Contribution ID: **78** Type: **Oral Communication**

The high-current mode performance of the proton beam at Ljubljana nuclear microprobe coupled to a multicusp ion source

Tuesday, 8 July 2014 10:00 (20 minutes)

One of the key parameters influencing the performance of an ion microprobe is the brightness of the ion source. Traditionally, negative proton beams for injection in tandem accelerators are from von Ardenne type ion sources (duoplasmatrons). This type of ion source provides moderate normalized beam brightness of up to a value of 2 A m-2 rad-2 eV-1 [1,2], one order of magnitude lower compared to best single-ended particle accelerators, where positive hydrogen ion beam is extracted from e.g. an RF ion source located in the terminal of the accelerator.

A high brightness direct negative H- extraction multicusp ion source has been put in use at the Jožef Stefan Institute (JSI) Tandetron accelerator facility. This multicusp ion source and the related Tandetron injection system has been custom developed by High Voltage Engineering Europa. A series of quantitative measurements revealed that an achievable high-energy normalized beam brightness of 14 A m-2 rad-2 eV-1 is available at the microprobe lens, a high-energy proton beam brightness significantly higher than any other value reported on tandem particle accelerators [2]. The brightness value was obtained at only 18% of the total available ion source output current, as the microprobe object slits could not handle the beam power available by the multicusp and Tandetron accelerator.

Recent efforts at JSI were dedicated to improve the matching of the intense H- beams from the multicusp ion source to the properties of the nuclear microprobe beam line. Extraction aperture size was chosen to reduce the ion source output current to ~ 50 µA H- at optimal plasma conditions. Furthermore, newly home-built water-cooled object slits were installed, allowing intercepting beam power densities of more than one hundred watts/mm2. The Oxford Microbeams OM-150 quadrupole triplet was realigned. By using Focused Ion Beam (FIB) produced nanometer standards with edge irregularities below 20 nm, we were able to evaluate beam profile in detail. The achieved high-current beam mode performance, with proton currents of over 100 pA and the corresponding beam profiles in a sub-micrometer regime, suitable for micro-PIXE with high lateral resolution, is reported.

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[2] P. Pelicon, N.C. Podaru, P. Vavpetič, L. Jeromel, N. Ogrinc Potočnik, S. Ondračka, A. Gottdang, D.J.M. Mous, Nucl. Instr. Meth. B, 2014, DOI: 10.1016/j.nimb.2014.02.067.

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Session Classification: Session 1 - Nuclear Microprobe Technology 1