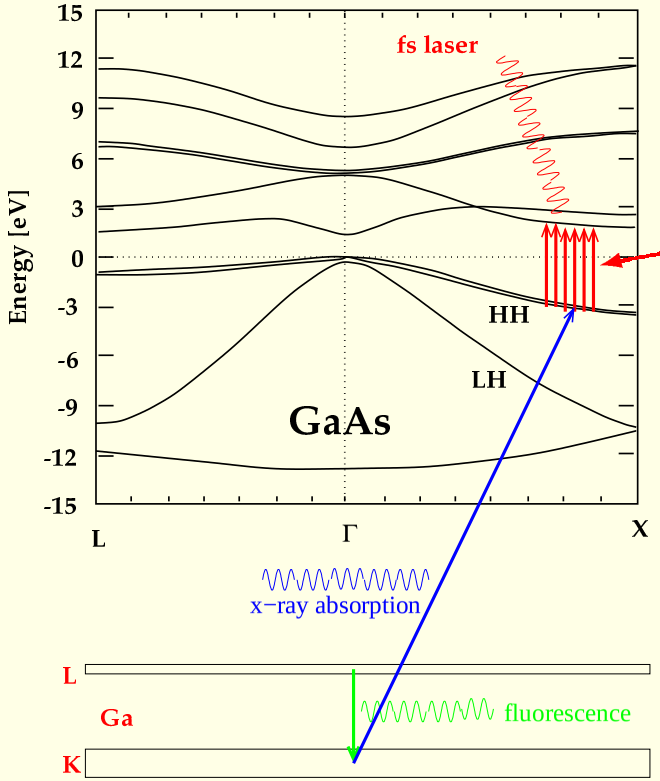
Picosecond Laser-Pump, X-Ray Probe Spectroscopy of GaAs

B.W. Adams (ANL)
M.F. DeCamp, D.A. Reis, E.M. Dufresne (U Mich.)

march 2002

Laser Pump / X-Ray Probe

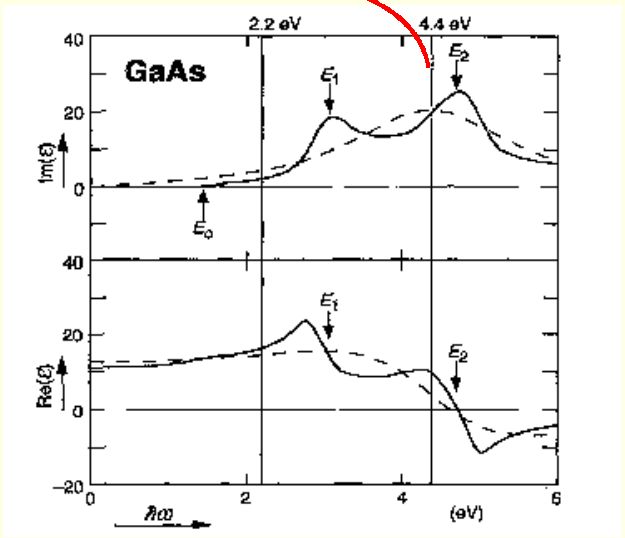
X-rays probe electronic, not structural excitation



laser excitation at 4.6eV

x-ray absorption at 10367eV (Ga K ae)

x-ray fluorescence at 9240eV (Ga K_α)



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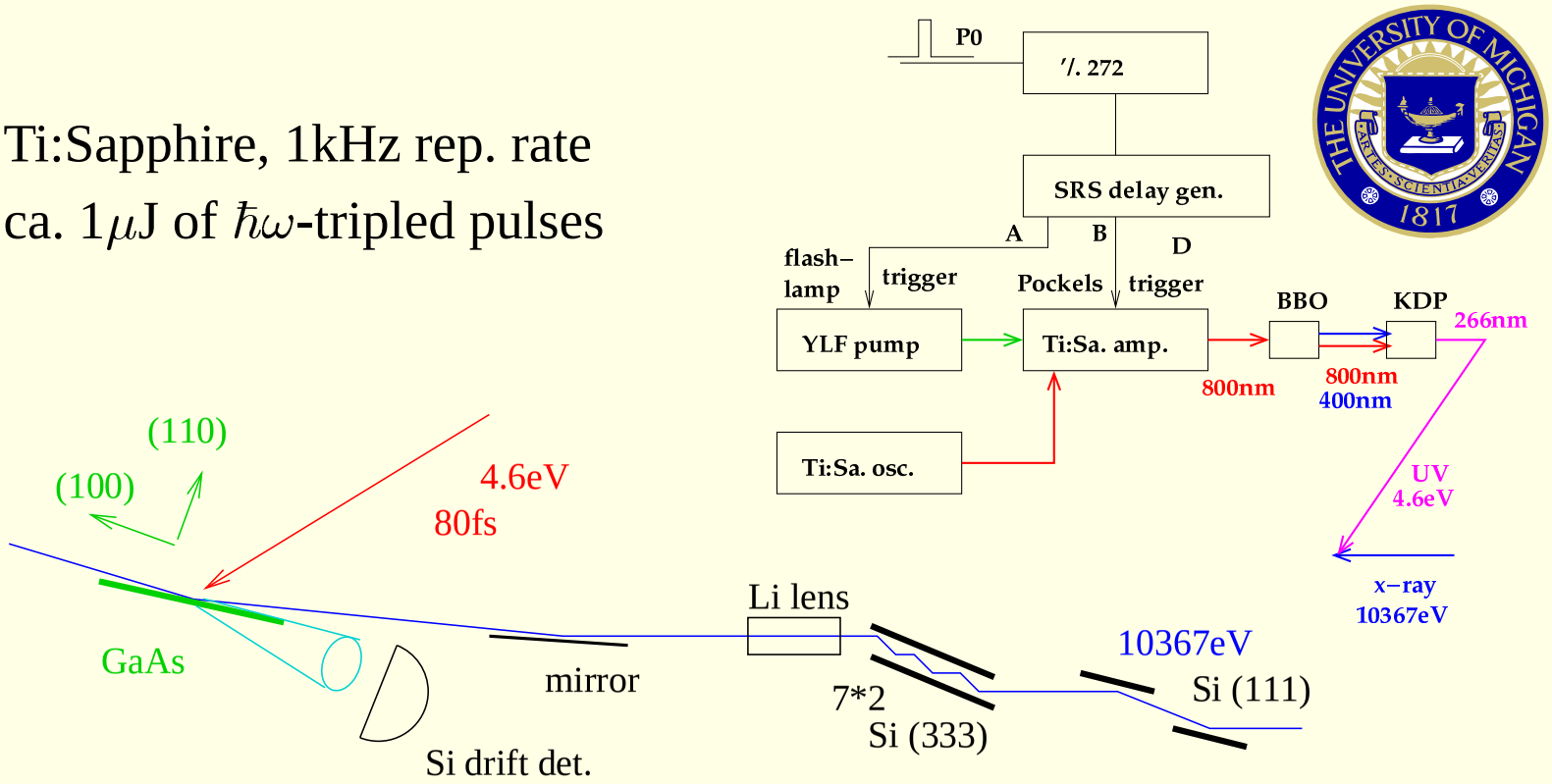
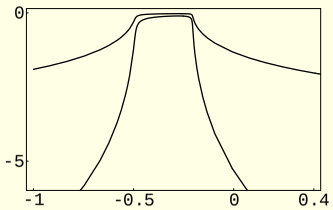
Setup at 7ID-D (MHATT-CAT)

Ti:Sapphire, 1kHz rep. rate

ca. 1μJ of $\hbar\omega$-tripled pulses

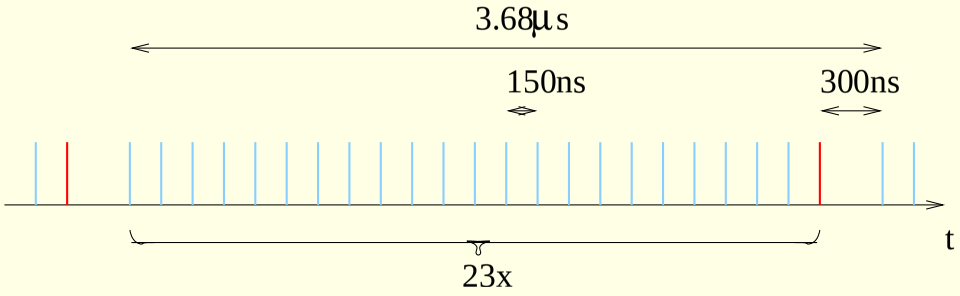




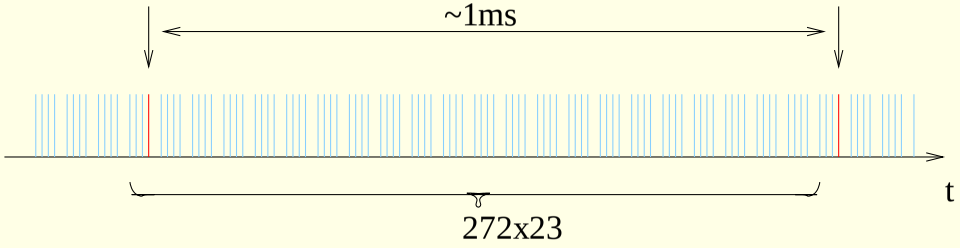
Timing Issues

1. Synchronize laser to one in 23*272 bunches
2. Gate pulse for signal and reference counters

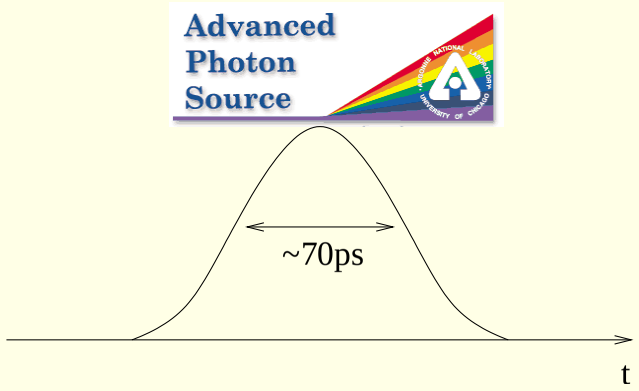
23 bunches in the ring:



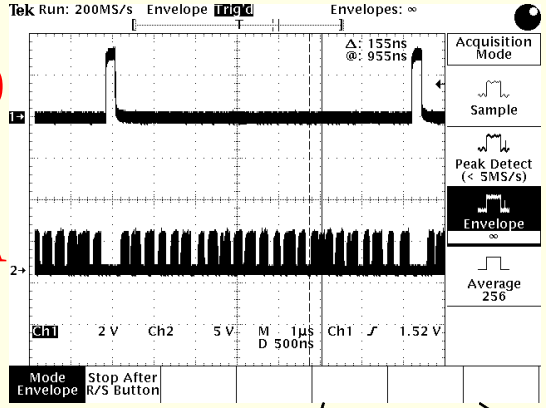
laser fires once in 272 round trips:



3. time laser to x-rays within 19ps (step size)

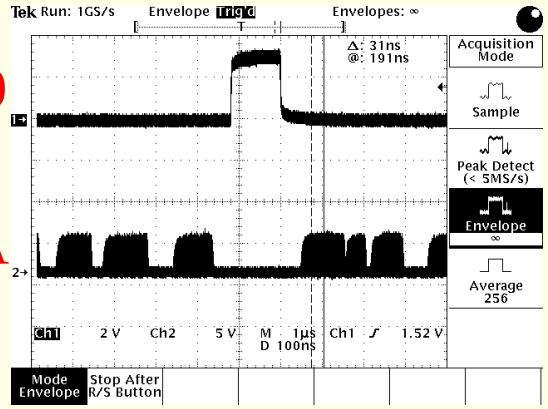


Timing



P0

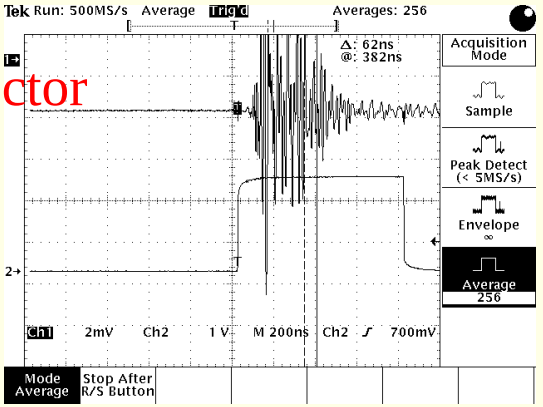
SCA



P0

SCA

make sure that gate is on the right bunch: Pockels cell noise



detector

D

gate is derived from ‘D’

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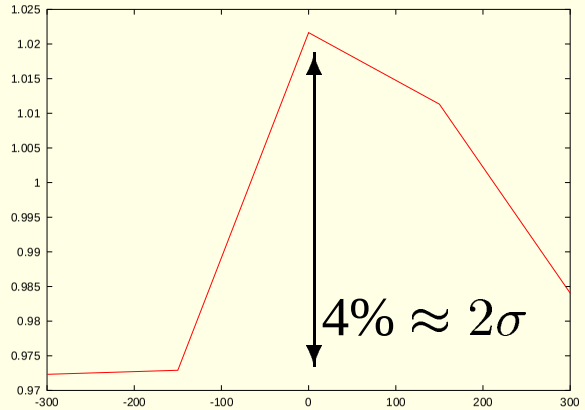
Results

Scans of laser timing over ±300ps, 5 points in multiple passes

Ga K_α fluorescence yield (from bunch with laser) / (buches w/o. laser)

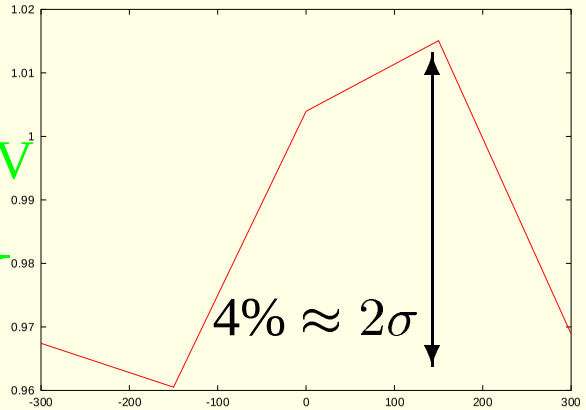


-300ps (laser late)

+300ps

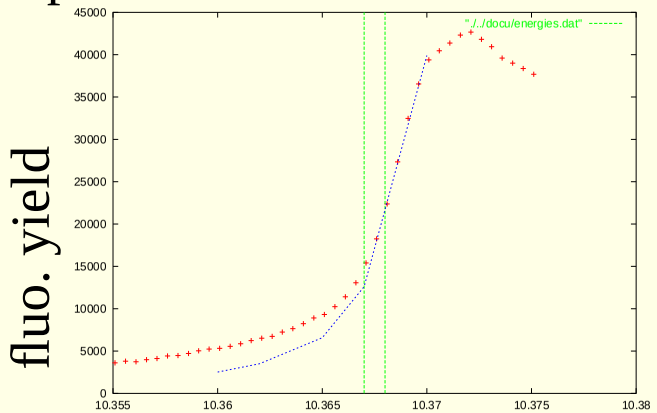
10.367keV

10.368keV



-300ps

+300ps



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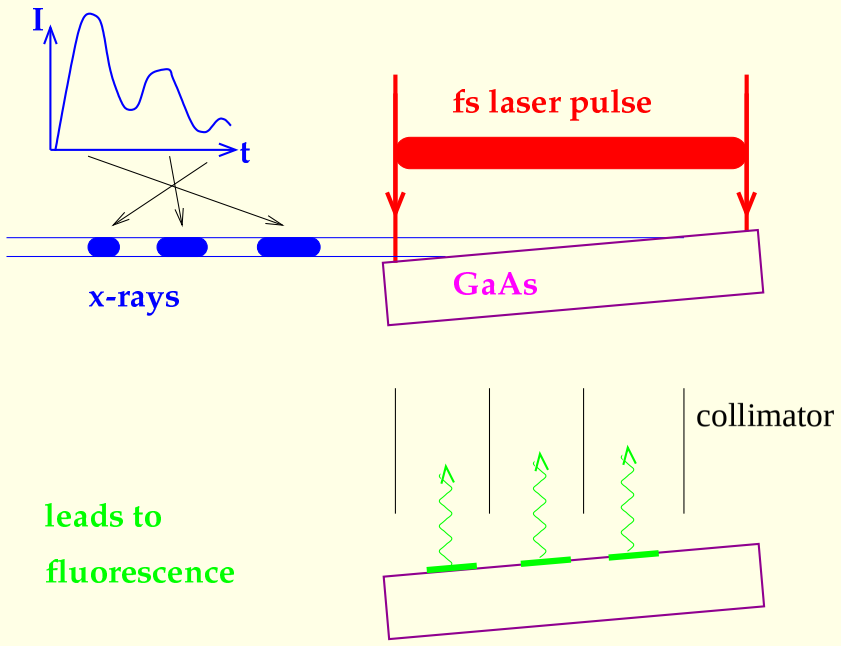
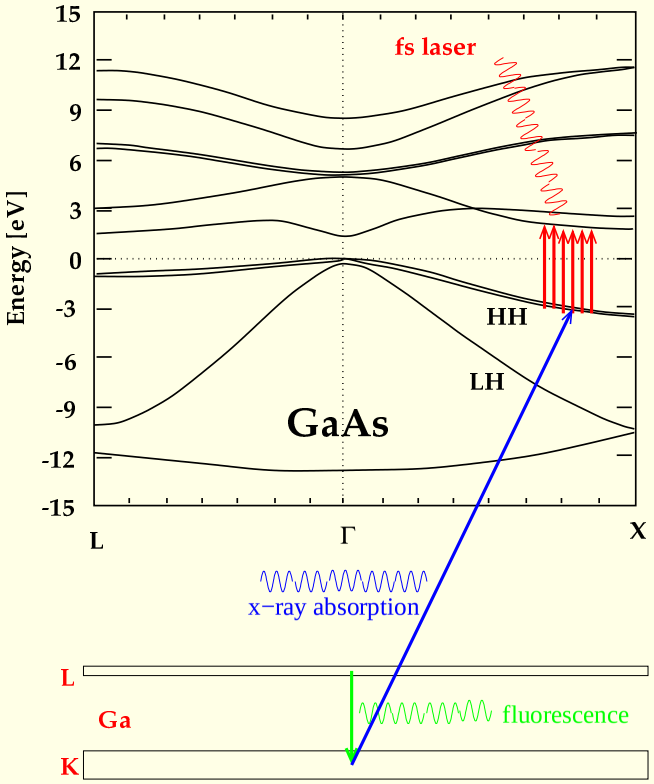
Applications: Femtosecond Timing, Spectroscopy

B.A., NIMA 459, 339 (2001)





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Summary

- Laser-pump, x-ray probe experiment on electron dynamics
- Timing issues
- Future applications: Femtosecond x-ray detector, pump-probe spectroscopy with reference energy level
- How to proceed: Improvements on electronics, fluorescence analyzer

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