Improving the Laser Ablation Ion Source at SHIPTRAP

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Introduction and Motivation

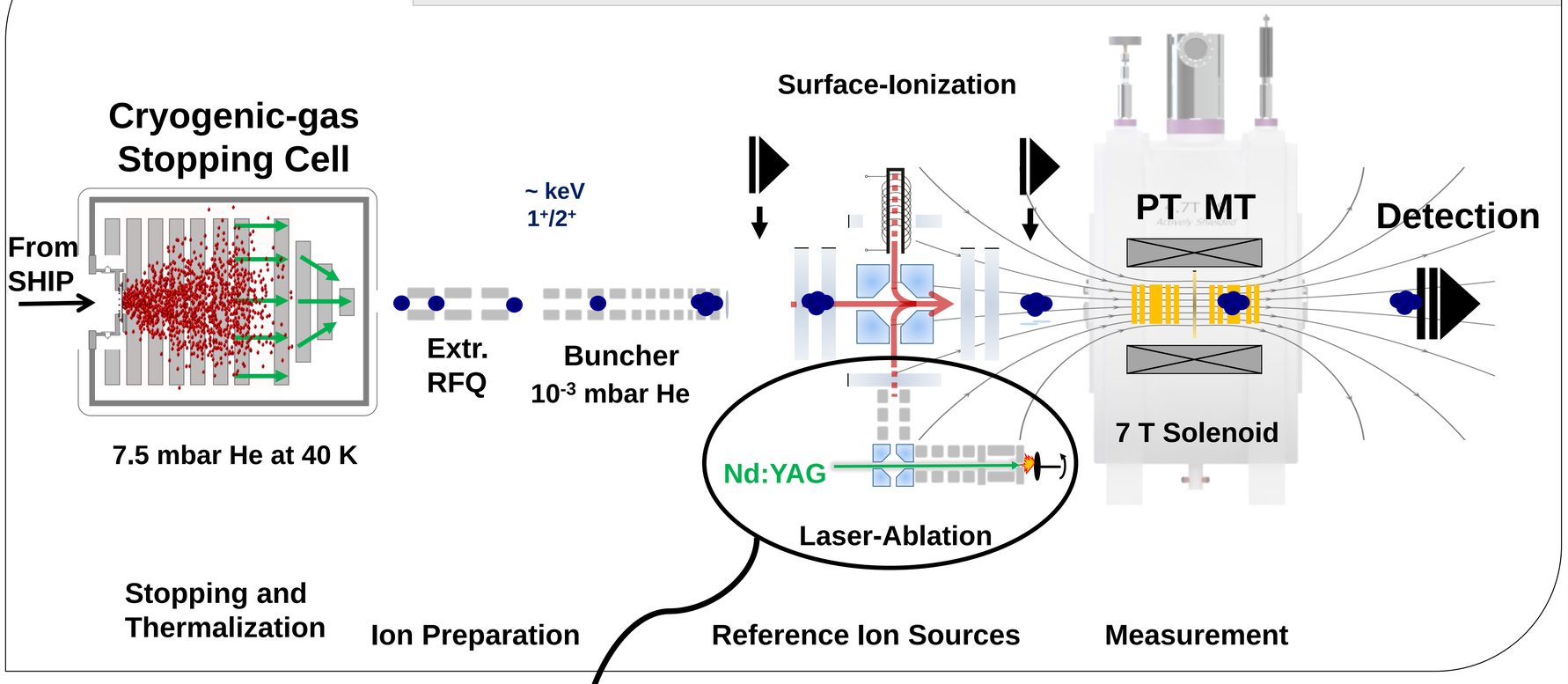
SHIPTRAP allows high-precision mass measurements giving insight into:

- the nuclear shell structure evolution of exotic nuclei
- decay probability of nuclei relevant in stellar nucleosynthesis and neutrino physics

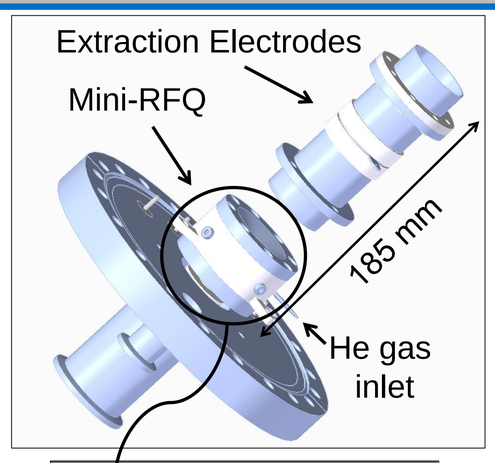
To perform offline experiments studying long-lived rare and radioactive isotopes we have to cope with small-size samples.

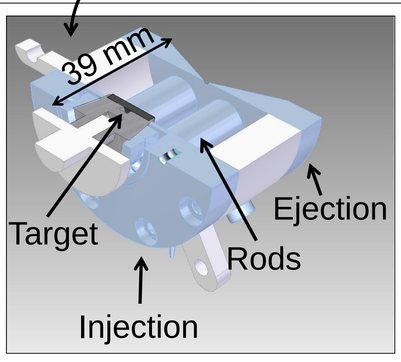
Therefore, an efficient ion production and injection into the traps in narrow ion bunches is of crucial importance.

High-precision mass measurements at SHIPTRAP



Laser Ablation Ion Source





Design taken from TRIGA-TRAP setup (F. Schneider et al., Eur. Phys. J. A 51, 89, 2015.)

1. Laser ablation by pulsed frequency-doubled Nd:YAG laser
2. Injection of the ions into the Mini-RFQ
3. Thermalization through collisions with He atoms at 0.01 mbar
4. Ejection of ion bunches from the Mini-RFQ section towards a region of high vacuum

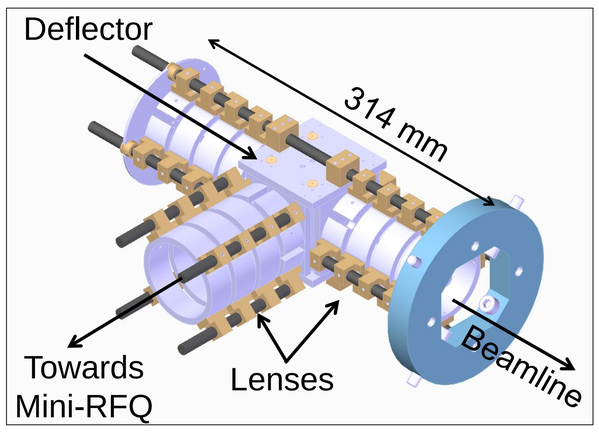
The Laser Abation Ion Source contains:

Mini-RFQ section

and

Deflector section

5. Transfer of the ions towards the beamline through a 90° deflector



- **Current limit for a mass measurement: 10^{15} atoms per target sample**
- **Requirement: lower limit of 10^{14} atoms per target sample**

→ **Improvement in efficiency of steps 1 - 4.**

Simulation Studies

Simulation parameters

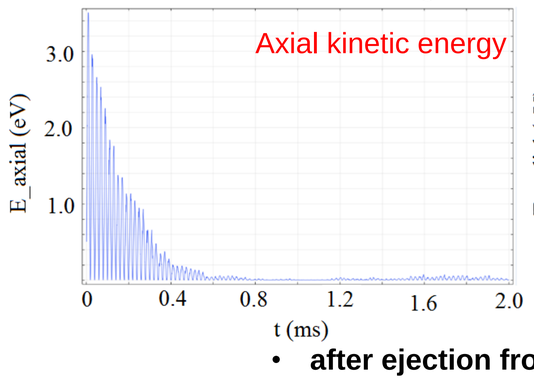
Ions:

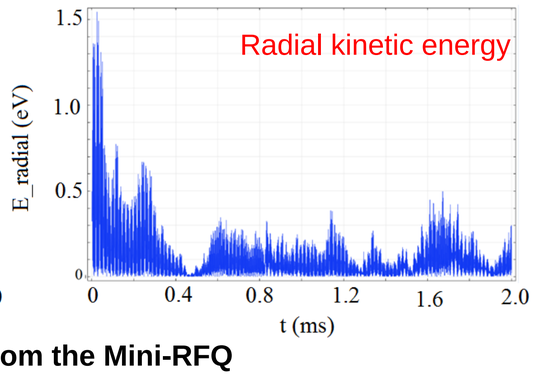
- m=193 amu
- E_{kin}=1.5 eV
- N=200 ions
- α=90 °

Mini-RFQ:

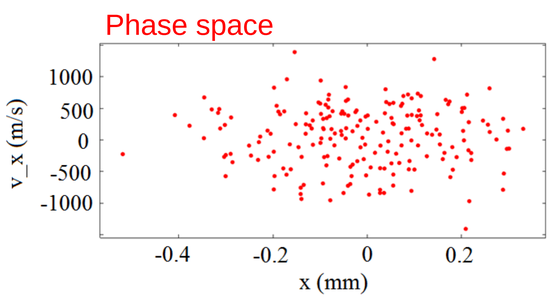
- f=500 kHz
- V_{RF}=110 V
- V_{inj1}=46 V, V_{inj2}=54 V
- V_{ej1}=54 V, V_{ej2}=-150 V
- V_{rods}=45 V
- t_{acc}=2 ms
- p=0.01 mbar

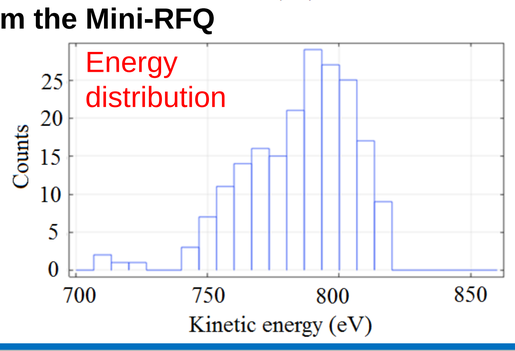
- during the cooling process





- after ejection from the Mini-RFQ





Summary

- **High efficiency of the Laser Ablation Ion Source is of great importance to deliver long-lived rare and radioactive isotopes.**
- **The main ion losses are due to the poor geometrical acceptance of the ablated ions into the Mini-RFQ through the injection electrode.**
- **Simulation studies with an optimized target plate configuration indicate that ion-bunch production can be improved relative to the present setup.**
- **A new design of the setup is ongoing and will be implemented in the near future.**

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