## §11. Plasma Collapse by Externally Injecting Fe Pellet

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The plasma collapse has been frequently observed at the end of the long-pulse plasma operation. There are two main causes: One is out-gassing of hydrogen from the hot divertor plates, which was easily overcome by many long-pulse plasma discharges within a few experimental days. The other is metal impurity penetration to the plasma. When the input heating energy exceeds 300~400MJ and the divertor temperature consequently reaches to about 500°C, many brilliant objects have been observed to penetrate to the plasma. The typical plasma collapse is shown in Fig.1. In this plasma operation the plasma was sustained for 1,641 seconds. At 1,641.34 seconds the hot impurity (Fe) penetrated to the plasma starting from the inner graphite divertor tiles. Simultaneously the decrease in the electron temperature and the increase in electron density, the radiated power, and the intensity of FeX line were observed as shown in Fig.1. In this case the reflected RF power was not increased, so the interlock system did not trip the RF generator. However the RF power was manually stopped 2 seconds later judging that the plasma would not be restored.

A series of the experiment was carried out to examine how large Fe pellet collapsed the ICRF heated plasma by externally injecting Fe-pellets, which was coated by graphite C. Time evolutions of plasma parameters are plotted during the plasma collapse, in which the Fe/C pellet with 250μm was injected. Here the initial plasma was produced by ECH (Electron cyclotron heating, f=82.6GHz) of ~100kW. Then the ICRF heating power of 0.7MW was added to sustain the plasma and the Fe/C pellet was injected at 6 seconds. The sudden decrease in $T_e$ and the sudden increase in FeX were similarly observed as observed in the long-pulse operation seen in Fig.1. Here a ratio of $W_{pa}$ to $W_{pb}$ was employed to evaluate the plasma collapse: $W_{pa}$ and $W_{pb}$ are the plasma-stored energy after and before the plasma collapse. In Fig.3 $W_{pa}/W_{pb}$ is plotted against the number of injected Fe atoms. It was found that the Fe sphere with diameter of 230μm was a critical size for the plasma collapse. We found many thin flakes consisting of Fe and C layers of a few μm thickness on the divertor plates. When the flake of a few $mm^2$ penetrates to the RF heated plasma, it is thought that the plasma must be collapsed.

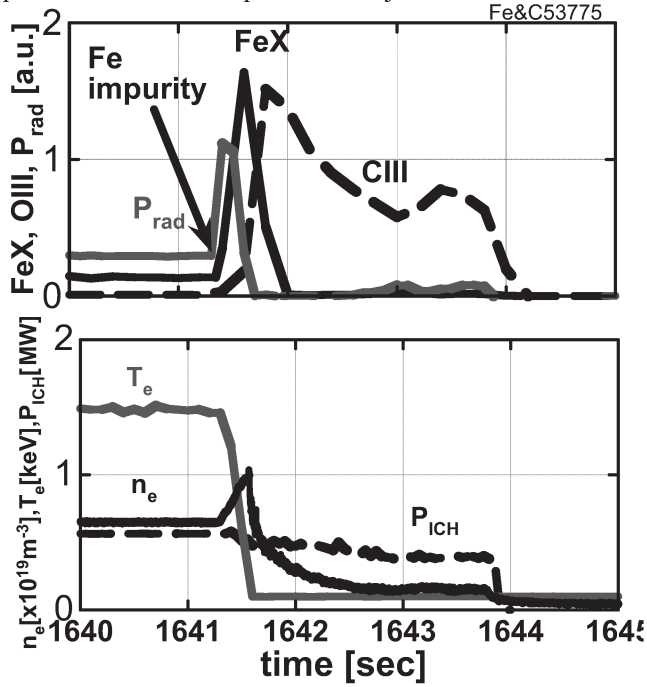


Fig.1 Time evolutions of plasma parameters at plasma collapse (~1641sec) by penetrating Fe impurity in long-pulse plasma operation.

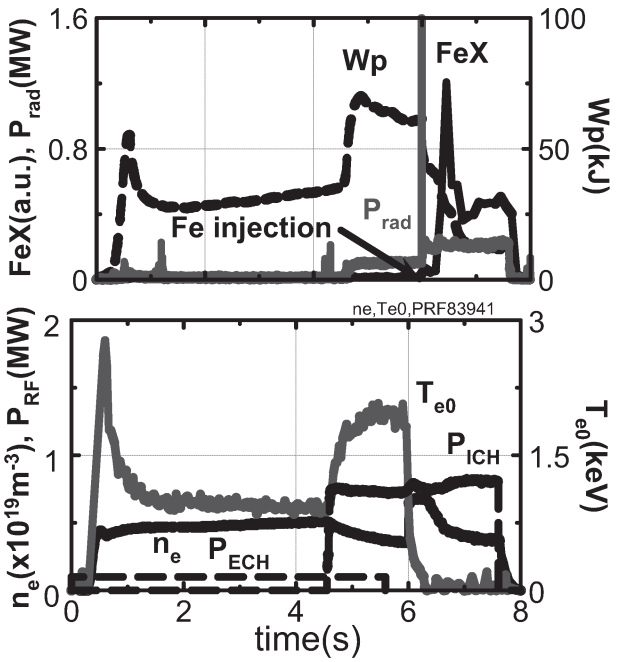


Fig.2 Time evolutions of plasma parameters in plasma collapse experiment by externally injecting Fe pellet.

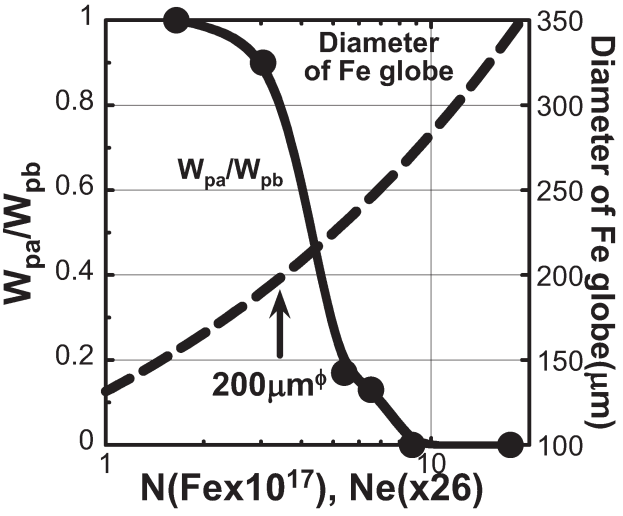


Fig.3 Dependence of plasma collapse on injected ion atomic number: It is evaluated by ratio of plasma-stored energy after to that before injection Fe pellet.