NSTX

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Confinement, Stability, and Boundary Control During Current Rampdown in NSTX

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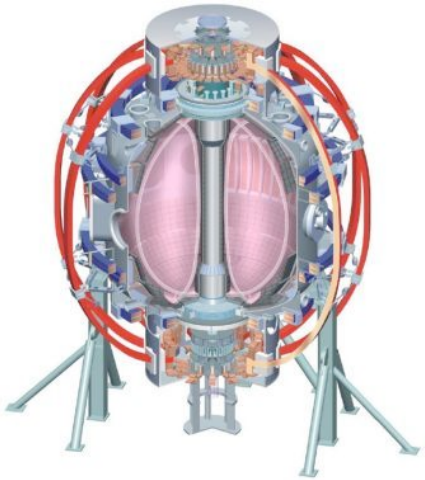
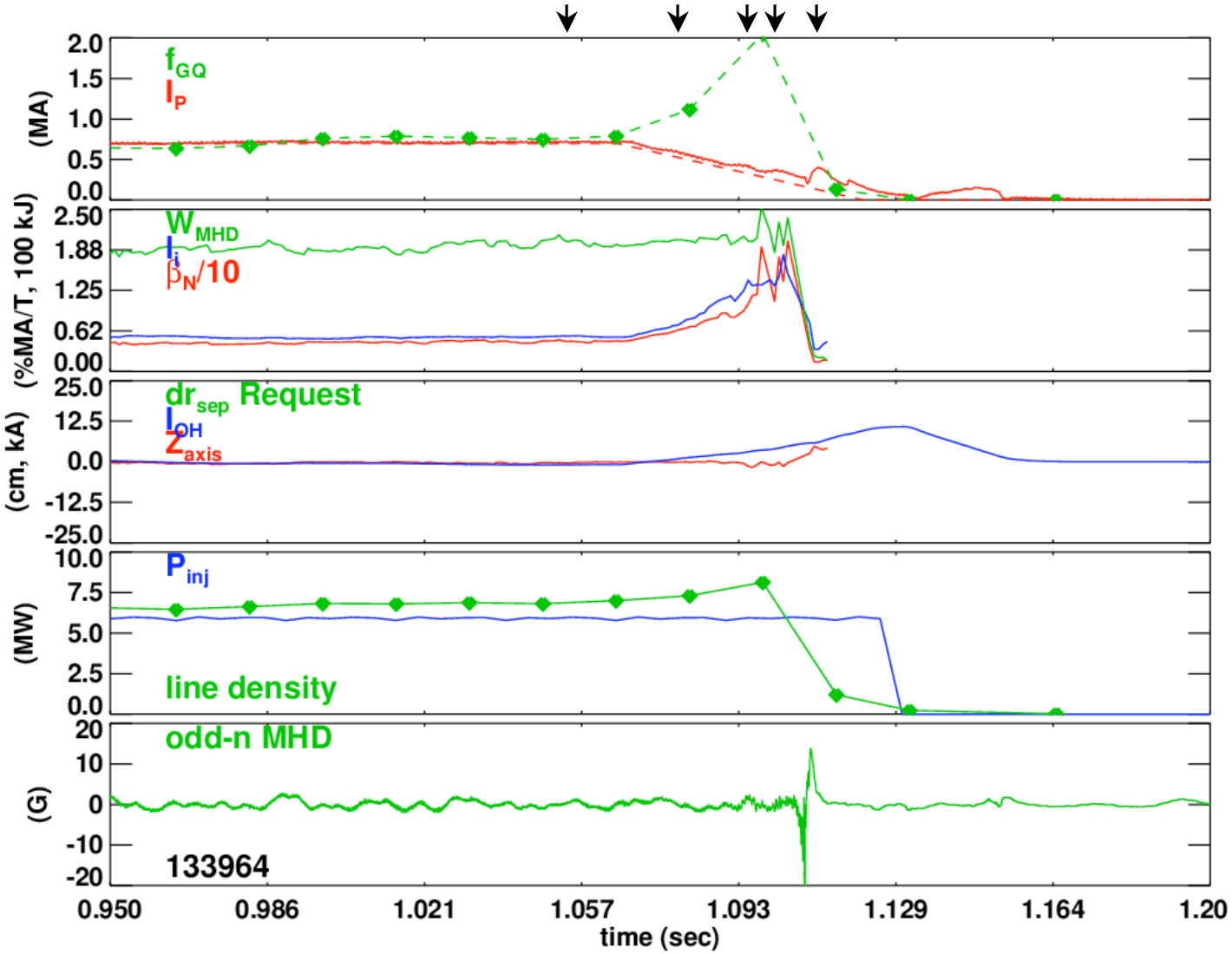


Overview

- Background:
  - Rampdown of the plasma current is a challenging phase of operation
    - Maintain strike-point positions.
    - Maintain vertical stability.
    - Avoid density limits.
  - High-priority near-term ITER issue.
  - NSTX ramps-down high current discharges in order to get fdia measurements, but typically ignores β, SP evolution.
- Goals of Proposed XP:
  - Develop ramp-down scenarios while maintaining S.P. locations and avoiding β and density limit MHD.
  - Study dependence of confinement, stability, on I_P ramp-down rate.
- Contributes to:
  - ITER need (Section 2.1.1 of ITER Physics Work Programme Rev. 1.2)
  - ITPA joint experiments
    - IOS 2.2: rampdown from ITER q_{95} (kinda)
    - IOS 6.2: l_i control during rampdown
    - IOSRT-2: Termination strategies for plasma discharges
  - Future ST devices such as ST-CTF and Aries-ST

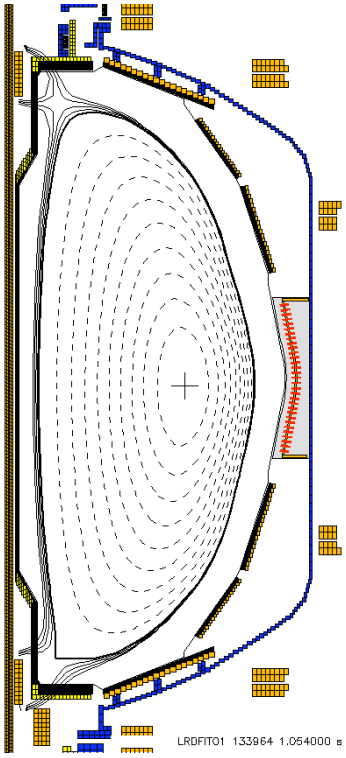
Rampdown Dynamics: High-κ, δ, β_P (I)



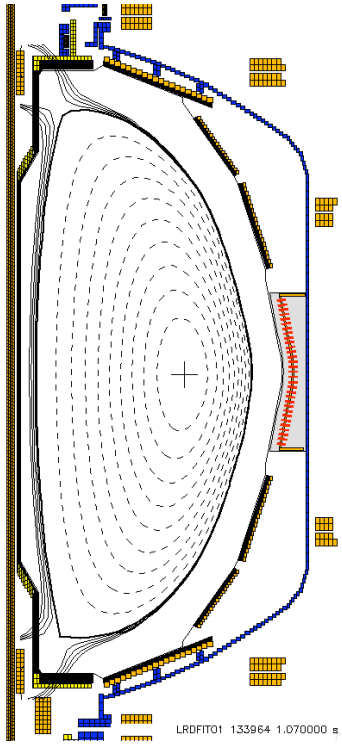
Rampdown Dynamics: High-κ, δ, β_P (II)

β-collapse

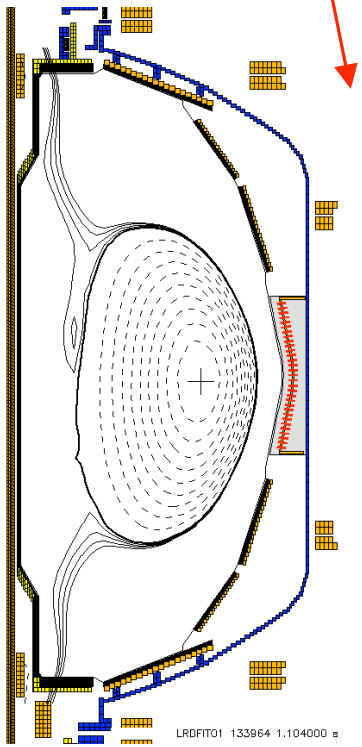
t=1.054 sec,
I_P=722kA,
W_{MHD}=200kJ,
β_N=4.6



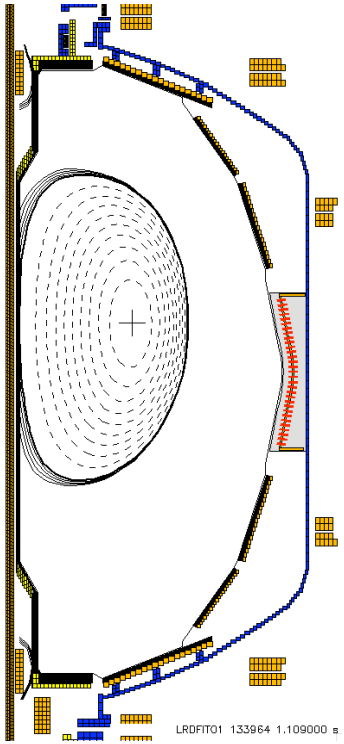
t=1.070 sec,
I_P=646 kA,
W_{MHD}=196kJ,
β_N=5.06



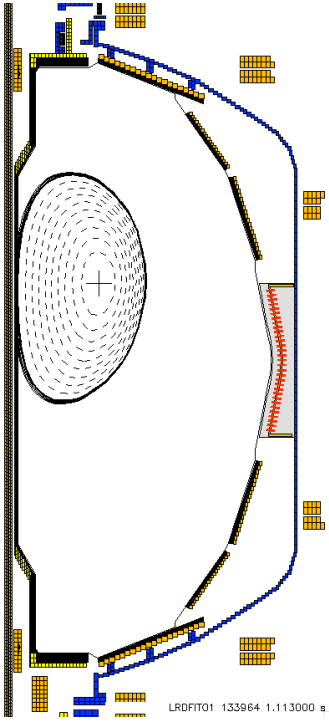
t=1.104 sec,
I_P=336 kA,
W_{MHD}=237 kJ,
β_N=18



t=1.109 sec,
I_P=315kA,
W_{MHD}=46 kJ,
β_N=2.7

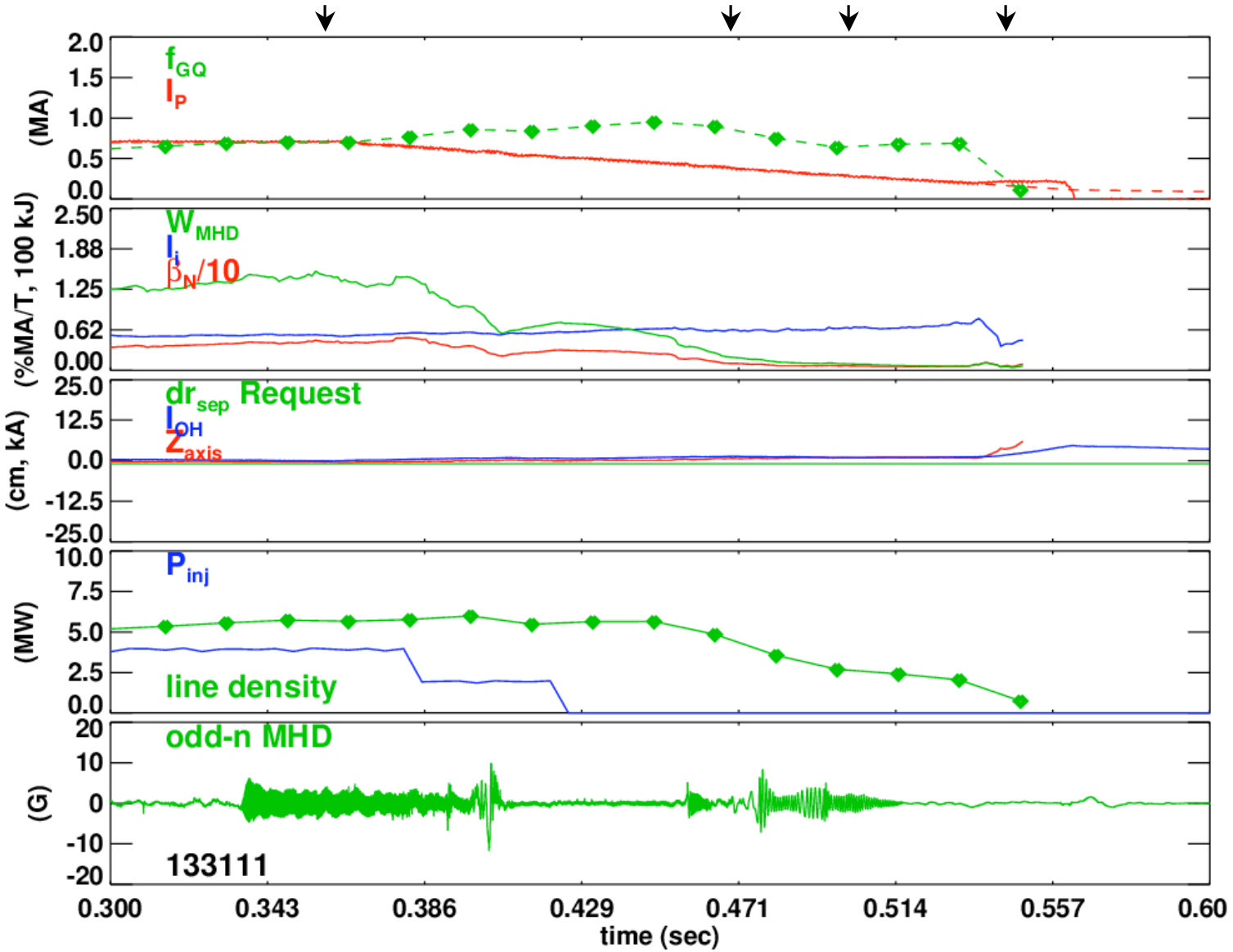


t=1.113 sec,
I_P=330 kA,
W_{MHD}=16kJ,
β_N=1.8



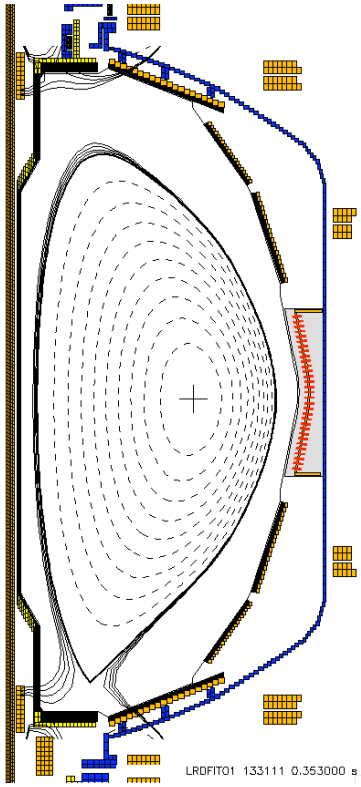
4 x 1mm SOL Flux Contours

Rampdown Dynamics: NB Shot From Retention XP (I)

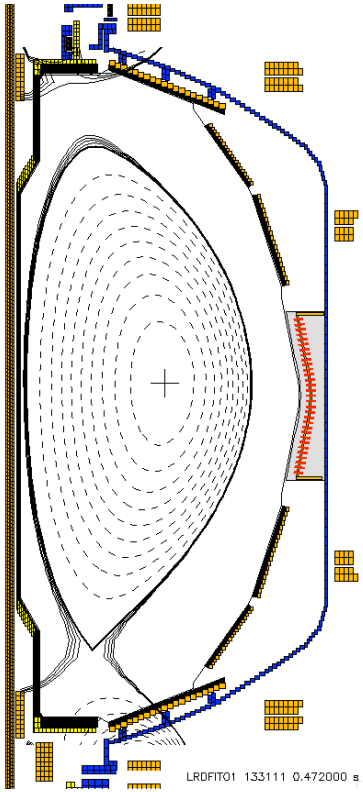


Rampdown Dynamics: NB Shot From Retention XP (II)

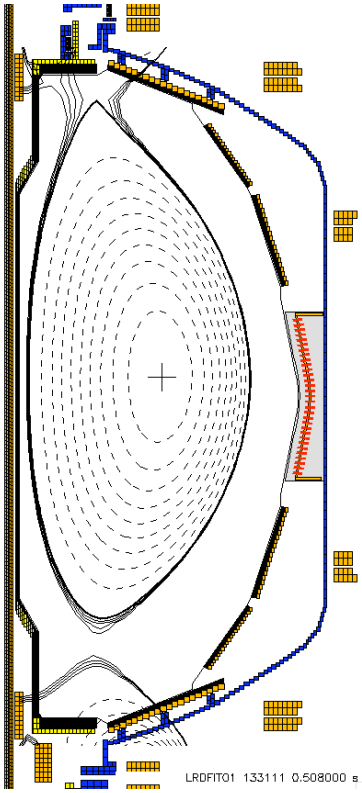
t=0.353 sec,
I_P=700 kA,
W_{MHD}=145 kJ,
β_N=4.4



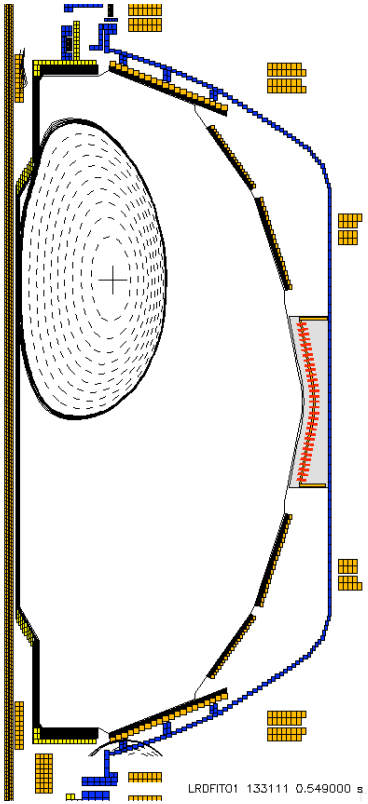
t=0.472 sec,
I_P=371 kA,
W_{MHD}=19 kJ,
β_N=1.1



t=0.508 sec,
I_P=271 kA,
W_{MHD}=9kJ,
β_N=.63



t=0.549 sec,
I_P=222 kA,
W_{MHD}=7 kJ,
β_N=0.97



4 x 1mm SOL Flux Contours

Tentative Shot Plan

- Establish Reference Discharge (3 shots)
  - High-δ discharge with ISP and vertical div. and OSP on horizontal inner divertor?
  - Medium-δ discharge with ISP on inner divertor and OSP on outer divertor?
  - No rotating MHD (no modes locking during rampdown for initial attempts).
    - Run at fairly high q_{95} to begin with.
- Add rampdown (rate to be determined): (10 shots)
  - Reduce heating power with I_P to avoid β excursions.
    - Trigger back-transitions? When is optimal?
    - Use β-control? (rtEFIT good till when?)
  - Reduce κ and dr_{sep} in order to stay connected to the SPs.
  - Extra gas puff to avoid restrike?
- Repeat with faster and slower ramp-rates. (10 shots)
  - Study l_i evolution and transport as a function of ramp rate with other things fixed.
- Repeat at higher plasma current (more demanding). (5 shots)
  - Effect of n=1 modes locking?