COSMIC – Future facilities at the ALS for Diffraction Microscopy and XPCS

Roger W. Falcone[1]**,** Malcolm R. Howells[1], Chris J. Jacobsen[2] **,** Stephen D. Kevan[3], Janos Kirz[1] , John C. H. Spence[4], ***Tony Warwick*** [1]
[1]Advanced Light Source, [2]Stony Brook University, University of Oregon[3], Arizona State University[4].

With the ALS upgrade to top-off operation during this calendar year, the brightness of the source and hence the coherent soft X-ray flux will increase by an order of magnitude or more. With a dedicated elliptically polarizing undulator, and optimized beamline designs we expect to dramatically increase the capabilities available at the ALS for diffraction microscopy and XPCS. Construction of this facility, named COSMIC has been designated the top priority in the ALS Strategic Plan. The optical design of COSMIC, based on a pair of coherence conserving spherical grating monochromators will be presented.

Speckle Patterns with Atomic and Molecular de Broglie Waves

Forest Patton[1]**,** Dan Deponte,[1] Greg Elliott,[2] ***Stephen Kevan***[1]

[1]Physics Department, University of Oregon, [2]Physics Department, University of Puget Sound

The burgeoning interest in coherent x-ray beams motivates consideration of other kinds of particle beams with adequate brightness to allow a comparable suite of experiments. For example, high brightness field emission sources enable electron microscopes to utilize transverse coherence in various imaging applications. Atomic coherence is an integral part of the Bose-Einstein condensation in atom traps, and this coherence is increasingly used in many novel applications – though none very similar to those being developed in the x-ray regime.

We have developed a free-jet nozzle source that delivers a continuous beam of atomic helium or molecular hydrogen having a high degree of transverse coherence and with an optical brightness about a factor of 100 lower than an x-ray undulator at a third generation synchrotron radiation facility. The de Broglie wavelength of ~1 Å suggests applications similar to those being developed using coherent x-ray beams – phase retrieval and imaging, correlation spectroscopy, speckle metrology, etc. Using this source we have measured single slit diffraction patterns and the first ever speckle-diffraction patterns using atomic and molecular de Broglie waves. Our results suggest fruitful application of coherent matter beams at short wavelength, with extreme surface sensitivity, and with essentially no sample damage.

Characterization of thin diamond windows using coherent scattering

Kenji Tamasaku[1,2], Yukio Takahashi[1,2], Yoshinori Nishino[1], Tetsuya Ishikawa[1]

[1]RIKEN SPring-8 Center, 1-1-1 Koto, Sayo-cho, Sayo-gun, Hyogo, 679-5148 Japan
[2]Dep. of Precision Science and Technology, Graduate School of Eng., Osaka Univ., 2-1 Yamada-oka, Suita, Osaka 565-0871 Japan

The construction of free-electron lasers (FEL) forced reconsideration of x-ray optical elements, such as monochromator crystals, terminating windows, and attenuators. One of the rigorous requirements for the optics is to handle the unprecedented peak power of FEL pulse, e.g. ~10 GW. The peak power is estimated to be close to the threshold of non-thermal melting for most materials. This estimation recommends low-Z materials. Other requirement is coherence preservation of the FEL beam. Considering these points, diamonds may be a good candidate for standard optical elements of FEL.

The coherent scattering techinique was used to investigate how diamond windows and/or attenuators affect the coherent beam. The sample was high-quality synthetic type IIa diamond crystals with the (100) surfaces. If the sample had been ideal, no pattern should have been observed. However, the measured image shown below had an oblique streak, and two independent fringes. Note that the vertical and the horizontal streaks were artifact. The origin of the observed features and the relation to the surface and the bulk quality of the sample will be discussed.

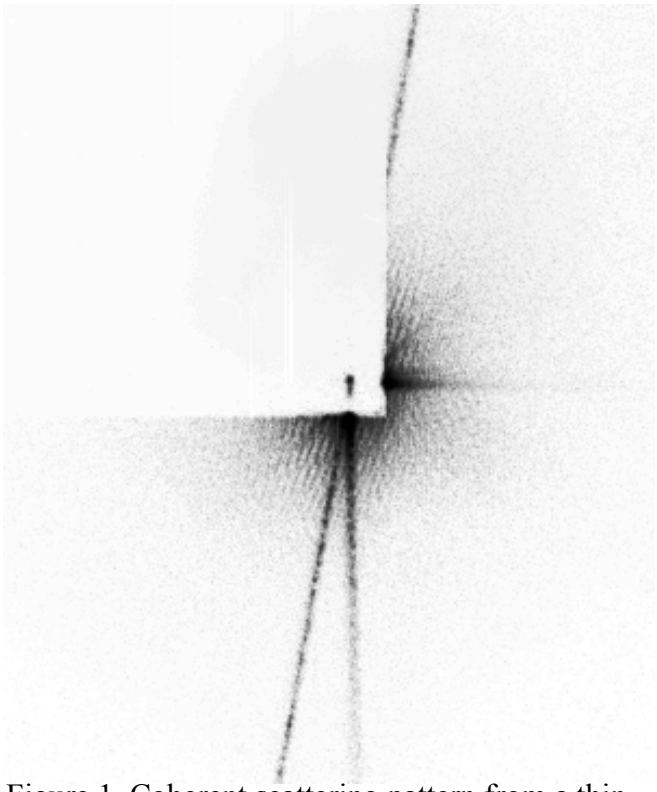

Figure 1. Coherent scattering pattern from a thin diamond window.

cSAXS – The new Coherent Small-Angle X-Ray Scattering Beamline at the Swiss Light Source

A. Menzel, O. Bunk, X. Donath, L. Schulz, E. Zimoch, P. Jalocha, C. Lüscher, P. Kraft, E.F. Eikenberry, B. Henrich, C. Brönnimann, T. Schmidt, Q. Chen, R. Abela, and F. Pfeiffer
Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

cSAXS is the new state-of-the-art facility at the Swiss Light Source (SLS) for small-angle x-ray scattering (SAXS), coherent diffraction imaging (CDI), and x-ray photon correlation spectroscopy (XPCS), among other techniques. We present the general layout and specifications, as well as first beamline characterization results.

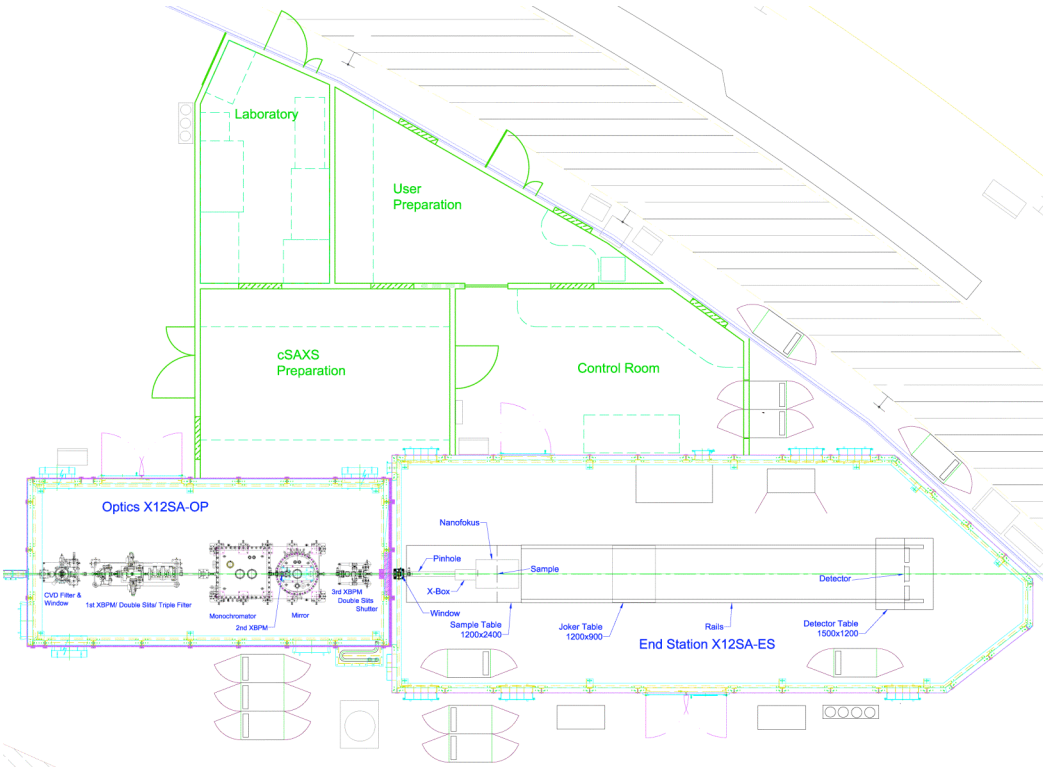

Figure 1: Overview of the layout of cSAXS (X12SA) at the Swiss Light Source.

Among the most salient tools at cSAXS is the PILATUS II detector, a PSI-developed two-dimensional hybrid pixel array detector[1] operating in single-photon counting mode. We will discuss some of its unique features, which include no readout noise, maximal count rate ~1MHz/pixel, framing rate up to 100Hz, dynamic range of 20bit, and no point spread beyond single pixels.

The pilot phase of user operation at cSAXS begins July 2007. Normal user operation is scheduled to commence beginning 2008.

---

[1]C. Brönnimann *et al.*, J. Synchrotron Rad. **13** (2006) 120, *The Pilatus 1M Detector*.