ChemRIXS Capabilities for Run 18

The ChemRIXS instrument is a new endstation targeting studies of samples in solution using monochromatic soft x-ray pulses and a tunable optical laser pump. It is designed with emphasis on soft X-ray spectroscopy experiments on liquid samples, measured with a Varied Line Spacing (VLS) portable spectrometer. For rapid XAS measurements and direct beam detection (in the case of transmissive samples), a suite of in-vacuum detectors will be implemented on a rotating arm. The chamber will be equipped with the following:

- Liquid jet delivery via a microfluidic chip
- A load-lock chamber that allows chip exchange
- Catcher for capturing and/or re-circulating sample
- Viewing and illumination
- Diagnostic paddle for calibration targets, spatio-temporal overlap, etc.
- Laser in- and out- coupling
- Detectors optimized for x-ray absorption and emission spectroscopies
- Arrival time monitor located ~1 m from the interaction point

Key Performance Parameters for Run 18:

X-ray Parameters			Laser Parameters	
Repetition rate (Hz)	Up to 120		Repetition rate (Hz)	120
Energy Range (eV)	400 - 1200		Wavelength (nm)	400, 800, 480 - 900 (tunable)
Spot Size (um), H x V	10 x 10, min 1000 max		Pulse Duration (fs)	<40 @ 800 nm
Energy per pulse (uJ)	>2		Fluence (mJ/cm^2)	>50
Pulse Duration (fs)	<40		Spot size (um)	Min <50 X 50, option for 1:4 aspect ratio with <50 minor axis
Beamline Resolving Power	>2,000		Polarization control	Horizontal and vertical, circular at select wavelengths
Temporal resolution (fs)	<60		Arrival time monitor precision (fs)	<20
Polarization	Linear horiz.			
Wavelength scanning	Yes			

ChemRIXS will be optimized for studying systems with C, N, O and transition metal elements using various spectroscopy methods. Spectroscopic studies of rare earth elements will also be relevant so the beamline reach will extend to 1600 eV.

The following detectors will be provided to the users:

- Avalanche PhotoDiode (APD) and MicroChanel Plate (MCP). These are single-photon sensitive fast detectors suitable for X-ray Absorption Spectroscopy (XAS) in Total Fluorescence Yield (TFY) mode. These detectors will be mounted on an in-vacuum rotatable stage and can be placed in the horizontal scattering plane.
- Andor Newton_SO, 512 X 2048 pixels, 13.5 microns pixel size, capable of full frame read-out at 120Hz when operated in Full Vertical Binning mode. This CCD detector will be placed outside chemRIXS in the direct beam and will allow for measuring XAS in transmission when using thin sheet jets
- Portable Varied-Line Spacing (VLS) X-ray Emission Spectrometer (XES). This is an existing XES spectrometer with resolving power of ~2000, that will nominally be equipped with the abovementioned Andor Newton_SO CCD. Plans to incorporate a flange mounted MCP assembly, providing a factor 5 increase in horizontal acceptance (higher throughput), are underway and are expected to be delivered early on in Run 18. The spectrometer will be mounted in the horizontal plane at 90 degrees with respect to the X-ray beam.

The community is encouraged to propose experiments focusing on the following techniques

- Time-resolved XAS, which can be implemented in three modes:
    - Direct transmission (for samples delivered in the form of a thin sheet)
    - TFY mode, using the in-vacuum APD or MCP
    - Partial Fluorescence Yield (PFY) mode, using the VLS spectrometer
- Time-resolved XES, using the VLS with non-resonant excitation

Resonant Inelastic X-ray Scattering (RIXS)measurements, while possible as demonstrated during LCLS-I operation, are expected to remain quite challenging given the similar average flux expected during early operation with the Cu linac. Unless a compelling case is made, we discourage users from submitting proposals for experiments targeting time-resolved RIXS, as these will be much more efficient when the superconducting linac is operational.