

Photonic time-stretch: A technique for single-shot acquisition of THz signals at high repetition rate and high sensitivity

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We present a strategy that enables THz signals to be recorded in single-shot, and high repetition rate. This work has been motivated by the needs to monitor THz radiation pulse shapes and electron bunch shapes in accelerator facilities. The principle consists to imprint the THz pulses to be investigated onto the shape of laser pulses (i.e., performing Electro-Optic Sampling, EOS [1]), and then to stretch the laser pulses in time, up to the nanosecond range, using a long fiber (i.e., performing photonic time stretch [2]). The resulting laser pulses are “replica” of the THz pulse, that are magnified in time, and can be straightforwardly recorded using a single photodetector and an oscilloscope.

We present recent developments of this technique, with the objective to achieve high acquisition rates (up to 88 Mega traces/s) and/or high sensitivity (few V/cm). We also present recent results concerning measurements of THz coherent synchrotron radiation at Synchrotron SOLEIL [3,4,5].

References

- [1] Jiang, Zhiping, and X-C. Zhang. "Electro-optic measurement of THz field pulses with a chirped optical beam." *Applied Physics Letters* 72.16 (1998): 1945-1947.
- [2] Coppinger, F., A. S. Bhushan, and B. Jalali. "Photonic time stretch and its application to analog-to-digital conversion." *IEEE Transactions on microwave theory and techniques* 47.7 (1999): 1309-1314.
- [3] Roussel, E., et al. "Observing microscopic structures of a relativistic object using a time-stretch strategy." *Scientific reports* 10330,.5 (2015).
- [4] Szwaj, Christophe, et al. "High sensitivity photonic time-stretch electro-optic sampling of terahertz pulses." *Review of Scientific Instruments* 87.10 (2016): 103111.
- [5] Evain, C., et al. "Direct observation of spatio-temporal dynamics of short electron bunches in storage rings." *Phys. Rev. Lett.* **118**, 054801 (2017).