DETERMINATION OF PLASMA DENSITY IN CURRENT SHEETS USING SPECTRAL LINES OF NEUTRAL HELIUM WITH FORBIDDEN COMPONENTS [[1]](#footnote-1)\*)

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The results are presented on the measurements of plasma density in the current sheets that are based on an analysis of the He I spectral lines’ profiles. We registered the dipole-allowed helium lines: He I 447.1 (43D - 23P) nm and He I 492.2 (41D - 21P) nm and the corresponding dipole-forbidden lines: He I 447.0 (43F - 23P) nm and He I 492.0 (41F - 21P) nm. For the first time, we have used a new method for determining the electron density that was proposed by G.S. Voronov. The method does not require the separation of the experimentally recorded profiles of the He I spectral lines into allowed and forbidden components. This method has significant advantages over classical methods under real conditions when there is a large dynamic range in the electron density changes, as well as a significant impact from the impurity spectral lines.

The studies were carried out with the CS-3D setup. Current sheets were formed in a strongly inhomogeneous magnetic fields with a singular line of the *X*-type, in both 2D and 3D magnetic configurations. The magnetic field gradient was *h* = 0.5 kG/cm, the longitudinal component of the magnetic field along the *X* - line was *BZ* = 2.9 kG. Plasma was produced by the discharge in helium, its initial pressure was either *p* = 100 mTorr, or *p* = 320 mTorr. The amplitude value of the electric current along the *X* - line was *JZ* = 45 kA. [1].

We used the two-channel optical scheme that collected plasma radiation from two plasma regions. The first was the central quasi-cylindrical region, elongated in a direction of the current in the sheet. The second region was elongated in a direction of the current sheet width (the largest of two transverse sheet dimensions). This scheme made it possible to determine the electron concentration in different regions of the current sheet. Spectral lines were recorded in one pulse of the experimental setup using a programmable digital camera Nanogate 1UF, which is an image converter with an intensity amplifier based on a microchannel plate and with a CCD matrix as a detector. The duration of the camera strobe pulse was *Δtgate* = 0.8 µs [2,3].

It was found that in the central region of current sheets formed in both 2D and 3D magnetic configurations, the electron density was: *Ne* ≈ (0.6 - 0.5)×1016 cm-3 in the time interval *t* = (1.2 - 3.2) μs at the initial helium pressure *p* = 320 mTorr, i.e. decreased slowly over time. At a pressure *p* = 100 mTorr, the electron density was *Ne* ≈ (0.2 - 0.3) ×1016 cm-3, i.e. lower than at *p* = 320 mTorr.

It was shown that at the side edges of the sheet formed in the 2D magnetic configuration, the electron density increased rapidly, from *Ne* ≈ 0.8×1016 cm-3 to *Ne* ≈ 16×1016 cm-3, i.e. increased by a factor of 20 during the time interval *t* ≈ (1.2 - 3.2) μs. In this case, the maximum value of *Ne* at the edges of the sheet was practically independent of the initial helium pressure. However, in a 3D magnetic configuration, the electron density at the edges of the sheet changed insignificantly, within the limits of *Ne* ≈ (0.6 - 1.3)×1016 cm-3. These data agree with the results of plasma density measurements obtained earlier on the basis of an analysis of the spectral line profiles of the helium ions [2-4].

Reference

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Lt/ru/EF-Kyrie.docx) [↑](#footnote-ref-1)