§32. Orbits of Fast Particles Reaching Natural Diamond Detectors on LHD

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Semiconductor detectors based on natural diamond are installed on the Large Helical Device(LHD) to measure energy distribution of charge exchange (CX) fast neutral particles from different viewing angle[1]. An NDD set on a tangential port have successfully measured time-resolved energy distribution of counter-going passing beam ions in LHD. Schematic drawing of a viewline of NDD on a tangential port is seen in Ref. 2. To see what type of orbits of fast ions we are detecting, full gyro-motion following orbit code were developed. Particle orbits are calculated in vacuum magnetic field on realistic coordinate. In this code, velocity vector of fast ions toward the detector after charge exchange is given on the line of sight of detector and energetic ion orbit is computed backward in time. The calculation shows that the pitch angle of particles we detect ranges from 140 to 180 degrees and particles have passing orbit in all positions on the line of sight. A measured energy distribution was compared with that predicted from neoclassical energetic ion transport by using GNET code. GNET code reproduced well measured energy spectrum in qualitative sense[2]. This means that ripple transport of energetic ion is important in understanding fast particle behavior in LHD. An NDD installed on a perpendicular port have diagnosed fast ion tail during ICRH[1]. A scenario of ICRH is proton minority heating in He-dominated plasmas. A typical measured spectrum of ICRF-produced fast ion tail is shown in Fig. 1. Energetic ions up to about 300 keV were observed in 3rd cycle of LHD experiment. An NDD on a perpendicular port measure fast particles having their pitch angle of 85 to 105 degrees. The calculation shows that particle coming from core region has so called blocked orbit. They tend to localize in the small *R* side of horizontally elongated cross section. Particle coming from relatively peripheral region is helically trapped particle(see fig. 2). It is noted that even in r/a = 0.95, particles still have drift surface in their poloidal projection, suggesting they are well confined if they do not experience collision. Measurements of ICRF-produced fast neutral particles were mostly done with B_t = 2.75 T and R_{ax} = 3.6 m. In this case, resonance layer of ICRF is not on the magnetic axis, is in relatively peripheral region. Therefore, particles we detect are supposed to be helically trapped particles. Fast ion tail grows with the increase of T_e. Analysis to check whether growth of fast ion tail due to increase of T_e agrees with expected from classical theory or not is now in process.

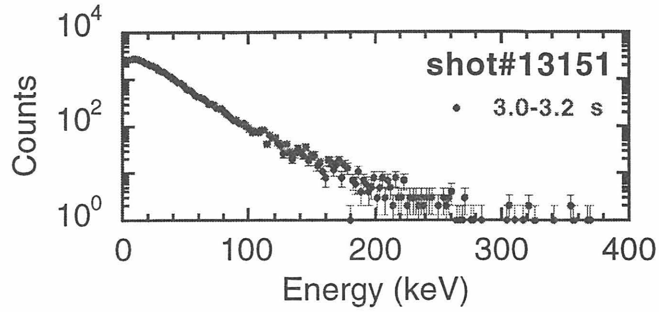

Fig. 1 ICRH-produced fast ion tail measured with a natural diamond detector set on perpendicular port(4.5L).

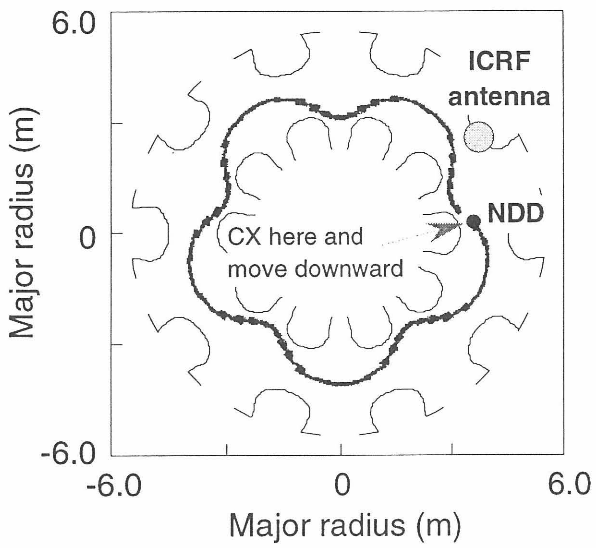

Fig. 2(a) Toroidal projection of an orbit of a helically trapped fast ion detected by an NDD after charge exchange.

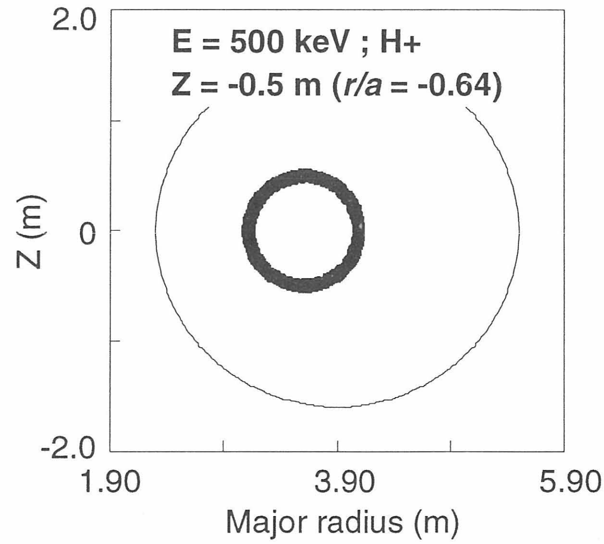

Fig. 2(b) Poloidal projection of a particle seen in fig. 2(a)

References
[1]Sasao, M. *et al.*, to be presented in IAEA conf., Solent.
[2]Murakami, S. *et al.*, stellarator news(issue#69).