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Energy deposition in Candidate Materials for the Whole-Beam Dumps for the Advanced Photon Source Upgrade

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The APS-U will generate high-brightness x-rays using small, intense, 6-GeV electron beams with transverse dimensions of 0.010-0.015 mm, rms. Full beam aborts in the APS-U storage ring will sometimes be required for machine and personnel protection. These involve removing power from the accelerating cavities, which allows the beam to spiral in until it hits a whole beam dump (WBD). Simulations with MARS show that any solid material subject to a full beam abort (720 nC, 6 GeV) will be damaged and pushed into a hydrodynamic regime (>15 MGy). As a result, the WBD must be re-positioned after each full beam abort to expose new surface. Aside from choosing the appropriate material, an understanding of how the material behaves during the beam abort is required both for personnel and machine protection. A significant change to the WBD density during a beam abort will modify its ability to absorb energy during the later stages of the loss event. As examples, we evaluate the dose in four candidate materials: aluminum, titanium alloy, copper, and tungsten. We show that static simulations coupled with simple back-of-the-envelope calculations strongly suggest the generation of shocks in high-density, high-Z materials, likely making them unsuitable for the WBD. The need to couple a hydrodynamics code with the static dose simulation is discussed.

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