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Studying the absolute behavior of pulse delay

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ABSTRACT

Pulse delay plays an important role in the process of signal or light propagation. Control of the alpha, phase and offset parameters lead to a rapidly change in the shape and function of the pulse delay. Offset contribute highly to this change.

Introduction

Pulse delay is an important factor in the process of propagation of pulse laser. The magnitude of the pulse delay depends on the target material or on the general purpose(s) of propagation laser. Pulse delay may be defined as the "interval between leading edge medians of trigger output pulse and output pulse itself". The specified and displayed value is that obtained with the fastest leading edge. Pulse delay has two components, a fixed delay from trigger output to output signal and a variable delay with respect to the trigger output1. Figure 1 shows the graph of pulse delay according to the mentioned definition.

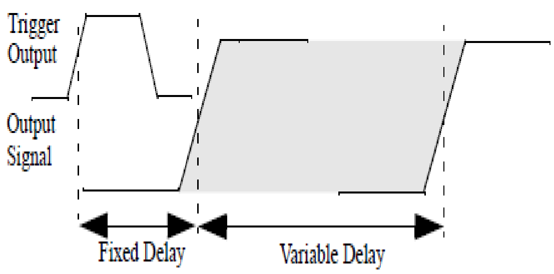

Fig. 1. Pulse delay

The energy gain in a single stage of a laser-plasma accelerator can be limited by the laser-plasma or beamplasma interaction lengths. For typical laser-plasma parameters, diffraction is the most effective limitation, and limits the interaction length to the order of a few laser Rayleigh ranges. This limitation can be overcome through a combination of preformed plasma channel guiding, relativistic self-focusing, and ponderomotive selfchanneling[2]. With diffraction overcome by laser guiding, the beam energy gain in the plasma wave can be limited by slippage between the beam position and the phase of the plasma wave. The slippage resulted from the difference between the beam velocity and the plasma wave phase velocity is referred to as electron dephasing. The dephasing limitation may be overcome by spatially tailoring the plasma density (i.e., plasma tapering). In the weakly-relativistic regime, the exact density variation required to phase-lock the electron beam to the phase of the accelerating and/or focusing forces may be derived[3]. Laser, and consequently plasma wave, evolution will ultimately limit the single-stage energy gain in a laser-plasma accelerator, and a fundamental limit to the laser propagation distance is the transfer of laser energy into the plasma wave (i.e., laser energy depletion)[4]. Typically, the evolution of a resonant laser pulse proceeds in two phases. In the first phase, the pulse steepens, compresses, and frequency red-shifts as energy is deposited in the plasma. And in the second phase evolution occurs after the pulse reaches a minimum length at which point the pulse rapidly lengthens, losing resonance with the plasma. Expressions for the rate of laser energy loss, rate of pulse steepening and compression, and rate of laser frequency red-shifting are derived. They are found to be in excellent agreement with the direct numerical solution of the laser field evolution coupled to the plasma response. These processes are shown to have the same characteristic length-scale (pump depletion length). An analytic expression for the nonlinear pump depletion length for a nearly-resonant Gaussian pulse

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is derived (equation 1 is a form of a laser pulse which is circularly polarized and has a Gaussian envelop[5]), and, in the high intensity limit, this scale length is shown to be independent of laser intensity.

$$a = a_0 \exp(-r^2 / r_l^2 - \xi^2 / L_l^2) \ \ldots (1)$$

Where; ζ is the longitudinal coordinate, r is the transverse coordinate and L is the length of the simulation region.

The resulting evolution of the nonlinear plasma wave amplitude is also derived and found to be in excellent agreement with numerical solutions. The plasma wave phase velocity determines the slippage between the beam and the plasma wave and therefore the energy gain. In the weakly-relativistic regime, the phase velocity is approximately the group velocity of the laser pulse.

Data collection and results

The Monte-Carlo simulation method provided by the Matlab programming environment was used here to facilitate the investigation process of the pulse delay behavior.

In order to get the required data, the following parameters were considered:

Delta: is the delay duration in seconds,

r1: is the magnetization component's longitudinal relaxation rate in 1/sec

r2: is the magnetization component's transversal relaxation rate in 1/sec

offset: is the magnetization component's offset from resonance in Hz

m0: is the magnetization component's equilibrium magnetization (weight)

The rotated magnetization is returned in the column vector which is used to show the delay pulse status at each scenario.

For more details about manipulating delay pulse, the reader is recommended to use this URL http://www.ebyte.it/library/educards/nmr/NmrMath_PulseAndDelayOps.html.

It is of interest to mention here that pulse phase, delta, and offset are the parameters that simulated and changed during running the program that used here to generate the delay pulse.

Of course it is not possible to try every possibility to generate the delay pulse. It is rather to try the following three different settings to focus on:- First alpha was varied while offset and phase were fixed unchanged. Second, phase was varied while alpha and offset were remain unchanged. Third, offset was varied while alpha and phase remain unchanged.

Figure 1 shows the high fluctuation of the rotated magnetization when alpha varied randomly.

Figure 2 shows the how the high fluctuation in the rotated magnetization factor reduced dramatically by increasing the phase value. The most significant change was noticed to happened when the offset value set to 2, figure 3 shows how the behavior of the delay changed to show the three zones of rotated magnetization.

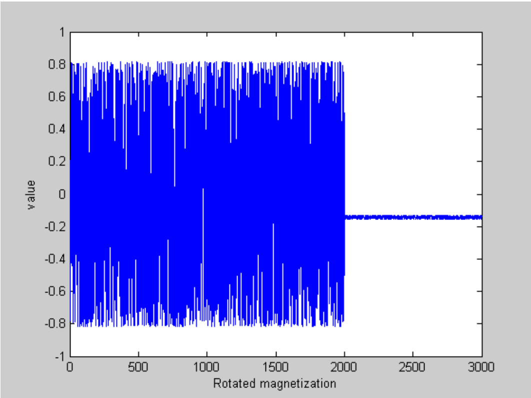

Fig. 1. Plot of the rotated magnetization with offset and phase unchanged.

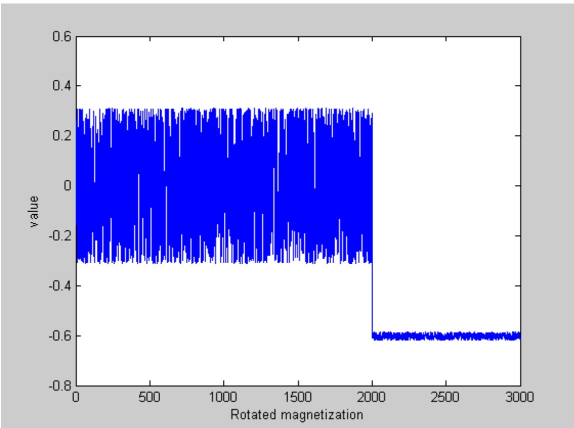

Fig. 2. Plot of the rotated magnetization with alpha and offset unchanged.

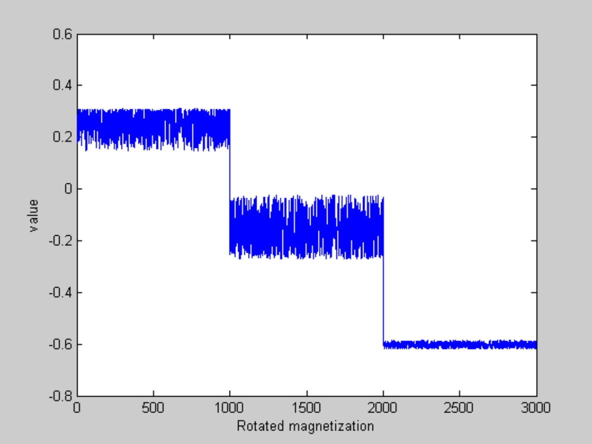

Fig. 3. Plot of the rotated magnetization with alpha and phase unchanged.

Conclusion

Pulse delay is so important factor in the process of signal or light propagation. The design or set up of the experiment must take in consideration the aim of the experiment when deciding the values of the alpha, phase and offset. The change of any of these values will change the process of propagation as a whole.

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دراسة السلوك المطلق لزمن تأخير النبضة

احمد عبيد فرحان

الخلاصة :

يلعب زمن تأخير النبضة دوراً مهماً في معالجة انتشار الضوء او الإشارة. إن السيطرة على الطور والفا والمعالم المرافقة تؤدي إلى التغير السريع في شكل ووظيفة تأخير زمن النبضة. هذه العوامل تساهم بشكل كبير في هذا التغيير.