ELECTRODE BIASING EXPERIMENT IN ADITYA TOKAMAK

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Introduction & Motivation

The physics of Low confinement – High confinement (L-H) transition in tokamaks still remains an open question. Sheared radial electric field is believed to be a key factor for L-H transition in tokamaks. Sheared radial electric field gives the sheared poloidal E x B flow, which reduces the fluctuations and in turn reduces transport leading to high confinement mode. In small tokamaks where external heating facilities are not present, radial electric field can be created by applying a voltage difference between an electrode placed beyond the last closed flux surface (LCFS) and limiter (or vessel wall). However, recent studies have shown that plasma current profile modification can also lead to L-H transition. It is still not clear that which phenomena (sheared electric field or plasma curent profile modifiication) comes first and which latter. To understand the detail physics of L-H transition in tokamaks, electrode biasing experiment has been carried out in Aditya tokamak.

Experimental Setup

To carry out biasing experiments in ADITYA tokamak by introducing a biased electrode in the edge regions an electrode assembly and a pulsed power supply has been designed and fabricated.

Electrode Assembly

Special Feature:
Double bellow assembly for two linear motions of electrode for changing its tip position and its dimension inside the plasma

Pulsed Power Supply

A ±300V/450A pulsed power supply (PPS) delivers power to electrode. PPS consists of 1400V/450A (pulsed) Silicon controlled Rectifier (SCR), SCR trigger circuit and 300V/83.3mF Capacitor bank

Signatures of confinement improvement

- Sudden decrease in hydrogenic (H_α) light emission from the plasma edge
- Increase in plasma density
- Enhancement in electron temperature
- Sharp density and temperature gradients inside the Last Closed Flux Surface (LCFS)
- Reduction in fluctuation near edge
- Increase in poloidal flow velocity
- Plasma current profile modification

Observations

The experiment has been carried out with positive bias for 5mm diameter Mo electrode at 10mm, 15mm and 20mm inside limiter. At all the three positions electrode exposed length in plasma was 10mm.

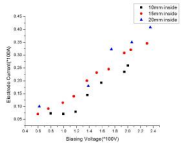

Fig. (1): Electrode Current vs. Biasing voltage

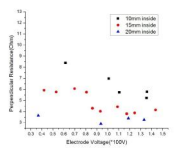

Fig. (2): Perpendicular resistance vs. electrode voltage

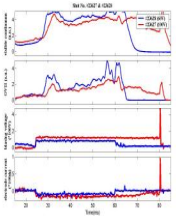

Fig. (3) shows that In 23627 (100V bias) and 23628 (60V bias) after the bias on there is rise in Visible continuum signal (which shows rise in density) and NIM (OVII line emission) Signal (which shows rise in Temperature).

Fig. (3): visible continuum signal and OVII signal vs. time

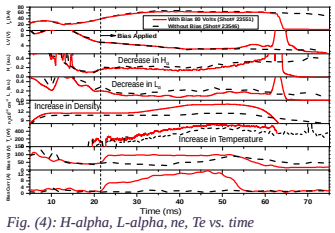

Fig. (4): H-alpha, L-alpha, ne, Te vs. time

In fig. (4) comparison of shot 23546 (no bias) and 23551 (80V bias), we find that on biasing H- alpha, L-alpha line emission from plasma edge decrease, which indicates that outgoing plasma flux is reduced, leading to reduction in "recycling". Whereas plasma density and electron temperature increase.

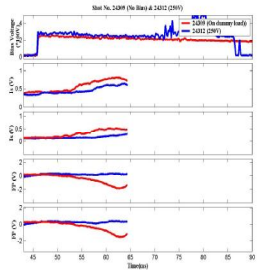

Fig. (5): Ion saturation current and floating potential at plasma edge

Fig. (5) shows langmuir probe signal placed at 20mm inside the limiter at the top of Aditya tokamak. It is evident that after the bias on Ion saturation current (Is) show low density at plasma edge in comparision to unbiased case, which might be a signature of pedestal formation). Change in floating potential signal observed with the bias indicates the change in electric field.

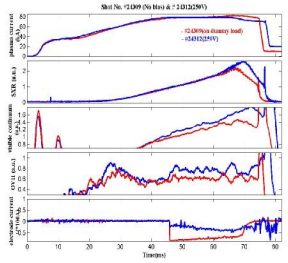

Fig. (6): plasma current, SXR, Visible continuum signal and OVII signal vs. time

Fig. (6) shows that in 24309 (No bias) and 24312 (250V bias) after the bias switch on slope changes in Visible continuum signal (which shows rise in density) and NIM (OVII line emission) Signal, which shows rise in Temperature,

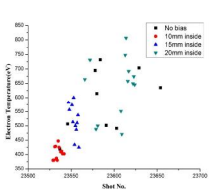

Fig. (7): Maximum electron temperature during discharge

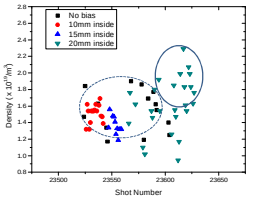

Fig. (8): Maximum plasma density during discharge

Conclusion

- All the signatures of improved confinementare observed in Aditya tokamak by placing an electrode inside the LCFS and biasing it positively upto 250V.
- With positive biasing we have observed increase in plasma temperature and density.
- Observed increase indensity and temperature with similar input power suggests an increase in energy confinement time with.

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