

# Versatile USAXS (BONSE-HART) facility for advanced materials research

Eighth International Conference on Synchrotron Radiation Instrumentation, Yerba Buena Center for the Arts, San Francisco, California, 24-28 August 2003

J. Ilavsky<sup>a</sup>, P. R. Jemian<sup>c</sup>, A. J. Allen<sup>b</sup>, and G. G. Long<sup>b</sup>



<sup>a</sup>Purdue University, West Lafayette, IN 47907 USA

<sup>b</sup>National Institute of Standards and Technology, Gaithersburg, MD 20899 USA

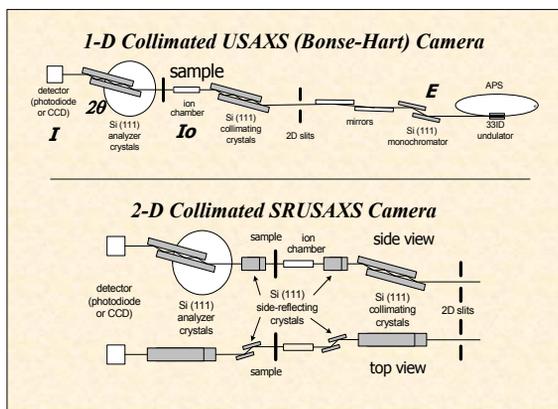
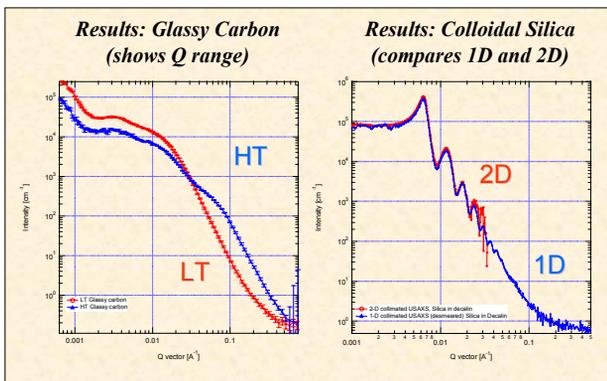
<sup>c</sup>University of Illinois, Urbana-Champaign, IL 61801 USA



Submitting author: J. Ilavsky, e-mail: ilavsky@aps.anl.gov, FAX: (630) 252-0862

## Abstract

The USAXS facility at UNICAT Sector 33 at the Advanced Photon Source (APS) is a world-class resource for advanced materials research emphasizing full-range characterization of nanometer-scale to micrometer-scale microstructures. Receiving photons from an APS Undulator A X-ray source, the instrument delivers  $\approx 10^{11}$  ph s<sup>-1</sup> incident in a 0.4 mm  $\times$  2.5 mm area at the sample position for 10 keV photons, has an incident photon energy range from 7 keV to 19 keV, a single-scan  $Q$  range (where  $Q = 4\pi/\lambda \sin \theta$ ,  $\lambda$  is the photon wavelength, and  $2\theta$  is the angle of scatter) from 0.00012  $\text{\AA}^{-1}$  to 1  $\text{\AA}^{-1}$ , over 10 decades of detector intensity range, absolute intensity calibration by primary methods, fluorescence rejection in the scattered beam, excellent energy resolution ( $\Delta E/E$ ) for anomalous USAXS, and a maximum unfocused beam size of 0.4 mm  $\times$  2.5 mm, with useful beams as small as 20  $\mu\text{m} \times$  20  $\mu\text{m}$ . The facility offers semi-automated data reduction, rapid and rigorous data analysis using state-of-the-art structure factors and models, and radiographic and USAXS-imaging. Both 1-D collimated (slit-smear configuration) and 2-D collimated configurations are routinely available. Ongoing development of this facility continues in an active partnership between the instrument scientists and the user community.



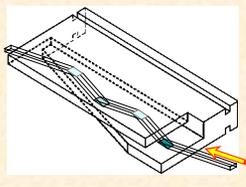
## Comparison of 1-D and 2-D collimation geometries

	standard USAXS	2-D collimated SRUSAXS
collimation	1-D	2-D
desmearing	needed	not needed
Studies	isotropic scatterers	colloids, anisotropic scatterers
$Q$ range	0.00012 $\text{\AA}^{-1}$ to 1 $\text{\AA}^{-1}$	0.00012 $\text{\AA}^{-1}$ to 0.1 $\text{\AA}^{-1}$
Intensity range	up to 9 decades	up to 8 decades
Maximum beam size	2.5 mm (h) $\times$ 0.4 mm (v)	1.0 mm (h) $\times$ 0.4 mm (v)

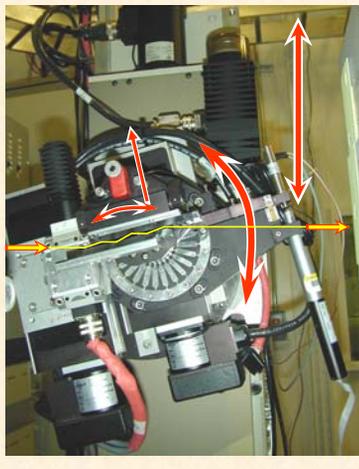
## Compact Instrument



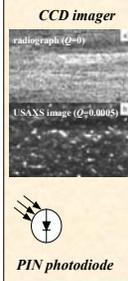
## Collimating channel-cut crystal



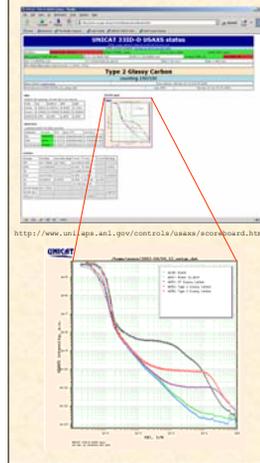
## Analyzer Crystal Stage



## Detectors



## Live data to WWW



- Instrument control and data acquisition in macro language (SPeC)
  - Simple command set, user-specific protocols supported, batch processing
- Customized USAXS data reduction macros in commercial package (Indra)
  - Transmission, blank subtraction, calibration, desmearing, multiple-scattering correction
- General SAS analysis macros in same commercial package (Irena)
  - Size distributions, modeling, desmearing, unified fit

For details see:

- <http://www.uni.aps.anl.gov/usaxs>
- <http://www.uni.aps.anl.gov/usaxs/livedata.html>
- [http://www.uni.aps.anl.gov/~ilavsky/indra\\_2.htm](http://www.uni.aps.anl.gov/~ilavsky/indra_2.htm)
- [http://www.uni.aps.anl.gov/~ilavsky/irena\\_1.htm](http://www.uni.aps.anl.gov/~ilavsky/irena_1.htm)
- <http://www.uni.aps.anl.gov/usaxs/docs/2003-SRI-poster.pdf>
- USAXS web page
- USAXS live data
- Indra web page
- Irena web page
- this poster

## Acknowledgements

The UNICAT facility at the Advanced Photon Source (APS) is supported by the University of Illinois at Urbana-Champaign, Materials Research Laboratory (U.S. Department of Energy (DoE), the State of Illinois-IBHE-HECA, and the National Science Foundation), the Oak Ridge National Laboratory (U.S. DoE), the National Institute of Standards and Technology (U.S. Department of Commerce) and UOP LLC. Use of APS is supported by the U.S. DoE, Basic Energy Sciences, Office of Science, under Contract No. W-31-109-ENG-38