Engineering challenges for the NEH2.2 beamline at LCLS-II

F.O'Dowd[†], D.Cocco, J.Defever, S.Guillet, C.Hardin, D.Morton, M.Owens, T.Osier, D.Rich, L.Zhang, G.Dakovski

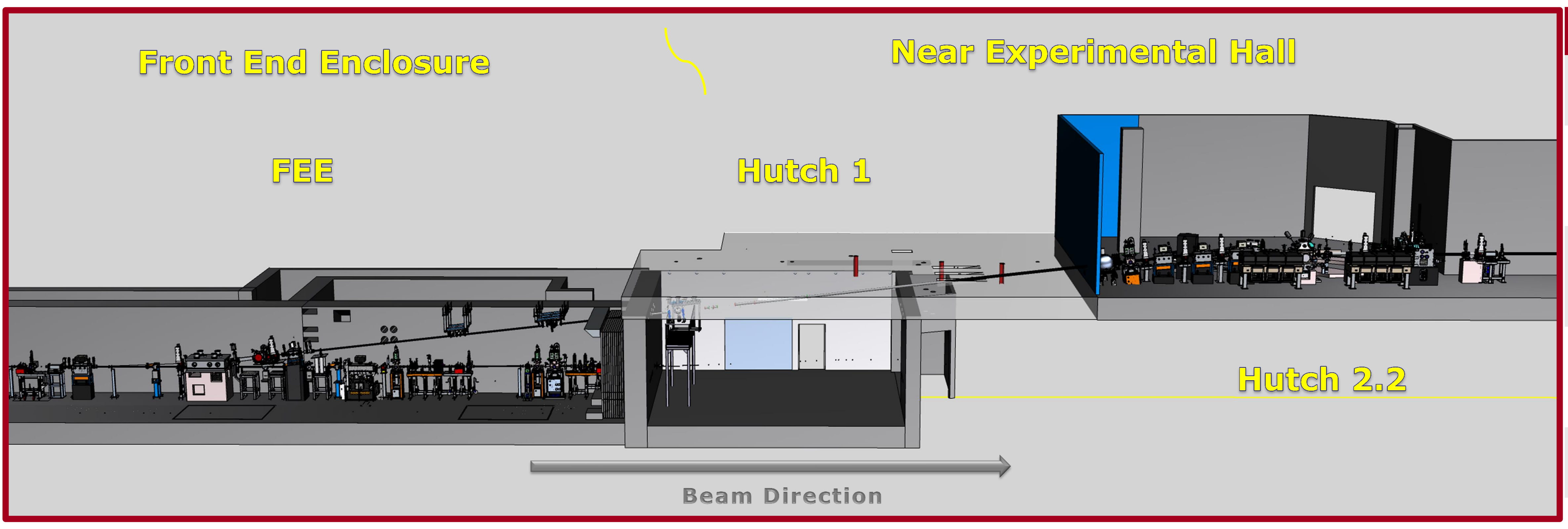
SLAC National Laboratory, Menlo Park, CA 94025, USA [†]fodowd@slac.stanford.edu

MEDSI PARIS 2018

U.S. DEPARTMENT OF ENERGY Office of Science

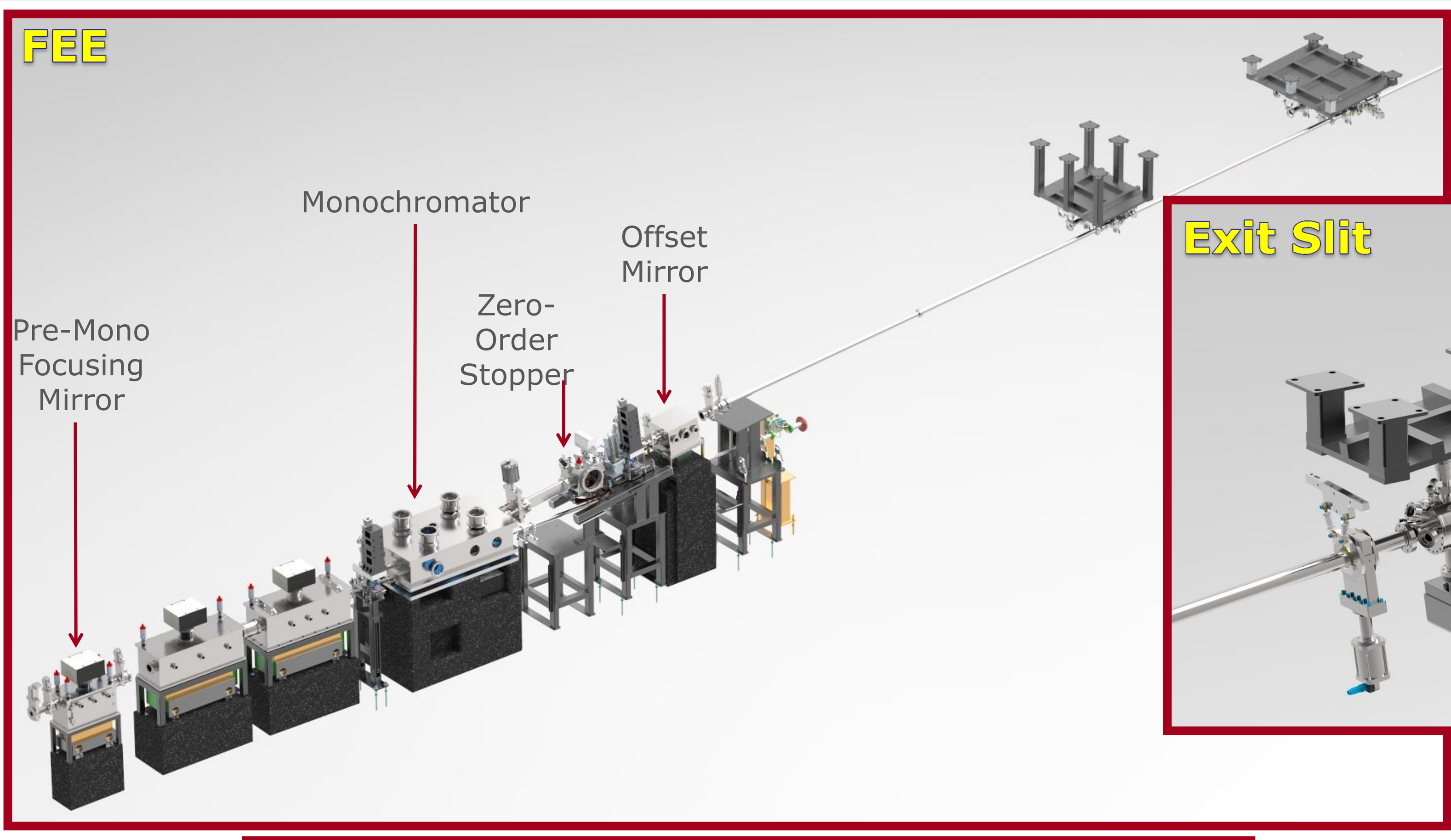
SLAC NATIONAL ACCELERATOR LABORATORY

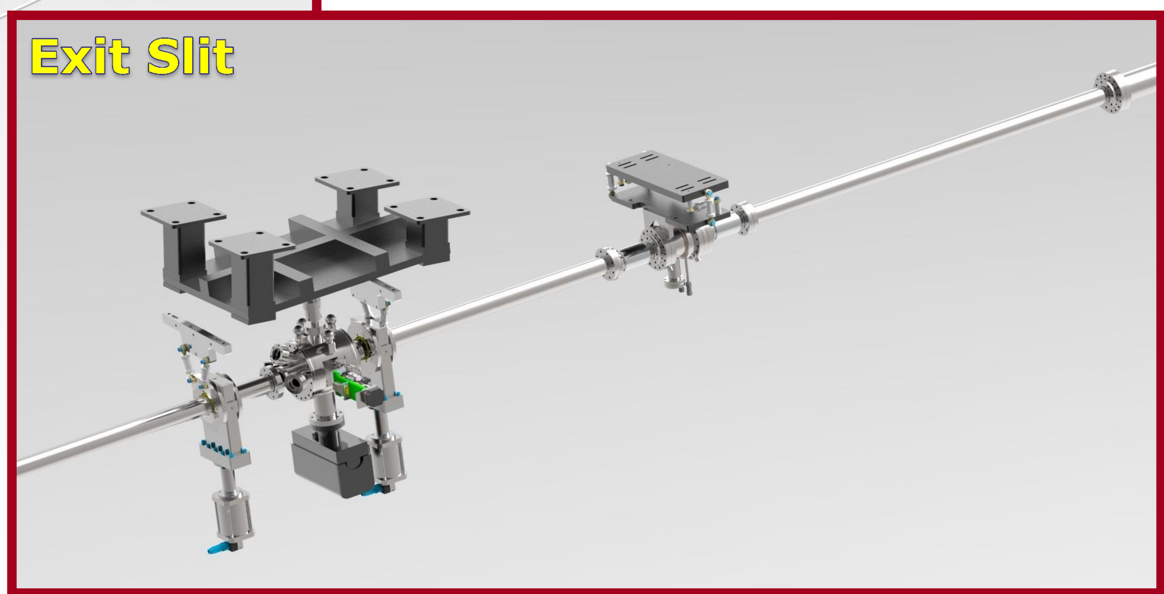
Abstract: SLAC National Accelerator Laboratory is developing LCLS-II, a superconducting linear accelerator based free electron laser capable of repetition rates up to 1MHz. The NEH2.2 Instrument at LCLS-II will use this combination of exceptionally high flux of monochromatic photons to achieve multidimensional and coherent X-ray techniques that are possible only with X-ray lasers. The challenges, which emanate from delivering the beam from the sub-basement level to the basement of the Near Experimental Hall (NEH) along with the stringent requirements for providing a stable beam at the interaction points, necessitate unique engineering solutions. Here we present the conceptual design for the NEH2.2 Instrument along with an overview of the R&D program required to validate design performance.

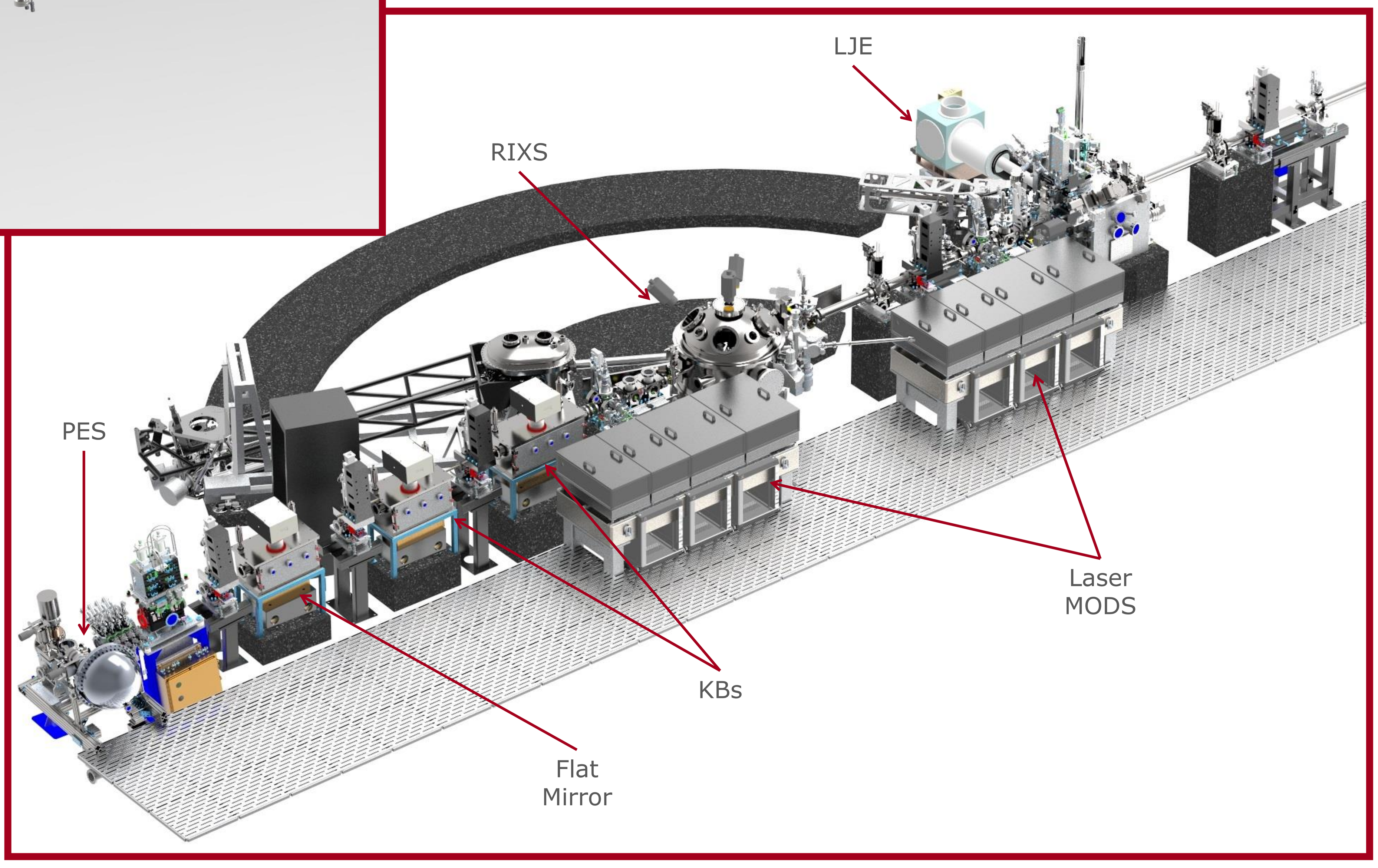


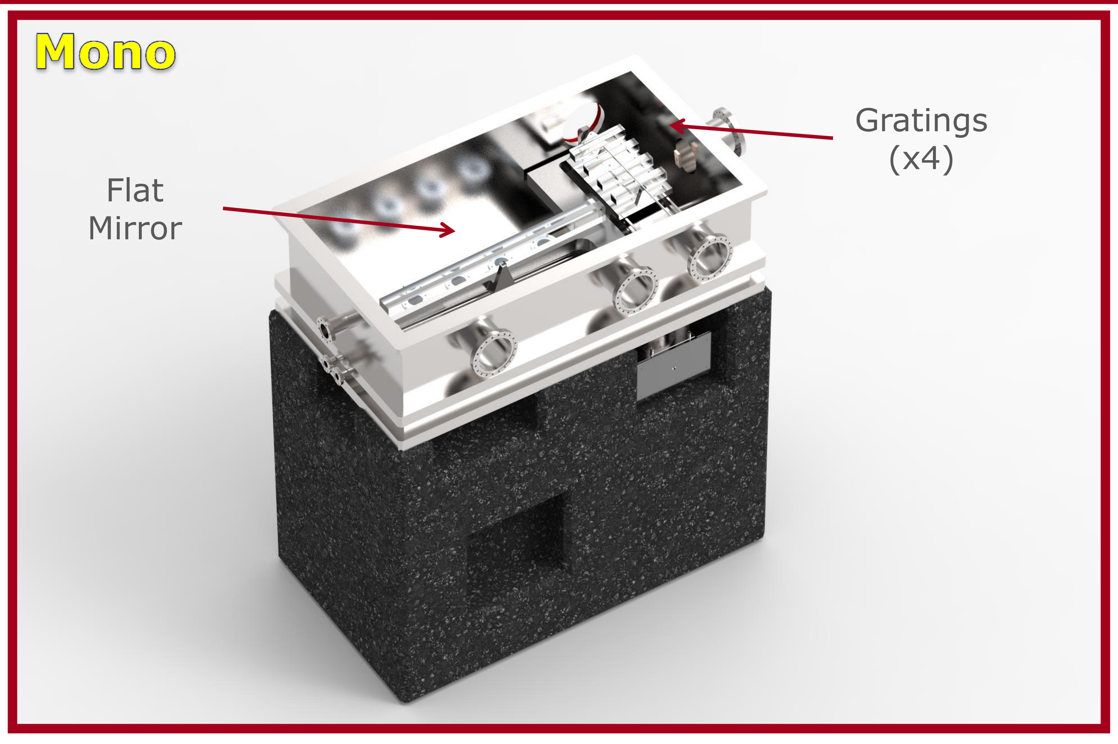
The layout of the beamline stretches from the Front End Enclosure (FEE), onto the ceiling of Hutch 1 and into the upper level of the Near Experimental Hall (NEH). The NEH2.2 beamline is progressing through its preliminary design stage, with the LJE expected to be operational in June 2020 and RIXS June 2021.

Parameter	Required	Comment
Photon Energy Range [eV]	250-1600	Oxygen K-edge 3rd harmonic rejection Experiments on rare earth M-edges
Beamline transmission [%]	20	For zero order (grating reflection) operating mode below 1000eV. Required transmission shall be maintained.
Bandwidth Control [Resolving Power]	50,000 10,000 5,000	Ref: Mono Requirements RP in the 52,000 range is needed for experiments with high temporal resolution.
X-Ray Spot Size 1.Horizontal [μm] 2.Vertical [μm]	 2-1,000 2-1,000	Spot size adjustable to each end station interaction location
Beam position stability [%]	<10	
Pulse stretching	<2 x TL	This requirement should be achievable for all RP modes of operation and at all photon energies in the range specified









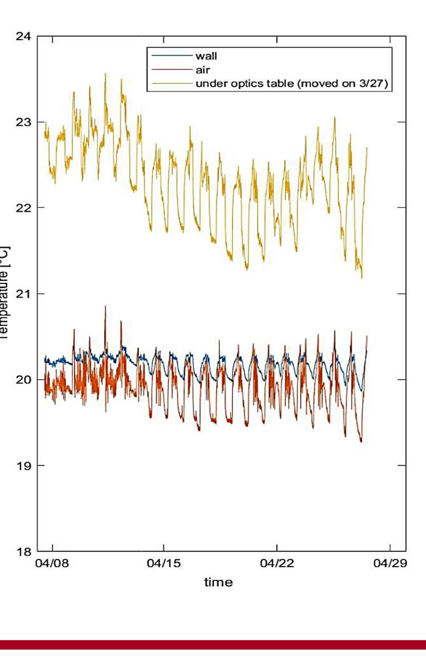
Stability

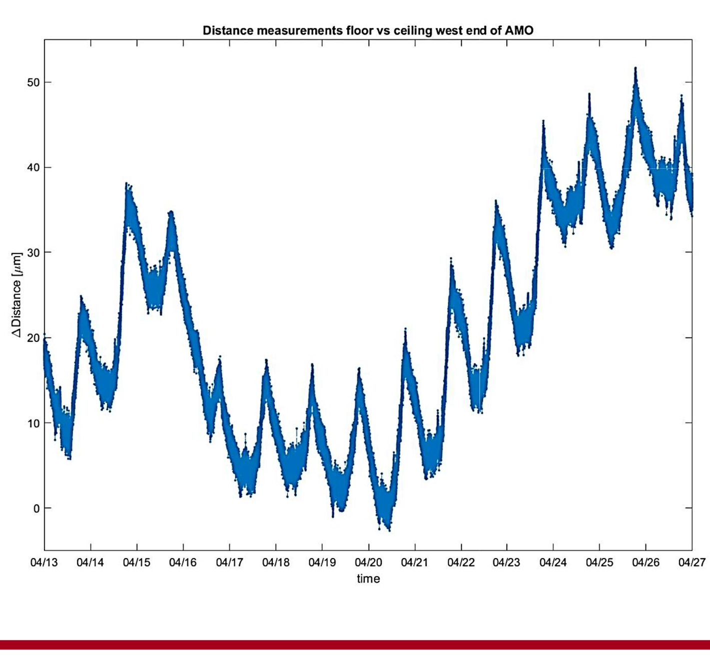
Interferometer measurements in the NEH show large variations in floor-to-ceiling heights, which can be correlated with induced heating of the building by solar radiation. Similar measurements were made at SSRL in 2010 which was partially corrected through insulation of the tunnel.

Initial analysis of the NEH has shown a 30-times reduction in motion through insulation of the north and west faces of the building.

NEH Building

- Tunnel painted white - 15% reduction
- Mylar covered asphalt – no effect
- Insulation of walls & roof - x7 reduction

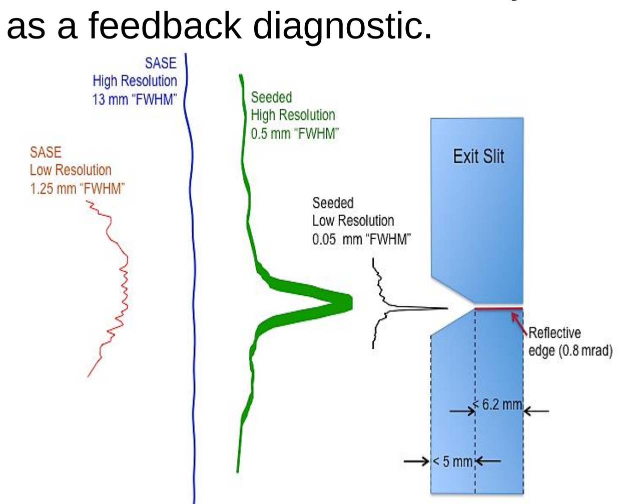




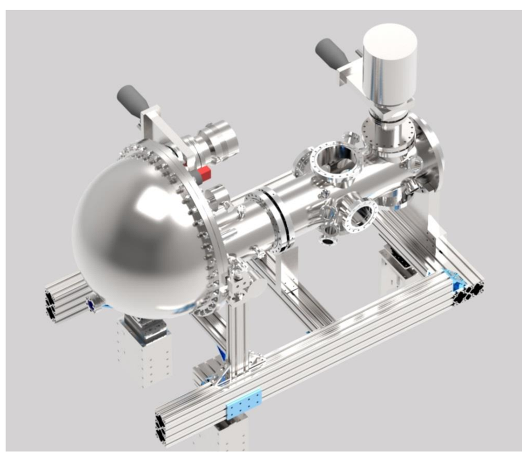
Building Structure

The basement floor of the NEH2.2 hutch is 36" of reinforced concrete, which then reduces to 18" towards the hutch door and walkway. Hydrostatic levelling system (HLS) measurements show relative motion across individual slabs.

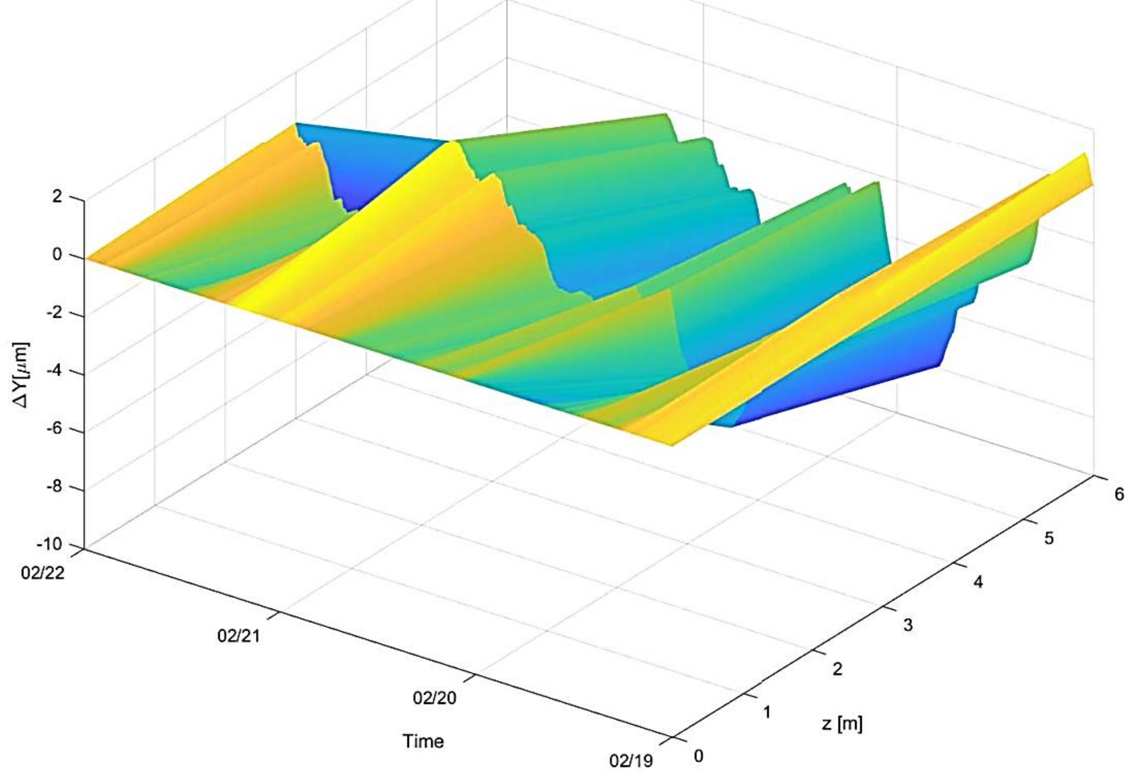
A concept solution is being developed which will pick-off beam at the exit slit and use this secondary beam in a photoemission spectrometer as a feedback diagnostic.



Exit Slit pick-off concept



PES



Hydrostatic Levelling System Measurements of Hutch 2.2 Floor

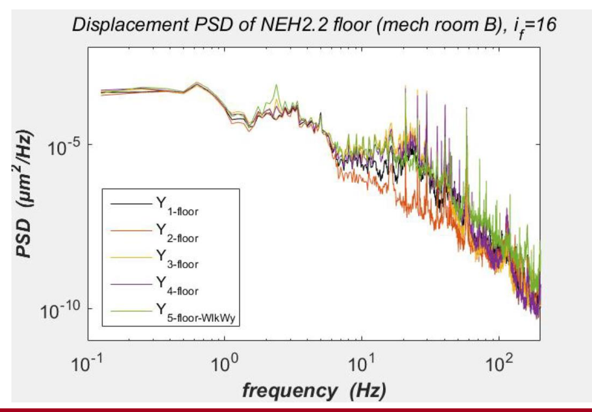
Vibration

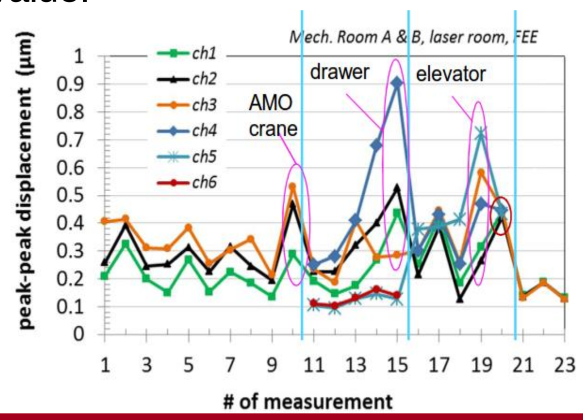
Vibration measurements in the hutch show external sources can play a significant role:

- Elevator
- Crane in other hutches
- Loading bay & walkway

Reftek Seismic Recorder

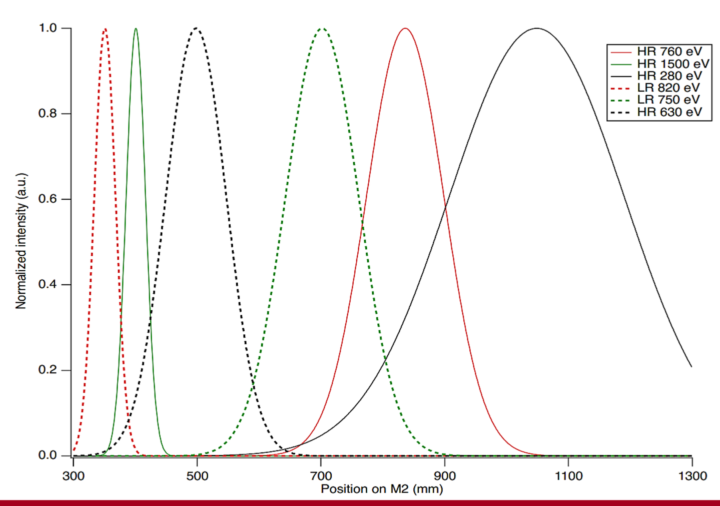
Efforts are being made to minimize vibrations sources, such as moving roughing pumps upstairs and providing active damping of nearby compressors; however we plan to include an accelerometer system to veto data taken above a threshold value.





Cooling

During an energy scan, the beam position on the flat mirror of the monochromator will change with energy. This leads to a temperature variation with an aspherical thermal 'bump' around the beam footprint. A novel cooling scheme is being developed that will allow optimization of the mirror cooling to change with the changing footprint and location of the beam.



Varying Beam Position on Flat Mirror of Mono