2001 Part II Q3 Exp

I. (a) temperature: ECE emission is in the microwave spectrum. Observing ECE along a major radius, then the frequency of radiation is directly proportional to B, which is known. This allows the radial temperature profile to be measured. Good timescale resolution, and also sensitive enough to measure $\tilde{T}_e$ fluctuations

(b) density: microwave interferometer: measure phase difference $\propto$ density
Limitation: measures line integrated density only

II a) detect 14 MeV neutrons: ^{238}U fission counter
- neutrons cause fission reactions to occur, which are counted (gas counter)
- difficulty: low sensitivity, absolute calibration required

Calibration: put neutron sources inside vessel, move around toroidally

b) ECE diagnostic, listed above
- Or, Thomson Scattering:

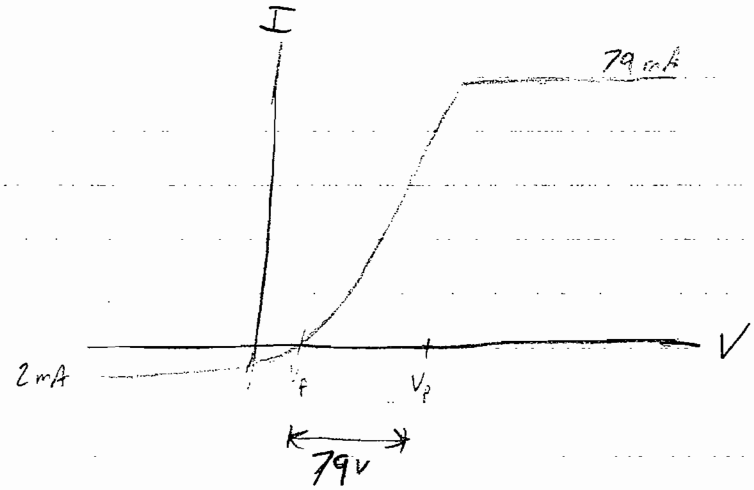
Send in incident light (via a laser, for example); the electron will radiate (scatter) light at the same frequency. Doppler broadening gives T_e. Absolute calibration gives n_e. Decent spatial and temporal resolution is possible for lasers with high rep rate.
Experimental difficulties: bremsstrahlung radiation background

III. $n = 10^{16}\ m^{-3}$ $A = \pi \frac{d^2}{4} + \pi d l = 6.6 \cdot 10^{-5}\ m^2$ $T_e = 20\ eV$

$$I_{is} = 0.6 n e A \sqrt{\frac{T_e}{m_i}} = 2\ mA$$

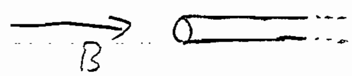
$$I_{es} = enA \sqrt{\frac{T_e}{2\pi m_e}} = 79\ mA$$

$$V_p - V_f = \frac{T_e}{e}\left(3.3 + \frac{1}{2}\ln\frac{m_i}{m_p}\right) = \frac{T_e}{e}(3.65) = 73\ V$$



1T field: $\rho_i = \frac{V_\perp}{\Omega} = \frac{\sqrt{\frac{T_i}{m_i}}}{4.8 \cdot 10^7} = 3602 \cdot 10^5 \sqrt{T_i} = .14 \sqrt{T_e(eV)}$ mm

Assuming cold ions such that $\rho_i \ll 2$ mm, the correct area to use is the projected area



$A = \pi \frac{d^2}{4} = 3.1 \cdot 10^{-6}\, m^2$

$I_{is} = .09$ mA