

# Experimental Test of Troyon Scaling Status and Plans of XP-016

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Parallel Session I  
ET1 - MHD Equilibrium and Stability

NSTX Research Forum 2001

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PPPL

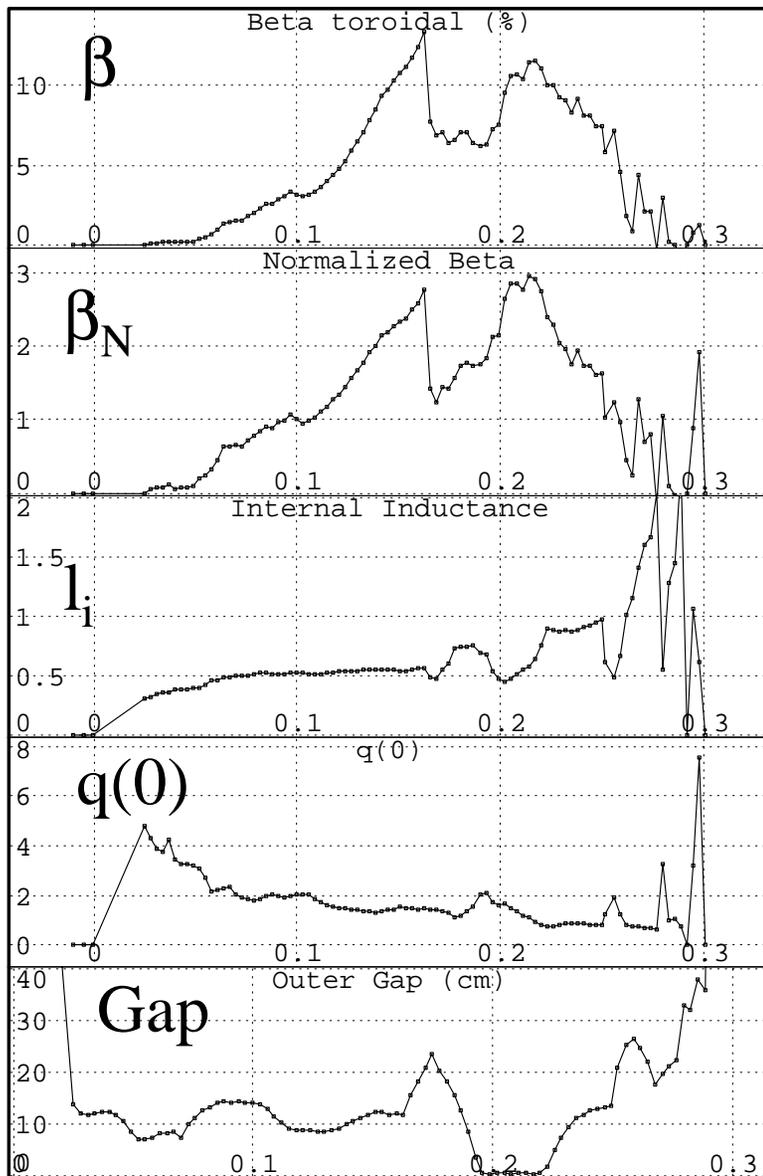


# Goals of XP-016

- Determine  $\kappa$  and  $B_T(q^*)$  scaling of ideal stability limit in regime with  $q(0) > 1$  (want  $q(0) > 1.5$  if possible)
  - Eliminate sawteeth and 1/1 activity
  - Reduce chances of exciting NTM
- Had 3/4 run day: Injected NBI into early HHFW injection target from XP-025 for first time:
  - Reproduced lower-li, higher  $q(0)$  target
  - Got to  $\beta=13\%$ ,  $\beta_N=2.9$  (15%, 3.3 in XP-017)

# Results of XP-016

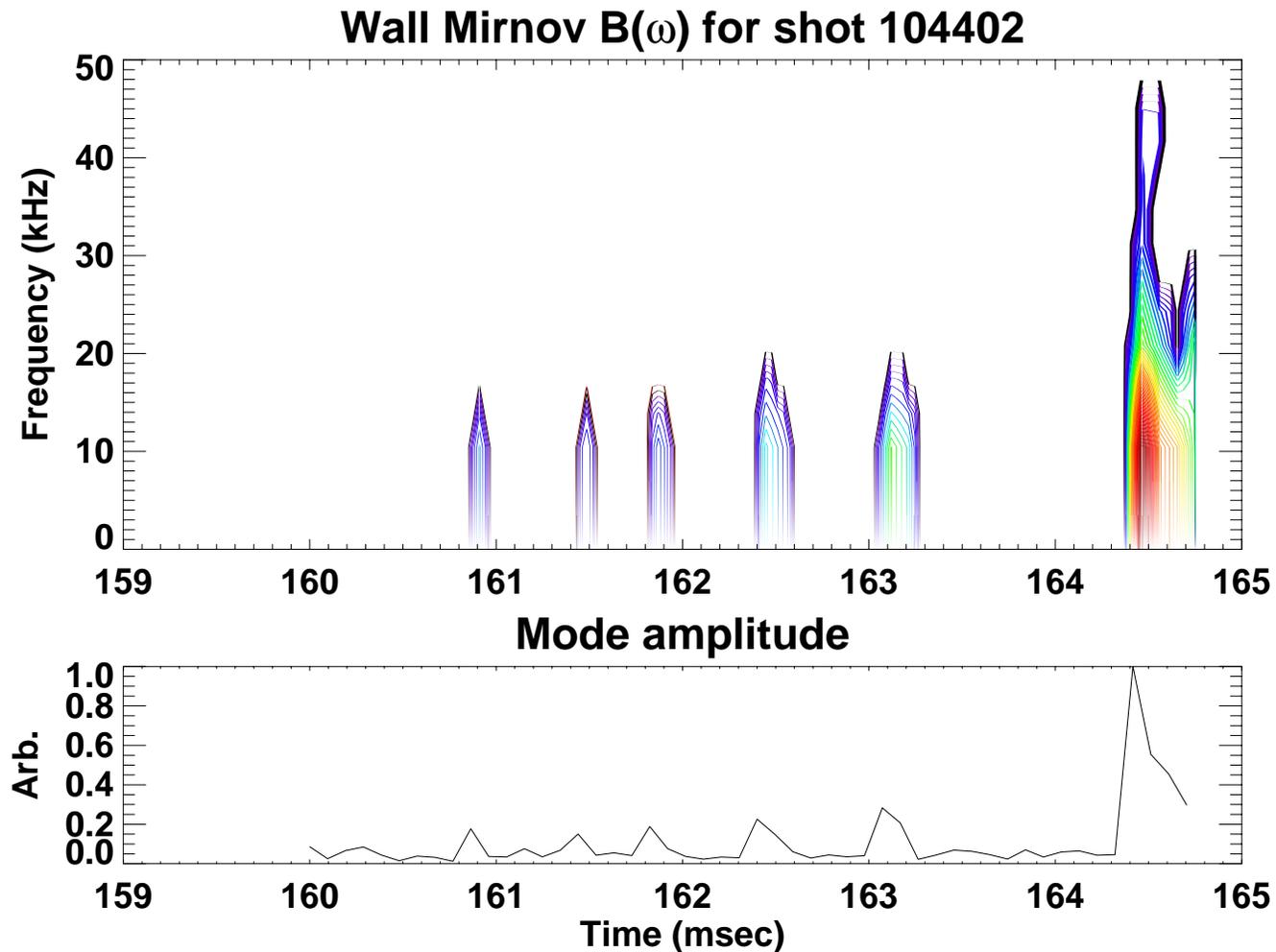
Shot 104403



- Rapid  $\beta$ -drop during ramp-up or early flat-top
  - **XP-25 had similar event  $\Rightarrow$  not necessarily beta driven (also seen for  $\beta_N = 1.5$ )**
- **Possibilities:**
  - Locked tearing mode
  - Impurity driven “reconnection-event”
  - Edge current driven external kink

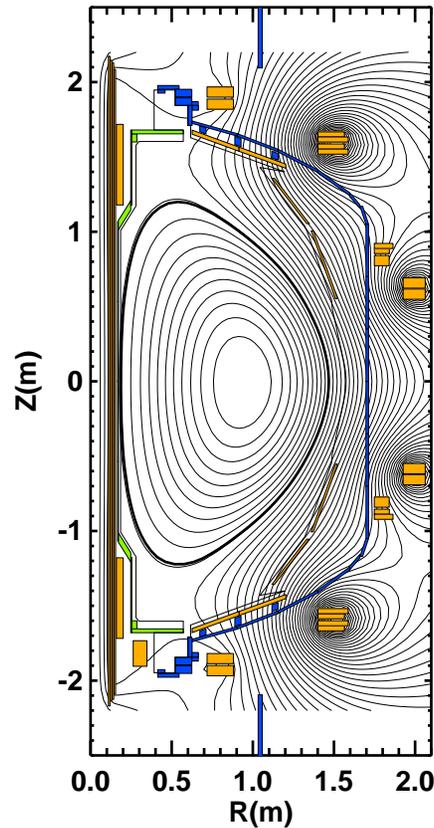
# Results of XP-016

- High-n array shows  $\sim 1\text{kHz}$   $n=1$  mode which locks, grows within few ms, then terminates 104402 ( $\beta_N=2.9$ )



# Future of XP-016

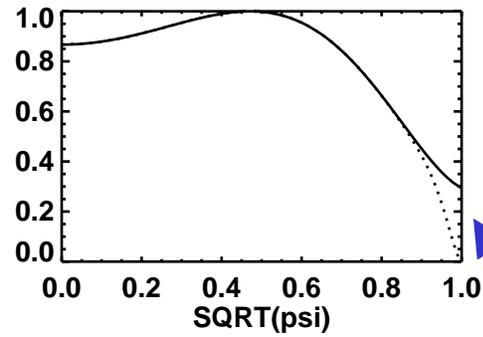
NSTX 104284 at t=211ms



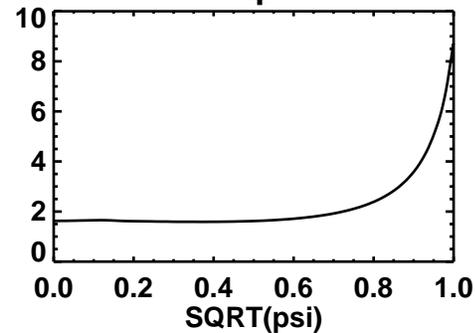
JSOLVER ID: NdbK0316

$I_p = 0.961\text{MA}$   
 $I_i = 0.493$   
 $q_0 = 1.63$   
 $q_{\min} = 1.59$   
 $q_a = 8.71$   
 $\beta_t = 10.5\%$   
 $\beta_N = 2.16$   
 $p_0/\langle p \rangle = 2.10$

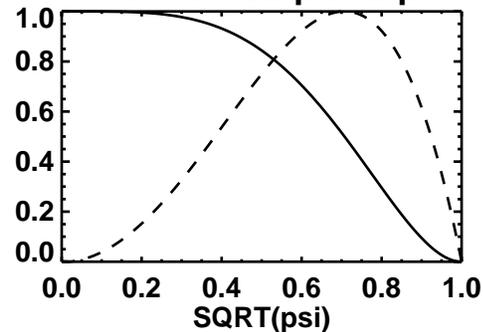
Normalized  $\langle J.B \rangle / \langle B_t/R \rangle$



q



Normalized p and p'



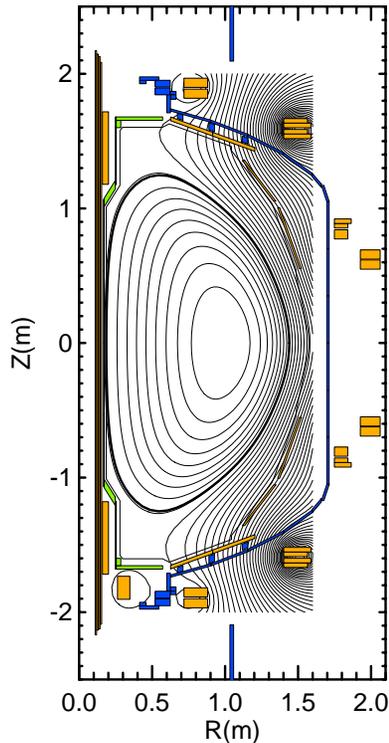
- EFITs indicate higher edge J for low- $I_i$  target plasma: **20-30% of max. (10% typical)**
- **Edge J critical in external kink stability:**
  - $J(\text{edge}) = 0 \Rightarrow n=1 \beta_N$  limit = 5.5 w/o wall
- Try lowering  $J(\text{edge})$  with gas puff
- HHFW in Helium may heat rather than create density - may give better J profile
- **Then, perform  $\kappa$ ,  $B_t$ , and gap scan to complete XP**

# Future XP Proposals:

- Current profile is only part of reaching high  $\beta_N$  regime
- Broadening the pressure profile will be crucial to:
  - Increase  $\beta$  limit with and without wall
  - Highlighting physics of pressure driven kink and RWM
- **First, propose XP in HHFW ET**
  - Use off-axis HHFW to broaden pressure profile
  - Attempt to control peaking with HHFW phasing
- If successful, propose MHD ET XP to investigate stability dependence on pressure peaking at low  $l_i$ :
  - **In effect, execute XP-016 with broader p profile**

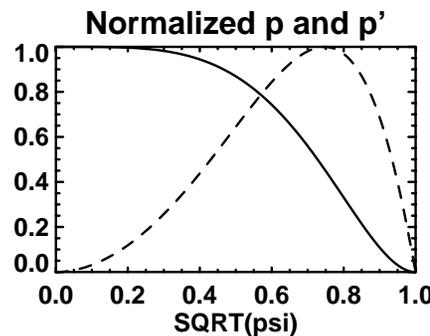
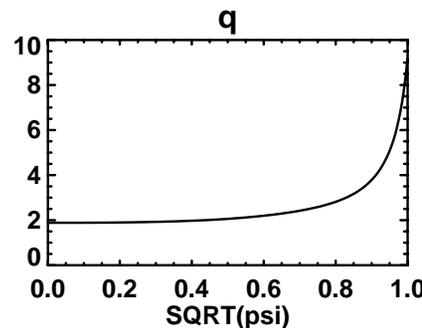
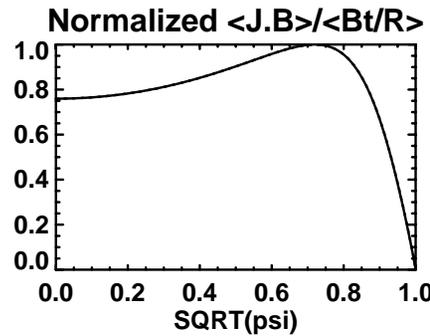
# Optimized Nearby Equilibria:

## Simulation



JSOLVER ID: N0000000

$I_p = 1.04\text{MA}$   
 $I_r = 0.413$   
 $q_0 = 1.88$   
 $q_{\min} = 1.88$   
 $q_a = 9.16$   
 $\beta_N = 34.3\%$   
 $\beta_N = 6.19$   
 $p_0/\langle p \rangle = 1.75$



- Equilibrium parameters:
  - $p(0)/\langle p \rangle = 1.7-1.8$
  - $I_i = 0.4$
  - $q(0) = 1.9$
  - 34%  $\beta$  limit w/ wall
    - $n=1,2,3$  ballooning
    - large outer gap = 12cm
- Smaller outer gap and  $q(0) > 2$  approaches published optimized case with  $\beta=40\%$
- Again, all need small  $J(\text{edge})$  with somewhat hollow  $\langle J_{\parallel} \rangle$