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Beam Dynamics Simulation of a High Brightness, High Repetition Rate RF C-band Photoinjector for Future EuPRAXIA@SPARC_LAB Upgrade

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High-brightness RF photo-injectors are crucial for generating high peak current and low transverse emittance electron beams, which are necessary for driving plasma Wake-field acceleration in advanced accelerator concepts and novel radiation sources. To enhance the EuPRAXIA@SPARC_LAB photo-injector for future upgrades, it is essential to investigate and assess the feasibility of achieving higher charge and multi-bunch working points, commonly referred to as the "comb configuration" for particle-driven Wake-field acceleration. A solution to reduce the photo-injector's footprint while preserving beam quality and brightness is to implement a C-band injector operating at 5.712 GHz. Evaluating the possibility of achieving a working point within the velocity bunching acceleration scheme is critical, as this will determine the degree of compression achievable with a full C-band injector. Start-to-end beam dynamics simulations will be conducted to identify the optimum configuration for the C-band photo-injector dedicated to particle-driven plasma-based acceleration.

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