3 XP ideas for HHFW experiments in 2010
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J. Hosea et al.

- XP Idea 1: Study HHFW power coupling versus ELM activity
  - 2 days desired after good control of ELMs is obtained for general operations
- XP Idea 2: Study of characteristics of RF heating at the divertor SOL regions
  - 2 days desired for extensive hot zone study
- XP idea 3: Interaction of HHFW SOL heating with LLD
  - Piggyback experiment

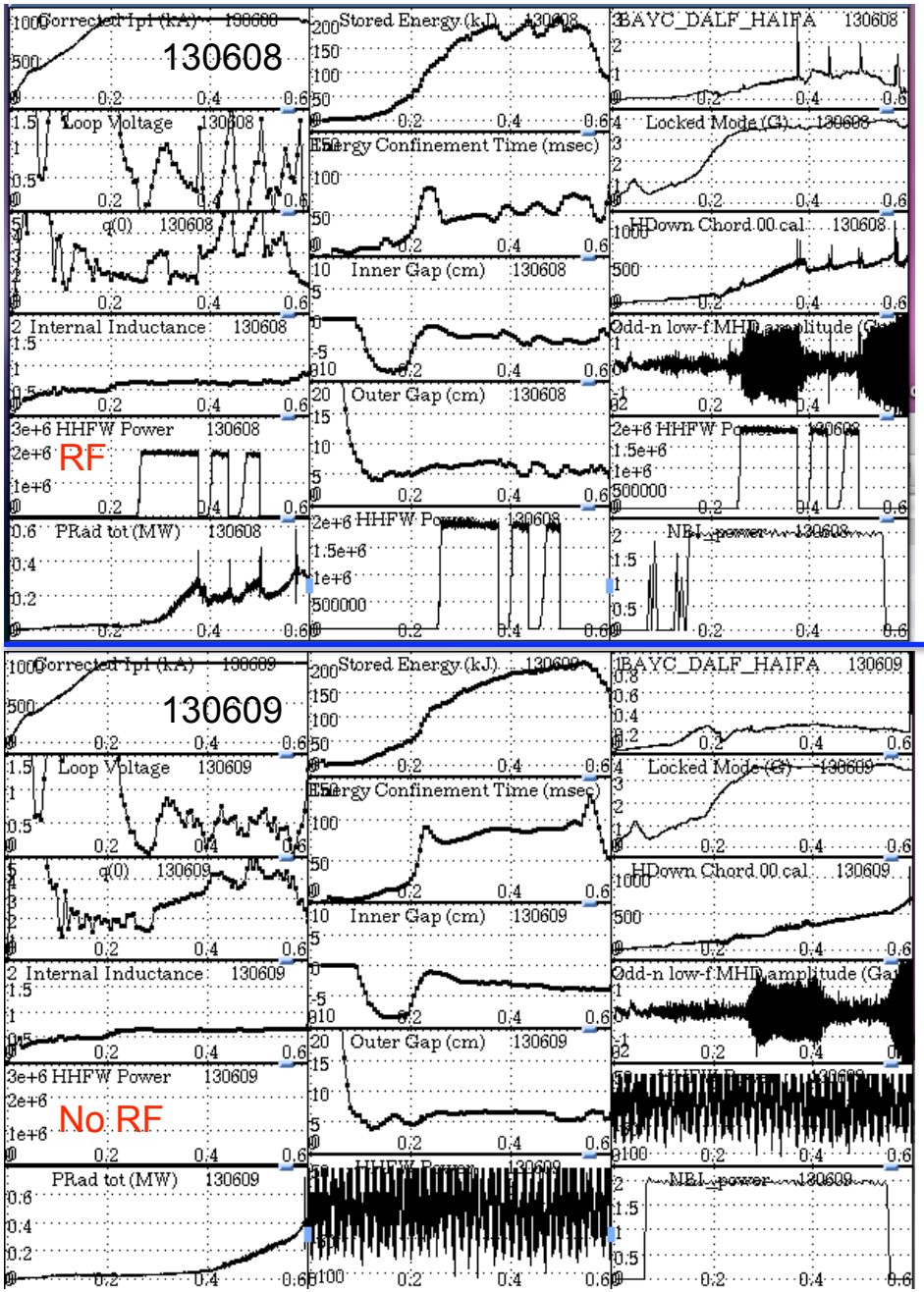
❖ XMP idea: Extensive HHFW plasma conditioning will be required to blast our way to high power for all phases

XP Idea 1: Study HHFW power coupling versus ELM activity

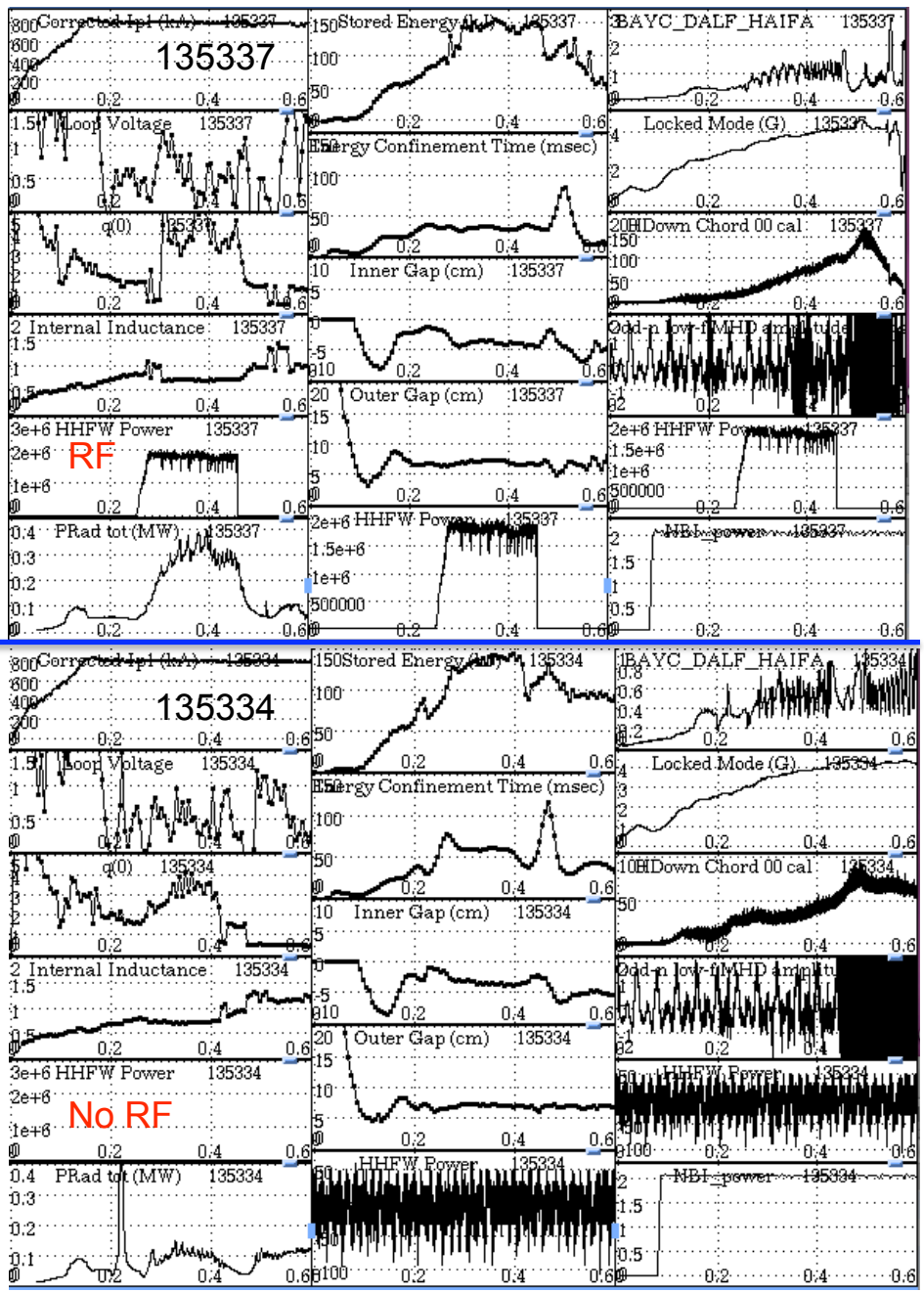
- Heating efficiency is reduced by ELMs for HHFW + NB and for NB alone
- We need to study and optimize HHFW heating efficiency versus ELM conditions in H-mode
  - Determine HHFW heating efficiency dependence on ELM properties and edge density in ELM free, small ELM, occasional medium to large ELM, and frequent medium to large ELM conditions
  - Use all techniques available to remove ELMs, or to add ELMs at selected times
  - Establish HHFW heating scenarios for optimizing HHFW heating of D_2 H-mode plasmas in support of the FY10 HHFW NSTX milestone
  - 2 days desired after good control of ELMs is obtained for general operations

ELMs affect W_{tot} and τ_E with NB + RF and with NB only

H-mode ELM free

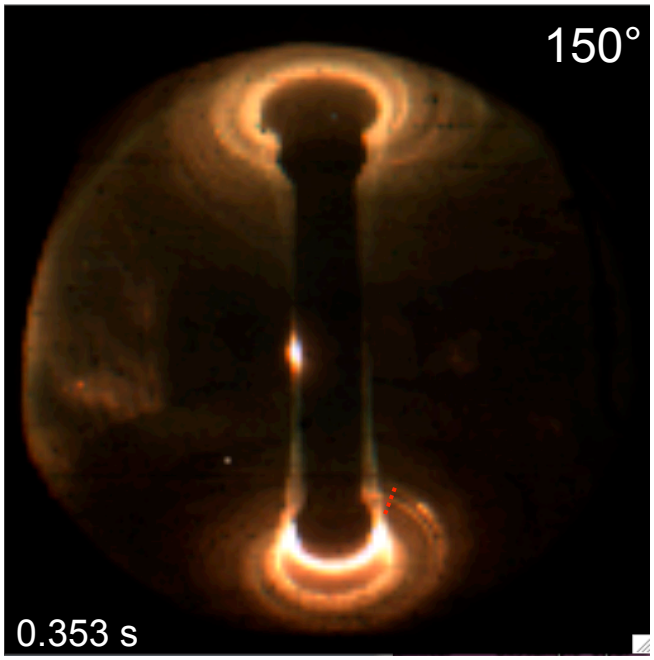


H-mode with ELMs

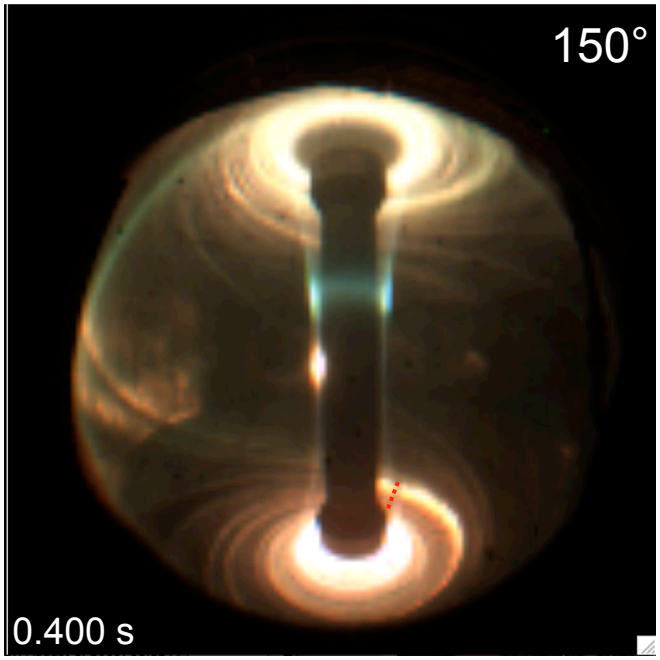


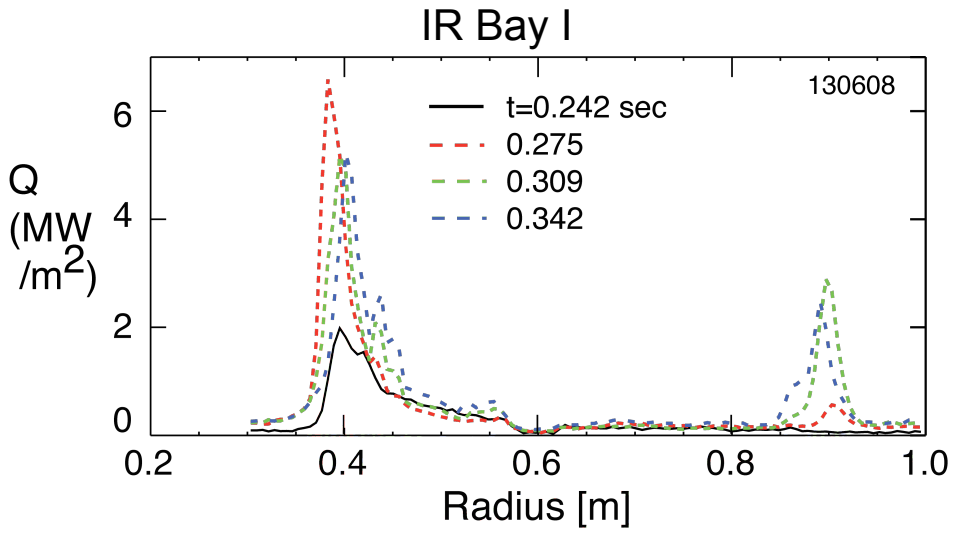
Heating on outer divertor plate is more intense with ELMs with same field pitch

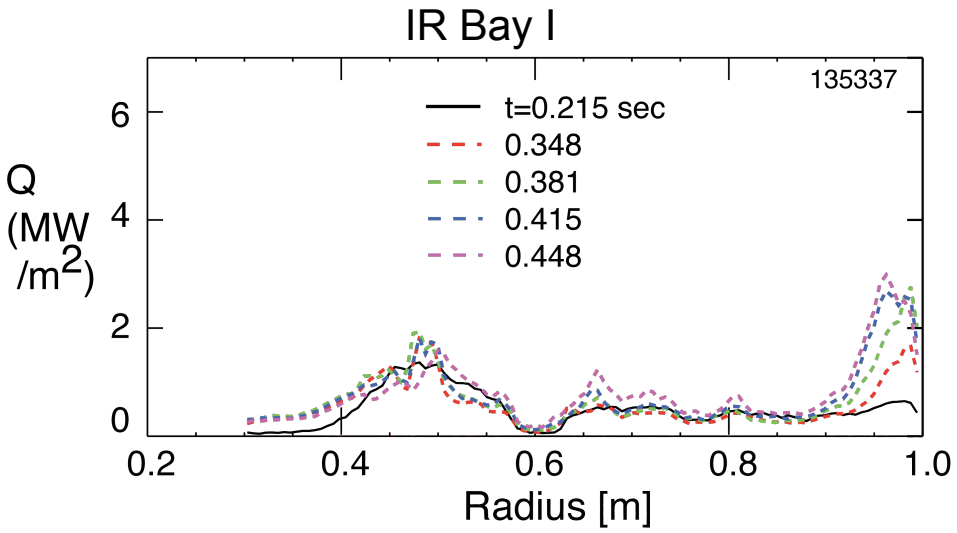
130608 ELM free – 5.5 kG, 1 MA



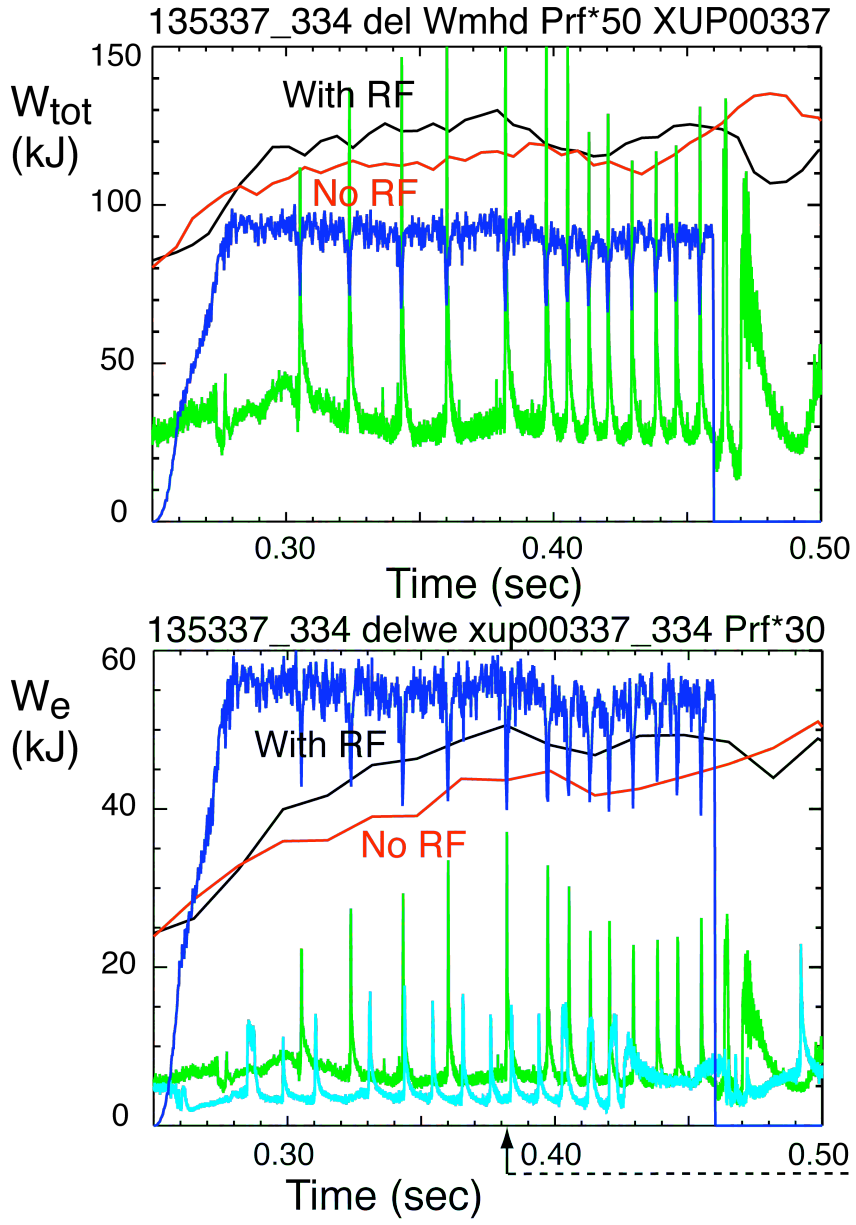
135337 with ELMs – 4.5 kG, 0.8 MA



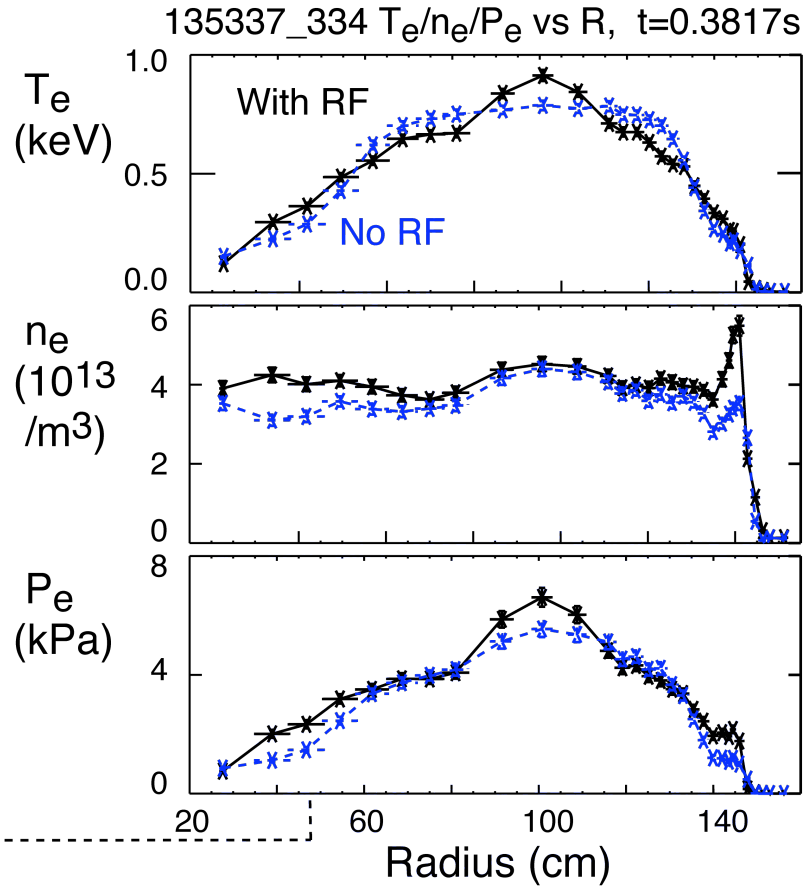




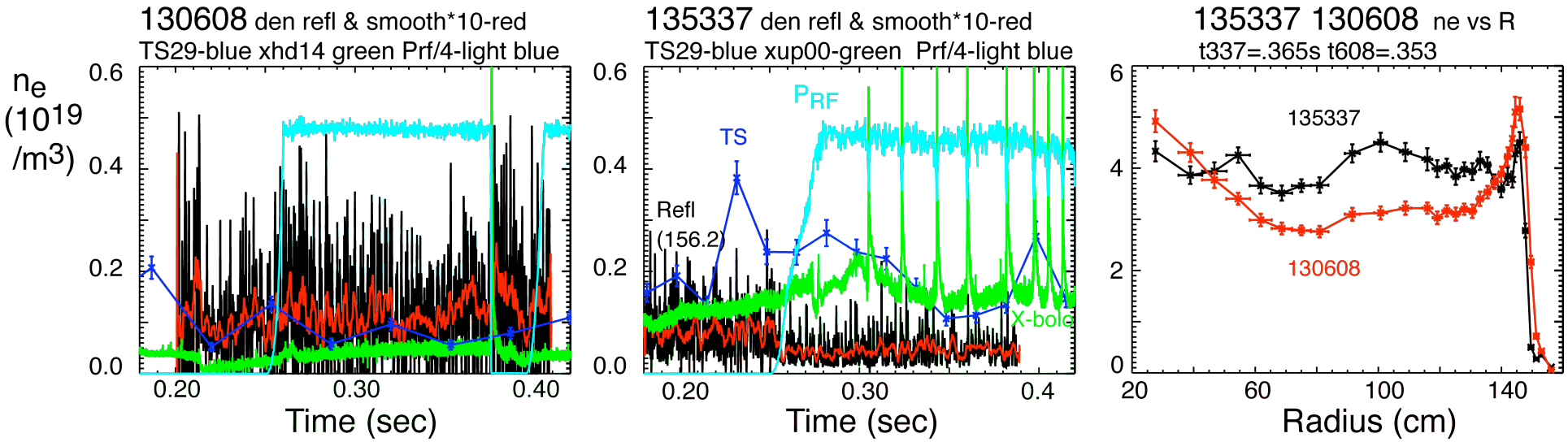
Power coupled to core is affected by ELMs and possibly by higher edge density



- ΔW_{tot} and ΔW_e for shot 135337 are reduced by more than 50% relative to shot 130608



ELMs may enhance edge density on average as well as during ELM period



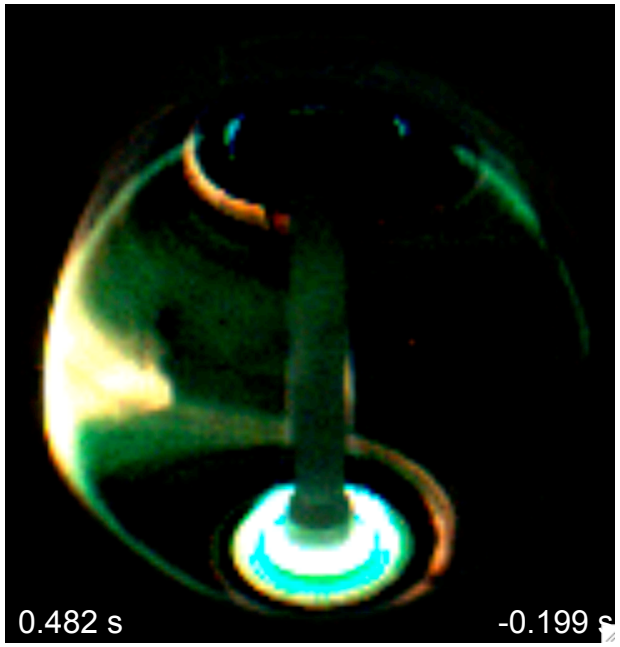
- Edge density appears to be higher for 135337 with ELMs from edge TS channel
- Reflectometer at R = 156.2 cm shows considerable turbulence both with and without ELMs – effect on coupling?
- Reflectometer appears to be calibrated differently for 2009 relative to 2008
  - need to use EFIT02 for better comparison to TS
- ELMs appear to be channeling more power to the divertor region
- Core density profile is similar for the two cases
- Need to study core vs edge heating versus ELM activity to benchmark theory for deposition

XP Idea 2: Study of characteristics of RF heating at the divertor SOL regions

- Study SOL hot zones
  - Versus pitch – extend pitch to I_P = 1.2 MA, B_T = 5.5 kG
  - With fast IR looking at Bay H bottom and added IR camera looking at Bay J bottom
  - Versus ELMs and edge density
    - View RF effects with and without ELMs with fast IR and other cameras
  - With added probe diagnostics at Bay J bottom and Bay K bottom
    - Measure RF characteristics and "DC" current at/near hot zone to investigate propagating surface waves vs local CD at antenna as causal mechanisms for the observed divertor SOL heating
  - Upper single null divertor versus lower single null divertor
    - Measure SOL heating characteristics with – and + phases to see if heating tracks with RF electron current drive direction
  - 2 days desired for extensive hot zone study

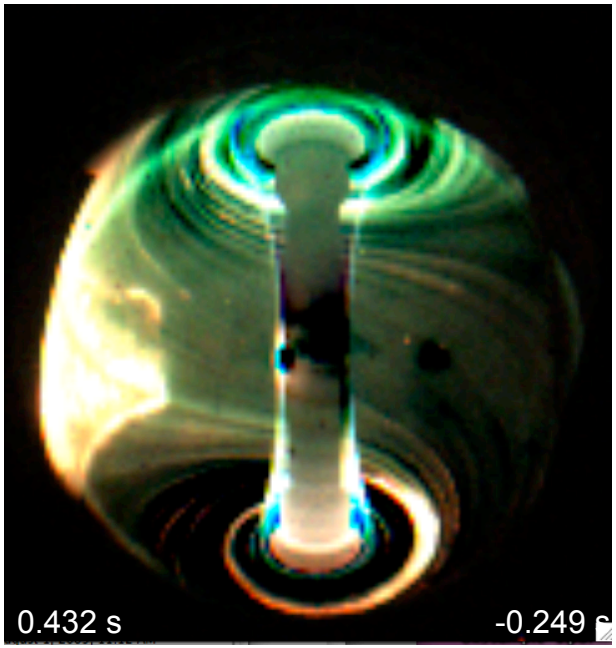
Heating zone moves in as the field pitch is increased, heating increases with ELMs and with decrease in n_{onset}

135260 0.65 MA, 5.5 kG



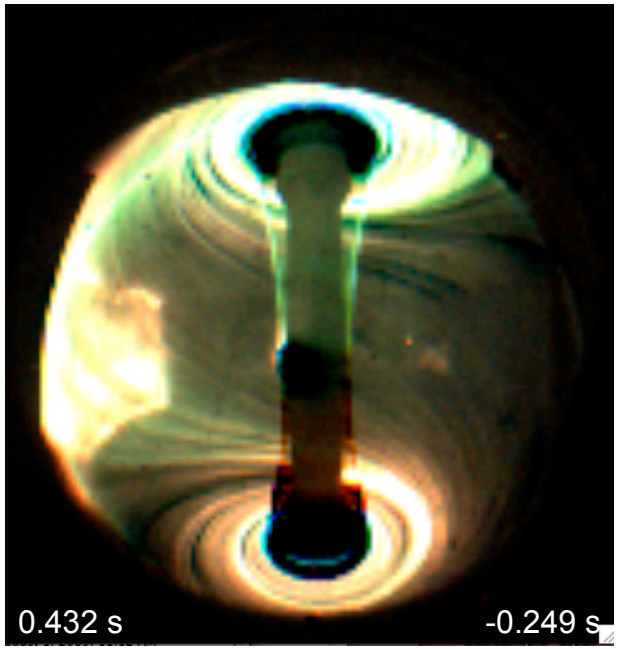
ELM free H-mode in He

135325 0.8 MA, 5.5 kG



H-mode with ELMs, D_2, 5.5 kG

135333 0.8 MA, 4.5 kG



H-mode with ELMs, D_2, 4.5 kG

- Camera shots are same intensity and for P_{RF} ~ 2.7 MW
- Elm free case has much less edge power deposition – edge density is relatively low
- Bay J IR and Bay H fast IR cameras will be employed for lower divertor heating studies
  - with and without ELMs
- Bay J and Bay K bottom probes will be applied at higher field pitches to investigate local RF heating characteristics
- Note that lower pitch should result in less RF power to the LLD
  - This is also true for upper single null operation

XP idea 3: Interaction of HHFW SOL heating with LLD

- Piggyback experiment to XP ideas 1 and 2
- May be necessary to operate in upper single null for some high power HHFW cases – high field pitch, frequent ELMs, etc.
- May need to drive electrons toward the upper divertor SOL in some high power HHFW cases

XMP idea: Extensive HHFW plasma conditioning will be required to blast our way to high power for all phases