Summary of Topics A3/B3:
Experiment/Theory of Transport & Turbulence

M.G. Bell

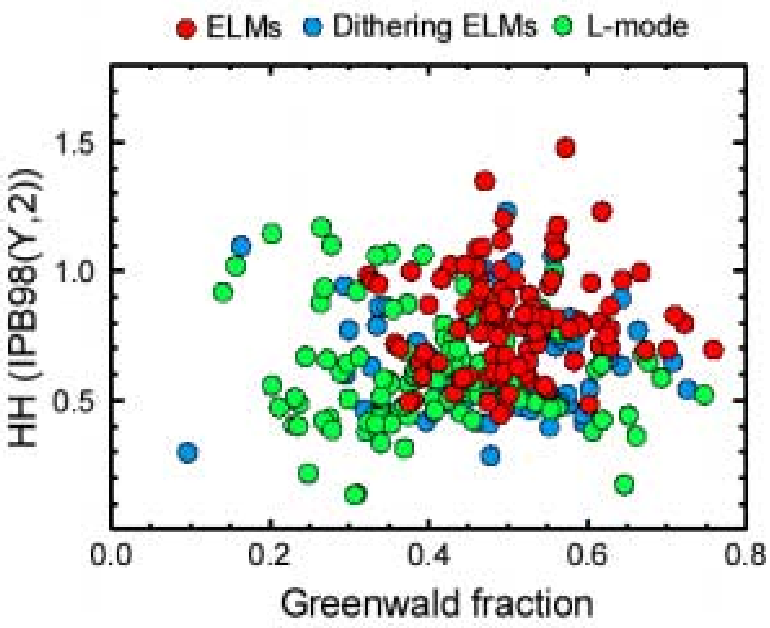
- topical summary, not a session summary

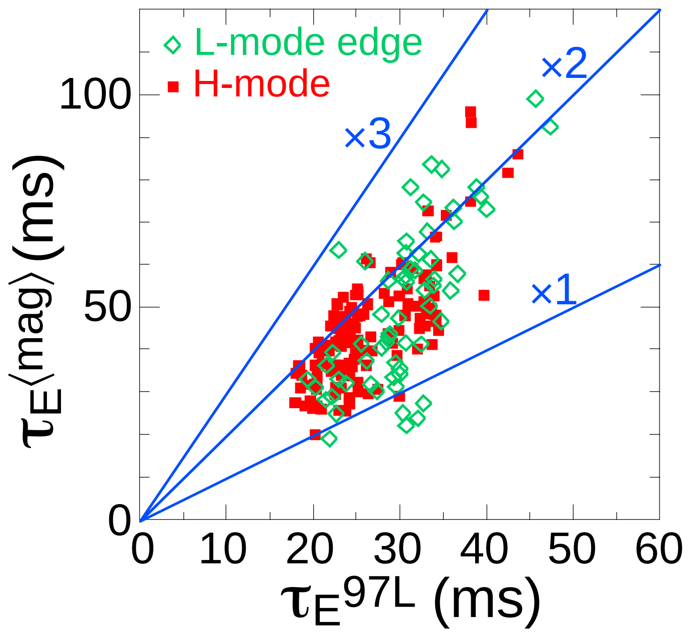
- my impressions, not a concensus!

Many Talks Included Transport Component

- Experiment
  - Gryaznevich *Overview of MAST Results*
  - Bell *Overview of NSTX Results*
  - Wilson *HHFW H&CD in NSTX*
  - Akers *NBI H&CD in MAST*
  - Kaye *NSTX confinement results*
  - Bush *H-mode, ELMs in NSTX*
  - Zweben *Imaging of edge turbulence*
  - Stutman *Poloidal Ultrasoft X-Ray System on NSTX*
- Theory
  - Bourdelle *Gyrokinetic simulation*
  - Shaing *Magnetic island effects on confinement*

Confinement with NBI Is Good *But..* There Are Interesting Differences





- Routine H-mode operation in both MAST, NSTX
- L and H -modes overlap in τ_E and H factor
- Good confinement extends to quite high density
- Single parameter scans reveal different dependences:
  - $\tau_E^{NSTX\text{-}L} \propto I_p^{0.76} B_T^{0.27} P^{-0.76}$; $\tau_E^{NSTX\text{-}H} \propto P^{-0.5}$
- With HHFW heating in NSTX, confinement is not so enhanced

Ion Channel Appears Good

- With NBI, $T_i > T_e$ despite $P_{b,i} < P_{b,e}$
  - $T_i(0) \approx 3$keV in MAST at $n_e(0) \approx 2 \times 10^{19} m^{-3}$
  - $\chi_I < \chi_I^{NCLASS}$ in mid-regions of profile in NSTX
    - T_i anomalously high at mid-radius in some cases
- High toroidal rotation rates are measured
  - extreme radial gradients in T_i, v_ϕ tend to coincide - role in turbulence suppression
- Particle confinement barriers are also observed
- Electron profiles with NBI are very stiff in NSTX *but…*
- With HHFW, electron ITBs have been observed
- NBI current drive is playing a role in both MAST, NSTX
  - benefit of good fast-ion confinement

Theoretical Insights

- Analysis of micro-stability for NSTX plasmas (positive shear) shows
  - increasing growth of ITG with β' up to a critical β', *then*
  - decreasing ITG for higher β' until KBM destabilized
  - could give rise to bifurcation in transport properties
    - $\tau_E \propto P^{\alpha}$, $\alpha < 0$ for low β, $\alpha > 0$ for higher β
  - Similar behavior for ETG and TEM
  - *But*, β' threshold for bifurcation is well above present NSTX level (x2)
  - Threshold could be reduced by lower η_I
    - role for pellet injection?
    - would this be compatible with high β necessary?

Theory (2)

- Effects of magnetic islands on transport nearby
  - radial particle flux driven by symmetry-breaking perturbation
  - can spontaneously generate local E_r
  - suppress turbulence & associated transport in neighboring region
- May help to explain occurrence of some types of ITB associated with low-order rational surfaces in conventional tokamaks
  - equally applicable to STs

Confinement and Transport Issues

- Although confinement can be good relative to conventional tokamak scalings, there are problems:
  - single parameter dependences are not established
  - *very* unfavorable power dependence ($P^{-0.75}$) in some conditions in NSTX
  - Confinement during rise in W_{tot} is much better than in steady state
    - role of pressure-driven instabilities?
  - Electrons appear to respond to B, not I (NSTX)
- Micro-stability theory suggests interesting possibilites *but*
  - Can we achieve β' levels to reap the benefits
  - Are benefits of lower η_I compatible with high β?