AMO Science in Run 21
LCLS Virtual Town Hall

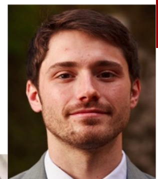
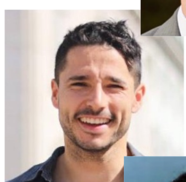
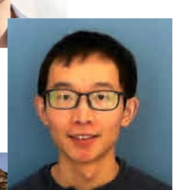
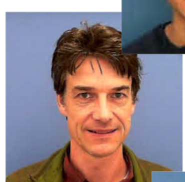
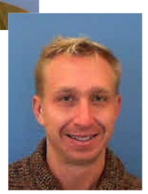
James Cryan
AMOS Department Head
March 21st, 2022

U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

AMOS Department at LCLS

People

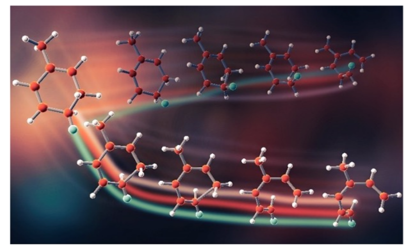






James Cryan
Ryan Coffee
Taran Driver
Andrei Kamalov
Xiang Li
Ming-Fu Lin
Stefan Moeller
Razib Obaid
Adam Summers
Peter Walter



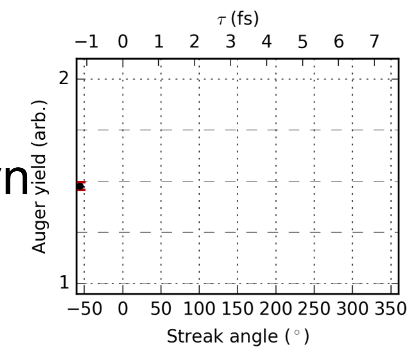


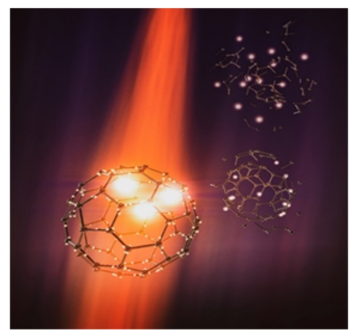
Research Areas



Gas Phase Photochemistry (Joint with Chem Sci.)

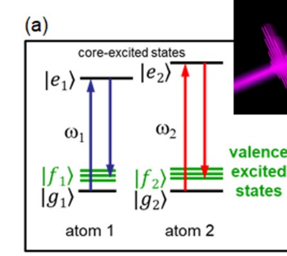
Attosecond Electron Dyn

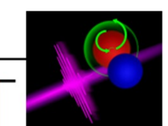




Dynamics in Complex Systems

Advanced Methodologies





AMOS Science at LCLS

TMO:

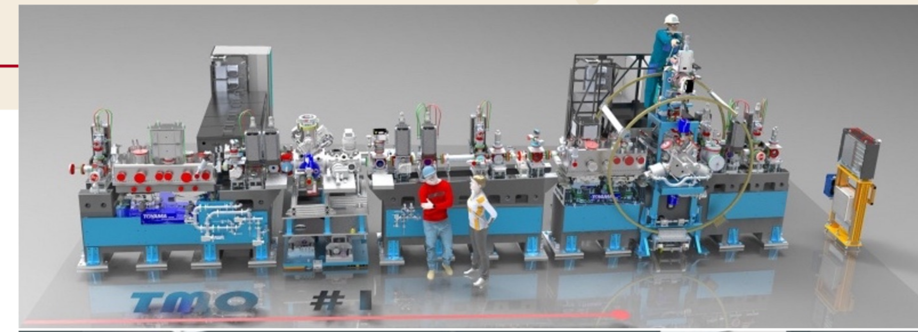
- Gas Phase SXR spectroscopy (Photochemistry)
- Attosecond Spectroscopy
- Coincidence Spectroscopy
- ~~Imaging Nano-systems~~ (moved to TXI)

CXI:

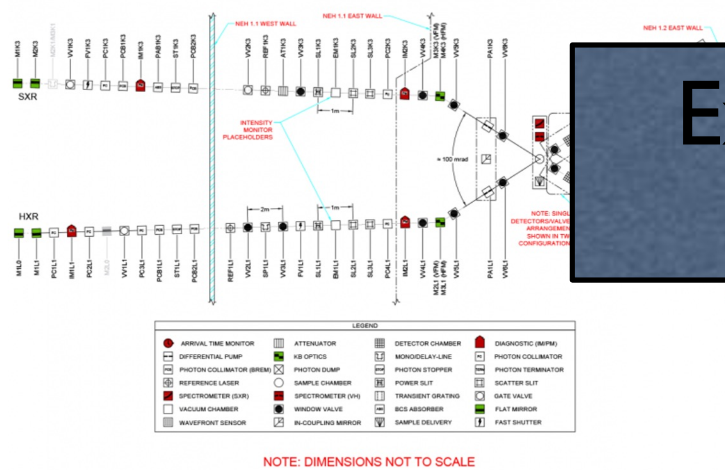
- X-ray scattering in gas phase samples
- X-ray scattering in nano-scale systems

TXI:

- X-ray scattering in nano-scale systems



Covered in Next Session



Expected 2023

The Early Science process

- Motivation:
  - The complexity brought by high repetition rate operation warrants the implementation of a 3-step approach:
    1. Allocate sufficient time for technical commissioning of beamline and instruments at high repetition rate
    2. Early Science, bridging the gap from technical commissioning of new instrumentation to regular user access
    3. 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 Planning

Goal is to demonstrate new capabilities of the LCLS-II SCRF accelerator and undulators

- High Rep. Rate Tunable X-ray Pulses
- New OPCPA pump laser
- Attosecond Duration Pulses

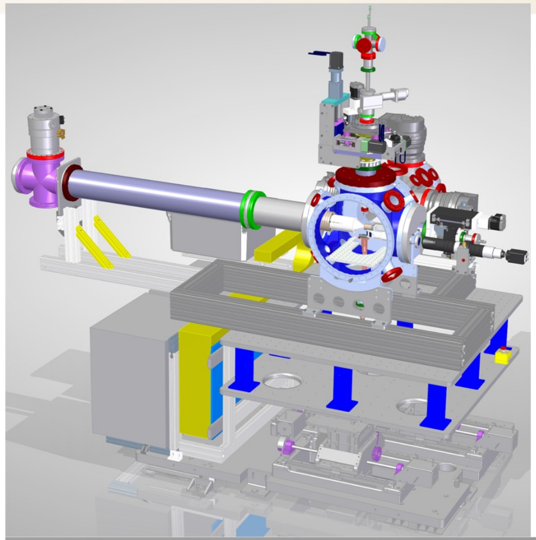
Early Science is led by LCLS scientists, but engages the whole community

- LCLS collects experiment ideas and prioritizes together with the instrument advisory panels.
- LCLS consolidates early science plans with the user community and broadly advertises a call for participation.
- LCLS updates interested user groups on adjustments to the early science plan.

Interested groups should send a note on their intention to collaborate

- You can send any ideas you would like to add to the Early Science Plan
- Gas Phase Studies in TMO
  - James Cryan (jcryan@slac.stanford.edu)
  - Thomas Wolf (thomas.wolf@slac.stanford.edu)

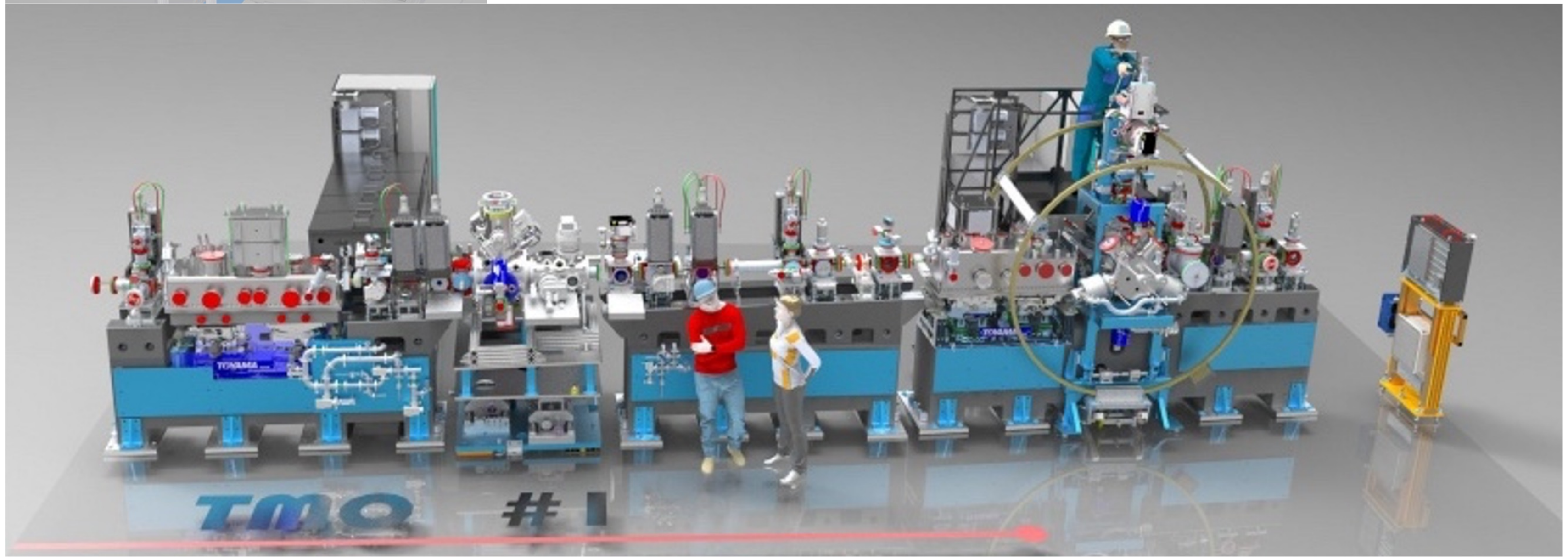
Spectroscopy: TMO Hutch for Run 21



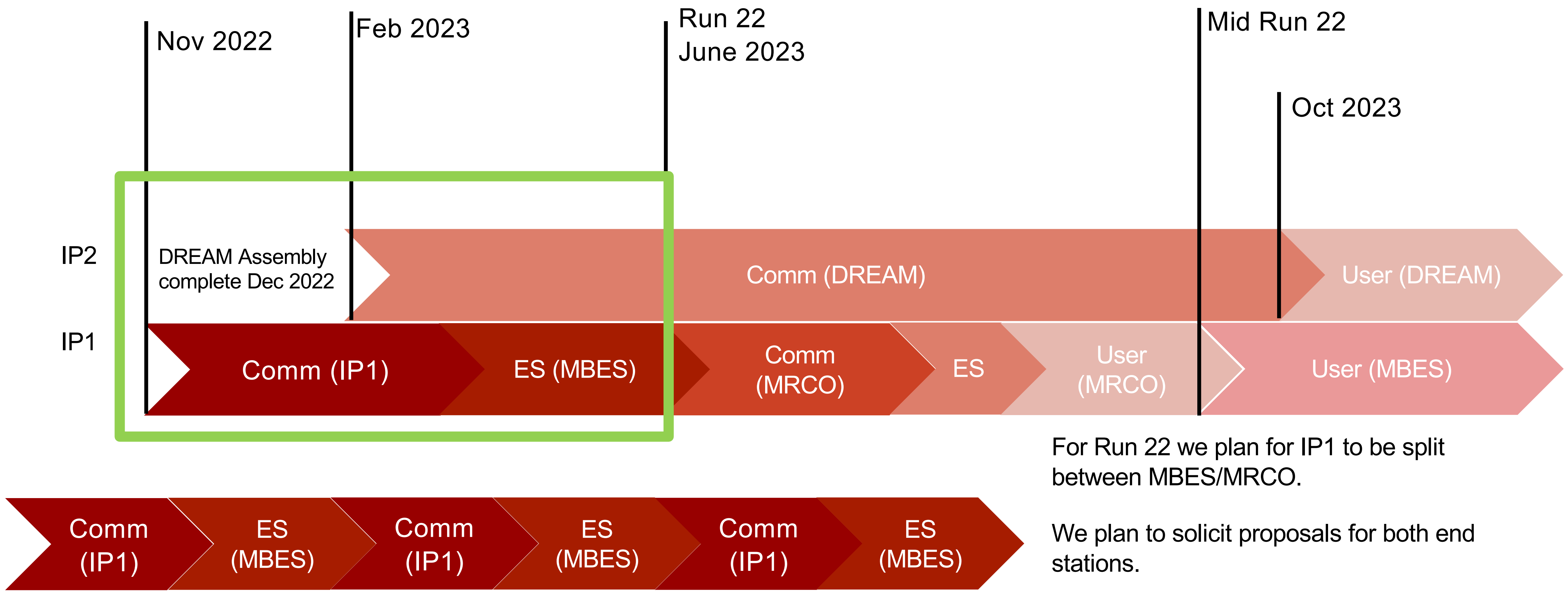
Commissioning/Early Science in IP1

- 2m Magnetic Bottle Electron ToF Spectrometer
- Fresnel Zone Plate Based Spectrometer after IP1 (diagnostic)

Commissioning of DREAM end station in IP2



Long Range Plans in TMO



For Run 22 we plan for IP1 to be split between MBES/MRCO.

We plan to solicit proposals for both end stations.

X-Ray Parameters for Run 21

SLAC

X-ray Parameters			
Repetition rate (Hz)	Up to 50 kHz		
Energy Range (eV)	250 - 1800		
Pulse Duration	20 fs (nominal)	Under Development (increased risk)	
		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 ($\omega/2\omega$, $\omega/3\omega$) the minimum delay ~200 as.		

- Commissioning of Super Conducting RF accelerator
  - Ramping rep. rate toward 100 kHz
  - Only modest pulse energies available while commissioning
- Continued Development of Advanced Modes:
  - XLEAP
  - Pulse-pairs
  - Tunable pulse duration
- TMO performance benchmarked in previous Runs.

Laser Parameters for Run 21

Laser Parameters				
Repetition rate (Hz)	Synchronized up to 33 kHz			
Wavelength			High Risk	ES Only
	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.			

- New OPCPA laser system
  - 33 kHz Repetition Rate
- Focus on 800 nm fundamental and harmonics for the Early Science period
  - OPA could also be available
- ATM should also be available for x-ray/laser timing

Areas to Highlight in Early Science

- UV Driven Photochemistry:
  - XAS and/or XPS with high repetition rate
  - Pumping with new OPCPA pump laser
- Time-resolving electron dynamics:
  - Attosecond pump/attosecond probe
  - Femto/femto or Femto/atto could be a good baseline as well.
- Electron-Electron Coincidence (Covariance) in MBES

Collaboration

We are always open to and interested in collaborations!

DOE Office of Science Graduate Student Research (SCGSR) Program:

https://science.osti.gov/wdts/scgsr

Applications due 05/04/2022

Other collaborative efforts also encouraged.

Questions?