Inelastic X-Ray Scattering (IXS)

Scientific scope

Many hot topics related to the high frequency dynamics of condensed matter require both a narrower and steeper resolution function and access to a broader dynamic range than what are currently available. This represents a sort of “no man’s land” that falls right in the dynamic gap lying between the high frequency spectroscopies, such as inelastic x-ray scattering (IXS), and the low frequency ones. New IXS spectrometers with improved energy and momentum resolutions would be required to fill this gap.

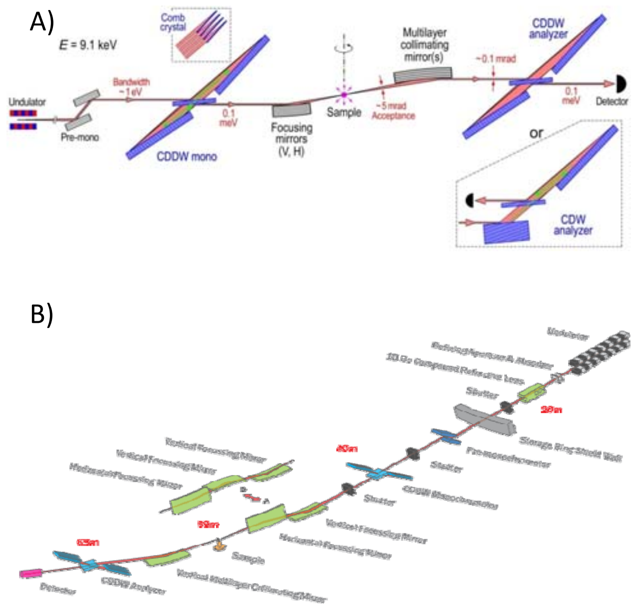
To achieve this goal, a new x-ray optics concept for both the monochromatization and energy analysis of x-rays will be implemented at the NSLS-II IXS beamline. This solution exploits the effect of angular dispersion in asymmetric Bragg diffraction, through the so-called CDW/CDDW arrangements (see figure A), for which aggressive R&D is currently being undertaken by NSLS-II. We aim to achieve within the baseline scope a 1 meV resolution with a sharp resolution tail and a momentum resolution better than 0.25 nm^{-1}. The setup of this novel spectrometer will benefit many areas of research, including:

- Relaxation dynamics, sound propagation and transport properties in disordered systems such as glasses, fluids, polymers, etc.
- Collective dynamics of lipid membranes and other biological systems
- Dynamical studies on confined systems

In the further development phase of the beamline, we aim to achieve the ultimate goal of a 0.1 meV resolution function and a momentum resolution substantially better than 0.1 nm^{-1}.

Beamline description

The baseline design of the beamline (see figure B) includes a compound refractive lens to pre-focus and a double crystal high heat load monochromator to pre-monochromatize the beam before it is delivered to the high-resolution CDDW monochromator. The monochromatic beam is then focused by a set of KB mirrors to the sample. A multilayer double (horizontal and vertical) collimating mirror, mounted on the spectrometer arm, allows collecting the beam scattered by the sample with a large angular acceptance and delivers a beam within a divergence low enough to be accepted by the CDDW analyzer system. The analyzed radiation will finally be recorded by a strip



Schematic layout of the beamline

[Conceptual Design Report]

Current status:	preliminary design
Construction:	begins January 2012
Commissioning:	begins June 2014
User operation:	begins June 2015

detector. In the mature phase, the dispersive elements of the analyzer will be replaced by the so-called comb crystal, and a channel cut crystal will be added after the CDDW monochromator to achieve the ultimate 0.1 meV resolution.

Techniques

- High resolution (1 meV) inelastic x-ray scattering
- Deep inelastic x-ray scattering at high momentum transfers

Beamline Performance

Source	In-Vacuum Undulator
Incident energy (keV)	9.132 KeV
Wavelength (Å)	1.358
Momentum transfer (nm^{-1})	0.5-80
Energy resolution (meV)	1
Beam size at sample (μm^2 FWHM)	~ 10(H) × 5(V)
Flux at sample @1meV (ph/s)	1.6×10^{10}

Sample environments

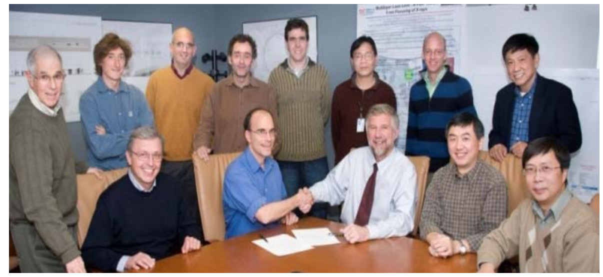
He cryostat	4 – 300 K
Cryostream	80 – 500 K
Pressure cells	< 100 GPa

Detectors

Si PIN photodiodes	$18\times18mm^2$, 0.3mm thick
Si Drift Detector (SDD)	$5\times5mm^2$, 0.5mm thick
Si strip detector	125µm pitch, $4\times80mm^2$

Contacts

Yong Cai	cai@bnl.gov
Alessandro Cunsolo	acunsolo@bnl.gov



Signing of the agreement between NSLS II Project Director Steve Dierker and the Beamline Advisory Team, December 5, 2008. Seated from left: Yuri Shvyd'ko (APS), Clement Burns (WMU, BAT chair), Steve Dierker, Qun Chen, and Yong Cai (IXS group leader).Standing from left: Steve Shapiro, Tullio Scopigno (Uniersity La Sapienza, Rome), Alessandro Cunsolo, Michael Krisch (ESRF), Marcelo Honnicke, Xianrong Huang, John Hill, and Ho-Kwang (David) Mao (Carnegie Institute).