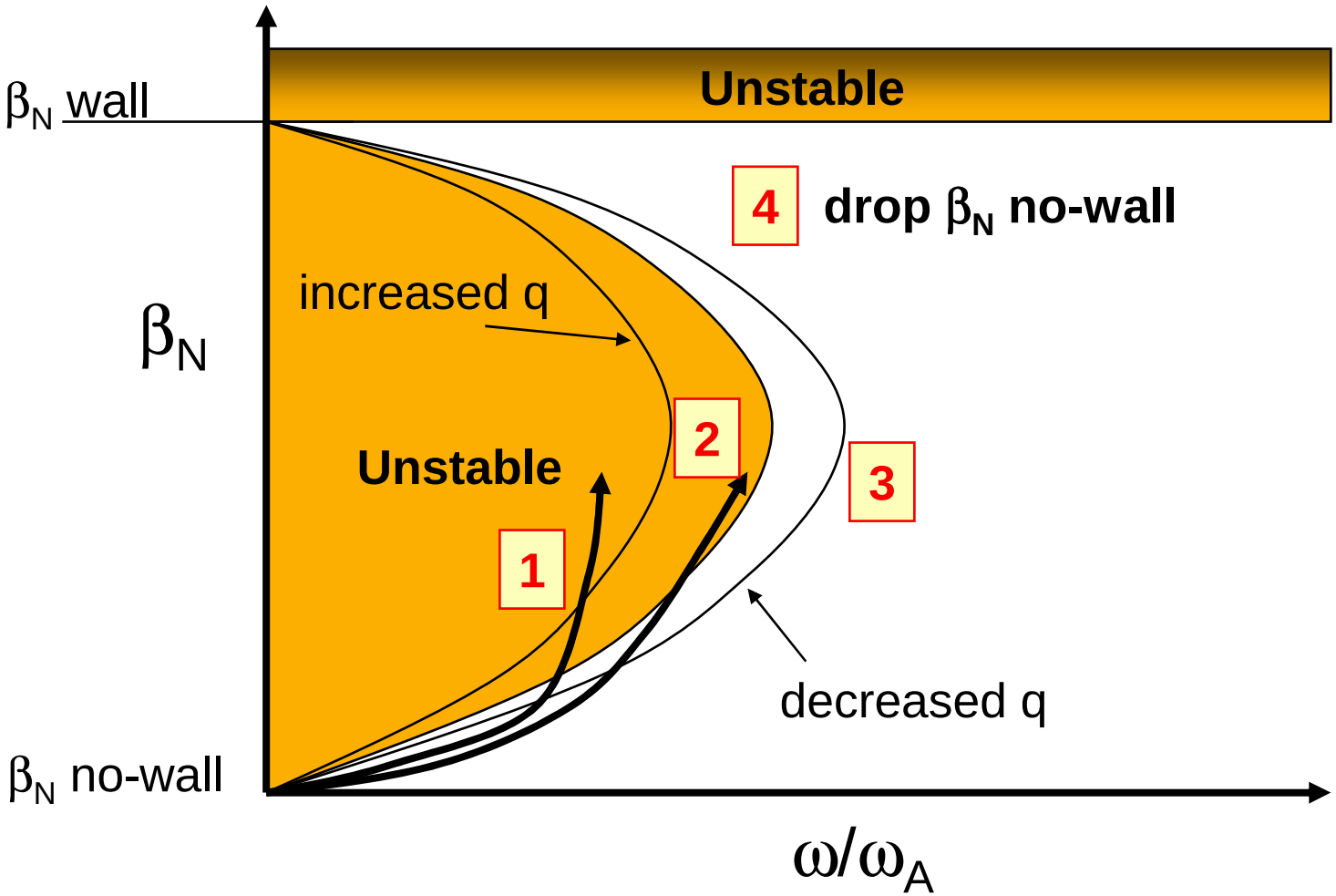
XP407: Passive Stabilization Physics of the Resistive Wall Mode in High β_N ST Plasmas

- Goals
  - Define RWM stability boundary in (V_ϕ, β_N) space
    - Use past XP experience and new theories to determine boundary
      - Present theory/experiment suggests: $\Omega_{crit}/\omega_A \sim 1/4q^2$
    - Define the operating space and criteria for active stabilization
  - Measure n > 1 resistive wall modes
    - Present high β_N plasmas are computed to be n = 2 unstable
    - Compare to theoretical computation of n > 1 stability (structure?)
    - Look for finite mode frequency
  - Set up conditions to examine physics of RWM passive stabilization in high β_N ST plasmas to compare to theory
    - Critical rotation frequency: XP by A. Sontag
    - Rotation damping physics: XP408 by W. Zhu

Approaches to probing (V_ϕ, β_N) stability boundary

- Rapidly drive across increasing growth rate contours
  - This is the standard approach
- Destabilize RWM by increasing Ω_{crit}
  - Decrease B_t slowly in stable discharge
- Stabilize RWM once triggered
  - Decrease by increasing slowly in unstable discharge
  - NBI step-down after destabilization
- Drop out of H mode with $\beta_N >> \beta_{NNo\text{-}wall}$
- Vary timing of NBI and B_t variation to change position in (V_ϕ, β_N) space

Schematic approach to probing stability boundary



- Additional approaches being considered based on CY2004 run

XP407 Run plan: 2/11/04

- **Scan boundary of passive stabilization space (F_ϕ, β_N) (21 shots)**

Task	Number of Shots
A) Restore shot 109025, or newer similar target	
(I_p ramped to 0.9 MA B_t = 4.5 kG (or above), l_i ~ 0.65)	
(i) 3 NBI sources to generate internal collapses at β_N > 6	3
(ii) 2 NBI + delayed 1 NBI	2
(iii) 3 NBI sources with 1 source step-down	3
B) Use toroidal field ramp to influence rotation evolution	
(B_t = 4.5 kG, reduced to B_t = 3.0 kG, vary start time of ramp)	4
(B_t = 3.5 kG, increased to B_t = 4.5 kG, vary start time of ramp)	4
C) Vary NBI timing to best cover (F_ϕ, β_N) space	6
D) Take plasma out of H-mode (ramp PF2) for high β_N / $\beta_{N\text{No-wall}}$	4
Total shots:	26

CY04 diagnostic improvements key to experiment

- Higher resolution CHERS system
  - Increased space and time resolution
    - Yields more accurate RWM onset determination
    - Yields more accurate determination of Ω_{crit}
    - Gives more insight into dissipation mechanism
- Internal locked mode sensors
  - Allows measurement of RWM structure
  - Allows measurement of n > 1 RWM
  - Yields more accurate determination RWM onset
    - Highly desired, but not required to determine Ω_{crit}
- Measure δT_e with TS laser timing change, USXR