LCLS | Linac Coherent Light Source

MEC Science in Run 21

LCLS Virtual Town Hall

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U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

MEC Department at LCLS

SRD @ MEC

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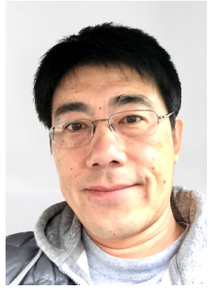


Research Areas

Ultra-intense Laser Matter Interactions

Dynamic Materials

Warm Dense Matter

Hot Dense Plasmas

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

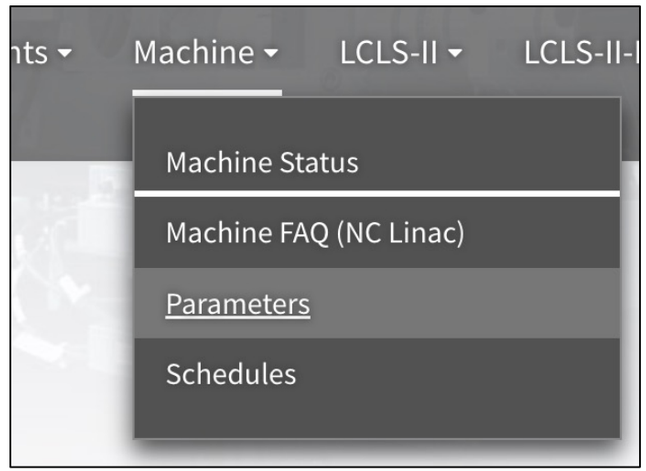
MEC Hutch for Run 21

- Standard configurations for coaxial shock + WAXS and side-drive shock + PCI
- New beam delivery platform for short pulse
- Opportunities for direct imaging experiments and multi-pulse
- New spectrometers commissioned

Hard X-Ray Parameters for Run 21

X-ray Parameters		
Repetition rate (Hz)	Up to 120 Hz	
Pulse Duration	40 fs (nominal)	
Modes	SASE	Self-seeded
Energy Range (eV)	4000 – 25,000	4500 – 11,000
Energy per pulse*	0.6 – 2 mJ	0.5 – 0.2 mJ
Bandwidth (FWHM)	~ 30 eV @ 25 keV; ~ 8 eV @ 4 keV	1.5 eV @ 11 keV; .35 eV @ 4.5 keV
Spot Size (FWHM);	~ 2.0 - 50 (μm) dia; to <200 nm with MXI + mono	
Polarization	Linear, Vertical	
Multi-bucket mode (requires substantial setup and tuning)	Two pulses: 350 ps increments of relative delay up to 120 ns. Energy separation up to ~1%; 0.5 to 1 mJ per pulse 4 or 8 bunches (*under development, offered at risk*) Two trains of 4 pulses; 700 ps between each pulse in the same train	

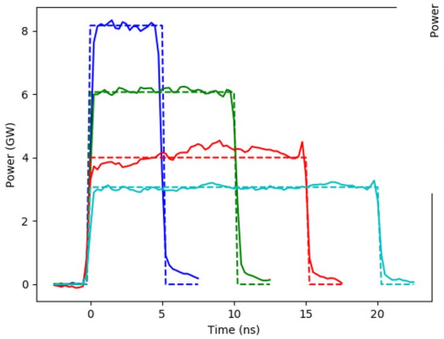
- New MEC X-ray Imager (MXI) used for tighter focusing (CRL lens stack)
- Collaborative use of Ultrafast X-ray Imagers for using multi-bucket mode in imaging configurations

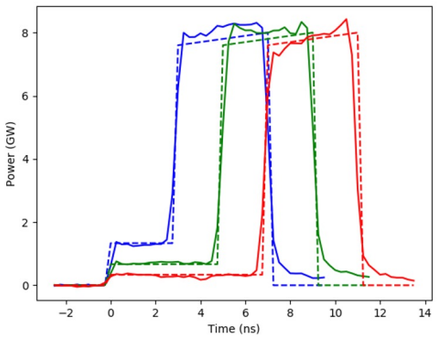


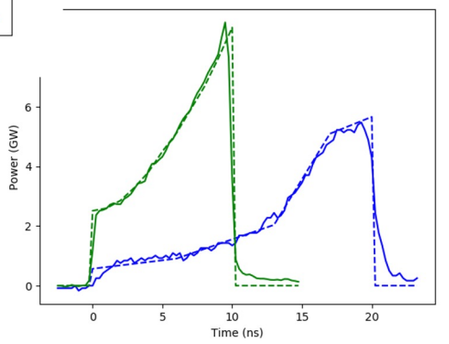
** Pulse energies presented do not include transmission losses to hutch*

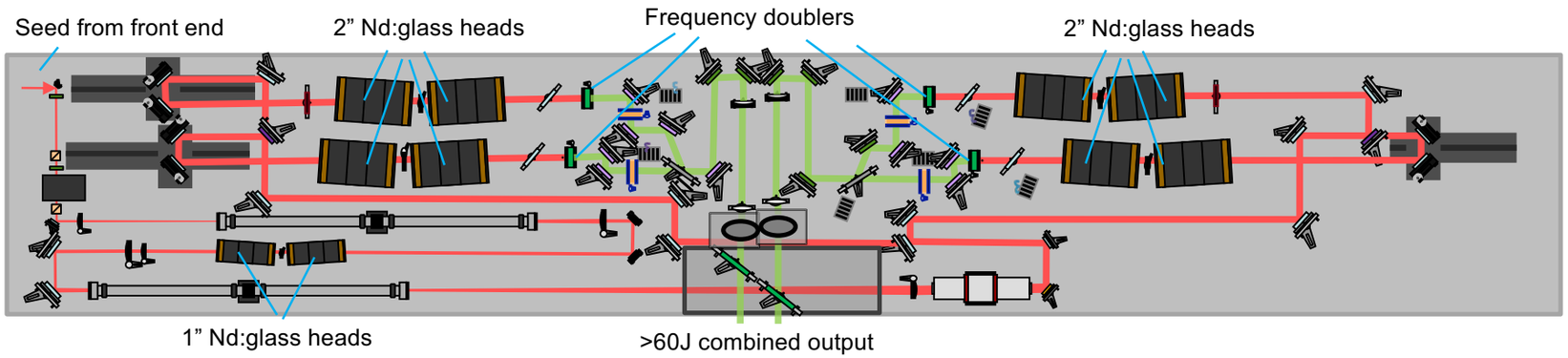
MEC Long Pulse Laser System

- **Seed: custom diode-pumped Nd:YLF**
- >100 mJ, 5-35 ns (arbitrary), 10 Hz
- **Power amp: 4 x 50mm Nd:Glass**
  - Total >60J for ≥10 ns; 6J/ns for < 10 ns
    - Energies are for flat-top beams
    - Divided in 4 arms polarization multiplexed to two beams
  - typical shapes: flat-top, ramp, step, etc.
  - CPPs: 150 µm, 300 µm, 600 µm diameter (intensity >10^{13} W/cm^2 with 150 µm CPPs)



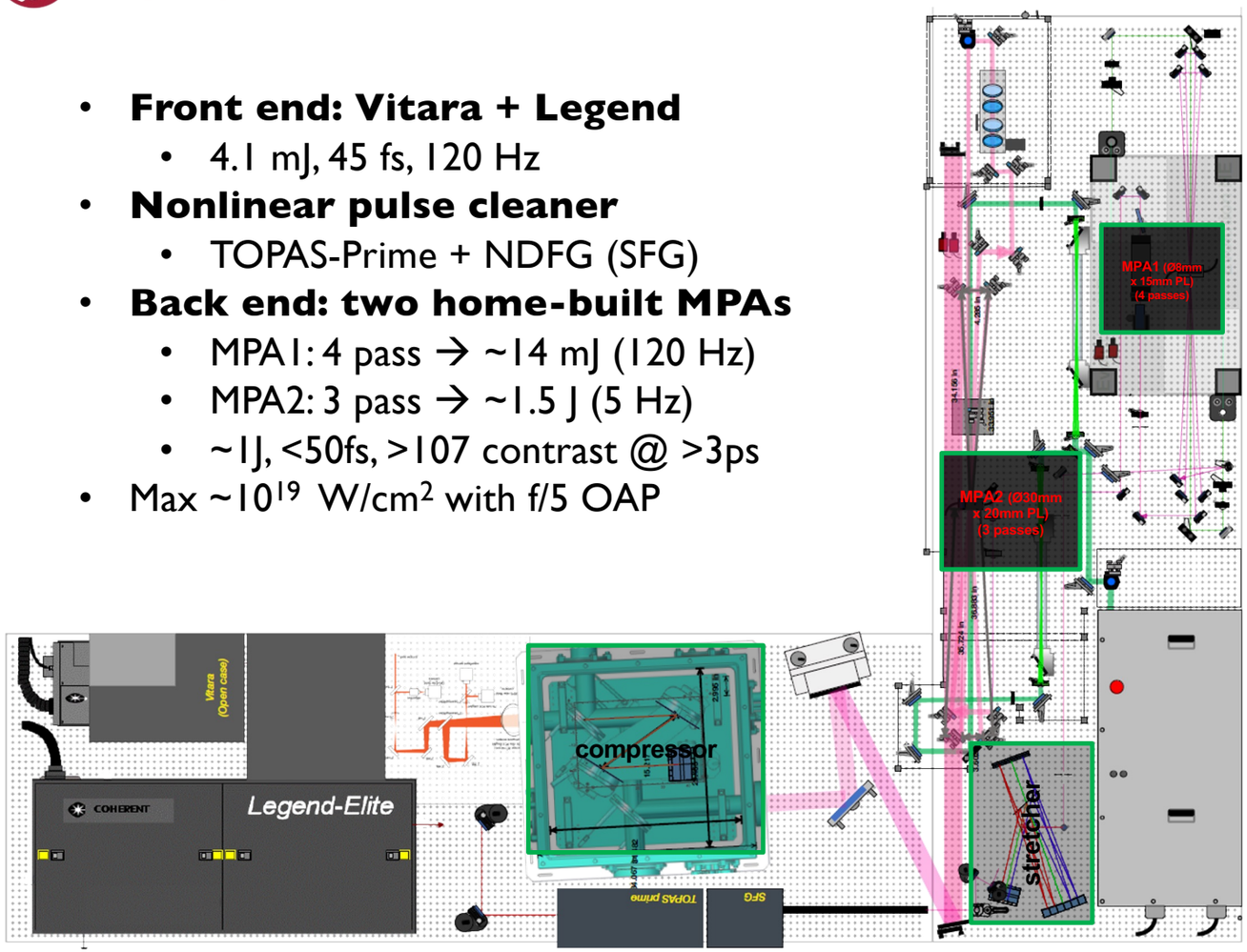






MEC Short Pulse Laser System

- **Front end: Vitara + Legend**
  - 4.1 mJ, 45 fs, 120 Hz
- **Nonlinear pulse cleaner**
  - TOPAS-Prime + NDFG (SFG)
- **Back end: two home-built MPAs**
  - MPA1: 4 pass → ~14 mJ (120 Hz)
  - MPA2: 3 pass → ~1.5 J (5 Hz)
  - ~1J, <50fs, >107 contrast @ >3ps
- Max ~10^{19} W/cm^2 with f/5 OAP



Alternate schemes delivered previously:

- MPA1 only (compressed)
- *MPA2 (uncompressed)*
- Secondary optical sources:
  - *SHG (~mJ @ 120Hz or ~100s mJ @ 5 Hz)*
  - OPA (<mJ, 50fs, 120Hz)
    - S: 1140-1600nm
    - I: 1600-2600nm
  - other wavelengths too* (THz, HHG, betatron)
- ns-OPO also newly acquired
  - S: 650-1064nm
  - I: 1064-2600nm

Recent changes and helpful reminders

Recent changes:

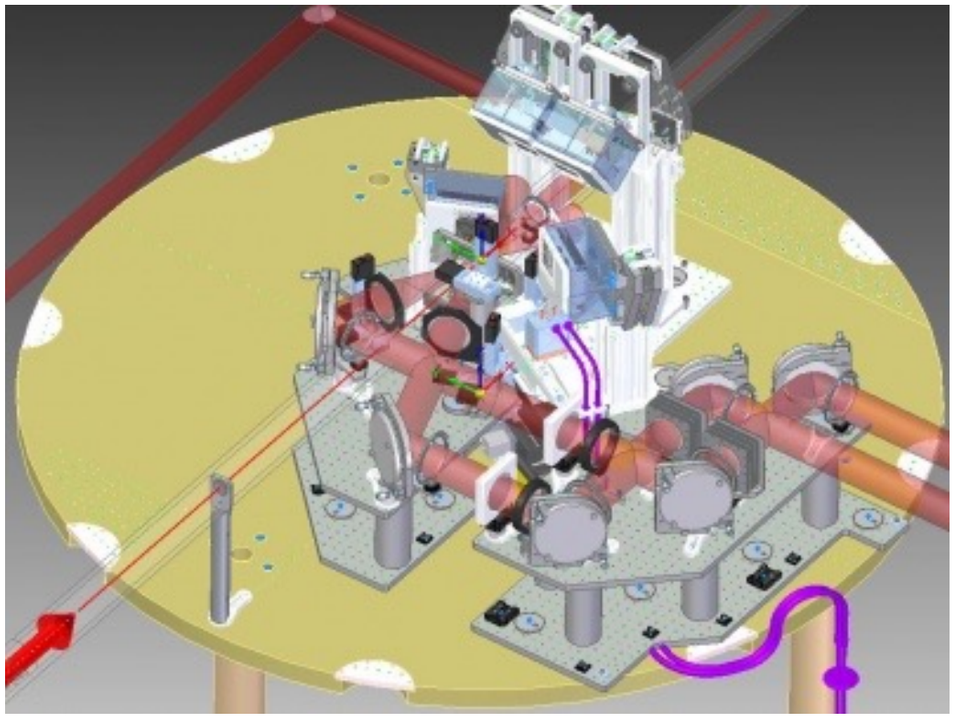
- MEC now considered as two laser safety facilities: MEC **Target** and **Laser** Areas
  - Target Area typically for **users**, Laser Area typically for **staff**
- Recent operational improvements
  - **LPL:** new waveform refresh and optimization functions in Python
  - **SPL:** new cameras, motors, energy meters for remote monitoring + control

Helpful reminders:

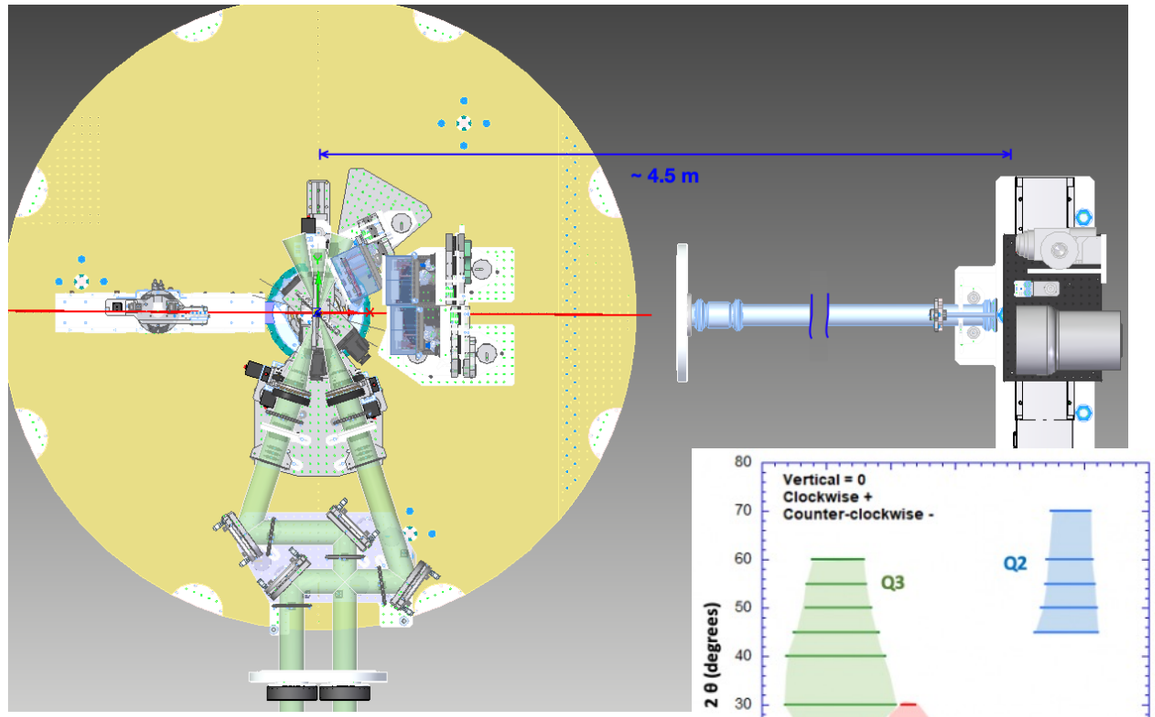
- Engage early with Laser POC on proposals, design reviews, etc. for best results
- Consider not just on-shot needs but also before/after shot (shutters? probe?)
- **LPL:** specify (a few) shapes ahead of time; easier to make if similar to existing
- **LPL:** shoot all arms for better results; can shape directly for lower energy
- **SPL:** plan extra time for everything (more to consider when non-standard!)
- **SPL:** include testing, characterization, etc. as part of preparation and schedule!

MEC Standard Configurations

Coaxial shock with XRD

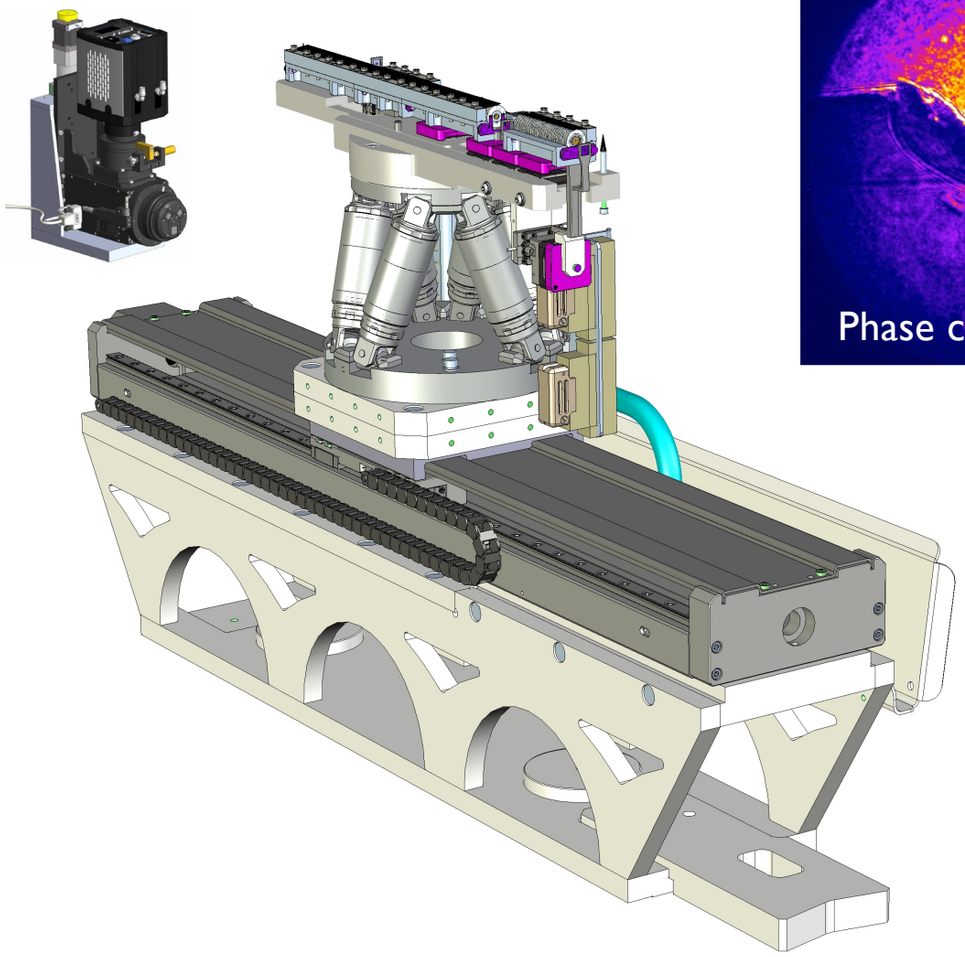


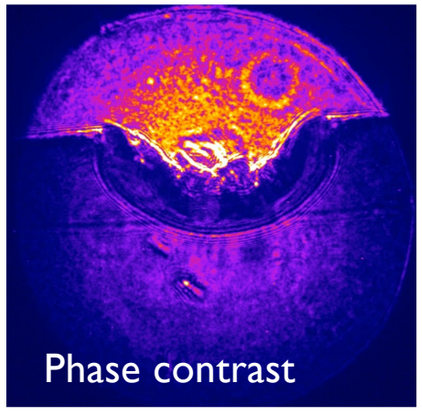
Coaxial shock with XRD
VISAR for 0° target
Sacrifice Q2 for Forward XRTS

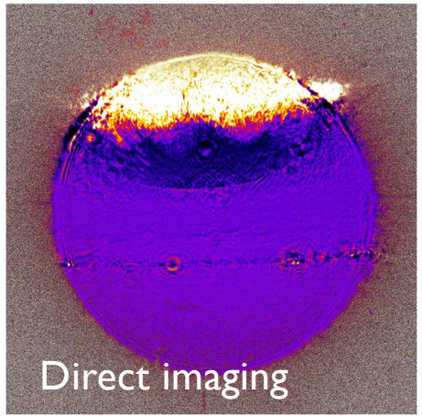


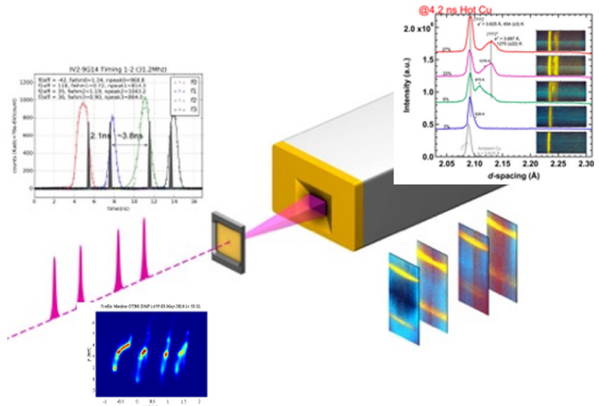
Orthogonal shock with XRD and PCI
VISAR for 90° target
Removes Q2

MEC X-ray Imager









Ultrafast X-ray imager*

Concept:

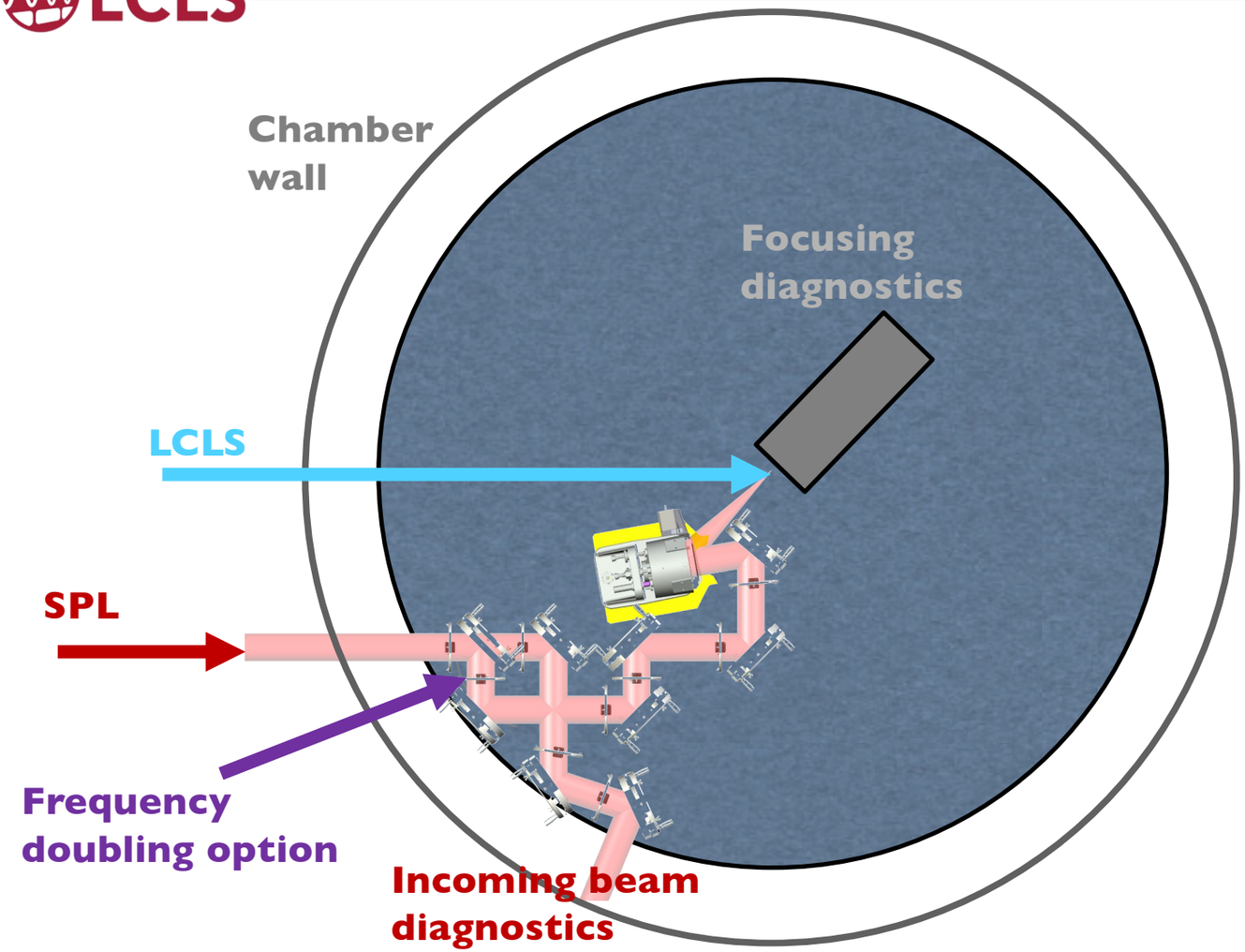
- Uses Be CRLs to produce phase contrast or amplitude sensitive indirect X-ray images from the FEL passing through a sample
- PCI (upstream TCC) or direct imaging (downstream TCC) mode

Capabilities:

- 200 nm resolution over a 100-μm field of view at about 8 keV
- imaging with a 92-lens stack demonstrated at 18 keV
- can carry 3 CRL stacks to adjust spatial resolution and field of view

* Contact Philip Hart (detectors) for inquiries about the UXI's potential availability in a collaborative experiment: philiph@slac.Stanford.edu

New Standard Short Pulse Beam Delivery



- Substantially reduces setup time, helping with experiment feasibility
- Supports delivery of full power, uncompressed, or frequency-doubled modes
- Leaves 3 quadrants of the chamber clear for diagnostics
- Contact Eric Galtier for more details
  - egaltier@slac.Stanford.edu