



Fiber Laser for ERL

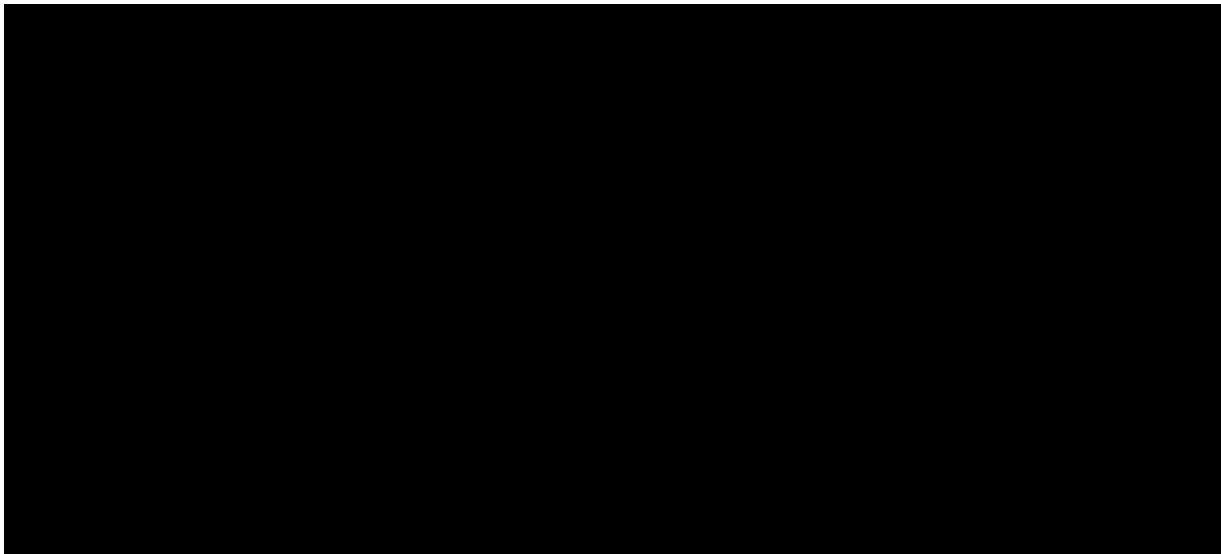
Zach Ulibarri

Mentor: Zhi Zhao



Introduction

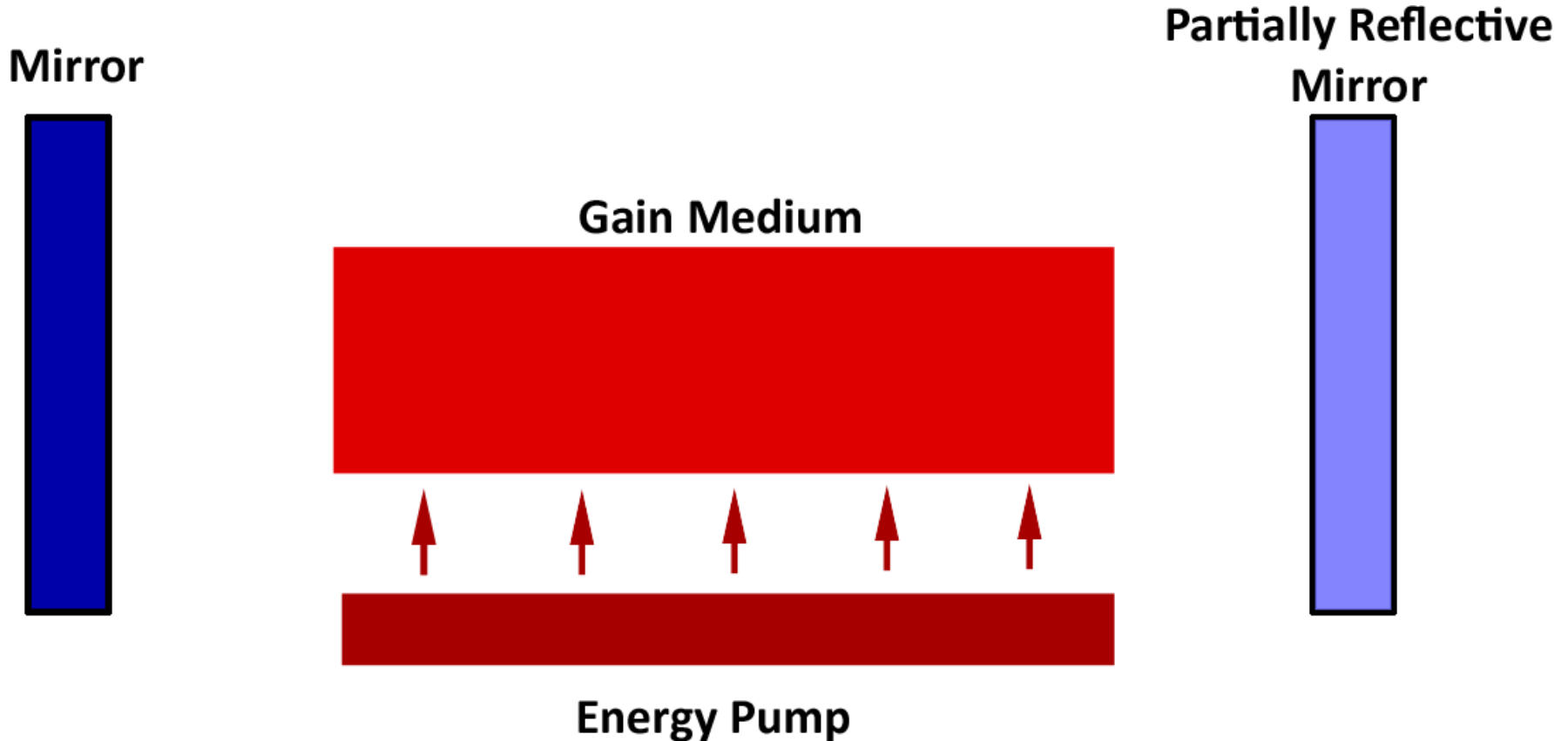
- Goal:
 - Mode locked laser oscillator
 - 50 MHz repetition rate
 - Designed for emittance measurement





Laser Basics

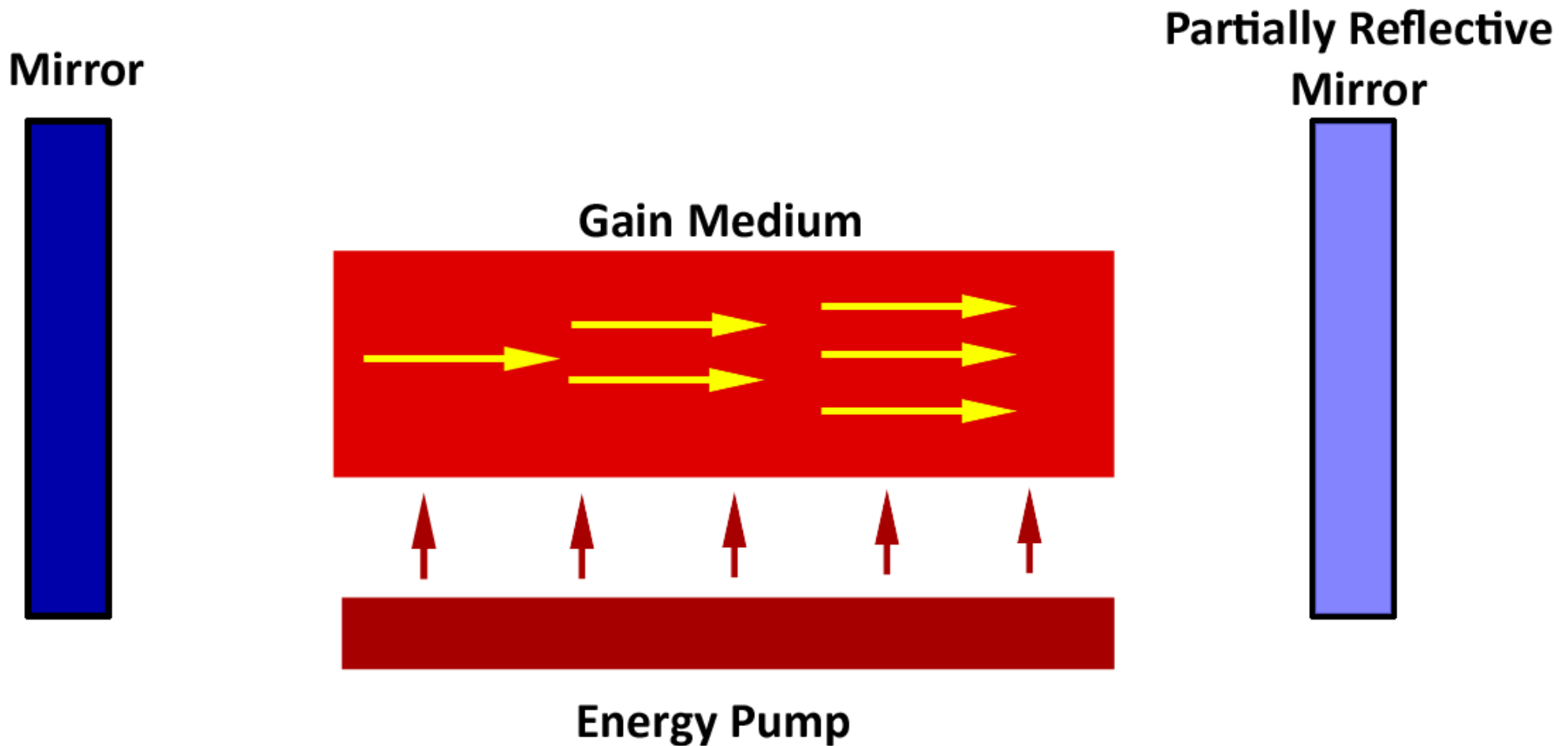
- Population inversion in gain medium





Laser Basics

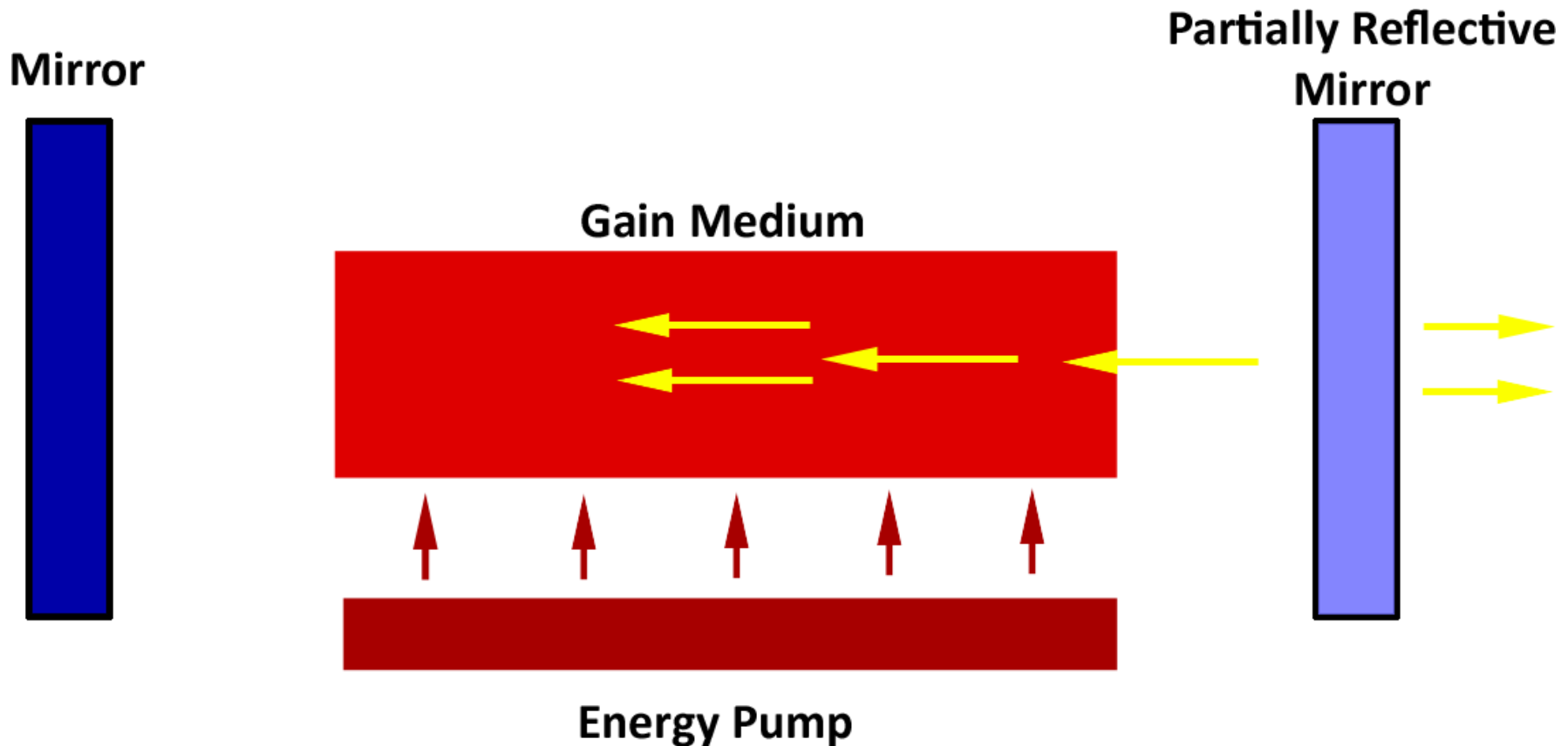
- Stimulated photon emission





Laser Basics

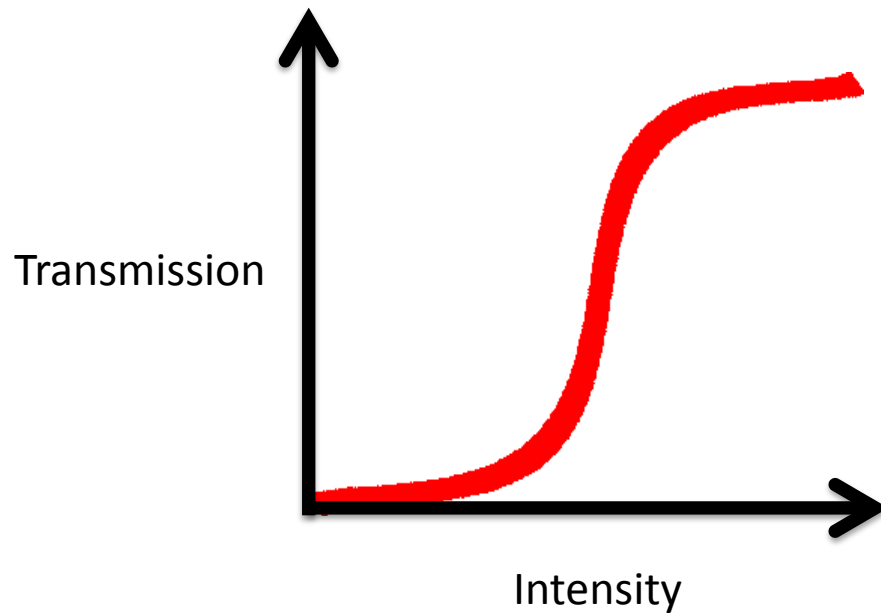
- Light emits and repeats process





Mode Locked Lasers

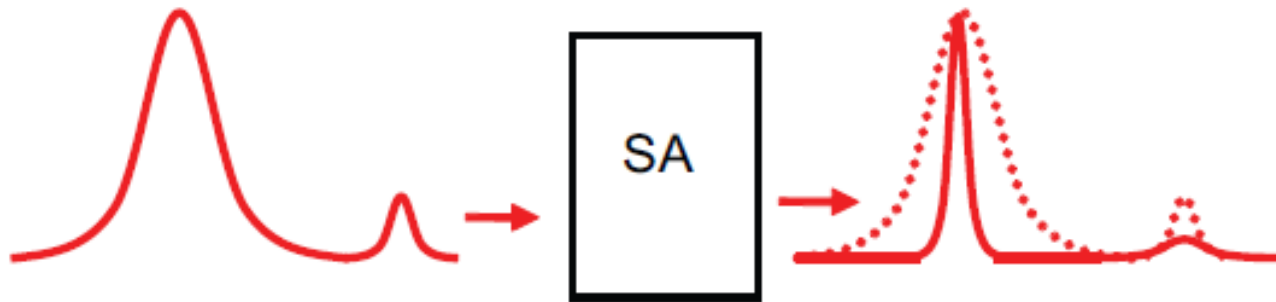
- Saturable absorber





Mode Locked Lasers

- With saturable absorber in place, random noise can create pulses





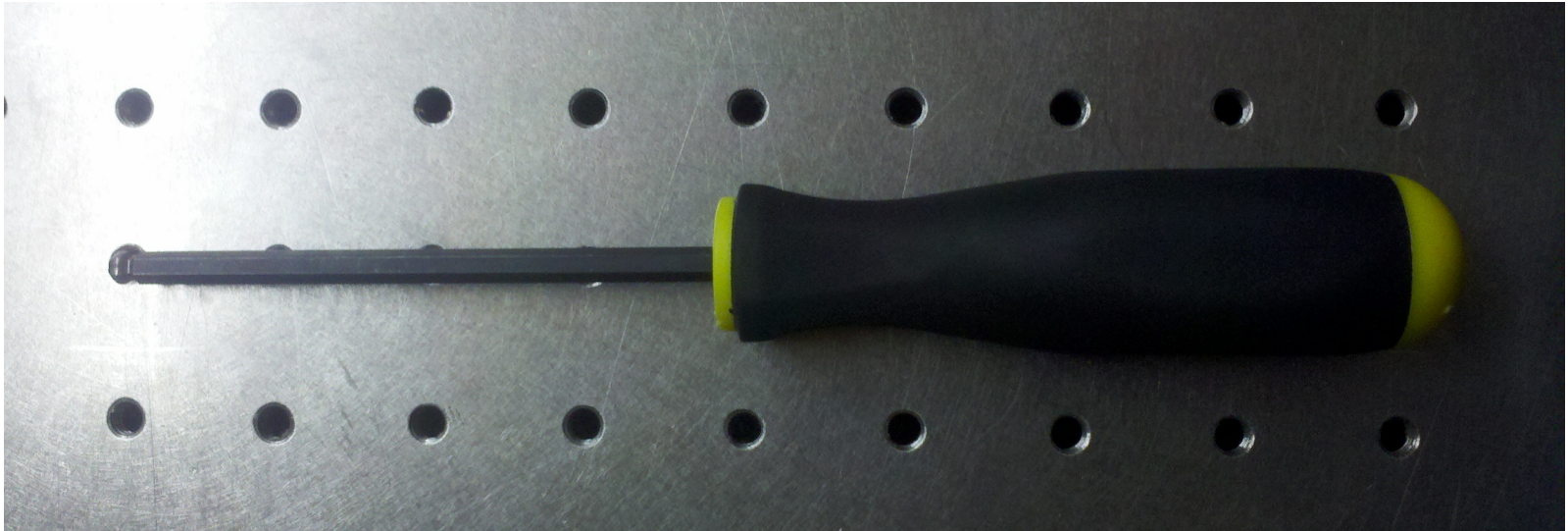
Mode Locked Lasers

- How do we add sufficient noise to the cavity?



Mode Locked Lasers

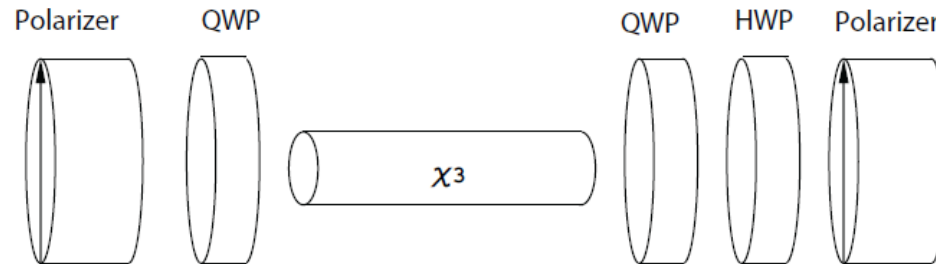
- How do we add sufficient noise to the cavity?





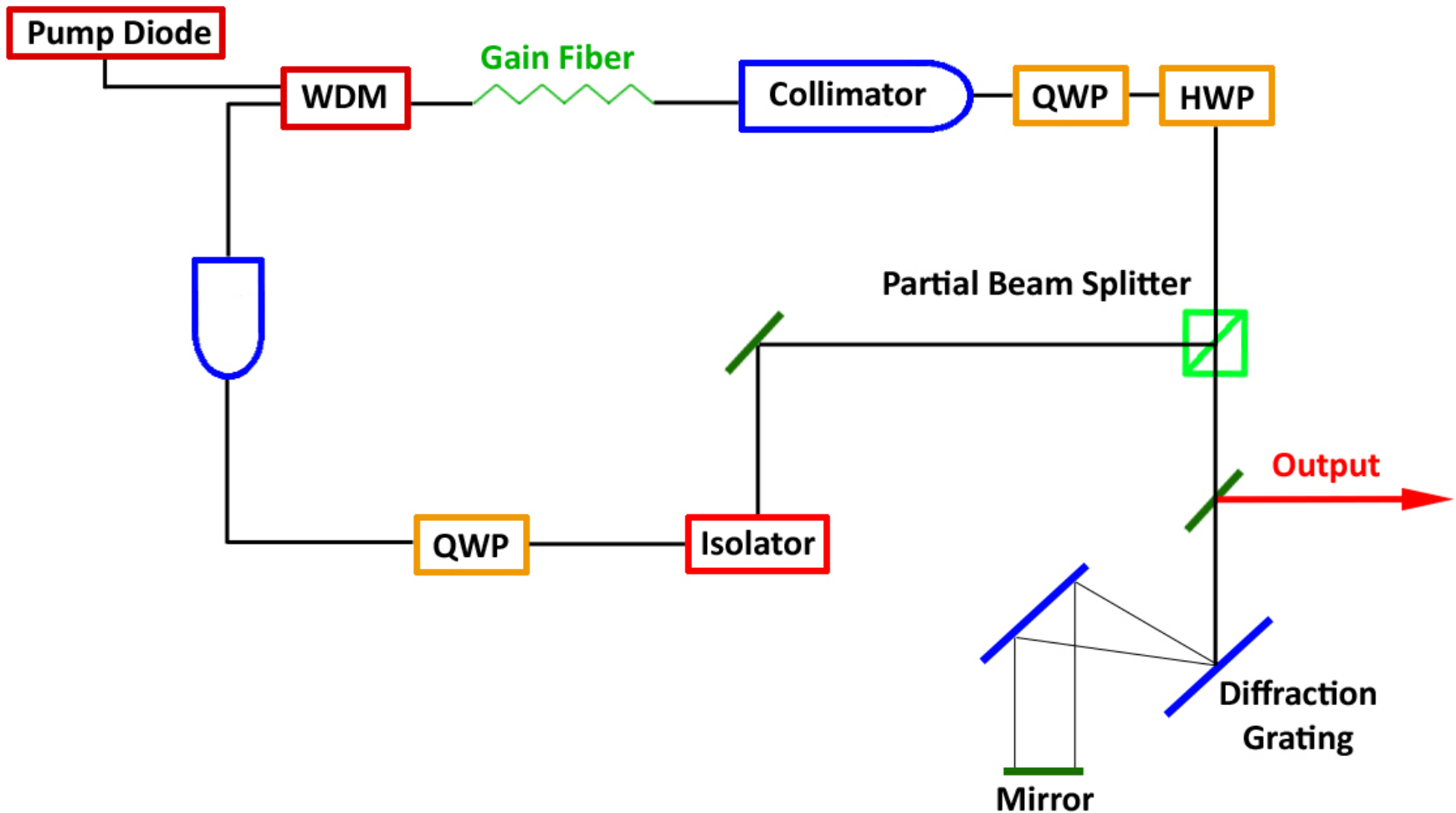
Artificial Saturable Absorber

- Wave plates create phase shift induced intensity modulation





Experimental Setup



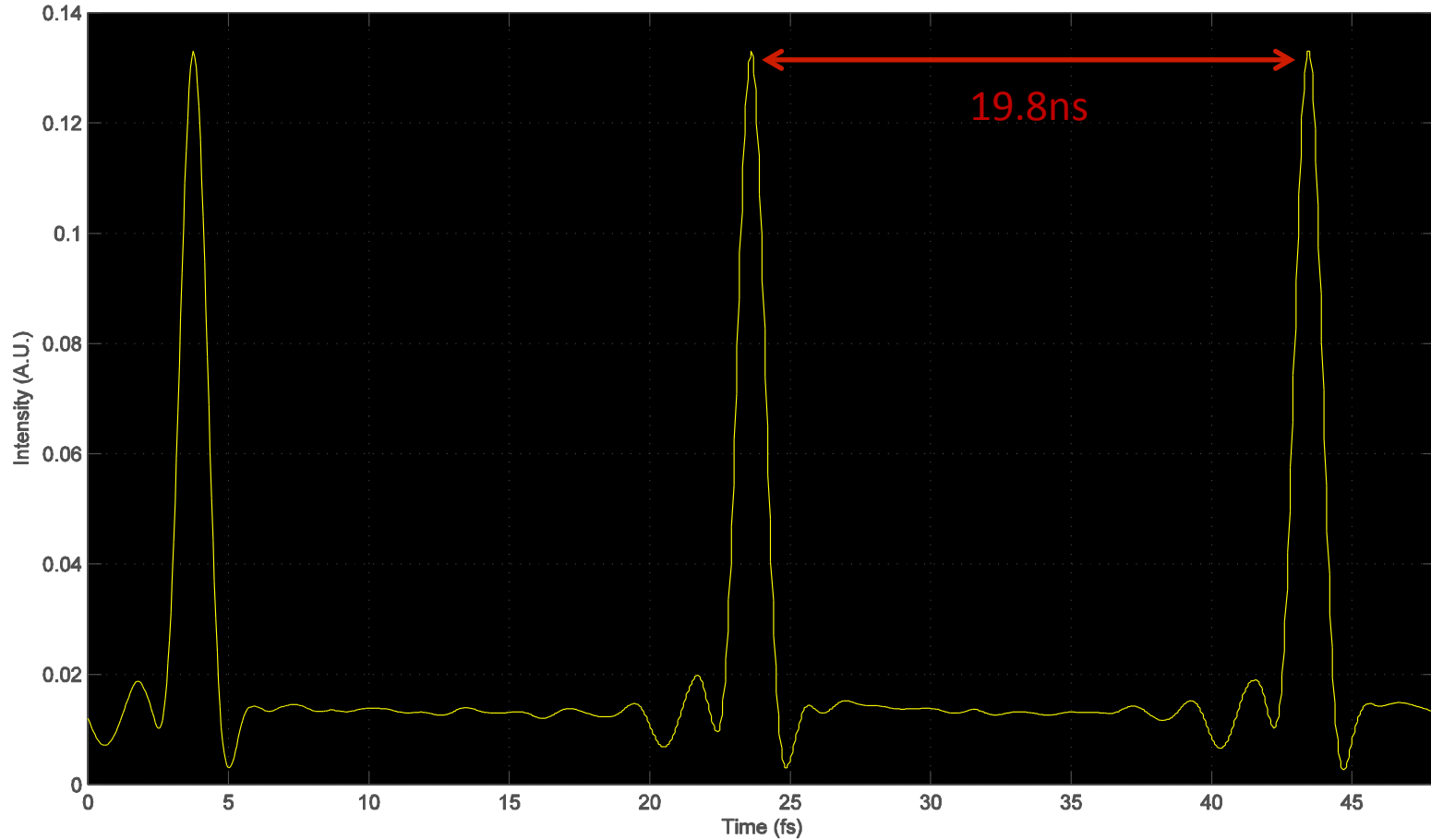


Top View





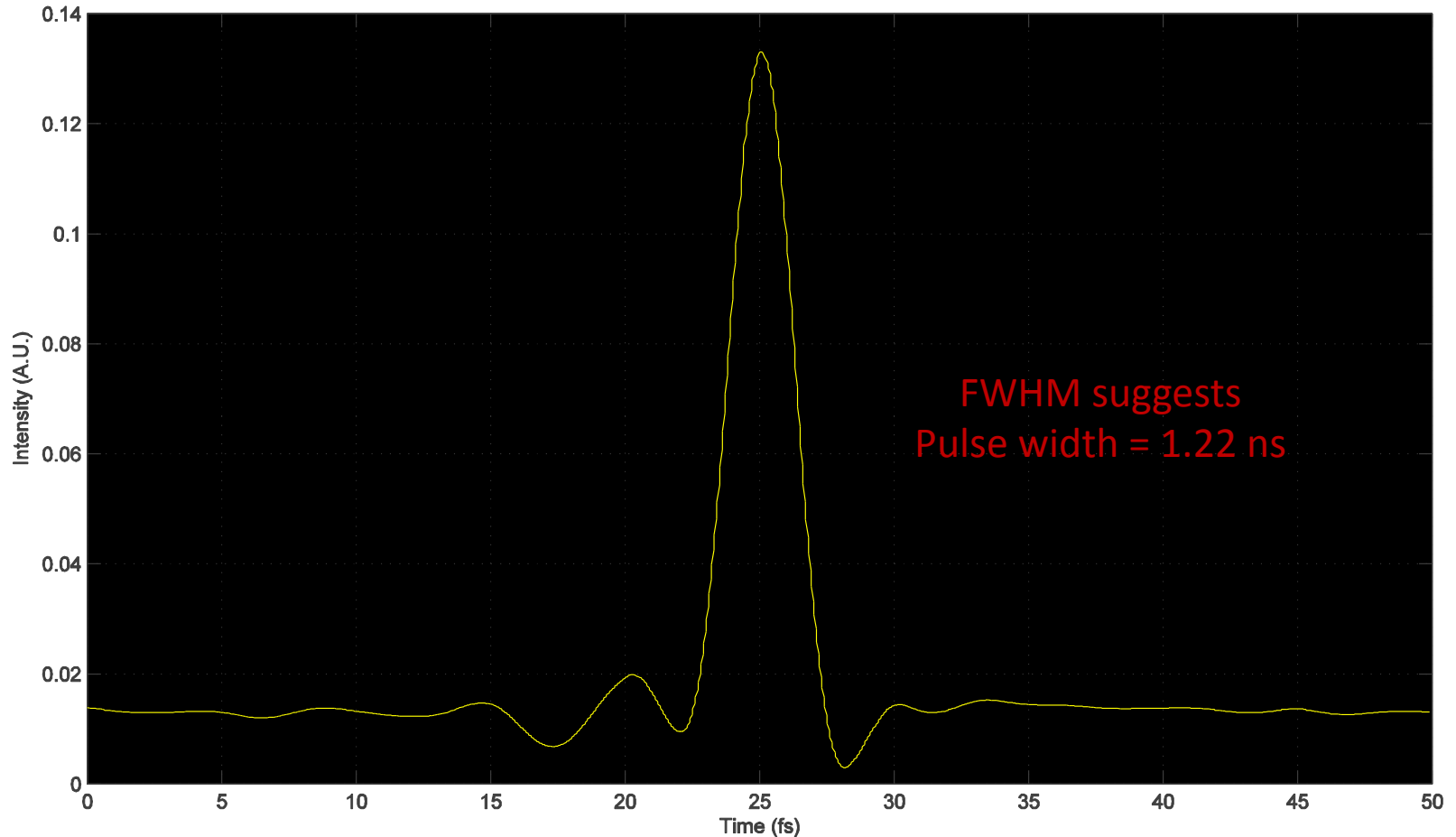
Mode Locked Lasers





Mode Locked Lasers

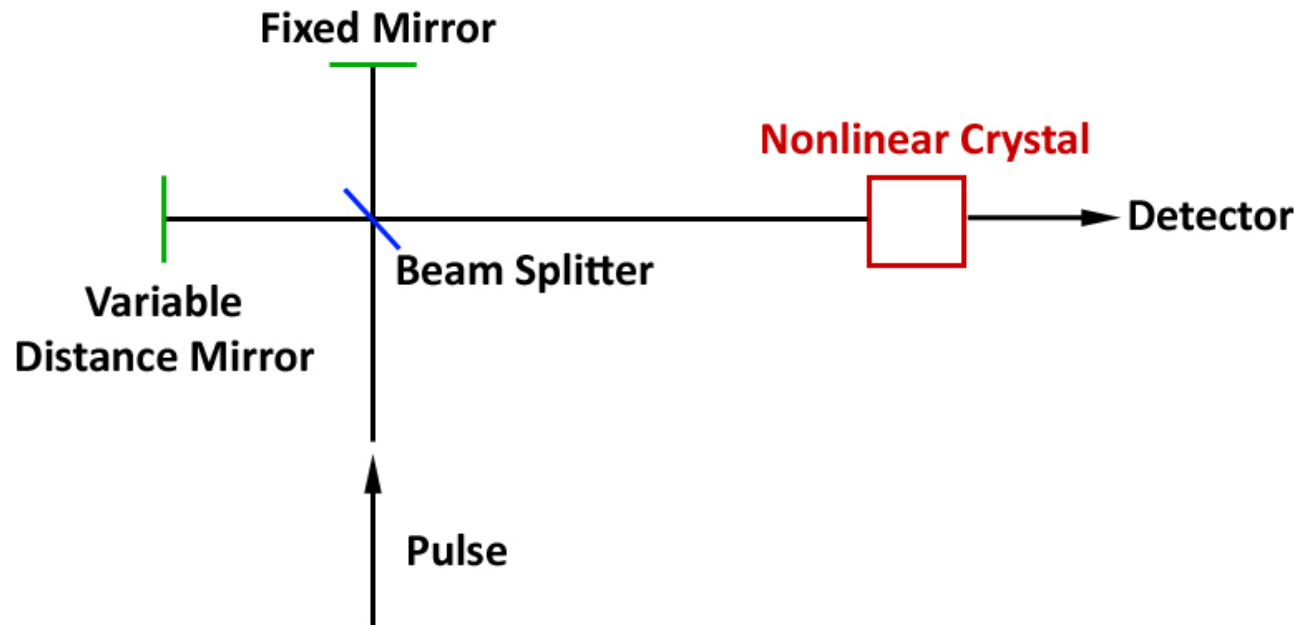
- Detector is too slow





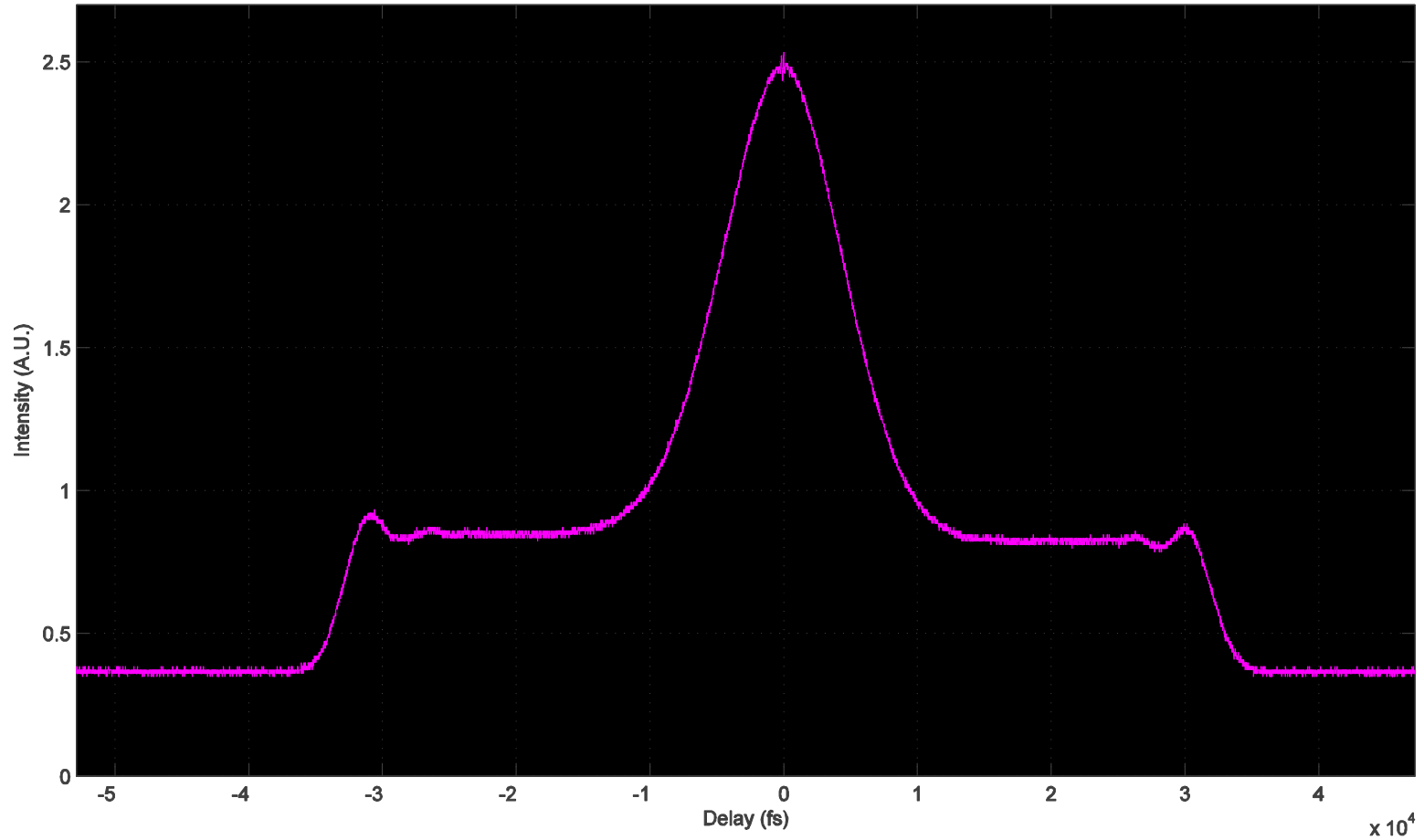
Autocorrelator Measurement

- Michelson interferometer creates small delay
- Aligned pulses create second harmonic generation



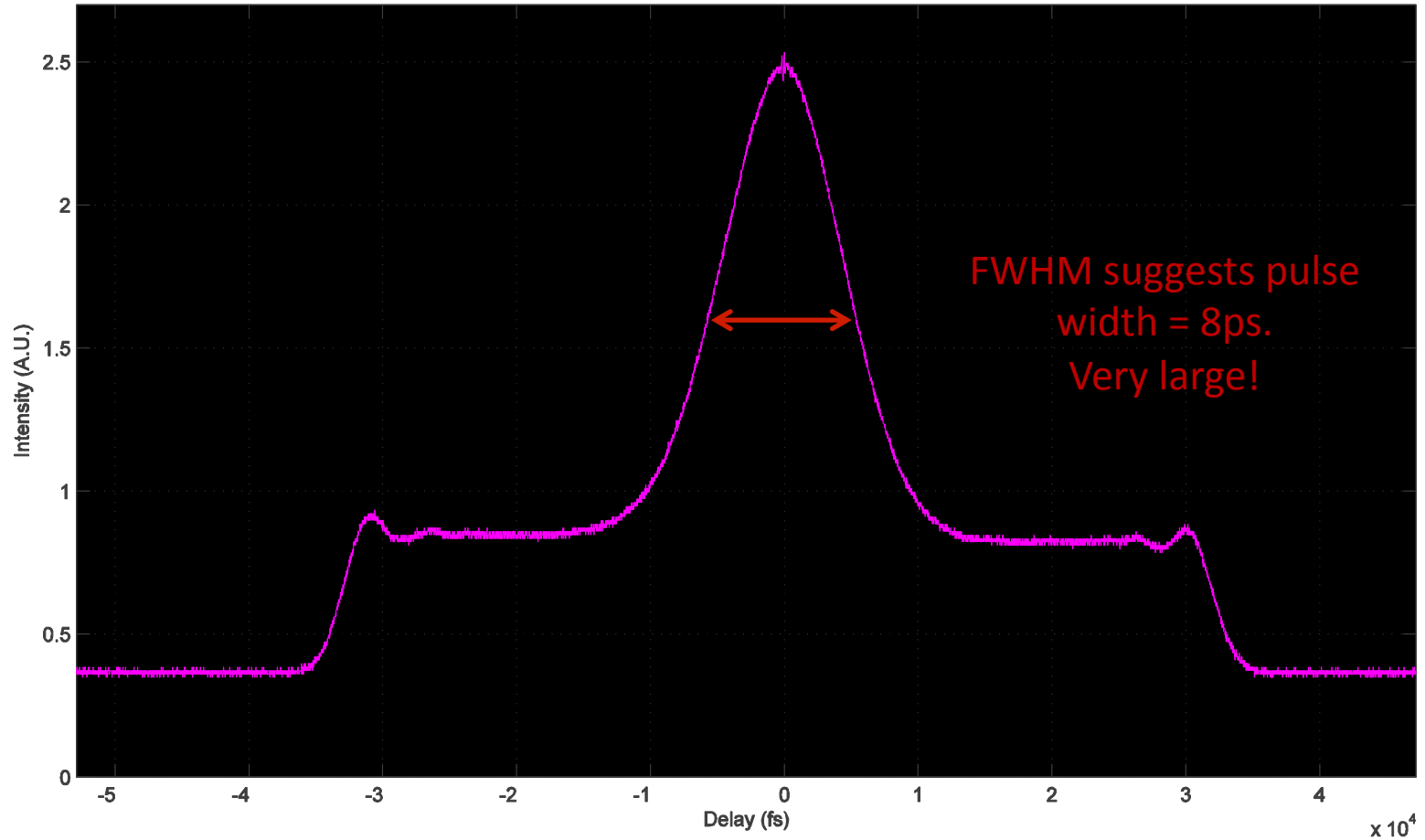


Intensity Autocorrelation





Intensity Autocorrelation





Chirp

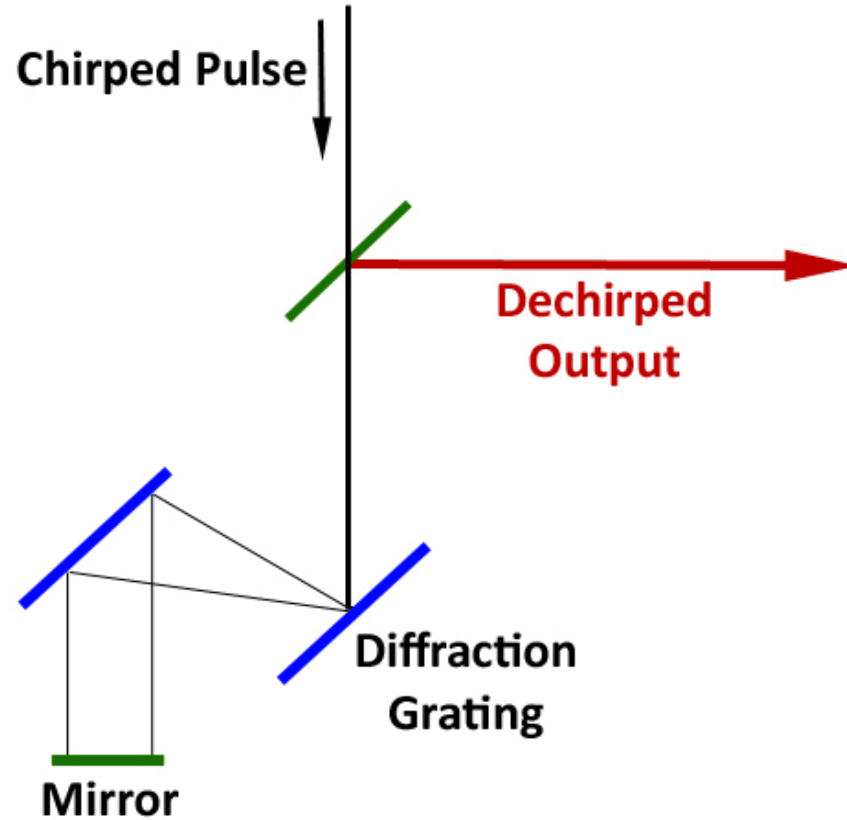
- Index of refraction depends on wavelength



- Compensate with diffraction grating

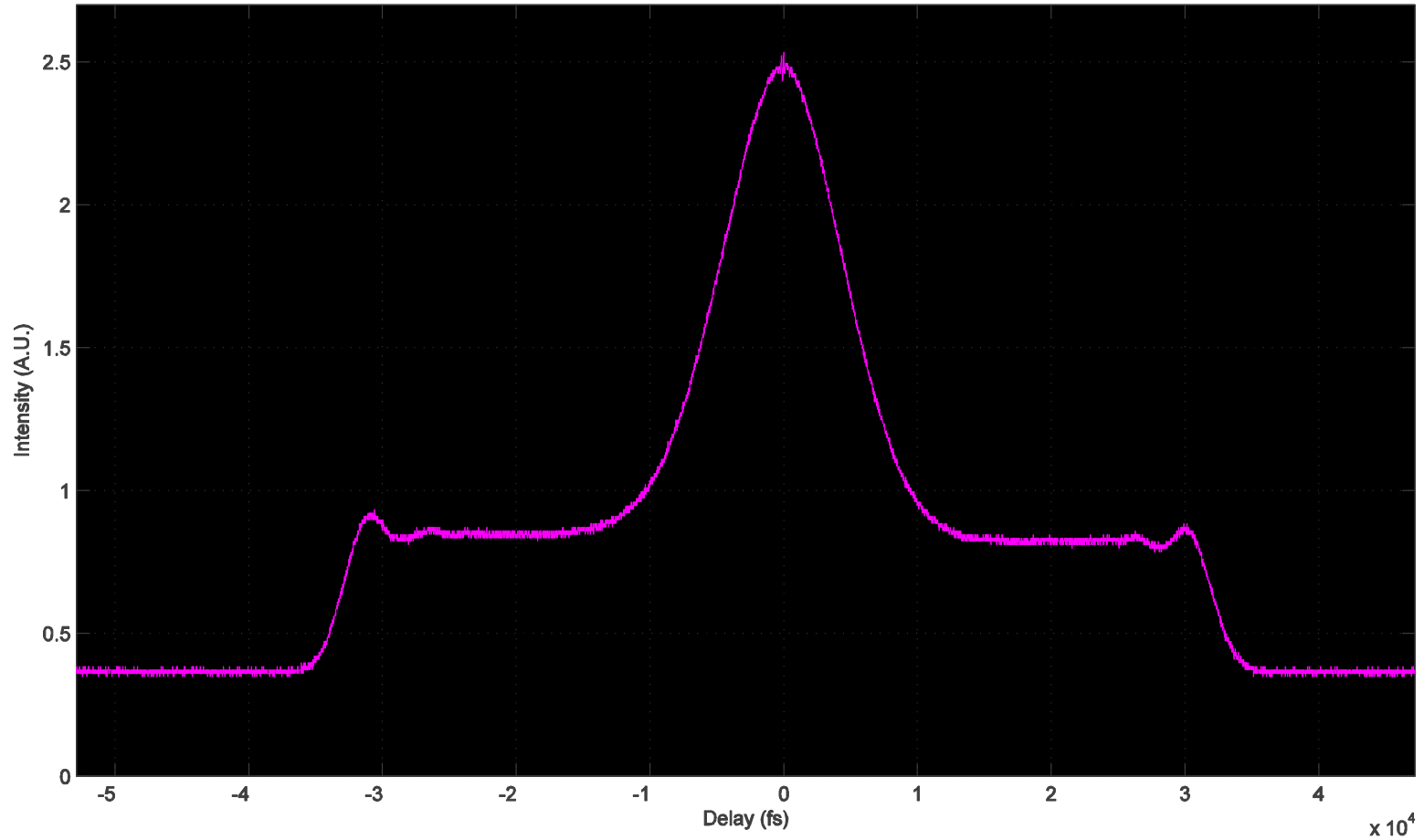


Chirp



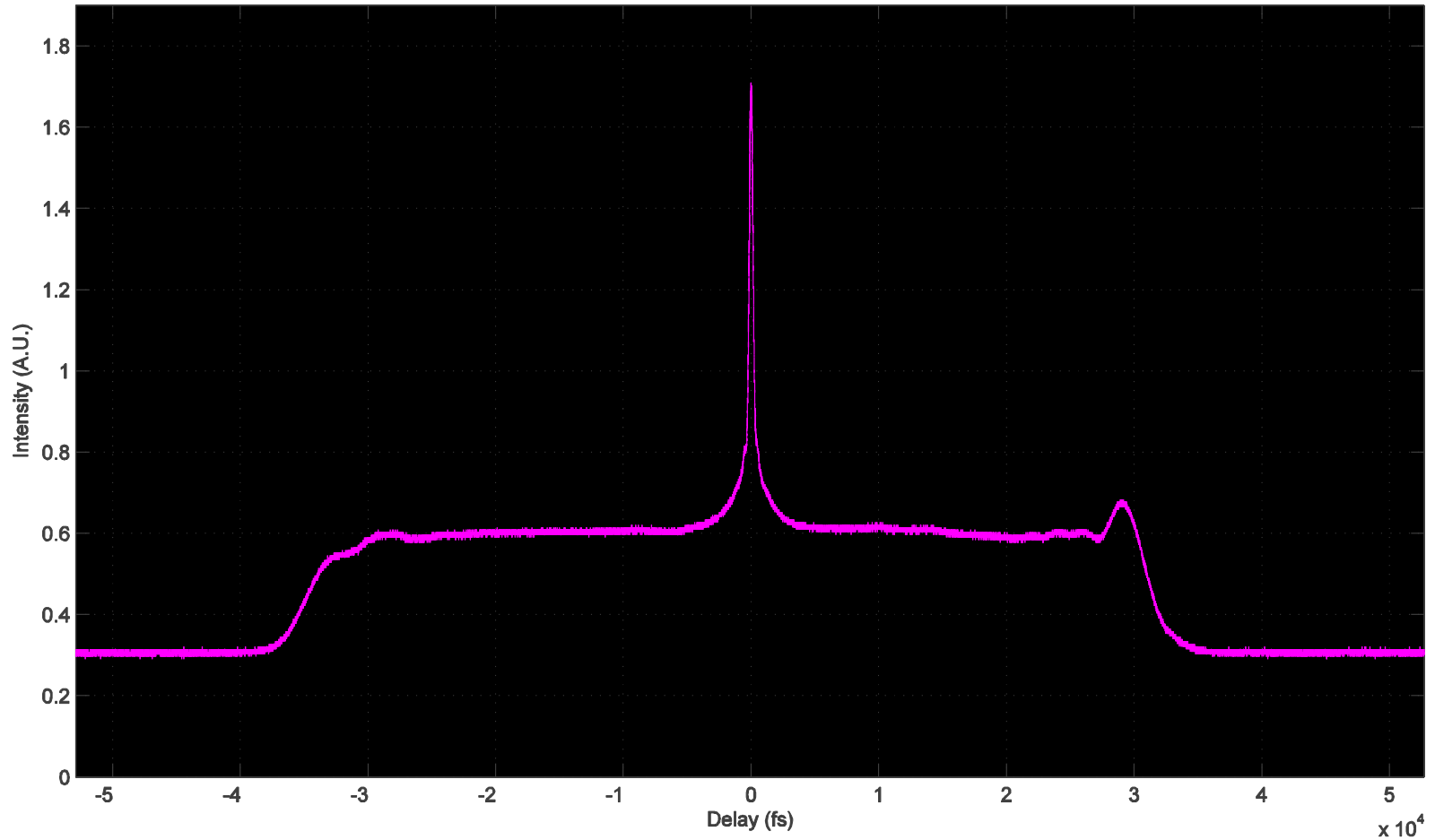


Intensity Autocorrelation



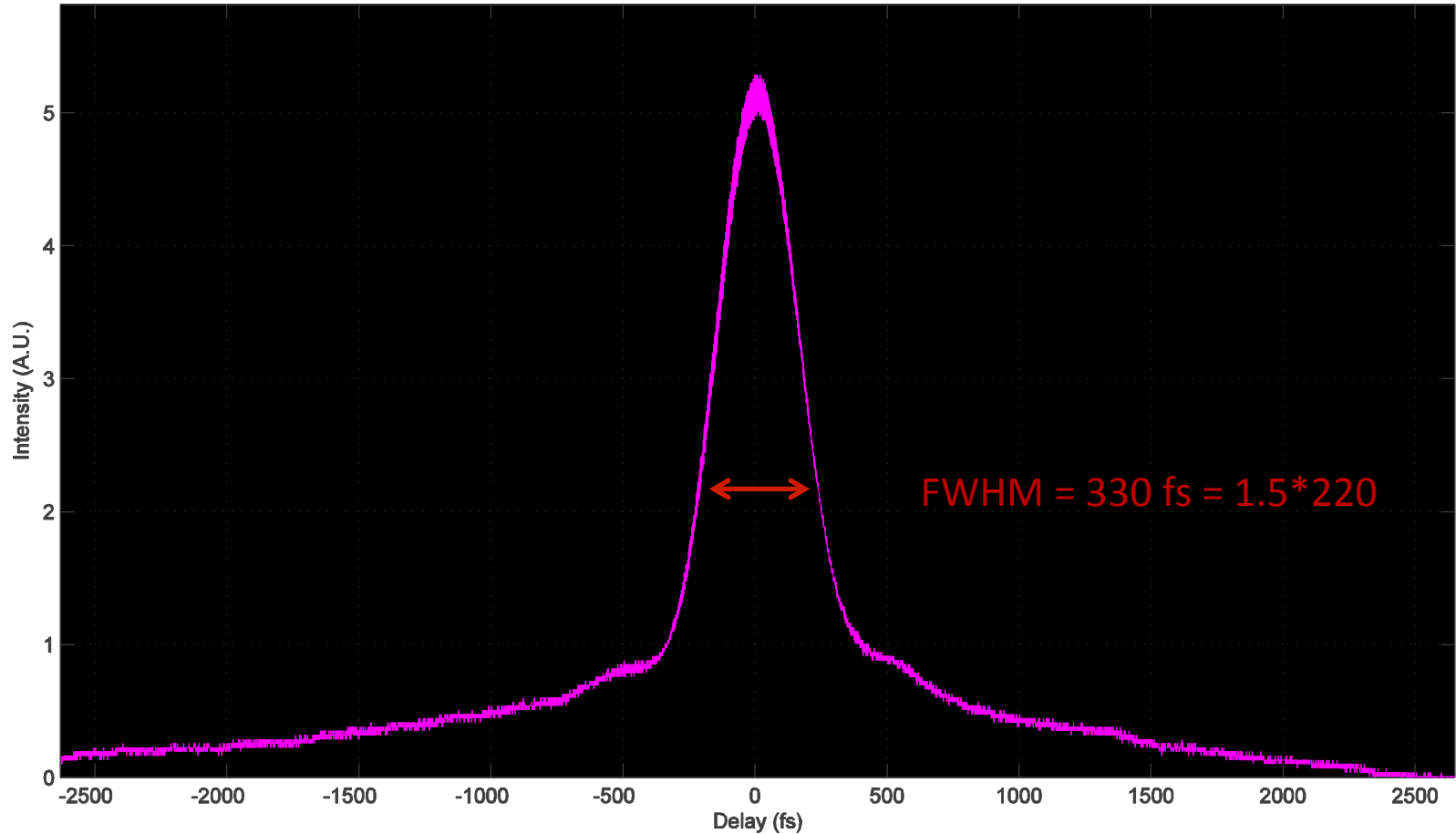


Dechirped Autocorrelation



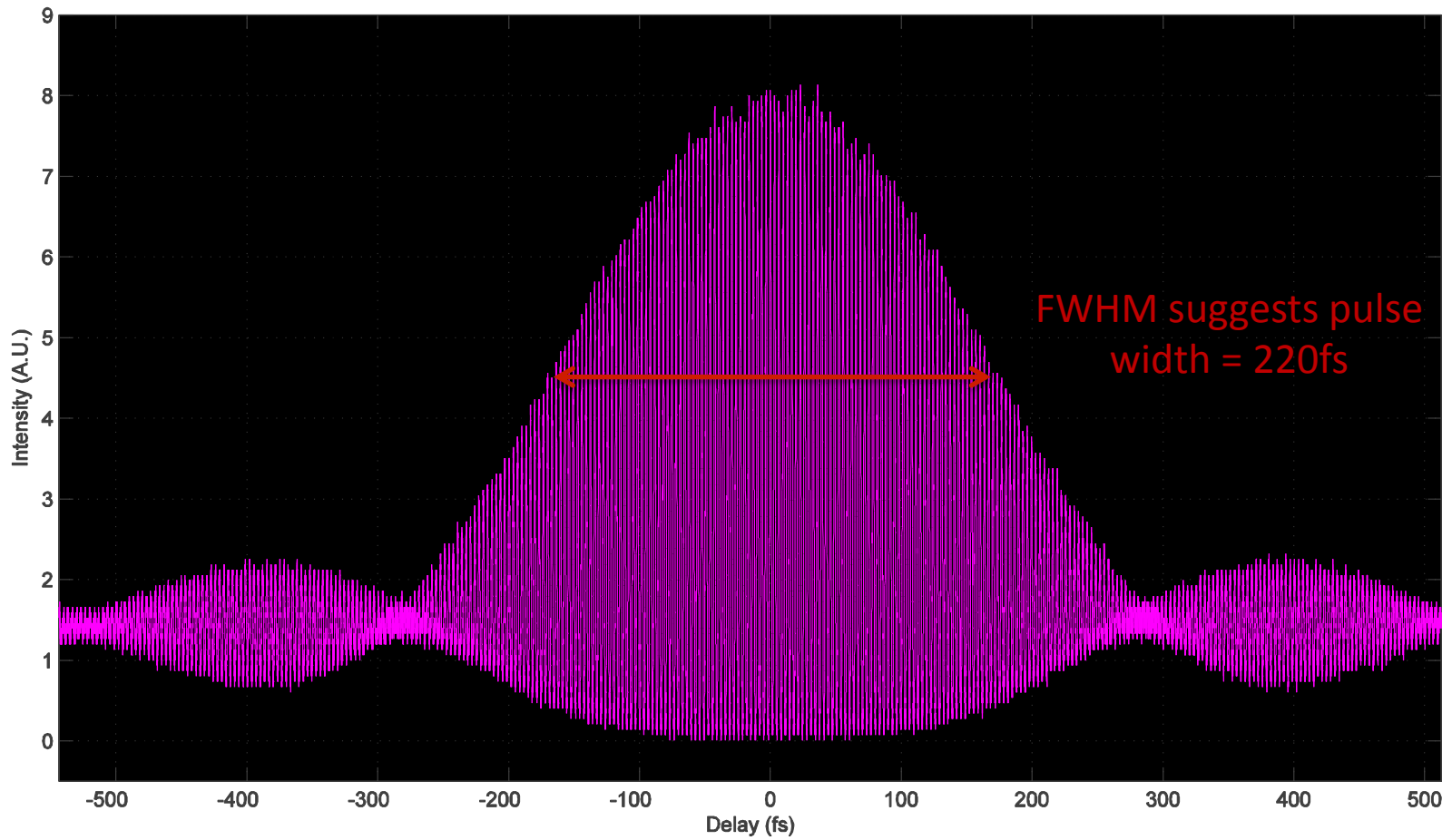


Dechirped Autocorrelation



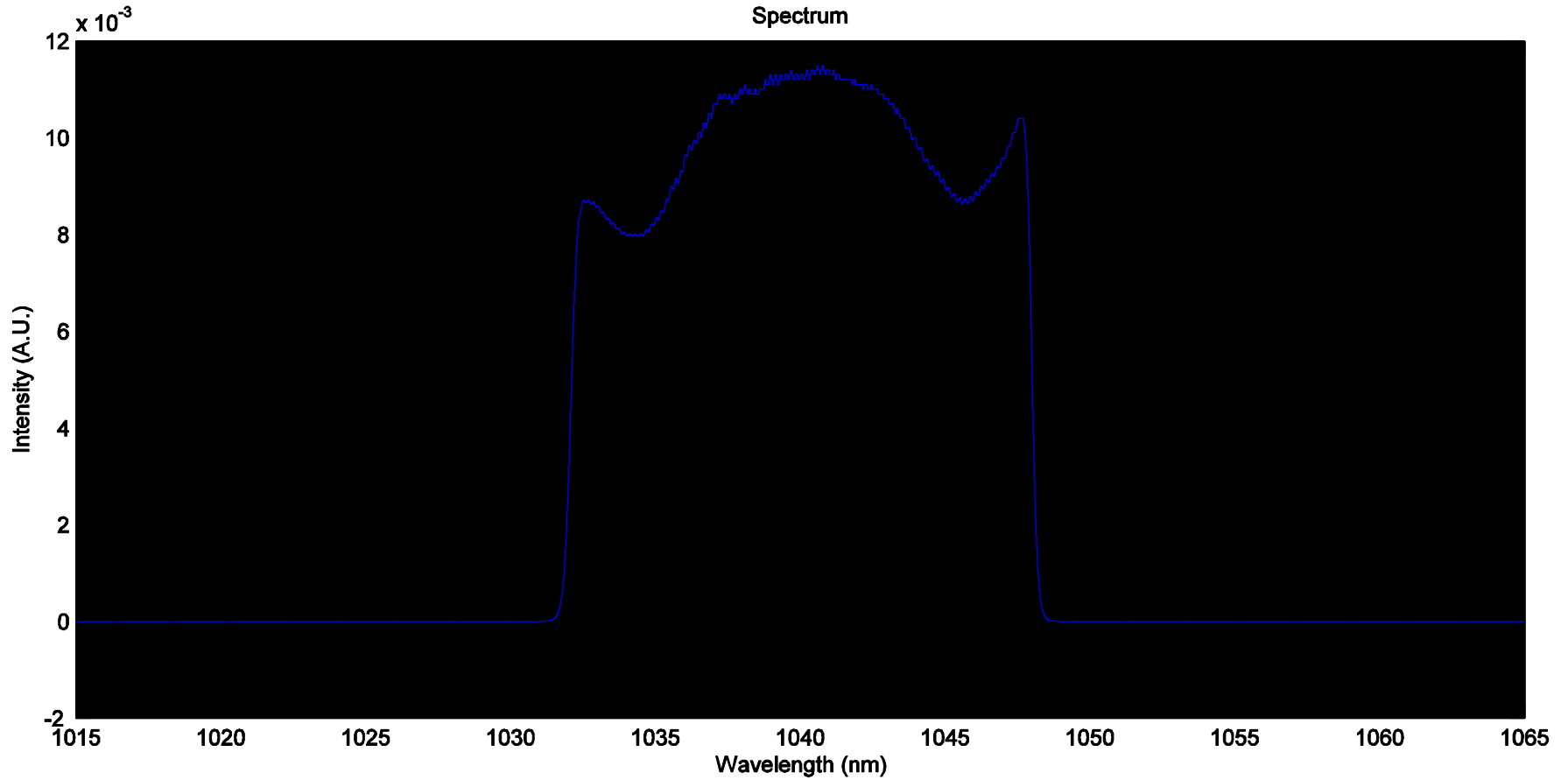


Interferometric Autocorrelation



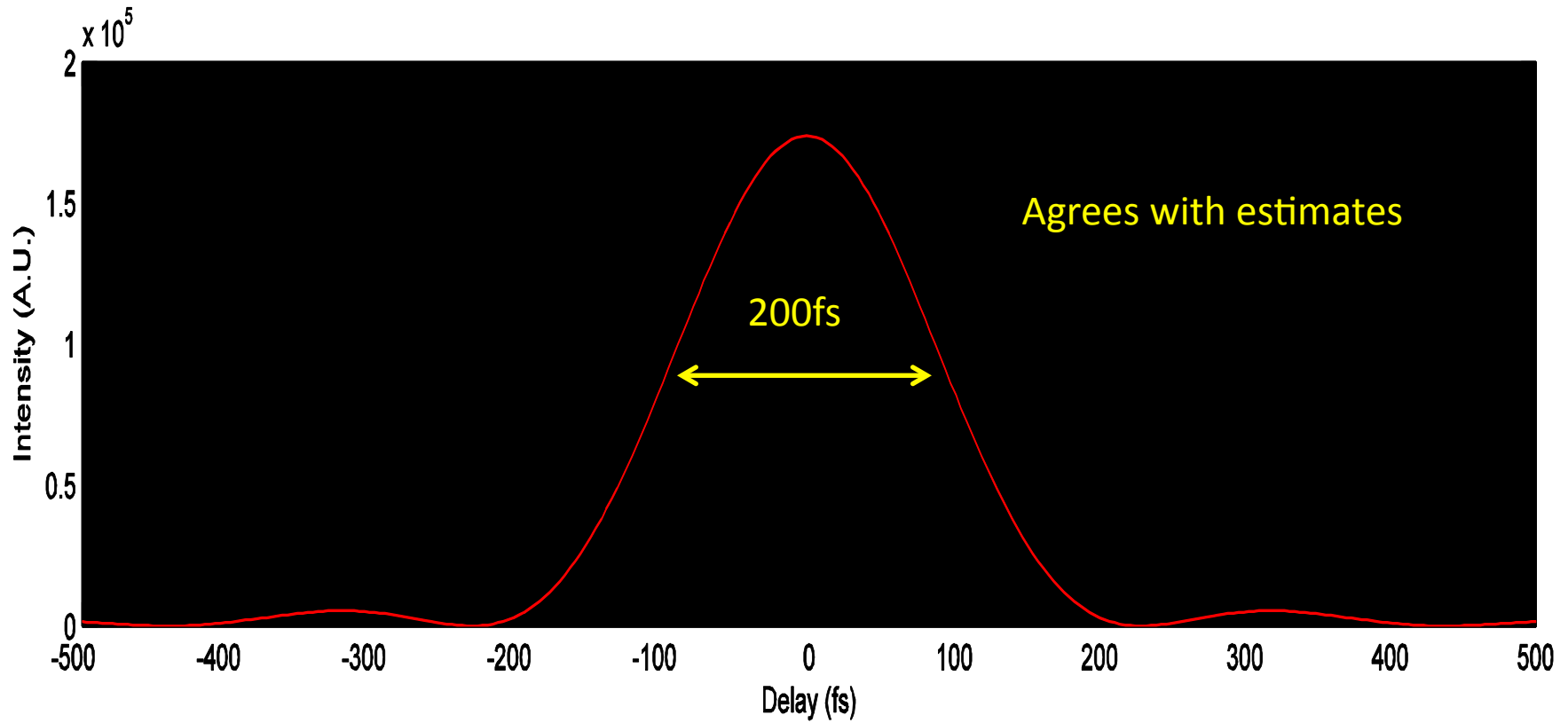


Spectrum





Simulated Results





Pulse Energy

- Peak power estimated from pulse energy and characteristics

Chirped

$$E_{\text{pulse}} = P_{\text{avg}} / f$$
$$= P_{\text{avg}} / f$$

$$= 203 \text{ mW} / 50.5 * 10^6$$

$$= 4.02 \text{ nJ}$$

Dechirped

$$E_{\text{pulse}}$$

$$= 53.3 \text{ mW} / 50.5 * 10^6$$

$$= 1.06 \text{ nJ}$$



Peak Power

Chirped

$$P_{peak} = E_{pulse} / \tau_{pulse}$$

$$= 4.02 * 10^{-9} / 200 * 10^{-15}$$

$$= 20.1 kW$$

Dechirped

$$P_{peak} = E_{pulse} / \tau_{pulse}$$

$$= 1.06 * 10^{-9} / 200 * 10^{-15}$$

$$= 5.28 kW$$



Questions?

