LCLS Town Hall Run 21

March 3rd, 2022

Agenda

- Overall facility updates (M. Dunne)
- UEC Update (E. Biasin)
- Accelerator / FEL Capabilities (T. Maxwell)
- Early Science Approach and How to get Involved (J. Cryan, T. Wolf & A. Mehta)
- Current laser capabilities and high rep rate plans (J. Robinson)
- Data systems in the high rep rate world (J. Thayer)
- Breakouts with details of standard configs
  - Session 1
    - Materials Science Capabilities (A. Mehta, M. Chollet, G. Dakovski, D. Zhu)
    - Biological Science Capabilities (M. Hunter, R. Sierra, A. Batyuk)
    - Gas Phase Chemical Science Capabilities (T. Wolf, M. Liang)
  - Session 2
    - AMO Science Capabilities (J. Cryan)
    - MEC Science Capabilities (G. Dyer)
    - Condensed Phase Chemical Science Capabilities (T, Wolf, K. Kunnus, R. Alonso-Mori, M. Chollet, R. Sierra)
- Q&A

User Executive Committee Update

March 3rd, 2022

LCLS Town Hall Run 21

LCLS User Executive Committee (LCLS UEC)

As LCLS UEC members, we represent the LCLS User Community!

We meet monthly with LCLS Management to communicates the needs and desires of users regarding LCLS operating policies, use of LCLS, user support, and other relevant issues of concern to those engaged in research at this facility.

Current Members & Minutes: https://lcls.slac.stanford.edu/lcls-users-organization

Please feel free to contact the LCLS UEC members with any suggestions or questions!

LCLC/SSRL User Survey

The LCLS and SSRL UEC have prepared an anonymous survey about climate, inclusion, work environment, accessibility to the facilities, experiment support, and demographics of the User Community.

https://bit.ly/2021-UEC-Survey
Deadline: 11 March 2022

Please provide your feedback!

Your comments will help us identify how SLAC user facilities can better support our user community.

User Meeting: Call for workshops

2022 LCLS/SSRL User Meeting: 26-30 September

Please use the link below to send us your suggestions for full or half day workshop.

Deadline: March 7th

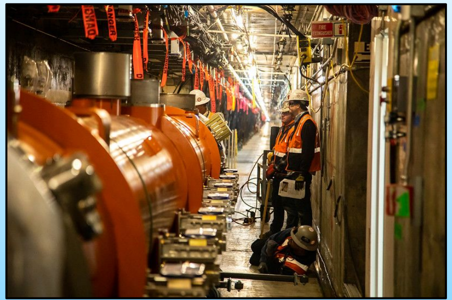
https://bit.ly/SLAC_UsersMeeting_Workshop

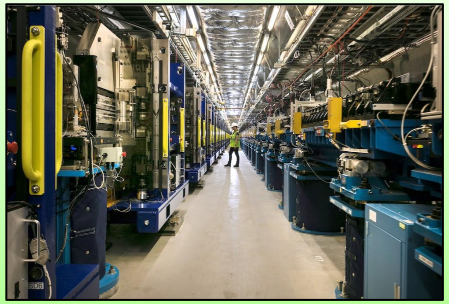
Accelerator / FEL capabilities for Run 21

March 3rd, 2022

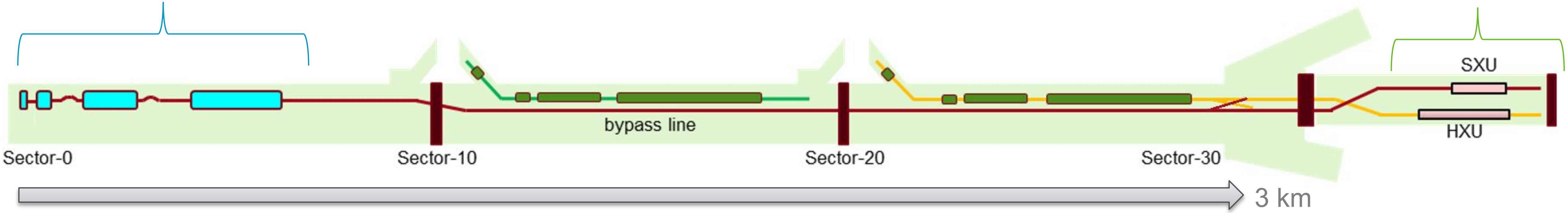
LCLS Linac & FEL Complex

Superconducting Linac
4 GeV, High
rep-rate, CW RF

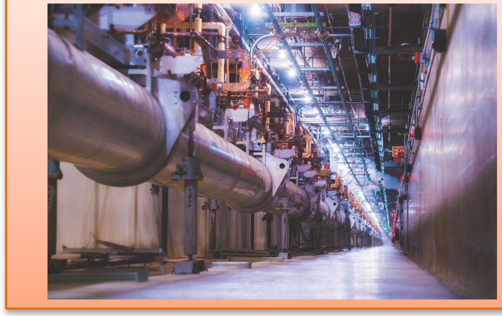




Soft and Hard X-ray
Variable Gap
Undulators (VGUs)



Linac gallery and new cryoplant viewed from Sector 0



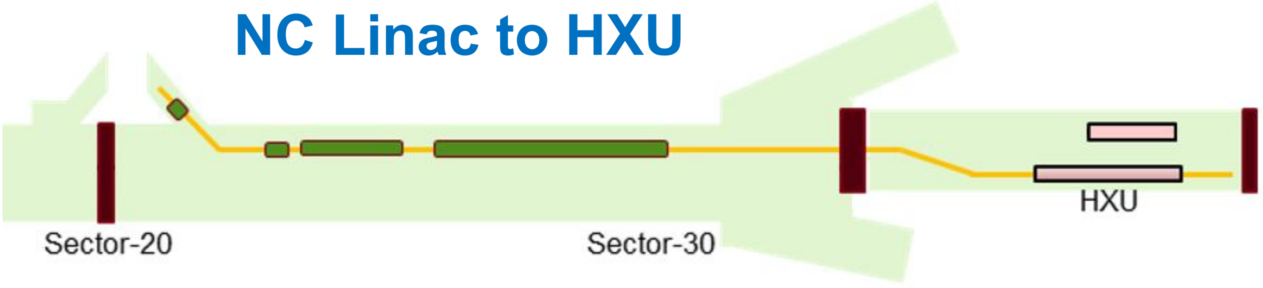
Normal Conducting Linac
3.5-17 GeV,
120 Hz Pulsed RF

LCLS Linac & FEL Facility Status

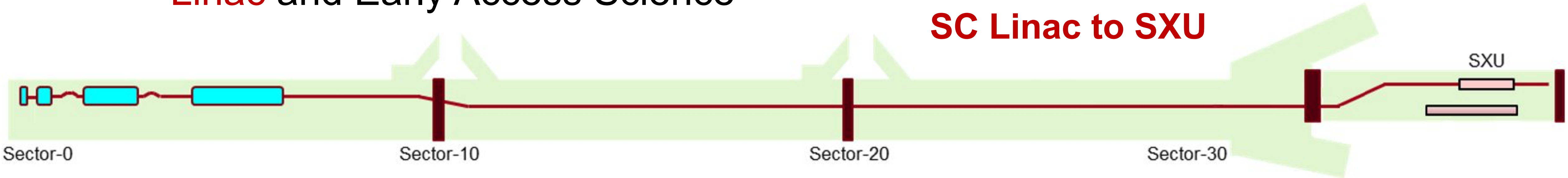
- **Runs 19 and 20:** Commissioned new LCLS-II HXR & SXR undulators and beamlines with the NC Linac along with old and new NC Linac capabilities

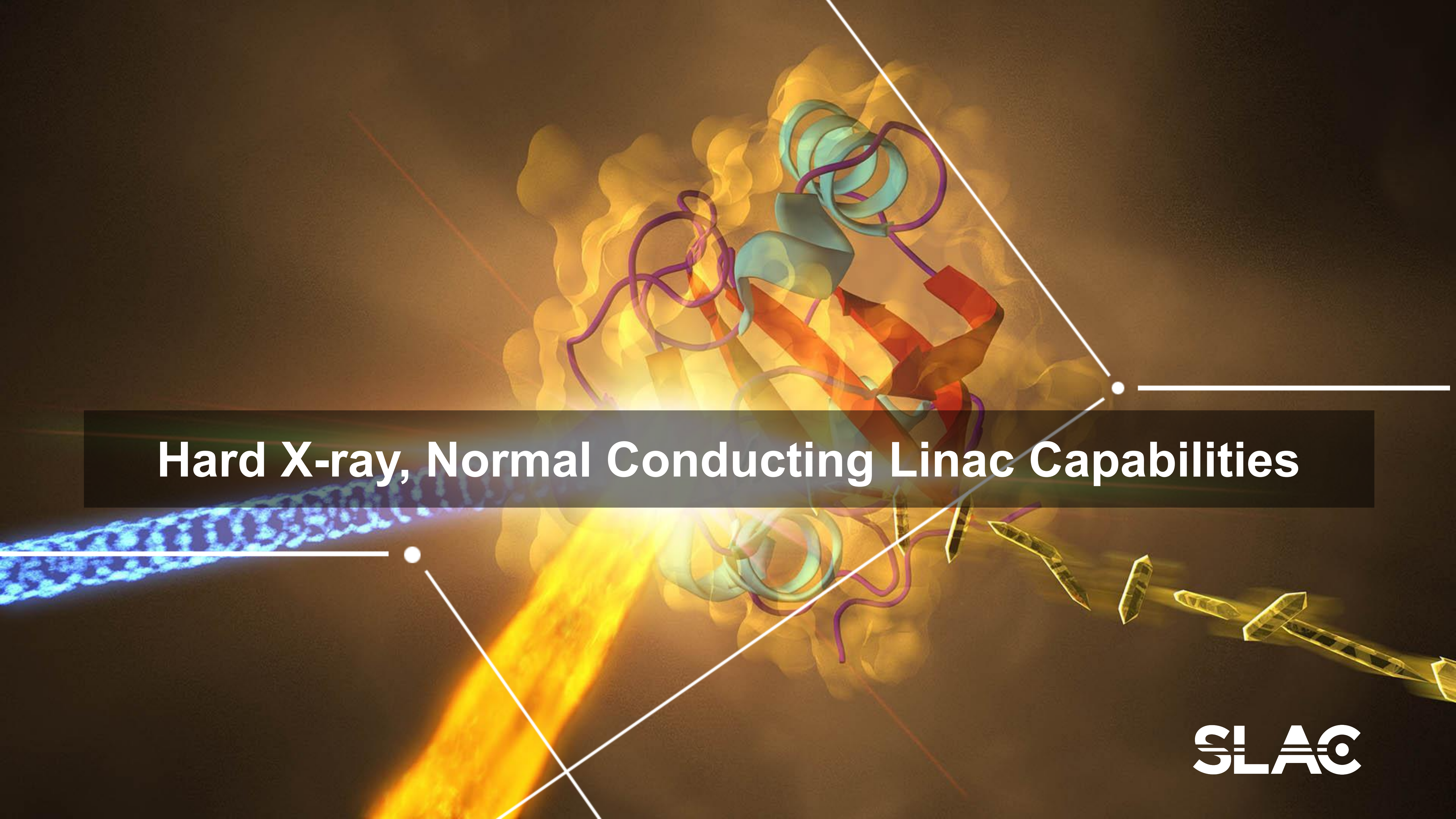
- **Run 21:**
  - HXR undulator to continue steady delivery with NC Linac
  - SXR undulator devoted to ramp up of exciting new, high-rate SC Linac and Early Access Science

NC Linac to HXU



SC Linac to SXU





Hard X-ray, Normal Conducting Linac Capabilities

HXR single-pulse SASE w/ NC Linac

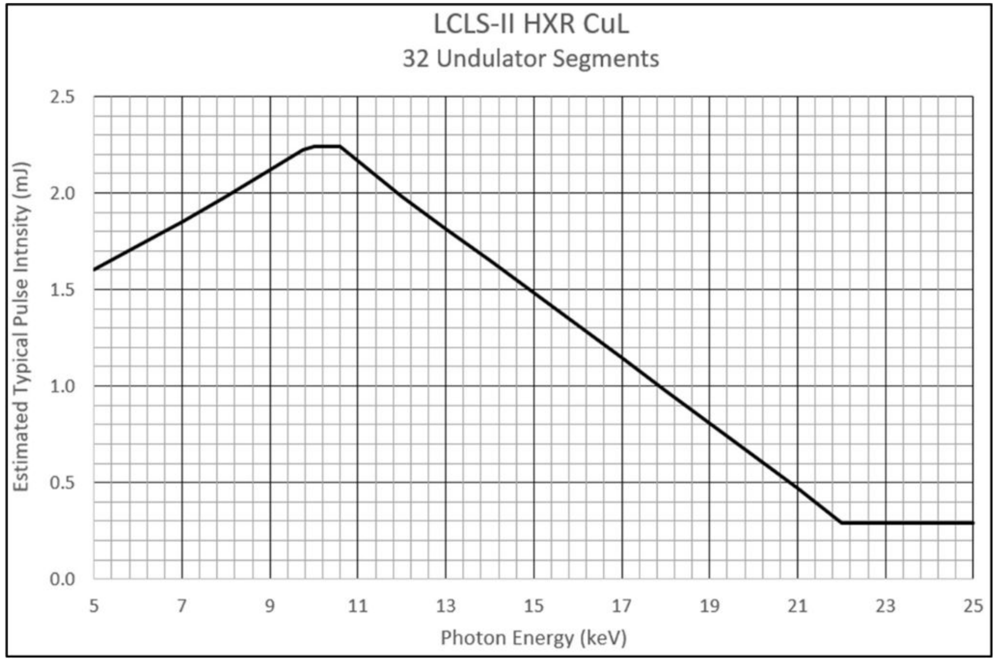
Beam Parameters	Symbol	Cu-HXU x-rays		Unit
		☐ω_{max}	☐ω_{min}	
Photon Energy	$h\omega$	**25000**	**1000**	**eV**
Fundamental wavelength	λ_r	0.5	12.4	Å
Final linac e- energy	γmc^2	16.5	3.5	GeV
FEL 3-D gain length	L_G	4	1	m
Peak power	P	20	80	GW
Pulse duration range (FWHM)		10 – 50		fs
Nominal pulse duration (FWHM)	$\Delta\tau_f$	**~30**		**fs**
Max Pulse Energy*	U	**0.6**	**2**	**mJ**
Photons per pulse*	$N\gamma$	0.15	14	10^{12}
Peak brightness*	$B_{pk, SASE}$	7800	425	10^{30} §
Average brightness (120Hz)*	$\langle B \rangle$	280	16	10^{20} §
SASE bandwidth (FWHM)	$\Delta\omega/\omega$	30	2	eV
Photon source size (rms)	σ_s	8	20	µm
Photon far field divergence (FWHM)	$\Theta_{FWHM,x,\infty}$	1	12	µrad
Max. Beam Rate	φ_{FEL}	**120**		**Hz**
Avg. x-ray beam power	P_x	0.07	0.24	W
Linear Polarization (100%)	$\langle P \rangle$	Vertical		

*Assuming nominal duration and undulator strength

§Brightness units are photons/sec/mm^2/mrad^2/0.1%-BW

High photon energy (to 25 keV) and pulse energy (0.5-2mJ)

Varies w/ duration, energy, beamline transmission, etc.



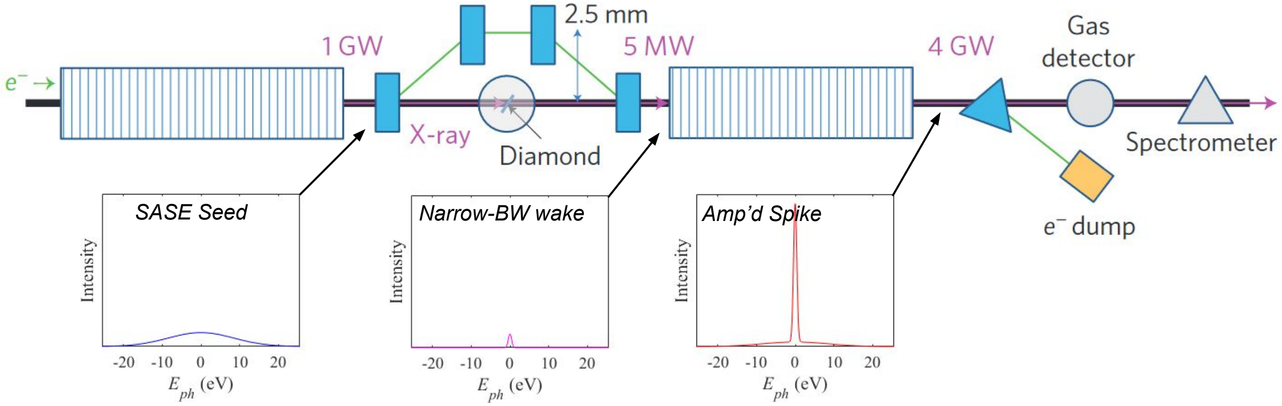
https://lcls.slac.stanford.edu/parameters

Hard X-ray Self-Seeding (HXRSS)

Spectral brightness enhancement for narrow bandwidth experiments

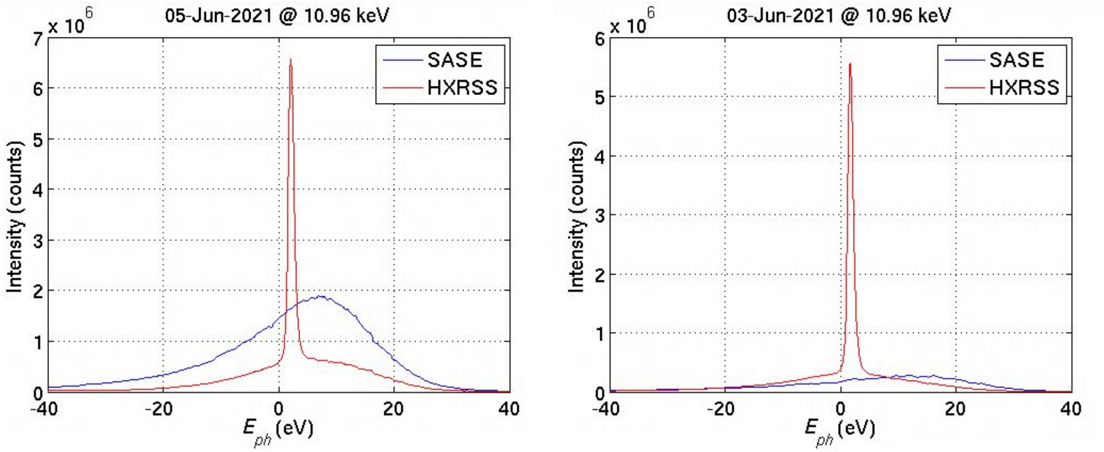
- Updated for LCLS-II *vertically* polarized HXU (90º rotation of crystal optics)
- Now used for 3 experiments, 3-6x spectral brightness at sample vs. SASE

Photon energy	4.5 – 11 keV
Bandwidth (FWHM)	**0.35 – 1.5 eV**
Max pulse energy	0.2 – 0.5 mJ
Duration	30 fs



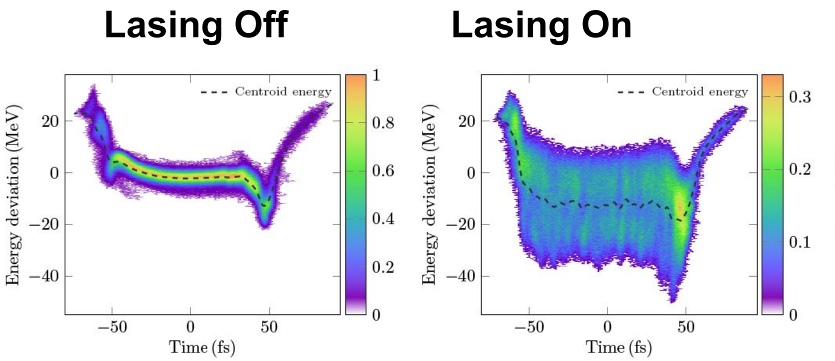
Initial SASE passes diamond wake monochromator, narrow BW amplified in 2nd half of undulator

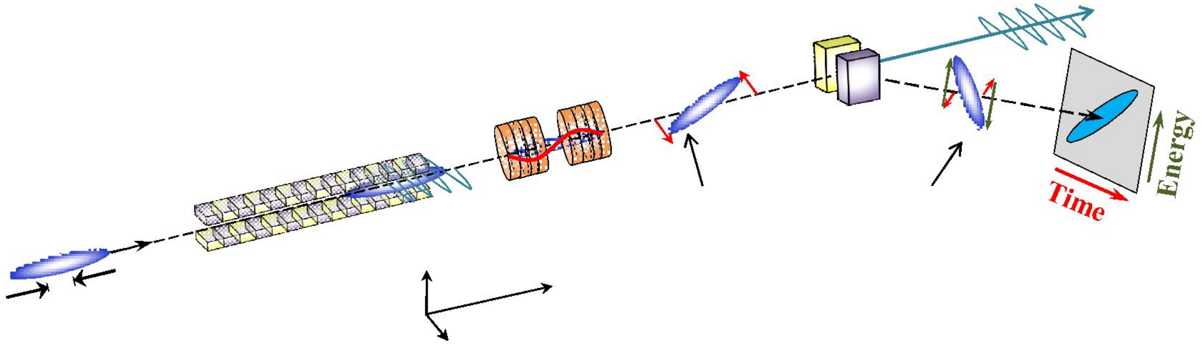
Full SASE vs. HXRSS average spectra at 11 keV

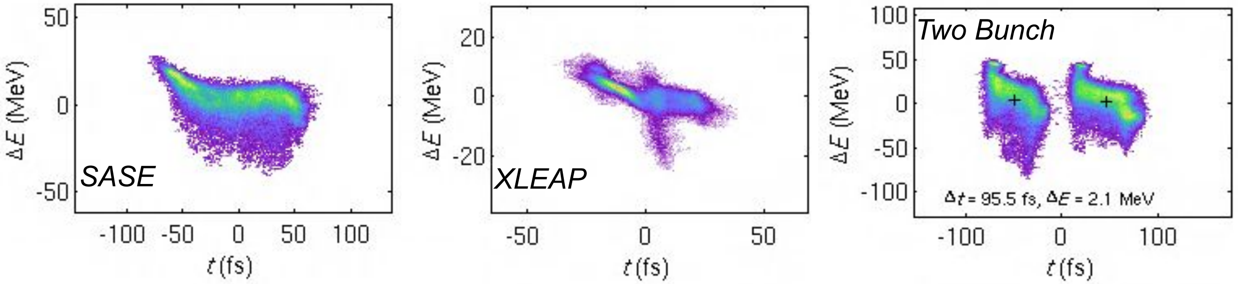


XTCAV: Femtosecond “streak camera” for e$^-$ beam

- 120 Hz images of e$^-$ beam time-energy distribution
- Observe energy loss due to FEL, **calculate x-ray temporal profile shot-by-shot w/ fs resolution**
- Available for recording/analysis at beamlines in coordination with ACR







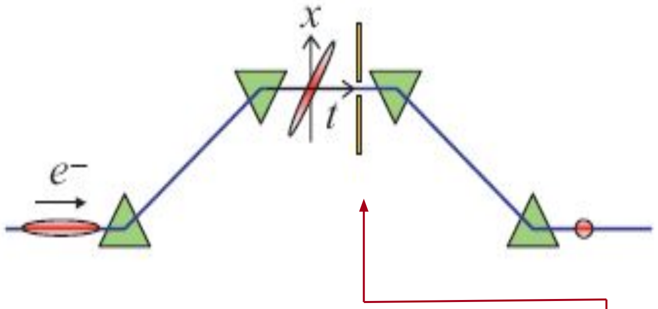
Cu linac

Short Pulses

- **~5-10 fs HXR pulses readily achievable** with corresponding reduction in pulse energy (change of charge, use of “slotted foil”)

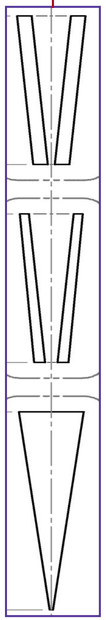
- Methods are available for **< 1 fs HXR pulses**, approaching single SASE spike limit

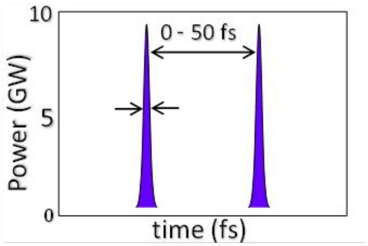
Technique	Min Pulse Duration	Energy/Pulse	single-spike rate
Slotted foil / optics / taper	400 as	5 uJ (76% fluct.)	65%
Non-linear bunch compression	200 as	10 uJ	45%



Slotted foil inserted in beam to spoil lasing in time

Make short single or double pulses





Discuss special requirements with your LCLS POC

Cu linac

Advanced Multi-Pulse/Color Modes

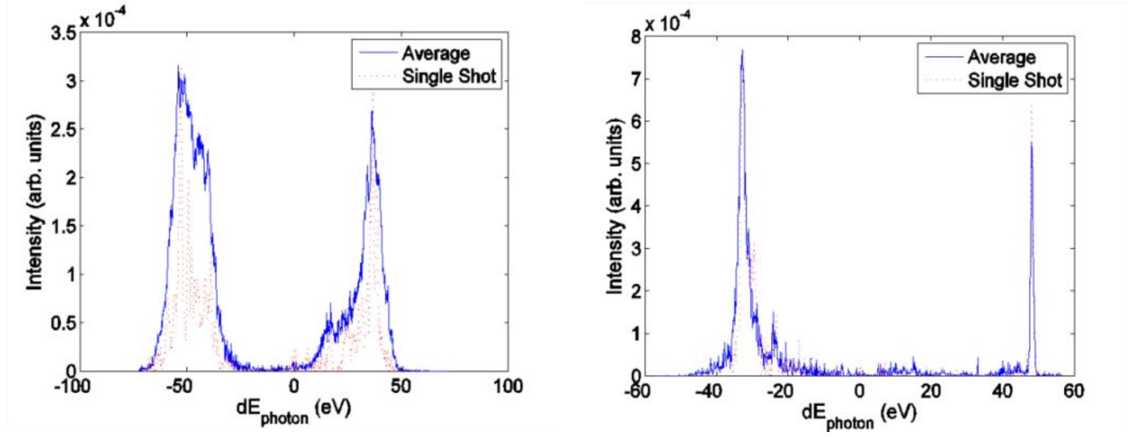
Multiple accelerator-based means for x-ray pump, x-ray probe on variety of time scales

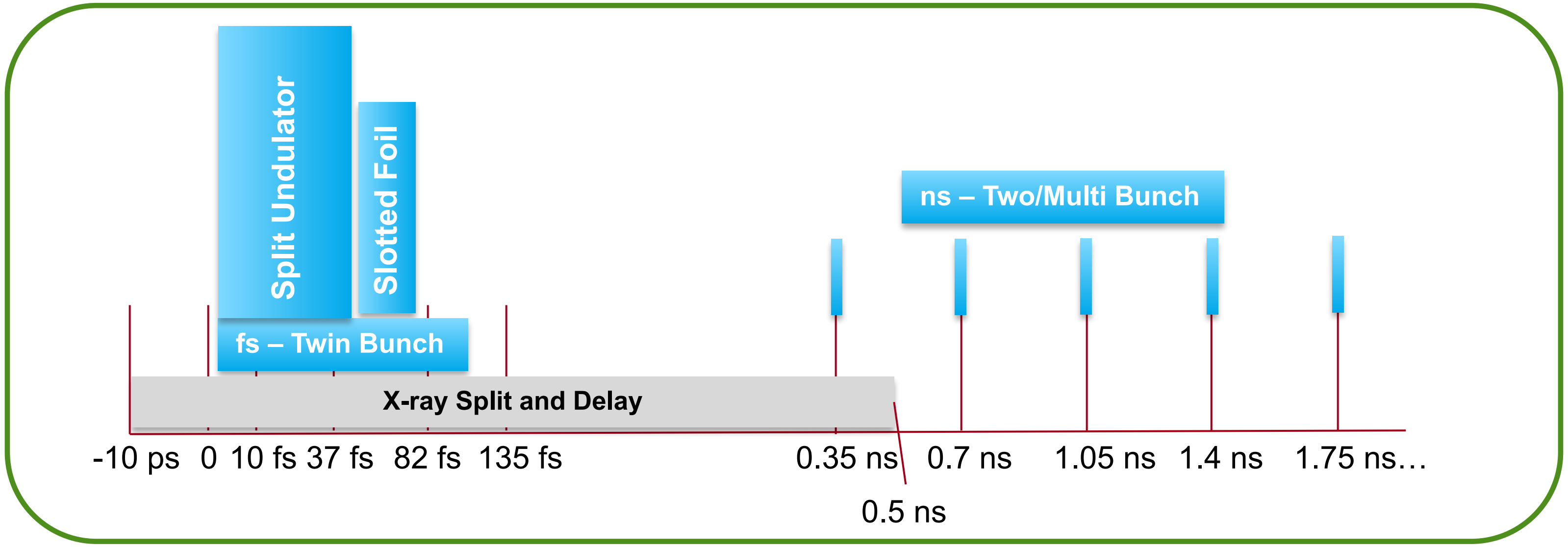
One electron bunch:

- Double slotted foil

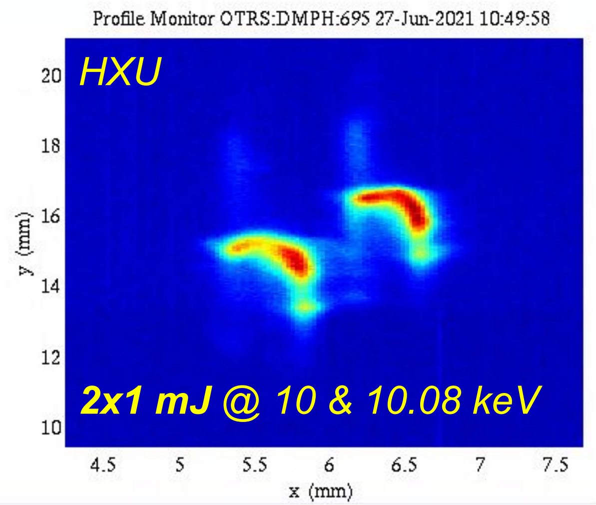
Two electron bunches:

- fs spacing: Injector laser pulse splitting ("twin bunches")
- ns spacing: Multiple laser pulses at cathode ("two/multi bunches")





Two-bunch XTCAV Images (ns spacing)



Advanced Multi-Pulse/Color Modes

Multiple accelerator-based means for x-ray pump, x-ray probe on variety of time scales

Technique	Pulse Separation	Pulse Duration	Energy Separation	Max Energy/Pulse
Split Undulator SASE	0 - 30 fs	15 fs	Up to factor 1.2 ratio in photon energies	40 uJ (25 fs pulse duration)
Double Slotted Foil	7-20 fs	~ 10 fs	+/-1.5%	100-200 uJ
Twin Bunches				
Two SASE Pulses	0 - 125 fs	~ 10 fs	0.2-2%	0.3 mJ (20 fs duration)
With slotted foil (shorter pulses)	+/- 50 fs	~5-10 fs	~2%	40 uJ
Two-(multiple) bunch				
Two bucket	350 ps increments, up to 120 ns	20 fs	~ 1%	0.5-1 mJ (30 fs duration SASE)
Multi bucket (4 or 8 bunches)	Two trains of 4 pulses. 700 ps between each pulse in the same train.	20 fs	~ 1%	To be tested

Discuss special requirements with your LCLS POC

SXR single-pulse SASE w/ NC Linac

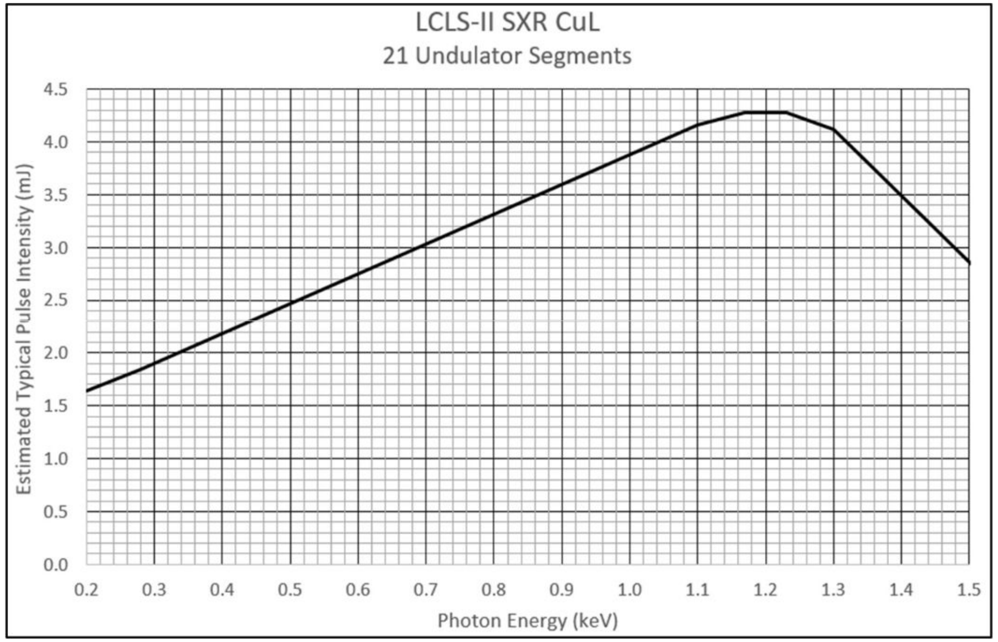
Beam Parameters	Symbol	Cu-SXU x-rays		Unit
		□ω_{max}	□ω_{min}	
Photon Energy	$\boldsymbol{h\omega}$	**5000**	**200**	**eV**
Fundamental wavelength	λ_r	2.5	62	Å
Final linac e- energy	γmc^2	10	3.5	GeV
FEL 3-D gain length	L_G	2.5	1	m
Peak power	P	50	30	GW
Pulse duration range (FWHM)		10 – 250		fs
Nominal pulse duration (FWHM)	$\Delta\tau_f$	**50**		**fs**
Max Pulse Energy*	U	**2.5**	**1.5**	**mJ**
Photons per pulse*	$N\gamma$	3.1	47	10^{12}
Peak brightness*	$B_{pk,\,SASE}$	2250	19	10^{30} §
Average brightness (120Hz)*	$\langle B \rangle$	138	1.5	10^{20} §
SASE bandwidth (FWHM)	$\Delta\omega/\omega$	10	2	eV
Photon source size (rms)	σ_s	16	46	µm
Photon far field divergence (FWHM)	$\Theta_{FWHM,x,\infty}$	3	25	µrad
Max. Beam Rate	φ_{FEL}	**120**		**Hz**
Avg. x-ray beam power	P_x	0.3	0.18	W
Linear Polarization (100%)	$\langle P \rangle$	**Horizontal**		

*Assuming nominal duration and undulator strength

§Brightness units are photons/sec/mm^2/mrad^2/0.1%-BW

Ready and able, but not planned for operation in Run 21

SXR line devoted to ramp of new SC linac and Early Access science…



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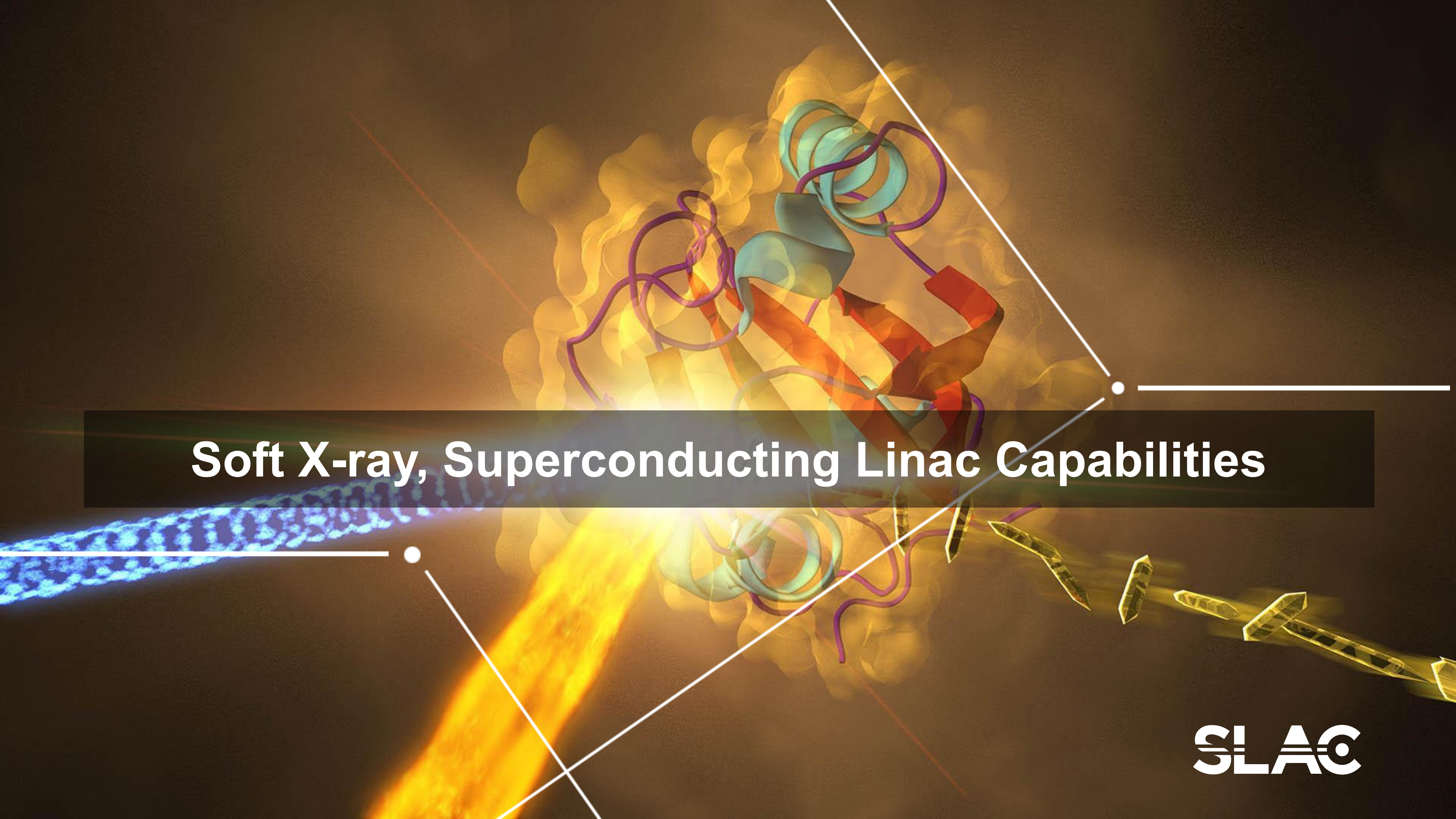
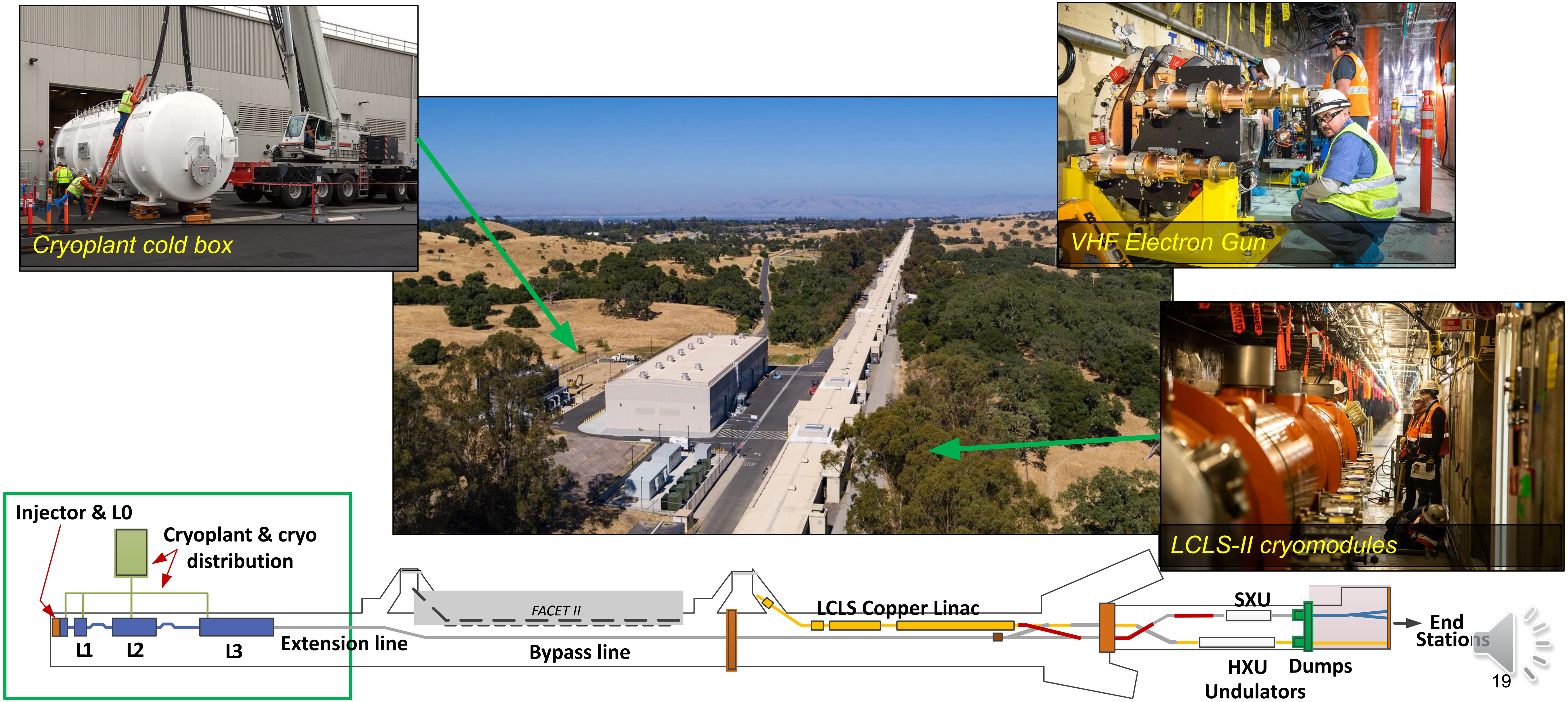


Soft X-ray, Superconducting Linac Capabilities

LCLS-II SC Linac: A New Frontier for XFEL Science



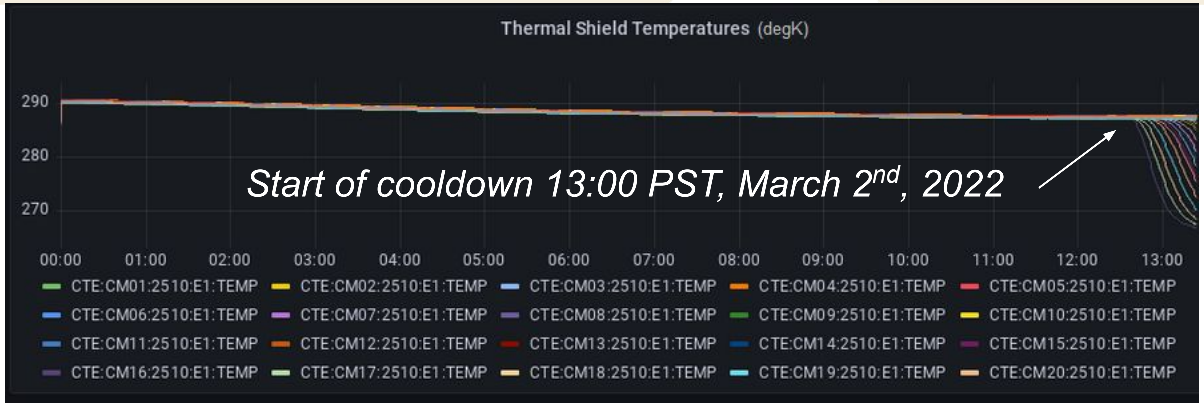
Cryoplant cold box

VHF Electron Gun

LCLS-II cryomodules

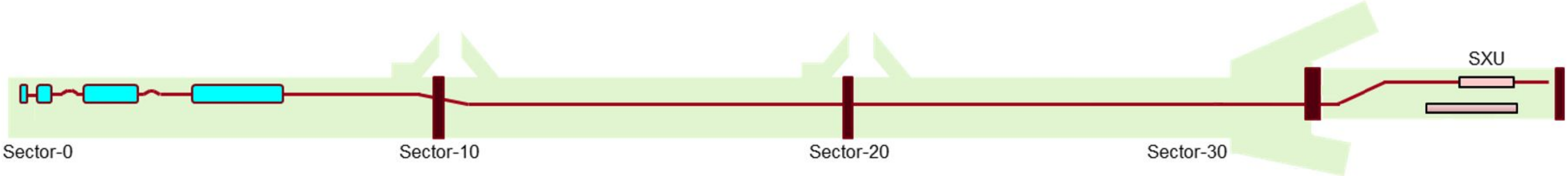
It’s getting cold in here…

- Cooldown of the new cryogenically cooled, super-conducting linac currently underway



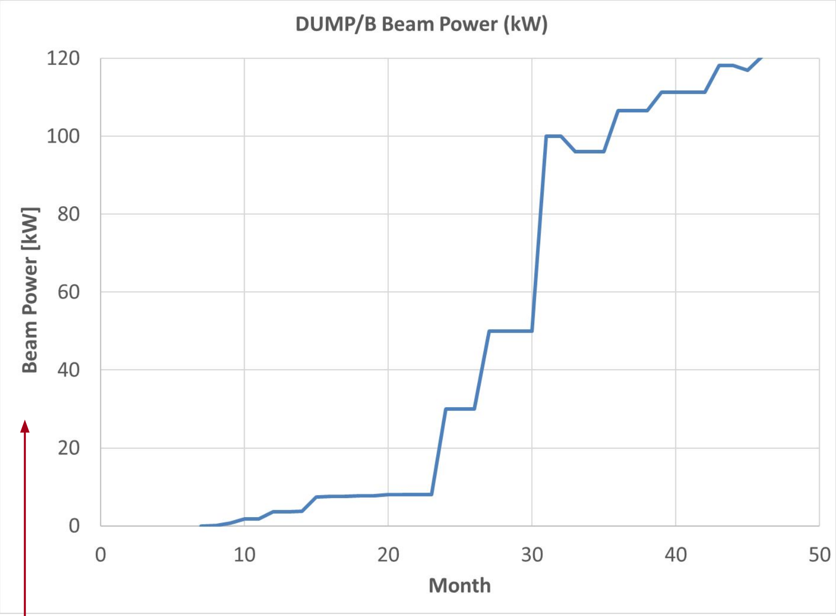
Start of cooldown 13:00 PST, March 2nd, 2022

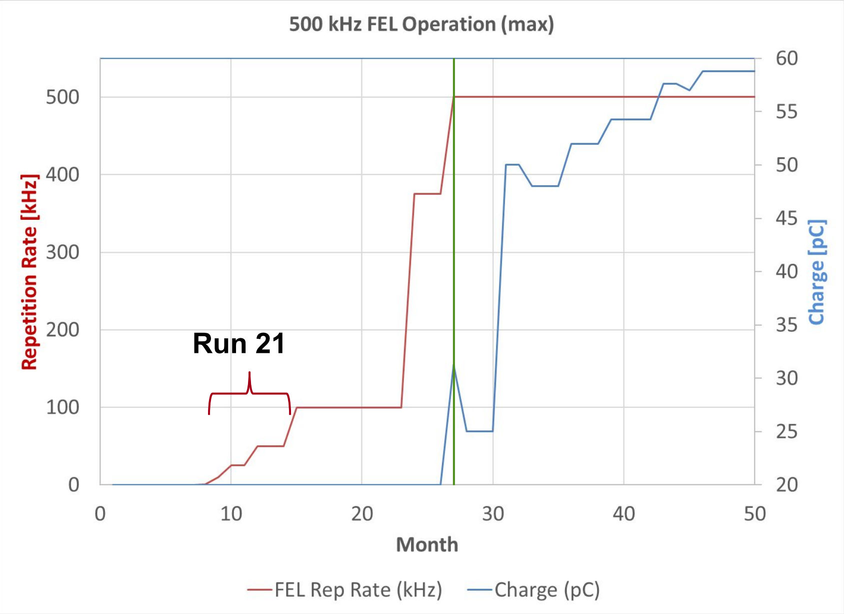
- Commissioning of the full accelerator will continue through 2022

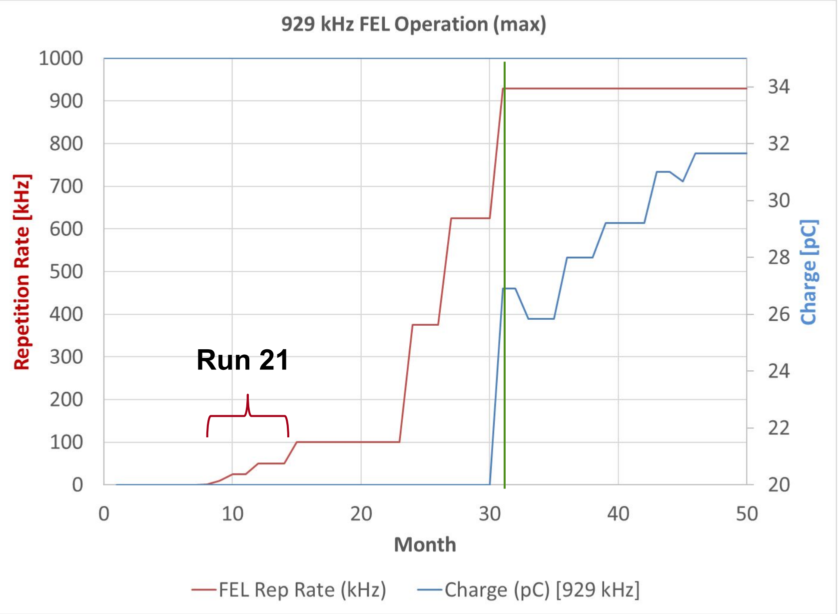


- As we integrate new systems and monitor the new 120 kW capable e^- beam, capabilities will be gradually ramped up into Run 21

SC Linac Rate Ramp-Up







- Beam Power related to [Repetition Rate * Charge], limited to 120 kW max at final beam dumps
- Beam losses & undulator irradiation are major potential issues/hazards
- Facility has 2 year plan for beam/radiation monitoring with a gradual increase of power
- First light mid November 2022 (20 pC, 1 kHz) then gradual ramp to 10’s kHz thru Run 21

20 pC with ramp of beam rate from 1 to 33 kHz, dedicated delivery to the SXU

SXR single-pulse SASE w/ SC Linac

Beam Parameters	Symbol	Cu-HXU x-rays			Unit
		$h\omega_{max}$	$h\omega_{nominal}$	$h\omega_{min}$	
Photon Energy	$\boldsymbol{h\omega}$	**1300**	**800**	**200**	**eV**
Fundamental wavelength	λ_r	9.5	15.5	62.0	Å
Final linac e- energy	γmc^2	3.5-4.0			GeV
FEL 3-D gain length	L_G	TBD			m
Peak power	P	3	2.5 - 7	8	GW
Pulse duration range (FWHM)		20 – 40			fs
Nominal pulse duration (FWHM)	$\Delta\tau_f$	**20**			**fs**
Max Pulse Energy*	$\boldsymbol{U}$	**0.06**	**0.05 - 0.14**	**0.16**	**mJ**
Photons per pulse*	$N\gamma$	0.28	0.4 - 1.1	5.0	10^{12}
Peak brightness*	$B_{pk,\,SASE}$	20	8.6 - 24	1.7	10^{30} §
Average brightness* **(@33 kHz)**	$\langle B\rangle$	137	57 – 161	12	10^{20} §
SASE bandwidth (FWHM)	$\Delta\omega/\omega$	4	3	3	eV
Photon source size (rms)	σ_s	TBD			µm
Far field divergence (FWHM)	$\Theta_{FWHM,x,\infty}$	TBD			µrad
Max. Beam Rate	$\boldsymbol{\varphi_{FEL}}$	1,000 – 40,000 **			Hz
Avg. x-ray beam power **(@33kHz)**	P_x	2.0	1.7-4.6	5.3	W
Linear Polarization (100%)	$\langle\boldsymbol{P}\rangle$	**Horizontal**			

Pulse energies of >100 µJ in 30 fs for Early Access Science

[*] Assuming nominal duration and undulator strength

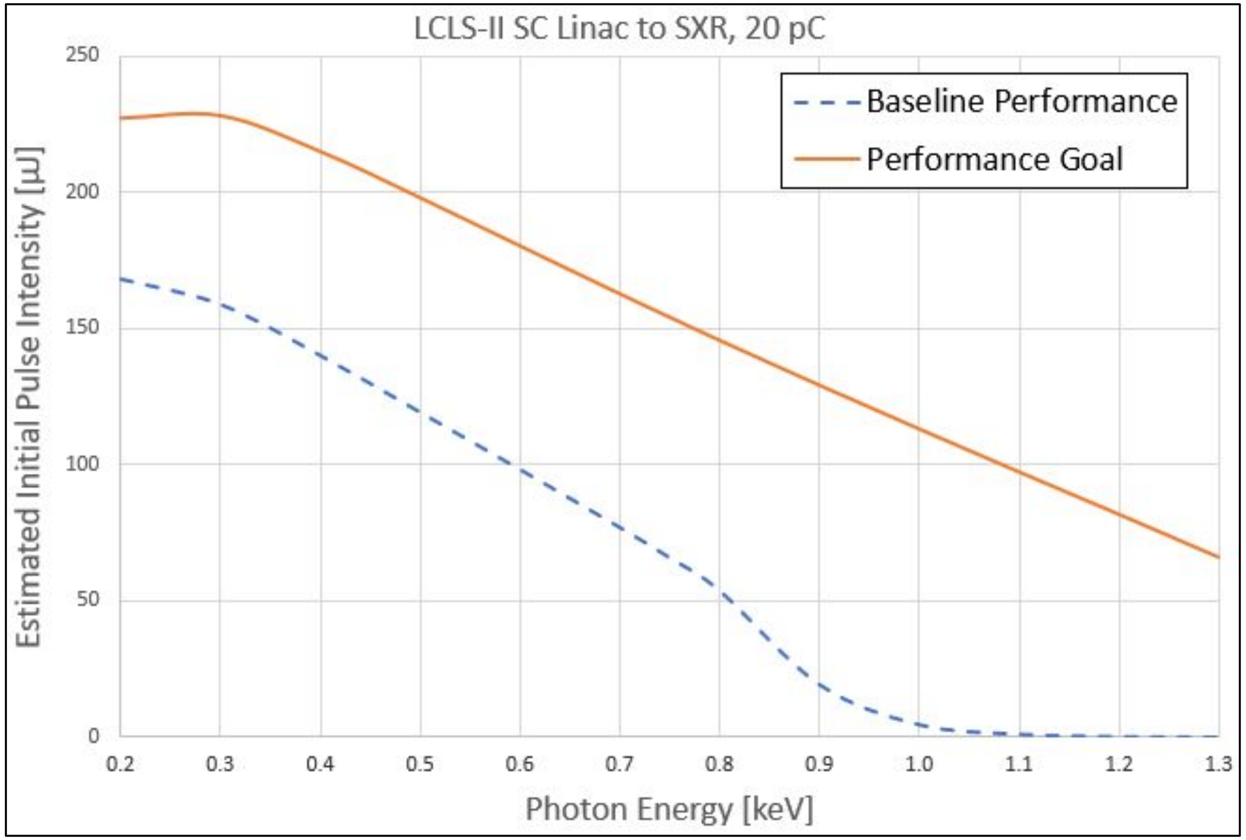
[§] Brightness units are photons/sec/mm²/mrad²/0.1%-BW

**** Highest rate will depend on accelerator protection and beamline acceptance**

https://lcls.slac.stanford.edu/parameters

SC Linac Beam Quality Ramp Up

- Initial SC linac beam quality / FEL performance expected to rapidly improve in first half of Run 21



Shorter Pulses

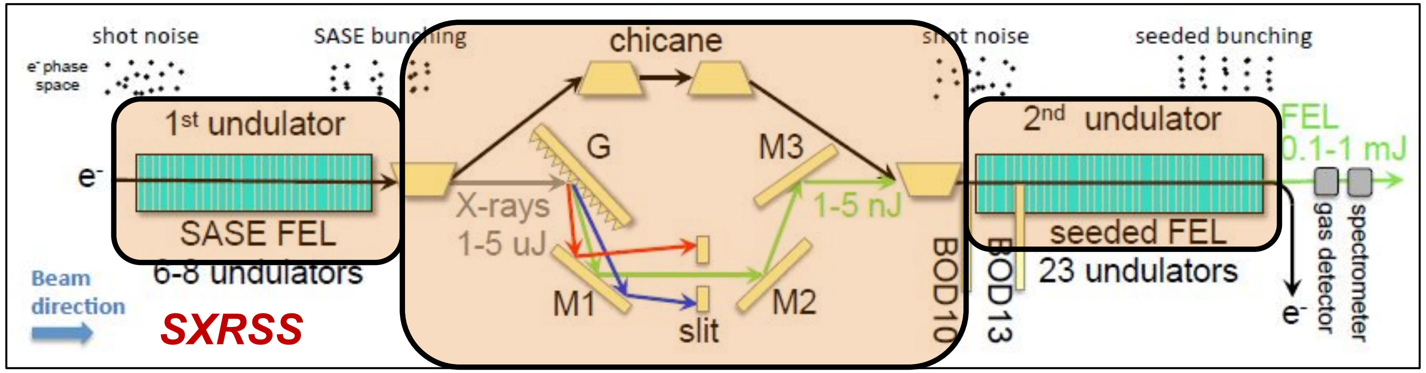
- Laser heater shaping (few fs pulses) and XLEAP (sub-fs pulses) demonstrated with NC Linac
- Capability to be extended to SC linac once performance is established

Technique	Min Pulse Duration	Linac (Max Rate)	Energy range	Energy/Pulse	Single Spike rate
Laser Heater Shaping	< 8 fs	**SC (1 kHz+)**	**SXR**	10-20 uJ	TBD
XLEAP	TBD	**SC (1 kHz+)**	**SXR**	TBD	TBD

fs and sub-fs pulses to be demonstrated w/ SC linac toward end of Run 21 (At Risk)

Soft X-ray Self-Seeding (SXRSS)

- Commissioning with NC Linac being completed now
- Capability to be extended to SC linac after performance is established, and charge increased (50 pC)

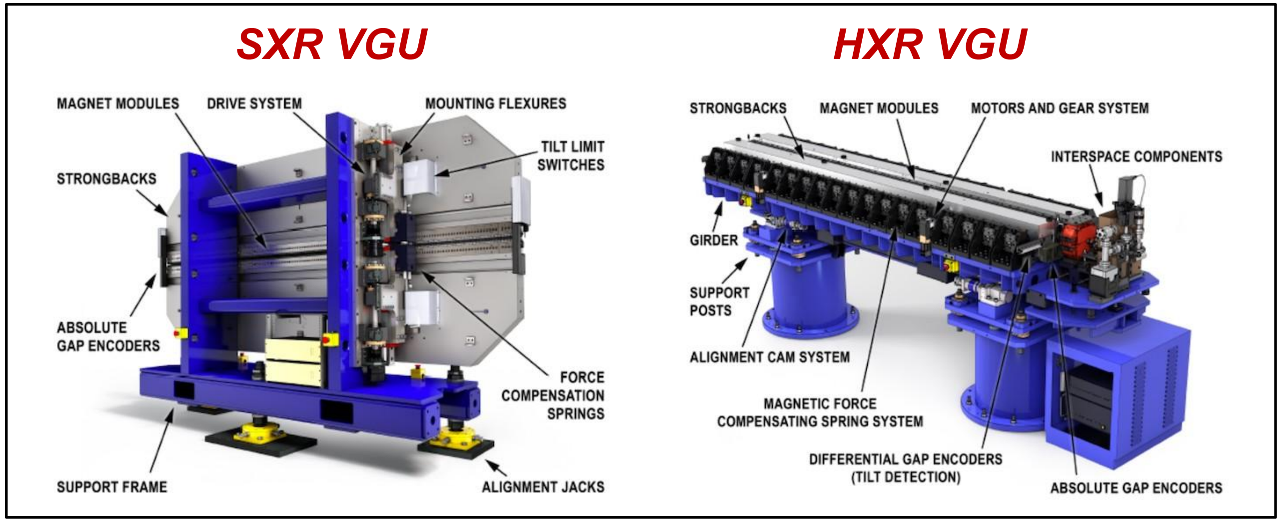


Photon energy	400-1200 eV
Bandwidth (FWHM)	**0.1-0.2 eV**
Max pulse energy	20 – 50 μJ @ 50 pC
Duration	20 – 50 fs

SXRSS to be demonstrated w/ SC linac toward end of Run 21 (At Risk)

Photon Energy Scanning

Linac+Und	Mode	Energy delta	Speed/step	Notes
NC + HXR	Und Gap (coarse)	20%	seconds	Range is performance limited
	Vernier (fine)	1-2%	milliseconds	
SC + SXR	Und Gap (coarse)	50-100%	seconds	Range is performance limited
	Vernier (fine)	1-2%	milliseconds	TBD end of Run 21



User control of photon energy scans ready and available via new variable gap undulators

SC Linac Summary

Will deliver for Early Access science to the SXU for Run 21

- **Rate:** Ramp from 1 kHz to 33 kHz delivery over Run 21
- **Intensity/quality:** Ramp intensity/ph. energy first 1-2 months
- Special capabilities:
  - **Photon energy scans** ready beginning Run 21
  - **Short pulses** (fs to sub-fs) – End of Run 21 (At Risk)
  - **SXRSS** – End of Run 21 (At Risk)

Communication with the Accelerator Team

- Weekly ‘User Meeting’ with the ACR team:

  Wednesday before your experiment starts, present experiment background and summarize key FEL parameters: photon energy, pulse energy, pulse length, other special conditions/requests that are important for FEL operation. (~10 min presentation each)

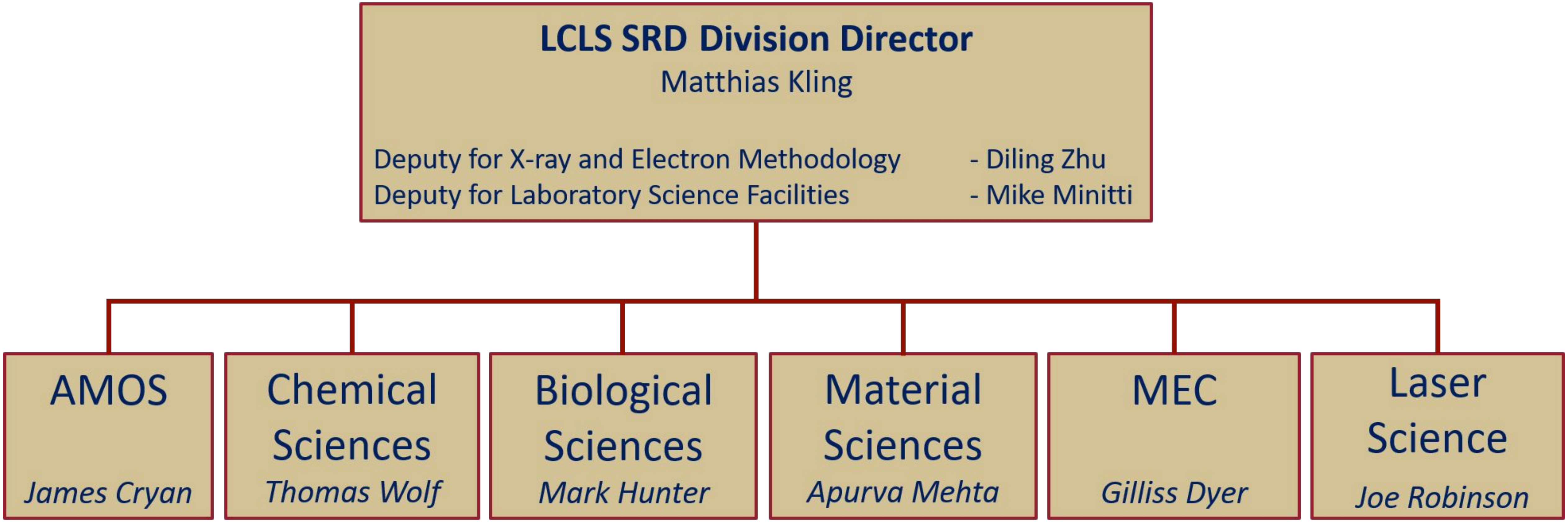
- Daily physics meeting at 08:00 for add’l feedback

- LCLS POC is the conduit for communication with the Accelerator teams

Early Science Plans for High Repetition Rate Soft X-ray Experiments

James Cryan, Apurva Mehta, Thomas Wolf, Run 21 Townhall,
3/3/2022

LCLS Recently Re-Organized its Beamline Scientific Staff into Departments Aligned by Science Area



LCLS SRD Division Director
Matthias Kling

Deputy for X-ray and Electron Methodology - Diling Zhu
Deputy for Laboratory Science Facilities - Mike Minitti

- AMOS — *James Cryan*
- Chemical Sciences — *Thomas Wolf*
- Biological Sciences — *Mark Hunter*
- Material Sciences — *Apurva Mehta*
- MEC — *Gilliss Dyer*
- Laser Science — *Joe Robinson*

Points of contact - by science area and by instrument

LCLS Instrument Contacts:

- **Time-resolved AMO (TMO)** - James Cryan (**jcryan@slac.stanford.edu**)
- **ChemRIXS** - Georgi Dakovski (**dakovski@slac.stanford.edu**) or Kristjan Kunnus, (**kristjan@slac.stanford.edu**)
- **qRIXS** - Georgi Dakovski (**dakovski@slac.stanford.edu**)
- **X-ray Pump Probe (XPP)** - Diling Zhu (**dlzhu@slac.stanford.edu**)
- **X-ray Correlation Spectroscopy (XCS)** - Matthieu Chollet (**mchollet@slac.stanford.edu**)
- **Macromolecular Femtosecond Crystallography (MFX)** - Alex Batyuk (**batyuk@slac.stanford.edu**)
- **Coherent X-ray Imaging (CXI)** - Meng Liang (**mliang@slac.stanford.edu**)
- **Matter in Extreme Conditions (MEC)** - Gilliss Dyer (**gilliss@slac.stanford.edu**)

LCLS Scientific Department Head Contacts:

- Atomic, Molecular and Optical Sciences - James Cryan (**jcryan@slac.stanford.edu**)
- Biological Sciences - Mark Hunter (**mhunter2@slac.stanford.edu**)
- Chemical Sciences - Thomas Wolf (**thomas.wolf@slac.stanford.edu**)
- Laser Science - Joe Robinson (**jsrob@slac.stanford.edu**)
- Materials Science - Apurva Mehta (**mehta@slac.stanford.edu**)
- Materials in Extreme Conditions - Gilliss Dyer (**gilliss@slac.stanford.edu**)

Overview: LCLS-II Upgrade for TMO and NEH2.2

- LCLS-II superconducting accelerator will startup during 2022/23
- First Light planned for November 2022
- For Run 21, the soft X-ray instruments will focus on using the high rep-rate beam
    - TMO, ChemRIXS, qRIXS
    - Technical commissioning followed by an LCLS-led, community-wide ‘Early Science’ period
    - No PRP proposals for Run 21 for these instruments
    - Users should submit ideas for the “Early Science” experiments (see next slides)

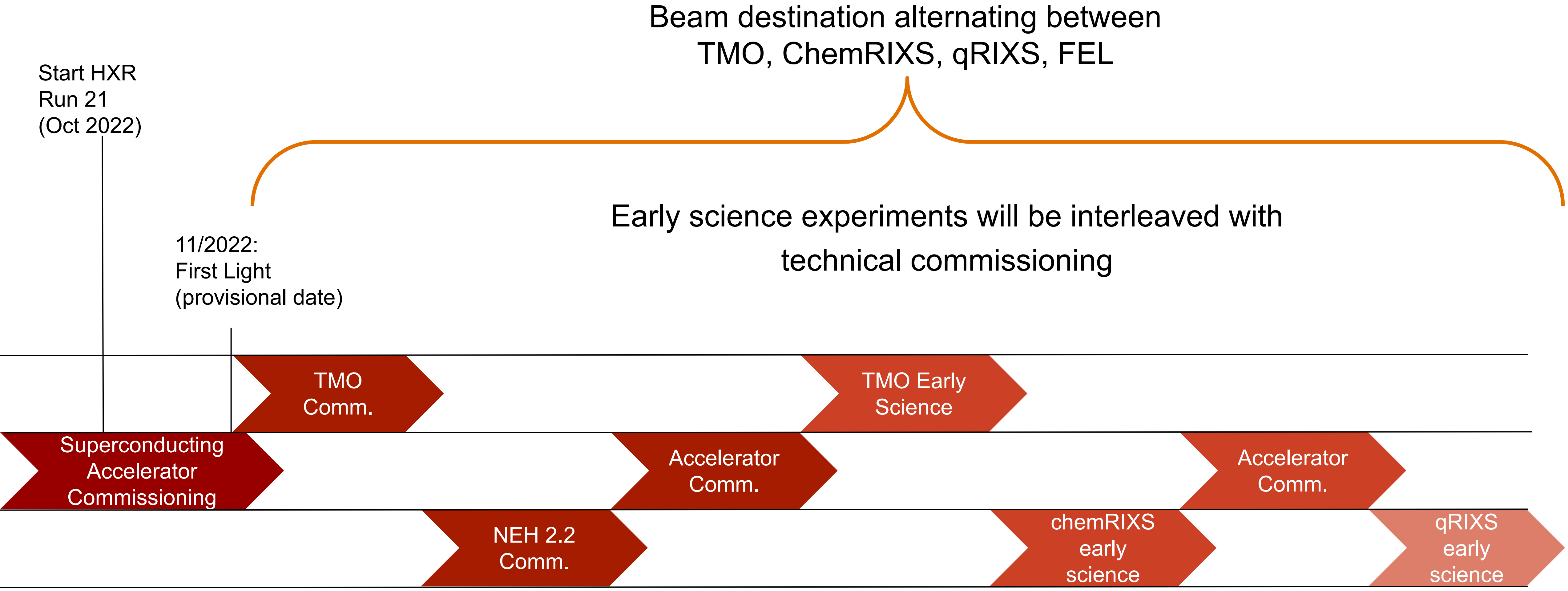
The Early Science process

- Motivation:
  - The complexity brought by high repetition rate operation warrants the implementation of a 3-step approach:
    - i. Allocate sufficient time for technical commissioning of beamline and instruments at high repetition rate
    - ii. Early Science, bridging the gap from technical commissioning of new instrumentation to regular user access
    - iii. PRP proposals (planned for the next Run)
  - Enables a more flexible response to emerging LCLS-II performance, and beamline/instrument readiness
- Early Science
  - Based on ideas solicited from the community
  - Led by LCLS staff, with broad involvement from the community
  - Overseen by the LCLS Scientific Advisory Committee (SAC) and the Instrument Advisory Panels (IAPs)
- Interested groups should contact the relevant department heads - deadline 30 March
  - **TMO**: James Cryan (AMOS, jcryan@slac.stanford.edu)
  - **ChemRIXS**: Thomas Wolf (Chemical Sciences, thomas.wolf@slac.stanford.edu)
  - **qRIXS**: Apurva Mehta (Materials Sciences, mehta@slac.stanford.edu)
- Experiment ideas will then be prioritized by LCLS staff and the instrument advisory panels.
- The resultant early science plans will be advertised to the user community to solicit participation.

Timeline For Early Science Program

- **March 30, 2022**: Deadline for Letters of Interest to LCLS (same date as regular proposals)
  - One-page summary of science / instrument areas of interest, or
  - Bulleted list of experimental ideas
- **April - June 2022**: LCLS engages with User Community to develop the plan.
- **June 30, 2022:** LCLS announces Early Science experiments to User Community
- **September 1, 2022**: Deadline for interested users to submit a description of their proposed contribution to the specific Early Science experiments.
  - Experiments are open enrollment, subject to forming a balanced onsite team.
- **November 2022:** Provisional date for ‘First Light’ from SCRF beam, followed by:
  - FEL commissioning
  - Beamline/instrument commissioning
  - Early Science (likely in early 2023 onwards)

Early Science during Run 21 will follow a phased approach between the instruments, interleaved with FEL ramp-up



Beam destination alternating between TMO, ChemRIXS, qRIXS, FEL

Start HXR Run 21 (Oct 2022)

11/2022: First Light (provisional date)

Early science experiments will be interleaved with technical commissioning

Provisional X-ray and Laser Parameters for high repetition-rate operation

X-ray Parameters			
Repetition rate (Hz)	Up to 50 kHz		
Energy Range (eV)	250 - 1800		
		Under Development (increased risk)	
Pulse Duration	20 fs (nominal)	Tunable to 5 fs	< 1 fs (XLEAP-II)
Energy per pulse	~ 50 μJ	Scales linear with pulse energy	2-3 μJ
Bandwidth (FWHM)	2 eV	2 eV	4-8 eV
Spot Size, FWHM (range)	1.0 - 200 (um) diameter		
Polarization	Linear, Horizontal		
Two Pulse Mode (jcryan@stanford.edu for more information)	Under development, offered at risk < 10 μJ / pulse with tunable delay via split undulator method. This provides a minimum delay of ~10 fs for arbitrary wavelength. For harmonic operation (ω/2ω, ω/3ω) the minimum delay ~200 as.		

Laser Parameters				
Repetition rate (Hz)	Synchronized up to 33 kHz			
			High Risk	ES Only
Wavelength	800 nm	400 nm	266 nm	1300-2400 nm
Pulse Duration	< 25 fs	< 50 fs	< 50 fs	< 100 fs
Energy per pulse (on target)	100 μJ	> 10 μJ	~ 1 μJ	< 10 μJ
Spot Size, FWHM (800 nm)	50 to 100 um			
Polarization	Variable: linear, circular			
Angle	~0.5 deg angle with x-ray beam			
Arrival Time Monitor	< 20 fs accuracy in x-ray/laser arrival time tagging.			

Run 21 Laser Capabilities

LCLS Town Hall

March 3rd 2022

U.S. DEPARTMENT OF ENERGY
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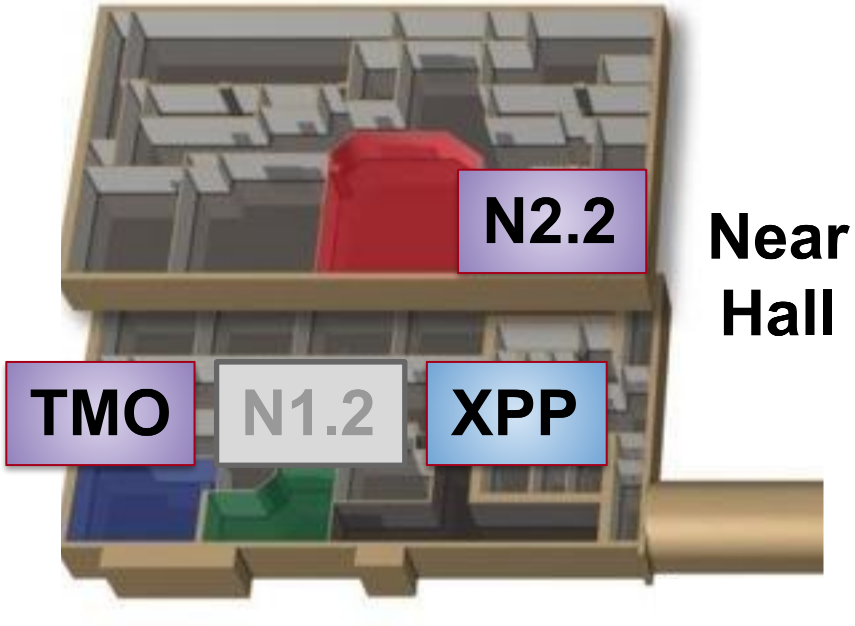
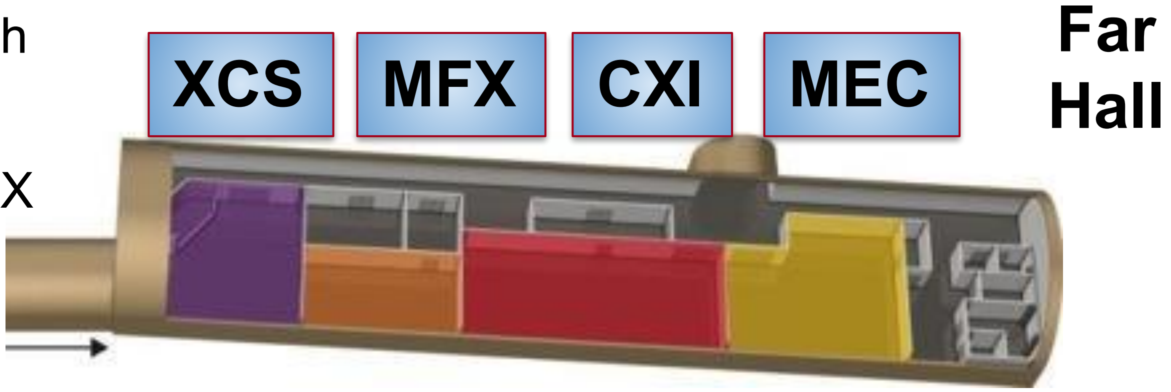
Ultrafast lasers available at all instruments for Run 21



- TMO and 2,2 will share the high rep-rate OPCPA system, running at 33 kHz for Early Science
    - Limited wavelengths available - see more later
- XPP will continue to use the 120 Hz Ti:S laser systems in the NEH Laser Hall
    - Maintains previous broad range of laser capability

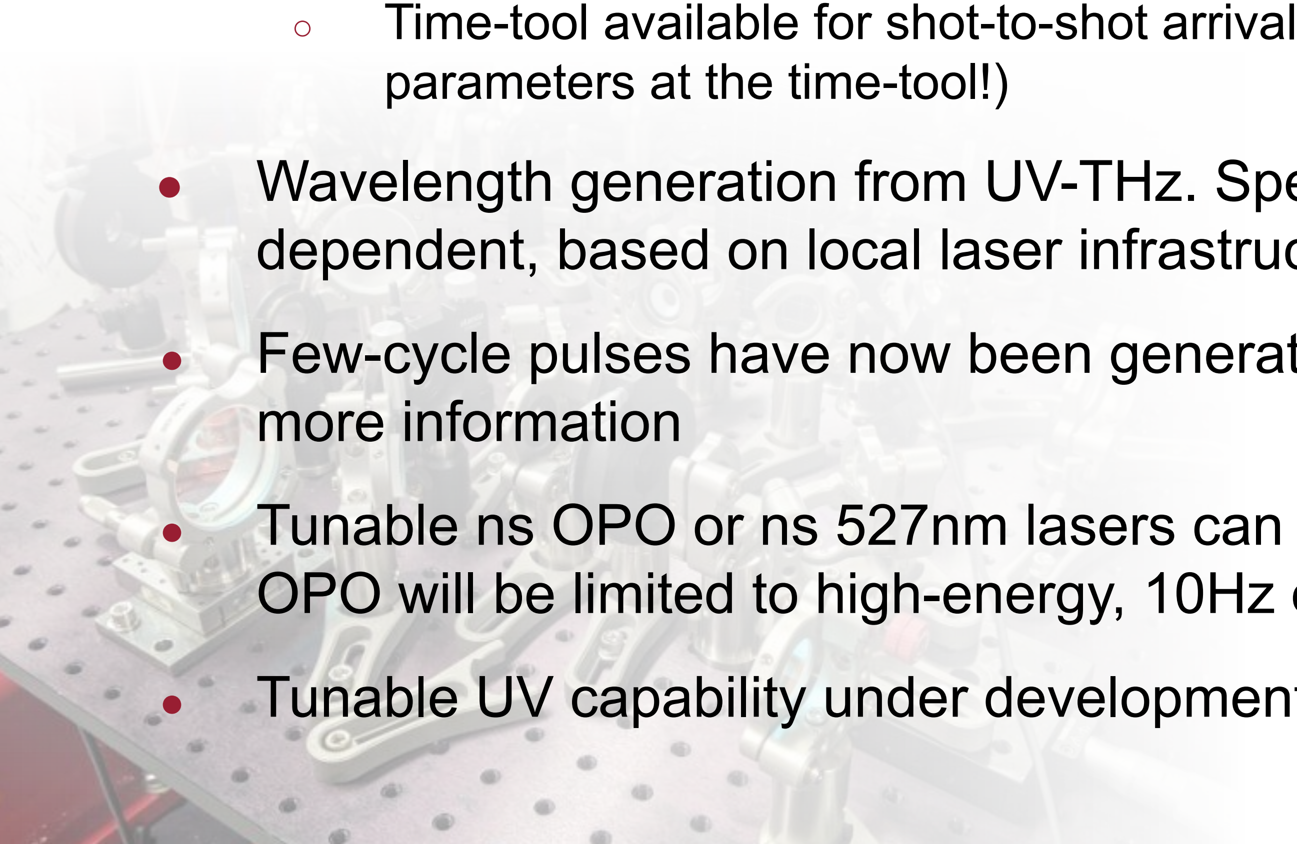
- All FEH hutches have ultrafast laser capability with Ti:S regen now commissioned in MFX
- High-energy OPO also available (primarily) at MFX
- Tunable UV capability under development at CXI



Laser capabilities at high rep rate

- High rep rate OPCPA system will be available, for the first time, for commissioning and Early Science experiments in TMO and Hutch 2.2
- OPCPA system will operate at 800nm, 33kHz, <25fs and ~35W output power
- Anticipated on-target parameters (include losses in transport and conversion efficiencies). Availability varies by instrument - check web pages for details
  - 800nm, <25fs, ~300 µJ
  - 400nm, <50fs, ~30 µJ
  - 266nm, <50fs, ~3 µJ
  - 1300-2400 nm, <100fs, <30uJ (signal), >10uJ (idler)
- Laser repetition rate can be picked down to <u>some</u> sub-harmonics of 33 kHz (maintaining the same pulse energy)
- Time-tool will initially be at lower rate (through averaging), and progress towards shot-to-shot through the run
- Pulsed fiber timing system will be incorporated to reduce timing drift and improve overall temporal resolution of experiments

Laser capabilities for hard X-ray hutches (not MEC)



- XPP, XCS, MFX, CXI primarily use femtosecond Ti:S systems:
  - 800nm, 120Hz, ~40fs, <20mJ with MPA, ~3mJ with regen
  - Programmable pulse-train to delay shots on demand for X-ray only background shots (“Goose trigger”)
  - Time-tool available for shot-to-shot arrival time tagging (dependent on the X-ray parameters at the time-tool!)
- Wavelength generation from UV-THz. Specific capabilities and geometries are hutch dependent, based on local laser infrastructure and typical need
- Few-cycle pulses have now been generated and used in XPP, XCS. Talk to POCs for more information
- Tunable ns OPO or ns 527nm lasers can be moved between MFX, CXI and XPP. OPO will be limited to high-energy, 10Hz operation in run 21
- Tunable UV capability under development at CXI. Details on instrument web pages.

LCLS laser capability varies between instruments

Y	Typically available. Depends on specifics of the experiment
~	May be available depending on specifics and interest
N	Not available at this time

See instrument webpages for details and standard configs

* Some flexibility in CXI UV wavelengths

Contact the laser POC for the instrument with questions

Instrument	MPA	800	Harmonics 200 nm	Harmonics 400, 266 nm	OPA 480-1200 nm	OPA 1.2-2.4 µm	MIR	THz	<10fs (800 nm)	527 nm (ns)	OPO (ns)	Time-Tool
1.1 IP1	N/A	Y	N	Y	N	~	N	N	N	N	N	Spatial
2.2 chemRIXS	N/A	Y	N	Y	N	N	N	N	N	N	N	Spatial
2.2 qRIXS	N/A	Y	N	N	N	N	N	N	N	N	N	Spatial
XPP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	~	Spectral
XCS	N	Y	~	Y	Y	Y	N	N	Y	N	N	Spectral
MFX	N	Y	N	Y	Y	Y	N	N	N	Y	Y	Spectral
CXI	~	Y	Y*	Y*	Y	Y	~	~	N	Y	Y	Spectral
MEC	Substantially different laser capabilities. Covered in the MEC instrument slides in the breakout.											

If you have any questions...

If you are interested in details of laser capabilities for a specific instrument, please contact the laser POC for that instrument:

TMO: Mike Glownia (jglownia@slac.stanford.edu)

2.2: Giacomo Coslovich (gcoslovich@slac.stanford.edu)

XPP: Matthias Hoffmann (hoffmann@slac.stanford.edu)

XCS: Patrick Kramer (pkramer@slac.stanford.edu)

MFX: Mike Glownia (jglownia@slac.stanford.edu)

CXI: Joe Robinson (jsrob@slac.stanford.edu)

MEC: Eric Cunningham (efcunn@slac.stanford.edu)

Precision timing: Stefan Droste (droste@slac.stanford.edu)

For general laser enquiries please contact Joe Robinson (jsrob@slac.stanford.edu)

Data Systems in the High Rep Rate World

March 3rd 2022
LCLS Run 21 Town Hall

Jana Thayer for the LCLS Data Systems Team
LCLS Data Systems: Hsing-Yin Chang, Richard Claus, Daniel Damiani, Mikhail Dubrovin, Christopher Ford, Wilko Kroeger, Xiang Li, Valerio Mariani, Christopher O'Grady, Ariana Peck, Frederic Poitevin, Murali Shankar, Monarin Uervirojnangkoorn, Matthew Weaver, Seshu Yamajala, Chun Hong Yoon

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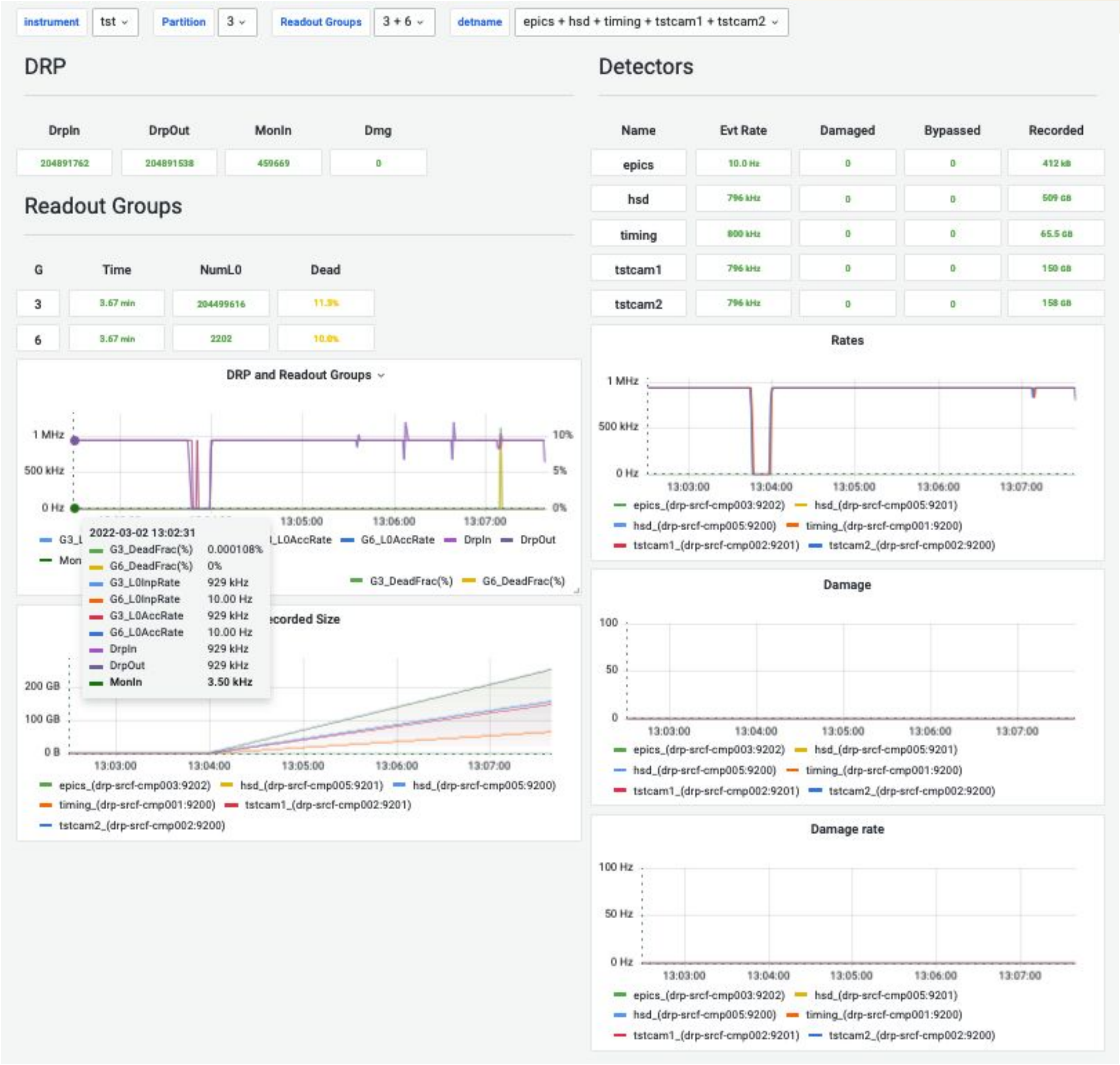
DAQ and Data Reduction at 1 MHz in action



instrument: tst
Partition: 3
Readout Groups: 3 + 6
detname: epics + hsd + timing + tstcam1 + tstcam2

DRP

DrpIn	DrpOut	MonIn	Dmg
204891762	204891538	459669	0

Readout Groups

G	Time	NumL0	Dead
3	3.67 min	204499616	11.3%
6	3.67 min	2202	10.0%

Detectors

Name	Evt Rate	Damaged	Bypassed	Recorded
epics	10.0 Hz	0	0	412 kB
hsd	796 kHz	0	0	509 GB
timing	800 kHz	0	0	65.5 GB
tstcam1	796 kHz	0	0	150 GB
tstcam2	796 kHz	0	0	158 GB

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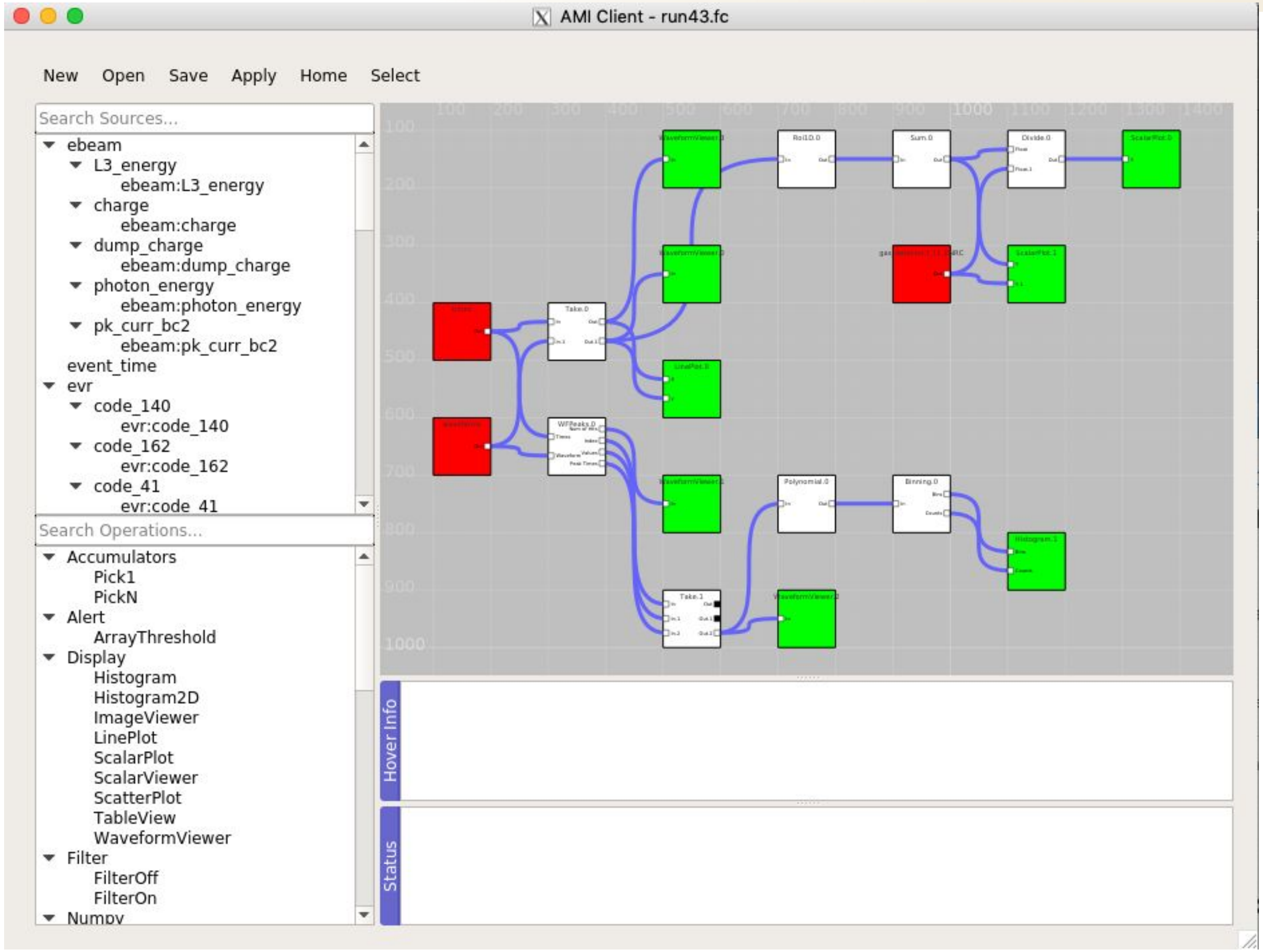
G3_DeadFrac(%)	0.000108%
G6_DeadFrac(%)	0%
G3_L0InpRate	929 kHz
G6_L0InpRate	10.00 Hz
G3_L0AccRate	929 kHz
G6_L0AccRate	10.00 Hz
DrpIn	929 kHz
DrpOut	929 kHz
MonIn	3.50 kHz

- Experiments have been running the LCLS-II Data System with Data Reduction, AMI2, and psana2 in TMO and chemRIXS at 120 Hz.
- The LCLS-II Data System has been tested (without beam) at 1 MHz.
- The LCLS-II Data System is prepared to take data at high repetition rate
- Functionally similar to LCLS-I, but capable of handling higher rates and on-the-fly data reduction

Real-time analysis with AMI2

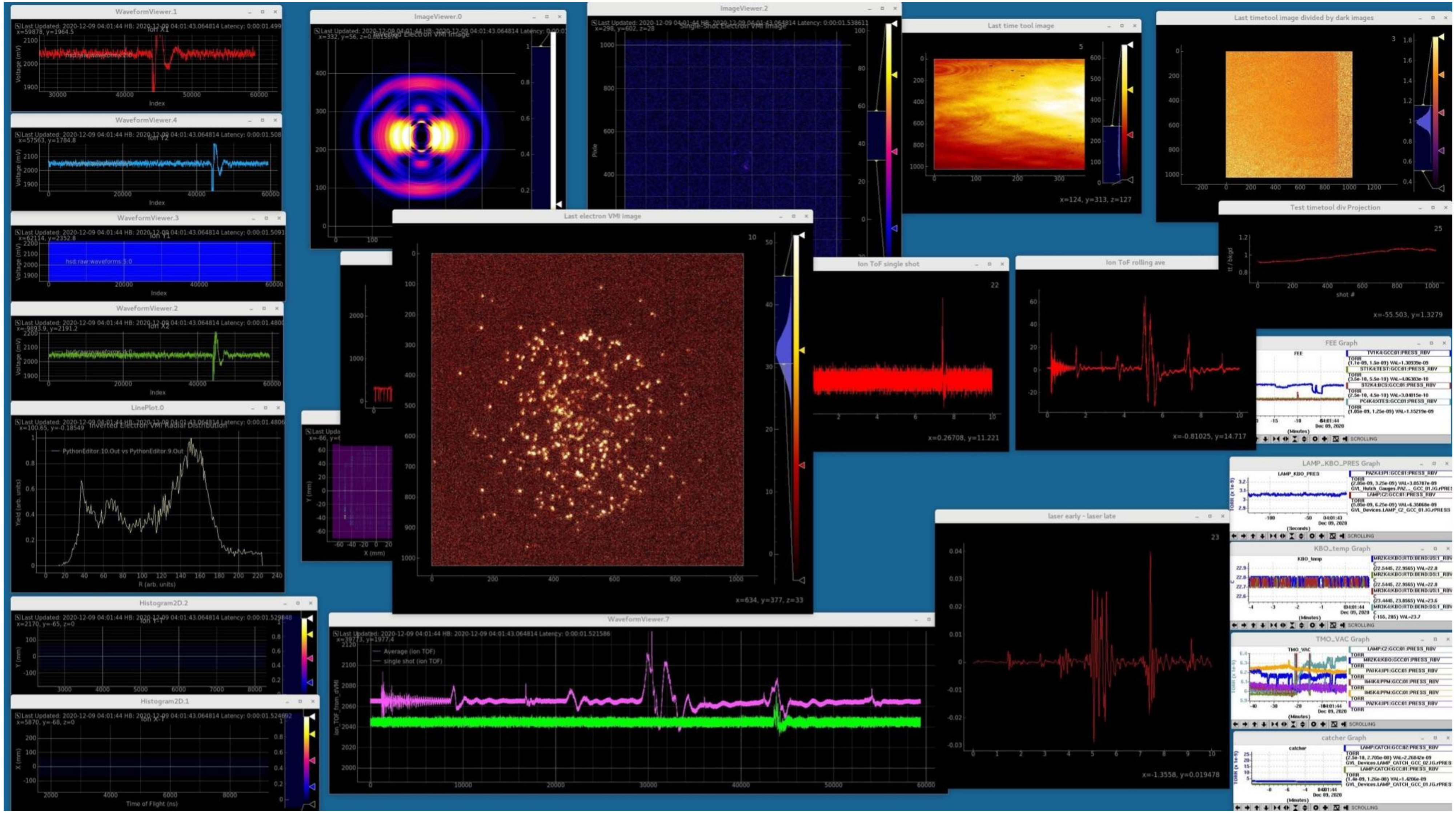


Slightly different interface for configuring an analysis

Similar functionality as the original AMI

Much more robust and scalable under the hood to handle the increased complexity of reduced data and higher repetition rate

Real-time (~1s latency) TMO Analysis With AMI2



AMI2 in action in TMO!

LCLS-II Supported Detectors

- LCLS-II Data System can acquire up to 1 MHz; record up to 20 GB/s
  - Data Reduction will be turned on for devices that have been fully commissioned/validated
  - High Speed Digitizers will perform (configurable) data reduction in FPGA
    - “Peak finding” in FPGA: When a peak goes above (or below) a threshold, we open a window keeping a configurable number of bins before value crossed threshold and extending a configurable number of bins after value falls below the threshold.
- LCLS-II Supported Data Sources:
  - 1MHz: High Speed Digitizer (6.5 GSamples/second), wave8, timing system, EBeam BLD, GasDet BLD
  - 100kHz: Piranha line camera (typically for time tool), Phase Cavity BLD
  - 120 Hz: Timestamped PVs
  - 1 Hz: EPICS
  - 300 Hz: RIXS-CCD
  - Imaging detectors (planned)

Documentation

- Lots happening on LCLS-I as well (see Mark Hunter’s presentation: OM)
- Automatic Run Processing capabilities are available via eLog: https://confluence.slac.stanford.edu/display/PCDS/Automatic+Run+Processing
- Data Analysis with psana: https://confluence.slac.stanford.edu/display/PSDM/LCLS+Data+Analysis
- SLURM job scheduling system for the LCLS batch compute systems: https://confluence.slac.stanford.edu/display/PCDS/Submitting+SLURM+Batch+Jobs
- New Fast Feedback (FFB) system: https://confluence.slac.stanford.edu/display/PCDS/Fast+Feedback+System
- Reminder of batch queues available: https://confluence.slac.stanford.edu/display/PCDS/Batch+System+Analysis+Jobs

Data Reduction Pipeline (DRP) policy

Once beam time is granted and before the experiment begins, users work together with CDS POC and science POC to determine which data reduction method and prescale are the best fit for their experiment