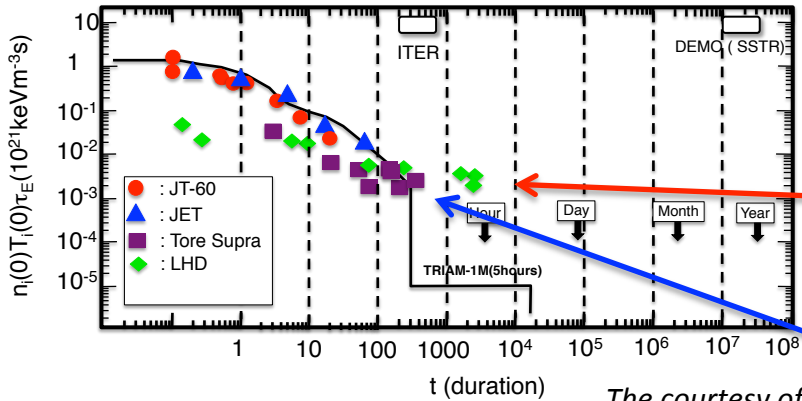


# EX7/3 Progress of High-Performance Steady-State Plasmas and Critical PWI issue in the LHD (H. Kasahara et al.)



The courtesy of  
M. Kikuchi in JAEA

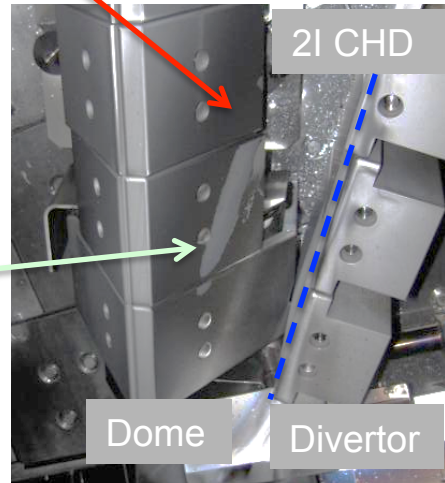
Improvements of Heating and PWI devices and the integrated plasma operation extend SSO regions:

- **The ultra-long pulse ( $\tau_d \sim 48$  min):**  
 $n_e \tau_E T_i \sim 3.5 \times 10^{18} \text{ keV m}^{-3} \text{ s}$ ,  $n_e \sim 1.2 \times 10^{19} \text{ m}^{-3}$ ,  $T_e \sim T_i \sim 2 \text{ keV}$ ,  $P_{RF} \sim 1.2 \text{ MW (ICH+ECH)}$ ,  $P_{inj} \sim 3.4 \text{ GJ}$ .  
 $(\tau_E \sim 2P_e / 0.7 * P_{RF})$
- **The long pulse ( $\tau_d \sim 6$  min):**  
 $n_e \sim 3.3 \times 10^{19} \text{ m}^{-3}$ ,  $T_e \sim T_i \sim 1.5 \text{ keV}$ ,  $P_{RF} \sim 2.3 \text{ MW (ICH+ECH)}$ . (Extending to high power SSO region)

**Carbon rich mixed-material layer (densely, hard and brittle) was covered on the dome plates (C > 90%, Fe ~ a few %)**

**The layer was grew around The geometrically dense region and large heat flux  $\Gamma_{heat} \sim \text{MW/m}^2$ -class.**

**The thick layer was easily exfoliated during SSO. (the ultra-long pulse plasma was broken by the exfoliations (12 cm x 10 cm))**



**High-performance SSO caused thick Carbon-rich mixed-material layer:**

- **Affect to the particle balances:**  
 $10.1(t < 300s) \rightarrow < 0.2(t = 500 \sim 1300s)$   
 $\rightarrow 1.5 \times 10^{19} (t > 1500s) \text{ He/s}$
- **Impurity sources at plasma edge:**  
**The thickness  $\sim 40 \text{ nm}/10000 \text{ sec}$**   
**Capture particles  $\sim 2.3 \times 10^{18} \text{ He/s}$**   
**(The layer covers 1/5 of the surface of the vacuum vessel.)**