charges are hence usually characterized by a high electron density or by an enhanced concentration of impurities.

We report here an analysis of experiments devoted to investigation of the radiative power losses and the global energy balance under various discharge conditions on the CASTOR tokamak. Some local features of the electron component, especially at high density discharges, are illustrated by an approximate analytic solution of a simplified model of the energy balance (section 2.2). The electron density has also been increased till the stability limit and discharges with disruptions have been studied as well (section 3).

Before describing results obtained, we mention briefly the diagnostics used. The plasma current I_p and loop voltage U_{loop} were monitored to determine the ohmic heating power $P_{OH} = I_p U_{loop}$. Line averaged electron density $\bar{n}_e$ was measured by a 4-mm interferometer. Radiative losses P_{RAD} were registered by an absolutely calibrated pyroelectric detector ($LiTaO_3$) [3], located toroidally 90° away from the limiter. More detailed description of the function of this pyroelectric detector is given in [4]. An absolutely calibrated VUV monochromator ($\lambda = 50$—610 nm) [5] was used for monitoring different spectral line intensities. Plasma magnetohydrodynamic (MHD) activity was detected by four magnetic probes, distributed uniformly around the liner and registering the fluctuations of the poloidal magnetic field.

2. ENERGY BALANCE

2.1. Experiment

Figure 1 presents typical temporal evolution of various characteristic parameters of the discharge: plasma current I_p, loop voltage U_{loop}, line average electron density $\bar{n}_e$ and radiative power P_{RAD}. All experimental results, presented below, have been obtained in hydrogen at the toroidal magnetic field $B_T = 1{\cdot}3$ T. Plasma current I_p reaches its maximum value at about $t = 1$ ms and since $t = 2$ ms it is, together with the loop voltage, approximately constant until $t = 6{\cdot}5$ ms. This quasistationary time interval has been used for the energy balance analysis. Plasma density is controlled by an impulse gas puffing. Radiative power losses are in the range of 10 kW in the presented case, i.e., they are approximately (30—40) % of the OH power.

Figure 2 shows the dependence of the ohmic and radiative powers on the average density $\bar{n}_e$ at different values of the plasma current. It may be seen that the absolute value of the radiative power does not depend substantially on the plasma current while it increases, in all of the investigated cases, approximately proportionally to the density. According to commonly used expression for the radiative power [6] $P_{RAD} = \bar{n}_e^2(\bar{Z}_{eff} - 1)$, this fact indicates the decrease of the effective plasma charge with increasing plasma density. It is in accordance with the spectroscopic measurements carried out in [5] as well. Consequently, for a given density, the relative radiative losses P_{RAD}/P_{OH} decrease with increasing plasma current.

Because of lack of sufficient experimental data on radial profiles, we have no possibility to investigate the problem locally; our aim is to estimate the role of different energy loss channels in the global plasma energy balance only. Therefore using

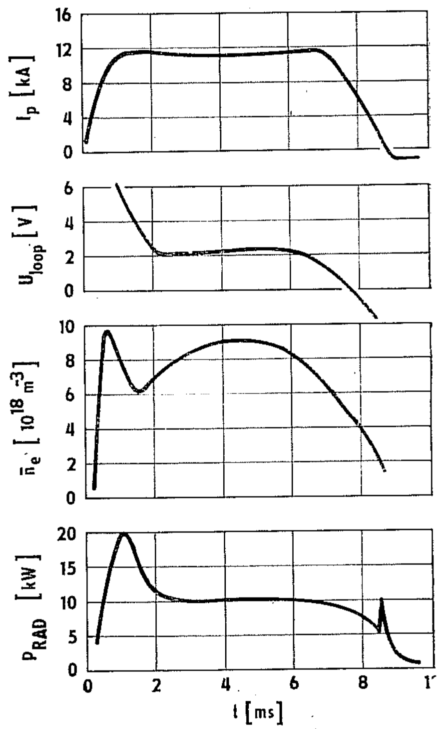

Fig. 1. The evolution of a low density discharge on the CASTOR tokamak. I_p — plasma current, U_{loop} — loop voltage, $\bar{n}_e$ — line average density, P_{RAD} — radiated power measured by the pyroelectric detector; toroidal magnetic field $B_T = 1{\cdot}3$ T.

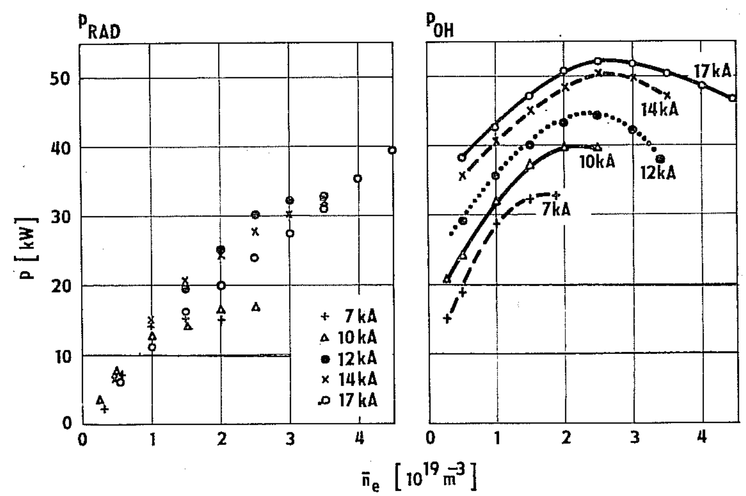

Fig. 2. Radiated P_{RAD} and ohmic heating P_{OH} powers versus line average density $\bar{n}_e$ for a few typical values of plasma current.