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The Laser Pulse-shaping System for the KAERI Laser Facility

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1. Introduction

The Korea Atomic Energy Research Institute (KAERI) has developed a 1 kJ Nd:Glass laser facility for basic research on quantum engineering and laser fusion on early 2008. The KLF (KAERI Laser Facility) system consisted 4 beam lines with a clear aperture of 100 mm and each beam-energy is more than 250 J at the nano-second regime [1-3]. For a wide application of laser facility, we are researching a temporal laser pulse shaping system of the seed-beam. The optimal temporal shape of the pulse is of importance when the processes occurring during the pulse are thermal and the pulse shape determines the temperature distribution in time and space. The generation of a temporally shaped pulse has been the subject of research, especially in the area of laser fusion research and femto-second pulses [4-7].

In this study we report on a temporal laser pulse shaping system with temporal waveforms defined by an arbitrary electronic waveform generator.

2. Experimental set-up and results

2.1 Experimental set-up

The experiments were conducted on a fiberised pulse shaping system as shown in Fig.1 and described as follows. The oscillator (KOHERAS [8], Denmark) is a fiber CW laser with maximum power 110 mW at available wavelength 1050~1060 nm. To enhance a contrast ratio of a CW background signal, type of electro-optic modulator was carried out by two low drive voltage electro-optic modulators with a DC bias using a Mach-Zehnder interferometer (EOSPACE [9], USA). An arbitrary electronic waveform generator (Tektronix AWG7051 [10], USA) is used to generate user defined RF signal waveforms with a high extinction ratio and a high resolution.

RF signal waveform user-defined by an arbitrary electronic waveform generator is only connected to one electro-optic modulator. DC bias source with an auto feed back or manual controller is connected to both electro-optic modulators. Emitting laser light from a CW fiber laser source is modulated to meet a user-defined laser pulse with a high extinction ratio by the two electro-optic modulators. This modulated pulse is amplified by a pulse fiber amplifier with a two stage Yb^{3+} doped.

In order to increase the pulse energy, the 4 pass bulk amplifier system is placed after a pulse fiber amplifier. These bulk amplifiers are consisted of a two stage Nd:YLF (Neodymium-doped Yttrium Lithium Fluoride) rod amplifier for a selected pulse by a Pockels cell.

2.2 Experimental Results

As experimental results (shown in Fig. 2) of the performance to adapt user-defined pulses, two other customized output pulse shapes were produced: a triangular pulse and a two shape pulse with a square pulse (durations of 1ns) and a triangular pulse (durations of 6ns), respectively. For the triangular pulse case, Figure 2(a) shows an input pulse of a user-defined electronic signal with durations of 8ns in an arbitrary electronic waveform generator. This electronic signal

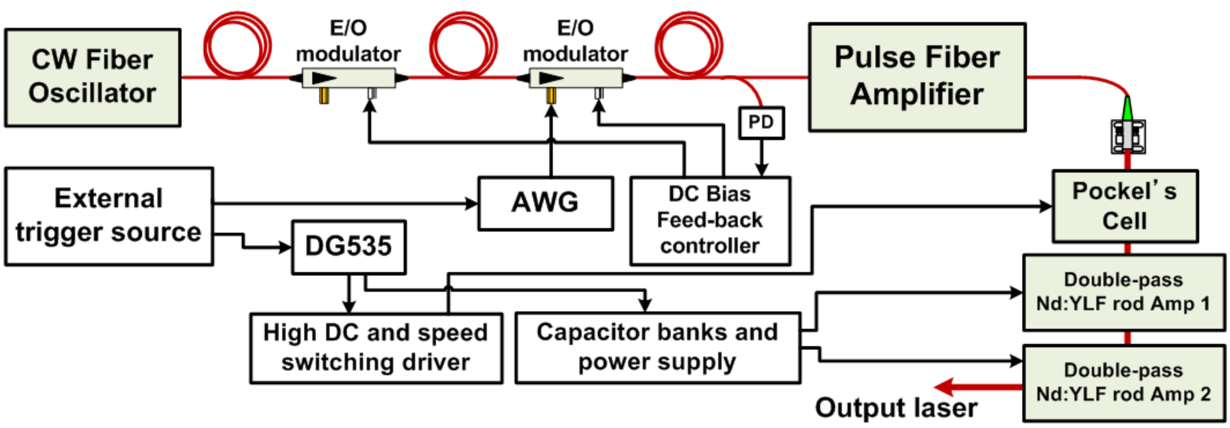

Fig. 1. The schematic diagram of a temporal laser pulse-shaping system for the KLF.

input consisted of four sections: a flat base (20 input data point of 0V at 4ns), a linearly increasing line (40 input data point of 0 ~ 0.8V at 8ns), an exponential falling edge (2 input data point of 0.8 and 0V at 200ps) and a flat base (20 input data point of 0V at 4ns). Figure 2(b) shows an output laser pulse after a pulse fiber amplifier with 5uJ/pulse energy. This result corresponds to an input pulse of a user-defined electronic signal.

The two shape pulse with a square and triangular pulse consisted of eight sections as shown in Fig. 2(c). Figure 2(d) shows the output laser pulses with 8mJ energy from the amplification results of the KLF beam shaping system. This result is somewhat different from an input pulse of a user-defined electronic signal in that a first peak value is less than a second peak value. The cause of the changed peak value is the difference of the inversion over the timescale of the pulse within the amplifier chain. In addition, Fig 2(d) first pulse shape seems like a triangular pulse because of an oscilloscope with 2GHz analogue bandwidth.

3. Conclusions

We have demonstrated a simple method for user definable pulses and output laser pulses with a sub-mJ energy from the amplification results of the KLF beam shaping system which can control the pulse-width ranges from 400ps to sub-us. The KLF beam shaping system could be applied to the area of laser fusion research and a number of industrial applications.

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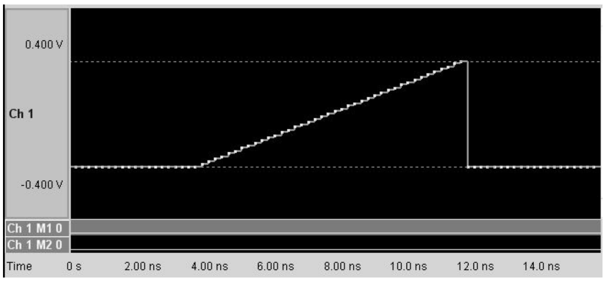
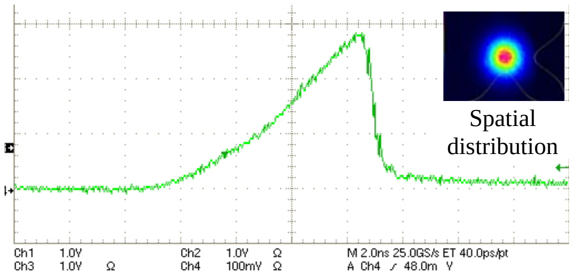
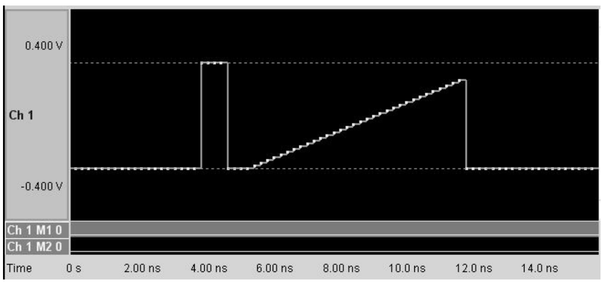


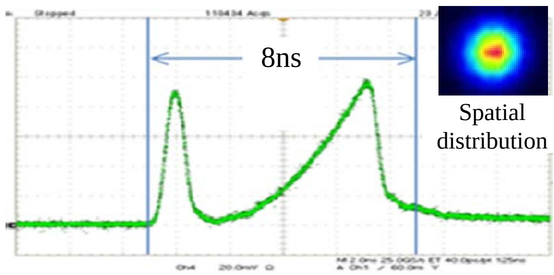
(a) User defined electronic signal



(b) Output laser pulse after a pulse fiber amp with 5 uJ



(c) User defined electronic signal



(d) Output laser pulse after YLF Amp 2 with 8 mJ

Fig. 2. Experimental results of the KLF laser pulse shaping system.