Characterization of X-ray Wavefields and Focusing Optics I

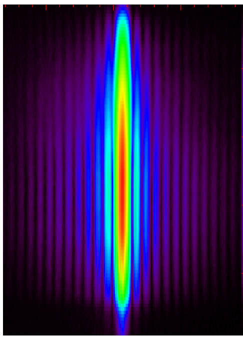
A. G. Peele[1], K. A. Nugent[2], C. Q. Tran[2], and C. H. Chen (陳家浩)[3]

[1]Department of Physics, La Trobe University, Victoria, Australia
[2]Department of Physics, University of Melbourne, Victoria, Australia
[3]National Synchrotron Radiation Research Center, Hsinchu, Taiwan

The purpose of this research was to characterise the coherence on beamlines 9A/B to establish whether it would be possible to conduct experiments in coherent diffractive imaging. In particular we wish to establish whether a zone plate can be coherently illuminated for tests of the curved beam method in coherent diffractive imaging. We imposed a main goal for the experiment:

> To study the spatial coherence properties of an unfocused beam using a simple Young's slit diffraction technique.

We conducted the bulk of the experiment at 500 eV in energy with a propagation distance of 1.7 m from the various Young's slit pairs to the detector. The quality of the experimental data can be seen in Fig. 1. This shows the recorded x-ray flux without corrections for the 37 μm separation Young's slits. The modulation due the width of each slit can be clearly seen for several periods. It is interesting to note there appears to be no "speckle" type deformations in the pattern as has been observed in other experiments. In Fig. 2 a close up of the central region is shown and the characteristic Young's slit fringes inside the modulation envelope can be seen.



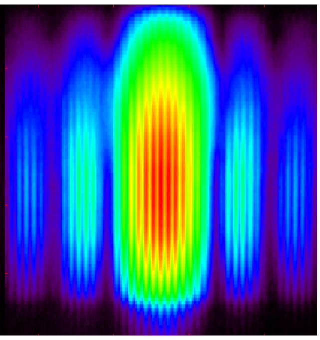


Figure 1. Figure 2.

We have commenced our preliminary analysis of the data. It is simple to demonstrate that the data is amenable to analysis by doing a forward estimate of the expected interference pattern based on reasonable estimates of the experimental parameters. The result of such an estimate compared with the experimental data from Fig. 1 is shown in Fig. 3.

It can be seen that the two compare very well. The parameters used indicate that the visibility for a slit separation of 37 μm is about 40%.

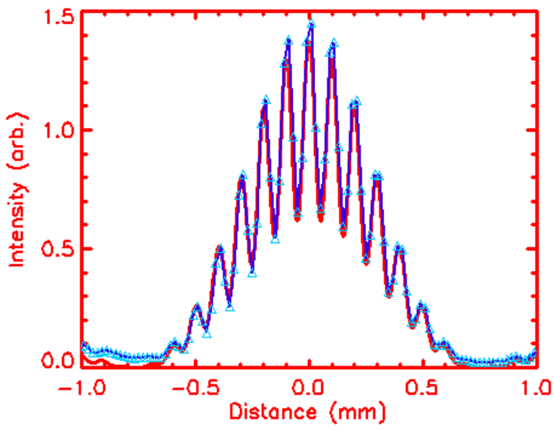


Figure 3.

The degree of coherence as a function of slit separation can be seen in Fig. 4.

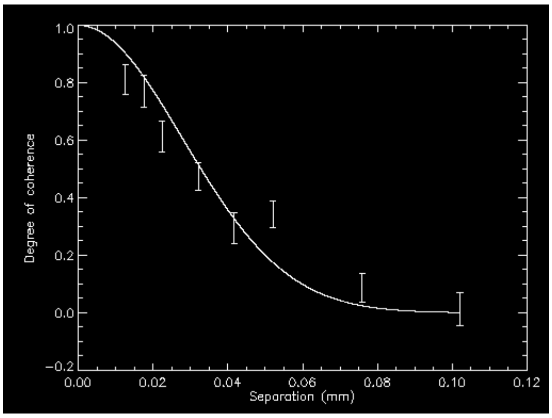


Figure 4.

In our analysis we will incorporate an accurate error estimate (based on repeated readings for the data) and will undertake least square fitting of the data to obtain the experimental parameters. Primarily we will obtain the vivibility (or degree of coherence) as a function of slit separation. Additionally, we can investigate the coherence as a function of position along the slit by virtue of the fact that our data is two dimensional.

Our data includes measurements for a range of vertical and horizontal slit separations so we can probe the coherence in two directions. Additionally, we have obtained data where other experimental parameters in the experiment, such as various aperture settings in the beamline were varied so we can investigate the effect of the geometry of the beamline on the coherence at the sample.