Characterization of GAE modes and their effect on electron thermal transport

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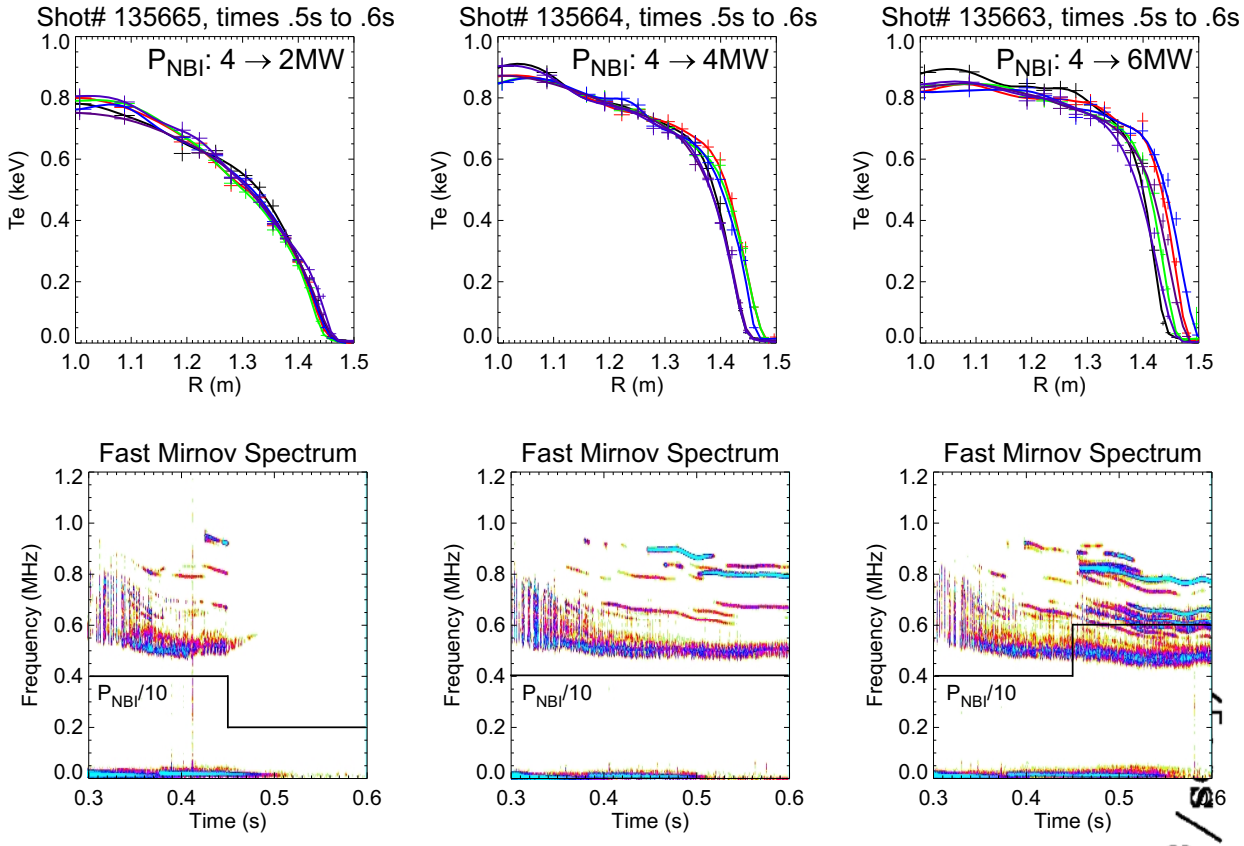
WPI TSG review XP1013

Research Motivation:

- Flat electron temperature profiles in NSTX core have no validated explanation
- Central temperature and density gradients too low to drive microturbulence
- Fast ion phase-space gradients can drive energetic particle modes which overlap and cause stochastic electron particle orbits
- Theoretical connection between GAEs and electron thermal transport demonstrated numerically

XP921 used P_{NB} power steps to modify GAEs



Central T_e remains ~ 0.8keV

GAE amplitude increases with increasing P_{NB}

Equilibrium/TRANSP analysis underway

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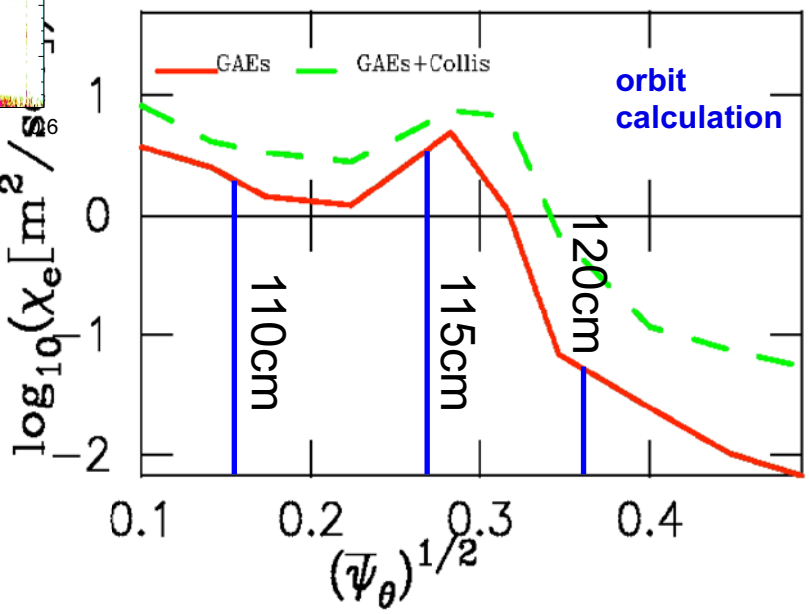
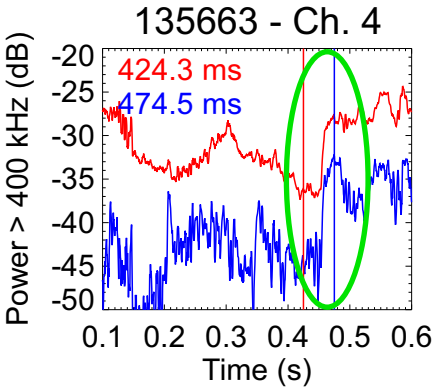
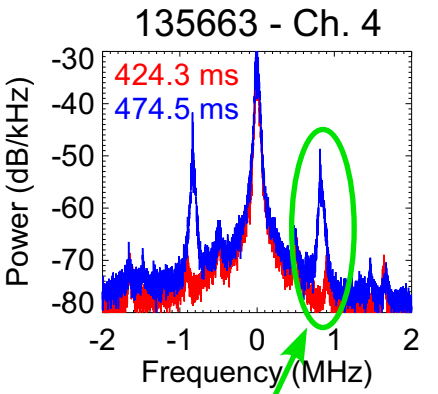


GAE modes peaked off-axis ~115cm

High-k scanned radially in interferometric mode: 115cm & 120cm

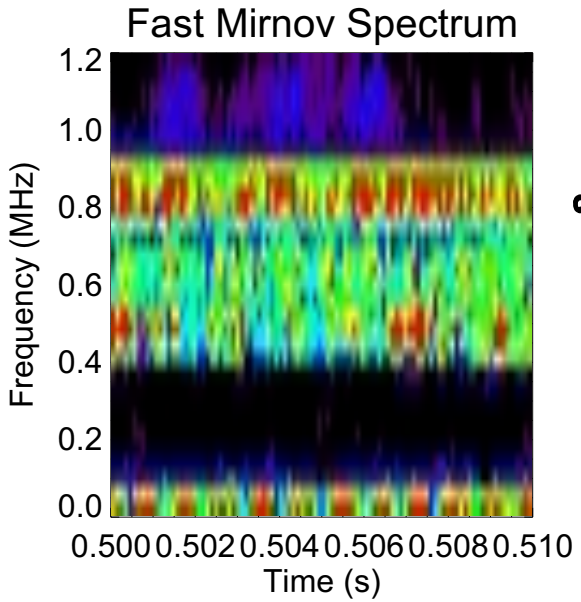
High-k interferometric signals show increase in GAE-induced density fluctuations for P_{NBI} step-up

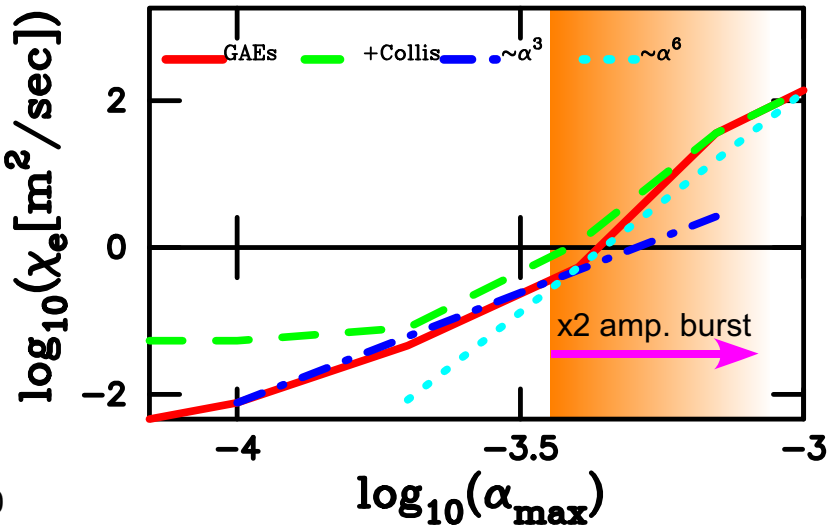




Density fluctuation power in 0.5-1MHz frequency band increases strongly at beam step

P_{NBI}: 4 → 6MW





GAE bursts may have amplitude much larger than time-averaged $\delta n/n$

Strong non-linear dependence of transport on mode amplitude (χ_e vs α_{max}) suggests bursting modes may dominate electron thermal transport

XP1013: Use new/upgraded diagnostics to obtain simultaneous radial eigenfunction of *AE modes

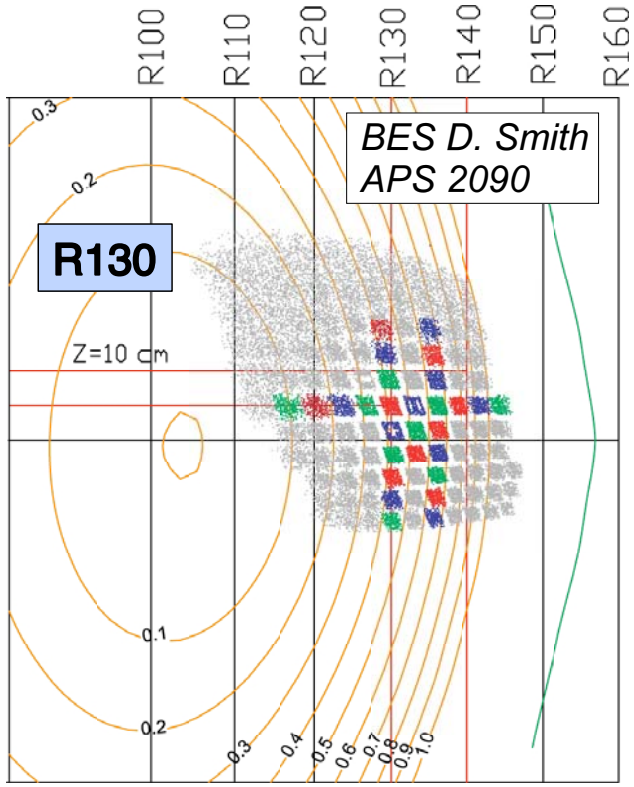
Previous XP921: probed only 2 locations (115, 120cm) with high-k interferometric measurement

New/upgraded diagnostics for proposed XP:

BES (D. Smith) will cover 115 - 140cm up to 1MHz

High-f reflectometer (N. Crocker) can cover core and edge (depends on ne profile)

FiRETIP (K.C. Lee) provides line-integrated n_e up to 2MHz at 32, 57, 85, 118, 132, 150cm

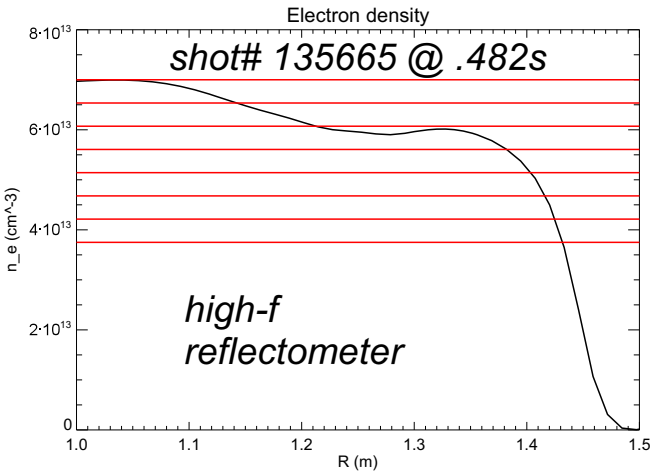


Simultaneous measurements allow condensed run plan:

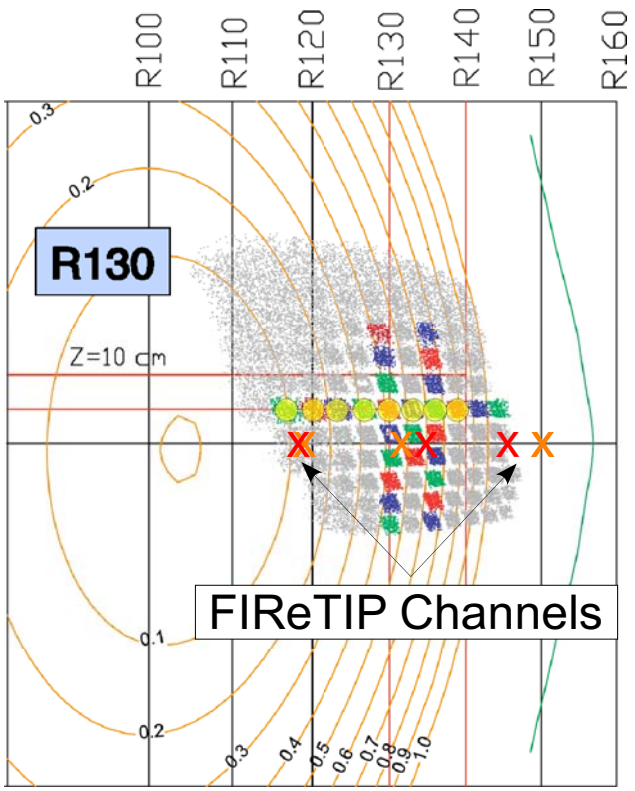
P_{NB} steps as before 4→2, 4→4, 4→6MW (2 ea. for 6 shots)

B field scan at constant q: B_T @ .45, .5, .55T (12 additional shots)

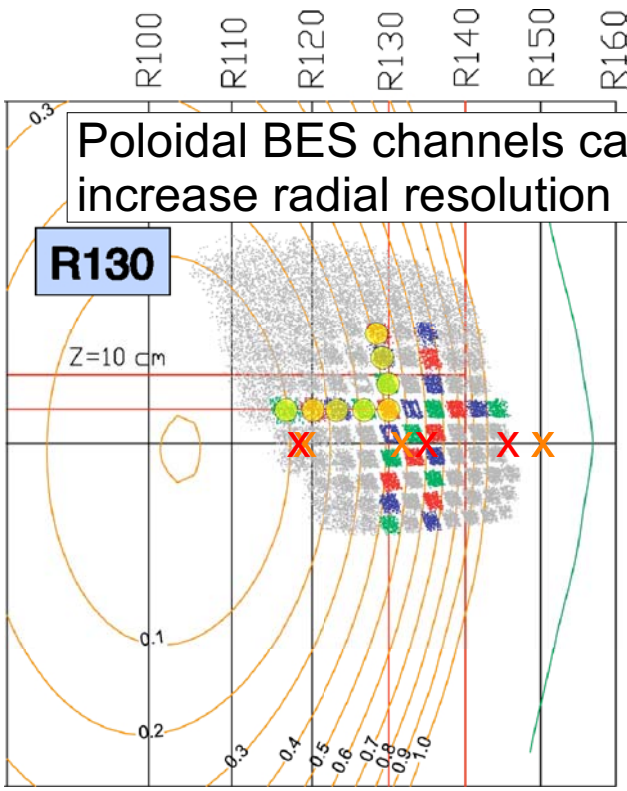
Shot total: 18 - 1 run day



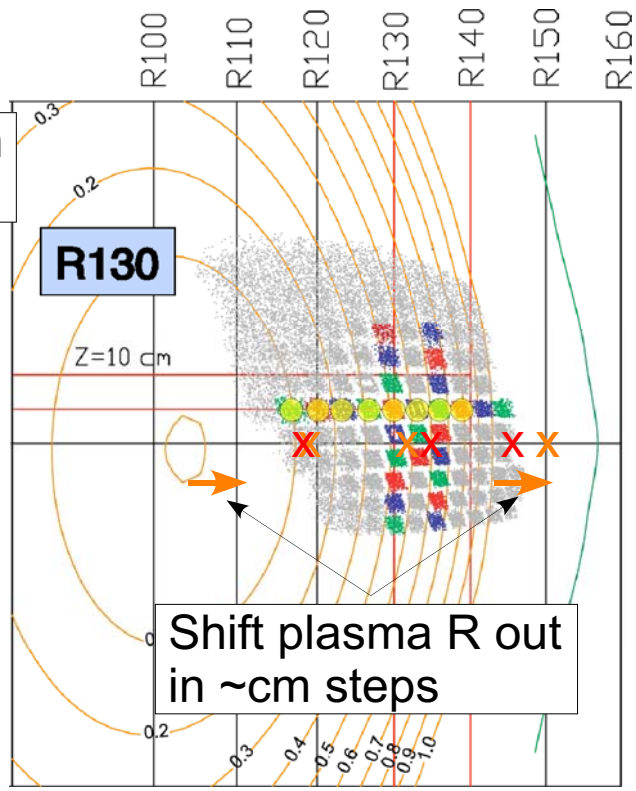
Optimize *AE mode characterization with 1/2 day run



Setup 1



Setup 2



Setup 3

Reduce shot 'block' to 4 shots: P_{NBI} 4→4, 4→6MW 2 shots each

Setup 1: 4 shots
Setup 2: 4 shots
Setup 3: 4 shots
Total: 12 shots