EM Implosion Memos

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Replacing Prolate-Spheroidal Reflector by Equivalent Source

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Abstract

In this paper we use an equivalent source on a sphere for separating the target-focusing-lens problem from that of the prolate-spheroidal reflector. Two different E-Field variations are imposed to this sphere surface.

1 Introduction

We have to deal with two different problems to find the focal waveform characteristics of our spheroidal IRA's geometry that is based on [1,2]. First of all our geometry is big compared to the wavelength, and we want to use high dilectric materials to obtain better focusing.We use increasing permittivity dielectric lens for better focusing. For simulation we use shells to obtain the increase in permittivity. This leads us to simplify the antenna geometry. We use two approaches for simplification. We use a spherical array as an equivalent geometry and we impose two different types of E-field variation.

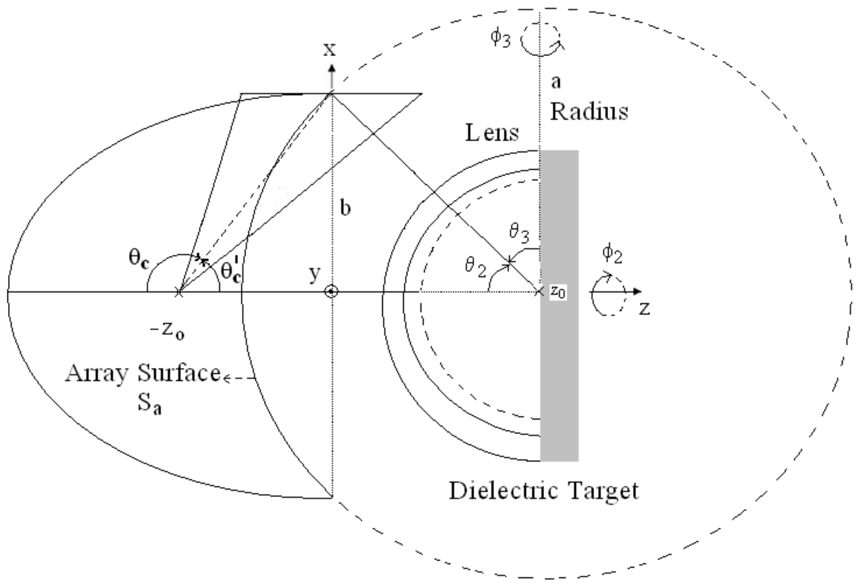

Figure 1 IRA and Equivalent Geometry

2 Description of geometry

The focal point is $z_0 = 37.5$ cm, $a = 62.5$ cm, $b = 50$ cm and the other parameters of prolate-spheroidal IRA is defined in [1,2]. θ , θ_2 , ϕ_2 angles are

$$0 < \theta < \pi/2 \ , 0 < \theta_2 < \pi/2 \ , 0 < \phi_2 < \pi/2 \qquad (2.1)$$

One can see for fixed ϕ_2 and constant θ_2, if we let fields vary along r_2 toward 0, the beam edge is around θ_c'.

3 Design Considerations

We impose two different kinds of E-Field variation on S_a surface. These imposed E-Field variatons are based on (3.13) in [1] and (2.1) in [3]. So the first imposed field is

$$E_1 = \frac{V_0 b}{\pi f_g a(a - z_0)} \left[\frac{2\cos(\phi_2)}{1+\cos(\theta_2)} \vec{1}_{\theta_2} - \frac{2\sin(\phi_2)}{1+\cos(\theta_2)} \vec{1}_{\theta_2} \right] \begin{cases} u(t) \text{ arrive center at } t = a/c \\ u(t + a/c) \text{ arrive center at } t = 0 \end{cases} \qquad (3.1)$$

Where $V_0 = .5$ V and the transmission line parameter $f_g = 400/377$ for the two feed-arm case.

The second imposed E-Field variation is

$$E_2 = \frac{V_0}{\pi f_g} \frac{b}{a^2 - z_0^2} \sin(\theta_3) \ \vec{1}_{\theta_3} \begin{cases} u(t) & \text{arrive center at } t = a/c \\ u(t + a/c) & \text{arrive center at } t = 0 \end{cases} \tag{3.2}$$

Let's write (3.2) in the same cordinate system of (3.1)

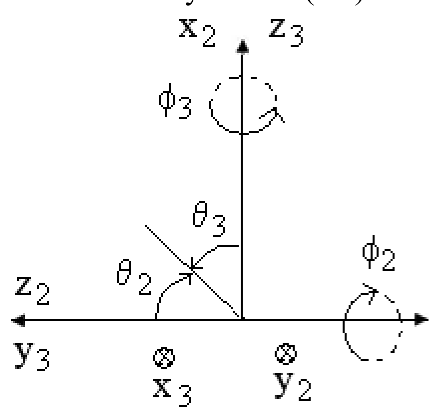

Figure 3.1 Coordinates

So at the end we will have

$$E_2 = \frac{V_0}{\pi f_g} \frac{b}{a^2 - z_0^2} \cos(\theta_2) \left(-\vec{1}_{\theta_2} \cos(\theta_2)\cos(\phi_2) - \vec{1}_{\phi_2} \sin(\theta_2) + \vec{1}_r \cos(\theta_2)\sin(\phi_2) \right) \tag{3.3}$$

$$\begin{cases} u(t) & \text{arrive center at } t = a/c \\ u(t + a/c) & \text{arrive center at } t = 0 \end{cases}$$

4 Conclusion

An equivalent source on a sphere is proposed and two different types of E-Field variaton on this array surface array are imposed. This paper can be used for numerical designs however it is hard to impose E-Field variation on the surface of a sphere numerically. This equivalent geometry simplifies the orijinal IRA geometry.

References

1. C. E. Baum, "Focal Waveform of a Prolate-Spheroidal IRA", Sensor and Simulation Note 509, February 2006.
2. S. Altunc and C. E. Baum, "Extension of the Analytic Results for the Focal Waveform of a Two-Arm Prolate-Spheroidal Impulse-Radiating Antenna (IRA)", Sensor and Simulation Note 518, Nov 2006.
3. C. E. Baum, "Electromagnetic Implosion Using an Array", Sensor and Simulation Note 517, July 2006.