Ground-Plane Backed Hemispherical Luneberg Lens Reflector

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A spherical Luneberg lens reflector provides an excellent passive wideband and wide-angular radar signature augmentation, and has been widely used. Much of its signature enhancement performance over half of its angular coverage can potentially be achieved by using a corresponding low profile, hemispherical Luneberg lens reflector mounted on a reflective ground plane. This paper presents a quantitative study of a practical design of an off-the-shelf hemispherical Luneberg lens reflector to gain insight and to fully explore its performance limits. Extensive wideband and wide-angle measurements were carried out for this lens configuration, and a comprehensive numerical analysis was also conducted using the finite element method combined with a boundary integral equation to complement the test data. The effect of a finite-size ground plane in practice and the resulting vertically polarized traveling-wave interference to the direct lens reflector return are demonstrated. Key design issues are discussed, and potential solutions are suggested. It has been found that

1. Angular coverage of a ground-plane backed hemispherical lens reflector is slightly less than half of the equivalent full Luneberg lens reflector.
2. Frequency coverage of the device is largely dependent on the Luneberg lens design, but lower frequency performance is influenced by the ground-plane size relative to wavelength.
3. Low grazing incidence performance is polarization sensitive and is affected by the size and shape of the ground plane.
4. Vertically polarized traveling waves excited by the front edge of the ground plane and the lens reflector strongly interfere with the desired lens response and must be controlled and minimized. Careful trade-off must be made between respective reductions in traveling-wave interference and angular coverage. Some potential solutions may be (a) shaping the front of the ground plane, (b) placing absorbers on part of the ground plane, and (c) changing the size of the ground plane.