UVSOR Users Meeting

Place: Okazaki Conference Center

November 15, 2007	
13:00 - 14:10	
Opening Remarks	S. Hino (Ehime Univ.)
Preface	N. Kosugi (UVSOR)
Present Status of UVSOR-II Accelerators	M. Katoh (UVSOR)
High-Resolution VUV ARPES Beamline BL7U	S. Kimura (UVSOR)
14:20 - 15:20	
A Project for Constructing a New Undulator Beamline BL6U	E. Shigemasa (UVSOR)
Evaluation of Higher Diffracted Light Contaminations in BL5B	F. Suzuki (Univ. Fukui)
Present Status of Application Experiments of the UVSOR-II FEL	M. Hosaka (Nagoya Univ.)
15:30 - 16:30	
Intense THz Coherent Synchrotron Radiation at UVSOR-II	M. Shimada (UVSOR)
Measurement of Photoabsorption Cross Sections of Fullerenes and Study on Their Photodissociation Dynamics at BL2B	H. Katayanagi (IMS)
How the Encapsulated Atoms Affect the Electronic Structure of the Fullerene Cages?	S. Hino (Ehime Univ.)
16:30 - 18:20 Poster Session	
18:30 Banquet	
November 16, 2007	
9:00 - 10:00	
Optical Reflectance, Photoluminescence, and Photoluminescence Excitation Spectra of AlN	K. Fukui (Univ. Fukui)
Exciton Decay Processes in AlGaN Alloys	T. Sakai (Univ. Fukui)
Impurity Band Structure of Boron Doped Diamond	T. Inushima (Tokai Univ.)
10:10 - 11:30	
Development of Radiation Watching by Nuclear Emulsion	Y. Taira (Nagoya Univ.)
Optical Response of Heavy Electron Meterials by Infrared Spectroscopy	T. Nanba (Kobe Univ.)
Chemical Evolution Study Using Synchrotron Radiation - Chirality Emergence in Amino-Acid-Films by Circularly Polarized FEL -	J. Takahashi (NTT Microsystem Integration Laboratories)
VUV・SX Spectroscopy of Amino Acid Films	K. Nakagawa (Kobe Univ.)
11:40 - 12:40	
Photoemission Study of Surface-Chemical-Controlled Surface-Passivated Si Nanoparticle	A. Tanaka (Kobe Univ.)
Electronic Structure of Crown Ether Ultrathin Films	K. Okudaira (Chiba Univ.)
Present Status of Angle-Resolved Photoemission End Stations at UVSOR-II	T. Ito (UVSOR)

Poster Session

P1	Characterization of Catalytically Active Mo Species for Methane Dehydroaromatization by Means of Mo L-Edge XANES	H. Aritani (Saitama Inst. Tech., Osaka Prefectute Univ.) et al.
P2	Luminescence and Excitation Spectra of Tl$^+$ Centers-Doped Phosphors	Y. Danhara (Osaka Electro-Communication Univ.) et al.
P3	Carrier concentration dependence of thermoelectric properties in layered cobalt oxides NaCoO$_2$	S. Kuno(Nagoya University) et al.
P4	Electronic structure and phase stability of Pd-based bulk metallic glasses	D. Fukamakia (Nagoya Univ.) et al.
P5	Investigation into the origin of unusual behaviors in thermoelectric power of La$_{2-x}$Sr$_x$CuO$_4$ by means of angle-resolved photoemission spectroscopy	H. Komoto (Nagoya University) et al.
P6	Photolysis of Isovaline by UV ray and various irradiation	T.Ogawa (Yokohama National Univ.) et al.
P7	Local structure analysis of trace elements in bioceramic materials	Y. Kawashima (Waseda Univ.) et al.
P8	XANES analysis of local environment of Ga ions in SrTiO$_3$:(Pr,Ga)	S. Matsuda (Waseda Univ.) et al.
P9	Theoretical analysis of impurity-induced phonon by first-principles lattice dynamics calculations	H. Murata (Waseda Univ.) et al.
P10	Optical Properties of Transparent Conductive Oxides β-Ga$_2$O$_3$	T. Ishikawa (Gifu Univ.) et al.
P11	Optical Properties in VUV to Visible Regions for Fluoride Crystals Doped with Rare Earth Ions	T. Nakamura (Gifu Univ.) et al.
P12	Phosphorescence Property of Rare Earth Ion-doped Hydroxyapatite excited by UVSOR	M. Ohta (Niigata Univ.) et al.
P13	Absolute Photoionization cross section of C$_{70}$ at 25-120 eV	B. P. Kafle (Grad. Univ. Adv. Studies) et al.
P14	Temperature dependence of the optical reflectance spectra of InN	T. Yanagawa (Univ. Fukui) et al.
P15	Crystal anisotropy effect on excitonic luminescence in AlGaN	M. Kishida (Univ. Fukui) et al.
P16	Correlation between Coloration and Optical Properties in Yttrium Oxysulfide Single Crystals	S. Tokunaga (Univ Fukui) et al.
P17	Comparative study of photoluminescence properties between YPO$_4$:Zr^{4+},Mn^{2+} and ScPO$_4$:Zr^{4+},Mn^{2+} phosphors	Y. Inada (Univ Fukui) et al.
P18	Dependence of photoluminescence properties on Br$^-$ ion concentrations- ion concentrations in PbCl$_2$:Br$^-$ crystals	S. Izuhara (Univ Fukui) et al.
P19	Measurements of time resolved decay spectra by using ICCD detector at the single bunch operation	F.Suzuki (Univ. Fukui) et al.
P20	The concentration dependency of Eu ions for excitation spectra of BaMgAl$_{10}$O1$_7$:Eu	H. Yoshida (Kwansei Gakuin Univ.) et al.
P21	Nd^{3+}:(La$_{1-x}$,Ba$_x$)F$_{3-x}$ Grown via Micro-Pulling Down as Vacuum Ultraviolet Scintillator and Potential Laser Material	S. Ono (Nagoya Inst. Tech.) et al.
P22	Ultraviolet Photoemission Spectra of Layered Metal Oxide Thin Film	T. Miyazaki (Ehime Univ.) et al.
P23	Electron structure of halogen bonding studied by UPS	R. Sumii (KEK-PF) et al.
P24	Nano-clusters in Pd-Ni-P Bulk Metallic Glasses Studied by Synchrotron Spectroscopy	T. Mochizuki (Nagoya Univ.) et al.
P25	Electronic Structure of Fe-based Heusler-type Thermoelectric Alloys	T. Mochizuki (Nagoya Univ.) et al.
P26	Photoinduced Phenomena in Amorphous Semiconductor Materials by UVSOR	K. Hayashi (Gifu University)
P27	XANES Spectra of Sulfur amino acids at S K-edge	Y. Izumi (Kobe Univ.) et al.
P28	A study of a molecular orientation of crown ether in thin films by ARUPS	Y. Suzuki (Chiba Univ.) et al.
P29	A study of molecular orientation of Bis-(o-diiminobenzosemiquinonate)Nickel(II) Complex in the films by AR-UPSin the films by AR-UPS	N. Mitsuo (Chiba Univ.) et al.
P30	Photoluminescence Analysis of Lanthanum Aluminate Single Crystals	K. Kanai (Waseda University) et al.
P31	Characterization of Mg-modified titanias synthesized by the glycothermal method	Y. Sazanami (Kyoto Univ.) et al.
P32	Change in the Metal 3d derived molecular electronic state due to Metal-phthalocyanine/Ag(111) interaction	T.Aoki (Chiba Univ.) et al.
P33	Change of electronic structure of para – ferro magnetic phase transition on EuO : Three-dimensional angle-resolved photoemission spectroscopy	H. Miyazaki (Nagoya Univ., UVSOR) et al.
P34	Infrared-Terahertz Spectroscopy of CeIn$_3$ under a pressure	T. Iizuka (Kobe Univ., UVSOR) et al.
P35	Terahertz Spectroscopy of SmS under Pressure	T. Mizuno (Grad. Univ. Adv. Studies, UVSOR) et al.
P36	Soft x-ray magnetic circular dichroism at high magnetic field and low temperature	T. Nakagawa (IMS) et al.
P37	Electronic states of a single crystal of Rubrene studied by Photoelectron Yield Spectroscopy	Y. Nakayama (Chiba Univ.) et al.
P38	Systematic Study of Quantum Criticality in Ce$_{1-x}$Gd$_x$CoSi$_3$:Ce and Gd 4d-4f resonant photoemission spectroscopy	H.J. Im (Sungkyunkwan Univ., UVSOR) et al.

UVSOR Lunch Seminar

FY2007

July 23	Prof. Yunsang LEE, Department of Physics, Soongsil University, Korea Charge-orbital ordered state in half-doped layered manganites
Feb. 8	Mr. Masahiro ITO, Graduate School of Science and Technology, Niigata University and UVSOR Metastability of carbonyl sulfide (OCS) dications
Feb. 8	Mr. Takuya IIZUKA, Graduate School of Science and Technology, Kobe University and UVSOR Infrared-to-Terahertz Spectroscopy of $CeIn_3$ under pressure
Mar. 13	Dr. Miho SHIMADA, UVSOR Facility, Institute for Molecular Science Generation of Coherent Synchrotron Radiation (CSR) produced by an interaction between electron beam and external laser
Mar. 13	Dr. Tatsuo KANEYASU, UVSOR Facility, Institute for Molecular Science Development of an electron-ion coincidence spectrometer and its application to decay dynamics in molecules following core hole creation

UVSOR Workshop on Terahertz Coherent Synchrotron Radiation

Place: Okazaki Conference Center and UVSOR Facility

September 23th, 2007

15:00- Registration and UVSOR site tour.

18:00- Get together party

September 24th, 2007

8:30- Breakfast

9:15- Opening Remark — M. Katoh (UVSOR)

1. Light Source (1); Linac

9:30- Status of Coherent Radiation Beamline at KURRI-LINAC — T. Takahashi (Kyoto U.)

9:55- Bunch compression at the SPring-8 linac for successive generation of THz pulse train in the isochronous ring — Y. Shoji (New SUBARU)

10:20- Coffee break

2. Light Source (2-1); Storage Ring

10:50- The BESSY (and MLS) Low Alpha Optics and the Generation of Coherent Synchrotron Radiation — G. Wuestefeld (BESSY)

11:15- Coherent THz radiation at NewSUBARU — Y. Shoji (New SUBARU)

11:40- Observation of THz CSR burst in UVSOR-II — M. Shimada (UVSOR)

12:05- Lunch

3. Light Source (2-2); Storage Ring

13:20- Status of the ANKA Short Bunch Operation — A.-S. Mueller (ANKA)

13:45- CSR studies at the ALS and optimizing a storage ring for THz — M.C. Martin (ALS)

14:10- Generation of THz CSR with laser-bunch slicing in UVSOR-II electron storage ring — A. Mochihashi (UVSOR)

4. Light Source (3); ERL

14:35- Applications of Intense CSR from a cw Linac at Jefferson Lab — G. P. Williams (J-lab)

15:00- An Intense Terahertz Radiation Source at the Compact ERL — K. Harada (KEK)

15:25- Coffee break

5. Applications

15:55- Scientific Experiments at BESSY using Coherent Synchrotron Radiation — U. Schade (BESSY)

16:20- Coherent Synchrotron Edge Radiation and Applications at ANKA — Y-L. Mathis (ANKA)

16:45- Coherent THz radiation from photo-injected linac and applications to studies of materials — L. Carr (NSLS)

17:10- Closing remark — S. Kimura (UVSOR)

18:30- Banquet at an Izakaya restaurant (Japanese pub)

September 25th, 2007

9:00- Move to Awaji Island by public transportations.

Status of Coherent Radiation Beamline at KURRI-LINAC

T. Takahashi
Research Reactor Institute, Kyoto University, Japan

In the electron linear accelerator at Research Reactor Institute in Kyoto University (KURRI-LINAC), properties of several types of coherent radiation (synchrotron radiation [1], transition radiation [2], Cherenkov radiation [3], diffraction radiation, and Smith-Purcell radiation [4], pre-bunched FEL [5]) in the THz-wave and millimeter-wave regions have been experimentally investigated since 1991. The beamline for the millimeter-wave spectroscopy has been constructed [6], in which coherent transition radiation (CTR) has been used as a light source and the spectroscopic research of N_2O gas [6] and electron spin resonance using a pulsed magnet [7] have been demonstrated.

The KURRI-LINAC consists of an injector, pre-buncher, two accelerator tubes. The specifications are represented in Table. 1.

Table 1. Specifications of KURRI-LINAC

Operation Mode	Short Pulse	Long Pulse
RF frequency	1300 MHz	
Energy	46 MeV	30 MeV
Pulse Width	2～100 ns	0.1～4 µs
Repetition Rate	1～300 Hz	1～200 Hz
Peak Current	8 A	500 mA
Beam Power	Max. 10 kW	

This linac has been operated for collaboration research programs with other universities since 1964 and research activities have covered the nuclear data with pulsed neutron source, electron irradiation, and coherent radiation. The time of operation in 2006 was about 2,700 hr. The distributed user-time to the research of coherent radiation is about ten weeks per year. The schematic diagram of the beamline is shown in Fig. 1.

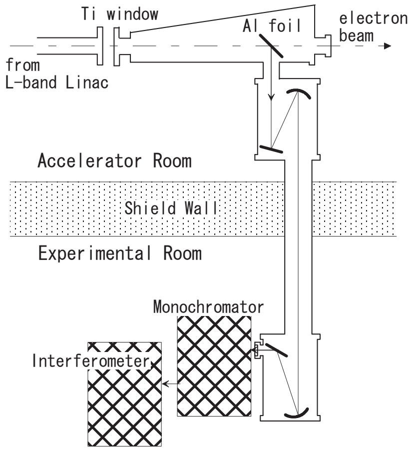

Fig. 1. The schematic diagram of the coherent radiation beamline.

The forward coherent transition radiation emitted from a Ti window and the backward one from an Al-foil are used as a light source. The beamline is equipped with a grating-type monochromator and a Martin-Puplett type interferometer in series. When the interferometer is used as a spectrometer the grating in the monochromator is replaced with a flat mirror. Three types of detectors are prepared, i.e. a liquid-helium-cooled Si bolometer (Infrared Lab.), a hot-electron InSb bolometer (Infrared Lab.), and a millimeter-wave diode-type detector (DXP-10, Millitec) according to the sensitivity and the response time. The degree of instability of the observed intensity is within 2%.

Coherent radiation is especially useful as a pico-second pulsed light source for the time-resolved spectroscopy and the pulseradiolysis study. Since the accelerating frequency of this linac is 1.3 GHz (L-band), the interval between pulses in the CTR pulse train is 770 ps (23 cm). The spectrum from the successive bunches is constituted of the higher harmonics of 1.3 GHz [6]. As a result, the CTR can be treated as a light source with a continuous spectrum only when the spectral resolution is lower than $1/23 = 0.0434\ \mathrm{cm}^{-1}$ and the delay in the time-resolved measurement is restricted within 770 ps. In order to lift these restrictions, the single-bunch beam has been generated by installing a high-speed avalanche-type pulser in the electron injector. The degree of impurity of single bunch was estimated to be 1.5% by means of the cross-correlation interferogram.

The following researches in the millimeter-wave region are in progress at this beamline:

a) Optical conductivity of superionic conductors (collaboration research),
b) Optical properties of water (collaboration research),
c) Optical properties of polymeric materials under irradiation (collaboration research),
d) Development of pulseradiolysis system.

[1] Y. Shibata, *et al.*, Phys. Rev. A **44** (1991) R3449.
[2] Y. Shibata, *et al.*, Phys. Rev. A **45** (1992) R8340.
[3] T. Takahashi, *et al.*, Phys. Rev. E **50** (1994) 4041.
[4] Y. Shibata, *et al.*, Phys. Rev. E **57** (1998) 1061.
[5] Y. Shibata, *et al.*, NIM **528** (2004) 162.
[6] T. Takahshi, *et al.*, Rev. Sci. Instrum. **69** (1998) 3770.
[7] Y. H . Matsuda, *et al.*, Physica B **346-347** (2004) 519-523.

Bunch compression at the SPring-8 linac for successive generation of THz pulse train in the isochronous ring

T. Asaka, H. Dewa, H. Hanaki, Y. Hisaoka*, T. Kobayashi, T. Matsubara*, T. Mitsui*, A. Mizuno, Y. Shoji*, S. Suzuki, T. Taniuchi, H. Tomizawa, and K. Yanagida
SPring-8, JASRI, Sayo-cho, Sayo-gun, 679-5198, Japan
**NewSUBARU, LASTI, University of Hyogo, Kamigori-cho, Ako-gun, 678-1205, Japan*

Abstract

We have already demonstrated our idea of circulating a short and intense bunch in a synchrotron radiation ring. The idea is based on the understanding that it is almost impossible to store short and high-charged electron bunch in a storage ring but it is not difficult to produce that kind of bunch at a linac. When the short bunch is produced at a linac and injected into an ideal isochronous ring, the time structure of the bunch is frozen and it emits short-pulsed radiation for every turn. It would supply a strong coherent radiation pulse train in THz region for beam lines in the storage ring.

In our previous work [1] we compressed the bunch of the SPring-8 linac to a few picoseconds (r.m.s.) by means of an energy compression system and a beam transport line from the linac to NewSUBARU. The bunch charge was about 0.02 nC. The NewSUBARU storage ring was set at quasi-isochronous condition and the bunch circulated for about 50 turns after injection while maintaining the short bunch length. A strong coherent radiation was observed using a Shottkey diode detector, which was sensitive to 0.1 - 0.14 THz radiation. Fig. 1 shows the turn-by-turn radiation power after injection in the storage ring. The radiation power at the initial turn was raised by the bunch compression. This high power radiation lasted longer by setting the ring quasi-isochronous. At the present, the imperfection of the isochronous condition produces the increase of bunch length and the reduction of coherent radiation power.

Our plan for the next few years, which is not yet approved, is to install the photo-cathode electron gun developed at SPring-8. According to the expected beam parameters listed in Table 1, the beam would be shorter and stronger with the smaller energy spread. Consequently it would supply more lasting shorter pulses in the ring. The smaller energy spread is important not only because this parameter is a trade-off of the bunch compression, but also that the small energy spread reduces the bunch elongation due to the higher order momentum compaction factor. Many improvements of the linac since 1998 for stability and reliability were also essential for this research.

Our method is partly very similar to ERL (Energy Recovery Linac). There is no stationary state in the ring or bending arc, therefore its performance as a light source strongly depends on the initial beam. Performance of the electron gun is essential. The quasi-isochronous ring as a circulator can be a model of a bending arc of ERL. Many circulations in the ring would enhance problems, which would occur in ERL arc.

We hope that this new beam handling would bring us new understandings on beam physics. What we would see is a transient process starts from a short pulsed intense beam. We can observe energy spreading by instabilities or CSR in time domain. The turn-by-turn time structure of a bunch will be measured using a streak camera and a beam profile by a fast gated ICCD camera. The diode detector in THz region is a diagnostic on fine time structure in a bunch.

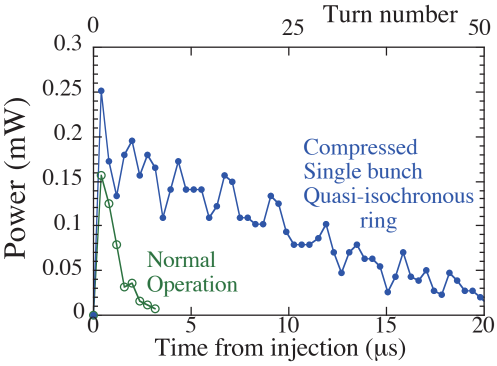

Fig. 1. The turn-by-turn coherent radiation power after injection. The line with open circles shows the power obtained with the parameters of normal operation, where there were three bunches in a pulse. The line with filled circles shows the power obtained from one compressed bunch in the quasi-isochronous ring. The bunch charge was about 0.02 nC/bunch in both cases.

Table 1. Beam parameters at 1.0 GeV with the present thermionic electron gun and the expected parameters with the new photo-cathode electron gun.

	Present	Next
Electron Gun	Thermionic	Photo-Cathode
Energy Spread	(+/-) 0.5%	(+/-) 0.1%
Bunch Length	2.2 ps	< 1 ps
Bunch Charge	< 0.1 nC	> 1 nC

The BESSY (and MLS) Low Alpha Optics and the Generation of Coherent Synchrotron Radiation

J. Feikes, K. Holldack, H.-W. Huebers[1], P. Kuske, G. Wuestefeld
BESSY, and [1]DLR, Berlin (Germany)

The BESSY II optics is tuned to a low alpha optics for bunch shortening. This machine mode is offered 4 times per year for 3 days for users experiments. About 1mm short bunches emit coherent synchrotron radiation in the THz range and short x-ray pulses. Characteristics of the machine optics and measured THz signals are discussed. Limitations to produce ultra short bunches and a possible upgrading scheme for intense, short bunches are discussed.

The presently commissioned Metrology Light Source (MLS) next to the BESSY site includes the option for low alpha operation. Plans for the short bunch generation are presented.

Coherent THz radiation at NewSUBARU

Y. Shoji
NewSUARU, LASTI, University of Hyogo, Kamigori-cho, Ako-gun, 678-1205, Japan

Abstract

NewSUBARU is a 1.5 GeV synchrotron radiation ring at the SPring-8 site. Laboratory of Advanced Science and Technology for Industry (LASTI) at the University of Hyogo is in charge of its operation, collaborating with SPring-8. The beam is injected from the SPring-8 linac with 1.0 GeV of electron energy. Three types of CSR (coherent synchrotron radiation) from three types of electron beam were detected in the storage ring, NewSUBARU.

One was quasi-dc CSR (in other wards, steady state CSR) from a low-current, short-bunched beam, which is used for application experiment at BESSY-II. The ring was operated in a quasi-isochronous mode (with a low momentum compaction factor), in which it a short-bunched beam can be stored stationary. At NewSUBARU a quasi-dc CSR was obtained at low current of 1 pC/bunch and short bunch length of 3.4 ps FWHM. In this state, the longitudinal coherent oscillation amplitude depended on the stored beam current probably because of a burst of CSR by a longitudinal instability. Burst CSR could produce a sudden energy loss and excite a coherent synchrotron oscillation. Fig. 1 shows the FFT power spectrum of the pulsed CSR signal. This quasi-isochronous operation requires delicate tuning and high stability of the storage ring.

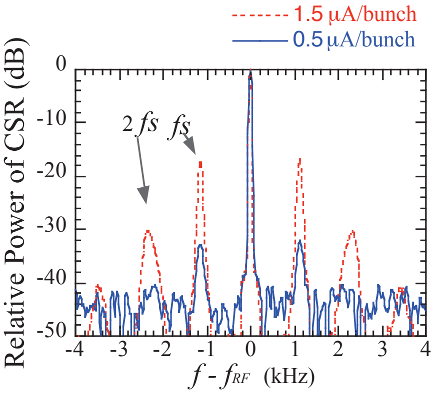

Fig. 1. Beam current dependence of the power spectrum of CSR signal. The main peak (rf frequency f_{RF}) is normalized to 0dB.

The second type was a radiation pulse following injection. A short-bunch linac beam, with a base width of 20 ps and a charge of 50 pC/bunch, emitted short-pulse CSR in the storage ring. It was almost impossible to store short and high-charged electron bunch in a storage ring but the production of short and intense bunch at a linac is not difficult. When the short bunch is injected into an ideal isochronous ring, the time structure of the bunch is frozen and it emits short-pulsed radiation for every turn. It would supply a strong coherent radiation pulse train in THz region for beam lines in the storage ring. This plan will be presented in the other presentation titled "Bunch compression at the SPring-8 linac for successive generation of THz pulse train in the isochronous ring" at the workshop.

The third type was a radiation burst from a high-density, single-bunch beam. Although its radiation power is extremely high and easy to be obtained in any electron storage ring, this type is not used for experiments. This is because the source of the CSR burst is a fine time structure in the bunch due to longitudinal beam instabilities, and is not stable. However, it could be used for some kind of application experiments with an appropriate time averaging. We investigated the time structure of the CSR burst using Schottky diode detector, which had a high time resolution. When we took an averaging period of 10ms (=25250 revolutions), the fluctuation of the integrated power was about 10% (standard deviation). In this time range, the relative fluctuation decreases with the period length faster than the square root scaling law as shown in Fig. 2. It is thought that the CSR burst can be obtained in most storage rings. This type does not require fine and delicate machine tuning as the quasi-isochronous operation does. However for a user operation, two accelerator techniques, an accurate bucket selection in the injection process, and the top-up operation are required. These two techniques are not common at the existing storage rings but coming to be a standard of new rings.

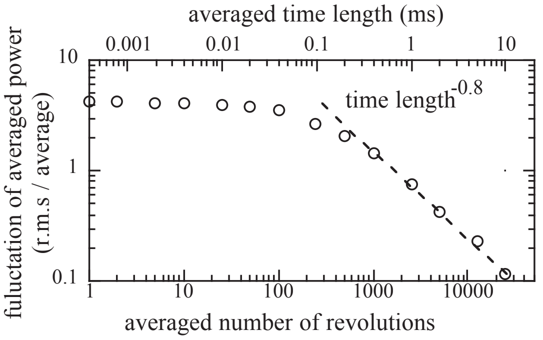

Fig. 2. Fluctuation of time-averaged power of CSR burst. The broken line is a guide which shows the dependence of period$^{-0.8}$.

Observation of THz CSR burst at UVSOR-II

M. Shimada[1], M. Katoh[1,2], M. Hosaka[2], A. Mochihashi[1*], Y. Takashima[2],
S. Kimura[1], T. Takahashi[3]
[1]UVSOR Facility, Institute for Molecular Science, Japan
[2]Graduate School of Engineering, Nagoya University, Japan
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**Present affiliation : JASRI Spring-8, Japan*

In 2004, we reported the first result from the observation of bursts of Terahertz Coherent Synchrotron Radiation (THz CSR) at UVSOR-II [1]. In this experiment, UVSOR-II electron storage ring was operated in a single-bunch mode with the electron beam energy of 600 MeV. The bursts were observed at the infrared/THz beamline BL6B which has a large solid angle, 215 × 80 mrad^2 [2]. A hot-electron bolometer, which is sensitive from a few cm^{-1} to 50 cm^{-1}, was used as a detector.

Figure 1 shows the average intensity of the terahertz radiation measured by using a mechanical chopper and a lock-in-amplifier, in the single bunch mode (black circles) and in the multi-bunch mode (gray circles) against the average beam current. Large fluctuations can be seen in two beam current regions around 80 mA and above 130 mA. In these regions, very intense bursts were observed. They appeared quasi-periodically at the lower current while chaotically at the extremely higher current. The time structure of each burst sometimes showed periodicity which was approximately same as twice of synchrotron frequency..

After the upgrade of RF cavity at 2005 [3], a correlation between the bursts and a vertical beam instability was discovered. The threshold beam current came to be lower down to around 40 mA. The quisi-periodic structure in each burst cannot be seen.

At 2006, a schottky THz diode detector was introduced for measurement with high time resolution of around 100 ps. We have successful in observing the THz CSR at each revolution of the electron bunch (5.6 MHz). The bursts seems to contain rapid temporal structure which could not resolved with the bolometer.

We have constructed a laser bunch slicing system by introducing a Titanium Sapphire (Ti:Sa) femto-second laser [4]. The minimum duration of Ti:Sa laser is 130 fs and the maximum power per pulse is 2 mJ. We could observe both bursting THz CSR and CSR produced by the bunch slicing simultaneously in some beam current region. So far, we have not observed that the slicing induced the bursts.

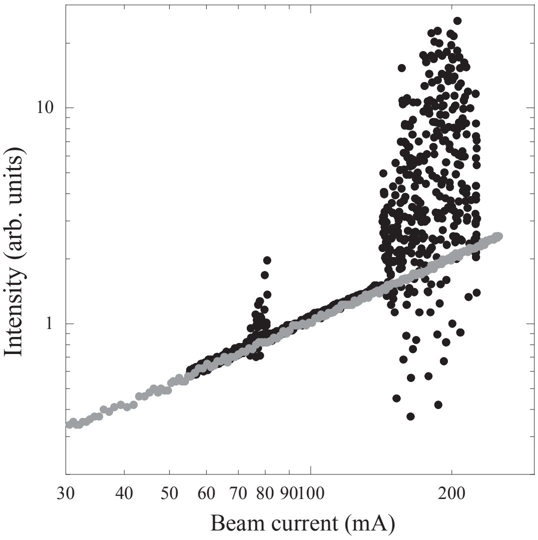

Fig. 1. Average intensity of the terahertz radiation in the single bunch mode (black circles) and in the multi-bunch mode (gray circles) as a function of the average beam current, measured by using a mechanical chopper and a lock-in-amplifier.

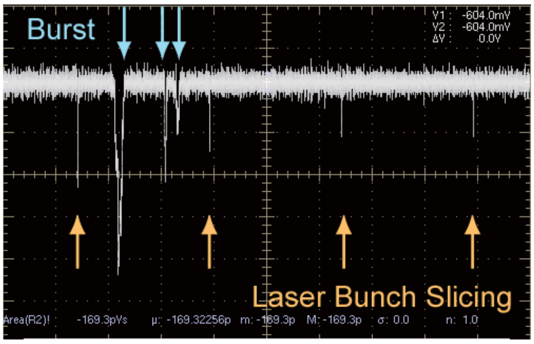

Fig. 2. THz CSR produced by the laser bunch slicing with the CSR bursts.

Reference

[1] Y. Takashima, *et. al.*, *Jpn. J. Appl. Phys.*, **44,** (2005) L1131
[2] S. Kimura, *et. al.*, *Infrared Phys. Tech.*, **49,** (2006) L 147
[3] A. Mochihashi *et. al.*, Proc. EPAC2006 (2006, Edinburgh), 1268-1270
[4] M. Shimada *et al.*, accepted for publication by Jpn. J. Appl. Phys.

STATUS OF THE ANKA SHORT BUNCH OPERATION

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Y.-L. Mathis, D.A. Moss, P. Wesolowski
Karlsruhe Research Center, Germany

The ANKA electron storage ring located at the Research Centre Karlsruhe in Germany operates in the energy range from 0.5 to 2.5 GeV. To generate coherent radiation in the far IR (THz) region, a dedicated operation mode with reduced momentum compaction factor is used. The beam behaviour with short bunches has been studied under various conditions and at different beam energies (see Fig. 1). This presentation gives an overview over the status and perspectives of the operation of the ANKA storage ring with short bunches.

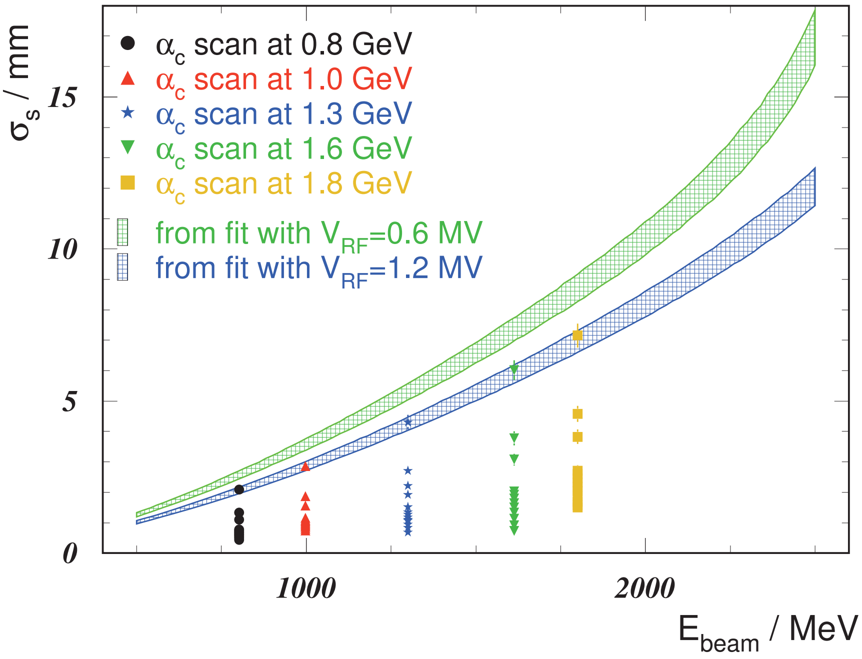

Figure 1: RMS Bunch length derived from measurements of the synchrotron frequency as a function of beam energy. The hatched regions are error bands obtained by a full error Monte Carlo. The markers represent bunch lengths derived from synchrotron frequency measurements for different beam energies.

Generation of THz CSR with laser-bunch slicing in UVSOR-II electron storage ring

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abstract

We have performed experiments for generation of THz CSR with laser-bunch slicing in UVSOR-II electron storage ring. A mode-locked Ti:Sa laser system generates femto-second high power laser pulse and injects the pulses into an undulator section of the UVSOR-II electron storage ring. The laser pulse induces energy modulation on an electron bunch in the undulator section and the energy modulation changes to longitudinal density modulation on the bunch by passing through a bending magnet section which is beyond the undulator section. The THz radiation generates at the bending magnet section where infra-red beam line (BL6B) is settled. Quadratic dependence of the intensity of the intense THz radiation on the peak bunch current indicates the coherent synchrotron radiation (CSR). Spectral measurement with an interferometer settled in the beam line shows dependence of the bandwidth and spectral range on the laser pulse duration; that indicates possibility to control the frequency and bandwidth of the THz CSR. To control both the frequency and the bandwidth of the THz CSR, we have performed a bunch-slicing experiment with amplitude-modulated laser pulse. The amplitude-modulated pulse laser is generated by 'chirped pulse beating' method[1]. The THz CSR spectral bandwidth by the modulated laser pulse becomes narrower than that by single laser pulse. Because the spectral peak frequency and the bandwidth depend on the modulation of the laser pulse, it is possible to tune the THz CSR frequency and bandwidth only by adjusting the optics for the laser modulation. Introduction of the laser-bunch slicing system in UVSOR-II, experimental results of the bunch-slicing with single and amplitude-modulated laser pulses are presented in the workshop.

[1] Weling, A.S. & Auston, D. H., J. Opt. Soc. Am. B **13**, 2783-2791 (1996)

Applications of Intense CSR from a cw Linac at Jefferson Lab

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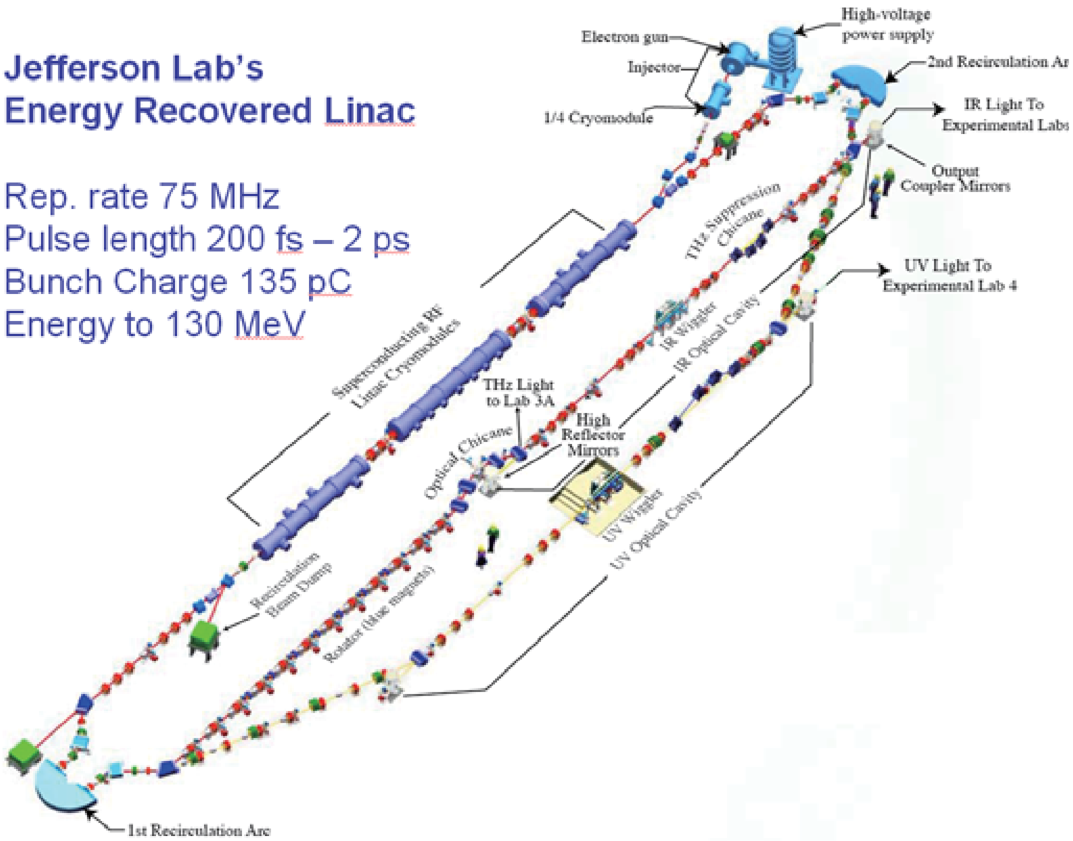
At Jefferson Lab we operate a superconducting linac with continuous-wave radio-frequency excitation to produce 135 pC sub-ps bunches of electrons at repetition rates up to 75 MHz. CSR, or multiparticle coherently enhanced emission is produced by modulating this bunch in a Free Electron Laser cavity, and is also produced for wavelengths that are longer than twice the bunch length. With electron beam energies of 100 MeV, the electron beam energy is 1 MW. Therefore we energy recover the electrons in a return loop.



We will describe the operation of the facility, and then applications of this intense beam. The applications fall into 2 categories, real-time imaging, and out-of-equilibrium dynamics.

G.R. Neil et al "The JLab High Power ERL Light Source", Nucl. Instr. & Methods **A557** 9 (2006).

J.M. Klopf, et al., Nucl. Instr. and Meth. A (2007), doi:10.1016/j.nima.2007.08.081.

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An Intense Terahertz Radiation Source at the Compact ERL

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The Compact ERL is the energy recovery linac (ERL) test facility that will be constructed at KEK Tsukuba campus as a joint project of the KEK, JAEA, and other institutes. The Compact ERL has a great feasibility of producing intense terahertz radiation using coherent synchrotron radiation (CSR) from its electron beams. Although the primary purpose of the facility is the demonstration of the key technologies that are essential to build ultra-brilliant new synchrotron light source based on the ERL, the limited user operation with the terahertz CSR is now examined. In this presentation, we show the parameters of the Compact ERL and discuss expected performances of the terahertz radiation.

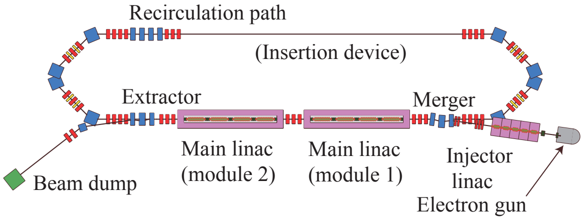

Fig. 1. Lattice of the Compact ERL.

Table 1 Tentative parameters of the test facility

	Parameters (final goal)
Injection energy	5 MeV (10-15 MeV)
Injector beam power	500 kW (1 MW)
Beam energy in the recirculation path	~60 MeV (160-200 MeV)
SC cavities for main linac	9 cells x 4: single module (two modules)
Normalized emittance	1 mm·mrad (0.1 mm·mrad)
Beam current	10 mA (100 mA)
RMS bunch length	Usual mode : σ_τ = 1-2 ps (Short bunch : σ_τ = 0.1 ps)

Figure 1 shows the plan of the Compact ERL and Table 1 lists the tentative parameters. In order to generate the CSR of the wavelength λ_{CSR} , the electron bunch length should be shorter than

$$\sigma_z = \frac{\lambda_{CSR}}{2}.$$

For example, the electron bunch with the bunch length of 0.2 ps (60μm) can generate the CSR of the energy 10 meV (120 μm). In order to achieve such short bunch length, however, the bunch compression is inevitable.

For the bunch compression [1],[2], the off-crest acceleration at the main acceleration module firstly generates the energy gradient in the electron bunch. Then the difference of the orbit length depending on the particle energy at the arc section can compress the bunch length. The linear path length difference of the arc, R_{56}, can be optimized by the quadrupoles and the second order effect, T_{566}, by the sextupoles. Furthermore, in order to suppress the emittance growth by the CSR, Twiss parameter α at the end of the arc section is fixed. Finally, the simulation results show that, if the bunch charge is smaller than about 0.5nC, the bunch length can be compressed to about 0.2ps at the 65MeV beam energy [3]. The estimated photon flux from the bending magnet at the arc of the ERL test facility is shown in Fig. 2.

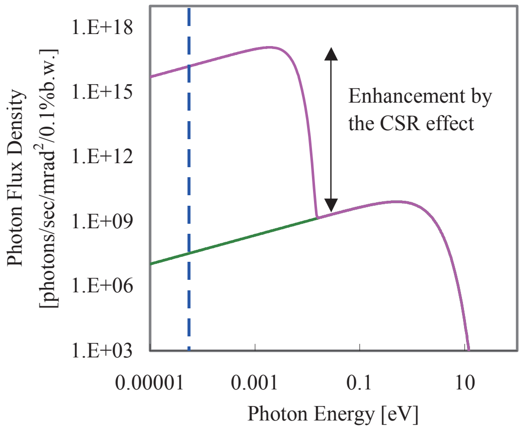

Fig. 2. Radiation spectrum from the bending magnet of the arc section of the Compact ERL. The beam current is 100 mA (= 77 pC x 1.3 GHz), the bunch length 0.2ps, and the beam energy 65MeV.

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Scientific Experiments at BESSY using Coherent Synchrotron Radiation

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Coherent synchrotron radiation (CSR) from a storage ring is a new spectroscopic source between microwaves and thermal black body radiation offering broadband radiation in the THz range. During the past few years, this new technique to generate powerful, stable, coherent sub-THz and THz radiation from the electron storage ring has been established at the electron storage ring in Berlin (BESSY). The spectral range between 3 and 30 wavenumbers (0.1 – 1 THz) which can be only poorly accessed by conventional sources is now covered by operating BESSY in special machine modes. Here, up to 10^8 more brilliance than from a black body source has been achieved. The production of stable, high power, coherent synchrotron radiation at THz and sub-THz frequencies at BESSY opens a new region in the electromagnetic spectrum offered at synchrotron radiation sources which now can be applied for imaging, spectroscopic and microscopic methods in solid state physics, material sciences and life sciences. The feasibility of using the coherent synchrotron radiation in scientific applications has been proven at the infrared beamline IRIS. Beside the characterization of the coherent synchrotron radiation source this talk will present a couple of applications spanning from spectroscopic investigations of new superconducting materials to scanning near-field microspectroscopy.