MEC Science in Run 21
LCLS Virtual Town Hall

Gilliss Dyer
MEC Department Head
March 3rd, 2022

U.S. DEPARTMENT OF ENERGY
Office of Science
SLAC NATIONAL ACCELERATOR LABORATORY

MEC Department at LCLS

SRD @ MEC

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* *Lasers*

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

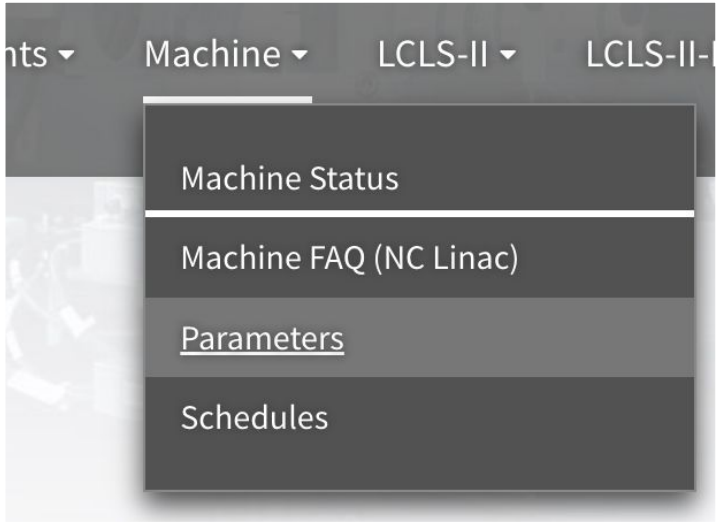
New spectrometers commissioned

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 (u*nder 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)

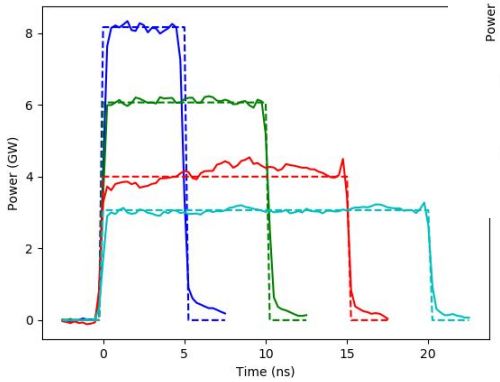
Collaborative use of Ultrafast X-ray Imagers for using multi-bucket mode in imaging configurations

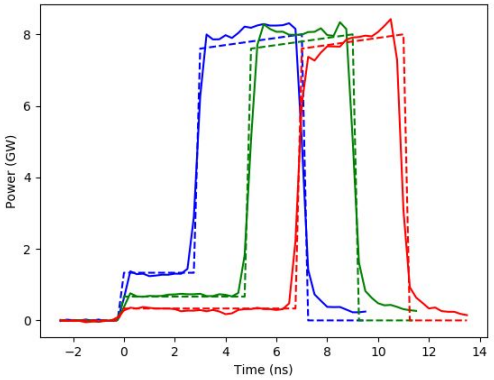


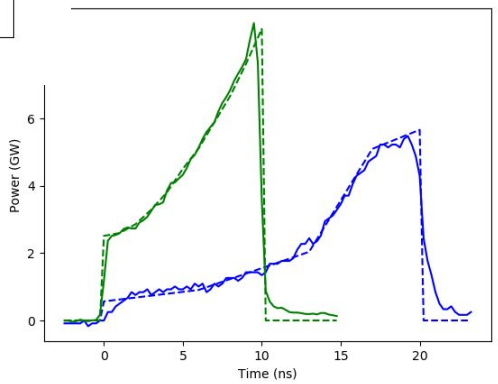
** Pulse energies presented do not include transmission losses to hutch*

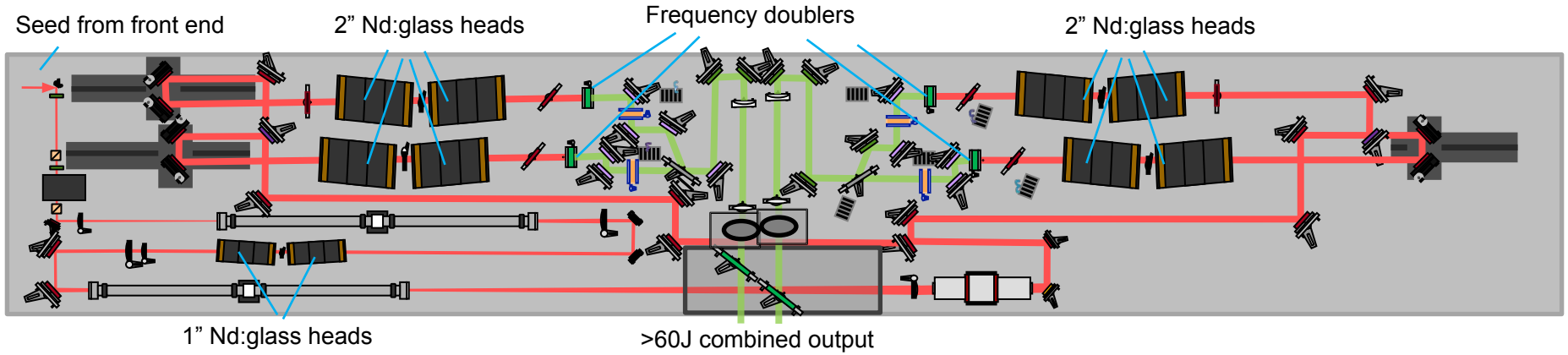
MEC Long Pulse Laser System

- **Seed: custom diode-pumped Nd:YLF**
- >100mJ, 5-35ns (arbitrary), 10Hz
- **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: 150um, 300um, 600um diameter
    (intensity >1013 W/cm2 with 150um CPPs)



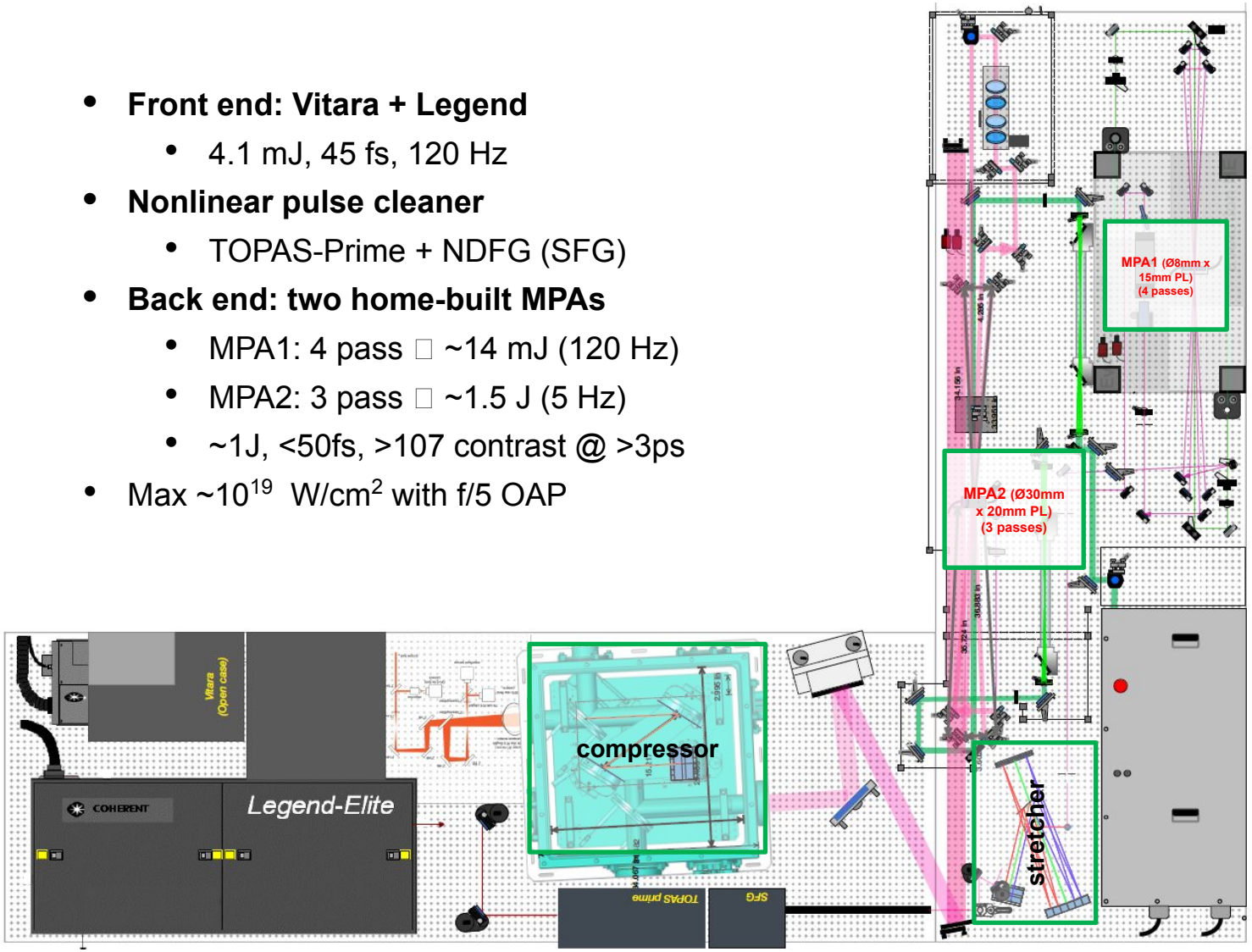






MEC Short Pulse Laser System

- **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

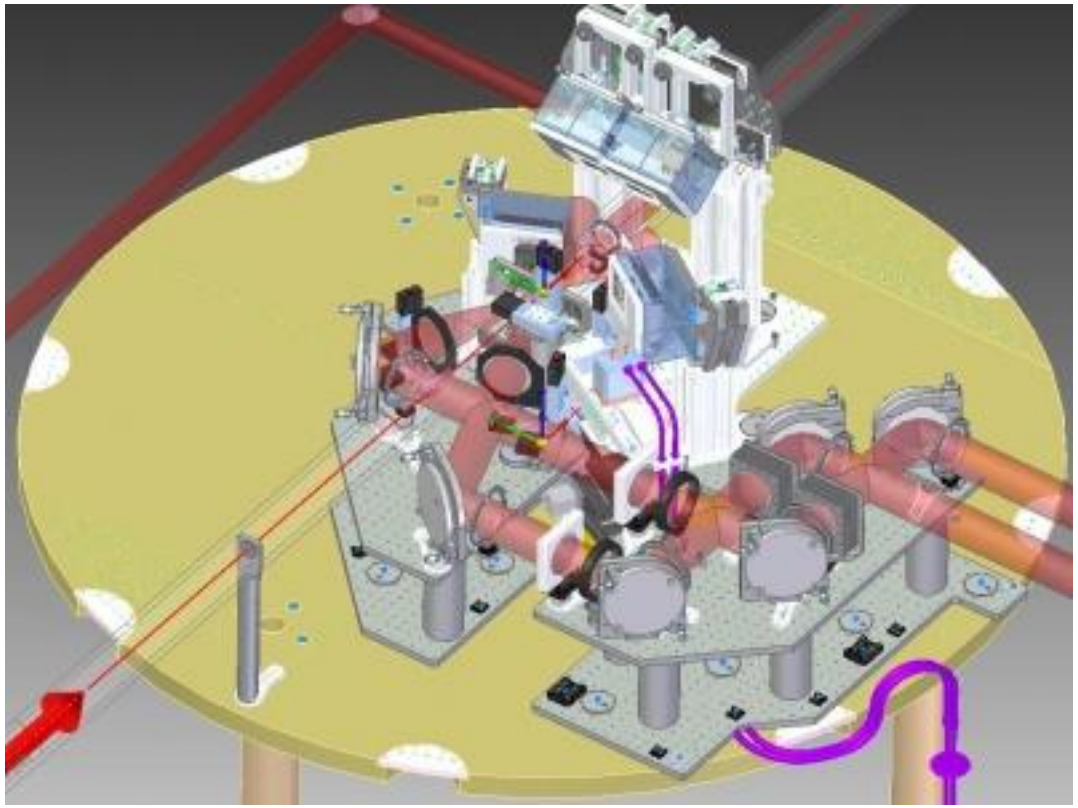


Alternate schemes delivered previously:

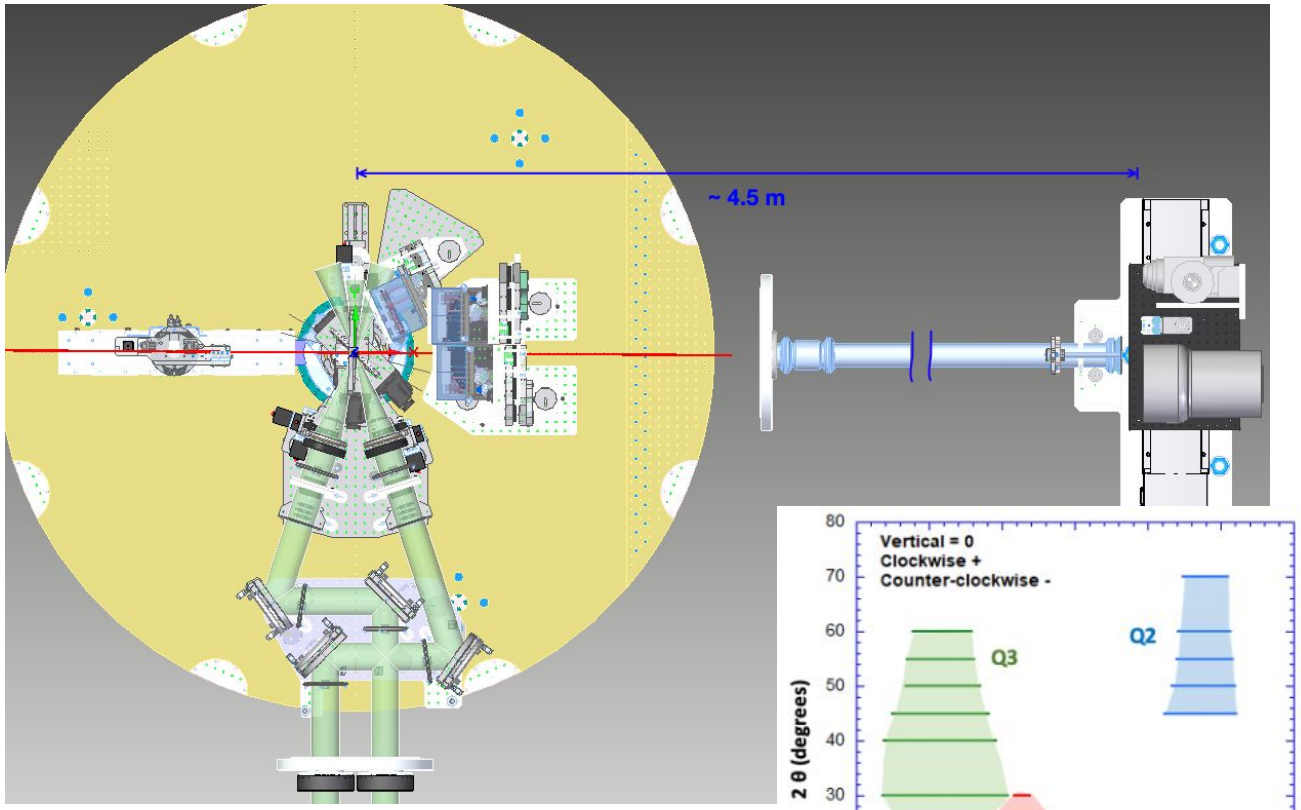
- MPA1 only (compressed)
- *MPA2 (uncompressed)*
- Secondary optical sources:
  - *SHG (~mJ @ 120Hz or ~100s mJ @ 5 Hz)*
  - OPA (<mJ, 50fs, 120Hz)
    - S: 1140-1600nm
    - I: 1600-2600nm
  - other wavelengths too* (THz, HHG, betatron)
- ns-OPO also newly acquired
  - S: 650-1064nm
  - I: 1064-2600nm

MEC Standard Configurations

Coaxial shock with XRD

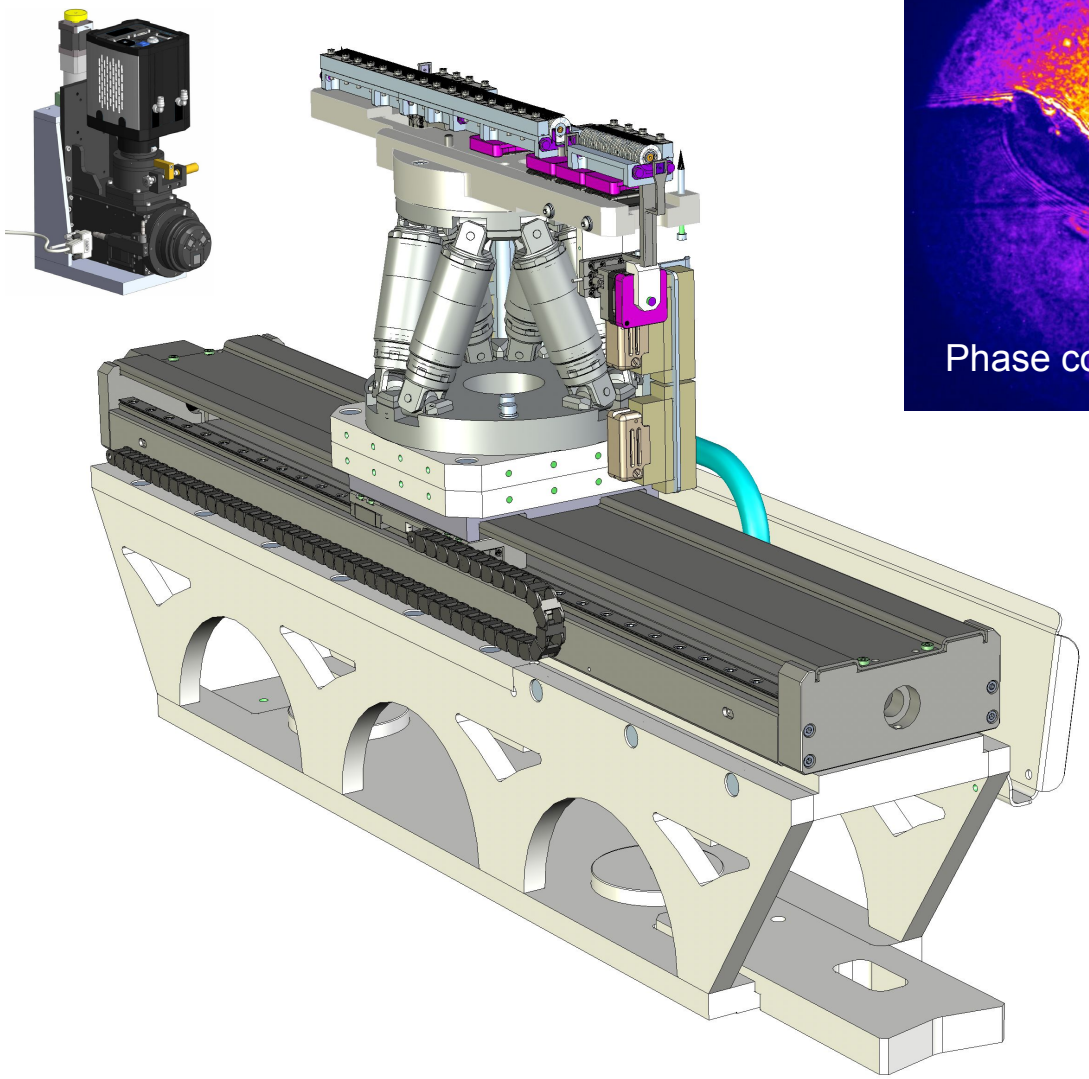


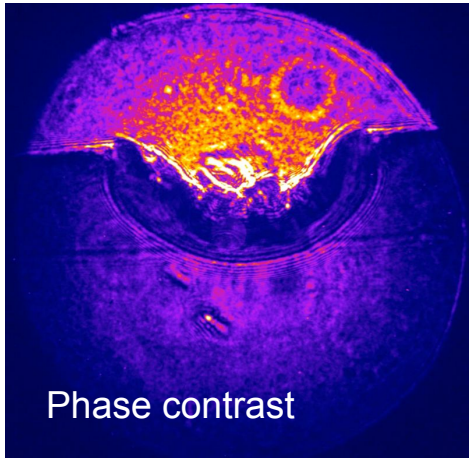
Coaxial shock with XRD
VISAR for 0° target
Sacrifice Q2 for Forward XRTS

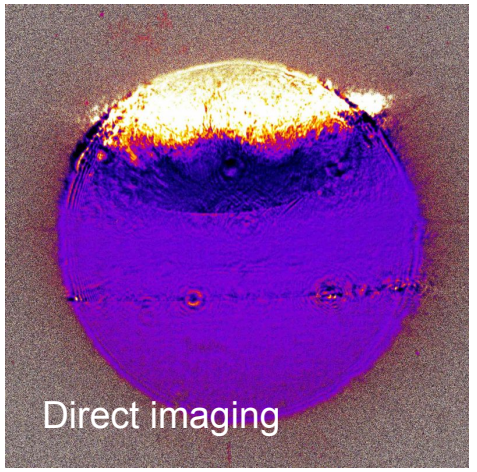


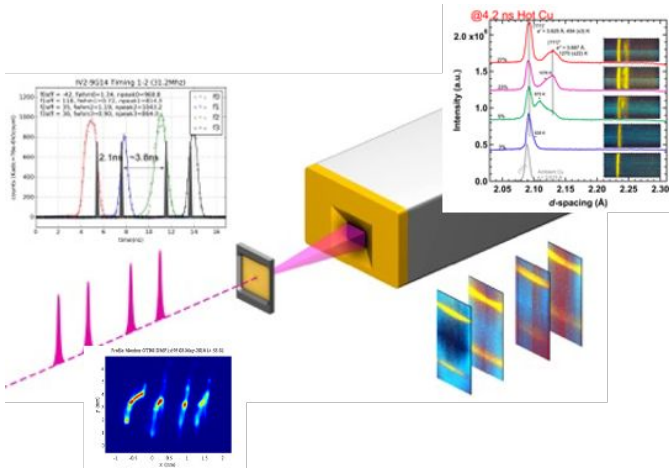
Orthogonal shock with XRD and PCI
VISAR for 90° target
Removes Q2

MEC X-ray Imager









Concept:

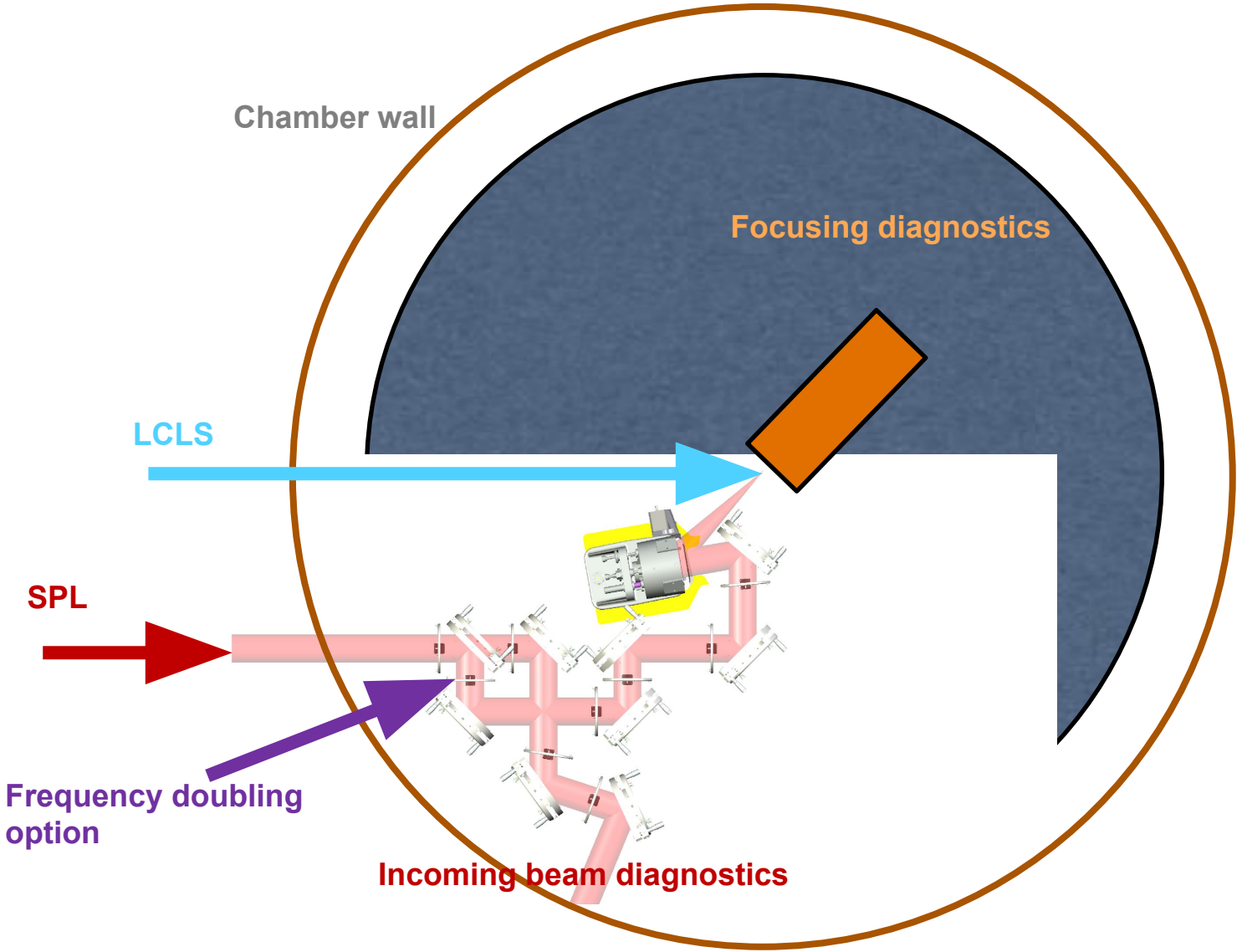
- Uses Be CRLs to produce phase contrast or amplitude sensitive indirect X-ray images from the FEL passing through a sample
- PCI (upstream TCC) or direct imaging (downstream TCC) mode

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