A PASSIVE CHANGE EXCHANGE DIAGNOSTICS AT ADITYA TOKAMAK FOR ION TEMPERATURE ESTIMATION USING ELECTROSTATIC PARALLEL PLATE ANALYSER (EPPA)

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Introduction

Ion temperature in hot plasma may be measured by several well developed methods [1], each having its advantages and disadvantages. Ion temperature measurement methods based on monitoring of Change Exchange (CEX) diagnostics are well established techniques [2, 3, 5, 7, 18, 20 & 21]. A convenient method is to obtain CEX Neutral/Energy resolved species using Electrostatic Parallel Plate Analyser (EPPA) which is designed to measure temperature along the beam line. EPPA is based on the fact that a charged particle passing through a uniform electric field (between parallel plates) and having a charge q, mass m, and velocity v undergoes a change in its velocity and is deflected as given by

\[ \frac{qE}{m} = \frac{v^2}{2} \]

Where q is the charge of the test particle, E is the electric field and v is the test particle velocity. The energy resolution and focusing [4, 5].

Results and Discussion

The estimation of ion temperature with ADITYA plasma discharge number 22735 has been illustrated (Figures 5, 7 and 8). Least square fitting of the straight line obtained by the plot of ln V/2 against 1/T ion was done and then the temperature was estimated as an averaged over 10 msec for each five such time intervals during flat-tops of Plasma Current L (Figure 5).

Figure 6 shows the temporal evolution of electron temperature during ohmic heating and its comparison with ion temperature data obtained using CEPPA. It has been found that the peak ion temperature is typically 40% to 45% of the central electron temperature.

Figure 5: Plot shows variation of central ion temperature T_i during flat top of the current pulse.

Figure 7: Plot shows temporal variation of central electron temperature T_e and central ion temperature T_i.

Figure 8: Plot shows temporal variation of central ion temperature T_i with applied heating power.

Conclusion:

Passive CEX-PPA is designed and developed for the Aditya tokamak ion temperature measurement. Energy calibrations of CEPPA were carried out using low energy ion sources and the results have been found to be in a good agreement with the calculated values. Temporal evolution of ion temperature has been presented during the flat top of the plasma current and peak ion temperature for some recent APPS discharges were found to be typically 200 ± 40 eV. It has also been found that the peak ion temperature is typically 40% to 45% of the central electron temperature. The core ion temperature shows rise during the ICRH power, but the time resolution of data acquisition [at present 15 ms (window)] need to be improved for more detailed study of ion temperature variation.