§31. Measurement of High Energy Neutral Particles from ICRF-/NBI-Plasmas by Natural Diamond Detectors

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During the 3rd campaign of LHD experiment, high energy neutral particle spectra have measured by two specially developed natural diamond detectors(NDD's)[1]. Parallel particles are supplied by 90 – 110 kV neutral beam injectors, and detected as fast neutral atoms by NDD viewing the helical plasma tangentially. Perpendicular particles are generated by ICRF, and detected by a NDD viewing the plasma center chord perpendicularly. Fig. 1 shows the experimental arrangement of the perpendicular measurement.

The viewing angle and the viewing volume are limited by 2 apertures, one is fixed (3 mm-diam.), the other is changeable, and the detector size, so that the counting rate is high enough for the statistics and low enough below the pile-up limitation. A pulse of fixed height is continuously supplied to the preamplifier in order to monitor the gain drift and the pile-up. Energy calibration of the system has been done by using an alpha source (Am-241) installed in the vacuum chamber. The energy resolution at 5.4 MeV was 8.7 % (FWHM). During the campaign, the perpendicular system worked properly for most of shots, but the tangential system often suffered from the pile-up problem. The tail temperature (T_{eff}) during ICRF was derived assuming the ICRF accelerates protons perpendicularly. Then the particle flux to the detector per second in the energy interval dE can be expressed as

$$F(E)dE = dv_x dv_y dv_z S\int_{-a}^{a} A(x)f(v_x,v_y,v_z) < \sigma_{cx}v > n^0(x)dx,$$

where the particle distribution of

$$f(v_x,v_y,v_z)=\left(\frac{m}{2\pi T_\perp}\right)\left(\frac{m}{2\pi T_i}\right)^{1/2} exp(-\frac{m(v_x^2+v_y^2)/2}{T_\perp})exp(-\frac{m(v_z^2)/2}{T_i}),$$

is considered ($T_{eff} = T_\perp$). We assumed that the charge exchange process between a high energy proton and an H^0 or an He^0 atom dominates for the production of neutral particles. Fig. 2 shows an example of the time evolution of the tail temperature(T_{eff}) during ICRF which is imposed on a NBI heated plasma (shot 12962). In most of discharge of this scenario, a clear increase of T_{eff} is observed. After the ICRF termination, the T_{eff} is gradually decreasing. In this case, the e-folding decay time of T_{eff} , i.e. the relaxation time, is about 200 msec.

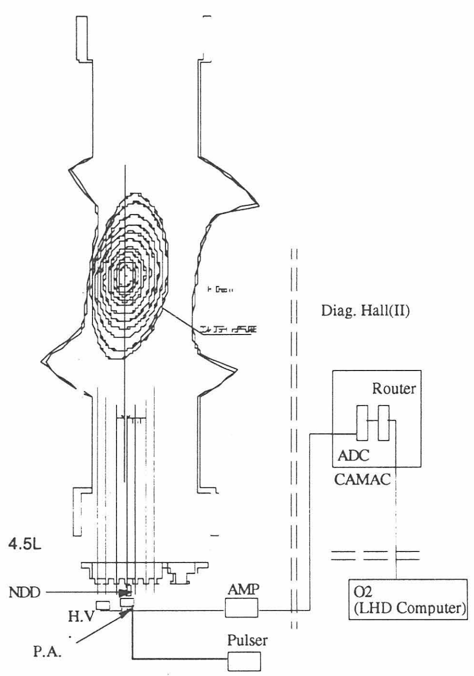

Figure 1 Schematic View of Experimental Arrangement of the perpendicular measurement.

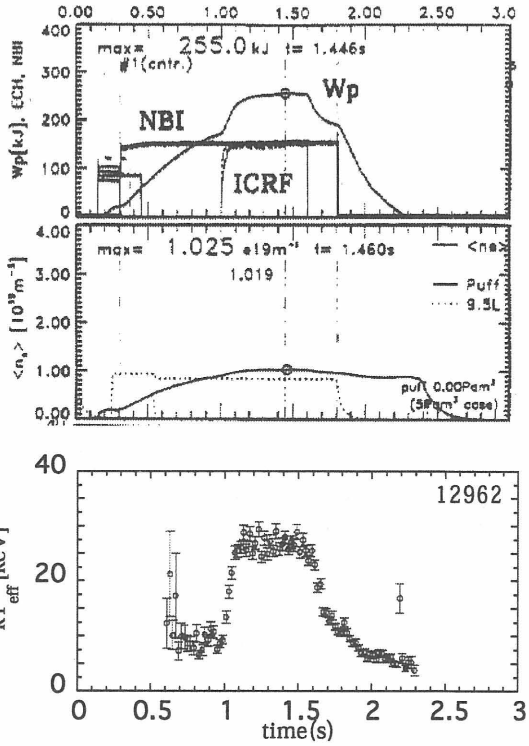

Figure 2. *Time evolution of Teff during ICRF which is imposed on a NBI heated plasma . (12962: B_0=2.75T, R_{ax}=3.6m) .*

References

[1] A. V. Krasilnikov, et al. J. of Plasma and Fusion Research, Vol. 75 (1999) PP. 967-976