DYNAMICS OF PLASMA PHENOMENA IN "PLASMA FOCUS" UNDER THE ACTION OF POWERFUL LASER RADIATION

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V.A. Gribkov, A.V. Dubrovsky, N.V. Kalachev, T.A. Kozlova and V.Ya. Nikulin.

P.N. Lebedev Physical Institute, U.S.S.R. Academy of Sciences, Leninsky prospect 53, 117924 Moscow, U.S.S.R.

A combined beam-laser method (CBLM) for plasma heating up to thermonuclear temperatures has been proposed in papers /1,2/. An installation of "Plasma Focus" (DPF) type has been used as the relativistic electron beam (REB) source /1/.

1.The influence of a powerful laser radiation (PLR) on plasma phenomena in the DPF at the magnetohydrodynamic stage is discussed in the present paper.Experiments have been carried out on the installation "FLORA" specially designed for CBLM investigations /3/. The DPF parameters are the following: capacitor bank energy, 50kJ; neutron yield, 5.10^9 n/pulse; maximum current, 800 kA. The Nd-glass laser has the following parameters: pulse duration, 2 nsec; energy, 500 J. We have used the following diagnostic methods: simulta - neous Ru-laser 5-frame interferometric and shadow photography, soft X-ray pin--hole camera, mica convex spectrograph, and the temporal evolution of hard X-ray radiation (E > 80 keV).

2. The typical 5-frame interferograms, pin-hole picture and shadowgram obtained during one "shot" without PLR are shown in Fig. 1.

1. Gribkov V.A., Krokhin O.N. et al.Pis'ma JETP 1973, v.18, N 9, 541.
Afanasiev Yu.V.,Basov N.G. et.al.Trudy FIAN (Proc.Lebedev Institute) 1978, Moscow, "Nauka", v.103,,202-230.

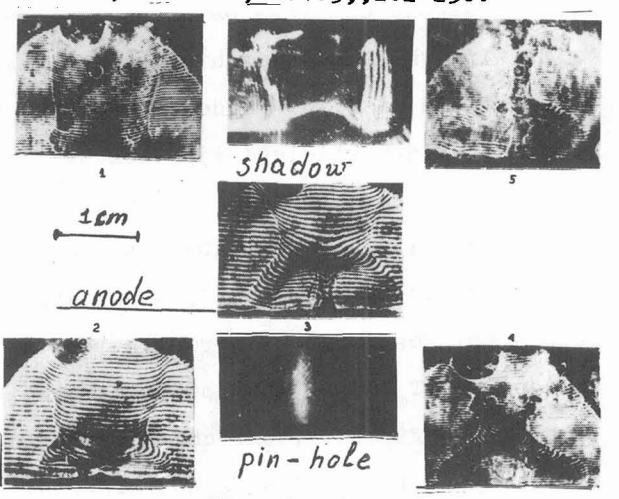

Fig. 1.
The window diameter is 4 cm.

2. Gribkov V.A. et al. JETP Lett., 1977, v.26, N 4, 209-214.
3. Veretennikov V.A., Gribkov V.A. et al. Proc.of the XIII Conf.on Phenom. in Ionized Gases, 1977, Berlin, 881-882.

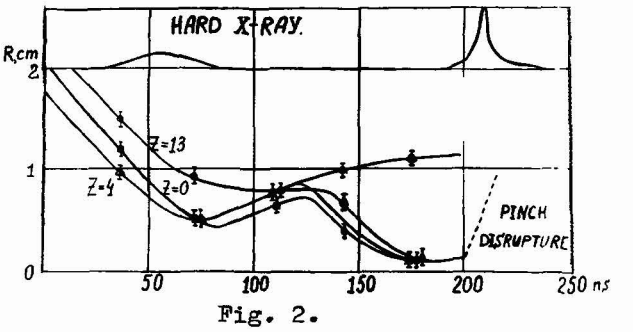

Fig. 2.

Fig. 2 presents R-t diagrams of the pinch in the DPF in respect to hard X-ray pul - ses. We have observed two compression

phases of the DPF with the time interval of 100 nsec.The minimum pinch radius at the moment of the first compression is about 5 mm, that is good agreement with the bright image of plasma column given by the pin-hole pictures. The electron density at this moment is $4 \times 10^{18} cm^{-3}$. The shadowgrams show a strong anode (Cu) erosion during the first compression.

The second compression in the DPF begins with the pinch catching by the magnetic field near the anode , resulting in considerable particles' ejection to the vertical direction.In this case the linear plasma density decreases by one order of magnitude up to $3.10^{17} cm^{-1}$, the sharp pinch compression to the radius 1 mm takes place, and T_e appears to be in keV region, that is confirmed by the characteristics of the line impurities' spectra.At this stage the pinch life-time is about 20-30 nsec.Then, the pinch is rapidly disrupted, and the hard X-ray burst is observed.

4. Veretennikov V.A., Gribkov V.A. et al. Proc.of IV S.U.Confer.on Plasma Accelerators and Ion Injectors, 1978 Moscow, VNTIC, 84-85.

5. Vikhrev V.V. et al. "Plasma Physics and Contr.Nucl.Fusion Res.", IAEA, 1977

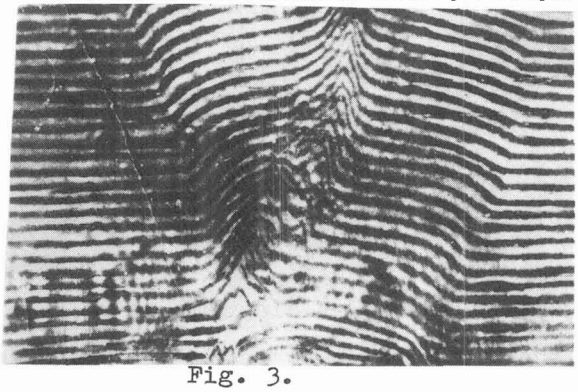

Fig. 3.

Fig. 3 shows the DPF interferogram after the action of PLR focused on the anode with flux of 10^{12} W/cm^2. Due to the action of PLR 30-50 nsec before the first compression stage there takes place the formation of the evaporated copper flare that moves vertically with the speed of 3.10^7cm/sec.In this case pin-hole picture shows the luminous "plume" 3mm in diameter, which coincides with the one on interferograms.The second compression is not observed due to PLR interaction with DPF.One may observe the rapid pinch disrupture accompaning hard X-ray and neutron bursts /4/.

3.Observed pinch catching near the anode may be explained by strong anode erosion, resulting in plasma conductivity decrease. Conductivity decrease may be caused by exitation of plasma instabilities. These processes result in current sheath perturbations /5/, and are responsible for sharp pinch catching near the anode zone after PLR action.The energy of the observed Cu streams consisting of 30keV ions does not exceed 30J.Existance of such thin Cu-ion stream seems to indicate the presence of magnetic field inside the pinch of the order of 10^5G.

In this way the performed experiments revealed PLR interaction with DPF to have essential influence on the dynamics of plasma phenomena in DPF, and may lead to new possibilities in CLBM experiments.

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