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TEOBAM –Innovative mmW pickup structures: Development of an ultra-low-charge BAM pickup geometry for fC operation modes

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Operating high-gain FELs with ultra-low bunch charges around 1pC or even less enables the generation of ultra-short, coherent pulses with significantly higher brightness, opening the path to explore processes at attosecond timescales [1,2]. Similar requirements exist for next-generation ultrafast electron diffraction (UED), which demands sub-pC bunches and arrival-time monitoring with single-digit femtosecond precision. Bunch arrival-time monitors (BAMs) based on electro-optical (EO) methods are already established at facilities such as FLASH, EuXFEL, ELBE, SwissFEL, and others [3-5]. They provide quasi non-invasive measurements relative to a sub-fs synchronized laser pulse, reaching 3.5 fs resolution for 250 pC bunches at EuXFEL [6]. However, adapting these systems for low-charge operation is necessary, since sensitivity strongly depends on bunch charge [7]. A previous project (05K19RO1) developed new broadband pickup structures exceeding 100 GHz bandwidth, showing promising results [8,9]. These concepts were further validated as a demonstrator at ELBE [10,11]. The proposed work aims to realize Mach-Zehnder-type EOMs and pickup structures with integrated networks to achieve sub-10 fs resolution for sub 1 pC bunches. Prototypes will be tested at facilities such as REGAE (DESY), FLUTE (KIT), ELBE (HZDR) to enable applications at EuXFEL, FLASH, and future FEL facilities.

References

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Speed talk:

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