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Scaling down the reflector dimensions

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Abstract

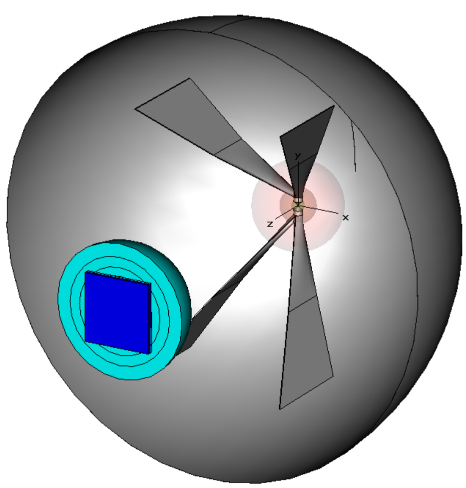
The shorter duration of the pre-pulse observed in the focal response of the T4FASC-CSS-SPVSHC and T4FASC-CSS-CPVCHC configurations allows one to scale down the size of the reflector. In this paper, the peak focal impulse amplitude and the beam width are explored as a function of the reflector size.

1 Introduction

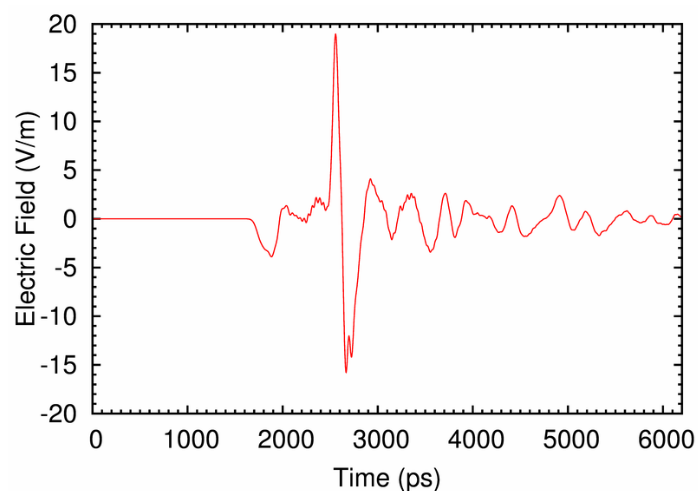
For the two and four feed-arm PSIRA configurations investigated in [1], it has been analytically established that the size of the reflector solely dictates the magnitude of the prepulse. For the T4FASC-CSS-SPVSHC and T4FASC-CSS-CPVCHC designs one observes that the prepulse is of a much shorter duration [2–4]. This shorter prepulse permits the scaling down of the reflector size and hence reduce the overall dimensions of the system. In this paper, the "original size" of the reflector and focusing lens, i.e., 100%, refers to the analytically optimized dimensions, e.g., in [5, 6]. The T4FASC-CSS-SPVSHC, with optimized dimensions [4], is used to illustrate the effect of the reflector size on the peak focal impulse amplitude and beam width.

2 Results

Fig. 2.1(a) shows the perspective view of the reflector, focusing lens and slab, all scaled down to 50%. Fig. 2.1(b) shows the focal impulse waveform for this configuration. The peak focal impulse amplitude is $E_{\max} = 18.957$ V/m and the spot size is approximately 1.173 cm. However, one notes the large post-pulse (lower frequencies) amplitude which is, as in [4], approximately 2/3 the peak impulse amplitude.



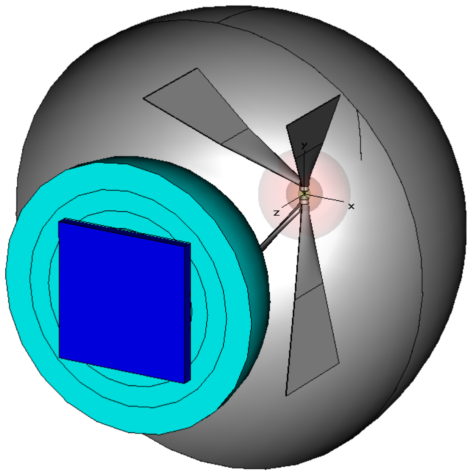
(a) Perspective view. Focusing lens diameter = 15.0 cm.



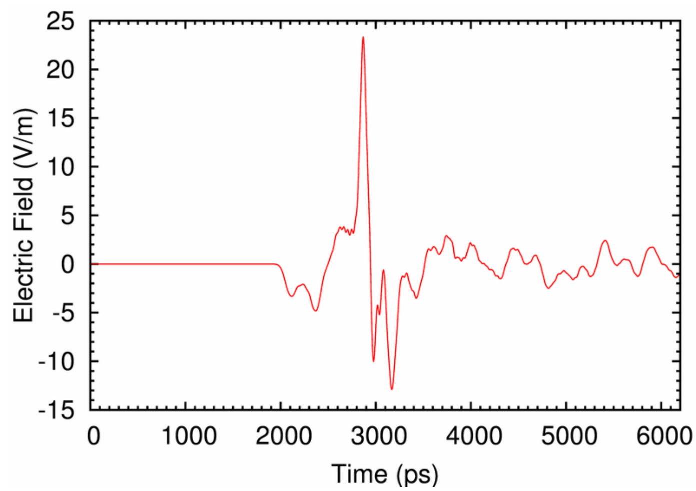
(b) Focal impulse waveform.

Figure 2.1: Perspective view and focal impulse waveform for the reflector, focusing lens and slab scaled down to 50% of the original size, for the T4FASC-CSS-SPVSHC configuration .

One can employ the filtering properties of the focusing lens to reduce the size of the post-pulse, i.e., filter out the lower frequencies in the focal impulse waveform. To accomplish this, the original size of the focusing lens must be used; focusing lens diameter = 30.0 cm. Fig. 2.2(a) shows the perspective view of the system with only the reflector scaled down to 50%. Fig. 2.2(b) shows the focal impulse waveform for this configuration. The peak focal impulse amplitude, $E_{\max} = 23.305$ V/m, is much higher than that in Fig. 2.1(b). The spot size, approximately 1.532 cm, is also larger. The most important observation is that, compared to Fig. 2.1(b), the lower frequencies are indeed effectively filtered. This is observed in the markedly reduced peak post-pulse amplitude.



(a) Perspective view. Focusing lens diameter = 30.0 cm.



(b) Focal impulse waveform.

Figure 2.2: Perspective view and focal impulse waveform with only the reflector scaled down to 50% of the original size, for the T4FASC-CSS-SPVSHC configuration.

The peak focal impulse amplitude and spot size as a function of the reflector size, with the focusing lens, are shown in Fig. 2.3. Observe that the smallest spot size and $E_{\max}$ occur when the reflector is 55%-70% of the original size. Half the reflector size, 50%, yields the largest $E_{\max}$ and spot size.

<u>**Note**</u>: Smaller reflector sizes require higher resolution in simulations. However, due to limited resources, the CST parameters were kept fixed for all simulations, i.e., LPW = 10 and Frequency range = $0 - 10$ GHz. Therefore, the results for the smaller reflector sizes are not very accurate. One should expect a deviation of approximately $\pm 20\%$.

3 Conclusion

Scaling down both the focusing lens and the reflector results in a large post-pulse. The lower frequencies can be effectively filtered by using the original sized focusing lens (30 cm diameter). The shorter duration of the pre-pulse for the T4FASC-CSS-SPVSHC configuration allows for reducing the size of the reflector thereby reducing the overall size of PSIRA system. A scaled down range of 55%-70% provides an acceptable $E_{\max}$ and spot size.

References

[1] Prashanth Kumar, Carl E. Baum, Serhat Altunc, Christos G. Christodoulou and Edl Schamiloglu, "Numerical simulations of a 60 degree four-feed-arm PSIRA to determine the beam width inside a focusing lens." EM Implosion Memo 35, Oct. 2009.

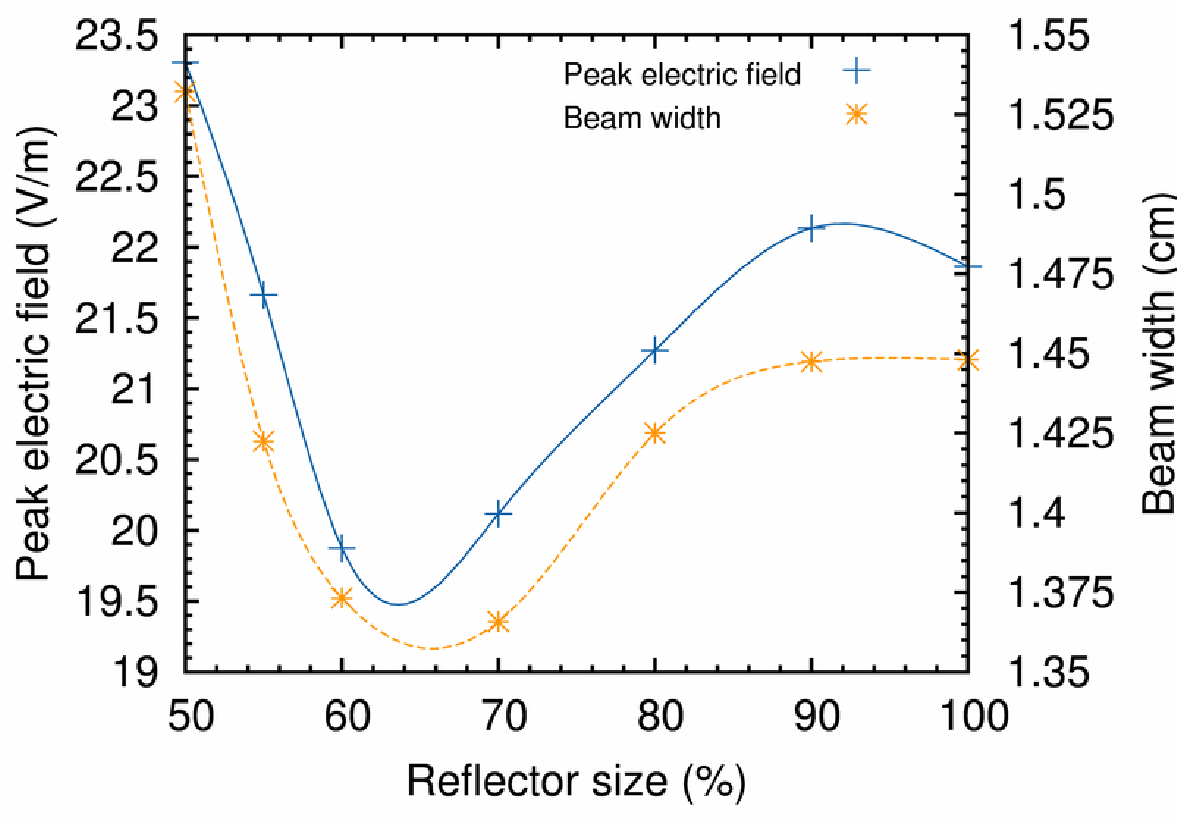


Figure 2.3: Peak focal amplitude and spot size as a function of the scaled-down reflector size with the focusing lens.

[2] Prashanth Kumar, Carl E. Baum, Serhat Altunc, Christos G. Christodoulou and Edl Schamiloglu, "The truncated four feed-arm configuration with switch cones (T4FASC) and a spherical pressure vessel." EM Implosion Memo 42, May 2010.

[3] Prashanth Kumar, Carl E. Baum, Serhat Altunc, Christos G. Christodoulou and Edl Schamiloglu, "The truncated four feed-arm configuration with switch cones (T4FASC) and a cylindrical pressure vessel." EM Implosion Memo 43, May 2010.

[4] Prashanth Kumar, Carl E. Baum, Serhat Altunc, Christos G. Christodoulou and Edl Schamiloglu, " Comparison of electromagnetic parameters for the T4FASC-CSS-SPVSHC and T4FASC-CSS-CPVCHC congurations with the focusing lens." EM Implosion Memo 45, May 2010.

[5] C. E. Baum, "Focal waveform of a prolate-spheroidal impulse-radiating antenna," *Radio Sci.*, vol. 42, no. RS6S27, 2007.

[6] S. Altunc, C. E. Baum, C. G. Christodoulou, E. Schamiloglu, and C. J. Buchenauer, "Focal waveforms for Various Source Waveforms Driving a Prolate-Spheroidal Impulse Radiating Antenna (IRA)," *Radio Sci.*, vol. 43, no. RS4S13, 2008.