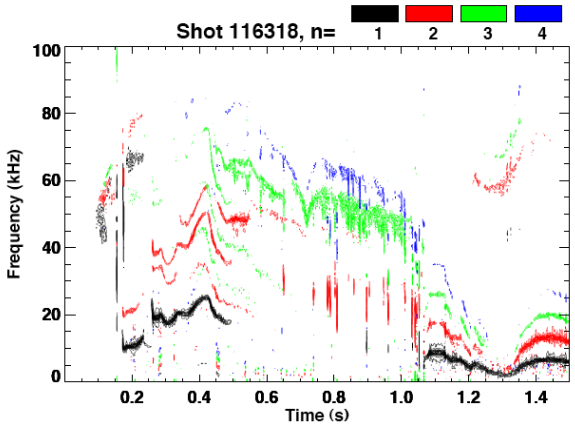
Effect of Impurities and Wall Conditioning on NTMs (XP 918)

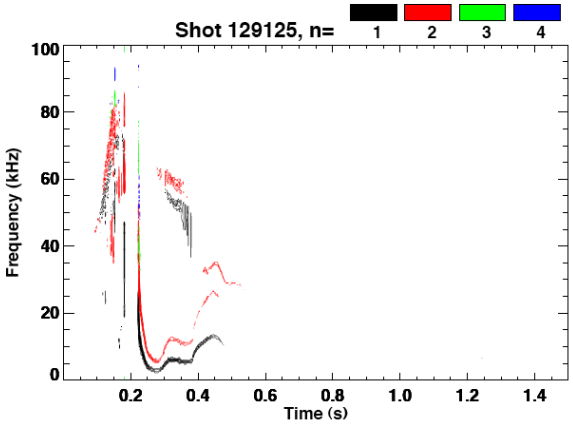
F. Volpe, S. Gerhardt & S. Sabbagh

Lithium wall conditioning, n=1 RWM control and n=3 EFC eliminated n=1 tearing modes at NSTX…

Without



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



Full suppression not in all shots

Courtesy: S. Sabbagh

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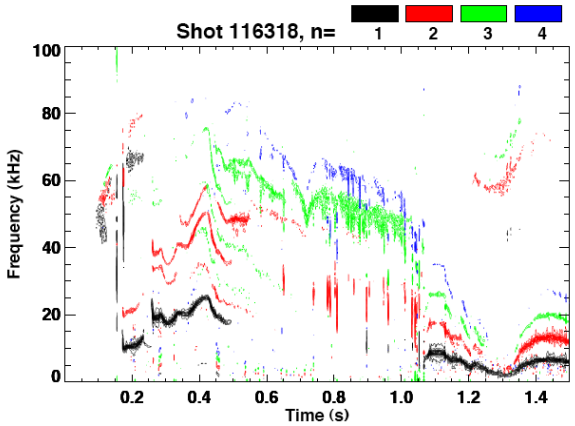

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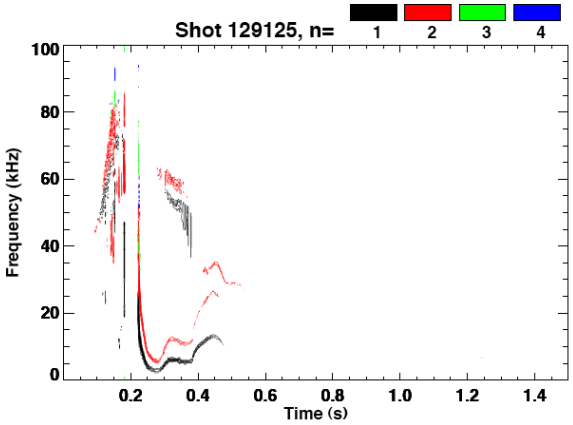
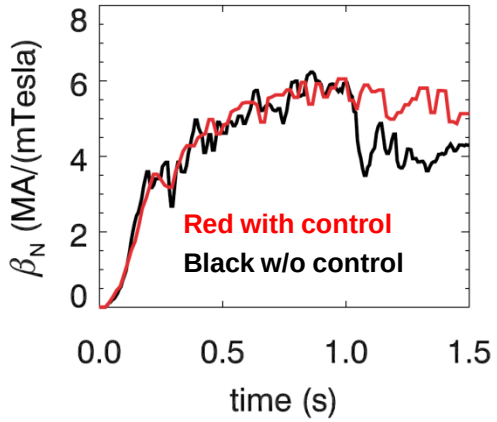
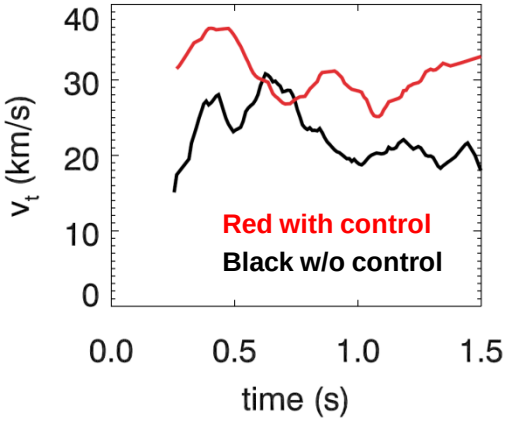


Full suppression not in all shots

TM suppression had beneficial effect on β_N and rotation:





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DIII-D experience also hints at effects of impurities and wall conditioning on NTMs

- DIII-D: more impurities → plasma more susceptible to 2/1 NTMs.
- In agreement with NSTX: Li conditioning → no n=1 TM
- However, at DIII-D:
  - Harder to get 2/1 and 3/2 NTMs in first shot post-disruption.
  - Sometimes 4/3, sometimes nothing.
  - A shot with less gas puffing helps re-obtaining NTMs in following discharge.
- Control room experience. Not a systematic study yet.

Motivation and open questions

- Correlation between
  1. impurity content, gas puffing and wall conditioning and
  2. NTM stability

  exists but was never experimentally, systematically characterized
- Not explained theoretically. Conjectures:
  - Impurities ↓ → Resistivity ↓ → Reconnection ↓ →(N)TM ↓
  - Impurities ↓ → Radiative losses ↓ → (N)TM ↓

    because rad. losses= driving mechanism in extended Rutherford Eq.

    "Radiative induced" TMs prior to disruptions in RFP [Salzedas, PRL 2002].
- Reproducibility: suppression not observed in all shots
- All ingredients (Li, RWM ctrl, EFC) necessary? Prominent role of Li?
- ITER relevance: wait for good wall conditioning before trying high β, if this poses a risk for NTMs → locking → disruptions.
- Power plant relevance: Liquid Lithium Divertor might prevent NTMs?

Tentative shot-plan, ½ day

Part 1: role of Li and wall conditioning

1. Repeat #129125 with Li-conditioned walls *(1 good shot)*
2. Repeat w/o re-conditioning, until first NTM if any *(2-3 shots)*
3. Repeat after 1 min (or longer?) glow to *completely* neutralize effect of Li (*1-2 shots*)
4. If time, repeat #129125 with reduced EFC and/or gains of magnetic f/back, to isolate effects on NTMs (*4-5 shots*)

Part 2: deliberate impurity seeding

1. Repeat 1 and 3 of part 1 with *edge* impurity seeding (puffing? laser blow off?) (*2-4 shots*)

Desirable (but not possible in this campaign?):
deep impurity seeding (pellet)

Other requirements

Diagnostics:

- CHERS, X-ray diagnostics and any other diagnostic of impurities in the core.
- Spectroscopic diagnostics and any other diagnostic of wall conditioning.

Analysis:

- Include impurity effects in PEST-III, NIMROD, DCON or other stability code.

Summary

Impurities and wall conditioning observed to affect NTMs in NSTX and DIII-D.

Goal of XP 918:

- First systematic characterization and interpretation
- Analogies and differences with DIII-D
- Extrapolation to ITER

Experimental approach

Part 1: #129125, with less Li and/or less f/back and/or less EFC

Part 2: deliberate impurity seeding