XP918 – Effect of Impurities and Wall Conditioning on NTM Stability

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NSTX Results/Theory Review
PPPL
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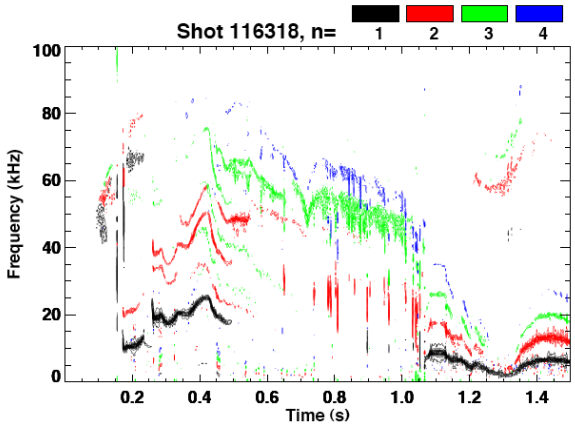
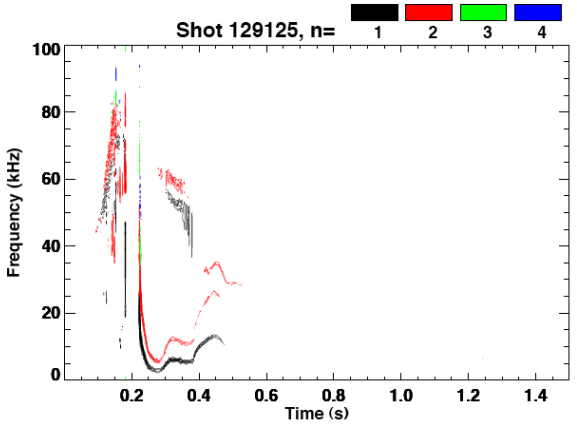
Goals of XP918

- Repeat NTM “stabilization” by Lithium wall conditioning



With Li, n=1 f/back and n=3 correction



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- Reproducibility
- Isolate role of Li from magnetic control (n=1 FB and n=3 EFC)
- Scan Li
- Puff Ne, scan Ne.
  - Different impurity
  - Only penetrates in the edge, whereas Li causes C increase everywhere
  - Partial separation of effects of impurities in the plasma and conditioning of the wall?

Scans of Li and Ne successfully completed

- No Li reference: #134077, 4MW NBI
- 50, 80, 120, 160, 200mg of Li evaporated *before* #134080-88
- (repeated and non-monotonic) reproducibility checks

- Ne puffed in Lithiumized machine at 1.5Torr l/s
  for 5, 10, 15, 30, 50, 80ms *during* # 134089-96
- Reference: 10ms Ne, w/o Li (before Li: #134079; after D2 and He glows: #134097)

- n=3 EFC and/or n=1 feedback (FB) off in #134106-110

- Stopped Li, started He-GDC to assess duration of Li benefits (#134111-115)

Questions and answers

- Direct/indirect: Li suppresses NTM or NTM trigger (e.g., ELM)?
  Both?

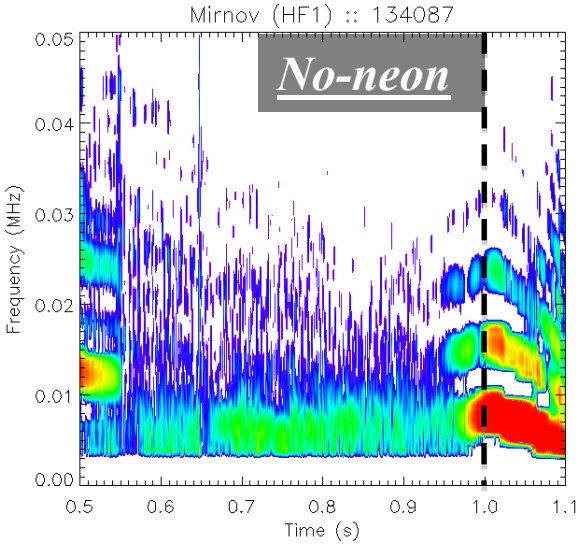
- Synergy with n=1 DEFC and n=3 DEFC?
  Role of Li is prominent? ancillary? or synergistic?
  NTMs suppressed by Li even w/o n=1 or n=3 DEFC.

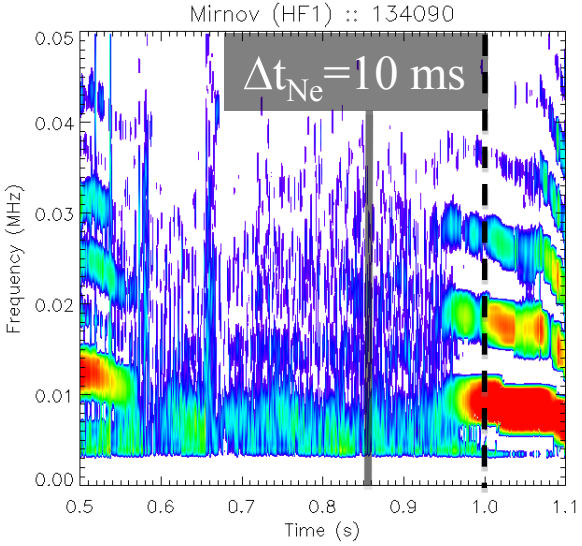
- Mode is suppressed or delayed (to after the end of the shot)?

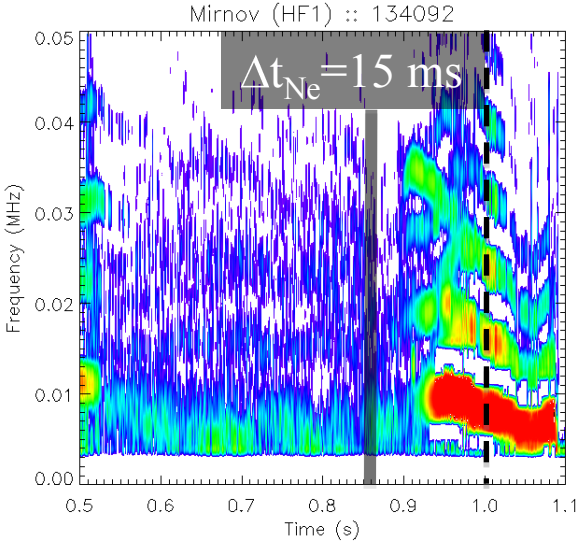
- A continuous effect or a threshold effect?

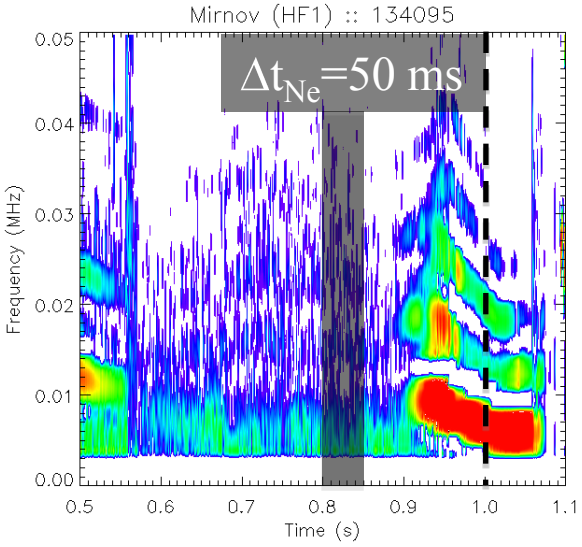
- Reproducibility: suppression was not observed in all shots
  but it was this time

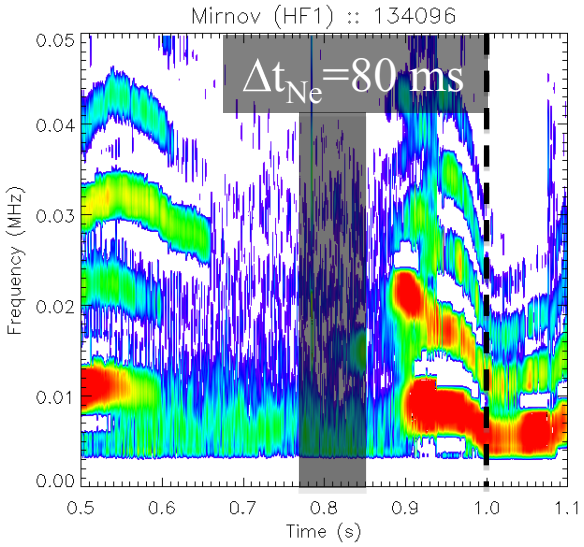
10-80ms Neon puff anticipate mode onset by 20-120ms



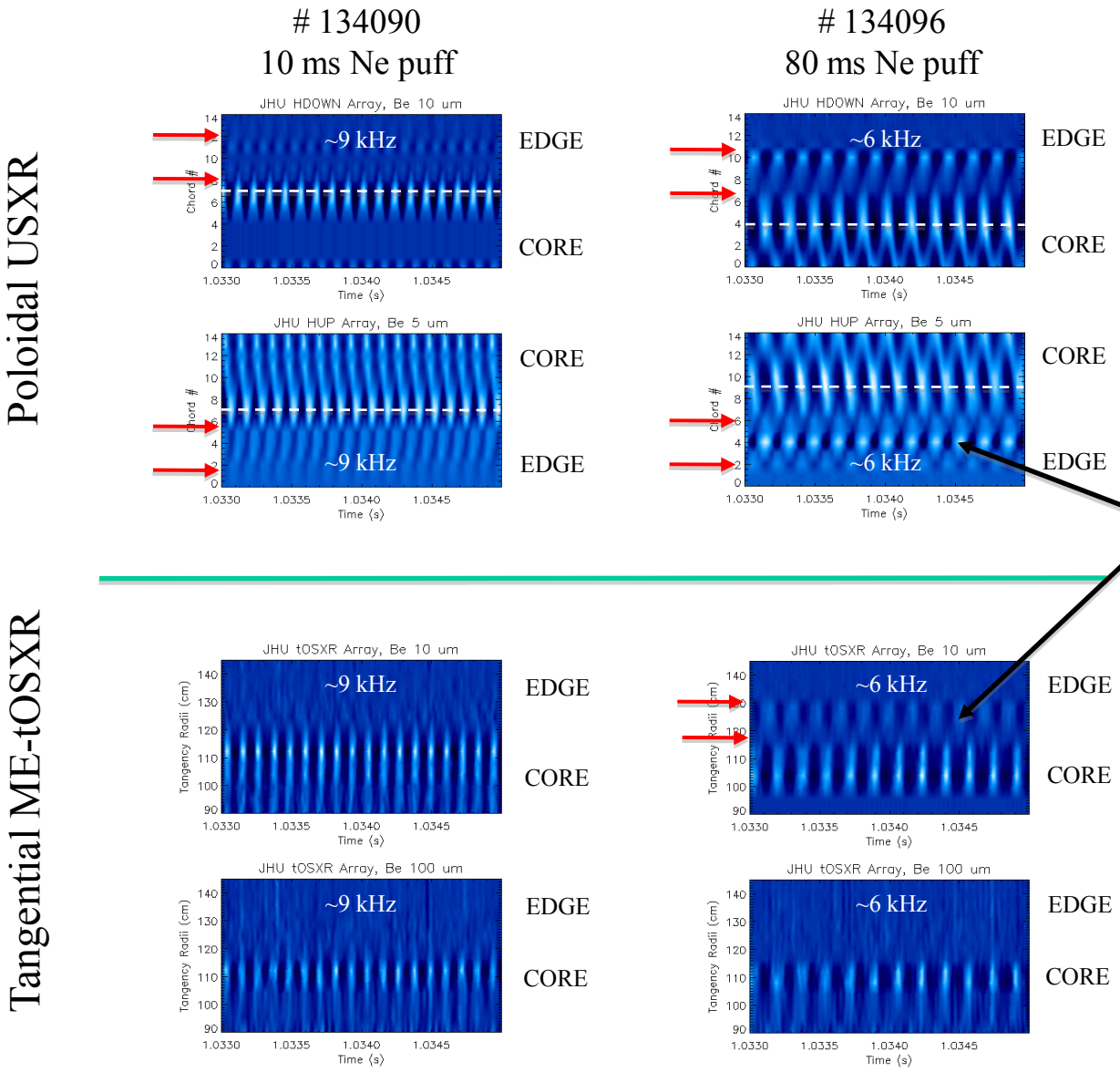








After Ne puff, SXR signals from NTMs are brighter and have higher contrast than usual



- Abel-invert SXR → emissivity profile
- Is local emissivity coming mainly from inside the island?
- Ne has increased the SNR (see inversion radii).
- Compare with synthetic diagnostic of island (Jon/Stefan).

Courtesy:
L.F. Delgado-Aparicio

Hypotheses still being debated

- Impurities ↗ → Resistivity ↗ → Reconnection "easier" →(N)TM
- Impurities ↗ → Radiative losses ↗ → cooling of the island → flattening of T_e → NTM

  Rad. losses= driving mechanism in extended Rutherford Eq.

  "Radiative induced" TMs prior to disruptions in RFP [Salzedas, PRL 2002].

Explanations of Ne results?

- Current profile evolution slowed down (through l_i)
- Modification of the pressure profile → BS drive and/or Δ' ↘
- Rotation or magnetic shear ↗ → Δ' ↘

Explanation of Li (C) results?

Summary, Conclusions and Future Work

- Lithiumization *reproducibly* plays a *prominent* role (more than magnetic control) in *delaying* NTMs
- The more the Li evaporated, the longer the NTM delay
- Effect of 160mg Li lasts >4 discharges

- Neon destabilizes NTMs (radiatively?)
- The more the Ne puffed, the earlier the NTM onset
- Line-integrated SXR suggests Ne penetrates as deep as resonant q location
- Ne lines clearly visible in CHERS and SPRED

- Analysis: TRANSP, UEDGE, DCON, PEST-III, NIMRAD (NIMROD + Bremsstrahlung)

Outlook

- ITER

  wait for good wall conditioning before trying high β, if this poses a risk for NTMs → locking → disruptions.

- Power plant

  Liquid Lithium Divertor might prevent NTMs?

Back-up Slides

DIII-D "Control room experience" on the effects of impurities and wall conditioning on NTMs

- More impurities → plasma more susceptible to 2/1 NTMs.
- However,
  - in first shot post-disruption it's harder to get 2/1 and 3/2 NTMs
  - Sometimes 4/3, sometimes nothing.
  - A shot with less gas puffing helps re-obtaining NTMs in the following discharge.
- Control room experience. Not a systematic study yet.