§56. Prospect of Measuring the Ion Component of the LHD Divertor Plasma by Means of Analyzers for CX Atoms

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The utilization of electrical probes to measure characteristics of an ion component in the LHD divertor plasma will be very limited because of high energy flux being transported by this plasma: up to ~10MW/cm^2 according to [1]. In such conditions very important is to analyse the probability to utilise methods which are routine ones for study the ion temperature (or ion energy distribution function) in a core plasma. For these purposes NPA and CHERS are widely used to have chordal or local data on the ion component.

In the case of LHD, due to peculiarities of the vacuum vessel construction, there will be no possibility to have the line of observation tangential to the divertor flux. In connection with this, two schemes have been analysed taking account these peculiarities. Every of them has advantages and disadvantages.

The first one is based on measuring the characteristics of atoms reflected from the target located on the pass of a divertor flux. With such scheme the "particle brightness" of ion-to-atom converter is very high: it is proportional to the production of ion sound velocity and ion density, and reflection of atoms (hydrogen or deuterium) with energy in the range of hundred eV is quite high: 20 - 60% depending on the target material [2]. But the energy reflection coefficients is much lower: ≤ 30% even for the tungsten target [2]. Because of this for such scheme the time-of-flight analyzer is suitable which can register atoms with as low energy as ~20 eV [3,4]. Targets made of refractory metals (Ta or W) with good water cooling can withstand the high energy flux during the whole plasma pulse duration. Spectroscopy methods can be also applied to measure the shape of H_α line with Doppler shifted wing appeared due to reflected atoms which are excited by divertor plasma electrons.

In the second scheme the H_2 cloud created by gas puffing can be used to convert ions of a divertor plasma into atoms. In the absence of ports for a tangential observation, the registered atoms will have larger $v_\perp$ than its mean value directly in the divertor flux. The "particle brightness" of gas target is much lower than of the solid one: about 10 times for H_2 density ~10^{14} cm^{-3}. But even such value of a gas flux density is very high, and to prevent the change of a confinement regime, the measurements of CX atom flux will be possible only if the gas puffing is pulsed with rather short pulse duration time: ~0.2s. At the same time, with this scheme in use the solution of an inverted problem (i.e., calculation of ion distribution from one measured for atoms) is not so complicated as with the solid target.

References

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