Advanced Research Center for Beam Science
– Particle Beam Science –

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

Assoc Prof
IWASHITA, Yoshihisa
(D Sc)

Techn Staff
TONGU, Hiromu

Researchers(pt)

HOKONOHARA, Hisao
KAZAMA, Ichiro

Lect (pt)

SHIMIZU, Hirohiko M. (D Sc) Laboratory for Particle Properties, Department of Physics, Nagoya University

Students

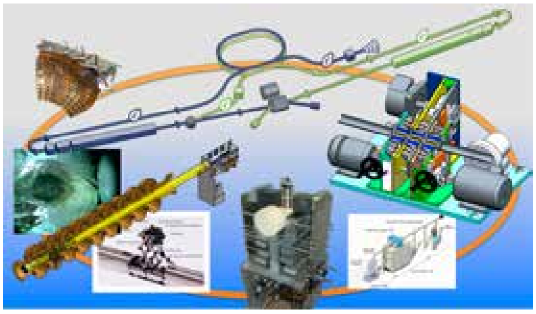
IMAJO, Sohei (D3)
FUWA, Yasuhiro (D3)
KITAHARA, Ryunosuke (D2)
IKEDA, Hideki (M2)

Guest Scholar

JAMESON, Robert A. (Ph D) Goethe University, Frankfurt Germany, 8 April-11 April. 10 November-30 November.

Scope of Research

Particle accelerators have contributed to the progress of science in a variety of fields. Our current research is in neutron science and participation in the International Linear Collider (ILC) project. The following subjects are our focus: 1) neutron beam focusing by modulating sextupole magnets, 2) neutron acceleration/deceleration, 3) compact neutron source including ion source, 4) permanent quadrupole magnets for final focusing of ILC, 5) nondestructive inspections for superconducting accelerating tube towards higher yield and performance and multi layered film structure for RF, and 6) their subsidiary subjects.



KEYWORDS

Beam Physics
Accelerator Physics
Neutron Optics
Phase Rotation
International Linear Collider

Selected Publications

Yamada, M.; Iwashita, Y.; Ichikawa, M.; Fuwa, Y.; Tongu, H.; Shimizu, H. M.; Mishima K.; Yamada, N. L.; Hirota, K.; Otake, Y.; Seki, Y.; Yamagata, Y.; Hino, M.; Kitaguchi, M.; Kennedy, S.J.; Lee, W. T.; Andersen, K. H.; Guerard, B.; Manzin, G.; Geltenbort, P., Pulsed Neutron-beam Focusing by Modulating a Permanent-magnet Sextupole Lens, *Prog, Theor. Exp. Phys.*, **043G01,** (2015).

Kubo, T.; Iwashita, Y.; Saeki, T., Radio-frequency Electromagnetic Field and Vortex Penetration in Multilayered Superconductors *Appl. Phys. Lett.*, **104,** 032603 (2014).

Fuwa, Y.; Iwashita, Y.; Tongu, H.; Kitahara, R.; Matsumoto, T.; Michizono, S.; Fukuda, S., Focusing System with Permanent Magnets for Klystrons, *IEEE Trans. on Applied Supercond*., **24,** 0502005 (2014).

White, G. R.; Ainsworth, R.; Akagi, T.; Alabau-Gonzalvo, J.; Angal-Kalinin, D.; Araki, S.; Aryshev, A.; Bai, S.; Bambade, P.; Bett, D. R.; Blair, G.; Blanch, C.; Blanco, O.; Blaskovic-Kraljevic, N.; Bolzon, B.; Boogert, S.; Burrows, P. N.; Christian, G.; Corner, L.; Davis, M. R.; Faus-Golfe, A.; Fukuda, M.; Gao, J.; Garc´ıa-Morales, H.; Geffroy, N.; Hayano, H.; Heo, A. Y.; Hildreth, M.; Honda, Y.; Huang, J. Y.; Hwang, W.H.; Iwashita, Y.; Jang, S.; Jeremie, A.; Kamiya, Y.; Karataev, P.; Kim, E. S.; Kim, H. S.; Kim, S. H.; Kim, Y. I.; Komamiya, S.; Kubo, K.; Kume, T.; Kuroda, S.; Lam, B.; Lekomtsev, K.; Liu, S.; Lyapin, A.; Marin, E.; Masuzawa, M.; McCormick, D.; Naito, T.; Nelson, J.; Nevay, L. J.; Okugi, T.; Omori, T.; Oroku, M.; Park, H.; Park, Y. J.; Perry, C.; Pfingstner, J.; Phinney, N.; Rawankar, A.; Renier, Y.; Resta-L´opez, J.; Ross, M.; Sanuki, T.; Schulte, D.; Seryi, A.; Shevelev, M.; Shimizu, H.; Snuverink, J.; Spencer, C.; Suehara, T.; Sugahara, R.; Takahashi, T.; Tanaka, R.; Tauchi, T.; Terunuma, N.; Tom´as, R.; Urakawa, J.; Wang, D.; Warden, M.; Wendt, M.; Wolski, A.; Woodley, M.; Yamaguchi, Y.; Yamanaka, T.; Yan, J.; Yokoya, K.; Zimmermann, F., Experimental Validation of a Novel Compact Focusing Scheme for Future Energy Frontier Linear Lepton Colliders, *PHYSICAL REVIEW LETTERS*, **112,** 034802 (2014).

Topics

RF Synchronized Short Pulse Laser Ion Source

In order to enhance the accelerating efficiency of a front-end ion accelerator and develop a compact ion beam injector, we were studying an RF synchronized short pulse laser ion source.

The interaction between lasers and matter is promising for producing high current ion beams. In conventional laser ion sources, laser plasma is produced in a field-free region with a laser pulse whose pulse duration is more than a few nanoseconds. In this case, laser plasma expands before ions are extracted and the pulse length of obtained ion beams is over a few microseconds. Since the operating frequencies of RF ion accelerators are usually between a few tenths of MHz and a few hundred MHz, the ion beam must be bunched before acceleration. To keep beam emittance low, bunching should be performed adiabatically and the length of bunching section must be long. If an ion source can produce a short pulse ion beam, ions can be accelerated without the bunching process and the bunching section is no longer needed. An interaction between matter and ultra-short (femto-second) pulse laser would allow production of plasma with a short pulse structure (<5 ns). If the production of the plasma occurs in RF electric field, ions can be extracted without expanding, and pulse length of obtained ion beam would be shorter than 5 ns. Ion beams can be accelerated as micro bunches (Figure 1) by connecting an RFQ (radio frequency quadrupole) linear accelerator to this ion source directly.

A proof-of-principle experiment was performed to produce a short pulse laser ion beam. In this experiment, hydrogen gas was ionized with 40 fs laser in RF electric field. To generate the longitudinal RF electric field, a 53.3 MHz RF resonator was designed and fabricated (Figure 2 and 3). The Q factor of the resonator was 190 and the gap voltage was 2.5 kV with 250 W input power. A pulse gas valve unit with a piezoelectric element was set in the resonator and a H_2 gas jet was supplied into the laser interaction region just before laser irradiation.

Tuning the laser power density to 10^{14}–10^{15} W/cm^2, charge particles extracted by RF electric field were detected by the ion probe at the exit of RF resonator. The detected current was changed depending on initial RF phase (Figure 4). Positive current was detected in a phase range between 180 degrees and 270 degrees. The pulse length of the ion beam was 3.1 ns (FWHM) and the peak current was up to 1.2 mA with an initial RF phase of 240 degrees. This pulse length is short enough to inject into the accelerating section of RFQ to enhance its accelerating efficiency of RFQ.

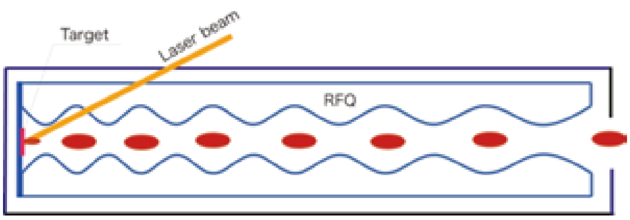


Figure 1. A schematic image of direct injection of bunched ion beam into RFQ.

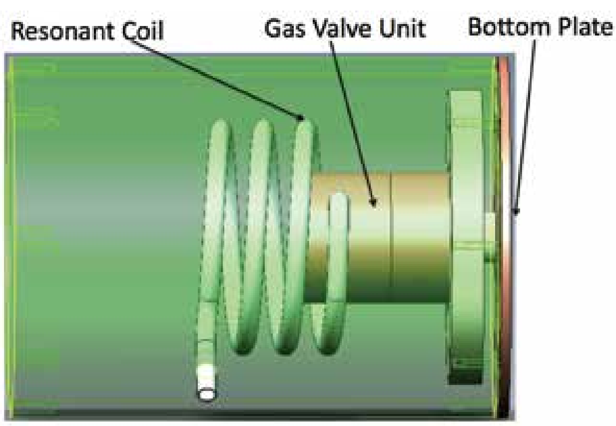


Figure 2. Design of RF resonator.

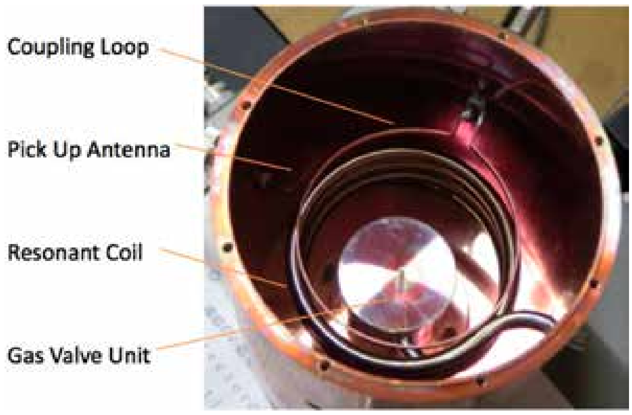


Figure 3. Fabricated RF resonator.

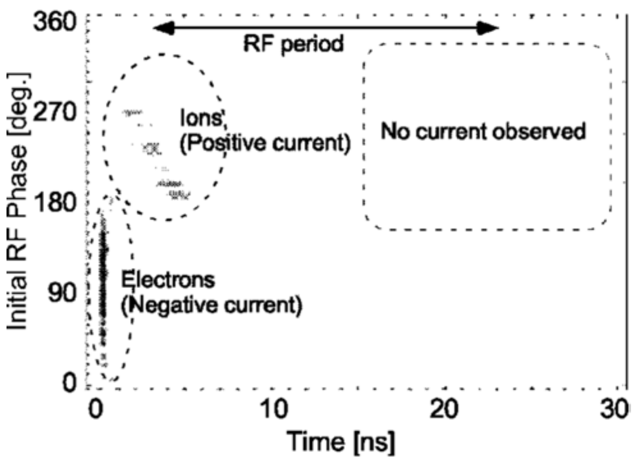


Figure 4. Measured current at the exit of the RF resonator with various RF phases.