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Controlling electron-beam emittance partitioning for future X-Ray light sources NIKOLAI YAMPOLSKY, BRUCE CARLSTEN, KIP BISHOFBERGER, LEANNE DUFFY, STEVEN RUSSELL, LANL, ROBERT RYNE, LBNL — Future hard X-ray free electron lasers (FEL) producing photons with energies significantly higher than 10 keV require electron beams having high transverse brightness. Typically, the constraints on the transverse beam emittance are much more stringent than limitations on the longitudinal beam emittance. Currently used photoinjectors produce electron beams having the same order of magnitude longitudinal and transverse emittances. Even though, the 6-D phase volume of such a beam can be smaller than what is required for FEL lasing, the partitioning between different emittances is not optimal. Poor overlap between radiation and electron phase spaces reduces FEL efficiency and even suppresses lasing. The quality of the electron beam can be described by three eigen-emittances which remain constant under linear beam optics transforms. Manipulating the beam cross-correlations at the photocathode surface allows one to affect partitioning between eigen-emittances. Once the cross-correlations are removed downstream, the eigen-emittances become the actual beam emittances. Therefore, the eigen-emittance partitioning can be used to generate extraordinarily transversely bright electron beams. We demonstrate that transverse-axial emittance partitioning can be performed using the generalized concept of the flat-beam transform.

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