A nugget from FOCUS:

Femtosecond x-ray stopwatch

A. Cavalieri, D. Fritz, S. Lee, P. Bucksbaum and D. Reis

FOCUS is a collaborator in the Subpicosecond Pulse Source (SPPS) experiment at the Stanford Linear Accelearator Center (SLAC). SPPS is the world's only accelerator-based source of femtosecond hard x-ray pulses. SPPS will continue to be the brightest source of laboratory x-rays until it is supplanted for construction of the first x-ray free-electron laser, the Linac Coherent Light Source (LCLS).

We use these pulses to study how matter moves on the fastest time scales, typically following intense laser excitation. In order to achieve the highest possible resolution it is imperative that the laser excitation and the x-ray pulses are exquisitely timed to each other. However, current technology does not permit a good enough level of synchronization. Therefore, it becomes necessary to measure the relative arrival time on each individual laser and x-ray pulses. The timing is performed by measuring the extremely large electric fields associated with the ultrarelativistic electron pulses in the accelerator, using a non-destructive technique known as electrooptic sampling (EOS), see figure below. These electron pulses then go on to produce the x rays as they pass through a device made of permanent magnets, known as an undulator. Ideally the electron beam arrival time measurement corresponds to the x-ray arrival time. An independent direct (but destructive) measurement of the x-ray timing shows that the two measurements can be correlated to approximately 60 fs. These measurements will allow us to use the SPPS and later LCLS beams with significantly improved temporal resolution.

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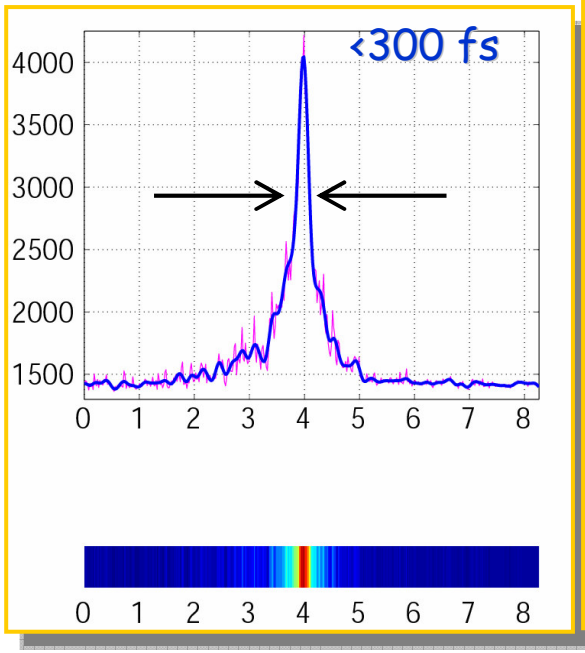
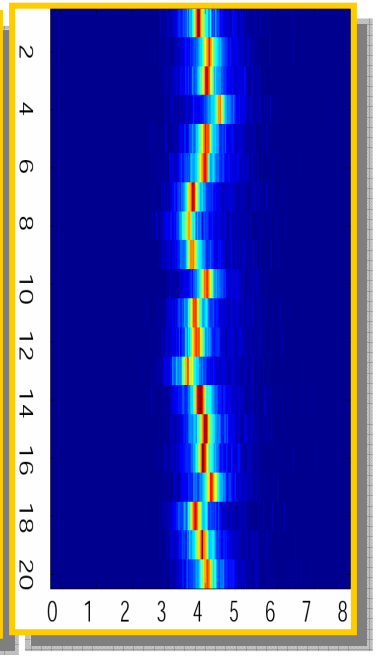
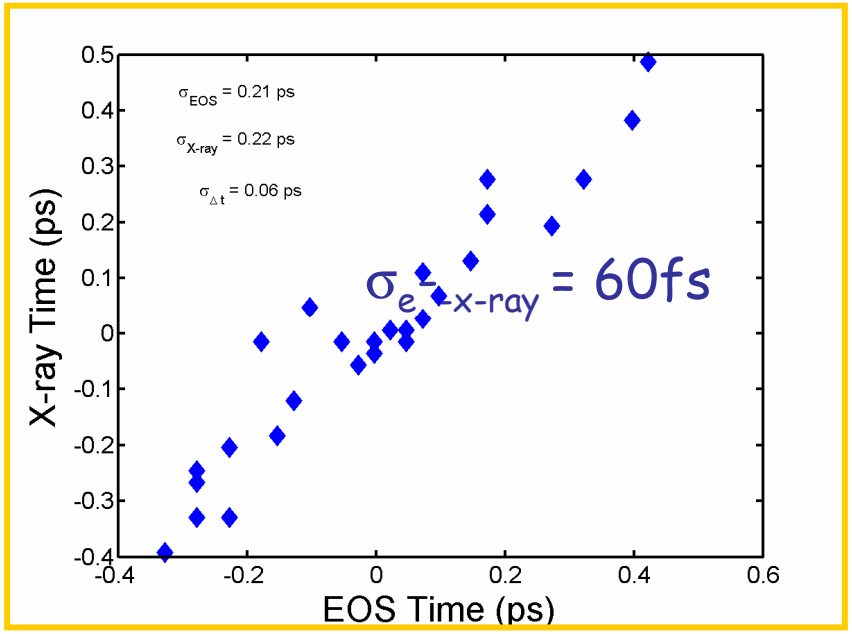


Single-Shot Electron Beam timing measurement



Timing Jitter (20 shots)



Strong Correlation between measured Electron Beam and X-ray beam timing