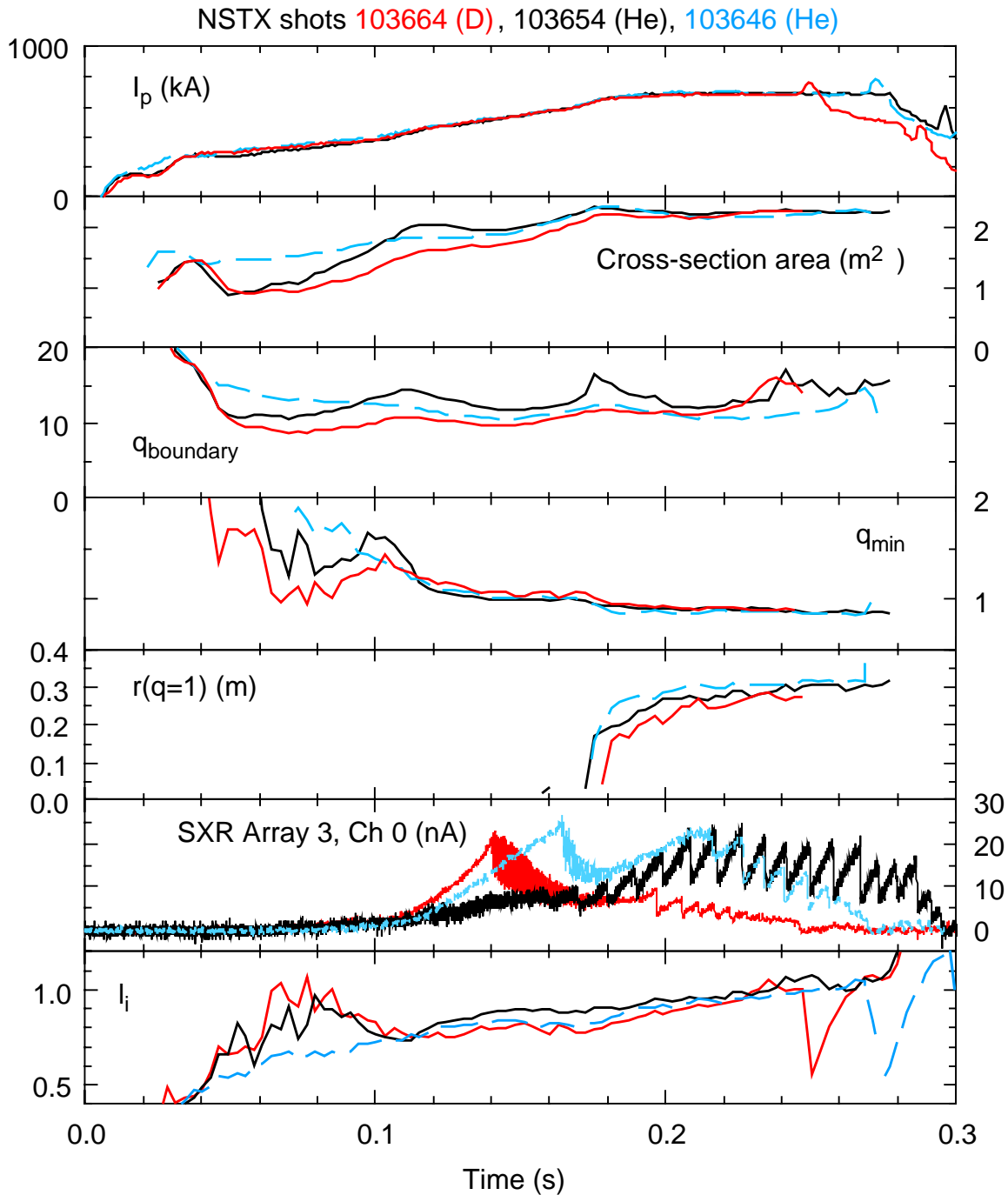


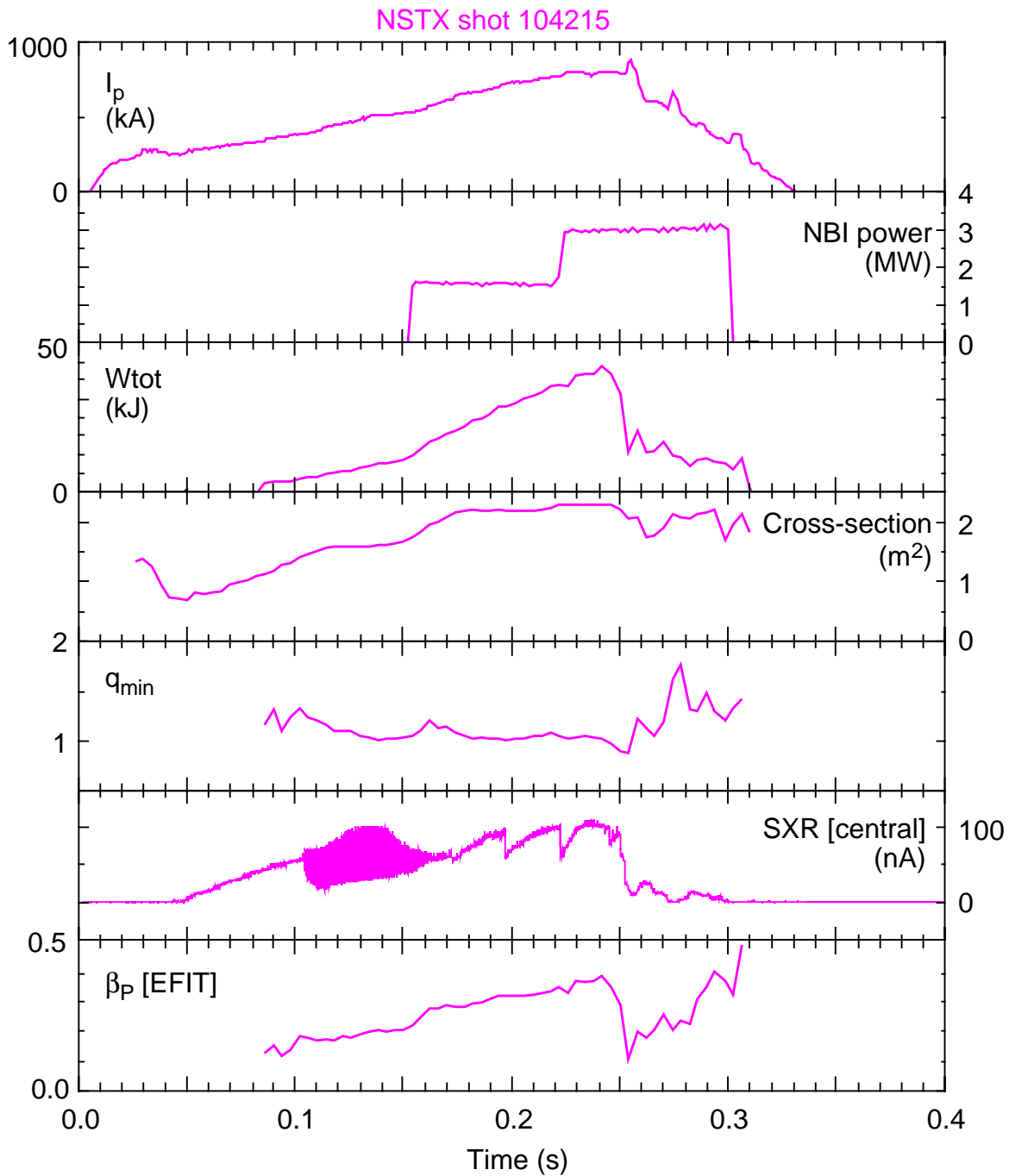
XP-23: NBI with Small $q = 1$

- ◆ Developed "growing" startup in MP-13 (11/12)
 - ▶ Start up with small cross-section on center stack
 - ▶ Keep q_a approximately constant as I_p ramps up
 - ▶ 700kA, 80ms f/t with repetitive sawteeth, ~10ms
 - $r_{q=1} = 0.25 - 0.3$ m (EFIT)
- ◆ First XP-23 session on Friday 11/17 (22 shots)
 - ▶ Preceded by MP-9 (Boronization) in morning
- ◆ Start with 700kA, 35kA TF, D_2 grown plasma
 - ▶ Gas requirement changed by wall and NB pumping
- ◆ Add NB-B after start of s/t then just before s/t
 - ▶ W_{MHD} sometimes unaffected by early sawteeth but
 - ▶ W_{MHD} reduced momentarily or collapsed at later s/t, particularly for $\beta_p > \sim 0.35$, suggesting NTM role
- ◆ Extend ramp to 800kA, add NB-C and finally A
- ◆ 104215 good example of heating through 2 s/t followed by minor then major collapse at next 2

Growing Startup Can Produce Small Repetitive Sawteeth



Small Sawteeth Do Not Affect NB Heating at Low β_P

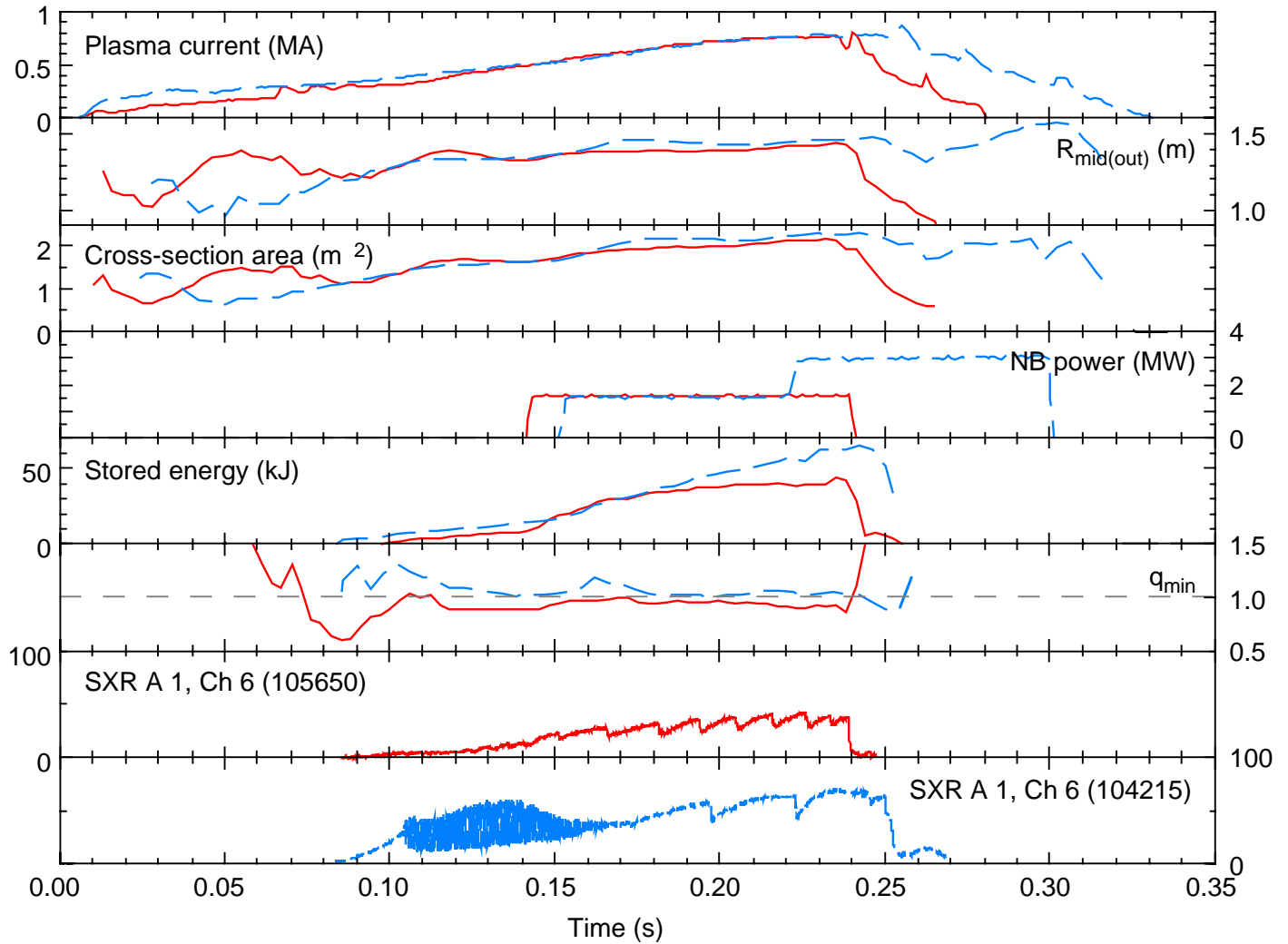


XP-23: NBI with Small $q = 1$ (2)

- ◆ Second round on Tuesday 7/3 (14 shots)
- ◆ Difficulties reproducing conditions from 11/17
 - ▶ 800kA, 35kA TF, D_2 (adapted from 104215)
 - graft on new startup program
 - change gas valve
 - adjust for change in sensor for B_{pol} at outer gap
 - ▶ Initial plasma current lower than before
 - ▶ Outer gap developed large oscillations
 - larger effect of eddy currents in passive plates?
- ◆ Eventually produced small sawteeth (105647)
 - ~5ms period starting around 85ms in OH phase
- ◆ NBI had trouble with permissive (105646 - 9)
- ◆ NBI on 105650
 - ▶ NBI-A + B modulated (20ms on/off) on 105651
 - ▶ Heating not as good as 104215 but no obvious deleterious effect of individual sawteeth

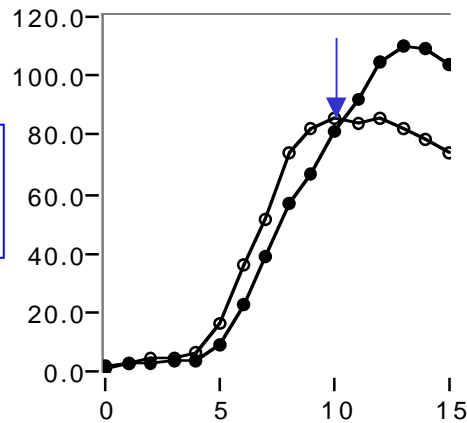
Changes in Growing Phase Affected Sawteeth Later

105650 (3-Jul-2001), 104215 (17-Nov-2000)



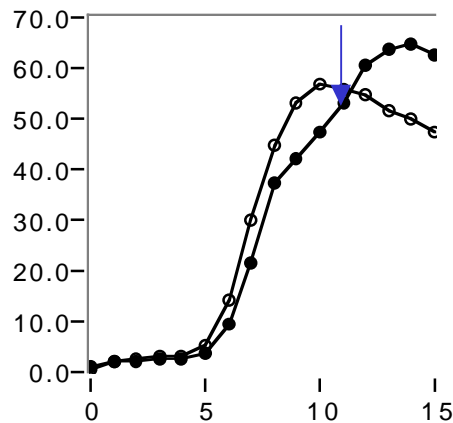
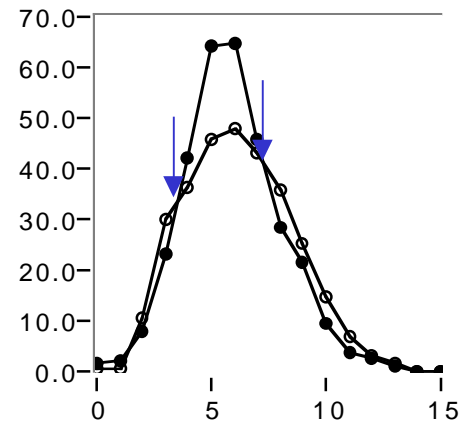
SXR (>0.6keV) profiles before, after crash (100 μ s average)

Midplane Upper

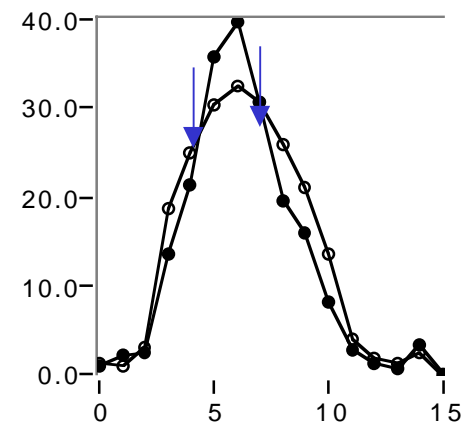


104215
 $r_{inv}/a \approx 0.25$

Top



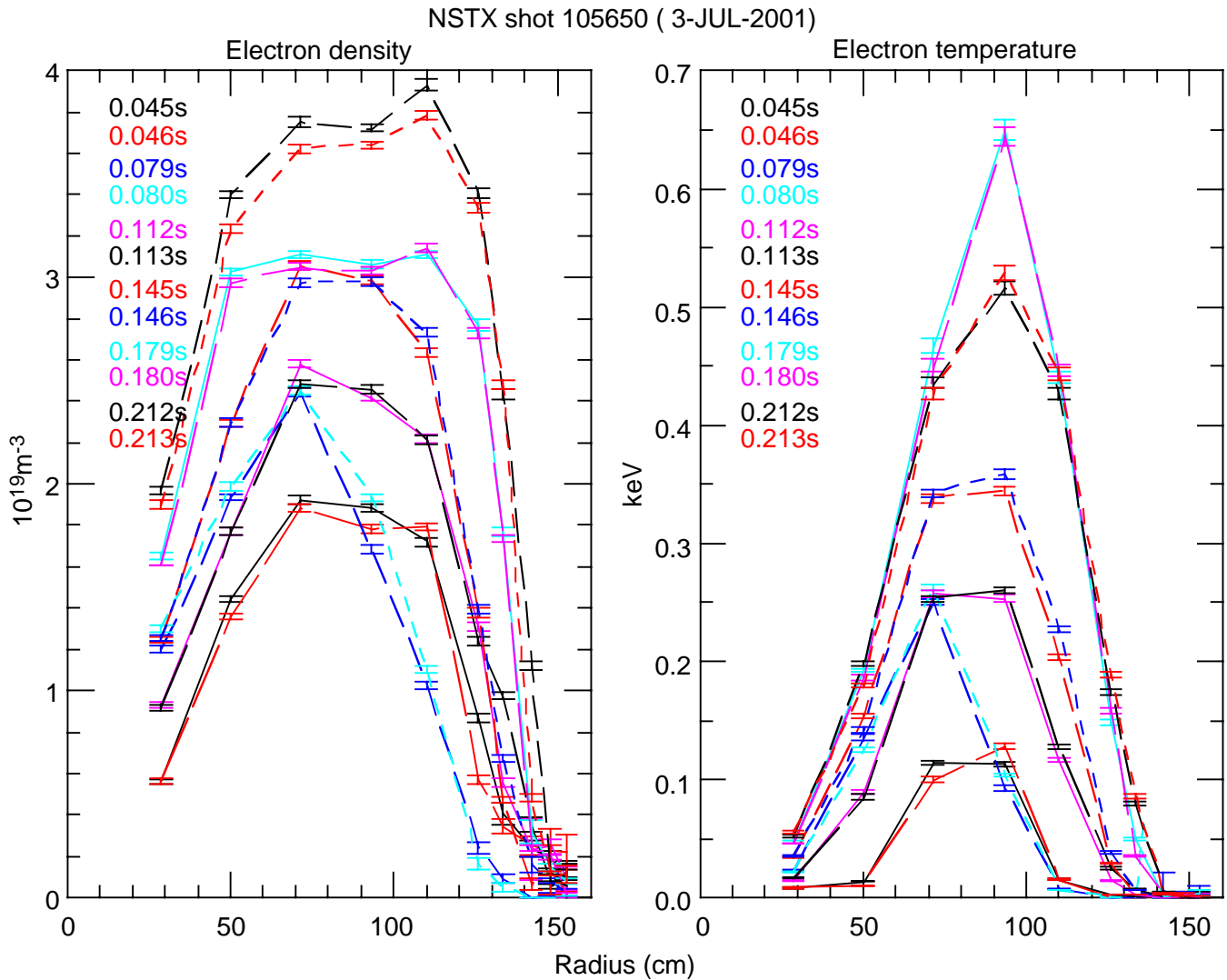
105650
 $r_{inv}/a \approx 0.2$



Chord number

D. Stutman

Thomson Scattering Profiles



- ◆ Temperature is quite peaked but density is relatively broad
- ▶ Result of strong gas puffing during ramp

Conclusions

- ◆ Successful in producing plasmas with small, benign sawteeth by growing cross-section
 - ▶ Limitations on control of large outer gaps impair day-to-day reproducibility
- ◆ Sawteeth *per se* do not degrade confinement during NBI
- ◆ At $\beta_p \sim 0.4$, sawteeth can trigger degradation
 - ▶ Progressively more severe as β_p rises
 - ▶ Suggestion that Neoclassical Tearing Modes are playing a role