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Mixed Pierce-two-stream instability development in extraction system of a negative ion source

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Negative ion source based on a volume ion production is characterized by essential working gas leakage into the extraction system. The working gas presence in the area of the beam propagation leads to both positive and negative effects, one of the positive effects being the compensation of the beam own space charge. One of the negative effects is the possible development of the plasma instabilities that may result in the beam current oscillation or breakdown, so it is of importance to work in the range of the gun parameters far from the instability threshold. In the paper presented the conditions of the development of the mixed Pierce-two-stream instability are discussed. Analytically the range of the stable beam propagation is determined. The instability threshold is shown to be increased compared with the pure Pierce instability caused by the finite mobility of the background ions. The conditions of the growth of the inclined perturbations are investigated in the case of the beam real geometry, when the transverse dimension of the beam is quite comparable or less than the specific inter-electrode distance. The instability simulation in COMSOL Multiphysics is performed too.