Recent improvements of the LPSC Charge Breeder
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Abstract

LPSC has developed the PHOENIX electron cyclotron resonance Charge Breeder since 2000. The performances have been improved over time acting on the 1+ and N+ beam optics, the base vacuum and the 1+ beam injection. A new objective is to update the booster design to enhance high charge state production and 1+ N+ efficiencies, reduce the co-extracted background beam and improve the ion source tunability. The first step, consisting in increasing the peak magnetic field at injection from 1.2 to 1.6 T was implemented and significant improvement in 1+ ion production of 14% was reported: 12.9% of 23Na1+, 24.2% of 40Ar1+ and 13.3% of 133Cs1+ and 13% of 133Cs1+. The next steps of the upgrade are presented: modification of the axial magnetic structure, significant increase of the plasma chamber radius (72 to 90 mm), plasma heating at 18 GHz (instead of 14 GHz), reduction of chemical elements composing the plasma chamber wall and the surrounding beam line.

Latest performances of the LPSC PHOENIX ECR Charge Breeder

Table of results

<table>
<thead>
<tr>
<th>Species</th>
<th>Initial configuration</th>
<th>Additional plug configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Efficiency (%)</td>
<td>Rise time (ms)</td>
</tr>
<tr>
<td>131Ba1+</td>
<td>16.2</td>
<td>9.8</td>
</tr>
<tr>
<td>19Ar1+</td>
<td>14.2</td>
<td>20.4</td>
</tr>
<tr>
<td>85Kr1+</td>
<td>11.5</td>
<td>14.6</td>
</tr>
<tr>
<td>109Ag1+</td>
<td>11.3</td>
<td>14</td>
</tr>
<tr>
<td>69Ga1+</td>
<td>9.9</td>
<td>12</td>
</tr>
<tr>
<td>133Cs1+</td>
<td>12.9</td>
<td>12.9</td>
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<tr>
<td>133Cs1+</td>
<td>10.4</td>
<td>29</td>
</tr>
<tr>
<td>134Cs1+</td>
<td>11.6</td>
<td>44.2</td>
</tr>
</tbody>
</table>

14.5 GHz 400 – 500W, base vacuum 3.10-7 mbar

All the efficiencies are higher than 10%
High increase of efficiencies for low masses
Shift of the peak charge state distribution function to higher value

Development plan 2016 - 2020

Objectives:
- Reduce co-extracted contaminants
- Improve efficiencies
- Increase charge states

Means:
- Magnetic field structure improvement
- Plasma chamber volume increase
- Operation at 18GHz
- UHV technique for ECRIS and beam line
- Reduction of chemical elements facing the plasma, use of liners

2016 (first step)
Injection axial magnetic field strength increase

2017
Radial magnetic field strength increase

2018
Yoke and coils redistribution

2019
Plasma chamber volume increase