LWDA Shelter Shielding Factor

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Summary

We report on measurements of the LWDA shelter shielding factors. From these measurements we adopt a minimum shielding of 30 dB for frequencies 0.2–3 GHz. On average, the shielding in this frequency range is of the order of 40 dB.

1. Test Description

The shielding factor can be estimated from the difference in power (corrected for space and cable losses) between a reference signal transmitted inside the shelter, and the same signal measured at a known position outside. In this experiment an HP8340A synthesized sweeper was used to generate the reference signal, which was transmitted through an antenna placed in the center of the shelter. For the 0.2–1 GHz frequency range, an Icom wideband omni-directional antenna was used, and for frequencies 1-3 GHz a 2 inch diameter, dual-arm, planar log spiral antenna.

On the outside of the shelter a receiving, directional Ailtech antenna was used (for both frequency ranges). The signal was amplified with a NuWave High Intercept Low Noise amplifier, supplying about 45 dB gain at UHF frequencies. This value rolls off at frequencies below 50 MHz, and at frequencies above 2 GHz, as could be noted in our data. The spectra were collected on an Agilent spectrum analyzer. All the measurements were taken August 16, 2006, during VLA maintenance time.

Six positions were marked around the shelter, each at a distance of 20 ft from the center of the shelter. The first position was located in front of the shelter door, and this position was used to take reference spectra with the shelter door open. Thus, no specific cable or space losses need to be taken into account in the analysis.

For the 0.2-1 GHz range the signal was swept with a resolution bandwidth of 100 kHz. After the reference spectrum was taken, the shelter door was closed and measurements were recorded at the six different positions. For the 1-3 GHz range the reference spectra and the first measurement in front of the closed door was taken with the same setup. However, because of a weaker signal, the following measurements were taken with 1kHz resolution bandwidth, and with setting the signal generator to frequencies 1.2, 1.4, 1.6, …, 3.0 GHz. Measurements at three additional positions were taken with this method, thus four in total for the 1-3 GHz range.

2. Analysis

Because the spectrum analyzer and the signal generator might have different step widths, the spectrum analyzer might not record the peak power at every single frequency. Therefore, a filter selecting the peak within a 50 MHz bandwidth was applied to every spectrum after the measurements. Further, for each frequency the maximum detected signal at any of the six (four) positions were determined. The difference between this maximum detected signal and the reference signal will therefore illustrate the worst scenario. Figure 1 shows this resulting minimum shielding factor, with a 3rd order polynomial fitted to each of the two frequency ranges. Considering an estimated noise of 5 dB in the data, the polynomial indicates that the minimum shielding of the shelter is 30 dB. This is slightly better than the minimum shielding level of 20 dB estimated by Kerkhoff (2006), probably because the Kerkhoff measurements were done inside a warehouse with possible reflections off the walls.

Instead of taking the maximum of the six positions for the 0-1 GHz range, we also considered the average. Figure 2 displays the resulting average shielding factor, which is about 40 dB (10 dB above the minimum shielding level).

Considering each spectrum individually, it is not surprising that the least amount of shielding was found in directions in front of the LWDA shelter door. We also discovered that pointing the receiving antenna slightly downward toward the shelter floor seemed to pick up more signal power.

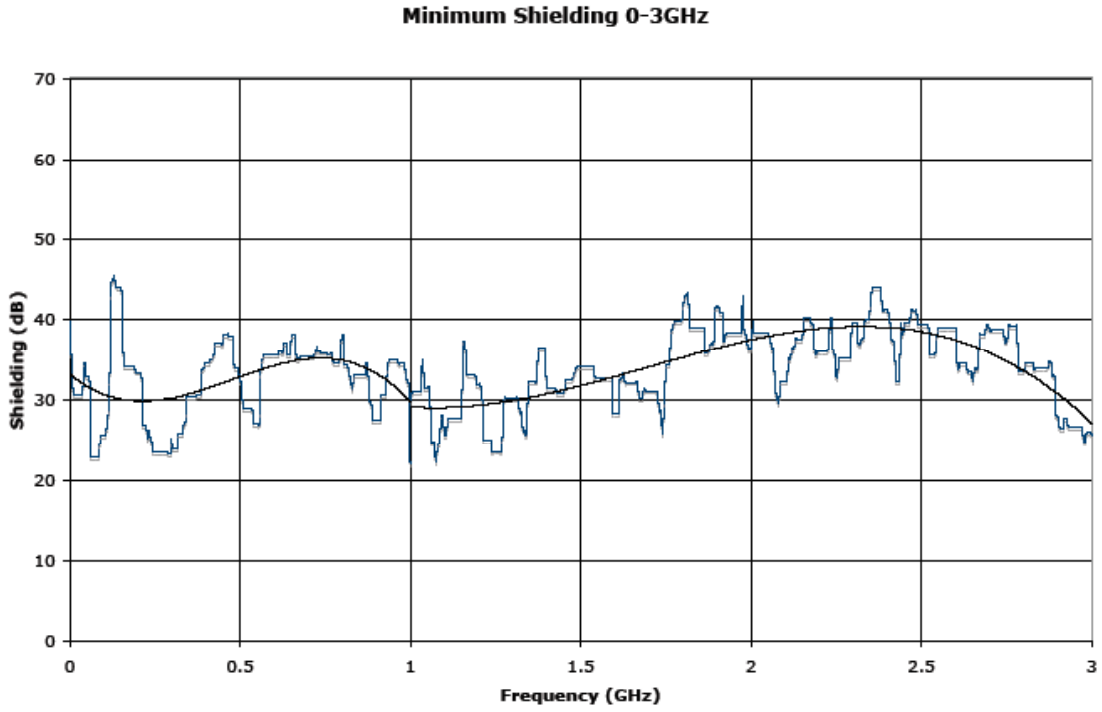

Figure 1. Minimum shielding factor of the LWDA shelter, the blue line is the data and the black solid line is a 3rd order polynomial fitted to the data.

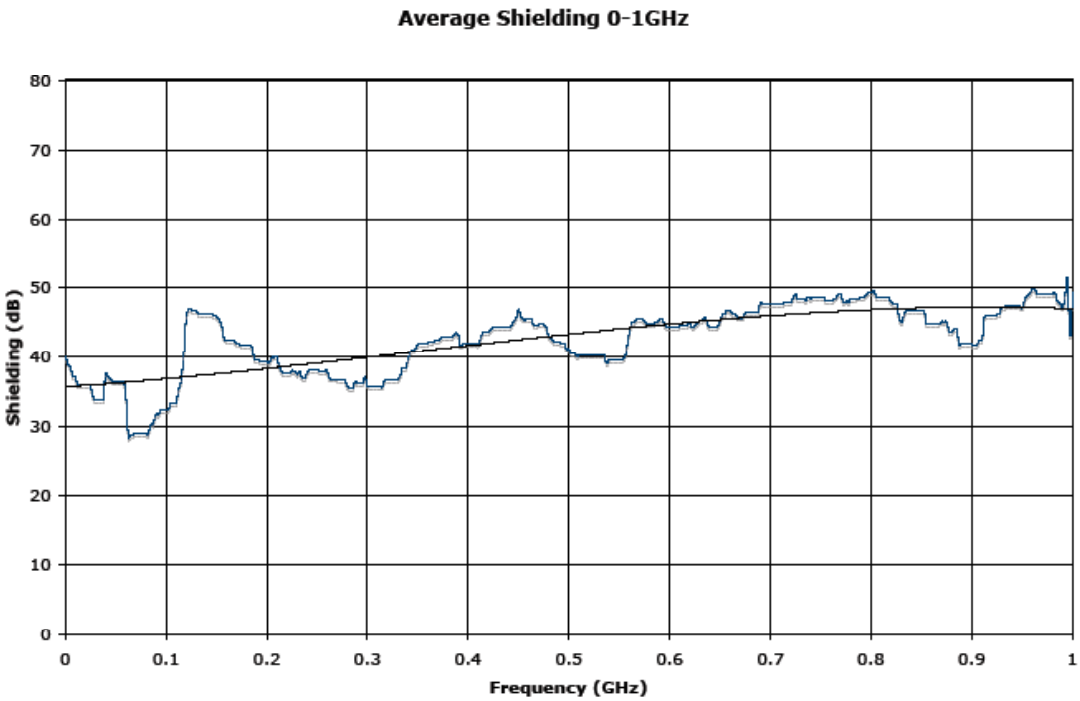

Figure 2. Average shielding factor of the LWDA shelter, the blue line is the data and the black solid line is a 3rd order polynomial fitted to the data.

2. Conclusions

Based on the results of these measurements, we adopt a shielding factor of 30 dB for the LWDA shelter. Despite the average shielding factor being 40 dB, we encourage using the lower limit, since we also found that the shelter is not shielding uniformly in all directions. The shielding is worst in directions toward the shelter door. Since these directions are facing the center of the VLA, it is therefore strongly recommended that when working on the LWDA site the shelter door should be kept closed at all times.

References:

Kerkhoff, 2006, LWA Memo #44