A New Experimental Station for Liquid Interface X-Ray Scattering At NSLS-II Beamline 12-ID

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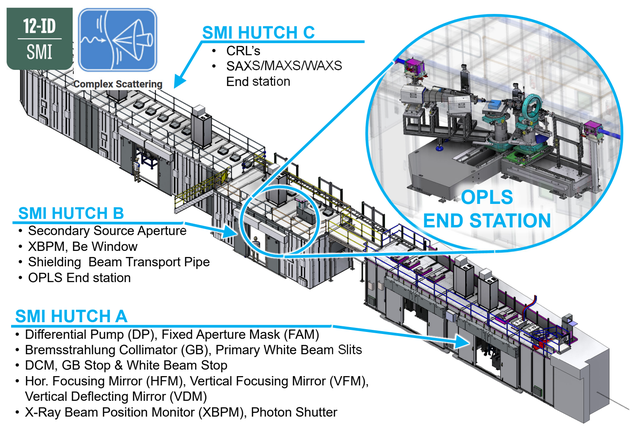
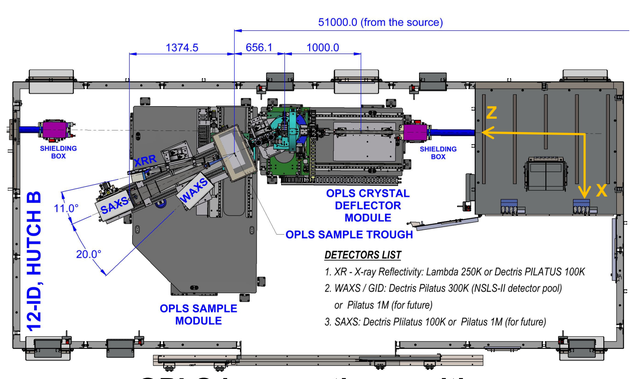
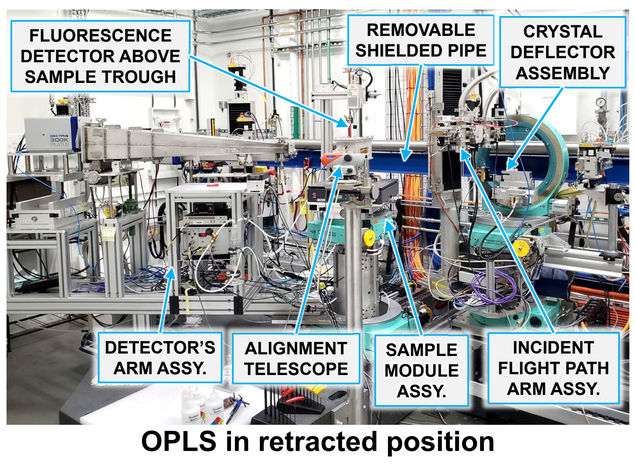


12-ID, SMI beamline overview
(OPLS is located inside Hutch B)

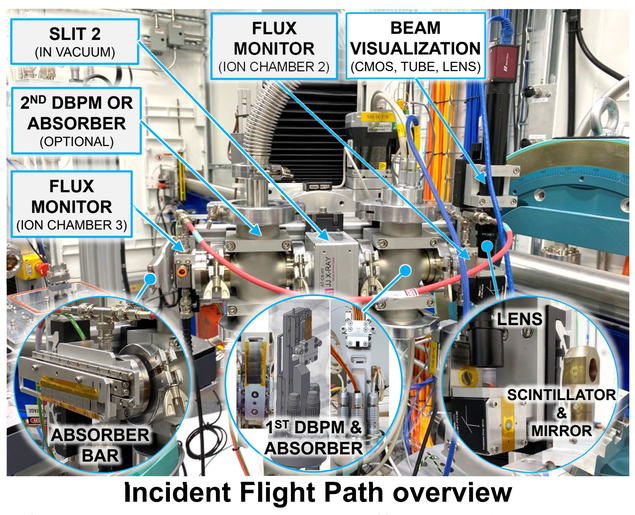
OPLS END STATION SPECIFICATIONS	
Port Number:	12-ID
Source:	In-Vacuum Undulator (IVU23), 23mm period
Energy Range:	8 – 24 keV
Flux:	> 1*10^{12} ph/s
Spot Size:	20 μm (Ver.) x 400 μm (Hor.)



OPLS in operation position
(Transport shielded pipe removed)



OPLS in retracted position
(Transport shielded pipe installed)



Incident Flight Path overview
(The beam visualization is offset and translated into the beam using the IFP motion)

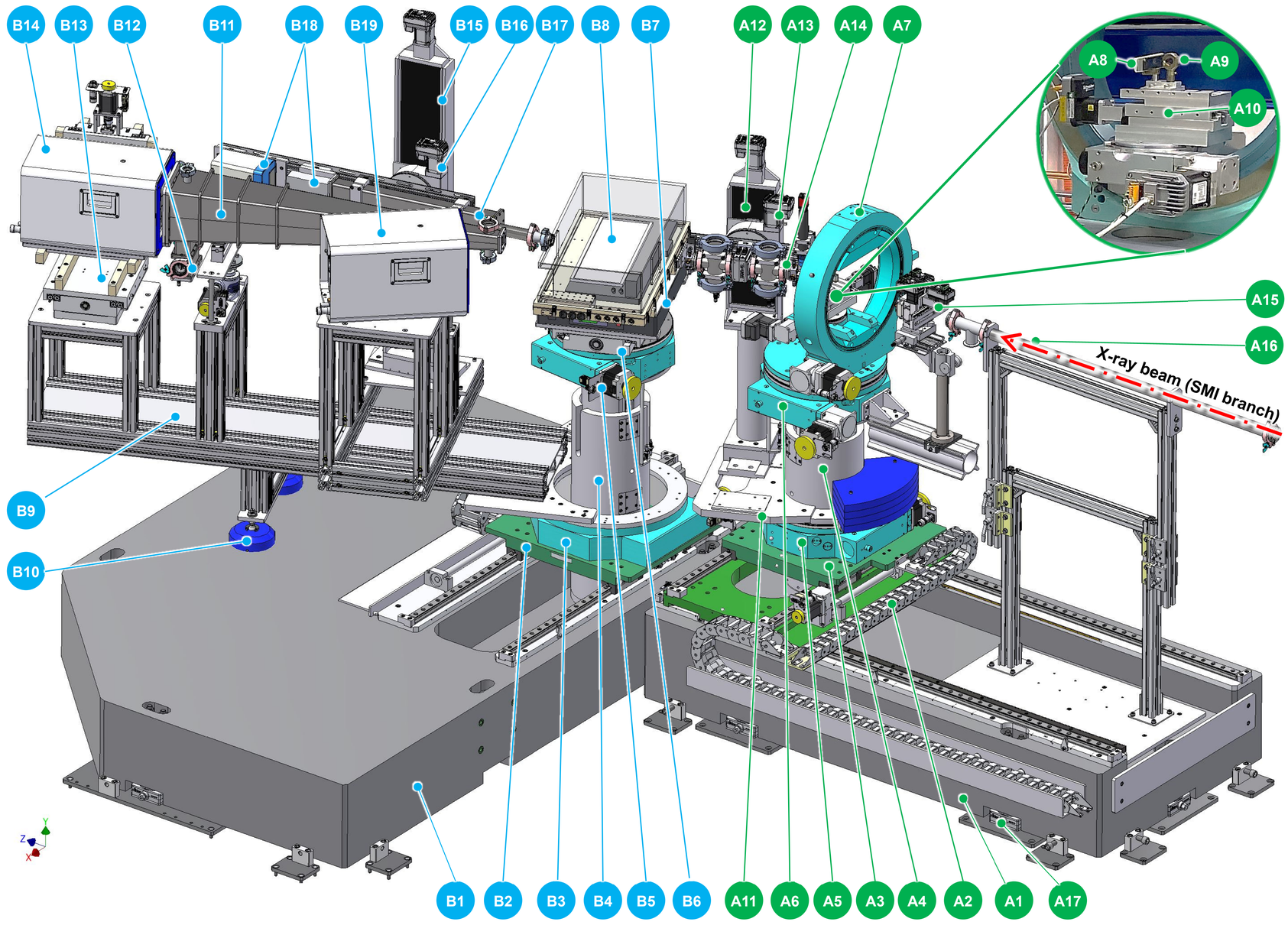
Abstract. **O**pen **P**latform and **L**iquids **S**cattering (OPLS) is a new experimental station recently built and currently being commissioned at the **S**oft **M**atter **I**nterfaces (SMI) beamline 12-ID at NSLS-II. The new instrument expands SMI's beamline scientific capabilities via the addition of X-ray scattering techniques from liquid surfaces and interfaces.

The design of this new instrument, located inside the 12-ID beamline shielding enclosure (hutch B) uses a single Ge (111) crystal deflector to bounce the incident x-ray beam downward by a variable angle α downwards away from the horizontal by rotating the large Huber Eulerian cradle χ stage. Tilting the beam is essential for liquid samples where gravity dictates the sample normal.

The OPLS instrument has a variable deflector-to-sample distance ranging from 0.6 m to 1.5 m. The X-ray detectors are mounted on a 2-theta scattering arm located downstream of the sample location. The 2-theta arm is designed to hold up to three X-ray detectors, with fixed 2-theta angular offsets, each dedicated to a different X-ray technique such as X-ray reflectivity (XR), Grazing Incidence (GI) Small-Angle X-ray Scattering (SAXS) and Wide-Angle X-ray Scattering (WAXS), and grazing-incidence angle X-ray fluorescence.

Currently, the OPLS experimental station intercepts the SMI beam that otherwise propagates to the experimental station located in the hutch C and can be retracted to a "parking" position laterally out of this beam, to allow installation of a removable beam transport shielded pipe that is needed to support operations in hutch C.

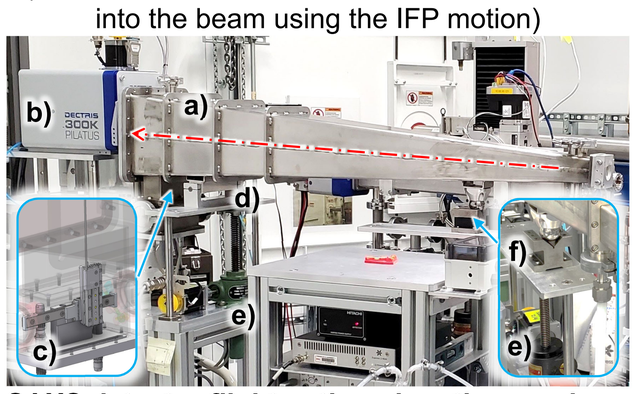
The design of OPLS is flexible enough to adapt to a planned future configuration of the SMI beamline in which a OPLS is illuminated independently via a second, canted undulator source and a separate photon delivery system. In this future configuration, both branches will be able to operate independently and simultaneously.



OPLS Experimental Station Overview

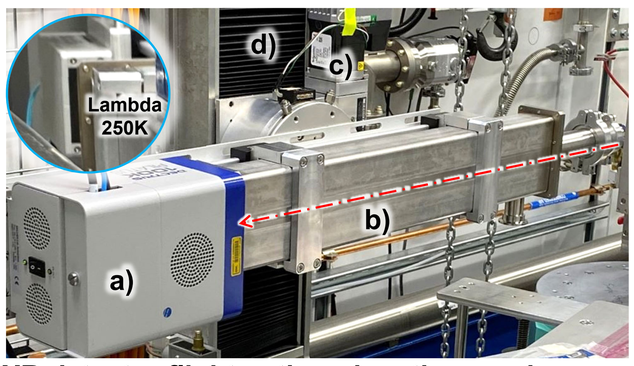
A. ***Crystal Deflector Assembly:*** ***A1****: Granite base support;* ***A2:*** *Linear stage (Z);* ***A3:*** *Linear stage (X);* ***A4:*** *Linear stage (Y);* ***A5:*** *Goniometer (2θ , Huber 430), for Incident Flight Path (IFP) arm;* ***A6:*** *Goniometer (θ , Huber 430), for crystal deflector ;* ***A7:*** *Eulerian cradle (χ and ϕ circle, Huber 512.1);* ***A8:*** *Crystal deflector Ge (111);* ***A9:*** *Cross hair alignment target;* ***A10:*** *Crystal deflector translation stage;* ***A11:*** *IFP arm;* ***A12:*** *IFP vertical translation stage;* ***A13:*** *IFP goniometer (Huber 411), rotates on horizontal axis;* ***A14:*** *IFP assembly, which includes the beam visualization, ion chambers, in-vacuum slits, Diamond Beam Position Monitor (DBPM) and absorber bar;* ***A15:*** *Upstream conditioning assembly;* ***A16:*** *Upstream flight path;* ***A17:*** *Granite base level adjustment (Airloc 2120-KSKC).*

B. ***Sample and Detectors Arm Assembly:*** ***B1:*** *Granite base support;* ***B2:*** *Sample linear stage (X);* ***B3:*** *Goniometer (2θ, Huber 440), for detector's arm;* ***B4:*** *Sample linear, vertical stage (Y);* ***B5:*** *Sample goniometer (θ, Huber 430);* ***B6:*** *Sample linear translation stage;* ***B7:*** *Active vibration control table (Herzan TS-150);* ***B8:*** *Liquid sample environment trough (e.g. modified Kibron G4 Langmuir trough) or processing sample environment (e.g. roll-to-roll processing, additive manufacturing);* ***B9:*** *Detector's arm, rotates around (Y) and move along with (X) stage;* ***B10:*** *Flat round air bearings (Newway Air Bearings S101501);* ***B11:*** *SAXS Detector flight path;* ***B12:*** *In-vacuum beam stop and positioning stages assembly (X-Y) ;* ***B13:*** *SAXS detector positioning stages assembly (X-Y);* ***B14:*** *SAXS detector Dectris Pilatus 100K or PILATUS 1M (currently unavailable);* ***B15:*** *XR detector arm, vertical motion stage (Y);* ***B16:*** *XR detector arm goniometer (Huber 411);* ***B17:*** *XR detectors flight path;* ***B18:*** *XR detectors, Lambda 250K GaAs or Dectris Pilatus 100K (both available on the mounting rail, with ability to swap position);* ***B19:*** *WAXS detector Dectris Pilatus 1M (currently unavailable) or Dectris Pilatus 300K (from NSLS-II detector pool).*



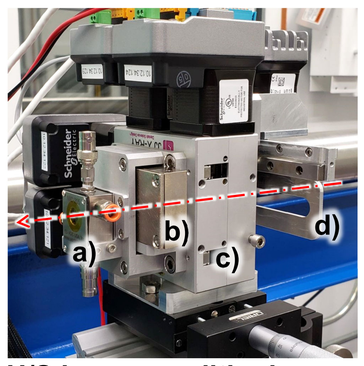
SAXS detector flight path and motion mech.

a) Flight path tube (can rotate on virtual pivot @ sample location);
b) Detector on X-Y positioning stages assembly, detached from a);
c) In-vacuum beam stop & X-Y (SmarAct) positioning stages;
d) D/S Flight path hinge;
e) D/S & U/S Motorized (Y) jack-screw actuator & linear guide;
f) Pivot (sphere on V groove).



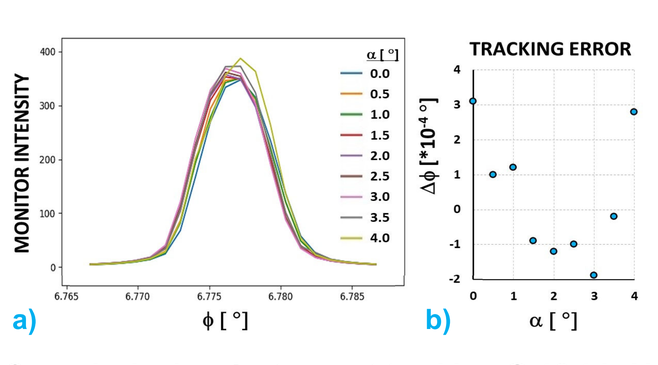
XR detector flight path and motion mech.

a) XR detector (Dectris Pilatus 100K or Lambda 250k GaAs);
b) Flight path tube (includes a beam stop);
c) Motorized rotation (around Hor. Axes) stage (Huber 411);
d) Vertical translation stage;



U/S beam conditioning

a) Beam flux monitor (Ion chamber 1);
b) Instrument photon shutter;
c) Beam slits;
d) Absorber bar.



Commissioning: Instrument tracking @ 16.1 keV

a) The ϕ rocking scan profiles at various downward projected angles $0°<\alpha<4°$; (The rocking curve width are dominated by the Ge (111) deflection crystal's Darwin width)
b) The variation in the centroid is ~ 0.0002°, more than adequate for a single χ motion to deflect the beam downwards. (The tracking error is less than 10% of the FWHM of the rocking curve)

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