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## **A Steerable, Compact 20 kV Einzel Lens with Low Aberrations**

Avalanche Energy is developing deuterium ion beams for the Orbitron fusion concept. To successfully deliver high currents to the reactor, both focusing and steering are necessary. Many concepts proposed to solve this problem rely on separated focusing and steering sections. However, doing so inherently extends the beamline and may enhance beam losses. Combining the two into a single piece, while decreasing beamline length, may induce aberrations when steering is applied. Based on simulation work by Mandal et al. (Mandal et al., 2011) for low energy beams, we utilized an “x-cut” pattern to separate the central electrode into four pieces, resulting in four unequally shaped lens segments. Biasing these segments relative to the others can steer the beam in any direction.

This improves on a simpler design of cutting the lens into four equal segments by smoothing out the electric field pattern within the lens and thus reducing aberrations in the beam. In this work, we present the design, analysis, diagnosis, and successful implementation of this steerable Einzel lens operable up to a 20 kV bias. In IBSIMU, we compared this design to the simpler concept of cutting the central lens into four equal segments, each of which can be individually biased. We tested both lenses with an 8 kV deuterium ion beam and analyzed the light patterns produced on a phosphor screen with a multichannel plate amplification. We found in both simulations and experiments that the steerable Einzel lens with the novel design can better focus the beam without losing current to aberrations due to a more uniform electric field pattern within the lens.

Mandal, P., Sikler, G., & Mukherjee, M. (2011). Simulation study and analysis of a compact einzel lens-deflector for low energy ion beam. *Journal of Instrumentation*, 6(02), P02004–P02004. <https://doi.org/10.1088/1748-0221/6/02/P02004>

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