Fusion Reactor Technology II
(459.761, 3 Credits)

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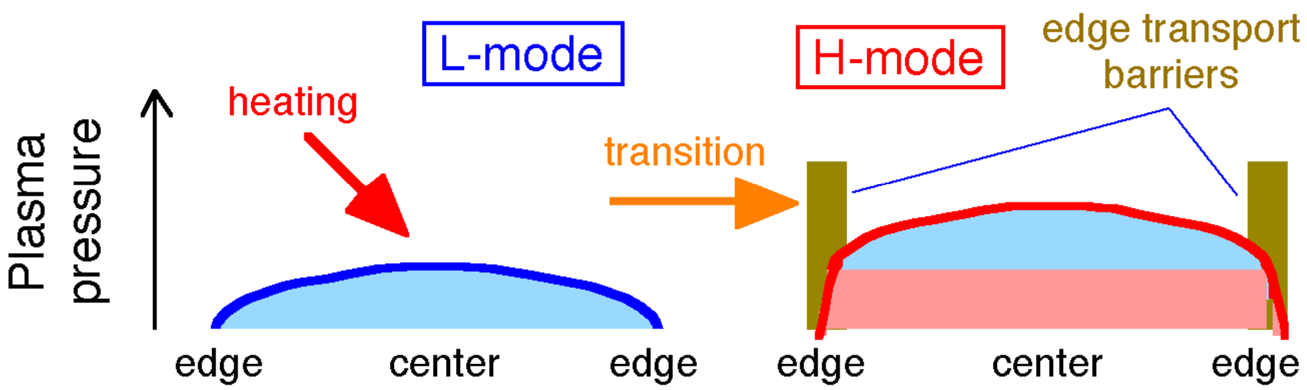
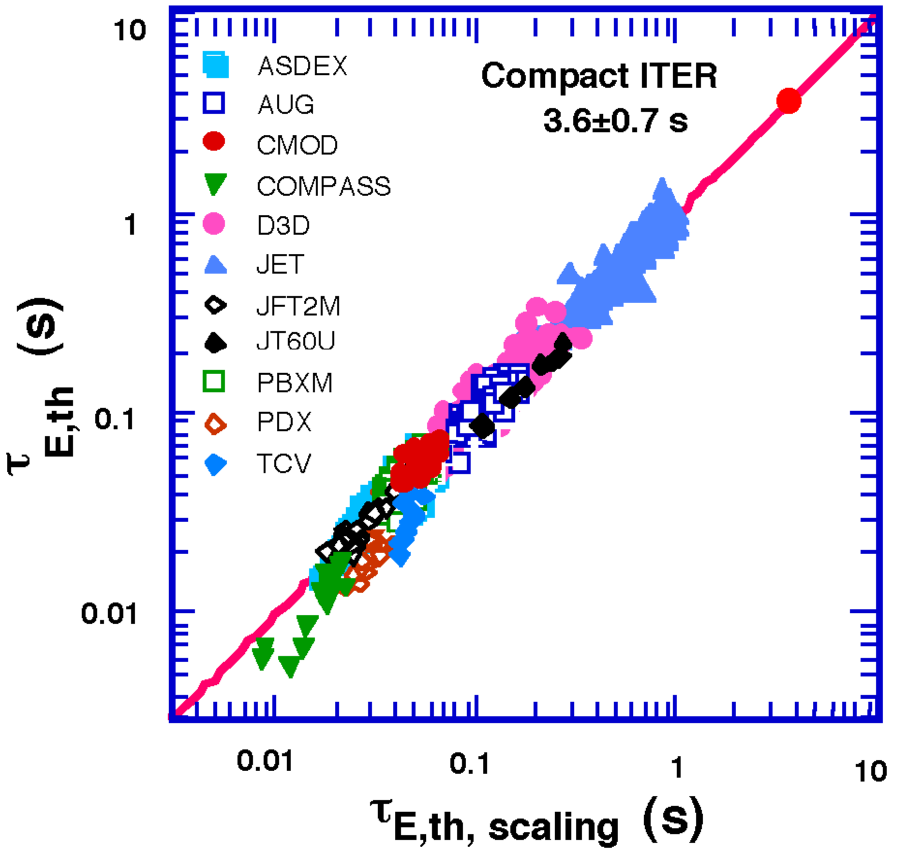
Confinement scaling

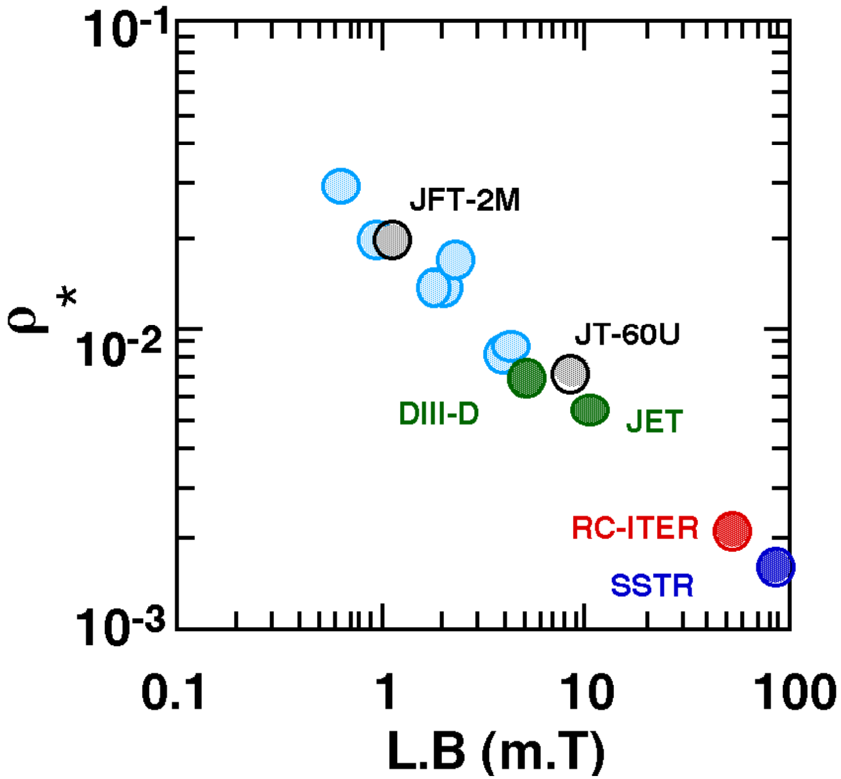


$$\tau_E^{ITER89P} = 0.048 M^{0.5} I_p^{0.85} B_t^{0.2} R^{1.2} a^{0.3} \kappa^{0.5} n_{20}^{0.1} P^{-0.5}$$

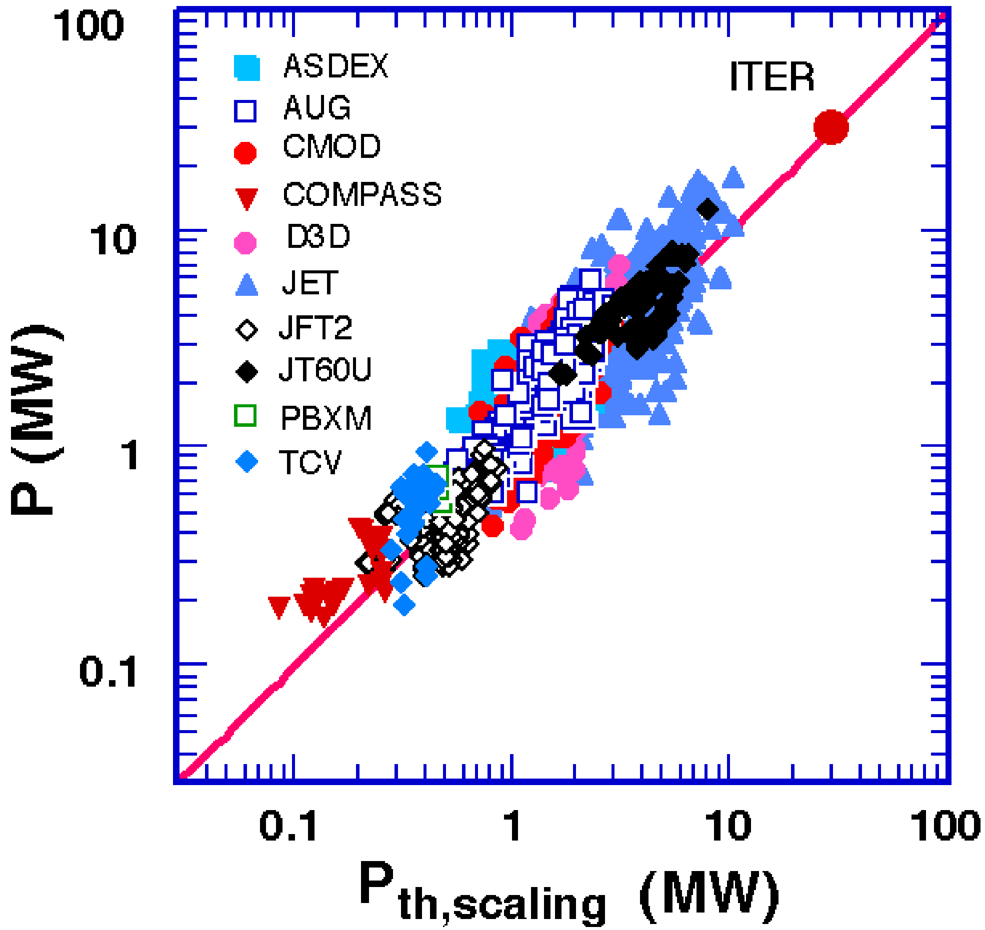
$$\tau_{E,th}^{IPB98(y,2)} = 0.0562 M^{0.19} I_p^{0.93} B_t^{0.15} R^{1.39} a^{0.58} \kappa_a^{0.78} n_{19}^{0.41} P^{-0.69}$$

Confinement scaling



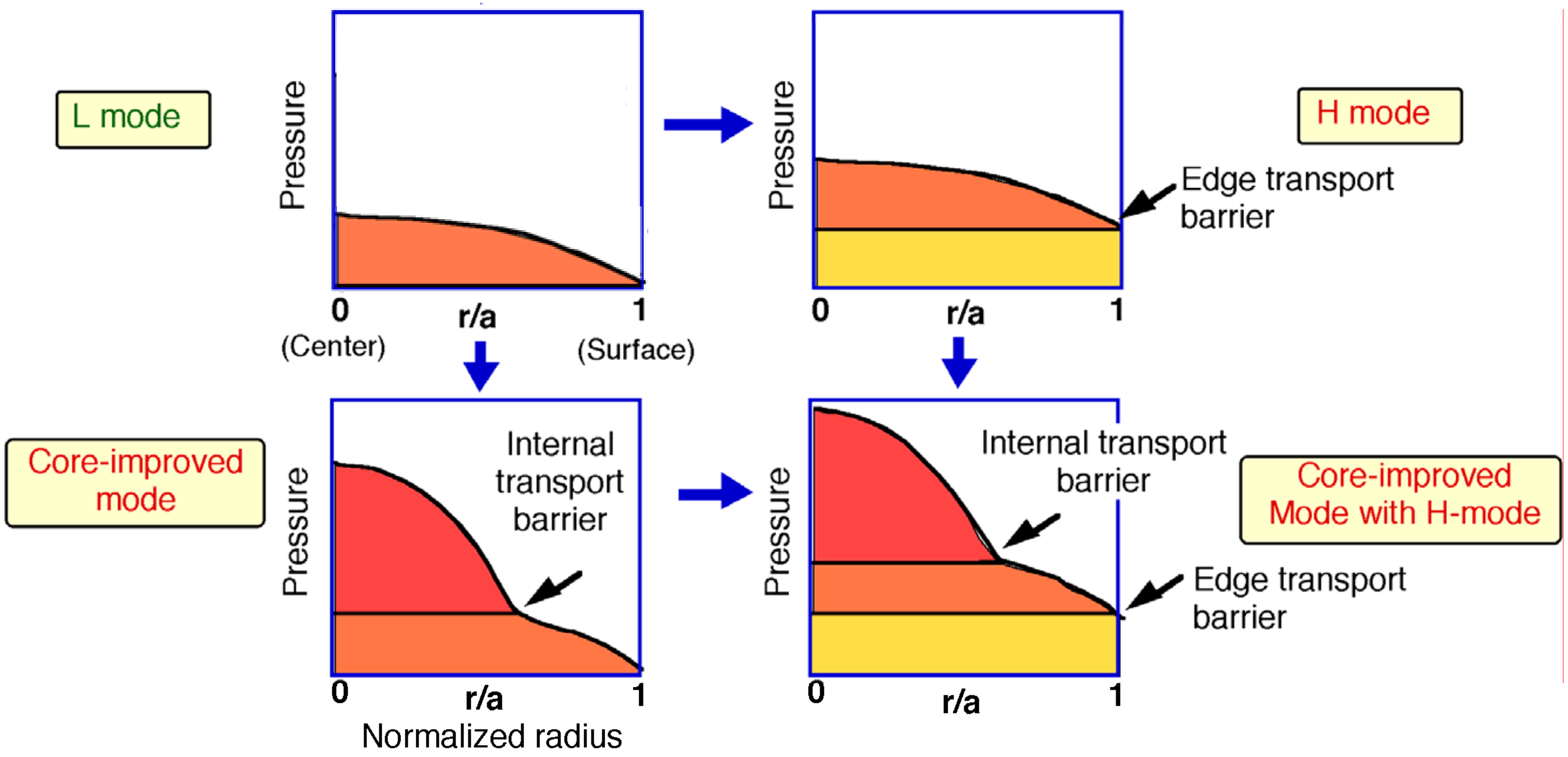


L-H transition threshold power

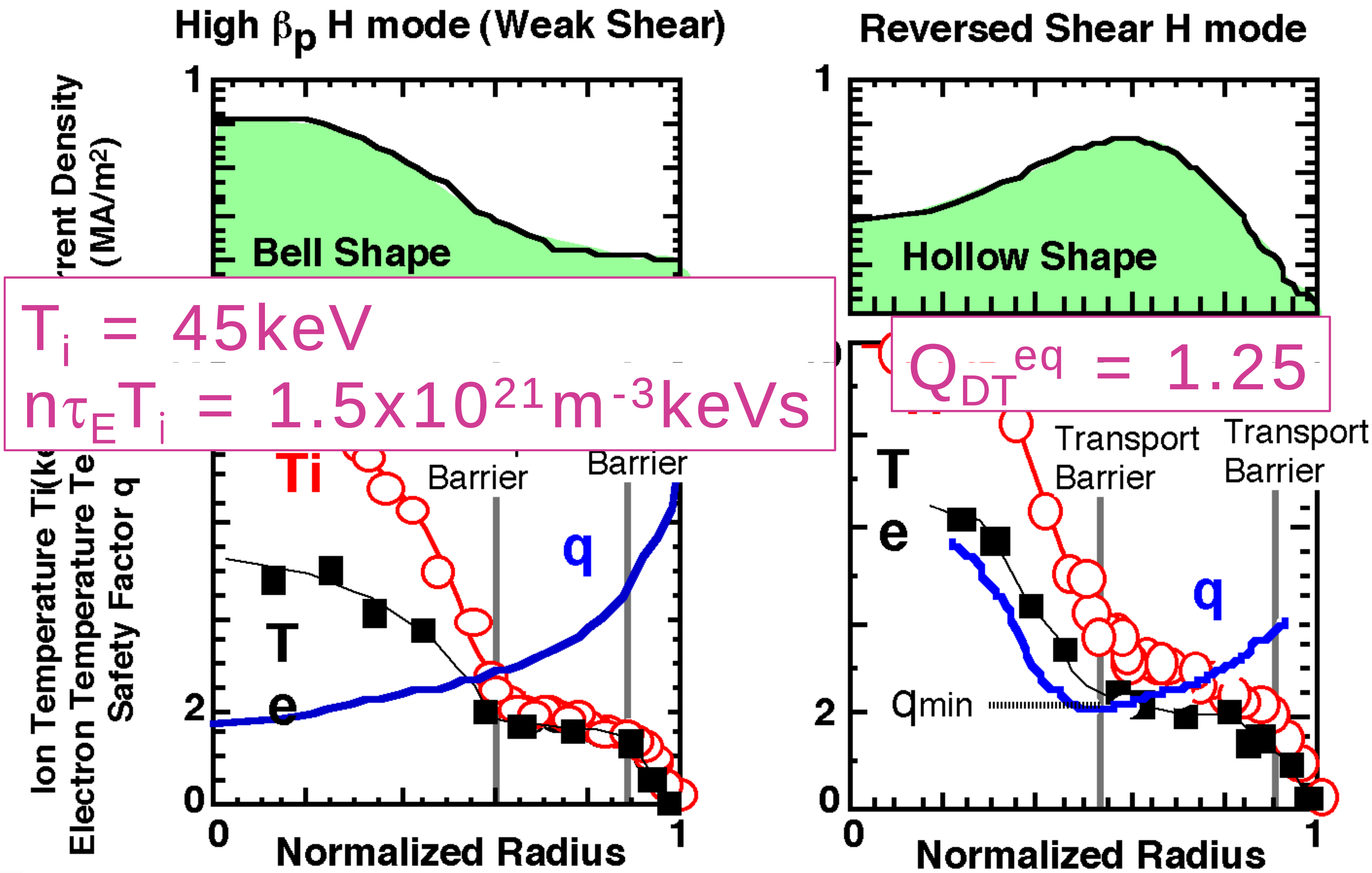


$$P_{th} = 2.84 M^{-1} B_t^{0.82} n_{20}^{0.58} R^{1.0} a^{0.81}$$

Improved confinement suitable for the steady-state operation



Improved confinement suitable for the steady-state operation

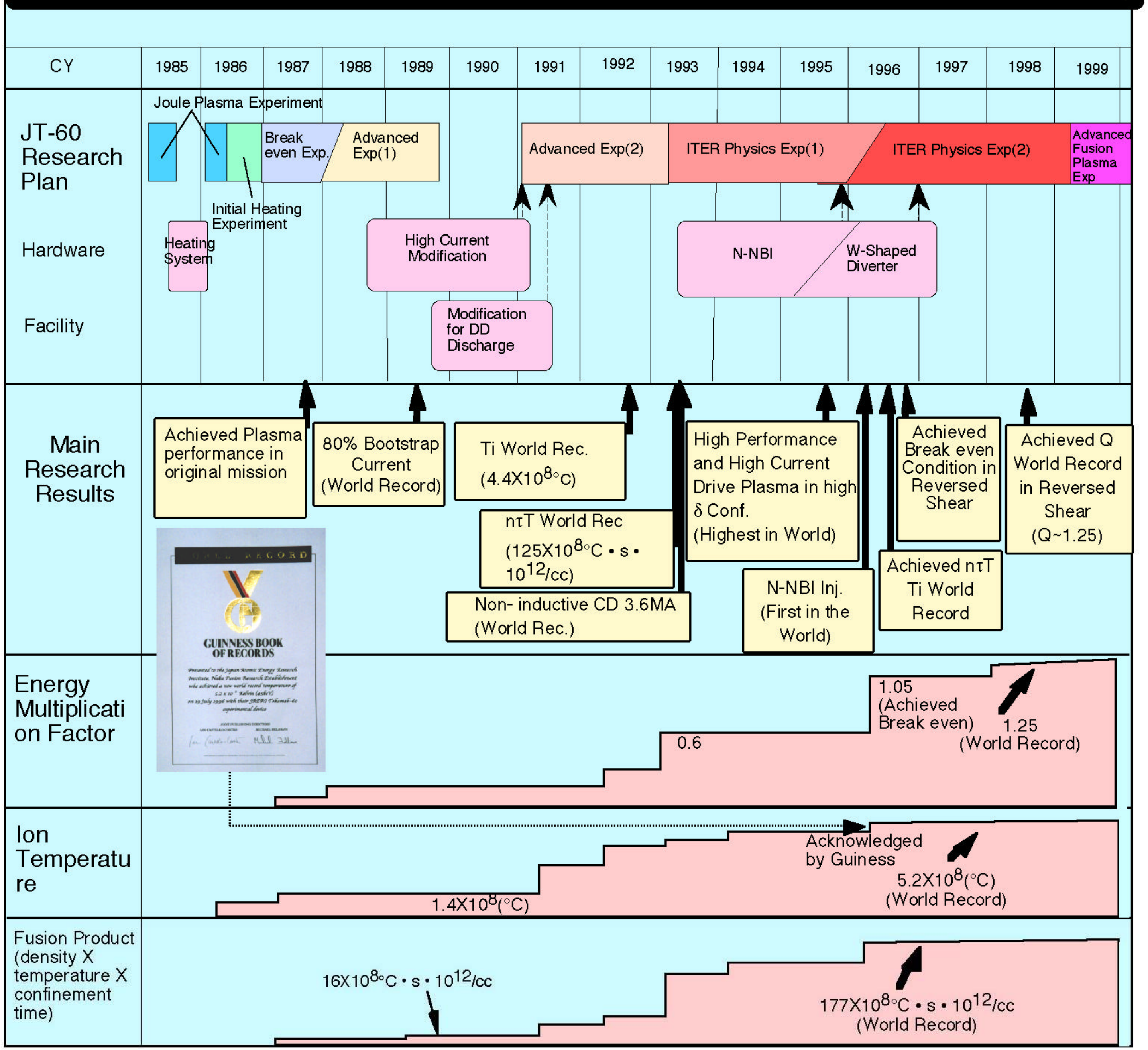


T_i = 45keV

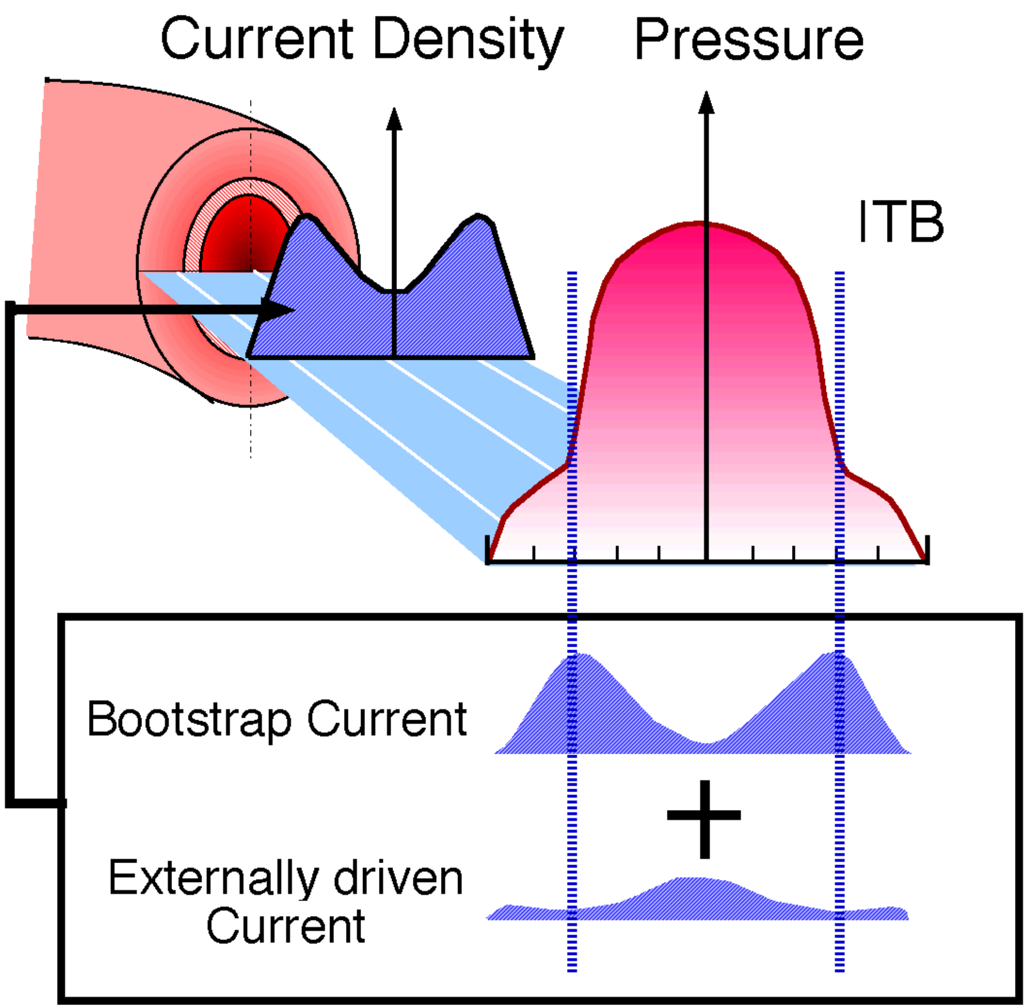
$n\tau_E T_i$ = 1.5x10^{21}m^{-3}keVs

Q_{DT}^{eq} = 1.25

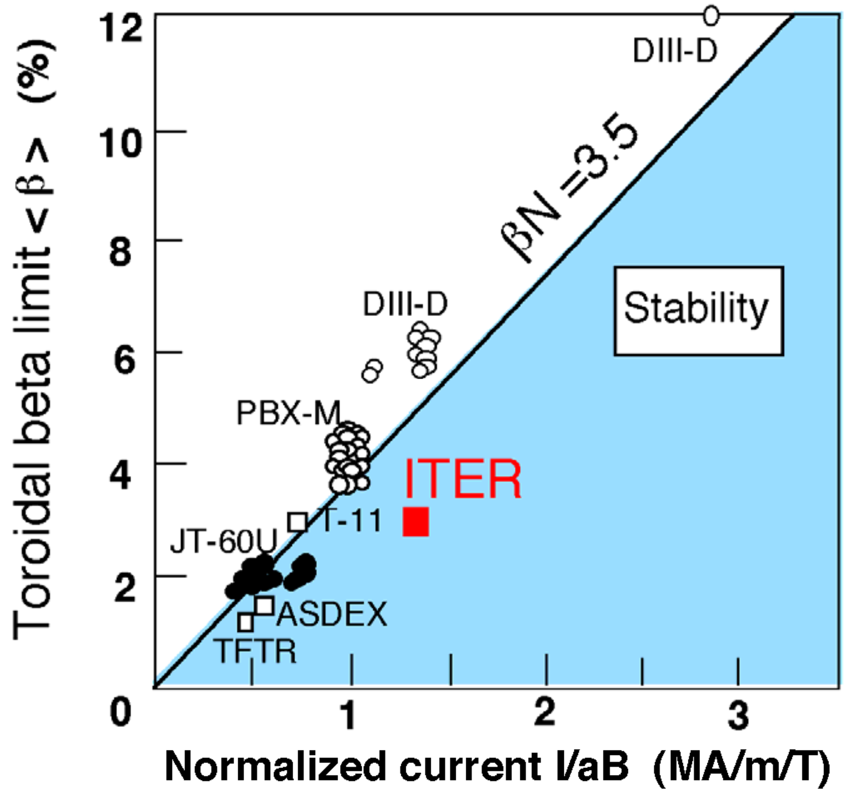
Transition of JT-60 Program and Progress in Plasma Performances



Improved confinement suitable for the steady-state operation



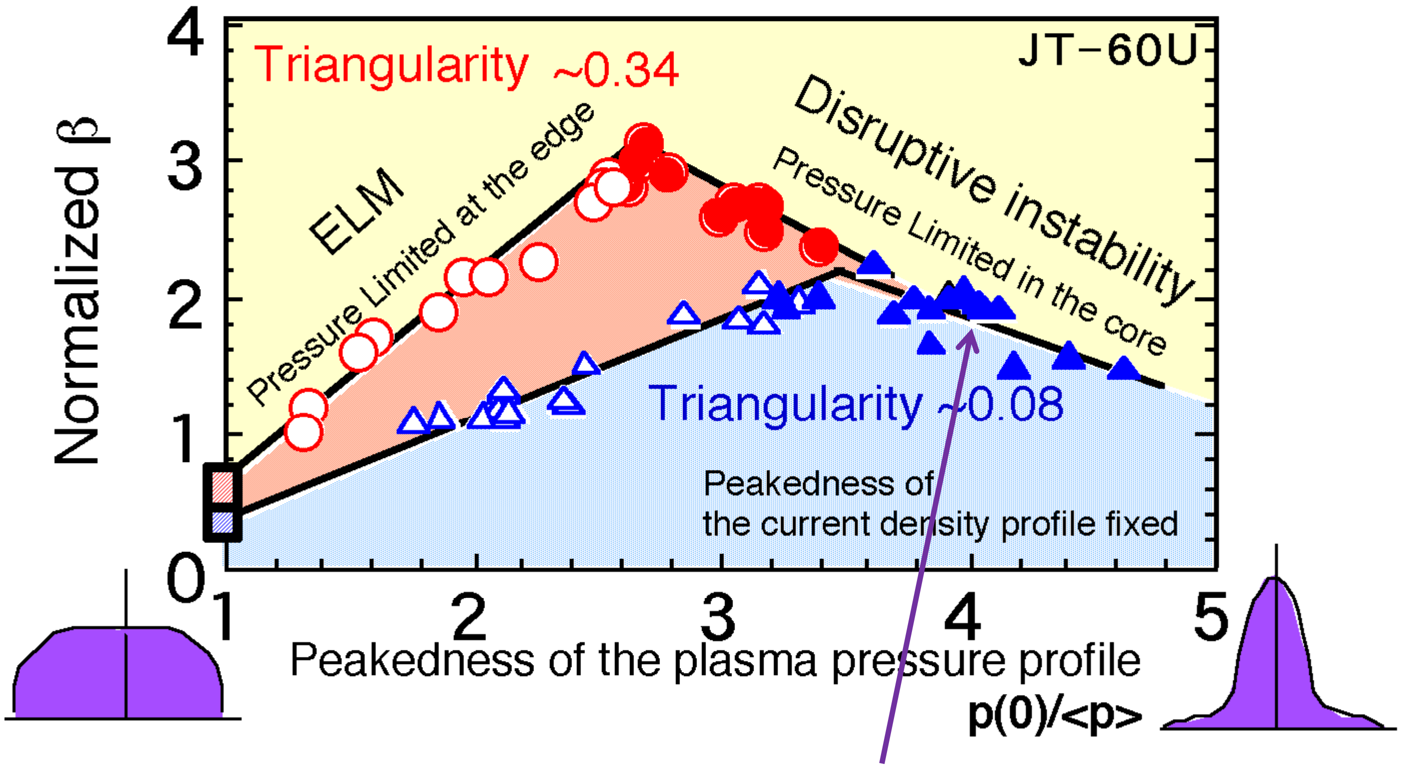
β-limit and optimisation of the MHD stability



- Fundamental elements for the β_N-limit

1. Current profile
2. Pressure profile
3. Plasma shape
4. Stabilising wall
5. Resistive instability

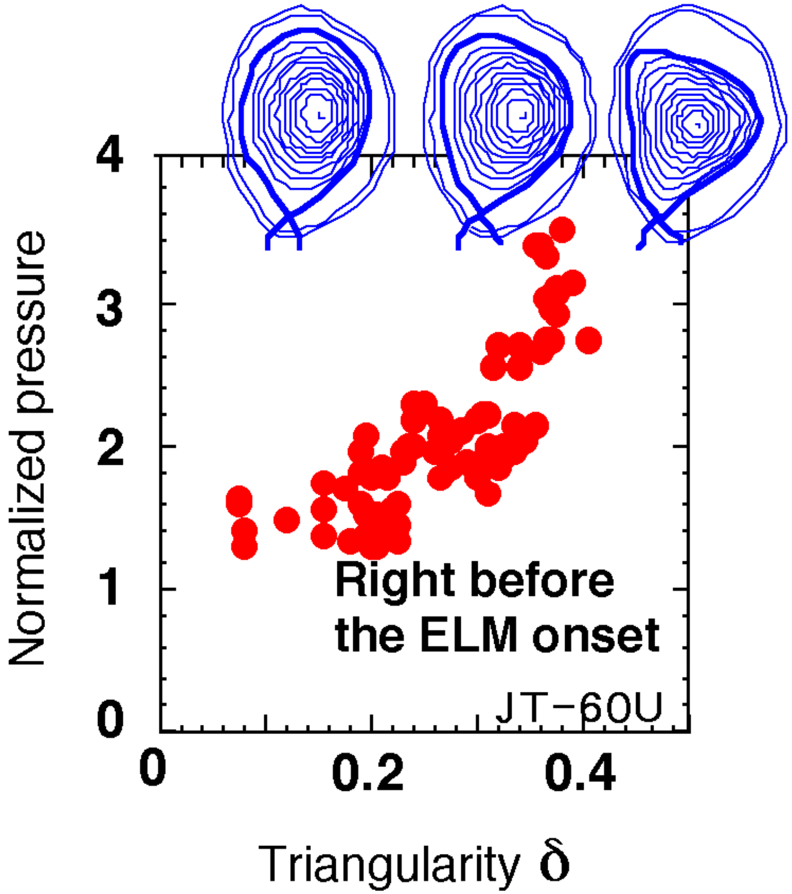
2. Pressure profile



Limited by the Kink-ballooning modes

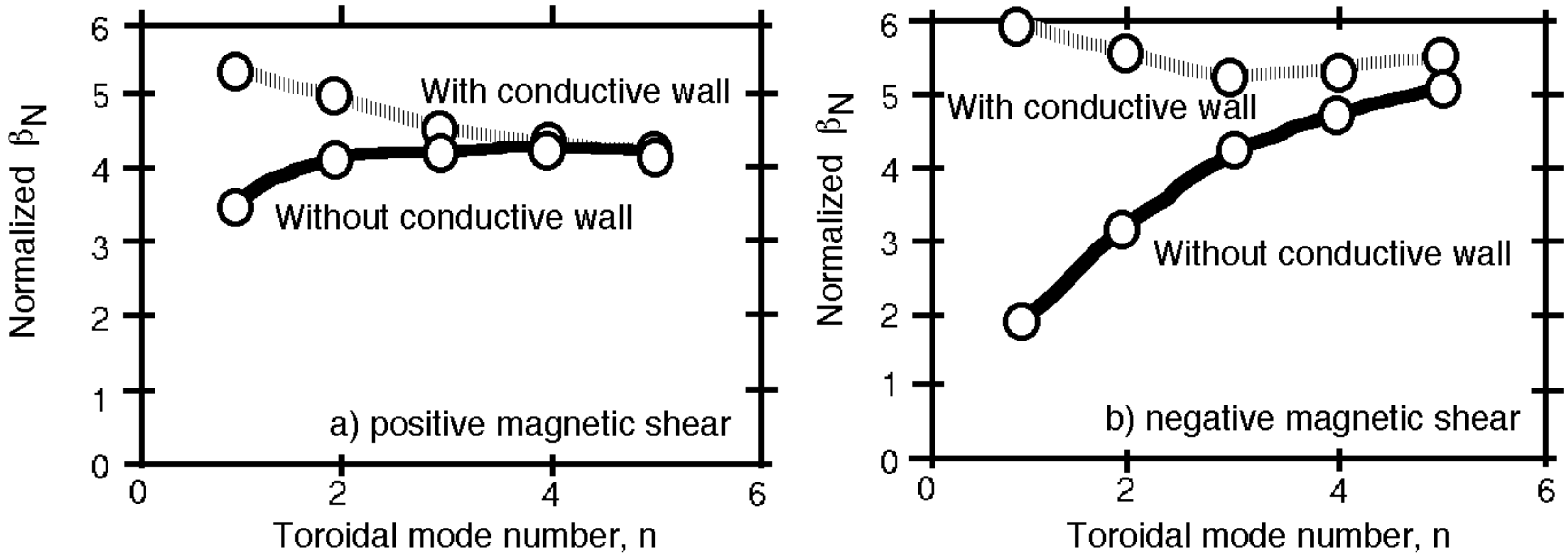
- Pressure profile determined by the a-particle heating with higher peakedness in ITER and DEMO

3. Plasma shape



- ITER designed to enable a high δ, 0.35-0.4

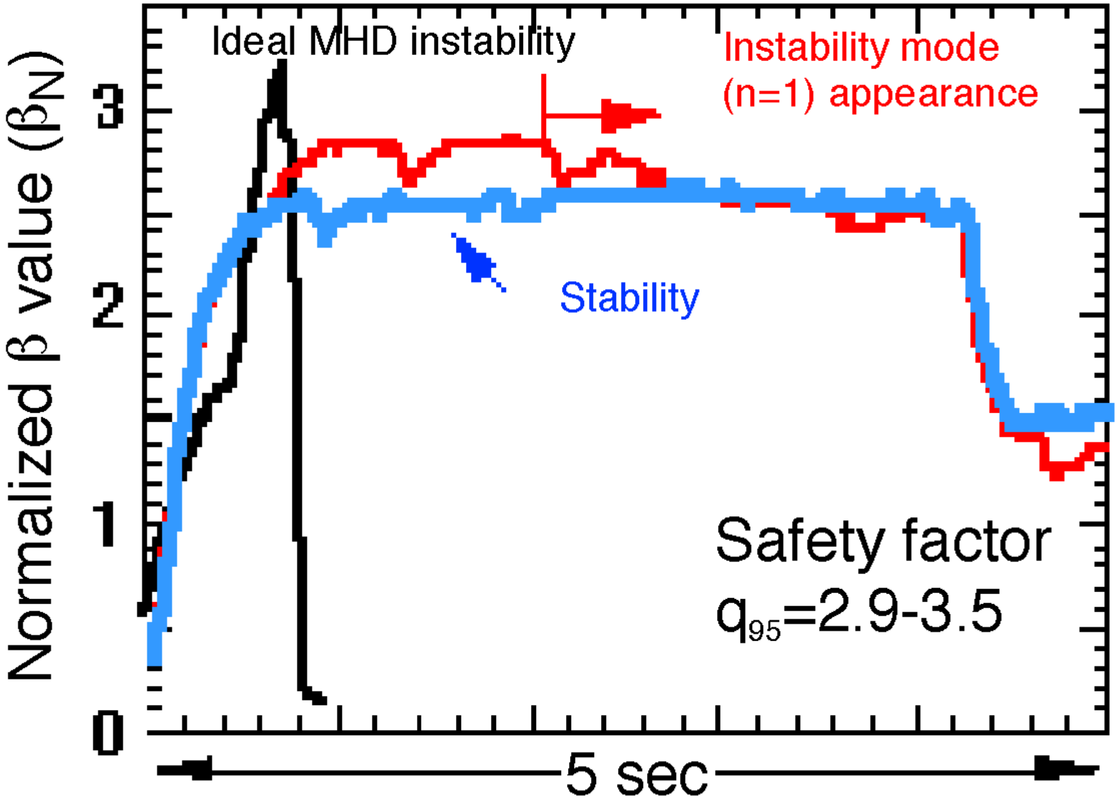
4. Stabilising wall



- Wall stabilising effect remarkable for RS plasmas
- Stabilisation of RWM

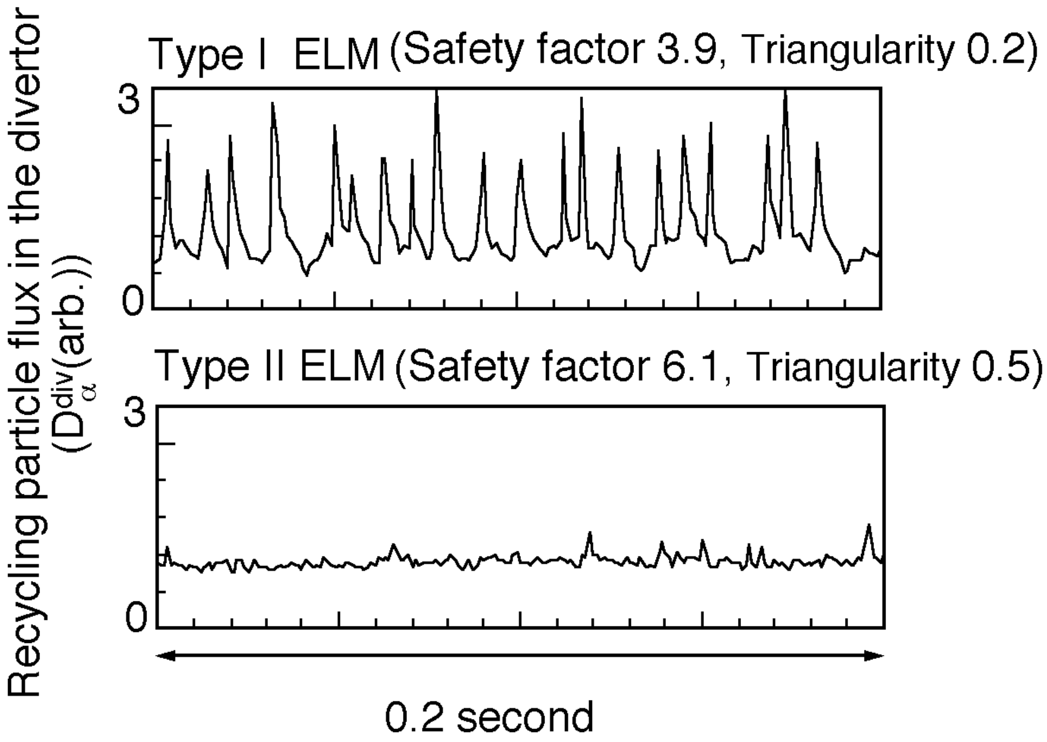
- plasma rotation
- corrective magnetic field canceling the perturbed magnetic field by the instability

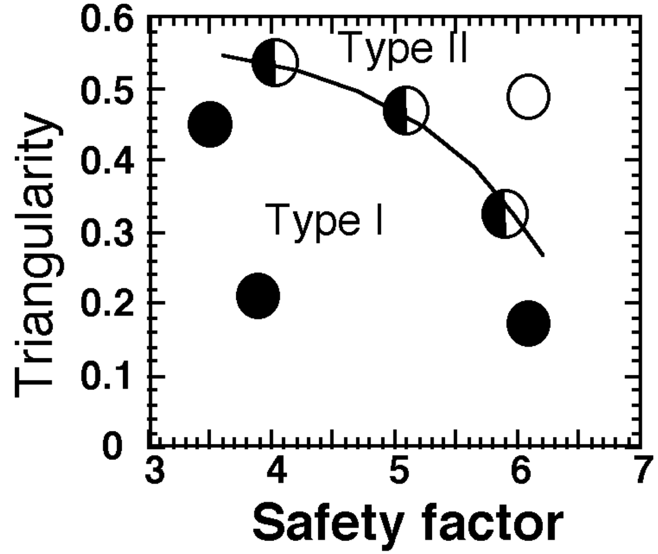
5. Resistive instabilities



- In quasi-SS discharges, β_N is lower than the ideal MHD limit due to appearance of resistive MHD instabilities (JT-60U)

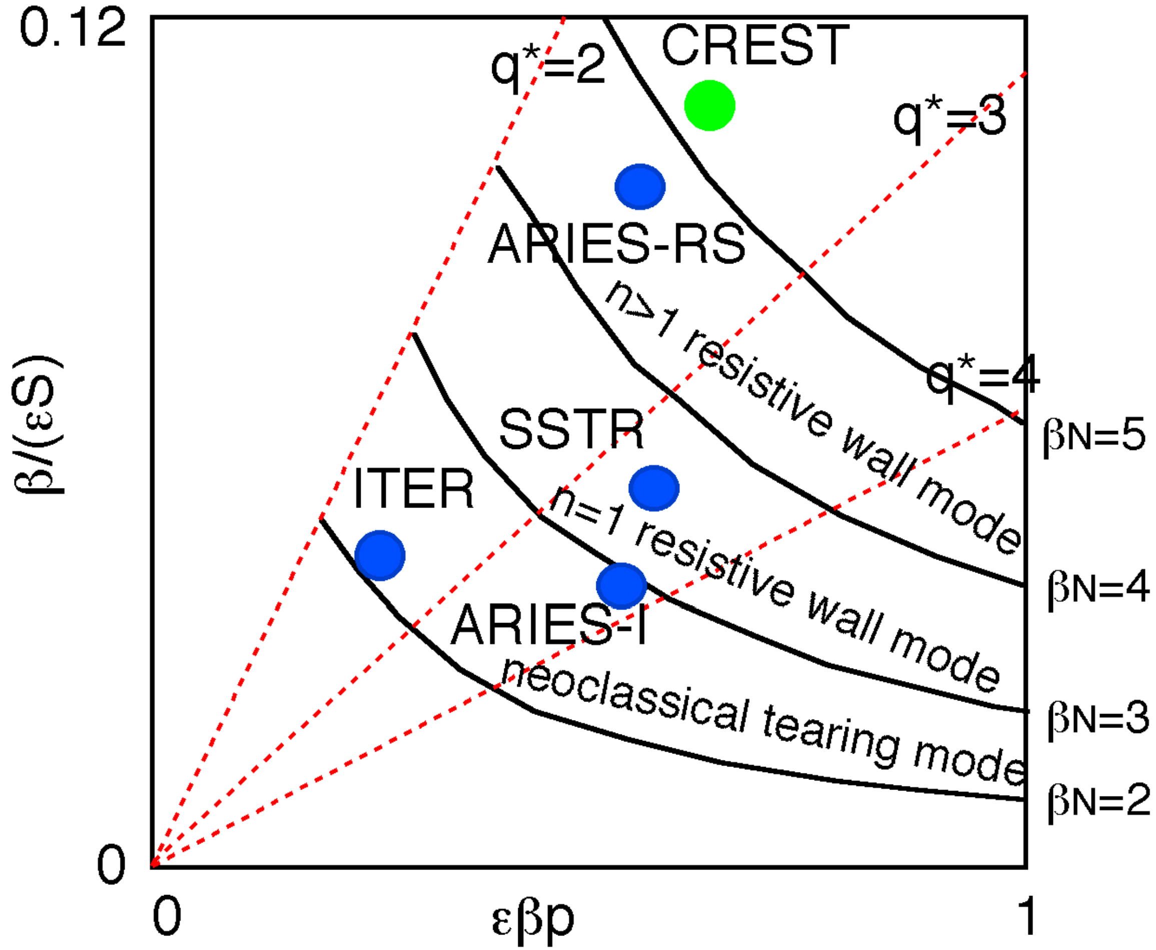
6. Heat and Particle control using the ELMs





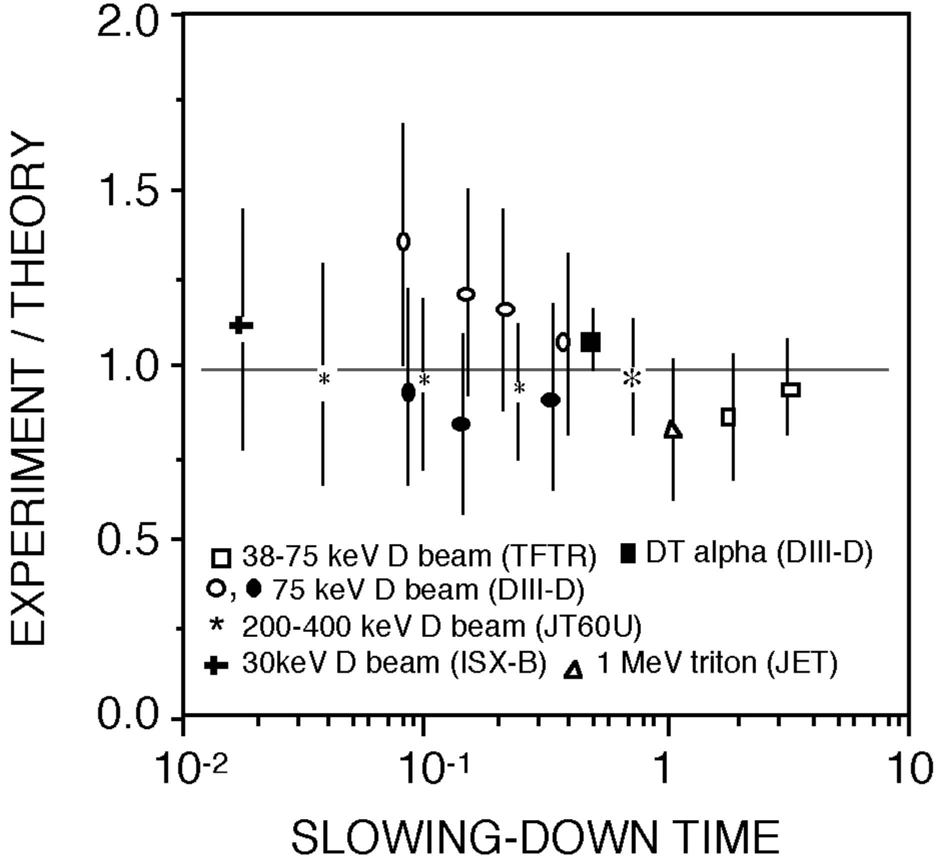
- Type II ELMs at high triangularity and in a high safety factor regime

Tokamak MHD operation region



Confinement of energetic particles

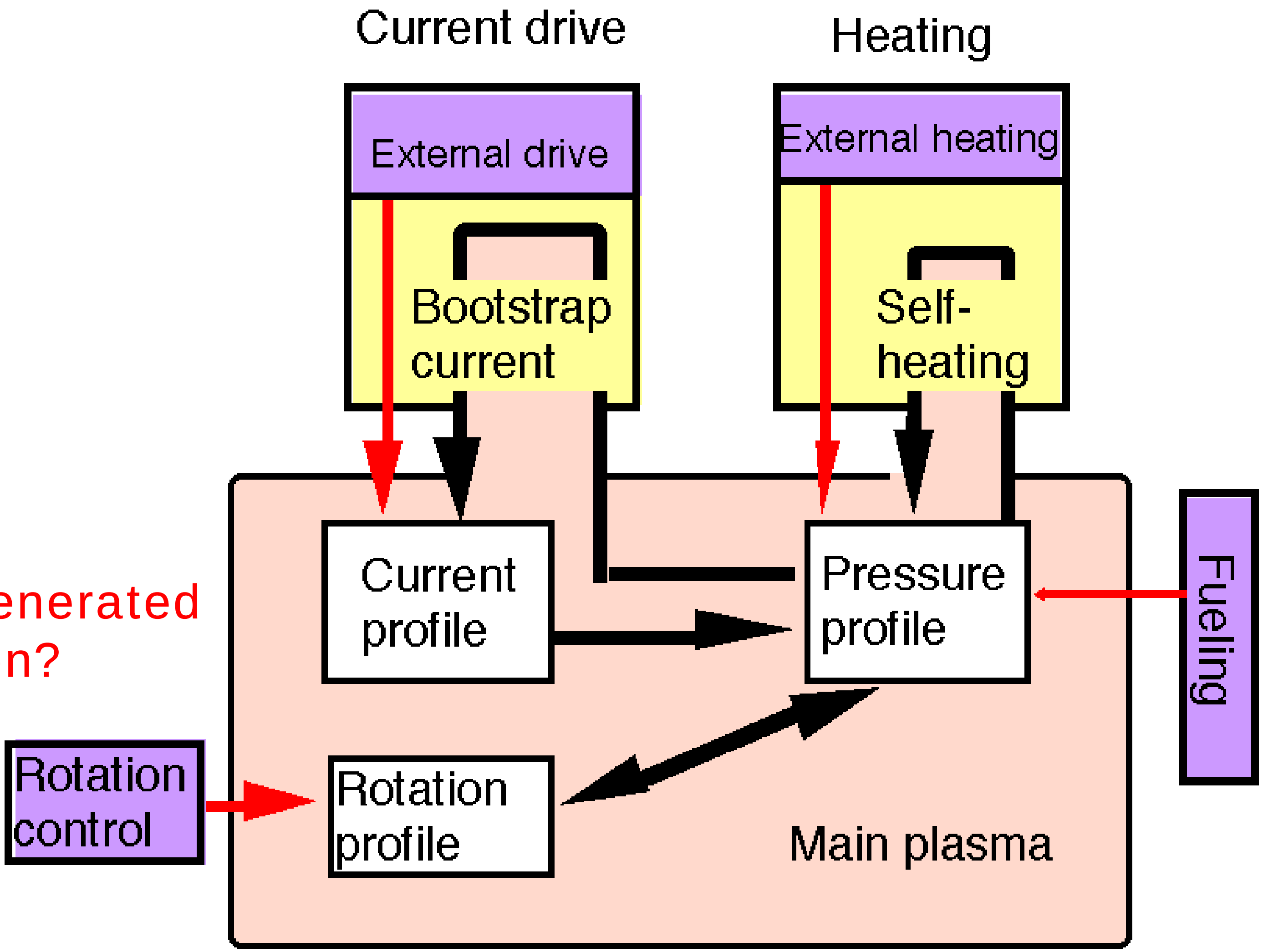
- Heating by energetic particles (alpha particles)
- Ripple loss
- Alfven eigenmodes (AE)



- The slowing-down time of energetic ions agrees well with classical estimate.

- The diffusion coefficient of energetic particles is consistent with the NC model.
  - orbit averaging
  - Small TAE due to small β_α

DT burning and burn control



Self-generated rotation?