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Ion-extraction from the CISe gas catcher

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1 Motivation

We want to use the CISe gas catcher in experiments for precision mass measurements in **three** regions of interest:
- **Nuclei around** ^{100}Sn to be produced and examined at the SHIPTRAP facility.
- **Nuclei around N = 126** and **transfermium region (Z > 100)** to be studied in the Neutron-rich, EXotic, heavy nuclei produced in multi-nucleon Transfer reactions (NEXT) experiment @ AGOR.

J. Even et al., Atoms **10** (2022) 59.
Mollaebrahimi et al., Nucl. Instrum. Meth. B **463** (2020) 508.

2 CISe project

Our goal is to develop a new **C**hemical **I**sobaric **Se**paration technique using a gas catcher. Gas catchers are used to slow down high-energy nuclear reaction products by interacting with a buffer gas. The ions lose energy in collisions with the buffer gas atoms through ionization and excitation. As a first step we are optimizing the ion extraction process within the gas catcher by testing different DC and RF settings.

3 CISe gas catcher
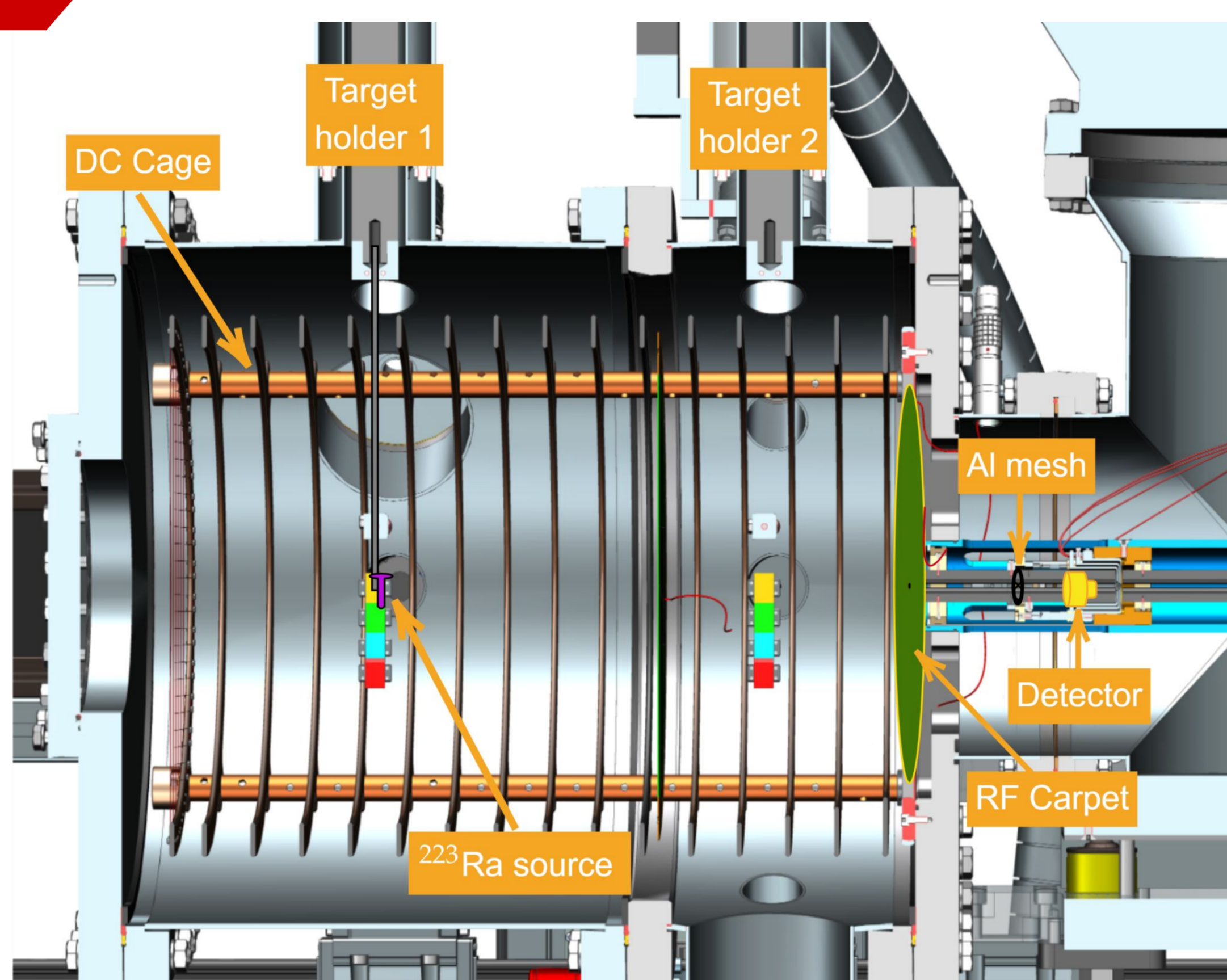
To study the extraction of ions we are using:
- A gas cell filled with 50 mbar of **Helium**. Helium has the advantage that it has a low density and high ionization potential, reducing the probability of ion neutralization.
- A ^{223}Ra source that decays into ^{219}Rn. Radon is a noble gas with high ionization potential, making it one of the most challenging elements to extract.
- High electric field gradients to reduce the probability of recombination and to achieve a shorter extraction time.
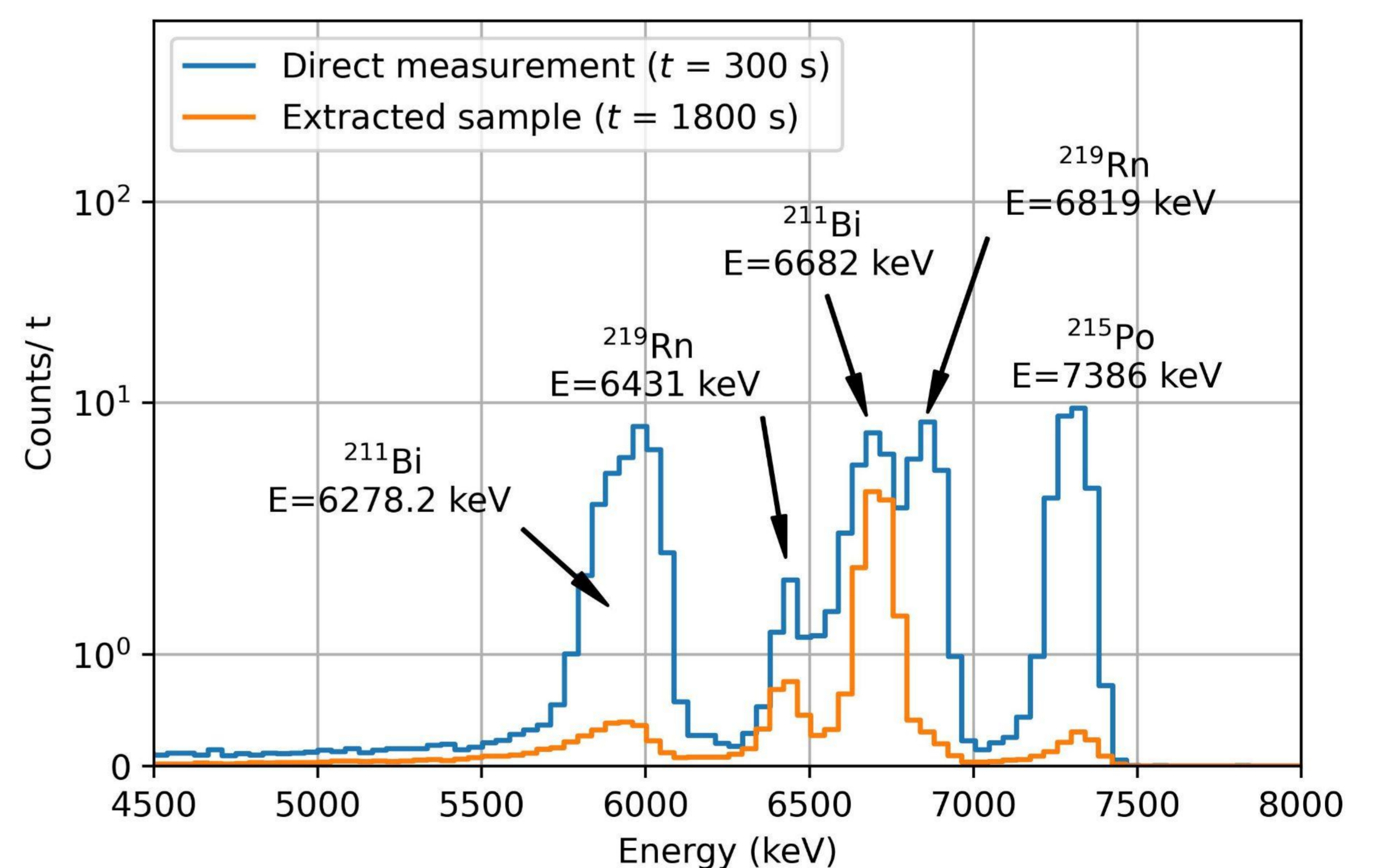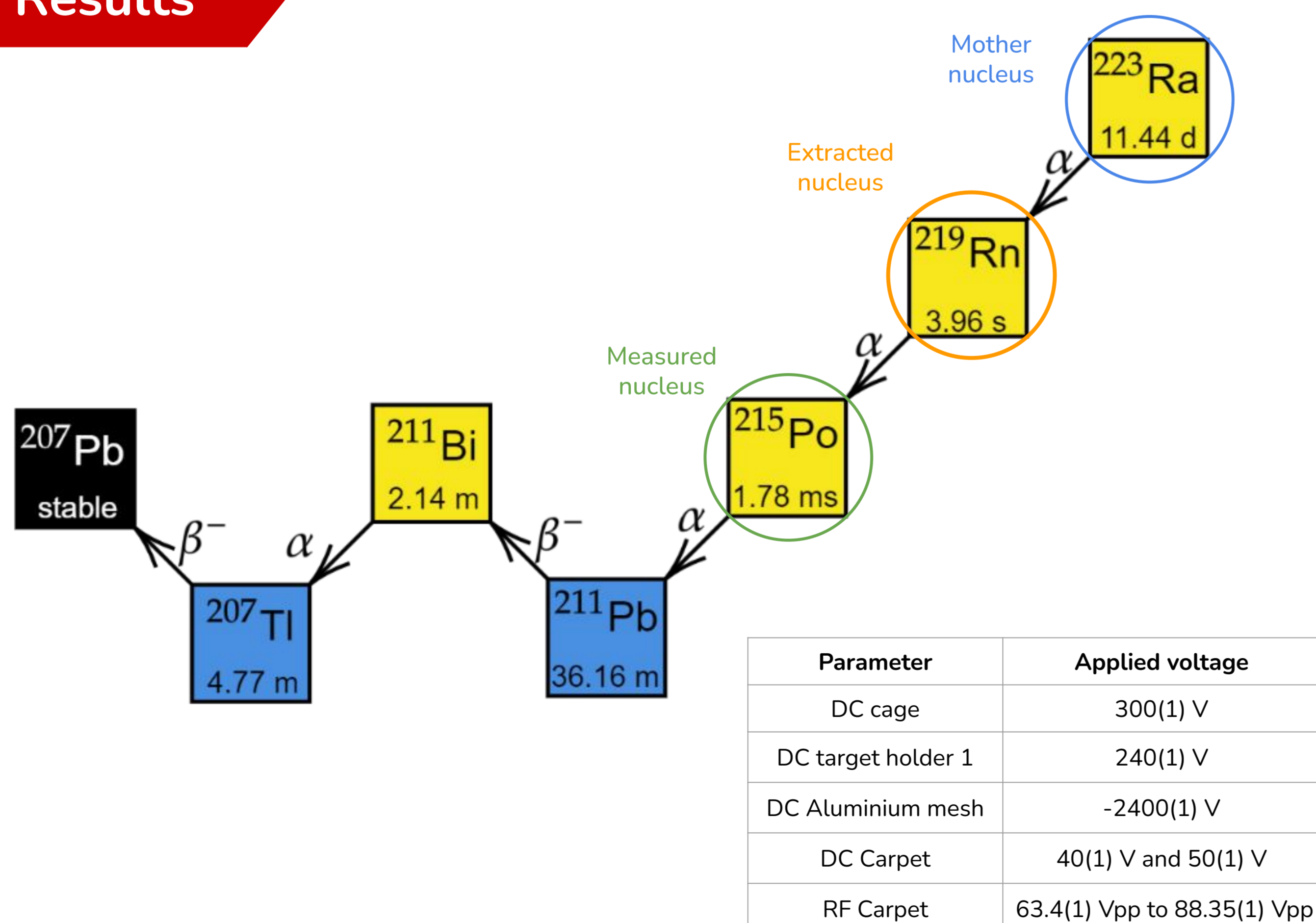
4 RF carpet
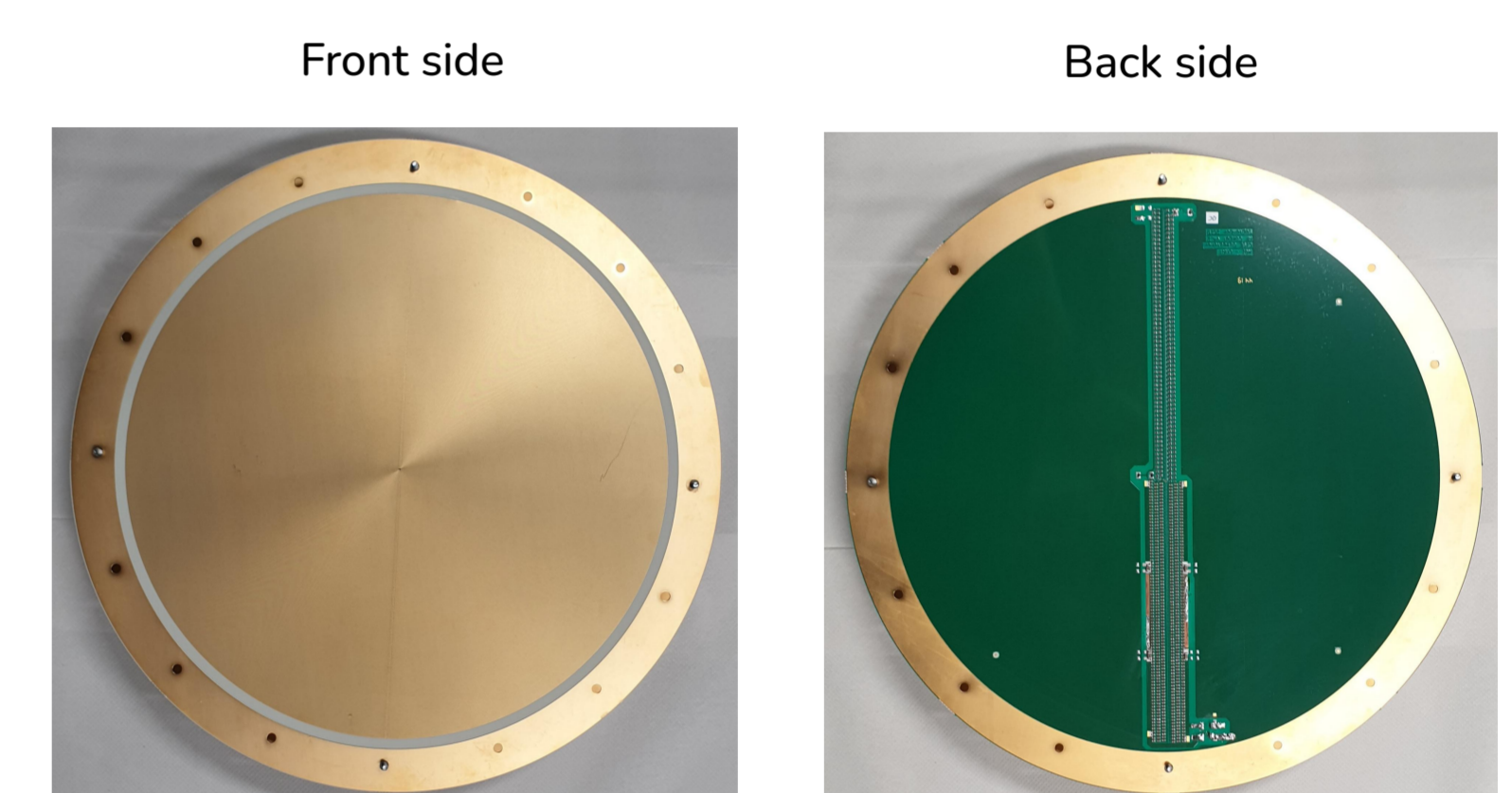
The DC carpet's electric field gradient pushes ions towards the center, while the time-averaged repelling force of the RF voltage makes them hover. Applying a 90° phase difference generates a traveling potential wave, allowing the ions to surf over the carpet towards the exit hole.

Simulated DC and RF potential distribution

Potential [V]
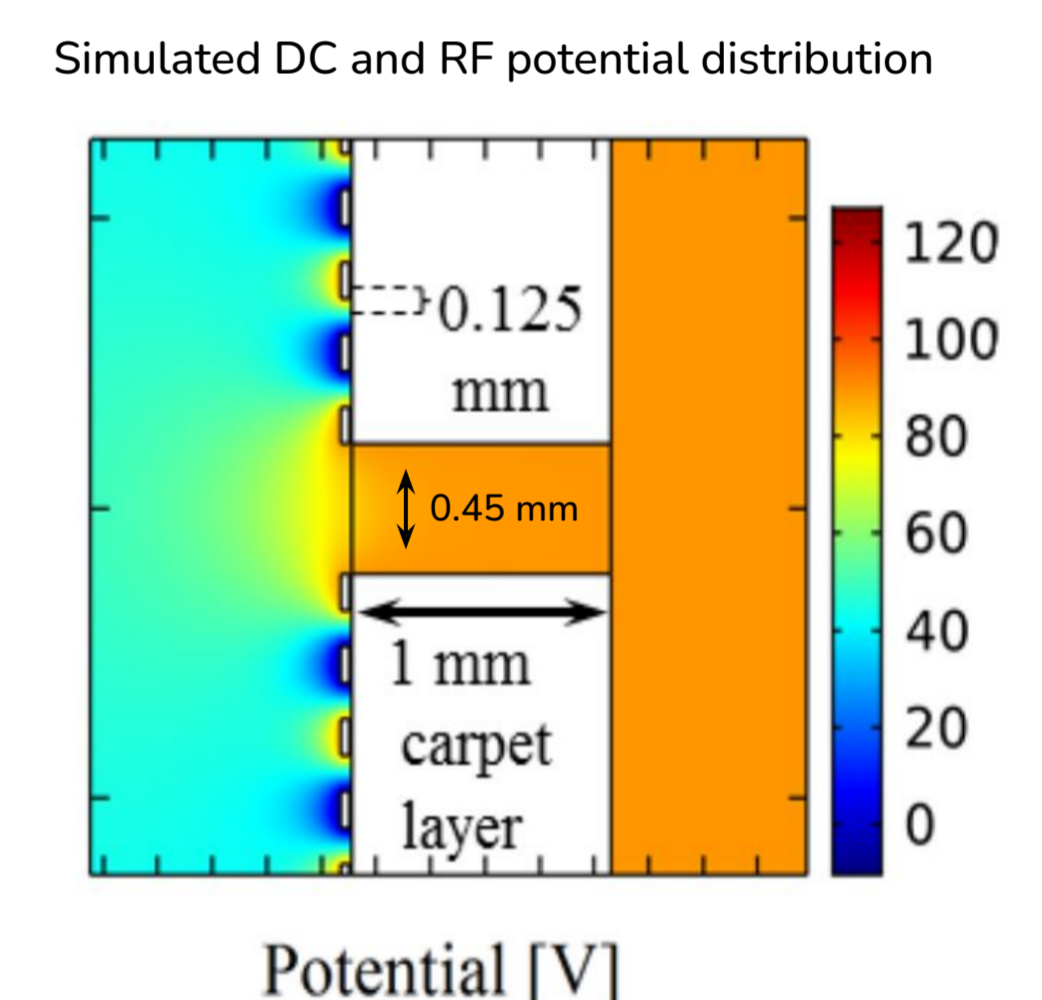
Anđelić, B. (2021). Direct mass measurements of No, Lr and Rf isotopes with SHIPTRAP and developments for chemical isobaric separation.

5 Results

Parameter	Applied voltage
DC cage	300(1) V
DC target holder 1	240(1) V
DC Aluminium mesh	-2400(1) V
DC Carpet	40(1) V and 50(1) V
RF Carpet	63.4(1) Vpp to 88.35(1) Vpp

Direct measurement (t = 300 s)
Extracted sample (t = 1800 s)

^{211}Bi E=6278.2 keV
^{219}Rn E=6431 keV
^{211}Bi E=6682 keV
^{219}Rn E=6819 keV
^{215}Po E=7386 keV

Extraction yields of 10-15% of ^{219}Rn have been achieved.

6 Summary

- In this study, alpha spectroscopy measurements showed that ^{219}Rn$^+$, which has a half-life of 3.96 s, was extracted from the gas catcher.
- The results indicated a maximum extraction efficiency of 15%. Further studies will be conducted to optimize the extraction efficiency and unlock the full potential of this technique.