Detector Development at LCLS 2018-2025+

Jana Thayer for the LCLS detector group

IFDEPS, March 11-14th 2018, Annecy, France

U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

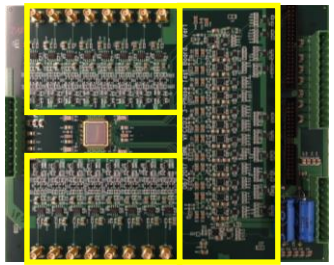
Recent work

- The LCLS detector department supports ongoing experiments and participates in development
  - Currently rely on CSPAD, ePix100, Rayonix, Jungfrau cameras (hard X-ray applications) and pnCCD (soft; also Andor and MCPs)
  - Planning tests this year on many ePix cameras, high-resolution CCD from STA, vfCCD prototype
  - Collaborating with Sandia/LLNL on UXI camera test (ns framing) to use new LCLS multi-bunch mode
  - Building test lab, SSRL endstation to support LCLS-II era camera testing at 10^n higher rates, higher energy

LCLS-II program

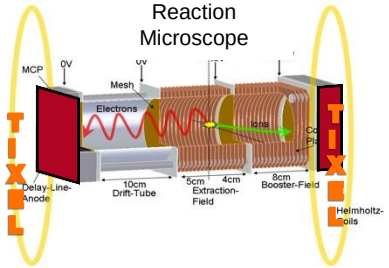
Coherent Scattering, Imaging & Diffraction at the Nanoscale

- Soft x-ray imaging – ***VeryFastCCD, FLORA, ePixM***
- Tender x-ray imaging - ***ePix-HighRate***



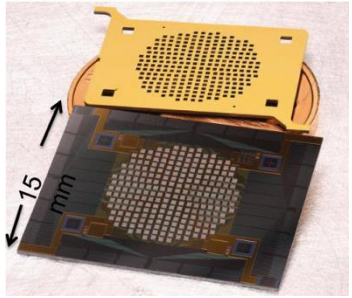
Fundamental Dynamics of Energy & Charge

- Molecular reaction microscope – ***MCP + delay-line anode***
- Strong-field AMO – ***Tixel/Particle detector***



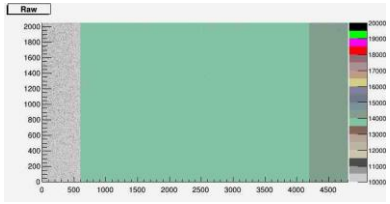
Catalysis, Photo-catalysis and Bio-spectroscopy

- Moderate resolution, high quantum (and collection) efficiency soft X-ray
- ***TES spectrometer***



High-resolution Spectroscopy: Quantum Materials & Physical Chemistry

- 2D, high quantum efficiency soft X-rays
- ***Very high spatial resolution (5 μm) area detector***



Hard X-ray Scattering & Spectroscopy

- 2D, high quantum efficiency up to 25 keV, 120 Hz - ***ePix with high-Z sensors***

Portfolio, development paths and phases

Application	Specification	Project Description	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23
Spectroscopy	Energy range: 250 - 1600 eV ≤ 0.5 eV, ≥ 10 kHz	TES Spectrometer		R&D	R&D Production	R&D Production	R&D Production	R&D Production	R&D LJE/Inst.	LJE/Depl.	
	2D High Spatial Resolution (5 µm)	RIXS CCD		First article	First article	First article					
							Production	LJE/Inst.	LJE/Depl.	RIXS/Inst. Depl.	
Scattering/Imaging tender/hard		epix 10k	Demo	Demo	Demo	First article					
	Energy range: 1500 - 7000 eV	epix HR	R&D	R&D	R&D	R&D					
	≥ 5 kHz, 100 µm, 2 x 2.4M & 0.5 M					First article	First article	First article			
	1 - 10,000 ph/pix/frame							Production	Production	Production	TXI/Inst. Depl.
		Jungfrau		Pr/Int	Pr/Int	Depl.	Depl.				
	High QE @ 25 keV	Hard X-ray detectors				R&D	R&D				
							First article	First article			
								Production	Production		
	≥ 10 kHz	Very High Frame detector						R&D	R&D	R&D	First Article
Scattering/Imaging soft	Energy range: 250 - 1500 eV									RIXS/Inst. Depl.	TXI/Inst. Depl.
	≥ 5 kHz, 50 µm, 1M	epixM		R&D	R&D						
	1 - 1,000 ph/pix/frame					First article	First article				
								Production	Production		
		Very Fast CCD		R&D	R&D	First article					
							Production	Production			
		FLORA			R&D	R&D	R&D				
							First article	First article	First article		
									Production	Production	Production
	≥ 10 kHz	Very High Frame detector						R&D	R&D	R&D	First Article
Particle detector	1 MHz, TOF < 500 ps, < 250 µm	MCP/Delay Line						TMO/Inst. Depl.			
		Tixel Detector			R&D	R&D					
		Particle Detector					R&D	R&D			
									First article	First article	
										Production	TMO/Inst. Depl.

Acknowledgments

Thanks to:

Gabriella Carini, BNL (formerly LCLS/SLAC)

A.Dragone, G.Haller, C.Kenney et al., SLAC TID-AIR (ePix family, Tixel)

P.Denes et al., LBNL (vFCCD)

Semiconductor Technology Associates (RIXS CCD)

K.Irwin et al., Stanford University/SLAC TID-AIR (TES)

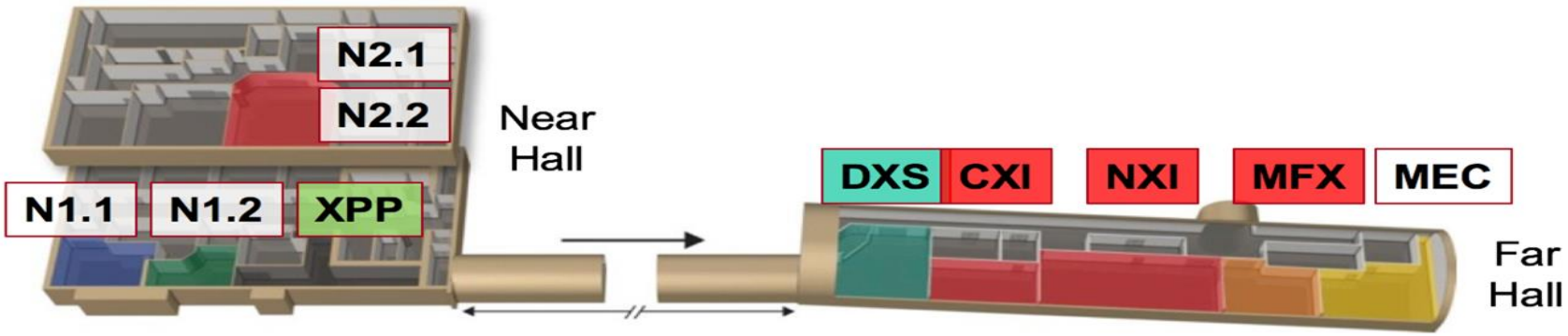
G.W. Deputch et al., Fermilab (FLORA)

M.Sanchez, A.Carpenter, et al. Sandia/LLNL (UXI)

B.Schmitt et al., PSI (Jungfrau)

P. Hart, K. Nakahara (LCLS/SLAC)

Instrument/Detector Phasing



Instrument	Photon Energy	Detector Needs	First Light
NEH 1.1	250-2500 eV	2D ToF Charged Particle (1 MHz) 2D ToF Multi-Particle	11/2020
NEH 2 (LJE)	250-1600 eV	2D High Spatial Resolution (5 µm) TES - 1000 pixel (≤1 eV, ≥10 kHz)	11/2020
NEH 2 (RIXS)	250-1600 eV	2D High Spatial Resolution (5 µm) 2D Imaging (≥ 2 kHz)	1/2022
NEH 1.2	400-6000 eV		1/2023