Asymmetric Edge Biasing for Scrape-off Layer Control in NSTX

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APS DPP 2008, paper CO3.00012

Convective Cell Generation

- Goal is to broaden heat / particle SOL width at divertor plate by creating local convective cells [Cohen/Rytuov '97]

electrode on divertor plate

SOL strike zone

convected density
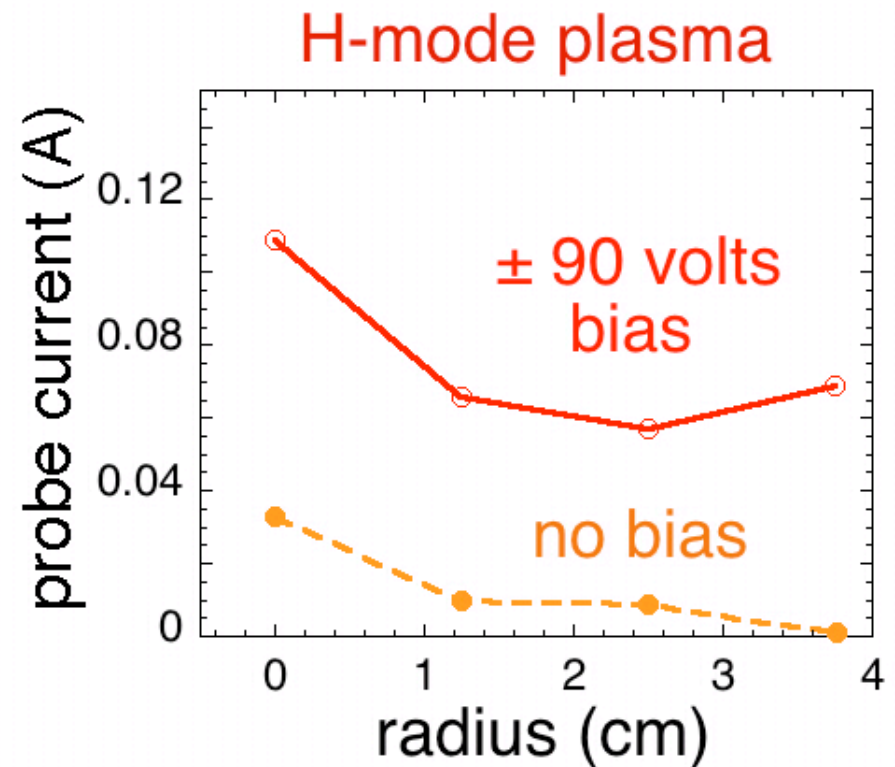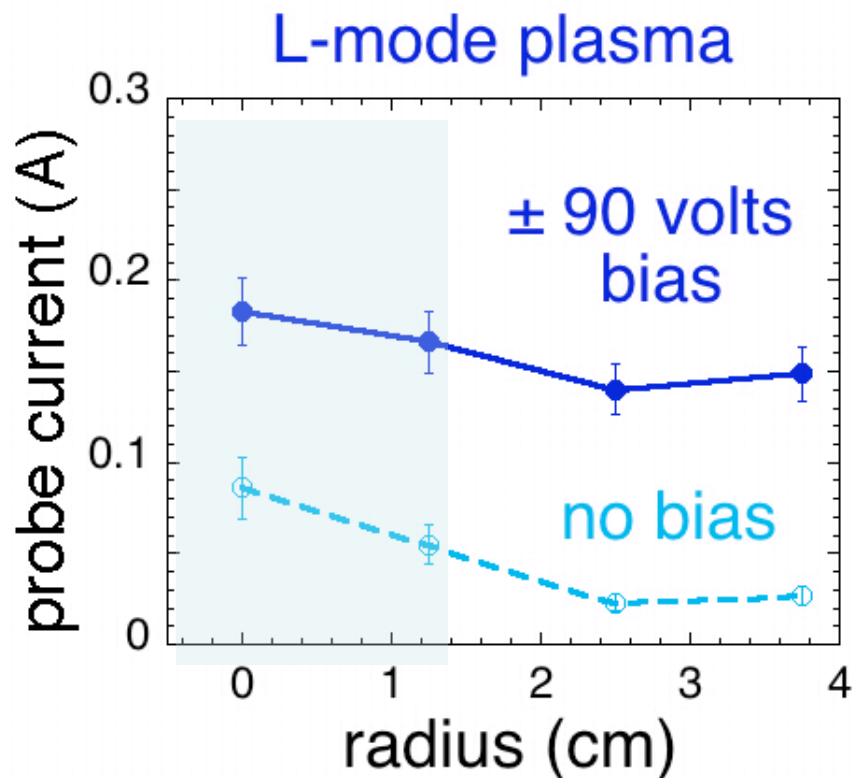
radially outward

B
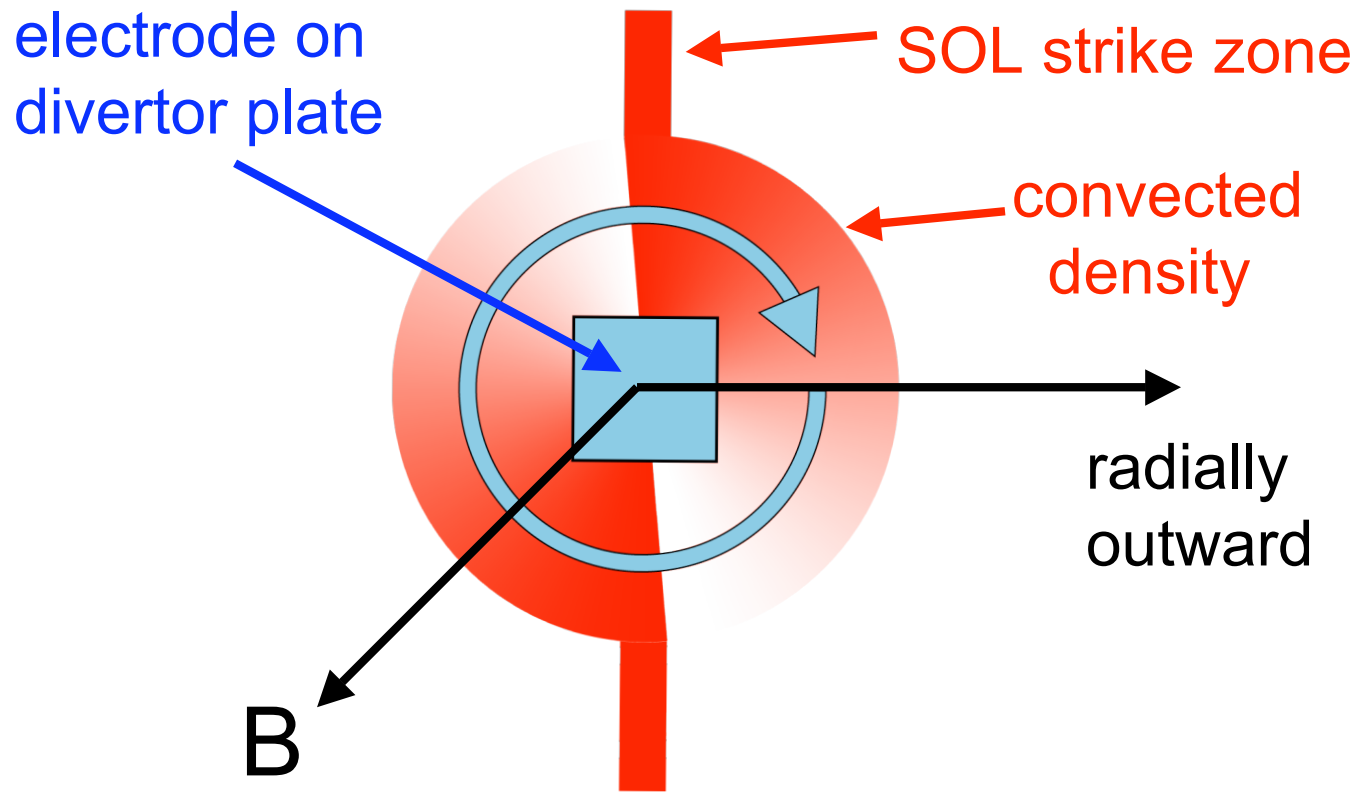
NSTX Electrodes and Probes

- Electrodes and probes located below outer midplane
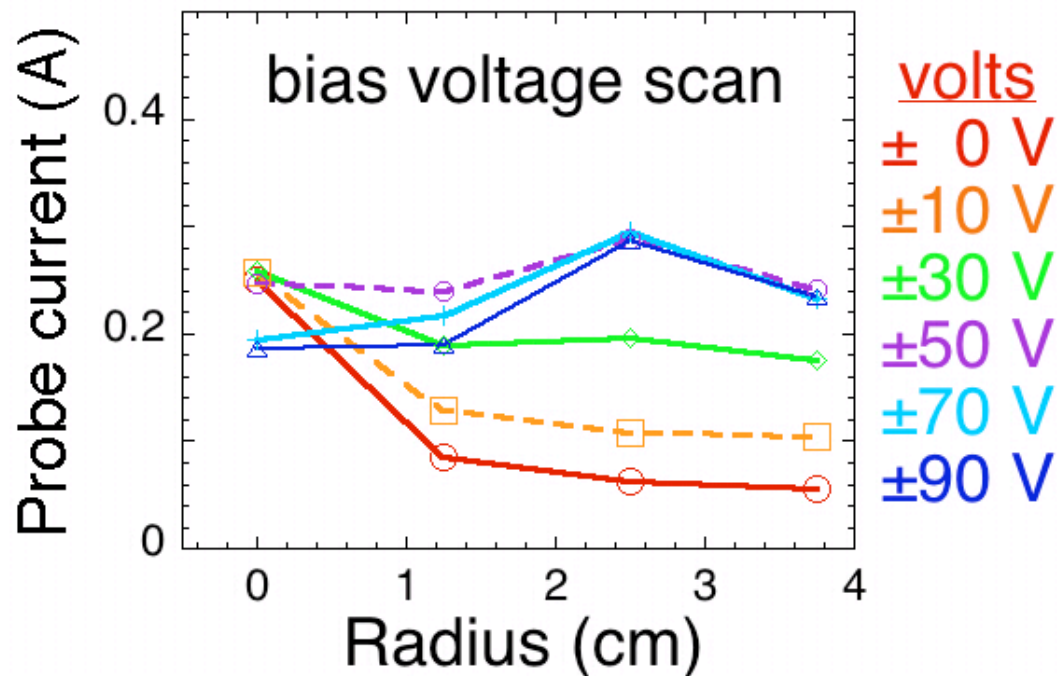
- Electrodes biased up to ±100 V with respect to vessel
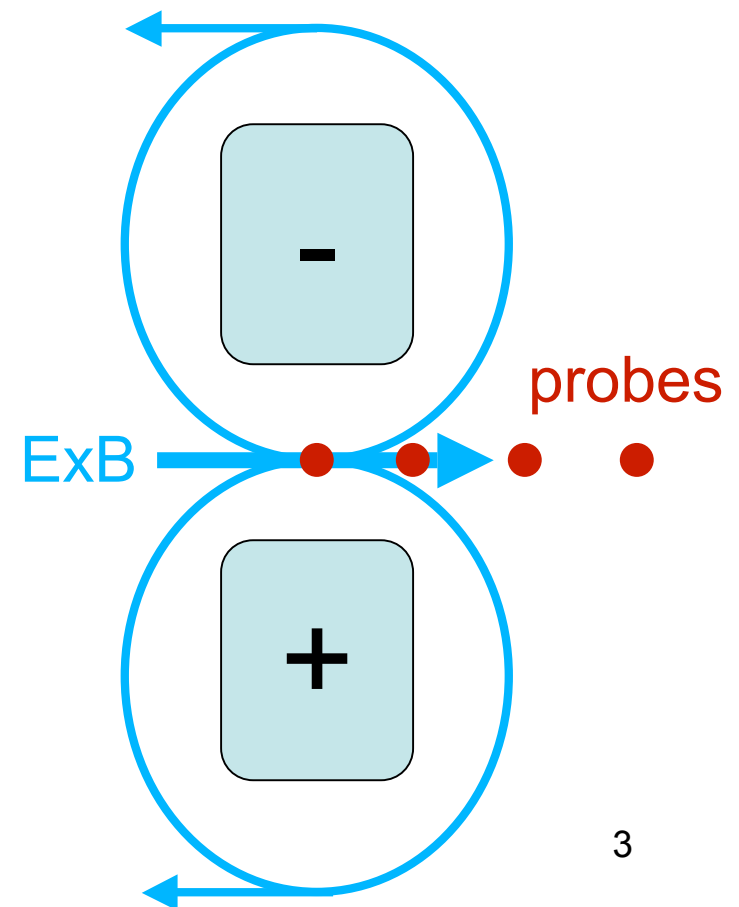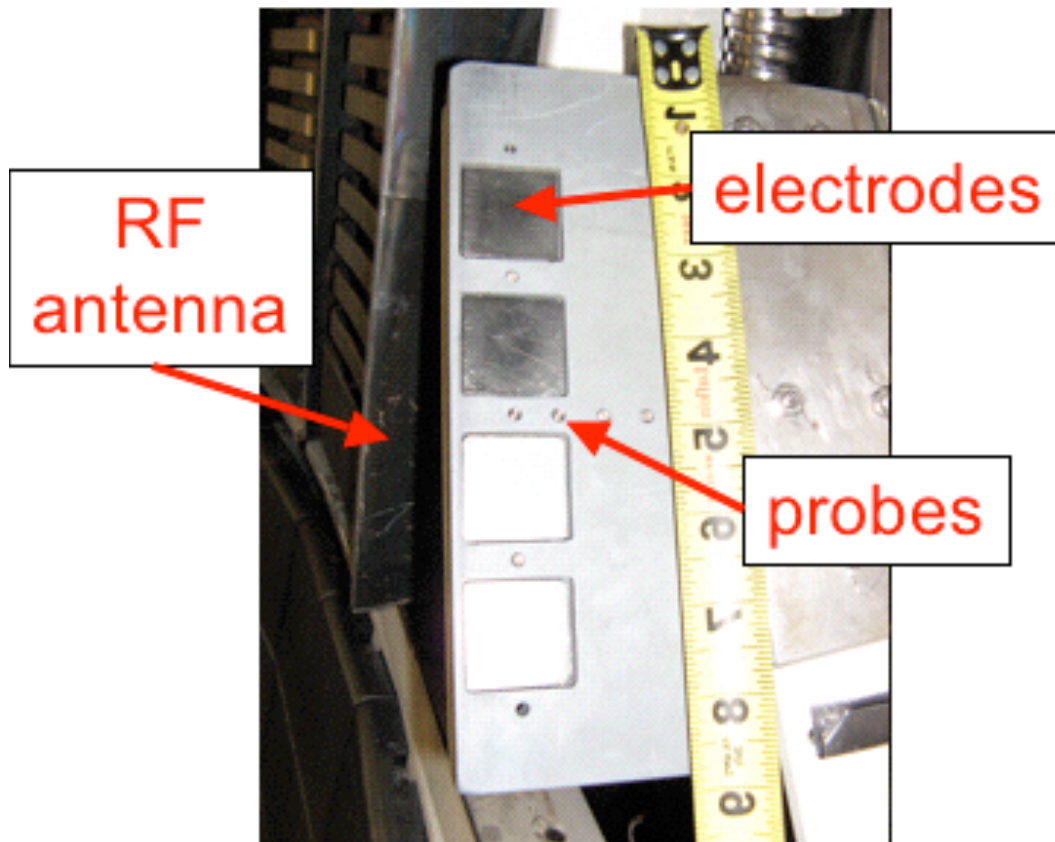
Density Profile Effects of Biasing

- Radial profiles of $I_{e,sat}$ averaged over many on/off cycles

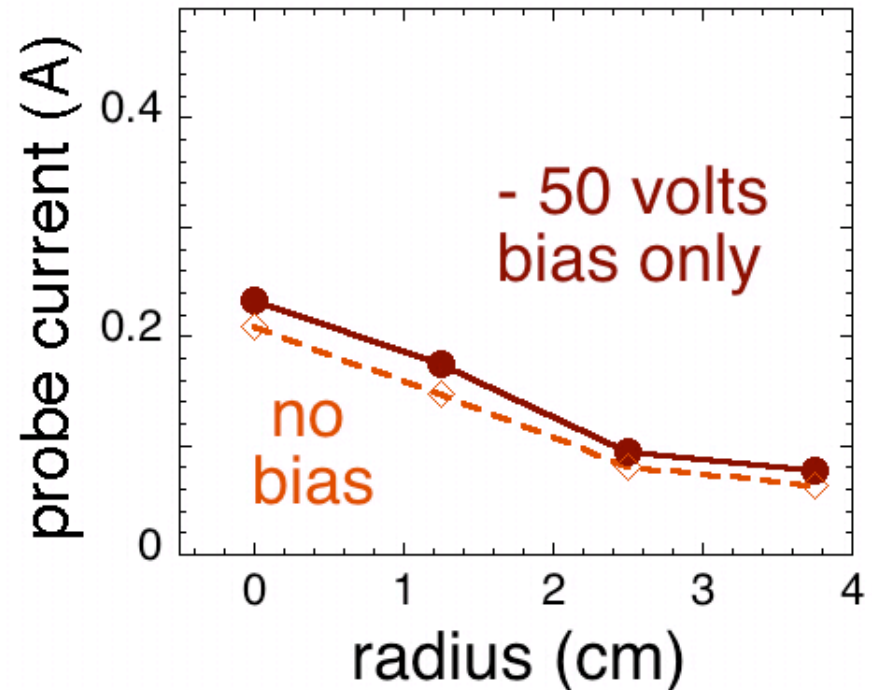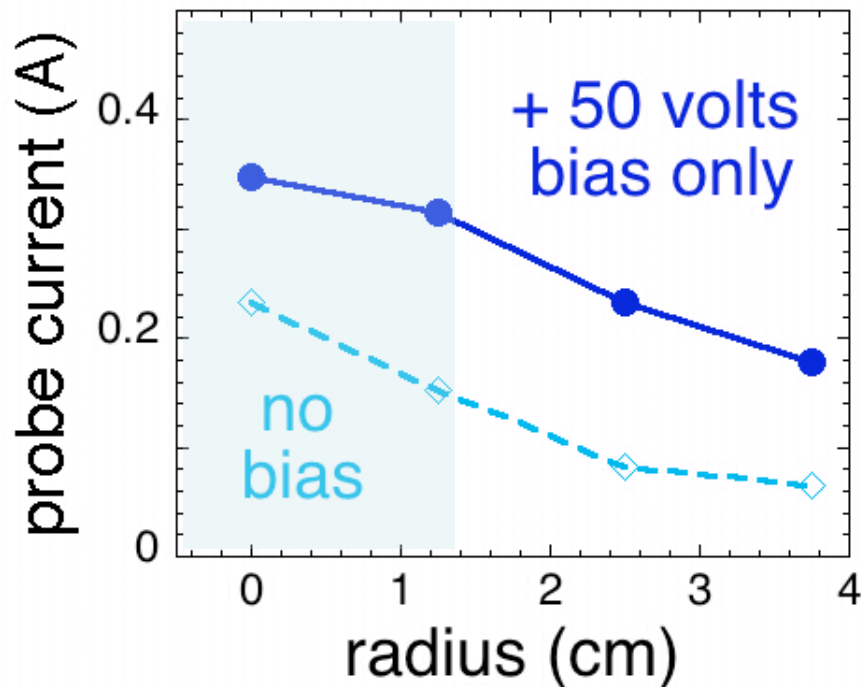- Typically n ~ 10^{11} cm^{-3} and T_e ~ 5-10 eV (at r=0 cm)

Electrode Bias Voltage Scan

- Effects on density profile vary with biasing voltage

- Need only V ~ 30 volts for most of effect to occur

Single Electrode Response

- Density responds more to positive than negative electrode, ~ as predicted by Ruytov/Cohen from sheath theory

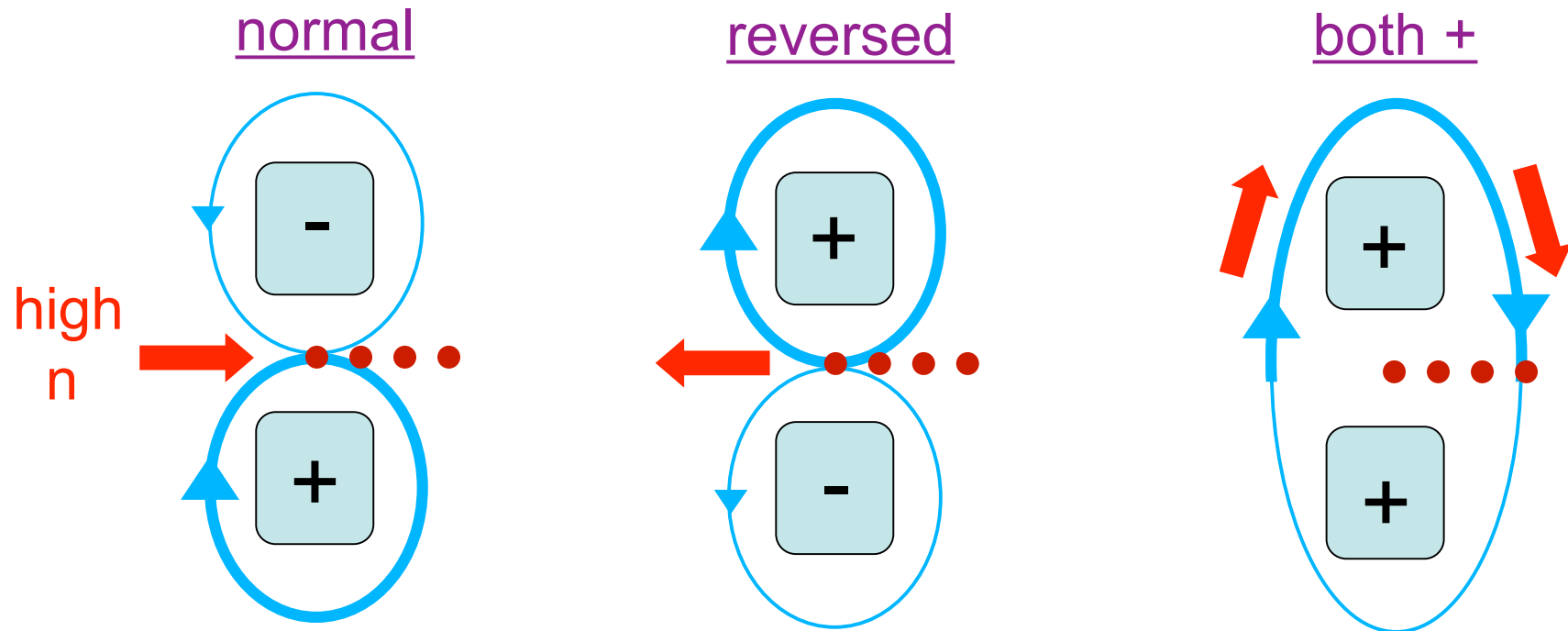- But positive biasing requires a large power ~ 0.5 MW/m^2

Reversed Polarity Electrodes

- Density profile reversed with opposite E polarity

- Similar effect when both electrodes are positive
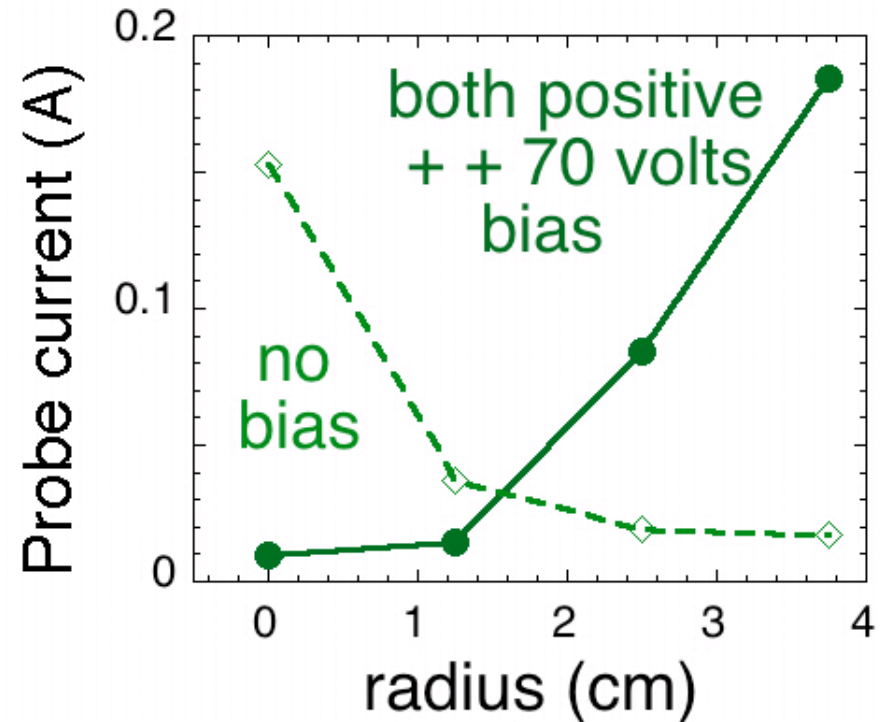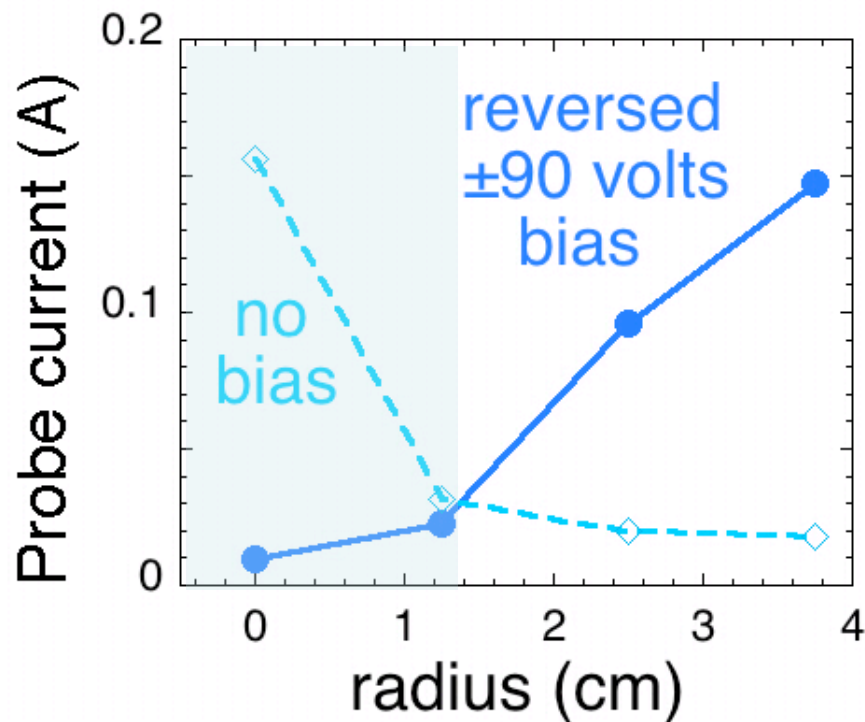
Qualitative Interpretation

- Profiles changes ~ consistent with expected ExB flows

normal

reversed

both +

high n

Conclusions

- Biased electrodes can control local SOL at outer midplane

- Results qualitatively consistent with convective cell model

For quantitative understanding, need to know range of

electric field penetration both II and $\perp$ to B

(no simple models)

Plans

- Electrodes in tiles between liquid lithium divertor segments

    - measure effects ‖ and ⊥ B with camera + probes

    - learn to minimize power needed for SOL control

R. Ellis