Nuclear Science Research Facility -Particle and Photon Beams-

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Visitors

Dr BISOFFI, Giovanni	Legnaro National Laboratory, Italy, 11-12, September 2001
Dr GRIESER, Manfred	Max-Planck-Institut für KernPhysik, Germany, 9-22, November 2001
Dr HASSE, Reiner	Gesellschaft für Schwerionenforschung, Germany, 11-14, November 2001
Dr DANARED, Hakan	Manne Siegbahn Laboratory, Sweden, 11-14, November, 2001
Dr HANGST, Jeffrey	Institute of Physics and Astoronomy, Aarhus University, Denmark, 11-14, 2001
Dr SIDORIN, Anatoly	Joint Institute for Nuclear Research, Dubna, Russia, 11-14, November 2001
Mr SCHAETZ, Tobias	Ludwig-Maximilians-University München, Germany, 8-16, November 2001

Scope of Research

Particle and photon beams generated with accelerators and their instrumentations both for fundamental research and practical applications are studied. 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: Radiation mechanism of photons by electrons in the magnetic field: R&D to realize a compact synchrotron dedicated for cancer therapy; and Irradiation of materials with particle and photon beams.

Research Activities (Year 2001)

Presentations

Slow Beam Extraction of Electron with Combination of Third Order Resonance and RFKO, SugimuraT, Shirai T, Tongu H, Noda A et al., Annual Meeting, Phys. Soc. Jpn., 28 March, 2001 Particle Accelerator Conference, 21 June

Field Measurement and Analysis of Combined Function Magnet, Morita M, Iwashita Y, Noda A et al., Annual Meeting, Phys. Soc. Jpn., 28 March

Electron Beam Cooling of Hot Ion Beam, Noda A, Fadil H, Grieser M (MPI, Heidelberg) et al., Annual Meeting, Phys. Soc. Jpn., 28 March

High Gradient Cavities for Long Bunch Muon Beam, Iwashita Y and Morita A, 2001 Particle Accelerator Conference, 18 June

Very High-Field Short-Pulse Dipole Magnet for Compact Proton Synchrotron, Tokura S (IHI), Miyauchi Y (IHI), Noda A et al., 2001 Particle Accelerator Conference, 21 June

High Gradient RF Cavities for Phase Space Manipulation of Muons, Iwashita Y, The Second Asian Particle Accelerator Conference, 20 September

Collection and Cooling Scheme of Laser Produced Ion Beam, Noda A, Nakamura S, Daido H (JAERI), et al., The Second Asian Particle Accelerator Conference, 21 September

Grants

Shirai T, Coherent X-ray production and beam cooling of electron with use of laser undulator, Grant-in-Aid for Scientific Research, Syourei (A) (2), 1 April 2000 - 31 March 2002.

Noda A, Beam Accumulation and Cooler Ring, Advanced Compact Accelerator Development, 25 June 2001-31 March 2002.

Iwashita Y, High gradient acceleration with standing-wave structure for linear collider, KEK joint research and development program, 1 April 2001 - 31 March 2002.

Topics

Pulse stretcher of electron beam with use of a storage ring, KSR

The duty factor of the S-band disc-loaded type electron linac at NSRF has been limited below $2x10^{-5}$ because of its maximum pulse width(1μsec) and repetiotion rate(20Hz). The electron storage ring, KSR is utilized as a stretcher of the output electron beam to increase the duty factor up to ~90 % for avoiding the pile up of the signals from the particle detector. A slow beam extraction using the third order resonance in combination with the RF knockout is utilized in order to spread out the beam spill, which can be changed in the range between 0.2 sec and 40 sec by adjustment of the transverse RF power from 0.55W to 0.09 W as shown in Figure 1. Beam extraction efficiency has been also measured with use of a Faraday cup and DCCT in the ring (Fig. 2). The extraction efficiency now exceeds 50 % [1].

1. Sugimura T. et al., to be printed in JJAP.

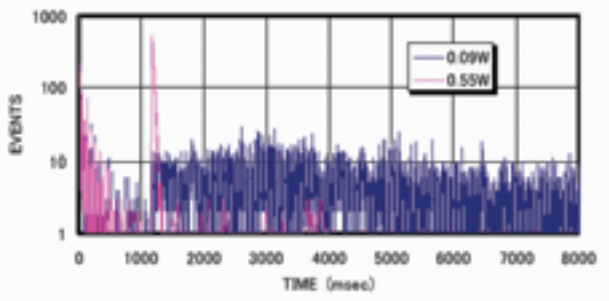

Figure 1. Beam spill of the electron beam stretched by KSR.

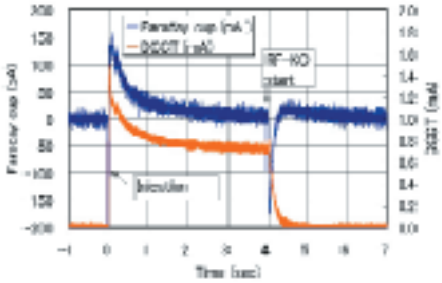

Figure 2. Electron beam intensity circulating in KSR(Orange) and extracted (Blue)

Research and development to realize a compact accelerators for cancer therapy

Recently cancer therapy with use of charged particles has been paid attention from the point of view of "quality of life" of the patient because of its merit of preserving function and shape of human body. Carbon beam irradiated with synchronization to the breathing of the patients at National Institute of Radiological Sciences(NIRS) has attained a good clinical results for liver and lung cancers. For the purpose of downsizing of such a cancer therapy facility, we have studied a combined-function proton synchrotron. This year, the evaluation of the fabricated model combined-function magnet has been completed by making particle tracking with use of the measured magnetic field, which showed the operating points of the synchrotron is well in the stable region free from major lower order resonances (Figure 3)[2].

In parallel, development of a scheme consisting of a laser ion soure followed by a compact cooler ring and a pulse high-magnetic field synchrotron has been started for the purpose of downsizing the needed cost and size of the facility to realize more wide-spread use of the charged particle therapy. Quantitative study of high energy ion production with a high power short pulse laser has been started in collaboration with Advanced Photon Research Center, JAERI, Kansai Research Establishmen, University of Tokyo and Hiroshima University. Feasibility of the electron beam cooling of hot ion beam has also been studied in collaboration with Max-Planck-Institut für Kernphysik, Heidelberg Germany and NIRS.

2. Morita A et al., Phys. Rev. ST-AB, Dec. 2001, 122401

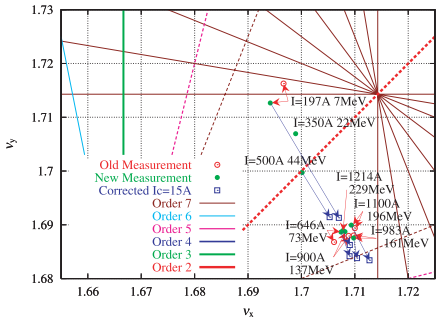

Figure 3. Operating points evaluated for the combined-function synchrotron.

Ion beam cooling --toward the crystalline beam

Recent electron beam cooling experiments of highly charged heavy ions at ESR of GSI in Darmstadt, Germany and CRYRING at Manne Siegbahn Laboratory in Stockholm, Sweden have shown the indication of one dimensional ordering effect. Three dimensional laser cooling is expected to realize much lower temperature although the applicable ion is limited due to the restriction of available lasers. A workshop was organized at Large Seminor Room of Joint Research Laboratory of ICR from the 12th to 14th in November with financial support from ICR and NIRS so as to obtain the common understanding among the participants of the presently attained results and desirable future approach . More than 40 participants including 6 from abroad joined. Many enthusiastic talks were presented as shown in Figure 4.

Figure 4. Invited talk on electron beam cooling by Dr. M. Grieser given at the workshop.