Fusion Reactor Technology II
(459.761, 3 Credits)

Prof. Dr. Yong-Su Na

(32-206, Tel. 880-7204)

Contents

Fusion Plasma Technology

Reactor Technology

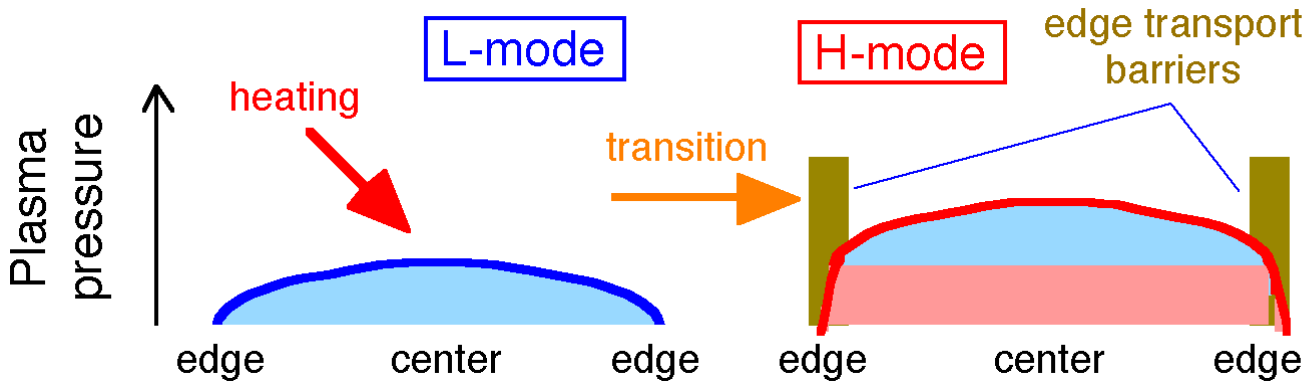
Blanket and Material Technology

Safety Technology

Operation and Maintenance Technology

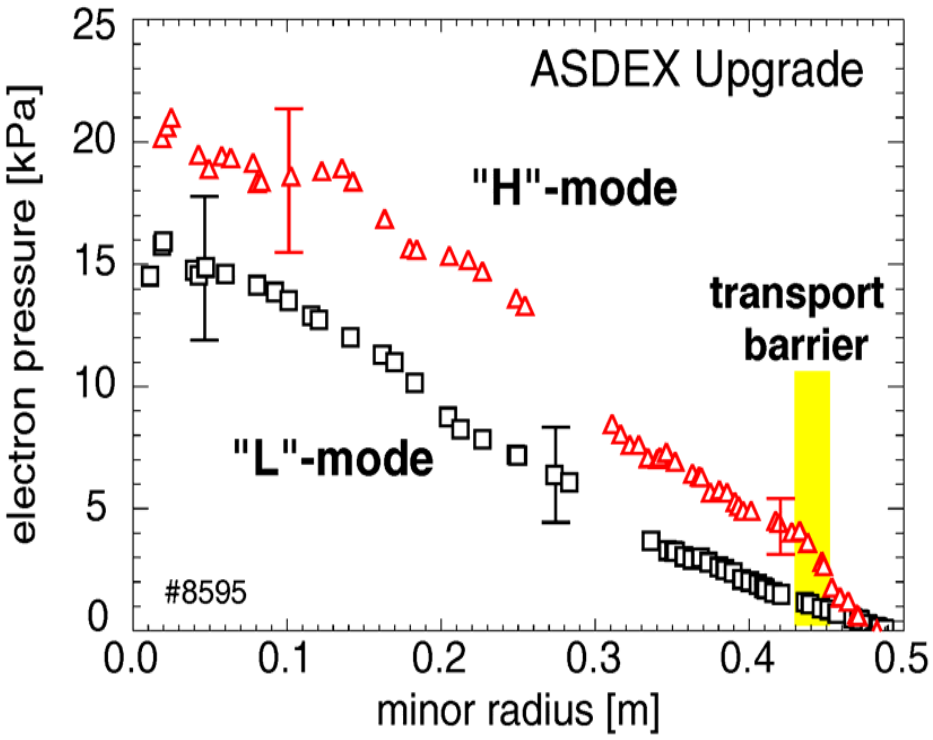
Issues and prospects for confinement performance

Confinement scaling



H-mode

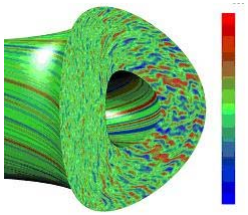
- 1982 IAEA F. Wagner et al. (ASDEX)

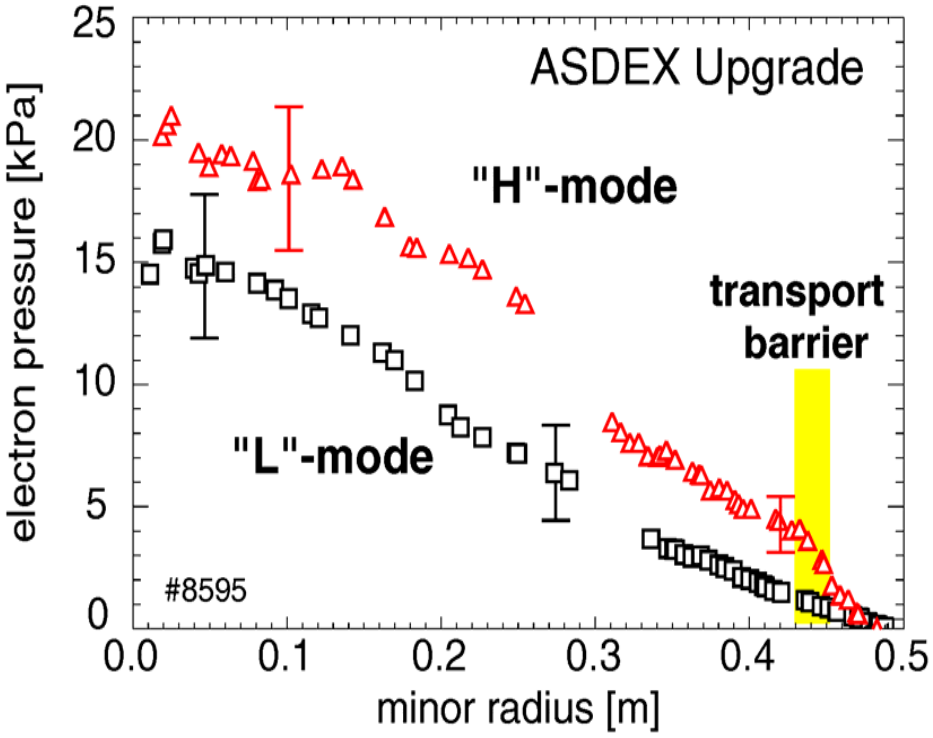


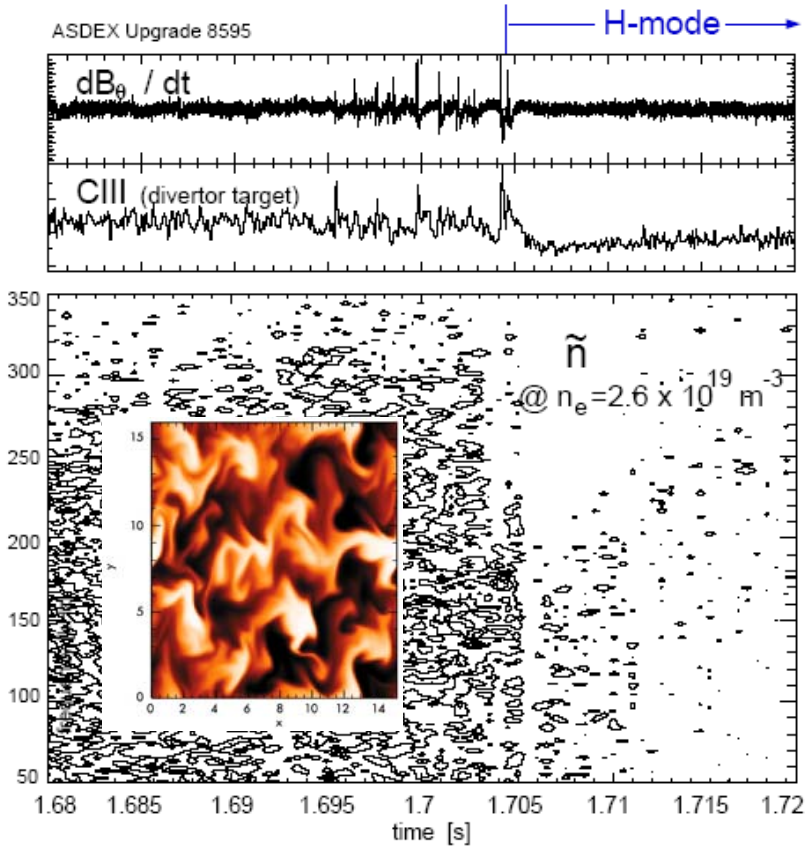
Hoover dam

H-mode

- 1982 IAEA F. Wagner et al. (ASDEX)

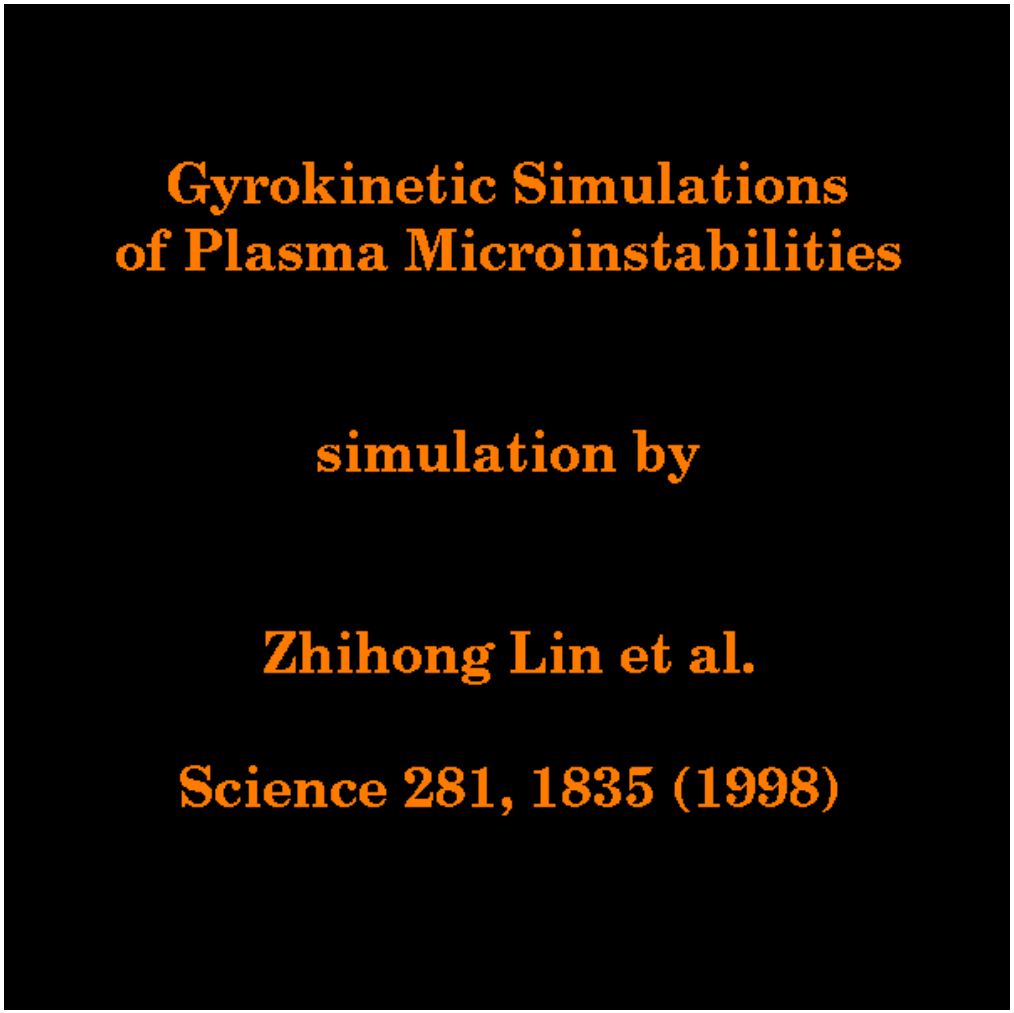




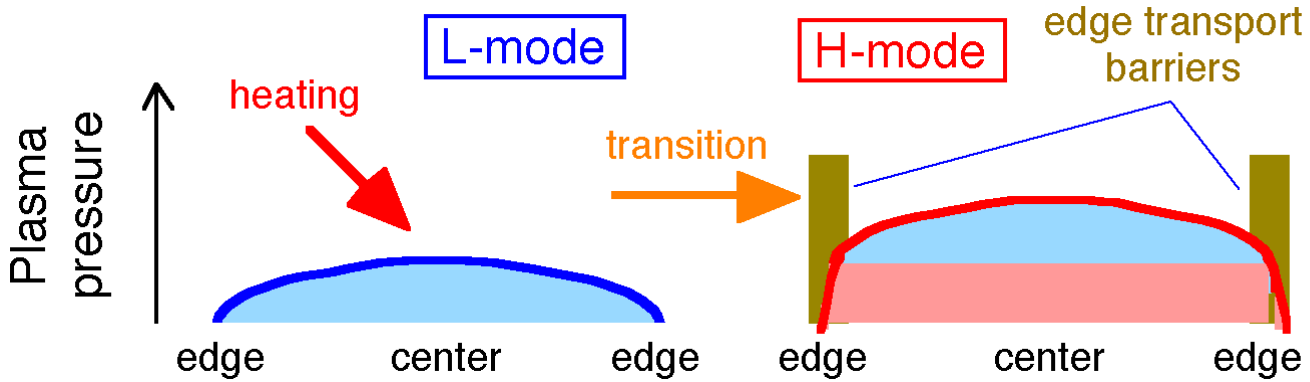


H-mode

- Turbulence Stabilisation



Confinement scaling



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

M for DT mixture?

$\chi \sim \frac{a^2}{\tau_E} \sim \chi_{Bohm} (\rho^*)^{\mu} F(\beta, \nu^*)$: nearly "Bohm" scaling ($\mu \sim 0$)

Why?

$$\chi_{Bohm} = \frac{cT}{eB}$$

HW: τ_E in dimensionless parameters

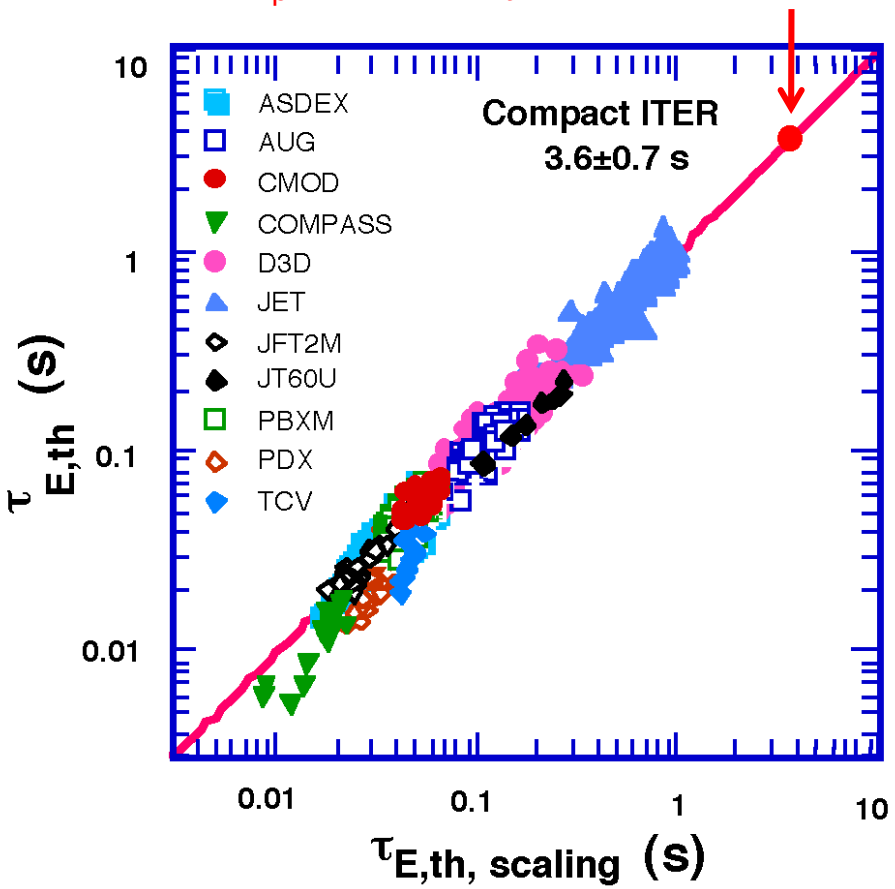
$\tau_{E,th}^{IPB98(y,2)} = 0.0562 M^{0.19} I_p^{0.93} B_t^{0.15} R^{1.39} a^{0.58} \kappa_a^{0.78} n_{19}^{0.41} P^{-0.69}$

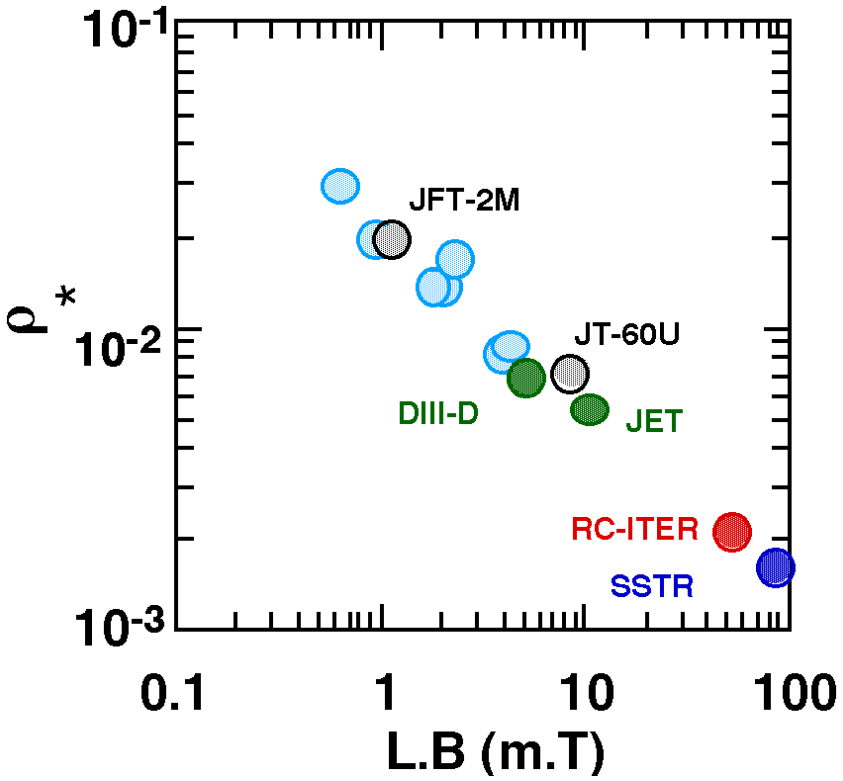
$\chi \sim \frac{a^2}{\tau_E} \sim \chi_{Bohm} (\rho^*)^{\mu} F(\beta, \nu^*)$: close to "gyroBohm" scaling ($\mu \sim 1$)

$$\chi \sim \left(\frac{\rho_i}{L}\right)\left(\frac{cT_i}{eB}\right) \qquad \left(\frac{\rho_i}{L}\right) << 1$$

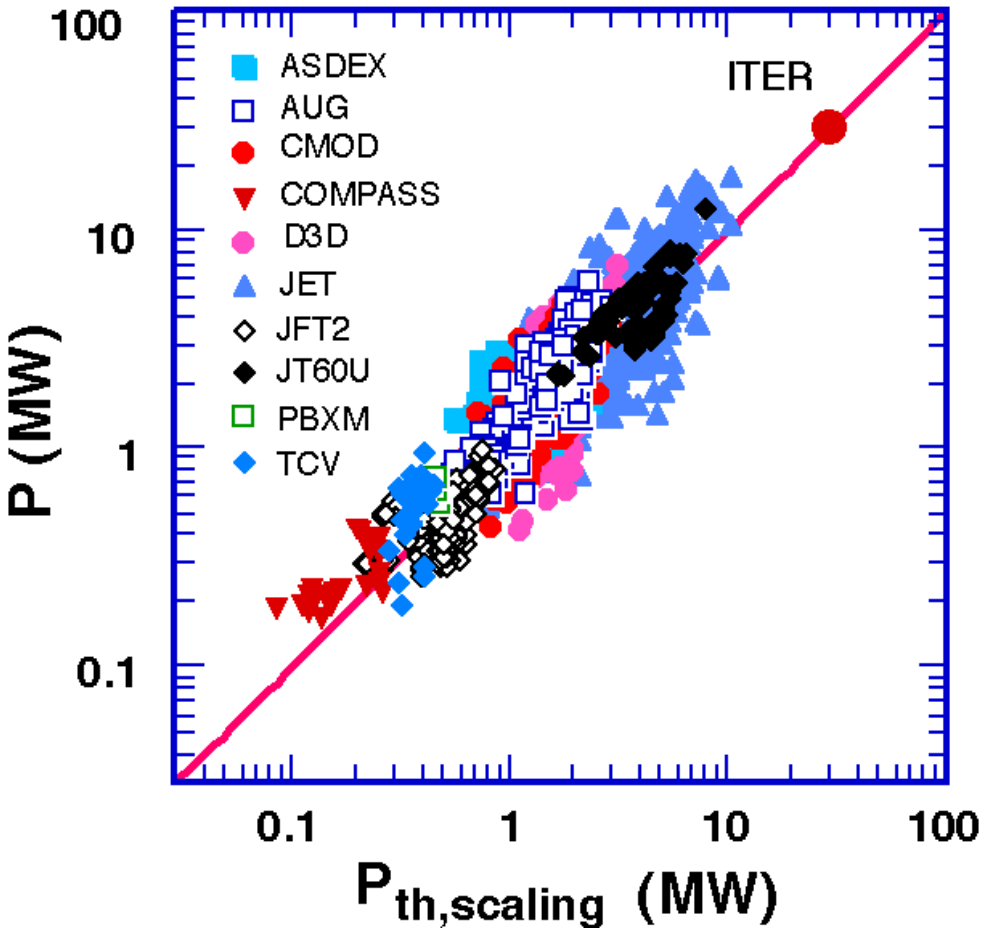
Confinement scaling

M=2.5, I_p=15MA, B_t=5.3T, R=6.2m, a=2.0m, κ_a=1.75, n_{19}=10, P=90MW





L-H transition threshold power



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

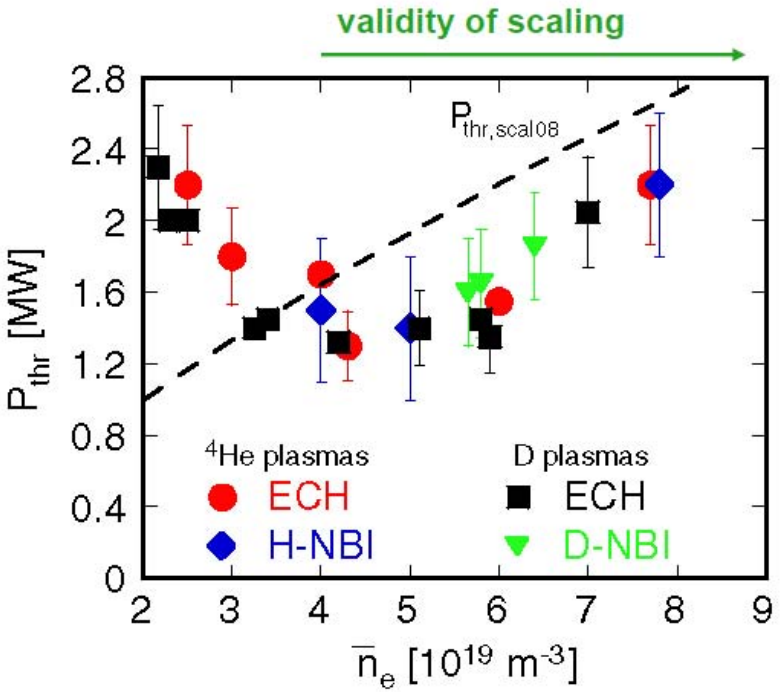
L-H transition threshold power

Progress in R&D - H-mode Access

Helium H-modes

- **Access to type-I ELMy H-modes during the non-active phase would have a significant impact on the ITER Research Plan:**
  - would allow, e.g., investigation and demonstration of ELM control
  - impacts on divertor changeout and deuterium operation ⇒ accelerates progress towards DT plasmas
- **AUG finds: P_{thresh} (He) ~ P_{thresh} (D)**
- **JET finds:**
  P_{thresh} (He) ~1.4 – 1.5 P_{thresh} (D)
- **Recent C-Mod results find:**
  $1.2 < P_{thresh}(He)/P_{thresh}(D) < 1.8$
- **More detailed studies are required**

ASDEX Upgrade Results



F Ryter et al, NF (2009) 062003