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Coupled Simulations of Collimator Irradiation in Fourth Generation Light Sources

Wednesday, 2 October 2024 17:00 (20 minutes)

Fourth-generation synchrotron light sources enable orders-of-magnitude increases in beam brightness and corresponding X-ray source flux. Operating these machines at such high energy densities necessitates improvements in machine protection systems, as equipment failures may trigger beam aborts capable of depositing significant energy in collimators and beam dumps. We present a code coupling methodology capable of estimating the deposition and response of collimator materials under irradiation of high-intensity electron beams. Our approach integrates particle dynamics modeling via elegant, particle-matter interaction via FLUKA, and hydrodynamic evolution of collimator material via FLASH. Careful arrangement and iteration between these three codes enables self-consistent modeling of the beam and structure response during simulated beam aborts. We apply these tools to the study of the APS-U storage ring, leveraging recent experiments with the APS to inform collimator material state characterization and response. We discuss the role of material response and phase change in determining the loss-characteristics of the beam and present comparisons of these simulations under different machine operating conditions and material response models. We also discuss efforts to enhance modeling efficacy and next steps in expanding the physics capabilities of our models.

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