§3. Caesium-deposition in the Large Area Negative Ion Source for LHD-NBI

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In high performance negative ion sources for negative-ion-based neutral beam injection, we had observed spectra of Cs neutral and ion lines[1)] from the source plasma light in the driver region of Cs seeded hydrogen discharge, and tested a crystal Cs deposition monitor equipped with a high speed shutter (>~50ms) to evaluate Cs deposition in the plasma source. The studies of the two topics derived from measurements of Cs consumption averaged over the LHD-NNBI injection shots in reference[2)].

In present[3)], Cs deposition monitor was used to cross-check the spectrometry observation and to quantify the spectrometer observation. A deposition monitor with a quartz crystal transducer was installed on an empty filament feedthrough port on the backplate of a 1/3rd scale H^- ion source (Fig.1). A high speed shutter designed paticularly was fabricated in front of the crystal sensor in order to diminish possible effects of radiation heating of the deposition monitor. The opening time for the shutter was changed over several tens of milliseconds.

A time chart/trace of the arc current, shutter open time, and the recorder output of the rate display (in 100 nano-gr/sec for 10V), are shown (Fig.2). The Cs rate value in the unit of nanograms per shot as a function of the shutter open time width was tested (Fig.3). With a caesiated arc at 30kW, the shutter open time of 0.12 to 0.5 sec seems to be available to be detectable on Cs deposition in the nano-gr per run shot. Longer shutter times (i.e., 1sec) lose the output proportionality with the time due to possibly electromagnetic interference. For the shorter time, the sensitivity reduces. Cs deposition of the deduced value averaged after the many arc shots was evaluated about 0.3 nano-gr per shot for 0.12sec shutter meant 2.5 nano-gr/sec, and converted to the flux of 2.9 nano-gr/sec/cm^2. The Cs flux would mean ~26 micrograms/sec Cs deposition rate to the plasma source wall. It might correspond to ~1.1 x 10^{-5} Pa of a low Cs pressure after the arc pulse. In earlier measurements[2)], Cs consumption over 20,000shots of the LHD-NNBI shots (almost, T_{cycle} of 180s) was evaluated to be 0.17 to 1.5 mgr per shot. Two numbers with different algorithms seem to be near order. A correlation between H^- current and Cs deposition had been checked by negative ion extraction/acceleration experiment (in another series of ~2000shots with 50kV of acceleration voltage).

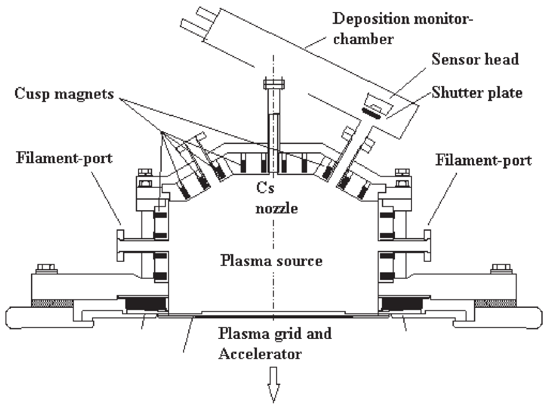

Fig.1 A sketch of short side cross section of 1/3rd H- ion source equipped with a deposition monitor system.

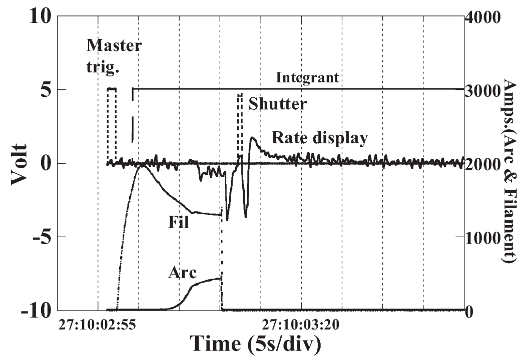

Fig.2 Time chart/trace of rate display output of deposition monitor, shutter open time, arc current, integral domain for weight display, and master trigger.

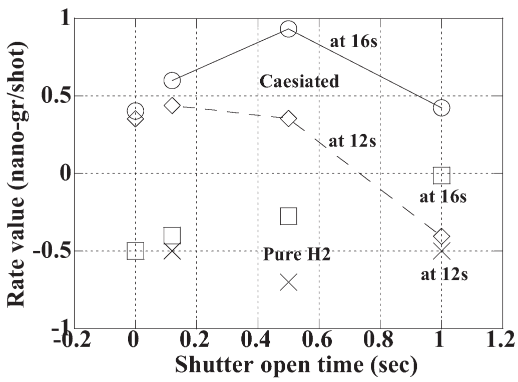

Fig3 Cs rate value (in the unit of nanograms per shot) deposited to the monitor crystal as a function of shutter open time at 16s (after the arc) and 12s (during the arc).

1). Y.Oka et al., Annual Report of NIFS (April 2005 to March 2006) p136
2). Y.Oka et al., Rev. Sci. Instrum. 75, 1803(2004)
3). Y.Oka et al., Rev. Sci. Instrum. 79, 02C105(2008)