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Wave-Particle Interactions TSG Mid-Run Assessment

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G. Taylor, *leader*

M. Podestà, *deputy*

N. Gorelenkov, *theory and modeling*

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NSTX Mid-Run Assessment Meeting

August 27, 2010

Overview

- One EP 1st tier XP run so far
  - XP-1011: "TAE/GAE avalanches studies in H-mode deuterium plasmas" (Fredrickson)
- Two RF 1st tier XP's (partly) run so far
  - XP-1017: "RF heating at the divertor SOL regions" (Hosea) – *1 hour run time*
  - XP-1009: "HHFW heating of low $T_e(0)$, I_p plasmas" (Taylor) – *1/2 day run time*
- RF XMP-26 run, 5.5 days in June + 2 days in July
  - HHFW plasma conditioning: *issues in coupling >1.5 MW reliably*
- Four HHFW 1st tier XP's ($4+1^{SFSU}$ run days) pending, based on availability of HHFW System
- Three EP 1st tier XP's (1.5 run days) scheduled
- Three EP, two HHFW 2nd tier XP's (2 run days)

Status of XP Results

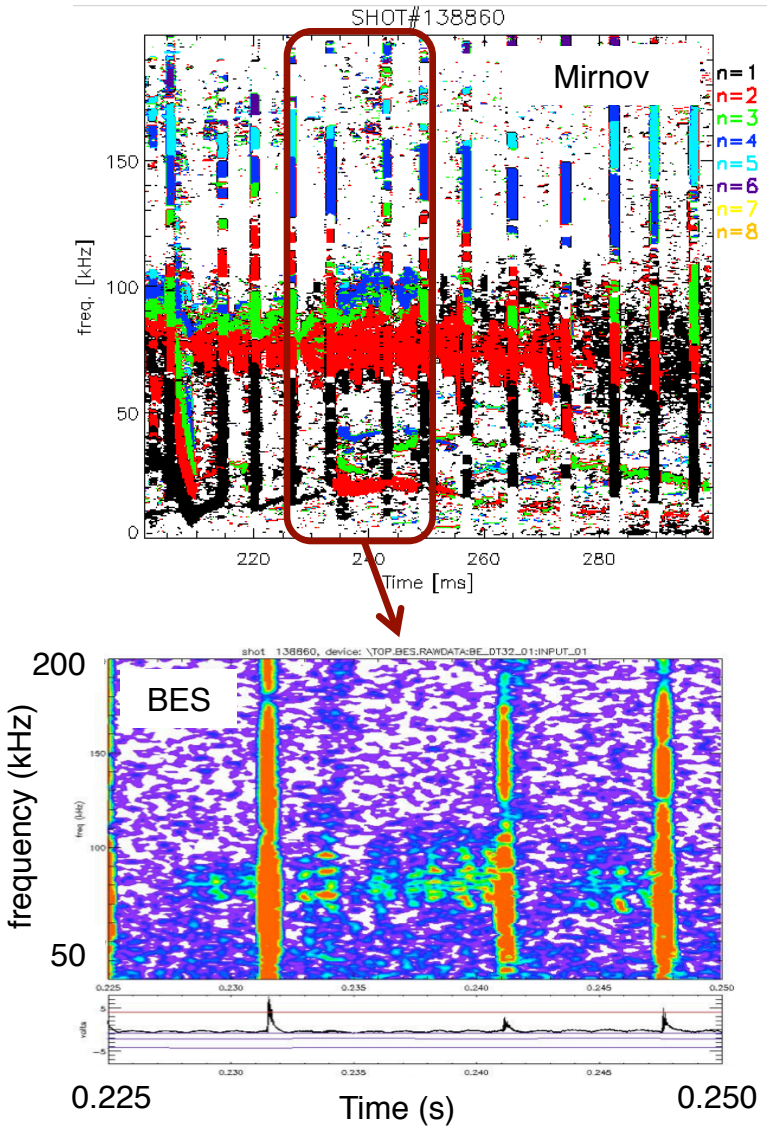
XP-1011: TAE avalanches in H-mode plasmas

Goals: Develop target plasma with TAE avalanches

- Study threshold for avalanches as a function of density, NB power, toroidal field
- Optimize target for mode amplitude measurements with BES, USXR and interferometer

Results: *XP completed*

- TAE avalanches obtained in H-mode plasma
  - Partial density, TF and outer gap scans performed
  - First BES data on mode amplitude collected (outer views only – shutter issues)

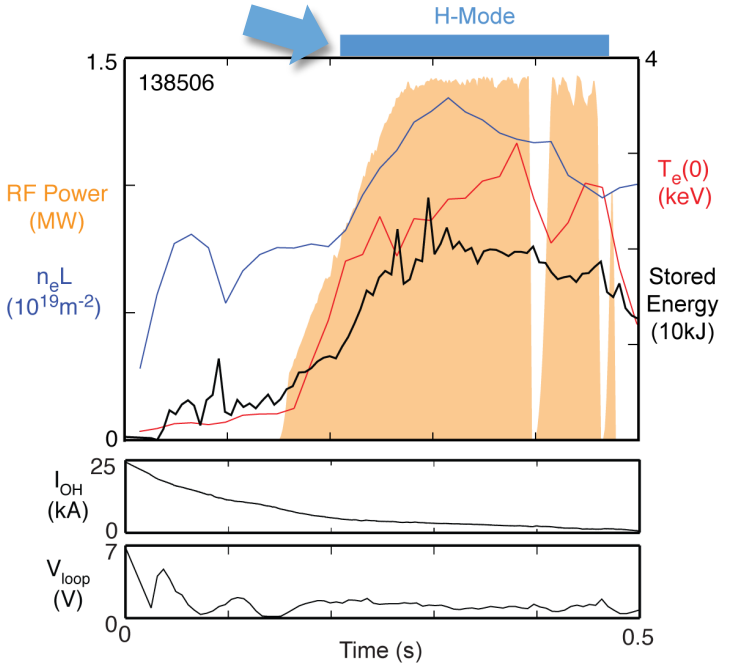


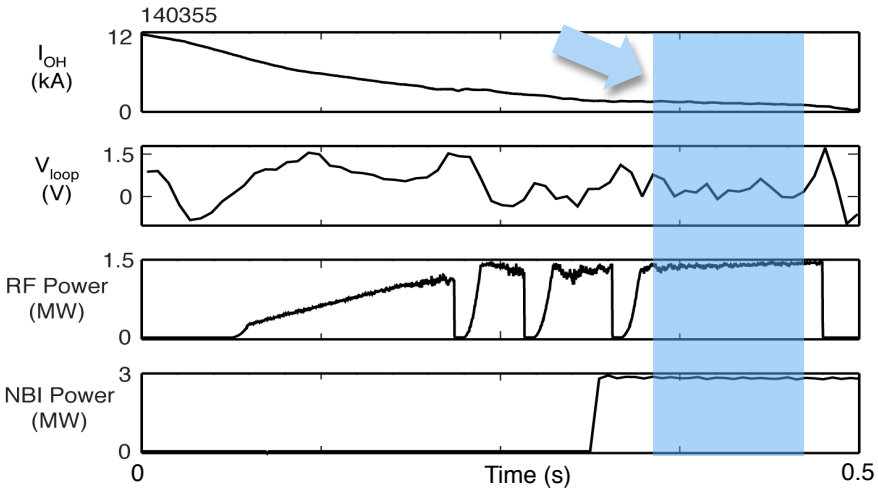
XP-1009: HHFW heating of low T_e, I_p plasmas

Goals: Generate non-inductive H-Mode discharge at I_p ~ 200-300 kA

Results:

- XP run time 0.5 day (vs. 1.5[SFSU] days allocated)
- June 14: Heated I_p = 300 kA plasma with 1.4 MW of $k_\phi = -8\ m^{-1}$ RF heating
  - Measured good electron heating during RF H-mode (138506)
- August 25: Heated I_p = 300 kA plasma with 1.5 MW of $k_\phi = -8\ m^{-1}$ RF & 3 MW NBI heating
  - Measured V_{loop}~0 and dI_{OH}/dt~0 during RF + NBI heating (140355)
- Need to increase P_{rf} to 2-3 MW:
  - Power limited by Li influx



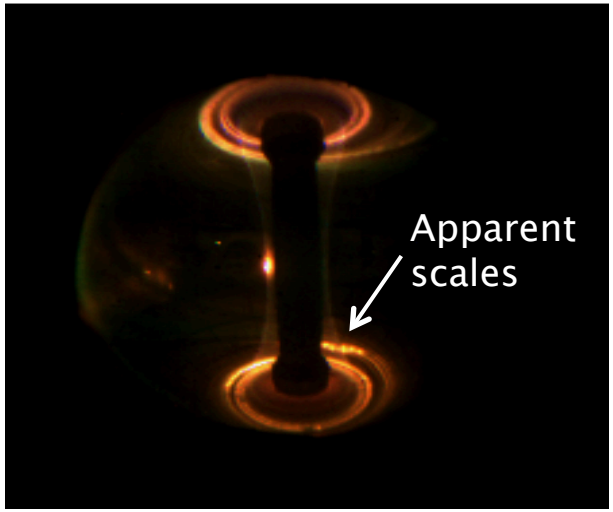


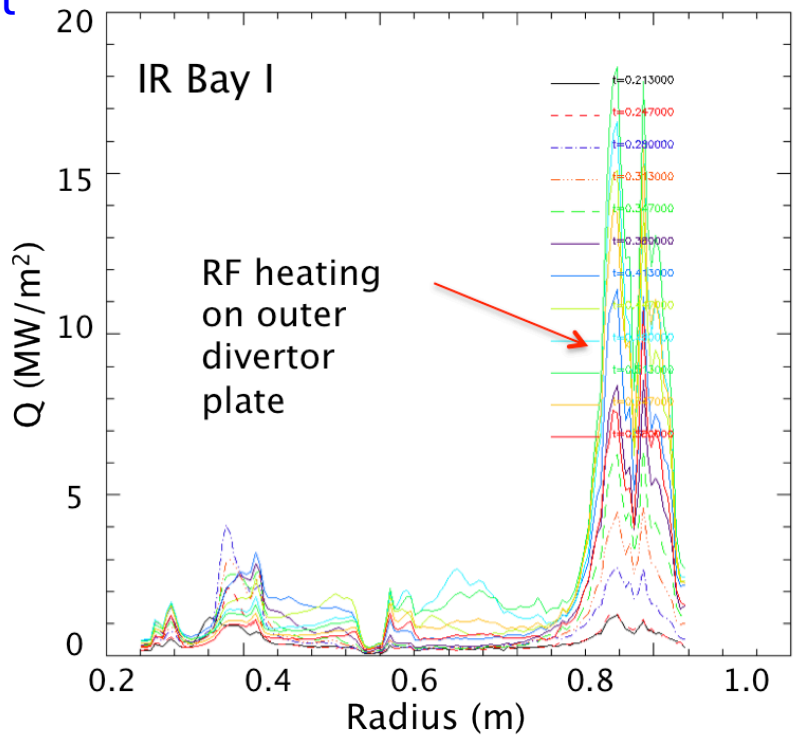
XP-1017: Divertor SOL heating during HHFW

Goals: Understand HHFW edge heating, Help benchmark edge heating effects in RF heating codes

Results: Scan of magnetic field pitch June 9 (1 hour) at P_{RF}=2 MW

- I_P(MA)/B_T(kG) = 0.8/5.5, 0.8/4.5, 0.9/4.5, 1.0/4.5
- Divertor RF heating inner radius moves with pitch
- IR measurement complicated by apparent *scales* of lithium on outer divertor plate
  → need to condition scales away





Remaining 1st & 2nd Tier XPs

Remaining 1st and 2nd Tier WPI TSG XPs would require ~6+1.5 Run Days

- **WPI-11/16/19:** M3D-K validation for Alfvénic modes [1] 0.5 day EP-2
- **WPI-18:** *AE induced electron transport [1] 0.5(1) day EP-2, TC-12
- **WPI-14/21:** Study of Angelfish instability & effect of HHFW [1] 0.5 days EP-2
- **WPI-1:** 100% non-inductive RF H-mode [1] 1(1.5) days R10-2, IOS-5.2
- **WPI-3:** HHFW power coupling vs ELMs [1] 1 day R10-2 *ITER
- **WPI-6/15:** HHFW heating in NB heated plasmas [1] 1 day R10-2, IOS-5.2
- **WPI-4:** RF heating at divertor/SOL regions [1] 0.5 days R10-2, IOS-5.2

- **WPI-7:** EPM effects on fast ion transport & current profile [2] (0.5) days EP-2
- **WPI-12:** Conversion of AEs to Kinetic Alfvén waves [2] 0 days EP-1
- **WPI-17:** Clamping of edge rotation by HHFW [2] (0.5) days R10.2, TC-9
- **WPI-26:** MSE measurements of HHFW-CD [2] 0 days R10.2

[1] priority 1st (1st & 2nd) priority days assigned Milestone/ITER/ITPA

Present conditions of HHFW system lead to reconsider/re-prioritize WPI TSG experiments

- **WPI-11/16/19:** M3D-K validation for Alfvénic modes [1] 0.5 day EP-2
- **WPI-18:** *AE induced electron transport [1] 0.5(1) day EP-2, TC-12
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[1] priority 1st (1st & 2nd) priority days assigned Milestone/ITER/ITPA

Proposal for WPI-TSG experiments for the remaining of the Run:

Must take into account status of HHFW

Prioritize remaining run time for WPI TSG XPs depending on availability of HHFW

	Experiment	BES	no RF	P_{RF}~2MW	P_{RF}>2MW
1st priority	RF in low T_e,I_p plasmas [0.5 day]			1	1
1st priority	HHFW coupling and ELMs				1
1st priority	RF heating at divertor SOL [1 hour]			0.8	0.8
1st priority	RF heating efficiency and fast ion accel. in NB plasmas	✓		0.5 (?)	1
1st priority	Angelfish instability (+ RF effects)	✓	0.5	0.5	0.5
1st priority	TAE avalanches in H-mode [0.5 day] (FY-12 Milestone)	✓	+0.5		
1st priority	*AEs and electron transport (APS invited)	✓	1	1	1
1st priority	M3D-K code validation for TAEs (FY-12 Milestone)	✓	0.5	0.5	0.5
2nd priority	EPMs: confinement, I_p modifications (high-speed camera)	✓	0.5		
2nd priority	Conversion of *AEs to kinetic *AEs (FY-12 Milestone)	✓	0.5		
2nd priority	Clamping of edge rotation by HHFW			0.5 (?)	
2nd priority	NEW Rotation effects on TAEs through n=3 braking NEW	✓	0.5 (?)		

** Run time so far*

** Proposed run time (days)*

** Notes*

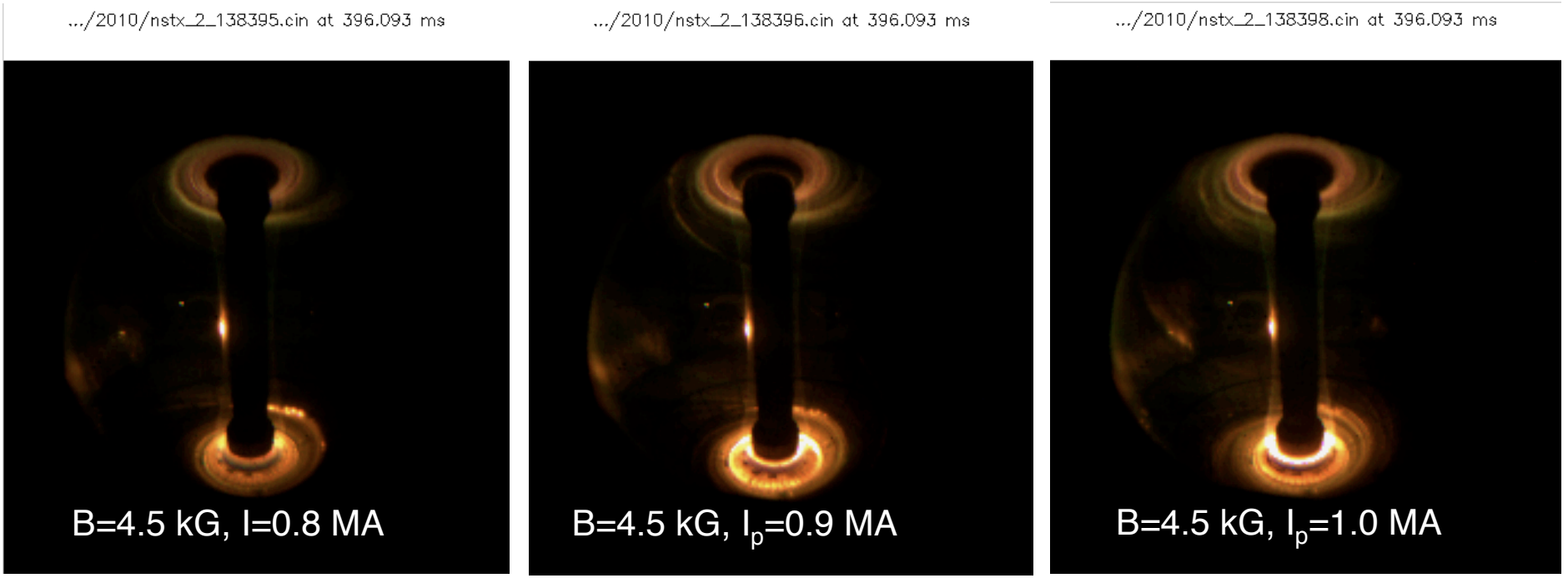
✓ *desired*

✓ *required*

- **Decision made based on next week's RF vacuum conditioning**
- **Need to fix BES shutter issues for (most of) EP experiments**

Backup slides

XP-1017: Divertor heating dependence upon magnetic field pitch



"Hot zones" sweep to divertor regions at smaller *R* as pitch increases

Energetic Particles experiments – 2 (3) days

- **WPI-8/9:**H-mode TAE/GAE avalanches [1] 0.5 days EP-2
- **WPI-11/16/19:**Characterize low freq. Alfvénic modes [1] 0.5(1) day EP-2*ITER
- **WPI-14/21:**Study of Angelfish instability & effect of HHFW [1] 0.5 days EP-2
- **WPI-18:***AE induced electron transport [1] 0.5 days EP-2, TC-12
- **WPI-7:**EPM effects on fast ion transport & current profile [2] (0.5) days EP-2
- **WPI-12:**Conversion of AEs to Kinetic Alfvén waves [2] 0 days EP-1
- **WPI-25:**Error field modulation of TAEs [3] 0 days EP-2
- **WPI-22:**Study of co-propagating CAEs piggyback, but BES limited to 1MHz
- **WPI-28:**Study of High Energy Feature with NPA [3] 0 days EP-2
  - Requires no-Lithium scenario
- **WPI-10:**Energetic particle driven GAM [3] 0 days
  - Needs reversed I_p
- **WPI-13:**Red/blue Doppler shift in FIDA spectra [3] 0 days
  - Needs reversed B_{tor} or I_p

Special conditions required

- **XMP?:**Plasma jogs to measure *AE mode structure w/ interferometer

*ITER = Possible ITER XP

[1] priority 1st (1st & 2nd) priority days assigned Milestone/ITER/ITPA

HHFW Experiments – 4 (5) days

- **WPI-1:**100% non-inductive RF H-mode [1] 1(1.5) days R10-2, IOS-5.2
- **WPI-2:**HHFW heating at low T_e, I_p [1] 0.5 days [+1 in SFSU] R10-2, IOS-5.2
- **WPI-3:**HHFW power coupling vs ELMs [1] 1 day R10-2 *ITER
- **WPI-6/15:**HHFW heating in NB heated plasmas [1] 1 day R10-2, IOS-5.2
- **WPI-4:**RF heating at divertor/SOL regions [1] 0.5 days R10-2, IOS-5.2
- **WPI-17:**Clamping of edge rotation by HHFW [2] (0.5) days R10.2, TC-9
- **WPI-26:**MSE measurements of HHFW-CD [2] 0 days R10.2
- **WPI-5:**Interaction of HHFW heating with LLD piggyback R10-2, IOS-5.2
- **WPI-20:**Measure RF wave amplitude with reflectometer piggyback R10.2
- **WPI-24:**Measure RF density fluctuations with FIReTIP piggyback R10.2
- **WPI-27:**Study of HHFW generated PDI piggyback R10.2

- **XMP:**HHFW plasma conditioning (XMP-26)
- **XMP:**RF power limiting mechanisms in HHFW antenna

*ITER = Possible ITER XP

[1] priority 1st (1st & 2nd) priority days assigned Milestone/ITER/ITPA