

# Determination of pulse duration and pulse arrival time at X-ray free-electron lasers

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Advent of the 4<sup>th</sup> generation pulsed X-ray sources, X-ray free-electron lasers (XFELs), enabled studies on the structure of matter not achievable before [1]. XFELs emit X-ray radiation in the process called *self-amplified spontaneous emission* (SASE) dependent on phenomena of a random nature causing a significant instability of the emitted radiation beam. The stochasticity of SASE makes it necessary to monitor different parameters of each XFEL pulse, which requires the development of apparatus for energetic and temporal characterization of photon pulses [2], as well as fundamental research on the interaction of X-rays with matter at the sub-fs time scale. In this presentation I will introduce the methods of temporal XFEL pulse characterization. The currently developed approaches: *spectral* [3] and *spatial encoding* [4] allow measurement of pulse arrival time and pulse duration at the sub-10 fs resolution. The so called *THz streaking* technique enables further determination of temporal distribution of the pulse intensity [5], bringing a new asset into X-ray science.

## References

- [1] B. W. J. McNeil, N. R. Thompson, *Nature Photonics* **4**, 814 (2010).
- [2] W. Helml *et al.*, *Applied Sciences* **7**, 915 (2017).
- [3] M. R. Bionta *et al.*, *Opt. Express* **19**, 21855 (2011).
- [4] T. Maltezopoulos *et al.*, *New J. Phys.* **10**, 033026 (2008).
- [5] I. Grguraš *et al.*, *Nature Photonics* **6**, 852 (2012).