Cryogenic gas target system for intense RI beam productions in nuclear astrophysics

Y. Wakabayashi\textsuperscript{a}, H. Yamaguchi\textsuperscript{a}, S. Hayakawa\textsuperscript{a}, Y. Kurihara\textsuperscript{a}, G. Amadio\textsuperscript{a}, H. Fujikawa\textsuperscript{a}, S. Kubono\textsuperscript{a}, J.J. He\textsuperscript{b}, A. Kim\textsuperscript{c} and D.N. Binh\textsuperscript{d}

\textsuperscript{a} Center for Nuclear Study, Graduate School of Science, University of Tokyo
\textsuperscript{b} School of Physics, The University of Edinburgh, Mayfield Road, Edinburgh EH9 3JZ, U.K.
\textsuperscript{c} Department of Physics, Ewha Womans University, 11-1, Daehyun-dong, Seodaemun-gu, Seoul, 120-750, Korea
\textsuperscript{d} Institute of Physics and Electronics, Vietnam Academy of Science and Technology, 8 Hoang Quoc Viet St., Nghia do, Hanoi, Vietnam

E-Mail: bayashi@cns.s.u-tokyo.ac.jp

Intense radio-isotope (RI) beams are the key to investigate directly astrophysical nuclear reactions under explosive conditions. A cryogenic gas target system was newly developed to produce intense RI beams at the low-energy, in-flight radio-isotope beam separator (CRIB)[1,2], of the University of Tokyo.

The main features of the cryogenic gas target system are the direct cooling of the target cell by a liq. N\textsubscript{2} finger and the circulation of the target gas that goes through the liq. N\textsubscript{2} tank.

Hydrogen gas was cooled down to 85-90 K by liquid nitrogen and used as a secondary beam production target which has a thickness of 2.3 mg/cm\textsuperscript{2} at the gas pressure of 760 Torr. Intense RI beams, such as the production of \textsuperscript{7}Be of \textasciitilde 2 \times 10\textsuperscript{8} particles per second, were successfully produced using the target.

A density reduction effect at the gas target was observed for high-current primary beams of which heat deposit at the target was about 7.5 W. We have studied the density reduction effect as a function of the target gas circulation rate, and observed for the first time that the density reduction effect can be remedied by the target gas circulation. The circulation of the target gas with the rate of 55 l/min was high enough to recover the density reduction up to 95\%, and the relation between the density reduction and the forced circulation rate is quantitatively discussed.

References