Biased Electrode Experiment

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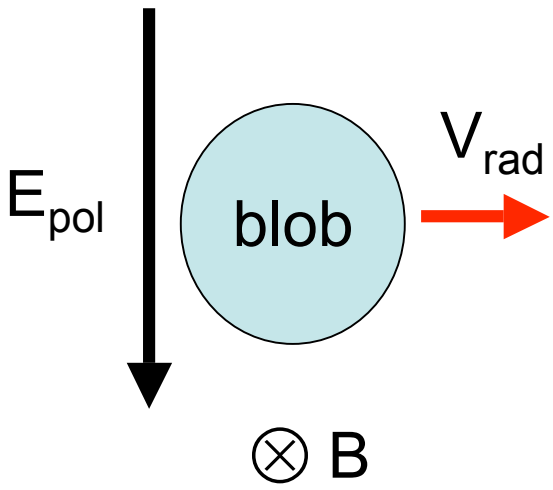
- Motivations and previous results
- Hardware upgrades for 2008
- Initial results from 2008
- Experiments for 2008

NSTX group mtg 2/18/08

Motivations

- Increase SOL width using localized poloidal electric fields
  (based on ideas of Cohen, Ryutov, et al)

- Understand physics of electric field penetration in plasma
  (surprisingly little is known from measurements)



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

- SOL 'width' increases by x10 when:

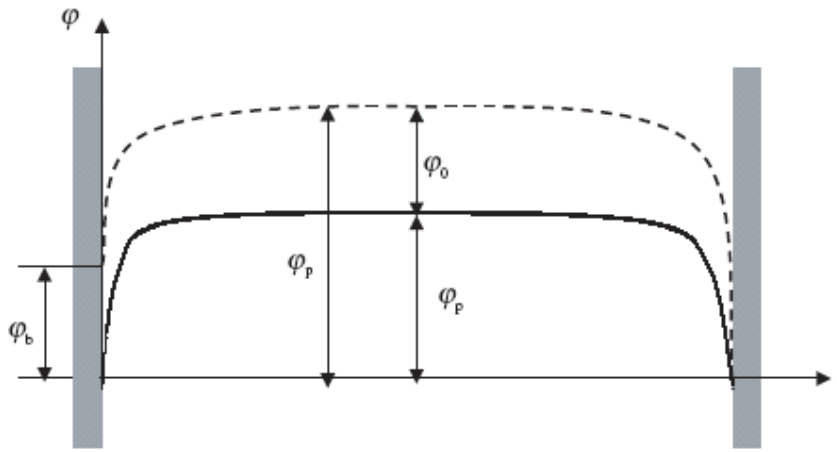
=> V_r (ExB) / V_r (blob) ~ 10 @ 30 V/cm

seems much easier than stochastic B !

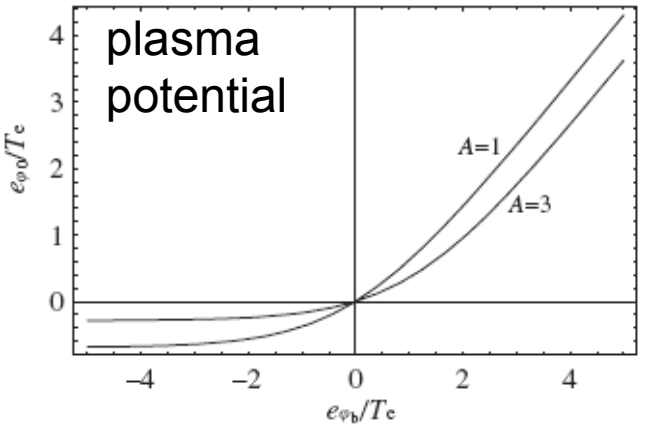
Simplest Theory of Electrode Biasing

(Ryutov, Cohen et al PPCF 2001)

plasma potential along B



potential vs. bias voltage



bias

- For + bias, $V_p \sim V_b$ - (few)T_e/e ; for - bias, $V_p \sim -0.8\ T_e/e$
- Voltage drop from parallel (Spitzer) resistance is negligible
- Increase in current collection area A (e.g. due to cross-B-field electrical conductivity) can decrease V_p

Previous Results from DITE

(Pitts and Stangeby PPCF 1990)

- Plasma potential goes + with + plate bias

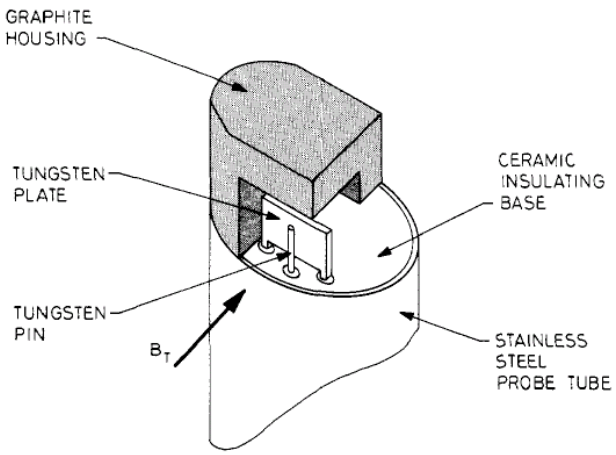
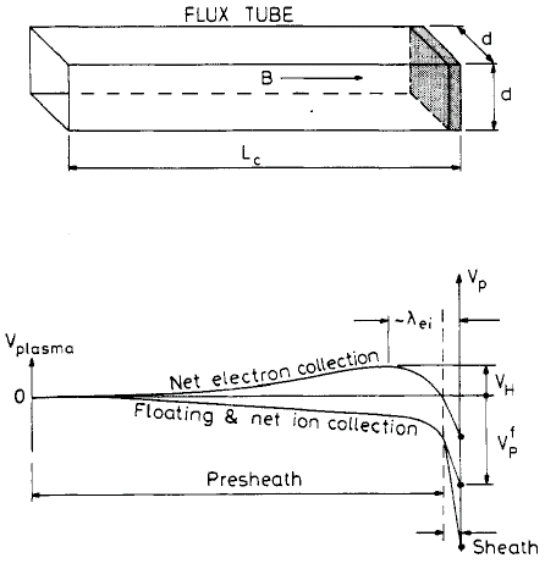
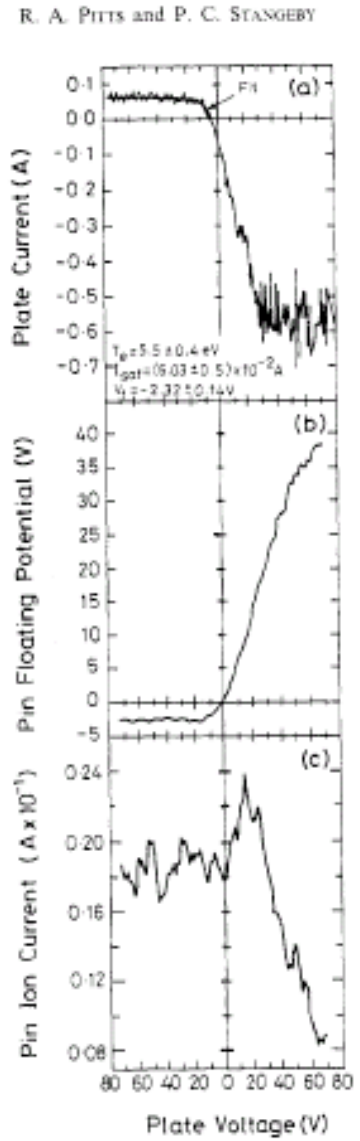


FIG. 2.—Cut-away isometric of the pin and plate probe head.



- Expect peak in V_p at $L_{II} \sim \lambda_{ei}$ (λ_{ei} ~100 cm in NSTX SOL)



Previous Results from TEXT

(Winslow et al PoP 1998)

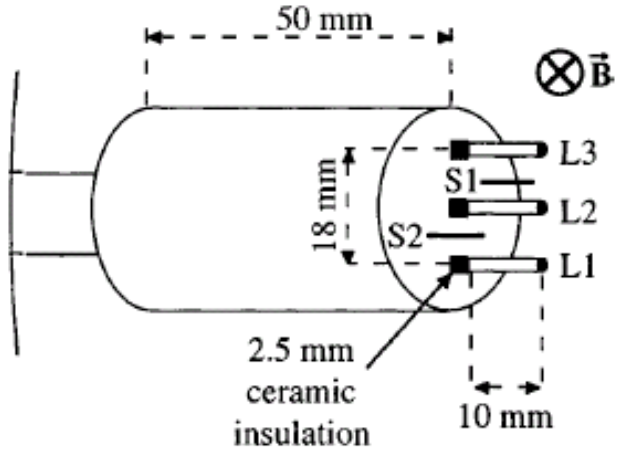
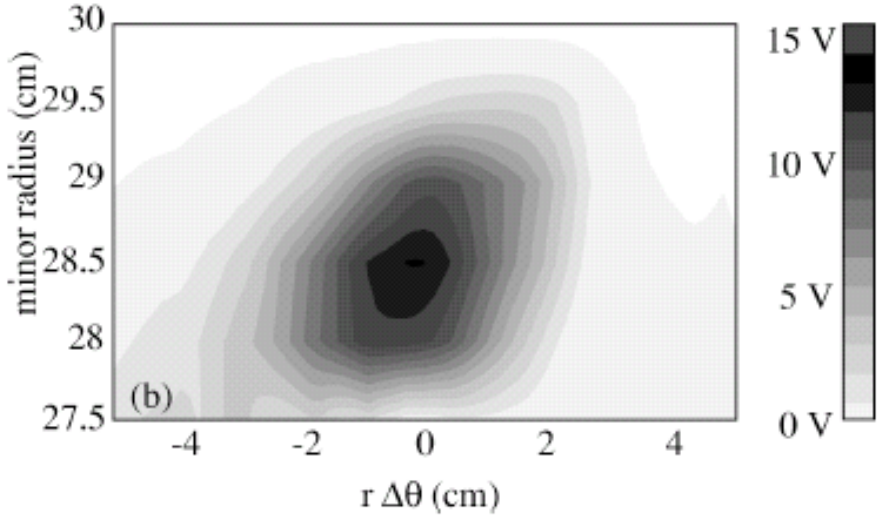


FIG. 1. The active probe. L1, L2, and L3 are driver tips and S1 and S2 are passive tips.

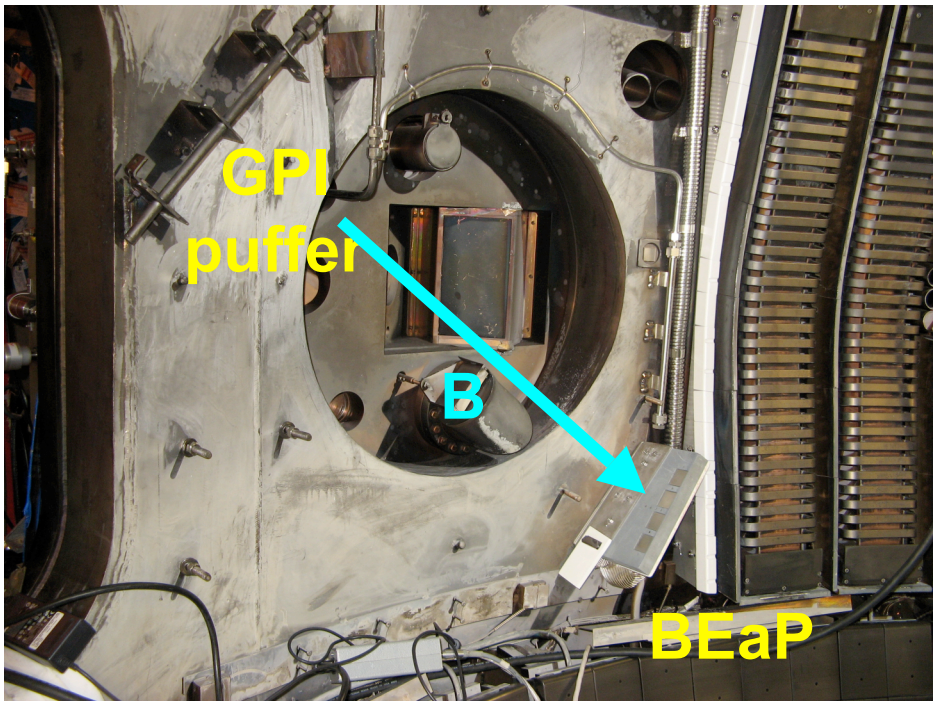
potential change @ 12 m

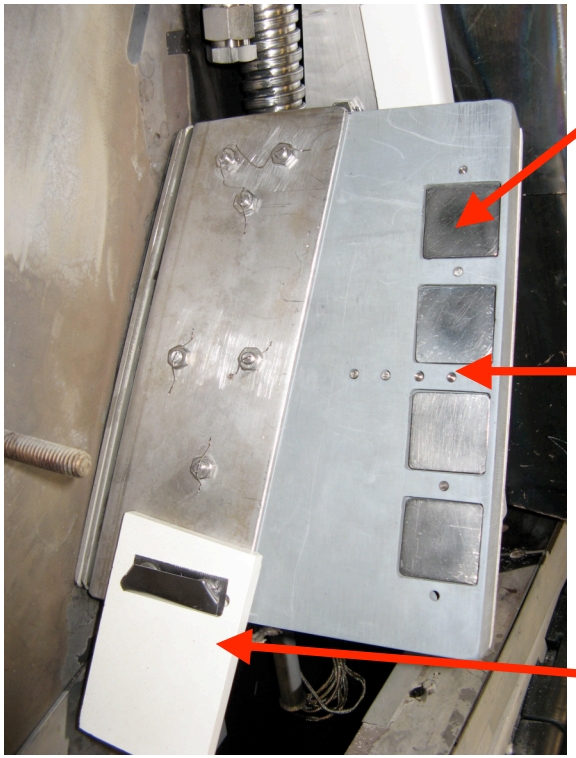


- For +50 V bias on 'driver', see + 15 V @ 12 m along B
- Radial and poloidal scales of potential change ~ 1 cm

Hardware Upgrades for 2008

- Two positive supplies increased from ~10 A to ~30 A
- Added radial array of probes to measure local SOL
- Now have 2 fast camera views of BEaP electrodes





BEaP Goals for 2008

- Measure effect of increased positive bias (up to +100 V)
- Measure effect of bias on SOL with radial probe array
- View effects of biasing on visible light near electrodes
- Evaluate effect of ‘floating electrodes’ (like double-probe)

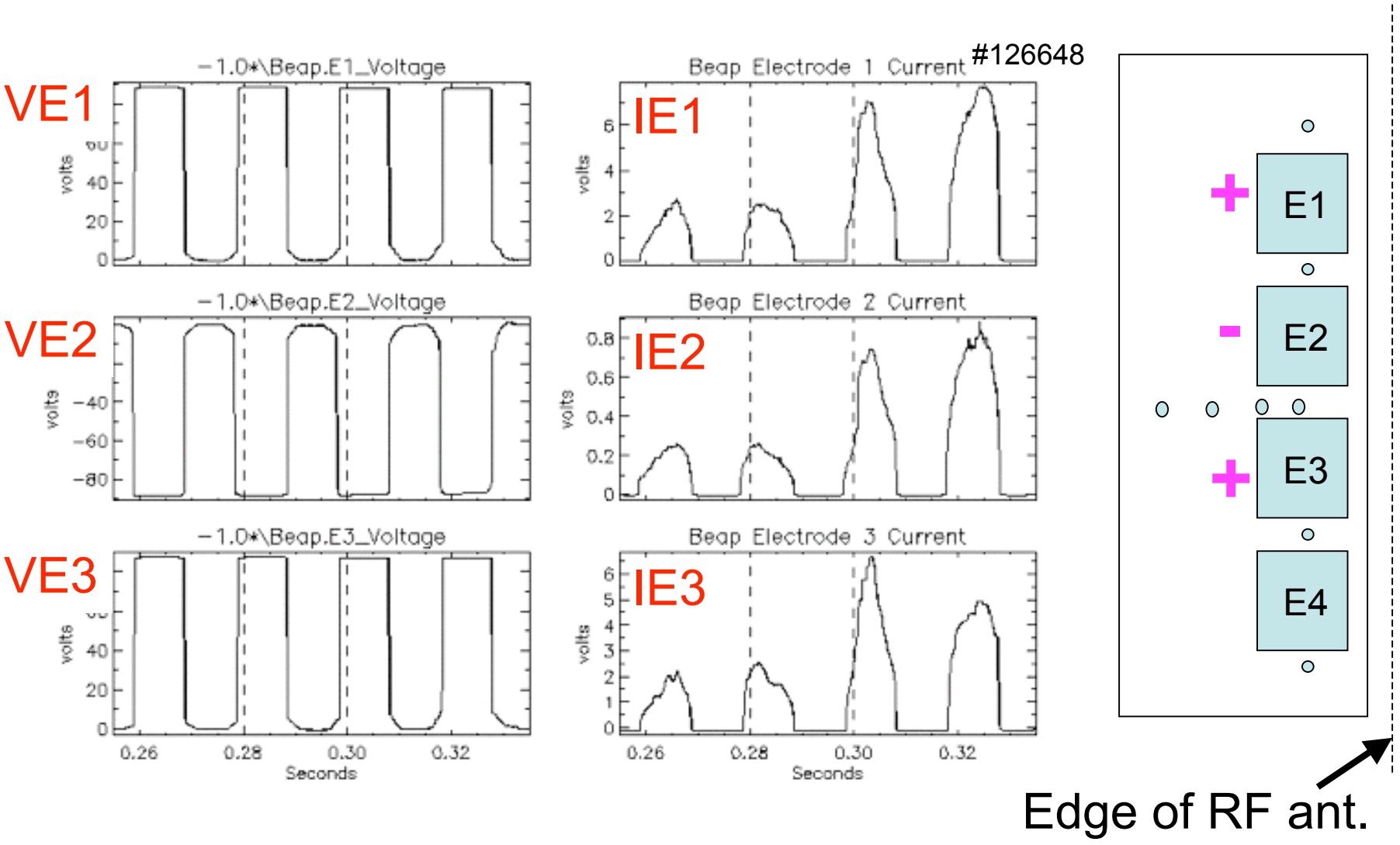
Initial Results from 2008

- Biased electrodes in ‘piggyback’ mode on shots with NBI
- Electrodes biased up to ±90 V and sometimes ~ 30 A
- Good radial probe data on floating potential and density
- Good images of GPI turbulence and BEaP electrodes
- However, uncontrolled plasma position was a problem

=> ready to do 1/2 day electrode biasing XP #806
when plasma is better controlled

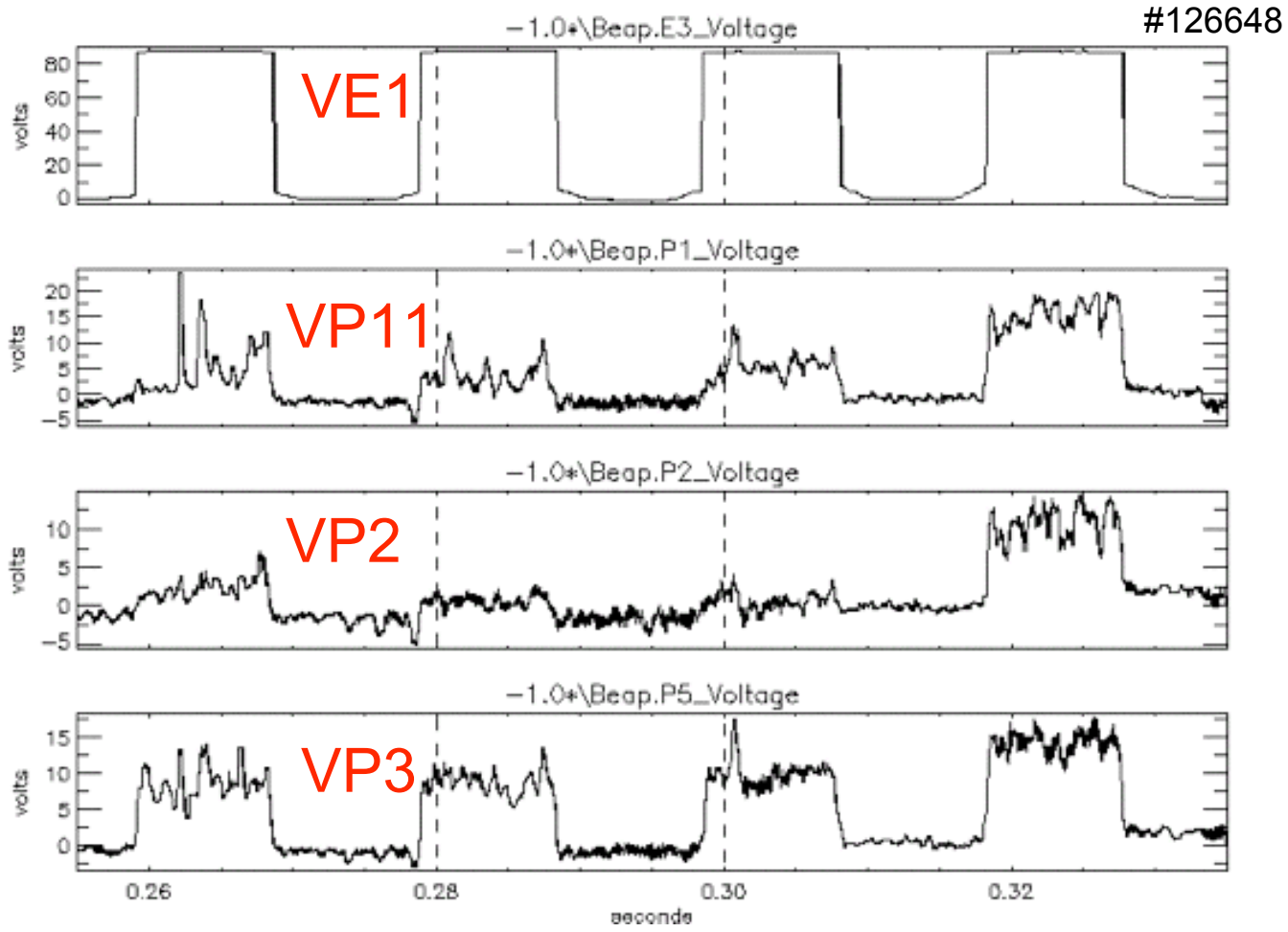
Electrode Voltages and Currents

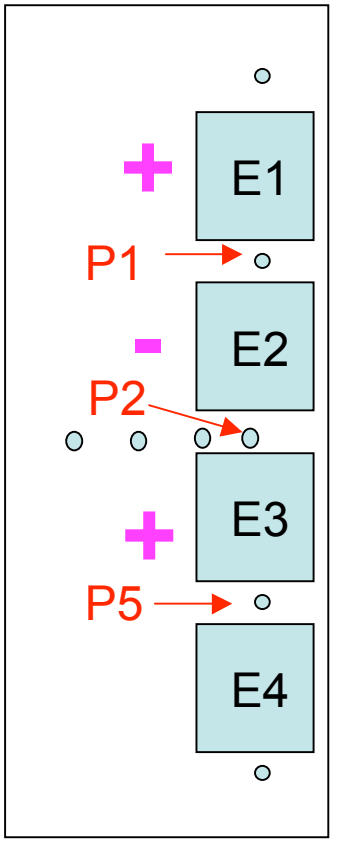
electrode voltages of ± 90 volts @ 4.5 kG, 0.8 MA, 3.6 MW



Floating Potential Effect

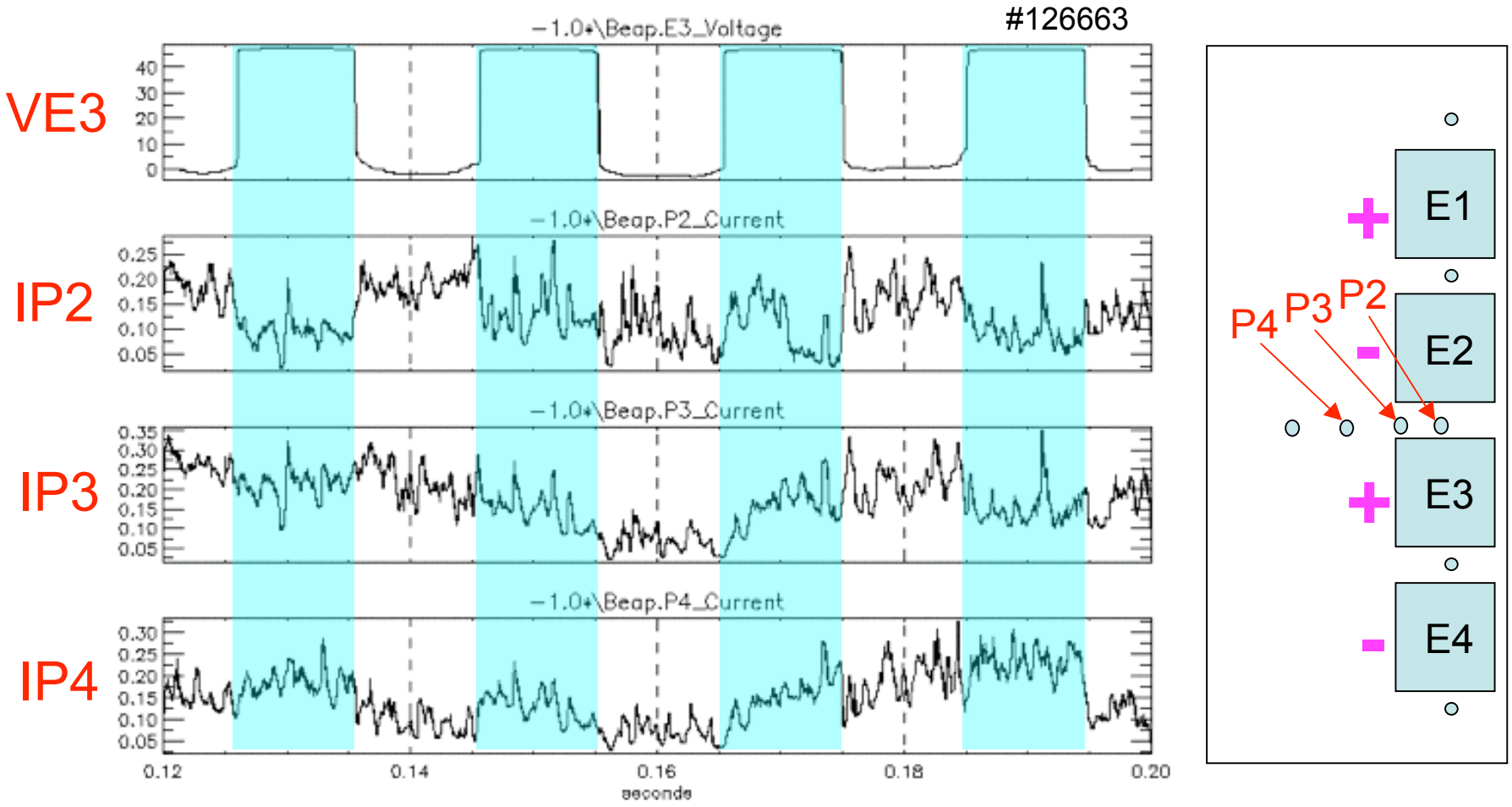
- probe floating potentials go +10-20 volts with + 90 V bias





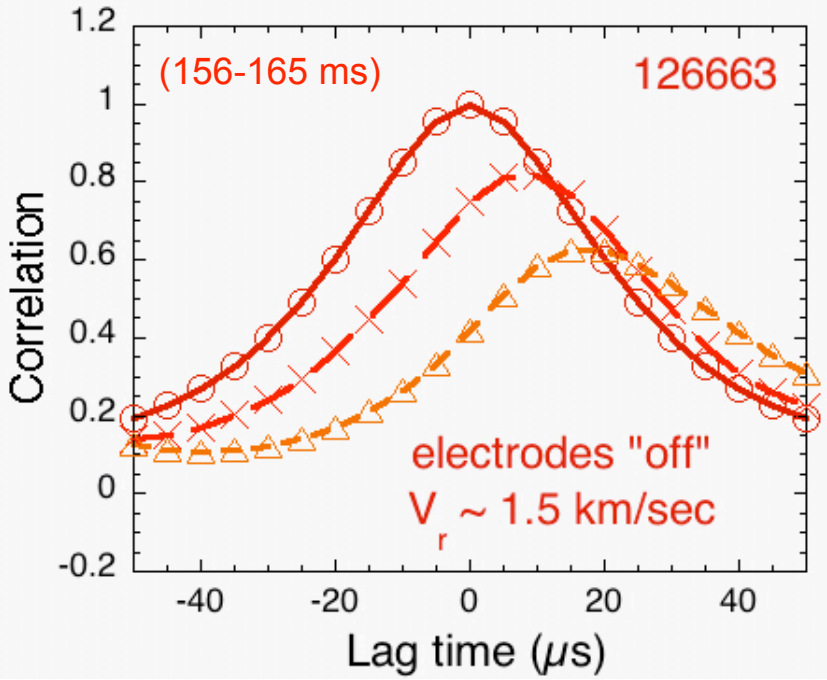
SOL Profile Effect ?

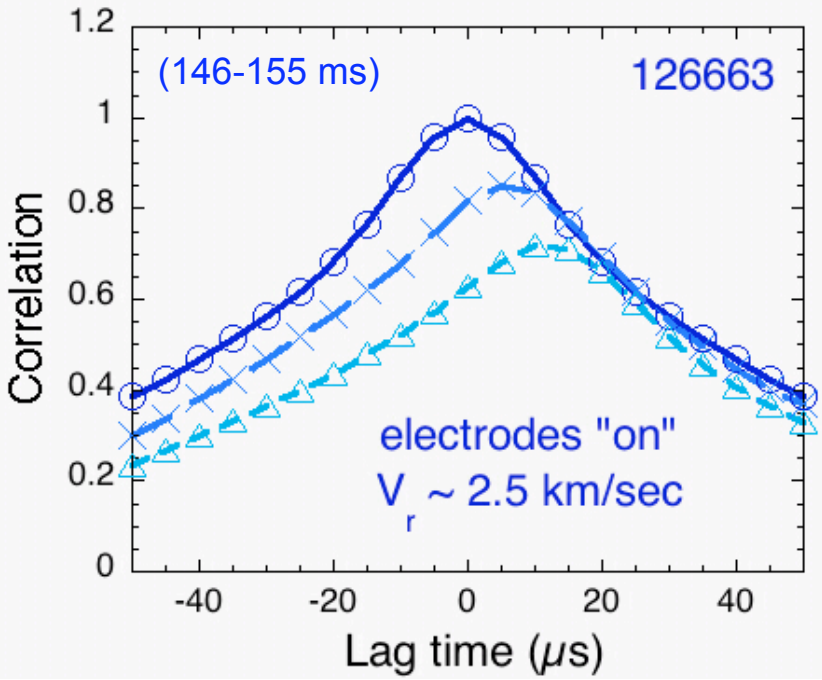
- Electric field of 100 V/cm between E2 and E3 (V_r outward)
- Radial probe array shows some increase in SOL width ?



Radial Turbulence Velocity

- Cross-correlate fluctuations in three radial probes
- Some evidence for increased V_r with electrodes on



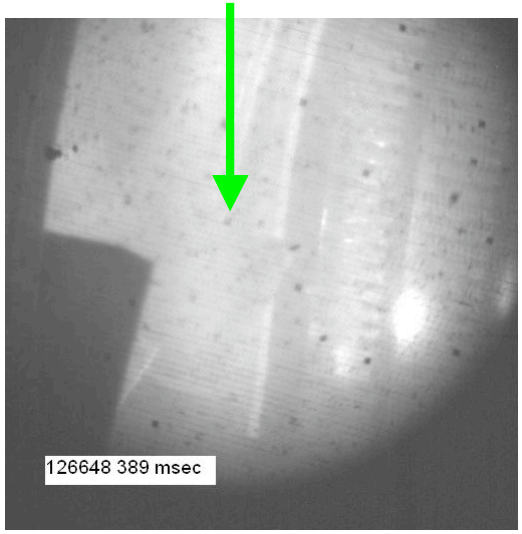


Wide Angle View of BEaP

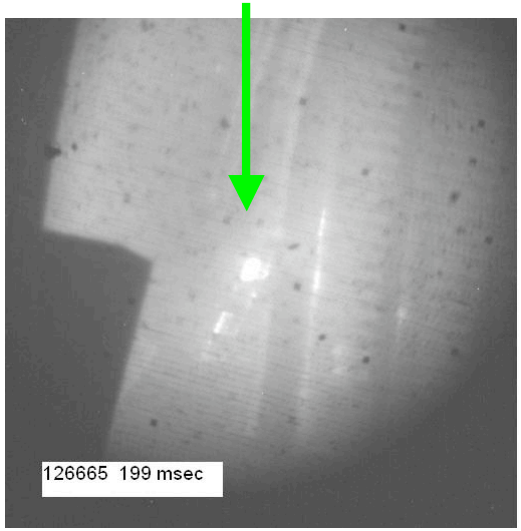
- No significant light from of BEaP during normal plasma

BEaP location (enhanced)

normal image w/ or w/o bias



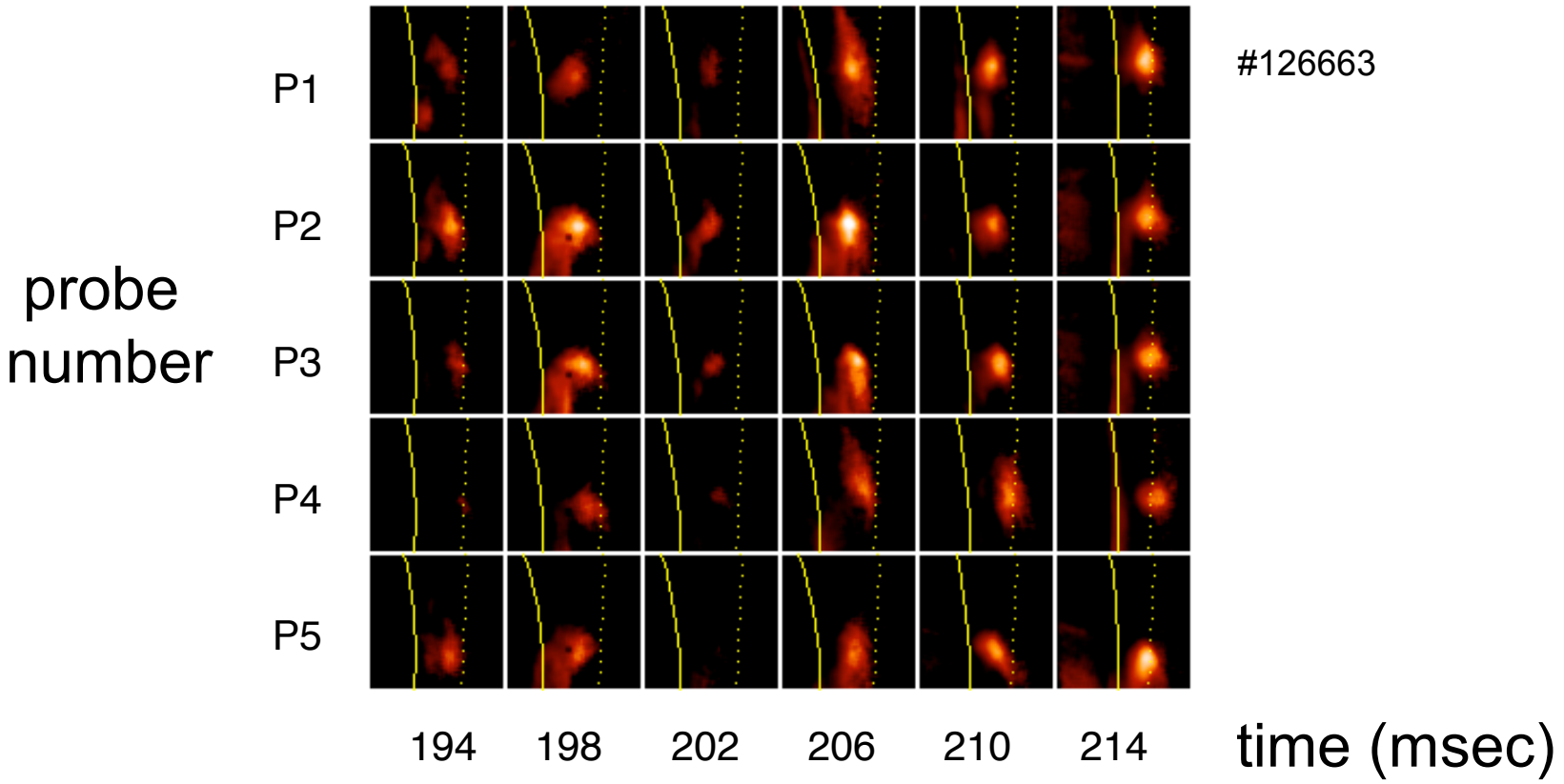
~ 30 amps in E1 during disruption



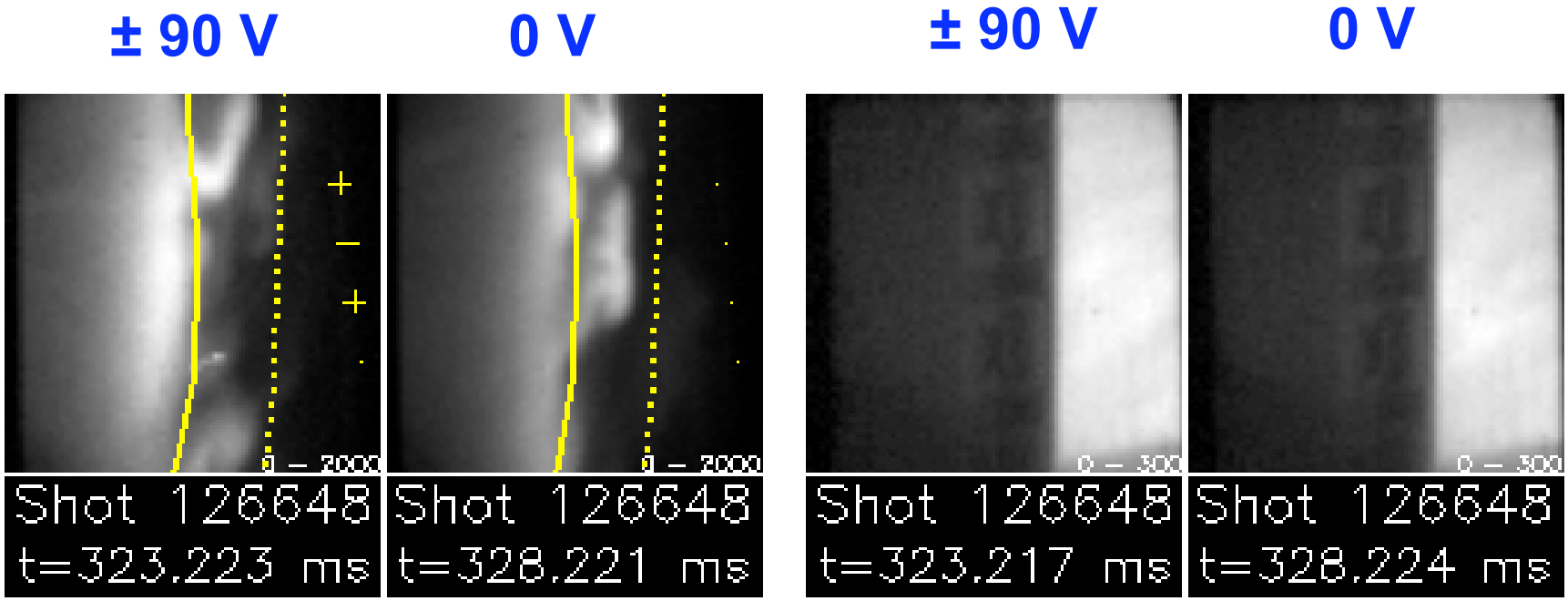
Phantom 4.2 camera @ 1 msec exposure

Correlation of BEaP Probes with GPI

- Fluctuations highly correlated between GPI and probes
- GPI well aligned along field line with probes (~ like EFIT)



Effect of Bias on GPI and Electrodes



- Turbulence motion seems to be affected by biasing
- Small ‘spots’ are correlated with arcing at - electrode

Experiments for 2008

- Continue to ‘piggy back’ electrode bias when possible
- Do XP 806 when possible including:
  - Ohmic plasmas with smaller outer gap
  - Systematic bias scan with NBI plasma
  - Try biasing with ‘floating double probe’
- Attempt detailed comparison with theory and simulation
- Design biasing scheme for divertor plates (if warranted)