Femtosecond and subfemtosecond carriers dynamics in wide-band gap dielectrics.

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Observing and understanding the dynamics of carriers in photo-excited materials is a long quest motivated both by fundamental research and rapidly growing applications, specially in the domain of laser manufacturing.
In a wide band-gap material set out of equilibrium by an intense laser pulse, a large number of elementary physical mechanism occurs in a short time: non-linear photoexcitation, electron-electron collisions leading to carrier cooling in the conduction band or impact ionization, etc. Time resolved pump-probe methods are among the most appropriate tools to resolve this cascade of ultrafast dynamics, but the temporal resolution available so far is not always sufficient to separate them, especially those already beginning during the pulse.
In this presentation, I will demonstrate that a double pulse sequence can allow bypassing this difficulty, provided the laser parameters are appropriately chosen. As an example, I will report the direct observation of laser induced electronic avalanche (see the figure for the case of silica), and show that this mechanism is not universal but strongly material dependent [1].

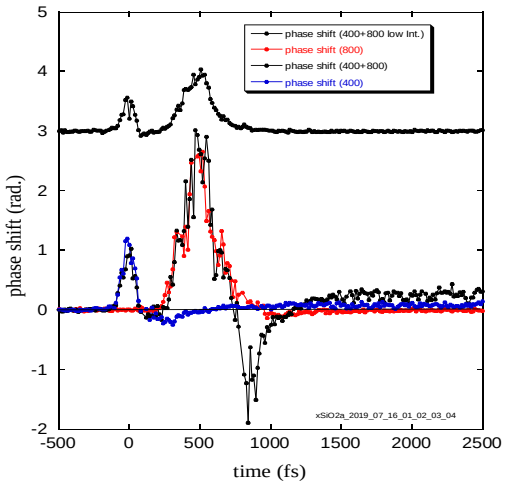

Figure 1: Phase shift measured by time resolved interferometry in silica (a-SiO_2) sample excited by a single pulse at 400nm (blue line) a single pulse at 800nm (red line) and when both pulses together (black lines). Upper curve -shifted by 3 rad.- at low intensity, only positive phase shift due to Kerr effect is observed. Lower curve: at higher intensity, after positive phase shift due to Kerr effect, negative phase shift due to free carriers appears. The strong increase of – negative -signal when both pulse are applied is due to laser induced electronic avalanche .

More recently, we have developed a new experimental setup aiming to measure reflectivity change in the VUV domain using high order harmonic generation. Our results demonstrate that interferometric stability is achieved, opening the way to attosecond resolution. A first set of measurements concerning MgO will be shown.

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Reference: [1] S. Guizard, A. Bildé, S. Klimentov, A. Mouskeftaras, under press.