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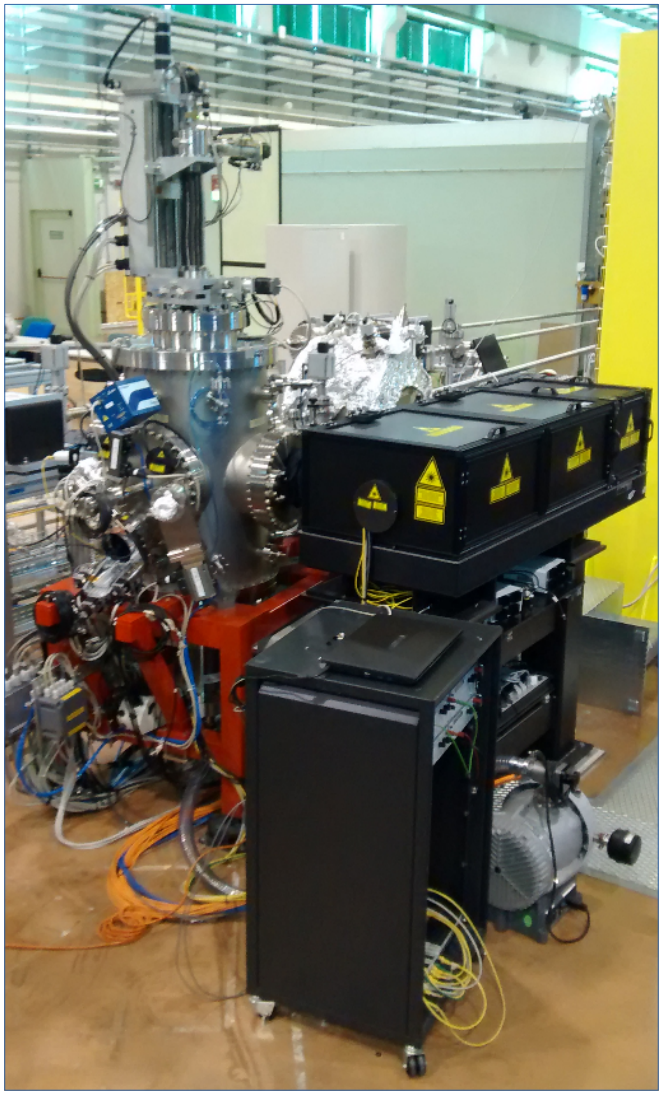
Time-resolved XAS with FELs: recent advances at FERMI

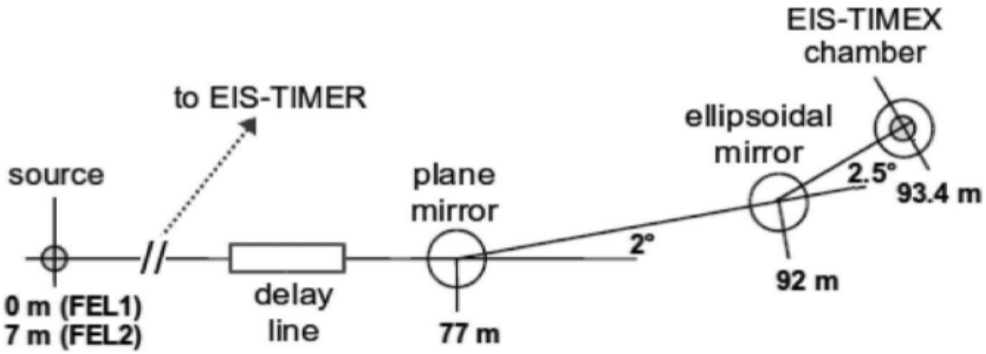
Emiliano Principi – Elettra-Sincrotrone Trieste

EIS-TIMEX beamline at FERMI



The beamline is designed for studying sub-ps dynamics in dense matter under extreme conditions

Pump-probe configuration with a FEL/laser jitter of 6 fs



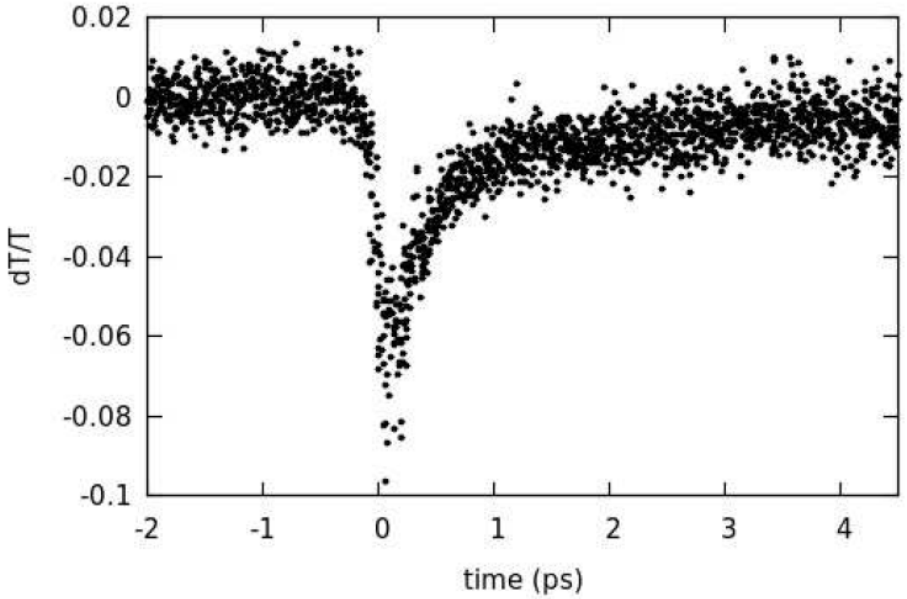
Ellipsoidal mirror

An ellipsoidal mirror focus the FEL on spots of 5 um diameter

Pump-probe setup (FEL/laser)

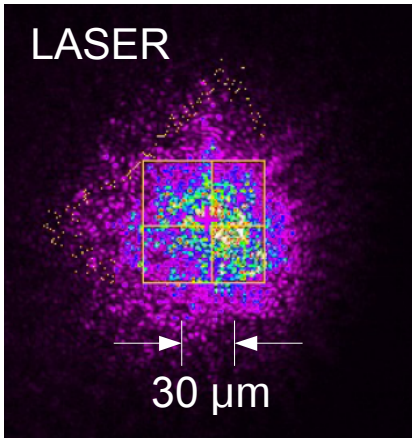
Pump-probe **longitudinal** superposition

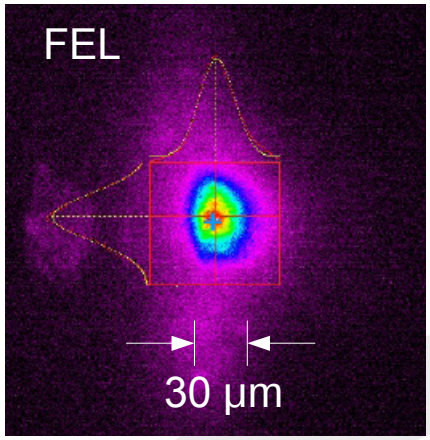
Steep VIS reflectivity change in Si_3N_4 pumped with FEL is used to find the longitudinal superposition of the pump-probe beams



Pump-probe **transversal** superposition

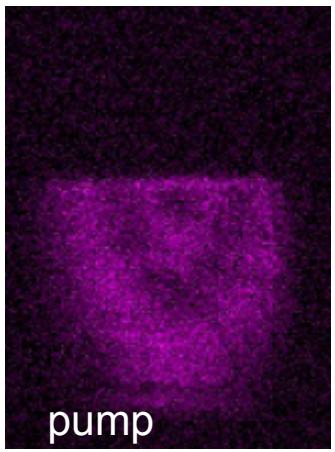
The two beams are superposed on a frosted YAG screen with an accuracy of about 10 µm.

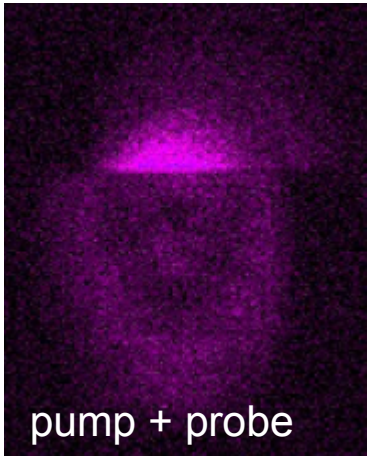




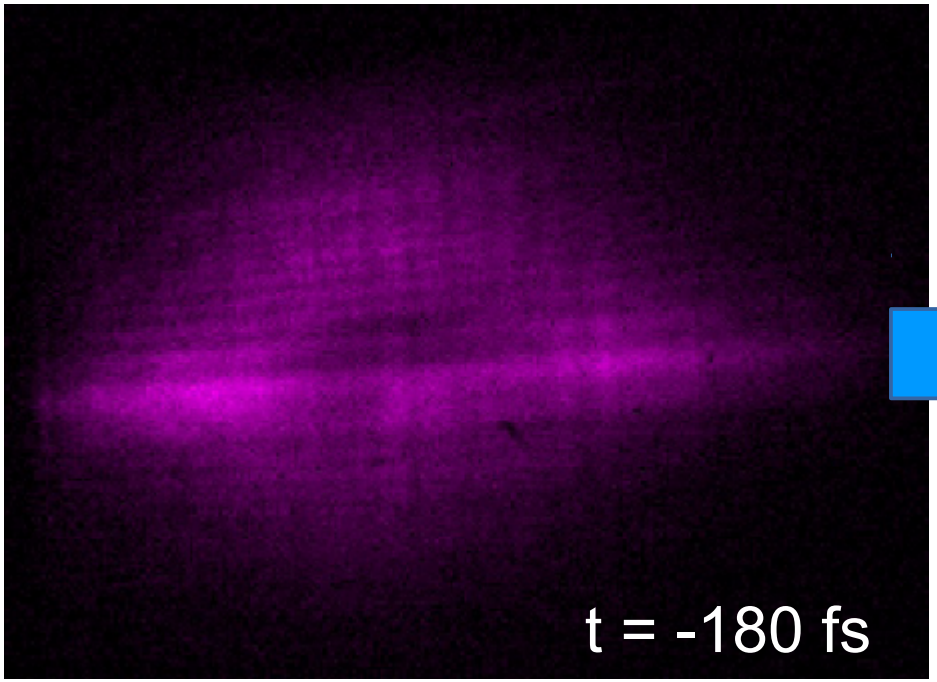
Pump-probe setup (FEL/FEL)

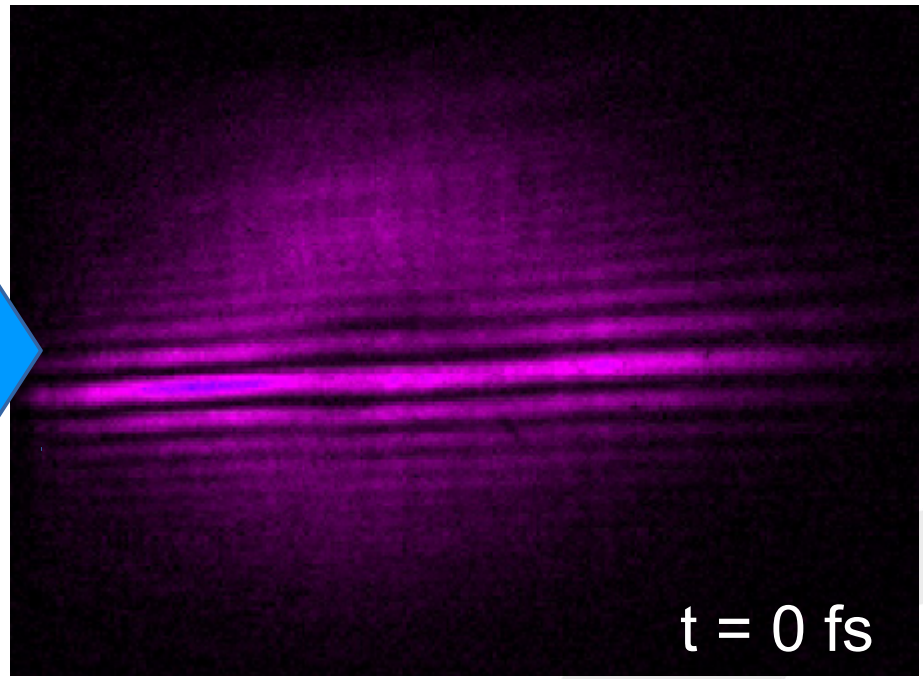
YAG screen on the beam transport after the FERMI delay line





Pump-probe longitudinal superposition
Interference fringes on a YAG screen close to the sample are used to find the longitudinal superposition of the FEL pump-probe beam





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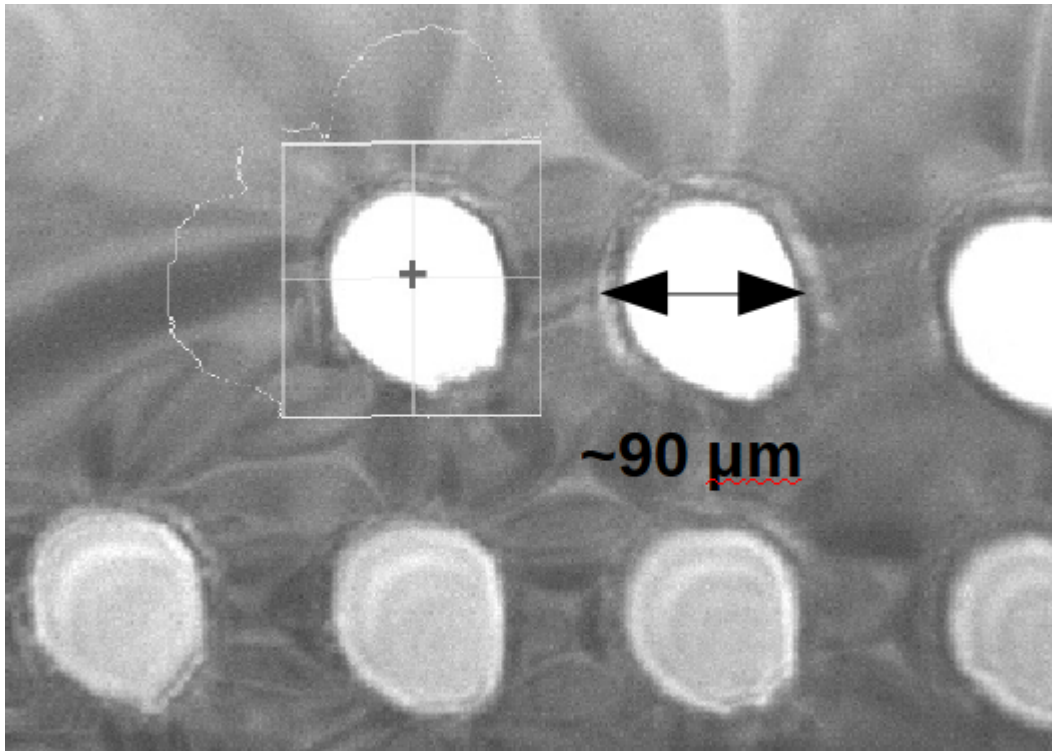
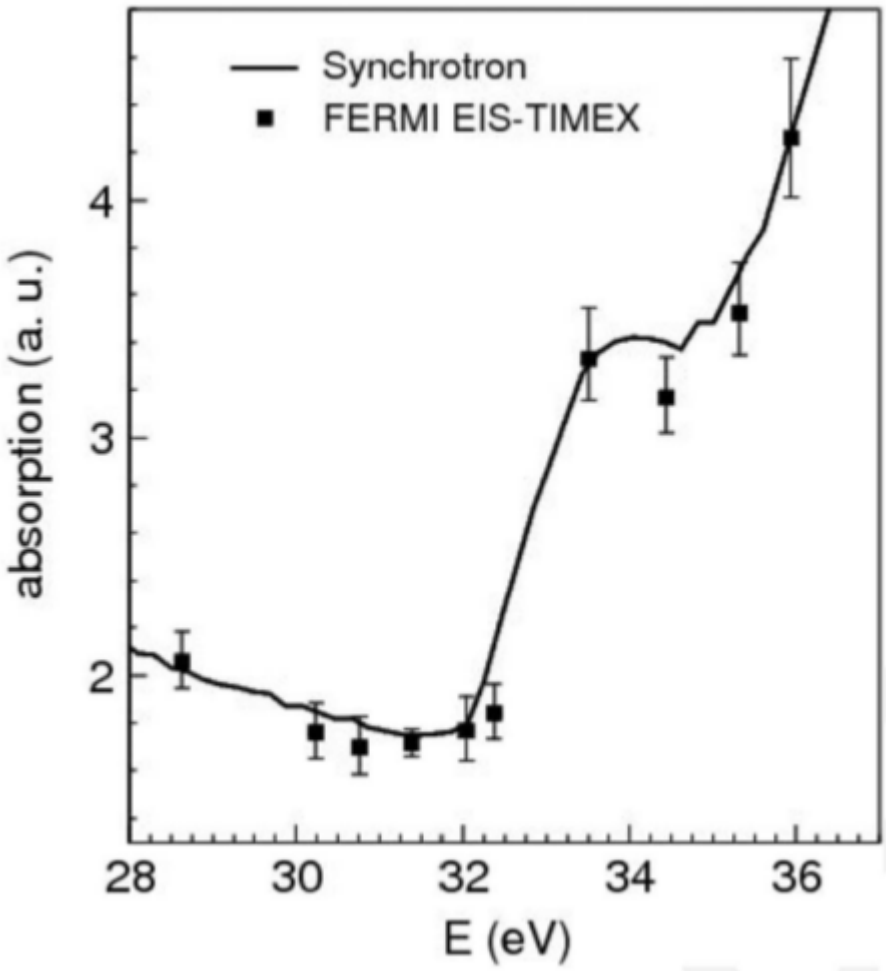
Pump-probe setup



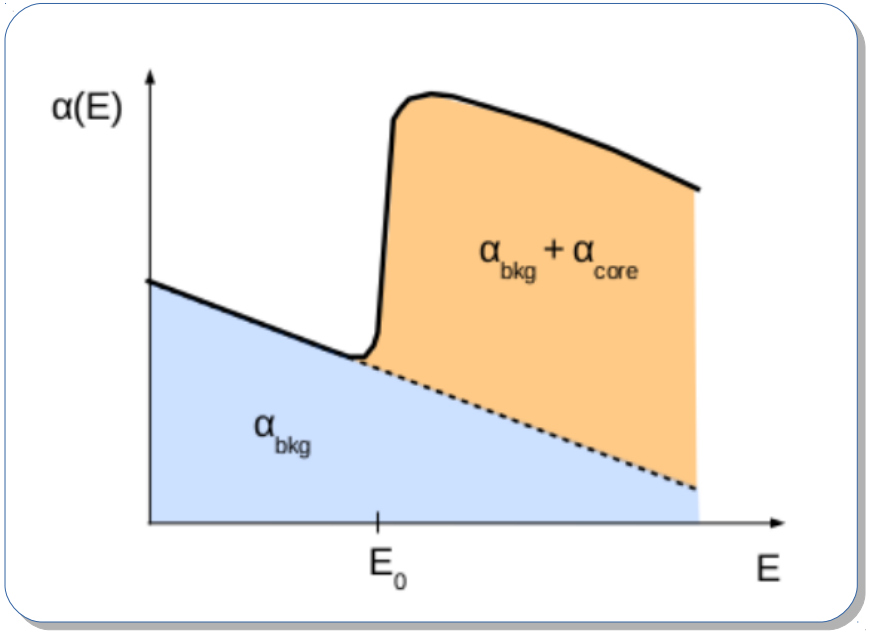
Experiments are carried out using a single-shot approach

XAS at EIS-TIMEX



M2,3-edge of Ti under ambient conditions measured at EIS-TIMEX

XAS theory



Under weak radiation field conditions, α_{core} is proportional to the transition rate between the initial state <i| and the final excited state |f>, provided by the Fermi golden rule.

Matrix element

$$\alpha_{core}(E) \propto |\langle i| H' |f\rangle|^2 \, \xi(E_f - E_i - E)$$

$$\xi(E) = \phi(E) g(E)$$

Density of empty electron states

Empty states distribution function

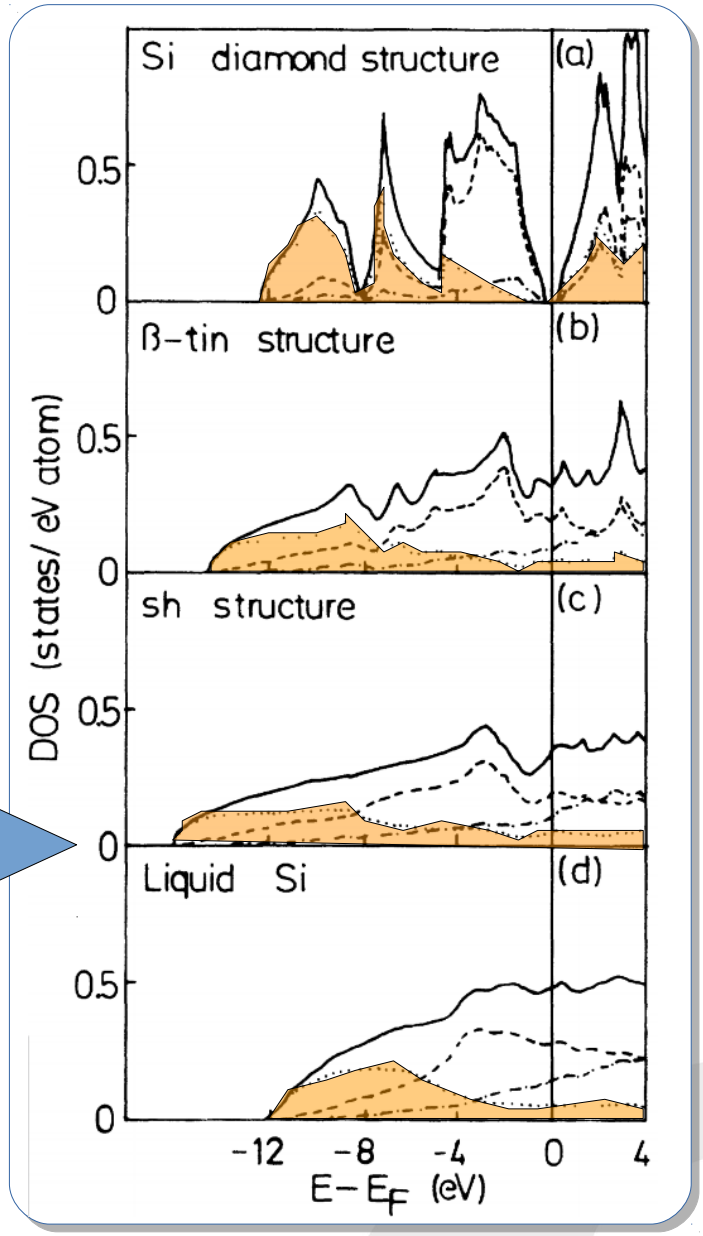
Partial DOS

Partial density of states

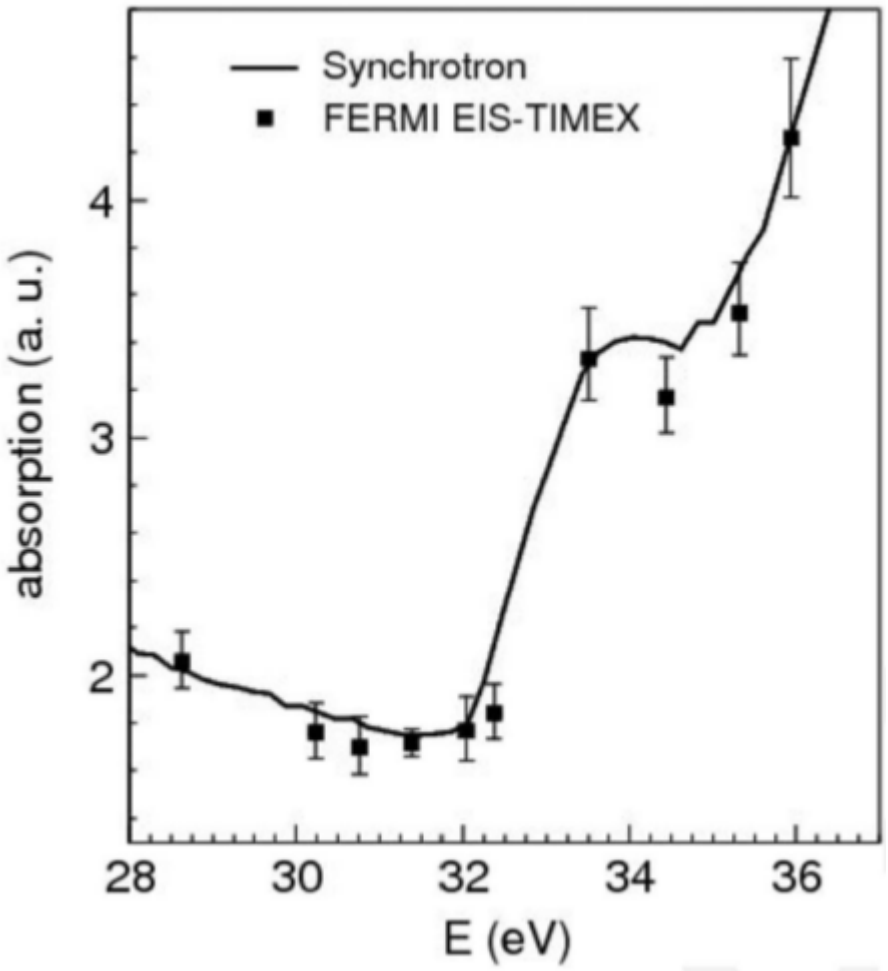
Dipole selection rules

Under the dipole approximation the matrix element is nonzero if the orbital quantum number of <i| differs by 1 from that one of |f> ($\Delta L = \pm 1$)

Absorption spectroscopy at the L2,3-edge of Si (p core electrons, L=1) provides sensitivity to the *s*-DOS and/or to the *d*-DOS (L=0, 2, respectively)



XAS at EIS-TIMEX



M2,3-edge of Ti under ambient conditions measured at EIS-TIMEX

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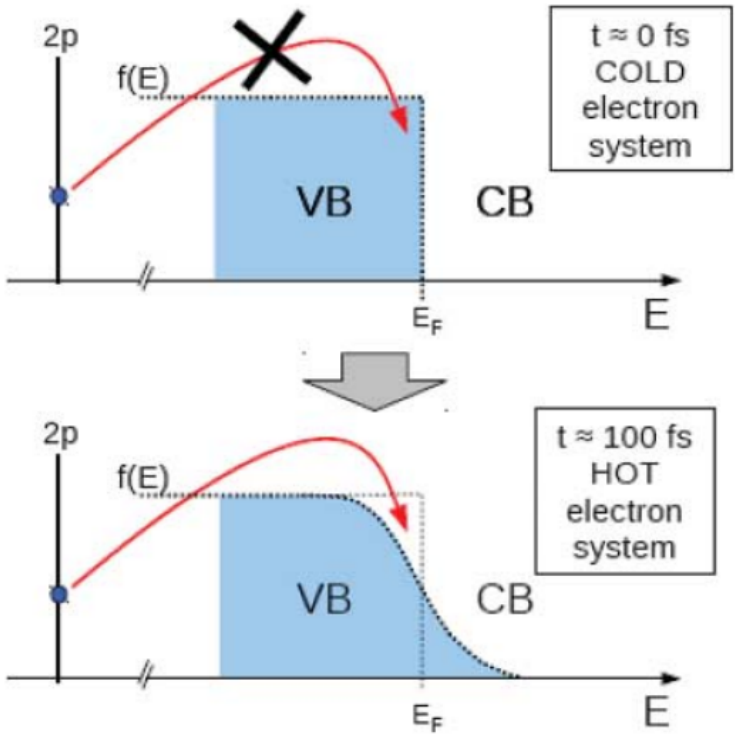
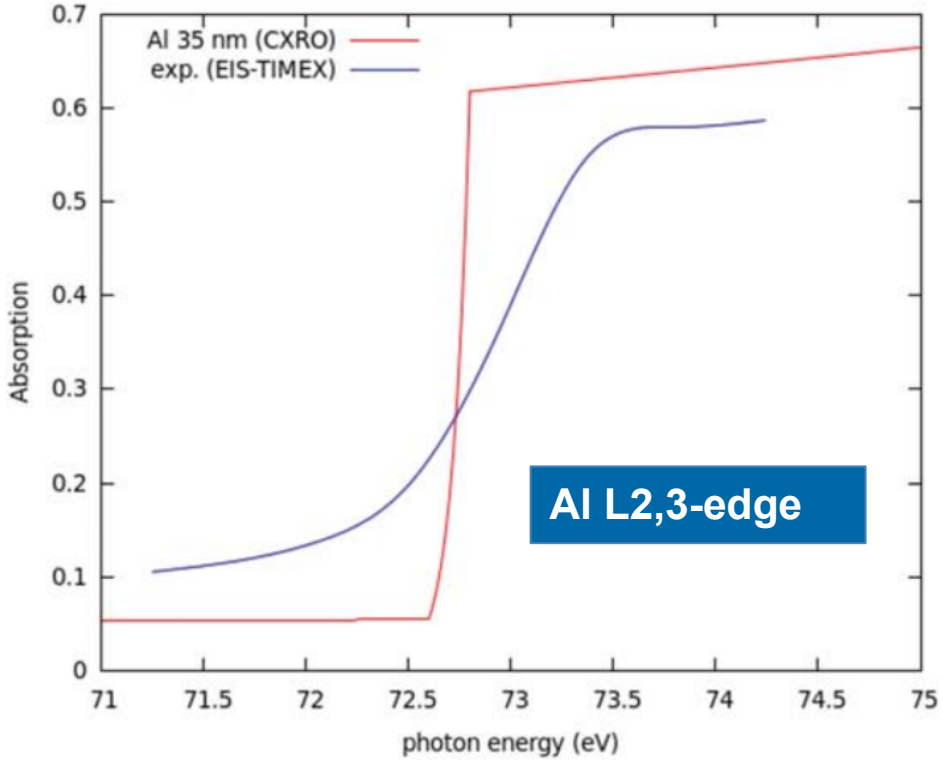
XAS on nonequilibrium samples





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