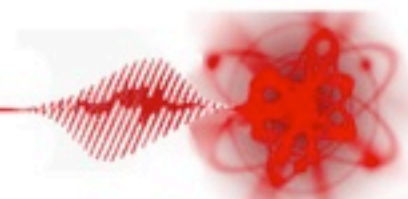


Autocorrelator

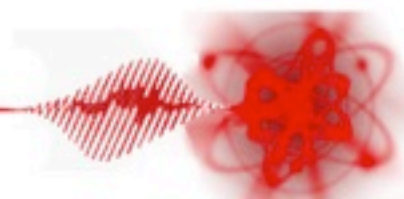
Short Pulse Width Measurement

Kevin M George



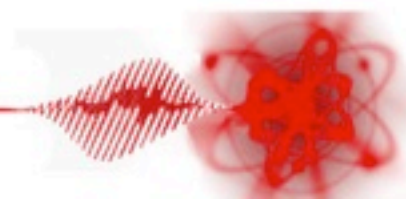
Outline

- Time Resolution Detectors
- Convolution
- Autocorrelator Design
 - Single Shot High Energy Specifics
- Pulse Measurement
- Conclusion



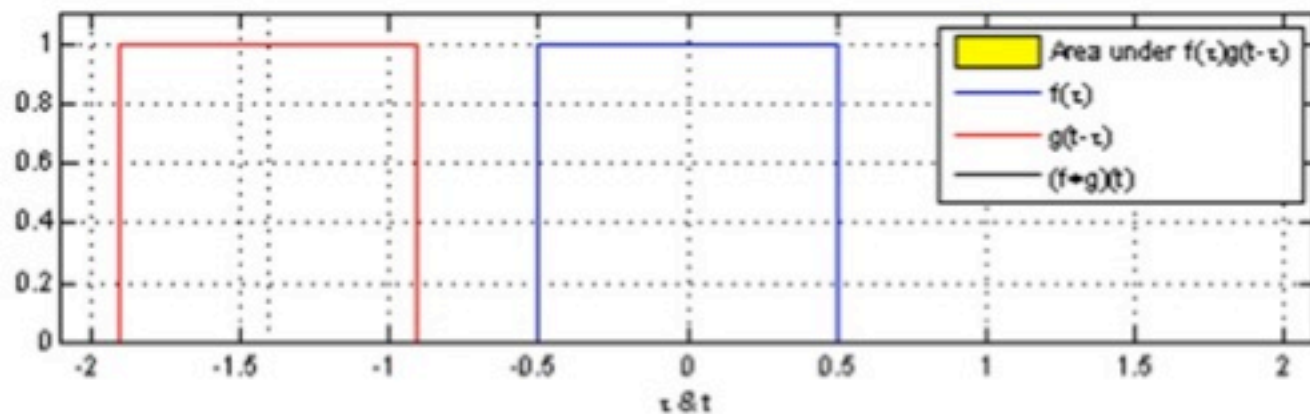
Time Resolution Detectors

- Insufficient Time Resolution
- Traditional Detectors
 - Picosecond Scale
- Streak Cameras
 - 100fs Time Resolution
 - High Price

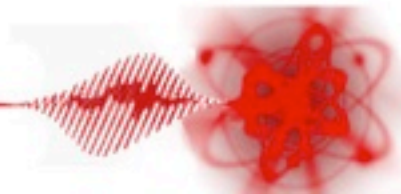


Convolution

$$h(\tau) = \int_{-\infty}^{\infty} f(t)g(\tau - t)dt$$

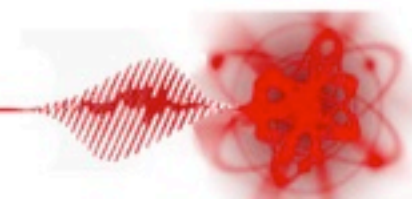
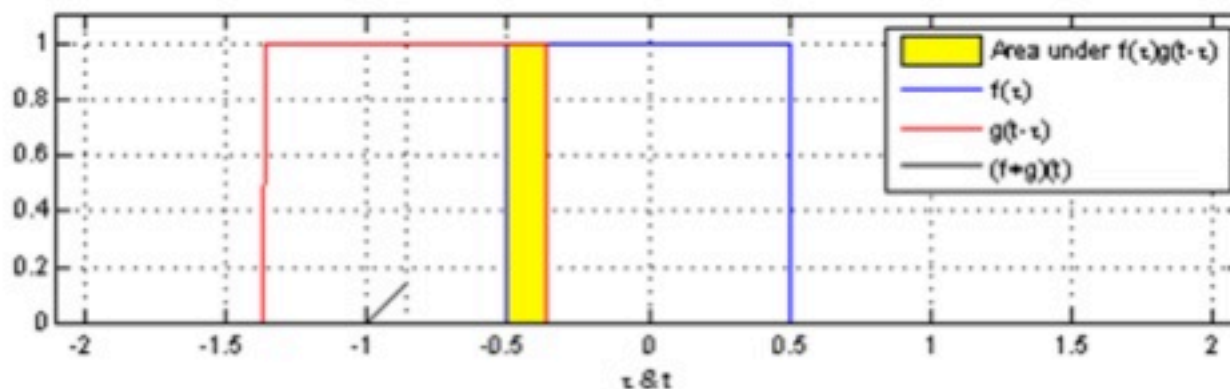


Source: Wikipedia “Convolution”



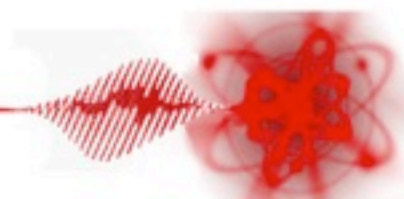
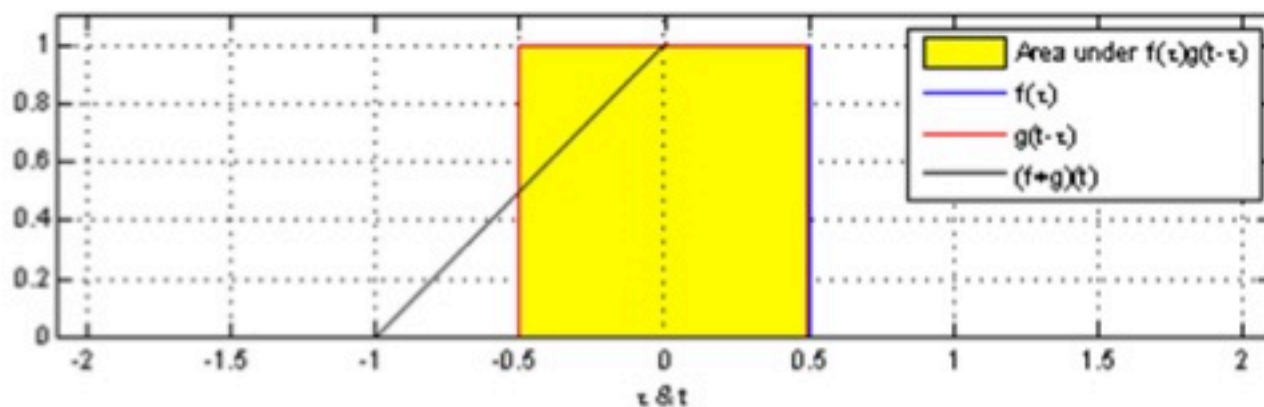
Convolution

$$h(\tau) = \int_{-\infty}^{\infty} f(t)g(\tau - t)dt$$



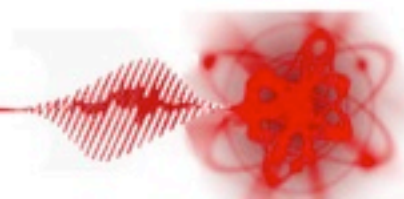
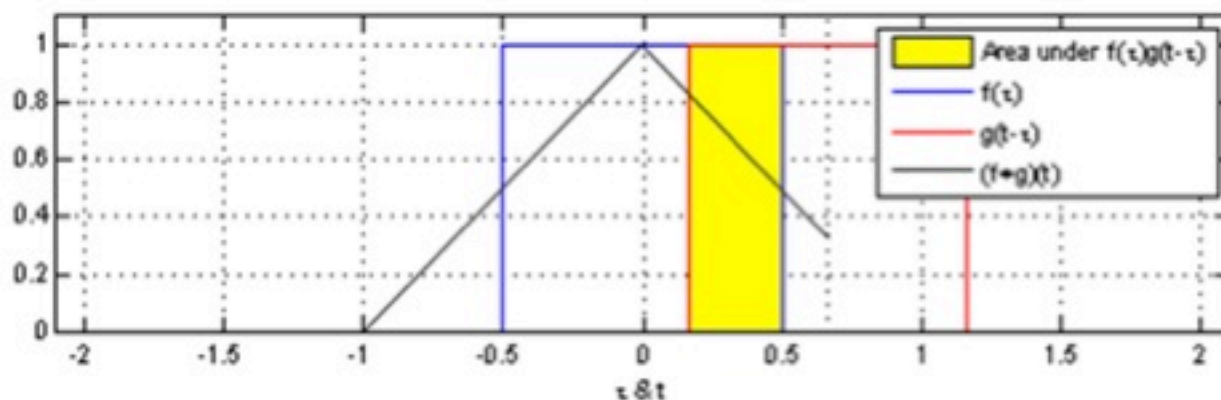
Convolution

$$h(\tau) = \int_{-\infty}^{\infty} f(t)g(\tau - t)dt$$

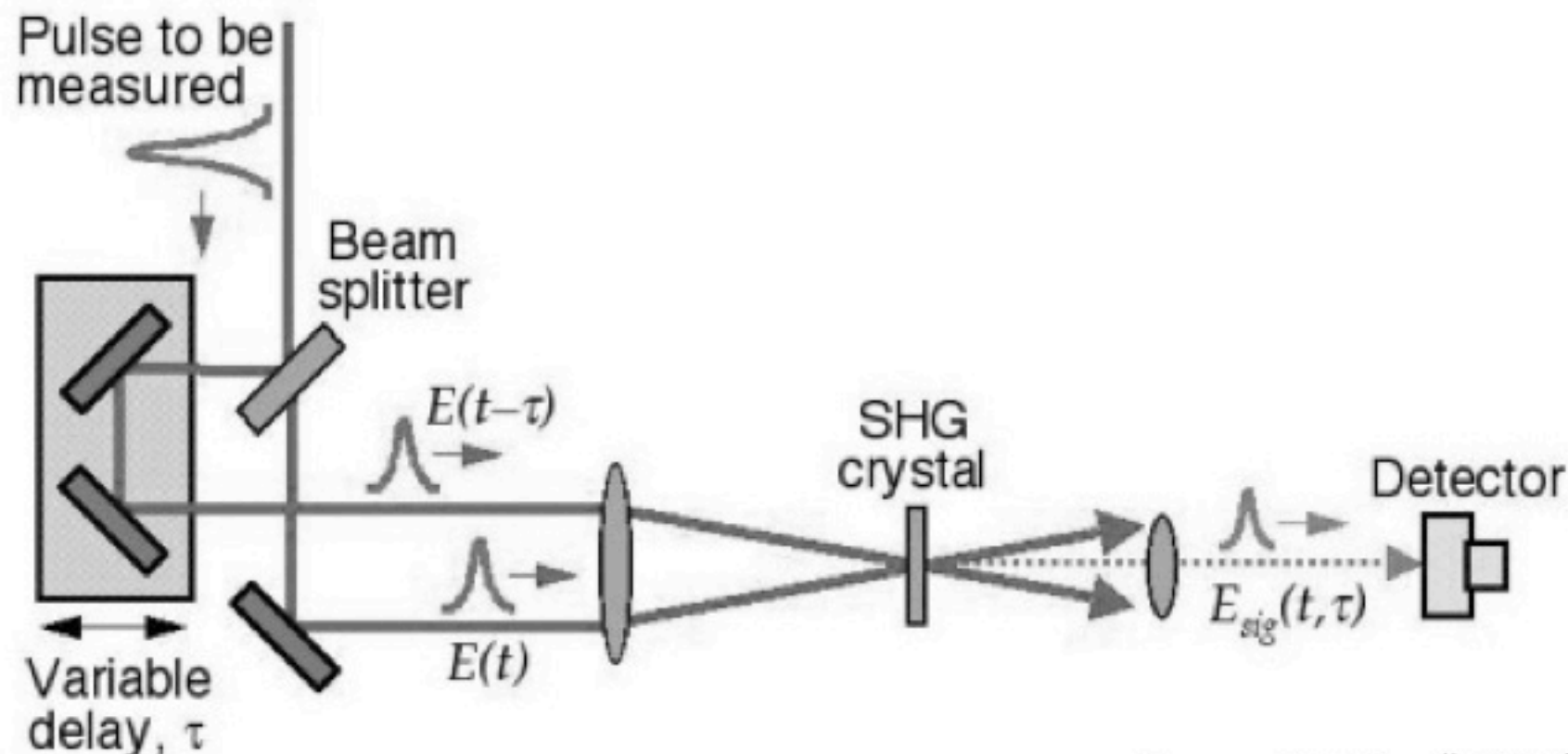


Convolution

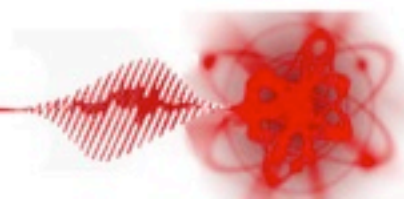
$$h(\tau) = \int_{-\infty}^{\infty} f(t)g(\tau - t)dt$$



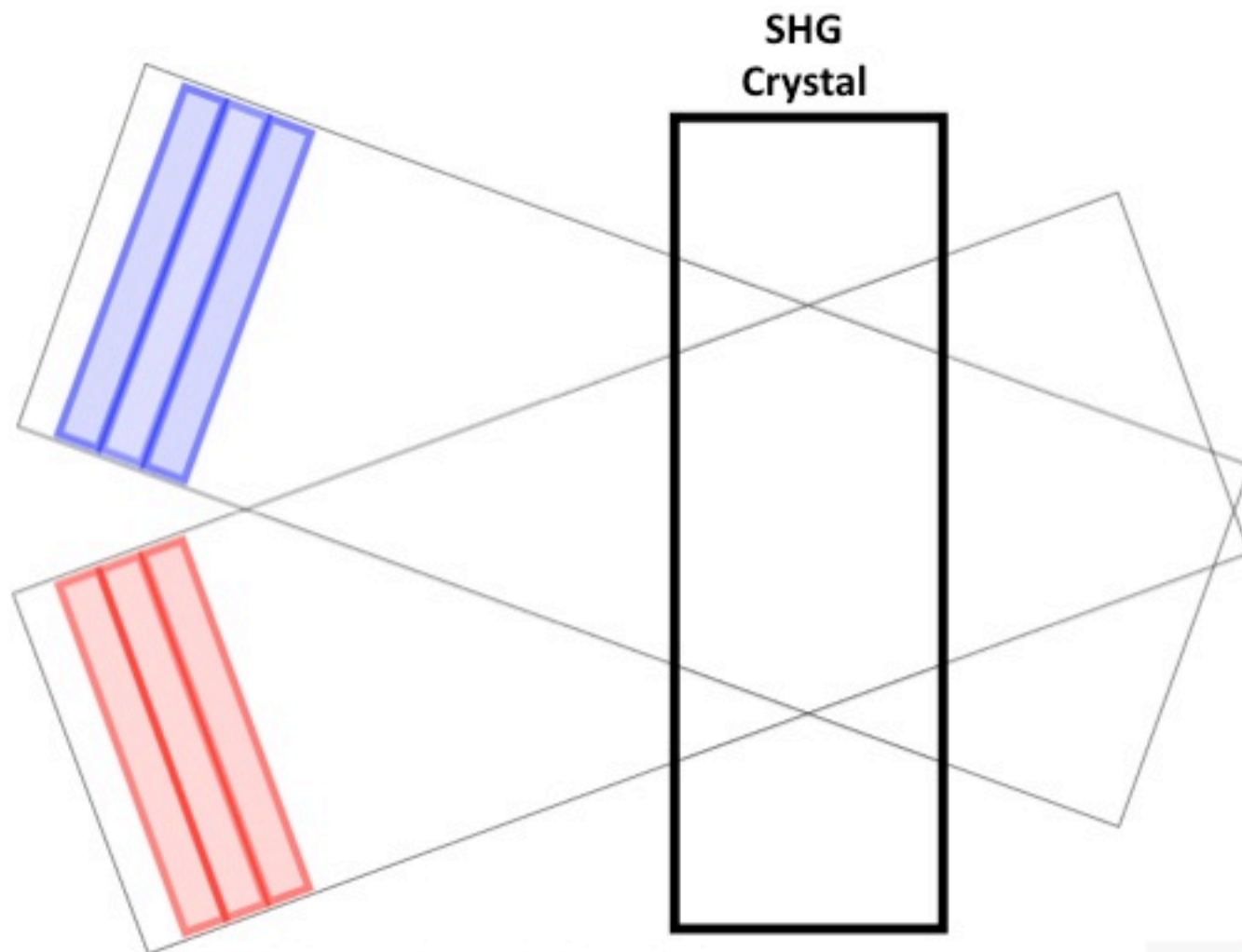
Autocorrelator Design



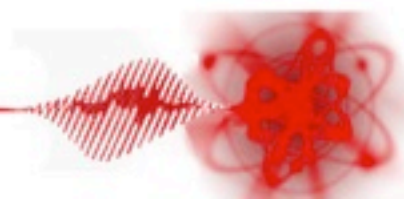
Source: Trebino "FROG"



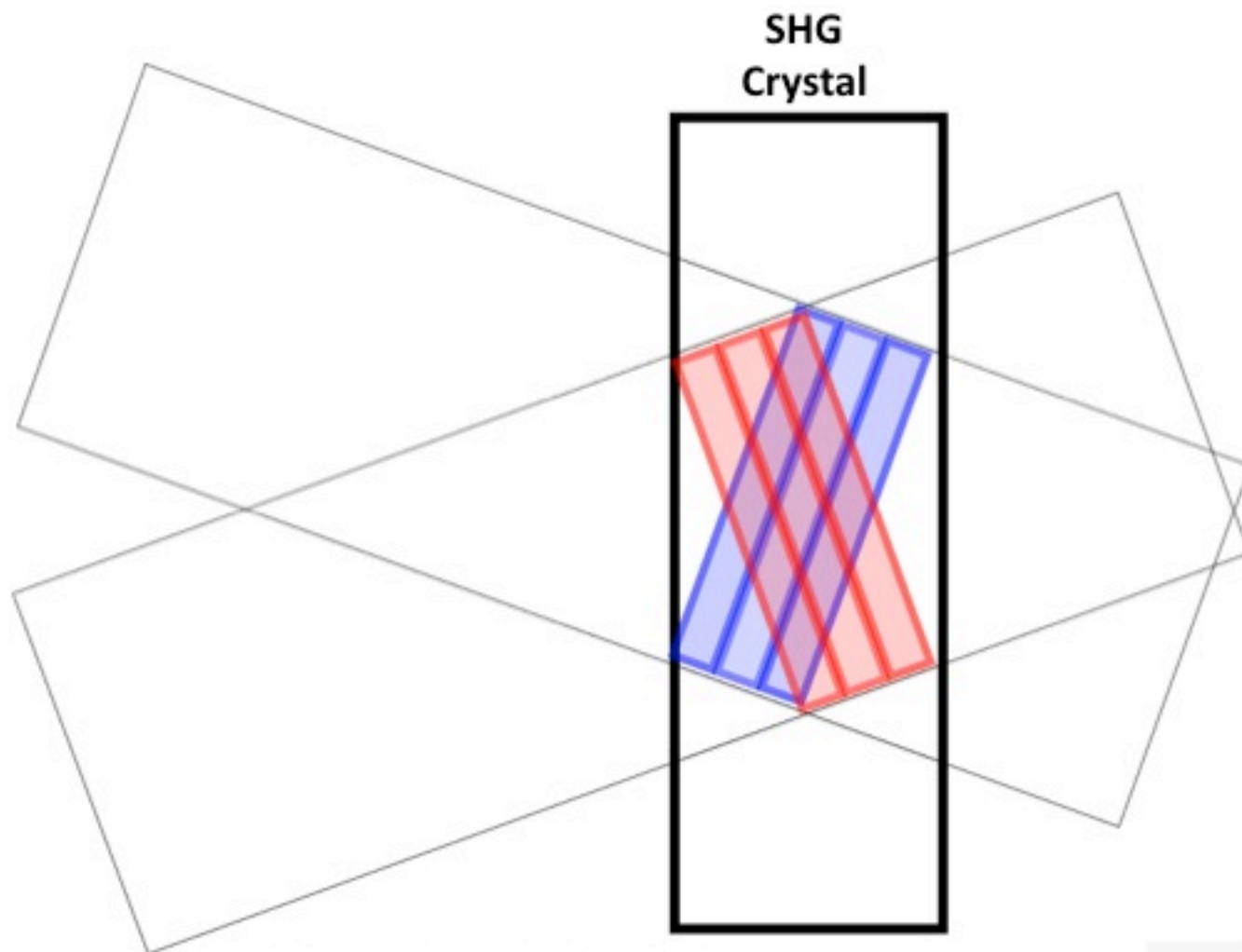
Autocorrelator Design



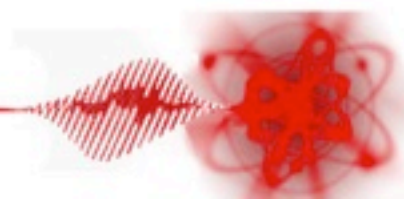
High Energy Density Physics Group
Scarlet Laser Facility



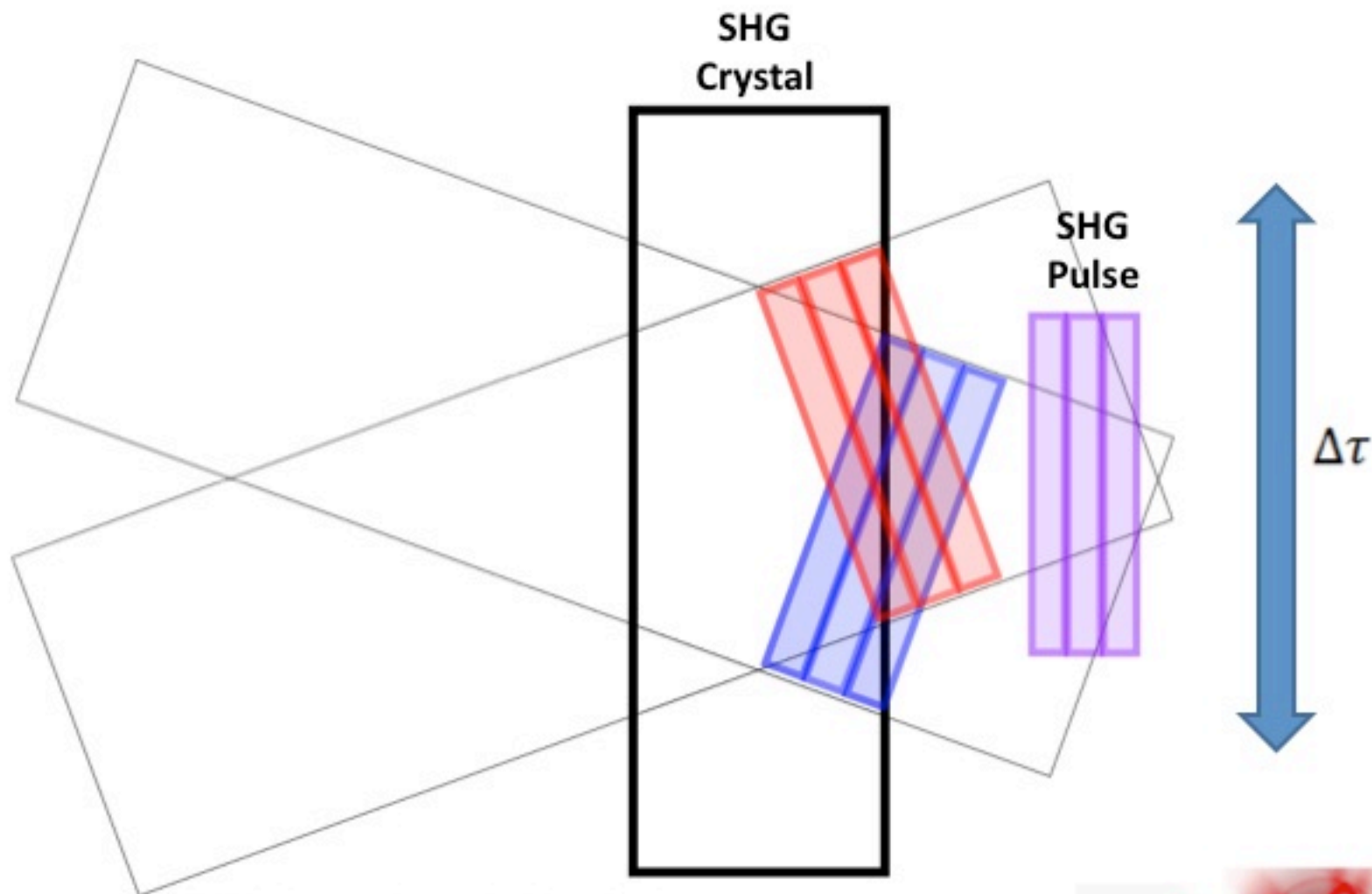
Autocorrelator Design



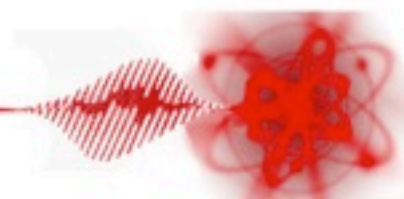
High Energy Density Physics Group
Scarlet Laser Facility



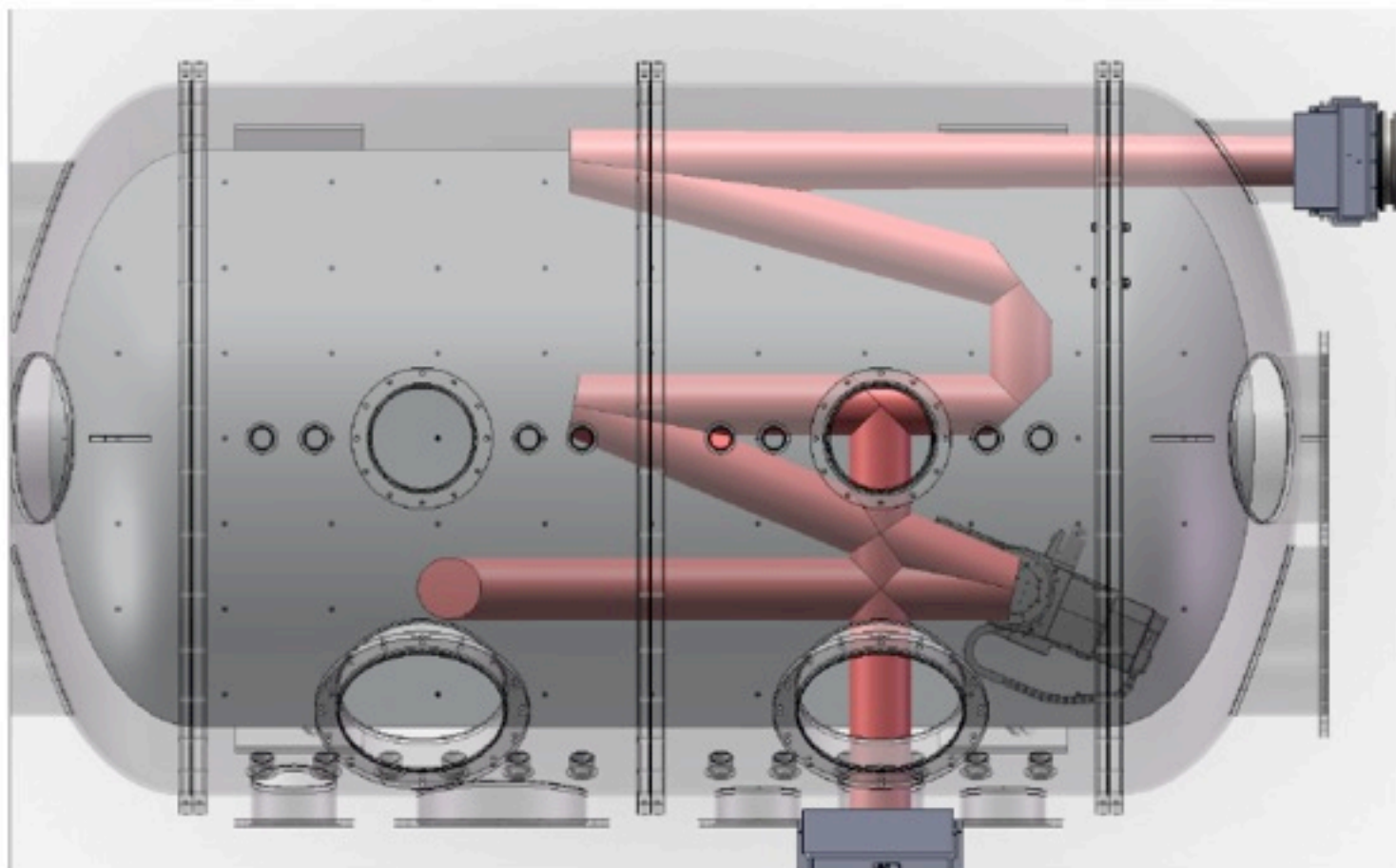
Autocorrelator Design



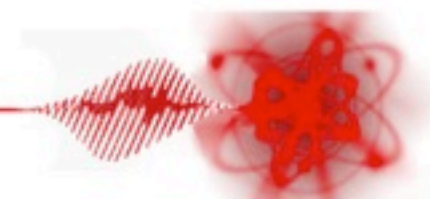
High Energy Density Physics Group
Scarlet Laser Facility



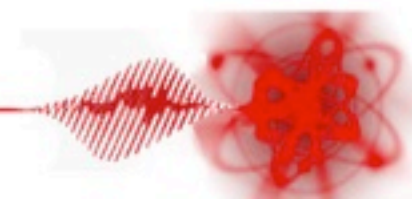
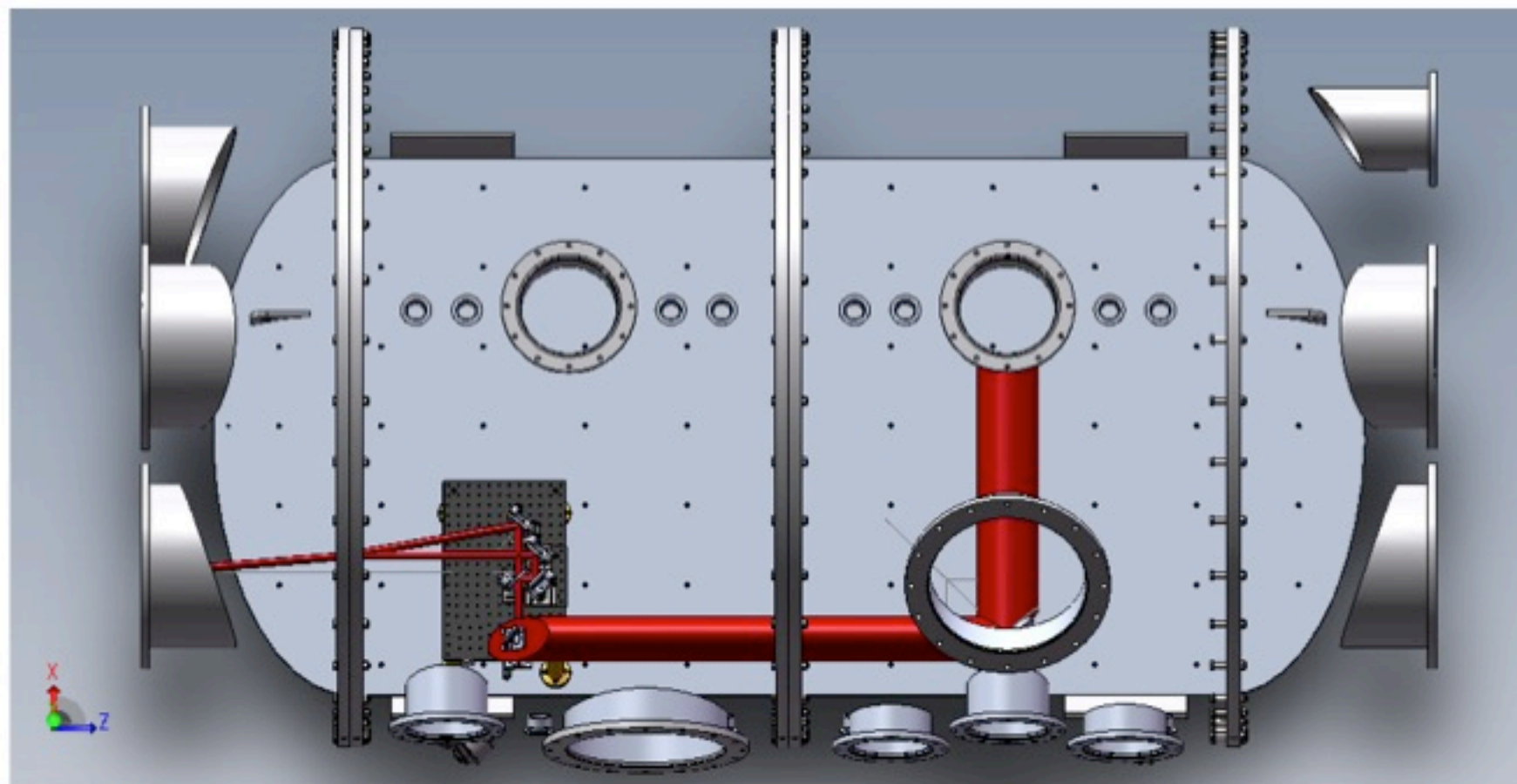
Autocorrelator Design



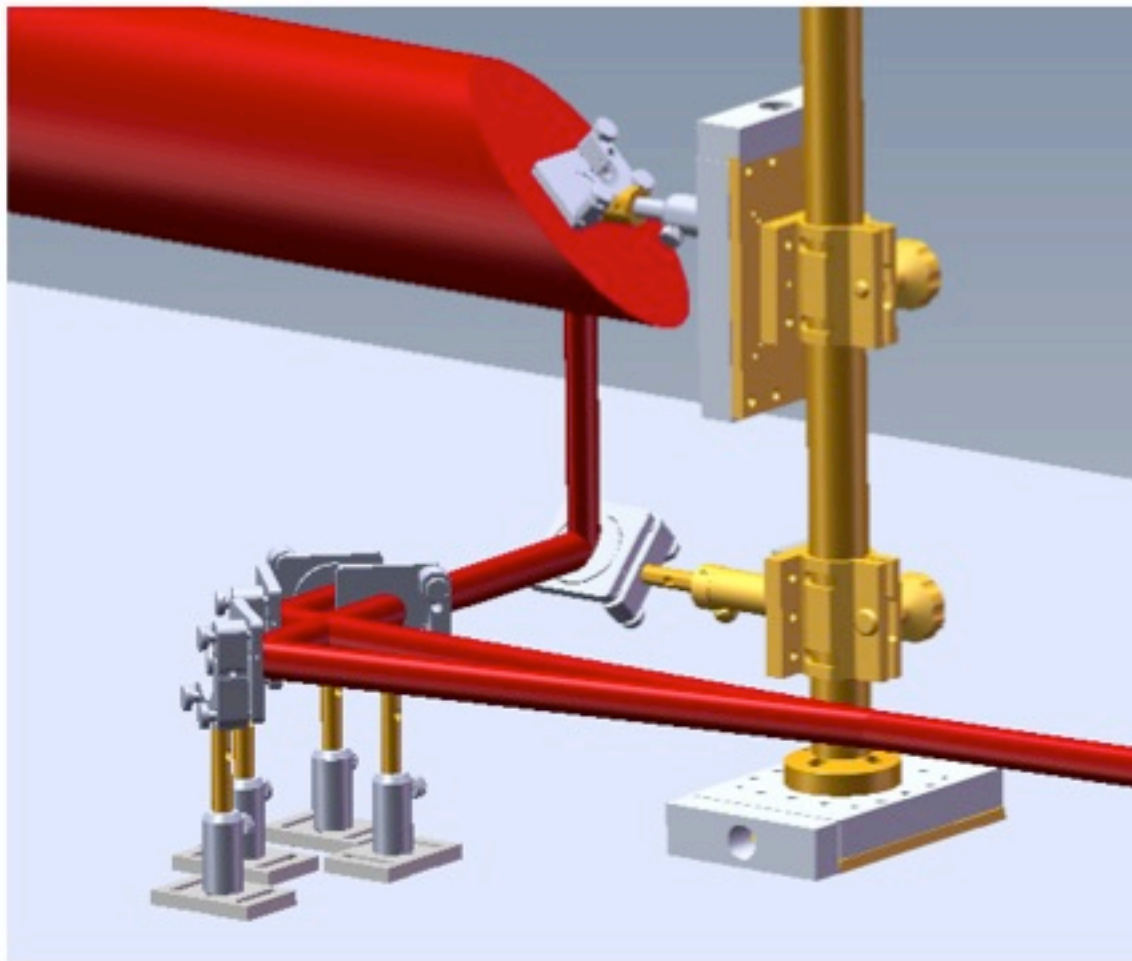
High Energy Density Physics Group
Scarlet Laser Facility



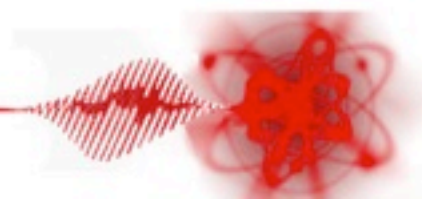
Autocorrelator Design



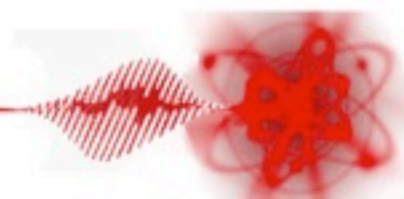
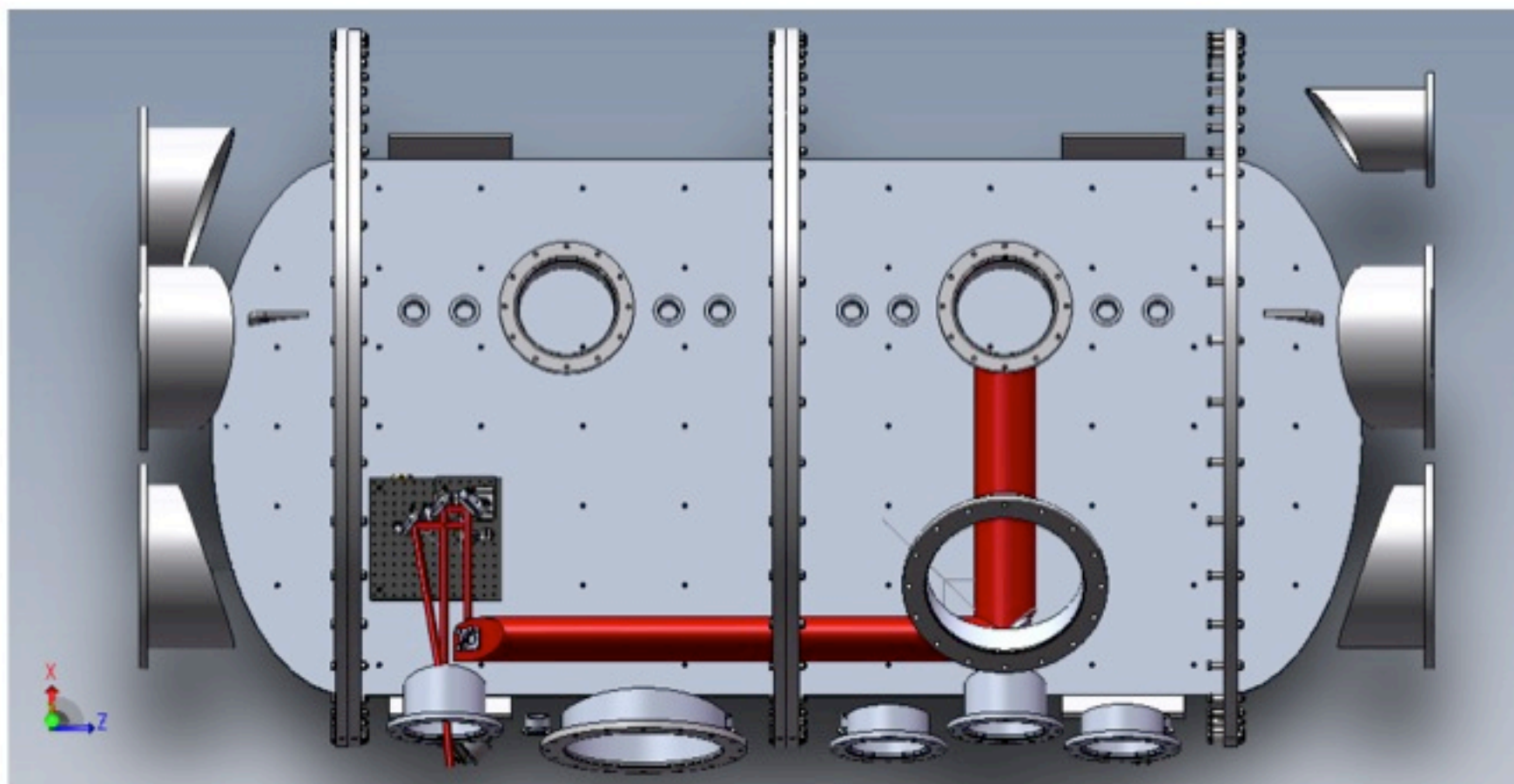
Autocorrelator Design



High Energy Density Physics Group
Scarlet Laser Facility



Autocorrelator Design



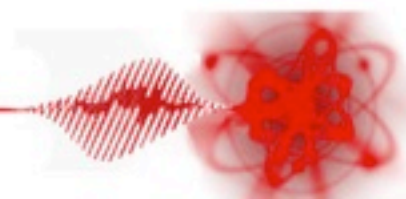
Pulse Measurement

- How to determine pulse width from AC Trace
 - Root Mean Squared (RMS) Pulse Length

$$t_{RMS} = \frac{(\tau_{RMS})_A}{\sqrt{2}}$$

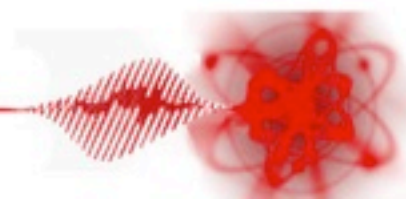
- Full Width Half-Maximum (FWHM) Pulse Length
 - Gaussian = 1.41
 - Sech² = 1.54

$$t_{FWHM} = \frac{(\tau_{FWHM})_A}{constant}$$



Pulse Measurement

- BBO Crystal
 - Type I (OOE)
 - 10mm x 5mm x .1mm
- Basler A641f
 - 1600 x 1200 resolution
 - 8.923mm CCD



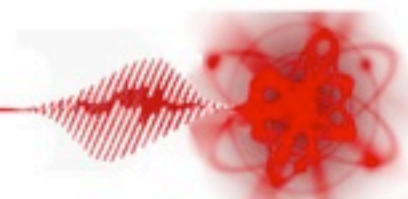
Pulse Measurement

- Incident angle into SHG Crystal = 10 degrees
- Maximum Autocorrelator Delay

$$\Delta\tau = 2.918 \text{ ps}$$

- Spatial Mapping

$$\tau(x) = x * 5.814 * 10^{-10} \frac{\text{seconds}}{\text{meter}}$$



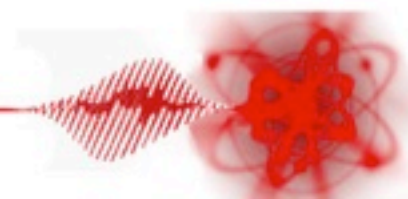
Pulse Measurement

- Unmagnified Spatial Mapping

$$\frac{0.5423 \text{ pixels}}{1 \text{ fs of pulse}}$$

- Magnified Spatial Mapping
 - 4x Magnification

$$\frac{2.169 \text{ pixels}}{1 \text{ fs of pulse}}$$



Conclusion

- Insufficient Detector Time Resolution
- Solution
 - Convolution
 - Autocorrelator
- Autocorrelator Design
- Pulse Measurement

