Beam Physics 2013 and Youth Workshop at OIST
28~29 November, 29~30 November 2013

Welcome

Tsumoru Shintake
Workshop Chair, Professor at OIST

I am very happy to host Beam Physics Workshop and Youth Workshop at Okinawa Institute of Science and Technology Graduate University (OIST).
OIST is conducting outstanding education and research in science and technology, promote and sustain the advancement of science and technology in Japan and throughout the world.
About fifty world-class faculties in the life science, physical and environmental sciences have joined OIST as leaders of the University's research units. The absence of academic departments, provide a natural home for truly inter-disciplinary research. Each year since September 2012, about twenty graduate students, selected from amongst the best available worldwide, have begun their studies at OIST.

Particle accelerator is truly inter-disciplinary science, i.e., we rely on basic classical electromagnetism, quantum, and various engineering fields such as fluid, mechanical and electrical engineering. This is one of the best subject for graduate student to study.

Particle accelerators is inevitable engine for basic physics research for high-energy physics, one of recent eminent result is higgs boson particle finding in LHC: Large Hadron Collider. In near future, we will extend machine to 30 km linear collider, and further size or higher beam power will make possible for dark-matter findings. Particle accelerators also provide powerful tool for bioscience as synchrotron light source or FELs.

Beam physics workshop is yearly held meeting within Japan for student and researcher from accelerator field, where we exchange ideas and news from home laboratories. I believe atmosphere of OIST, freedom of research, will provide attendees a great chance to discuss not only academic subject but also various non-academic issue amount laboratories, and find better solutions for our future.

Prof. Tsumoru Shintake
Quantum Wave Microscopy Unit
& Ocean Power Research

OIST: Okinawa Institute of Science and Technology
1919-1, Tancha, Onna-son, Okinawa 904-0495 Japan

Web Information of Workshop

Website of workshop is at https://groups.oist.jp/ja/beamphysics.

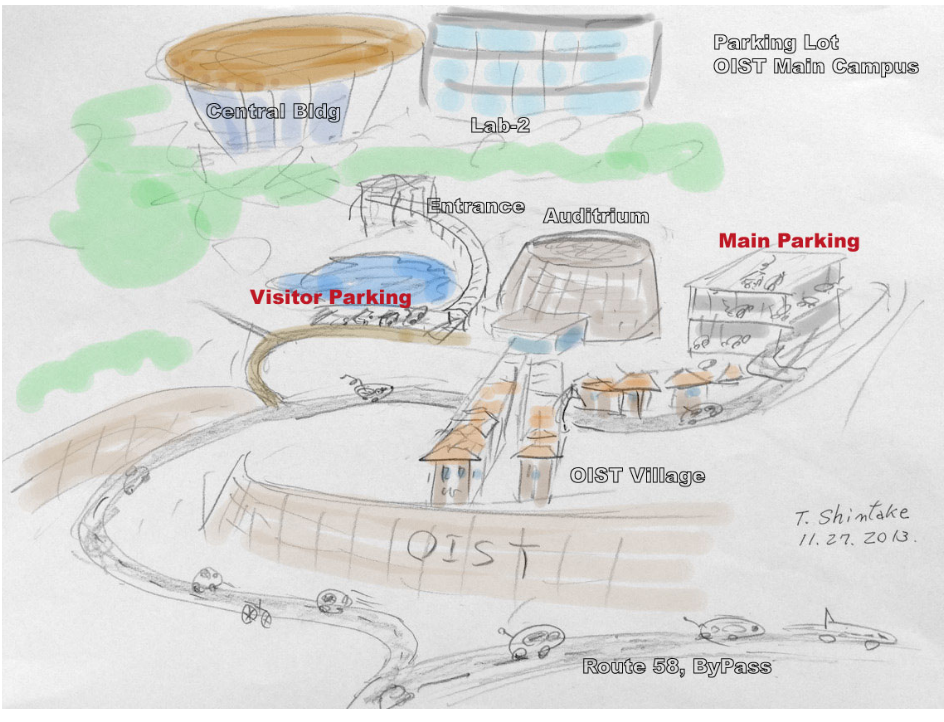
Location

Beam Physics Workshop: OIST Main Campus, Seminar Room B250
　OIST では１階を A、２階を B、3 階を C と呼びます。B250 は Center Bldg の２階（カフェの１階下）です。地図、スケッチ参照。

Beam Physics Youth Workshop: OIST Seaside House, Seminar Room
　OIST Main Campus から海岸へ向け 2km、徒歩で 15 分程度。車で５分。駐車場あり。地図参照。

Parking Lot

レンタカーの方は、下図の駐車場を利用ください。



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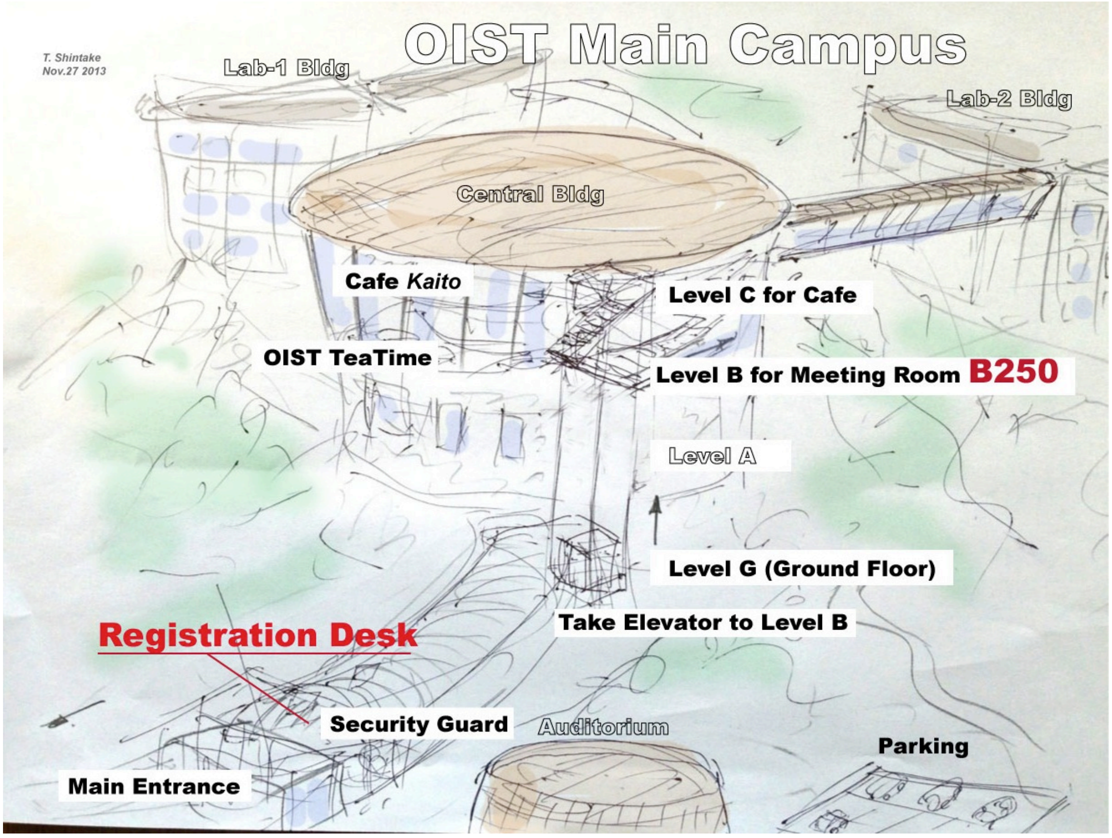

飲酒運転　禁止

　レンタカーを利用して参加している方へ。レセプション、BBQ での飲酒の後、たとえ近距離でも絶対に車を運転しないように。運転代行が安価で便利です。沖縄の経済の活性化のためにも、運転代行やタクシーの利用をお願いします。なおワークショップから資金の援助はできません。乗り合わせ等で割り勘にて負担願います。

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Program of the Beam Physics Workshop 2013

Nov. 28 (Thu), 2013, OIST Main Campus, Seminar Room B250

Oral Session 1
(Presentation: 30 min. Questions and Answers: 10 min.)

9:00 – 9:10		Opening
9:10 – 9:50	O01	An optimization of Positron Injector of ILC Masao Kuriki (Hiroshima University/KEK)
9:50 – 10:30	O02	The status of conventional positron source for ILC Junji Urakawa (KEK)
10:30 – 10:45		Break
10:45 – 11:25	O03	Commissioning of Compact-ERL injector Yosuke Honda (KEK)
11:25 – 12:05	O04	Low emittance electron beam transportation from photocathode DC gun Tsukasa Miyajima (KEK)
12:05 – 13:50		Lunch

Oral Session 2
(Presentation: 30 min. Questions and Answers: 10 min.)

13:50 – 14:30	O06	Recent Progress : Undulator Radiaton Carrying OAM Shigemi Sasaki (Hiroshima Synchrotron Radiation Center, Hiroshima Univ.)
14:30 – 15:00		Break

Invited Seminar (OIST Seminar)

15:00 – 15:15	S01	Introduction to 4D Electron Microscopy Keshav Dani (OIST)
15:15 – 15:50	S02	MeV Electron Diffraction and Microscopy Jinfeng Yang (Osaka university)
15:50 – 16:00		Break
16:00 – 16:30		Tea time
16:30 – 17:15		Campus tour
18:00 – 20:00		Dinner Party (Rizzan Sea-Park Hotel)

Nov. 29 (Fri), 2013, OIST Main Campus, Seminar Room B250

Oral Session 3
(Presentation: 30 min. Questions and Answers: 10 min.)

9:00 – 9:25	O07	Study of Longitudinal Phase Space Distribution Measurement via a Linear Focal Cherenkov Ring Camera Anusorn Lueangaramwong (Electron Light Science Centre, Tohoku University)
9:25 – 9:40	O08	Transverse Emittance Exchange for Smith-Purcell Backward-wave Oscillator FEL Hiroyuki Hama (Electron Light Science Centre, Tohoku University)
9:40 – 10:20	O09	Study of integer resonance crossing in non-scaling FFAGs with an ion trap system Kei Fukushima (Hiroshima University Graduate School of Advanced Sciences of Matter)
10:20 – 10:35		Break
10:35 – 11:15	O10	Beam injection study at aichiSR and UVSOR-III Naoto Yamamoto (Nagoya University)
11:15 – 11:55	O11	Thin Film on Bulk Conductor Yoshihisa Iwashita (Kyoto Univ.)
11:55 – 12:00		Closing

Program of the Beam Physics Youth Workshop 2013 (Tentative!!)

Nov. 29 (Fri), 2013, OIST Seaside House, Seminar Room

15:30 – 15:35		Opening
		Introduction of Laboratory *(each 10 min.)*
15:35 – 16:05	YI01	Satoru Nagasawa (Tohoku University)
	YI02	Kazuo Tanaka (University of Tokyo)
	YI03	Shohei Otsuki (The University of Tokyo)
		Short Oral Session *(each 5 min.)*
16:05 – 17:30	YS01	Direct diagnostic technique for a high intensity laser based on laser Compton scattering Ryo Sato (Waseda University)
	YS02	Study on optical enhancement cavity for CO2 laser Naoto Takeichi (Waseda University)
	YS03	Evaluation of a 2 Cell RF-Deflector Cavity for Longitudinal Beam Profile Measurement Masahiro Nishiyama (Waseda University)
	YS04	Development of photo cathode for semiconductor electron gun Ryo Inagaki (Nagoya University)
	YS05	Measurement of temporal response of transmission-type spin-polarized photocathodes Toshiki Inagaki (Nagoya University)
	YS07	Measurement of muonium hyperfine splitting at J-PARC Kazuo Tanaka (The University of Tokyo)
	YS08	DEVELOPMENT OF TRANSMISSION-TYPE POLARIZED ELECTRON SOURCE FOR INVERSE PHOTOEMISSION SPECTROSCOPY Yohei Kajiura (Nagoya University)
	YS09	Commissioning of observation system and seed light source of coherent harmonic generation So Sekita (Nagoya University)
	YS10	Measurement of emittance in Aichi synchrotron radiation center Ryo Kawakami (Nagoya University)
	YS11	Optical focusing corrections for 2D visible light beam profile monitor Takuya Matsumoto (University of Hyogo)
	YS12	Development of Multi-Alkali Photocathode for Quantum Efficiency and Long Lifetime Yuji Seimiya (Hiroshima University)
	YS13	Design of Knot-APPLE undulator Nobumitsu Kawata (Hiroshima University)
	YS14	Laser-driven On-chip Particle Accelerator Shohei Otsuki (The University of Tokyo)
	YS15	Measurement of radially polarized terahertz radiation profile using a terahertz camera Yoshitaka Taira (National Institute of Advanced Industrial Science and Technology (AIST))
	YS17	Recent Progress on Ion Beam Acceleration with Direct Plasma Injection Scheme Yasuhiro Fuwa (Kyoto University)
	YS20	Recent Activities of THz Generation at KU-FEL Heishun Zen (Kyoto University)
	YS22	STUDY OF EXTREME SHORT ELECTRON BUNCH PRODUCTION USING ITC-RF GUN Satoru Nagasawa (Tohoku University)
		Poster Session
17:30 – 18:30	YP01	Ryo Sato (Waseda University) Direct diagnostic technique for a high intensity laser based on laser Compton scattering
	YP02	Study on optical enhancement cavity for CO2 laser Naoto Takeichi (Waseda University)
	YP03	Evaluation of a 2 Cell RF-Deflector Cavity for Longitudinal Beam Profile Measurement Masahiro Nishiyama (Waseda University)
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	YP05	Measurement of temporal response of transmission-type spin-polarized photocathodes Toshiki Inagaki (Nagoya University)
	YP06	Development of an evaporation chamber for photocathode study Shuri Matsuzaki (Waseda University)
	YP07	Measurement of muonium hyperfine splitting at J-PARC Kazuo Tanaka (The University of Tokyo)
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	YP16	Yoshihisa Iwashita (Kyoto University)
	YP17	Recent Progress on Ion Beam Acceleration with Direct Plasma Injection Scheme Yasuhiro Fuwa (Kyoto University)
	YP18	Study on New Method for Producing Highly Charged Ions with Double Pulse Laser Ion Source Tatsunori Shibuya (Tokyo Tech.)
	YP19	Lattice Design of Ultra-Low Emittance Light Source with a Torus-Knot Type Accumulator Ring Atsushi Miyamoto (Hiroshima University)
	YP20	Recent Activities of THz Generation at KU-FEL Heishun Zen (Kyoto University)
	YP21	Present Status of Laser Ion Source with ps Laser System at BNL Masafumi Kumaki (Waseda University, RIKEN)
	YP22	STUDY OF EXTREME SHORT ELECTRON BUNCH PRODUCTION USING ITC-RF GUN Satoru Nagasawa (Tohoku University)
18:30 – 20:30		Dinner (BBQ@Seaside House)

Nov. 30 (Sat), 2013, OIST Seaside House, Seminar Room

Seminar
– Learning from experienced persons –

9:00 – 10:25	YL01	Experiences on High- Power Microwave Technology on Accelerator Science Atsushi Miura (NIHON KOSHUHA Co., Ltd.)
10:25 – 10:35		Break
10:35 – 12:00	YL02	C-band Accelerator Construction at SACLA: X-ray Free Electron Laser Sadao Miura (Mitsubishi Heavy Industries LTD.)
12:00 – 13:00		Lunch

Tutorial Lecture

13:00 – 15:00	YT01	Electron Vortex Beam -- A unique propagation mode of electron waves with helical wavefronts Koh Saitoh (Eco Topia Science Institute, Nagoya University)
15:00 – 15:05		Break

Introduction of Laboratory
(each 10 min.)

15:05 – 16:35	YI04	Ryunosuke Kuroda (National Institute of Advanced Industrial Science and Technology (AIST) Laboratory)
	YI05	Kazuyuki Sakaue (Waseda University)
	YI06	Ryo Kawakami (Nagoya University)
	YI07	Yasuhiro Fuwa (Kyoto University)
	YI08	Heishun Zen (Kyoto University)
	YI09	Takuya Matsumoto (University of Hyogo)
	YI10	Yuji Seimiya (Hiroshima University)
	YI11	Atsushi Miyamoto (Hiroshima University)
	YI12	Taro Konomi (Institute for molecular Science)
16:35 – 16:40		Closing

O01

An Optimization of Positron Injector of ILC

○ Masao Kuriki[1], Toshiyuki Okugi[2], Masanori Satoh[2], Junji Urakawa[2], Shigeru Kashiwagi[3]

1Adsm, Hiroshima University, 2 KEK, 3 RCEPS, Tohoku University

ILC (International Linear Collider) is a future project of high energy physics. LHC at CERN discovered Higgs boson and detail study of the Higgs sector is the most important issue in the high energy physics. ILC TDR (Technical Design Report) was published in 2013 as a result of the intense R&D and design efforts since 2004. In TDR , 6 GeV electron beam driven positron source (NIM, A 672, pp. 52-56, 2012) is expressed as a backup option. From the technical point of view, this conventional scheme is feasible, since a technical integration of the undulator gamma ray scheme prior to ILC construction is principally difficult. In this presentation, an optimization of the ILC positron source based on the conventional scheme is discussed. The positron is generated in 60ms instead of 1ms (pulse length in main linac) to suppress potential damage on the production target. The positron is captured and boosted by NC linac in a multi-bunch format. An optimization of damping ring acceptance with an energy compressor and beam-loading compensation with the amplitude modulation are essential for adequate capture efficiency. The capture optimization based on these schemes is discussed. The expected performances with AMD (Adiabatic Matching Device) followed by L-band and S-band for the capture section with a solenoid field, and the booster linac are compared.

The Experimental Plan on Heavy Beam Loading Compensation for ILC Conventional Positron Source*

Junji Urakawa

KEK

We proposed a 300Hz Linac scheme for conventional positron source as ILC backup positron source (NIM, A 672, pp. 52-56, 2012). In this design, the 300Hz electron linac is employed to create positrons with stretching pulse length in order to cure target thermal load. Each pulse of the 300Hz linac creates about 130 bunches, then 2600 bunches are created in 63ms, because ILC requires about 2600 bunches in a train which pulse length is 1ms. The bunch-to-bunch separation in the damping ring is 6.15ns, therefore the bunch-to-bunch separation of 6.15 ns in the 300Hz linac is chosen. In order to avoid instabilities in the damping ring caused by electron clouds, the positron beam has a mini-train structure where about 40 bunches form a mini-train. The gaps of about 100ns between adjacent mini-trains are the key to prevent instabilities. So, we have to compensate the energy spread which is generated by transient beam loading effect due to multi mini-trains. We propose the experimental plan using the injector part of ATF linac which consists of photo-cathode RF gun, 3m long S-band structure and 90 degree bending magnet for beam diagnoses and beam dump.

Fast amplitude control of input RF power to RF gun cavity and 3m long structure is necessary. We introduce the technique to control the input RF power by change of fast RF phase, which means we need additional set of 3m long structure system after the bending magnet in order to make the amplitude control by phase modulation.

* This work is supported by Photon and Quantum Basic Research Coordinated Development Program of MEXT. † Collaborators: S. Araki, Y. Honda, T. Omori, T. Okugi, N. Terunuma, K. Kubo, T. Akagi, T. Naito, S. Kuroda (KEK, High Energy Accelerator Research Organization), R. Tanaka, Y. Uesugi, T. Takahashi (Hiroshima University), K. Sakaue, M. Washio (Waseda University), E. Bulyak, P. Gladkikh (NSC KIPT, Kharkov, Ukraine), F. Zimmermann (CERN), French-Japan and PosiPol Collaboration

Commissioning of Compact-ERL injector

○ Yosuke Honda[1]

1 KEK

An Energy Recovery Linac has been expected to be an advanced accelerator which can produce a low emittance and short bunch beam at high average current. One of the applications will be a future light source facility. An ERL test accelerator, compact-ERL, has been constructed in KEK. Operation of the injector part started in April of 2013.

Since ERL is a linac based machine, its beam performance is mostly determined by the injector. Proving a low emittance and short bunch beam at the injector is the most important. There is a special beam line for diagnosing beam quality of the injector. It has an emittance monitor system of slit scanners, a bunch length monitor of RF deflector, and an energy measurement system at a bending line. We report the beam measurement results at the first commissioning period of Spring 2013.

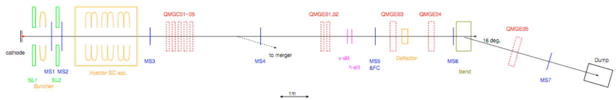


Fig. 1, Layout of the injector and diagnostic line.

LOW EMITTANCE ELECTRON BEAM TRANSPORTATION FROM PHOTOCATHODE DC GUN

○ Tsukasa Miyajima[1], Yosuke Honda[1], Nobuyuki Nishimori[2], Ryoji Nagai[2], Masahiro Yamamoto[1], Takashi Uchiyama[1], Kentaro Harada[1], Miho Shimada[1], Ryota Takai[1], Tatsuya Kume[1], Shinya Nagahashi[1], Takashi Obina[1], Shogo Sakanaka[1], Norio Nakamura[1], Ryoichi Hajima[2], Ji-gwang Hwang[3]

1 KEK, 2 JAEA, 3 KNU

In order to generate a low emittance, short pulse and high bunch charge electron beam, a photocathode DC gun has been developed for future light source based on Energy Recovery Linac (ERL). In compact ERL (cERL) which is a test accelerator to develop key technologies for ERL, the generation of low emittance electron beam with 0.1 mm mrad normalized emittance and 390 keV beam energy from the photocathode DC gun with GaAs cathode was demonstrated for low bunch charge operation. After generating electron beam, to keep the high quality in the beam transportation is important issue. To optimize the condition of the beam transportation, understanding the focusing effect due to the electric field of the gun, and beam optics in the transportation line, which contains solenoid magnets and a bunching cavity is required. In this presentation, we will show that how to measure and correct the gun focusing effect, which depends on the shape of the gun electrode, by experimental method. Using this method, we succeeded in correcting the analytical model to give the good agreement with the measured gun focusing. And, we will show the relation between the measured beam profile and an initial excitation laser condition for the photocathode.

RECENT PROGRESS: UNDULATOR RADIATION CARRYING OAM

○ Shigemi Sasaki

Hiroshima Synchrotron Radiation Center, Hiroshima University

The light's orbital angular momentum (LOAM) was theoretically predicted by Allen, *et. al.* in 1992 [1]. Since then, this exotic property in visible laser light regime has been studies extensively for manipulating nano-particles and developing optical communications. However in the VUV and soft X-ray regime, not much work has been done because there are some difficulties to generate such a property though the light of this regime may be useful to probe transmission between electronic states of atoms and molecules. In 2007, we predicted that higher harmonic radiation from a helical undulator has LOAM [2]. This theoretical prediction has been proven experimentally at BESSY-II [3]. Also, a recent experiment demonstrated that a combination of a laser beam and a relativistic electron beam in a helical undulator can manipulate the coherent light beam properties including LOAM [4]. In my talk, recent trend in this research filed and our preliminary experimental results at HiSOR will be presented. In addition, planned experiment at UVSOR will be mentioned.

[1] L. Allen, *et. al.* Phys. Rev. Lett. **45**, 8185 (1992).

[2] S. Sasaki & I. McNulty, Phys. Rev. Lett. **100**, 124801 (2008).

[3] J. Bahrdt, *et. al.* Phys. Rev. Lett. **111**, 034801 (2013).

[4] E. Hemsing, *et. al.* Nature Phys. **9**, 549 (2013).

STUDY OF LONGITUDINAL PHASE SPACE DISTRIBUTION MEASUREMENT VIA A LINEAR FOCAL CHERENKOV RING CAMERA

○ A. Lueangaramwong*, F. Hinode, S. Kashiwagi, T. Muto, I. Nagasawa, S. Nagasawa, K. Nanbu, Y. Shibasaki, K. Takahashi, K. Yanagi, H. Hama

Electron Light Science Centre, Tohoku University

A study on generation of intense coherent THz radiation from sub-picosecond electron bunches has been developing at Tohoku University. Initial electron distribution in the longitudinal phase space produced by an electron gun is predominantly essential for extreme short electron bunch production. For relatively lower energy electrons, a novel method for measurement of electron kinetic energy (*or* momentum) applying velocity dependence of the opening angle of Cherenkov radiation was proposed. Combined use of a streak camera and a "turtle-back" mirror that confines the Cherenkov light on to a linear focal line may allow us to observe the longitudinal phase space distribution directly. To achieve the best energy resolution, a radiator and the "turtle-back" mirror were designed to be placed inside a vacuum chamber called "radiator chamber". The "4f" imaging system consisted of two off-axis parabolic cylinder mirrors can transport the Cherenkov light to outside of the vacuum system through a quartz window and enhance energy resolution of the system as well. We examined experimental setup with reflective optics by a numerical ray tracing to optimize the optical elements' parameters and configuration. Sufficient energy (*or* momentum) and time resolutions were derived.

Study of integer resonance crossing in non-scaling FFAGs with an ion trap system

○ K. Fukushima[1], K. Moriya[1], T. Okano[1], K. Ito[1], H. Okamoto[1],

S. L. Sheely[2], D. Kelliher[2], S. Machida[2], C. Prior[2]

1 *Graduate School of Advanced Sciences of Matter, Hiroshima University,*

2 STFC, Rutherford Appleton Laboratory

The collective motion of a non-neutral plasma confined in a linear Paul trap (LPT) is approximately equivalent to that of a charged particle beam propagating through an alternating-gradient focusing channel. This physical analogy can be employed to experimentally explore various beam instability mechanisms by means of the compact LPT instead of large-scale accelerators. On the basis of this idea, a unique tabletop experimental system called "S-POD" has been developed at Hiroshima University. S-POD is the abbreviation of "Simulator for Particle Orbit Dynamics". In this talk, we report on results of recent S-POD experiments performed to study integer-resonance crossing in non-scaling fixed field alternating gradient (NS-FFAG) accelerators. In a NS-FFAG, the operating point inevitably crosses several resonance stop bands during beam acceleration. We here assume the typical lattice condition of the first NS-FFAG "EMMA" that was recently constructed in England. An additional rf dipole perturbation is applied to the LPT electrodes in order to excite arbitrary integer resonances. Ion losses within specific stop bands are measured for a wide range of resonance crossing speed. We also carry out multi-particle simulations and compare the numerical results with experimental data from S-POD.

Beam injection study at AichiSR and UVSOR-III

○ Naoto Yamamoto[1], M. Hosaka[1], H. Zen[2], T. Konomi[3], K. Hayashi[3], J. Yamazaki[3], Y. Takashima[1], M. Katoh[3]

1 Nagoya University, 2 Kyoto University, 3 UVSOR

The pulsed multipole injection has been developed in KEK. In this scheme, the injected beam is captured into the ring acceptance by the result of a pulsed multipole kick, while the stored beam passes through the center of the multipole magnet where the magnetic field is almost zero. Thus, it allows realizing a high quality photon beam for SR users without coherent oscillation of the stored beam in top-up injection.

We designed pulsed multipole magnets for the UVSOR-III and AichiSR rings and have manufactured for the UVSOR-III one. A sextupole-like magnetic field could be excited by using the multipole magnet and the residual field at the center position of the magnet due to machining errors was compensated by using thin ferrite sheets. As results of the injection experiments, the multi-turn injection by using the pulsed multipole magnet was successfully introduced to the UVSOR-III ring. The injection efficiency of 23 % was achieved and electron beams are stored up to the operation current of 300 mA. We also confirmed that oscillations of the stored beam during beam injections were drastically suppressed compared from conventional pulsed dipole magnet injection.

Thin Film on Bulk Conductor

○ Y. Iwashita[1], T. Kubo[2], T. Saeki[2]

1 Kyoto University, 2 KEK

Structures of alternating layers of normal-conducting and insulating films formed on a bulk normal-conductor (M-I-M structure) proposed by A. M. Clogston in 1951 and those of superconducting (Sc) and insulating films formed on a bulk superconductor (S-I-S structure) proposed by A. Gurevich in 2006 are actively discussed these years, because of their great possibility in reducing power consumptions of the normal- and Sc RF cavity and in enhancing RF breakdown field of the Sc RF cavity. Although both the M-I-M and the S-I-S structures are attractive ideas for RF-cavity applications, not many confirmed results are reported. In this contribution we will present our recent achievement in studies of the M-I-M and the S-I-S structures. An experimental confirmation of the idea of the M-I-M structure and issues on its applications to the cavity will be reported. This study was motivated for mitigations of the skin effects. An advancement of theoretical study on the S-I-S structure, which may raise the cavity gradient, will also be introduced. General formulae for the vortex-penetration field of the superconductor layer and the magnetic field on the bulk superconductor are derived with a rigorous calculation. Using the formulae, a combination of the thicknesses of superconductor and insulator layers to enhance the RF breakdown field limits can be found for any given materials.

YP01

DIRECT DIAGNOSTIC TECHNIQUE A HIGH INTENSITY LASER BASED ON LASER COMPTON SCATTERING

○ Ryo Sato, Yasufumi Yoshida, Ko Nonomura, Kazuyuki Sakaue, Masakazu Washio, Akira Endo

Waseda university

In laser produced plasma (LPP) EUV source, high intensity pulse CO2 laser is essential for plasma generation. To achieve high conversion efficiency and stable EUV power, we would like to measure laser profile in collision point. There is no way to directly measure high intensity lasers profile. Therefore, we have been developing laser profiler based on laser Compton scattering. Laser profile can be measured by scanning focused electron beam while measuring Compton signal. In this method, very small spot size of electron beam is need. We use S-band rf gun system at Waseda university and solenoid lens. We have succeeded in observing minimum beam size of about 20 μm rms. In this conference, we will report the results of focused electron beam measurement and future prospective. .

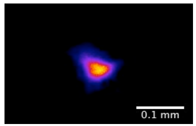


Fig. 1, Focused electron beam profile

YP02

Study on optical enhancement cavity for CO_2 laser

○ Naoto Takeichi, Kohei Ando, Kazuyuki Sakaue, Akira Endo, Masakazu Washio

Waseda University

A laser-Compton X-ray have several advantages, energy variability, directivity, short-pulse, high intensity, high polarization, and compact. Thus it has a possibility to be widely used for several fields such as physics, chemistry, medicine, and industry. We develop a laser-Compton X-ray source using an optical enhancement cavity for CO_2 laser. An optical enhancement cavity is the equipment which accumulates a laser in a resonator. It can enhance dramatically the intensity of laser by accumulating laser waves. The wavelength of CO_2 laser is 10 μm. It is ten times longer than that of 1μm lasers we usually used, so we can one-order increase the photon number of X-ray by using CO_2 laser. In this experiment, we measured two parameters, finesse and enhancement, and achieved 553 and 37 respectively. In this conference, we will report the setup of the optical enhancement cavity for CO_2 laser, experimental results and future prospects.

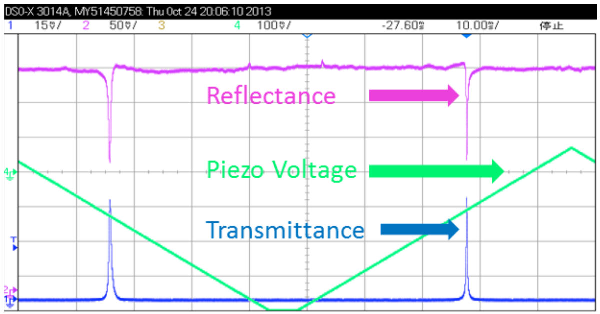


Fig1. Transmittance and reflectance of CO_2laser enhancement cavity

YP03

Evaluation of a 2 Cell RF-Deflector Cavity for Longitudinal Beam Profile Measurement

○ Masahiro Nishiyama[1], Yuichi Nishimura[1], Takenoshin Takahashi[1], Kazuyuki Sakaue[1], Masakazu Washio[1], Toshikazu Takatomi[2], Junji Urakawa[2],

1 Waseda University, 2 High Energy Accelerator Research Organization

We have been studying a compact electron accelerator with an S-band Cs-Te photocathode rf electron gun at Waseda University. We are applying this high quality electron bunch to a pulse radiolysis experiment and a laser Compton scattering experiment. These experiments need high quality and well-controlled electron beam. In order to measure the ultra-short electron bunch length and longitudinal profile precisely, the rf-deflector system is adopted. It kicks the electron bunch with electromagnetic field. With this technique, the longitudinal bunch profile can be obtained as the transverse profile. The rf-deflector was optimized for operating on π-mode, standing wave, dipole (TM_{120}) mode at 2856 MHz. Resulting temporal resolution was around 100 femto-seconds bunch length in simulations. We report the latest progress of the bunch length measurement by the rf-deflector at Waseda University.

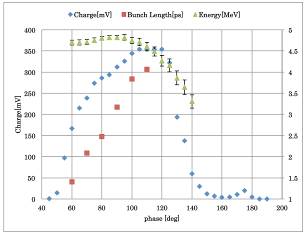


Fig. 1, Experimental data.

YP04

Development of multi-alkali photo cathode with transparent superconductor

○ Ryo Inagaki[1], Taro Konomi[2], Tetsuzyou Tokushi[2], Masahiro Katoh[2,1], Eiji Kako[3], Seiya Yamaguchi[3], Yukinori Kobayashi[3], Naoto Yamamoto[1,2], Masato Hosaka[1] Yoshifumi Takashima[1], Susumu Shiraki[4], Taro Hitosugi[4], Kosswattage. K. Rasika[5], Yasuyoshi Okano[6]

1 Nagoya Univ., 2 UVSOR, IMS, 3 KEK, 4 Tohoku Univ., 5 Chiba Univ., 6 Laser center, IMS

In UVSOR, the X-ray free electron laser (XFEL) based on linear accelerator with high pulse repetition about 1MHz are being designed as a future plan. By combining a superconducting RF cavity and a photocathode, an optimal electron gun for the new accelerator may be constructed. For this electron gun, we propose a back-illuminated multi-alkali photocathode with transparent superconductor $LiTi_2O_4$ (Fig.1). The transparent superconductor can reflect RF because the London penetration depth is about 100nm. We expect it enable the back-illumination in the high power RF field. We will present a conceptual design and discuss its advantage. We will also report some early experimental results of Multi-Alkali deposition on some substrates.

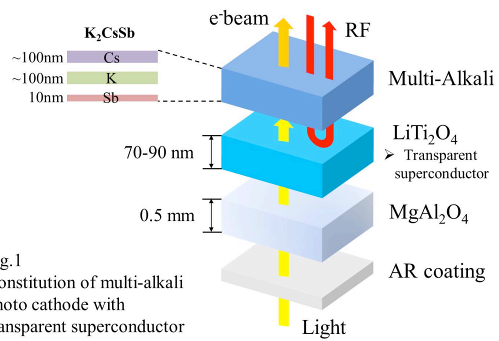


Fig.1
Constitution of multi-alkali photo cathode with transparent superconductor

MEASUREMENT OF TEMPORAL RESPONSE OF TRANSMISSION-TYPE SPIN-POLARIZED PHOTOCATHODES

○ Toshiki Inagaki[1], Naoto Yamamoto[1], Yohei Kajiura[1], Taro Konomi[2], Yasuaki Okano[3], Masahiro Adachi[4] , Xiuguang Jin[1], Masato Hosaka[1],Yoshifumi Takashima[1], Masahiro Kato[2]
1 Nagoya University, 2 UVSOR, 3 Laser Research Center for Molecular Science, IMS, 4 KEK,

Spin polarized electron beam is essential for "International Linear Collider". In Nagoya University, transmission-type spin-polarized photocathodes have been developed. In the development, the quantum efficiency of 0.5 % and the polarization of ~90 % were achieved. However, the response time of the transmission-type electron source has not been measured. Therefore, in order to measure the response time, we have developed a pulse length measurement system by using a RF deflecting cavity. In the poster session, we will describe the details of the measurement system and present some early experimental results.

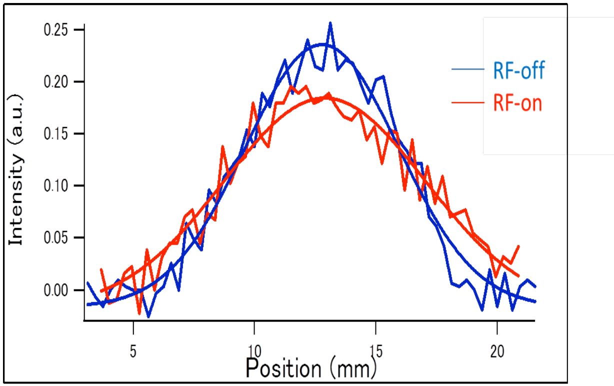


Fig. 1, The expansion of electron beam by using an RF deflecting cavity.

YP06

Development of an evaporation chamber for photocathode study

○ Shuri Matsuzaki, Mizuki Sakamoto, Kazuyuki Sakaue, Masakazu Washio

Waseda University

A photocathode is a key component for a high quality, high charge and stable electron gun. A Cesium Telluride (CsTe) photocathode has been performed in a photocathode RF electron gun since 2007 at Waseda University. Comparing with metal cathodes, a CsTe photocathode has higher quantum efficiency (Q.E.) of several percent. However, this value is going down in several hours-days because of its short life time. We have been developing a cathode evaporation vacuum chamber which enables us to not only manufacture a fresh CsTe photocathode for an accelerator frequently but also regulate and observe formation process precisely to research suitable growth recipes in order to obtain higher Q.E. and longer life time. A new cathode, which is manufactured in this chamber, can be transferred into an accelerator without being exposed to the air owing to a load-lock system. Although the size of the chamber is small (1.2m ×1.3m ×1.2m), it has some spare ports which enable further studies of other types of photocathodes. We have already tried to evaporate CsTe cathodes and these showed good performances in the RF gun operation. In this presentation, we will report details of the new evaporation chamber system at Waseda University, a property of manufactured photocathodes and our future plans.

YP08

DEVELOPMENT OF TRANSMISSION-TYPE POLARIZED ELECTRON SOURCE FOR INVERSE PHOTOEMISSION SPECTROSCOPY

○ Yohei Kajiura[1], Toshiki Inagaki[1], Naoto Yamamoto[1], Masahito Hosaka[1], Atsusi Mano[1], Yoshifumi Takashima[1], Taro Konomi[2], Masahito Katoh[2, 1]

1 Nagoya University, 2 UVSOR

Transmission type (NEA-GaAs) spin-polarized electron sources, in which pumped laser light is injected from the back side of the photocathodes and the polarized beam is extracted from the front side, have been developed. By using this type of photocathode, the high brightness of ~2×10^7A.cm^{-2}.sr^{-1} and the high polarization of ~90% were achieved. In UVSOR, we are planning to apply these types of photocathodes to the inverse photoelectron spectroscopy. The compact 90° bend spin rotator is under construction. The design and the expected performance will be presented.

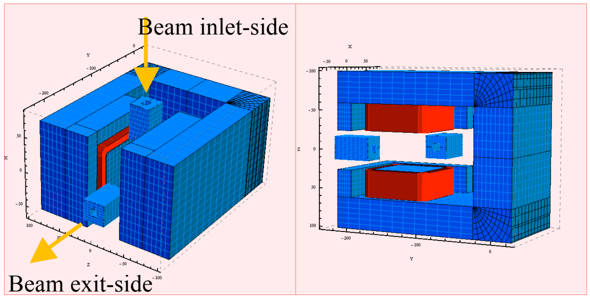


Fig. 1, 3D bending magnet model.

YP09

Commissioning of observation system and seed light source of coherent harmonic generation

○ So Sekita[1], Masahito Hosaka[2], Yoshifumi Takashima[1,2], Naoto Yamamoto[1,2], Jyunichiro Yamazaki[3], Kenji Hayashi[3],Taro Konomi[3], Masahiro Katoh[3,2]

1 Nagoya University, 2 NUSR, 3 UVSOR

At UVSOR-III, we are developing a coherent VUV light source using coherent harmonic generation (CHG) technique. An optical klystron, consisting of two Apple-II type undulators and an electro-magnetic buncher, has been already installed in a long straight section called U1.

Recently, we installed a spectrometer at the U1 experiment end station and made a first CHG experiment. In the experiment, we use 800 nm laser as a seed light source and observe 3rd-CHG (266 nm) using the spectrometer and a photomultiplier tube. Figure 1 shows the measured CHG spectrum.

In the presentation, we also report on the expected CHG radiant energy calculated using UVSOR electron beam parameters and the comparison with the experimental result.

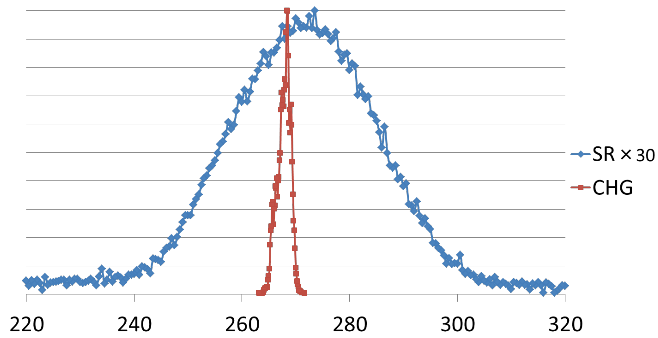


Fig. 1, 3rd-CHG spectrum.

YP10

Measurement of emittance in AICHI synchrotron radiation center

○ Ryo Kawakami[1], Atsushi Mano[1],Hosaka Masahito[1],Naoto Yamamoto[1],Takumi Takano[1],

Yoshifumi Takashima[1,]Masahiro Kato[1,2],

1, Nagoya Univercity 2 UVSOR

We have constructed a diagnostic beamline in the Aichi synchrotron radiation center (Aichi SR) storage ring for measurement of electron beam property. We observed a beam image using a CCD camera and deduced horizontal beam size. For the vertical direction we designed an interferometer using the double slit in order to obtain a sufficient resolution.

In order to reduce the beam vertical dispersion and emittance, we designed skew quadrupole magnets and introduce to the storage ring. Apparent reduction of the vertical dispersion and emittance are observed.

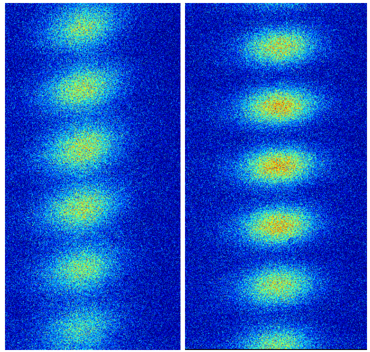


Fig. 1, Double slit interferogram image after the introduction and before the introduction of the skew magnet taken by a CCD camera.

OPTICAL FOCUSING CORRECTION FOR 2D VISIBLE LIGHT BEAM PROFILE MONITOR

○ Takuya Matsumoto[1], Karin Kobayashi[1], Yoshihiko Shoji[1], Yasuyuki Minagawa[2], Yasuhiro Takemura[2]

1 Laboratory of Advanced Science and Technology for Industry, University of Hyogo,

2 Japan Synchrotron Radiation Research Institute

NewSUBARU is 1.0 GeV and 1.5 GeV electron storage ring in SPring-8 site. It has the visible light beam monitor line SR5. We obtain two dimensional beam images on this line with CCD cameras.

The initial mirror on this line is deformed by heat load of synchrotron radiation, and the effect of this deformation is approximated by a defocusing function. One of problems produced by the deformation was that the image focusing depended on the stored beam current and energy and was different in horizontal and vertical directions.

In order to eliminate the difference in two directions we installed a weak cylindrical lens, with which we have one focusing point in two directions. The current dependence of the imbalance was cancelled by changing position of the lens according to the prediction. We succeeded to obtain a good two dimensional beam image at any electron beam energy and stored current.

YP12

Development of Multi-Alkali Photocathode for High Quantum Efficiency and Long Lifetime

○ Yuji Seimiya, Masao Kuriki, Rai Kaku, Norihito Yamamoto, Taro Konomi[1]

Hiroshima University, 1 Institute for molecular science

Multi-alkali photocathode has excellent features: high quantum efficiency, long lifetime, and the cathode can be excited by green laser. We are studying thickness condition for cathode performances by measured multi-alkali evaporation quantities. Furthermore, design of multi-alkali evaporation device for XPS, UPS, and LEED measurements at Institute for molecular science is in planning. These measurement can be cleared relations of electronic state, crystal structure, and surface condition, moreover, relation between evaporation condition and cathode performances. On the other hands, design of multi-alkali evaporation device for cERL to demonstrate high current and long run.

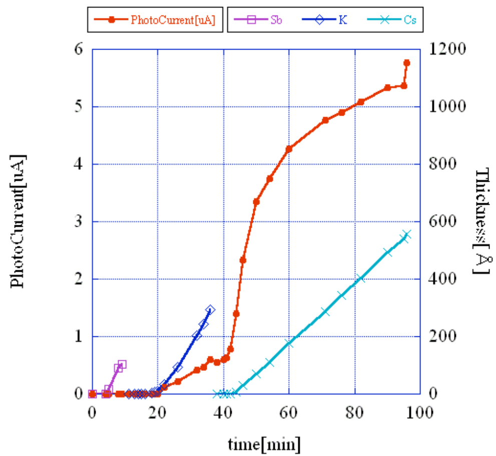


Fig. 1, Photocurrent change in cathode evaporation

Design of Knot-APPLE undulator

○ Nobumitsu Kawata[1], Shigemi Sasaki[2], Atsushi Miyamoto[2]

[1]Department of Physical Science, Faculty of Science, Hiroshima University

[2]Hiroshima Synchrotron Radiation Center, Hiroshima University

It is necessary to increase the undulator's diffraction parameter *K* to generate low energy photon beam in a high energy storage ring. In this case, a high heat load on beamline elements is a serious problem because the on-axis radiation power increases drastically for a linear undulator. This problem can be overcome by using a Figure-8, a Pera or a Knot undulator [1,2]. However, none of them has the ability to change polarizations. We propose a novel Knot-APPLE undulator which is capable to reduce an on-axis high heat load and generate every polarization state. In my presentation, I present a conceptual design of Knot-APPLE undulator and its expected performance.

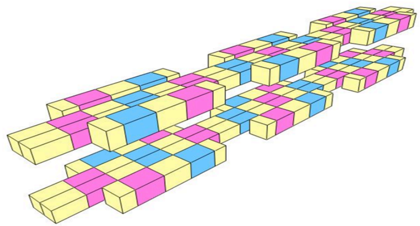


Figure 1 : Cutout view of a Knot-APPLE undulator structure

[1] S. Sasaki, "Undulators, wigglers and their applications," pp.237-243 (Ed. by H. Onuki and P. Elleaume, Taylor & Francis Inc, New York, 2003).

[2] S. Qiao, et. al, Rev. Sci. Instrum., 80, 085108 (2009).

YP15

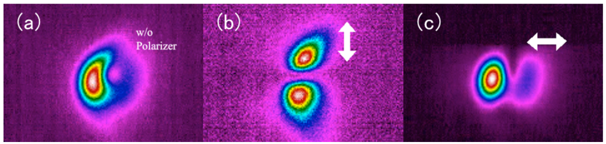
Measurement of radially polarized terahertz radiation profile using a terahertz camera

○ Y. Taira[1], R. Kuroda[1], M. Tanka[1], H. Toyokawa[1], H.Tomizawa[2]

1 AIST, 2 RIKEN

A coherent transition radiation (CTR) and a coherent synchrotron radiation (CSR) terahertz sources have been developed using an ultra-short pulsed electron beam generated by an S-band compact electron linac at AIST. We have constructed a polarization analysis system using a polarizer and a terahertz camera (NEC, IRV-T0831) for radially polarized CTR. The terahertz camera contains an uncooled microbolometer focal plane array. The pixel number, pixel pitch, and frame rate are 320 x 240 pixels, 23.5 μm, and 30 Hz. The CTR is emitted when the ultra-short pulsed electron beam pass through the interface between the Al_2O_3 plate and a vacuum. It then reflected at an off-axis parabolic mirror and passed through the three lenses and a polarizer. The profiles of the CTR measured with the terahertz camera in real time are shown in Fig. 1. Since the CTR is radial polarization, a bow-tie profile of CTR rotates by rotating the polarizer. In this workshop, we will present a polarization analysis of the radially polarized CTR and an electron bunch length measurement using the terahertz camera.

Fig. 1, Profile of the CTR measured with a terahertz camera.



(a): w/o polarizer, (b) vertical polarization component, and (c) horizontal polarization component.

RECENT PROGRESS ON ION BEAM ACCELERATION WITH DIRECT PLASMA INJECTION SCHEME

○ Yasuhiro Fuwa[1]

1 Kyoto University

Direct Plasma Injection Scheme (DPIS) is a successful scheme to supply high intensity heavy ion beams to Radio Frequency Quadrupole (RFQ). In the early phase, very high current beam acceleration using light mass species was demonstrated, and the achieved beam currents measured after an RFQ were more than 60 mA using carbon and aluminum ions. Later, confinement solenoid was also adopted to supply higher intensity heavy ions (Fig. 1).

Recent years, for application of DPIS to heavy mass ion acceleration, the commissioning study using iron plasma has been carried out. In this presentation, a new combination of the DPIS and the solenoid confinement, and the result of iron beam acceleration will be reported.

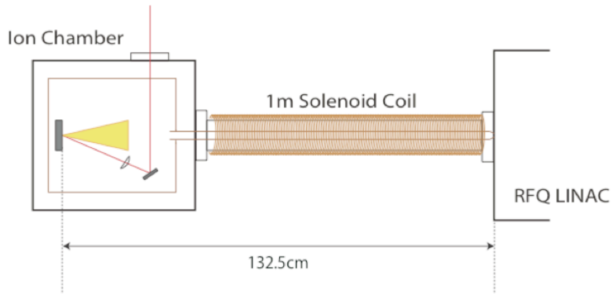


Fig. 1, Layout of laser ion source, solenoid and RFQ.

YP19

Lattice Design of Ultra-Low Emittance Light Source with a Torus-Knot Type Accumulator Ring

○ Atsushi Miyamoto and Shigemi Sasaki

Hiroshima Synchrotron Radiation Center, Hiroshima University

We proposed a torus knot type synchrotron radiation ring in that the beam orbit does not close in one turn but closes after multiple turns around the ring. This ring is capable to have many straight sections and it is advantageous to installation of many insertion devices. Currently, we are designing a new ring based on the shape of a (11, 3) torus knot for our future plan[1]. This ring is mid-low energy light source ring with a beam energy of 700 MeV. It has eleven 3.6-m-long straight sections though the ring diameter is as compact as 15 m.

In late years, some compact light source rings achieved very low emittance of several tens of nmrad. However for the ring we propose, the emittance can be reached less than 10 nmrad when the multi-bend scheme is adopted to the arc section. With this ultra-low emittance, the size and divergence of electron beam is smaller than the diffraction limited light in low energy part of VUV region, and it will be very useful for many synchrotron radiation users' experiments.

The multi-bend lattice has many families of the magnets, therefore it is not easy to decide the parameters of the lattice. Especially, it is difficult for the torus-knot type SR ring because there is a lot of geometric limitation around the cross points of orbits. We present the details of the designing procedure and the specifications of the ultra-low emittance light source ring having innovatively odd shape.

[1] A. Miyamoto and S. Sasaki, Proc. of IPAC2012, New Orleans, Louisiana, USA, TUPPP014, pp.1635-1637 (2012).

YP20

Recent Activities of THz Generation at KU-FEL

○ Heishun Zen[1], Norihiro Sei[2], Sikharin Suphakul[1], Yusuke Tsugamura[1], Toshiteru Kii[1], Kai Masuda[1], Hideaki Ohgaki[1]

1 Institute of Advanced Energy, Kyoto University, 2 National Institute of Advanced Industrial Science and Technology

KU-FEL is a mid-infrared free electron laser (MIR-FEL) facility at institute of advanced energy, Kyoto University. Recently, we have started THz generation projects. There are two main projects. One is the project utilize the existing accelerator for MIR-FEL to coherent THz generation. The other is the THz-FEL using S-band photocathode RF gun.

We have already observed Coherent Synchrotron Radiation (CSR) from a bending magnet of existing MIR-FEL machine by using a pyroelectric detector and diode detectors. The 2D profiles of the CSR have already been measured. The CSR measurements using diode detectors were performed under the collaboration with AIST. Those results will be reported in this poster.

The THz-FEL is now under designing. However, we already have an RF gun cavity, a focusing solenoid, a photocathode illumination laser and a short undulator. By combining those components and adding bunch compressor and focusing quadrupoles, we will establish new THz-FEL system in our facility. Present status and future plan will be discussed in this poster.

Present Status of Laser Ion Source with ps Laser System at BNL

○ Masafumi Kumaki[1, 2], Shunsuke Ikeda[2, 3], Yasuhiro Fuwa[2, 4], Naoya Munemoto[3],
Masahiro Okamura[5] and Masakazu Washio[1]
1 Waseda University, 2.RIKEN, 3 Tokyo Institute of Technology, 4 Kyoto University, 5 Brookhaven National Lab.

The Laser Ion Source (LIS) developed at Brookhaven National Laboratory (Fig.1) is a heavy ion source by plasma generation via 1064 Nd:YAG laser irradiation of a solid target. The LIS can easily generate a multi charge-state and high current heavy ion beam such as a 60 mA carbon beam. We will report the measurement result of generated ion beam using ps laser system and ns laser system respectively. The plasma temperature and ion charge-state distribution depend on the laser power density. Therefore, we used the 500mJ, 500 ps laser system which is estimated higher by one to two orders compared with 700mJ, 6 ns laser system for the purpose of generating highly charge-state ions. The ions in the plasma were detected by Faraday cup with suppressor voltage for separating ions from electrons, and the charge-state distribution was provided by Electrostatic Ion Analyzer and Secondary Electron Multiplier.

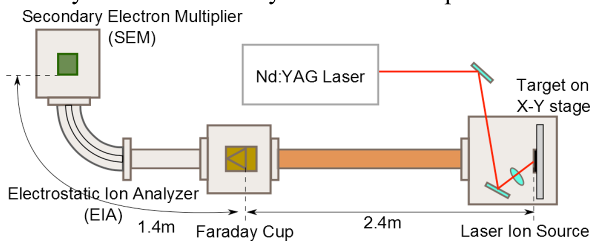


Fig. 1, Laser Ion Source Analytic Beam Line at BNL

STUDY OF EXTREME SHORT ELECTRON BUNCH PRODUCTION USING ITC-RF GUN

○ S. Nagasawa*, F. Hinode, S. Kashiwagi, T. Muto, I. Nagasawa, A. Lueangaramwong, K. Nanbu, Y. Shibasaki, K. Takahashi, K. Yanagi, H. Hama

Electron Light Science Centre, Tohoku University

Test-Accelerator as Coherent Terahertz Source project (t-ACTS) has been under development at Electron Light Science Centre, Tohoku University. Since the generation of a coherent radiation in THz region requires a very short bunch length less than 100fs, the key technology is how such extremely short electron pulse can be stably produced. In t-ACTS, a method of velocity bunching is employed for bunch compression. The injector parts of t-ACTS consists of a thermionic RF gun, an alpha magnet and a 3 m-long accelerating structure. We have developed a thermionic RF gun consists of two independent cavities so as to manipulate the longitudinal phase space distribution of electron beam, named the Independently-Tuneable Cells (ITC) RF gun. The electron beam produced by combination of the ITC-RF gun and alpha magnet can realize the appropriate longitudinal phase space distribution for velocity bunching scheme in the accelerating structure. The injector part of t-ACTS has been constructed and a beam commissioning has just started in this month. In this workshop, we will report the status of t-ACTS including a preliminary beam measurement results.