Supported by

XP1031: MHD/ELM stability dependence on thermoelectric J, edge J, and collisionality

S.A. Sabbagh[1], T.E. Evans[2], L.E. Zakharov[3], J-W. Ahn[4], J. Canik[4], R. Maingi[4], J.W. Berkery[1], J.M. Bialek[1], S. Gerhardt[3], J-K. Park[3], Y-S. Park[1], H. Takahashi[3], K. Tritz[5], et al.

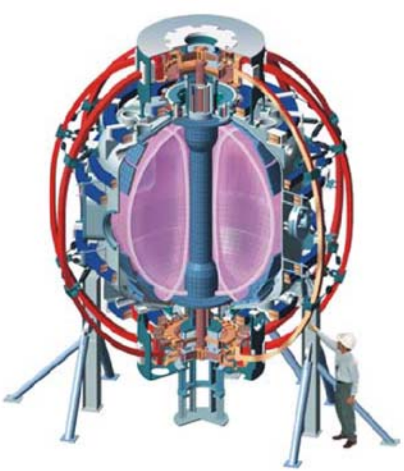
[1]Department of Applied Physics, Columbia University

[2]General Atomics

[3]Princeton Plasma Physics Laboratory

[4]Oak Ridge National Laboratory

[5]Johns Hopkins University



NSTX Physics Meeting

June 28th, 2010

Princeton Plasma Physics Laboratory

Columbia U
Comp-X
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
NYU
ORNL
PPPL
PSI
SNL
UC Davis
UC Irvine
UCLA
UCSD
U Maryland
U New Mexico
U Rochester
U Washington
U Wisconsin
Culham Sci Ctr
Hiroshima U
HIST
Kyushu Tokai U
Niigata U
Tsukuba U
U Tokyo
JAERI
Ioffe Inst
TRINITI
KBSI
KAIST
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
U Quebec

Continuation of XP1031 last week: MHD/ELM stability dependence on thermoelectric J, edge J, ν

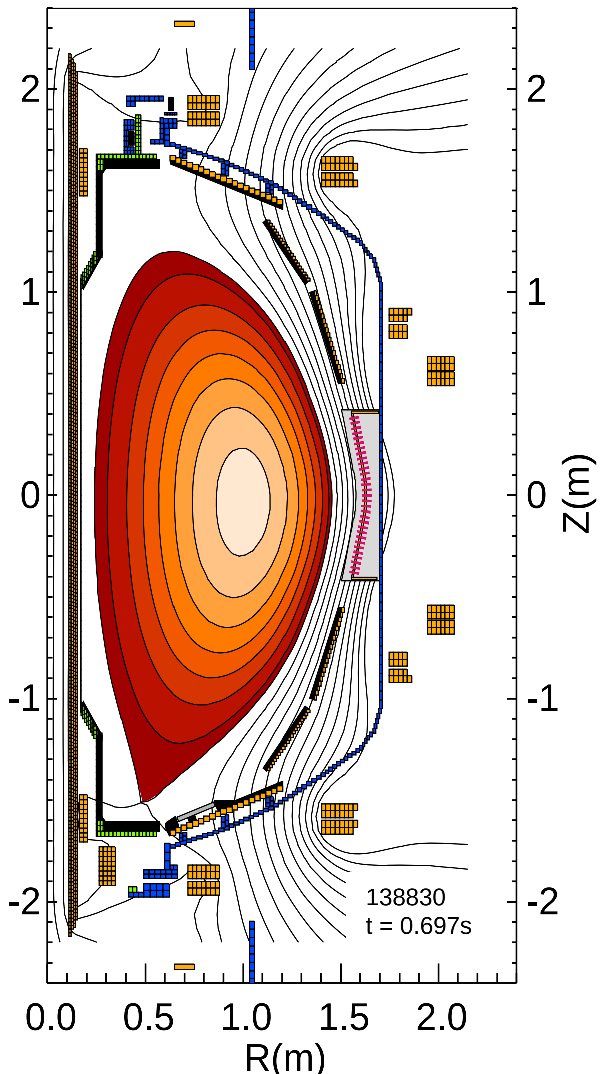
- Goals/Approach
  - Test expectations ELM stability theory considering changes to edge toroidal current density, field-aligned thermoelectric current, and collisionality
    - 1) Generate target
    - 2) Vary TE current connection length at fixed 3D field (Vary x-point height; DRSEP)
    - 3) Vary 3D field amplitude
    - 4) Vary toroidal current density near the edge
    - 5) Vary collisionality with LLD
- Data from last week
  - Ran many shots on list (except reduced ν); need to examine data in detail
    - X-point height and DRSEP varied separately (tricky for operators early on)
      - ELMs change with variation – much detail to sort out here
    - Target reproduced with ELMs induced by 3D field
    - 50 Hz n = 3 field primarily used, DC field tried but led to rotation issues
    - Scrape-off layer currents detail measured by LLD shunt tiles / Langmuir probe arrays
      - e.g. n = 1 clearly seen during initial part of ELM, changing to n = even
    - Evidence of ELM stabilization when positive edge current applied (constant B_t)

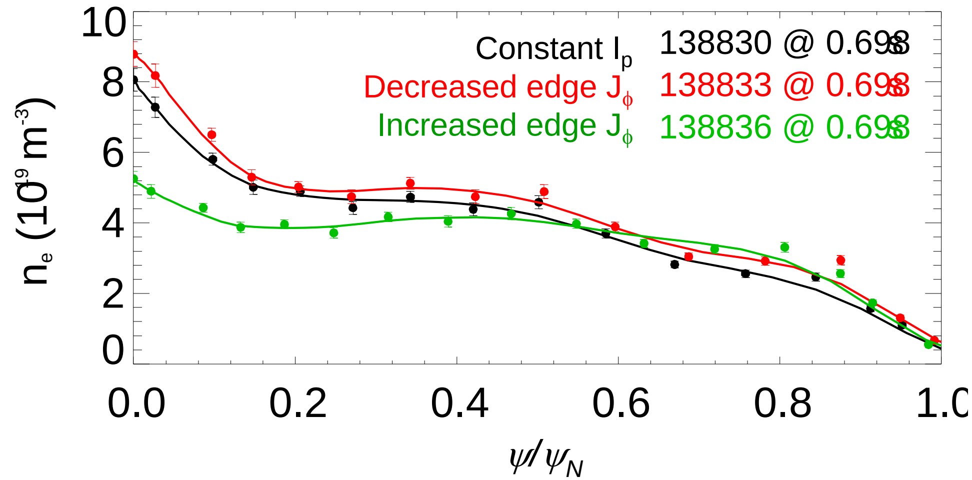
XP1031: MHD/ELM stability dependence on thermoelectric J, edge J, and collisionality – shot plan

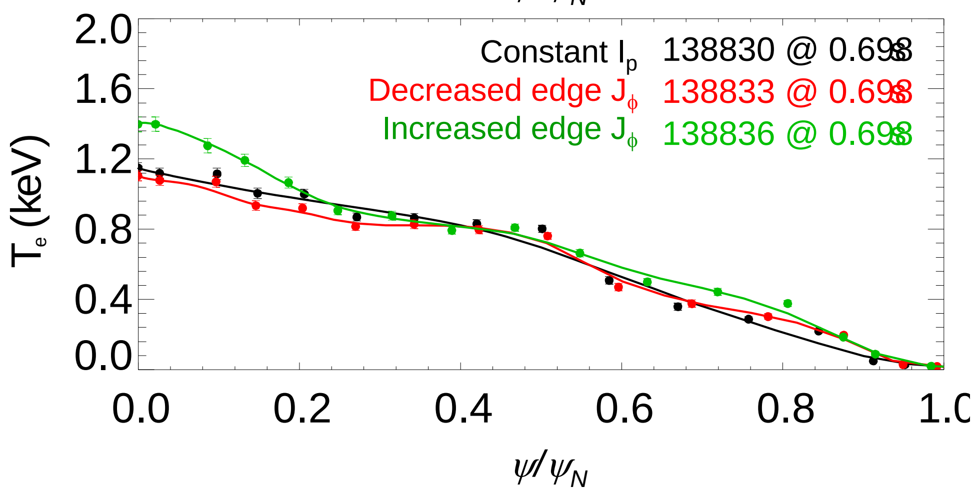
Task	Number of Shots	
1) Generate target		completed
A) Preferable is LSN ELMing plasma target (138129, or 137564), suitable for +/- Z movement	4	
- Add 3D field (use shot 138132); then try DC field - choose 3D field magnitude based on XP818		
- Plasma control: suggest (i) PF3-boundary position (squareness), (ii) DRSEP, (option: use outer SP control)		
2) Vary TE current connection length at fixed 3D field		
A) LSN: (change PF3-boundary to vary Z, vary DRSEP independently if possible) (three Z positions)	6	
B) DND:	1	
C) USN: (two Z positions) - (contrast grad(B) drift direction / effect to condition (2A))	4	
3) Vary 3D field amplitude		
A) near marginal condition from (2), still ELMing, decrease n = 3 field until ELMs go away	3	
B) near marginal condition from (2), not ELMing, increase n = 3 field until ELMs return	3	
4) Vary toroidal current density near the edge		completed
A) near marginal condition from (2), still ELMing, decrease I_p with slow ramp, attempt ELM stabilization	3	
B) near marginal condition from (2), not ELMing, increase I_p with slow ramp, for ELM destabilization	3	
C) redo (A) and (B) with TF ramp up/down to keep q approximately fixed	4	
5) Vary collisionality with LLD		
A) Rerun successful conditions above at reduced collisionality with LLD		16

Total: 31; 16

One XP1031 scan examined the effect of toroidal edge current change on ELM stability

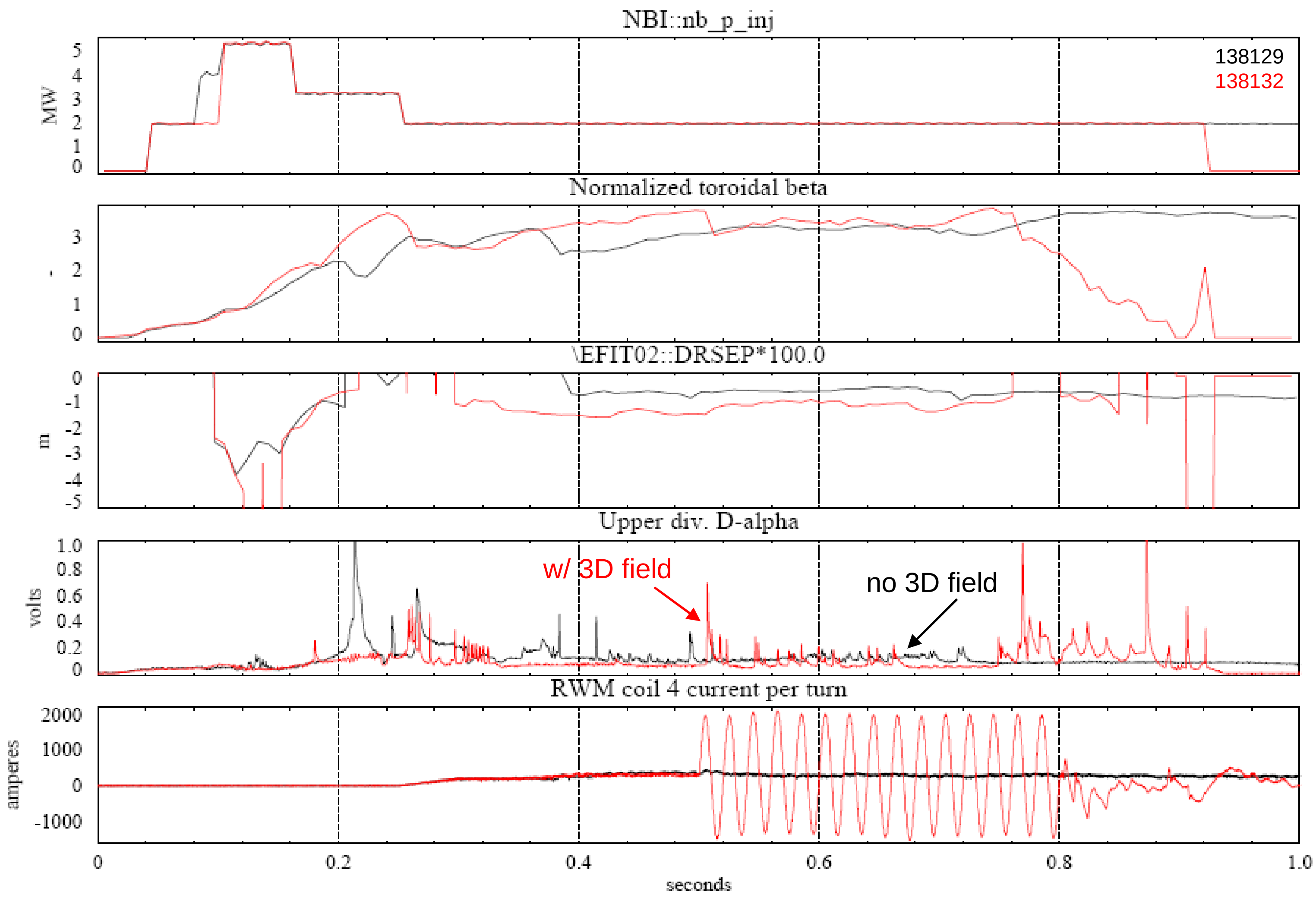






- Profile comparison (ne, Te vs. psiN) for shots with edge current changed

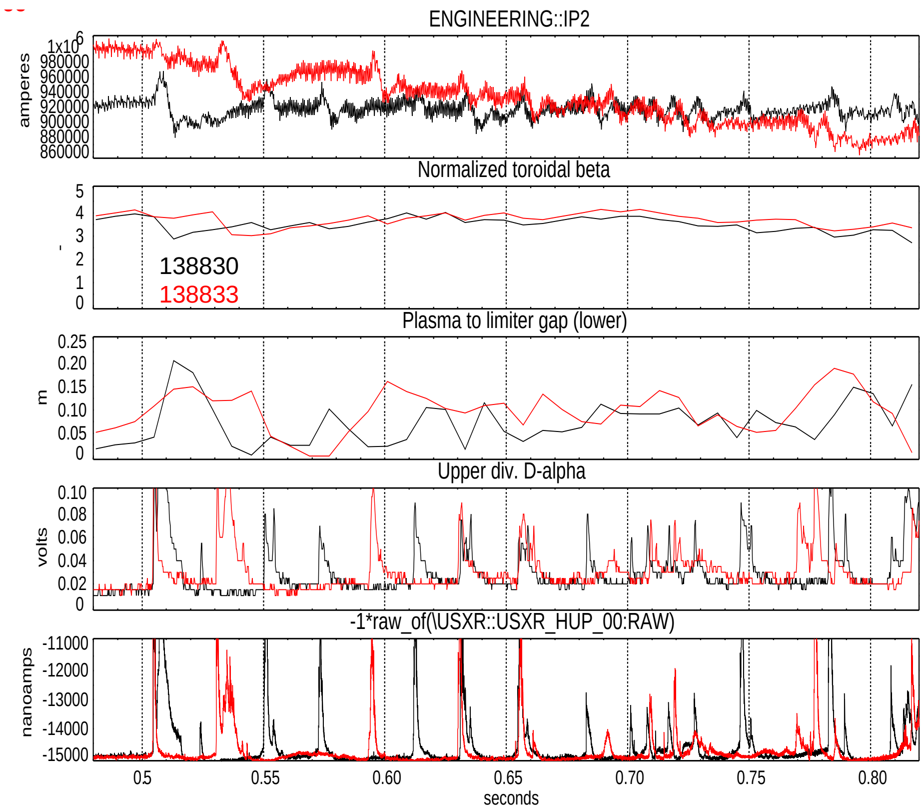
ELMs generated when 3D field was applied



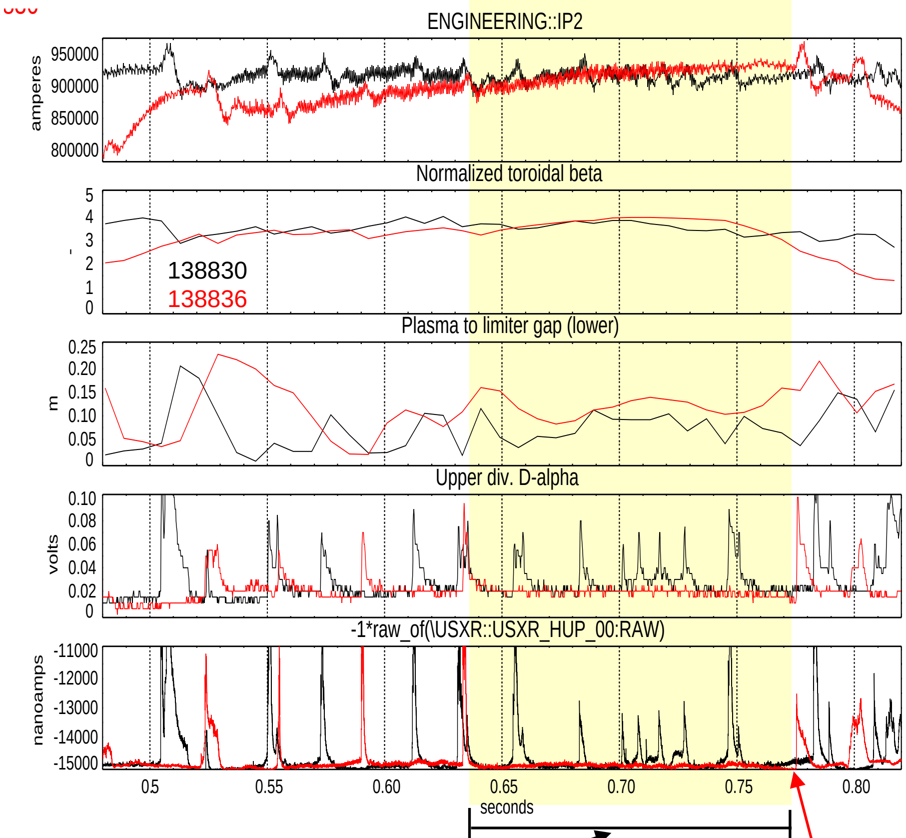
NSTX

XP1031: Evidence of ELM stabilization with positive current ramp + 3D field during ELMing phase

Constant I_p and decrease edge J: similar ELMing



Constant I_p and increase edge J: ELM-free period found

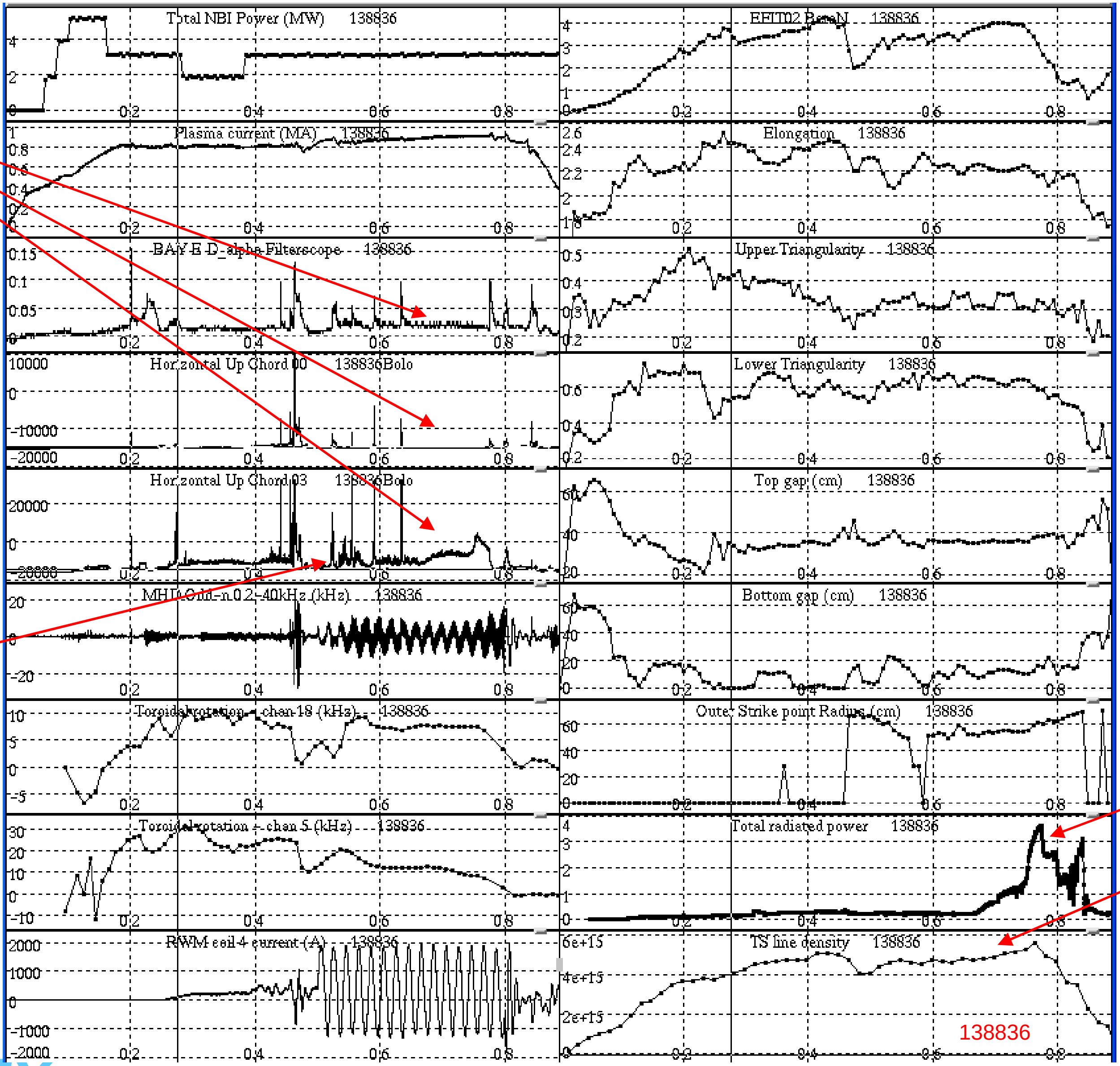


ELM-free period
(plasma in H-mode)

H-L back-transition

H-mode terminates in ELM-free discharge from P_{rad} increase

ELM free period



H-L back-transition, at I_P ramp start, but recovers H-mode

Density rises, and P_{rad} sharply rises during ELM-free period