**Abstract**

In accelerator-based light sources, there is a growing need for high repetition rate, single-shot, characterization of electron bunch shapes and THz pulses. At moderate repetition rate, an efficient strategy consists in encoding the ultrafast information onto a laser pulse, which is subsequently analyzed (electro-optic sampling). However, these methods usually require cameras as the final detector, which represents a bottleneck in the quest for high-repetition rates. A promising candidate for breaking this “high repetition rate barrier” is the so-called photonic time-stretch technique. In this poster, we present the first results obtained with time-stretch in the accelerator context: Electro-optic sampling of successive terahertz bursts of coherent synchrotron radiation at SOLEIL[1], with 88 MHz acquisition rate (and picosecond resolution). In practice, the time-stretch is potentially realizable as a relatively simple upgrade of existing setups (provided it is possible to imprint the ultrafast signal on chirped laser pulses). Finally we also present a performance analysis, including a comparative study of standard and time-stretched electro-optic sampling setups.

**General principle of the experiment**

- Relativistic electron bunch with microstructures at ps scale
- Revolution frequency: 0.84 MHz
- Detection strategy: to “slow-down” the information at the ns scale, and to use conventional oscilloscope for recording

**Time-Stretch Spectrally Encoded Electro-Optic Detection (TS-EOSD)**

**Spectral encoding**

\[ |T(\nu)|^2 \propto |\delta(\nu - \nu_0)|^2 \]

**Time stretching**

\[ T(\nu) = \frac{M - \nu}{\nu_0} \]

**Experimental results**

- Single-shot recordings of 3 successive turns in the storage ring (i.e. one shot every 1 µs). Upper scale: time scale at the oscilloscope input. Lower scale: real time of the phenomenon.
- Fiber lengths: \( L_1 = 10.5 \) m, \( L_2 = 2 \) km
- \( M = 1 + L_2/L_1 = 190.0 \)

**Conclusion**

We presented a novel strategy for recording short pulses in the ps, sub-ps range. The time-stretch spectrally encoded electro-optic detection (TS-EOSD) allows single-shot, high-acquisition-rate and high-sensitive detection of CSR pulse shapes. We apply the TS-EOSD setup to the direct real-time monitoring of THz CSR pulses emitted during the microbunching instability at Synchrotron SOLEIL. The transfer of this photonic technique to accelerator physics can be effective in other situations than THz CSR that require high acquisition rate single-shot measurements.

**Comparison between TS-EOSD and EOSD**

**Time-Stretch-EOSD**: use dispersion in fiber

**Classical EOSD**: use of spectrometer

**Detection strategy**

- EO effect in GaP crystal
- Balanced detected signal
- Wavelength-to-time mapping and Trade-off between acquisition rate and stretch factor
- Penalty dispersion → limited bandwidth

**References**