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Substrate material studies for PCB-based electro-optical bunch arrival-time monitors for XFELs

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The all-optical synchronization system used in many X-ray free-electron laser facilities (XFELs) relies on electro-optical bunch arrival-time monitors (EO-BAM) for measuring the single bunch arrival-time with regards to an optical reference. An upgrade of the established EO-BAM is intended to achieve a sensitivity that enables stable operation with bunches down to charges of 1 pC or significantly increase the resolution in normal operation. Therefore, the pickup structure, the RF path and the electro-optical modulators are undergoing a fundamental redesign. The novel concept of the pickup structure comprises planar pickups on a printed circuit board (PCB) with integrated combination network and a bandwidth of up to 100 GHz. The theoretical jitter charge product of the preliminary concept has been estimated to be in the order of 9 fs pC and the concept was proven experimentally with a 67-GHz demonstrator at ELBE. In this contribution, we compare ceramic and glass substrates in terms of radiation hardness, sensitivity, and manufacturing capabilities. The achievable bandwidth and sensitivity are influenced by material losses and varying tolerances due to different fabrication methods.

Footnotes

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