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Tomographic reconstructions of the 2D emission distributions of impurity with EAST visible tangential wide-angle viewing systems

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The amount and spatial distribution of impurity radiation in the divertor of a tokamak is of fundamental importance for the behaviours of power exhaust, detachment and erosion/re-deposition properties [1]. The visible tangential wide-angle viewing systems for its high spatial, temporal resolution and data visualization, is widely used in fusion devices. Tomographic reconstructions of tangential camera views are an established method for resolving the 2D distribution of divertor emission in various tokamak devices [2]. Four integrated infrared and visible tangential wide-angle viewing systems (WAVS) and one multi-band wide-angle high-speed viewing systems (MWHVS) have been mounted in Experimental Advanced Superconducting Tokamak (EAST).

Plasma emission of impurities is measured with MWHVS equipped with interference filter of bandwidth centred on the CIII (400.88 nm) emission line during the CD4 seeding from the lower divertor. The inverse problem includes: calibration of the detailed camera viewing geometry and the tomographic inversion. A Zhang's calibration algorithm [3] is utilized to calibrate the intrinsic, extrinsic and distortion parameters of MWHVS using checkboard with the geometric dimensions of (12×9)*0.06m. With the help of the transformation between the EAST real world coordinate and the camera coordinate, The pixel and camera positions in EAST coordinate are calculated. By modeling the 2D camera image pixels as line of sight integrals through an axisymmetric discrete grid, the sparse response matrix is calculated. To obtain the poloidal plasma line emission distributions, the Algebraic Reconstruction Technique (ART) is used to solve the sparse matrix-vector linear system. The tomography reliability has been tested with a known emission function where the error is also discussed. The typical tomography results have been analyzed for the EAST shot (#117765) with the CD4 seeding from the lower divertor to achieve the detachment phase. The peak intensity of the CIII migrates from the lower outer strike point to the LCFS near the high field side during the detachment. And also, the temperature of the lower divertor measure by the IR camera is decreased.

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