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The plasma injector for Petra IV: Conceptual Design Report

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We present the conceptual design of an alternative injector system based on laser-plasma accelerator technology, aimed at delivering high-quality electron bunches to PETRA IV—the upcoming 4th-generation synchrotron light source at DESY. The proposed design features a laser-plasma accelerator capable of producing 6 GeV electron bunches with state-of-the-art energy spread and stability ($\sim 1\%$), followed by an X-band energy compression beamline that reduces energy deviations to the sub-permille level. This enables efficient charge injection into the PETRA IV storage ring. Powered by the Petawatt-class upgrade of DESY's flagship laser, KALDERA, the plasma injector system offers a promising solution for top-up injection, significantly alleviating the load on the conventional RF injector chain. Looking ahead, continued advancements in high-efficiency, high-power laser drivers operating at high repetition rates could allow the plasma-based injector to fully replace the RF system—ultimately reducing the injector's spatial footprint and energy consumption. The Report can be found at [A. Martinez de la Ossa et al., DESY, 2024 <https://doi.org/10.3204/PUBDB-2024-06078>].

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