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High gradient ultra-high brightness C-band photoinjector

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Recent studies and investigations show the possibility to increase the cathode peak field, using normal conducting structures with a reduced RF pulse duration or using copper structures operated at cryogenic temperatures. In this context we studied the beam dynamics advantages using a 1.6 cells C-band gun operated at the gradient of 240 MV/m, in order to set the photo-injector layout for the XLS design study. The higher gradient combined with a shorter RF gun structure, pushes the beam to a relativistic energies faster and in less space compared to the 1.6 cells S-band case operated at 120 MV/m. In order to use only one frequency in the entire injector and to save longitudinal space, we used in the simulations two TW C-band structures operated at the accelerating gradient of 40 MV/m. Scaling the beam parameters from the S-band scenario and re-optimizing the solenoid magnetic field and all the device positions, it is possible to increase the beam brightness at least of an order of magnitude. The beam exiting the C-band gun completely match the requests of the XLS design study, also saving a factor two in the longitudinal photo-injector size compared to the S-band scenario.

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