

Contribution ID: 315

Type: talk

Challenges and tolerances for a compact and hybrid ultrafast X-ray pulse source based on RF and THz technologies

Wednesday, 18 September 2019 18:40 (20 minutes)

A hybrid concept for an Inverse Compton Scattering (ICS) based compact ultrafast X-ray pulse source, relying on the combination of a conventional S-band electron gun with a dielectric-loaded waveguide driven by a multicycle THz pulse (THz linac), is under investigation by the authors. The target of this hybrid concept is to generate pC-class ultrashort electron bunches (\leq 1 fs rms), at moderate energies (15 to 20 MeV) and focused to a transverse size below 10 µm rms while keeping a compact beamline (\leq 2 m). This contribution first presents the optimization of the concept through beam dynamics simulations and the simulation of the properties of the X-rays generated via ICS. The main part is then dedicated to two aspects. First, a description of the main technical requirements for the concept and the associated challenges is given. Finally, a tolerance study deals with the influence of various jitters and beamline imperfections on the achievable electron bunch properties.

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Session Classification: WG3 - Thz acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures