

Study of Fluctuations in the CW Penning Surface-Plasma Source of Negative Ions

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Surface-Plasma Sources (SPS) of negative ions for accelerators with Penning or magnetron geometry exploit the hydrogen-cesium discharge in external magnetic field and deliver pulsed H- beams with intensity of about 100 mA [1] or the cw beams with current level 10-15 mA [2]. The beams, extracted from these sources show a noticeable level of fluctuations which could be decreased in discharge “noiseless” mode or by adding of nitrogen to discharge.

The study of current fluctuations for cw Penning SPSs was done at BINP. The noiseproof measurements of negative ion beam current, current in extracted electrode circuit, discharge current and voltage were measured by the low-inductive probes in wide frequency range. Spectrum and intensity of fluctuations at various operation modes, parameters and electrode geometry was recorded for two versions of cw Penning SPS.

The low level of ripples was recorded in discharge current and discharge voltage signal for the standard source conditions, while the H- beam current and the extracted circuit current (including the beam current, the extracted electrons, the counter flux of positive ions, etc) have about ten times higher level of fluctuations.

Frequency spectrum of beam current fluctuations displayed several stable peaks. The main peak had location in the range 0.2÷2 MHz and FWHM of about 0.1 MHz. For the standard source conditions and geometry (discharge 10 A/80 V, magnetic field 0.08 T, beam 15 mA main peak was at 0.3-0.4 MHz. Much smaller peaks at frequencies 20÷40 MHz with low contribution to overall level of fluctuations were also displayed in spectrum. The fluctuations of current in extracted electrode circuit and in accelerated electrode circuit had the similar structure and have correlated with the beam current fluctuations.

The discharge current with oscillations was artificially produced after changing the hollow cathode insert geometry. These artificial discharge current oscillations were correlated with the beam current fluctuations as well.

The correlation of discharge current fluctuations and of extracted current fluctuations with the beam current fluctuations confirms, that the oscillations of plasma density are the main sources of beam current fluctuations. Under special conditions these oscillations of plasma density are enforced by the non-uniform emission from the cesiated cathode surfaces.

The data on currents fluctuations for different source parameters and discharge configuration is presented. The origin of beam fluctuations and methods of theirs reduction are discussed.

[1] P.Allison and J.Sherman, AIP Conf. Proc., **111**, p.511 (1983).

[2] Yu. Belchenko, A. Sanin, A. Ivanov, AIP Conf. Proc. **1079**, p.214 (2009).