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Overview of optical plasma diagnostics for novel accelerators

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The research activities in the field of plasma-based particle acceleration is shifting from the investigation of fundamental processes to the actual practical implementation of such promising technology. Laser wake-field acceleration is foreseen to be implemented in user oriented facility expected to deliver high-quality GeV electron bunches suitable for injection in a free-electron laser (FEL) [1]. Beam-driven plasma wake-field acceleration is also considered as suitable methodology for GeV injectors in compact FEL facility [2]. The implementation of plasma-based acceleration stages in user oriented facility requires the definition and deployment of proper diagnostic methodologies to monitor and control the acceleration process.
To this end, an overview is given about state-of-the-art optical diagnostics for density measurement in plasma-based acceleration stages with emphasis on well established and easy to implement approaches, highlighting real-time measurement capability. Optical interferometry in its various configurations from standard two-arm to more advanced common-path design is presented, along with spectroscopic techniques as Stark broadening and Raman scattering.

[1] Horizon 2020 EuPRAXIA design study,
J. Phys. Conf. Ser. 874, 012029 (2017).

[2] EuPRAXIA@SPARC_LAB Design study towards a compact FEL facility at LNF,
Nucl. Instr. Meth. Phys. Res. A 909, 134 (2018).

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