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Optimizing the Spatial Resolution and Fluctuation Wavenumber Sensitivity during Design of the Wendelstein 7-X Heavy Ion Beam Probe T. P. CROWLEY, D. R. DEMERS, P. J. FIMOGNARI, Xantho Technologies, LLC, Madison, WI, O. GRULKE, Max-Planck-Institute for Plasma Physics, Greifswald, Germany and Technical University of Demark, Department of Physics, PPFE, DK-2800 Lyngby, Denmark, R. LAUBE, Max-Planck-Institute for Plasma Physics, Greifswald, Germany — A heavy ion beam probe diagnostic is being designed for the Wendelstein 7-X (W7-X) stellarator. The diagnostic will measure equilibrium electric potential, fluctuations of electric potential and density, fluctuation wavenumbers, the cross-phase between fluctuations of density and potential, and electrostatic fluctuation induced particle flux. As part of the design process, we have developed computational techniques that optimize the spatial resolution of the electric potential measurement and maximize sensitivity to high wavenumber fluctuations. A small number of beam ion trajectories are used to numerically determine an ion optics matrix which describes how the W7-X magnetic field will focus the injected and detected ions. The ion optics matrix is used to determine the optimum initial focal length of the injected beam, and correspondingly, the properties of a quadrupole lens that provides the required focus. Computational results show that this tailored beam focus produces significantly smaller sample volumes than an initially parallel beam. The new techniques also allow us to simulate a finite phase-space volume beam and obtain more realistic estimates of the sample volume characteristics than with our traditional approach. This work is supported by US DoE Award DE-SC0013918.

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