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Ultimate Pulse-to-Pulse Stability in Non-Linear Bunch Compressors

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Recent advances in bunch compression and FEL schemes have enabled ultrashort sub-fs electron and X-ray pulses. The timing jitter is, at best, one order of magnitude larger that the pulse duration. This can be handled by high precision pump-probe delay measurements and data sorting. However, only a small fraction of the pulses will be in the relevant time window.

The acceleration and compression in non-linear achromat bunch compressors enables cancellation of the energy and timing jitter caused by modulator high voltage (HV) ripple.
The cancellation works at a specific off-crest acceleration phase, the so-called magic angle.
We present experimental data showing the current performance at the MAX IV linac, and the benefit of operating at the magic angle.

Another major contribution to energy and arrival time jitter is lasers, both for the electron guns and the experiment, and how they are synchronized to the reference RF field. The RF distribution can either be optical or electrical.
By extracting the reference RF directly from the gun laser, we have eliminated the relative jitter between the gun laser pulses and the reference field. We show data of the improved performance in our optical master oscillator scheme.
A full synchronization system that includes the experimental lasers is under development.
Our current plan is to base the synchronization system on a continuous wave reference laser to take advantage of the high frequency of optical waves, instead of relying on the envelope of pulsed lasers.

Combining acceleration at or around the magic angle with the high-precision synchronization system we aim at a timing jitter on the order of 1 fs at the end of the linac.

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Yes

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