§11. Energy Measurement of Neutrons from D-T Fusion Plasmas

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A new type of neutron spectrometer, named COTETRA (counter telescope with thick radiator), to measure the neutron energy spectra around 14MeV has been developed. In COTETRA, a plastic scintillator (ΔE-detector) fills the role of radiator, and the energy of neutron is evaluated by the sum of the energy loss of recoil proton both in ΔE- and E-detectors.

D-T fusion plasma experiments have been performed since November 1993 at TFTR. The tritium was introduced to the torus by gas puffing and/or by neutral beam injection (NBI). As auxiliary heatings, the NBI heating and ion cyclotron range of frequency (ICRF) heating are provided.

The D-T neutron energy spectra was obtained for 'NBI and ICRF' heated plasmas and for NBI only heated plasmas(Fig.1). The full width at half maximum (FWHM) of the peak for the ICRF heated plasma is wider than that for NBI only heated plasma (Table 1). The calculated energy spectra for ICRF heated D-T plasmas suggested this broadening was due to existence of the high energy tritium ion tail of 100~300 keV in the perpendicular direction (Fig.2). The calculation also suggested the necessity of neutron energy measurement for ICRF heated D-T plasma in evaluating the effect of heating.

References

[1] M.Osakabe, et. al., Rev. Sci. Instrum. 66 , 920 (1995)

Table 1 The energy width of the obtained spectra for a NBI-discharge and for RF-discharges.

Type of discharge	Original FWHM [%]	Estimated FWHM [%]
NBI-discharge	23 ± 2	7.4
RF-discharge (a)	28 ± 2	17 ± 4
RF-discharge (b)	26 ± 1	14 ± 4
RF-discharge (c)	25 ± 2	12 ± 6

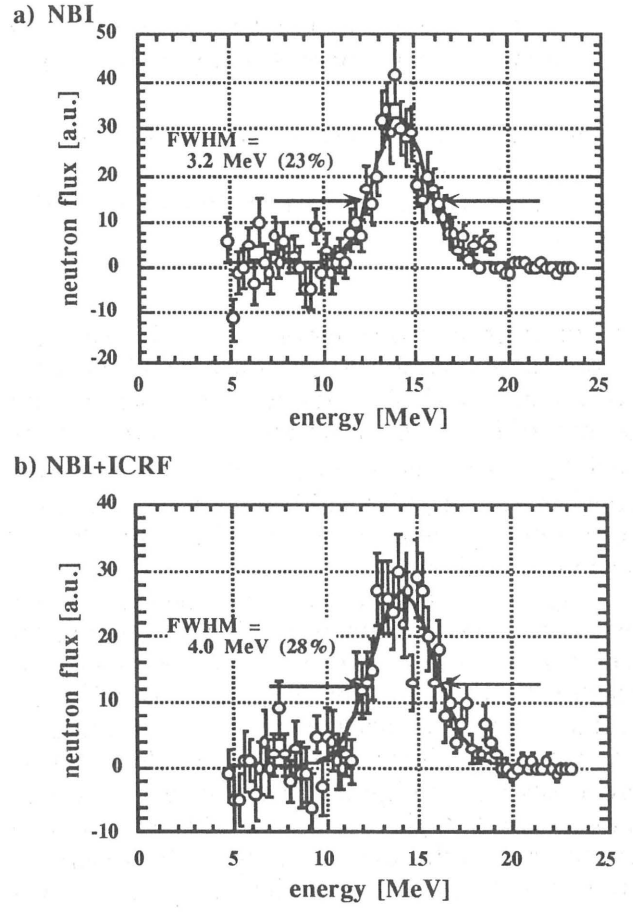

Fig.1 D-T energy spectra for (a) NBI heated D-T plasma and (b) NBI + ICRF heated plasma.

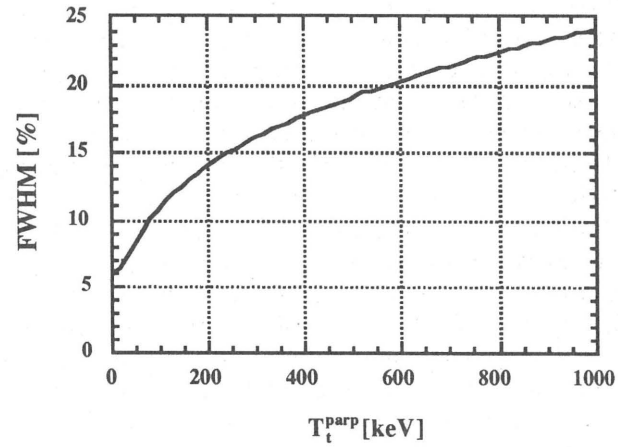

Fig.2 Calculated energy broadening of D-T neutron for ICRF heated plasma. The velocity distribution function of deuterium is assumed to be an isotropic maxwellian of temperature 36keV, while that of tritium is assumed to be an anisotropic maxwellian having different temperature in the direction parallel to the magnetic field line and in the parpendicular direction. The tritium parallel temperature is assumed to be 36 keV, and the parpendicular temperature is varied in the calculation.