Oral presentation

The new Debye beamline at SLS2.0: a versatile platform for operando X-ray chemical and structural analysis with multimodal X-ray absorption spectroscopy and scattering

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The newly constructed Debye beamline at the Swiss Light Source (SLS), available after the SLS upgrade mid-2025, is positioned to provide multimodal X-ray absorption spectroscopy (XAS) and X-ray diffraction (XRD) analysis to investigate the chemical, geometrical and electronic structure of functional materials under operating conditions. Equipped with a 5 T superbend magnet source and utilizing an in-house engineered quick scanning channel-cut monochromator (Si111, Si311), the Debye beamline offers an accessible energy range from 4.5 keV to 60 keV. A cutting-edge motion control system provides a diverse range of control options, facilitating Quick-scanning XAS through sinusoidal motion and custom trajectories as well as precise step-scanning measurements, all seamlessly executed with the same direct-drive motor. Precise motion position triggered XRD pattern collection at stationary points in the monochromator oscillation or through automated energy switching allows to realise quasi-simultaneous XAS and XRD analyses. Further enhancement of the Debye beamline will be achieved by extending measurement capabilities to include time-resolved X-ray total scattering.

The modular designed experimental end-station allows for rapid changes between experiment types affording the full flexibility demanded by the chemistry and material science communities. Development of integrated experimental controls, data acquisition, data handling and analysis pipelines lay the foundations for a streamlined user interface allowing rapid results visualization and experiment automation. By offering standard reaction environments for electrochemical, battery, catalysis and materials science research together with potentiostat, micro gas chromatograph, mass spectrometer and gas delivery infrastructure (up to 60 bar), the Debye beamline is designed for *operando* research.

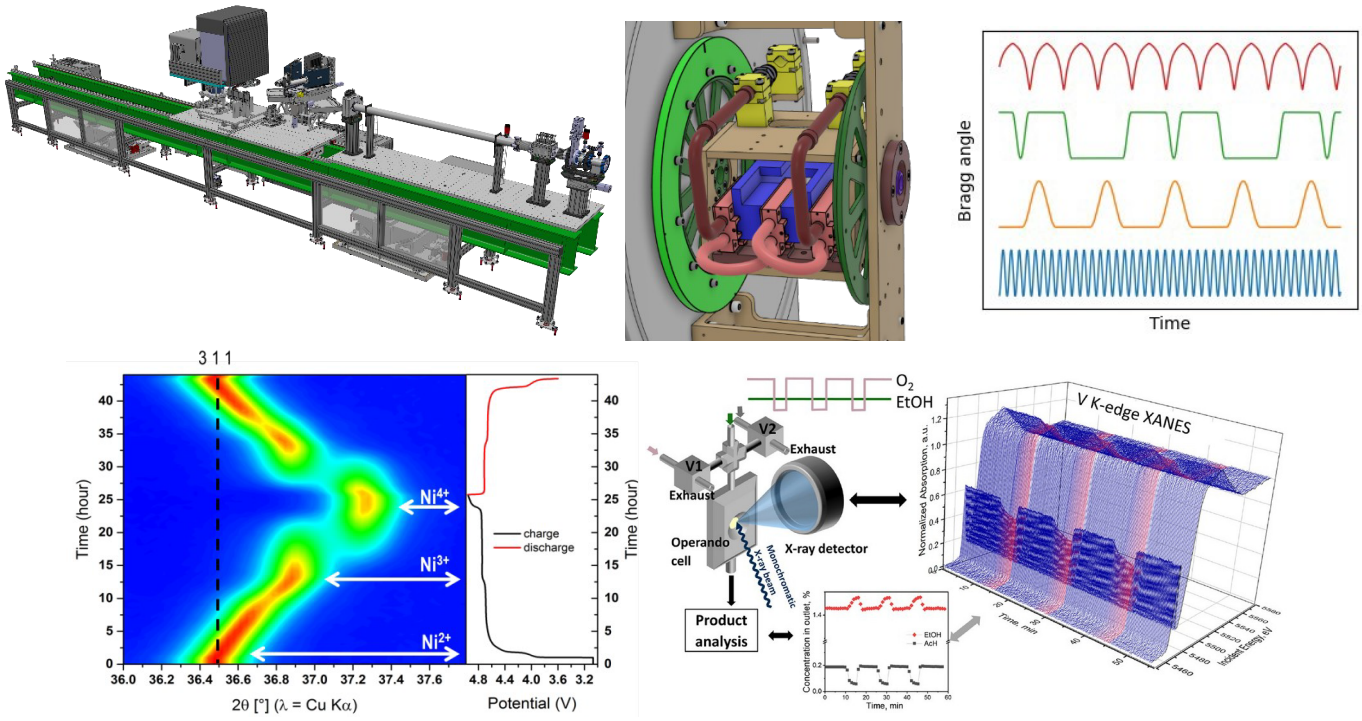

Figure 1. Design of the Debye end-station experimental table, monochromator, motion patterns and experimental capabilities for operando XAS and XRD analyses.