Electrode Biasing Experiment for Local SOL Control In NSTX

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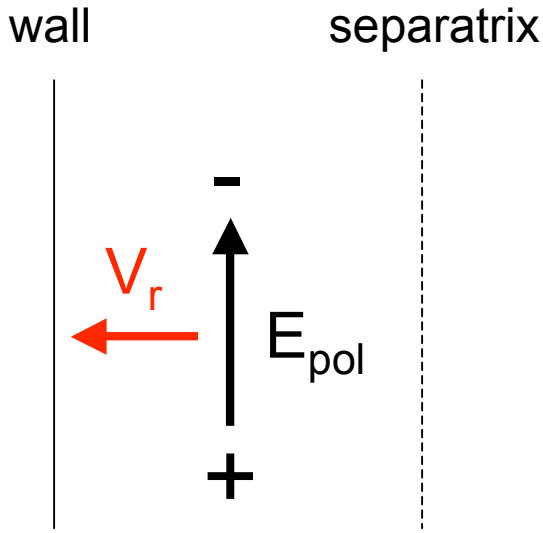
SOL Control by Edge Biasing

- Create localized poloidal electric fields in SOL to make local radial $V_r = E_{pol} \times B$ drift to drive plasma outward [Ryutov, Cohen et al, PPCF (2001)]

- If V_r is larger than the outward turbulent transport speed, local SOL width will be increased (particles and heat)

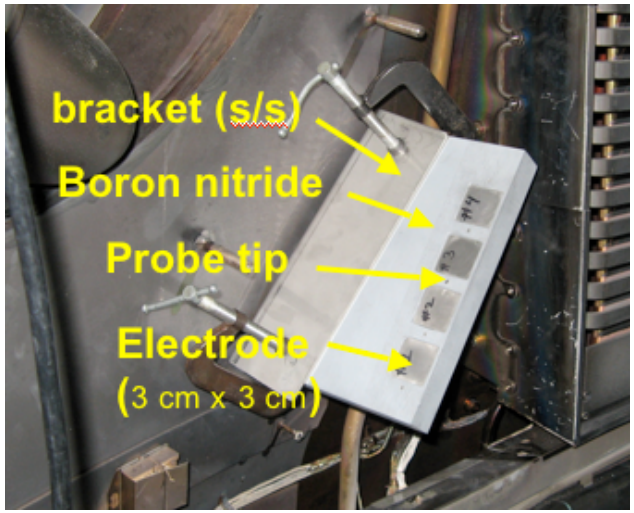


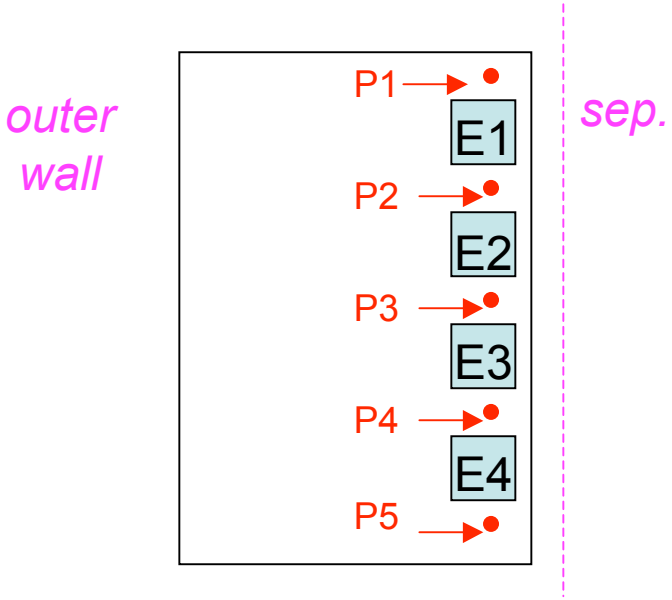
- $V_r(\text{cm/sec}) = 10^8 \, E_{pol}(\text{V/cm})/B(\text{G})$

- turbulent 'blob' speed ≤ 1 km/sec

⇒ need only $V_r \sim 5$ V/cm to broaden SOL in NSTX (because of low B)

BEaP (Biased Electrodes and Probes)





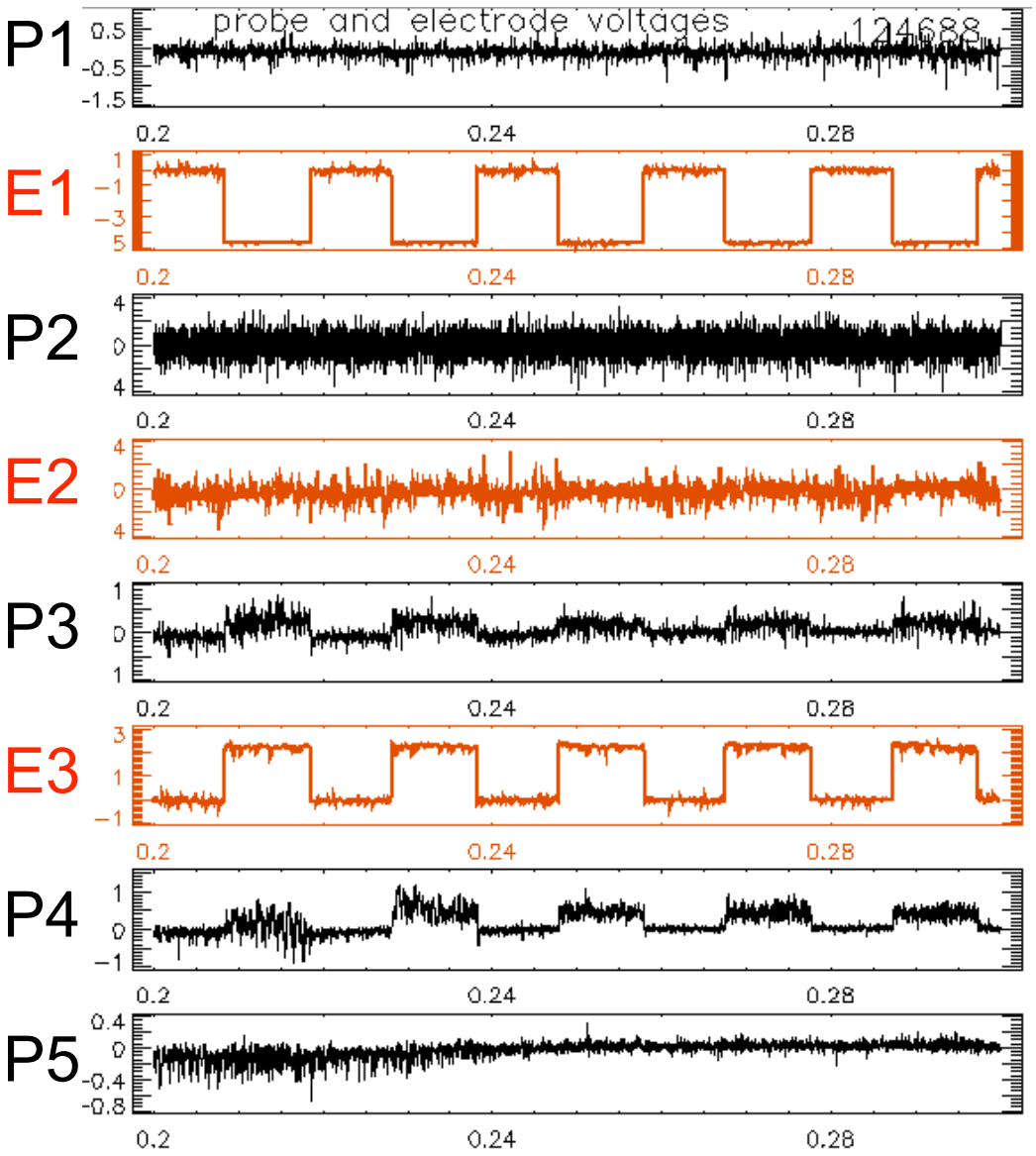
Shot list for 2007 run (XMP51, XP744):

Shot	Electrode #1	Electrode #2	Electrode #3	probes
123678	0	0	off	swept
123679	-20 volts	-20 volts	off	swept
123680	0	0	off	swept
124059	0	0	off	+50 volts
124060	-70 volts	-70 volts	off	+50 volts
124061	-70 volts	-35 volts	off	+50 volts
124062	-35 volts	-70 volts	off	+50 volts
124676	0	-90 volts	0	swept
124677	0	-95 volts	+10 volts	swept
124678	0	-95 volts	+20 volts	swept
124679	0	-95 volts	+25 volts	floating
124680	0	-95 volts	+30 volts	floating
124681	0	-95 volts	+30 volts	-50 volts
124682	0	-95 volts	+30 volts	+50 volts
124683	0	-95 volts	+40 volts	+50 volts
124684	0	-95 volts	+40 volts	floating
124688	-95 volts	0	+50 volts	floating

electrode #4 hard grounded for all shots (without any current monitor)

local electric field up to ~150 V/cm !

Probe Floating Potential Response

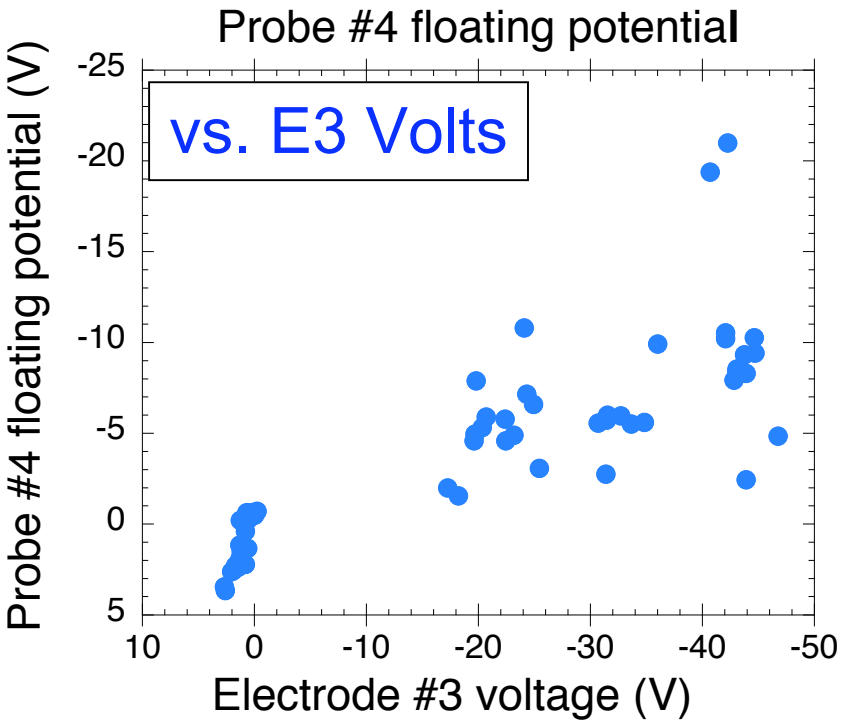


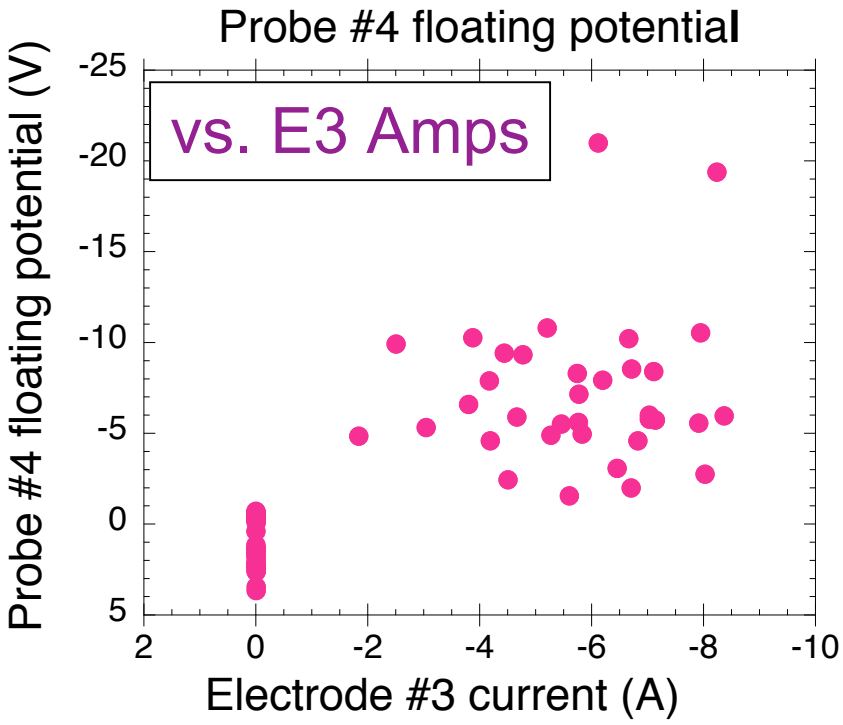
- floating potential of probes near + bias electrode go up ~20% of voltage on electrode
- floating potential of probes near - bias electrode has much smaller change (~ 0)

=> positive electrode affects local V_f

negative electrode does not

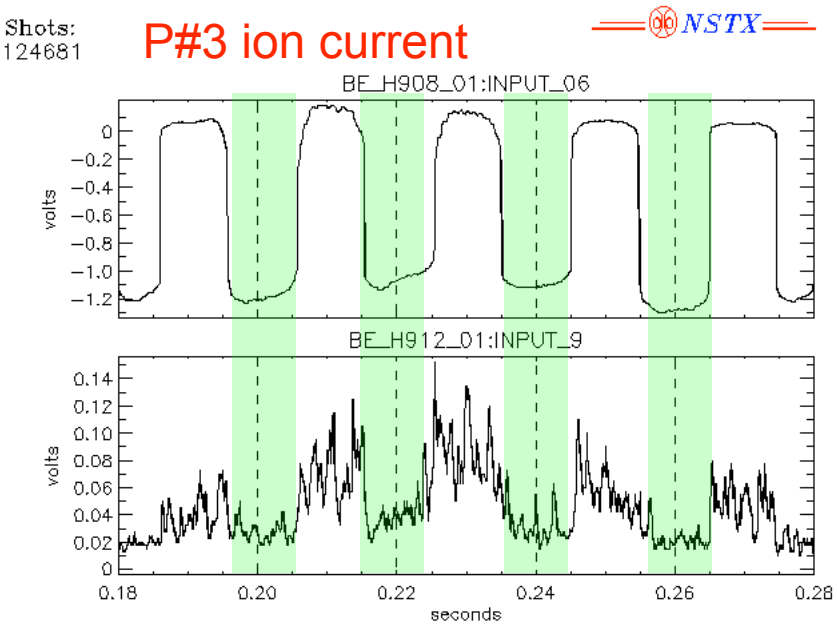
Floating Potential vs. Electrode (I,V)

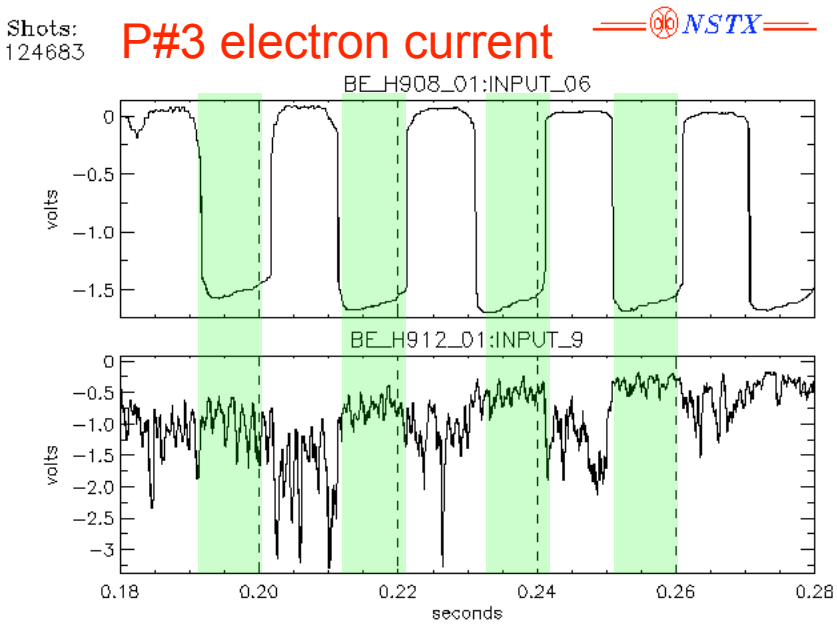




- Probe responds more to electrode voltage then current
- Some other factor(s) determining probe voltages changes

Probe Saturation Current Response

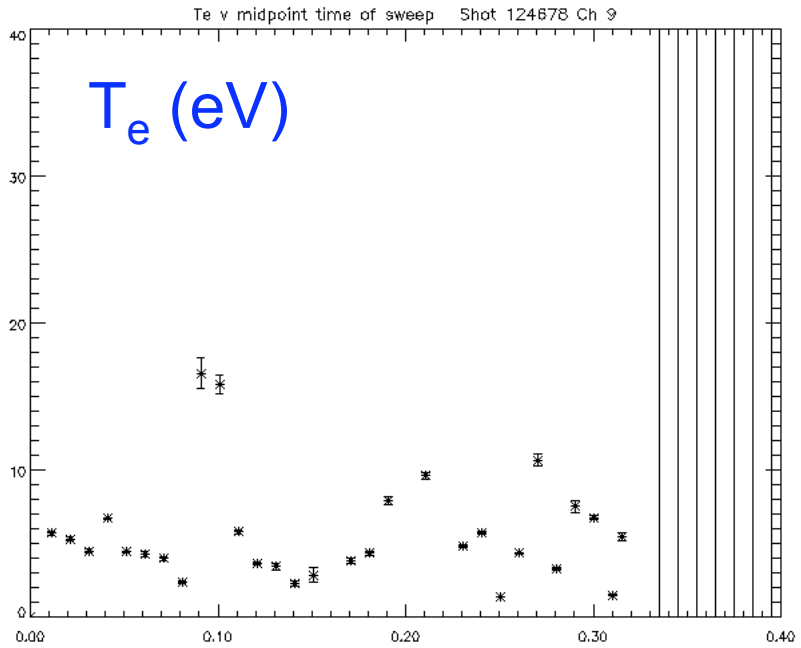


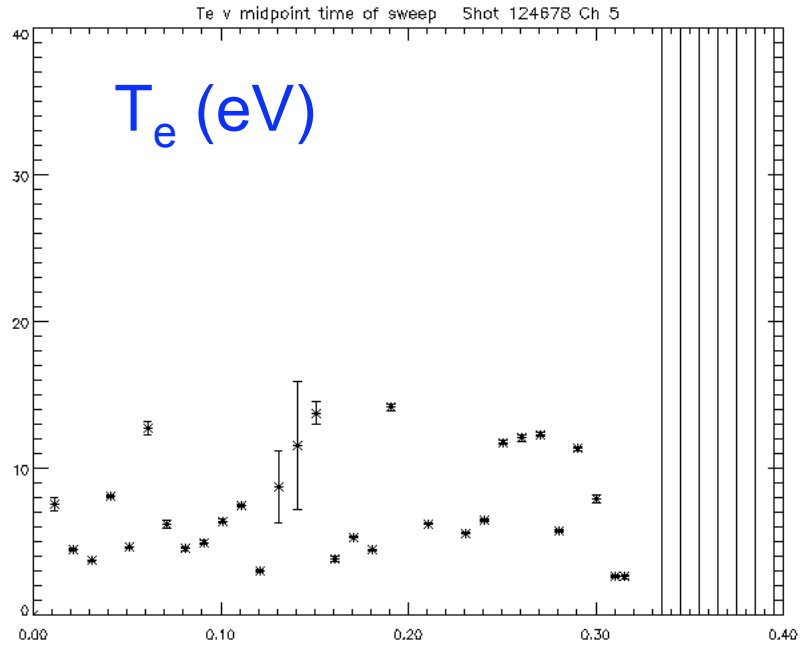


- I_{sat} (both i+ and e-) decreases with positive electrode bias

$\Rightarrow$ local density *decreases* with positive electrode bias
(may also be some effect due to local V_f change)

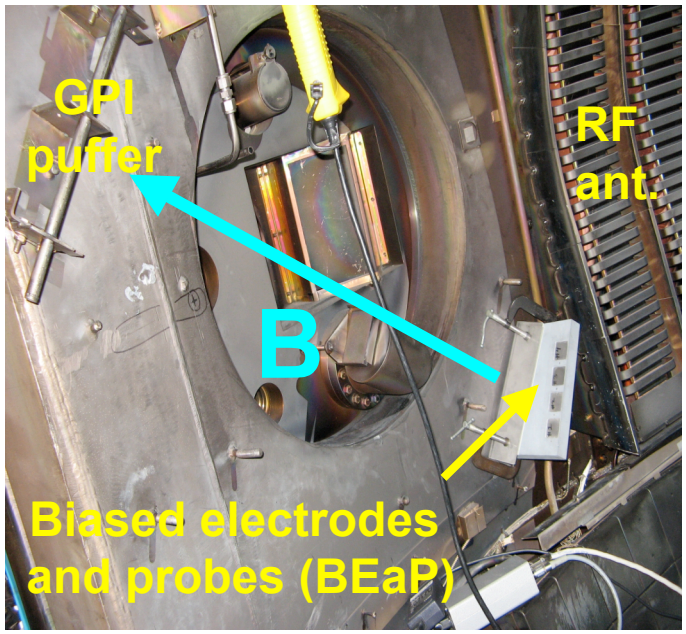
Probe Electron Temperatures

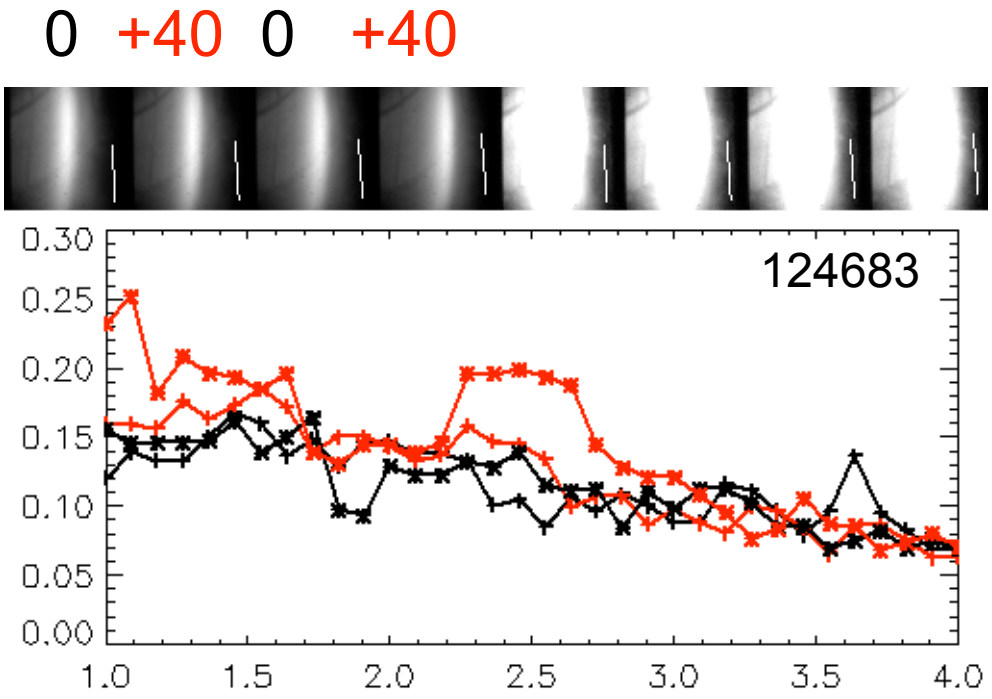




- T_e ~ 5-15 eV for most of time during biasing
- not clear yet if T_e is correlated with biasing

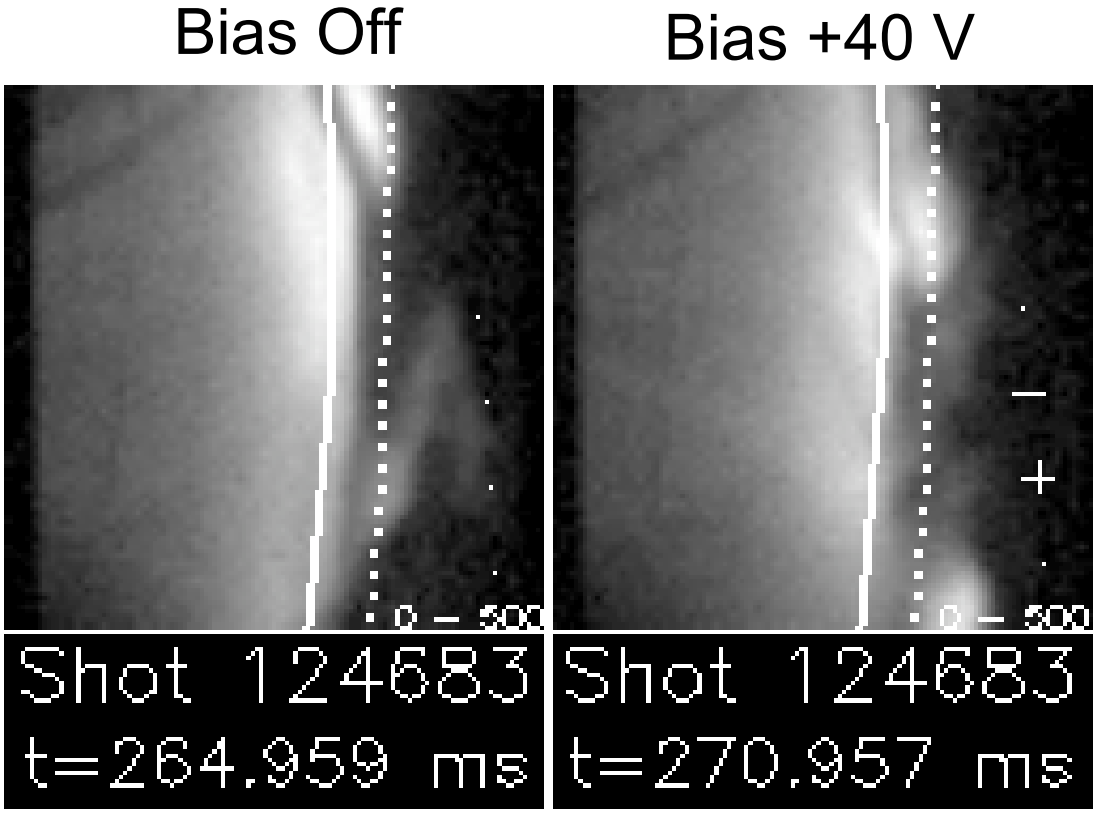
GPI D_α Profile Response to Bias





- No significant change in main D_α profile (near separatrix)
- Some increase in D_α between electrodes #2 and #3 ?

GPI Turbulence Response to Bias



- Turbulence ‘sucked’ between electrodes #2 and #3 ?

Summary of Experimental Results

- Positive bias has *some effect* on the local density and floating potential measured by nearby Langmuir probe
- Bias *seems to have some effect* on the local D_α profile and turbulence seen by the GPI diagnostic ~1 m away

Open questions:

- What determines change in plasma potential during bias ?
- How can we make a bigger change in local SOL with bias ?