Optimization of a neutron source parameters based on mirror trap restricted by dclc instability development [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2020.47.1.217

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One of the possible applications for mirror traps is their use as a source of D-T neutrons in hybrid fusion-fission reactors. The most important parameter in this case is the efficiency of neutron production:

*Qpl* = *PDT* / *Pin*, (1)

where *Pin* is the power introduced into the plasma, and *PDT* is the power of the fusion reactions got by neutrons. This work is a continuation of [1], the objective is to find the parameters of an axially symmetric mirror device providing the maximum value of *Qpl*. The microstability of plasma in [1] was estimated as follows:

*K* = *tkin* / *tgd* < *Kcrit*, (2)

where *tkin* and *tgd* are the confinement times of warm ions in the kinetic and gas-dynamic modes, and *Kcrit* is a value of the order of one. In this paper, the procedure for selecting acceptable device configurations included a direct test of stability against drift-cyclotron loss-cone (DCLC) and double-humped (DH) modes.

The DOL code [2] was used as the main tool of numerical simulations. The underlying theoretical model assumes the division of the ion distribution function into two parts. The first is fast ions, which have a low collision frequency. Their distribution function is found from the solution of the kinetic equation averaged over the period of longitudinal motion. The second is warm ions with a high collision frequency. Their confinement is determined by the equations of balance of particles and energy.

A device with an equal ratio of deuterium and tritium isotopes and a longitudinal magnetic field profile close to a "rectangular well" is considered (the field value is almost constant in the main cell and rapidly increases near the mirrors). The magnetic field inside the mirrors is 25 T, the mirror-to-mirror distance is 20 m. the Energy is introduced into the device by injection of atomic beams with a power of *Pin* = 100 MW. The stability of the plasma was checked by the dispersion relation from [3]. To adopt it the ion distribution functions must be expressed by the sum of Gaussian profiles. The distribution of each component is approximated by the sum of two profiles. For fast ions the parameters were determined by the least squares method according to the calculated distribution function. For warm ions, the degree of loss cone filling was estimated.

As a result, it is shown that the restriction (2) is qualitatively true, and the maximum value of *Qpl* is several percent, which agrees with the results of previous calculations [1].

References

1. D.V.Yurov, V.V.Prikhodko. Optimization of a mirror-based neutron source using differential evolution algorithm. Nuclear Fusion, v. 56, iss. 12, p. 126003 (2016).
2. D.V.Yurov, V.V.Prikhodko, and Yu.A.Tsidulko. Nonstationary Model of an Axisymmetric Mirror Trap with Nonequilibrium Plasma. Plasma Physics Reports, v. 42, n. 3, pp. 210-225 (2016).
3. I.A.Kotelnikov, I.S.Chernoshtanov, V.V.Prikhodko. Electrostatic instabilities in a mirror trap revisited. Physics of Plasmas v. 24, p. 122512 (2017).

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Cm/ru/KD-Prikhodko.docx) [↑](#footnote-ref-1)