A Novel, High Brightness Ion Source Based on Laser Cooled Atoms

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We will present measurements of the emittance and brightness of a novel ion source derived from laser cooled atoms.[1] The magneto-optical trap ion source, or MOTIS, is a source of ions created via photoionization of a cloud of laser cooled, neutral atoms. The extracted ions have the same cold temperature (≈150 μK) as the initial neutral atom cloud, which gives rise to an ion beam of low emittance. We have created an experimental realization of a MOTIS using laser cooled chromium atoms. The extracted beam is allowed to propagate over one meter before being imaged by a multichannel-plate-intensified phosphor screen. By varying the energy of the beam and measuring its size on the screen, we are able to determine an upper bound on the emittance of the source of $1\times10^{-5}\pi$ mm mrad$\sqrt{\text{MeV}}$. In addition, the beam current is measured by placing a Faraday cup in the beam path allowing us to determine the brightness of the source. Currents as high as 1.5 pA have been measured. The measured emittance and brightness values show that this source has excellent potential for high-resolution focused ion beam applications. We will also describe the implications of these results with respect to the development of ion sources of different elements such as noble gases.

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[1] J. L. Hanssen, J. J. McClelland, E. A. Dakin, and M. Jacka, Phys. Rev. A **74**, 063416 (2006).