NSLS-II Beamline Controls Requirements

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Outline

Project beamlines

- Coherent Soft X-ray
- Coherent Hard X-ray
- Hard X-ray Nanoprobe
- Inelastic X-ray Scattering
- Sub-micron X-ray Spectroscopy
- X-ray Powder Diffraction

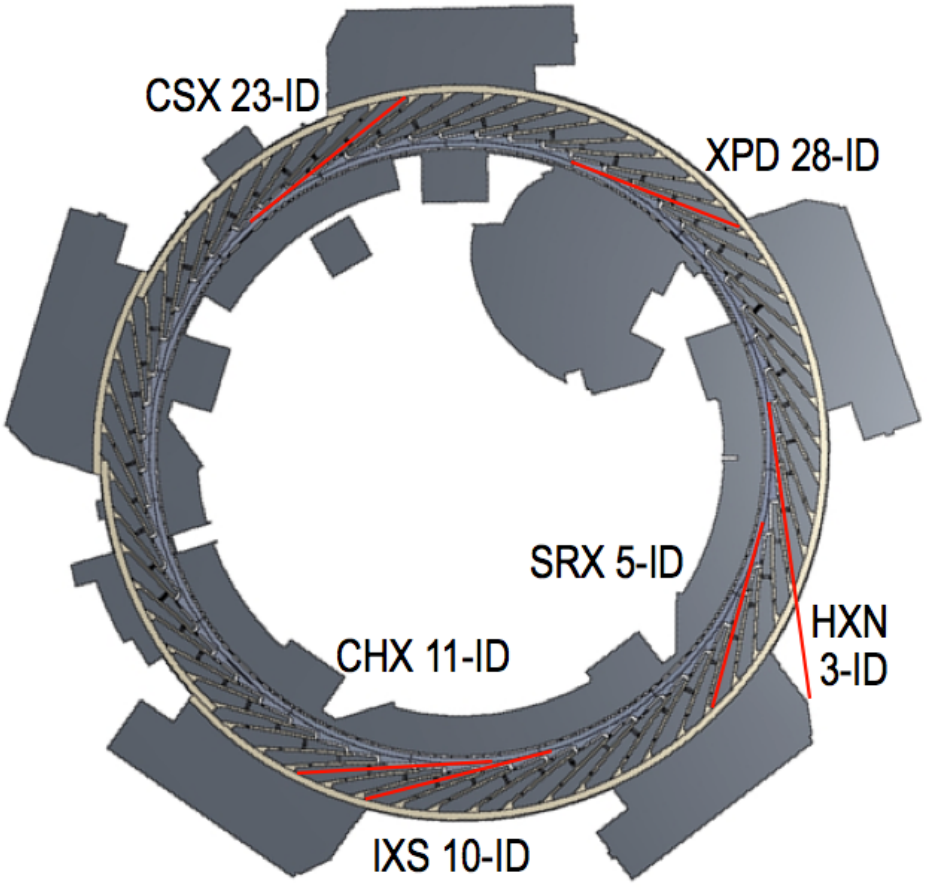

Figure: NSLS-II beamline layout

Identification of controls requirements

Currently in early stages of design process.

Working with beamline scientists to define experimental techniques and specific equipment operational capabilities.

Need to ensure control system (instrumentation, software, hardware, infrastructure) is capable of supporting experimental process.

Define form of experimental data and required metadata.

Identification of specific motion control applications.

Coherent Soft X-ray

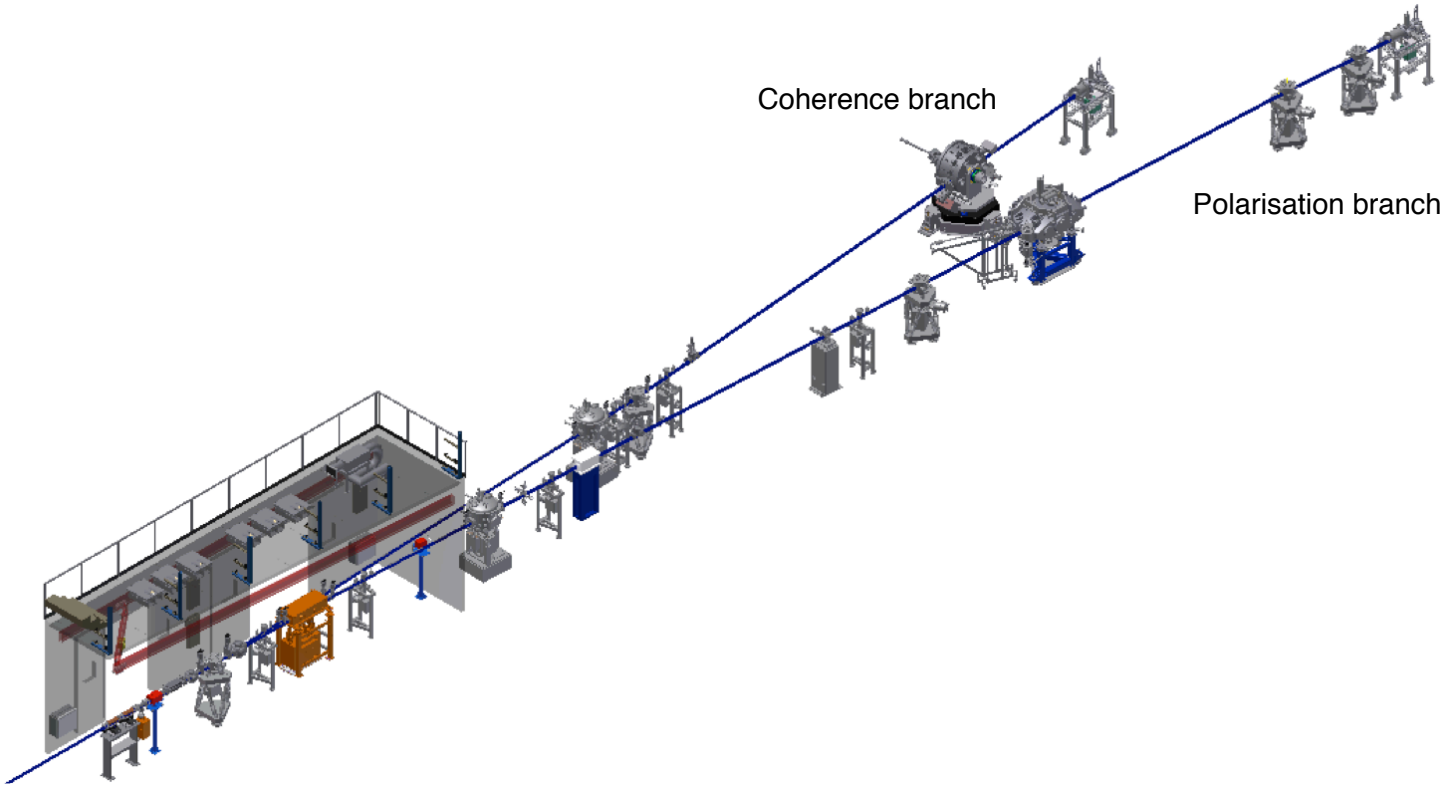

Figure: CSX beamline layout

Coherent Soft X-ray

Twin elliptically polarising undulators - inline with phasing/canting magnet

Three operating modes

- Two branches operating independently (requires canting)
- Coherence branch only (requires phase matching)
- Polarisation branch only (requires canting)

High speed detectors (1 kHz frame rates initially, future 100 kHz) - extremely large data volumes and rates

Coordination between undulator and monochromator required for polarisation mode energy scans

High speed alternation of polarised beams

Coherent Hard X-ray

Extremely high stability optics - coherence preservation critical

Simultaneous experimental techniques - SAXS, WAXS, XPCS

High speed area detectors (similar to CSX)

Hard X-ray Nanoprobe

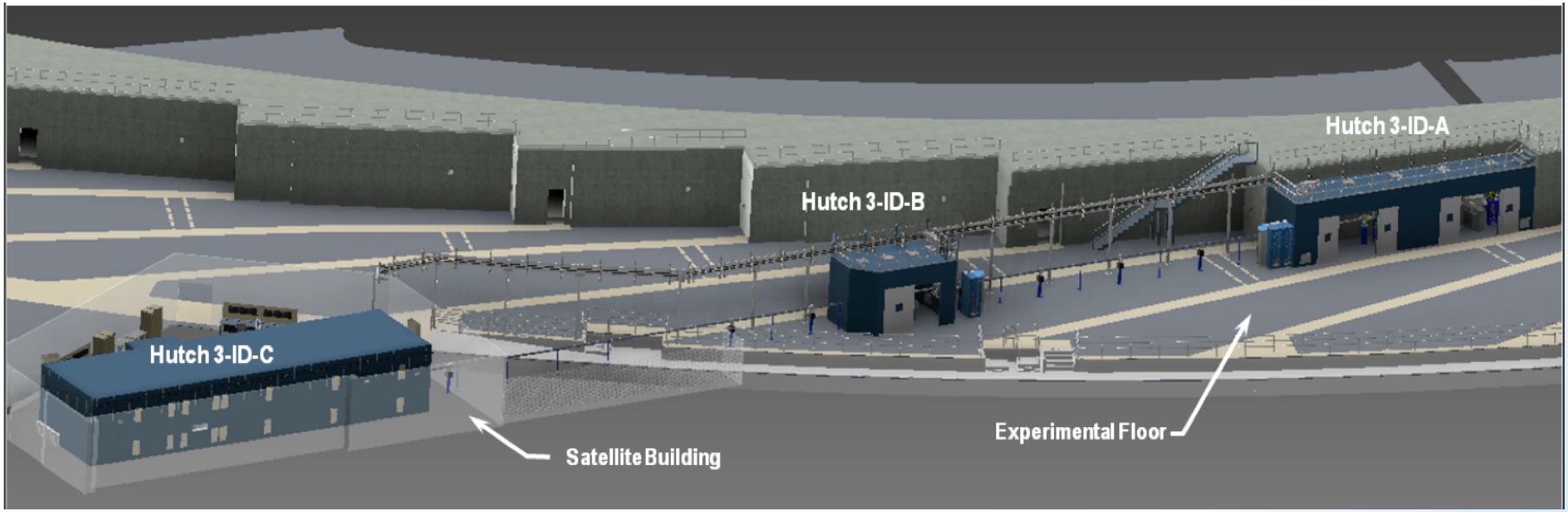

Figure: HXN overview

Hard X-ray Nanoprobe

Initial beam focus size 10 nm

Ultimately focusing to 1 nm

High precision sample and optics position control (< 1 nm)

Extremely tight stability requirements - mechanical, thermal

Inelastic X-ray Scattering

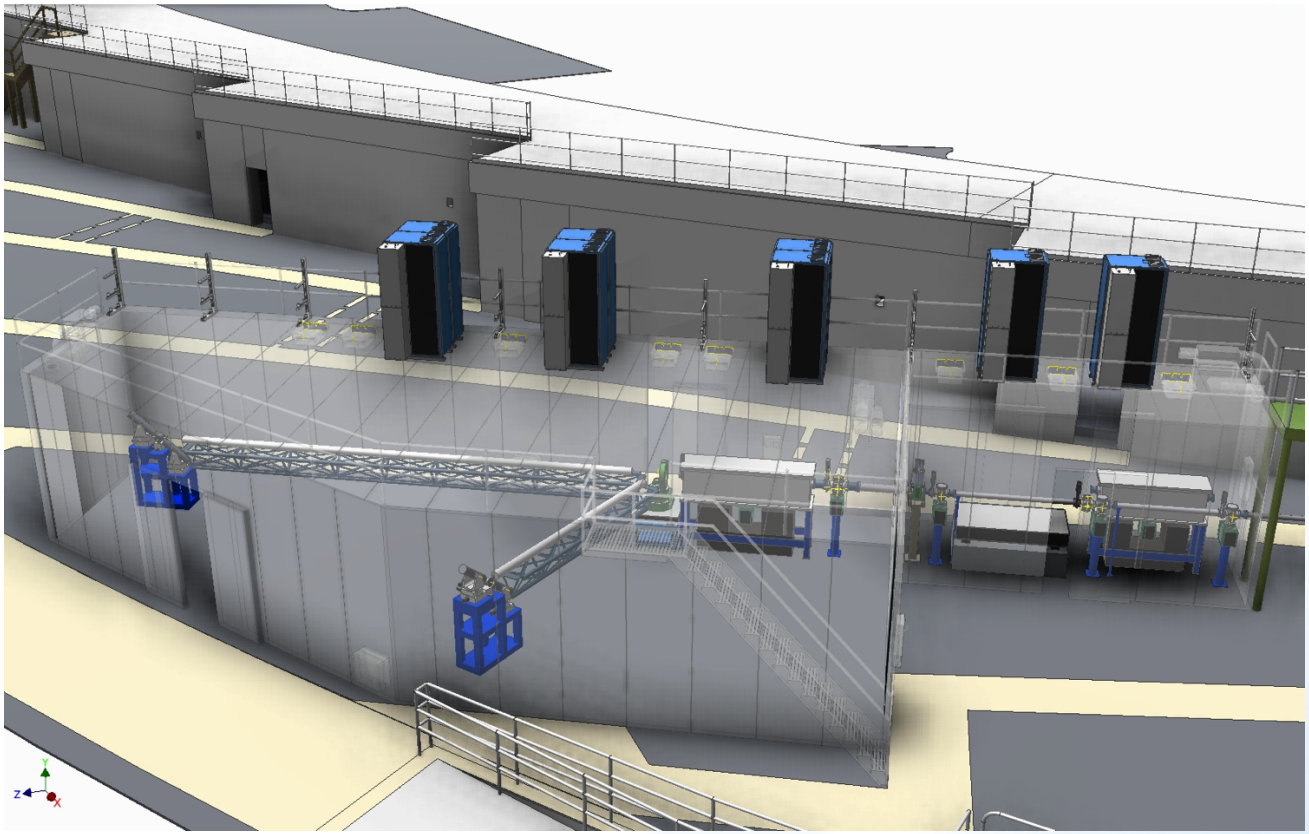

Figure: IXS overview

Inelastic X-ray Scattering

Extremely high energy resolution (1 meV initially, 0.1 meV later)

Complex high-resolution monochromator and analyser

Very low photon count rates

Energy scanning possibly done by changing crystal temperature

Sub-micron Ray X-ray Spectroscopy

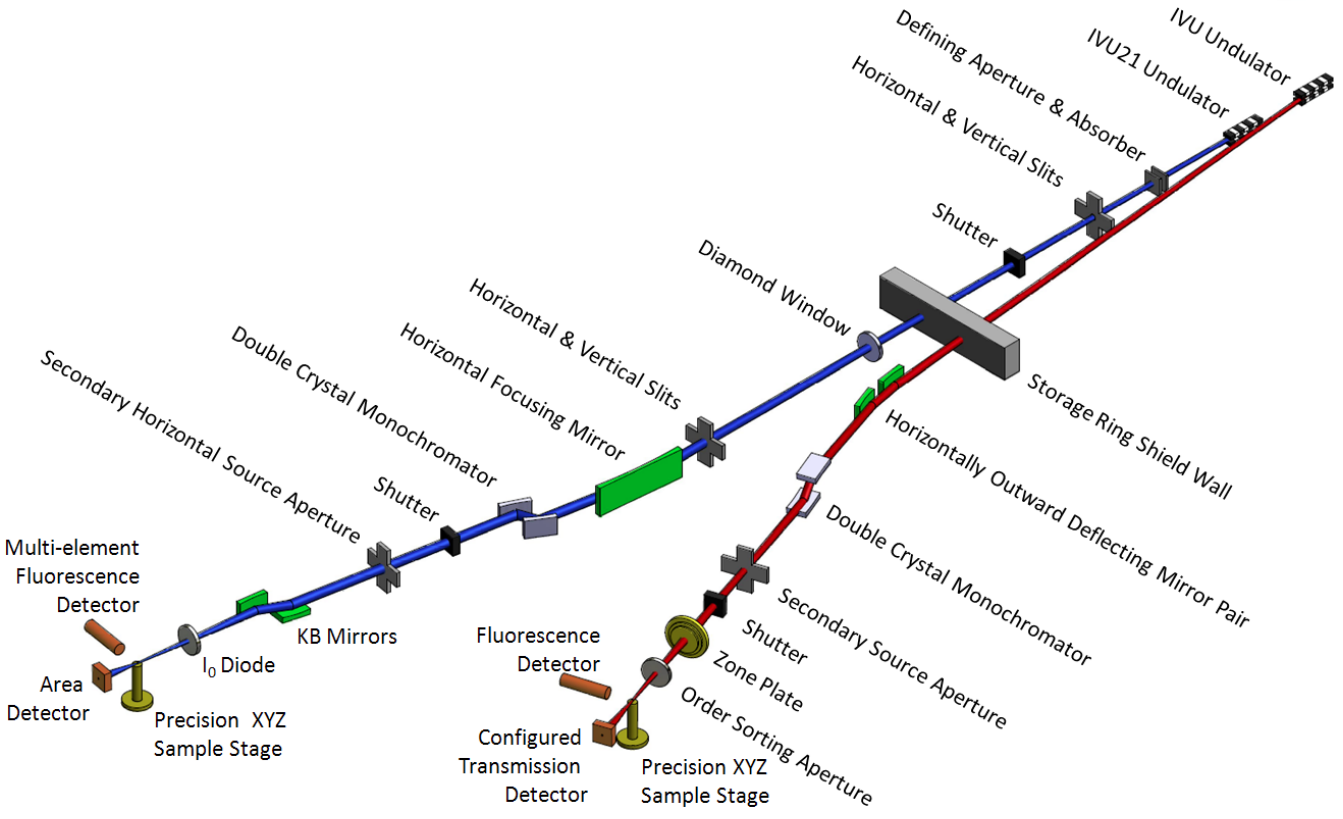

Figure: SRX overview

Sub-micron Resolution X-ray Spectroscopy

Focus size down to < 100 nm

Three dimensional scans - two spatial dimensions and energy

Need to synchronise undulator and monochromator motions for energy scans on the fly

Large data volumes from energy sensitive photon counting detector (e.g. MAIA)

Hard X-ray Powder Diffraction

High energy - 30 - 65 keV

Different operating modes - high flux, high energy resolution

Combination of point, 1-D and 2-D detectors

Simultaneous experimental techniques - PDF, standard diffraction, medium angle scattering

Significant software development requirements to support experimental operation

Automatic sample changing

High heat load - 60 kW from wiggler

Future beamlines

6 project beamlines

12 new ID beamlines already approved and being developed

At least 12 more will be developed soon

Common controls requirements across beamlines

Integrated experiment control, data acquisition and data analysis software

Analysis of data on the fly to allow direction of the experiment

Fly-scanning - most experiments will be controlled in hardware rather than software

Large data volumes and large data rates

Simultaneous experimental techniques - multiple detectors

Questions?