QSH mode occurs spontaneously in MST

QSH mode is defined by a single core resonant mode surviving an amplitude much larger than the sum of the higher n modes. (Phenomenologically, it is observed to occur more frequently in - higher current discharges - shallow central discharges - shallow neutralizer discharges. Recently, it has been observed to occur much less frequently in - NBI heated discharges.

Black line: a typical MST discharge transitioning to QSH mode at ~2 s. The amplitude of the n=5 core mode resonant mode quadruples while higher n resonant at larger r remain the same. Red line: a nearly identical discharge prior to NBI heating at ~0.1 s. and QSH onset.

Right: The mode spectrum of the typical discharge (black) and the spectrum from the QSM period (green).

NBI is a useful tool for probing RFP physics.

25KV, 40A neutral hydrogen beam.
Fuel doped with 3% deuterium to produce deuterium neutrinos for particle diagnosis.
Tangential injection favorable for core disruption.

NBI yields peaked n=1 profile; ions have large parallel component.

TRANSP modeling

Fast ion concentration strongly dependent on direction (co- or counter-) of injection.

Co-injection: (low prompt loss)
- good radial confinement of fast ions (3x58 confinement time of background plasma)

Counter-injection:
- high prompt loss (up to 30%)
- large radial excursion of core-born ions

Measurement of fast ions in plasma

Expected NBI current drive difficult to measure.

Above: TRANSP modeling of co-injection predicts finite fast ion current near the core. Experiment: Total toroidal plasma current measured to net change during NBI.
- possible inductive injection within plasma, could lead to profile effect only.
- equilibrium changes due to this effect are difficult to measure.

If the current profile is changed as hypothesized, there is a significant change in the s profile, known to affect tearing mode stability.

NBI reduces core mode amplitude; outer modes unaffected.

Top left: Plot of mode amplitude versus time for non-NBI discharge (black); co- NBI (red); and counter NBI (blue).

Above: There is a strong stabilizing effect on n=5 mode with co-injection, possibly a small stabilizing effect with counter-injection.

Left: The n spectrum of the MHD activity is unaffected by NBI for n>5.
Two time slices are shown; the first only a few ms after NBI onset; the second is near the end of the NBI pulse.

Mechanism of mode stabilization not yet identified.

Presented in remainder of this poster are illustrations of some possible mechanisms.

* Altered Jll profile affects tearing mode stability
* Altered Jll profile removes core mode resonance condition
* Stabilization due to NBI-induced flow shear
* Stabilization due to fast particles at tearing mode layer
* Similar mechanisms affecting an ideal internal kink mode at the plasma core, with the typical tearing modes resonant at other rational surfaces.

Core-most mode may be ideal internal kink.

Current (and slightly pressure) driven mode; NBI effect would be expected to destabilize.

If current profile is altered, the resonance condition may no longer be satisfied for n=5.
(same argument holds for resistive tearing near core).

Plotted here: Regions of stability in k, r space for 3 different MST experimental profiles.

Favorable Position (117, November 2004)

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