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The effect of gas mixing on the afterglow transient of beams extracted from an electron cyclotron resonance ion source

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Gas mixing and afterglow operation are common methods to improve high charge state ion beam performance with Electron Cyclotron Resonance (ECR) ion sources. In gas mixing a light gas species is introduced into the ion source plasma to enhance the ion currents of a heavier main element. The benefits of this technique are commonly attributed to the "cooling"of the heavier element ions through collisions with the lighter element particles, leading to longer ion confinement times and enhanced high charge state ion production. In afterglow operation the plasma heating microwaves are pulsed, and as a result, an intense short burst of high charge state ions is observed following the microwave switch-off, with a current that can be several times higher than the steady-state ion current. This effect is also attributed to ion confinement in plasma, namely the change of confinement scheme from ambipolar potential dip confinement to diffusive losses.
This work studies the influence of gas mixing on the properties of high charge state ion beams extracted from an ECR ion source operated in afterglow mode. The focus is on the temporal structure and magnitude of the extracted ion currents during the steady-state phase of the beam pulse and the afterglow current transient. The experimental results with different combinations of main and mixing gas species provide new insight into the mechanisms related to the gas mixing effect and the formation of the afterglow current transient, especially on the role of ion confinement in pulsed ECR ion source operation.

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