1. 2/1 NTM stability and EF sensitivity vs q profile
2. EF scalings in H mode

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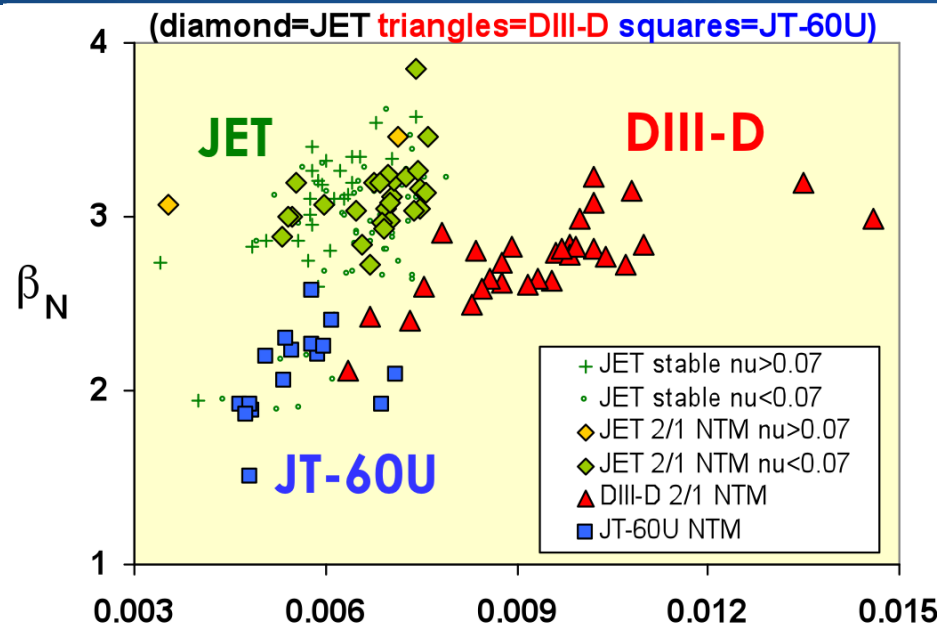
DIII-D NATIONAL FUSION FACILITY
NATIONAL SPHERICAL TORUS EXPERIMENT
PPPL PRINCETON PLASMA PHYSICS LABORATORY
GENERAL ATOMICS

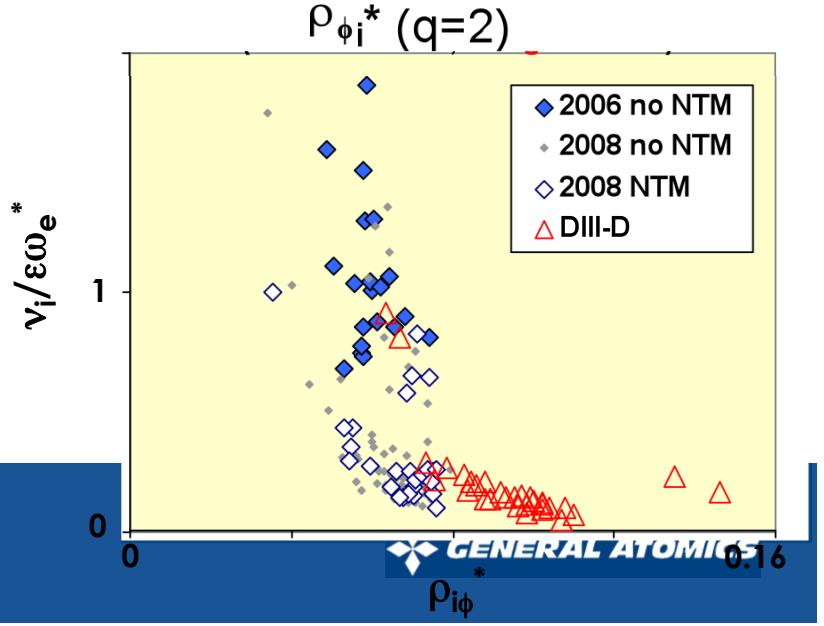
JET Hybrid Plasma Sit Above β Limit of Other Devices: *Other parameters coming into play – q profile?*

- **JET sits above DIII-D and JT-60U trends**
  - JT-60U lower rotation →lower β_N
  - But DIII-D high rotation
- **Possible collisionality role? No:**
  - JET unstable at ◆low ν^*
  - But stable at +high and ◦low ν^*

→**Collisionality provides 'access condition' for NTM**

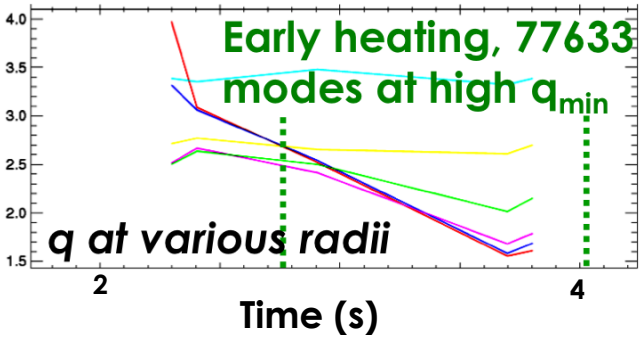
  - Enables q profile modification
  - Can change Δ'
  - ***q profile is the parameter to test…***



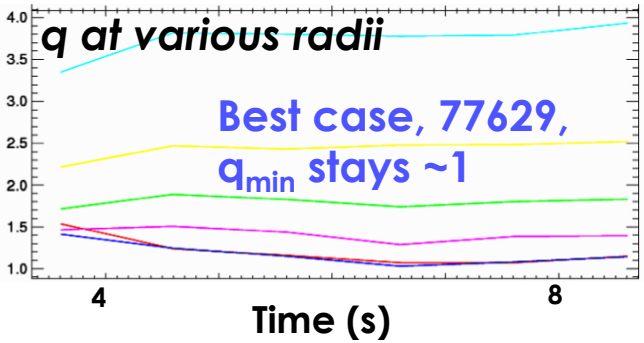


Heating timing scan shows 'just right' degree of relaxation needed

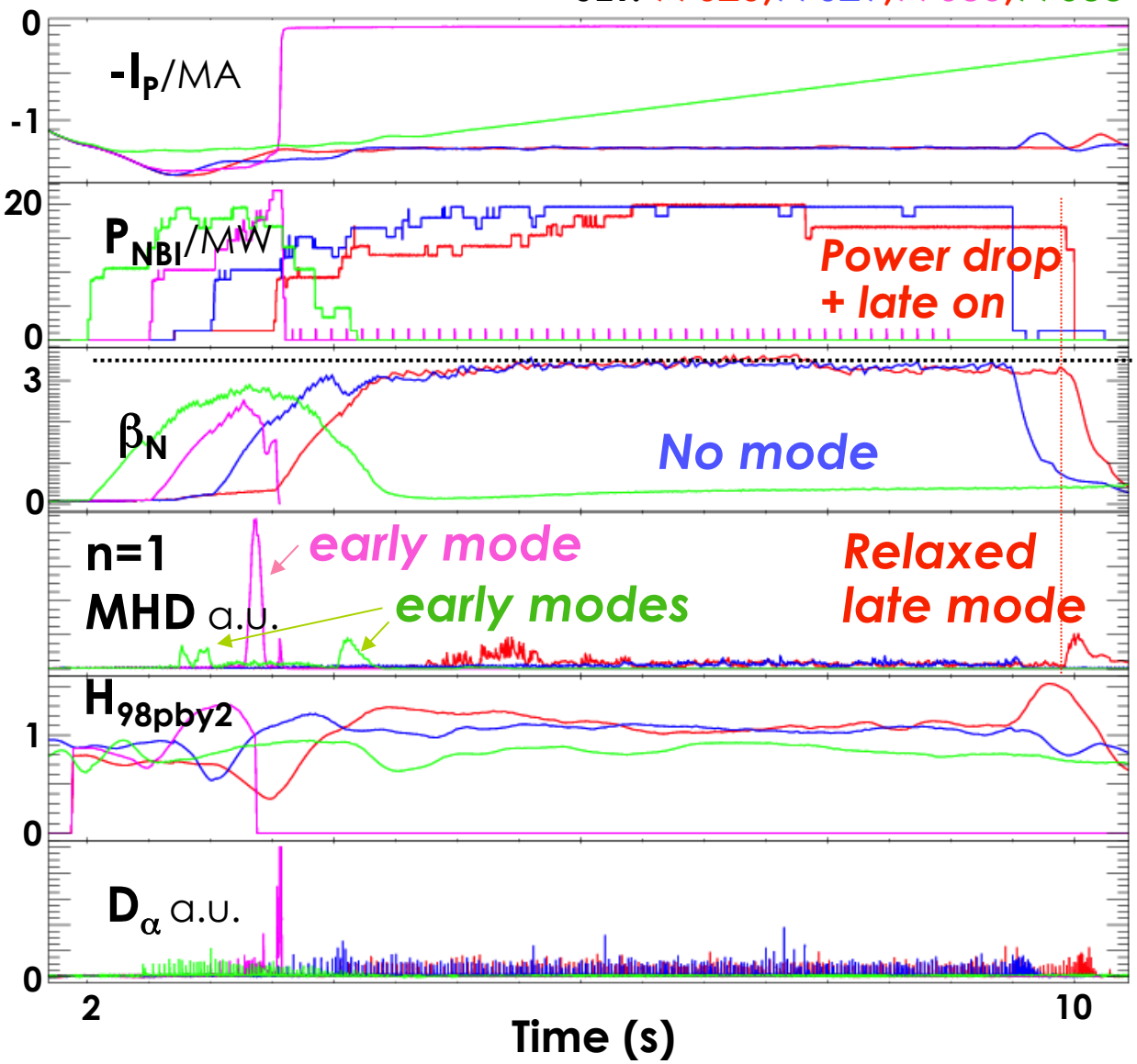
- **Mode if profiles too 'advanced':**



- **Fully relaxed plasma also less stable**
  - Mode at lower β_N or occurs later

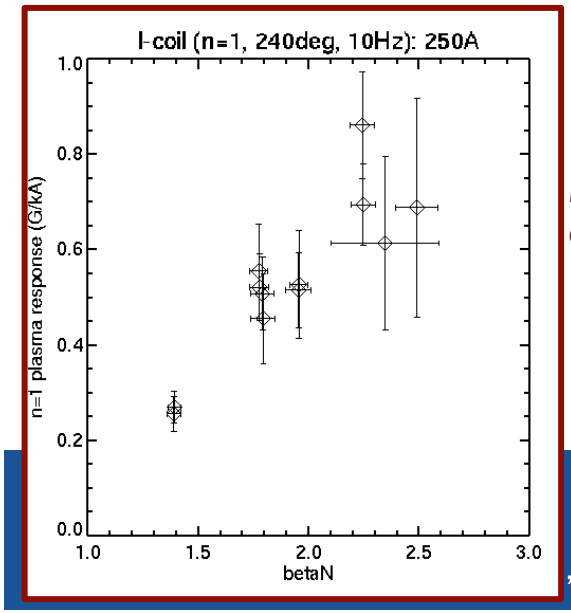


JET: 77626,77629,77636,77633



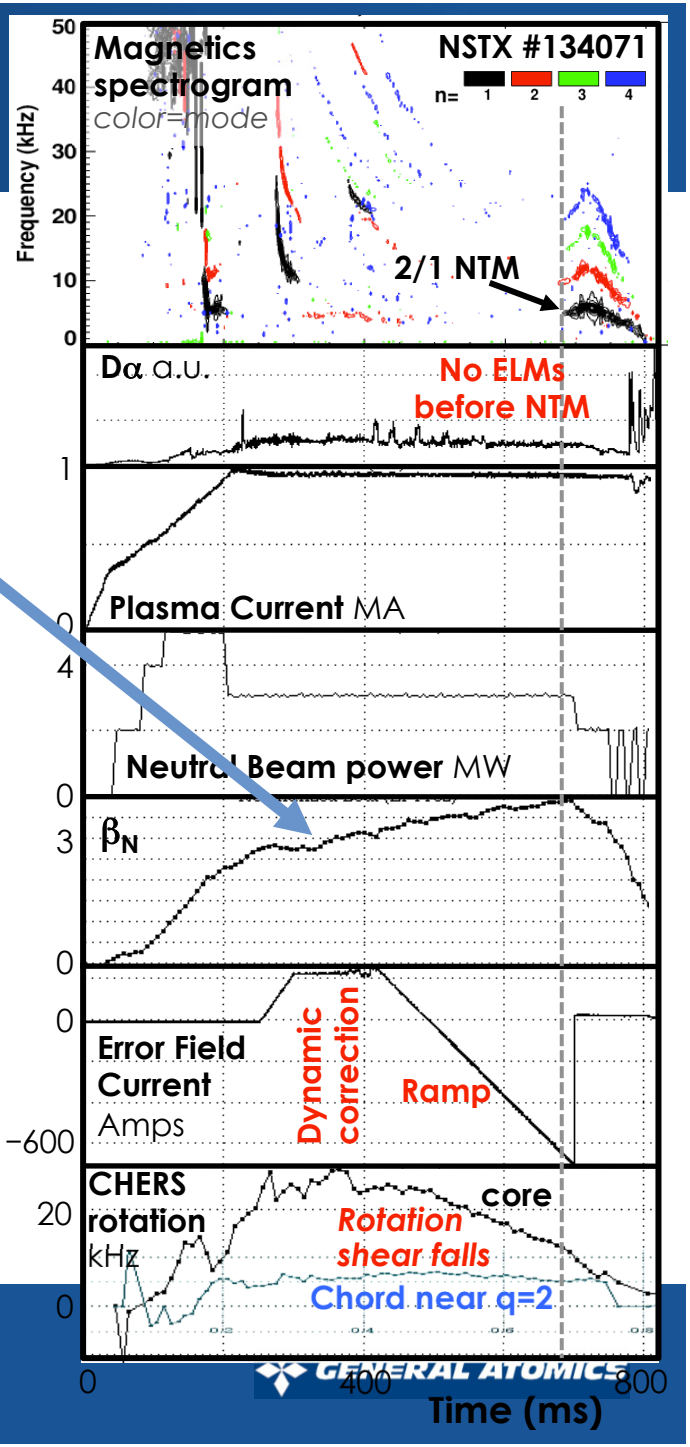
NSTX an ideal place to explore q profile role in detail

- **Plasma naturally relaxes vs time**
- **Can ramp beta to excite mode**
  - Scan NBI timing & power to vary q_{min} vs β_N trajectory
- **Repeats with EF applied**
  - to see if plasma response stronger as tearing mode β limit applied

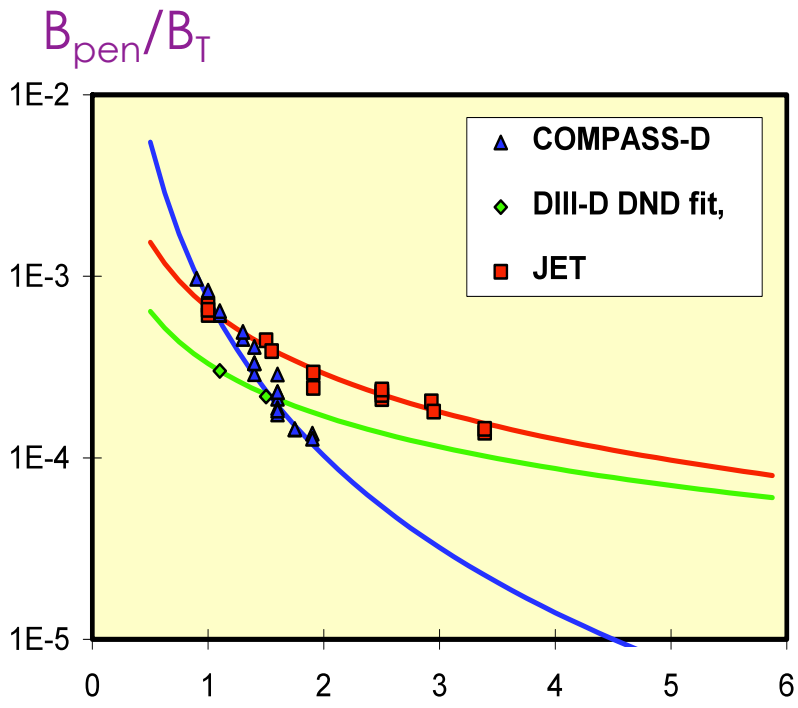


DIII-D: Plasma response to error field increases with β_N:

- ***How does response change with Δ'?***



ITER's Error Field Scalings Deduced for *Ohmic* Plasmas
– *regime of concern at the time (pre-access to H mode)*



- Scale using power law form:

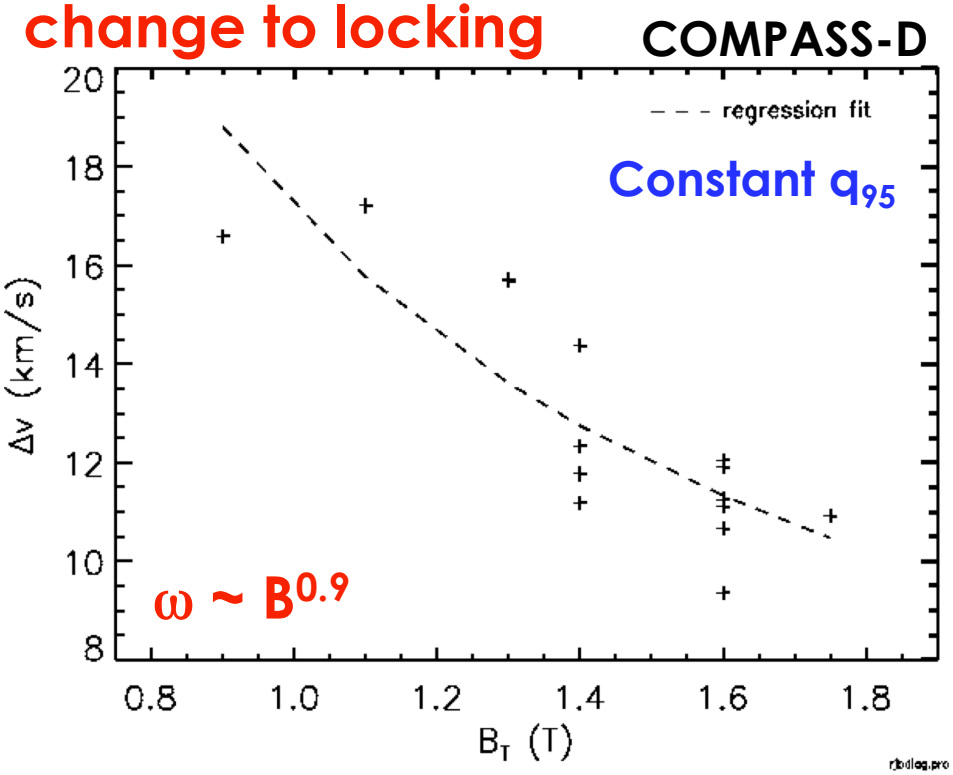
$$B_{pen} / B_T \propto n^{\alpha_n} R^{\alpha_R} B^{\alpha_B} q^{\alpha_q}$$

  - deduce $\alpha_R = 2\alpha_n + 1.25\alpha_B$ from dimensional considerations,
    - in line with approach for confinement scaling

    (Connor and Taylor NF 17 1047)
  - ***But COMPASS-D behaves differently***
    - ***Rotation behavior is different!***

COMPASS-D had much stronger rotation scaling with BT than other devices – *likely due to rotation behavior*

Boron III rotation change to locking



- **Error field threshold when EF overcomes plasma rotation**
  - EF scaling implicitly folds in rotation variation with Bt, ne
- **Will plasma rotation in NBI heated H mode scale same as self generated rotation in Ohmic plasmas?**
  - ***No!*** (unless you're lucky)

- **Need new experiment to determine how EF thresholds scale in H-modes!**

New experiments needed if we are to extrapolate EF physics to next step devices!

- **Ramp up error field to measure mode thresholds**
- **Scan in ne and Bt**
  - Infer machine size scaling from Connor-Taylor constraint
- **Hard part:**
  - Maintain constant shape, betan, li and q profile at time of mode onset ***– can we do this?***
  - Also what to do with rotation? (Natural beam drive, or n=3 braking to control to given M_A)

- ***These experiments are essential if you want to understand how the torque balance based error field threshold extrapolates to future devices.***