Requirements for an Imaging Heavy Ion Beam Probe at ASDEX Upgrade

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We present a conceptual study and hardware investigations in preparation of an imaging heavy ion beam probe (i-HIBP) for the ASDEX Upgrade tokamak [1]. The main feature of this new type of a heavy ion beam probe (HIBP) is the imaging of the secondary beams by means of an in-vessel scintillator screen in combination with a high speed camera. The spatio-temporal pattern on the scintillator contains two-dimensional information about the plasma density, the plasma potential and the poloidal magnetic field at the points of ionization of the primary beam, where the secondaries are created. Due to the use of a neutral beam as primary beam and the in-vessel imaging of the secondaries, the i-HIBP system is much more compact than a classical HIBP [2] consisting of large accelerators and bulky electrostatic energy analyzers.

A numerical study for a neutral 80 keV cesium beam as primary beam has shown [1], that information about the density, the plasma potential and the poloidal magnetic field from 10 cm inside the last closed flux surface up to the far scrape-off layer can be obtained for a typical low-density ASDEX Upgrade plasma. The variation of the pattern on the scintillator has shown to depend linearly on the perturbation amplitude of the measured quantities, and localized measurements of plasma potential fluctuations down to 10 eV seem possible if certain beam properties are fulfilled.

Laboratory tests with a neutral cesium beam and a scintillator material, which is typically used in fast ion loss detectors [3], have shown that we can meet all necessary requirements for a high measuring sensitivity of an i-HIBP at ASDEX Upgrade. We present details of the planned technical implementation and show the capabilities of this new diagnostic for investigations of plasma edge phenomena like edge localized modes, zonal flows, geodesic acoustic modes and blob filaments.

References

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