FAA William J. Hughes Technical Center, ACB-430

Technical Memorandum

Date: 07/14/2003

To: File

From: Dave Lamb, FAA ACB-430

RE: dBs-200A 16-element Dipole Array Performance

Background

The FAA procured four Integrated Multipath Limiting Antennas (IMLAs) to support research of Local Area Augmentation System equipment and concepts. These IMLA's consist of the dBs-200A 16-element dipole array (with double-wall radome) and the dBs-200A cross-V dipole High Zenith Antenna (HZA). The antenna serial numbers are 001, 002, 003, and 004.

The FAA has experience with an earlier model of the IMLA, the dBs-200 14-element dipole which are installed in the original LAAS Test Prototype (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. In addition to the difference in number of elements, the antennas also have different radomes. The dBs-200's installed at the LTP have a single-wall radome. The dBs-200A's have a double-wall radome.

Initial data collection and analysis using the dBs-200A's in 2001 showed atypical performance when compared to the historical dBs-200 performance at the original LTP sites. The dBs-200A has a higher peak gain and sharper roll-off at the horizon than the dBs-200. The cause for the atypical performance was attributed to a mismatch between the antenna and the GPS receivers utilized in the LTP. Specifically, it appeared that the Novatel was unable to accommodate the larger dynamic range delivered by the dBs-200A over the 4-40 degree elevation range.

Tests were conducted in October-November 2002 with two receiver types to better characterize the antenna performance. Data was collected on two Novatel OEM-4 receivers. One OEM-4 was configured with a narrow correlator. The other receiver was configured with a pulse-aperture correlator (PAC). The antenna under test was serial number 003. The antenna was configured without an HZA which was being used in other tests at the time. The antenna was installed at a test site in proximity to Bldg. 279 on the ACY airfield.

Test Results

Figures 1 and 2 shows the baseline performance of a dBs-200 14-element dipole array at LTP antenna site LT2. The LTP utilizes Novatel OEM-3 GPS receivers. Figure 1 shows the all-SV-in-view ensemble data for a 24-hour data set collected on 10/10/02. The four plots in the figure show C/No and smoothed pseudorange error, estimated using Code-minus-carrier (CMC) techniques, versus elevation and time. Figure 2 shows smoothed pseudorange error mean and standard deviation in 2-degree elevation bins. This figure corresponds to the CMC vs. elevation plot in the upper right-hand corner of Figure 1. 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.

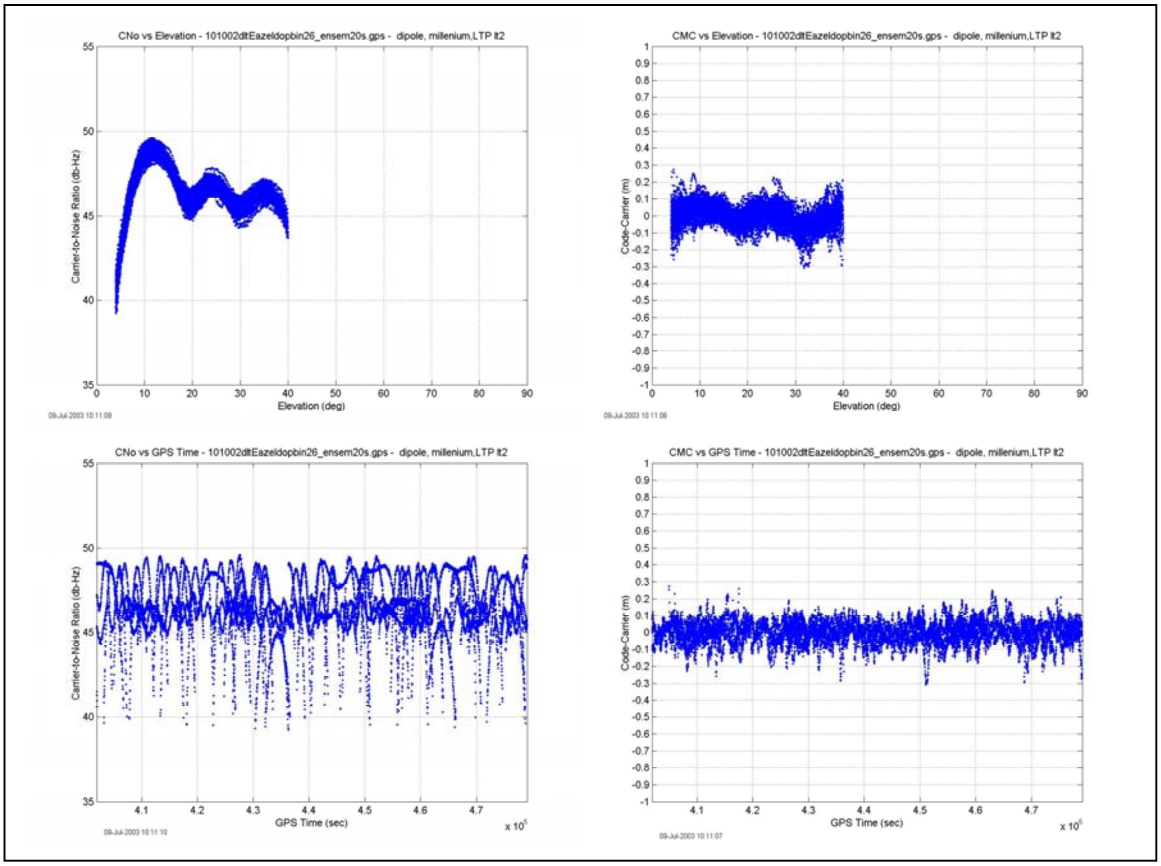

Figure 1. dBs-200 14-element Dipole Array Ensemble Plots – OEM-3 Narrow Correlator

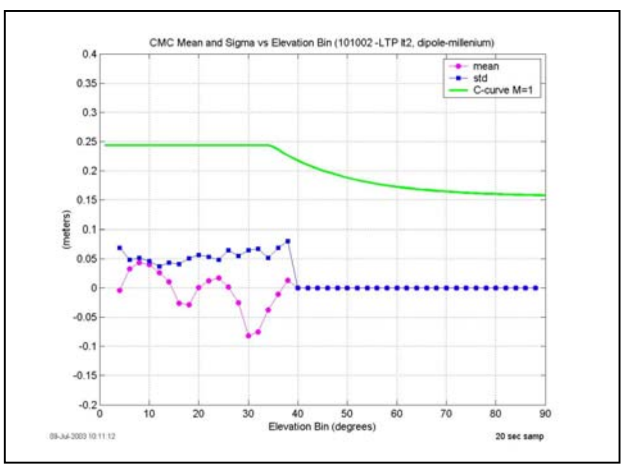

Figure 2. dBs-200 14-element Dipole Array Statistics Plot – OEM-3 Narrow Correlator

Figures 3 and 4 show the same plots for the dBs-200A 16-element dipole array antenna. The observed performance is repeatable over the data collection period.

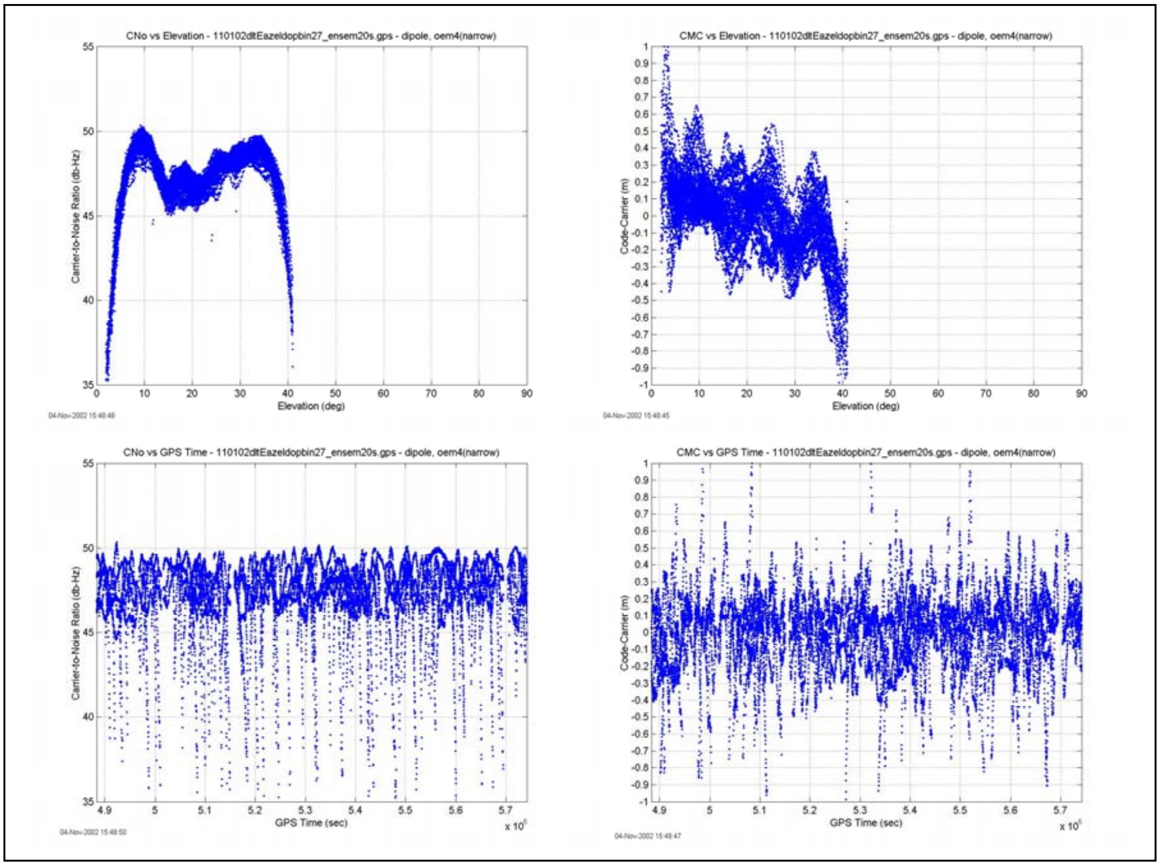

Figure 3. dBs-200A 16-element Dipole Array Ensemble Plots – OEM-4 Narrow Correlator

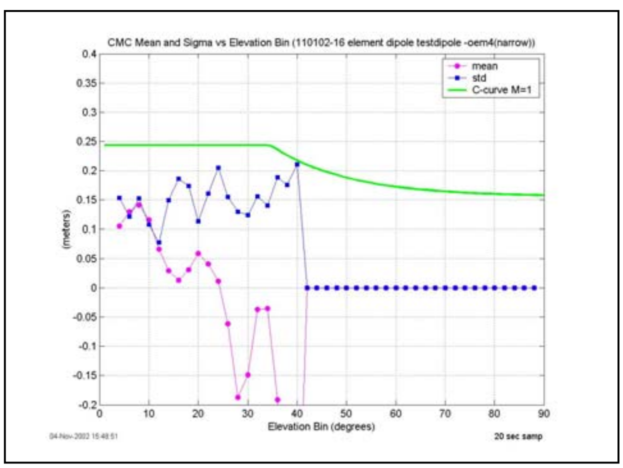

Figure 4. dBs-200A 16-element Dipole Array Statistics Plot – OEM-4 Narrow Correlator

The dBs-200A results show larger standard deviations and means than the dBs-200 results. The antenna is designed to optimize performance in the 4 to 35 degree elevation range. In this region of interest, the maximum estimated pseudorange error standard deviation is approximately 20 cm (24-26 elevation bin). This is approximately three times the maximum standard deviation for the dBs-200 data in the elevation region of interest. Figures 5 and 6 show the performance plots from 11/01/02 for the dBs-200A/OEM-4 in PAC mode.

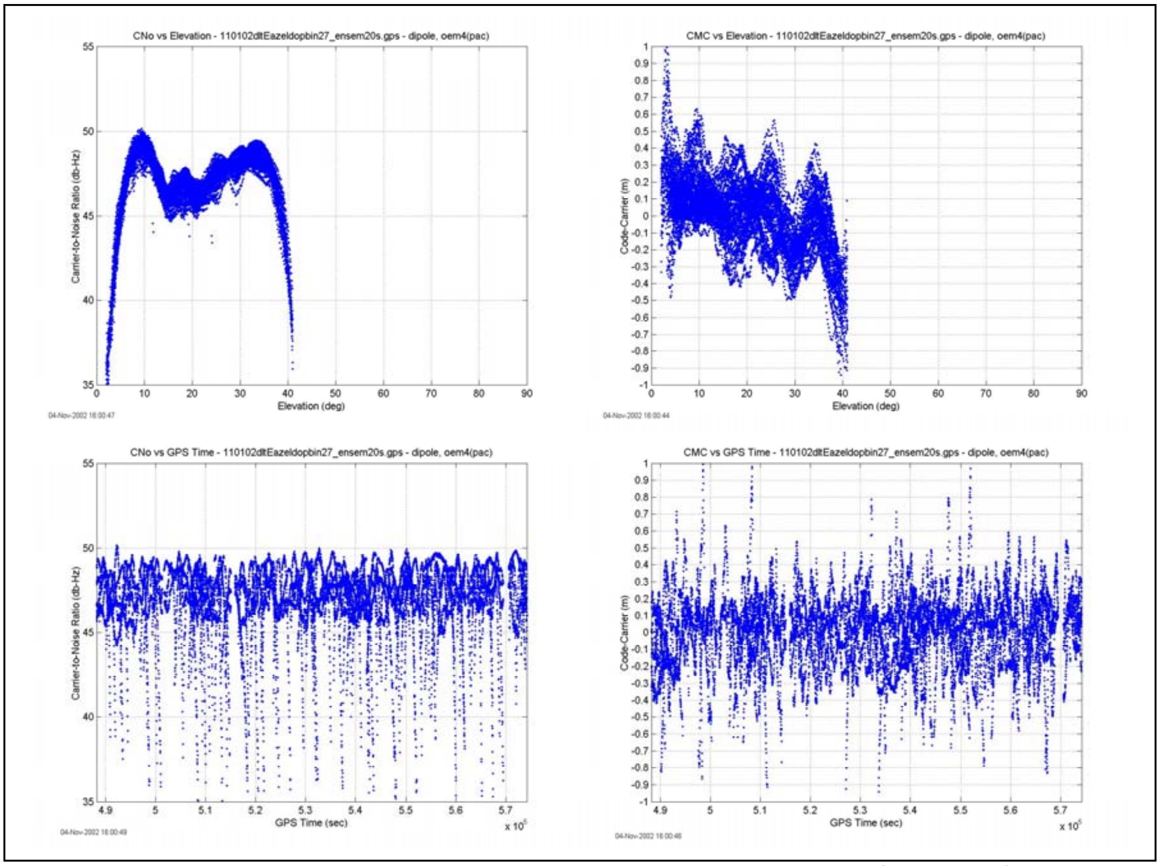

Figure 5. dBs-200A 16-element Dipole Array Ensemble Plots – OEM-4 PAC

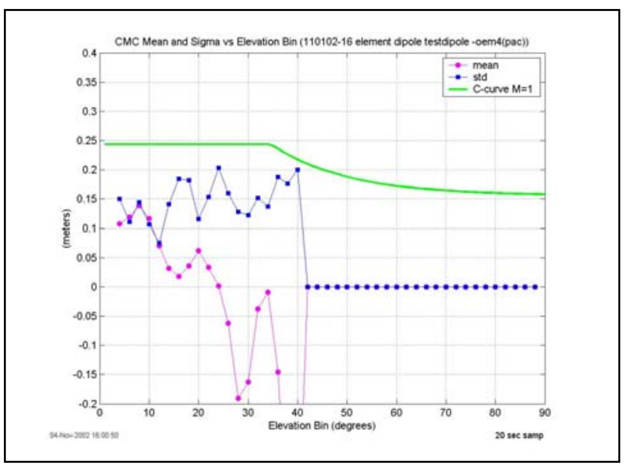

Figure 6. dBs-200A 16-element Dipole Array Statistics Plots – OEM-4 PAC

Comparison of the PAC and narrow correlator results show generally good agreement. The results are also very consistent over the duration of the tests. Figure 7 shows a comparison of means and standard deviations for both the narrow correlator and PAC results over a three-day period.

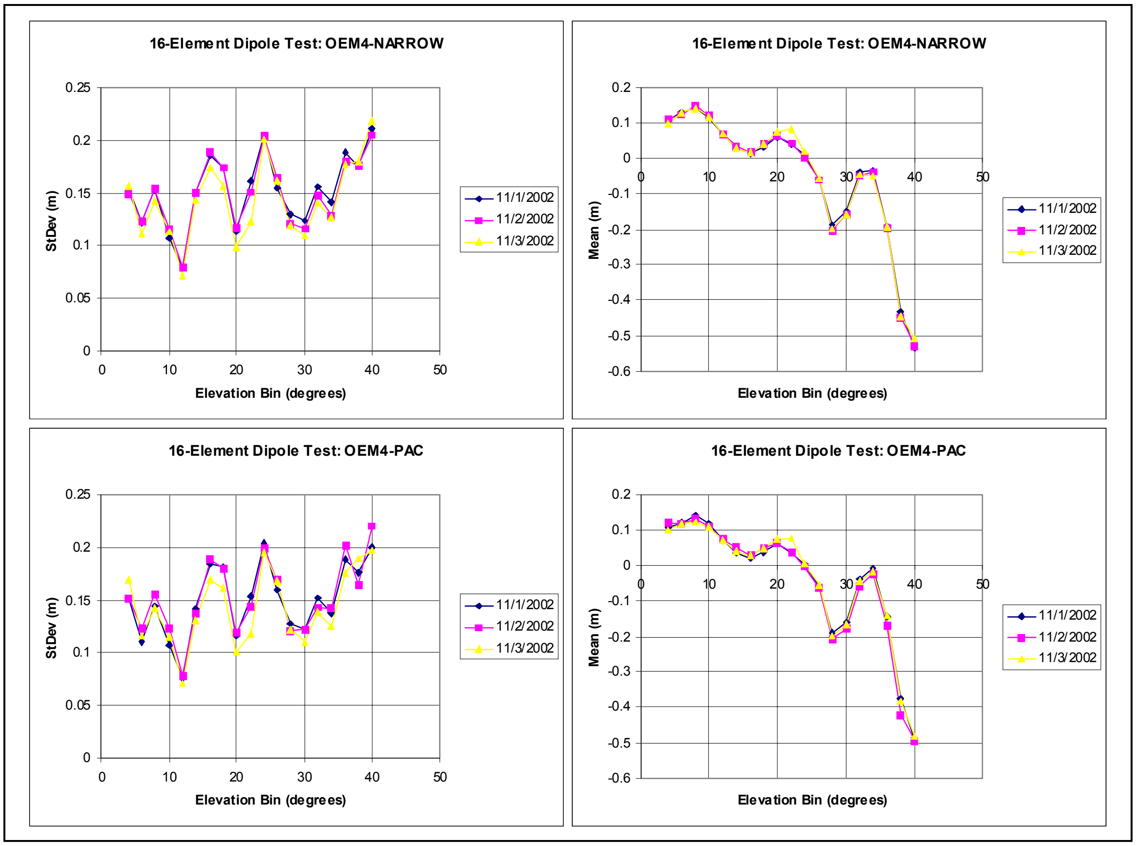

Figure 7. dBs-200A Estimated Pseudorange Statistics Day-to-day Repeatability

Summary and Conclusions

A test was conducted to characterize the performance of the dBs-200A 16-element dipole array. Data analysis shows that the dBs-200A has larger estimated pseudorange error means and standard deviations than the dBs-200 baseline LTP data. At worst case, the maximum dBs-200A standard deviation was approximately three times the magnitude of the maximum dBs-200 standard deviation. The results were repeatable for both the narrow-correlator and PAC receivers over the three-day test period. The results of the narrow correlator and the PAC compared well to each other. This indicates that the observed errors are probably not due to medium-long delay multipath, which would be mitigated with the PAC technology.

The difference in performance may be caused by the inability of the Novatel receiver to properly adjust for the dynamic range of signals delivered by the dBs-200A. Recent testing with 14-element dBs antennas with double-wall radomes has shown inconsistent performance [1]. The dBs-200A has a double-wall radome and the dBs-200's installed in the LTP have single-wall radomes. Tests are ongoing to determine the cause of the inconsistent dual-radome antenna performance results.

References

1. Lamb, Dave. Technical Memo L-TM-0703-001Draft, *"dBs-200 14-element Dipole Array w/ Double-Wall Radome Performance"*, 8 July 2003.