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Laser induced ultrafast electron and spin dynamics investigated by time resolved X-ray magnetic circular dichroism.

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The microscopic mechanisms responsible for IR laser induced electron and spin dynamics is among the hottest topics in modern magnetism. It is also of paramount importance at the technological point of view to increase the recording speed and densities in data storage devices. Identifying these mechanisms requires probing the spin and electron dynamics on the sub-picosecond time-scale and down to the nanometer length scales. Since the first observation of laser induced spin dynamics [1] performed by time resolved magneto-optics, the mechanisms responsible for the femtosecond demagnetization have been widely debated, but no consensus could be found. The element-selectivity and high sensitivity of time-resolved X-ray Magnetic Circular Dichroism (XMCD) at large scale facilities (synchrotron or X-ray free electron sources) provided new insights into the description of femtosecond demagnetization dynamics via magnetic, electronic and structural dynamic studies in thin magnetic layers [2 - 4]. For instance, fundamental differences between the 3d and 4f spin dynamics in 3d4f alloys have been evidenced in X-ray transmission experiments [3 - 4]. Laser fluence thresholds could be identified by single-shot magnetic resonant scattering experiments describing ultrafast electronic excitations or irreversible configurations in magnetic domains at longer time scales [5]. Recently, time-resolved and surface sensitive soft XMCD in resonant photoemission spectroscopy evidenced specific 4f spin dynamics at the surfaces of 3d4f alloys, linked to surface effects and exchange coupling in those magnetic films.

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