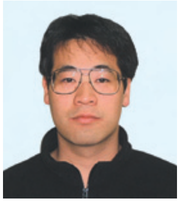
Advanced Research Center for Beam Science
– Particle Beam Science –

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
TONGU, Hiromu

Lect (pt)

OKAMOTO, Hiromi (D Sc) Graduate School of Advanced Sciences of Matter, Hiroshima University

Techn (Pt)

KAZAMA, Ichiro

Students

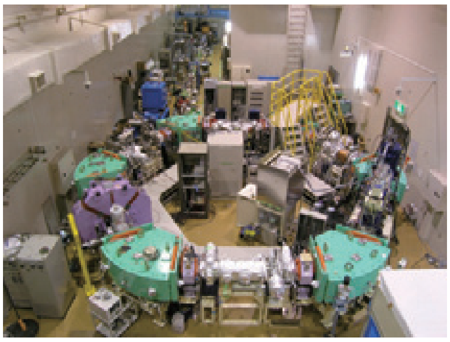
ICHIKAWA, Masahiro (D3)
NAKAO, Masao (D3)
YAMADA, Masako (D2)
USHIJIMA, Shotaro (M2)
HIROMASA, Tatsuya (M2)

Visitors

Prof KENNEDY, Shane J — Australian Nuclear Science and Tecnology Organization, Australia, 31 January–27 February
Prof SESSLER, Andrew M — Lawrence Berkeley National Laboratory, USA, 30 May–3 June
Prof WEI, Jie — Tsinghua University, China, P. R., 31 May–1 June
Prof GRIESER, Manfred — Max-Planck-Institut für Kernphysik, Germany, 31 May–4 June
Prof JAMESON, Robert A — Goethe University, Germany, 18–20 September

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 states of proton and Mg^+ ion beams created by the electron cooling and laser cooling, respectively: Compression of the energy spread of laser-produced ion beams by an rf electric field for phase rotation: Research and development of permanent quadrupole magnets for final focusing of International Linear Collider(ILC) and for focusing of neutron beam: 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, Souda H, Shirai T: Physics of Beam Cooling and Low-temperature Beams, *J. Plasma Fusion Res.*, **86,** 461-465 (2010) (in Japanese).

Iwashita Y, Ichikawa M, Yamada M, Sugimoto T, Tongu H, Fujisawa H, Masuzawa M, Tauchi T, Oku T, Hirota K, Shimizu HM, Shi C, Zhu Y: Practical Applications of Permanent Magnet Multipoles, *IEEE Trans. Appl. Supercond.*, **20,** 842-845 (2010).

Noda A, Souda H, Tongu H, Fujimoto T, Iwata S, Shibuya S, Noda K, Shirai T: Linac Followed by an Electron Cooler to Provide a Short Bunch Proton Beam, *Proc. of the LINAC10*, P1-P3 (2010).

Souda H, Nakao M, Hiromasa T, Tongu H, Noda A, Okamoto H, Smirnov AV, Jimbo K, Grieser M, Shirai T: Transverse Laser Cooling by Synchro-betatron Coupling, *Proc. of IPAC'10*, 861-863 (2010).

Sakaki H, Nishiuchi M, Hori T, Bolton PR, Yogo A, Katagiri M, Ogura K, Sagisaka A, Pirozhkov AS, Orimo S, Kondo K, Iwase H, Niita K, Souda H, Noda A, Iseki Y, Yoshiyuki T: Prompt In-Line Diagnosis of Single Bunch Transverse Profiles and Energy Spectra for Laser-Accelerated Ions, *Appl. Phys. Express*, **3,** 126401(2010).

Collaboration with the Use of Ion Storage and Cooler Ring, S-LSR

ICR has become a collaboration Institute open for outside users. This year, two collaborations has been started.

a) Approach to ultra-low temperature ion beam by laser cooling

We have already obtained an indication of transverse laser cooling of 40 keV $^{24}Mg^{+}$ ion beam with the use of "Synchro-Betatron Coupling" (Annual Report 2009). This year, more quantitative approach to reach crystalline beam has been triggered by collaboration with the group from Hiroshima University, Tsinghua University and Max-Planck-Institut für Kernphysik through Skype meeting.

b) Irradiation of electron cooled short bunch proton beam onto biological cells

In order to obtain quantitative data on the capability of double strand breaking by irrdadiation of proton beam with a very high peak intensity in a short pulse as indicated by laser-produced proton beam [1], an irradiation system of biological cells by a electron cooled 7 MeV proton beam has been under development. By electron cooling, we have already realized a short bunch 7 MeV proton beam beam with 3.1 ns pulse duration for beam intensity of 1.4×10^{8} [2]. For the purpose of keeping the cells alive throughout the irradiation process the extracted proton beam is to be deflected vertically as large as 90 degrees and irradiated through a thin foil. By hitting the cells from below, the irradiation condition is expected to be kept constant independent on the thickness of cultivating liquid, which evaporates during the irradiation. Such a beam line is now under construction with collaboration of the group from National Institute of Radiological Sciences.

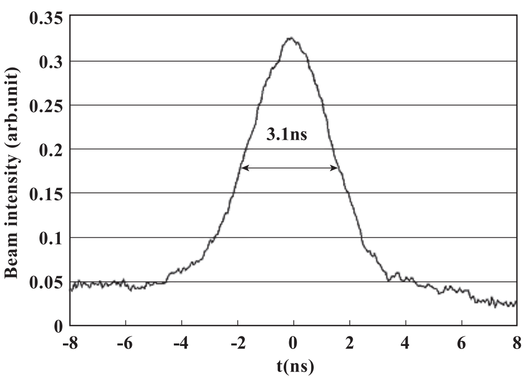


Figure 1. Electron cooled proton beam.

Neutron Optics and Physics (NOP)

Neutron is unique probe for material research and fundamental science because it does not have charge and interacts only by nuclear force, while x-ray interacts with electromagnetic force. Light atoms, which are difficult to be observed by x-rays, can be investigated by neutrons. Among many methods, Small Angle Neutron Scattering (SANS) has been commonly used to investigate structures of materials. Unfortunately, the availability of such facility seems not good because of its huge size (~40 m). By using Very Cold Neutrons (VCN), the length can become very short and be distributed to many laboratories. This situation allows us to invite or raise new neutron users. In addition, wider q-ranges and smaller minimum q's are available on this VCN-SANS, because the scattering angles are no longer small.

We have been investigating a focusing magnetic lens for neutrons that has sextupole magnetic field to interacts with magnetic dipole moment of neutrons. The focusing properties were studied at ILL, Grenoble, France. Figure 2 shows the typical results. Using this lens, test measurements of VCN-SANS were performed. Figure 3 shows the result for tri-block-copolymer case. The resolution Figure 3 was better than the conventional facility. We are still studying towards the better performance.

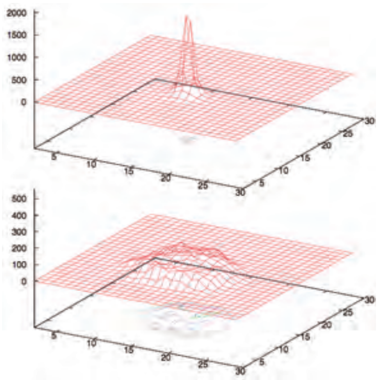


Figure 2. The beam profiles on the 2D detector. Top: PMSx is well synchronized and the beam spot is kept small during the beam pulse. Bottom: the beam spot is increasing for off-synchronized case.

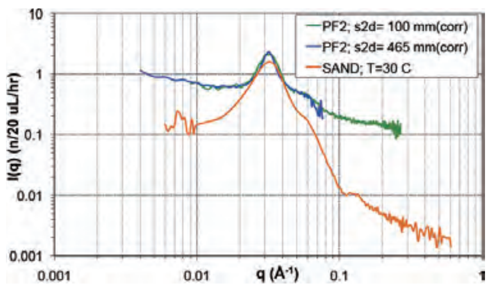


Figure 3. VCN-SANS plots for 15 wt% Pluronic in D2O (28 °C), compared with SAND@IPNS.

References
[1] A. Yogo et al., Appl. Phys. Lett. **94,** 181502 (2009).
[2] T. Fujimoto et al., N.I.M. **A588,** 330-335 (2008).