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## Spectrometer-Based X-Ray Free-Electron Laser Pulse Duration Measurements of Chirped Beams

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Accurate measurements of the x-ray pulse duration produced by x-ray free-electron lasers (XFELs) typically rely on longitudinal electron beam phase space diagnostics, e.g. in a transverse deflecting cavity or TCAV, or from measurements of spectral correlations. All of the known spectral methods share the weakness that they will underestimate the pulse length in the case that the FEL spectrum is broadened due to the electron beam having an energy chirp. We present a statistical analysis of FEL radiation in the presence of a linear electron beam energy chirp which extends previous results by including an accurate description of the FEL gain process. In doing so, we show that with measurements of the spectral intensity correlations and the average spectrum, one can reconstruct the x-ray pulse length, e-beam chirp, and spectrometer resolution. Our approach is validated by comparison with 1D FEL simulations.

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Yes

**Primary author:** ROBLES, River (SLAC National Accelerator Laboratory and Stanford University)**Co-authors:** CESAR, David (SLAC National Accelerator Laboratory); LUTMAN, Alberto (SLAC National Accelerator Laboratory); Mr HALAVANAU, Aliaksei (SLAC National Accelerator Laboratory); STUPAKOV, Gennady (SLAC National Accelerator Laboratory)**Presenter:** ROBLES, River (SLAC National Accelerator Laboratory and Stanford University)**Session Classification:** Monday posters**Track Classification:** FEL Theory