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High repetition rate and coherent Free-Electron Laser in the X-rays range tailored for linear spectroscopy

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Fine time-resolved analysis of matter - i.e. spectroscopy and photon scattering - in the linear response regime requires fs-scale pulsed, high repetition rate, fully coherent X-ray sources. A seeded FEL driven by a Linac based on Super Conducting cavities, generating 10^8 - 10^{10} coherent photons at 2-5 keV with 0.2-1 MHz of repetition rate, can address this need. Three different seeding schemes, reaching the X-ray range. are described hereafter.

The first two are multi-stage cascades upshifting the radiation frequency by a factor 10-30 starting from a seed represented by a coherent flash of extreme ultraviolet light. This radiation can be provided either by the High Harmonic Generation of an optical laser or by a FEL Oscillator operating at 12-14 nm. The third scheme is a regenerative amplifier working with X-ray mirrors. The whole chain of the X-ray generation is here described by means of start-to-end simulations.

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