TRANSPORT STUDIES ON C-MOD AND RELEVANCE TO HIGH FIELD IGNITION EXPERIMENTS

Outline

- RF Heating
- Global Energy Confinement and Scaling
- Comparison with Theory Based Models
- H-mode Thresholds
- Density Limits
- Fueling

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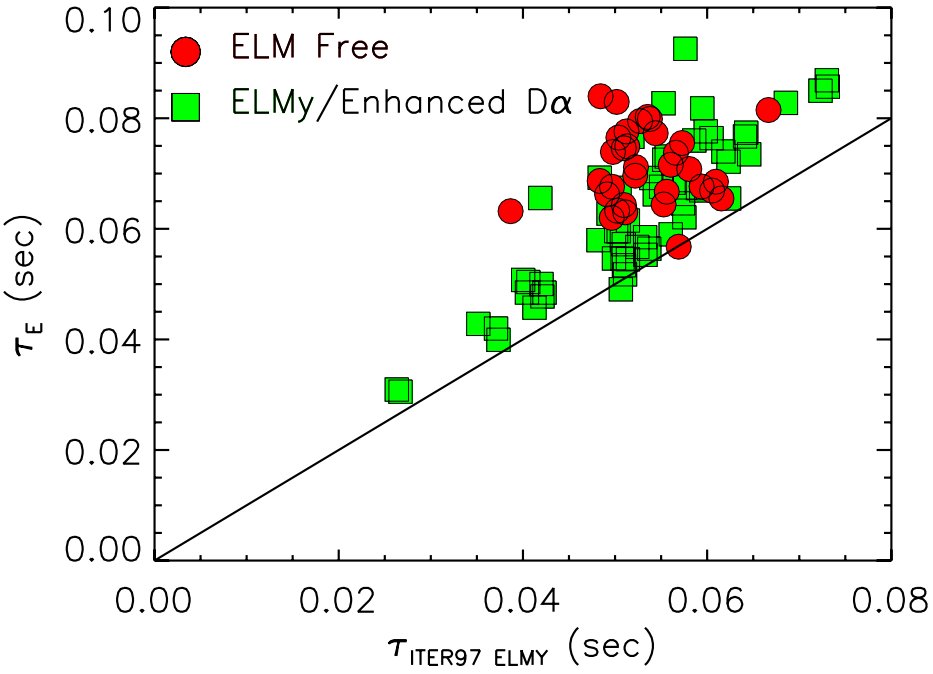
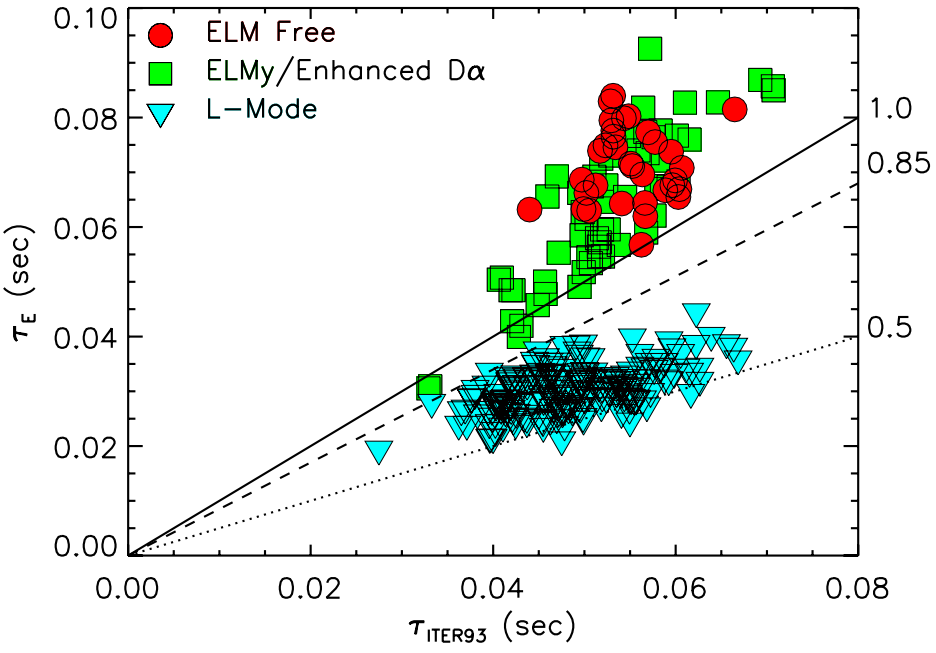
At meeting of US Ignitor Working Group

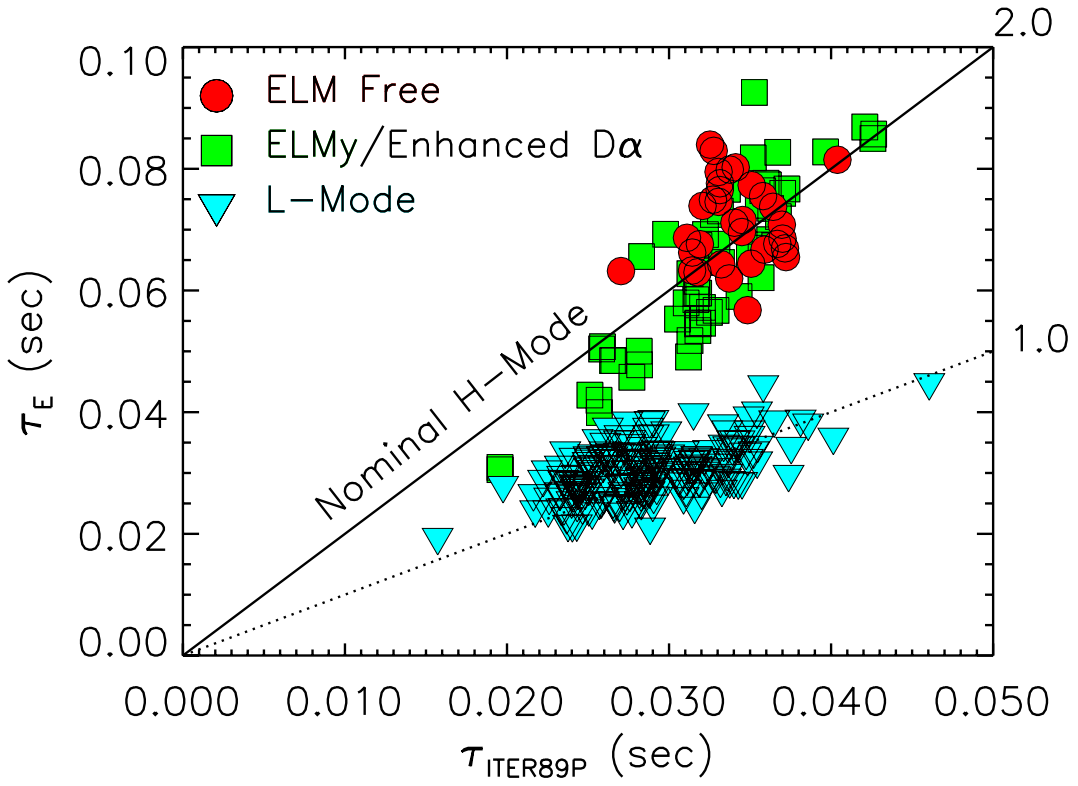
November 3, 1998 - MIT

ITER SCALING LAWS GIVE SATISFACTORY AGREEMENT WITH C-MOD DATA - ABILITY TO EXTRAPOLATE IS IN DOUBT



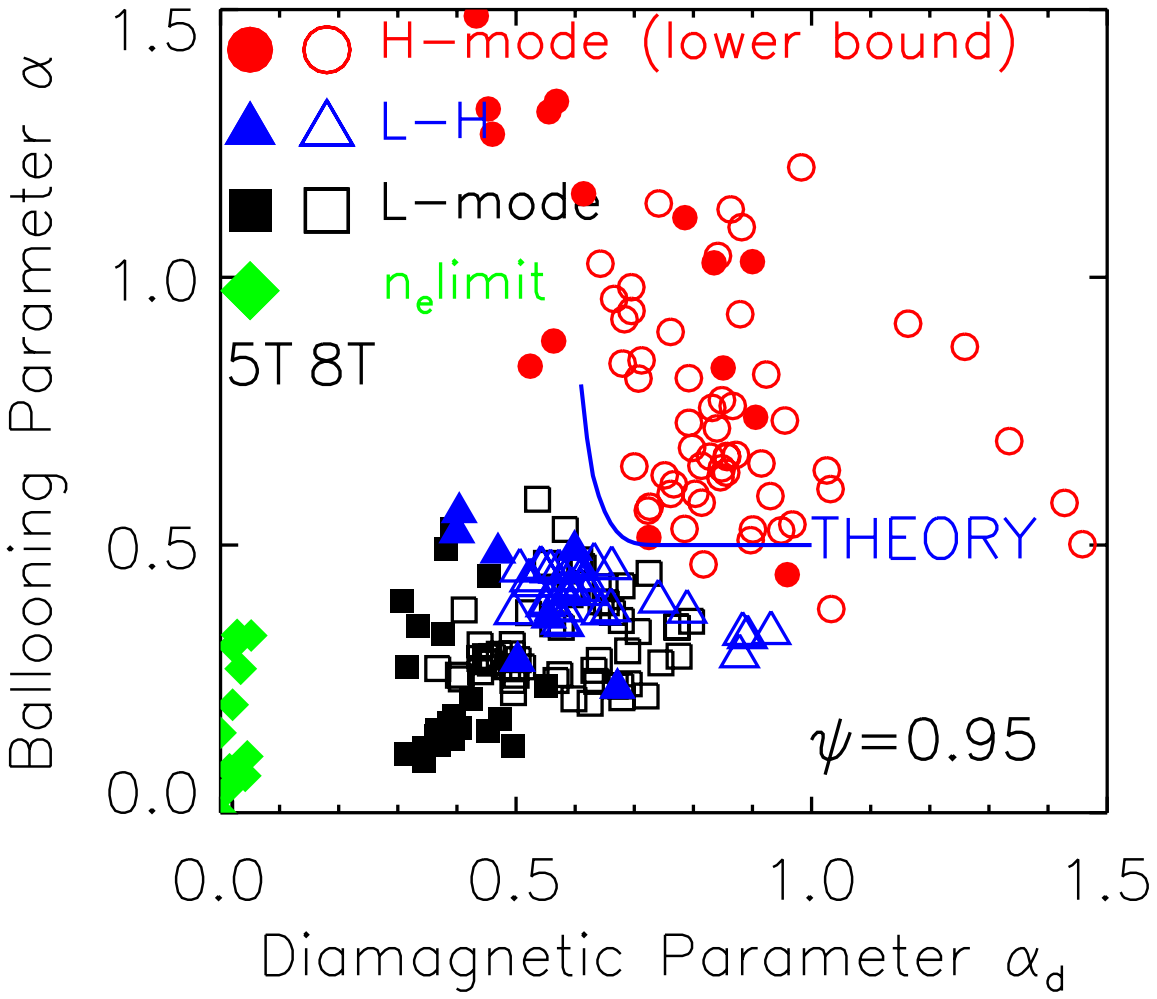


2xITER89 SCALING IS ADEQUATE FOR C-MOD H-MODES



- While 2 x L-mode scaling does not give the best fit to the multi-machine H-mode database, it might not be ruled out on statistical grounds.
- The strong n, B, L, and κ scaling in the recent ITER H-mode laws may be artifacts of data covariance.

LOCAL PARAMETERS AT L/H TRANSITION ARE IN ROUGH AGREEMENT WITH DRIFT ALFVEN SIMULATIONS



- Data from 5 and 8 T align in this space
- The simulations do not use real geometry and take no consideration of the separatrix and SOL.

REQUIREMENTS FOR "GOOD" H-MODES

- Power > Threshold power, evaluated in H-mode
  - Input power must compensate for density rise
  - Density rise following L/H transition is 2-3 x
  - Thus power must exceed minimum for L/H transition by 2-3 x
- Low Radiation;
  - $P_{RAD}/P_{IN} < 0.5$
- Low neutral pressure
  - $Po_{DIV} < 40$ mTorr
  - $Po_{MID} < 0.3$ mTorr
- Gaps
  - Inner and outer gaps > λ_{SOL}
  - C-Mod has some limiter H-modes, but these have ample inner and outer gaps and an x-point very close by.

FUELING

- Gas Fueling
  - Compared to previous devices at MIT, the maximum density rise on C-Mod is quite low
  - Alcator A >10^{22}/sec
  - Alcator C ~ 4x10^{21}/sec
  - Alcator C-Mod ~ 5x10^{20}/sec
- Differences are: size, divertor topology and plasma volume to vacuum volume ratio

- Pellet Fueling
  - With deep pellet fueling densities approaching 2x1021 have been achieved
  - Penetration depth limited in strongly heated plasmas
  - Potential for inside launch limited in compact device

SUMMARY

- Ohmic confinement linear only at very low densities, otherwise L-mode like.
- Efficient ICRF coupling and heating at high density.
- L-mode confinement in good agreement with ITER89P
- H-mode easily obtained despite high n and B
- Global threshold “similar” to other devices
- Threshold better characterized by local temperature
- H-mode confinement somewhat better than that predicted from other machines (n, R, B??)
- EDA H-modes offer significant advantages over ELMy or standard ELMfree operation.
- Good H-mode confinement requirements outlined
- H/L and disruptive density limits similar to empirical scaling
- Density rise rate limited with gas fueling