ChemRIXS Breakout Session

LCLS Run 23 Users Town Hall

January 30th 2024

SLAC NATIONAL ACCELERATOR LABORATORY

Stanford University | U.S. DEPARTMENT OF ENERGY

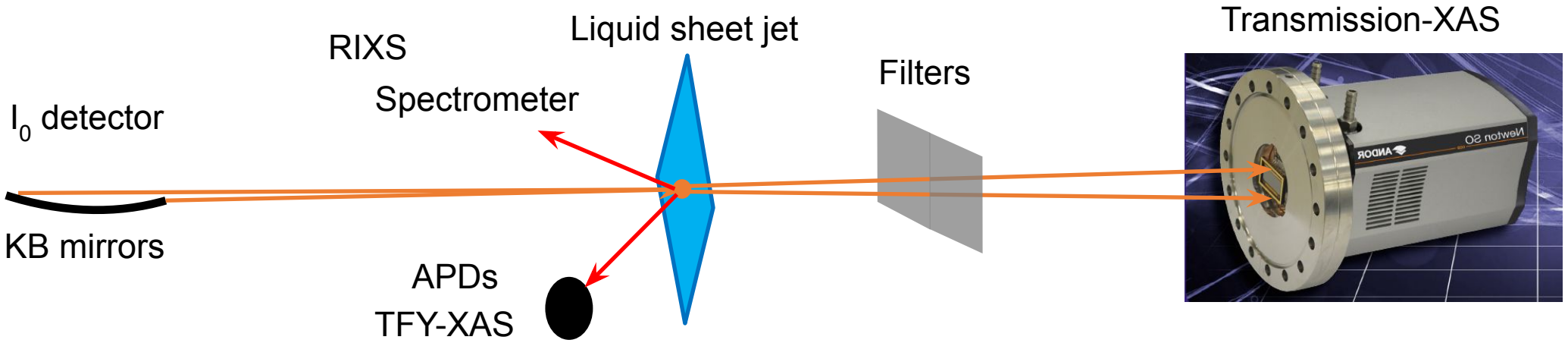
ChemRIXS Run 23 call

Liquid standard configuration:
Liquid samples, sheet jets.

- Time-resolved XAS with monochromatic beam (scanning)
  - Transmission experiments (sheet jets)
  - Total Fluorescence Yield (TFY) mode
  - Partial Fluorescence Yield (PFY) mode
- Time-resolved RIXS/XES

- Please contact beamline scientist for non-standard configurations.
  - Zero-order operation at high rep-rate (e.g. attosecond XLEAP experiments), note: no in-line spectrometer available in run 23
  - Solid samples

ChemRIXS liquid standard configuration



SCRF operation
- Repetition rate up to 33 kHz
- Pulse enegy up to 100 uJ

RIX beamline
- I0 at the IP >10^{14} photons/s
- Photon energy range 250 – 1000 eV and up to 1600 eV
- Mono resolving power 2000
- Spot size 10 – 1000 um (variable)
- I0 detector 5% shot-by-shot noise

OPCPA laser system
- Repetition rate 33 kHz
- 800, 400 and 266 nm
- Vis-OPA 480 – 900 nm

Transmission XAS
- Direct detection with downstream X-ray CCD
- 2048x512 Andor CCD read-out 1 Hz (Image), 120 Hz (FVB)

TFY-XAS
- APDs mounted close to the jet
- Shot-by-shot readout

RIXS/XES/PFY-XAS
- VLS spectrometer mounted at 45 deg backscattering
- 2048x512 Andor CCD read-out 1 Hz (Image), 120 Hz (FVB)
- Resolving power ~2000
- Detection efficiency $4 \cdot 10^{-8}$ (FVB), $1.6 \cdot 10^{-7}$ (Image)

Sample delivery

Liquid sheet jets for Transmission XAS

- Thin gas accelerated sheets (Nat. Commun. 9, 1353)
  - Thickness 0.1 - 1 µm
  - Flow rates 250 µl/min
  - Optimal for bulk liquids measurements
- Converging nozzles (Phys. Rev. Fluids 3, 114202)
  - Thickness 0.2 - 2 µm
  - Flow rates 2 - 4 ml/min
  - Optimal for solutes

Cylindrical jets for FY-XAS and XES

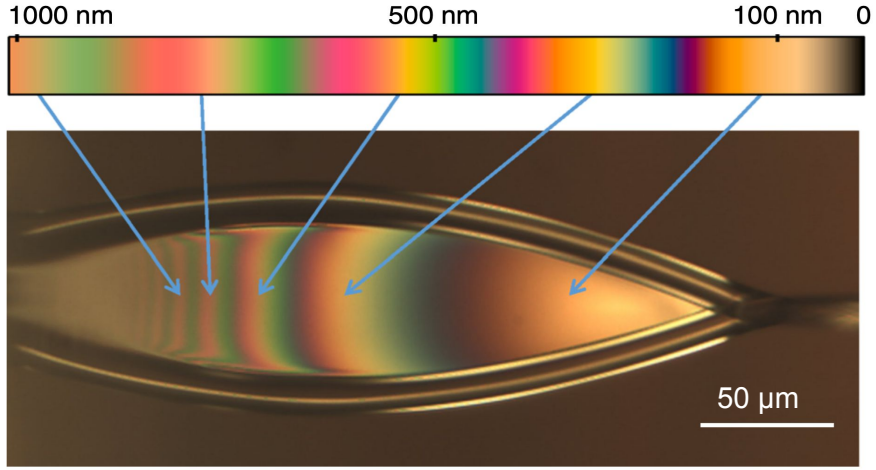
- Gas Dynamic Virtual Nozzle (GDVN)
  - Diameter 1 - 10 µm
  - Flow rates ~20 µl/min
- Rayleigh jet
  - Diameter >20 µm
  - Flow rates ~1 ml/min

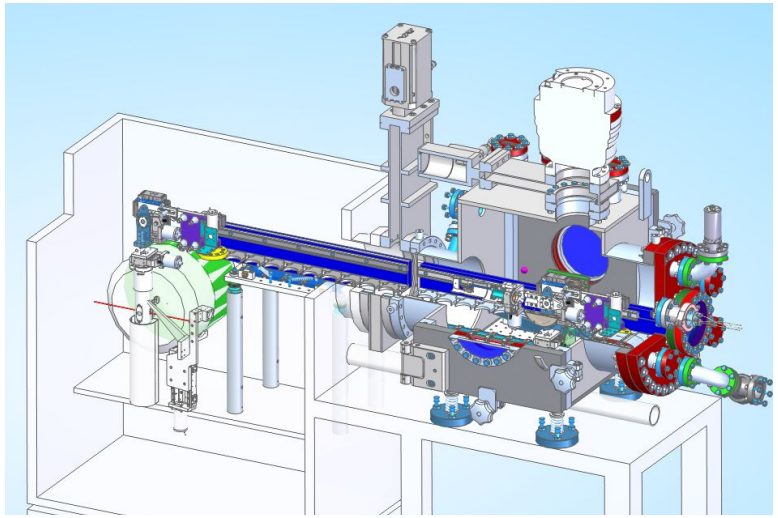
Sample recirculation

- Min. sample volume requirement 50-100 ml

Load-lock systems

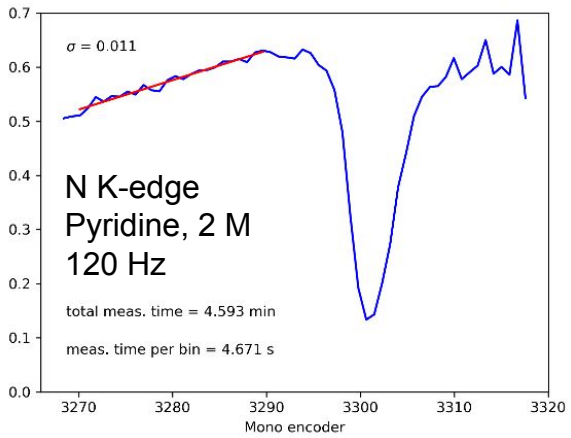
- Enables fast nozzle exchange

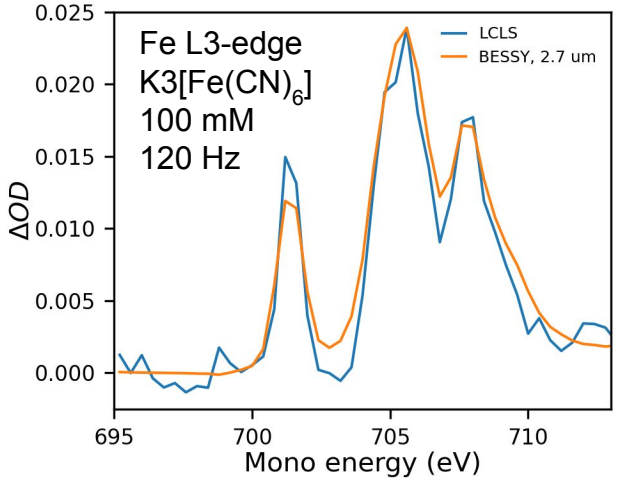




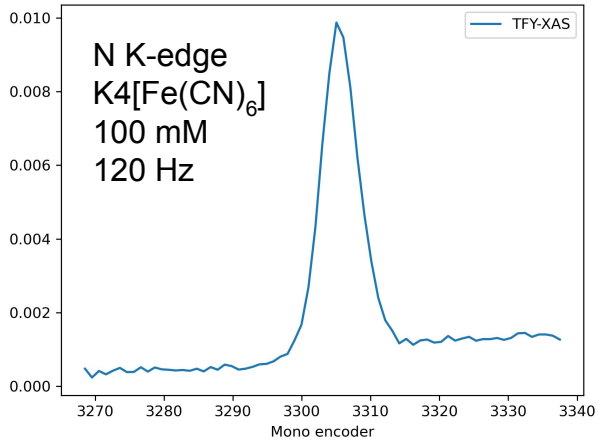
Performance expectations

Trasmission-XAS





TFY-XAS



Noise ~1% (10 mOD) at 120 Hz **-> <0.1% (1 mOD) at 33 kHz**

x10 SNR improvement at 33 kHz

RIXS

33 kHz
$I_0 = 10^{14}$ photons/s
VLS througput = 10^{-7}
Fl. Yield = 0.005

Concentration (mM)	μ_{solute}/μ_{total}	Total count rate (1/s)	Tr-RIXS?
1000	1/2	10^4	Yes
100	1/20	10^3	Possible
10	1/200	10^2	Hard

ChemRIXS Run 23 key parameters

X-ray

Repetition rate (Hz)	Up to 33 kHz
Energy Range (eV)	250 - 1600 eV
Pulse Duration (fs)	20 fs (nominal, SASE)
Energy per pulse at the IP (monochromatic)	>100 nJ (250 - 1000 eV) >10 nJ (1000 - 1300 eV) >1 nJ (1300 - 1600 eV)
Beamline Resolving Power	>2000
Spot Size, FWHM (range)	10 - 1000 (um) diameter
Polarization	Linear, Horizontal

Laser

Repetition rate (Hz)	Synchronized up to 33 kHz				
Wavelength (fs)	800	400	266	480 - 600	600 - 900
Pulse Duration (fs)	20	30	35	<50	<50
Energy per pulse (μJ) (on target)	500	50	5	>15	>5
Spot Size, FWHM (800 nm)	50 to 100 μm				
Polarization	Variable: linear, circular				
Angle	~0.5 deg angle with x-ray beam				
Arrival Time Monitor	< 20 fs accuracy in x-ray/laser arrival time tagging should be available. Overall temporal resolution will be dependent on machine and instrument configuration.				

Please contact us for any questior
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