Analytical Calculations of an Electromagnetic Lens to Obtain a Spherical TEM Wave

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IRAs have been developed for the transient far-field region using paraboloidal reflectors. However, we focus on the near field region and develop the field waveform at the second focus of a prolate-spheroidal IRA. Recent research has shown that it is possible to kill certain skin cancers by the application of fast, high-amplitude electric-field pulses. This has been accomplished by the insertion of electrodes near the tumor, with direct contact from a high-voltage pulse generator. It has been suggested that it would be desirable to be able to apply fast, high-electric-field pulses without direct contact for this biological application, i.e., to irradiate them using an antenna from a distance.

Designing the feed point is one of the most important concern that one should consider to obtain a fast-rising (100 ps) spherical TEM wave. Diverging a spherical TEM wave to another diverging spherical TEM wave is the key point of this design. A uniform dielectric lens can be used to ensure the launching of an approximate spherical TEM wave onto the TEM feed arms of our prolate-spheroidal IRA. We design a lens such that within the lens we have a spherical TEM wave centered on the switch center. However, outside the lens we have an approximate spherical TEM wave which is centered at the first focal point of the prolate-spheroidal IRA. High-pressure hydrogen can be used as an insulating medium containing the switch. The risetime of the pulser is 100 ps. The dimensions of the lens geometry can be calculated as in (C. E. Baum and A.P. Stone, "A Uniform Dielectric Lens for Launching a Spherical Wave into a Paraboloidal Reflector," Sensor and Simulation Note 360, July 1993). However, we should manipulate the equations and change the constraints that are suitable for out prolate-spheroidal IRA design. The bigger lens gives better launching. However, we have to deal with loss and dispersion as a price for larger dimensions. Determining the dimensions of the lens is also a numerical problem. More detailed numerical simulations should be done to determine the optimum geometry.