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## Principles of the Delta single shot autocorrelator

The Δ Autocorrelator is based on second harmonic generation (SHG) to characterize an unknown laser pulse. The SHG process can be represented by

SHG: $\omega_1 + \omega_1 \Rightarrow \omega_2$

where $\omega_1$ and $\omega_2$ are the fundamental and second harmonic frequencies, respectively. In the Δ Autocorrelator, an input beam (fundamental) is first separated into two beams. Then the two fundament beams are recombined at a cross angle θ in a SHG crystal to generate the SHG signal.

In a single shot autocorrelator the time delay information are transformed into a special distribution and recorded by a multichannel CCD detector. As shown in Figure 1 the time delay between the two beams along the cross section is a function of the cross angle (2θ) of the two beams and the distance (x) from the center,

$$\Delta t=(20/3)\cdot x\cdot n\cdot \sin(\theta),$$

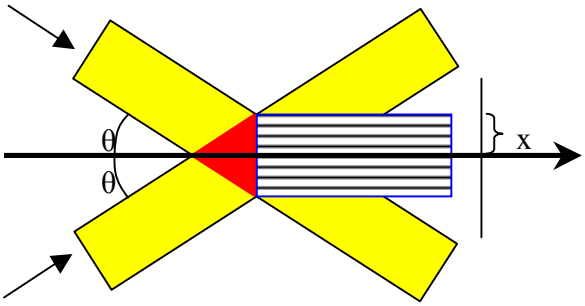


**Figure 1**

where n is the diffraction indices of the material, in air n is 1. The time delay Δt is in the unit of picosecond when the distance x is millimeter. Therefore the generated SHG signal due to the two crossed beams will have an intensity distribution along the x direction depending on the laser pulse width. A longer pulse will generate a broader SHG signal while a shorter pulse will generate a narrower SHG signal along the x direction. For θ=8° in the Δ Autocorrelator a 100 fs and a 1 ps pulse will have about 0.1 mm and 1 mm width, respectively. Thus measuring the intensity of the SHG signal along the x direction will give the pulse width of a laser beam. Usually, the SHG signal is recorded by a CCD multichannel detector.

## Triangle delay line in the Δ single shot autocorrelator

In the Δ single shot autocorrelator we used the triangle delay line design (US Patent pending) to achieve the reliable performance and easier operation.

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The benefit from the triangle delay line design is the alignment free operation. In principle there is no need for alignment after the initial alignment done in the manufactory except of aligning the input laser into the autocorrelator at a right direction and adjusting the SHG crystal angle. In a few minutes a pulse width can be measured without the difficulties suffered by other autocorrelators.

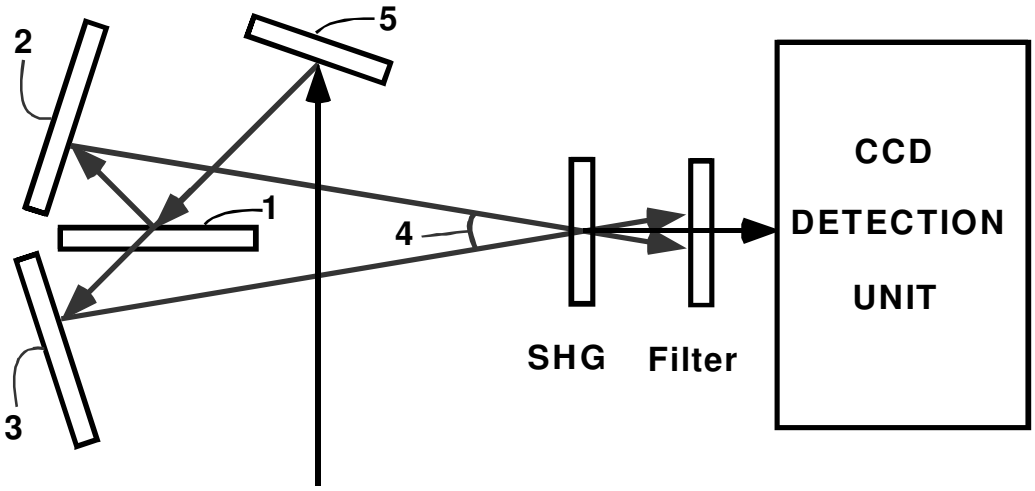


Figure 2

In Figure 2 we show a diagram of the triangle delay line. Basically it is consisted of a beam splitter (1) and two mirrors (2 and 3). An input laser beam is separated into two beams by the beam splitter and then they are recombined at a cross angle (4) in the second harmonic generation (SHG) crystal. The SHG autocorrelation signal then passes through the filter and detected by CCD detection unit while the fundamental beams are cut off by the filter. Due to the simple but very reliable design of the triangle delay line the $\Delta$ single shot autocorrelator can be constructed with very compact size and is user friendly.