# Warm dense matter generation and DD synthesis at vacuum discharge with deuterium-loaded Pd anode.

Yu. K. Kurilenkov, V.P. Tarakanov, S.Yu.Guskov[1]

*Joint Institute for High Temperatures of Russian Academy of Sciences, 13/19 Izhorskaya Str., 125412 Moscow, Russia (yukurilenkov@rambler.ru)*
*[1]Lebedev Physics Institute, 119991 Moscow, Russia (guskov@fci.lebedev.ru)*

The energetic ions and DD neutrons from microfusion at the interelectrode space of a low energy nanosecond vacuum discharge has been demonstrated recently. To understand better the physics of fusion processes the detailed PIC simulation of the discharge experimental conditions have been developed using a fully electrodynamic code. The dynamics of all charge particles was reconstructed in time and anode cathode (AC) space. The principal role of a virtual cathode (VC) and the corresponding single and double potential well formed in the inter-electrode space are recognised. The calculated depth of the quasi-stationary potential well (PW) of the VC is about 50-60 kV, and the $D^+$ ions being trapped by this well accelerate up to energy values needed to provide collisional DD nuclear synthesis. Both experiment and PIC simulations illustrate very favourable scaling of the fusion power density ($\sim 1/r^4$) at decreasing of VC radius for the chosen inertial electrostatic confinement fusion scheme based on nanosecond vacuum discharge. Meanwhile, the initial stage of discharge is understood still poorly. When voltage is applied, the electron beam extracted from cathode starts to interact with the surface of Pd anode loaded by deuterium. This early stage of discharge manifests sometime the peaks registered by photomultipliers which are similar to neutron ones from time-of-flight measure used under study of collisional DD synthesis at the further stage of discharge. The detailed study of Pd anode surface morphology have been performed and recognized, in particular, the number of various pores and craters of different sizes. We remark that besides of rather usual craters (due to electron beams – anode interaction) some of the craters on the Pd anode surface may correspond to anode ectons (explosive centers) and discuss their possible nature. Specifics of warm dense matter (WDM) generated at different stage of discharge is discussed. The data obtained are compared with recent results on initiation of DD –reactions by electron beams at deuterium loaded Pd samples and correspondent data on their surface morphology.