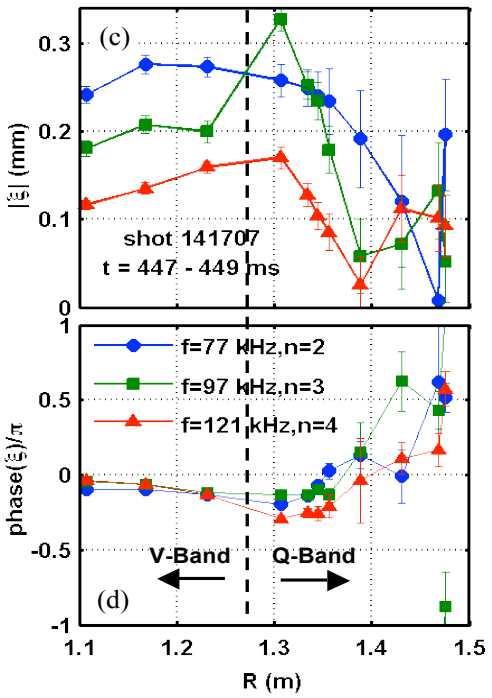
TAE phase varies strongly with radius: Is ideal MHD sufficient?

- Reflectometers measure strong radial TAE phase variation ($\Delta\Phi \sim \pi/2$) near midplane
  - XP 1015 – M3D-K validation
- Ideal MHD predicts no phase variation in up-down symmetry plane
  - only sign changes allowed (Φ = 0 or 180°)
  - midplane was up-down symmetry plane in XP 1015

Possible explanations?

- measurement geometry (i.e. reflectometers slightly elevated above midplane)
- coupling to fast-ions (and other non-ideal effects?)
  - suggested by recent DIII-D simulation + experiment & NSTX simulation

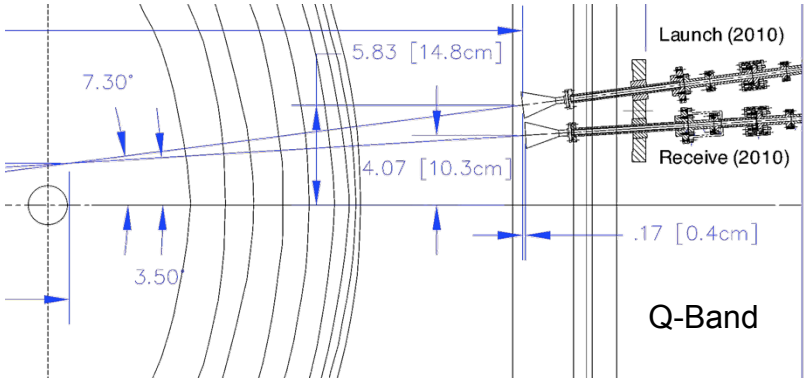
NSTX TAE structure



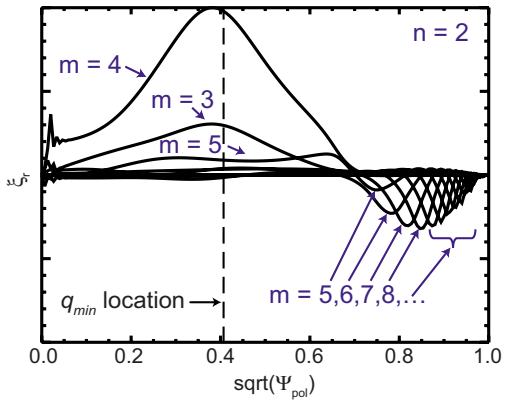
Measurement geometry may contribute to phase variation

- Ideal MHD sometimes predicts broad poloidal harmonic spectrum
  Harmonics peak where $m \sim n^*q(r)$
- Reflectometers slightly elevated above midplane ($\theta \sim 1/7$ radians)
- Dominant harmonic [$m(r)$] determines measured phase
- Possible phase variation: $\Phi(r) \sim m(r)\theta \sim n^*q(r)^*\theta$
  - $\theta \sim 1/7$, $n = 3$, $q_{min} \sim 1$, $q_{edge} \sim 10$ ➔
    $\Delta\Phi \sim (10 - 1)^*3/7 \approx 4$ radians

Reflectometer Position



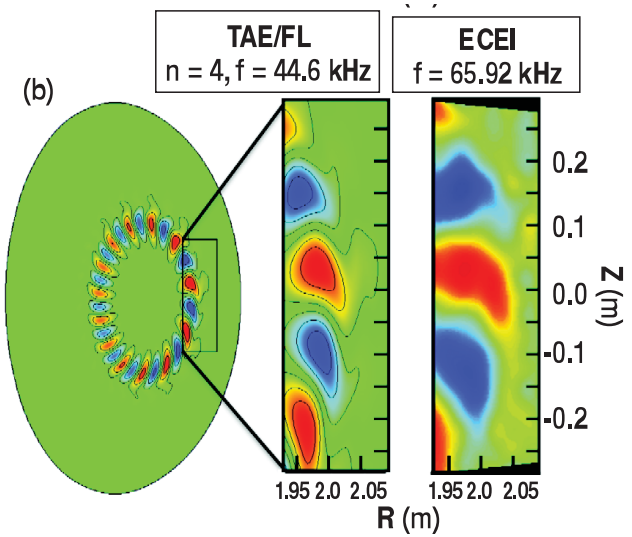
NSTX NOVA-K eigenmode
RSAE/TAE hybrid



Coupling to fast-ions causes phase variation in up-down symmetry plane

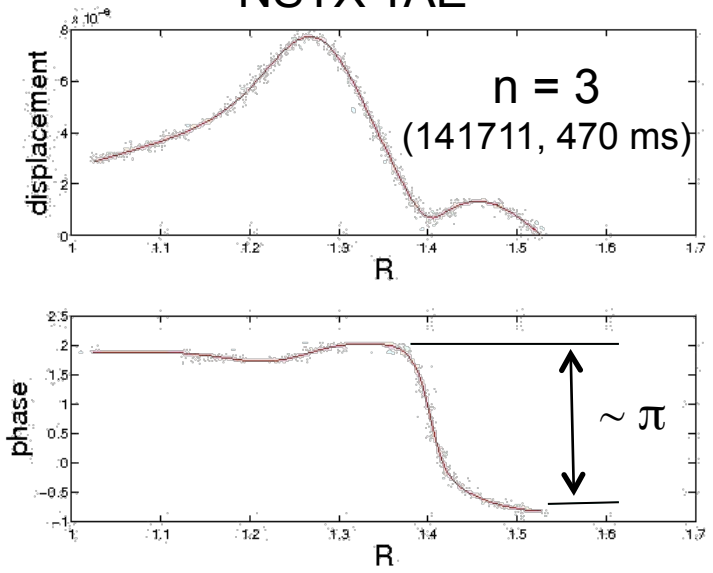
- Coupling to fast-ions has been predicted by TAE/FL in DIII-D to cause spiral structure
  - Strong phase variation in midplane
- M3D-K predicts strong phase variation in NSTX midplane due to fast-ion coupling
- Do other non-ideal effects cause spiral structure (e.g. resistivity)?

DIII-D RSAE



B. J. Tobias *et al* Phys. Rev. Lett. **106,** 075003 (2011)

M3D-K calculation
NSTX TAE



Proposal: Investigate cause of TAE radial phase variation

- Milestone: IR(12-2)
- Experimental Plan:
  1) Position edge (Q-band) reflectometers in midplane – minimize Ideal MHD effect
  2) Reproduce suitable plasma from XP 1015 (e.g. 141711)
  3) Small vertical jogs: measure local k_θ with reflectometers & local k_{vert} with BES
     – further discriminate between ideal MHD and fast-ion coupling (former is very height sensitive
  4) Compare with M3D-K & NOVA-K Fold local k_θ & k_{vert} into XP1015 validation
- Run time: ½ day (minimum ¼ day)
- Diagnostics: Reflectometer array, BES, Fast-ion diagnostics (e.g. FIDA), MSE, CHERS, MPTS
- Analysis: M3D-K, NOVA-K, TRANSP, EFIT, LRDFIT