Trajectory simulations for the HIBP probing particles in the T-15MD tokamak

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Plasma research in fusion reactors requires precise non disturbing method of analyzing hot plasma zone. Heavy ion beam probing (HIBP) is one of these methods. This particular approach is based on beam injection of single-charged ions of Tl+ (Cs+, Au+) transversely the magnetic field (this beam is called "primary beam"), and furthermore registration of Tl++ (Cs++, Au++) ions that leave plasma zone ("secondary beam"). Primary beam's particles ionize in plasma during collisions with electrons. A fan of "secondary" particles emerges. Exit aperture cuts out secondary beam from this fan, so the field where particles ionized being the sample field. Secondary beam's location on detector's plates inside energy analyzer makes it possible to determine value of electrical potential.

Sample field can be moved along "detector line" by altering the entrance angle of primary beam. Detector line can be shifted deeper into the plasma by increasing primary beam's energy. Set of detector lines with different energies forms detector grid, which is essential to define location of sample volume.

At the moment diagnostic is planned to be installed on a new tokamak T-15MD. Preparatory trajectory calculations and detector grids are required to determine optimum injection angle of Tl+ ions primary beam, location and size of exit aperture and angle of secondary beamline. For this purpose authors created software suit based on Python programming language.

This report represents method of calculations, examples of trajectory and detector grids and implications about disposing capabilities of HIBP diagnostic on T-15MD tokamak.

References

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