RADAR CROSS SECTION BENCHMARK FOR SIMPLE SHAPES

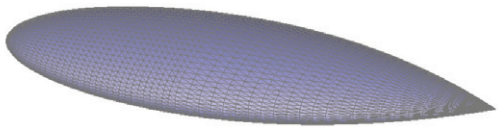
Introduction

This application demonstrates Radar Cross Section (RCS) calculation for simple shapes including the NASA almond, ogive, double-ogive, cone-sphere and cone-sphere with gap. Simulation data is compared with published measurements data from A. C. Woo, H. T. G. Wang, and M. J. Schuh, "Benchmark Radar Targets for the Validation of Computational Electromagnetics Programs," IEEE Antennas and Propagation Magazine, vol. 35, no. 1, February 1993, pp. 84 - 89.

NASA Metallic Almond

The NASA almond geometry and analytical expressions used for shape generation are shown below. The total length of the almond is 9.936 inches.
The RCS values for both horizontal (HH) and vertical (VV) polarizations are plotted in dBSM [dB with respect to one square meter] as a function of the azimuthal angle.

Metallic Almond Geometry



$$for \quad -0.4167 < t < 0 \quad and \quad -\pi < \psi < \pi$$

$$x = d \cdot t \ \ inches, \quad d = 9.936 \ \ inches$$

$$y = 0.13333 \cdot d \cdot \sqrt{1-\left(\frac{t}{0.416667}\right)^2}\cos\psi$$

$$z = 0.064444 \cdot d \sqrt{1-\left(\frac{t}{0.416667}\right)^2}\sin\psi$$

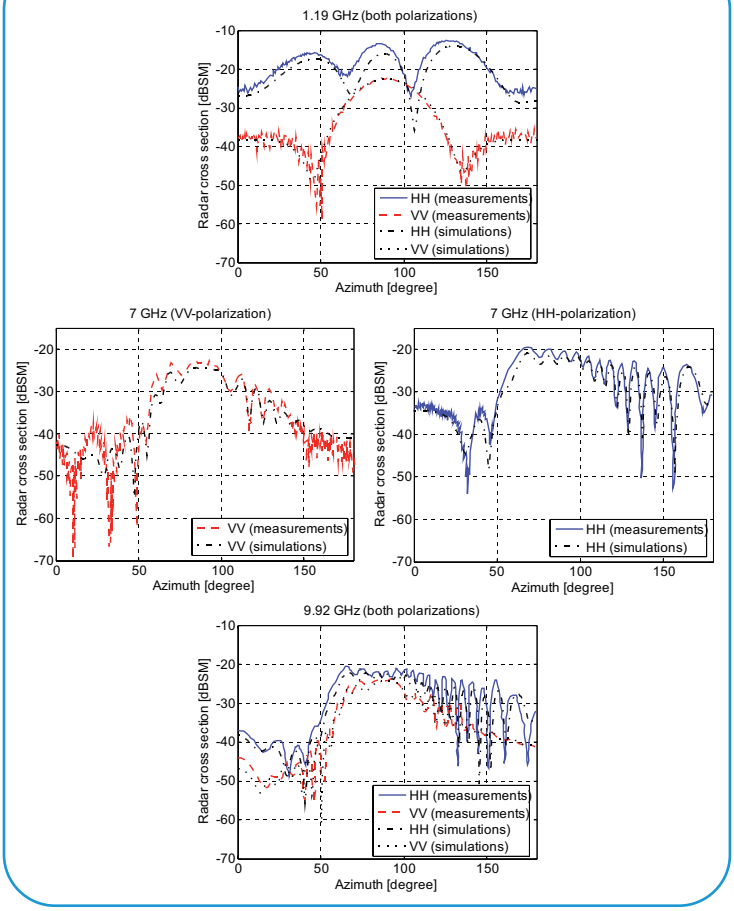
$$for \quad 0 < t < 0.58333 \quad and \quad -\pi < \psi < \pi$$

$$x = d \cdot t \ \ inches, \quad d = 9.936 \ \ inches$$

$$y = 4.83345 \cdot d \cdot \left[\sqrt{1-\left(\frac{t}{2.08335}\right)^2} - 0.96\right]\cos\psi$$

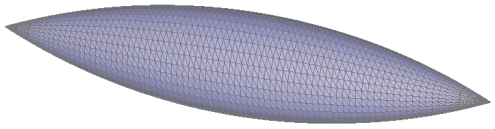
$$z = 1.91115 \cdot d \cdot \left[\sqrt{1-\left(\frac{t}{2.08335}\right)^2} - 0.96\right]\sin\psi$$

NASA Almond RCS Comparisons



Metallic Simple Ogive

Metallic Simple Ogive Geometry



$$for \quad -5 \ in < x < 5 \ in \ and \quad -\pi < \psi < \pi$$

$$f(x) = \left\{\sqrt{1-\left(\frac{x}{5}\right)^2}\sin^2(22.62^o) - \cos(22.62^o)\right\},$$

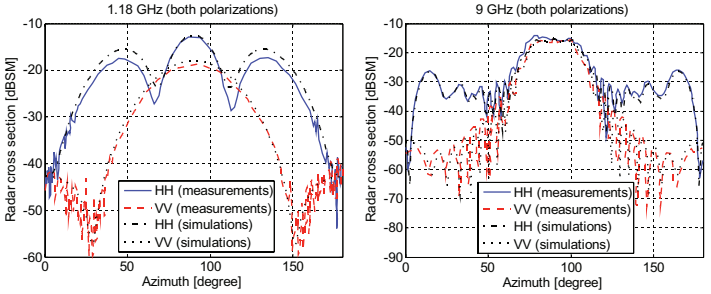
$$then$$

$$y = \frac{f(x)\cos\psi}{1-\cos(22.62^o)}$$

$$y = \frac{f(x)\sin\psi}{1-\cos(22.62^o)}$$

The metallic ogive geometry and analytical expressions used for shape generation are shown below.
The RCS for both horizontal and vertical polarization is plotted in dBSM as a function of the azimuthal angle.

Metallic Simple Ogive RCS Comparisons



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RADAR CROSS SECTION BENCHMARK FOR SIMPLE SHAPES

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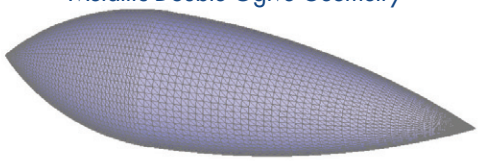
Metallic Double Ogive

Metallic Double Ogive Geometry



$$for\ -2.5\ in < x < 0\ in\ and\ -\pi < \psi < \pi$$

$$g(x) = \left\{\sqrt{1-\left(\frac{x}{5}\right)^2}\sin^2(46.6^o) - \cos(46.6^o)\right\},\ then$$

$$y = \frac{f(x)\cos\psi}{1-\cos(46.6^o)} \qquad y = \frac{f(x)\sin\psi}{1-\cos(46.6^o)}$$

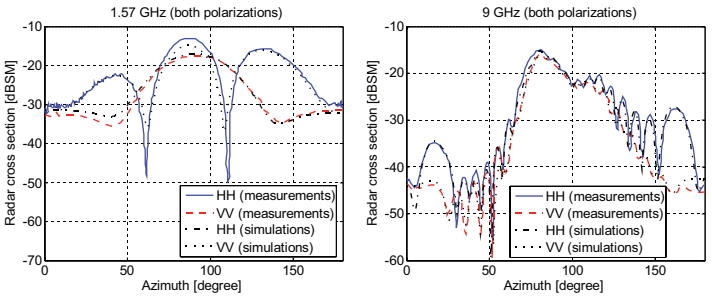
$$for\ 0\ in < x < 5\ in\ and\ -\pi < \psi < \pi$$

$$f(x) = \left\{\sqrt{1-\left(\frac{x}{5}\right)^2}\sin^2(22.62^o) - \cos(22.62^o)\right\},\ then$$

$$y = \frac{f(x)\cos\psi}{1-\cos(22.62^o)} \qquad y = \frac{f(x)\sin\psi}{1-\cos(22.62^o)}$$

The double ogive consists of two different-size half ogives. The metallic ogive geometry and analytical expressions used for shape generation are shown below. The RCS for both horizontal and vertical polarization is plotted in dBSM as a function of the azimuthal angle.

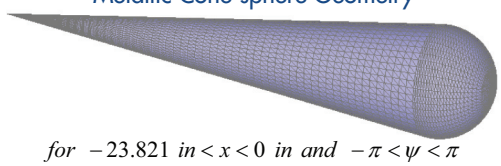
Metallic Double Ogive RCS Comparisons



Metallic Cone-sphere

The metallic cone-sphere geometry and analytical expressions used for shape generation are shown below.
The RCS for both horizontal and vertical polarization is plotted in dBSM as a function of the azimuthal angle.

Metallic Cone-sphere Geometry



$$for\ -23.821\ in < x < 0\ in\ and\ -\pi < \psi < \pi$$

$$y = 0.87145(x + 23.821)\cos\psi$$

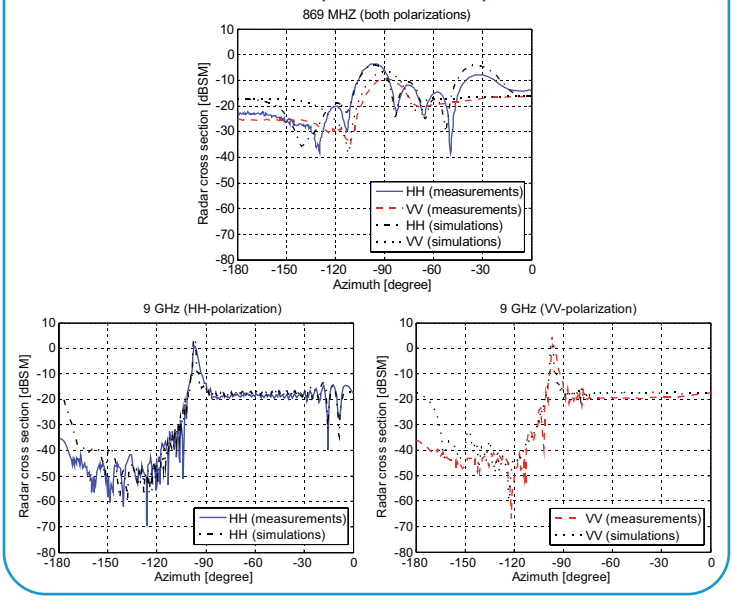
$$z = 0.87145(x + 23.821)\sin\psi$$

$$for\ 0\ in < x < 3.306\ in\ and\ -\pi < \psi < \pi$$

$$y = 2.947\sqrt{1-\left(\frac{x-0.359}{2.947}\right)^2}\cos\psi$$

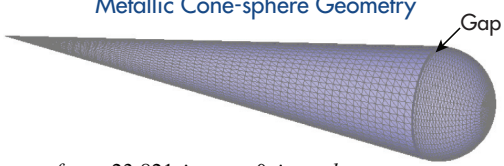
$$z = 2.947\sqrt{1-\left(\frac{x-0.359}{2.947}\right)^2}\sin\psi$$

Metallic Cone-sphere RCS Comparisons



Metallic Cone-sphere with Gap

Metallic Cone-sphere Geometry



$$for\ -23.821\ in < x < 0\ in\ and\ -\pi < \psi < \pi$$

$$y = 0.87145(x + 23.821)\cos\psi$$

$$z = 0.87145(x + 23.821)\sin\psi$$

$$for\ 0\ in < x < 3.306\ in\ and\ -\pi < \psi < \pi$$

$$y = 2.947\sqrt{1-\left(\frac{x-0.359}{2.947}\right)^2}\cos\psi$$

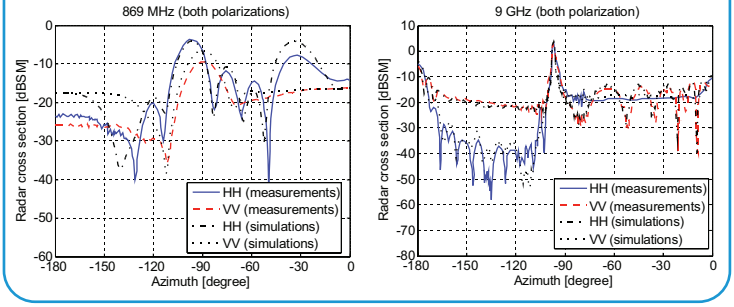
$$z = 2.947\sqrt{1-\left(\frac{x-0.359}{2.947}\right)^2}\sin\psi$$

$$for\ 0 < x < 0.25\ in\ and\ -\pi < \psi < \pi$$

$$y = 2.697\cos\psi \qquad z = 2.697\sin\psi$$

The metallic cone-sphere geometry with gap and analytical expressions used for shape generation are shown below.
The RCS for both horizontal and vertical polarization is plotted in dBSM as a function of the azimuthal angle.

Metallic Cone-sphere with Gap RCS Comparisons



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