2012.10.15. La3NET course CAEN, GANIL

Problem 2. Pulsestacker in the visible range

A 3.8ps long gaussian pulse of the second harmonic wave from a Nd:YVO4 laser needs to be stacked to produce a quasy flat-top shape.
a) Find central wavelength for second harmonic using web resources
b) Calculate delay between consecutive pulses when using a 10 mm and a 20 mm long z-cut YVO4 crystal for stacking (Sellmeier equations can be found on CASIX website).
c) Draw the arrangement showing input polarization and crystal axes
optional) Calculate total intensity profile not taking into account interference

I.) The original pulse profile

$c := 0.299792$ mm/ps speed of light

$\tau_0 := 3.8$ ps pulse length

$\lambda_0 := 0.532 \cdot 10^{-3}$ mm central wavelength

$\Delta\lambda := 0.000004$ mm spectral range included in calculation

$\Pi := 2 \cdot \pi \cdot c$ $\quad \omega_0 := \frac{\Pi}{\lambda_0}$

$\omega_0 = 3.541 \times 10^3$ central frequency

Complex field spectrum of the Gaussian pulse

$\Delta := \frac{4 \cdot \ln(2)}{\tau_0}$ spectral width

$K2 := \frac{\sqrt{2 \cdot \ln(2)}}{\Delta}$ $\quad \varepsilon 0(\Delta\omega) := \exp[-(K2 \cdot \Delta\omega)]^2$

The temporal shape

(in the case of broadband pulses full spectral domain can be calculated, not necessary for this case)

$\Omega_1 := \frac{\Pi}{\lambda_0 - \frac{\Delta\lambda}{2}} - \omega_0$ $\quad \Omega_2 := \frac{\Pi}{\lambda_0 + \frac{\Delta\lambda}{2}} - \omega_0$

$N := 1000$ $\quad d\omega := \frac{\Omega_1 - \Omega_2}{N}$

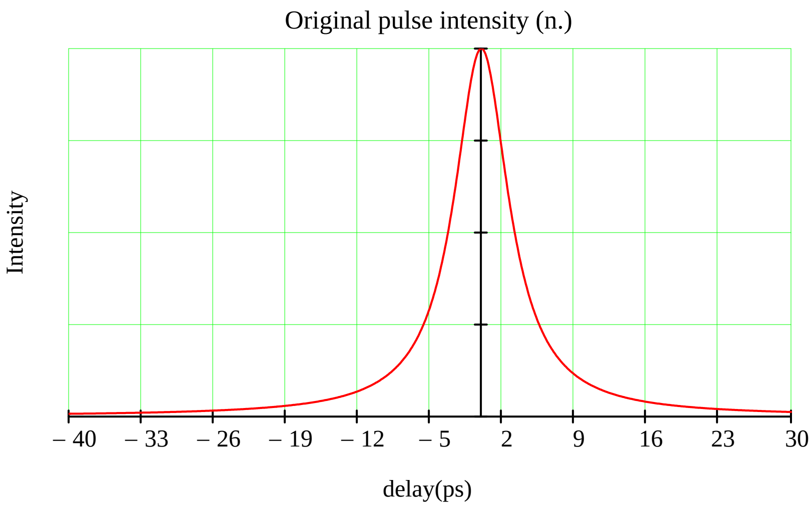
$p := 0 .. N - 1$ $\quad d\omega = 0.027$

$\omega_p := \Omega_2 + p \cdot d\omega$

$$E(t) := \frac{1}{2.\pi}\cdot\sum_{p=0}^{N-1}\left[\varepsilon 0\left(\omega_p\right)\cdot\exp\left[i\cdot\left(\omega_p\cdot t - \omega_0\cdot t\right)\right]\cdot d\omega\right]$$

time window

$tt_1 := -40$ $\quad tt_2 := 30$ $\quad ddt := 0.1$ $\quad tt := tt_1, tt_1 + ddt .. tt_2$



III.) The stacking

Delay generated by the YVO4

Sellmeier equations from CASIX website

$$o(\lambda s) := 3.77834 + \left[\frac{0.069736}{\left(\lambda s^2 - 0.04724\right)}\right] - 0.0108133\cdot\lambda s^2$$

$$e(\lambda s) := 4.59905 + \left[\frac{0.110534}{\left(\lambda s^2 - 0.04813\right)}\right] - 0.0122676\cdot\lambda s^2$$

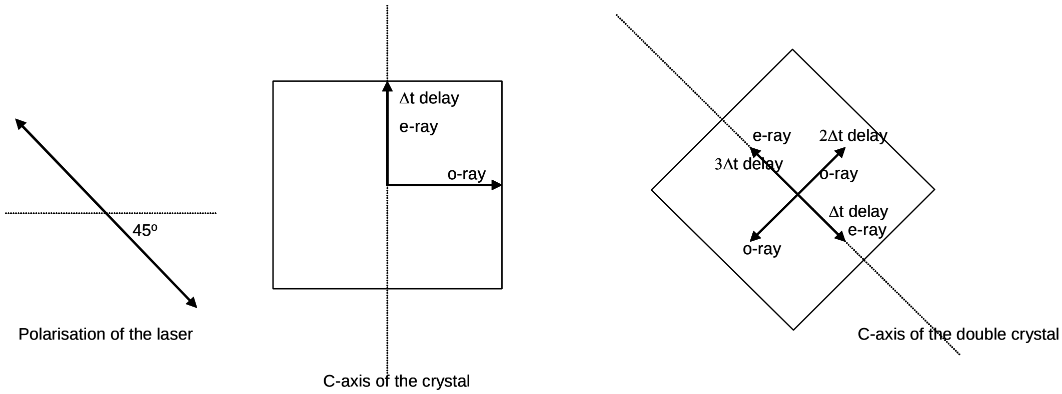
$l := 10$ mm

$$ne := \left(\sqrt{e\left(\lambda_0\cdot 10^3\right)}\right)$$

$$no := \left(\sqrt{o\left(\lambda_0\cdot 10^3\right)}\right)$$

$deltat := |ne - no|\cdot\frac{l}{c}$ $\quad deltat = 7.776$ ps

Polarization setup



Following allows to calculate pulse shape error resulting from inaccurate alignment of the cystals

$\alpha := 45\text{deg}$ crystal axis to input polarisation

$\beta := 90\text{deg}$ 2nd crystal axis to input polarisation

$Ee(t) := [\cos(\alpha)\cdot(E(t)\cdot\cos(\beta-\alpha) + E(t+2\cdot deltat)\cdot\sin(\beta-\alpha))]$ extraordinary fields

$Eo(t) := [\sin(\alpha)\cdot(E(t-deltat)\cdot\cos(\beta-\alpha) + E(t+deltat)\cdot\sin(\beta-\alpha))]$ ordinary fields

$Sum(t) := \left[(|Ee(t)|)^2 + (|Eo(t)|)^2\right]$ total temporal intensity distribution