NSTX

Supported by

U.S. DEPARTMENT OF ENERGY | Office of Science

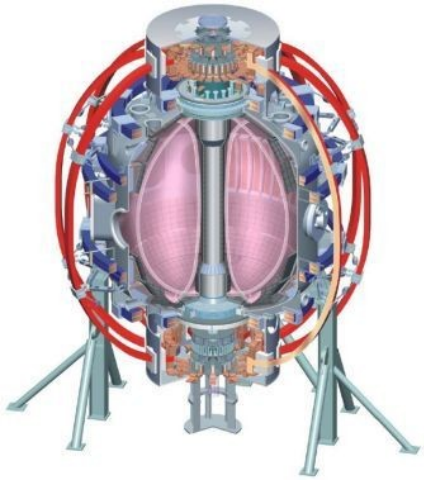
Initial results from the dense Langmuir probe array (HTPD and PSI extracts+)

College W&M
Colorado Sch Mines
Columbia U
CompX
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Illinois
U Maryland
U Rochester
U Washington
U Wisconsin

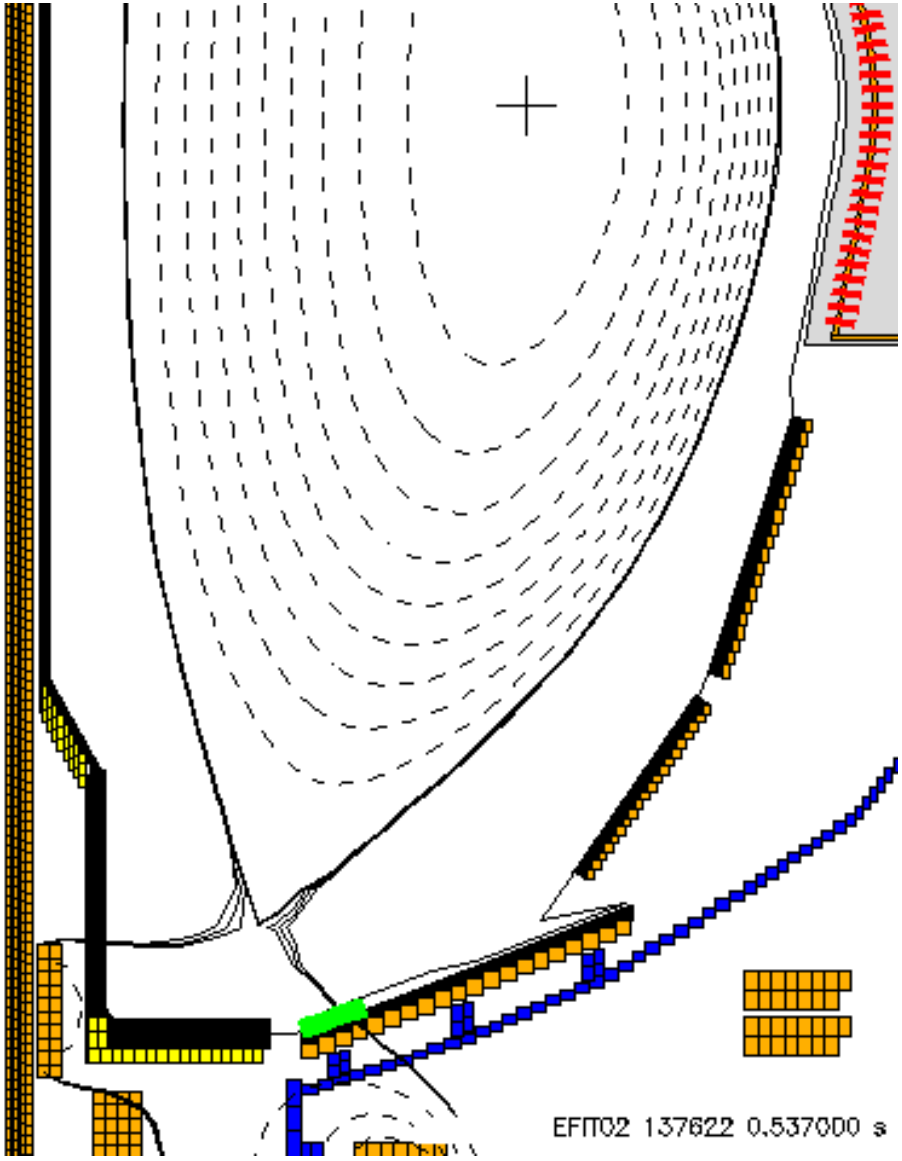
M.A. Jaworski, *et al.*

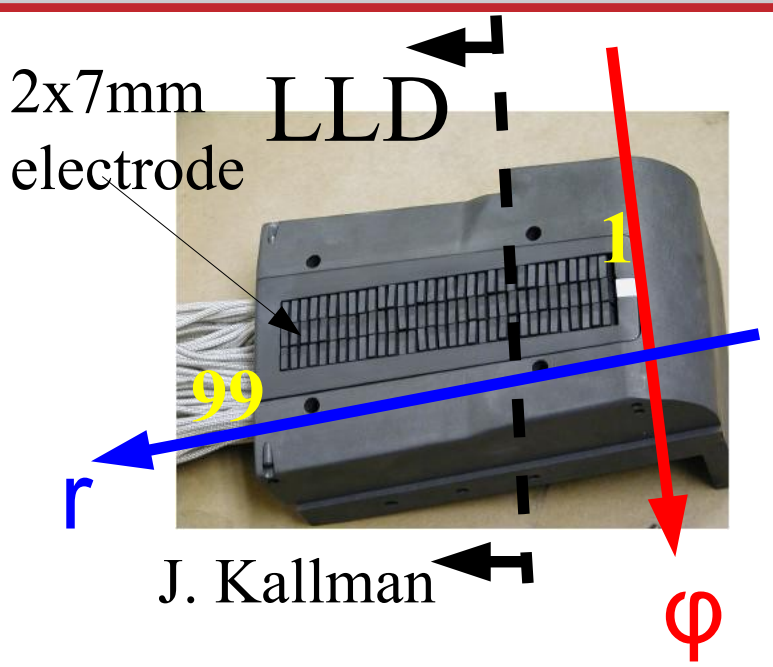
Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

NSTX Monday Physics Meeting
June 7th, 2010



New Langmuir probe array

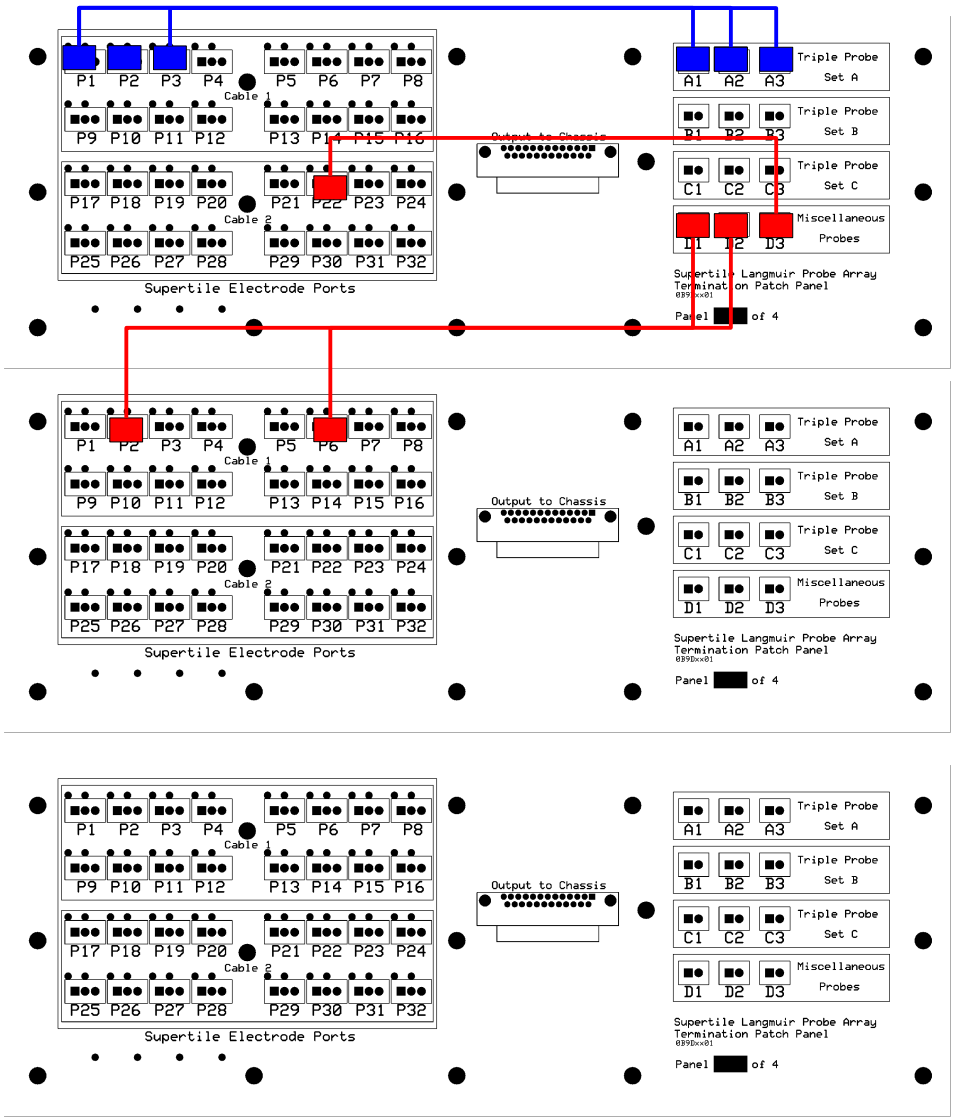




- Dense Langmuir probe array now installed
  - In vessel design J. Kallman, *et al.*, (PPPL)
  - Ex-vessel design work M.A. Jaworski (U-Illinois & PPPL)
- Most useful for medium-low triangularity shots

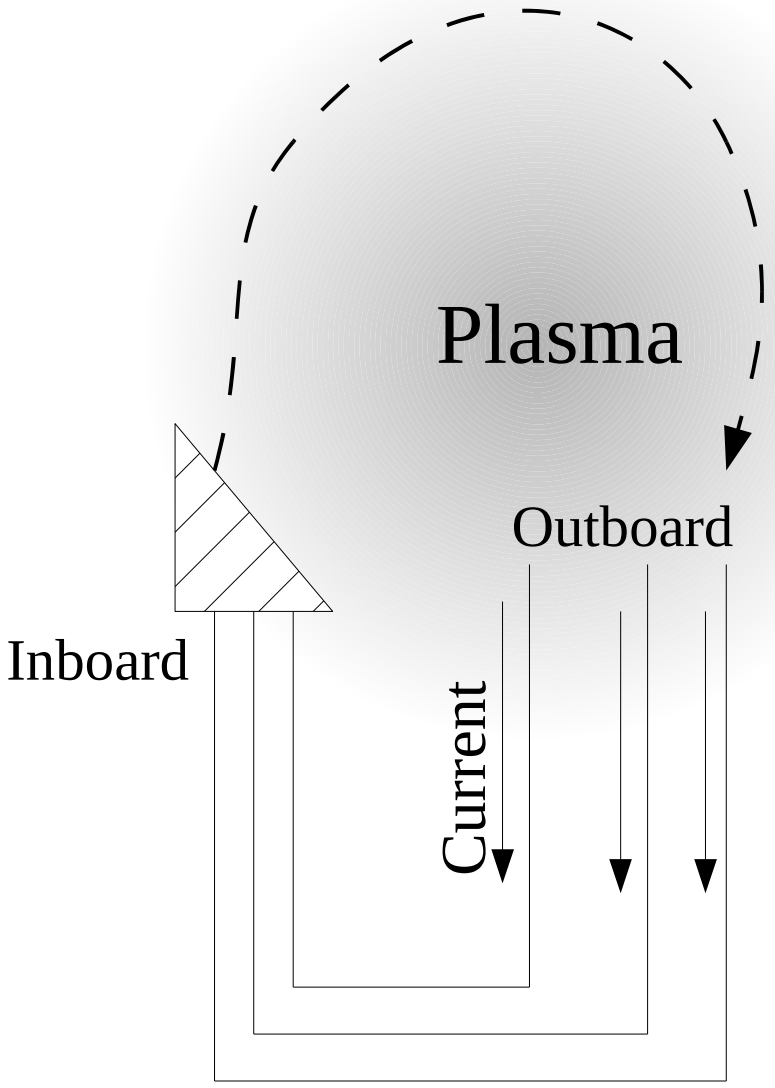
An elaborate game of telephone

- Patch Panels route 99 electrodes into biasing system
  - Complete flexibility of which electrodes are chosen
  - Additional paperwork to maintain configuration files – will be on tree eventually
  - Controlled access required to make changes
- Easy access to both electrode and electronics
  - Facilitates electrode testing (has it shorted out?)
  - Facilitates electronic troubleshooting



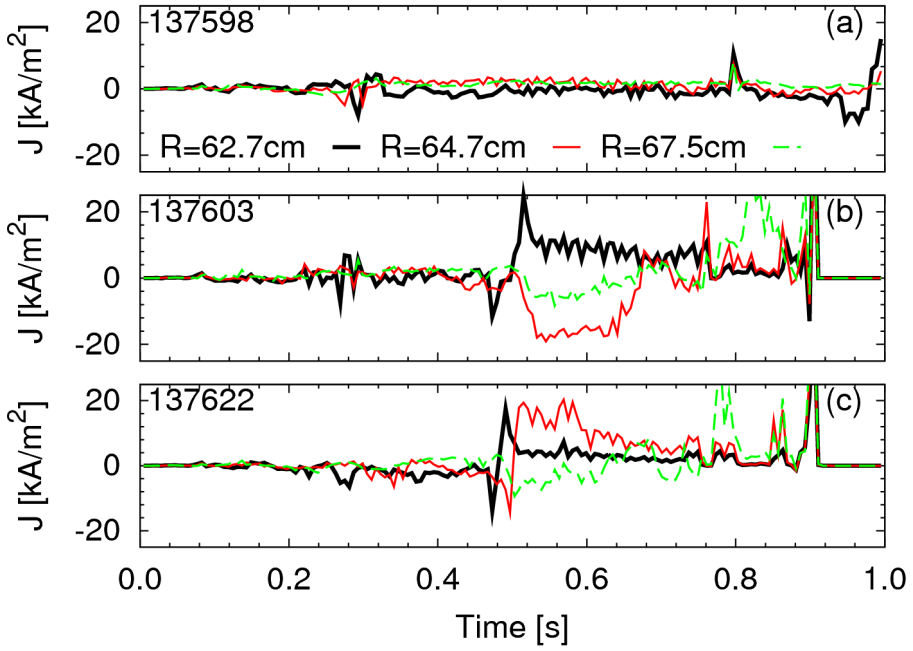
Scrape-Off-Layer Current Monitor (machine-linked)

- Measure machine-linked currents
  - Halo
  - Thermoelectric SOLC (parallel)
  - Other net currents?
- Measure current from electrode to vessel ground (*not* rack class IV)
- Fast (125 kHz) and spatially resolved (2.5x7mm)



Initial Measurements Provide Order-of-Magnitude Estimate

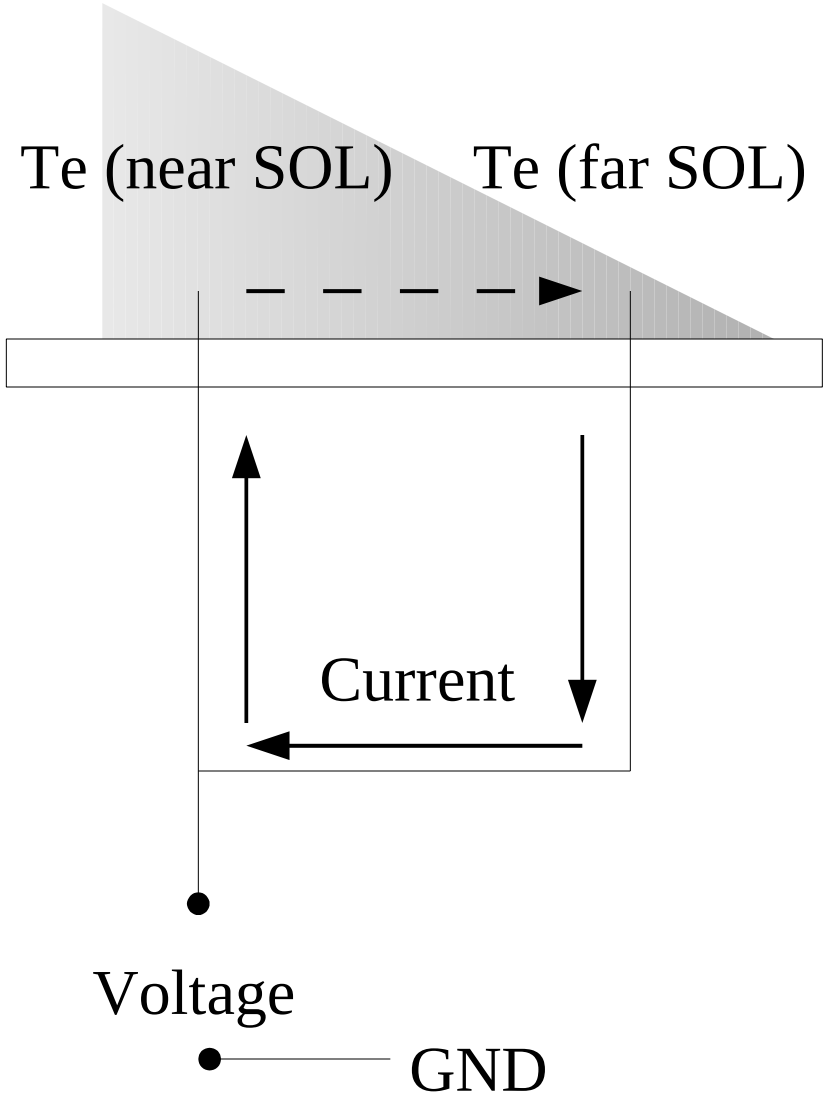
- Three similar shots shown here
  - 900kA, 2MW NBI, ELM-free
  - Strike point control enabled after 0.5s
- Strike point (SP) position modified for these three shots
  - 137598, SP nominally inboard of all probes (a)
  - 137603, SP moved outboard over the first SOLC probe (b)
  - 137622, SP moved outboard for two SOLC probes, but not quite over the third (c)
- Indicate steady parallel currents flowing in SOL of order 10 kA/m^2



Magnitude of currents used for estimates of liquid metal motion (PSI paper draft in drag'n'drop for review – bottom line: not much in NSTX at current fill depths)

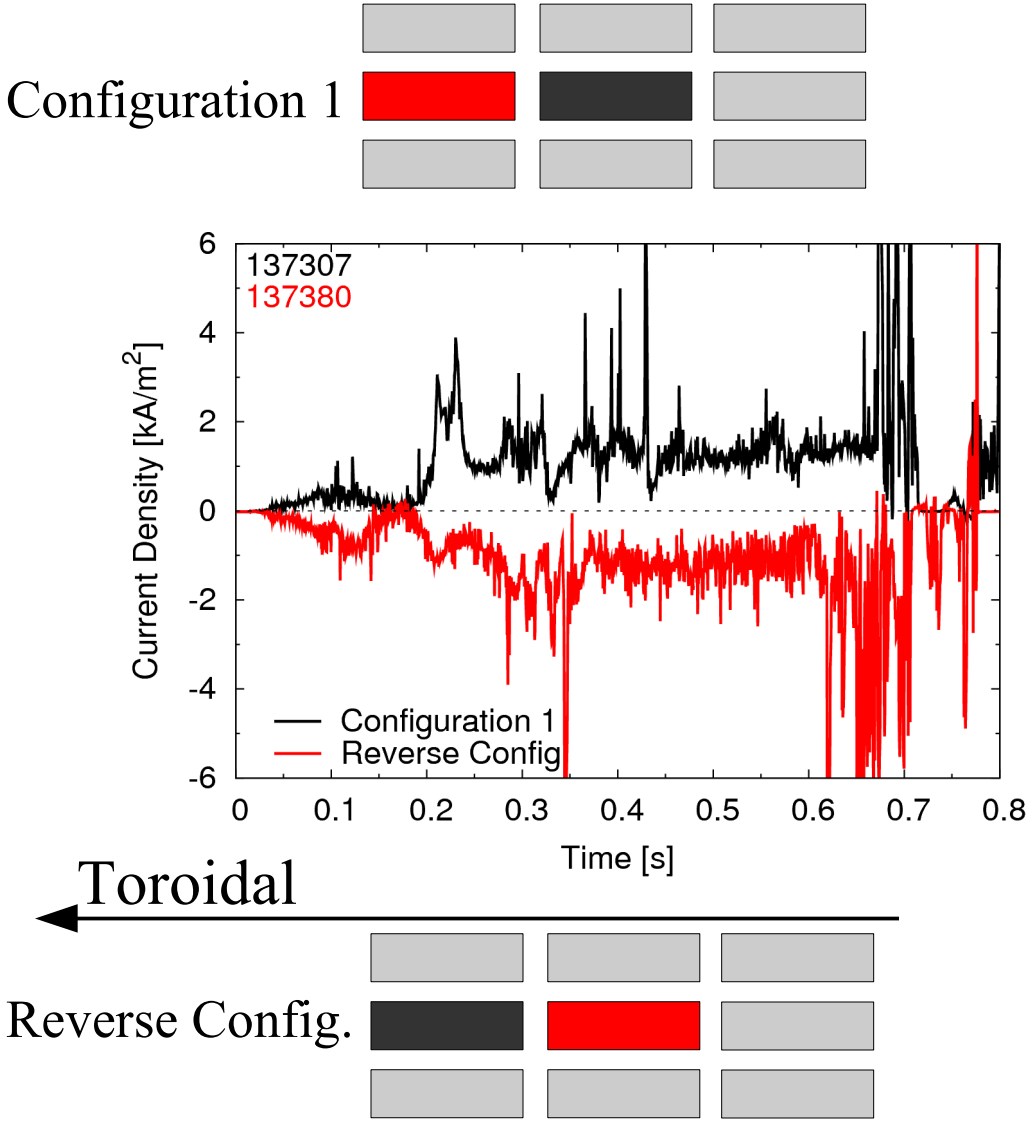
Scrape-Off-Layer Current Monitor (PFC-linked)

- Measure currents linked in the PFC
  - Perpendicular, thermoelectric SOLC
  - Other generators of potential variations (e.g. liquid lithium PFCs next to graphite?)
- Depend on non-zero perpendicular conductivity
- PFC linked currents critical to liquid metal motion (Jaworski, PSI)
- 2 electrodes for this measurement only, but movable



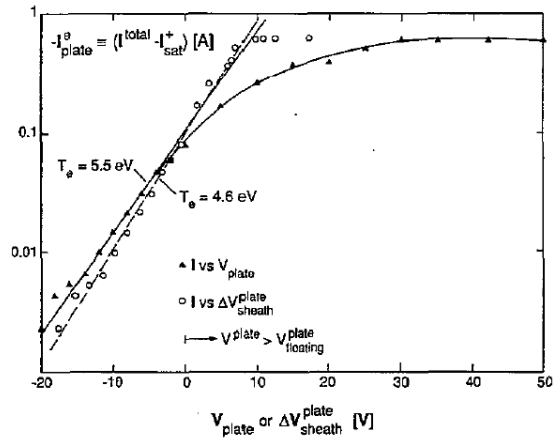
Initial Measurement of PFC-Linked SOLC

- Two discharges compared
  - 900kA
  - 137307 – 4MW NBI
  - 137380 – 3MW NBI
  - Strike point inboard of measurement location
- In initial configuration, two probes at same toroidal location
  - Unexpected current signal obtained
  - Upon reversal of probe order, current signal also reversed
  - Source of current subject of ongoing study – but provides proof of principle



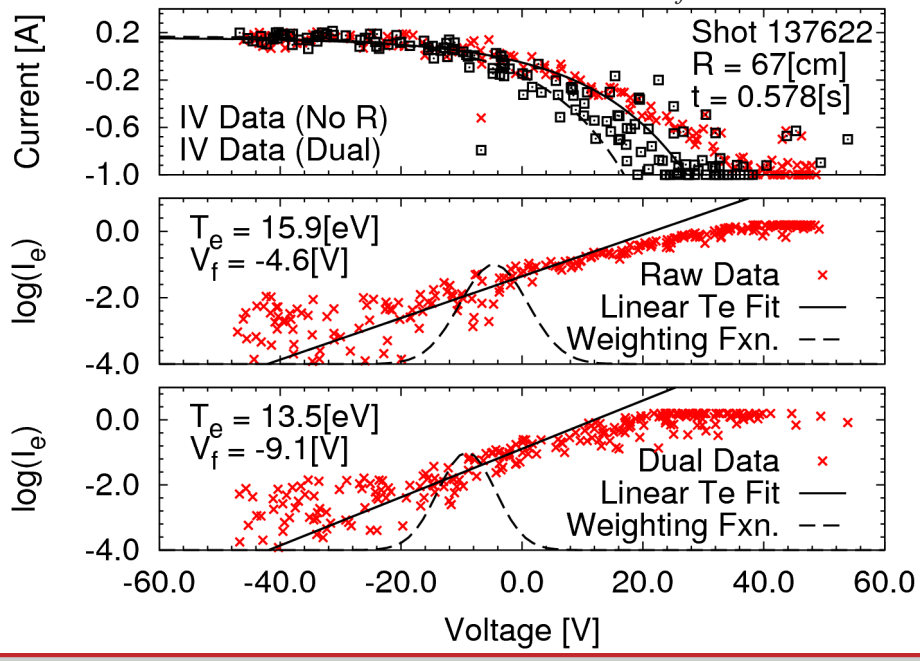
A "Dual-Probe" Method and Circuit Correction

- Initial configuration paired triple with single probes
  - Allowed for cross-checking
  - Enabled novel measurements types
- A "Dual-probe" attempts to correct fast fluctuations
  - Subtract floating potential measurement from single probe bias
  - Analog to "pin-plate" probe (e.g. Stangeby, 1995, PPCF)
  - Re-analyze using the same algorithm
- In general, seems to improve the sharpness of the turn to electron saturation
- Raw data shows circuit correction effect
  - At high currents (~1A), voltage correction significant
  - Correction reduces temperature est.



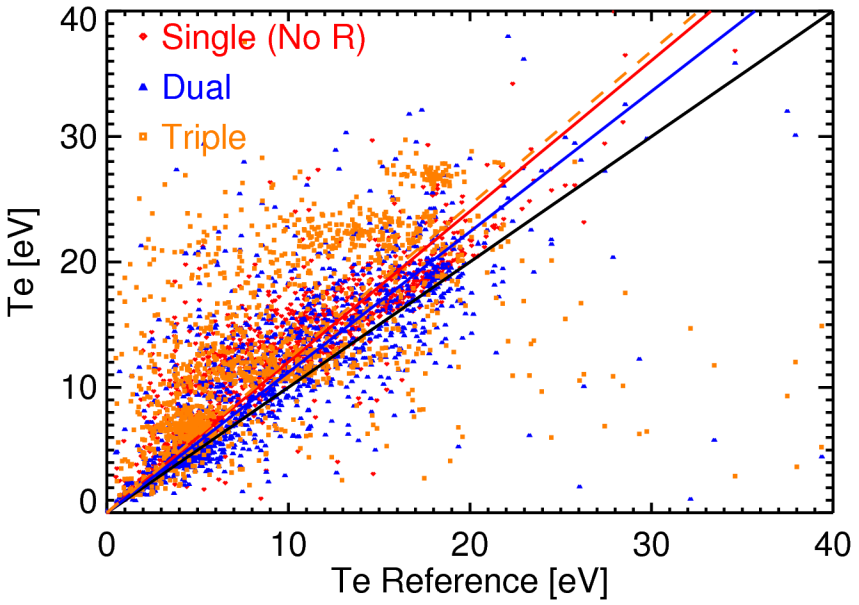
Stangeby, PPCF, 1995

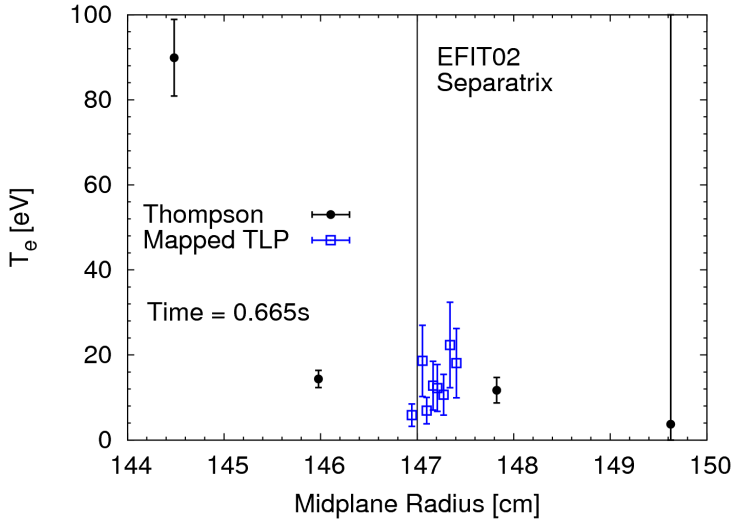
$$I = I_{sat}\left[1 - \exp\left((V - V_f)/T_e\right)\right]$$



Overall Comparison of Methods

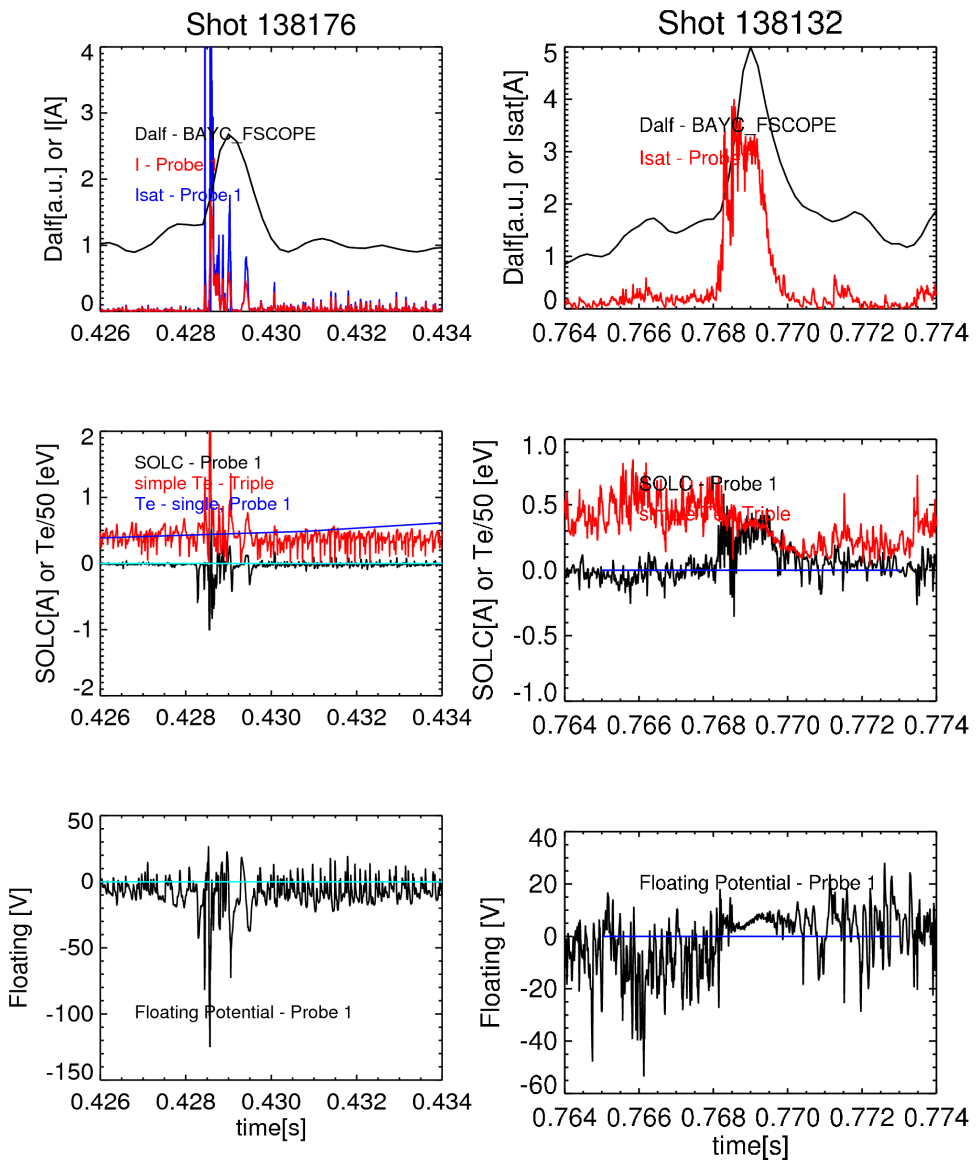
- Comparison of Te calculation
  - Data from 10 shots utilized
  - During I_p flattop with strike-point control
  - Results in 1245 data points for each method
- Results indicate significant scatter, but relative agreement from circuit corrected single probe
  - No circuit correction: +20.%
  - Dual probe method: +12.%
  - Triple probe method: +23.%
- Magnetic solution mapping to midplane indicates, *at the least*, we are not exceeding Thompson by a significant amount
  - SP location determined by EFIT
  - Uncertainty in EFIT not addressed here
  - Only triple Langmuir probes compared here





Fluctuation measurements

- Preliminary measurements of ELMs
  - So far, recent ELM-ing discharges have SP inboard of array
  - Still obtaining useful signals for analysis
- Additional analysis
  - Frequency response drop-off at high frequency
  - PDF of “turbulence” and correlation with visible emission
  - Better triple probe interpretation
  - Error estimation and accounting



Summary and future work

- Priority 1: Fix up MDS model tree for more public access
  - At present, probe locations recorded in LP-operator notebook
  - Tree tags recently changed by computer division, cleaning up for model tree
  - IDL routines of present analyses if you're willing to hold your nose (I need to clean these up)
- Frequency response characteristics and analysis
  - Determine probe circuitry response curves to make sure design calculations are accurate (no time prior to run)
- Improve interpretation
  - Single probe algorithm (see HTPD manuscript) can have problems in low density, turbulent plasmas, also need better quantification of uncertainty
  - Triple probes currently using a “simple” interpretation – room for improvement here
- Make use of probe data for OSM model of NSTX plasmas
  - Obtained DIVIMP code from J.D. Elder at PSI
  - Interpretative modeling code for the SOL to aid in producing cohesive (as many diagnostics as possible) picture of the plasma