

## Time-resolved X-ray spectroscopy: towards sub-femtosecond resolution

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X-rays with sub-femtosecond duration are a key tool for future ultrafast probes of matter. The challenge is not only to generate photon pulses of this ultrashort duration but also to develop measurement methodologies that enable the high temporal resolution even in condensed phase systems. X-ray spectroscopy is a promising route that we are investigating using both HHG based and XFEL based sources. I will discuss our recent work on using HHG driven by 800 nm and 1800 nm CEP stable few cycle sources to generate sub-femtosecond pulses from the VUV (20 eV)[1] to the SXR (600 eV)[2], and measurements that have so far been undertaken with these sources[3][4]. This will be compared with recent work at the LCLS that we have undertaken to develop ultrafast X-ray measurement methods[5][6].

[1] D.Fabris et al, Nature Photonics, 9, 383 (2015).

[2] A.S.Johnson et al. Science Advances, 4, 3761 (2018).

[3] A.S.Johnson et al, Structural Dynamics, 3, 062603 (2016).

[4] T.Barrilot et al, Chemical Physics Letters, 683 38 (2017).

[5] C.E.Liekhaus-Schmaltz et al, Nature Communications, 6, 8199 (2015).

[6] A.Sanchez-Gonzalez et al, Nature Communications, 8, 15461 (2017).

**Presenter:** Prof. MARANGOS, Jon (Imperial College London)