Characterization of the n=1 mode activity

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- The n=1 mode observed previously on smaller machines (HIT, HIT-II, HIST and SPHEX) is deemed necessary for the presence of closed flux in CHI produced discharges.

- Pages 2 to 5 describe the characteristics of this toroidal mode activity on HIT-II and in present NSTX CHI discharges. These were seen in NSTX CHI discharges during this year's run after the CHI produced toroidal current exceeded 250kA and the mode became more robust at currents above 300kA.

- On HIST and SPHEX, the amplitude of this mode was found to decrease as the toroidal field was increased and it could even diminish to zero at the highest toroidal field in these machines (at 0.15T). However, on HIT-II, robust n=1 is observed even at 0.5T. This is probably due to the improved boundary shape capability possible on HIT-II.

- On NSTX, we will vary the magnitude of the toroidal field, and measure the absolute amplitude and frequency of the n=1, to understand the implications of the n=1 to the externally produced toroidal field, the total CHI produced toroidal current and for ultimately for closed flux generation.

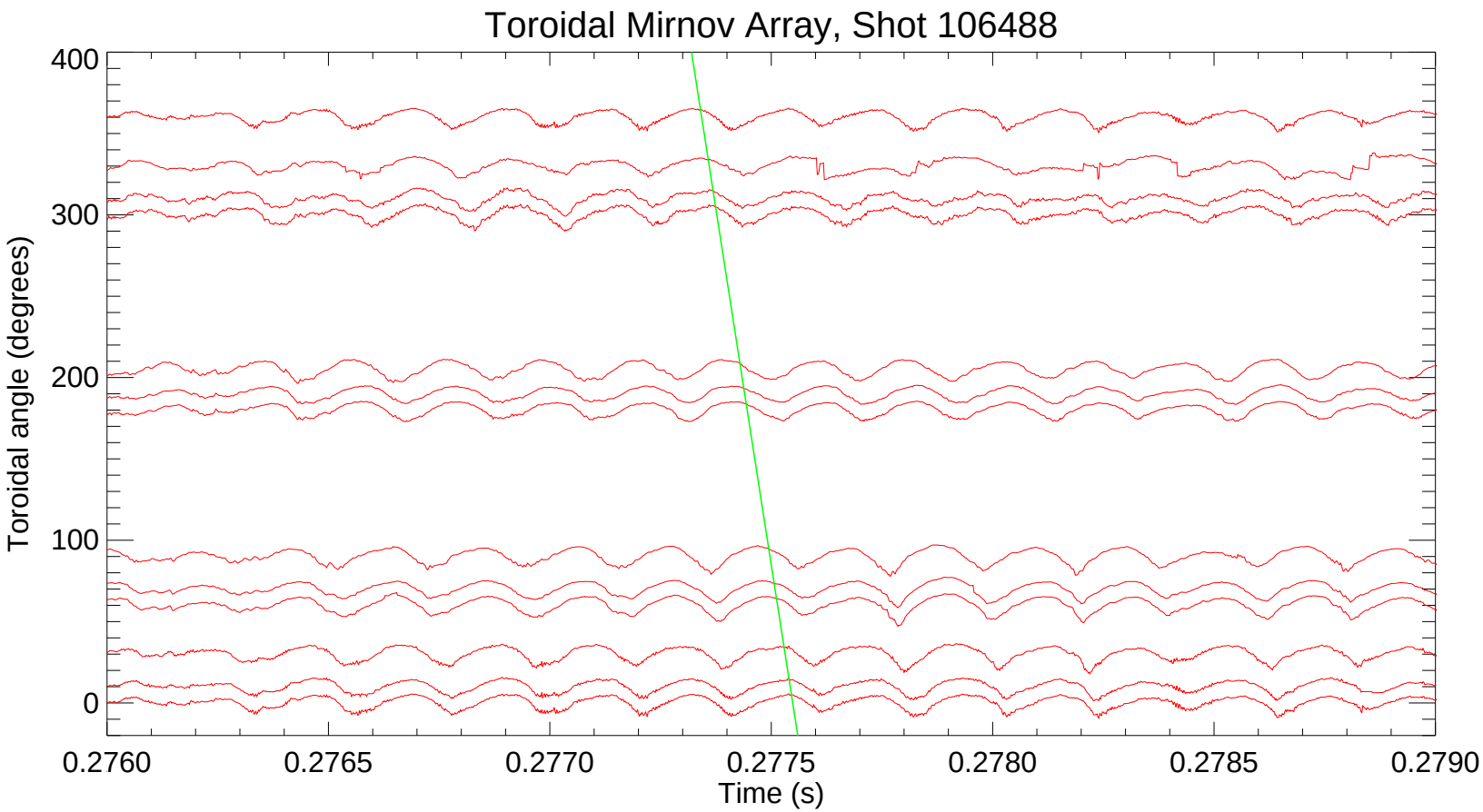
Characteristics of the n=1 Rotating Distortion in HIT and HIT–II

- Onset coincident with drop in wall current and edge density. Always seen with high current ($I_p > 100$ kA)
- Observed by surface probes only on outer shell. Has the same pitch as the edge magnetic field lines.
- Rotates in the direction of $\mathbf{E} \times \mathbf{B}$, with frequency $40 - 70$ kHz (HIT), $10 - 60$ kHz (HIT–II)
- Predicted by ideal MHD for a hollow current profile with a rational q in a vacuum layer

Major Differences of HIT–II and NSTX

- HIT and HIT–II
  - Robust insulators (accessibility to explore operating regimes)
  - Plasma near conducting wall (limits n=1 amplitude)
- NSTX
  - Insulators limit operational regimes
  - Much more complete diagnostic suite, larger volume (injector more isolated, larger S), longer pulse length, and higher current capability

NSTX Shows Continuous n=1 Toroidal Oscillations



Characteristics of the n=1 Rotating Distortion in NSTX

- Appears for $I_p \sim$ 200–250 kA, robust for $I_p >$ 300 kA
- Observed near outer midplane
- Rotates in the direction of $\mathbf{E} \times \mathbf{B}$
- Rotation frequency 5 - 12 kHz
- Need more magnetic measurements to determine poloidal structure and more analysis to determine up/down symmetry