Determination of the Radial Profile of Hydrogen Isotope Composition in TCV plasmas

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INTRODUCTION

A direct measurement of plasma neutral hydrogen isotopes erosion has been used to study transport processes in TCV. A compact neutral particle analyser (CNPA) with mass and energy separation was used to measure transport and reionisation of hydrogen (H) particles in a horizontal (D) background plasma using programmed gas puff profiles. The CNPA views the TCV plasma along a central horizontal view line and measures the escaping neutral flux in 11 hydrogen energy channels (0.6-5keV) (CNPA View). A series of thermal H gas injections into a D plasma, with simultaneous D puff off-line, is a technique for the replacement of D plasma by H. Hydrogen pulses with duration (0.7-30ms) ranging between 28ms are injected during the current flattop of a D plasma central in the TCV vessel (0.75-1s). Following D-puff off-line, a minimal time is required to stabilise the plasma density. Hydrogen CNPA count rates increase by a factor of 2 to 10 and rate density decreases by ~1/2. The D ion density was estimated to increase from 30-50%, typical for pure D plasmas on TCV, to 80-100% during a H puff typically 10-30ms (CNPA View).

Experimental scenario: H-gas injection

- A series of thermal hydrogen gas injections into a D plasma, with simultaneous D-puff switch-off, ~200ms) are injected during the current flattop of a D plasma centred in the TCV vessel (0.75-1s).
- Following D-puff off-line, a minimal time is required to stabilise the plasma density.
- Hydrogen CNPA count rates increase by a factor of 2-5 and D rates decrease by ~1/2. The H/D density ratio was estimated to increase from 5-10%, typical for pure D plasma on TCV, to 20-40% during a H puff (CNPA View).

CNSA Data

- During H-puff, the 19He/12He ratio evolves from a hollow radial profile (~20%) to a flat profile (25-25%). After puff, hydrogen accumulation in internal regions has been observed.
- h” confinement time” for TCV low density low current OH discharges is 15-20ms.
- An estimation of effective diffusion coefficients reveals a value ~tms/sec, pinch velocit y ~ tms/sec.

CONCLUSION

- A compact neutral particle analyser (CNPA) has been successfully used to measure the hydrogen isotope composition in TCV plasmas.
- A recovery algorithm of the temporal behaviour of the radial H density profile from NPA measurement was developed and used for TCV Ohmic L-mode low density, low current discharges.
- Described method may potentially be applied to study of particle transport phenomena in other machines.

In an implementation of the described technique to operational discharges of TCV Tokamak becomes increasingly complicated at high current by perturbation of CX measurement due to sawtooth activity, in H mode by ELMy and in ECH discharges by the appearance of a superthermal ion population.

References