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RF injector design studies for the witness beam for a plasma-based user facility

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The interest in plasma-based accelerators as pilot of user facilities is growing worldwide thanks to its compactness and reduced costs. The most demanding user application, as the operation of an X-ray FEL, requires ultra-high brightness electron beams in the GeV energy range. Intense beam dynamics studies have been performed to provide a reliable working point for the EuPRAXIA injector aiming to drive a witness bunch suitable for external injection schemes, both in particle beam and laser driven plasma wakefield acceleration. A case of interest foresees a 1 GeV witness beam energy with less than 1mm.mrad slice emittance and 30pC in 10 fs fwhm, which turns into 3kA peak current at the undulator entrance. The witness beam has been successfully compressed down to 10fs in a conventional SPARC-like photoinjector and boosted up to 500 MeV in an advanced high-gradient X-band linac reaching the plasma entrance with 3 kA peak current, 0.07% energy spread, 0.5 mm.mrad transverse normalised emittance and a focal spot down to 1 μm. RF injector studies are here reported with the aim to satisfy the EuPRAXIA requests for the Design Study of a plasma-based user facility.

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