Advanced Research Center for Beam Science
– Particle Beam Science –

http://wwwal.kuicr.kyoto-u.ac.jp/www/index-e.htmlx

Prof
NODA, Akira
(D Sc)

Assoc Prof
IWASHITA, Yoshihisa
(D Sc)

Assist Prof
SOUDA, Hikaru

Techn Staff
TONGU, Hiromu

Lect (pt)

KAMADA, Susumu   Accelerator Laboratory, High Energy Accelerator Research Organization

Assist Techn Staff

KAZAMA, Ichiro

Students

NAKAO, Masao (D3)
YAMADA, Masako (D3)
IMAJO, Sohei (D2)
NASU, Yuji (M2)
FUWA, Yasuhiro (M2)
KITAHARA, Ryunosuke (M1)
IKEDA, Hideki (M1)

Visitors

Prof MADSEN, Niels   Swansea University, Department of Physics, U.K., 1–8 October
Mr PLOSTINAR, Ciprian   Rutherford Appleton Laboratory, Romania, 15–17 October

Scope of Research

The Following Subjects are being studied: Beam dynamics related to space charge force in accelerators: Beam handling during the injection and extraction processes of the accelerator ring: Ultra-low Emittance state of a proton beam created by the electron cooling: Laser cooling of Mg^{+} ion beam: Irradiation of short bunch proton beam by electron cooling and phase rotation: Research and development of permanent quadrupole magnets for final focusing of International Linear Collider(ILC): Development of electron-cyclotron resonance(ECR) ion source for small neutron source.

KEYWORDS

Beam Physics
Accelerator Physics
Beam Cooling
Phase Rotation
Neutron Optics

Selected Publications

Noda, A., Ion Beam Cooling at S-LSR Project, *Nucl. Instrum. Meth.*, **A532,** 150-156 (2004).

Shirai, T.; Ikegami, M.; Fujimoto, S.; Souda, H.; Tanabe, M.; Tongu, H.; Noda, A.; Fujimoto, T.; Iwata, S.; Shibuya, S.; Smirnov, A.; Meshkov, I.; Fadil, H.; Grieser, M., One Dimensional Beam Ordering of Protons in a Storage Ring, *Phys. Rev. Lett.*, **98,** [204801-1]-[204801-4] (2007).

Nakamura, S.; Ikegami, M.; Iwashita, Y.; Shirai, T.; Tongu, H.; Souda, H.; Daido, H.; Mori, M.; Kado, M.; Sagisaka, A.; Ogura, K.; Nishiuchi, M.; Orimo, S.; Hayashi, Y.; Yogo, A.; Pirozhkov, A. S.; Buranov, S. V.; Esirkepov, T.; Nagashima, A.; Kimura, T.; Tajima, T.; Takeuchi, T.; Fukumi, A.; Li, Z.; Noda, A., High-Quality Laser-Produced Proton Beam Realized by the Application of a Synchronous RF Electric Field, *Jpn. J. Appl. Phys.*, **46,** L717-L720 (2007).

Wakasugi, M.; Emoto, T.; Furukawa, Y.; Ishii, K.; Ito, S.; Koseki, T.; Kurita, K.; Kuwajima, A.; Masuda, T.; Morikawa, A.; Nakamura, M.; Noda, A.; Ohnishi, T.; Shirai, T.; Suda, T.; Takeda, H.; Tamae, T.; Tongu, H.; Wang, A.; Yano, Y., Novel Internal Target for Electron Scattering off Unstable Nuclei, *Phys. Rev. Lett.*, **100,** [164801-1]-[164801-4] (2008).

Iwashita, Y.; Tajima, Y.; Hayano, H., Development of High Resolution Camera for Observations of Superconducting Cavities, *Phys. Rev. S.T.-Accel. Beams*, **11,** [093501-1]-[093501-6] (2008).

Arimoto, Y.; Geltenbort, P.; Imajo, S.; Iwashita, Y.; Kitaguchi, M.; Seki, Y.; Shimizu, H. M.; Yoshioka, T., Demonstration of Focusing by a Neutron Accelerator, *Phys. Rev. A*, **86,** 023843 (2012).

Efficiency Enhancement of Indirect Transverse Laser Cooling by Synchro-Betatron Resonance Coupling with Suppression of Circulating Ion Beam Intensity

The capability to cool down the transverse temperature of the circulating $^{24}Mg^{+}$ ion beam with the kinetic energy of 40 keV by application of "Synchro-Betatron Resonance Coupling" (SBRC) [1] has already been experimentally demonstrated [2]. The transverse cooling rate, however, was so slow to reach crystalline string state [3] that an approach to enhance the efficiency of the indirect transverse laser cooling by SBRC with suppression of the circulating ion beam current using scraping has been proposed and tested [4] After suppression of the circulating beam intensity, the transverse beam profiles were measured using another scrapers with the measurement of survival rate for various scraper positions, which enabled us to observe the beam size for the circulating beam intensity down to 10^4. In Figure 1(a) the cooled beam sizes for various beam intensities are shown. Together with recent optimization of overlapping between the laser and the ion beam using adjusters by piezo-driven mirrors, the cooling time of the transverse beam size has been reduced by suppression of the circulating ion numbers as shown in Figure 1 [5].

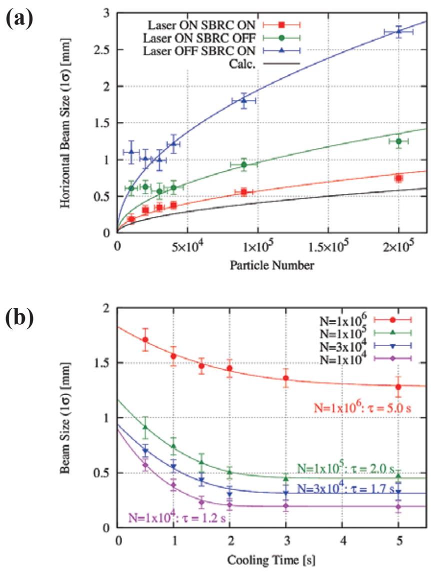

Figure 1. Circulating beam intensity dependence of the indirectly transverse cooled $^{24}Mg^{+}$ ion beam size.

References

[1] H. Okamoto, A.M. Sessler, D. Mohl, *Phys. Rev. Lett.*, **72** (1994) 3977-3980.

[2] M. Nakao et al., *Phys. Rer. ST Accel. Beam*, **15,** 110102.

[3] J. Wei, H. Okamoto, A.M. Sessler, *Phys. Rev. Lett.*, **80** (1998) 2606-2609.

[4] A. Noda et al. *Proc. of the 23rd Russian Particle Accelerator Conference*, St. Petersburg, Russia, 24-28 September 2012, 48-52.

[5] H. Souda et al., *Jpn. J. Appl. Phys.*, 52 (2013) 030202.

Controlled Acceleration of Neutrons

Today, neutron beam is utilized widely, for example investigations of material structure and cancer therapy. The utilizing efficiency, however, is limited because controlling neutrons, which have no electric charge, is difficult with the conventional accelerator technique. On the other hand, a neutron has the magnetic dipole moment, which feels a force in a gradient magnetic field. Already developed neutron lens exerts the force for transverse direction by sextupole magnetic field, which focuses neutron beams and improves the efficiency on the small angle neutron scattering (SANS) experiments. Although such a force in the longitudinal direction has been well known, net velocity change is not available when the magnetic field strengths of initial and final positions are the same (it acts as the magnetic potential) if the spin preserves. Combination of a static gradient magnetic field and an RF field, whose frequency is well modulated, makes the spin flip in the static magnetic field to change the sign of the force. The demonstration experiment was performed at ILL, France and a space-time focusing of neutrons (can increase space density at an experimental area) are successfully observed by controlling the velocities of the neutrons. This will be a powerful technique for variety of measurements that require high density of neutrons, for example, the search of the permanent electric dipole moment of neutrons, which relates to the violation of time-reversal invariance in particle physics.

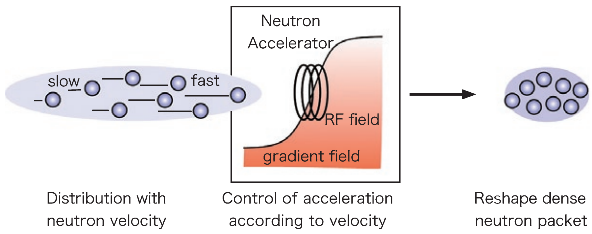

Figure 2. Our neutron accelerator system can reshape the neutron bunch at the experimental position by using gradient magnetic field and RF field.

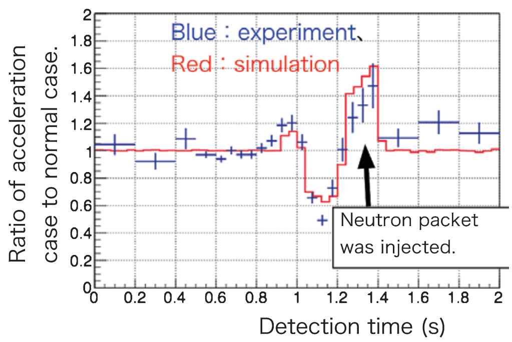

Figure 3. The neutron packet was injected and made the peak in the graph.