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Investigation of focusing properties of the high-current plasma lens in the range of low magnetic fields

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ABSTRACT

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Investigation of focusing properties of the high-current plasma lens
in the range of low magnetic fields

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We present results of experimental studies of the operation of the high-current wide-aperture plasma lens in the range of low magnetic fields. Investigations of focusing of copper and carbon ion beams with current up to 0.5 A and energy up to 20 keV by a plasma lens with aperture ~7 cm were conducted in Kiev; studies of focusing of tantalum, copper, zinc and carbon ion beams with current up to 0.5 A and energy up to 50 keV were studied in Berkeley. In both cases ion beams were produced by a vacuum-arc (MEVVA-type) ion source. Substantial increase of the beam current density at the focus of the lens was found for low magnitudes of the magnetic fields. A maximum in beam current density is observed for magnetic fields 60-200 Oe, in a notably narrow range. The optimal magnetic field increases with increasing voltage applied to the lens. For a copper ion beam the optimal current density reaches ~250 mA/cm², then drops by a factor 3-4 with increasing magnetic field, after which it grows again and reaches a saturation value ~120 mA/cm² for magnetic fields exceeding 500 Oe. The effect is observed for different distributions of the external potential of the lens electrodes. Measurement of the radial distribution of potential in the mid-plane of the lens reveals a self-consistent optimal electric field topography with minimal spherical aberrations. It is observed also in the optimum case, a drastic decrease (by a factor of more than an order of magnitude) in the amplitude of oscillations in the lens and focused ion beam. A decrease of the half-width of the ion beam at the lens focus is also observed.