MAST Results review

Presented by D. Gates

At the NSTX Physics Meeting

9/23/02

Meeting Format

- Group leaders make presentations
  - Brian Lloyd — Intro/Overview
  - Howard Wilson — ST Design Concepts
  - Martin Valovic — Transport Experiments
  - Paddy Carolan — Profile Diagnostics/ITB regime
  - John Storrs — Control Software Development
  - Geoff Cunningham — Plasma Control
  - Vladimir Schevchenko — EBW
  - Glen Counsell — Edge/Divertor Physics
  - Rob Akers — Fast Particle Physics
  - Mikhail Gryaznevich (others) — MHD/Scenario Development
  - Alan Sykes — Project Development

ST Design concepts (H. Wilson)

- CTF
  - $\kappa \sim 2.5, \beta_N < 3$?
- Q = 10 burning plasma experiment
  - $\kappa \sim 3, \beta_N \sim 3.9, A \sim 1.5$
- ST Reactor
  - $\kappa \sim 3.2, \beta_N \sim 8.2, A \sim 1.4$

H-mode scalings (M. Valovic)

- H-mode confinement scaling agrees with MAST data - fast particle energy not yet removed
- Helium transport studies with Helium doped neutral beams no τ^*_{He} yet - to be analyzed
- H-mode threshold ~ x1.5 ITER scaling
- Pellet studies underway – studies underway
- Density achieved peaking with pellets,
  - $1.1*n_{Greenwald}$, I_p = 600kA
  - Multi-pellet injection in next year

Confinement (P. Carolan)

- CDND,LSN,USN comparison (H. Meyer)
  - No single null H-mode
  - Lowest threshold in true DND
- Claims observation of ITB
  - 3.2 keV peak central temperature,
  - $n_e \sim 2.0 \times 10^{19} m^{-3}$
  - correlates with region of high velocity shear
- Data from 200 channel Z_{eff} array - (VB)
- Showed profile data from CXRS and multi-pulse Thomson Scattering also 300pt single pulse

Plasma control development (J. Storrs)

- Have tested digital system (coil current control)
- Feb. 2003 Routine digital plasma control.
- Apr. 2003: Integrate MAST central (EPICS equivalent) with PCS. Continue algorithm development, including basic boundary reconstruction (rtEFIT later - 2004).

Plasma control (G. Cunningham)

- Optimize vertical position control
  - Use Mirnov coils away from metal to measure plasma vertical motion. Avoid phase lag
  - No passive plates!
- $l_i \sim 0.6\text{-}0.8$ with preheat and current ramp

EBW (V. Shevchenko)

- Tried low density ECH at 60GHz – failed. Blamed on large diffraction and outboard radial resonance position.
- Have seen enhanced ~100% EBW emission with angled antenna. Angle at which cut-offs of the O-mode and the X-mode are at the same density (B. Lloyd).
- Have 3 mirror launcher with angular control. Installed. Ready for deployment. O-X-B mode conversion scheme.
  - Focuses – Focal length infinite (parabolic mirror)
  - Poloidal range of +/- 15°, toroidal +/- 25°, 0.5° accuracy
  - Also useful for breakdown.
- Power supply limitations – only 1 NBI source during EBW.
- Find a degradation of EBW emission during ELM free H-mode. Due to edge pressure driven currents changing cutoff profiles?
- Have built LH antenna as a diagnostic for EBW absorption. Frequency chosen to match X-B mode conversion at the Upper Hybrid resonance.

Boundary Physics (G. Counsell)

- ELM energy loss analysis $\delta W_{ELM} \sim 1kJ$
- All MAST ELMs are type III, losses are convective. $\delta W \sim \delta n_e * T_e$
- Measures energy propagation delay.
- $T_i/T_e \sim 4$ in edge - (Argument T_i elevated due to ion orbit loss, T_e cooled by convection) See below.
- Uses Langmuir probes to account for 100% of power in the SOL in L-mode. 50% in H-mode.
- Detailed divertor ratio measurements (inner/outer).
- SOL broadening by divertor biasing. 80V alternating divertor plate bias.
- 30cm sweep of the divertor strikepoint due to ohmic leakage flux. Biasing shifts strike point position
- SOL radiation and divertor detachment. (are these heated or Ohmic?) Observe “detachment”. Are there impurities?
- SOL width measurements – SOL widens with increasing density and q95.

Fast Particles (R. Akers)

- Neutral beam current drive experiments
  - counter current drive campaign
  - matching co campaign
- Co-counter-Ohmic comparison shows clear loop voltage difference and consistent pulse length variation. Almost no T_e variation. 1 – 1.8MW.
- Lose half the counter beam ions… low currentWorking on TRANSP (has made progress with data preprocessing)
- LOCUST – Full fast ion code, wants to benchmark it.
- LOCUST can do NPA spectra!

MHD (M. Gryaznevich)

- M. Hole - ideal stability
  - MAST below no-wall limit
  - Uses EFIT shape with TS and fixed $T_i/T_e=1.2$ and $n_i = 0.8n_e$.
  - Suggests best regime was H-mode early.
  - States that the magnetics only EFITs unreliable. Denies knowledge of β
  - Shows $\beta_t \sim 21\%$ with TF ramp down (I_p = 1.2MA)
  - Claims β_N*H of 10 (optimistic).

MHD (cont.)

- Richard Buttery - NTMs
  - No new results
- Lynton Appel - TAEs
  - TAEs observed
  - Adding new high frequency Mirnovs.
  - Only 1/100 of co-injected shots have high frequency modes.
  - Counter injection gives more active beam mode activity.
  - See 400kHz TAEs.

MHD (cont.)

- M. Gryaznevich - B_v ramp-up
  - Vertical field ramp can drive current
- Path to high β
  - Raise pressure at low field

MAST development plan (A. Sykes)

- EBW - Heating, ionization, I_p ramp-up
- New center stack 37% more flux, adding gas puff near top to replace midplane puffer
- New TF 90kA (was 85)
- New divertor - Full coverage on bottom. Imbrocated (sloped) tiles
- Higher kappa – no plan mentioned
- Higher NBI -
  - Next few months ~4MW for 400ms (was 2.9 fro 300ms)
  - 2004 - 5MW, 5s
- New PF config - (more PF current) up down pairs are in series…
- Inboard pellet launch – in the plan???
- Error field correction coils – under discussion
- Considering methods for making SND… more PF PS mods

Collaborations

- DND vs. SND threshold studies (H. Meyer)
- HFS vs. LFS fuelling comparisons (A. Field)
- Co- counter NBI CD studies (R. Akers)
- Hi resolution Z_{eff} measurement (A. Patel)
- Tearing modes and IREs (R. Buttery)
- With wall vs. no β-limit studies (M. Gryaznevich)
- High voltage low voltage beam comparisons ???