# Negative hydrogen ion beam extracted from a Bernas-type ion source

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High current negative hydrogen/ deuterium ($H^-$/ $D^-$) ion sources have been developed for a neutral beam injection (NBI) system to heat up a plasma to thermonuclear fusion condition [1, 2]. These ion sources have large size plasma generators to produce high current negative ion beams. The principle mechanism of the high current density $H^-$/ $D^-$ ion beams is believed to be volume production [3]. However, the present sources are operated with cesium seeding, which should alter the interaction between the source plasma and the surface of plasma grids.

The volume production mechanism consists of two steps. One; production of highly excited states of vibrationally excited molecules. Two; negative ions are produced by dissociative attachment of low energy electrons to vibrationally excited molecules. The production of vibrationally exited molecules needs high energy electrons. The reaction rate for negative ion production by dissociative electron attachment takes the maximum at low electron energy, while high energy electrons destroy produced $H^-$ in the plasma. Therefore, a high density high temperature plasma should be separated from a plasma electrode of an ion extractor.

The small size Bernas-type ion source equipped with a coaxial thermionic cathode has been developed [4-6]. The plasma produced by a coaxial cathode in a Bernas-type ion source had indicated clearer and focused plasma shape along the external magnetic field. A high density plasma column has been sustained straight from the coaxial cathode along the external magnetic field. Namely, the two layers necessary regions to form negative ions exist in the arc chamber: a layer to form vibrationally excited molecules, and a layer to production $H^-$ by dissociative electron attachment. The Bernas-type ion source with a coaxial cathode is expected produce large current of $H^-$ ions as the plasma geometry can be easily optimized by changing the cathode position to properly divide a region of the arc chamber into two layers. The detail of the Bernas-type ion source and the experimental results will be presented at the conference.

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