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Experimental design challenges for single-shot electro-optical measurements of electron bunch shapes at high repetition rates

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DESY and PhLAM are developing electro-optical measurements systems aiming at single-shot operation and high (MHz+) acquisition rates to characterize electron bunch shapes of short wavelength FELs as well as the temporal properties of pulsed THz sources. We review here the design strategies developed at DESY, and that allow the latest high-resolution measurements strategy based on diversity techniques DEOS to be implemented. The basic principle relies on the well-known spectral decoding technique, where the electric field of interest modulates a chirped laser pulse, whose optical spectrum is eventually recorded. However the actual performance of such electro-optic monitors crucially relies on key points of the design, in particular the management of optical signals with small polarization ellipticity, temporal interleaving, and the performance of fast (MHz+) readout cameras. This paper will outline design rules, challenges and solutions, that enable the implementation of DEOS in an effective manner at FLASH and the European XFEL as well as at other THz sources.

Footnotes

[*] Phase Diversity Electro-optic Sampling: A new approach to single-shot terahertz waveform recording, E. Roussel et al., Light: Science & Applications, 11, 14 (2022)

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