Pulse shaping and characterization with a 4f system

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Abstract: The design of the pulse shaping setup as well as factors taken into account in choosing a specific setup will be discussed. We investigate the generation of simple shaped pulses to test our pulse shaper setup. Difference frequency mixing is used to transfer the pulse shape to the mid infrared regime.

1. Introduction

Time domain ultra fast pulse shaping can be done by using a spatial light modulator (SLM), to shape the frequency components of the pulse in the Fourier domain or using sound waves with an acousto optic modulator or even configurations of moveable or deformable mirrors.

In the time domain the output of the filter (shaper) is $e_{out}(t)$, and the input is $e_{in}(t)$. h(t) represents the input response function

$$e_{out}(t) = e_{in}(t) * h(t) = \int dt' e_{in}(t') h(t-t'), \qquad E_{out}(\omega) = E_{in}(\omega) H(\omega),$$

$$H(\omega) = \int dt h(t) e^{i\omega t}, \quad h(t) = \frac{1}{2\pi}\int d\omega H(\omega) e^{i\omega t} \qquad [1]$$

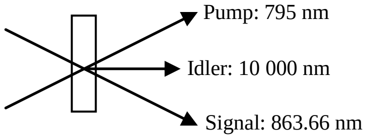
In the frequency domain the filter is characterised by its frequency response H(ω). The output of the linear filter $E_{out}(\omega)$ is the product of the input signal and response function, with $e_{out}(t)$, $e_{in}(t)$, h(t) and $E_{out}(\omega)$, $E_{in}(\omega)$, H(ω)

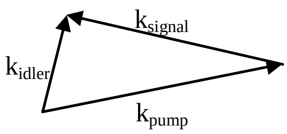
Since the SLM can only shape light in the visible and near infrared wavelength regime, difference frequency mixing (DFM) is used to transfer the shaped pulse to the mid infrared regime [2], using the following equations

$$\frac{\partial E_s}{\partial u} = \frac{i\omega_s \chi_{eff}^{(2)}}{2n_s c} E_p E_i^*$$

$$\frac{\partial E_i}{\partial u} + \left(\nu_i^{-1} - \nu_s^{-1}\right)\frac{\partial E_i}{\partial t} = \frac{i\omega_i \chi_{eff}^{(2)}}{2n_i c} E_p E_s^*$$

$$\frac{\partial E_p}{\partial u} + \left(\nu_p^{-1} - \nu_s^{-1}\right)\frac{\partial E_p}{\partial t} = \frac{i\omega_p \chi_{eff}^{(2)}}{2n_p c} E_s E_i^*$$





2. Results

The experimental setup in figure 1 was chosen due to the fact that it can be folded and so minimize the volume of the setup.

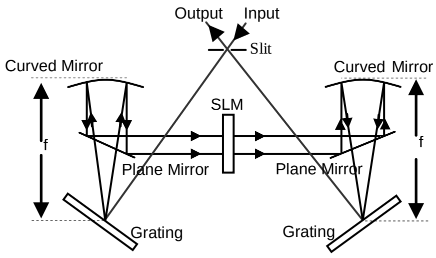


Fig.1: 4f pulse shaper experimental setup.

The results are discussed for the shaping of femtosecond pulses using the above setup. Mid infrared light at 10μm is generated via difference frequency mixing and so the shape can be transferred to the mid infra red regime as shown in the simulations that will be discussed.

3. References

[1] A. M. Weiner, *Review of Scientific Instruments, Volume 71, Number 5, p. 1929-1960*
[2] M. Cavallari, G.M. Gale, F. Hache, L.I. Pavlov, E. Rousseau, *Optics Communication, Volume 114, p. 329 - 332*