Validating Simulations of Coherent X-ray Scattering Experiments in the Hard X-Ray Range

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Abstract

The Synchrotron Radiation Workshop software (SRW) generates simulations of coherent X-ray scattering and imaging experiments on user-defined samples. SRW supports simulations of both fully and partially coherent radiation propagation through X-ray and infrared beamlines at modern light source facilities. Detailed simulations of coherent X-ray scattering experiments are of paramount importance for modern storage-ring based SR sources. We describe the general approach of SRW simulation methods and present examples of simulations, and their experimental validation, that were generated using nano fabricated samples that were studied at the Coherent Hard X-ray (CHX) beamline at Brookhaven National Laboratory's National Synchrotron Light Source II (NSLS-II).

References

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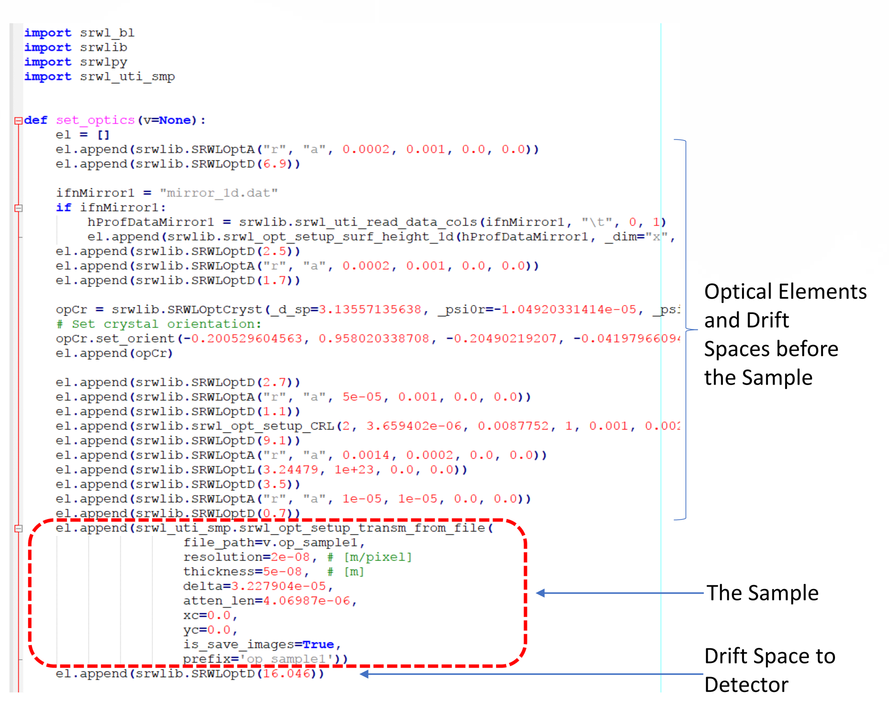
1 Sirepo-Generated Python Source Code Defining CHX Beamline Sample for SRW Simulation

Sirepo and SRW are free to download!

SRW

Sirepo



2 Nano Fabricated Samples

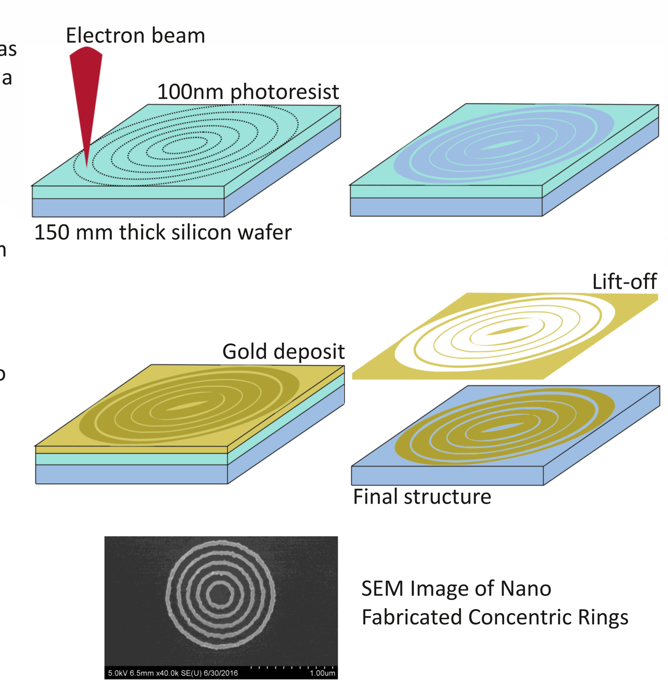
A variety of samples were fabricated by Kevin Yager and Julien Lhermitte using a JEOL JBX6300-FS electron-beam lithography system by patterning gold features onto silicon wafers. We will present our results for three different kinds of nanopatterns: nanodots (roughly hemispherical in shape) arranged in hexagonal arrays, concentric rings, and a combination of nanodots and concentric rings.

1) The patterning was created by applying a layer of photoresist (ZEP520A) and exposing it to an electron beam of accelerating voltage 100 kV at 2 nA beam current, with a dose of 250–750 uC cm^{-2}.

2) The exposed resist was developed in amyl acetate at room temperature for 90 s and rinsed in propan-2-ol for 45 s.

3) Pattern transfer to gold was accomplished by deposition via electron-beam evaporation.

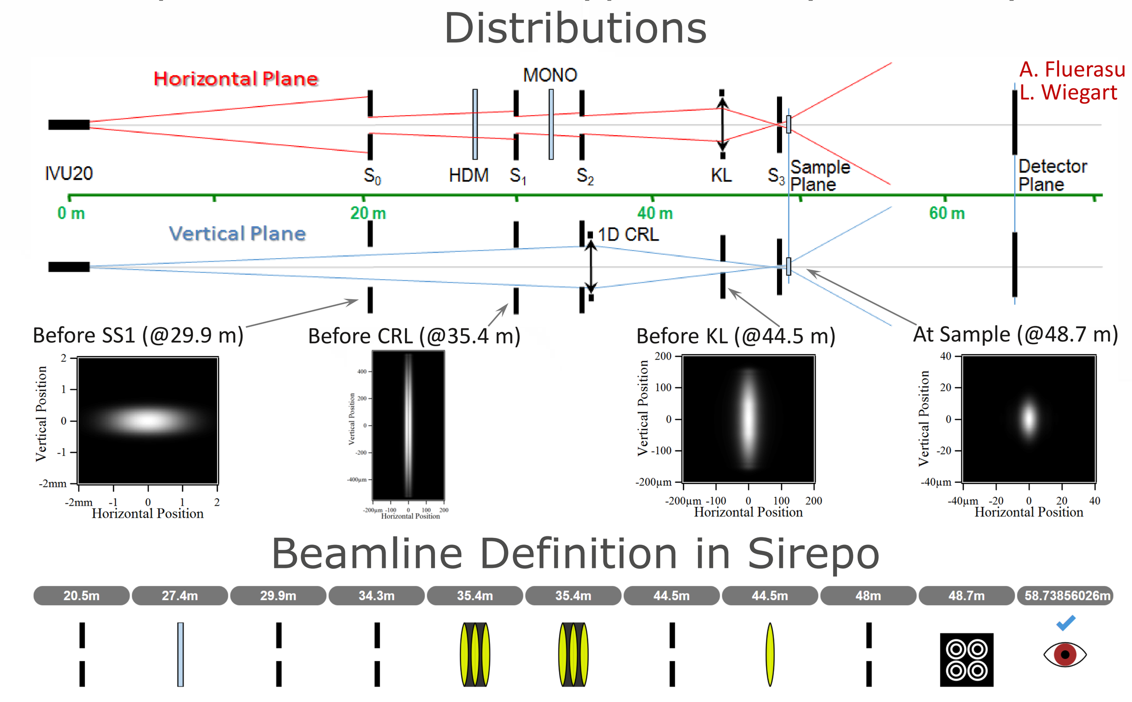
4) The lift-off of excess, in n-methyl pyrollidone at 353 K for 2–4 h, leaves the five concentric rings of one of our samples.



SEM Image of Nano Fabricated Concentric Rings

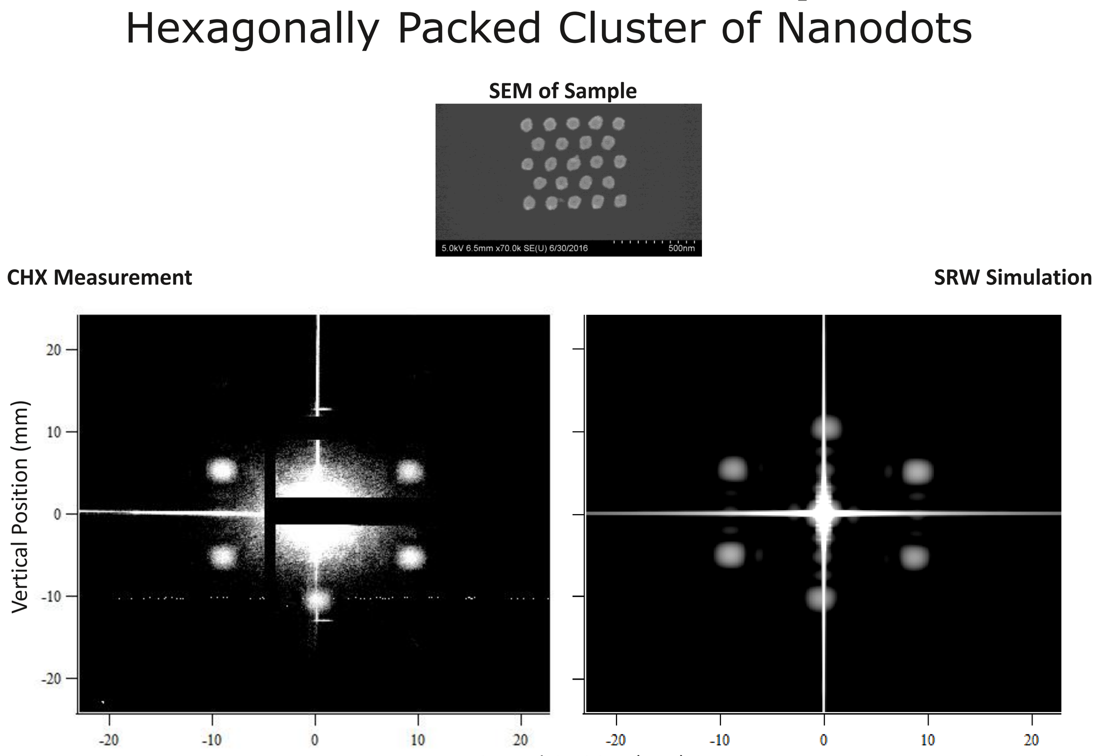
3 Optical Layout of CHX Beamline at NSLS-II

Optical Scheme and Typical X-ray Intensity Distributions



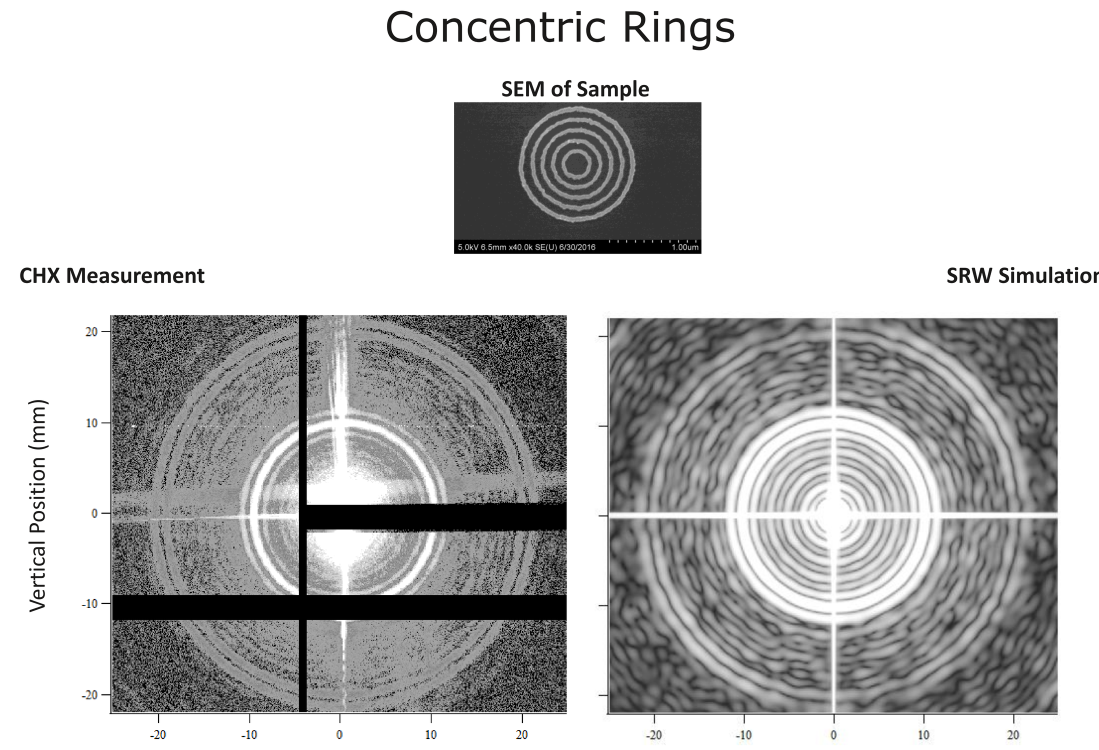
4 Measurement and Simulation of Nano Fabricated Sample

Hexagonally Packed Cluster of Nanodots



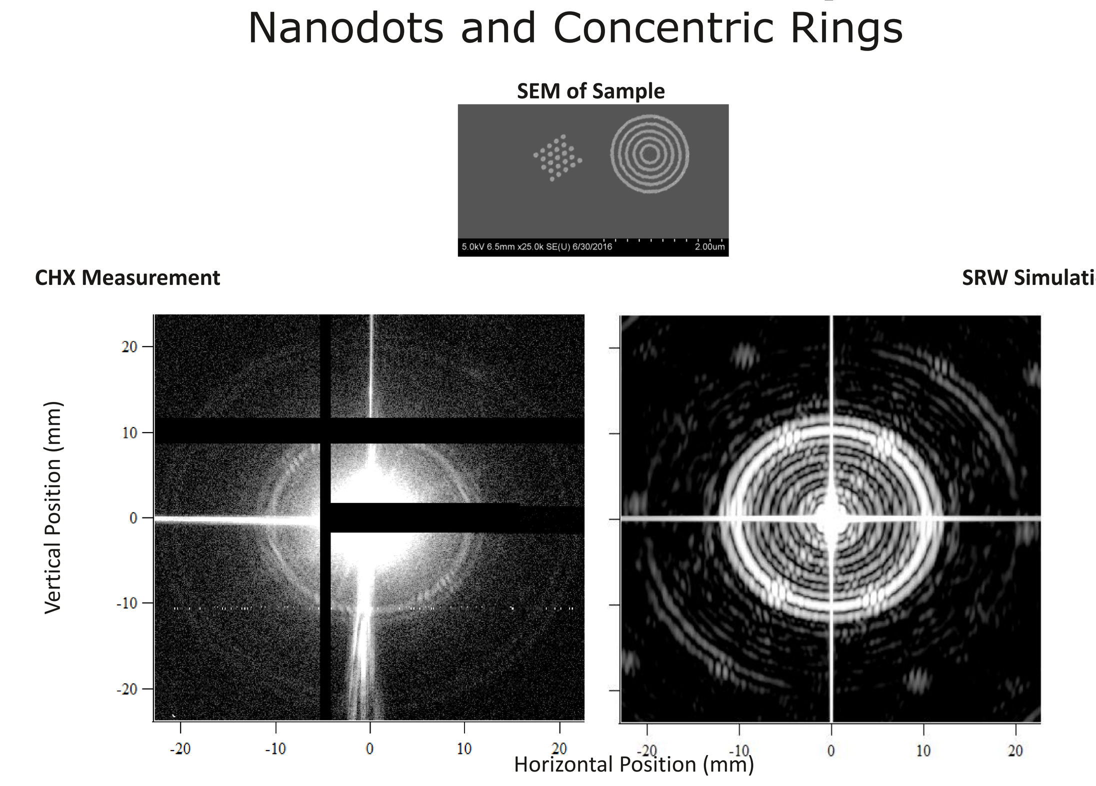
5 Measurement and Simulation of Nano Fabricated Sample

Concentric Rings



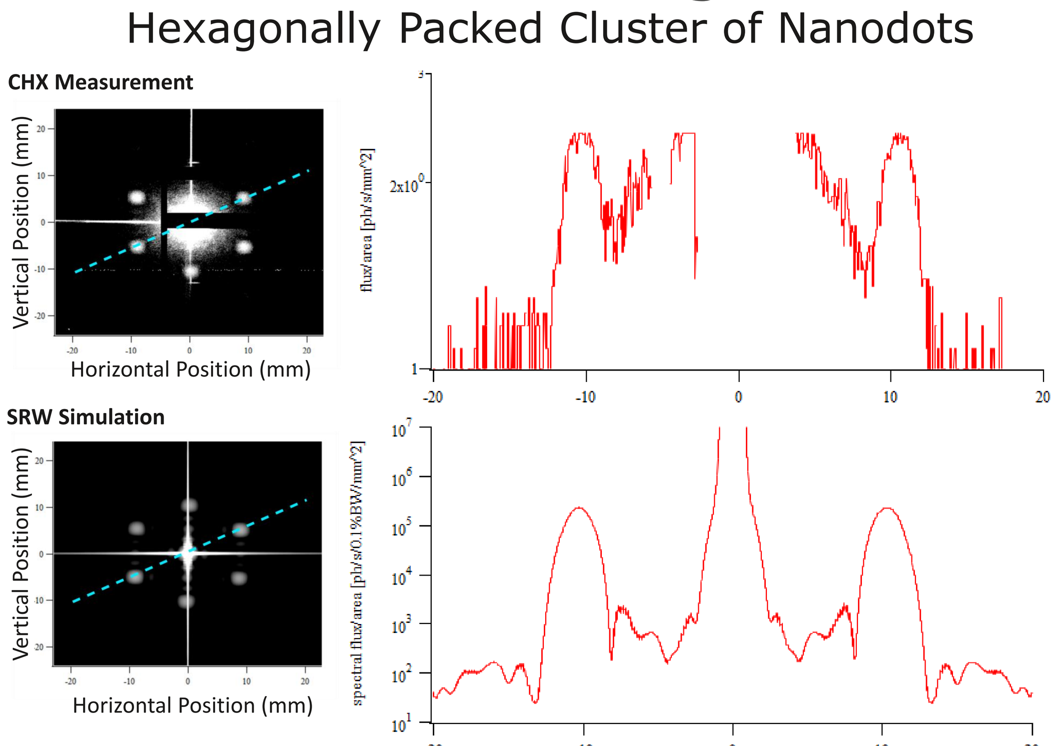
6 Measurement and Simulation of Nano Fabricated Sample

Nanodots and Concentric Rings



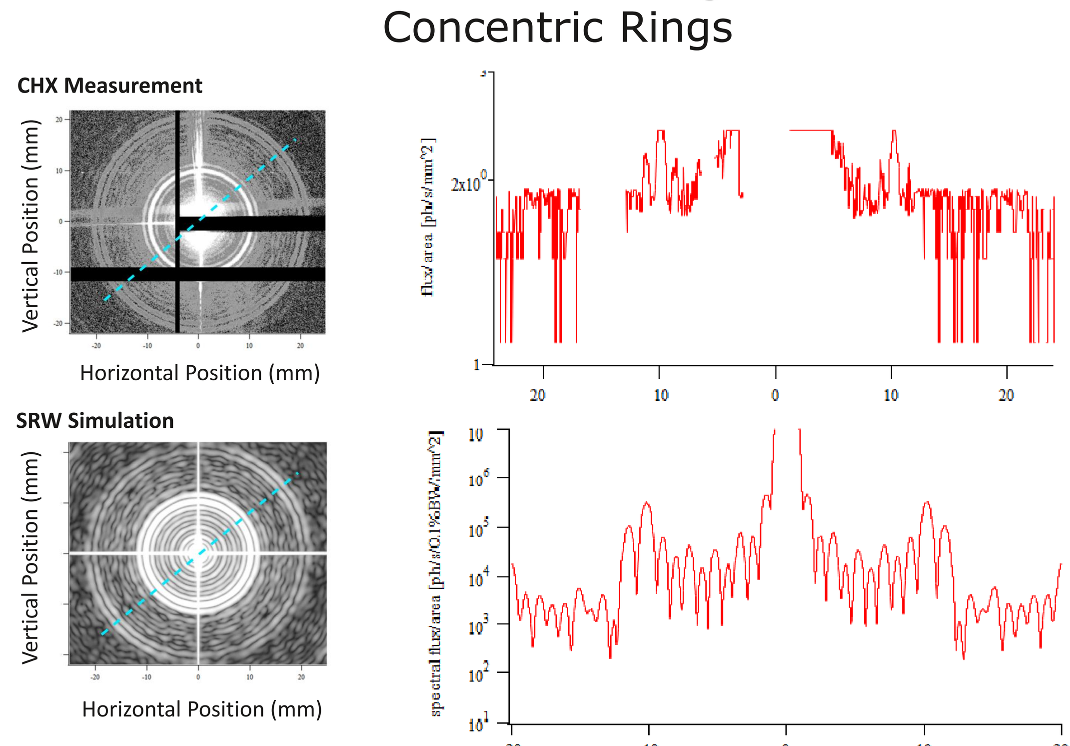
7 Scattered X-Ray Intensity Distribution Cuts Along ~30° Line

Hexagonally Packed Cluster of Nanodots



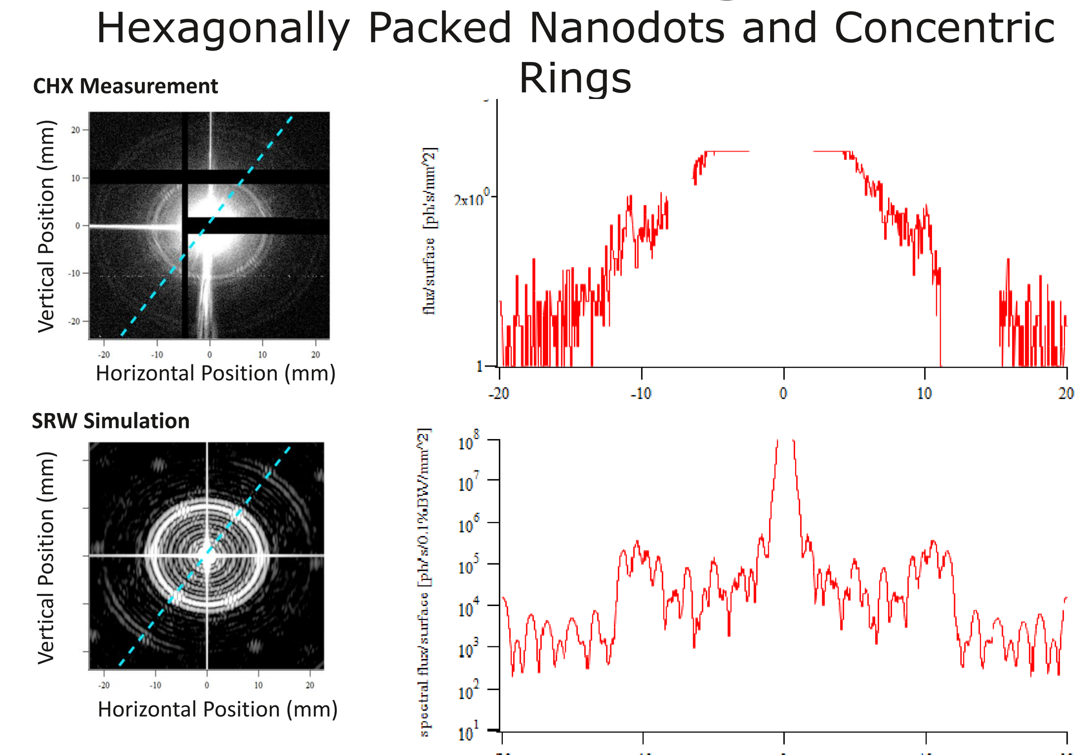
8 Scattered X-Ray Intensity Distribution Cuts Along ~45° Line

Concentric Rings



9 Scattered X-Ray Intensity Distribution Cuts Along ~50° Line

Hexagonally Packed Nanodots and Concentric Rings



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