



Biassing Experiments in HSX



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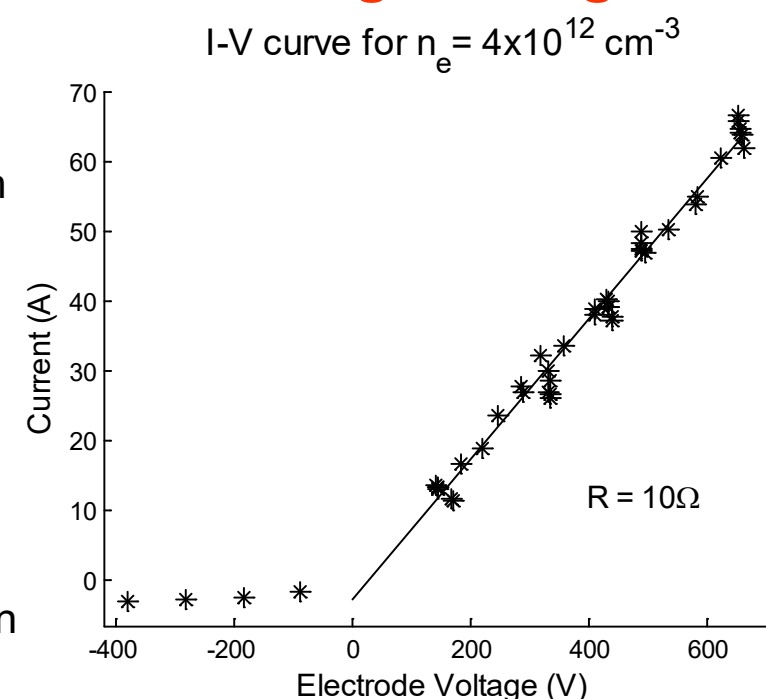
Overview

- Eventual goal is to do zonal flow studies in the presence and absence of an applied bias
- Start of a comparative study with TJ-II studying the role of magnetic configuration and flow damping on zonal flows
- Bias applied relative to carbon limiter placed just outside the last closed flux surface
- Limiter grounded to vessel through a cable at the bias probe ground, measurements show that almost all current goes through the limiter
- Molybdenum bias probe tip in a BN shell, 10mm diameter with 5mm of thickness exposed to plasma
- All results presented here have positive bias applied relative to the vessel (negative bias goes quickly to ion saturation)

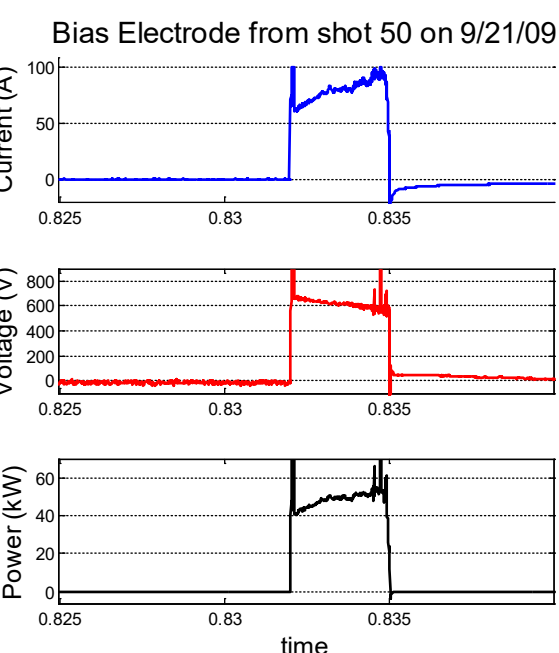
Biased Discharge Characteristics

I-V curve remains linear at high voltages

- Linear resistive characteristic similar to previous results at 0.5 T with the density scaled up
- Inducing an electric field above the value of the poloidal resonance (when the ExB drift cancels out the poloidal ion rotation) should greatly reduce particle transport in the biased region



High Voltage Biassing



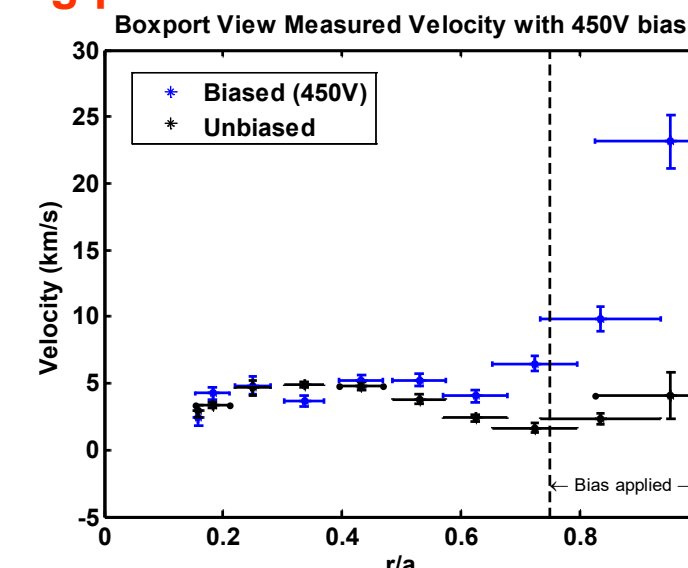
- Density rises quickly to cutoff
- Impurities accumulate quickly. This effect is nonlinear with additional applied voltage.
- Current rises with increasing density, Voltage droops as cap bank is discharged
- Energy dissipated across bias probe exceeds 50kW

Possible losses include finite limiter and vessel resistance, as well as edge plasma heating

Large Edge Flow Shear Induced with Biassing

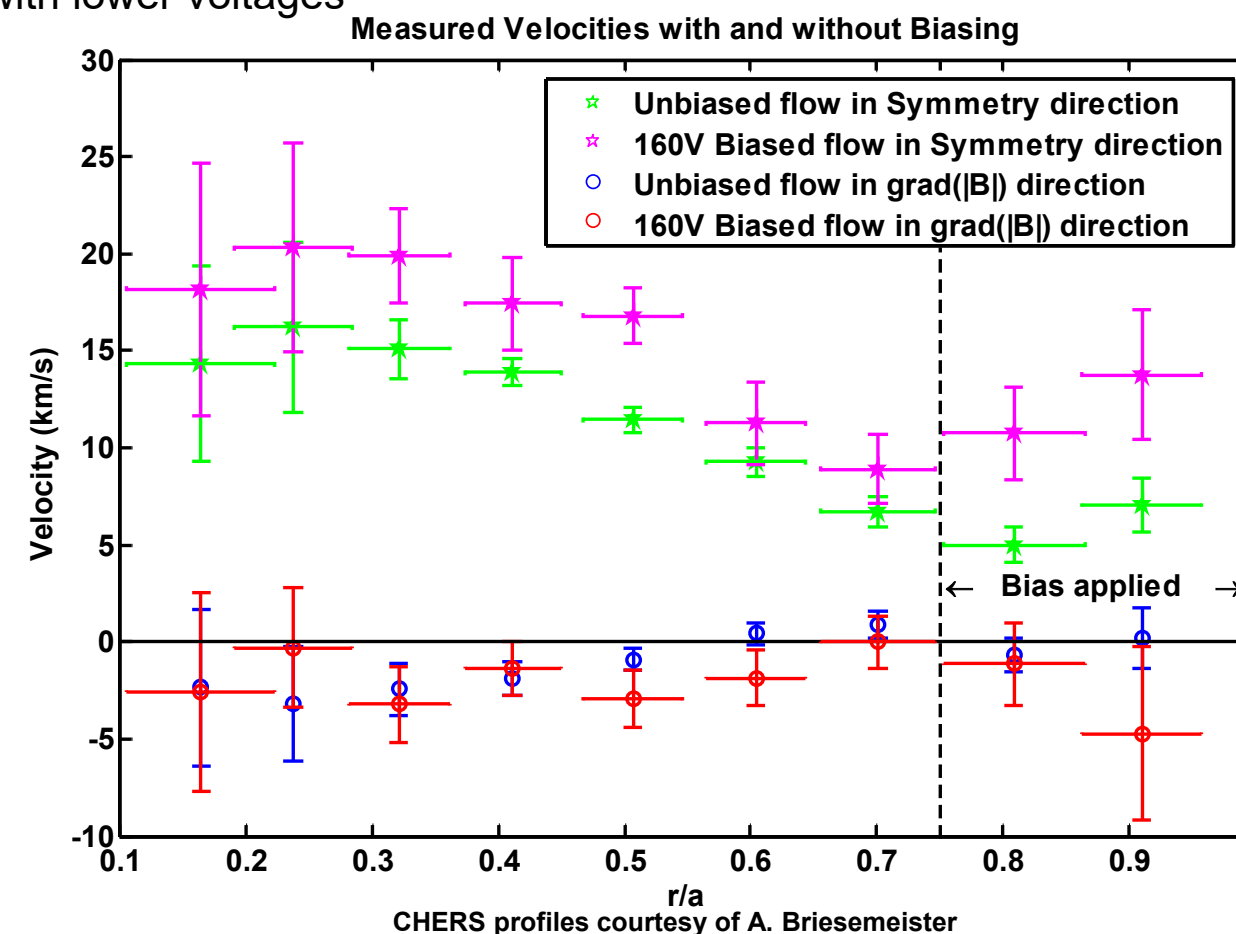
Measurements of evolving plasma

- For high bias voltages, flow shear is measured at the edge by CHERS
- Impurities accumulate with high voltage discharges, leading to increased photon count
- Density and stored energy rise over the course of the bias
- CHERS background subtraction is complicated by changes in background light during the shot

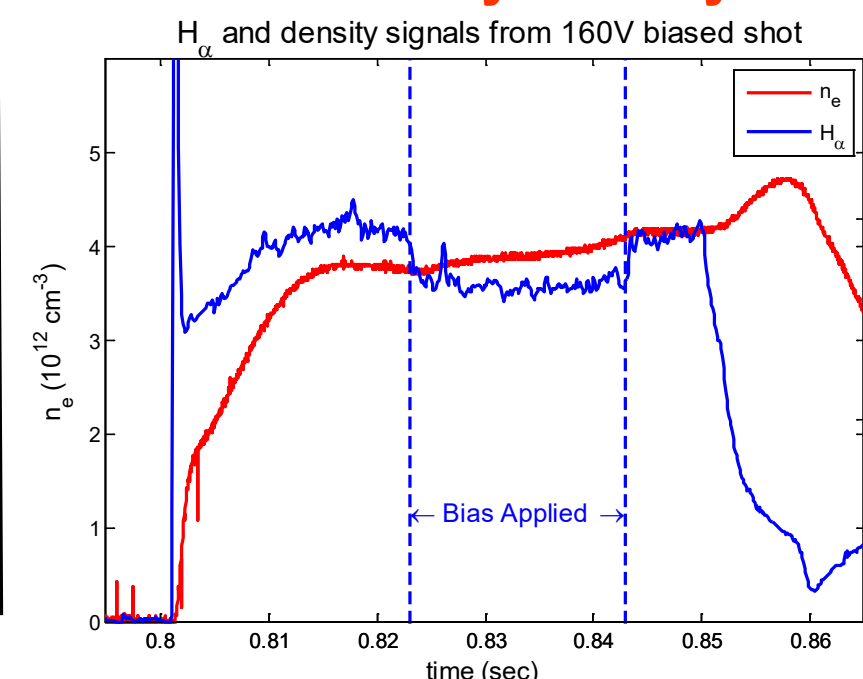


Steady state flow shear increases with bias

- At low bias voltage, puff reduction can be used to maintain density control during bias, making CHERS measurements more reliable
- CHERS measurements show increased flow outside bias probe location even when biasing with lower voltages



Steady density with reduced fueling

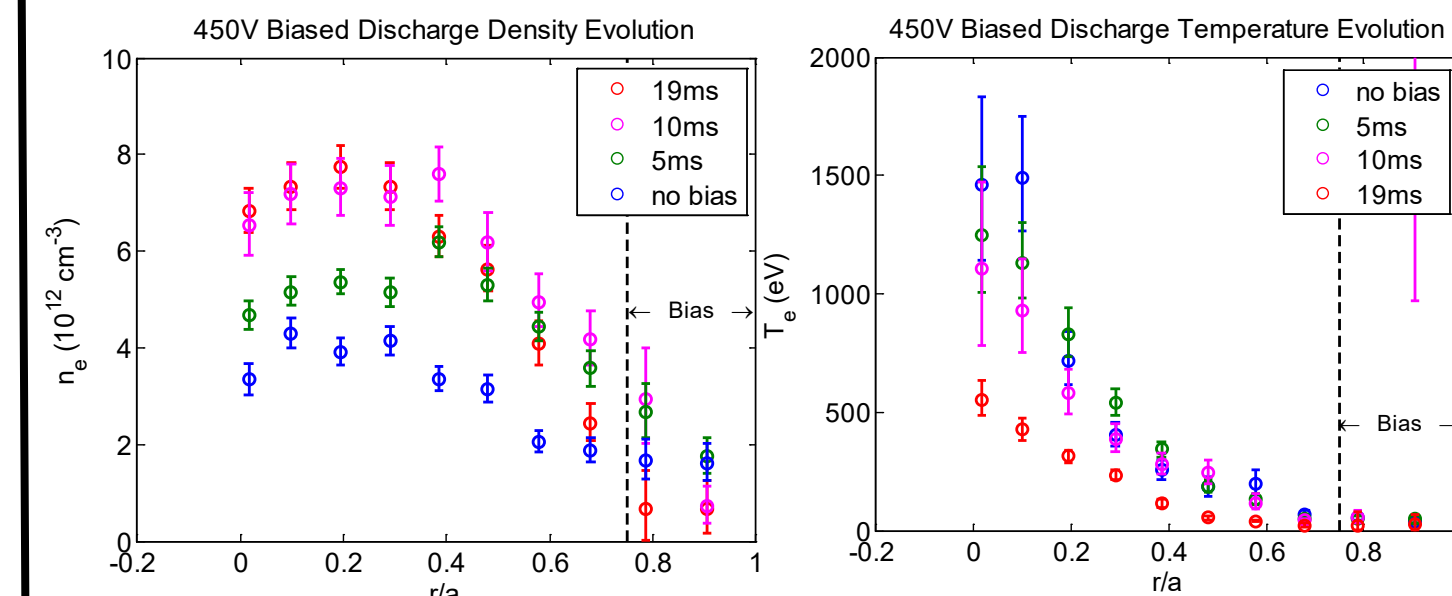


- Can see that with density held relatively constant during bias, H-alpha signal decreases
- For low-voltage biases, impurity levels do not differ greatly from non-biased shots (higher voltage biases see large increases in impurities)
- Reduced fueling and flat or slightly increasing density shows improved particle confinement

Improved Particle Confinement

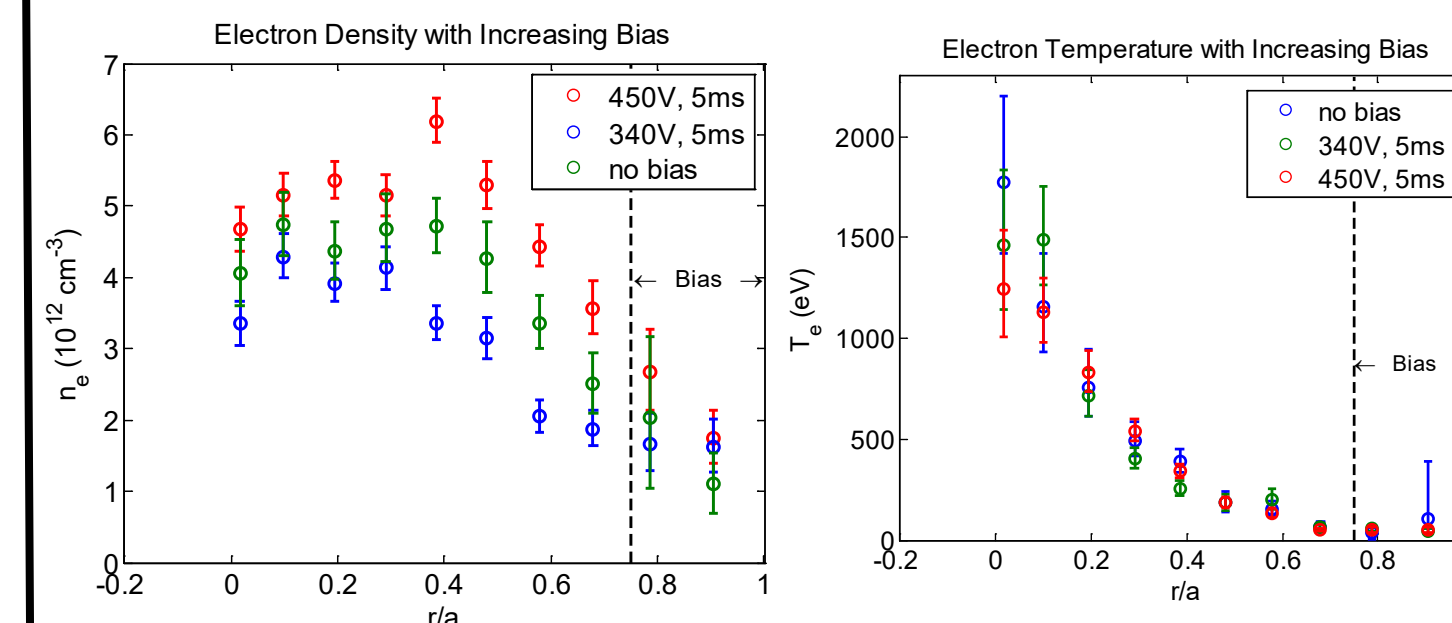
Density rise during bias

- Density inside location of probe increases as soon as bias is applied if puff is not decreased
- For high enough levels of bias, stopping puff during bias is not enough to control density increase (there is significant H fueling from the wall as indicated by H_α signals, as well as impurity fueling)
- Temperature collapses due to increased electron density (less ECH power per particle) and increased radiated power from impurities as they accumulate over the course of the bias.



Increased density with higher voltage

- Rate of change of density appears proportional to the applied bias



Summary and Future Work

- CHERS measurements confirm induced flow shear in the biased region
- Particle confinement is improved with edge biasing
- In the future, density and electrostatic fluctuations will be measured with and without bias applied
- Looking for evidence of changes in long-range correlations with biasing
- Beginning comparative study of zonal flows with TJ-II