FLS 2023, summary talk
Working Group B

Nicola Carmignani
Francis Cullinan, Simon Leeman,
Andreas Jankowiak, Masamitsu Aiba,
Naoto Yamamoto

ESRF | The European Synchrotron

FLS PROGRAM

Future Light Sources 2023 Program

Time	Sunday, Aug. 27	Monday, Aug. 28		Tuesday, Aug. 29		Wednesday, Aug. 30		Thursday, Aug. 31		Friday, Sep. 1
		Plenary Session MO1 (Chair: Romain Ganter) Coronado		**TU1 – Working Group C – Coronado Compact Light Sources Chair: Alexander Yu. Molodozhentsev**	**TU1 – Working Group B – Orion – DC3 Storage Ring Light Sources Chair: Andreas Jankowiak**	**Plenary Session WE1 (Chair: Andreas Jankowiak) Coronado**		**TH1 – Working Group D – Coronado Key Technologies Chair: Sara Casalbuoni**		**Plenary Session FR1 (Chair: Hans-Heinrich Braun) Coronado**
08:30		EuPRAXIA: the first FEL user facility driven by a plasma accelerator – Ralph Assmann		Vlad Musat (CERN) [20 + 5 min] Abel Pires (CEA) [20 + 5 min] Ishay Pomerantz (Tel Aviv University) [20 + 5 min] William Graves (Arizona University) [20 + 5 min]	Paul Goslawski (HZB) [20+5 min] Zhilong Pan (TUB, Beijing) [20+5 min] Yongjun Li (BNL) [20+5 min] Zhenghe Bai (USTC/NSRL) [20+5 min]	Status and Future of XFEL Source Developments – Sven Reiche		Johann Baader (EuXFEL) [20+5 min] Toshiteru Kii (Kyoto University) [20+5 min] Patrick Krejcik (SLAC) [20+5 min] Angela Potet (SOLEIL) [20+5 min] Discussion		Coronado Summary WG-A: Eduard Prat, Erik Hemsing, Marc Guetg, Takahiro Inagaki Summary WG-B: Nicola Carmignani Summary WG-C: Yen-Chieh Huang
09:00		Free-electron–light interactions in nanophotonics – Charles Roques-Carmes				Progress and update on cavity based XFELs – Zhirong Huang				
09:30		Production and Characterization of hard X-rays beyond 25 keV – Ye Chen				Enabling technologies for compact multiline XFELs – John Byrd				
10:00		The Challenges and Benefits of Increased Application of Permanent Magnets to Future Light Sources – Joel Chavanne				Operating Liquid MetalJet X-ray Sources for Materials Research – Mirko Boin				
10:30		Coffee Break		Coffee Break		Coffee Break		Coffee Break		Coffee Break
11:00–12:30		**Plenary Session MO2 (Chair: Kwang-Je Kim) Coronado**		**TU2 – Working Group A – Coronado Linac Based Light Sources "Coherence" Chairs: Erik Hemsing, Marc Guetg**		**WE2 – Working Group A – Coronado Linac Based Light Sources "e- beam & FEL physics" Chairs: Takahiro Inagaki, Erik Hemsing**	**WE2 – Working Group C – Orion – DC3 Compact Light Sources Chair: Cheng-Ying Tsai**	**TH2 – Working Group C – Coronado Compact Light Sources Chair: Philippe Regis-Guy Piot**	**TH2 – Working Group A – Orion – DC3 Linac Based Light Sources "Short Pulses" Chairs: Marc Guetg, Eduard Prat**	**Plenary Session FR2 (Chair: Hans-Heinrich Braun) Coronado**
11:00		Future of the multi bend achromat – Pantaleo Raimondi		Giovanni de Ninno [12+3 min] Dinh Cong Nguyen (xLight) [12+3 min] Shan Liu (DESY) [12+3 min] Rachel Anne Margraf (Stanford University) [12+3 min] Discussion, 30'		Kwang-Je Kim (ANL) [12+3 min] Nicholas Sigmund Sudar (SLAC) [12+3 min] Meredith Henstridge (SLAC) [12+3 min] Simone Di Mitri (Elettra) [12+3 min] Discussion, 30'	Aliaksei Halavanau (SLAC) [20 + 5 min] Yen-Chieh Huang (NTHU) [20 + 5 min]	Marie-Emmanuelle Couprie (SOLEIL) [20 + 5 min] Alexander Yu. Molodozhentsev (Czech Republic Academy of Sciences) [20 + 5 min] Fei Li (TUB) [20 + 5 min]	Christoph Bostedt (PSI) [12+3 min] Weilun Qin (DESY) [12+3 min] Jiawei Yan (EuXFEL) [12+3 min] Guanglei Wang (PSI) [12+3 min] Discussion: 30'	Summary WG-D: Jim Clarke
11:30		Storage ring based steady state microbunching – Alex Chao								Closing Conference
12:00		Review of Harmonic Cavities in Fourth-Generation Storage Rings – Francis Cullinan								
12:30		Group Photos and Lunch Break		Lunch Break		Lunch Break		Lunch Break / IOC Lunch		
14:00–16:00		**MO3 – Working Group B – Coronado Storage Ring Light Sources Chair: Francis Cullinan**	**MO3 – Working Group A – Orion – DC3 Linac Based Light Sources "Status of Facilities" Chairs: Eduard Prat, Takahiro Inagaki**	**TU3 – Working Group D – Coronado Key Technologies Chair: Dmitry Bazyl**	**TU3 – Working Group B – Orion – DC3 Storage Ring Light Sources Chair: Masamitsu Aiba**	**WE3 – Working Group A – Coronado Linac Based Light Sources "High Duty Cycle & Injectors" Chair: Erik Hemsing, Eduard Prat**	**WE3 – Working Group D – Orion – DC3 Key Technologies Chair: Jim Clarke**	**TH3 – Working Group B – Coronado Storage Ring Light Sources Chair: Naoto Yamamoto**	**TH3 – Working Group D – Orion – DC3 Key Technologies Chair: Olivier Marcouille**	
		Xiaobiao Huang (SLAC) [20+5 min] Alexis Gamelin (SOLEIL) [20+5 min] Naoto Yamamoto (KEK) [20+5 min] Weihang Liu (IHEP) [20+5 min]	SHINE, Dong Wang, 10' PSI, Thomas Schietinger, 10' SLAC, Dan Gonnella, 10' EUXFEL, Mathias Scholz, 10' FLASH, Mathias Vogt, 10' PAL XFEL, Myunghoon Cho, 10' Spring 8, Takahiro Inagaki, 10' Fermi, Simone Di Mitri, 10' SXFEL Shanghai, Chao Feng, 10' Discussion: 30'	Daniel Gonnella (SLAC) [15+5 min] Marcus Lau (TRUMPF GmbH) [15+5 min] Emilio Alessandro Nanni (SLAC) [15+5 min] Hiroyasu Ego (KEK) [15+5 min] Boris Militsyn (STFC) [25+5 min] Discussion	Simon Leemann (LBNL) [25+5 min] Thorsten Hellert (LBNL) [20+5 min] Lu Xiaohan (HEPS) [20+5 min] Vadim Sajaev (ANL) [20+5 min]	Romain Letrun (EuXFEL) [12+3 min] Zhen Zhang (SLAC) [12+3 min] Cheng-Ying Tsai (HUST) [12+3 min] Zhen Wang (SARI-CAS) [12 +3 min] Sandeep Kumar Mohanty (DESY) [12+3 min] Thomas Geoffrey Lucas (PSI) [12+3 min] Discussion: 30'	Holger Schlarb (DESY) [25+5 min] Patrick Krejcik (SLAC) [25+5 min] Volker Schlott (PSI) [25+5 min] Discussion	Atoosa Meseck (HZB) [20+5 min] Boris Podobedov (BNL) [20+5 min] Kwang-Je Kim (ANL) [20+5 min] Haisheng Xu (IHEP) [20+5 min]	Shan Liu (DESY) [20+5 min] Andrea Santamaria Garcia (KIT) [20+5 min] Jingyi Tang (SLAC) [20+5 min] Pierre Schnizer (HZB) [20+5 min] Discussion	
16:00		Coffee Break		Coffee Break		Coffee Break		Coffee Break		
16:30–18:00	Registration and Welcome Apero – Conference Center Foyer	**MO4 – Working Group B – Coronado Storage Ring Light Sources Chair: Simon Leeman**	**MO4 – Working Group C – Orion – DC3 Compact Light Sources Chair: Yen-Chieh Huang**	**Conference Room Coronado Poster Session**		**Conference Room Coronado Poster Session**		**TH4 – Working Group A – Coronado Linac Based Light Sources "Novel Concept" Chairs: Marc Guetg, Takahiro Inagaki**	**TH4 – Working Group D – Orion – DC3 Key Technologies Chair: Dmitry Bazyl**	
		Aiba Masamitsu (PSI) [25+5 mi Alberto Martinez de la Ossa (DESY) [20+5 min] Richard Fielder (Diamond) [20+5 min]	Yen-Chieh Huang (NTHU) [20 + 5 min] Philippe Regis-Guy Piot (Northern Illinois University) [20 + 5 min] Illya Drebot (INFN) [20 + 5 min]					Fei Li (TUB) [12+3 min] Andrea Latina (CERN) [12+3 min] Jingyi Tang (SLAC) [12+3 min] Zhangfeng Gao (SSRF) [12+3 min] Discussion: 30'	Marek Grabski (MAXIV) [15+5min] Renkai Li (TUB) [15+5 min] Rong Xiang (HZDR) [15+5 min] Discussion	
18:00										
18:30–22:30						Lake Lucerne Conference Dinner				

OUTLINE

Francis Cullinan

MO3B Working Group B: Storage Ring Light Sources
28-AUG-23 00:00 14:00–16:00
Coronado

MO3B1 **Obtaining Picosecond X-ray Pulses on 4th Generation Synchrotron Light Sources**
Xiaobiao Huang – SLAC National Accelerator Laboratory

MO3B2 **Beam Dynamics using Harmonic Cavities with High Current per Bunch**
Alexis Gamelin – Synchrotron Soleil

MO3B3 **Bunch-lengthening RF System Using Active Normal-conducting Cavities**
Naoto Yamamoto – High Energy Accelerator Research Organization Accelerator Laboratory

MO3B4 **Generating High Repetition Rate X-ray Attosecond Pulses in SAPS**
Weihang Liu – Institute of High Energy Physics China Spallation Neutron Source

Simon Leeman

MO4B Working Group B: Storage Ring Light Sources
28-AUG-23 00:00 16:30–18:00
Coronado

MO4B1 **A Review on Injection Schemes**
Masamitsu Aiba – Paul Scherrer Institut

MO4B2 **The Plasma Injector for PETRA IV: Conceptual Design Report**
Alberto Martinez de la Ossa – Deutsches Elektronen-Synchrotron

MO4B3 **Development of a Pulsed Injection Stripline for Diamond-II**
Richard Fielder – Diamond Light Source Ltd

Andreas Jankowiak

TU1B Working Group B: Storage Ring Light Sources
29-AUG-23 00:00 08:30–10:30
Orion

TU1B1 **A Highly Competitive Non-Standard Lattice for a 4th Generation Light Source With Metrology and Timing Capabilities**
Paul Goslawski – Helmholtz-Zentrum Berlin für Materialien und Energie GmbH Elektronen-Speicherring BESSY II

TU1B2 **Low-alpha Storage Ring Design for Steady-State Microbunching to Generate EUV Radiation**
Zhilong Pan – Tsinghua University in Beijing Accelerator Laboratory Department of Engineering Physics

TU1B3 **Nonlinear Optics From Hybrid Dispersive Orbits**
Yongjun Li – Brookhaven National Laboratory

TU1B4 **Minimizing the Fluctuation of Resonance Driving Terms for Analyzing and Optimizing the Storage Ring Dynamic Aperture**
Zhenghe Bai – University of Science and Technology of China National Synchrotron Radiation Laboratory

Masamitsu Aiba

TU3B Working Group B: Storage Ring Light Sources
29-AUG-23 00:00 14:00–16:00
Orion

TU3B1 **Machine Learning Applications for Performance Improvement and Developing Future Storage Ring Light Sources**
Simon Christian Leemann – Lawrence Berkeley National Laboratory Accelerator Technology & Applied Physics

TU3B2 **Recent Developments of the Toolkit for Simulated Commissioning**
Thorsten Hellert – Lawrence Berkeley National Laboratory

TU3B3 **Pyapas: A New Framework for High Level Application Development at HEPS**
Xiaohan Lu – Institute of High Energy Physics China Spallation Neutron Source

TU3B4 **Use of Automated Commissioning Simulations for Error Tolerance Evaluation for the Advanced Photon Source Upgrade**
Vadim Sajaev – Argonne National Laboratory Advanced Photon Source

Naoto Yamamoto

TH3B Working Group B: Storage Ring Light Sources
31-AUG-23 00:00 14:00–16:00
Coronado

TH3B1 **Development of the In-vacuum APPLE II Undulators at HZB**
Atoosa Meseck – Helmholtz-Zentrum Berlin für Materialien und Energie GmbH Elektronen-Speicherring BESSY II

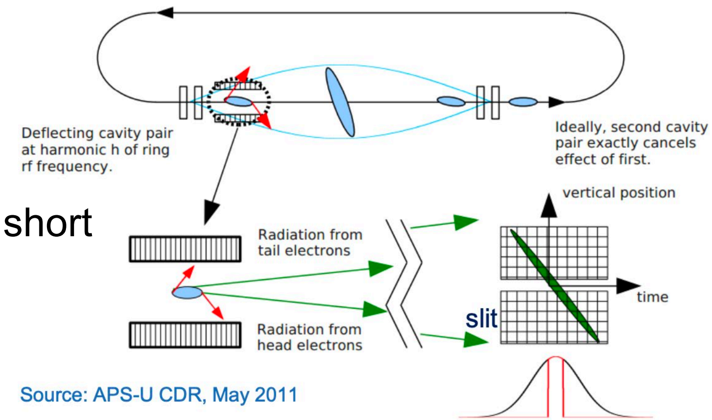
TH3B2 **Novel X-Ray Beam Position Monitor for Coherent Soft X-Ray Beamlines**
Boris Podobedov – Brookhaven National Laboratory National Synchrotron Light Source II

TH3B3 **Transverse Gradient Undulator for a Storage Ring X-Ray Free-Electron Laser Oscillator**
Kwang-Je Kim – Argonne National Laboratory Advanced Photon Source

TH3B4 **Generation of Multi X-Ray Pulses with Tunable Separation in Electron Storage Rings**
Haisheng Xu – Chinese Academy of Sciences Institute of High Energy Physics

Obtaining picosecond x-ray pulses on fourth generation synchrotron light sources

Xiaobiao Huang



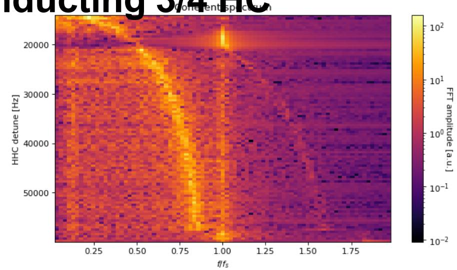
Source: APS-U CDR, May 2011

- Presented the 2-frequency crab cavity (2FCC) scheme for short ~ps pulses
  - Crab kick to every other bunch followed by cancellation
- Vertical emittance degradation due to bunch tilt in dipoles
- Low momentum compaction of MBA reduces emittance growth
- Lower performance for lengthened bunches due to crab-cavity waveform curvature
- Presented 4.5 harmonic HC+2FCC scheme for APS-U
  - Shorten bunches to be crabbed (every other bunch) while lengthening the others
  - Users may benefit from shortened bunches also without the crab cavities operating

Bunch Lengthening Using Harmonic Cavities in High Current per Bunch Modes

Alexis Gamelin

Combined broadband machine impedance with simulations of superconducting 3/4 HC



- 500 mA uniform fill when impedance model included:
  - more bunch lengthening before mode-1/PTBL instability
- 8-bunch mode at 100 mA when impedance model included:
  - longer bunches but a weak longitudinal instability at intermediate bunch lengthening due to coupling of quadrupole Robinson mode with dipole mode driven by the broadband impedance
- 1-bunch mode at 20 mA:
  - fast beam loss due to beam/cavity-mode coupling - appears at lower lengthening when broadband impedance is included

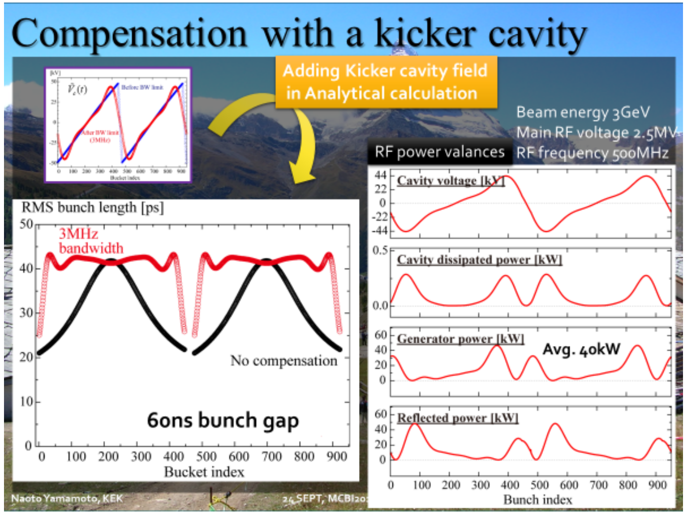
Method presented for calculating Touschek lifetimes for non-Gaussian bunches and including IBS

- HC provides less lifetime improvement than expected for high-charge bunches because of reduced IBS effects

Bunch-lengthening RF system using active normal-conducting cavities

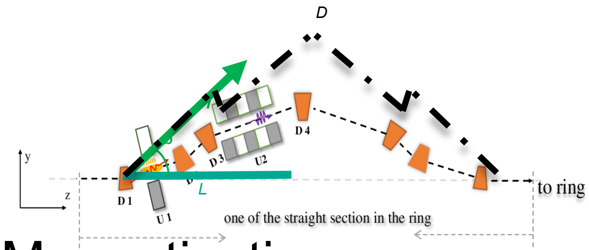
Naoto Yamamoto

- Normal conducting active HC for bunch lengthening - low R/Q
  - Smaller beam transients
  - Lower detuning before excitation of mode-1 (PTBL) instability
- Broadband kicker cavity
  - Compensate for inhomogeneous beam loading
  - Can also be used to prevent the mode-1 instability in simulation
- Presented several hardware developments:
  - TM020 NC active HC
  - broadband kicker cavity
  - Bunch phase monitor with button pick-up



Generating High Repetition Rate X-ray Attosecond Pulses in SAPS

Weihang Liu



- Science case for attosecond x-ray pulses:
  - high-temperature superconductivity, Ultrafast Magnetization Dynamics, physical mechanism of PN junction
- Presented scheme with vertical dogleg in one synchrotron straight section and few-cycle laser pulse for attosecond pulse generation - angular dispersion-induced microbunching (ADM)
- Requires low vertical emittance/dispersion - good control of coupling
- Degradation of dynamic aperture (2 %) and momentum acceptance (25 %) acceptable
- Large maximum repetition rate of 1.35 MHz because only affects part of bunch and can switch between 405 bunches

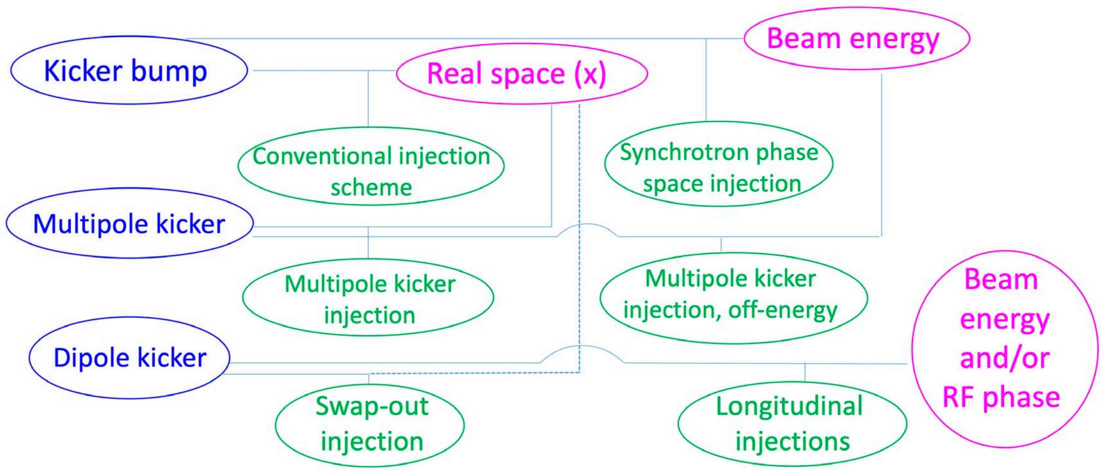
Review of Injection Schemes (Masamitsu Aiba, PSI)

Top-off has become 3GLS standard, but 4GLS with MBAs have smaller physical & dynamic apertures as well as smaller beam sizes (transparency!)

Successful injection in 4GLS will require

- excellent quality beam from injector (low-ε booster or on-energy linac)
- ε gymnastics in booster or TL
- thin septum & large β at septum

- Top-off injection = kicker ⊗ beam separation
  → Many injection schemes & optimum injection scheme will depend on SR design ring as well as the demands of beamline users (eg. high-current single bunch swap-out)



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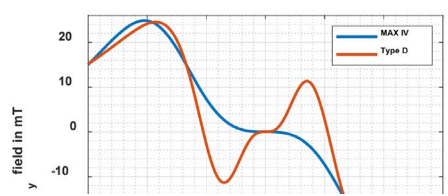

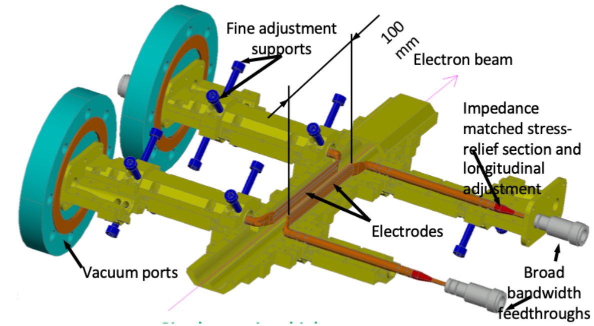

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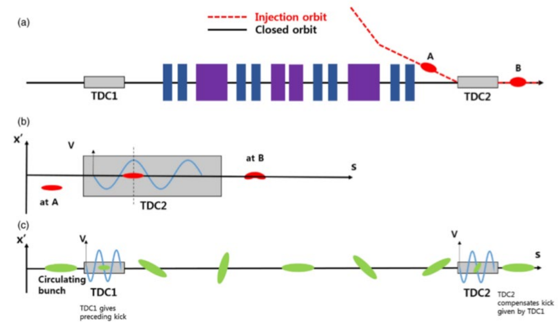

Promising technology developments

- in-vac NL kicker (SOLEIL)
- ns kicker via low-voltage pulser design (PSI)
- inj TDC plus compensation TDC (SPring-8)

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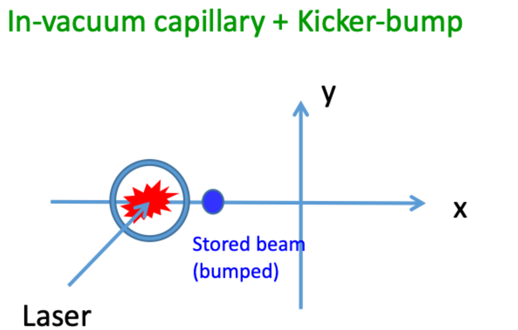

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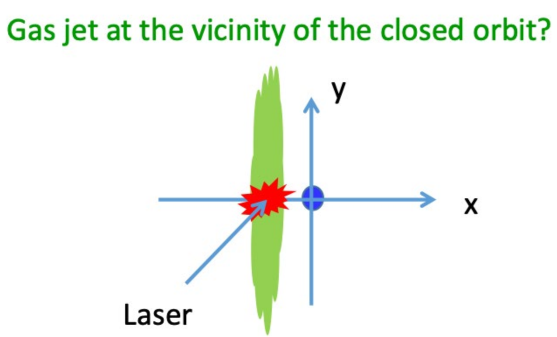
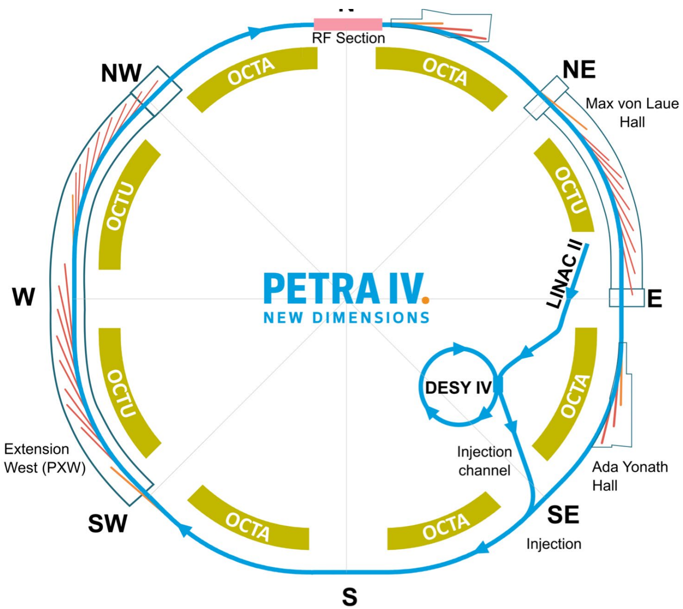
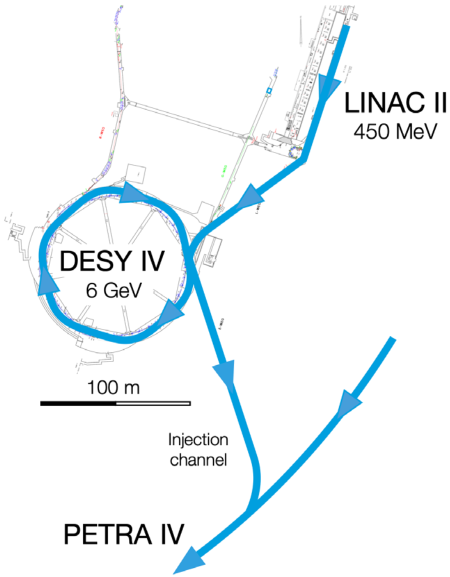


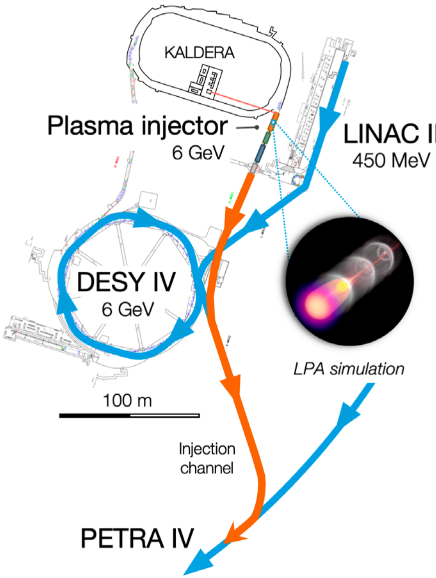
"Crazy idea": direct generation via laser plasma wake at IP (beam parameters almost meet SR acceptance while charge reproducibility not critical)

Plasma Injector for PETRA IV (Alberto Martinez de la Ossa, DESY)

- Injection for PETRA IV = LINAC II + DESY IV @ 6 GeV → 3 MW
- LPA would be much more compact & require just 245 kW







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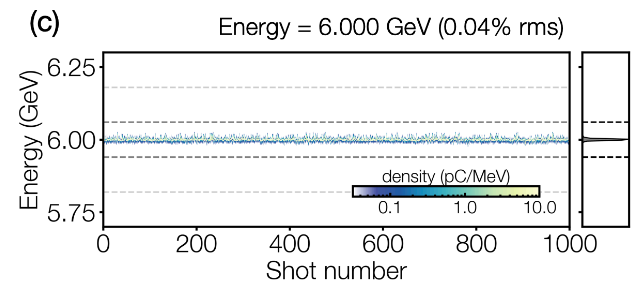
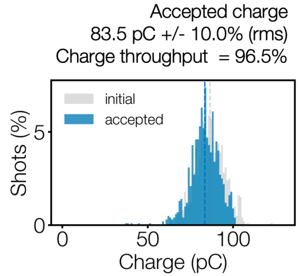
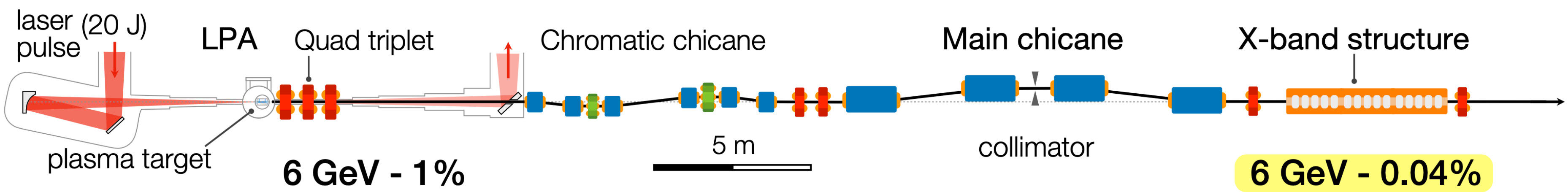
- LPA would be much more compact & require just 245 kW
- State of the art achieves 62 pC @ 6 GeV & ≈1% E spread but PETRA IV needs 0.1% & 2.6 nC/s (initial fill <10 min) → add chicane decompressor & X-band RF dechirper for ≲0.1%, 6 ps fwhm
- Requires ≈20 J Ti:Sa laser at 800 nm → maximize charge throughput & stability → ≈80 pC while overall length <50 m → ≈32 Hz rep rate







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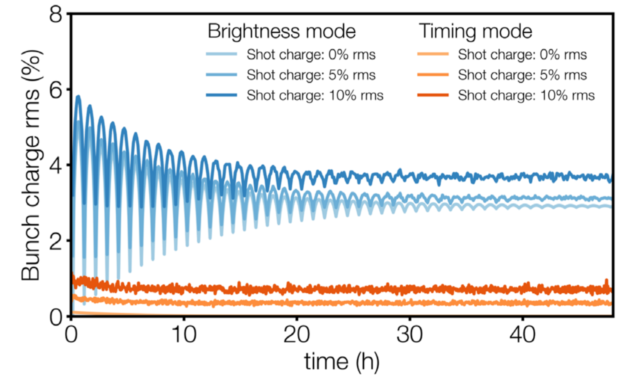
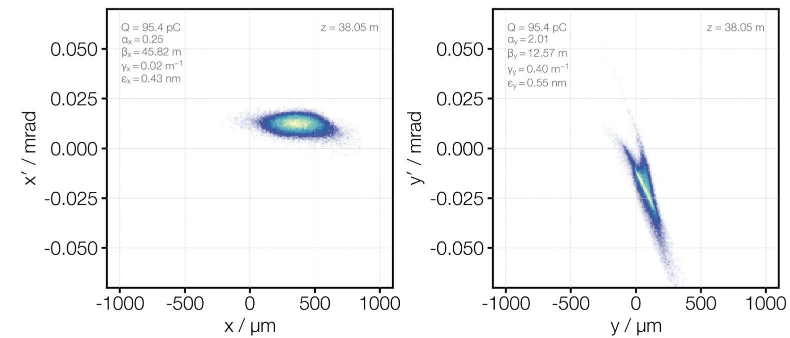
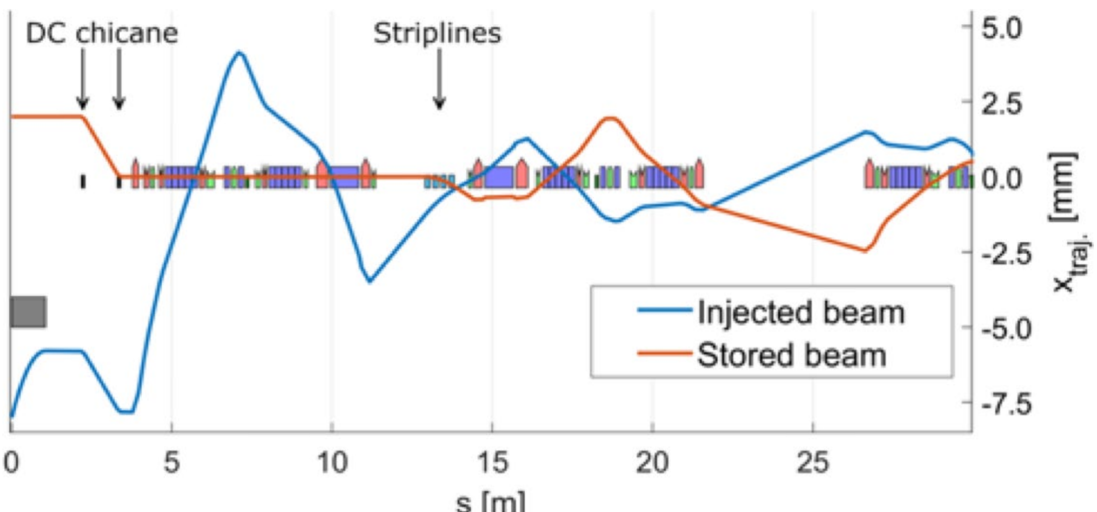
- Requires ≈20 J Ti:Sa laser at 800 nm → maximize charge throughput & stability → ≈80 pC while overall length <50 m → ≈32 Hz rep rate
- Extensive optimization required but have now set up start-to-end simulations that includes realistic jitter → tolerance analysis
  → tracking in PETRA IV for 3 damping times shows no losses
- Target 5 Hz top-off injector by 2031
- Full operation at ≈32 Hz by 2036

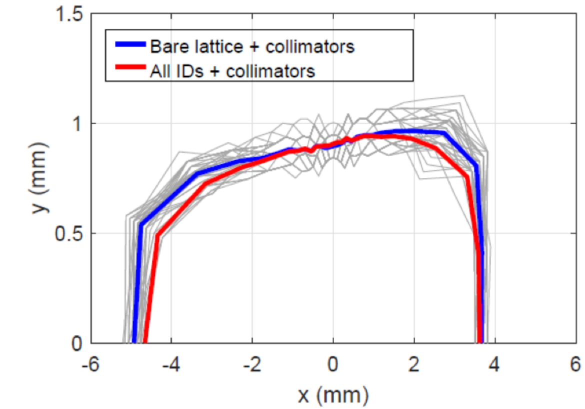




Pulsed Inj. Stripline for Diamond-II (Richard Fielder, DLS)

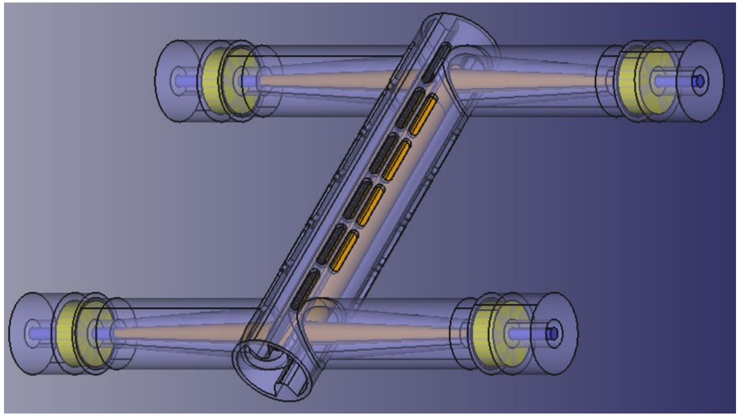
- Diamond 3 GeV DBA, 3.1 nm rad → Diamond-II 3.5 GeV H6BA, 120 pm rad
- Diamond-II has significantly reduced DA compared to Diamond → new injection scheme → aperture sharing for a single bunch → kick within 2 ns onto off-axis trajectory in small DA
- Stripline design evolved starting from SLS 2.0

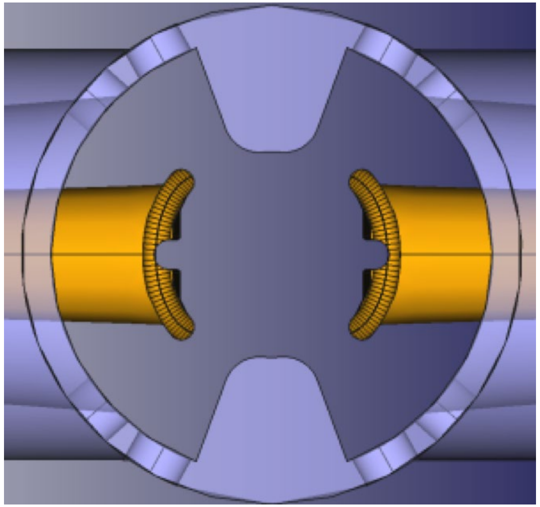




Pulsed Inj. Stripline for Diamond-II (Richard Fielder, DLS)

diamond





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- Stripline design evolved starting from SLS 2.0
  - 150-mm stripline in 180-mm module
  - 7 mm radius with flat central section & vertical inserts for field uniformity
  - Cut-outs for SR rad & optimize geometry for roll-off, reflections, arcing
- Impedance & beam power loss OK @ 300 mA
- 0.6 ns rise, 1.4 ns flat top, 0.7 ns fall (slight ringing @ following bunch)
- Particle tracking with kick maps shows good efficiency (stored beam OK)

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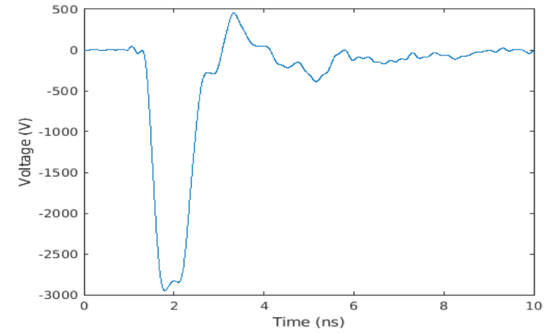
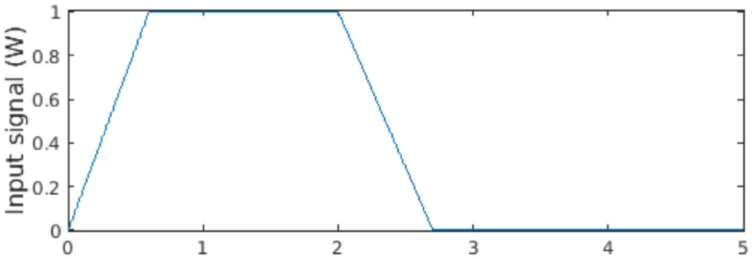
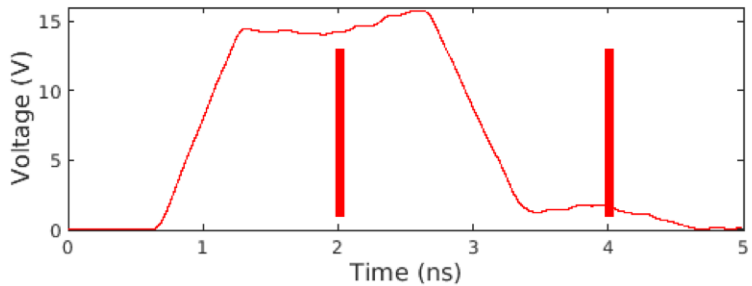
- 0.6 ns rise, 1.4 ns flat top, 0.7 ns fall (slight ringing @ following bunch)
- Particle tracking with kick maps shows good efficiency (stored beam OK)
- Low-jitter pulser design proposal by Kentech based on array of voltage avalanche cards → early demonstrator shows 3 kV at 1 ns (want 175 µrad –> 15-20 kV)
- Prototype to be installed in Diamond BTS and SR (rotated) in 2024







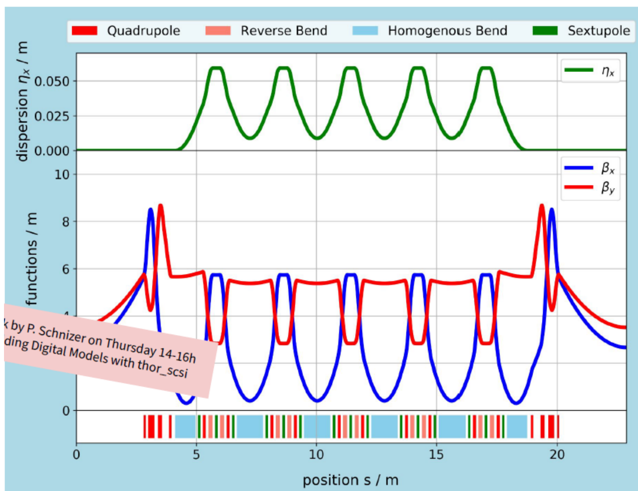
Paul Goslawski – A Highly Competitive Non-Standard Lattice for a 4th Gen. Light Source

HZB BESSY II Light Source

A Green Field Materials Discovery Facility
BESSY III – 100 pm, 2.5 GeV, 366 m circumference, 16 x 5 m straights, Metrology Capabilities

LEGO approach - Systematic analysis and optimization of Unit Cell, Dispersion Suppressor Cell, Matching cell und considering clearly defined boundaries and target conditions

Clear indications, that a 6-MBHOA with **homogenous bends** (and revers bends) is in terms of robust non-linear behavior a superior solution!



- strongly reduced sextupole strengths
- larger momentum acceptance
- conservative magnet parameters
  → will allow robust engineering design and/or increased performance / sustainability (PM dipoles and quads)
- integration of longitudinal bends will further reduce emittance and support tailored dipole radiation

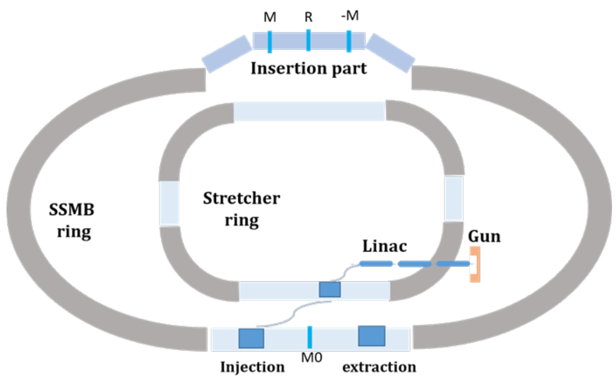
For the CDR (2025): non-linear optimization, tolerance studies (simulated commissioning), injection scheme, coll. effects

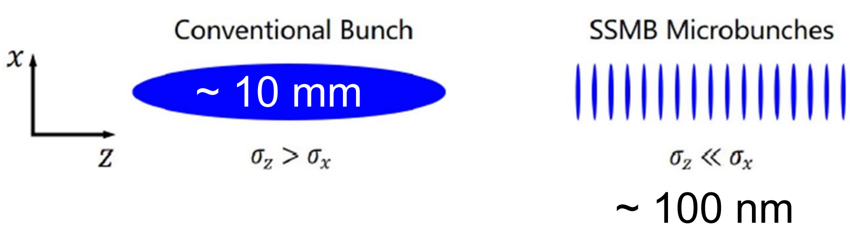
Zhilong Pan – Low-alpha SR Design for SSMB to Generate EUV Radiation

Tsinghua University

Orthogonal to DLSRs: SSMB rings tackles “ultimate” longitudinal phase space performance!

Longitudinal focusing on laser wavelength and stable storage of ultra short bunches allow generation of highest intensity (kW level) CW EUV (nm) radiation!





- prerequisite is control and minimization of partial (local) alpha effects in a low-alpha ring
- linear lattice designed to allow for 100 nm bunch length (harmonic number 10^8) with MW laser power in a optical resonator cavity at μm wavelength.
- preliminary studies showed that 6-D DA is limited by transversal-longitudinal coupling, which could be optimised by a specialized sextupole scheme

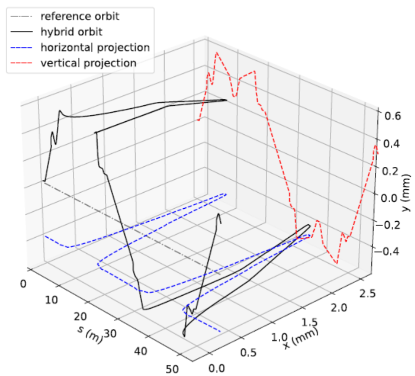
To be addressed in more detail in the future: IBS, other coll. effects, CSR

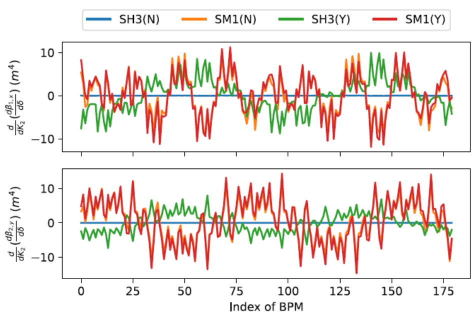
Yongjun Li – Nonlinear Optics from Hybrid Dispersive Optics

Brookhaven National Laboratory

Order-by-order optics correction in real machines by dipole kicks (orbit), quads (beta-beat), dispersive orbits (chromatic sextupoles) – What about harmonic sextupoles?

At NSLSII method introduced to use hybrid dispersive orbits (using skew quads).





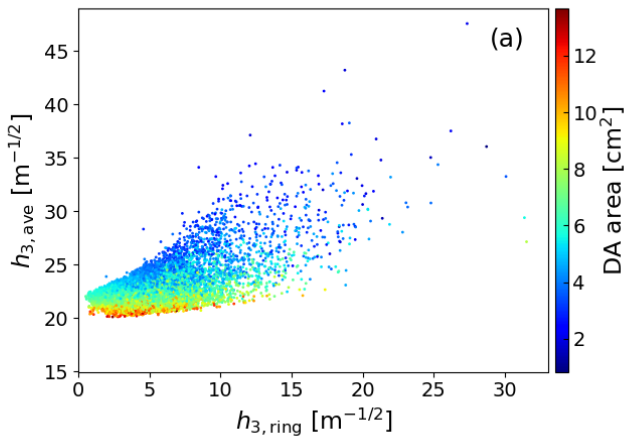
What is needed (at best)?
- individual powered sexupoles
- sufficiently strong skews
- sufficiently accurate BPM

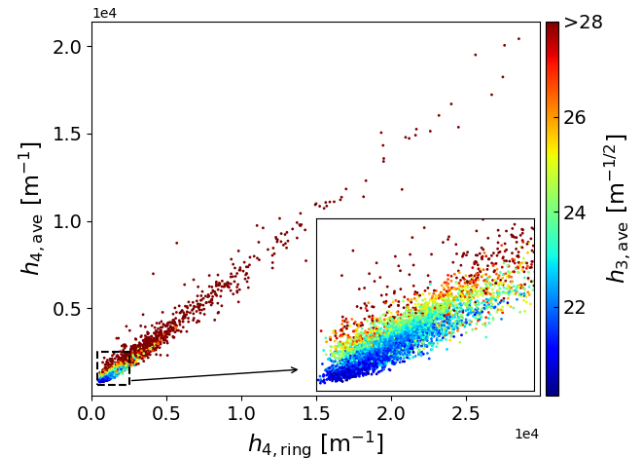
Two stage calibration:
1) calibrate chromatic sextupoles from horizontal dispersive orbits
   → derive model including these errors and use it as reference for next step
2) calibrate harmonic sextupoles from hybrid dispersive orbits

Zhenghe Bai – Minimizing the Fluctuations of RDTs for Optimizing the SR DA

USTC NSRL
NSRL
National Synchrotron Radiation Laboratory

Reducing the fluctuation (represented by the average) of RDTs (here 3rd Order)
- comes in hand with reduced fluctuation of 4th order RDTs and 4th order one-turn RDTs
- is correlated with increased dynamic aperture (which is not the case for one-turn RDTs)



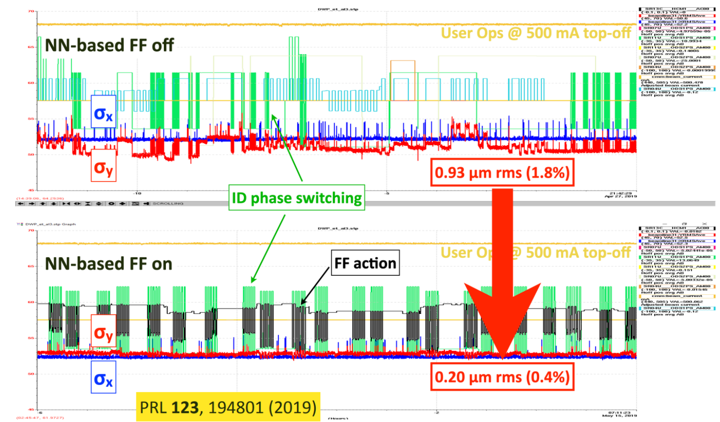


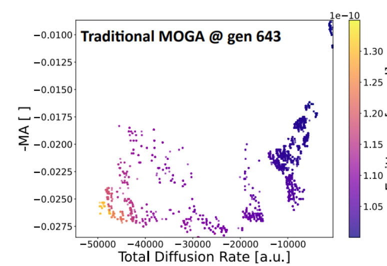
- minimizing RDTs fluctuations are more effective than minimizing one-turn RDTs!
- reducing lower-order RDT fluctuations help to reduce higher order RDTs fluctuations and one-turn RDTs

→ large DA are possible by using genetic algorithms to minimize RDT fluctuations

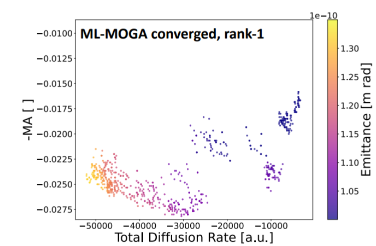
Machine Learning Applications for Performance Improvement and Developing Future Storage Ring Light Sources (Simon Leeman, LBNL)

- Stabilizing Electron & Photon Beams
  - ID gaps are varied during operation by the user
  - Feed-forward (FF) correction based on look-up table is not satisfactory
  - Neural network based FF has been applied, and the beam is well stabilized!
- Machine Learning for Lattice Optimization
  - Design of 4GLS largely rely on the numerical
  - Multi-Objective Genetic Algorithm (MOGA) is widely used but very time-consuming
  - Deep neural network can be set up by using MOGA result as an input data





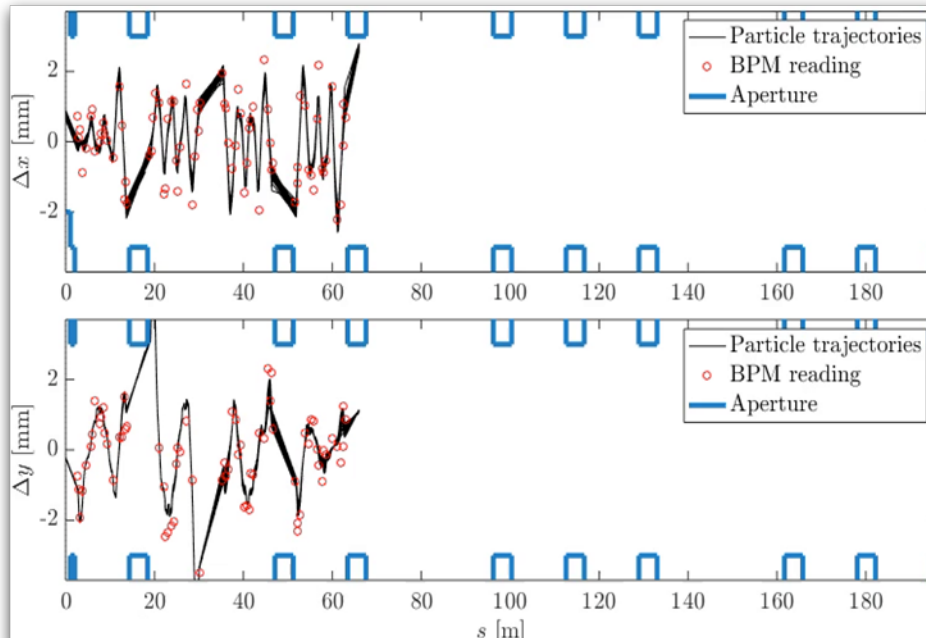
NIM-A **1050**, 168192 (2023)



x40 faster!

Recent Developments of the Toolkit for Simulated Commissioning (Thorsten Hellert, LBLN)

- 4GLS may work only when
  - the storage ring is constructed within tight error tolerances
  - and, beam-based corrections are properly applied
- It is important to verify the designed storage ring by simulating the entire commissioning process
- Toolkit offers visualizations of the lattice properties that is useful during the lattice design
- Toolkit is available at with well documented manual https://sc.lbl.gov/



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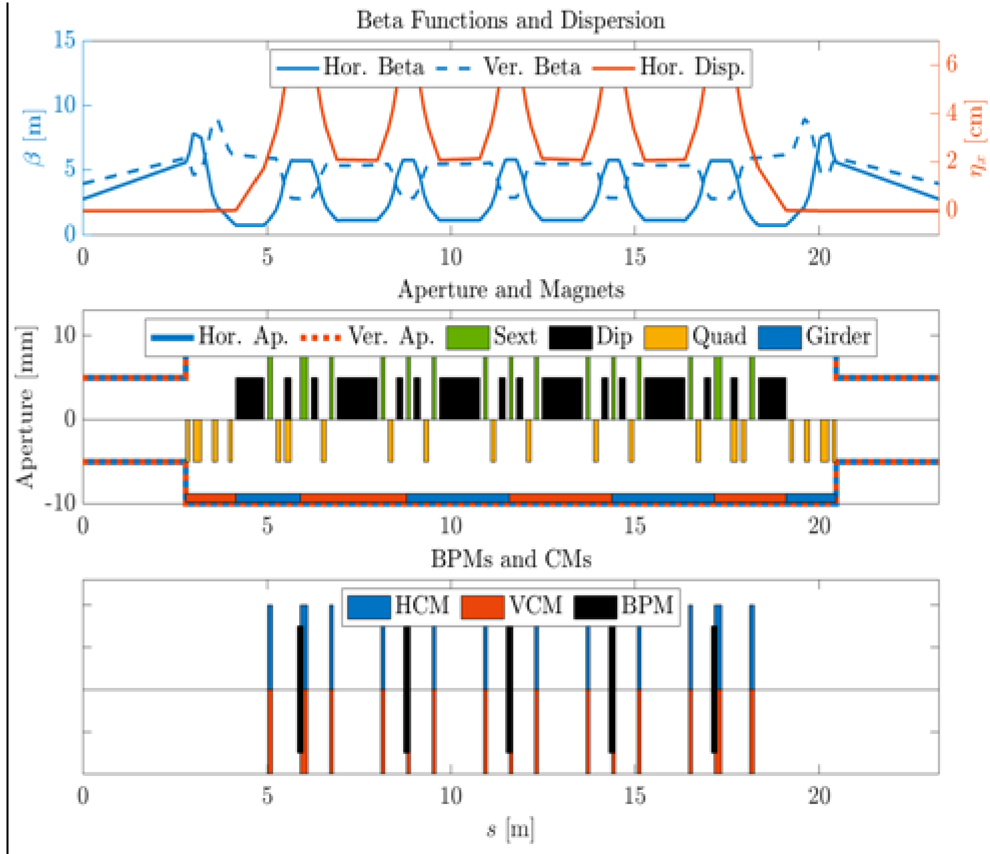
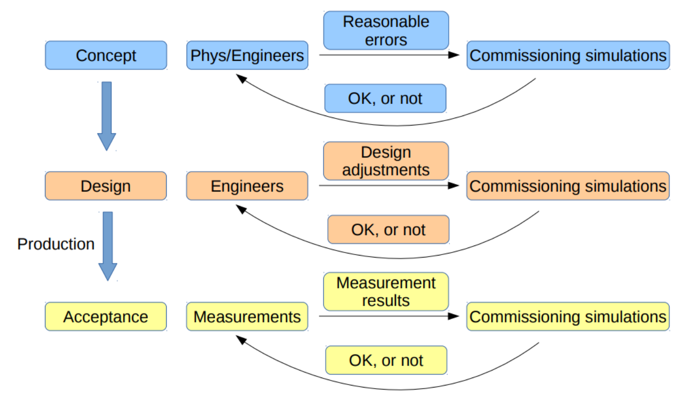


Use of Automated Commissioning Simulations for Error Tolerance Evaluation for the APS-U (Vadim Sajaev, ANL)

- APS-U – the nearest Future Light Source
  - Brightness increase factor: up to 500
  - APS is in dark time now – started April 2023
  - The first light will be delivered in April 2024
- Automated commissioning simulation is used, at each stage of the project, for the error tolerance evaluation
  - It is impossible to examine the entire parameter space of error tolerances
  - The initial set of tolerances at the conceptual design is based on educated guess
  - Engineering design may require revisions of the tolerance
  - Some manufactured components do not meet the tolerance, and we have to decide if they are accepted or not

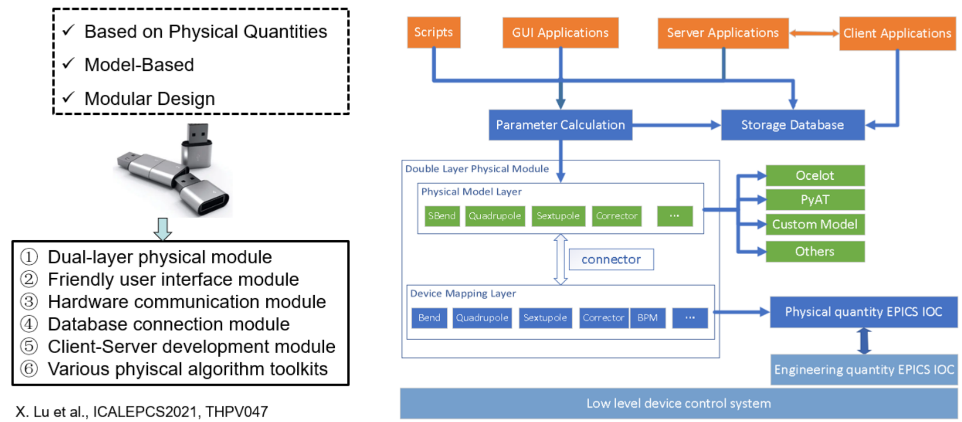
Typical APS-U workflow



Pyapas: A new framework for High-Level Application development at HEPS (Xiaohan Lu, HEPS)

- Framework for high level application (HLA) development
  - Commissioning of 4GLS necessitate a set of well-prepared HLAs
  - HLAs are tested with a virtual accelerator before commissioning
  - Common modules to avoid double-work
  - Increases maintainability

Pyapas Architecture Design
(Python-based accelerator physics application set)



X. Lu et al., ICALEPCS2021, THPV047
X. Lu et al., IPAC2023, THPA125

https://code.ihep.ac.cn/heps-hla/pyapas.git   luxh@ihep.ac.cn

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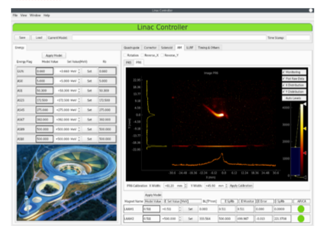
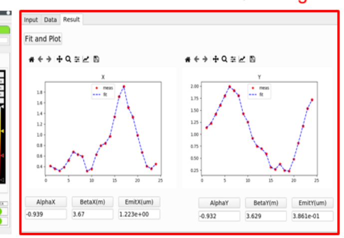
Linac control（Xiaohan Lu）



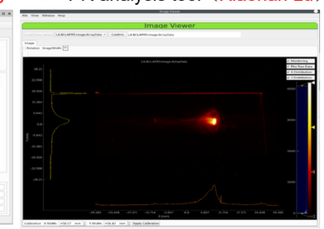
Emittance measurement（Yaliang Zhao）



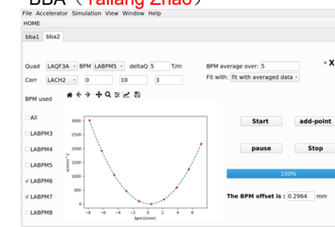
Orbit correction（Cai Meng）

Energy spread measurement（Hongfei Ji）

PR analysis tool（Xiaohan Lu）



BBA（Yaliang Zhao）



https://code.ihep.ac.cn/heps-hla/pyapas.git　　luxh@ihep.ac.cn

Atoosa Meseck – **Development of the In-vacuum APPLE II Undulators at HZB**

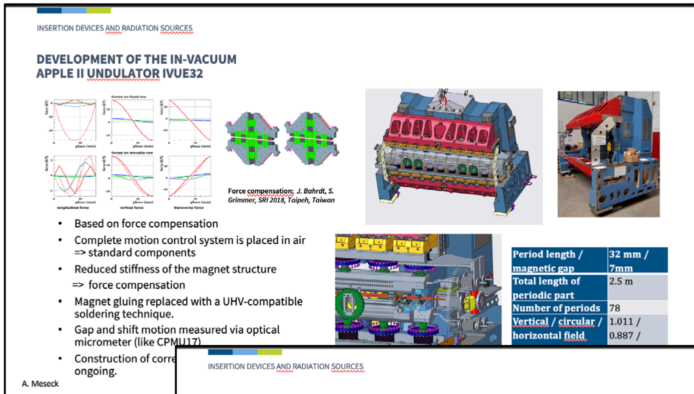
HZB BESSY II Light Source

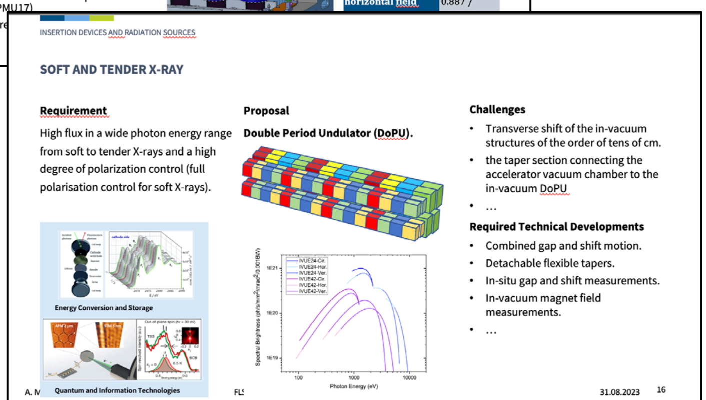
- The development work for in-vacuum APPLEs were introduced with the following motivation
  - A broad spectrum, with a core range from soft-to-tender X-ray energies.
  - Full polarization control for ever higher photon energies.

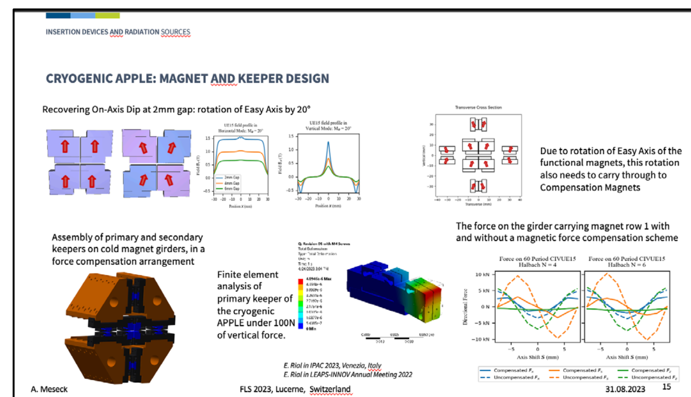
Initial Proposal

No.	Name	Photon Energy	ID or ID combination
1	VUV to Hard	5 eV - 20 keV	UE80 + CPMU21
2	Soft and Tender	100 eV - 4 keV	IVUE 42-24 (DOPU)
3	XUV to Soft	60 eV - 1.5 keV	U70
4	Magnetic Imaging	150 eV - 2 keV	IVUE42
5	VUV Spectroscopy	5 eV - 200 eV	UE140 or UE150
6	Soft and Tender Imaging	180 eV - 8 keV	IVUE38
7	Inelastic Scattering	180 eV - 3 keV	IVUE42
8	Spectro-Microscopy	100 eV - 1.8 keV	UE56
9	Macromolecular Crystallography	5 keV - 20 keV	CPMU18
10	Multimodal Spectroscopy	20 eV - 8 keV	UE80 + IVUE24

U are planar devices and UE are APPLE-II devices.
CPMU are cryogenic planar in-vacuum devices.
IVUE are in-vacuum APPLE-II devices..

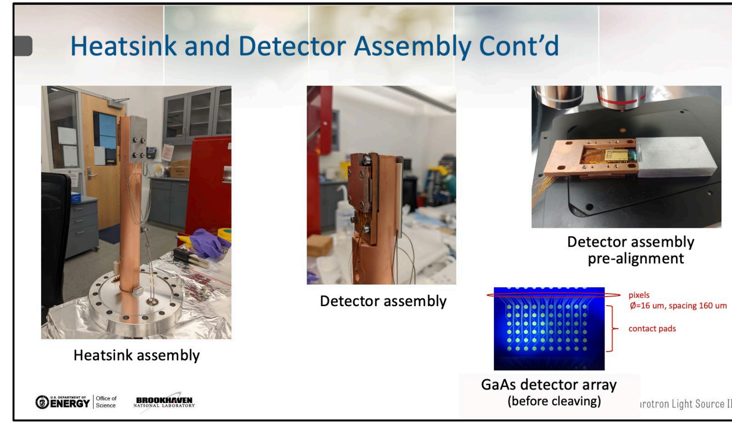


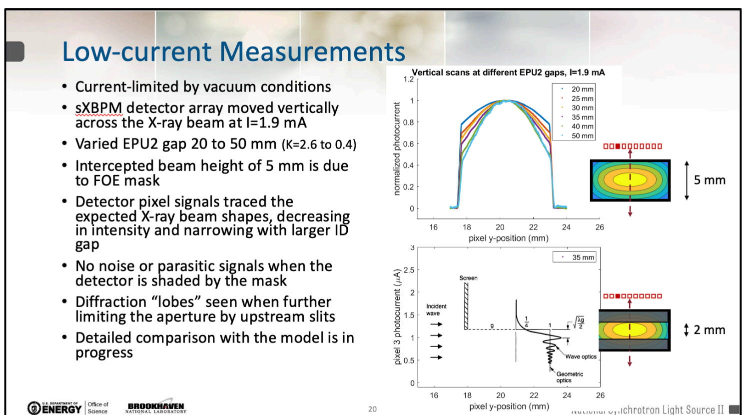


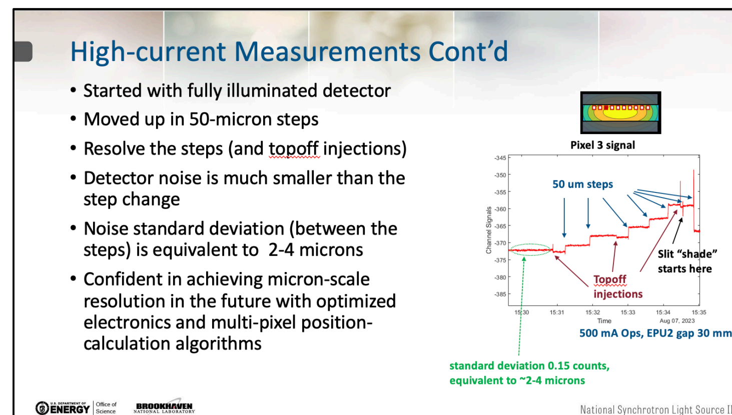


Boris Podobedov – **Novel X-Ray Beam Position Monitor for Coherent Soft X-Ray Beamlines**

- Soft X-ray BPM (sXBPM) R&D Project at NSLS-II was introduced.
- Multi-pixel GaAs detector arrays are placed into the outer portions of X-ray beam. Beam position (+ other info) is inferred from the pixel photocurrents.
- Tailored detector responsivity from sub-keV to a few keV photon energies was accomplished with shallow p-on-n junction design
- Detector array prototypes have been manufactured and extensively characterized with high-power Ar-ion laser, and then tested in soft- and hard X-ray beamlines of NSLS-II
- sXBPM prototype with a single detector array was recently installed in high-power X-ray beam from two canted EPUs in C23-ID straight of NSLS-II
- The device successfully resolved small beam motions and gap-change-induced variations of X-ray beam shape during 500 mA user operations.

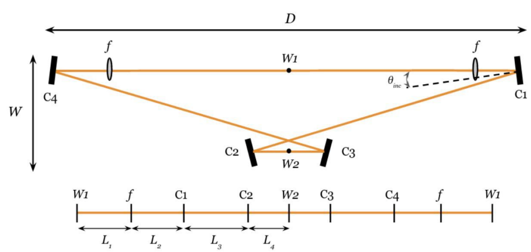




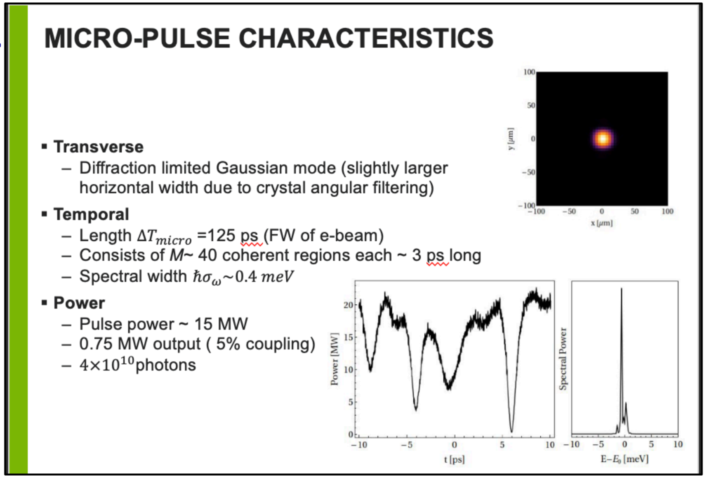


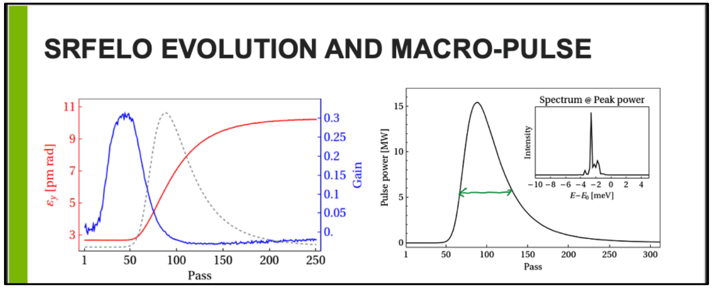
K.-J. Kim – TGU for a storage ring XFELO

- transverse gradient undulator (TGU) to mitigate large $\Delta\eta$ in storage ring
- After some key techniques were reviewed, some ideas and results of “START-TO END modeling of SRXFELO” for PETRA-IV parameters was presented.



- High reflectivity diamond mirror
  - C(337): $\hbar\omega$ =14.4 keV, $\theta_0 = 9.25°, \Delta\hbar\omega = 10\text{meV}$
- Beryllium compound refractive lens (CRL)
- Bowtie optical path for tuning



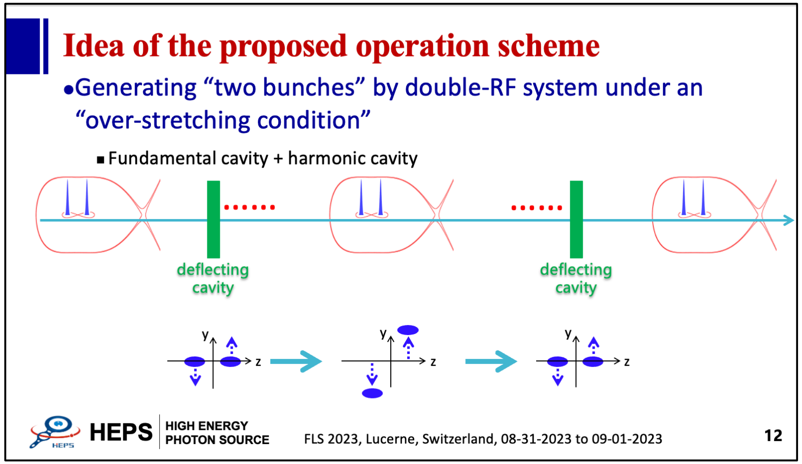


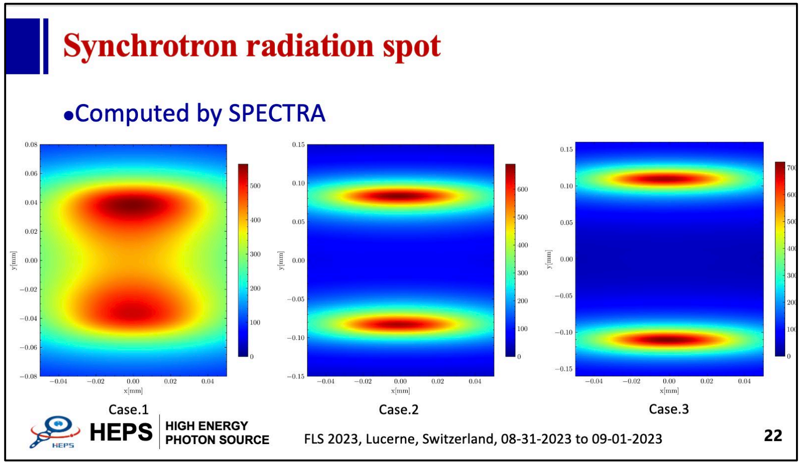
It is concluded that

- With TGU and enhanced FEL bunches, an XFELO appears feasible in large ultimate storage rings, e.g., PETRA-IV
- With temporal gain modulation with RF frequency detuning (however energy change due to rf frequency change is pointed out), the output is reproducible, periodic, and non-invasive .

XU, Haisheng – Studies of the generation of two X-ray pulses with tunable separation in electron storage rings

- Variable operation schemes were reviewed in this presentation,,, then
- An operation scheme which can provide two X-ray pulses with tunable separation (vertically and longitudinally) was presented.
- In this scheme, Generating "two bunches" by double-RF system under an "over-stretching condition"





Poster presentations, WGB

22 posters presented

ID	Title	Authors
TU4P17	Non-destructive Vertical Halo-monitors on the ESRF Electron Beam	K.B. Scheidt
TU4P18	Nonlinear Dynamics Measurements at the EBS Storage Ring	N. Carmignani, L.R. Carver, L. Hoummi, S.M. Liuzzo, T.P. Perron, S.M. White
TU4P19	Evolution of Equilibrium Parameters Ramp Including Collective Effects in the Diamond-II Booster	R. Husain, R.T. Fielder, I.P.S. Martin, P. Burrows
TU4P20	Simulated Commissioning for Diamond-II Storage Ring from On-axis to Off-axis Injection	H.-C. Chao, I.P.S. Martin
TU4P23	Knot APPLE X Undulators for SLS 2.0	T. Schmidt, P. Boehler, M. Bruegger, M. Calvi, S. Danner, L. Huber, A. Keller, M.S. Schmidt
TU4P24	New Compact Modular In-vacuum Undulators for SLS2.0	T. Schmidt, P. Boehler, M. Bruegger, M. Calvi, S. Danner, L. Huber, H. Joehri, A. Keller, M.S. Schmidt, D. Stephan
TU4P25	SLS 2.0 Machine Protection	F. Armborst, M. I. Besana, J. Kallestrup, M. Paraliev
TU4P26	Special Operational Modes for SLS 2.0	J. Kallestrup, M. Aiba
TU4P27	Progress of the HEPS Accelerator Construction and Linac Commissioning	C. Meng, J.S. Cao, P. He, Y. Jiao, J.Y. Li, W.M. Pan
TU4P28	Useful Formulas and Example Parameters Set for the Design of SSMB Storage Rings	X.J. Deng, A. Chao, W.-H. Huang, Z.Z. Li, Z. Pan, C.-X. Tang
TU4P29	Why is the Coherent Radiation from Laser-induced Microbunches Narrowbanded and Collimated	X.J. Deng, A. Chao
TU4P30	Optical Stochastic Cooling in a General Coupled Lattice	X.J. Deng
WE4P18	Preliminary Design of Higher-Order Achromat Lattice for the Upgrade of the Taiwan Photon Source	N.Y. Huang, M.-S. Chiu, P.J. Chou, G.-H. Luo, H.W. Luo, H.-J. Tsai, F.H. Tseng
WE4P19	Simulation Study of Orbit Correction by Neural Network in Taiwan Photon Source	M.-S. Chiu, Y.-S. Cheng, G.-H. Luo, H.-J. Tsai, F.H. Tseng, C.P. Felix
WE4P20	Alignment Results of Tandem EPUs at the Taiwan Photon Source	Y.-C. Liu, C.M. Cheng, T.Y. Chung, Y.M. Hsiao, F.H. Tseng
WE4P21	Some Beam Dynamic Issues in the HALF Storage Ring	J.Y. Tang, Z.H. Bai, T.L. He, G. Liu, Y. Mo, A.X. Wang, P.H. Yang, Z. Zhao
WE4P24	Optics for an Electron Cooler for the EIC Based on an Electron Storage Ring	J. Kewisch, A.V. Fedotov, X. Gu, Y.C. Jing, D. Kayran, I. Pinayev, S. Seletskiy
WE4P25	Nonlinear Dependence of Storage Ring Emittance on Chromaticity	J. Tang, X. Huang
WE4P26	High Average Power EUV from FEL Oscillator in Storage Ring	C. He
WE4P27	Simulation Study of S-Bend Photocathode Gun for 4th Generation Storage Ring in Korea	C.-K. Min, W.J. Byeon, T. Ha, S.J. Park, Y.J. Park
WE4P29	Design Study of a Booster Ring for a Fourth-Generation Storage Ring Light Source	C.S. Park
WE4P31	Deterministic Approach to the Lattice Design of BESSY III	B.C. Kuske, P. Goslawski