Chapter 5. Conclusions

The high intensity focused Ar beam system has been set up and studied. The rf multicusp ion source has been constructed and characterized. Studies have included theory to elucidate limiting factors, simulations to deduce how different configurations would work, and real experiments. The Argon plasma simulation results by the code XOOPIC for distribution and density are in agreement with the measured results. Replacing the more expensive Sm-Co_5 permanent magnet with a 30 % stronger field Nd-Fe-B magnet results in an increase in plasma density of about 20 %. The simulated results by the code XOOPIC for plasma distribution and density illustrate the role of a multicusp magnetic field. This is supported by results from the Langmuir probe measurements. This ion source can deliver plasma density up to 1.5×10^{18} m^{-3} at 500 W rf power uniformly distributed over the radial axis within 8 % deviation. The electron temperature is found to be 2.5 eV for normal operating pressure at up to 500 watts rf power.

The source can delivered Ar ions at a current density up to 36 mA/cm^2. The beam property such as beam emittance from the triode extractor, the rms emittance at 9 kV extracting voltage is measured to be 32 ± 4 mm mrad. The use of an rf-choke of 1.2 mH to function as a low pass filter, in series with the extraction dc power supply can eliminate the interference from the rf voltage in this range of rf power which results in a reduction of axial beam energy spread. The accelerated Ar axial beam energy spread have been observed to vary from 3 to 5 eV for an extracting voltage decreasing from 4 to 0.5 kV. The micron size beam profile monitor was developed with minimum resolution of 0.5 micron.

Beam profile controller and data analysis can be done on a PC with a serial interface.

Over the course of this work, several observations were made regarding design of the plasma source FIB system. For the ion source side, Ar current density may be increased by increasing of rf power especially by the use of a pulsed power mode instead of cw power mode to avoid a heating problem. It is known that beam current density is a linear function of rf driving power. For the beam transport, an electrostatic lens such a set of Einzel lens could be added downstream to improve the focused beam optics.