Contribution ID: **93** Type: **Poster**

Simulation studies of producing attosecond-terawatt X-ray FEL pulses using irregularly spaced current peaks at SwissFEL

We present simulation results of a scheme to generate high-power and short FEL pulses using an electron beam with irregularly spaced current peaks. Such an electron beam produces a train of short pulses with low power in the first undulator section. In the next sections, the electron beam is delayed in a way that only one of the short pulses is continuously amplified to a very high power. The irregular spacing of the current peaks is obtained by using the ESASE mechanism, where the electron beam is modulated with a chirped optical laser and later compressed in a magnetic chicane. In comparison to previous proposals, we suggest to use a chirped electron beam to reduce the requirements on the optical laser chirp, and to transversely tilt the electron beam to select the number of current peaks able to lase for best final performance. The simulations are done for the soft X-ray beamline of SwissFEL, Athos, which has small magnetic chicanes placed within the undulator line suitable to delay the electron beam between the different amplification stages. Our simulation results show that soft X-ray FEL pulses with TW peaks power and hundreds of attoseconds pulse durations can be achieved in SwissFEL.

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Session Classification: Poster