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Development of a non-linear plasma lens for achromatic transport

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Conventional beam-transport optics, such as quadrupole magnets, are problematic for staging of plasma accelerators, mainly due to their footprint and chromaticity. This causes emittance growth and potentially charge loss. Based on the results obtained by Steinke et al. [1] and further developments on plasma lenses by Lindstrøm et al. [2], we propose an achromatic lattice using a new type of optics element: a non-linear plasma lens with a transversely tapered B-field across its radius (a focusing and sextupole-like field). This device uses the Hall effect of an external transverse B-field on a longitudinal discharge current [3]. A prototype design is presented, with an experimental demonstration planned for 2024-2026 at the CLEAR electron test facility at CERN. This work is part of the ERC StG project SPARTA [4] at the University of Oslo.

[1] Steinke, S. et al. (2016). Multistage coupling of independent laser-plasma accelerators. *Nature*, 530, 190-193.

[2] Lindstrøm, C. A. et al. (2018). Emittance preservation in an aberration-free active plasma lens. *Physical Review Letters*, 121, 194801.

[3] Kunkel, W. B. (1981). Hall effect in a plasma. *American Journal of Physics*, 49, 733-738.

[4] European Commission - Staging of Plasma Accelerators for Realizing Timely Applications, <https://doi.org/10.3030/101116161>

Working group

WG5 : Beam sources, monitoring and control

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