

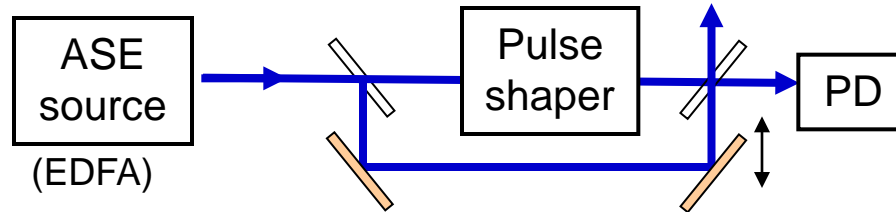
ECE-616: Fall 2011

**Lecture 12:
Electric Field Cross-Correlation
and Spectral Interferometry**

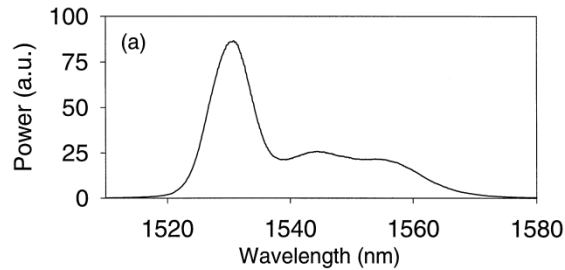
Professor Andrew Weiner
Electrical and Computer Engineering
Purdue University, West Lafayette, IN USA

8/25/11

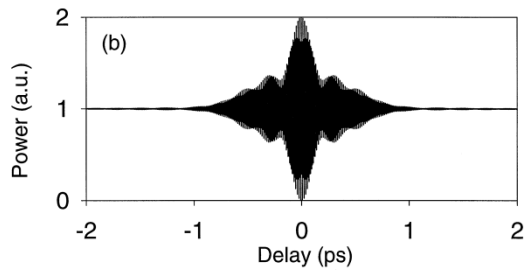
Electric-Field Cross-Correlation



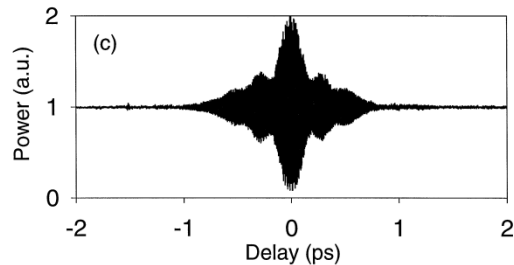
Autocorrelation



Spectrum

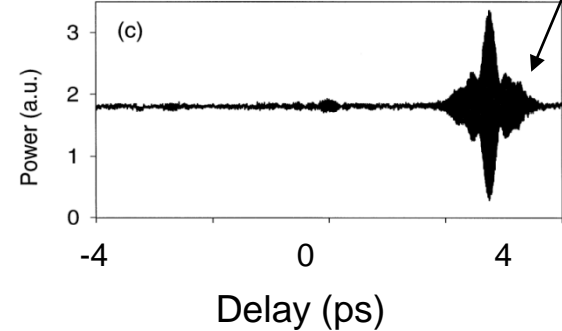
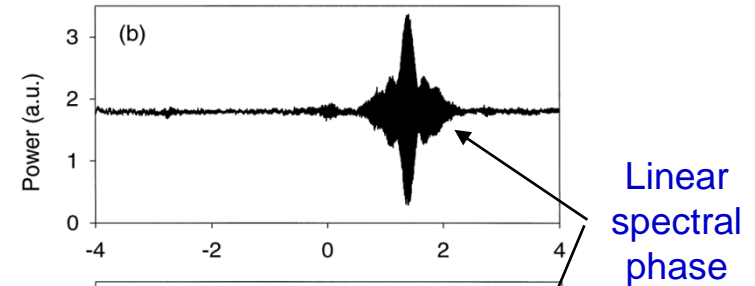
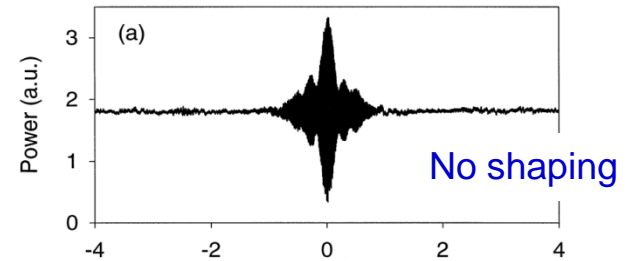


Simulated



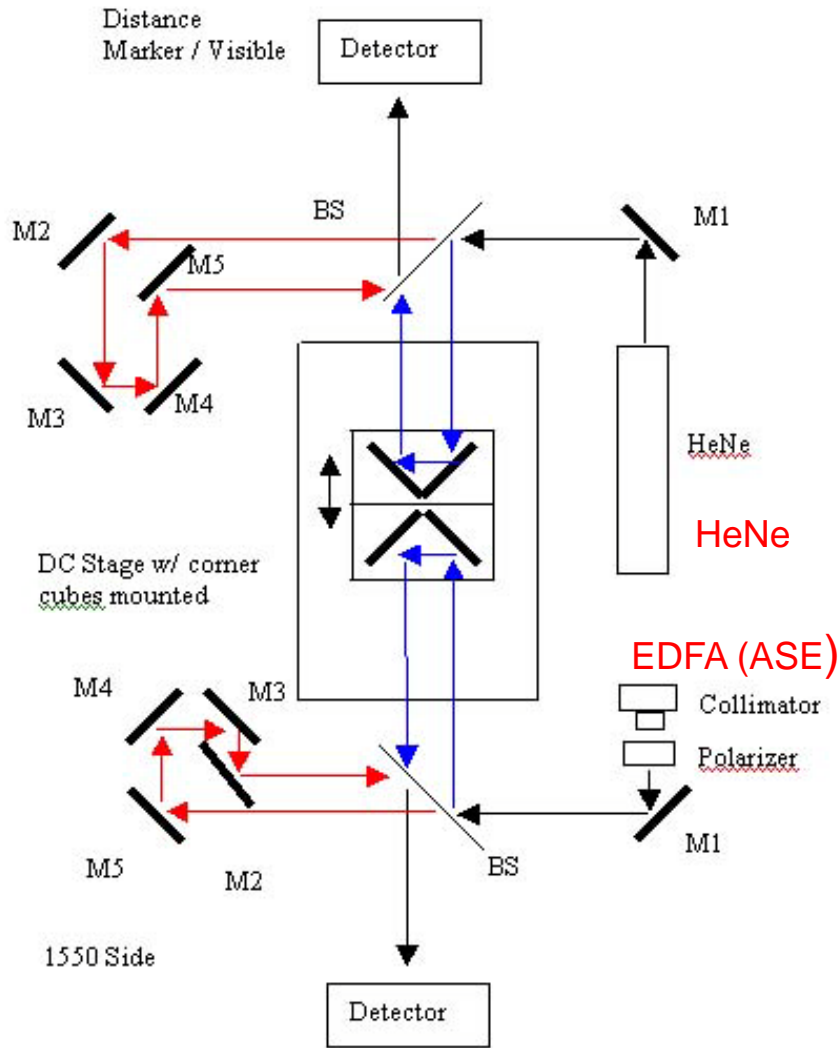
Data

Cross-Correlation

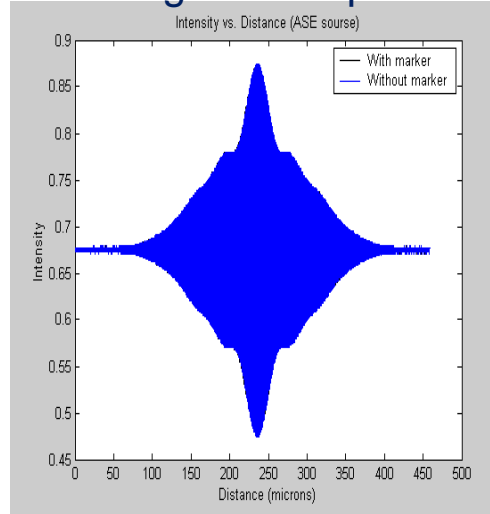


Electric-Field Cross-Correlation

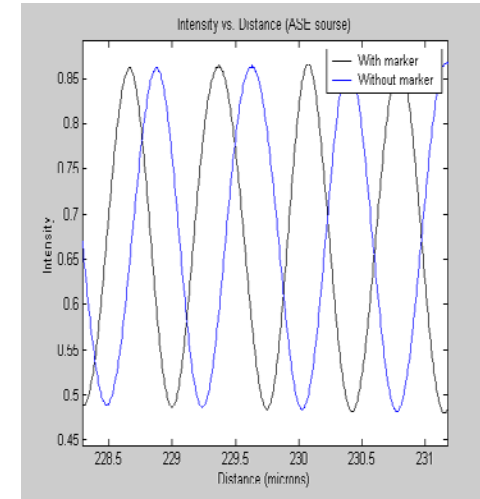
Purdue undergraduate student project



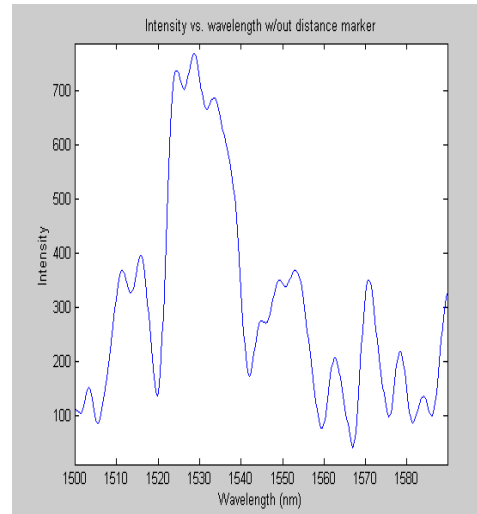
Fringe envelope



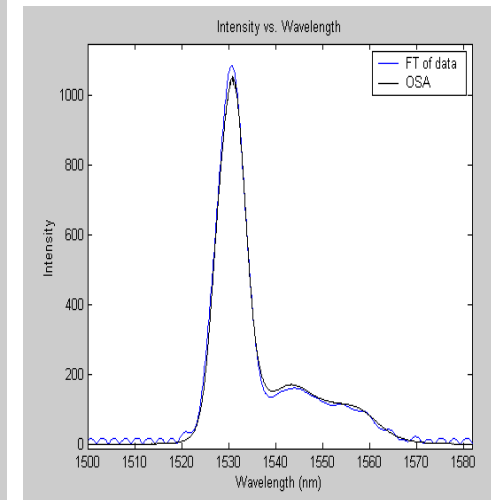
Fringe details



Spectrum with fringe errors



Spectrum with fringes corrected

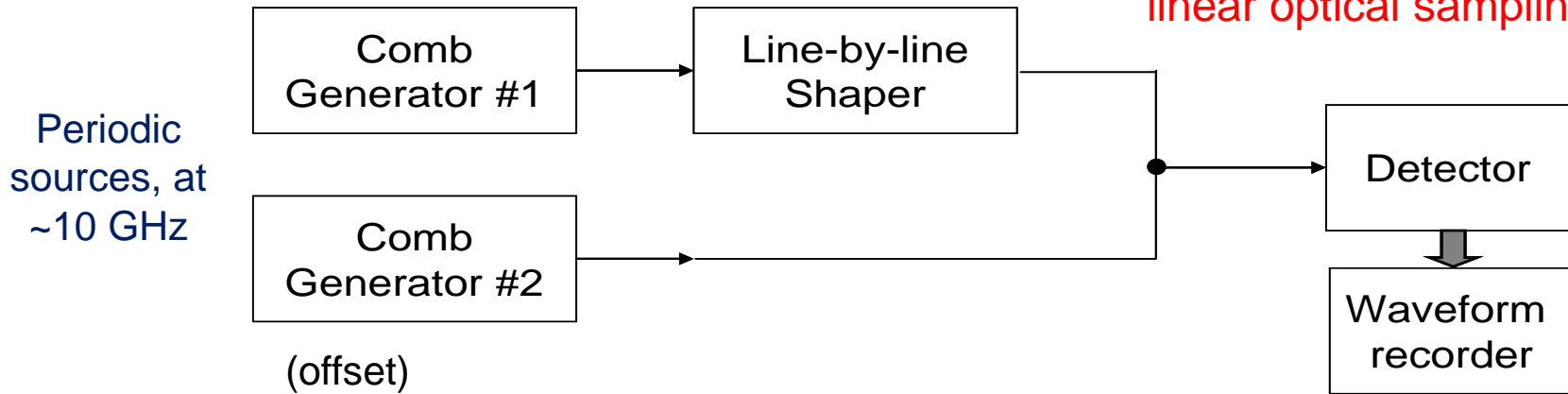


Concept : K. Naganuma et al, Optics Letters **15**, 393-395 (1990)

Electric-field cross-correlation

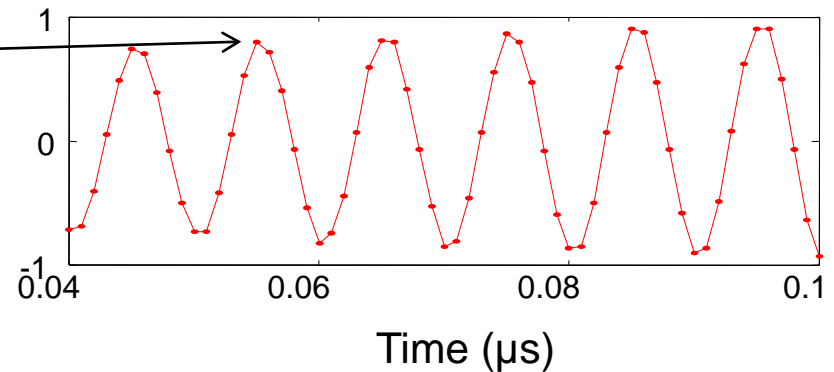
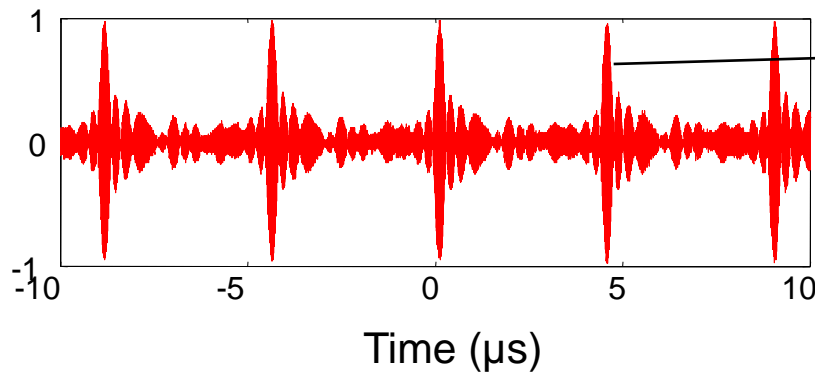
Repetitive sampling

Similar: dual comb spectroscopy,
linear optical sampling



$$\langle P_{out}(\tau) \rangle \sim U_r + U_s + \left[e^{j\omega_o\tau} \int dt a_s(t) a_r^*(t-\tau) + c.c. \right]$$

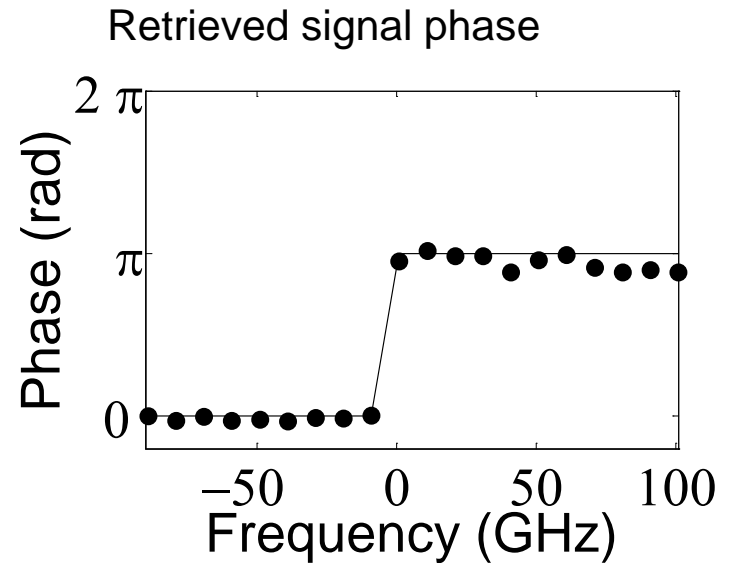
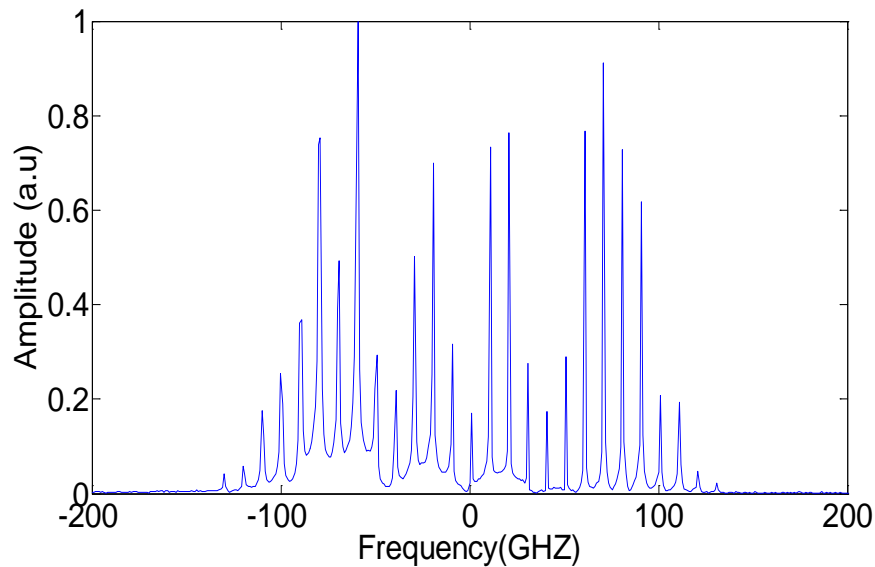
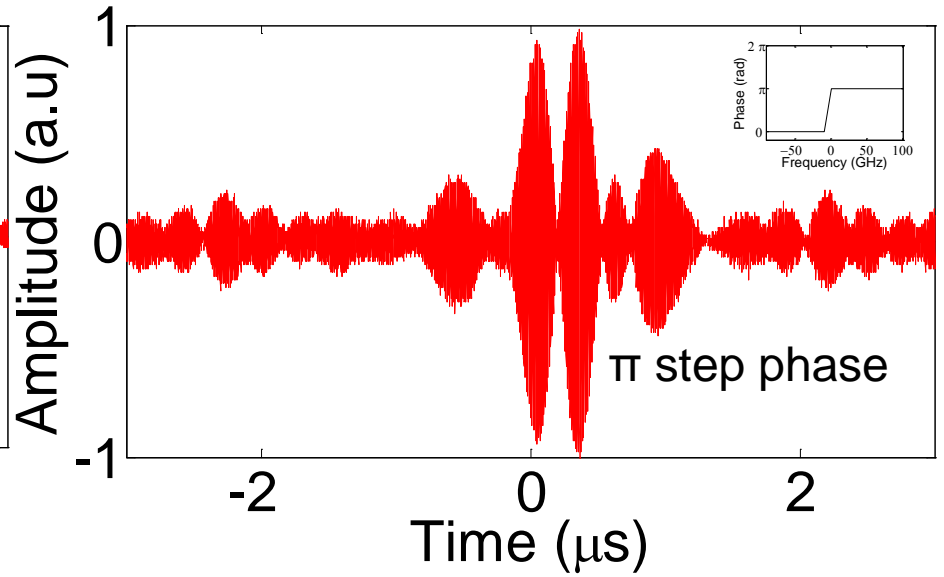
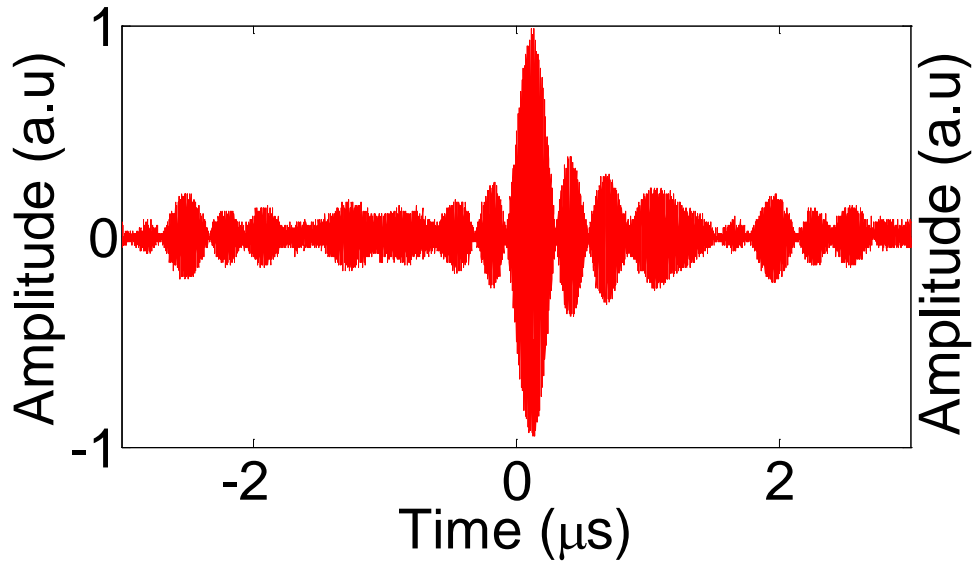
Expanded view



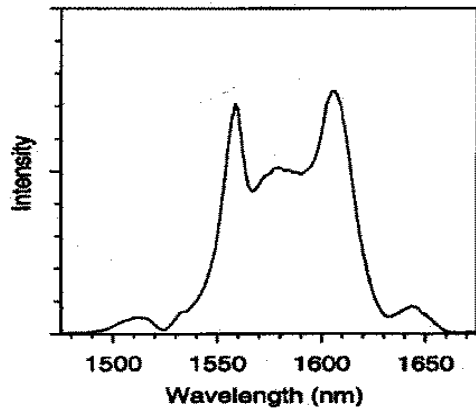
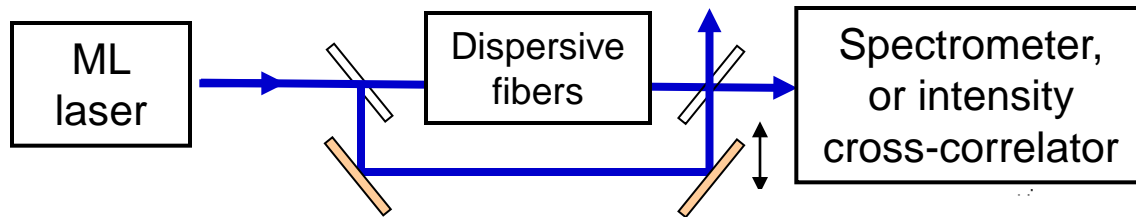
Here two repetitive sources with slightly detuned center frequencies and repetition periods scan automatically!

Electric-field cross-correlation

Repetitive sampling

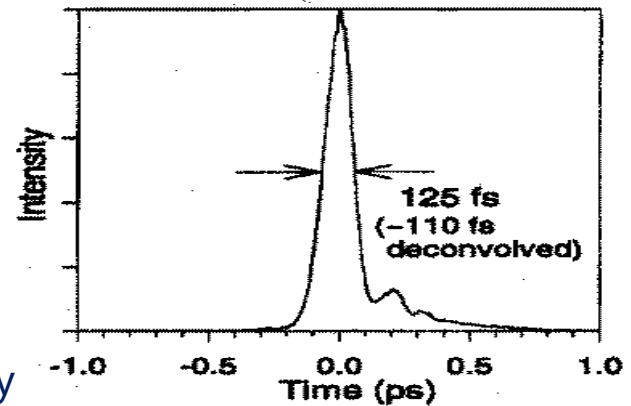


Spectral Interferometry



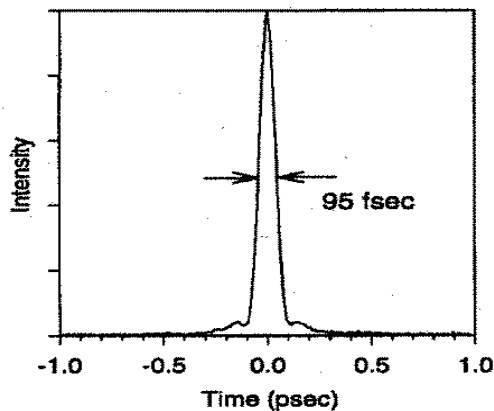
(a)

Input spectrum

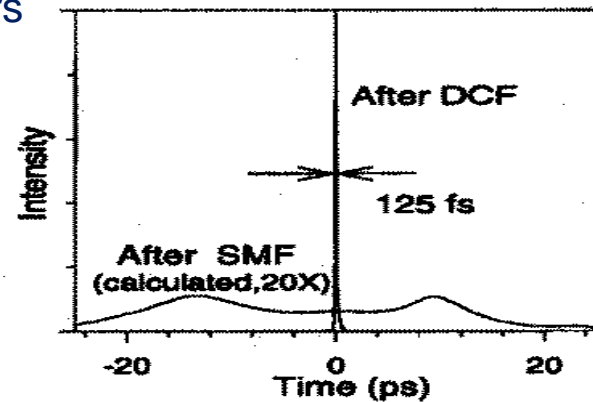


(a)

Intensity cross-correlation, after fibers

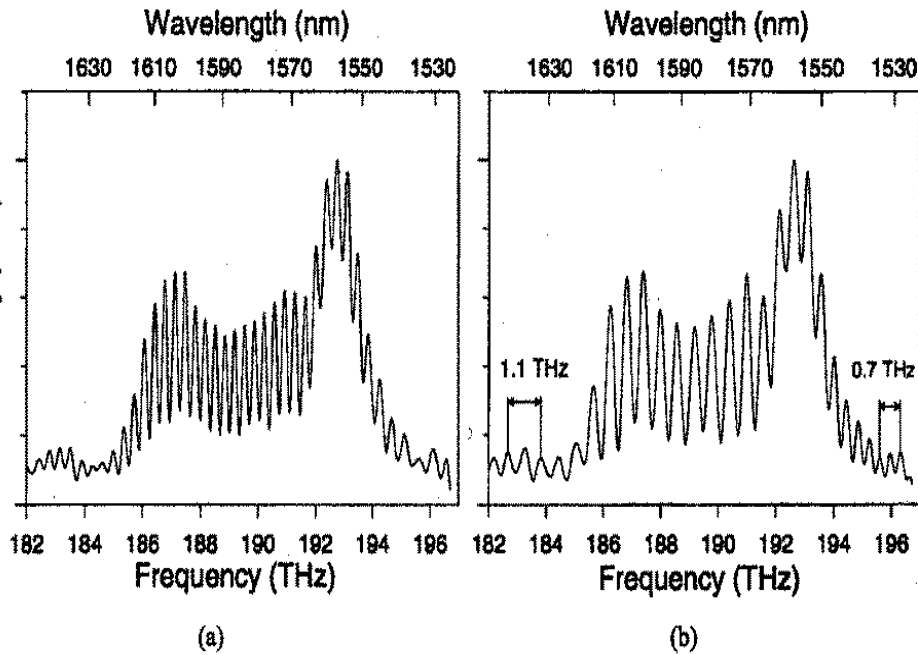
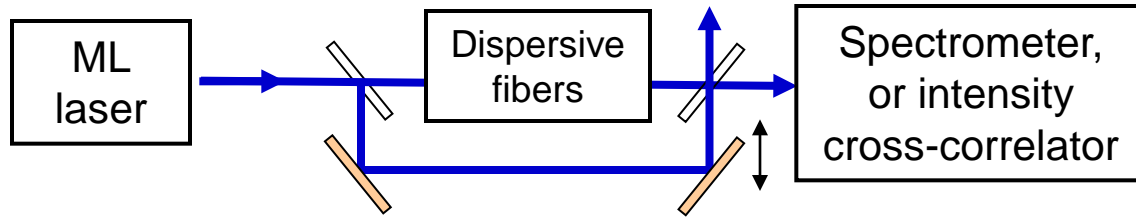


Intensity autocorrelation, before fibers



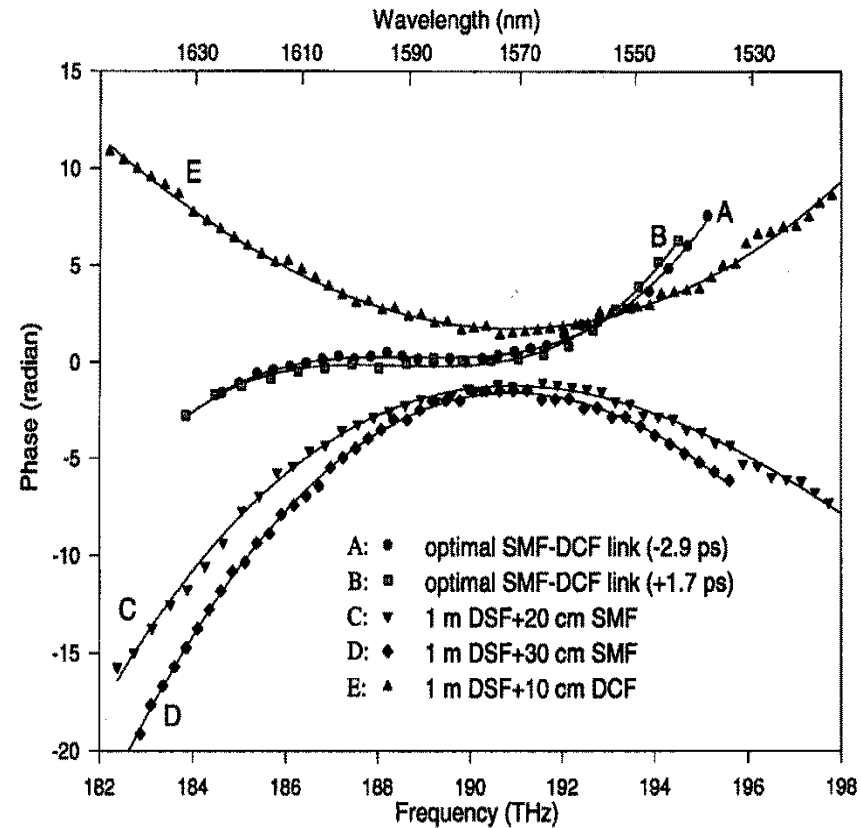
(b)

Spectral Interferometry

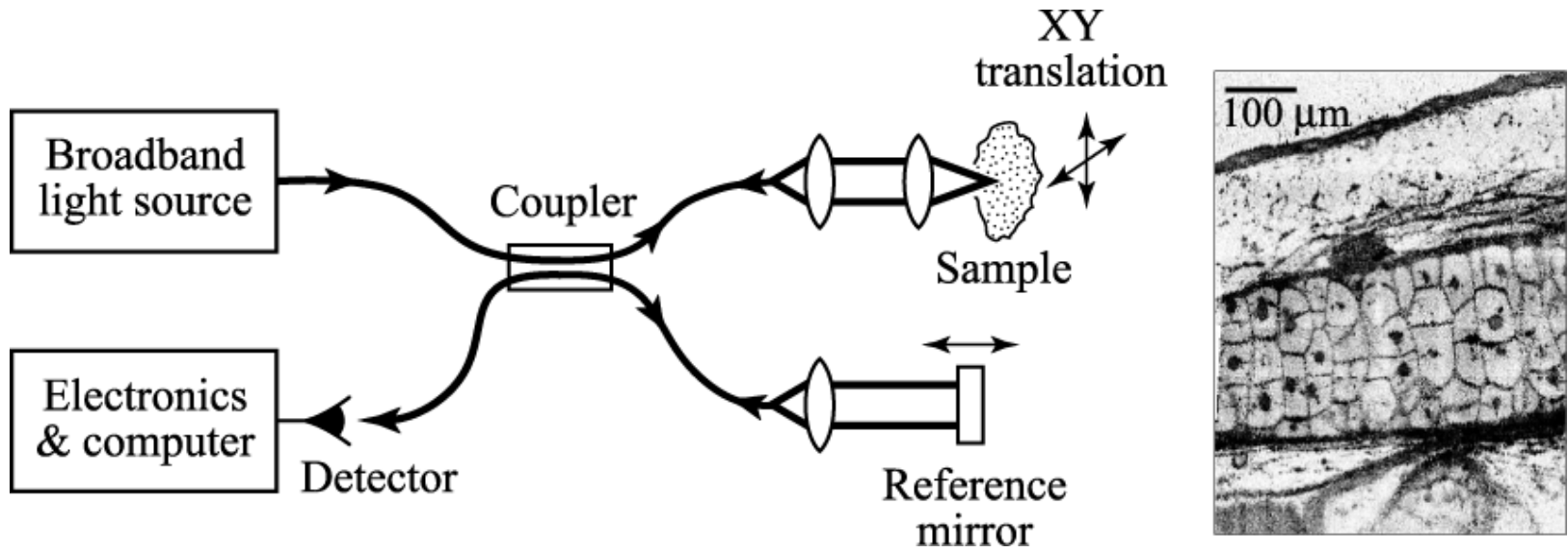


-2.9 ps delay

+1.7 ps delay



Optical Coherence Tomography



reproduced from *Ultrafast Optics*, A.M. Weiner, © John Wiley & Sons, 2009, Figs. 3.6.
– image from Drexler, Morgner, Kaertner, ..., and Fujimoto, *Opt. Lett.* **24**, 1221 (1999)