On DD and proton – boron burning at inertial electrostatic confinement in nanosecond vacuum discharge. Experiment and PiC simulations

Yuri K.KURILENKOV [1], Sergey Yu.GUS'KOV [1,2] and Vladimir P.TARAKANOV [1]

1) Joint Institute for High Temperatures, RAS, Moscow, Russia

E-mail: kurilenkovyuri@gmail.com

2) Lebedev Physical Institute, RAS, Moscow, Russia

Inertial electrostatic confinement (IEC) fusion represents rather old branch of controlled thermonuclear fusion study [1-3]. However, at traditional schemes of IEC [2] with beam-like distribution of ions by energies the high fusion power density is incompatible with high efficiency $Q = E_{fusion}/E_{input}$. To try to overcome at least partially this problem, it have been suggested at LANL at the end of 90-th [4] to inject the electron beams into internal space of grid-like cathode sphere. In this case the potential (of parabolic type) will appear at inter electrode space, where the ions will undergo harmonic oscillations. This variant of IEC have been titled as periodically oscillating plasma spheres (POPS) and this scheme have been demonstrated in experiment successfully also [5]. At the moment of throw out the ions are practically stopped, and ions subsystem turns out to be strongly coupled. At the next moment ions are accelerating at the potential well (PW) of virtual cathode (VC) up to fusion reactions at PW "bottom", where, for example, head-on collisions of deuterons leads to DD fusion with corresponding neutron yields. Collapses of deuterons during their periodic oscillations at PW provide the pulsating neutron yield. At the present work the results of table-top experiment on DD fusion, where IEC at POPS-like scheme with VC have been realized on the basis of miniature nanosecond vacuum discharge (NVD) in cylindrical geometry, are compared with the data on PiC modeling of particle dynamics and DD neutrons yield in NVD on the framework of fully electrodynamic code KARAT [6]. Remark, in the experimental set-up presented [6] we don't need to inject synchronized electron beams additionally (as in [5]) since we have the streams of auto electrons from cathode which are appearing automatically when just the voltage applied. Looking forward to future experiments, the results of PiC modeling of proton– boron nuclear burning ($p+{}^{11}B \rightarrow \alpha + {}^{8}Be \rightarrow 3\alpha$) at IEC scheme based on NVD are presented and discussed in detail also [7].

This work was supported by a grant No. 14-50-00124 of the Russian Science Foundation.

References

[1] O.A.Lavrent'ev, On the History of Thermonuclear Synthesis in USSR (Kharkov PhTI 2012)

[2] G.Miley and S.K.Murali, Inertial Electrostatic Confinement (IEC) Fusion (Springer 2014)

[3] W. C. Elmore, J. L. Tuck and K. M. Watson, Phys. Fluids **2**, 239 (1959)

[4] R. A. Nebel and D. C. Barnes, Fusion Technology **38**, 28 (1998)

[5] J.Park, R.Nebel et al Phys. Plasmas **12** 056315 (2005)

[6] Yu. K. Kurilenkov, V.P.Tarakanov et al J. Phys. Conf. Ser. **653**, 012025 (2015)

[7] Yu. K. Kurilenkov, V.P.Tarakanov and S.Yu.Gus'kov, J. Phys. Conf. Ser. **774**, 012133 (2016)