Gas Phase Photochemistry Run 21

Thomas Wolf, Mengning Liang
LCLS Chemical Sciences Department Head
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U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

Gas Phase Photochemistry in the SRD Department Structure

AMOS Department
(James Cryan)

Gas phase photochemistry
Group
(Ming-Fu Lin)

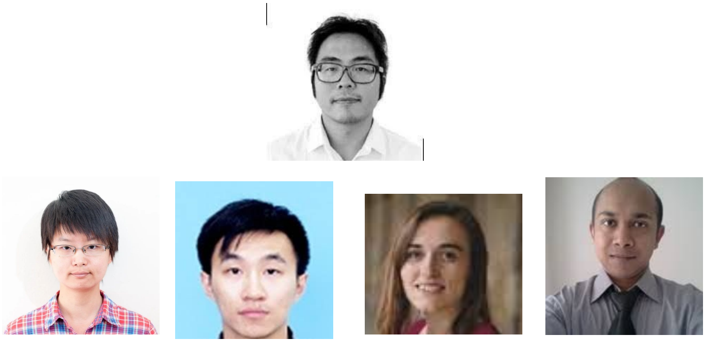
Chemical Sciences
Department
Thomas Wolf

Techniques and Instruments Supported by the Group

Hard X-ray diffraction (CXI)

Soft X-ray spectroscopy (TMO)

Gas phase photochemistry Group
(Ming-Fu Lin)



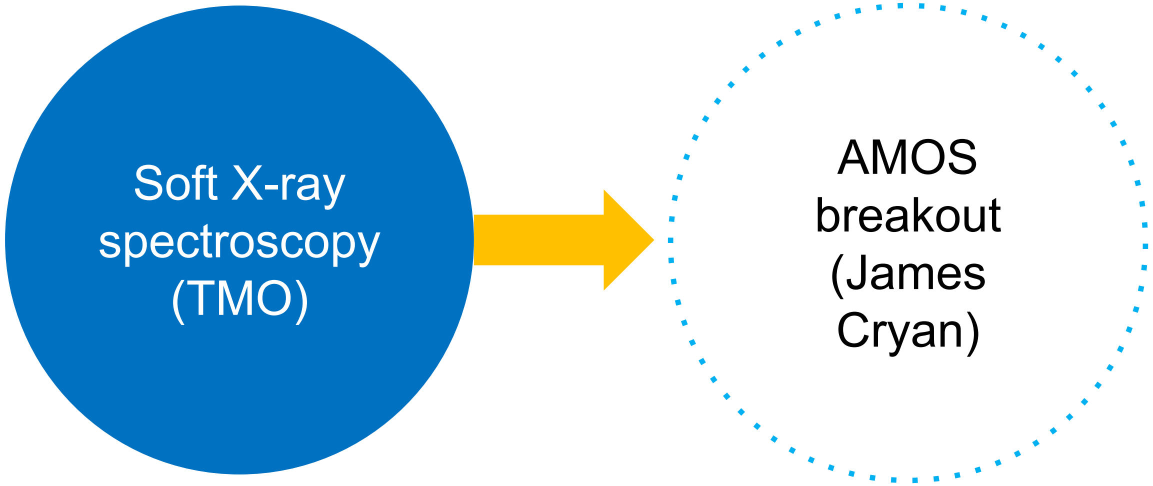
Electron diffraction (MeV-UED, separate proposal calls)

Collaborate with Us

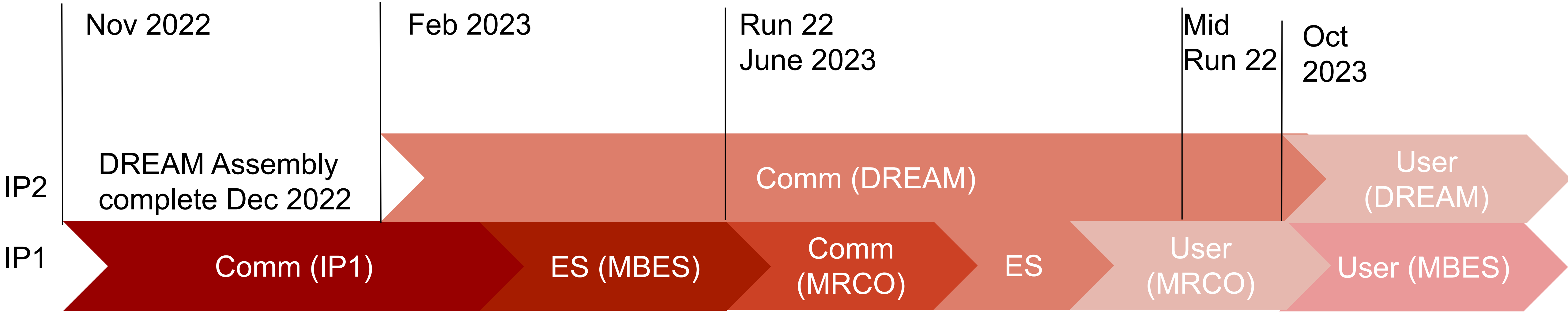
We are always open to and interested in collaborations!

Available fellowships from DOE and NIH:

- DOE Office of Science Graduate Student Research (SCGSR) Program:
  https://science.osti.gov/wdts/scgsr
  Applications due 05/04/2022
- NIH:
  - NIH F31 graduate student fellowships:
    https://www.ninds.nih.gov/Funding/Training-Career-Development/Award/F31-Individual-NRSA-PhD-Students-MDPhD-Students-MSTP-0
    Deadlines: 04/08, 08/08, 12/08
  - NIH F32 Postdoctoral fellowships:
    https://www.niehs.nih.gov/research/supported/training/fellowships/f32/index.cfm


Soft X-ray spectroscopy (TMO)
AMOS breakout (James Cryan)

Long-Range plans at TMO



Run 22 IP1 will be split between MBES/MRCO. For Run 22 we will solicit proposals for both end stations.

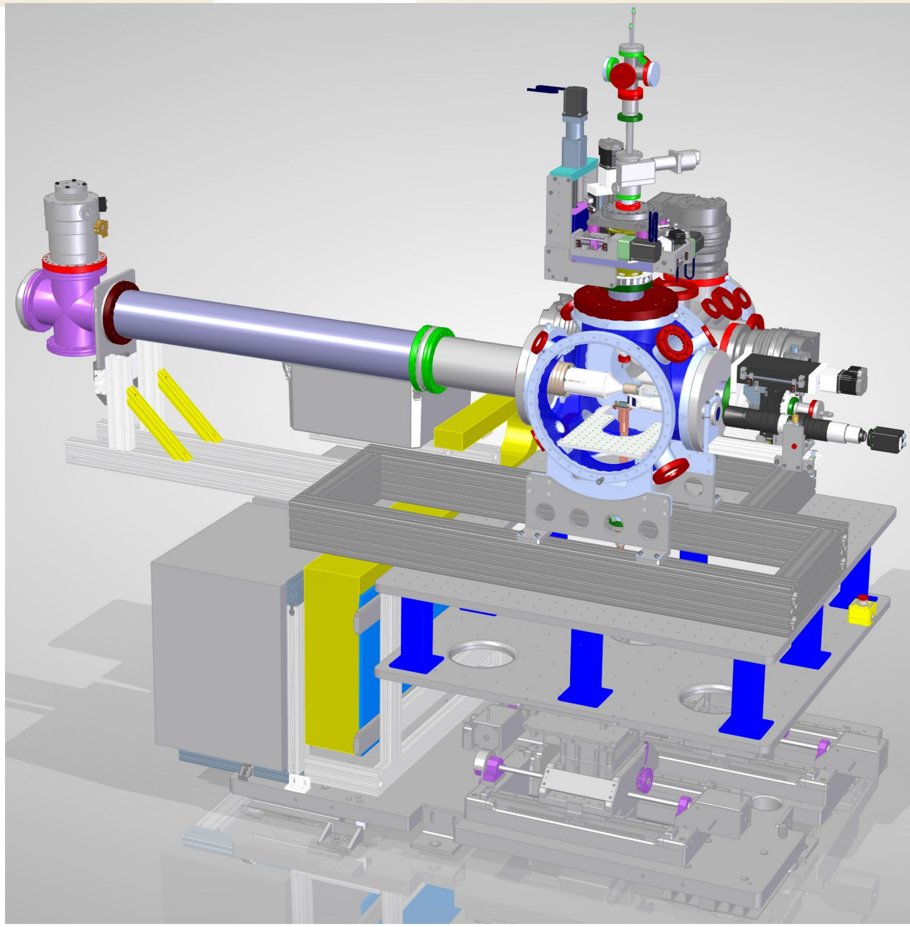
X-ray and Laser Parameters for TMO inRun 21

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.		

Laser Parameters				
Repetition rate (Hz)	Synchronized up to 33 kHz			
Wavelength	800 nm	400 nm	High Risk 266 nm	ES Only 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.			

User Involvement in Early Science

- Early Science is lead by LCLS scientists
- Interested groups should contact James (jcryan@slac.stanford.edu) and Thomas (thomas.wolf@slac.stanford.edu)
- Department heads collect experiment ideas and prioritize together with the instrument advisory panels.
- Department heads communicate consolidated early science plan with user community and broadly advertise participation.
- Department heads update interested user groups on adjustments to the early science plan.



Gas Phase Chemistry at CXI

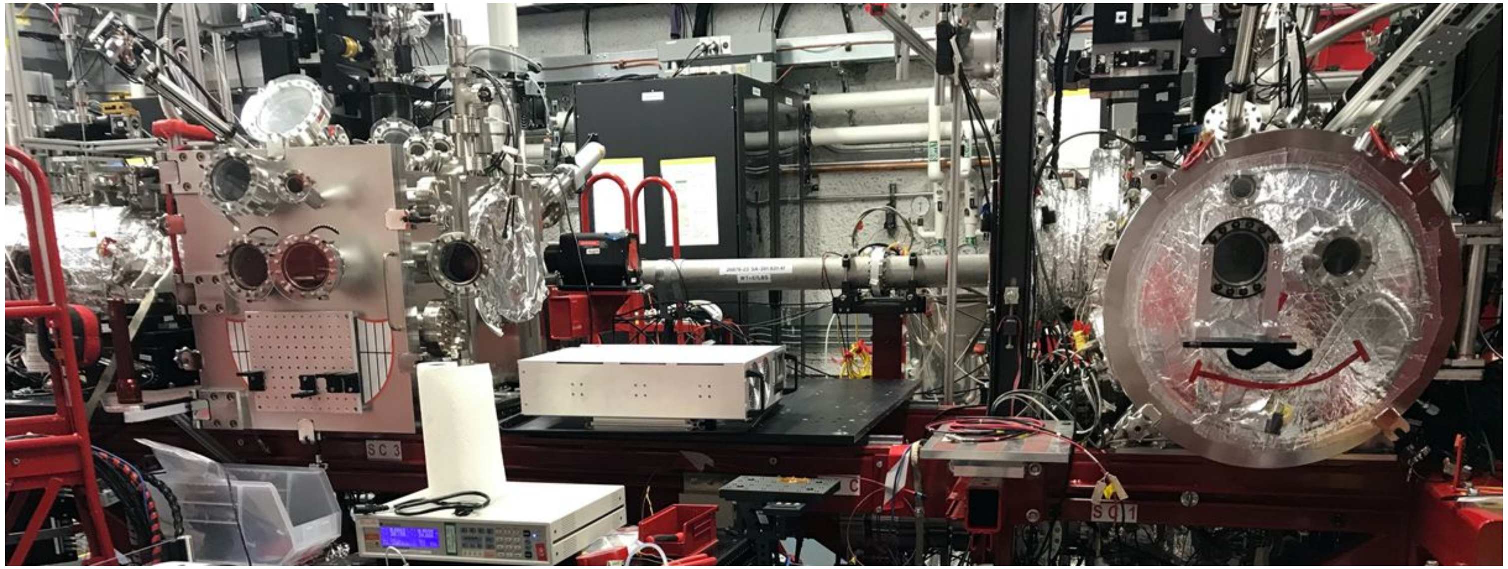
[CXI - Coherent X-ray Imaging | Linac Coherent Light Source (stanford.edu)]

Primary considerations:

- Low background scatter – Vacuum environment at hard X-ray energies with numerous slits for a clean focal spot
- Short Pulse UV capabilities

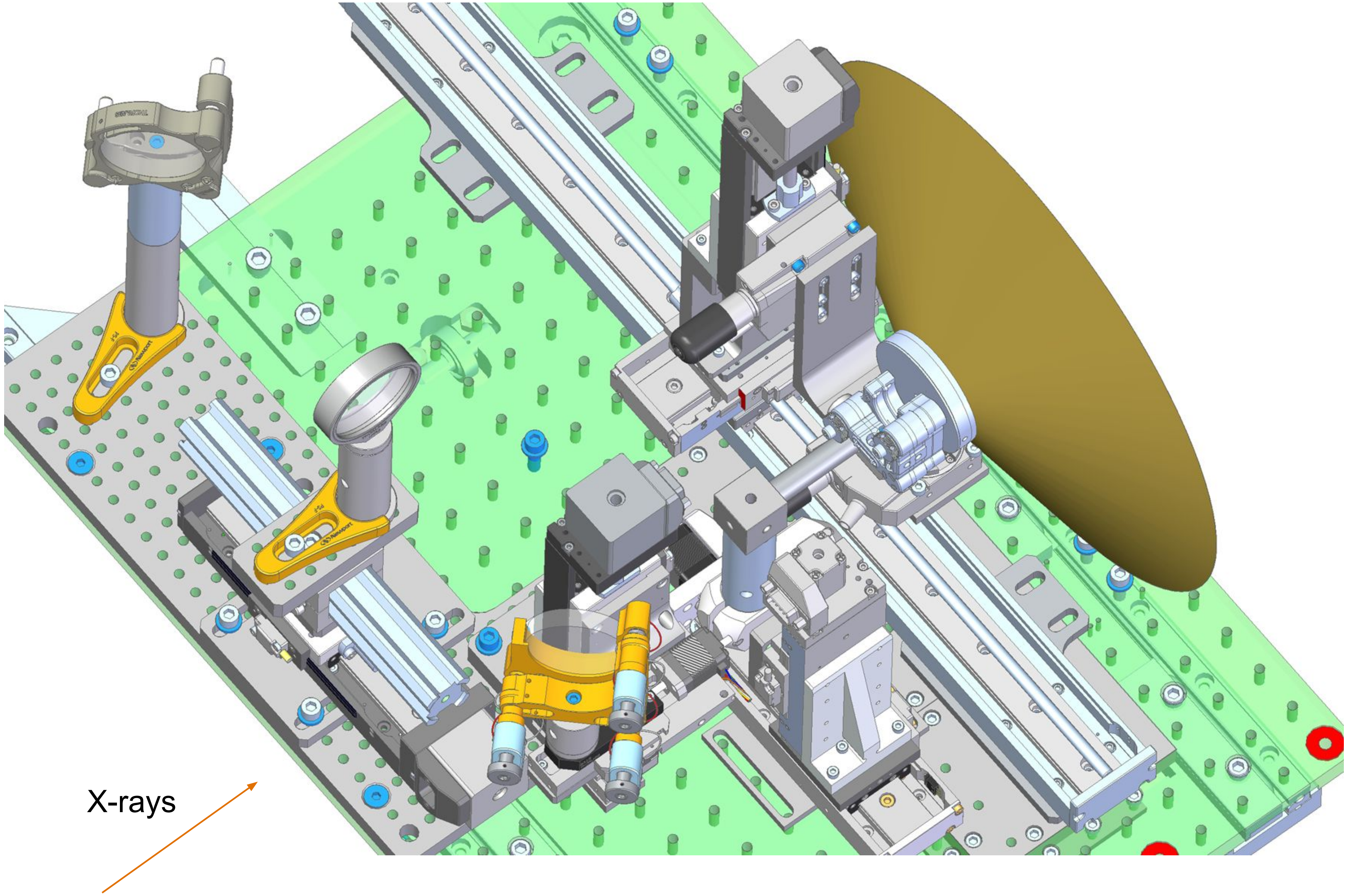
Standard configuration for gas phase chemistry:
[CXI Standard Configuration | Linac Coherent Light Source (stanford.edu)]

- Photon energy
  - 7keV-11keV (1 µm focal spot) – KB mirrors (reflective optics)
  - 11keV-25keV (2-3µm – 50µm focal spot) – CRLs

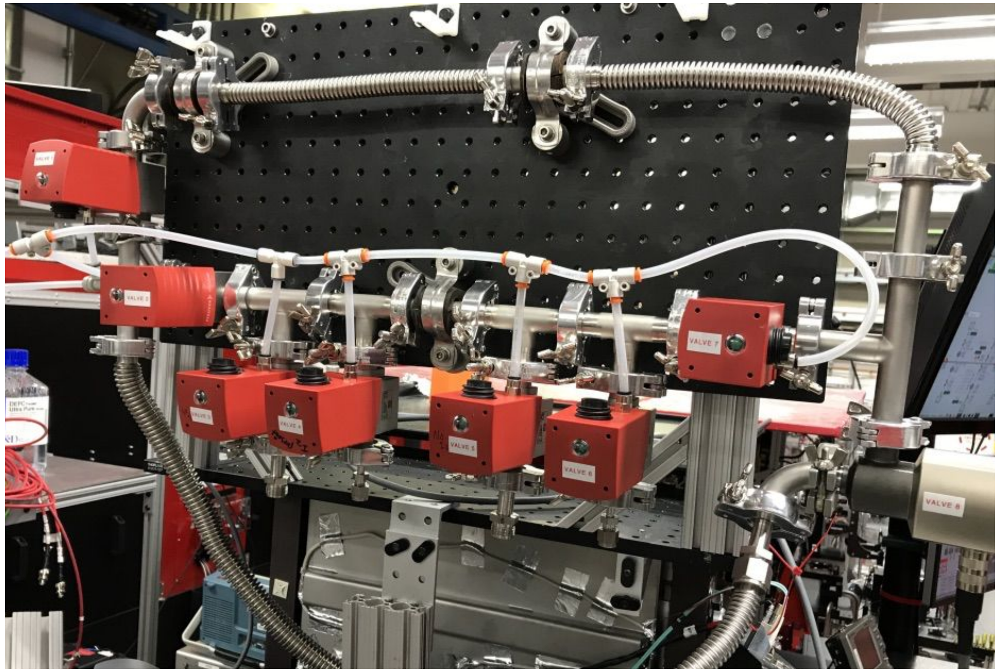


Standard Configuration

- Gas cell
- Be exit window downstream
- Pt pinhole entrance
- Additional Pt pinhole upstream
- Scattering cone
- UV pump propagates in-line with the X-rays
- Fully controllable sample delivery manifold

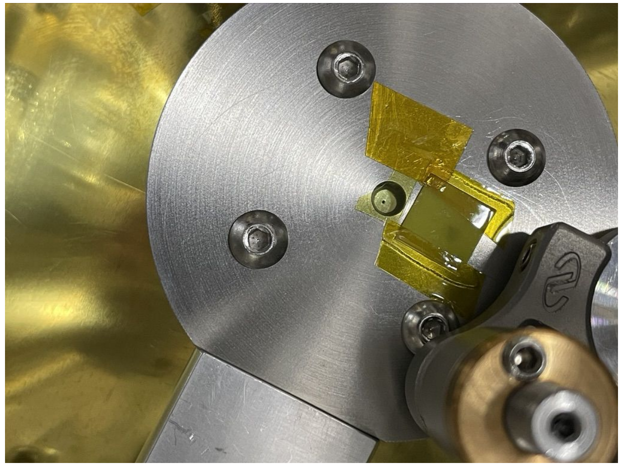


Standard Configuration



gas manifold - accommodates 4 samples

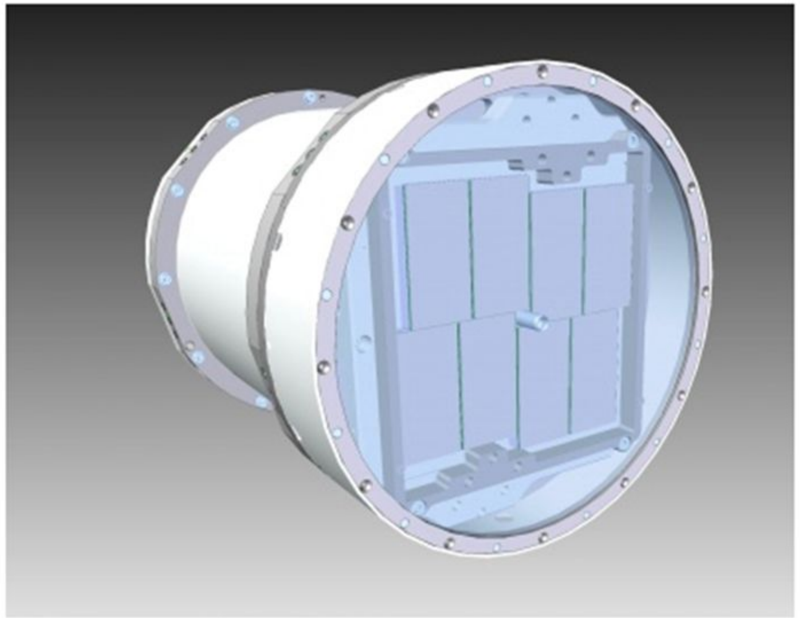
Gas cell, pinhole, scattering cone



gas cell, entrance pinhole and frosted YAG for spatial overlap

Standard Configuration

- Detector – 4M Jungfrau detector
  Jungfrau | Linac Coherent Light Source (stanford.edu)
    - Adaptive gain
    - background is <1 photon / image with proper alignment
- in-line X-ray spectrometer available as needed
- Downstream I0 monitor



New for Run 21

- Prefocusing lenses in the XRT to increase flux when using the CRLs by avoiding losses due to the clear aperture of the CXI CRLs
- Downstream monitor of the UV pump power (after sample), likely in SSC (downstream chamber)

Short Pulse UV development

Short Pulse UV capabilities are under constant development
CXI Specifications | Linac Coherent Light Source (stanford.edu)

Phase 1: Improving the time resolution of the 3rd and 4th harmonics

	Current Pulse Width (FWHM)	Expected Performance (FWHM)
267 nm (3ω)	~80 fs	~35 fs
200 nm (4ω)	~120 fs	~50 fs

Phase 2: Generating tunable deep UV pulses

	Current Capability	Target Capability
245-260 nm	Available Run 21	~35 fs
220-245 nm	Possible for Run 21*	~40 fs
280-330 nm	Possible for Run 21*	~35 fs

Please contact CXI team member about your UV laser needs!