Progress In Electromagnetics Research Letters, Vol. 8, 19–24, 2009

HIGH POWER ELECTROMAGNETIC TRANSIENT PULSE IN-PHASE SYNTHESIS

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Abstract—PCSS low jitter trigger can reach 65 ps in the condition of high bias electric under the non-liner mode [1–5]; high power transient pulse can be gained by virtue of it. The high power transient pulse in-phase characteristic and other tenets are verified by testing axial electric field strength and axial energy density, which is energy per area at the antenna main radiation direction. In the experiment, axial electric field strength and energy density of antenna array measured in different conditions indicate that axial electric field strength is proportional to the number of antenna elements and the energy density is proportional to the square of the number of radiation units, which means the transient electromagnetic pulses could synthesize in phase perfectly.

1. INTRODUCTION

Around 1990, a series of laws about transient electromagnetic pulse transmission have been established, such as transient electromagnetic pulse slow decay theory, the array antenna beam focus theory, high efficient transmission theory, beam scanning theory and etc. [6]. There are two views about transient electromagnetic pulse: times and frequency domain. From the point of frequency domain, due to different phase velocities, it is difficult to achieve a rich spectrum of electromagnetic pulse in-phase synthesis in a given point on the axis. On the other hand, from the point of time-domain, the array of transient electromagnetic pulse is able to reach the observation point on the axis as long as distance and feed time to the antenna, which depends on the wave path difference are strictly controled. If

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the distance from array to observation points is far longer than the wave path difference, it will be able to achieve precise synchronization for series of time domain electromagnetic wave beam, and thus achieve transient electromagnetic pulses fields in-phase synthesis in the space.

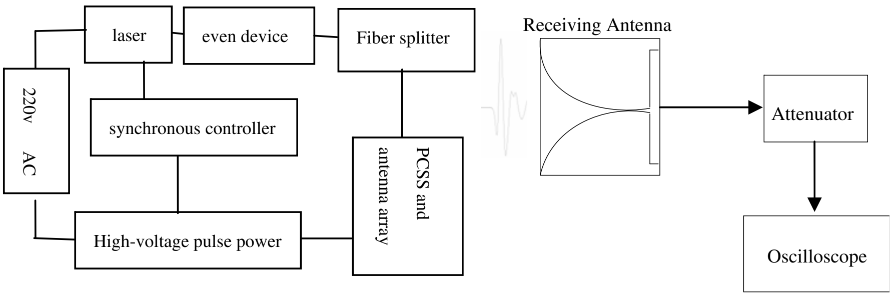

Figure 1. Experiment system.

2. EXPERIMENT DESIGN AND VERIFICATION

The experiment picture is shown in Figure 1, which includes electricity feed system, optical feed systems, synchronous controller system, radiation and reception system. Electricity feed system is constituted by the 220 v AC power and compact high voltage pulse powers, which dimension is 124 mm × 80 mm × 45 mm; weight is 350 g. Its designment is based on the flyback transformer design method. While the optical feed system is composed by YAG laser, even device, fiber splitter, fibers shown in Figure 2 are arranged as hexagon. The feed time delay of electricity and optic is controlled by the synchronous controller, which makes the optical pulse in time incent PCSS when electric pulse reaches peak. The radiation system is made up of an antenna array of m × m

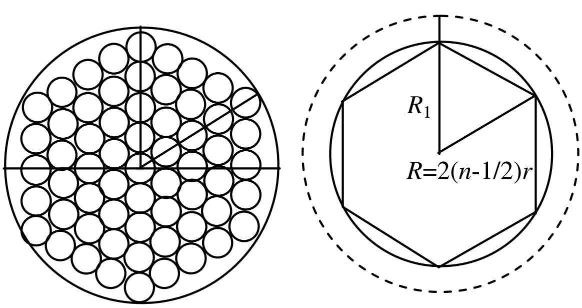

Figure 2. Fibers arranged as hexagon.

Figure 3. Antenna array.

Figure 4. Transient electromagnetic pulse at the distance of 100 m.

units. The reception system is composed by an Vivaldi antenna. The way of radiation antenna array arrangement can be seen fin Figure 3 [7–9]. The electromagnetic beam signals from array of UWB antenna is received by reception system. Experiment procedures are as follows: synchronous controller sends a TTL level to the picosecond laser and ps laser sends it to panel controlled by pulsed power; just on pulse forming [10, 11], 271 beams laser through even device arrive to feed PCSS which are on antennas. Then the transient electromagnetic pulses generated by PCSS are radiated by antennas.

In [12], we know that the calculation of antenna array radiation energy is similar to that of light grating intensity. In the paper, it analogizes with interference and diffraction theory, educes the calculation formula, which is in accordance well with the numerical results gained from the electromagnetic field theory. The antenna is placed as shown in Fig. 5. As shown in Fig. 5, h is antenna dimension, R0, R1, R2 is the distance from relevant reantenna to observation point respectively. From [12], we can conclude that in the experiment, despite generating electric pulse by PCSS has a jitter at non-linear model, the amplitude and timing jitter can be negligible to large array. Transient electromagnetic pulse arrays can achieve perfect synthesis. In order to improve voltage conversion efficiency, blumlein circuit has been introduced into the circuit [13]. In theory, PCSS conversion efficiency can reach 100%. First of all, we fix observation point on antenna axis 100 meters away from the array, change antenna array element number, and then measure the electric field strength of array at the point. Figure 6(a) is the experimental result. As can be seen from the chart, electric field strength is proportional to the

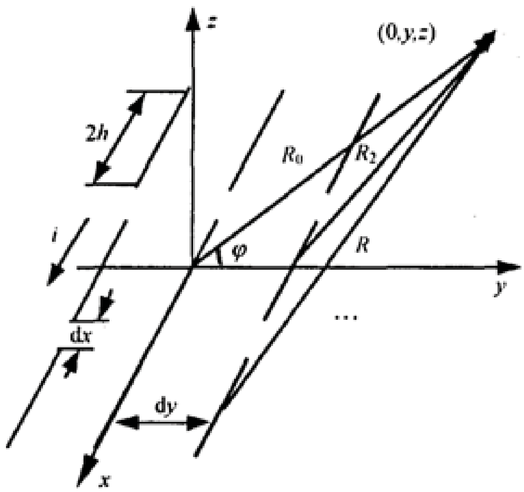

Figure 5. Line element array at yz plane.

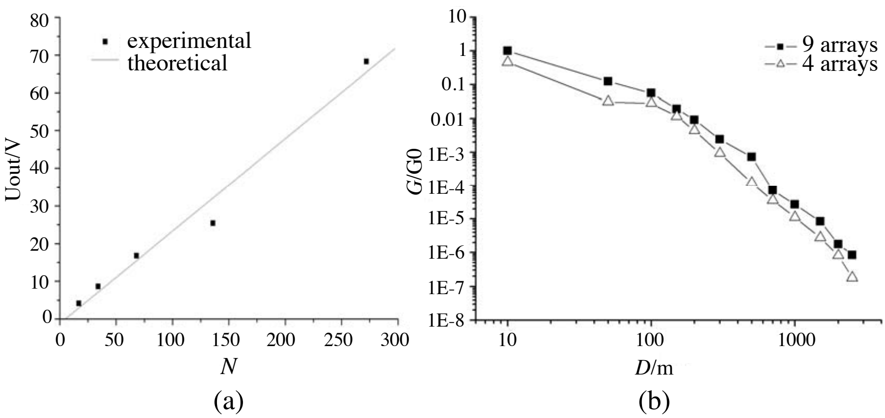

Figure 6. Axis field component synthesis of different number sub-arrays. (a) Axis field component at distance of 100 m, (b) 4, 9 sub-array axis energy at the same condition.

number of array elements within the experiment error. Secondly, we fix the number of array element and measure axial energy density of the points. From Figure 6(b) we can see the curves of 4 sub-array and 9 sub-array basicly parallel, which indicates that the transient electromagnetic pulse synthesizes in phase perfectly.

3. CONCLUSIONS

Fiber splitter can feed 271 PCSS simultaneously, which solves the problem in optic synchronization. PCSS arrays with small trigger jitter can output high power ns width pulse in the condition of high bias voltage in the non-linear mode. The transient electromagnetic pulse in-phase synthesis feature and other tenets are verified by array axial transmission energy of 271 units ultra-wideband antenna. Transient electromagnetic pulse has very bright prospects in future [14]. The experiment provides direct experimental foundation.

ACKNOWLEDGMENT

This work was supported in part by the State Key Laboratory Funds of China and Defense Innovation and Technology Fund of China.

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