WG1 Summary
AFAD2018

Sung-Ju Park

15 talks from 9 institutes in 6 countries
They were allocated to 4 sessions

WG1: Accelerator and its related technologies for photon science. Room 101

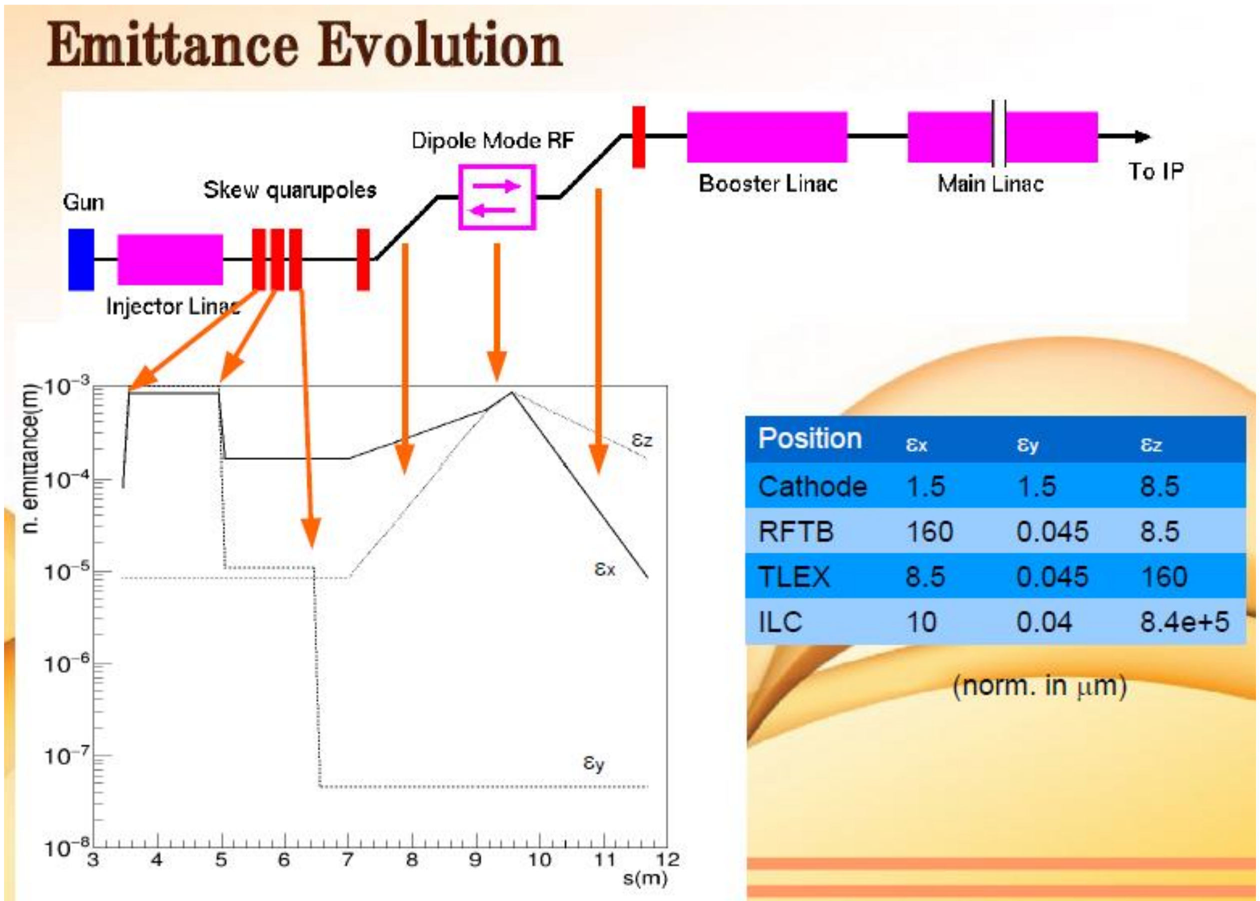
January 29			
Time	Title	Speaker	Affiliation
Session 1 Chair: Dong-Eon Kim (PAL, Korea)			
13:30 - 13:55	Emittance Exchange Program at KEK STF	Masao Kuriki	Hiroshima University, Japan
13:55 - 14:20	Status of Free Electron Lasers in SINAP	Bo Liu/ZHAO, Zhentang	SINAP, China
14:20 - 14:45	Sub-20-femtosecond timing jitter of PAL-XFEL	Chang-Ki Min	PAL, Korea
14:45 - 15:10	NOVOSIBIRSK FREE ELECTRON LASER FACILITY	Yaroslav Getmanov	Budker INP, Russia
15:10 - 15:40	Coffee break		
Session 2 Chair: Dong-Eon Kim (PAL, Korea)			
15:40 - 16:05	Free Electron Laser based Delhi Light Source Project at IUAC, NewDelhi	Bhuban Kumar Sahu	Inter University Accelerator Centre, India
16:05 - 16:30	Recent Results on X-ray Generation at LUCX	Junji Urakawa	KEK, Japan
16:30 - 16:55	Development of Coherent THz Radiation Source and MIR-FEL in Thailand	Sakhorn Rimjaem	Chiang Mai University, Thailand
16:55 - 17:20	Accelerator R&D activities at PAL	Jang-Hui Han	PAL, Korea
17:20 - 17:45	Study of BINP damping ring performance with the streak camera	Oleg Meshkov	Budker INP, Russia
January 30			
Session 3 Chair: Heung-Sik Kang (PAL, Korea)			
9:00 - 9:25	Harmonic Lasing Self-seeded FEL at PAL-XFEL	In-Hyeok Nam	PAL, Korea
9:25 - 9:50	LUCX pre-bunched e-beam generation and its application to THZ experimental studies	Alexander S. Aryshev	KEK, Japan
9:50 - 10:15	Latest results on the 100-mA CW RF Electron Gun for Novosibirsk ERL FEL	Vladimir Volkov	Budker INP, Russia
10:15 - 10:45	Coffee break		
Session 4 Chair: Heung-Sik Kang (PAL, Korea)			
10:45 - 11:10	Status of the DIRAMS C-band standing-wave accelerator for a radiotherapy machine	Heuijin Lim	DIRAMS, Korea
11:10 - 11:35	The Commissioning and Early User Operation of Dalian VUV Free Electron Laser	Weiqing Zhang	Dalian Institute of Chemical Physics, China
11:35 - 12:00	Structured Light from Helical Undulators	Shunya Matsuba	Hiroshima University, Japan

Emittance Exchange Program at KEK STF

Masao KURIKI
Hiroshima University

AFAD 2018, 29-31 Jan, at Daejeon Convention Center, Daejeon, Korea

- RFTB(Round to Flat Beam Transformation)) and TLEX(Transverse to Longitudinal Emitatnce eXchange)) combined to generate the ILC-compatible beams
- The pilot experiments are expected to be done in the KEK-STF and ANL-WFA



Position	εx	εy	εz
Cathode	1.5	1.5	8.5
RFTB	160	0.045	8.5
TLEX	8.5	0.045	160
ILC	10	0.04	8.4e+5

AFAD2018 (9th Asian Forum for Accelerators and Detectors)

January 28 -31, 2018, Daejeon, Korea

Status of Free Electron Lasers in SINAP

Zhentang Zhao, Dong Wang, Lixin Yin, Guoping Fang, Ming Gu, Yongbin Leng, Qiang Gu, Bo Liu

On behalf of the FEL team @ SINAP

Shanghai Institute of Applied Physics

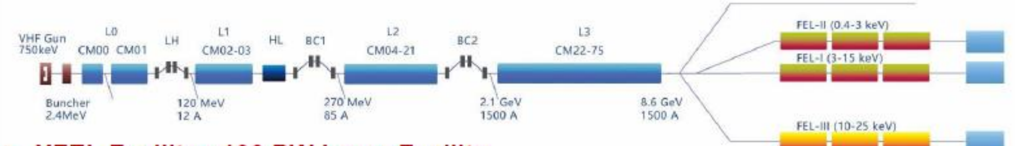
Chinese Academy of Sciences

2018.01.29

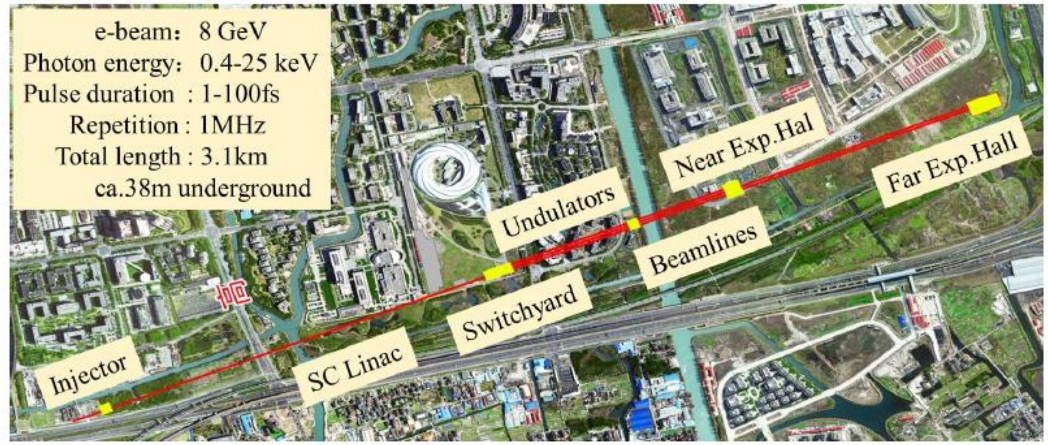
High-gain FELs constructed in China

	SDUV-FEL	DCLS	SXFEL-TF	SXFEL-UF
	Test facility	User facility	Test	User
Status	Shutdown	Commissioning/ Operation	Commissioning	Construction
Wavelength	150-350nm	50-150nm	8.8nm	2.0nm
Length	65m	150m	293m	532m
Accelerator	S band	S band	S+C band	S+C band
Beam energy	100-200MeV	300MeV	0.84GeV	1.5GeV
FEL principle	HGHG, EEHG	HGHG	HGHG, EEHG	Cascaded HGHG SASE
Location	Shanghai	Dalian	Shanghai	Shanghai
First lasing	2009	2016	2017	**2019**

SCLF: A high-rep rate XFEL based on SCRF



- **XFEL Facility +100 PW Laser Facility**



Present & Future FELs in China

SDUV-FEL:
65m, 180MeV, 250-350nm

Under commissioning

DCLS:
150m, 300MeV, 50-150nm

Under commissioning / Operation

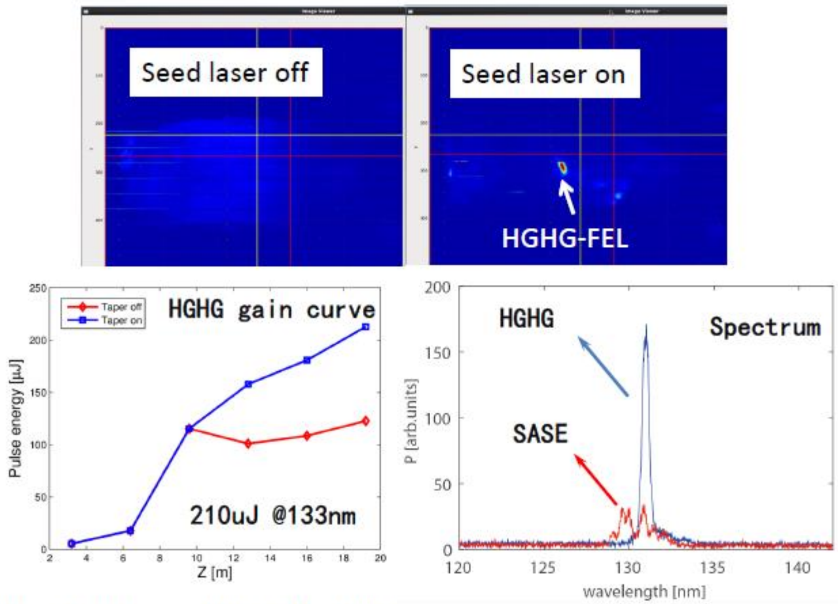
SXFEL Facility:
293m, 840MeV, 9-40nm
532m, 1.5GeV, 2-10nm

The Commissioning and Early User Operation of Dalian VUV Free Electron Laser

Weiqing Zhang on behalf of DCLS team

Dalian Institute of Chemical Physics, CAS

HGHG at DCLS

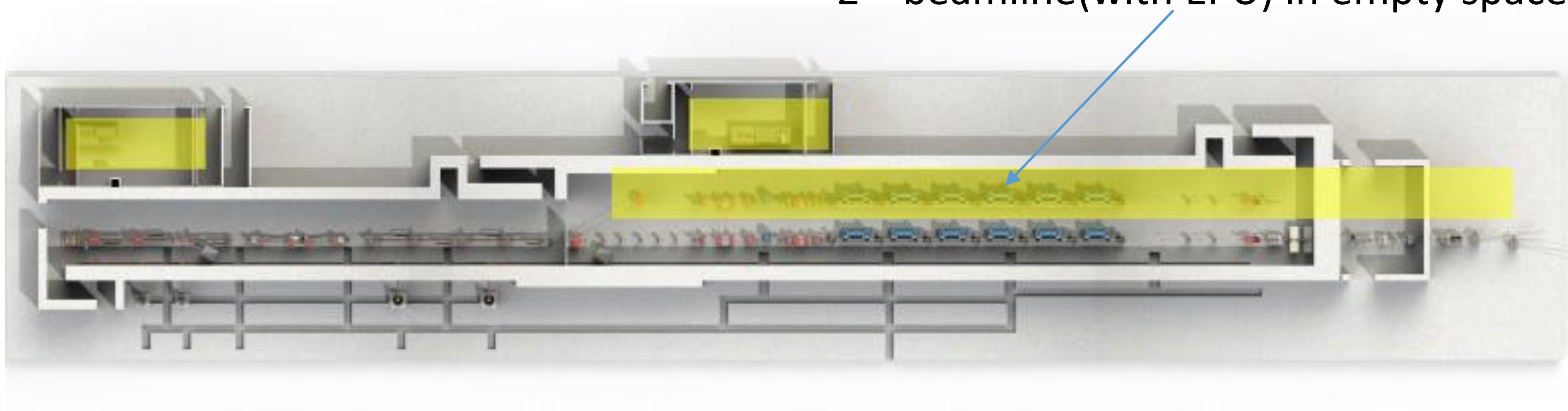


Seed laser is 266nm, which is 3rd of 800nm.
88nm (3rd harmonic of seed laser) is also achieved, energy is about 30uJ.

	Design number	*Achieved number at the moment*
➢ Tunable Wavelength：	50 – 180 nm	150nm-50nm,
➢ Pulse Energy：	>100 uJ (1 mJ)	350 uJ
➢ Pulse length：	100 fs /1 ps	~1ps
➢ Bandwidth：	Fourier transform limit	<0.05%(HGHG)
➢ Jitter：	<30 fs	Not measured
➢ Rep Rate：	50 Hz	20Hz

DCLS upgrade : 2nd FEL line

2nd beamline(with EPU) in empty space

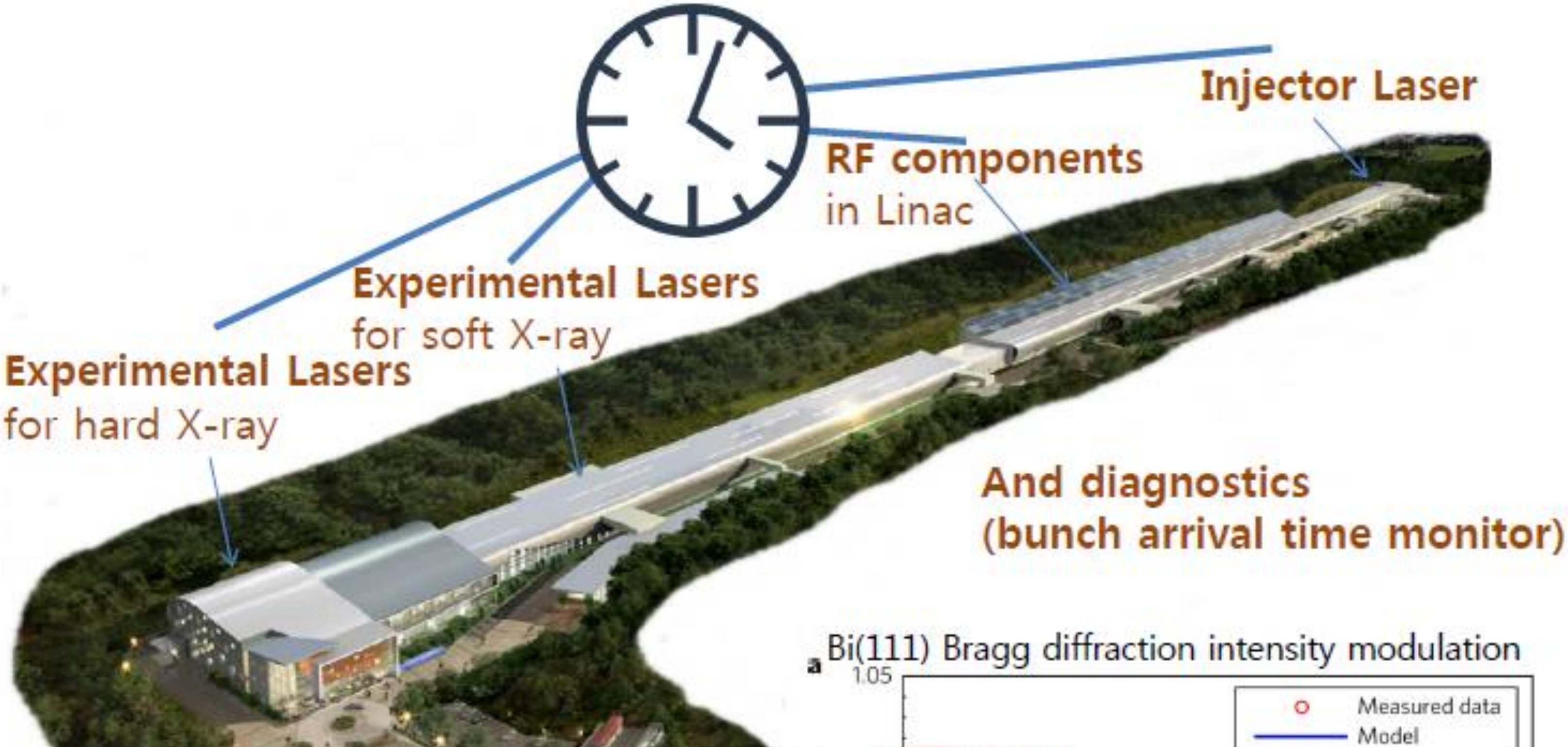


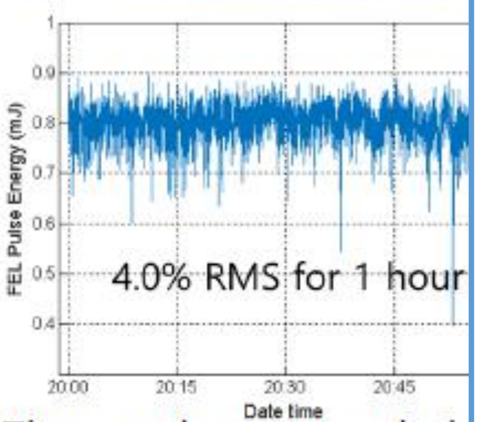
Sub-20-femtosecond timing jitter of PAL-XFEL

Jan 29, 2018

Chang-Ki Min
on behalf of PAL-XFEL team

Pohang Accelerator Laboratory





Time and energy relatio
(phase space)

- Currently, PAL-XFEL and optical laser for exp. shows sub 20 fs jitter performance at the measurement time scale of time-resolved experiment(~10 minutes).
  - Temperature stabilized, vibration resistive coaxial cable based RF timing distribution with the combination of low phase RF oscillators provide ~ 1 fs RMS (1 second time scale), ~ 15 fs RMS (10 minutes time scale), ~500 fs drift (1 day)

- ~10 fs RMS arrival time jitter at the gun become twice at the undulator end and which is correlated with energy jitter : 100 fs drift /10^{-3} energy change at BC2

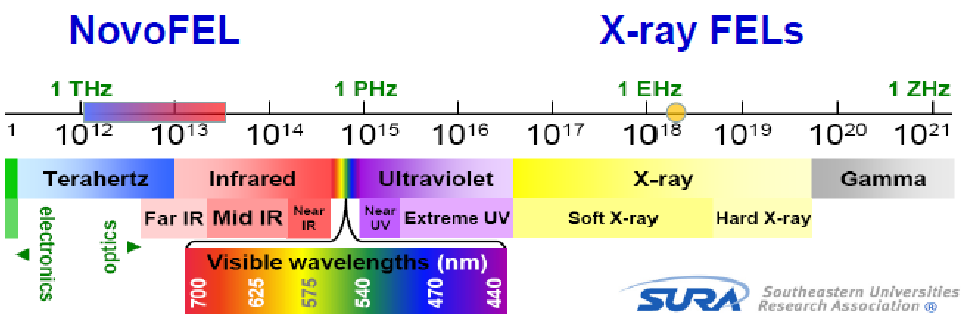
The 9th Asian Forum for Accelerators and Detectors

Novosibirsk Free Electron Laser Facility

WG1: Accelerator and its relates technologies for photon science

Presented by Dr. Ya. V. Getmanov

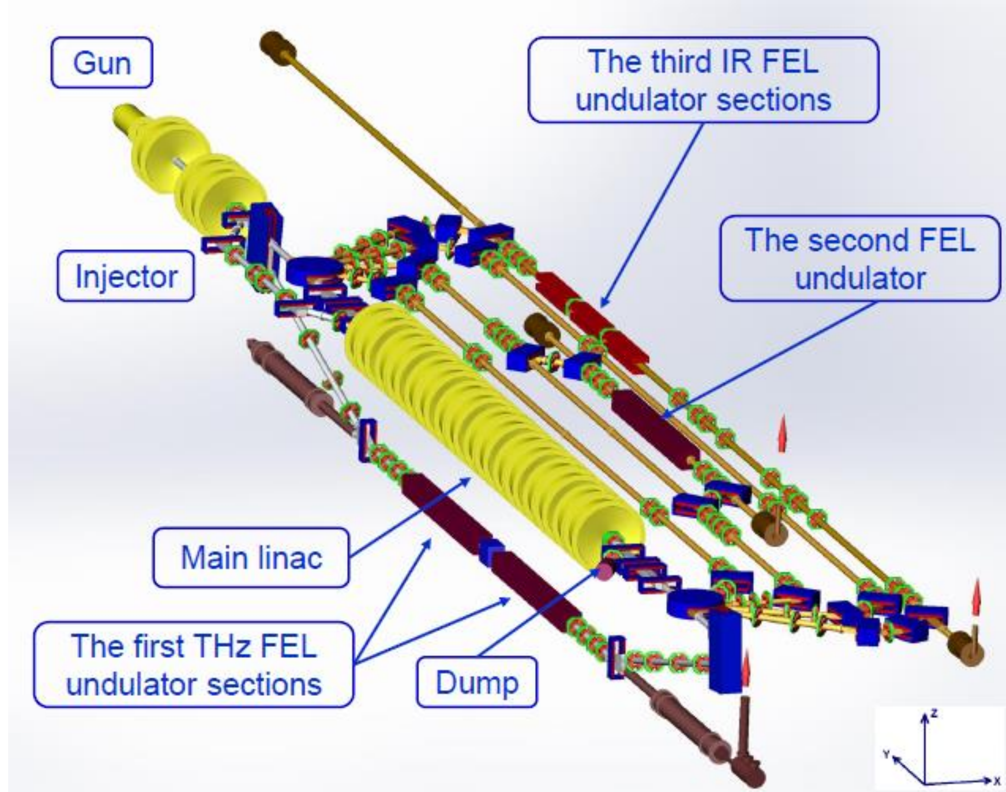
Budker INP, Novosibirsk, Russia



The most attractive ranges for FELs are at very short and at very long wavelength, where there are no other lasers

Overview of the NovoFEL facility

- The first stage of Novosibirsk high power free electron laser (NovoFEL) based on one track energy recovery linac (ERL) working in spectral range (90 – 240) μm was commissioned in 2003.
- The second stage of NovoFEL based on two track energy recovery linac, working in spectral range (37 – 80) μm, was commissioned in 2009.
- The third stage of NovoFEL based on four track ERL was commissioned on July of 2015. Spectral range now is (8-11) μm. First operation for users was done in 2016.



Nearest and far future plans

- Optical (SR) diagnostics of electron beam parameters
- Launch the electron gun attenuator for high peak and low average power radiation experiments
- Increase DC gun voltage and improve beam quality in injector
- Optimize electron efficiency of FEL
- Install the new undulator to extend the wavelength range
- Install RF gun
- Launch the electron outcoupling scheme

Progress with CW 100 mA Electron RF Gun for Novosibirsk ERL FEL

V. Volkov, V. Arbuzov, E. Kenzhebulatov, E. Kolobanov, A. Kondakov, E. Kozyrev, S. Krutikhin, I. Kuptsov, G. Kurkin, S. Motygin, A. Murasev, V. Ovchar, V.M. Petrov, A Pilan, V. Repkov, M. Scheglov, I. Sedlyarov, S. Serednyakov, O. Shevchenko, S. Tararyshkin, A. Tribendis, N. Vinokurov , BINP SB RAS, Novosibirsk

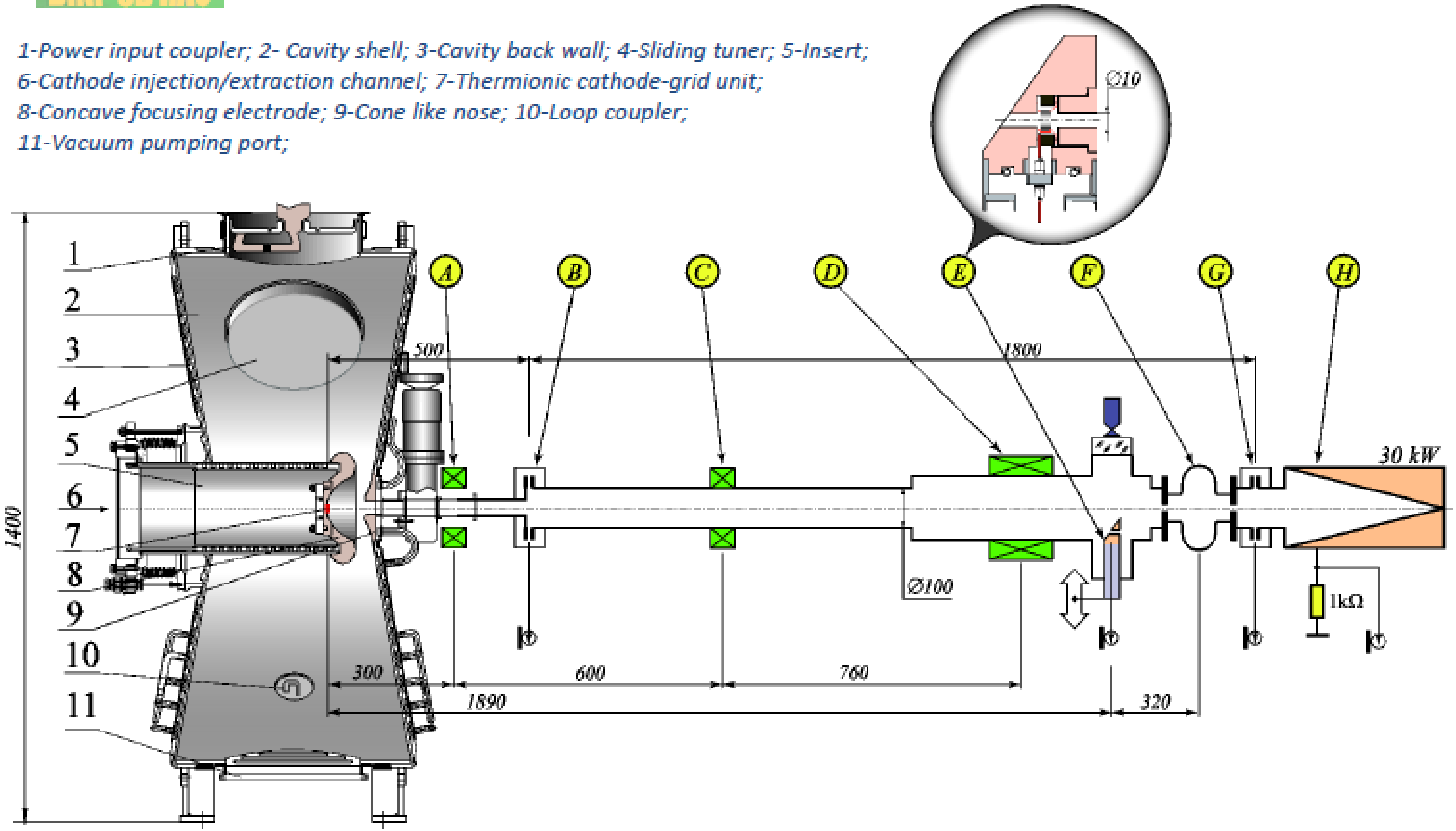
The most powerful in the world Novosibirsk CW FEL driven by ERL can be more powerful by an order of magnitude with this RF Gun

Measured rf gun characteristics	
Average beam current, mA	≤100
Cavity Frequency, MHz	90
Bunch energy, keV	100 ÷ 400
Bunch duration (FWHM), ns	0.06 ÷ 0.6
Bunch emittance, mm mrad	10
Bunch charge, nC	0.3 ÷ 1.12
Repetition frequency, MHz	0.01 ÷ 90
Dark Current Impurity, mkA	0
Radiation Dose Power, mR/h	100/2m
Operating pressure , Torr	~10^{-9}-10^{-7}
Cavity rf loses, kW	20

RF Gun Features: *Gridded thermionic dispenser cathode driven by special modulator with GaN rf transistor;*
Strong rf focusing of the beam just near the cathode;
Absolute absence of dark and leakage currents in the beam.

RF Gun and Diagnostic stand sketches

1-Power input coupler; 2- Cavity shell; 3-Cavity back wall; 4-Sliding tuner; 5-Insert; 6-Cathode injection/extraction channel; 7-Thermionic cathode-grid unit; 8-Concave focusing electrode; 9-Cone like nose; 10-Loop coupler; 11-Vacuum pumping port;



A-Emittance compensation solenoid; B-First Wall Current Monitor (WCM); C, D -Solenoids ; E-Wideband WCM and transition radiation target; F – Test Cavity; G-third WCM; H-Faraday cup and Water-cooled beam dump

Free Electron Laser based Delhi Light Source (DLS) project at IUAC, New Delhi

B.K. Sahu

Inter University Accelerator Centre (IUAC), New Delhi

On behalf of FEL team of IUAC and collaborators

ACCELERATORS AT IUAC

16 MV Pelletron

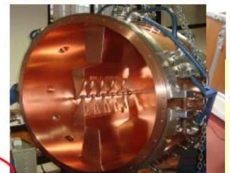
Nb QWR based Superconducting LINAC

1.7 MV RBS Facility

Dedicated AMS Facility

MC-SNICS
Negative Ion Facility

ECR
Positive Ion Facility

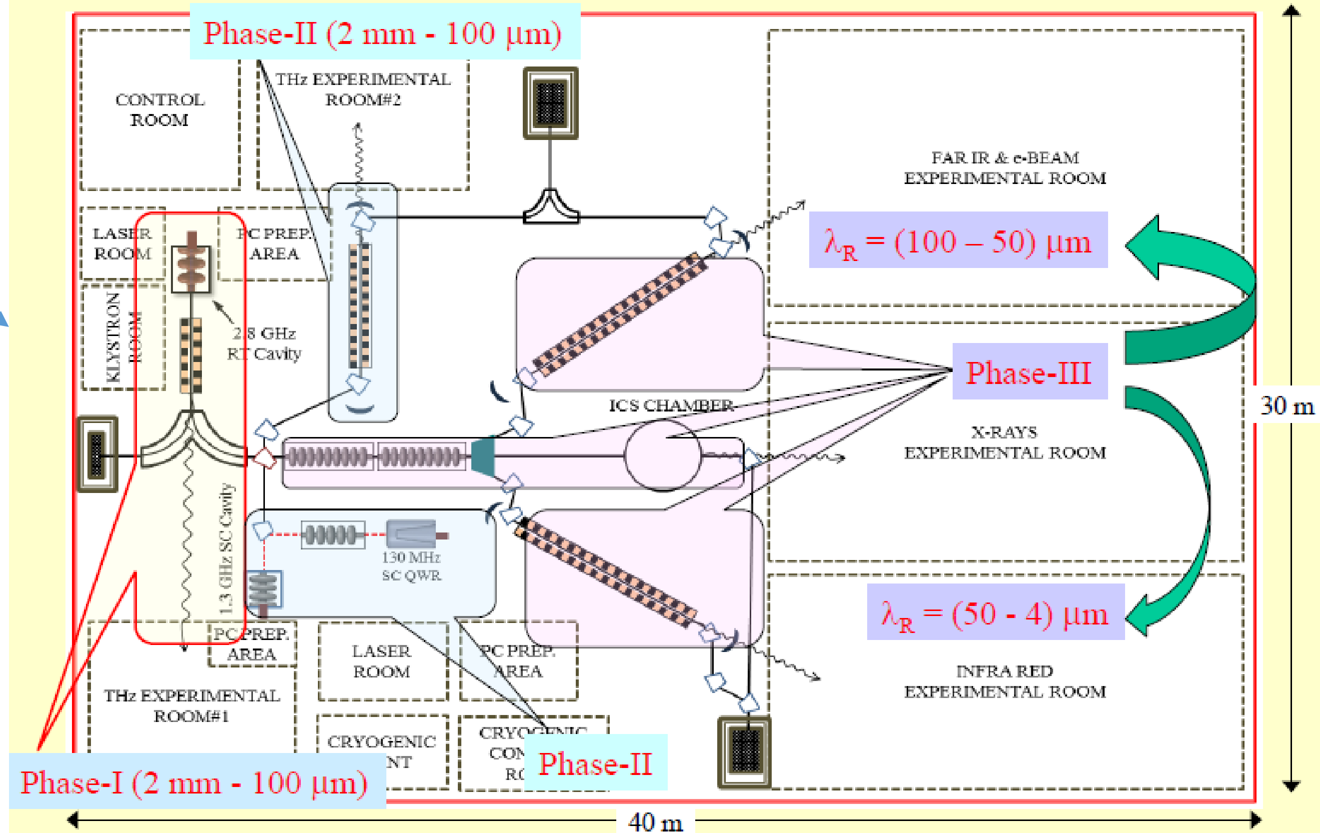


Drift tube Linac

Light source is planned to serve more number of inter disciplinary research

FEL BASED DELHI LIGHT SOURCE (DLS)

Layout of Delhi Light Source (DLS)



Recent Results on X-ray Generation at LUCX

AFAD-2018 at Daejeon Convention Center (DCC), Korea

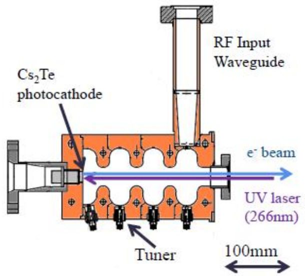
KEK, Junji Urakawa

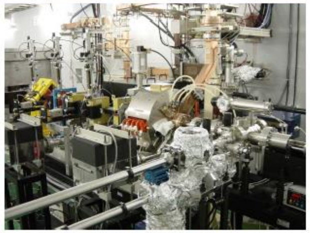
Contents :

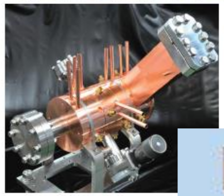
1. LUCX
2. Laser Pulse Accumulation with Burst Amplification
3. Results at LUCX
4. Summary

LUCX and ATF electron source: 3.6-cell RF gun

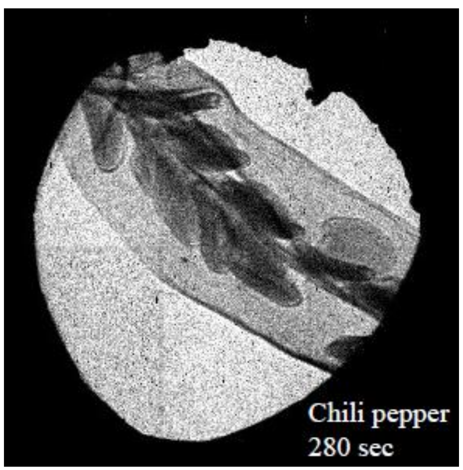
Frequency (π-mode)	2856 MHz
Qvalue	15000
Coupling β	0.99
R/Q	395Ω
Mode separation (π-2π/3)	2.8 MHz

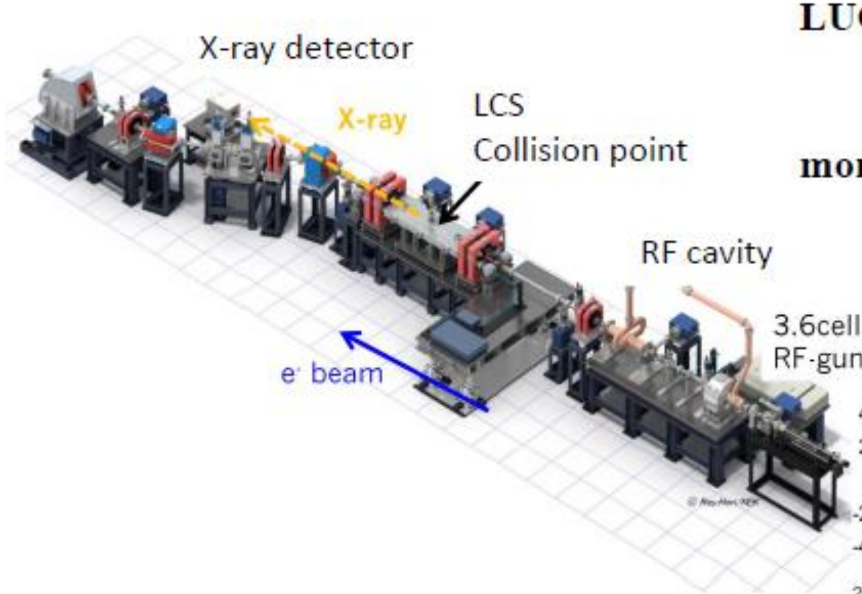






Development of multi-bunch e⁻ beam at LUCX





LUCX beam target:

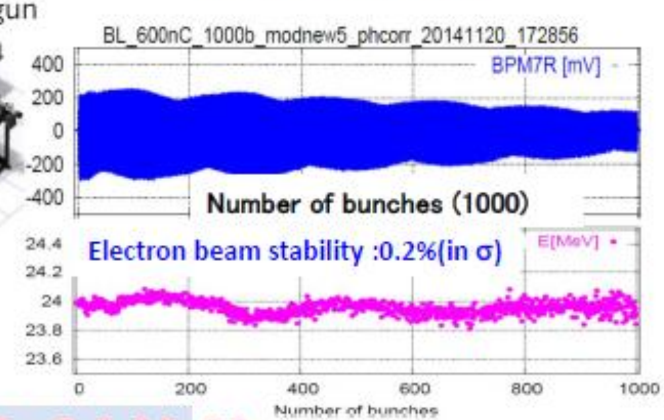
30 MeV, 357 MHz

bunch spacing 2.8 ns

more than 1000 bunches/pulse,

beam size less than 100μm

Electron Bunch Charge



2012 : 150 bunches, 90 nC

2013 : 300 bunches, 380 nC

2014 : 1000 bunches, 600 nC, 24 MeV

Energy compensation by RF amplitude modulation

LUCX PRE-BUNCHED E-BEAM GENERATION AND ITS APPLICATION TO THz EXPERIMENTAL STUDIES

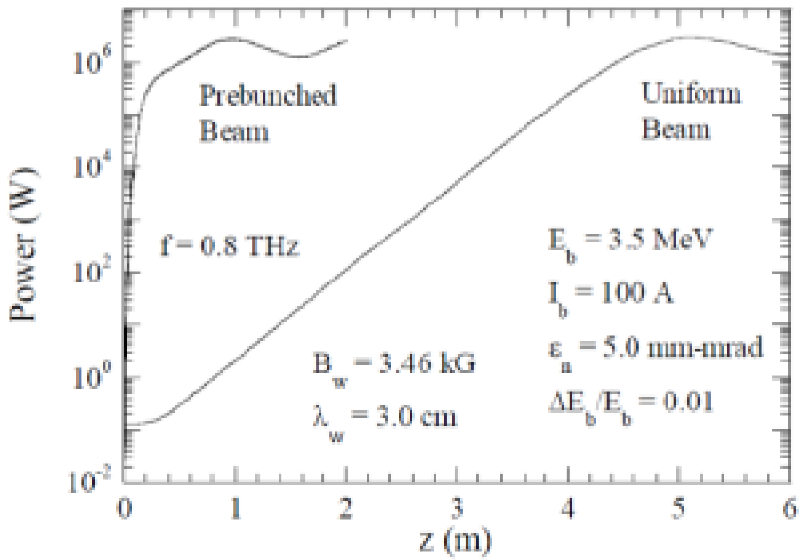
A. Aryshev

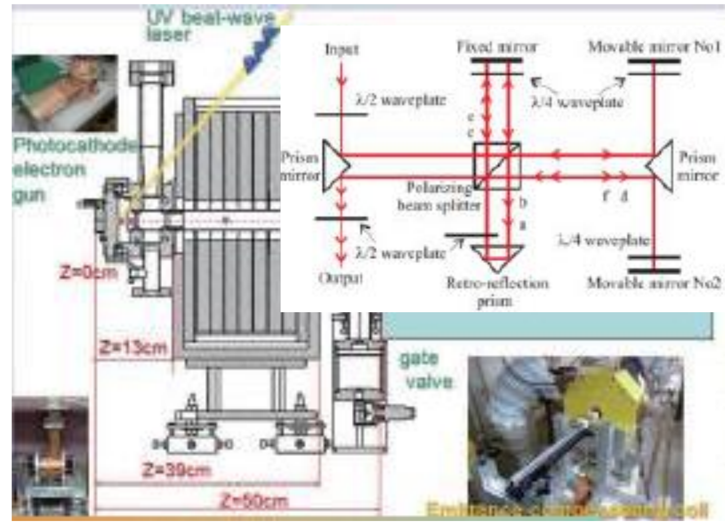
on behalf of

Advanced Generation of THz and X-ray (AGTaX) collaboration

KEK: High Energy Accelerator Research Organization, 1-1 Oho, Tsukuba, Ibaraki 305-0801, Japan

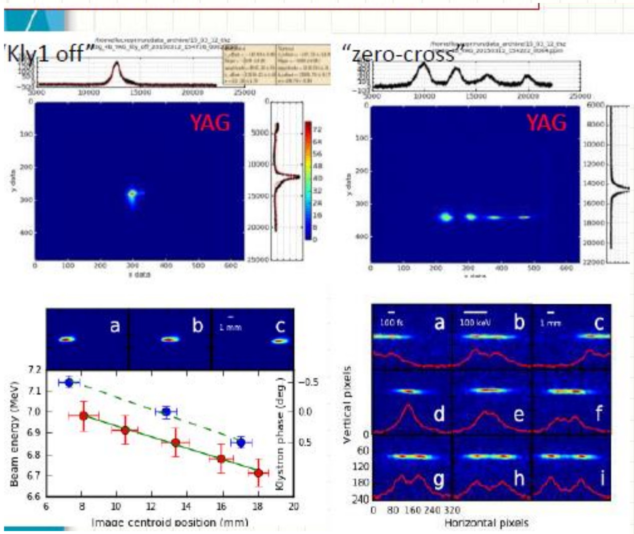
Pre-bunched injection: “Super-radiant” emission & Spectra manipulation

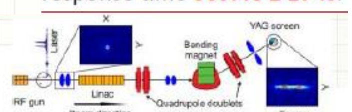




4-micro bunch generation

Te photocathode response time **369.48 ± 27 fs.**





Collaborative experiments

1. **KEK-RHUL-MEPhI, Experimental Investigations of THz radiation from composite corrugated capillaries.**
   - Spectra-angular, polarimetry. Single- and micro-bunches.
2. **KEK-RHUL-MEPhI, Drive-witness acceleration scheme based on corrugated dielectric mm-scale capillary.**
   - E, dE, (emittance in future). Beamline optics, micro-bunches.
3. **KEK-Oxford, Longitudinal beam diagnostics development based on coherent Smith-Purcell radiation.**
   - Modified Fabry-Perot interferometer.
   - Spectra-angular, polarimetry. Single- and micro-bunches.
4. **KEK-TPU, Intense THz source development using periodical conductive structures.**
   - cSPR, GDR/GTR, single- and micro-bunches.
   - Spectra-angular, polarimetry.
5. **KEK-TPU-(Oxford), Super-radiant radiation emission study.**
   - Spectra measurements
   - E-beam characterization

Tunability

Accepted Paper

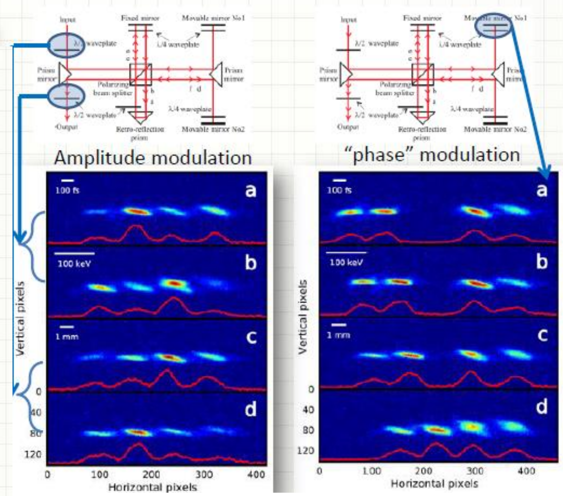
Generation of a femtosecond electron microbunch train from a photocathode using twofold Michelson interferometer

Phys Rev Accel Beams

M. Shevelev, A. Aryshev, N. Terunuma, and J. Urakawa

Accepted 14 September 2017

“phase” modulation



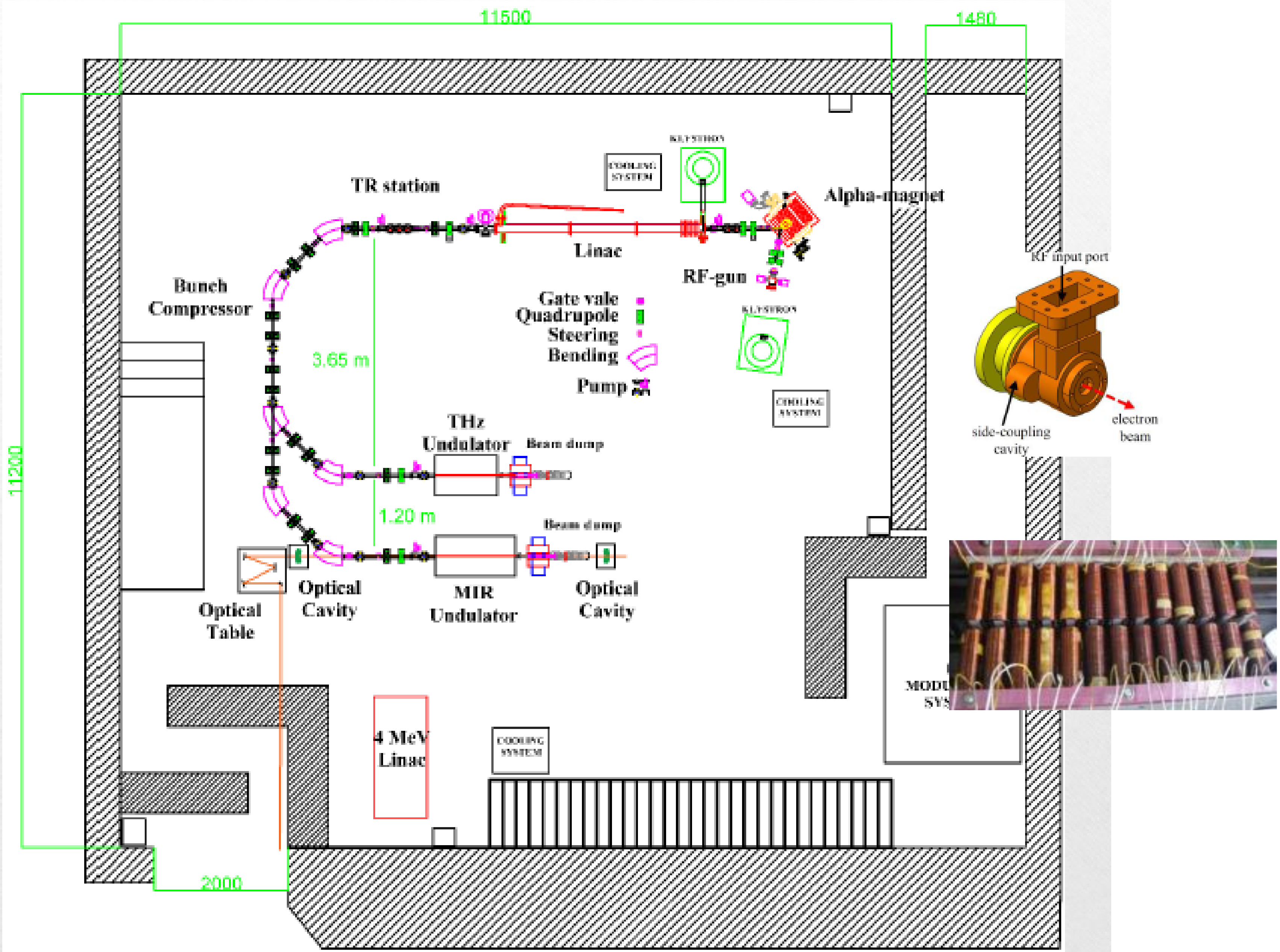
Development of Coherent THz Radiation Source and MIR-FEL in Thailand

Sakhorn Rimjeam

On behalf of the PBP-CMU Linac Laboratory Team
Plasma and Beam Physics (PBP) Research Facility
Faculty of Science, Chiang Mai University, Thailand

The 9th Asian Forum for Accelerators and Detectors (AFAD 2018)
Daejeon Convention Center (DCC), Daejeon, Republic of Korea
January 28-31, 2018

Plan of PBP-CMU Linac Laboratory



Review of Few of

Accelerator R&D Activities at PAL

Jang-Hui Han

Accelerator R&D Activities at PAL

<PLS-II related>

- Storage ring injection upgrade (2017~2019)
- Electron beam stabilization (transverse feedback, …)
- High photon energy X-ray source
- fs-THz beamline source renovation (independent facility)

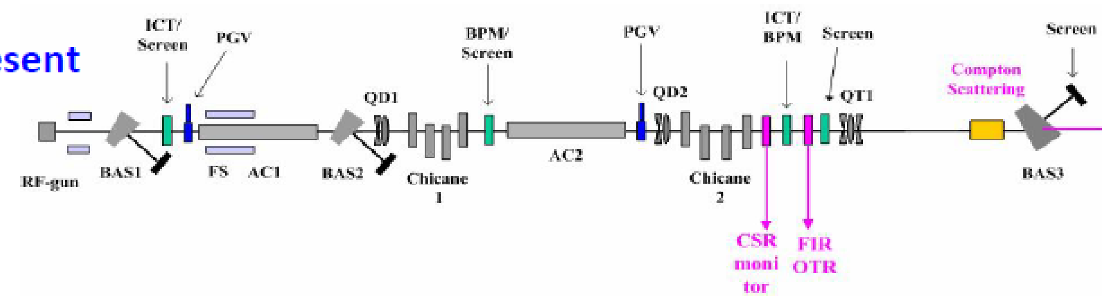
<PAL-XFEL related>

- Self-seeding
- EPU for soft X-ray

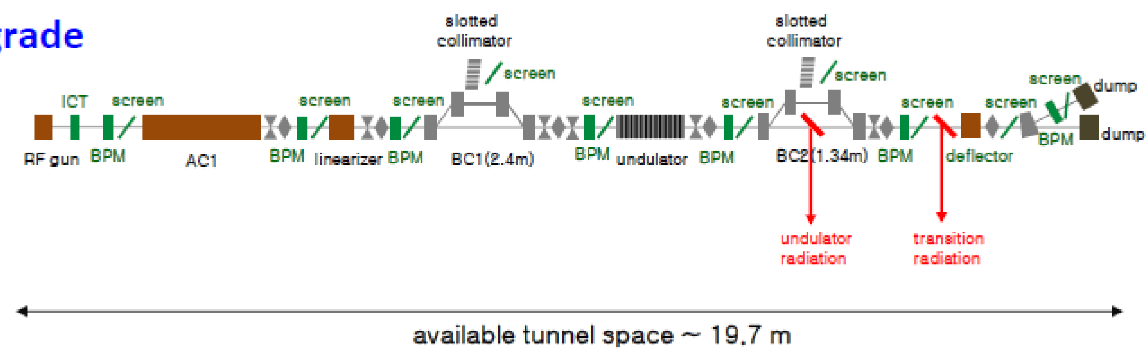
<Others>

- Klystron development (2016~2018)
- Ultimate storage ring
- Plasma wakefield acceleration
- High power FEL
- Compact storage ring

Present



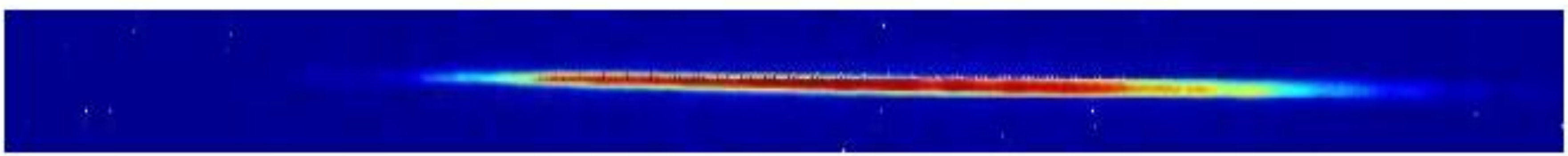
Upgrade



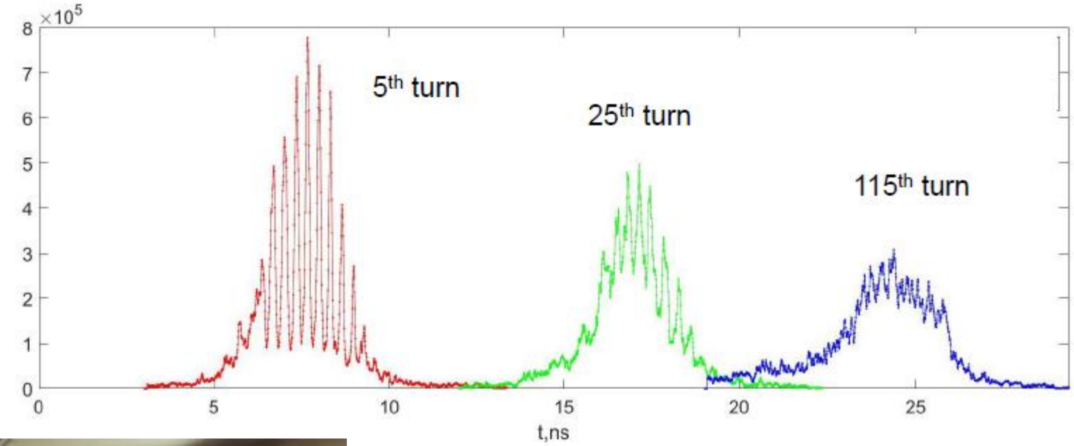
O. Meshkov

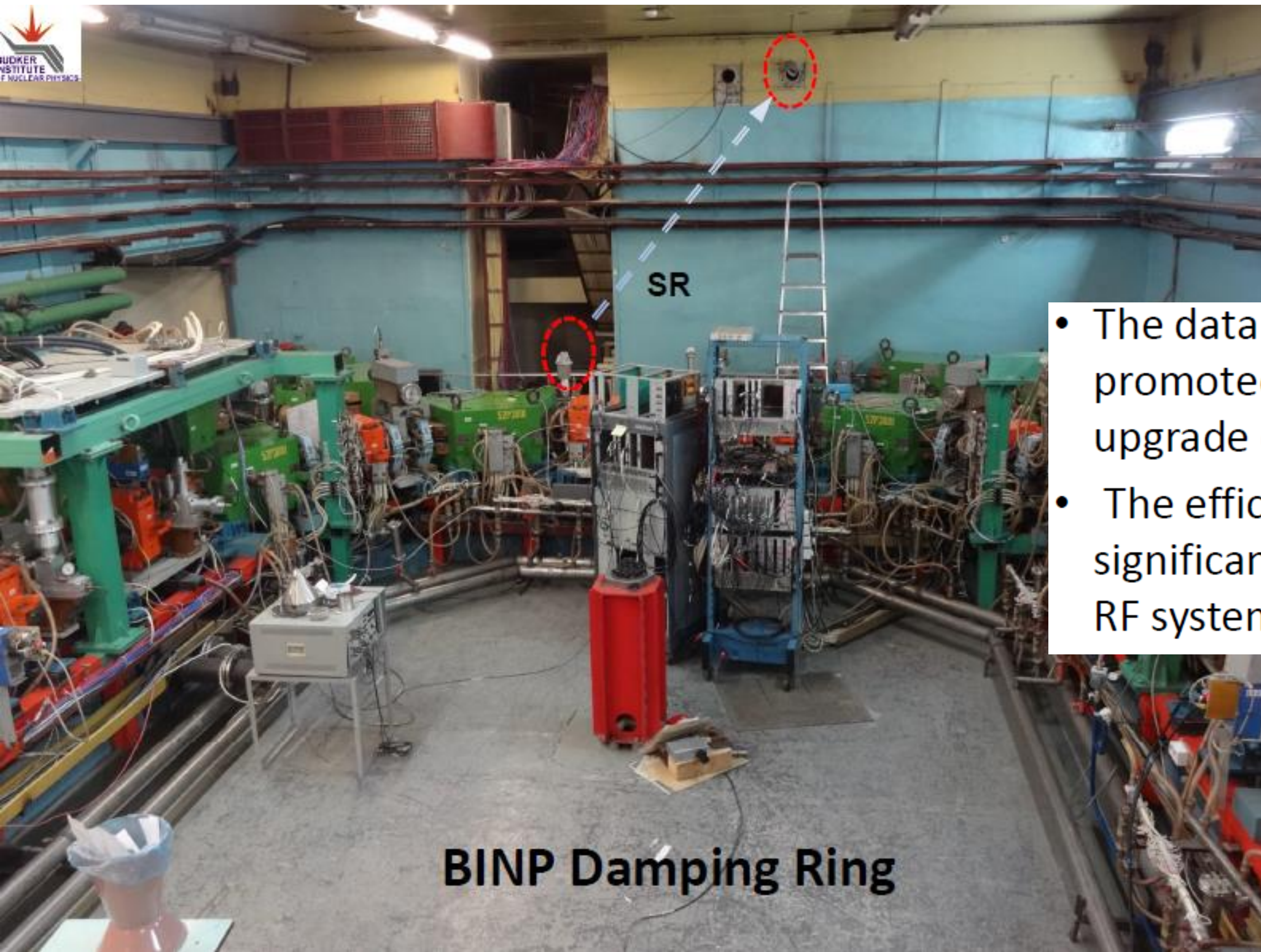
Study of the BINP damping ring performance with the streak camera

Budker Institute of Nuclear Physics SB RAS, Novsibirsk, Russia



PS-1/S1 streak camera





- The data acquired by the streak camera promoted to make up a decision about upgrade of the RF system of the installation.
- The efficiency of the Injection Complex significantly improved after the upgrade of the RF system of the Damping Ring

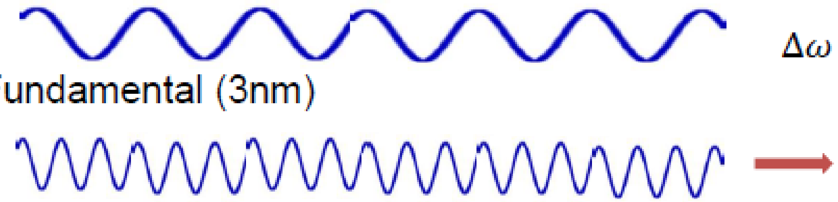
Harmonic lasing self-seeded free electron laser down to 1 nm at PAL-XFEL

Inhyuk Nam, Chang-Ki Min, Changbum Kim, Haeryong Yang, Gyujin Kim, Hoon Heo, Su Nam Kwon, Sang Han Park Heung-Sik Kang

Pohang Accelerator Laboratory XFEL, POSTECH, Korea

K = 3.3 ($\lambda_{res} = 3\ nm,\ \lambda_{3rd}$ = 1nm)

K = 1.515 (λ_{res} = 1 nm)



$\Delta\omega \sim \omega_0 / h N_u$

Fundamental (3nm)

3rd Harmonic (1nm)

Seeded FEL tuned at 1 nm

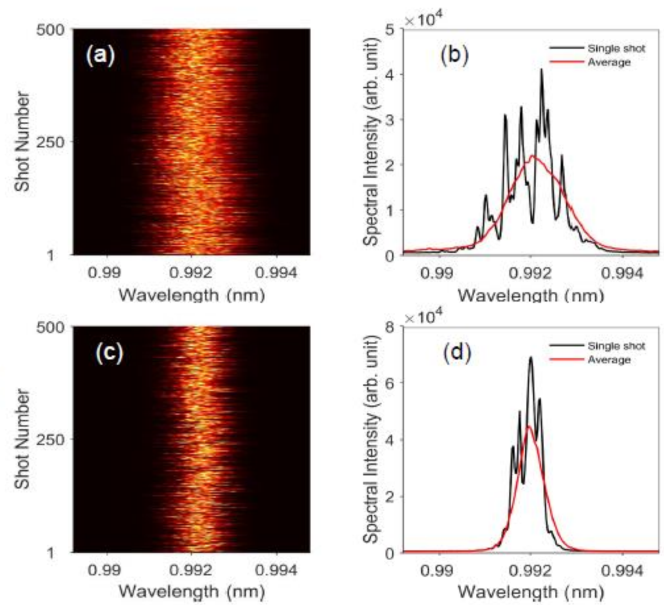
Experimental results

SASE

$\Delta\omega/\omega_0$(FWHM) = 0.255%

HLSS (3)

$\Delta\omega/\omega_0$(FWHM) = 0.145%



R ~ 1.76

Single shot spectrometer:
resolution: 0.076eV/pixel
(Grating: 200 l/mm)

Dongnam Institute of
Radiological & Medical Sciences

Status of the DIRAMS C-band standing-wave accelerator for a radiotherapy machine

9th ASIA FORUM FOR ACCELERATORS AND DETECTORS
Daejeon Convention Center, 2018 Jan. 28-31,

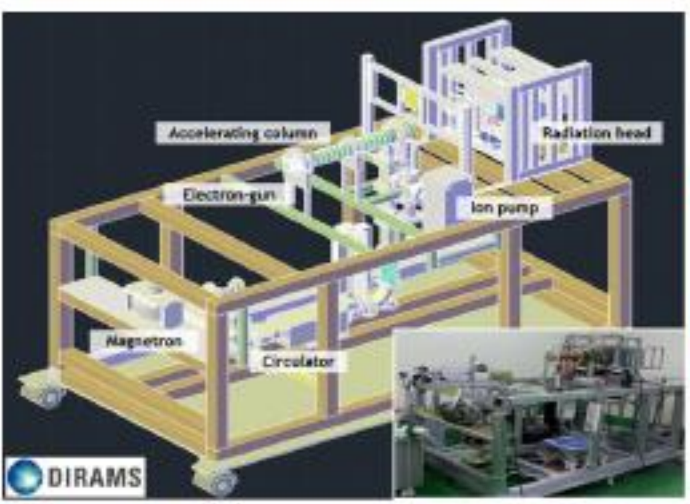
Heuijin Lim*, Wol-soon Jo, Dong Eun Lee, Manwoo Lee,
Seung Heon Kim, Sang Woong Shin, Jungyu Yi, and Dong Hyeok Jeong
Dongnam Institute of Radiological & Medical Sciences, Busan, Korea

동남권 Dongnam Institute of Radiological & Medical Sciences
원자력의학원

Conclusion

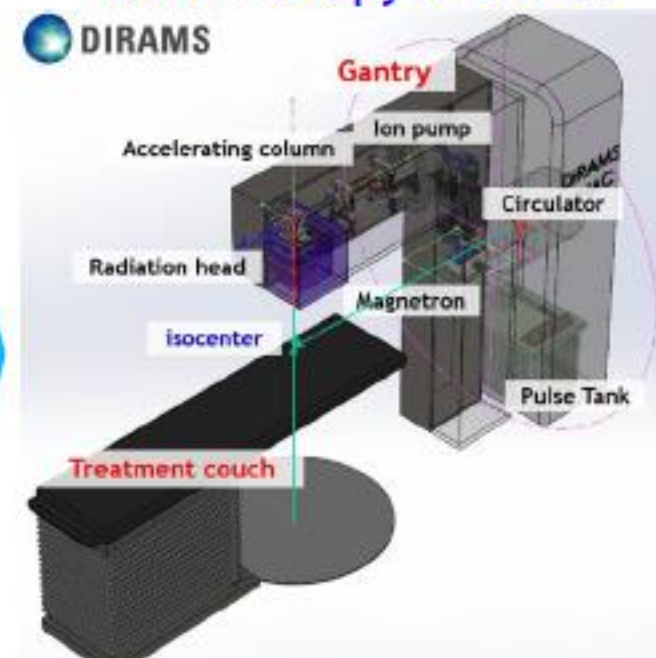
- Since the 6 MeV C-band Linac was constructed, it currently is used as an irradiator machine for biological effect study, radiation hardness study, also the development for sub-components and so on.
- We have the plan to generate the high dose of X-ray beam, that the precise measurement and the advanced study based on X-ray beam will be improved.
- Currently, we're preparing the 9 MeV C-band Linac which also will be verified for the gantry design in the radiotherapy machine.

6 MeV C-band Linac



9 MeV C-band Linac

Radiotherapy machine

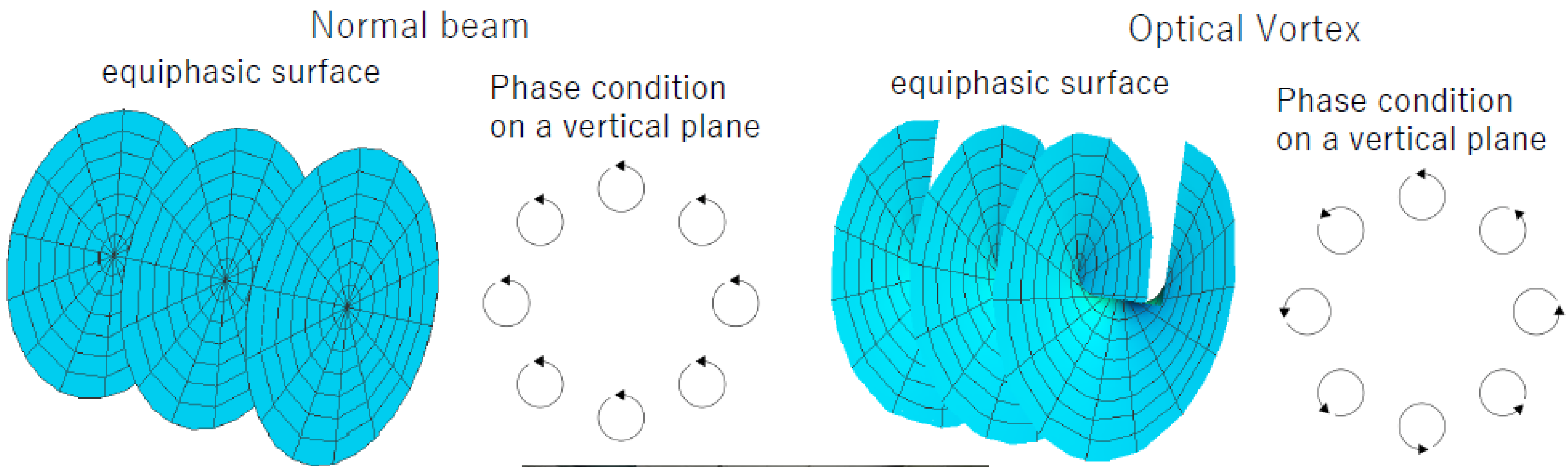


Structured light from helical undulators

Shunya Matsuba
Hiroshima synchrotron radiation center Hiroshima University

The 9th Asian Forum for Accelerators and Detectors

2018/0131



Experiment at UVSOR-III