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一つのビューイングポートからのプラズマ三次元輝度分布再構成

Reconstruction of three-dimensional emissivity profile of plasma from one viewing port

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Three-dimensional (3D) information not only for plasma itself but also for plasma faced material and levitating particles are important for a wide range of plasma research fields. Recent progresses have shown the importance of helically deformed configurations and 3D mode structures in high temperature plasmas [1]. In process plasmas, the non-uniform density of plasma would cause non-uniform deposition on the wafer. Among the various devices, separated two or more detectors with computed tomography are widely used to determine the 3D information. However, many experimental devices are faced with a limitation of the number of viewing ports and viewing areas. It is required that a method distinguishing 3D structure of plasma from a certain image obtained from one viewing port.

To obtain 3D structure of plasma from one direction, we are developing two methods. Basic idea of both of them is using multi lens or multi-pinhole camera. In reconstruction phase, there are two approaches. One is integral photography [2] and 3D deconvolution techniques. Another approach is basis expansion.

First, we have developed 3D imaging system for plasma with integral photography and 3D deconvolution techniques [3]. Developed system is conducted with multi lens and captures visible light emitted from plasma. The system has been applied a surface wave plasma. Reconstructed distribution suggests that plasma emission is localized around the powered antenna of microwave with hollow structure [4].

Next, basis expansion technique has been applied to a torus plasma [5]. Figure 1 shows results of numerical test for the technique. Developed system is conducted with multi-pinhole disk and micro channel plate. Projected intensity of soft X-ray is expressed as convolution between emissivity and projection matrix. We apply basis expansion with suitable orthogonal functions to emissivity. Then, projected image is also expressed as summation of basis patterns. In reconstruction from obtained image, we use the Ridge and Lasso regressions. Despite the use of a single disk, the 3D shape of the toroidal plasma is successfully reproduced in the numerical test.

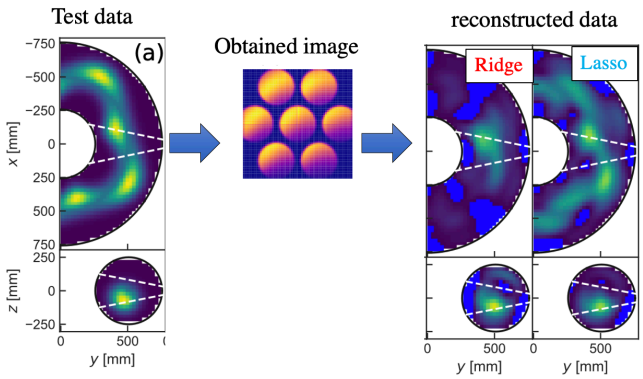

Fig. 1: Cross-sectional views of test data. Obtained image from test data. Reconstructed distribution with Ridge and Lasso regressions.

References

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