

Status and future of XP-229



Pulse-length limits of NBI-heated LSN H-mode plasmas

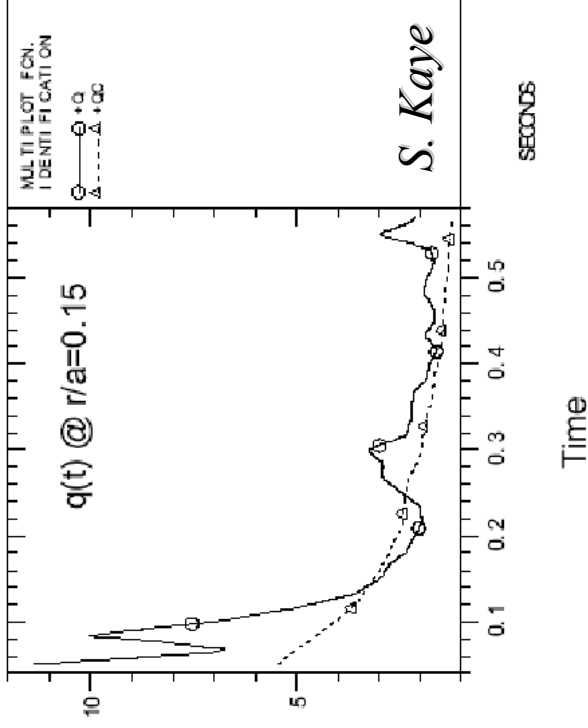
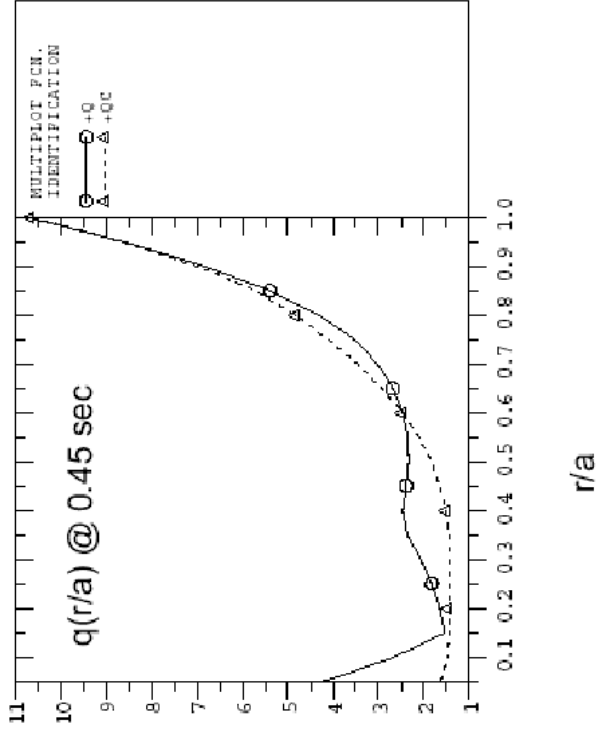
XP successful, but questions remain:

- 1) What is the disruptive event in flat top?
- 2) How do we make even longer pulses?
- 3) How do we raise β ?

Disruption likely due to $q(0) \rightarrow 1$



- Evidence from TRANSP & Mirnovs



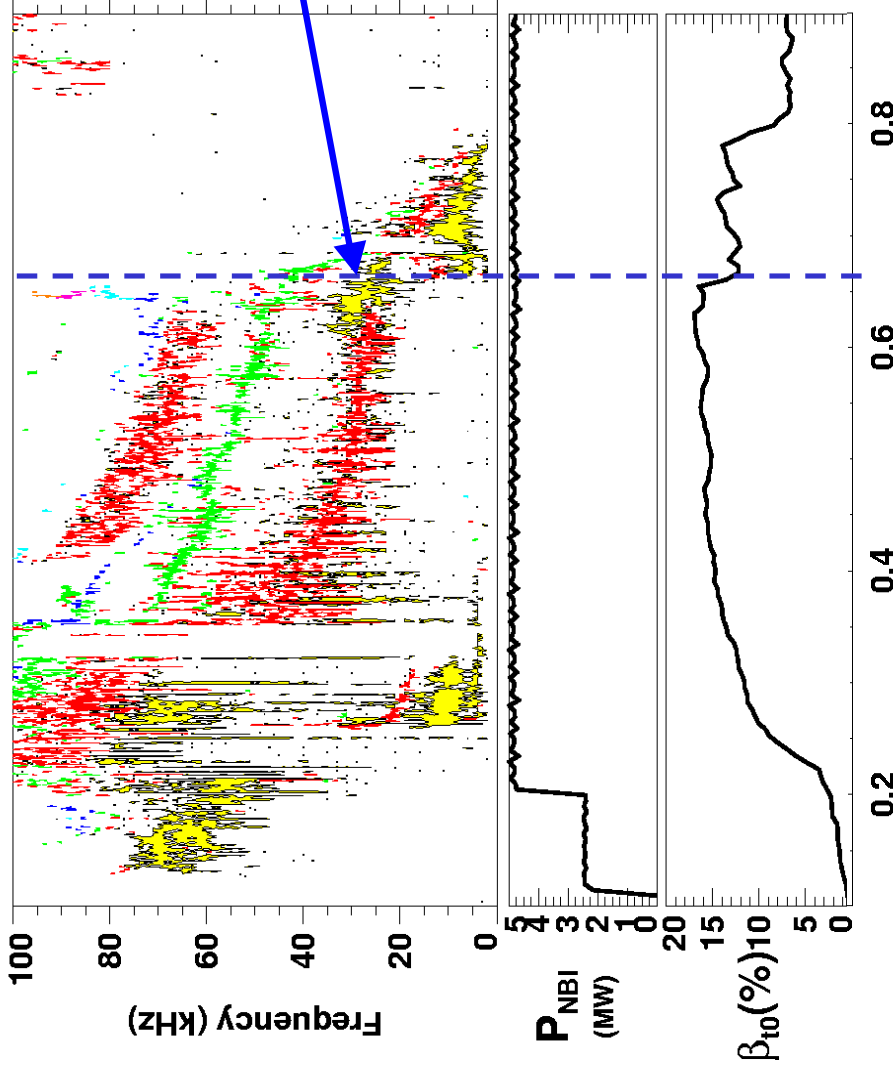
- Few other things can explain such persistent events which exhibit variability in time but also depend on β

MHD: $n=1$ collapse precursor typical



NSTX Shot 109063

Toroidal Mode Number: 1 2 3 4 5 6 7 8



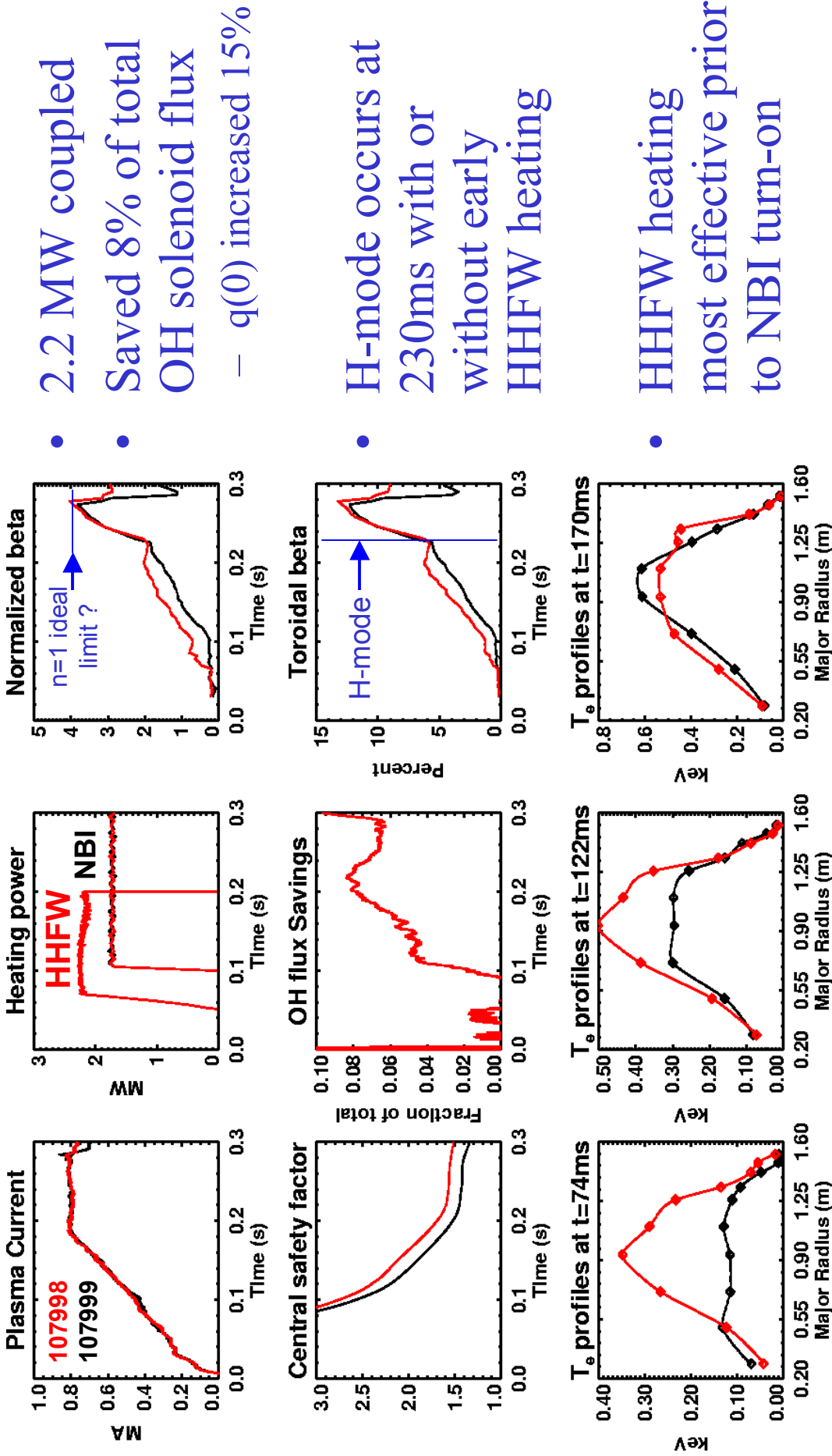
- $n=2,3$ active present prior to 1st collapse
- Rapid transition to $n=1,3$ ($n=1$ largest)
- f matches core rotation frequency: $f=25\text{-}30\text{kHz}$
- TAE, TM, or kink?

Appears longer pulse will require higher $q(0)$



- *Can only run 5kG to $t=950\text{ms}$
 \Rightarrow must drop to 4-4.5kG for longer pulse*
- 100kV A, B results:
 - Extra CD helpful
 - 4.8MW no more disruptive than 4MW, but...
 - With 3 sources, plasma **does** disrupt earlier
 - 1-1.5 sources $\Rightarrow \beta_p$ not high enough, run out of flux
- No shots sustained W_{TOT} past 750ms

Early HHFW compatible with NBI H-mode



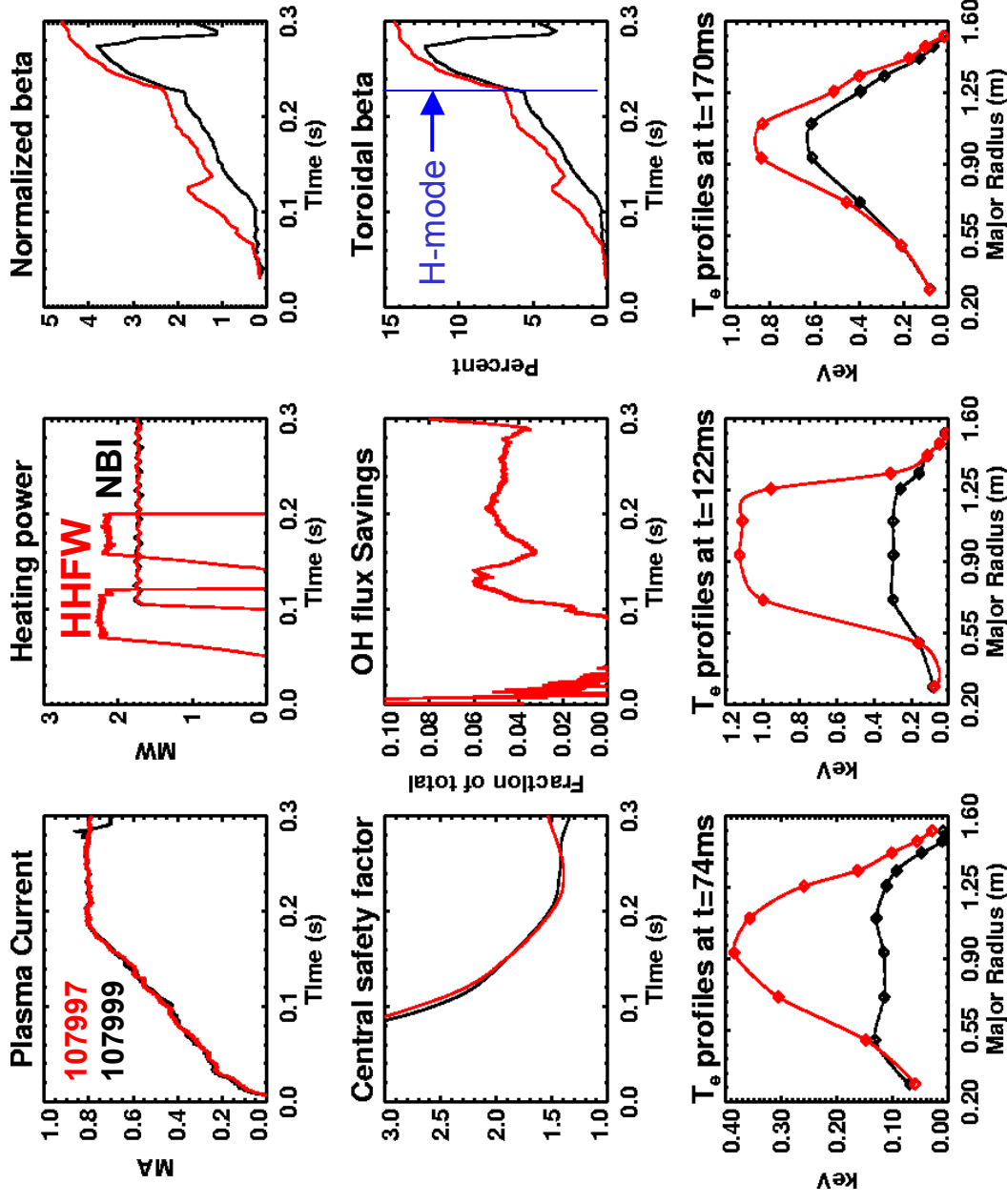
- 2.2 MW coupled
- Saved 8% of total OH solenoid flux
- — $q(0)$ increased 15%
- H-mode occurs at 230ms with or without early HHFW heating
- HHFW heating most effective prior to NBI turn-on

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Enhanced early HHFW heating observed....



- T_e reaches 1.1keV by $t=120\text{ms}$ in core
 - Barrier formation inside $r/a = 0.5$?

- Higher W_{TOT} moves plasma out too far, causes RF trip
 - Need to better optimize gap programming

- If heating could be sustained, flux savings $> 10\%$ is possible

XP Goals



- Try running at higher β_p – steady J profile?
 - $\beta_p \propto q^* \beta_N, q^* \propto (1+k^2) / (I_p/aB_t)$
 \Rightarrow try increasing k
 - setup and determination of β_N limits in MHD XP
 - Also try this without dropping B_t
 - Generate “clean” 1s pulse w/o MHD events?
- Raise I_p to 0.9-1MA in LSN for higher β
- Attempt early HHFW
 - Only try HHFW again if heating is reliable