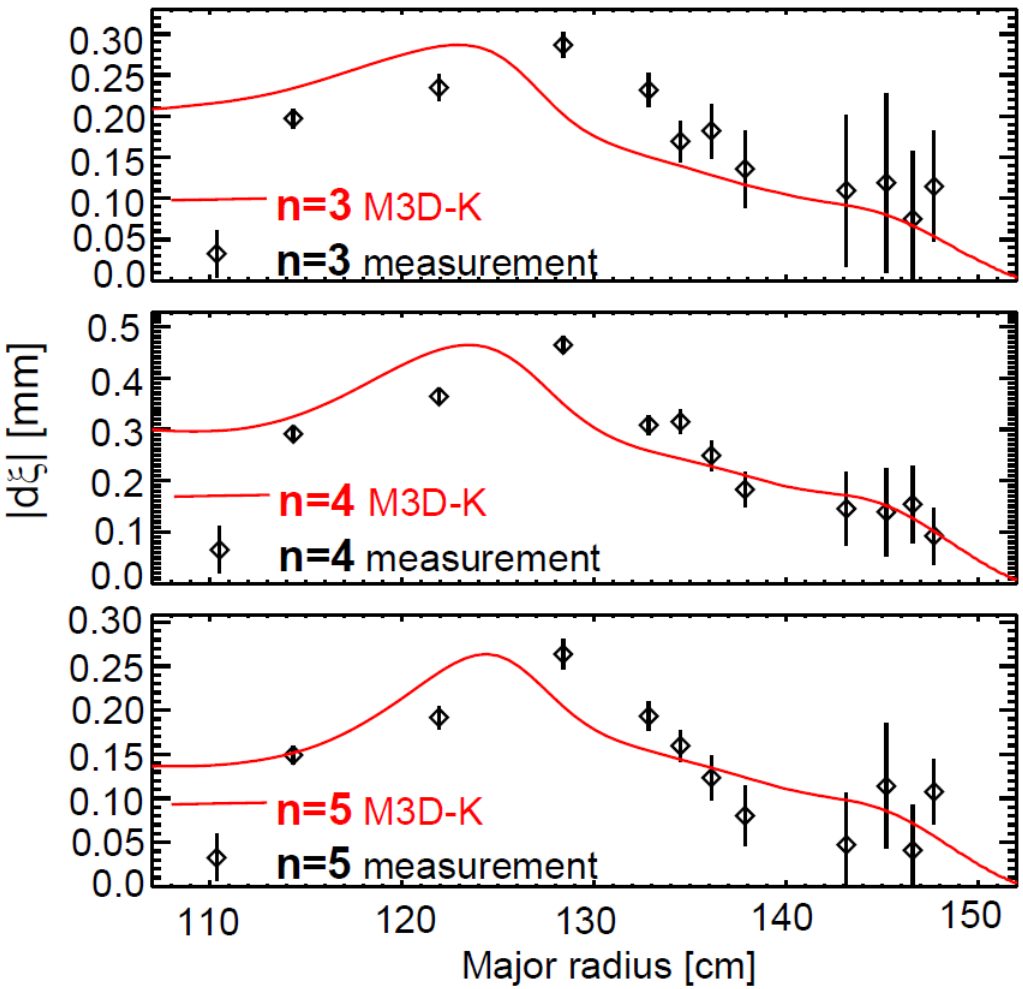
M3D-K Modeling of NSTX/NSTX-U Plasmas: Results and Future Plan

Guoyong Fu
In collaboration with
J. Breslau, D.Y. Liu, F. Wang,
N. Crocker, E. Fredrickson, W. Heidbrink, M. Podesta, K. Tritz et. al.

Recent Results

- M3D-K simulations of beam-driven TAEs show robust mode structure consistent with measurement (D.Y. Liu et al, paper under preparation);
- Developed Interface with NUBEAM for realistic modeling of beam ion distribution (D.Y. Liu et al);
- Simulation of non-resonant kink mode shows plasma rotation reduces width of (2,1) island (F. Wang et al, Phys. Plasmas 2013).
- Simulation of beam-driven n=1 non-resonant kink mode shows: (a) fishbone is preferentially excited at higher q_min ; (b) fishbone saturates with strong frequency chirping; (c) fishbone drives m>1 magnetic island. (F. Wang et al, Phys. Plasmas 2013).

Mode Structure and Mode Frequency of Simulated n=3,4,5 TAE are Similar to Experimental Measurements



Black: NSTX reflectometer measurements

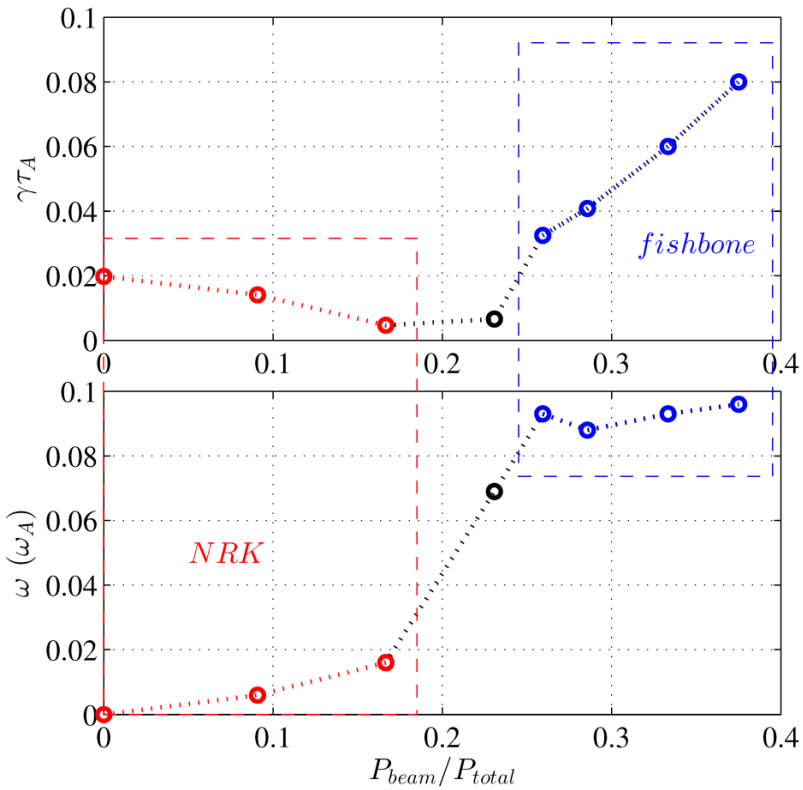
Red: M3D-K synthetic reflectometer response

D. Liu, W. Heidbrink, G.Y. Fu et al.

	n=3	n=4	n=5
f_{exp} (kHz)	100	120	140
$f_{M3D\text{-}K}$ (kHz)	106	130	149

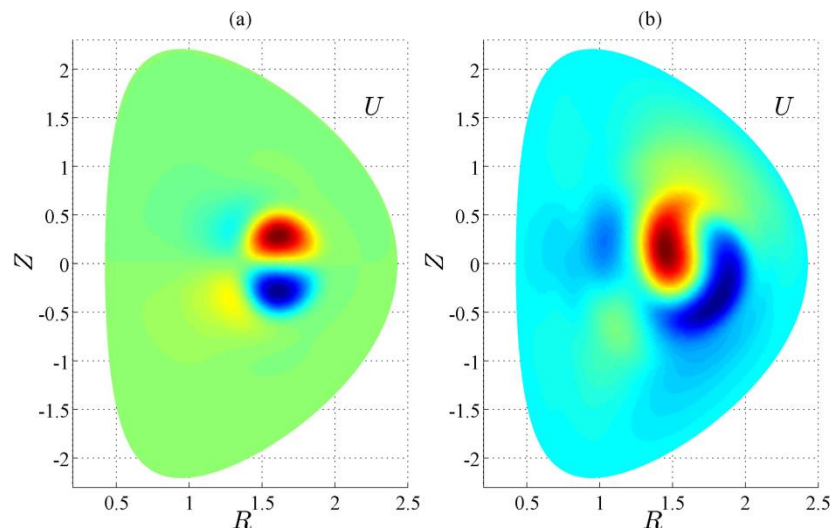
A sensitivity study of n=3 TAE simulations shows that the mode structure and mode frequency are relatively insensitive to q profile variation (within experimental error bar)

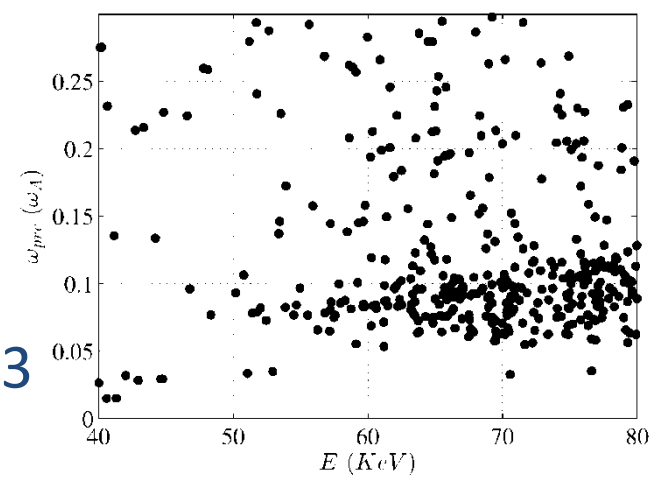
M3D-K simulation shows energetic particle stabilization of ideal kink mode and excitation of fishbone



Ideal kink

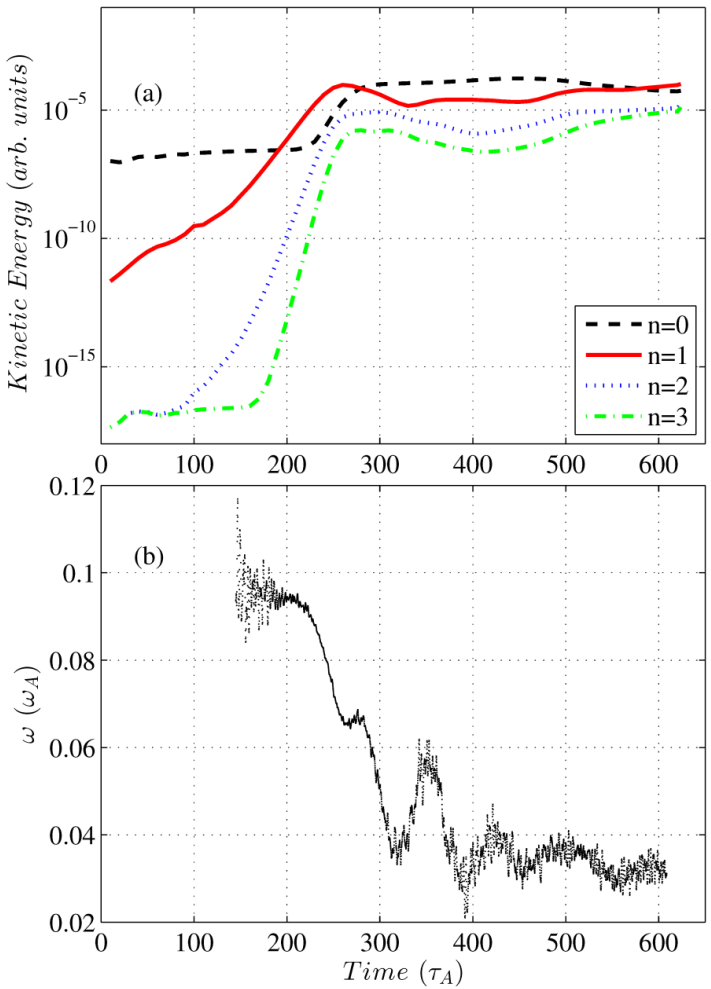
fishbone

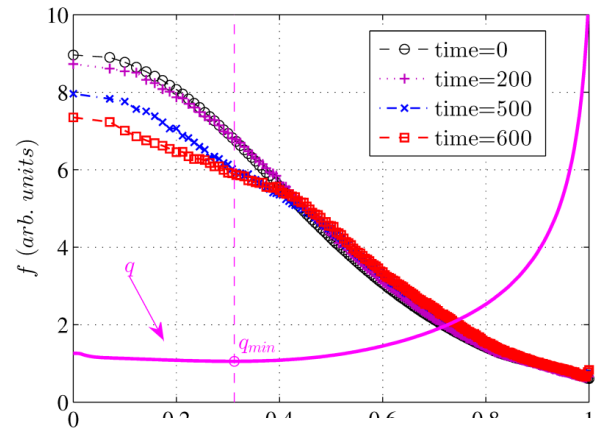


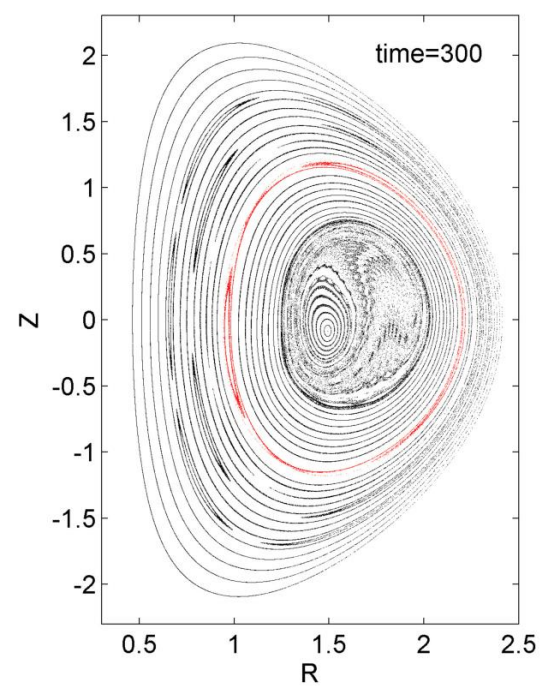


F. Wang, G.Y. Fu et al., Phys. Plasmas 2013

M3D-K simulation shows fishbone saturation with strong frequency chirping, beam ion profile flattening and nonlinearly-driven magnetic islands







F. Wang, G.Y. Fu et al., Phys. Plasmas 2013

Future Plan

- Compare fishbone simulation with NSTX plasmas;
- Simulation of multiple beam-driven TAEs and fishbone (avalanches?)
- Code development: full orbit?