quently the efficiency of the RF current drive. Such toroidal electric field is created in our noninductive experiment mainly due to the inductance of the plasma loop ($E_T = U_{loop}/2\pi R = (L_p/2\pi R)$. $(dI_p/dt) \simeq 0{\cdot}1$ V/m), see fig. 4d. Especially during the I_p ramp-up phase ($t \lesssim 5$ ms) this electric field acts against the RF current drive and the counter-current caused by this field can achieve several tens of amperes. This fact should have negative influence on the LHCD efficiency as well.

While the ECR radiation is not measurable during the initial phase of the discharge (limited bandwidth of the 8 mm waveguide receiver), quite a noticeable level of the signal is observed after that phase until the end of the RF pulse. It indicates the presence of an overthermal component in the electron distribution function. However, no hard X-ray emission ($E \gtrsim 150$ keV) was registered. It shows that no electrons with corresponding energy are produced. This is an additional argument for the above-mentioned statement that the current is driven by the high $N_{\parallel}$ part of "parasitic" branch of the spectrum only.

Evolution of spectral line intensities exhibits a sharp peak at the moment of maximum plasma density. It should be noted that the line CV with a high value of the excitation potential reaches its peak value at the same time as the lines H_β and CIII (see fig. 4f, g, h).

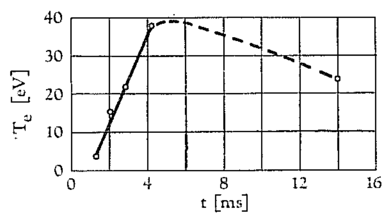

Fig. 5. Evolution of electron temperature.

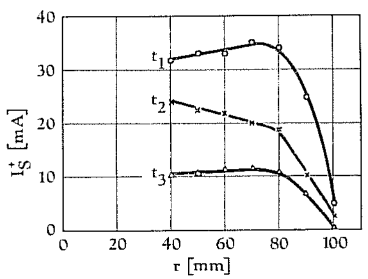

Fig. 6. Radial profiles of the ion saturated current at times $t_1 = 1{\cdot}3$ ms, $t_2 = 2{\cdot}8$ ms and $t_3 = 14$ ms.

According to the probe measurements, the electron temperature T_e increases smoothly from $T_e = 4 \div 5$ eV until the maximum value of the plasma current is reached ($t \simeq 5$ ms), where it amounts to a value of about 40 eV (see fig. 5). The radial profiles of the ion saturated current (see fig. 6) are rather flat or sometimes even hollow. It is necessary to note that the local electron density evaluated from probe measurement at $r = 40$ mm is $2-3$ times greater than the line average density n_e measured along the central chord by a 4 mm interferometer.

According to the probe measurements the energy confinement time $\tau_E = Q/P_{inc}$ (Q – total energy in the plasma column) has been estimated as $30 \div 40$ μs at the beginning of the discharge. Such a low value of τ_E is not surprising as, owing to a low value of the generated toroidal current (insufficient to establish the rotational transform), there is no real confinement in the given toroidal configuration.

The plasma density, as well as the driven toroidal current, depends only weakly on an initial pressure of the working gas. An effective breakdown has been achieved, however, only for hydrogen pressure greater than $p_{H_2} \simeq 34$ mPa.

As we have mentioned above, the experiment was performed at a zero level of the external compensating magnetic fields $B_\perp$. We have found that any other value of $B_\perp$ makes the RF breakdown difficult. It can be explained by a substantial elimination of the stray magnetic fields in comparison with the standard inductive breakdown, as a consequence of the transformer short-circuiting and owing to the very low toroidal magnetic field during the breakdown. Therefore, any external perpendicular field increases vertical helicity of the toroidal field lines and consequently enhances the plasma losses.

4. SUMMARY AND CONCLUSIONS

Preliminary results of a RF plasma formation in a tokamak during ramp-up of the toroidal magnetic field are reported. When ECR condition for a given pumping frequency is fulfilled inside the vacuum chamber, a plasma with the density about $\bar{n}_e = 2 \times 10^{18}$ m^{-3} and a temperature of a few tens of electronvolts is formed. After that the plasma is sustained during the whole RF pulse, even when ECR zone is already outside the plasma (we have observed such an effective absorption of RF power for frequencies much lower than f_{ce} earlier in linear [5] and toroidal devices [8] for B_T = const.). Moreover, the toroidal current generated by a RF wave is also observed. RF-sustained plasma has an overthermal character. However, after a few milliseconds the plasma density and current fall down as a consequence of a poor confinement. To reach a tokamak regime of the CASTOR, it is necessary to ramp up the plasma current substantially. There are two possibilities how to do it:

(i) According to our opinion it is necessary to use a controlled or at least a preprogrammed power source for vertical compensating field just after the ECR breakdown. In that case more suitable conditions for confinement of current carrying electrons will exist and it should be possible to ramp up the plasma current by the same or maybe an additional waveguide grill.

(ii) To use the RF breakdown for generation of the sufficiently dense target plasma for the inductive-driven discharge (i.e., RF preionization). In that case we will be able to control the evolution of the loop voltage and ramping-up of the inductive plasma current. Furthermore, such experimental arrangement enables us to study simultaneous ramp-up of I_p and B_T (to keep the safety factor q_a close to constant). Recently it has been found on JET that higher values of I_p can be reached under such conditions without any increase of MHD activity [9].

In both cases an effective prolongation of the tokamak pulse can be achieved (up to about 50 ms in our case) without any additional demands on the toroidal field capacitor bank.