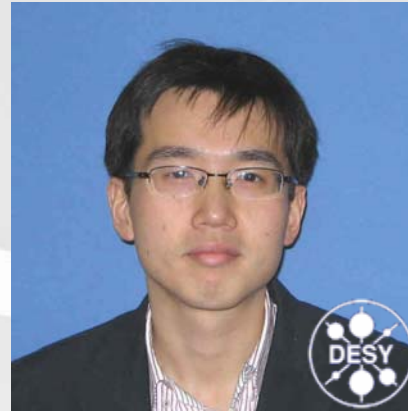


The X-ray Correlation Spectroscopy Instrument at LCLS

Aymeric Robert

XCS Group User Support and Science team

S. Lee



C. Caronna



LUSI Engineering Team



Lead by E. Bong

and MANY others ...

T. Osier



V. Srinivasan



H. Navtej



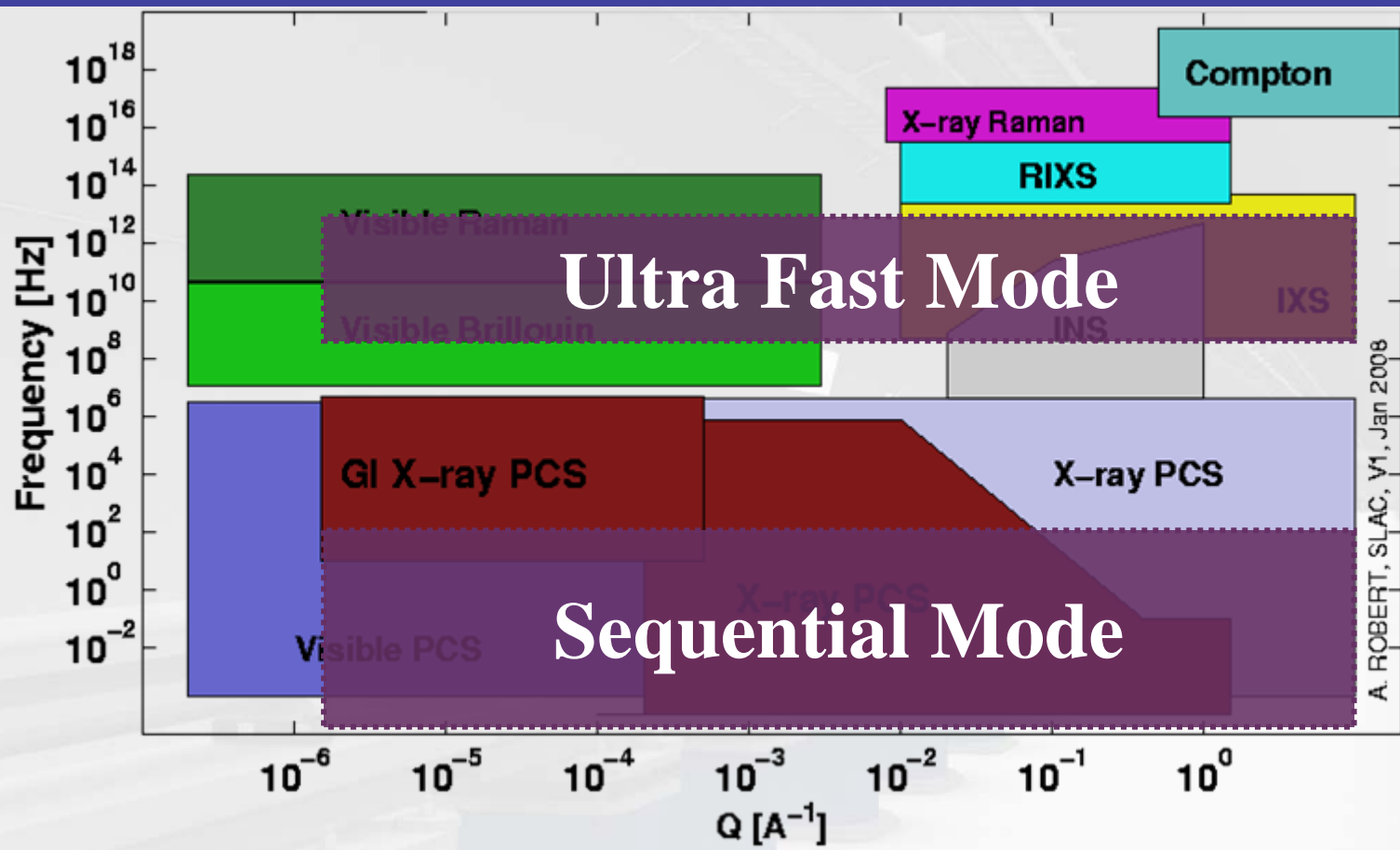
M. Kosovsky



H. Alvarez



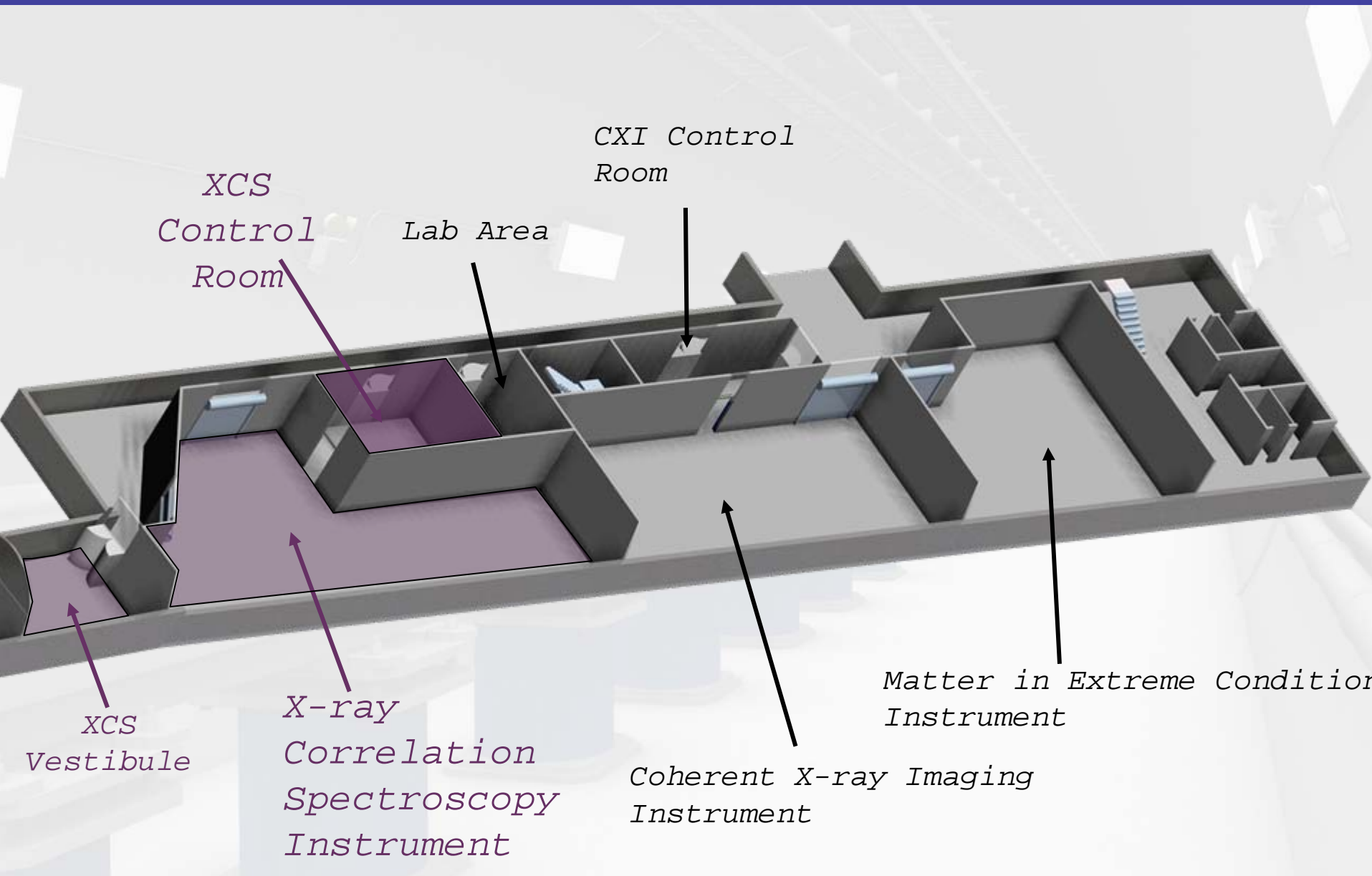
Parameter	Hard X-ray	Unit
Fundamental Wavelength	≥ 1.4	Å
Photon Energy	≤ 9000	eV
Photons per Pulse	2-0.1	10^{12}
Repetition Rate	Up tp 120	Hz
Pulse Bandwidth	0.2	%
Pulse Duration (fwhm)	80-2	fs

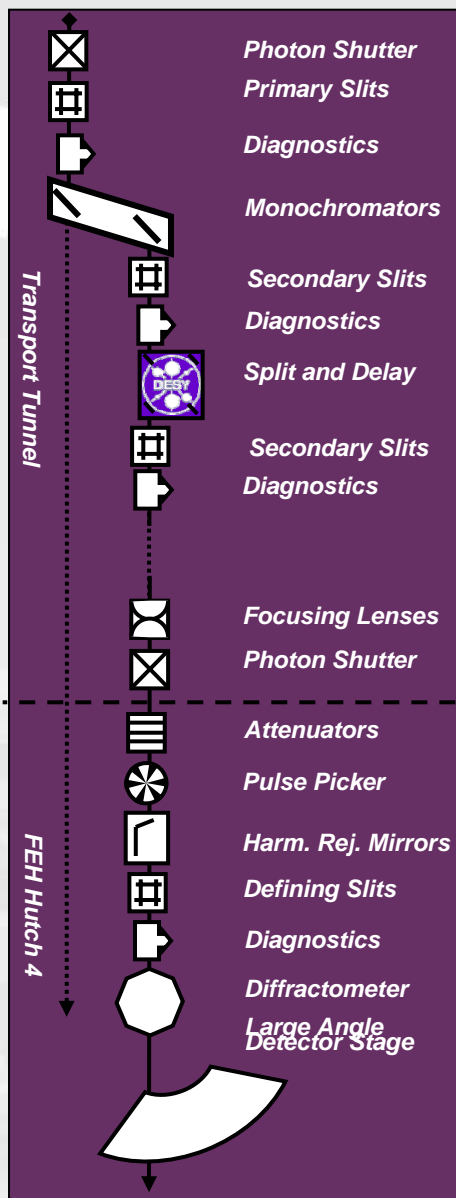


LCLS Beam Parameters

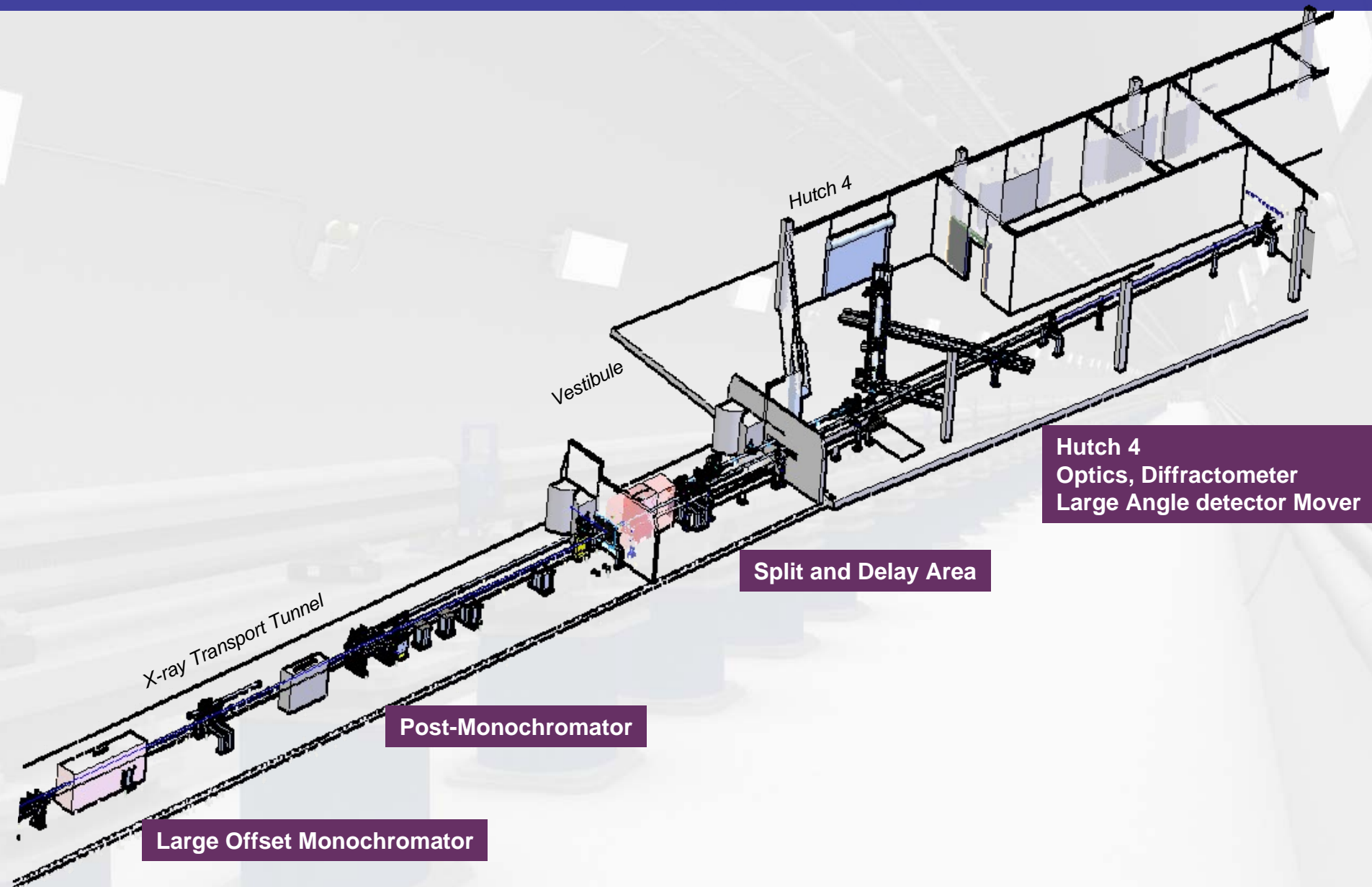
- Full Transverse Coherence, 4-24keV
- High Time-average Brilliance, rep. Rate 120 Hz
- High Peak Brilliance, short pulse duration <200fs







Requirement	Device
Tailor X-ray spatial profile	X-ray Slits
Select X-ray energy and tailor spectrum width Control longitudinal coherence length	Monochromators
Split X-ray pulse and control the delay	Split and Delay (MoU DESY)
Tailor X-ray spatial profile (< 50 microns)	X-ray Focusing Lenses
Tailor X-ray intensity and spectrum	Attenuators
Tailor X-ray repetition rate	Pulse Picker
Tailor X-ray spectrum	Harmonic Rejection Mirrors
Characterize X-ray pulse intensity	Intensity Monitor
Characterize X-ray spatial profile	Profile Monitor
Characterize incident X-ray intensity before optical component of before sample	Non-destructive Intensity Monitor
Sample orientation and alignment	Diffractometer
Position X-ray area detector and minimize air absorption and air scattering	Large Angle Detector Stage
Measure X-ray speckle patterns	2D Detector (BNL)



X-ray Transport Tunnel

Large Offset Monochromator

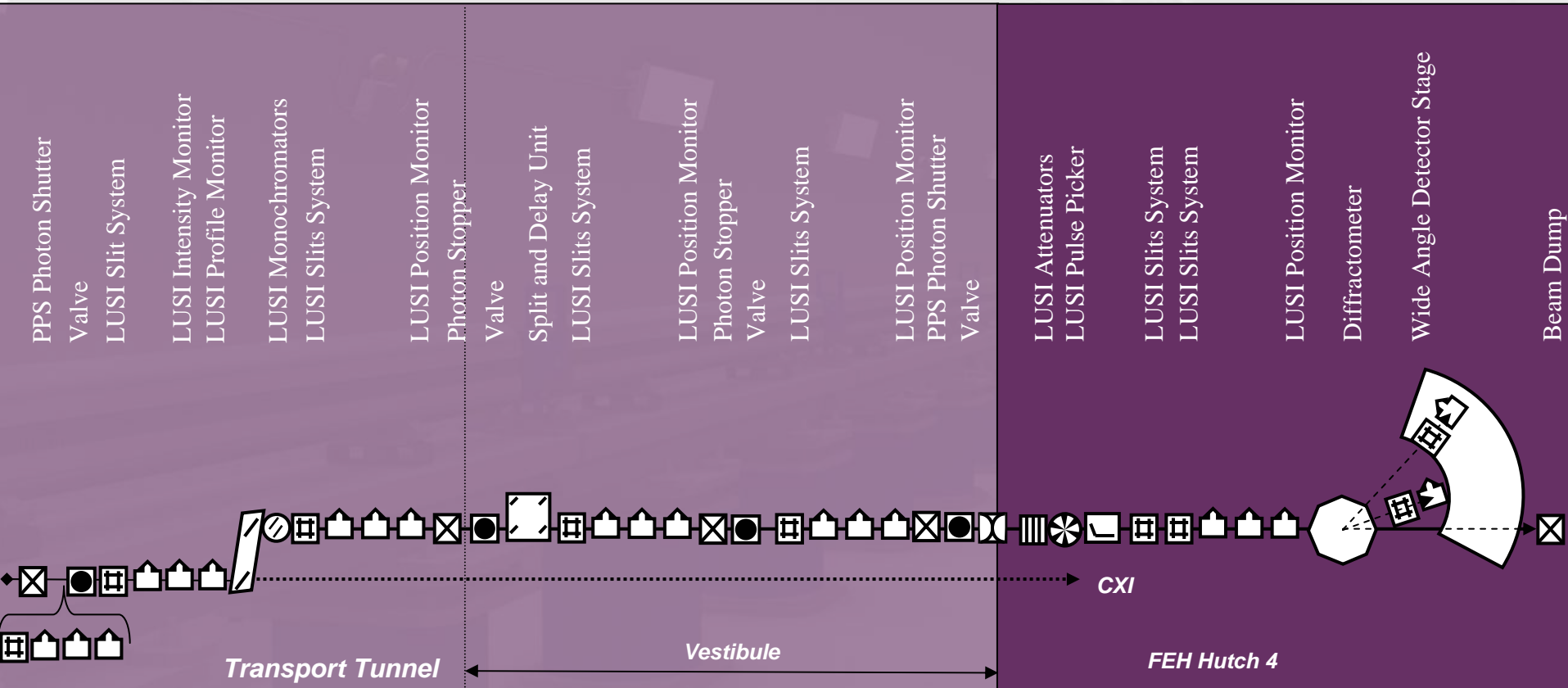
Post-Monochromator

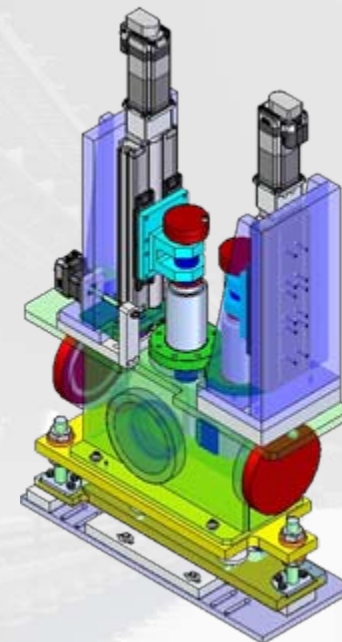
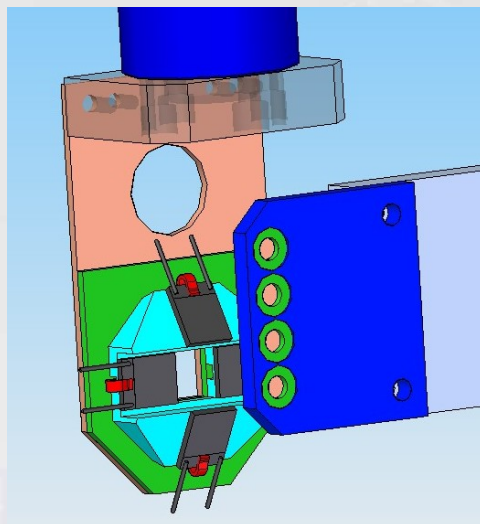
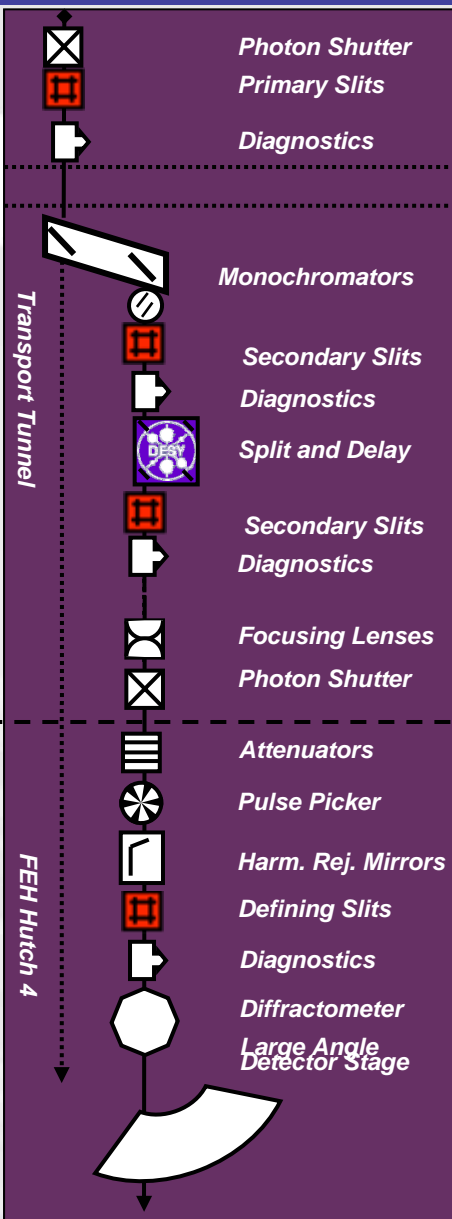
Split and Delay Area

Vestibule

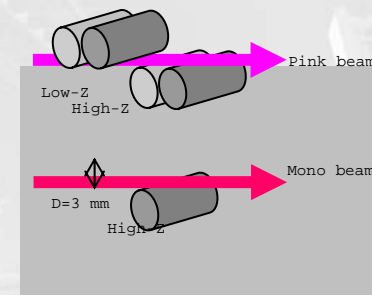
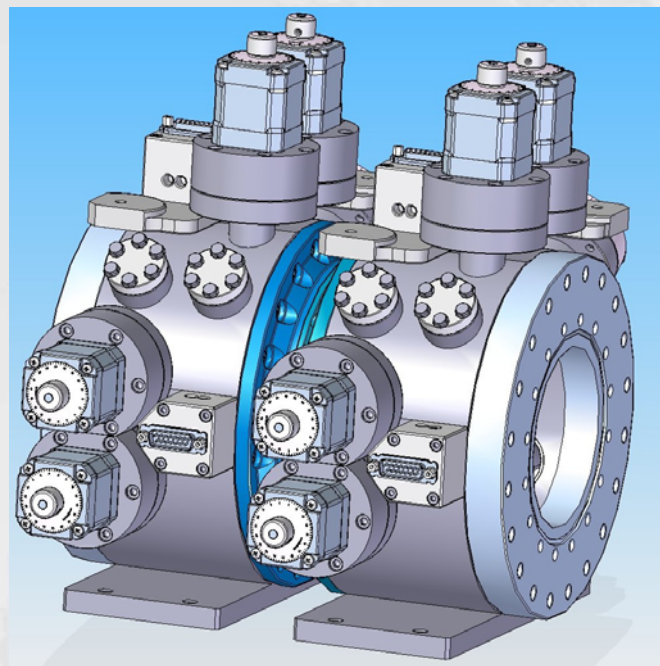
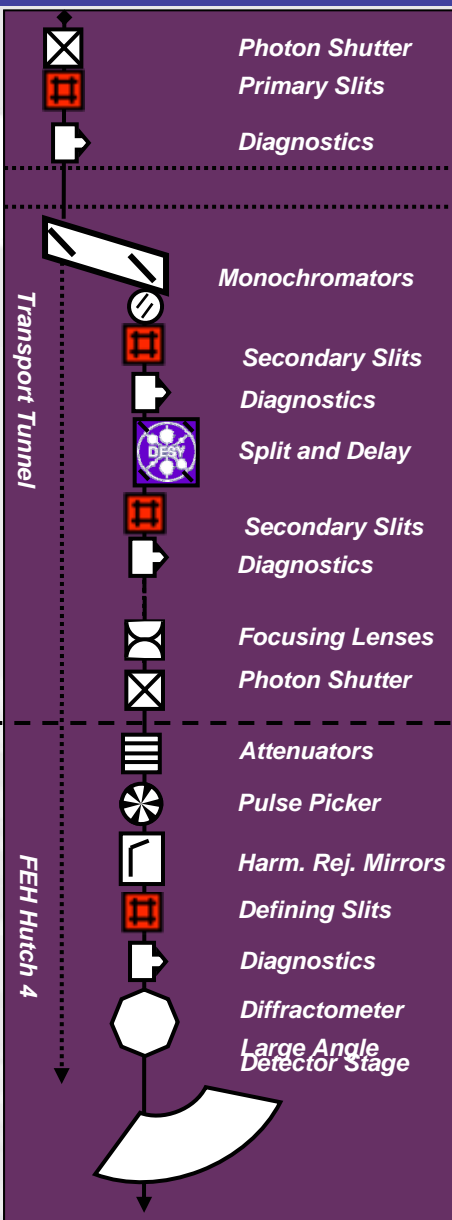
Hutch 4

Hutch 4
Optics, Diffractometer
Large Angle detector Mover

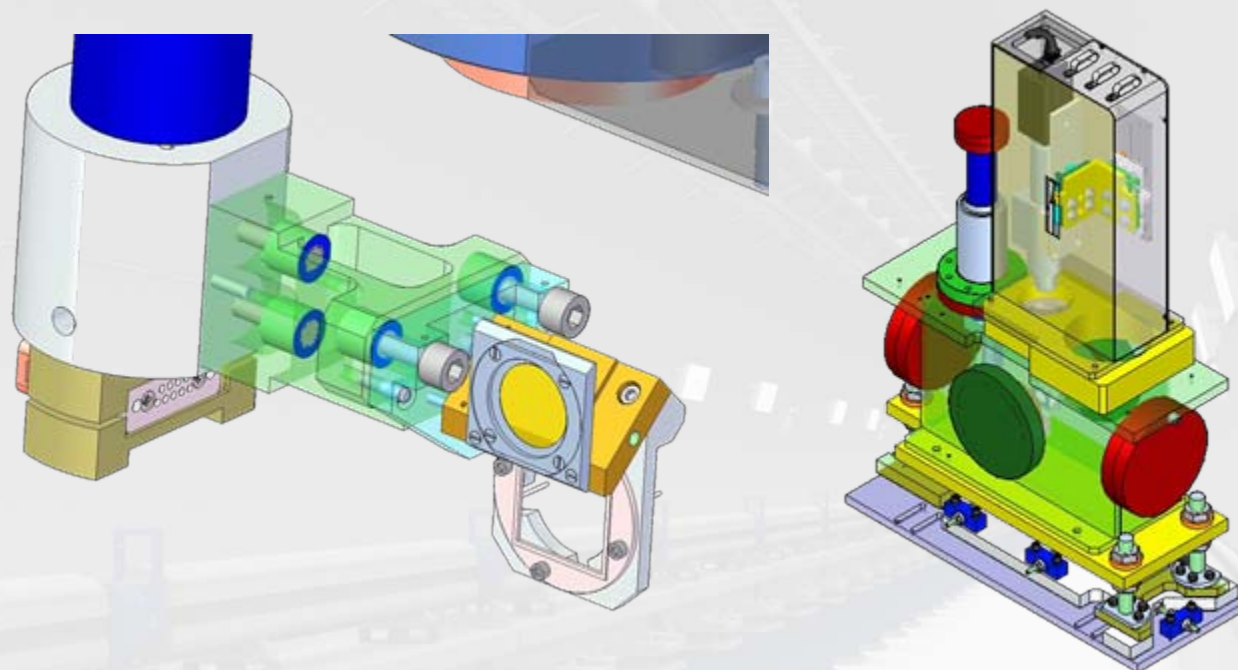
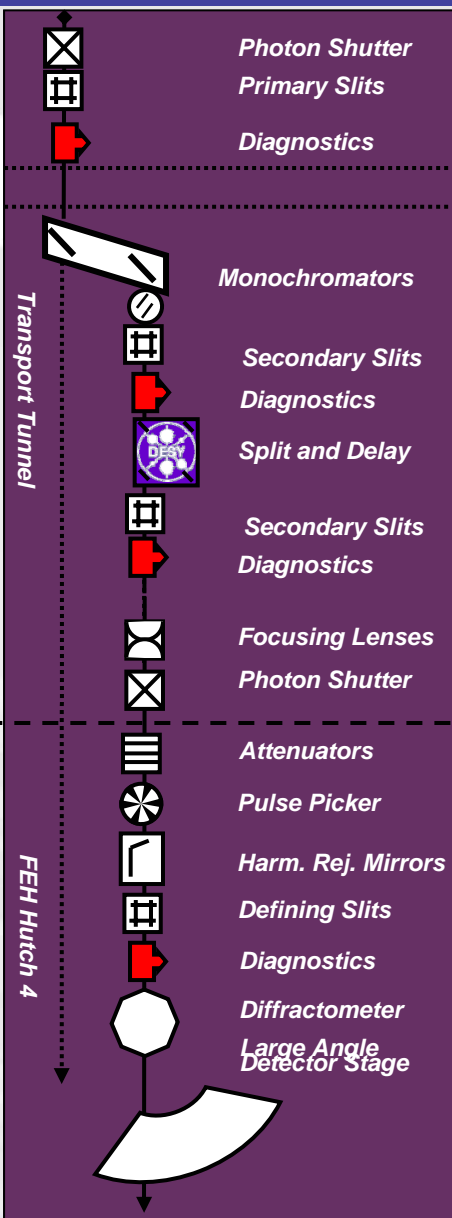




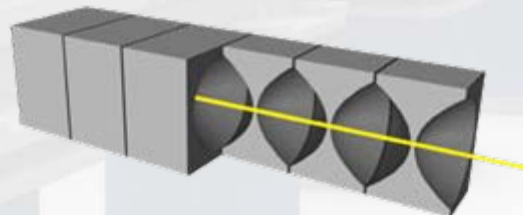
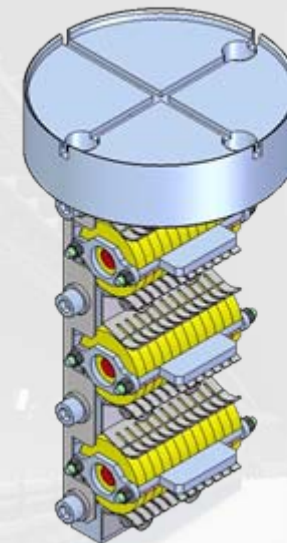
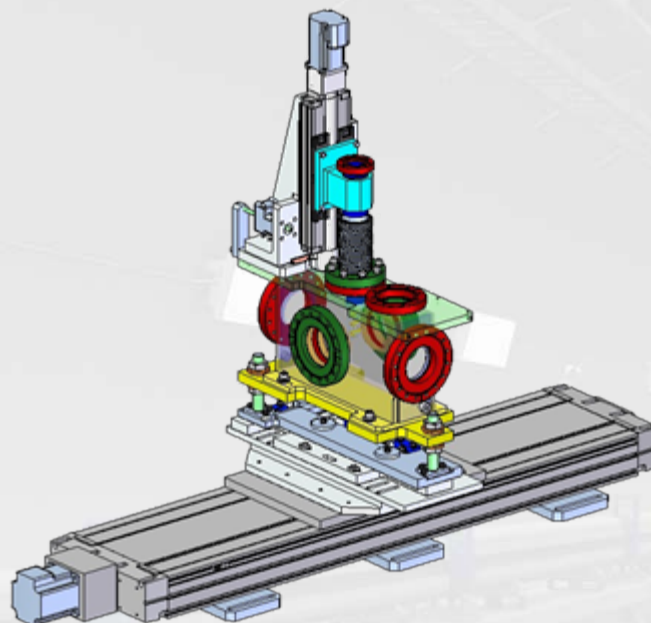
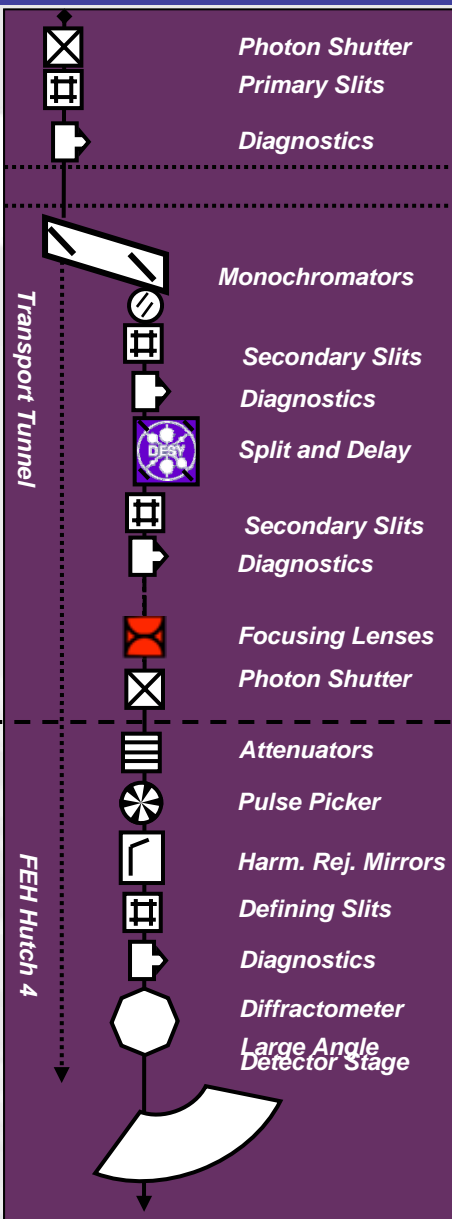
- Purpose:
 - Per-pulse normalization of experimental signals
 - High-resolution beam position monitoring
- Specifications:
 - Highly transmissive (< 5% loss)
 - Relative accuracy < 0.1%
 - Dynamic range 1000
 - Per-pulse op. at 120 Hz



- Purpose:
 - Defines the beam size & position
 - Clean up scatterings (halo) around beam perimeter
- Specifications:
 - Can withstand full LCLS flux – unfocused
 - Minimize background scatter from blades
 - 0.5 μ m accuracy

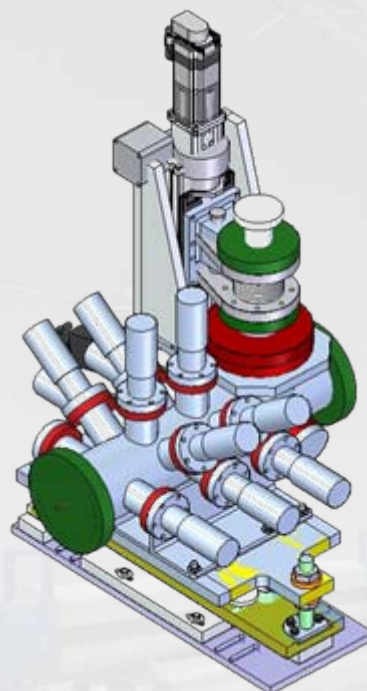
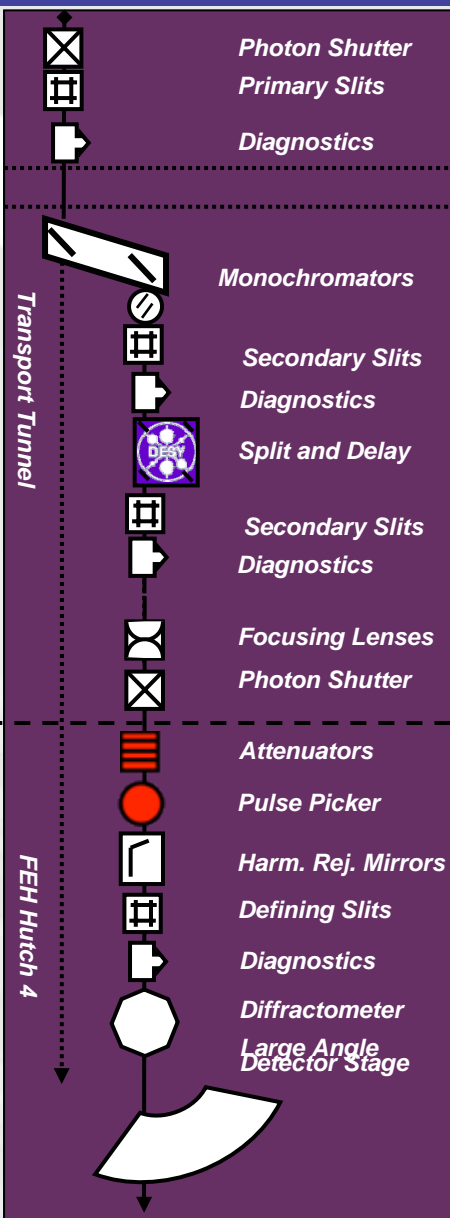


- **Purpose:**
 - Coarse beam alignment/monitoring; Coarse/fine beam profile
- **Specifications:**
 - Destructive; Retractable
 - At 100 μm resolution - 24x24 mm^2 field of view;
 - At 8 μm resolution - 2x2 mm^2 field of view
 - Capable of per-pulse op. @ 120 Hz

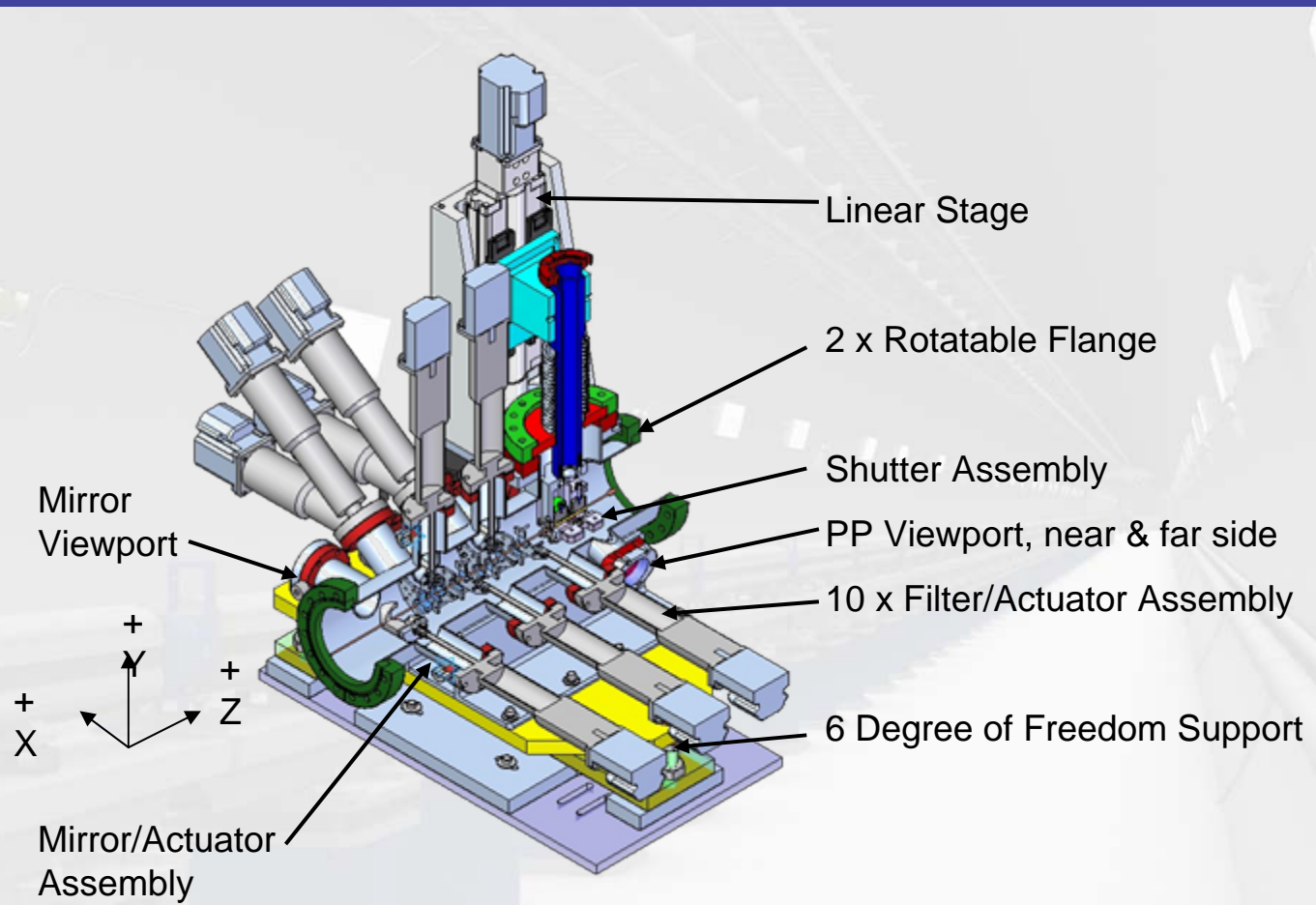
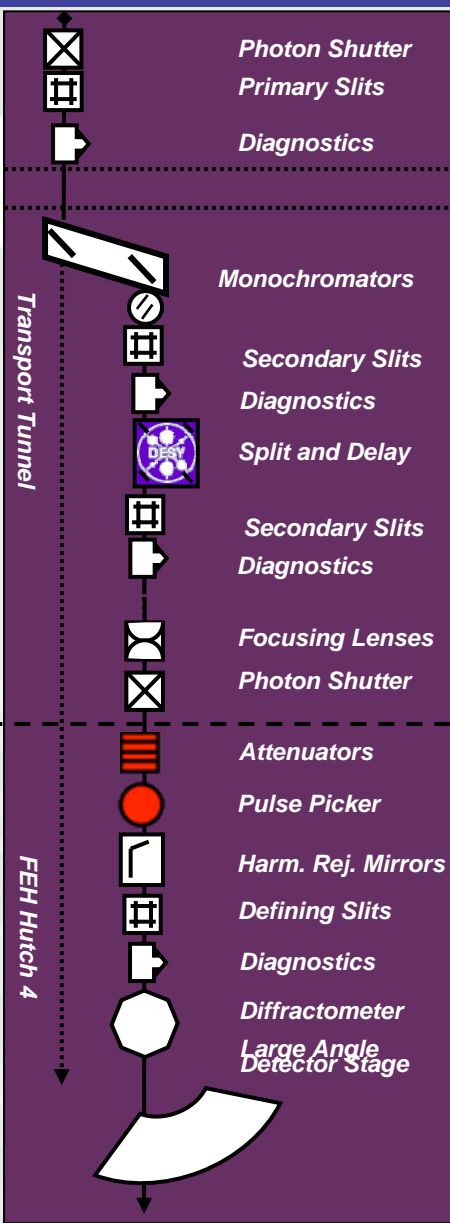


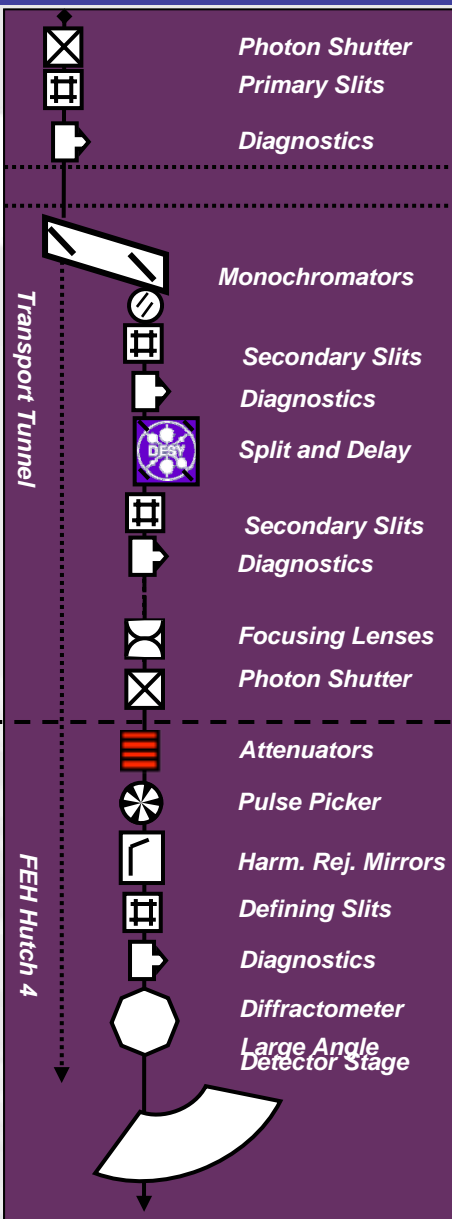
B. Lengeler et al., *J. Synchrotron Rad.*, 6, 1153-1167 (1999).

- X-ray Focusing Lens System
 - Down to 2 μm beam waist
 - Variable spot size from 2-10 μm and 40-60 μm when working out of focus
 - Can withstand full LCLS flux
 - Variable lens to sample distance



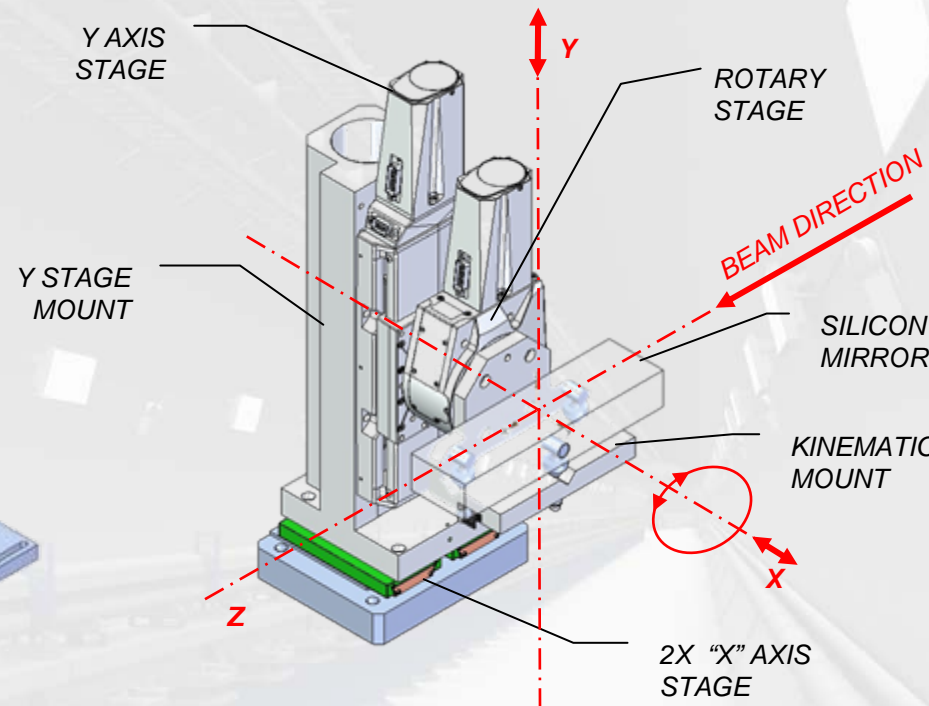
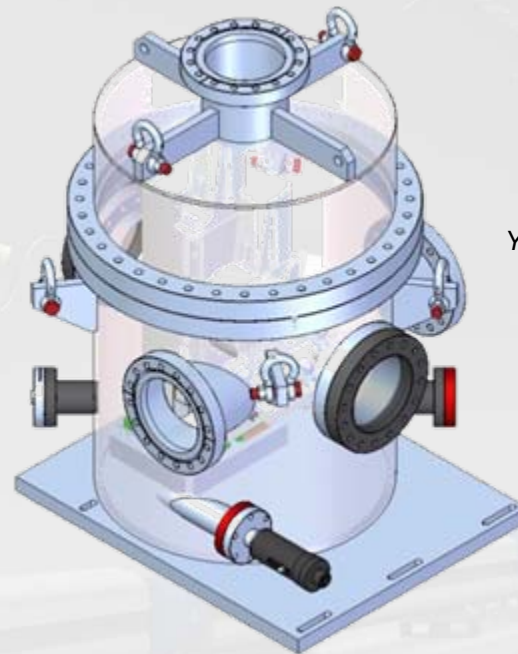
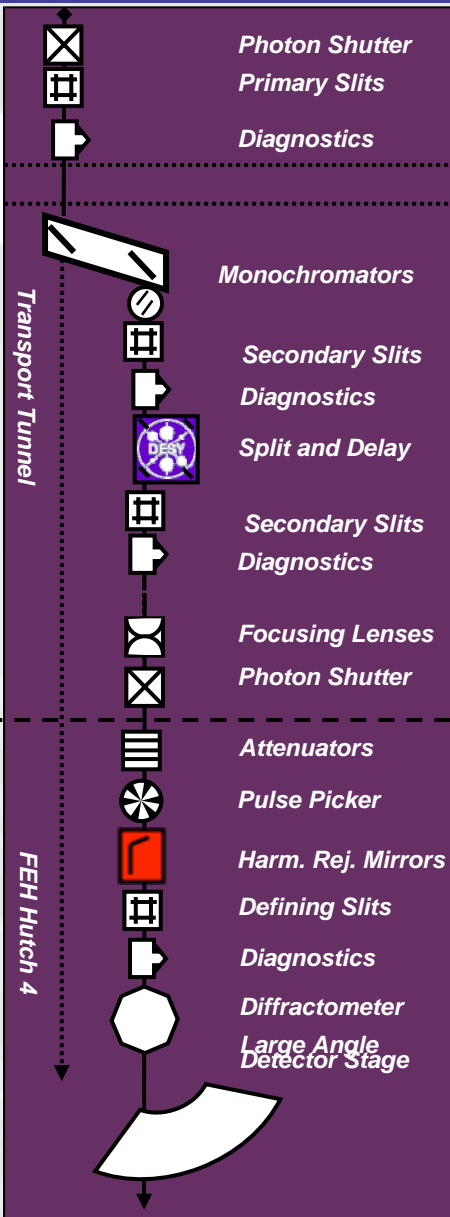
- LUSI Attenuator\Pulse Picker System
 - Excellent Optical Quality
 - > 3 steps per decade of attenuation above 6 keV
 - > 10^{12} attenuation < 17 keV
 - Isolate 3rd harmonic from fundamental
 - Tailor rep rate up to 10 Hz



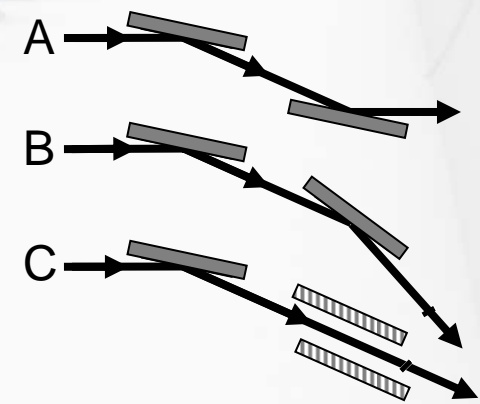


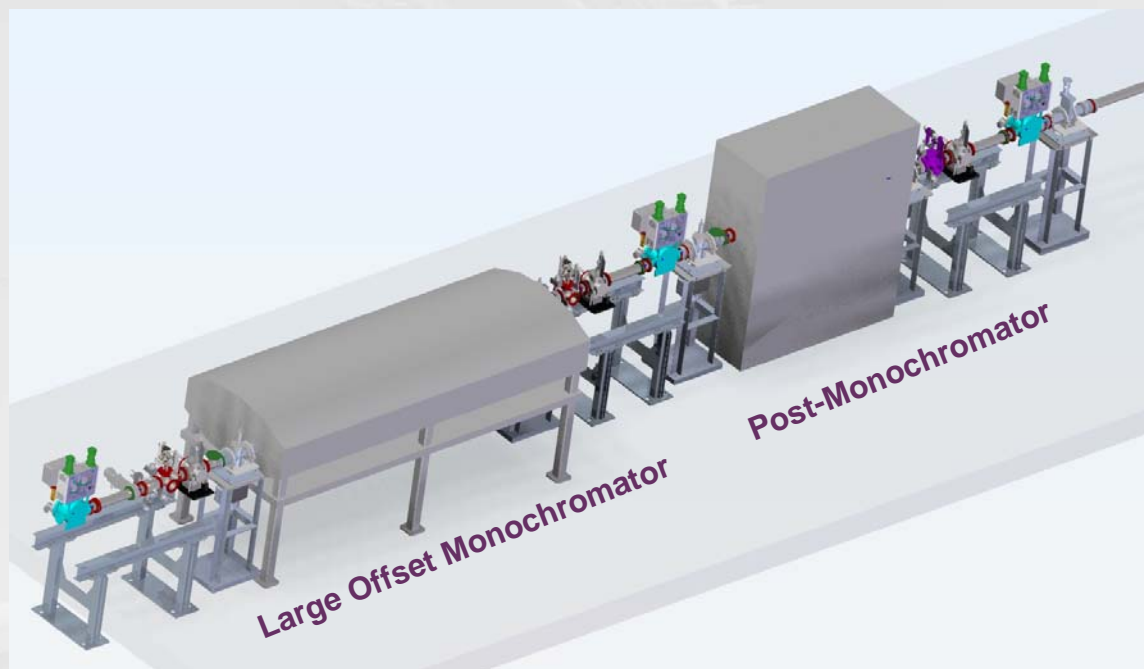
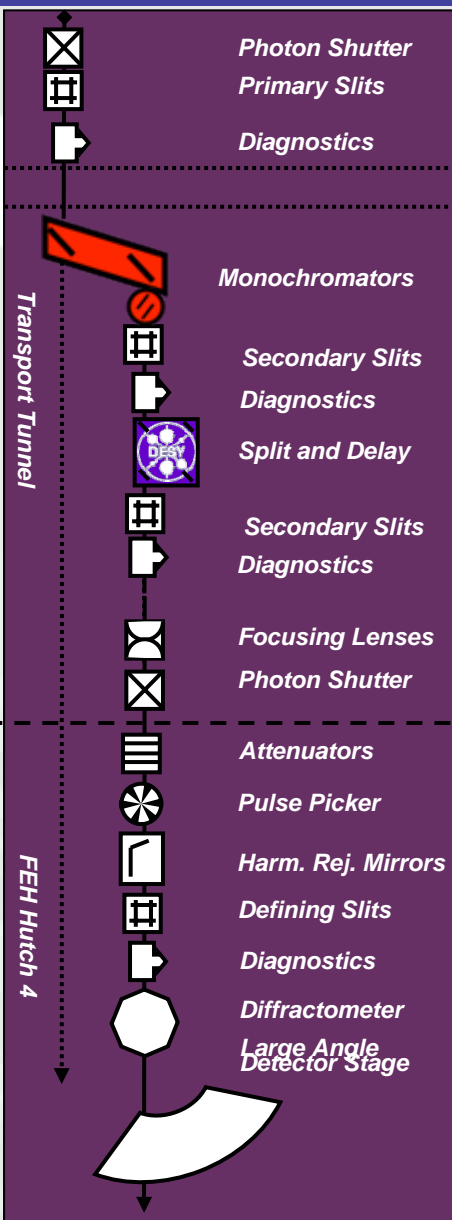
Attenuator Label	Thickness (μm)
Filter 1	20
Filter 2	40
Filter 3	80
Filter 4	160
Filter 5	320
Filter 6	640
Filter 7	1280
Filter 8	2560
Filter 9	5120
Filter 10	10240





- Harmonic Rejection Mirror System
 - Good optical quality
 - Si single crystal
 - 300 mm
 - No prefigure, no bender



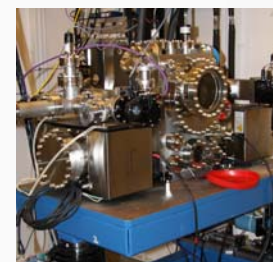


■ Large Offset Monochromator

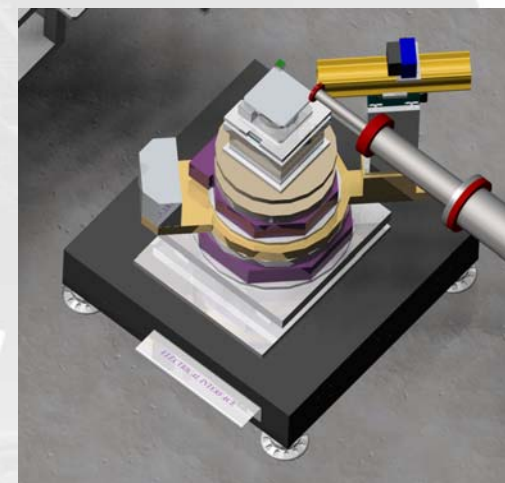
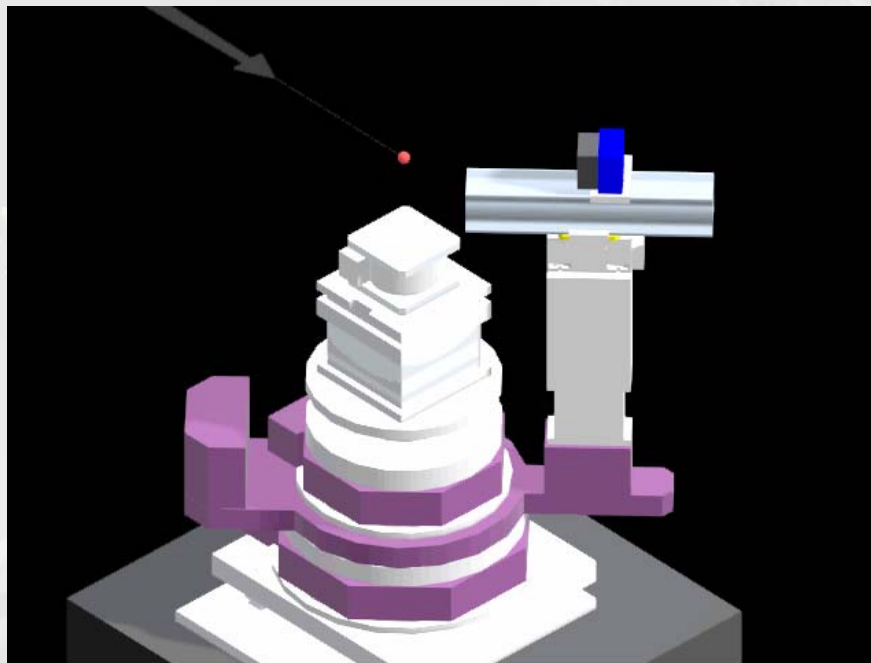
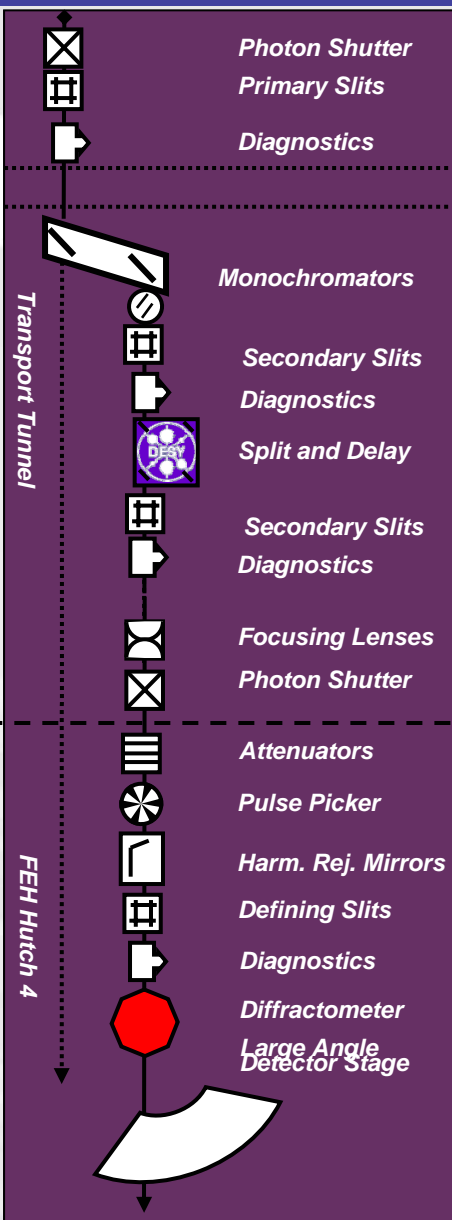
- 600mm offset
- 6-25keV
- Si(111) and Si(220)
- PETRA III design (i.e both crystals move at the same time)

■ Post-Monochromator

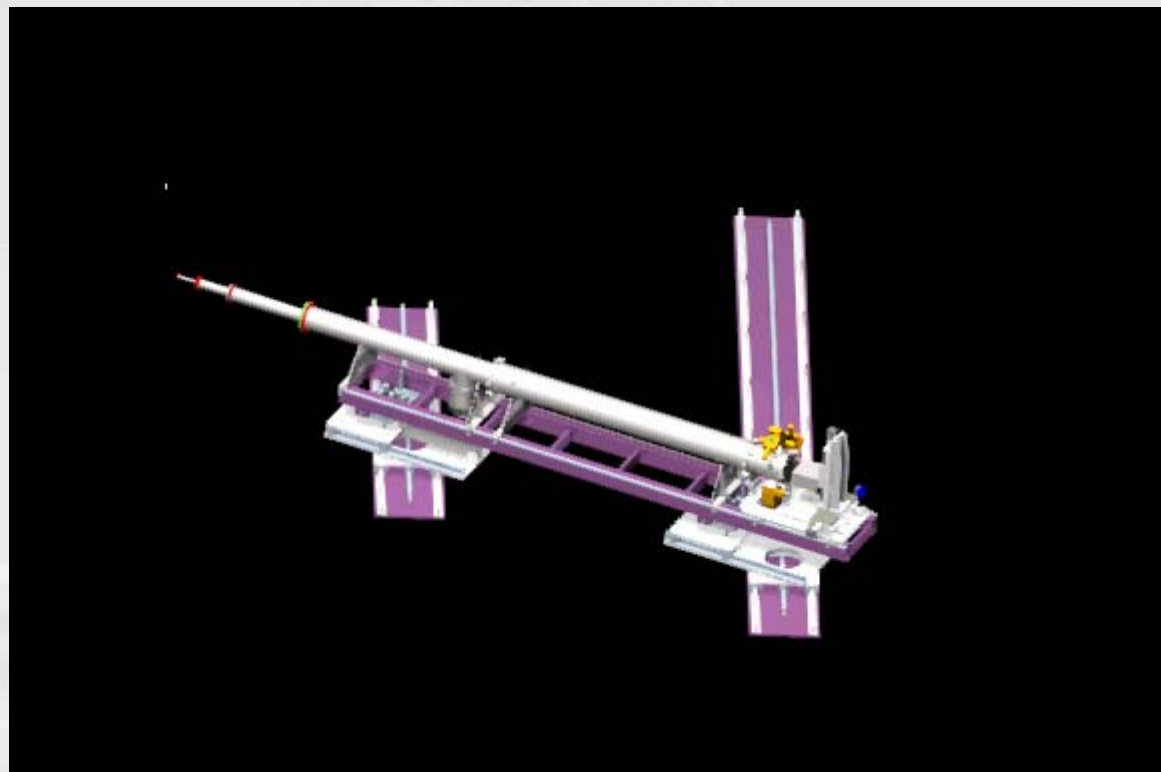
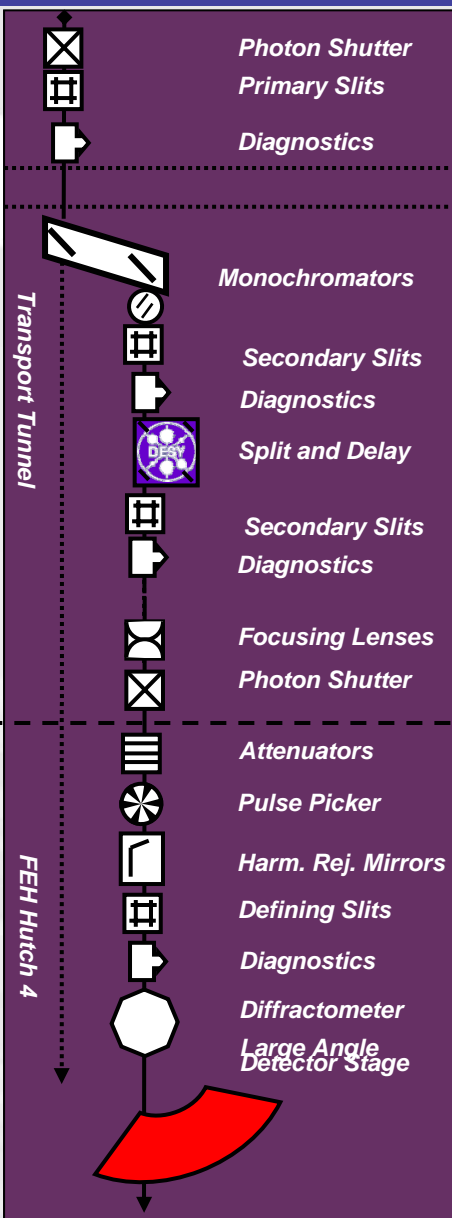
- DCM
- 6-25keV
- Si(111) then Si(511)



APS,8ID

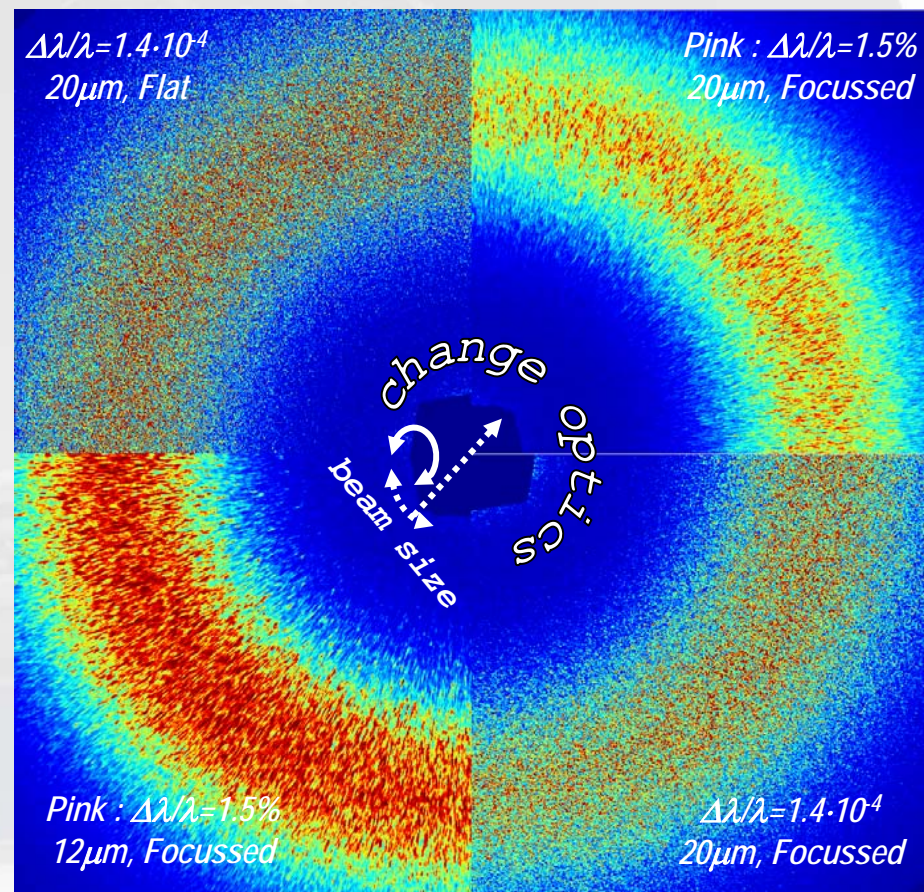


- Multipurpose Diffractometer System
 - Horizontal Scattering 4-circle Diffractometer
 - Same platform-CoR distance as XPP Diff
 - Possibility to remove from the beam path (airpads)
 - No interference with CXI beamline (600mm aside)
 - Local 2-theta arm for sample alinement



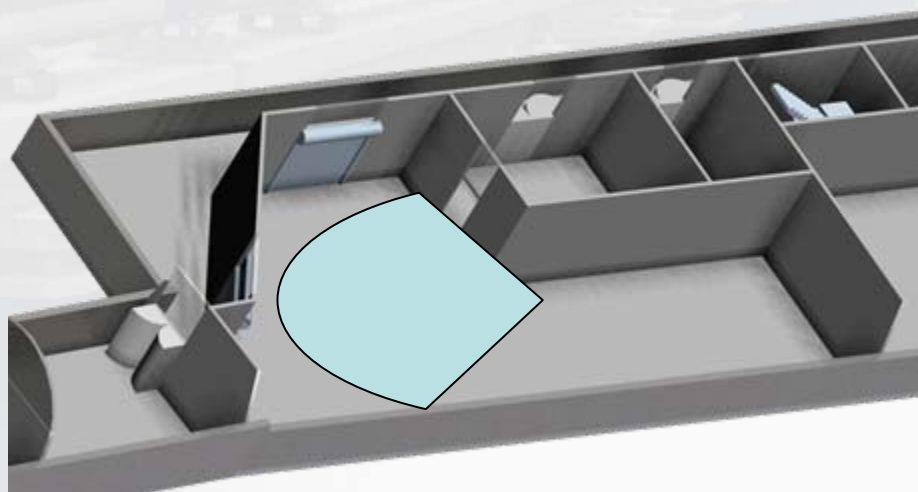
- Large Angle Detector Mover
 - Sample/detector distance 4 and 8m
 - Decoupled from diffractometer
 - SAXS, WAXS, GI
 - 2θ up to 55° , vertical tilt up to 2°
 - Local motion of detector, beamstops,...

- 2D Pixel Array Detector
 - Developed at BNL
 - 1024 x 1024 pixels
 - 55 x 55 μm^2 pixel size
 - High DQE
 - 10^2 dynamic range
 - Noise \ll 1 photon
 - 120 Hz Readout Rate
- Already looking to get it tile-able and to get more modules

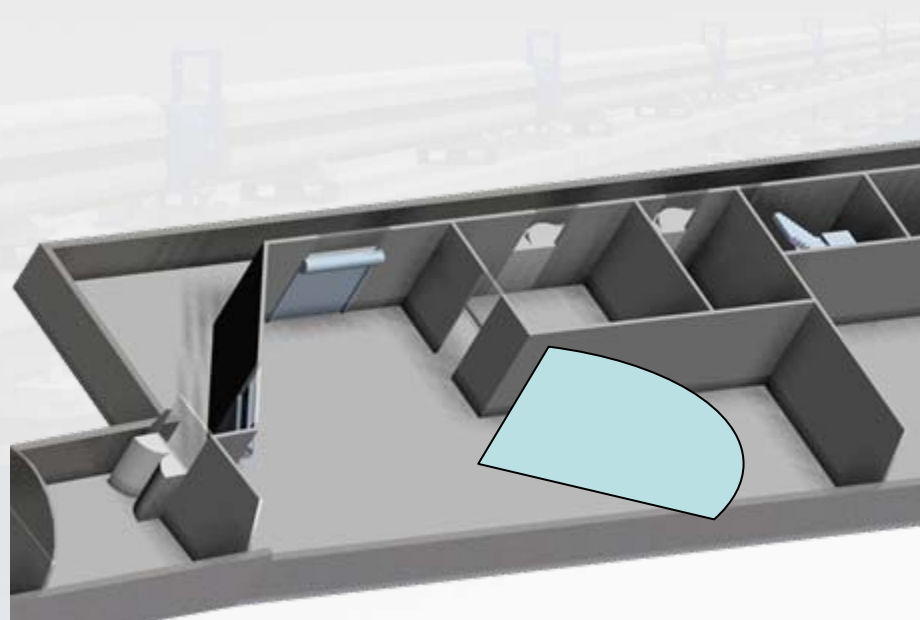


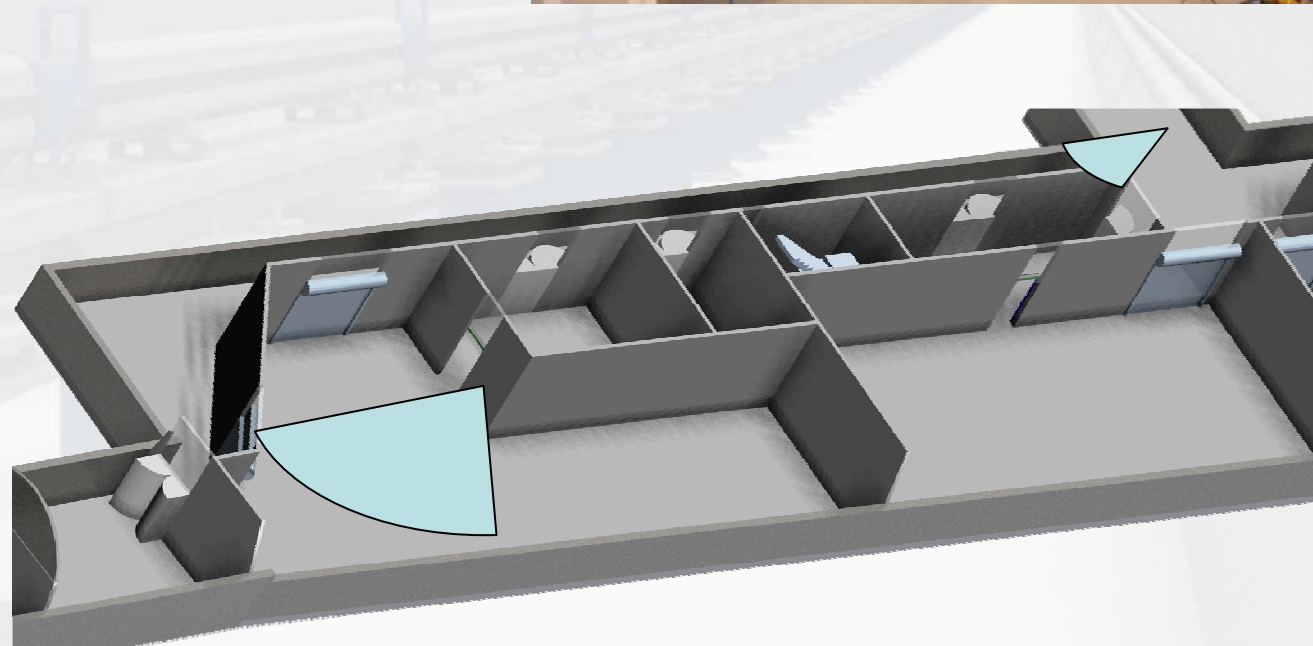
A perspective view of a long, brightly lit particle accelerator tunnel. The tunnel is lined with various pipes, conduits, and support structures, receding into the distance. The lighting is bright and even, highlighting the industrial nature of the facility.

Current Status

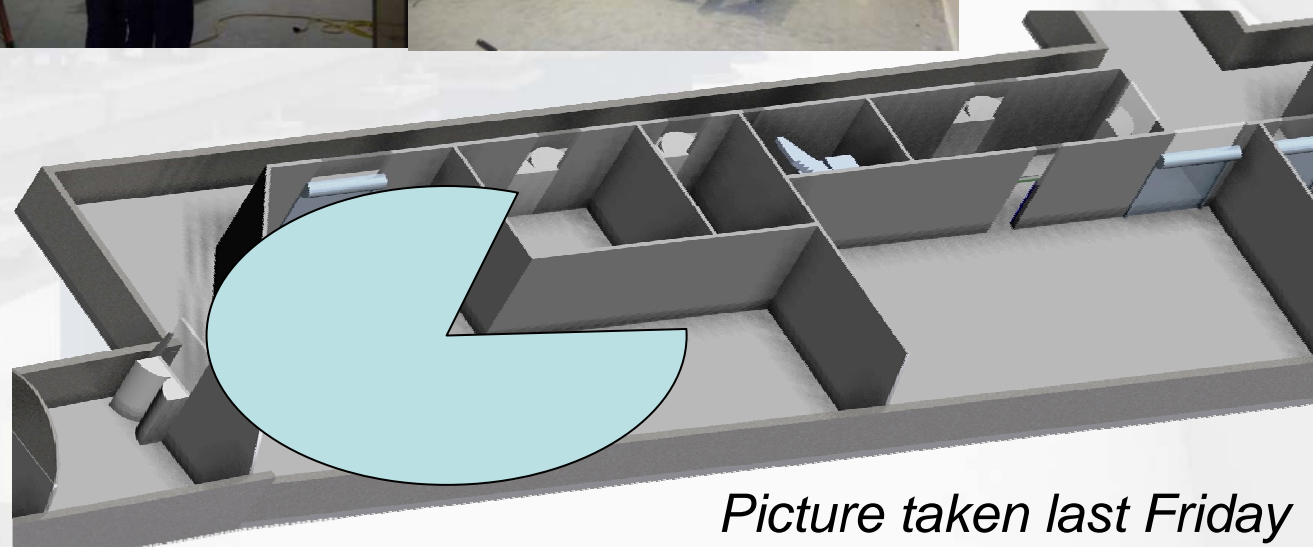


1 month ago

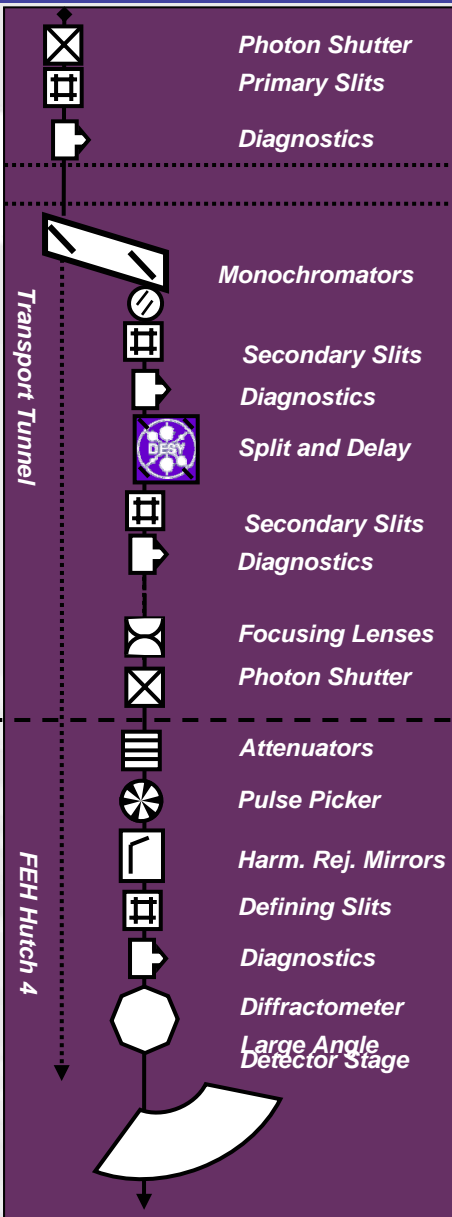




Picture taken last Friday

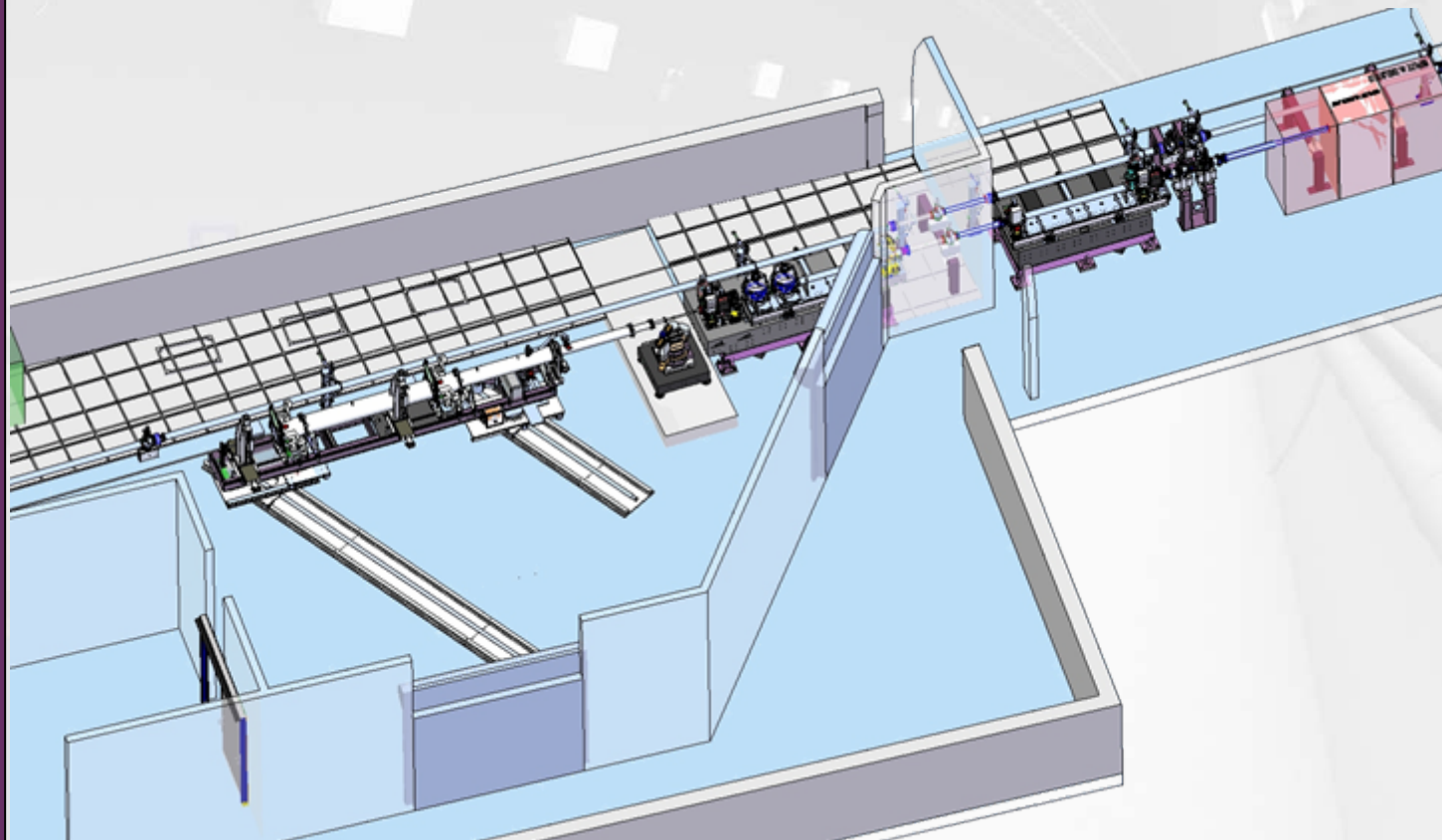


Picture taken last Friday

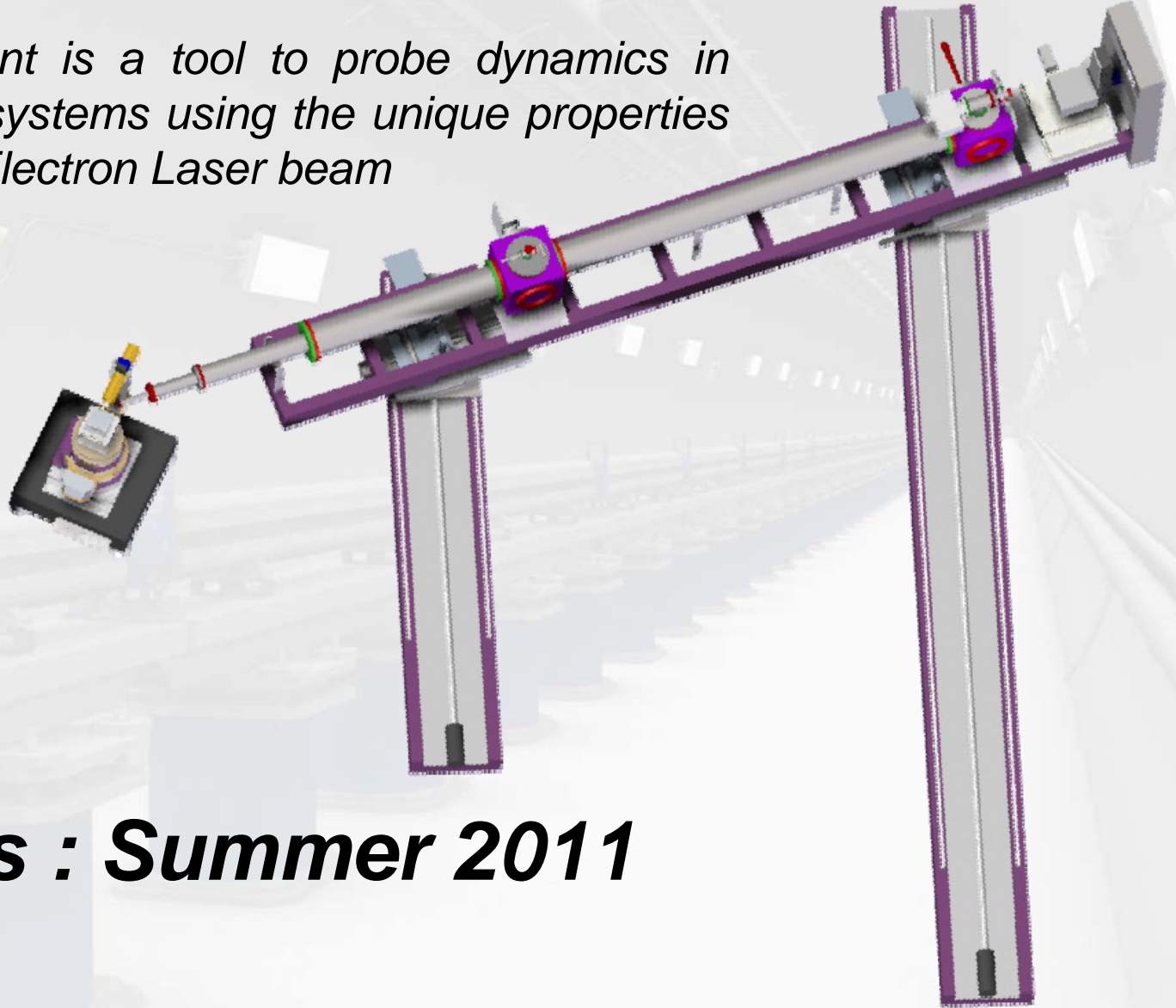


- Energy Range : 4-25keV
- Monochromators
- Si (111), (220), (511)
- Focusing capabilities with CRL's
- Fixed Energy Split and Delay
- Four-Circle Diffractometer
- Sample-detector distance = 4-8 m

•Future SAXS section at 20m



The XCS Instrument is a tool to probe dynamics in condensed matter systems using the unique properties of the LCLS Free Electron Laser beam



First Users : Summer 2011