FAA William J. Hughes Technical Center, ACB-430

Technical Memorandum

Date: 07/8/2003

To: File

Cc: Bryce Thornberg, dB Systems

From: Dave Lamb, FAA ACB-430

RE: dBs-200 14-element Dipole Array w/ Double-Wall Radome Performance

Background

The FAA has procured five Integrated Multipath Limiting Antennas (IMLAs), four of which are planned to be included in a new LAAS Test Prototype (LTP) installed at the William J. Hughes Technical Center. These IMLA's consist of the dBs-200 14-element dipole array (with double-wall radome) and the dBs-200A cross-V dipole High Zenith Antenna. The antenna serial numbers are 025, 026, 027, 028, and 029.

The FAA has experience with an earlier model of the IMLA, the dBs-200 14-element dipole array housed in a single-wall radome which are installed in the original LTP. The original LTP has been operating continuously since 1998 and a large body of data has been collected and analyzed. A consistent bias trend has been observed in the data collected on the dBs-200's and is being investigated by the FAA.

To distinguish the two antenna types from each other, this paper refers to the 14-element dipole array with single-wall radome and double-wall radome as dBs-200sw and dBs-200dw respectively.

Initial data collection and analysis using the dBs-200dw's showed atypical performance when compared to the historical dBs-200sw performance at the original LTP sites. It is important to note that the antenna types are identical except for the radome type.

In order to isolate the cause for the atypical performance, a controlled test was conducted at one of the established LTP sites (site LT2). Data was collected on each of the five antennas for a minimum of three days.

Test Results

Figure 1 shows the baseline performance of the four dBs-200sw's at the original LTP antenna sites. The plots show smoothed pseudorange error mean and standard deviation in 2-degree elevation bins. The pseudorange error is estimated using code-minus-carrier techniques. The standard deviation is relatively flat at approximately 5 cm through 30 degrees elevation. The mean shows a trend vs. elevation that is present in all of the LTP data. This single day performance is representative of the historical LTP data.

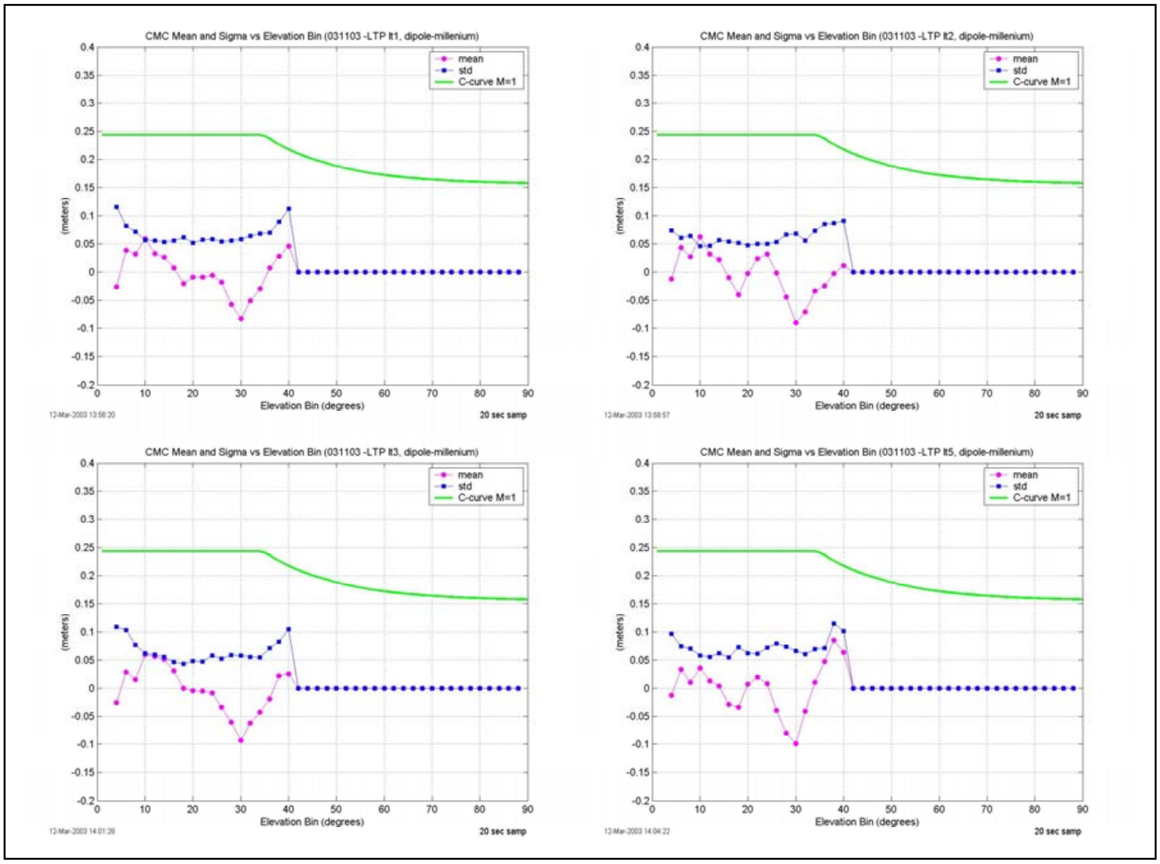


Figure 1

Figures 2 and 3 show the same plots for the five dBs-200dw antennas that were installed at LT2. The plot shown in Figure 3 shows the performance of antenna S/N 029, which had the worst performance of the five antennas. The observed performance for each individual antenna is repeatable over the data collection period.

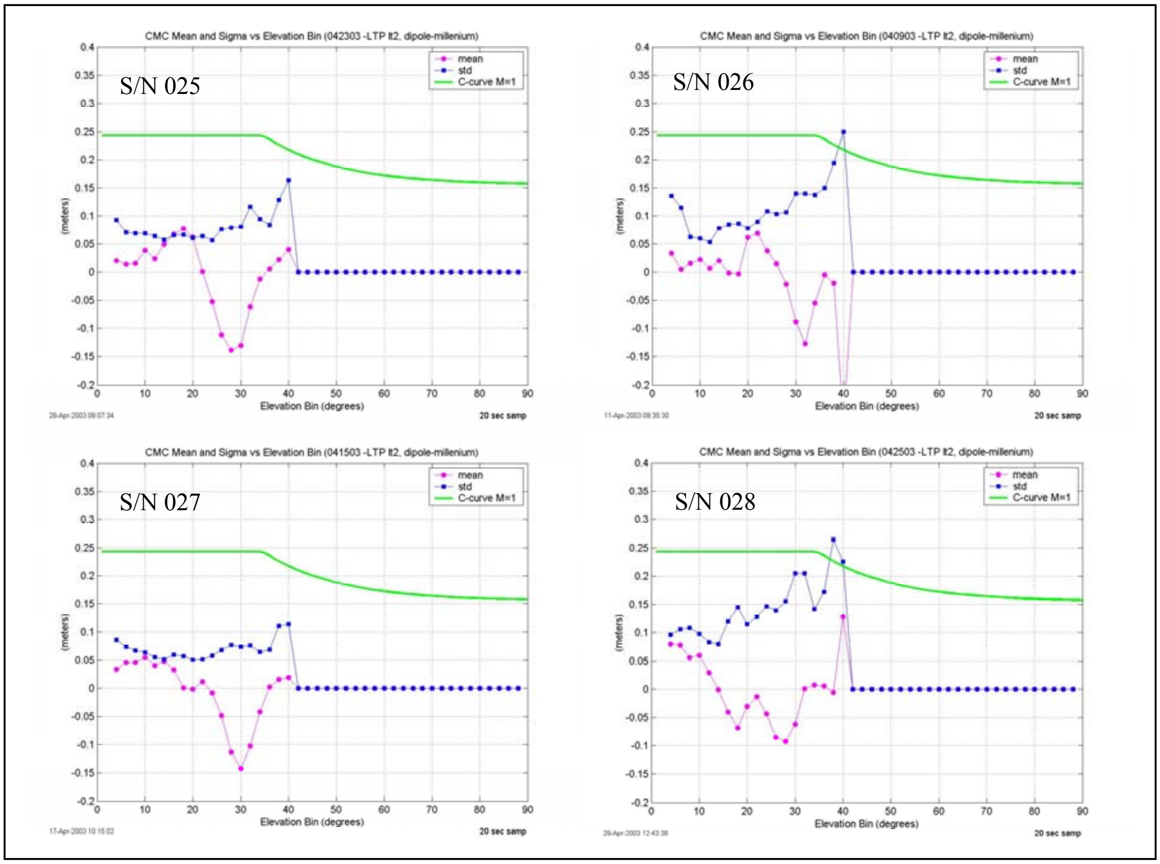


Figure 2

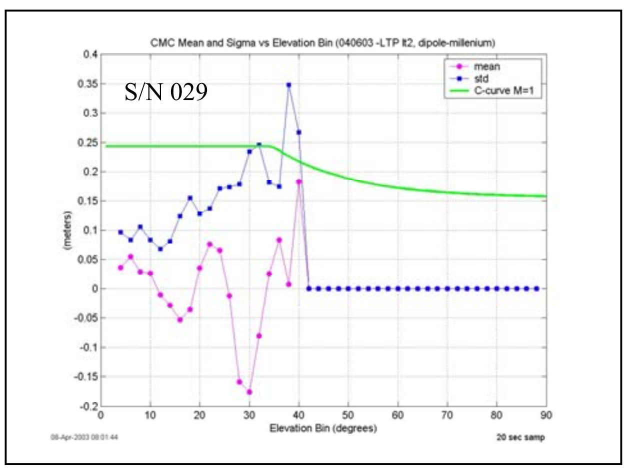


Figure 3

The plots show that three out of five antennas have an uncharacteristic increase in pseudorange error standard deviation as elevation increases. The standard deviation in the 30-32 degree elevation bin for antenna S/N 029 is approximately 23 cm. The plots also show larger mean trends than in the baseline data. Since it is assumed that the only difference between the 200sw and 200dw is the radome, data was collected with the dBs-200dw antenna housed in a single-wall radome. The antenna with the worst performance (S/N 029) shown in Figure 3 was selected for this test. Figure 4 shows the performance plot for the single-wall configuration.

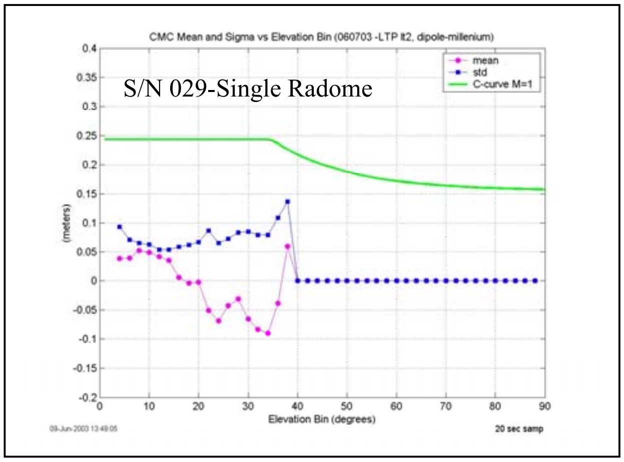


Figure 4

The figure shows a great improvement in the performance of the antenna when housed in a single-wall vice a double-wall radome. The amplitude of the mean trend is now consistent with the baseline dBs-200sw data although the trend signature is different in the elevation bins between 20 and 30 degrees. The standard deviation is a now only a little worse than the baseline LTP at the higher elevation angles. The 30-32 degree bin standard deviation is now 8 cm, an improvement of 15 cm over the double-wall radome results.

In order to confirm the repeatability of the double-wall radome results after the disassembly and reassembly of the antenna, data was collected with the antenna in the original double-wall configuration. Figure 5 shows the performance plot for the original double-wall configuration.

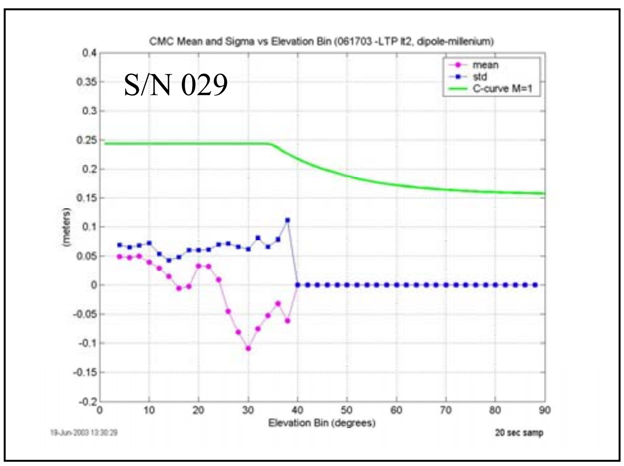


Figure 5

The figure shows that the performance is still an improvement over the original double-wall results. In fact, the reassembled double-wall results are more consistent with the historical LTP performance than the single-wall results for S/N 029.

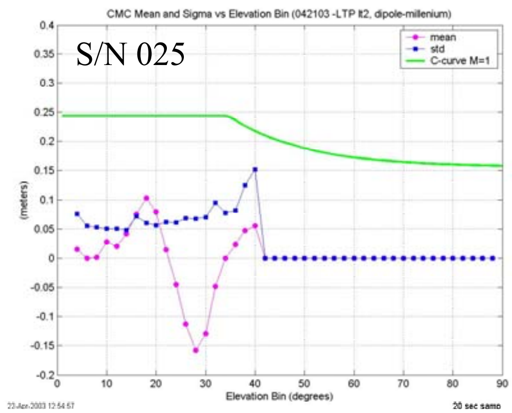
Summary and Conclusions

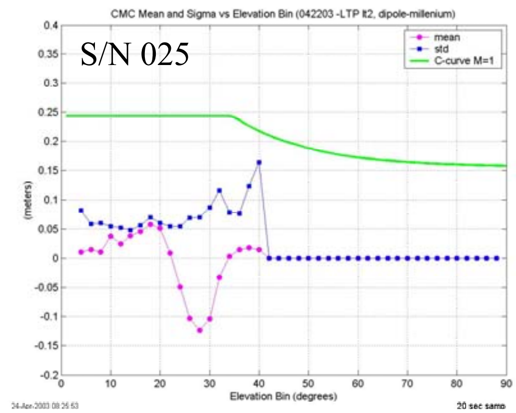
A controlled test was conducted to isolate the cause of atypical performance observed during initial testing of the dBs-200dw 14-element dipole array antennas. The performance of the antenna greatly improved when the double-wall radome was replaced with a single-wall radome. The performance improved further when the antenna was returned to its original double-wall radome configuration. The large change in the observed data suggests that there may have been condensation inside the antenna that evaporated when the antenna was disassembled prior to the single-wall radome test. (The antenna was left disassembled overnight.)

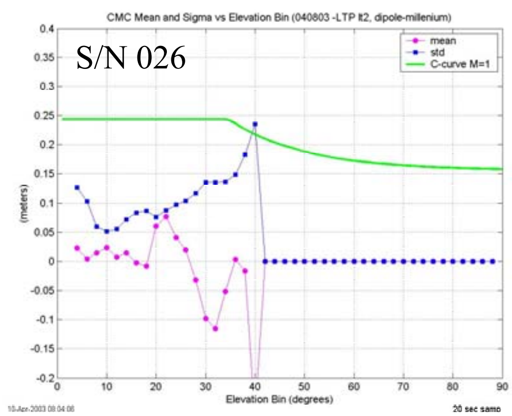
The difference between the single-wall and double-wall radome results suggests that the radomes may not be electromagnetically transparent and that multiple scattering in the cavity between the two radome walls may be affecting antenna performance. The gap between the radome walls is about a half wavelength at a satellite elevation of 40 degrees. Condensation between the two walls may also affect system performance.

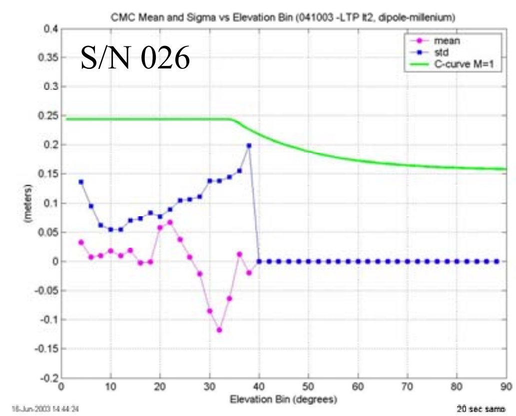
Follow-on testing will be conducted with no radome to establish the baseline performance of the dBs-200sw/dBs-200dw antennas. Testing will also be conducted with the dBs-200sw antenna housed in a double-wall radome. It is interesting to note that FAA experience with the dBs-200A, 16-element dipole array with double-wall radome was also atypical of the historical LTP performance. This was attributed to receiver/antenna compatibility problems but the performance may need to be re-evaluated based on the findings presented herein.

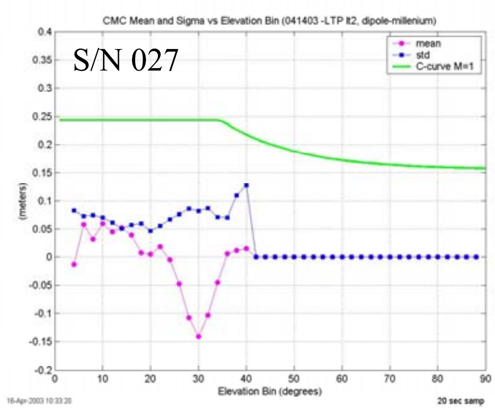
APPENDIX. ADDITIONAL PERFORMANCE PLOTS

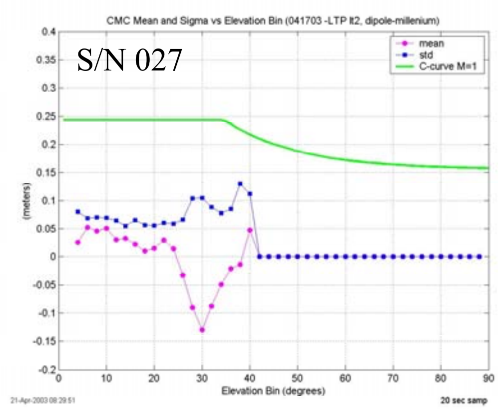


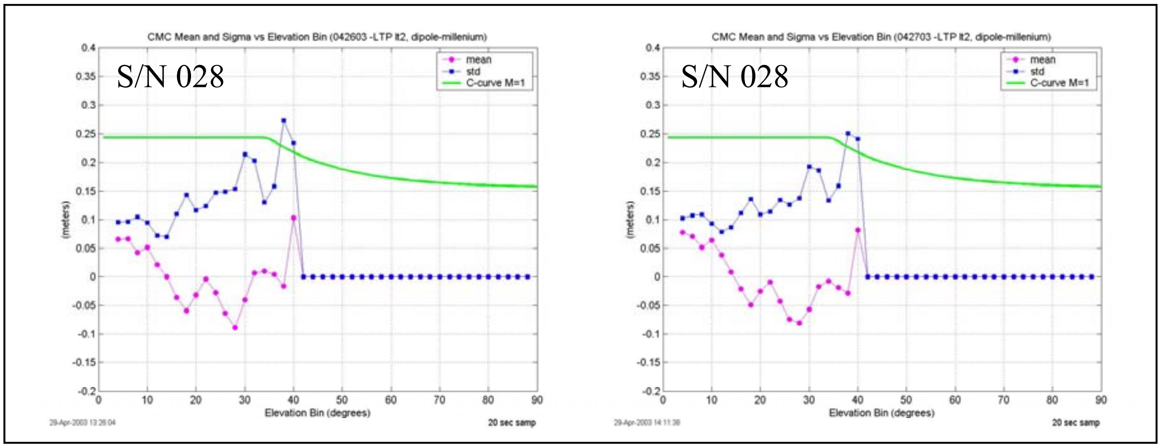








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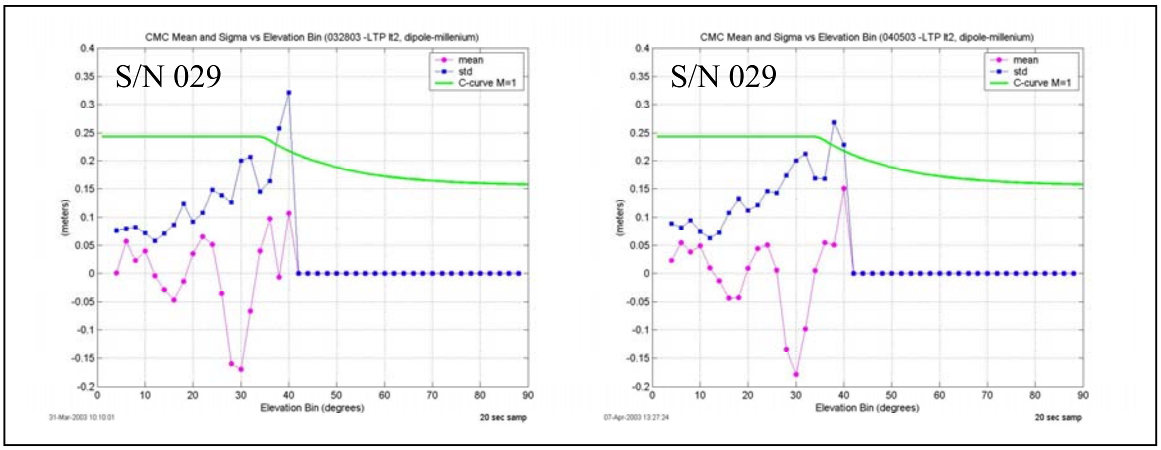
S/N 028
mean
std
C-curve M=1
(meters)
Elevation Bin (degrees)
20 sec samp
CMC Mean and Sigma vs Elevation Bin (042703 -LTP lt2, dipole-millenium)
S/N 028
mean
std
C-curve M=1
(meters)
Elevation Bin (degrees)
20 sec samp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S/N 029
mean
std
C-curve M=1
(meters)
Elevation Bin (degrees)
20 sec samp
CMC Mean and Sigma vs Elevation Bin (040503 -LTP lt2, dipole-millenium)
S/N 029
mean
std
C-curve M=1
(meters)
Elevation Bin (degrees)
20 sec samp