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Few-femtosecond synchronisation at EuXFEL and FLASH

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We report latest advancements in achieving drift-free, single-digit femtosecond synchronisation at the free-electron laser (FEL) facilities European XFEL and FLASH. Achieving this level of facility-wide stabilisation, and ultimately enabling femtosecond temporal resolution in user experiments at the scientific instruments necessitates not only tight synchronisation of optical lasers (e.g., pump-probe, photoinjector) but also the linear accelerator (linac) itself through LLRF reference control and active feedback on electron bunch arrival time, which, in turn, determines the X-ray photon pulse arrival time. Moreover, we have implemented novel optical laser pulse arrival time monitors for the compensation of drift at the interaction points of the experiments caused by laser pulse amplification, transportation, and manipulation. The entire synchronisation system, based on the distribution of an ultra-stable optical reference signal on an actively stabilised network of optical fibres, has not only been benchmarked independently, but additionally including the linac, and finally pump-probe experiments. Furthermore, the influence of natural and civilisation-induced seismic activities on the synchronisation performance has also been evaluated. Based on our findings, developments for sub-femtosecond synchronisation got under way for future utilisation of the accelerator's capabilities.

I plan to submit also conference proceedings

Yes

Author: SCHULZ, Sebastian (Deutsches Elektronen-Synchrotron)**Co-authors:** CALENDRON, Anne-Laure (MSK (Strahlkontrollen)); CZWALINNA, Marie Kristin (DESY, MSK); FELBER, Matthias (MSK (Strahlkontrollen)); GRUENHAGEN, Arne (MSK (Strahlkontrollen)); KOZAK, Tomasz (DESY - Deutsches Elektronen-Synchrotron); KSCHUEV, Nick (MSK (Strahlkontrollen)); LAMB, Thorsten (MSK (Strahlkontrollen)); LAUTENSCHLAGER, Bjoern (MSK (Strahlkontrollen)); LUDWIG, Frank (MSK (Strahlkontrollen)); SCHMIDT, Christian (MSK (Strahlkontrollen)); SCHWICKERT, David (MSK (Strahlkontrollen)); SCHUETTE, Maximilian (MSK (Strahlkontrollen)); ZUMMACK, Falco (MSK (Strahlkontrollen)); Dr SCHLARB, Holger (DESY)**Presenter:** SCHULZ, Sebastian (Deutsches Elektronen-Synchrotron)**Session Classification:** Mikrosymposium 12/2: Time Resolved Techniques**Track Classification:** 12. Time resolved techniques