PhotonMEADOW2023

Contribution ID: **58** Type: **Poster**

Determination of astigmatism in XFEL sub-10 nm focusing system using speckle patterns from random nanoparticles

The intense X-ray free-electron laser (XFEL) focused on a single-nanometer scale has facilitated the exploration of new frontiers in X-ray nonlinear physics. We have developed an XFEL sub-10 nm focusing mirror system, based on Wolter III-advanced KB mirror optics, for achieving 10^22 W/cm^2 intensity at SACLA. The focus size has been characterized by ptychography and reached 6.8 × 6.9 nm. However, in the ptychography, the sample has required to be placed at defocus position to avoid radiation damage, making a determination of the low-order wavefront errors difficult. This lead to subtle remaining astigmatism that significantly affects the intensity reduction of the focus.

In this study, we applied speckle interferometry to determine the low-order wavefront errors. When sufficiently small nanoparticles are illuminated by coherent X-ray, distinctive scattering patterns are observed, referred to as the speckle. The randomly distributed nanoparticles provide an inversely proportional relationship between the sizes of the speckle and the focused beam. The experiment was performed at SACLA BL3 with a photon energy of 9.124 keV. As a scattering media, 2-5 nm diameter Pt particles were randomly spread on a 50-μm-thick polyimide film. The nanoparticles were placed near the focus of the sub-10 nm XFEL and speckle patterns were acquired by MPCCD placed 0.7 m downstream from the focus. As a result, we identified remained astigmatism from the difference of the center of speckle size envelopes. By correcting the 3 μm astigmatism, a finely focused sub-10 nm spot corresponding to the intensity of 1.45×10^22 W/cm^2 was achieved.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?

no

Primary author: Mr ITO, Atsuki (Osaka university)

Co-authors: Prof. YAMADA, Jumpei (Osaka university & RIKEN SPring-8 Center); Mr TANAKA, Yuto (Osaka university); Mr SHIOI, Kota (Osaka university); Dr INOUE, Ichiro (RIKEN SPring-8 Center); Dr OSAKA, Taito (RIKEN SPring-8 Center); Dr YAMAGUCHI, Gota (RIKEN SPring-8 Center); Dr INUBUSHI, Yuichi (Japan Synchrotron Radiation Research Institute); Dr YABASHI, Makina (RIKEN SPring-8 Center); Prof. YAMAUCHI, Kazuto (Osaka university)

Presenter: Mr ITO, Atsuki (Osaka university)

Session Classification: Poster Session