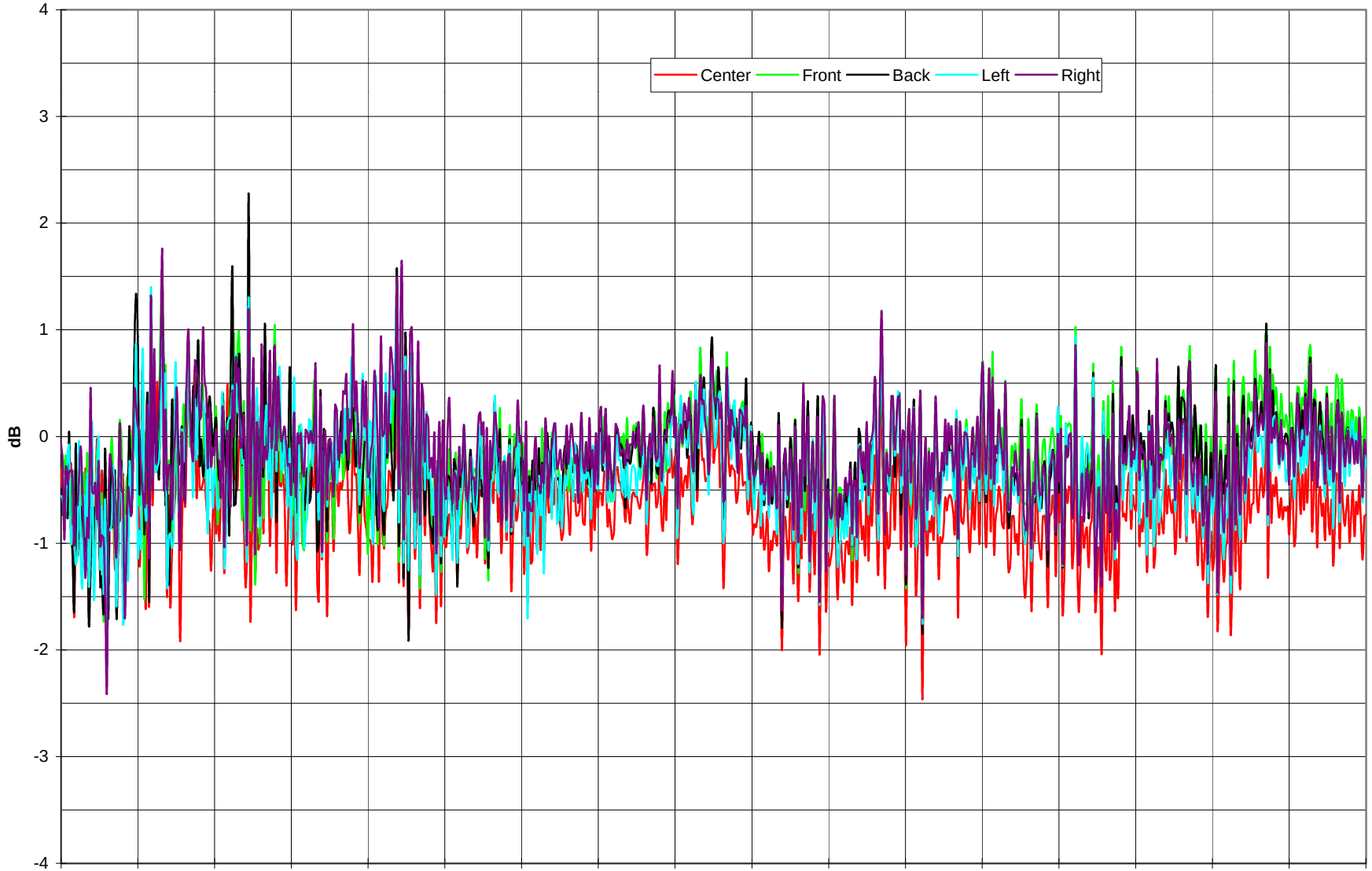

Fig. 11. Primary 3m Range: Measured NSA Vert. Pol., D=3m, Tx=1m

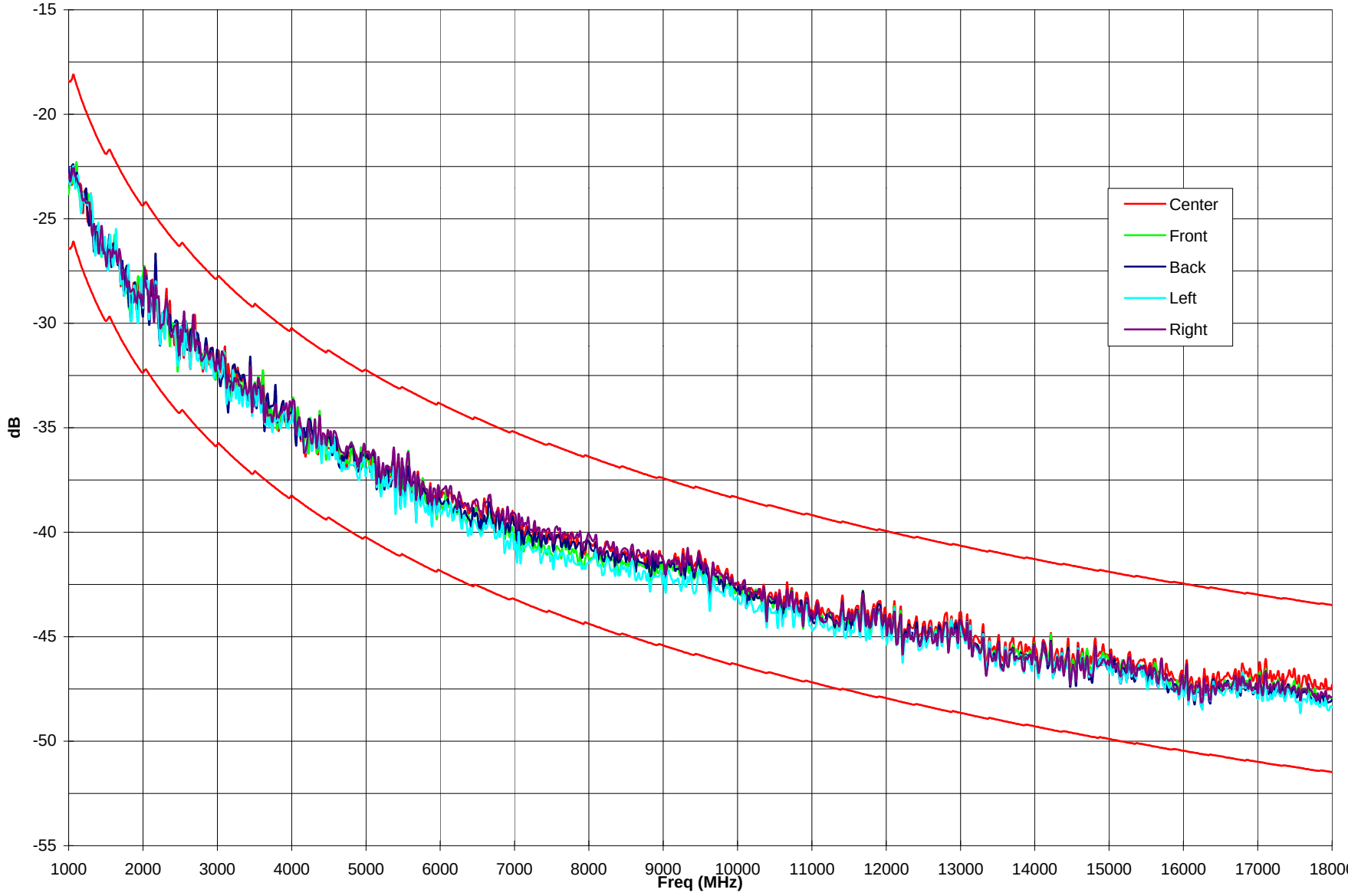

Fig. 12. Primary 3m Range: Delta NSA Vert. Pol., D=3m, Tx=1m

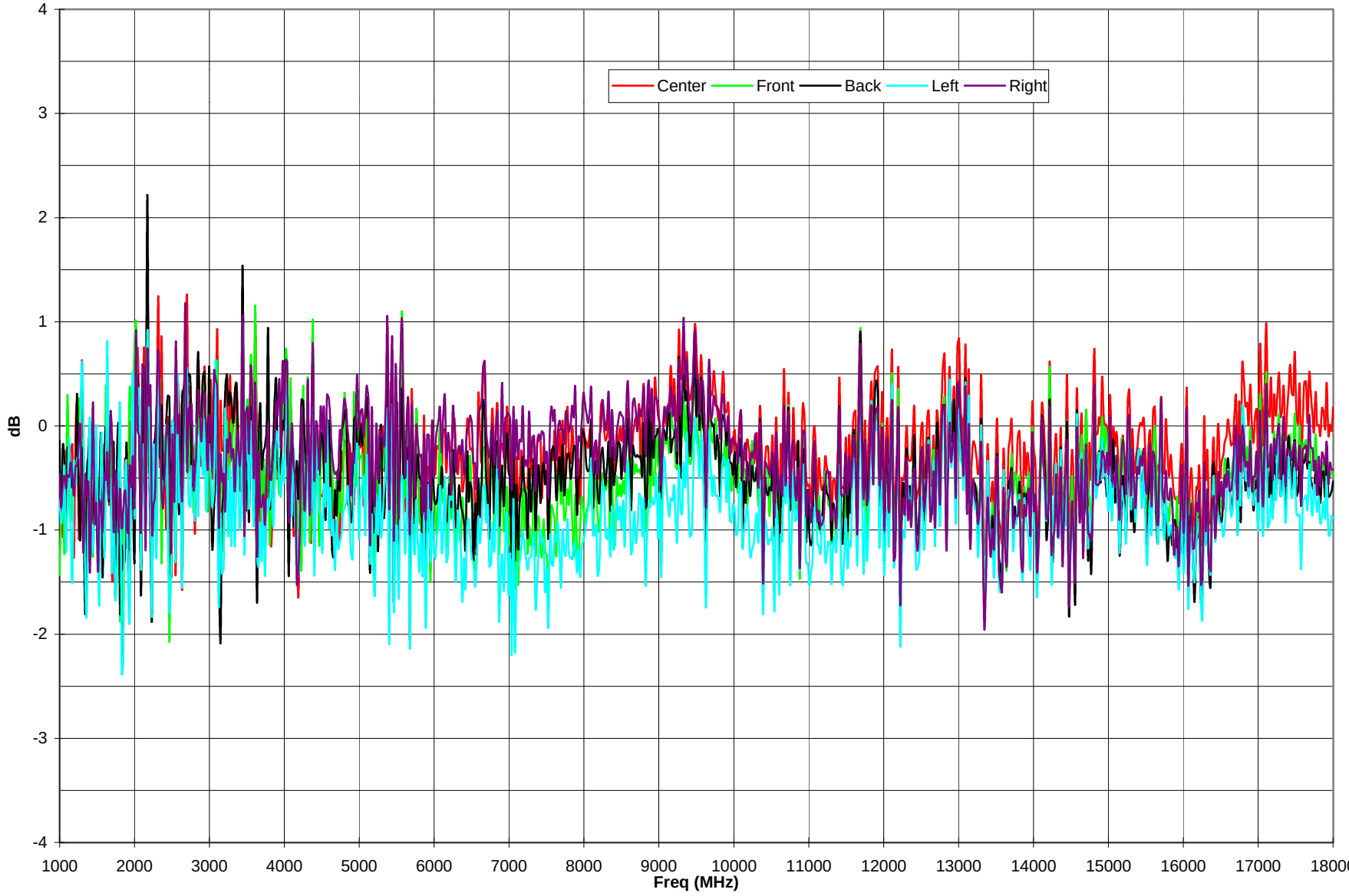

Fig. 13. Primary 3m Range: Measured NSA Vert. Pol., D=3m, Tx=1.5m

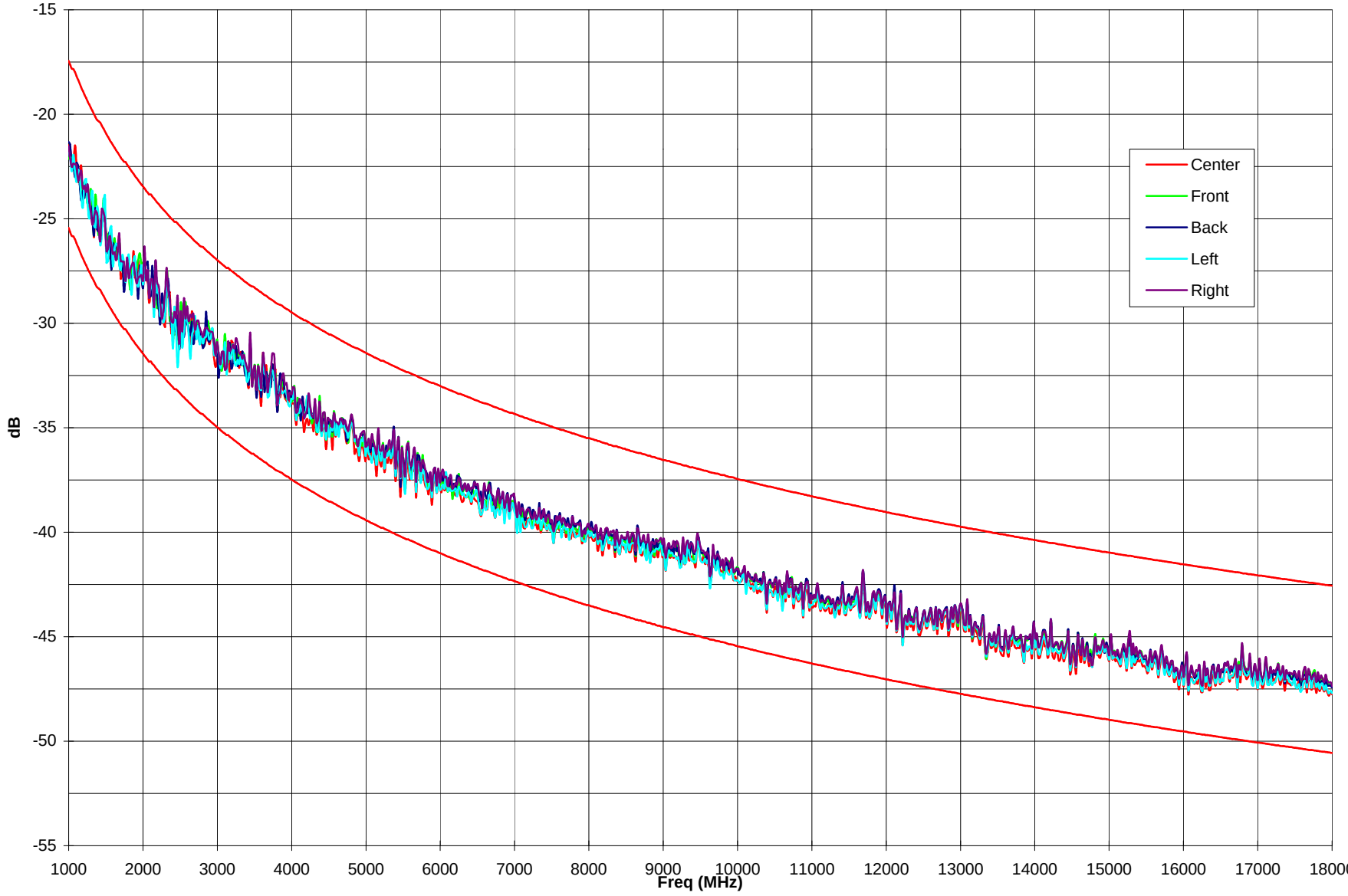

Fig. 14. Primary 3m Range: Delta NSA Vert. Pol., D=3m, Tx=1.5m

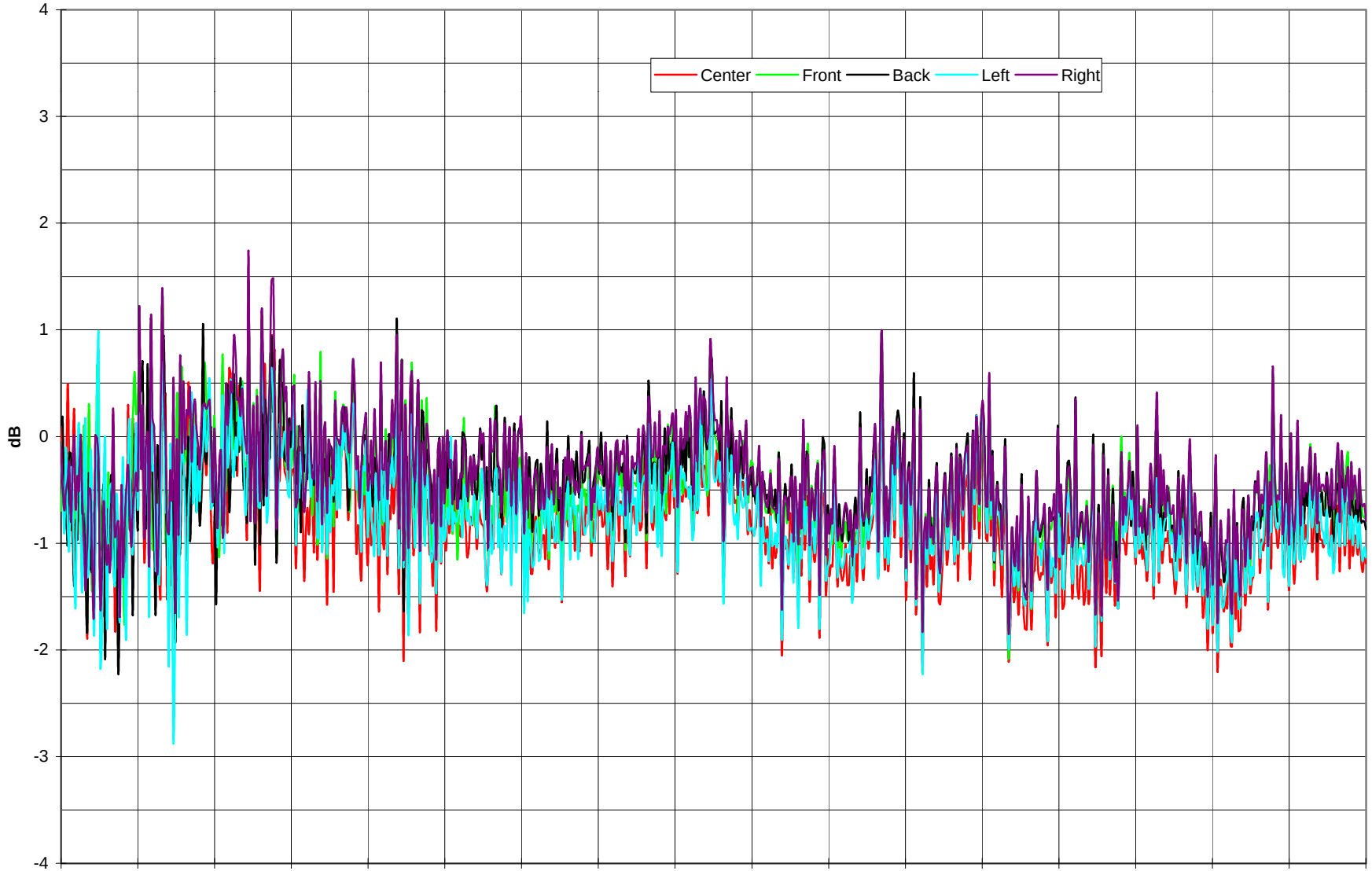

Fig. 15. Primary 3m Range: Measured NSA Horiz. Pol., D=3m, Tx=2m

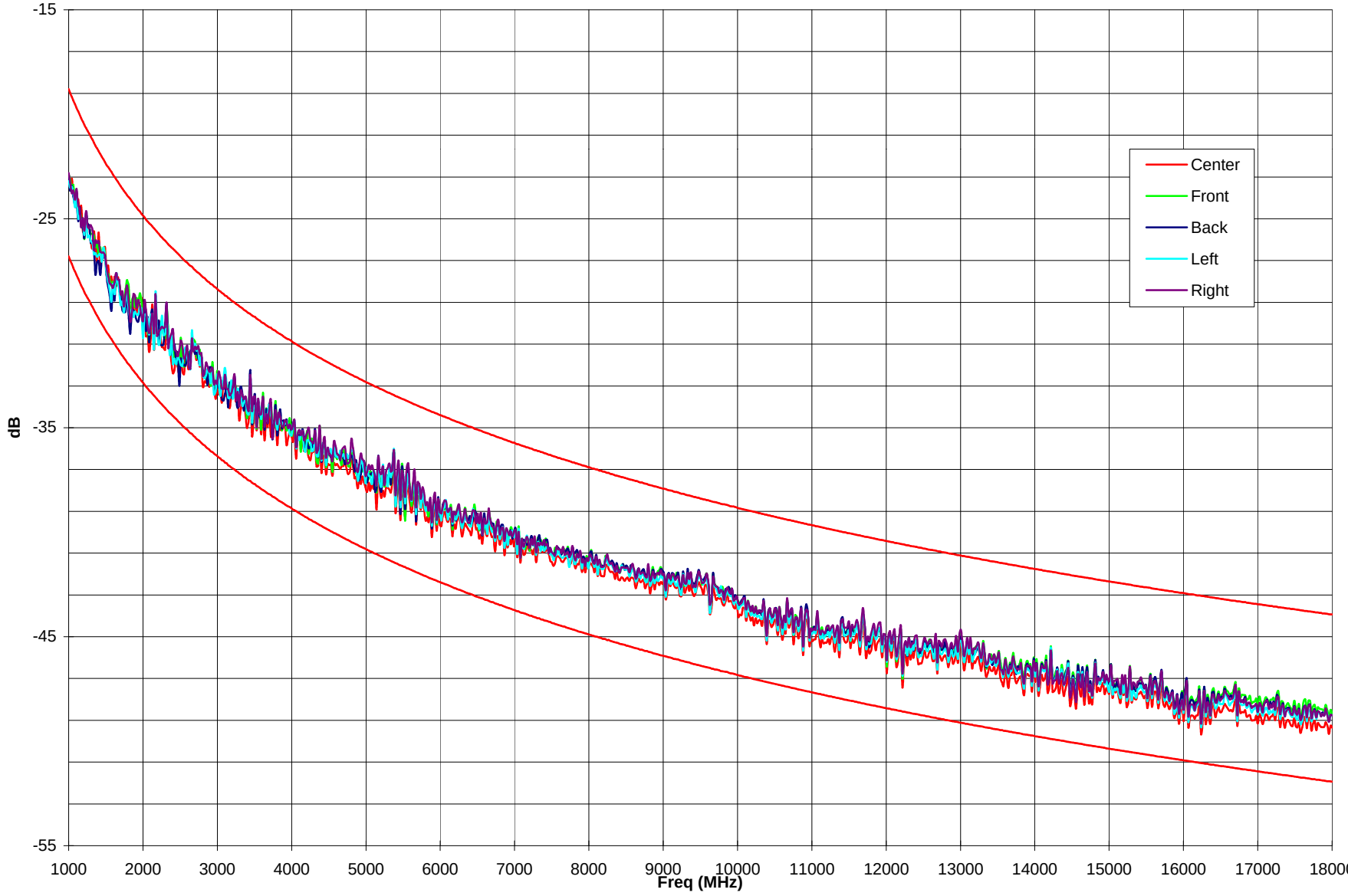

Fig. 16. Primary 3m Range: Delta NSA Horiz. Pol., D=3m, Tx=2m

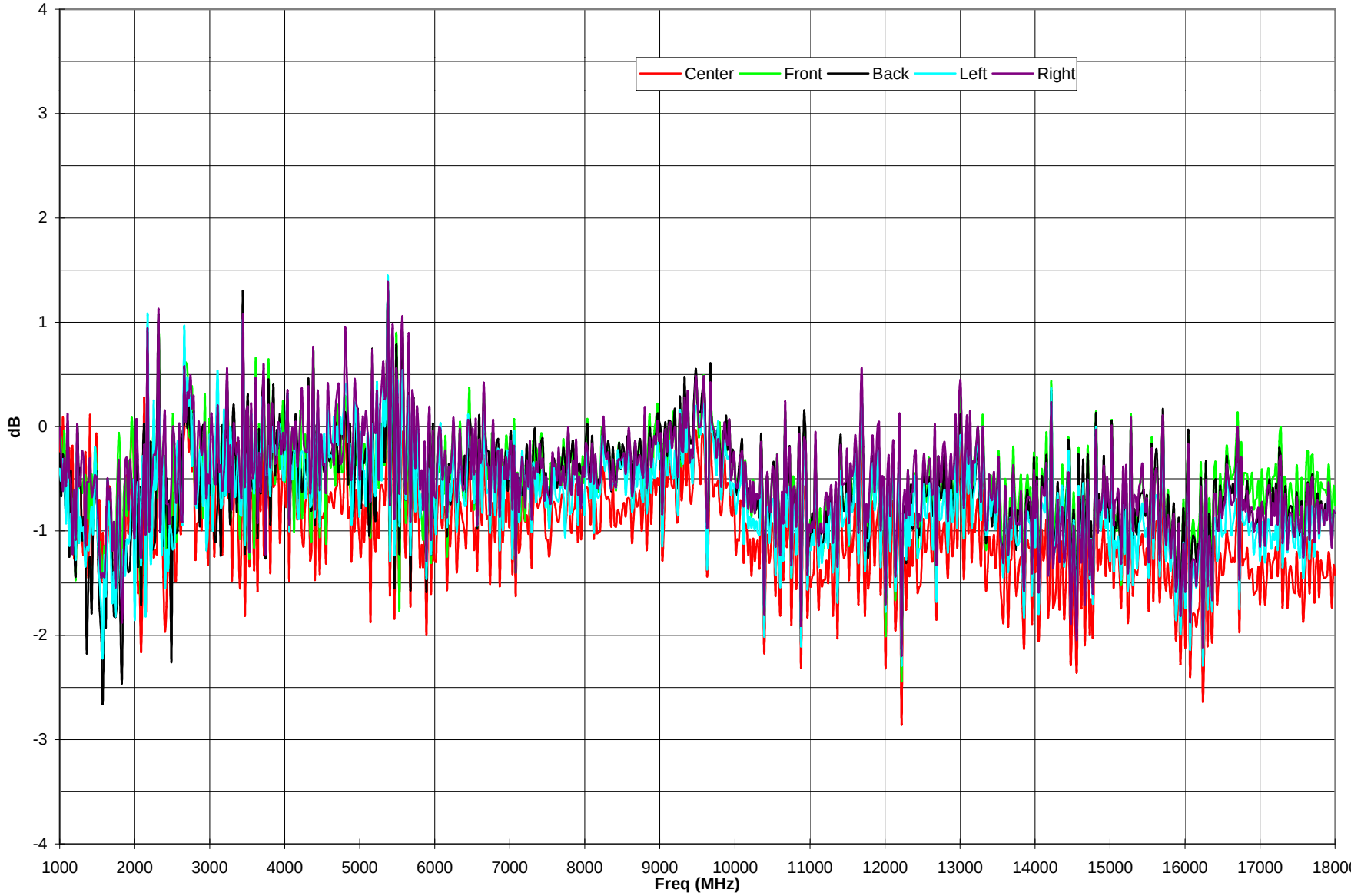

Fig. 17. Combined Antenna Factors for the EMCO Model 3124 S/N 0004-1001 (Tx) and 0004-1002 (Rx)
Biconical antennas at 3m test distance measured by ETS at Liberty Labs Inc.

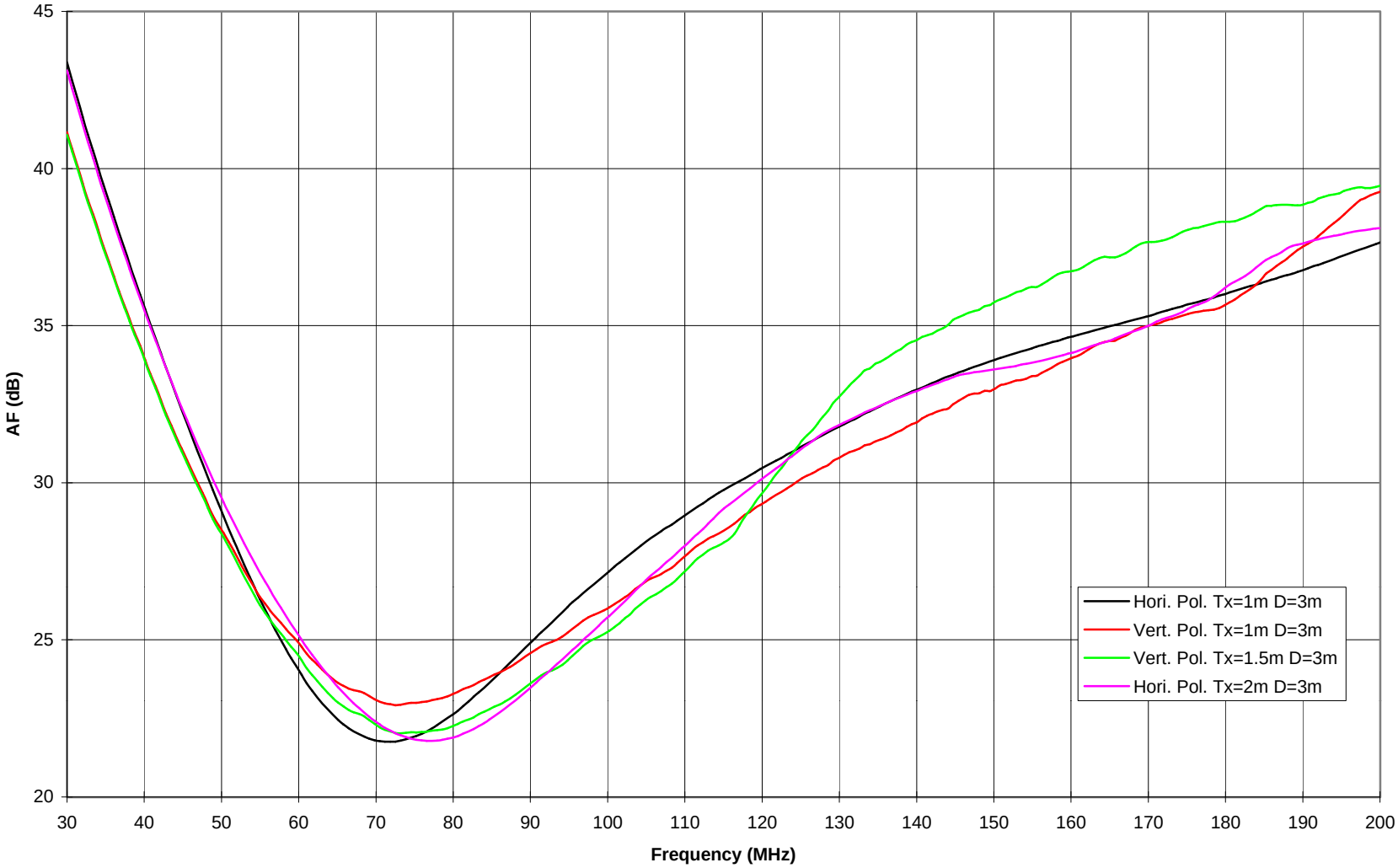

Fig. 18. Combined Antenna Factors for the EMCO Model 3148 S/N 9907-1071 (Tx) and 0003-1149 (Rx) Log-periodic antennas at 3m test distance measured by ETS at Liberty Labs, Inc., Kimballton,IA

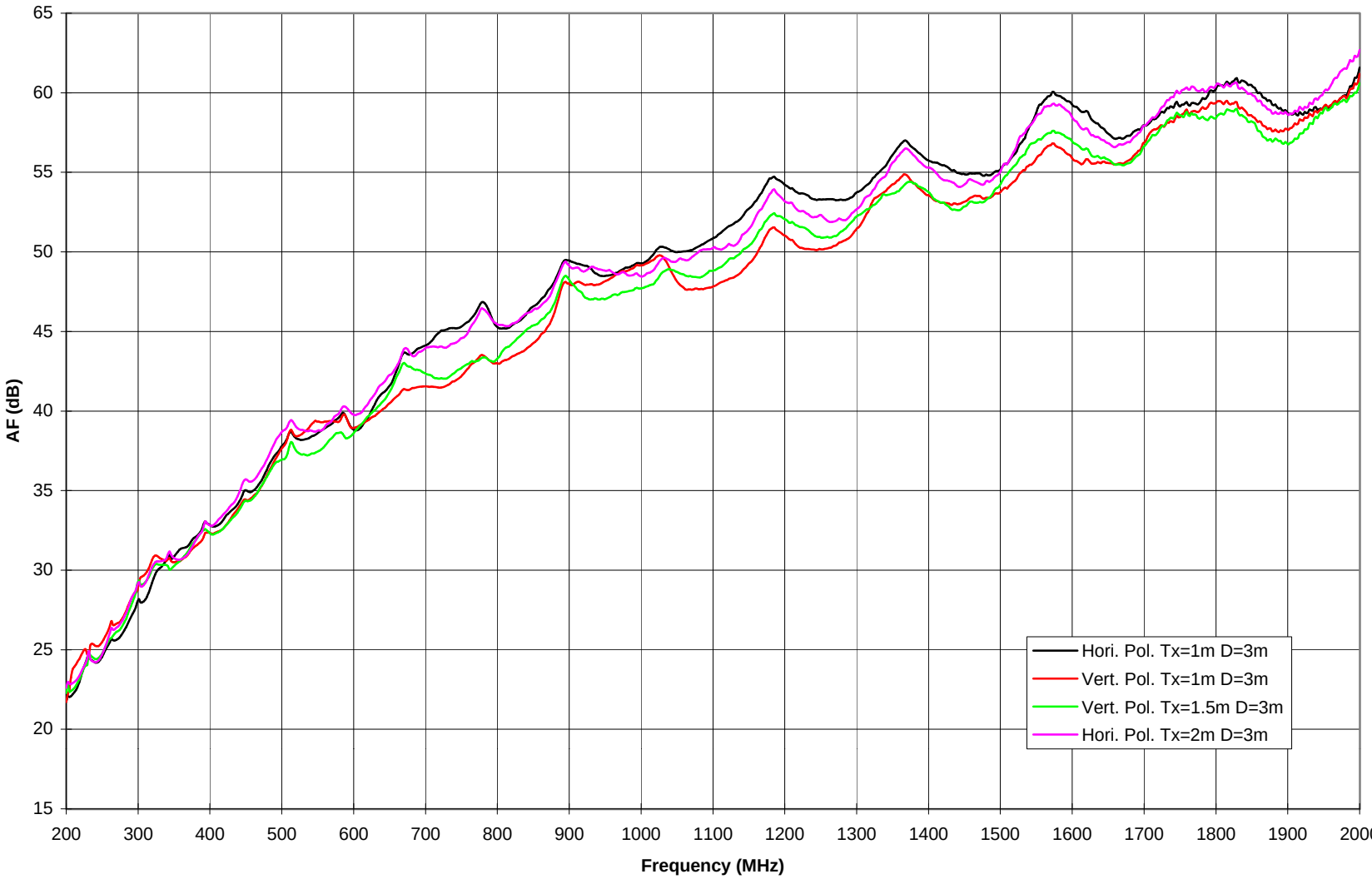

Fig. 19. Antenna Factors for the General Instrument Model A6100 Quad-Ridge Horn Antennas S/N C76700 (Tx) and S/N C76800 (Tx) at 3m test distance measured at ETS OATS.