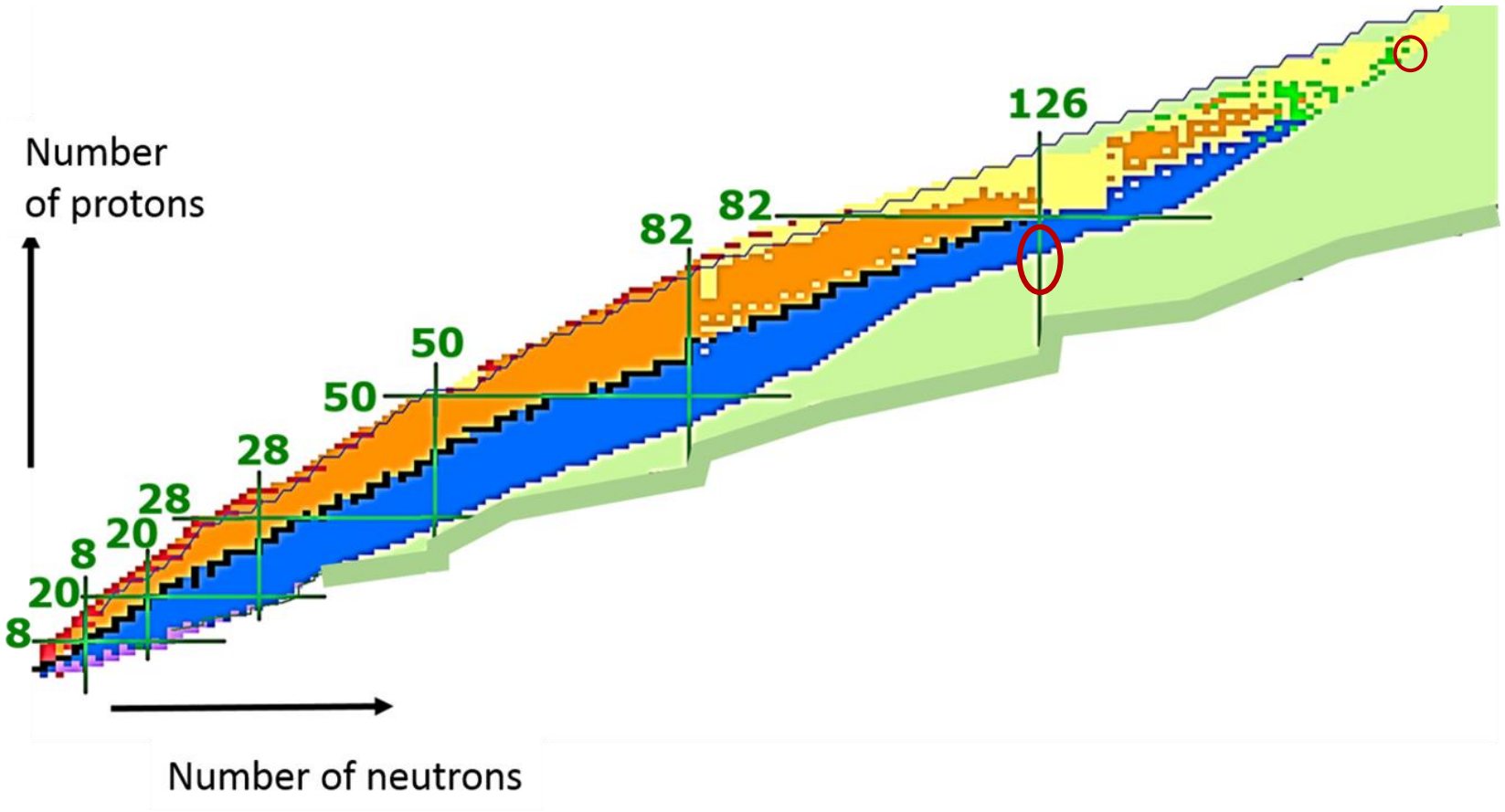
Commissioning of the NEXT Experiment

Presenter: Briain Drew Hartigan

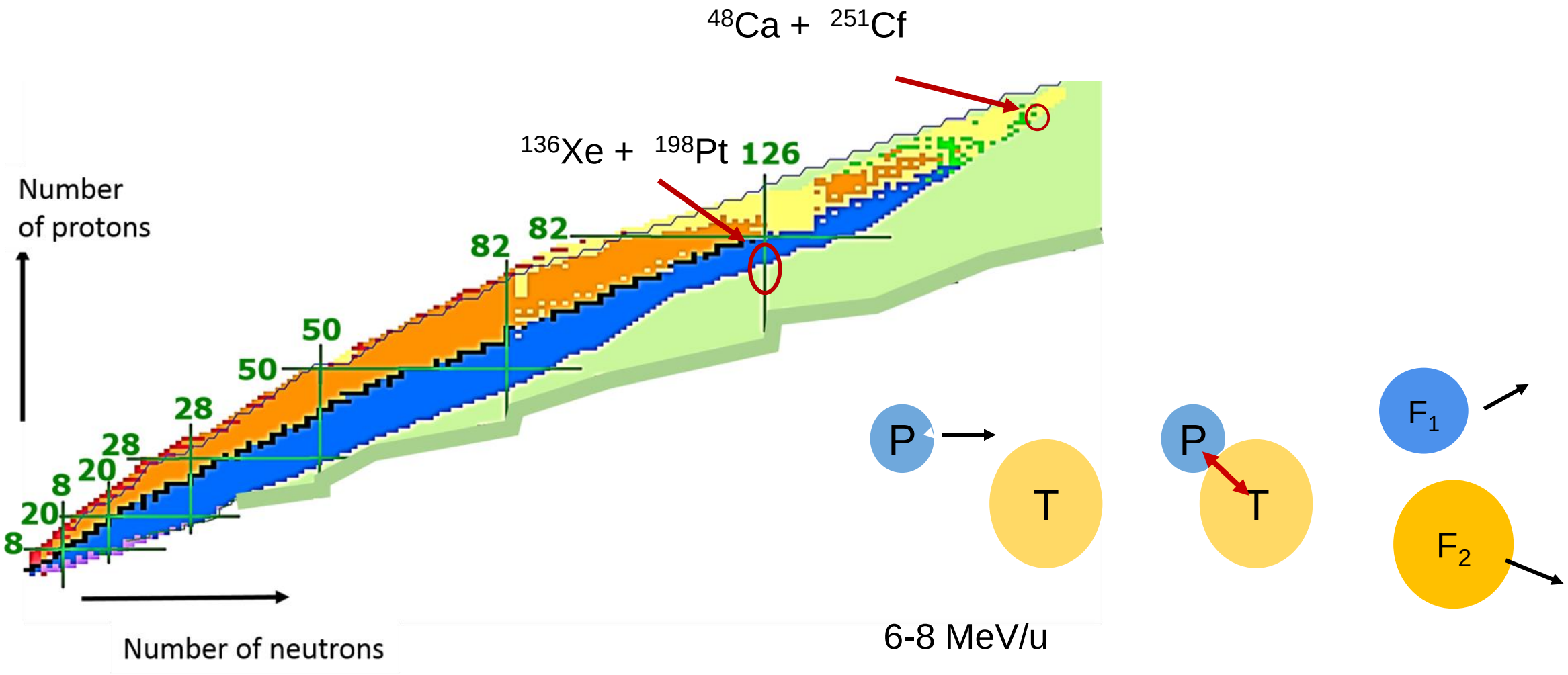
Co-authors: J. Even, X. Chen, M. Brajković, J.B. Cipagauta Mora, A. Soylu, M. Schlaich, N.N. Moorrees, P. Fischer, L. Schweikhard, F. Wienholtz.

NWO
erc
European Research Council
Established by the European Commission

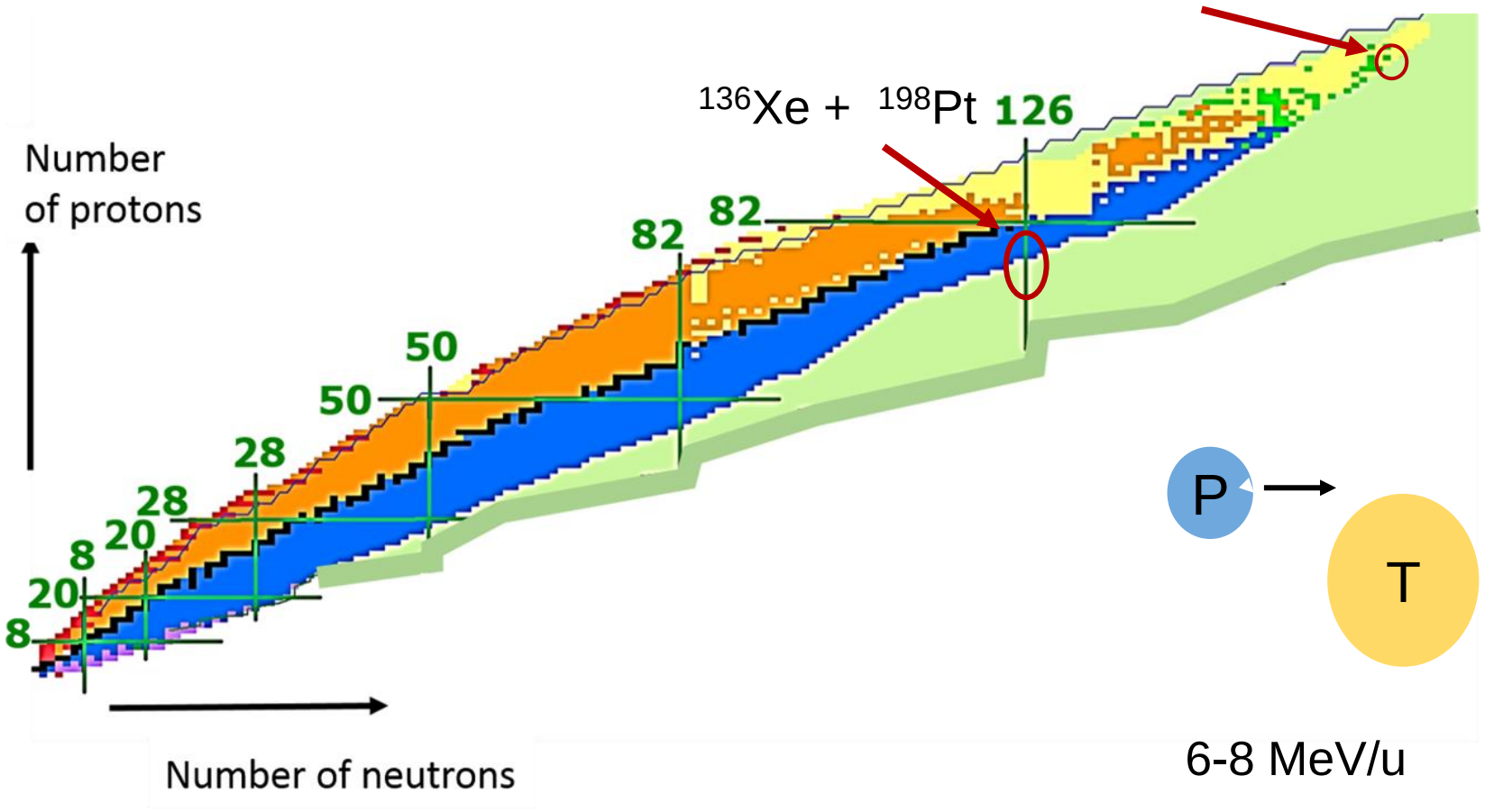
Motivation


Number of protons
Number of neutrons
8
20
8
20
28
28
50
50
82
82
126

Motivation


^{48}Ca + ^{251}Cf
^{136}Xe + ^{198}Pt
126
82
82
50
50
28
28
20
8
20
8
Number of protons
Number of neutrons
P
T
P
T
F_1
F_2
6-8 MeV/u

Motivation

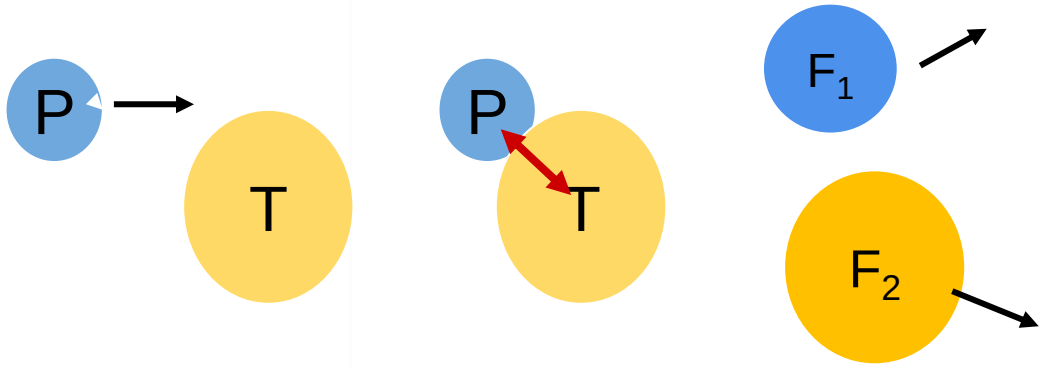


Requirements…

Large angular acceptance.

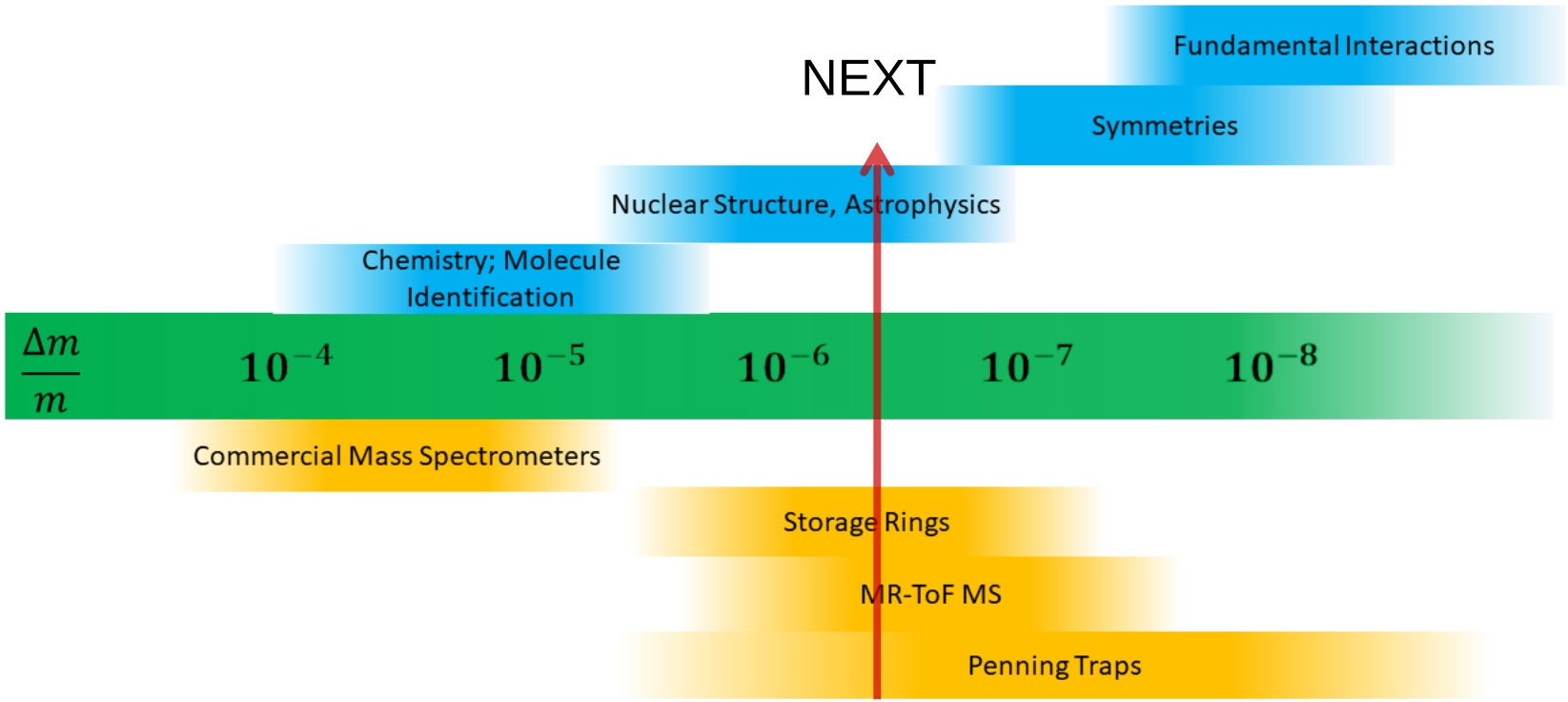
Background suppression.

Isobaric separation.



6-8 MeV/u

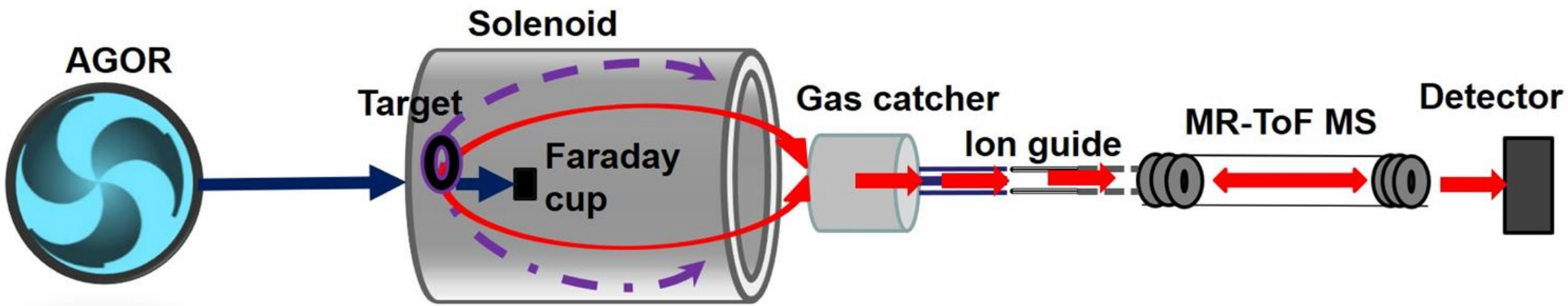
Probing with mass measurements



Access neutron-rich isotopes and probe nuclear structure with designed set-up.

Figure adapted from Yamaguchi et al, Prog. Part. Nucl. Phys. 2021, vol 120

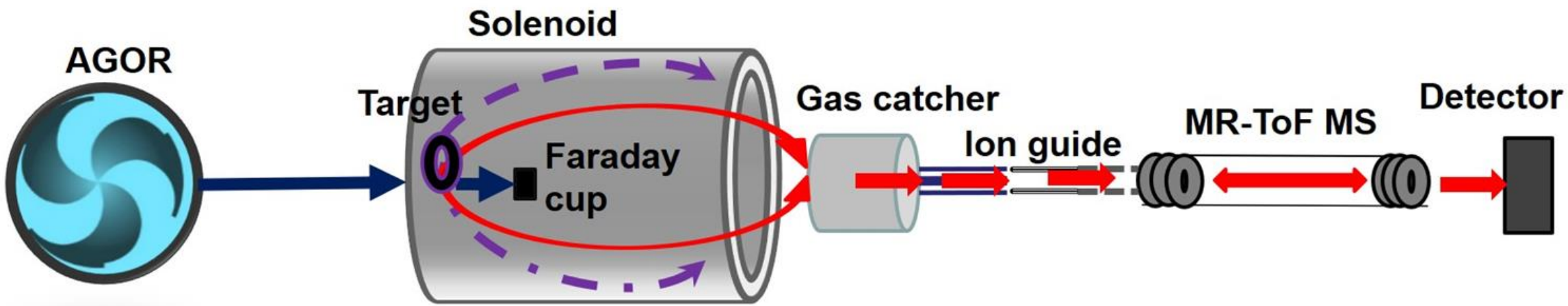
NEXT @ AGOR



partrec

J.Even et al.,Atoms 2022, 10(2), 59

NEXT @ AGOR

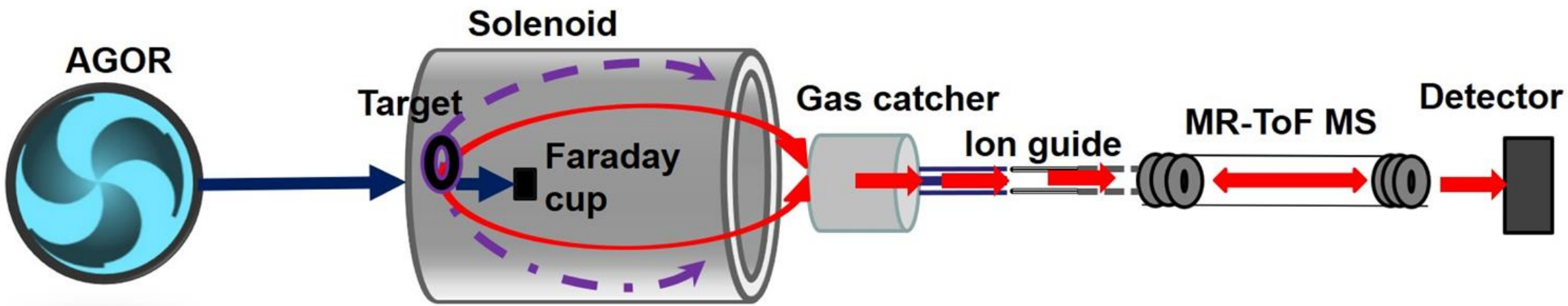


300 MeV
to
1 GeV

partrec

J.Even et al.,Atoms 2022, 10(2), 59

NEXT @ AGOR



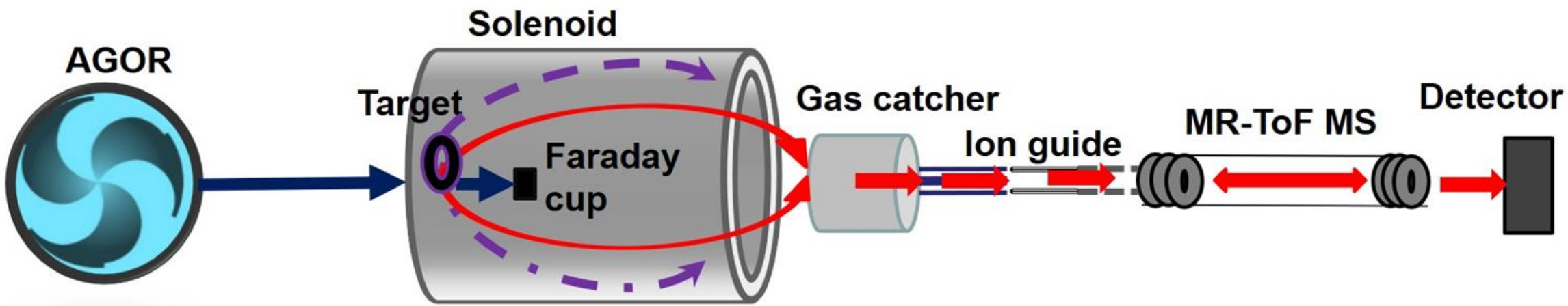
300 MeV
to
1 GeV

40 MeV
to
350 MeV

partrec

J.Even et al.,Atoms 2022, 10(2), 59

NEXT @ AGOR



300 MeV to 1 GeV

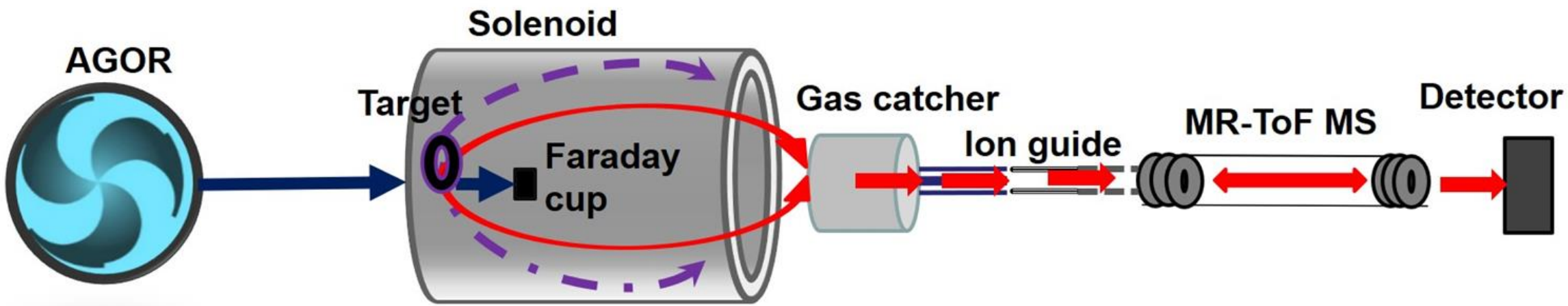
40 MeV to 350 MeV

~3 eV

partrec

J.Even et al.,Atoms 2022, 10(2), 59

NEXT @ AGOR



300 MeV to 1 GeV

40 MeV to 350 MeV

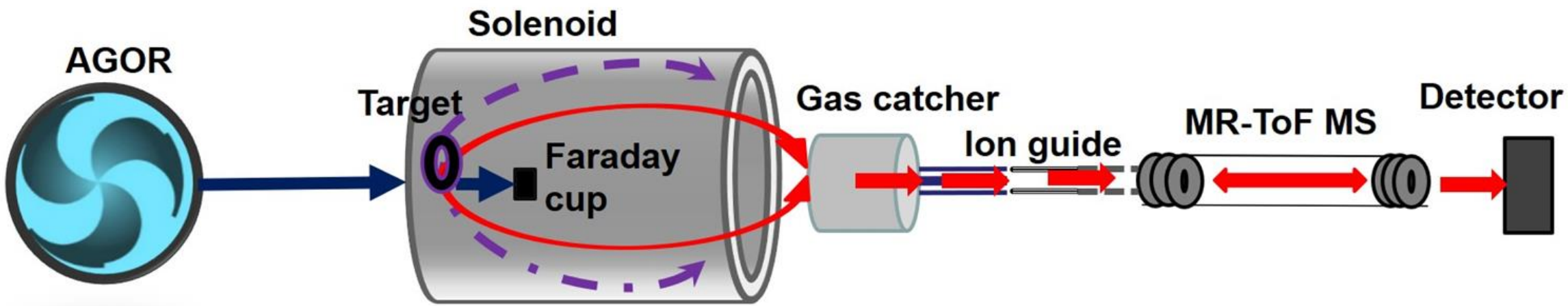
~3 eV

~1 eV

partrec

J.Even et al.,Atoms 2022, 10(2), 59

NEXT @ AGOR



300 MeV to 1 GeV

40 MeV to 350 MeV

~3 eV

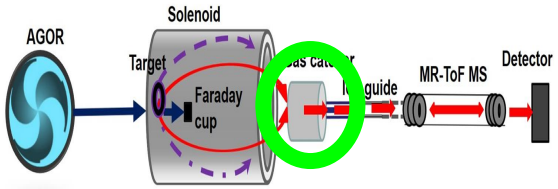
~1 eV

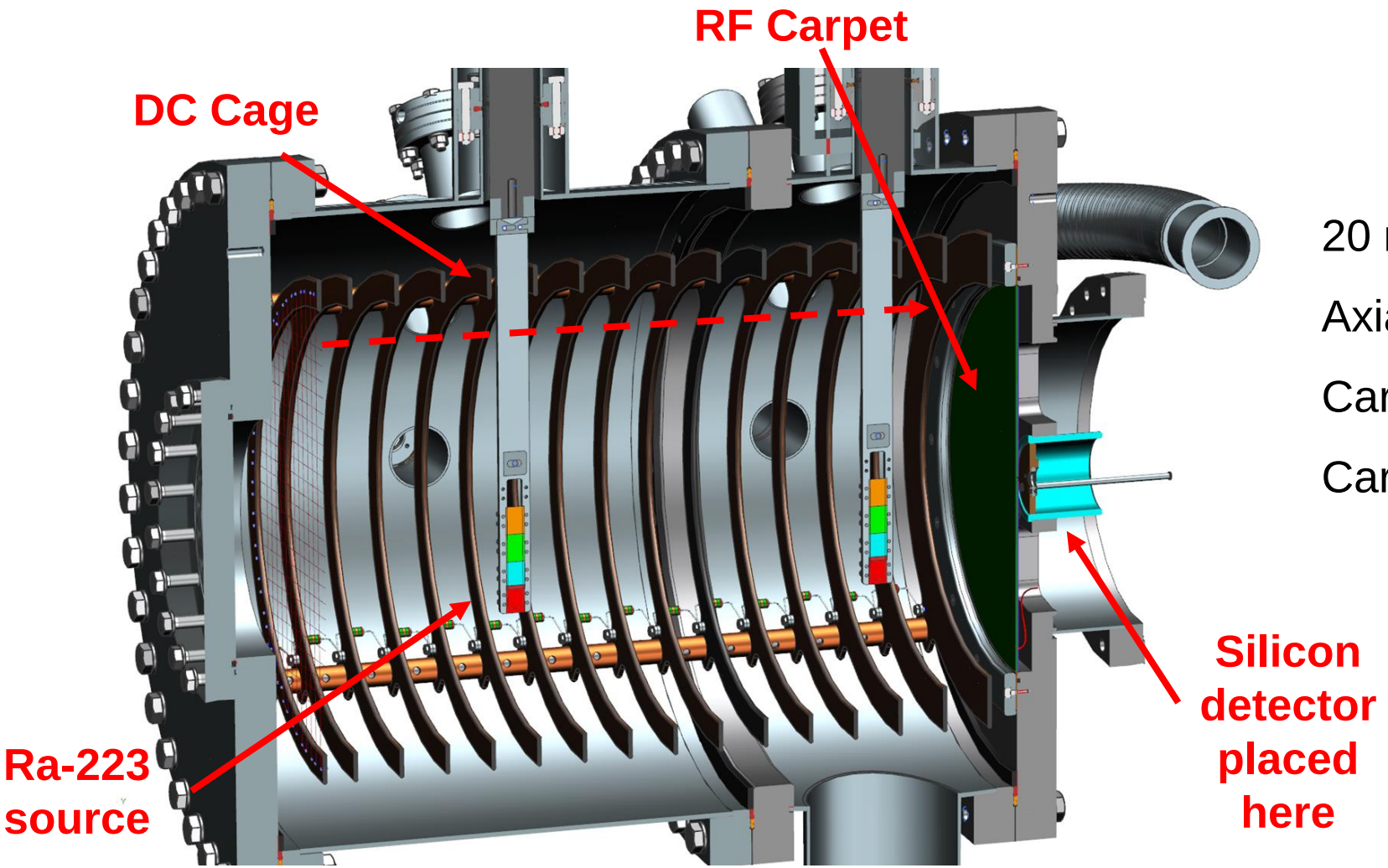
3 keV

partrec

J.Even et al.,Atoms 2022, 10(2), 59

Gas Catcher





20 mbar He.

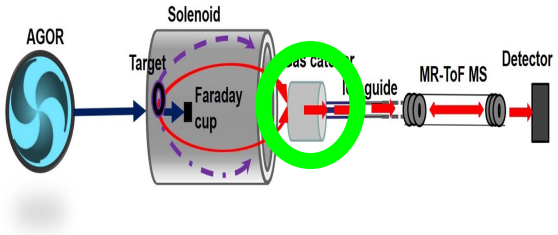
Axial gradient: 6.8 V/cm.

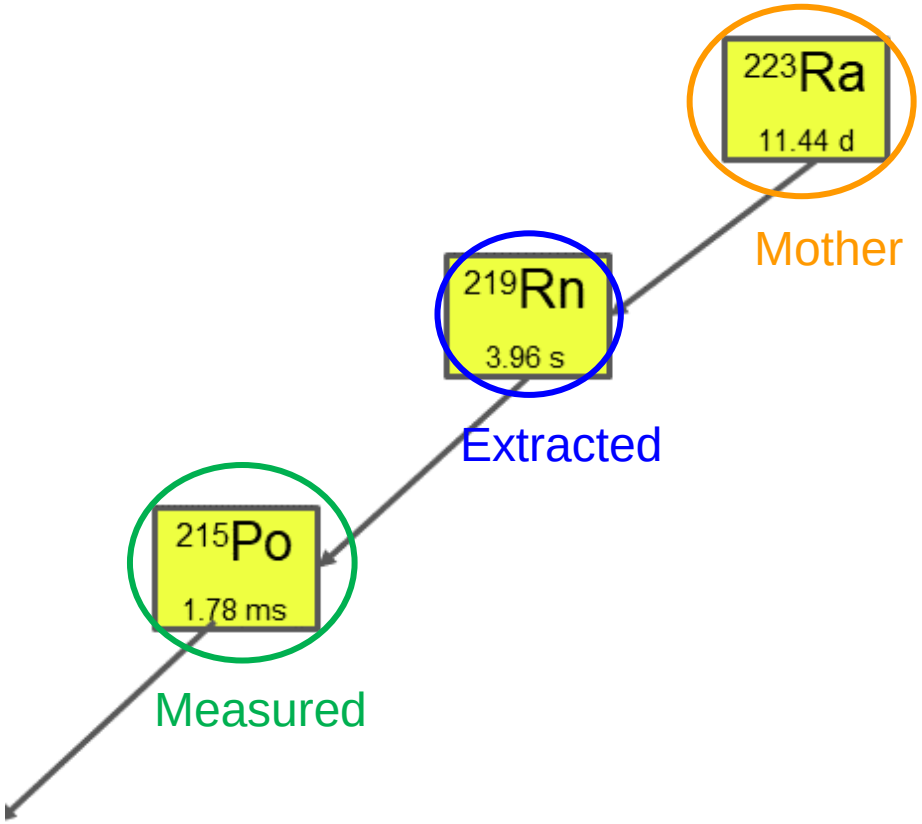
Carpet RF: 75 Vpp @ 5.64 MHz.

Carpet gradient: 3 V/cm.

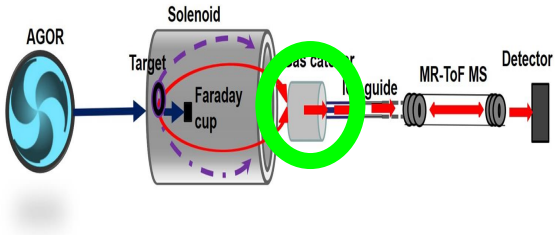
A. Mollaebrahimi et al., *Nucl. Instrum. Methods Phys. Res.* 463 (2020) 508-511

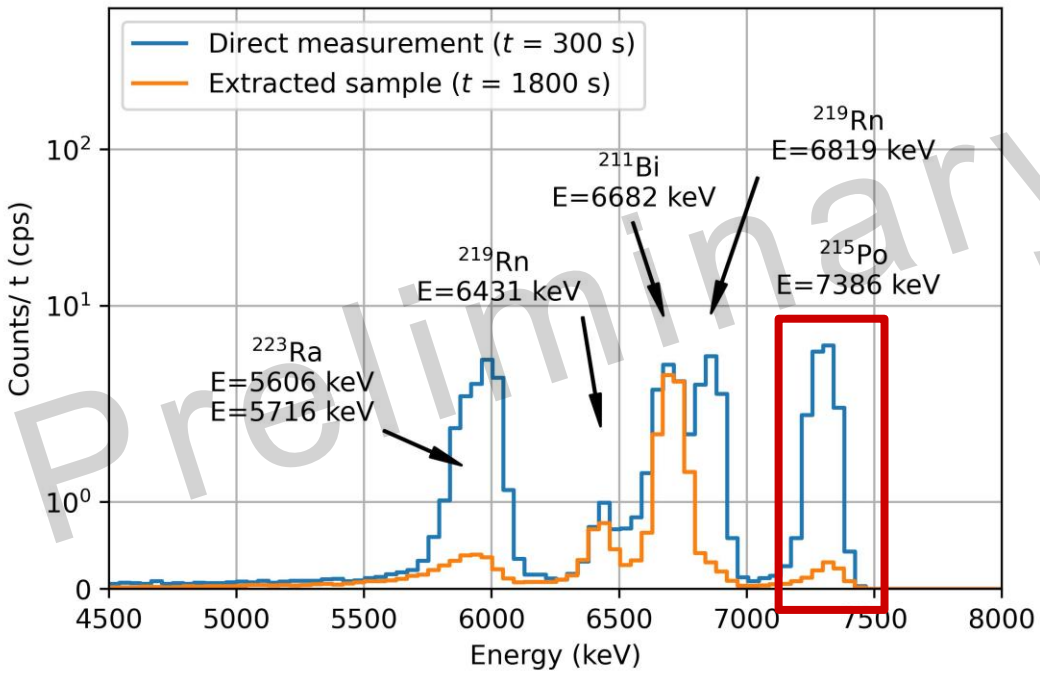
Gas Catcher

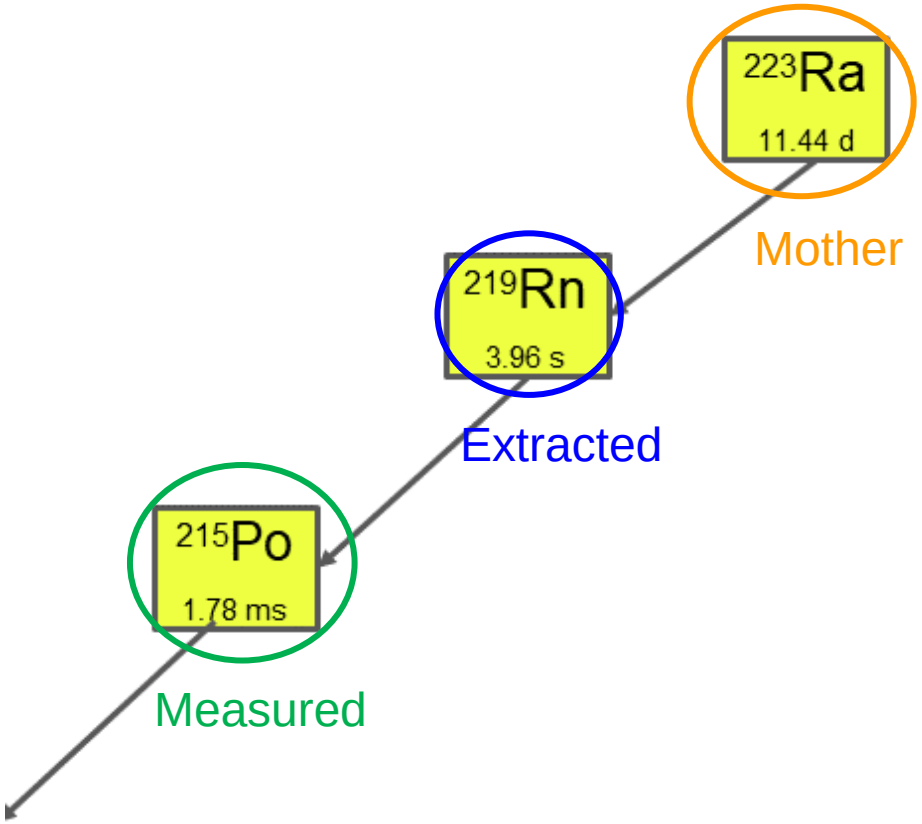

AGOR
Solenoid
Target
Faraday cup
guide
MR-ToF MS
Detector


223Ra
11.44 d
Mother
219Rn
3.96 s
Extracted
215Po
1.78 ms
Measured

Gas Catcher

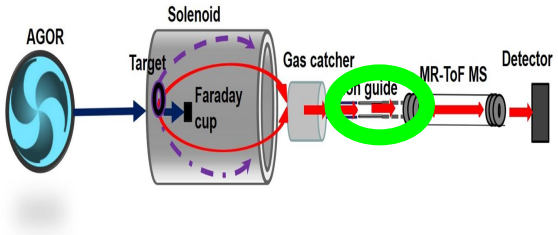






Efficiency 10-15%

Ion Guide



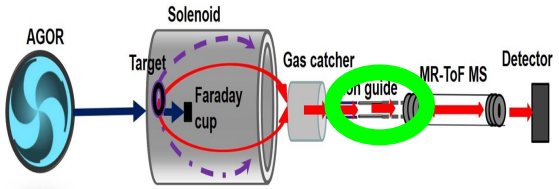
Gas-catcher → Ion guide → MR-TOF MS

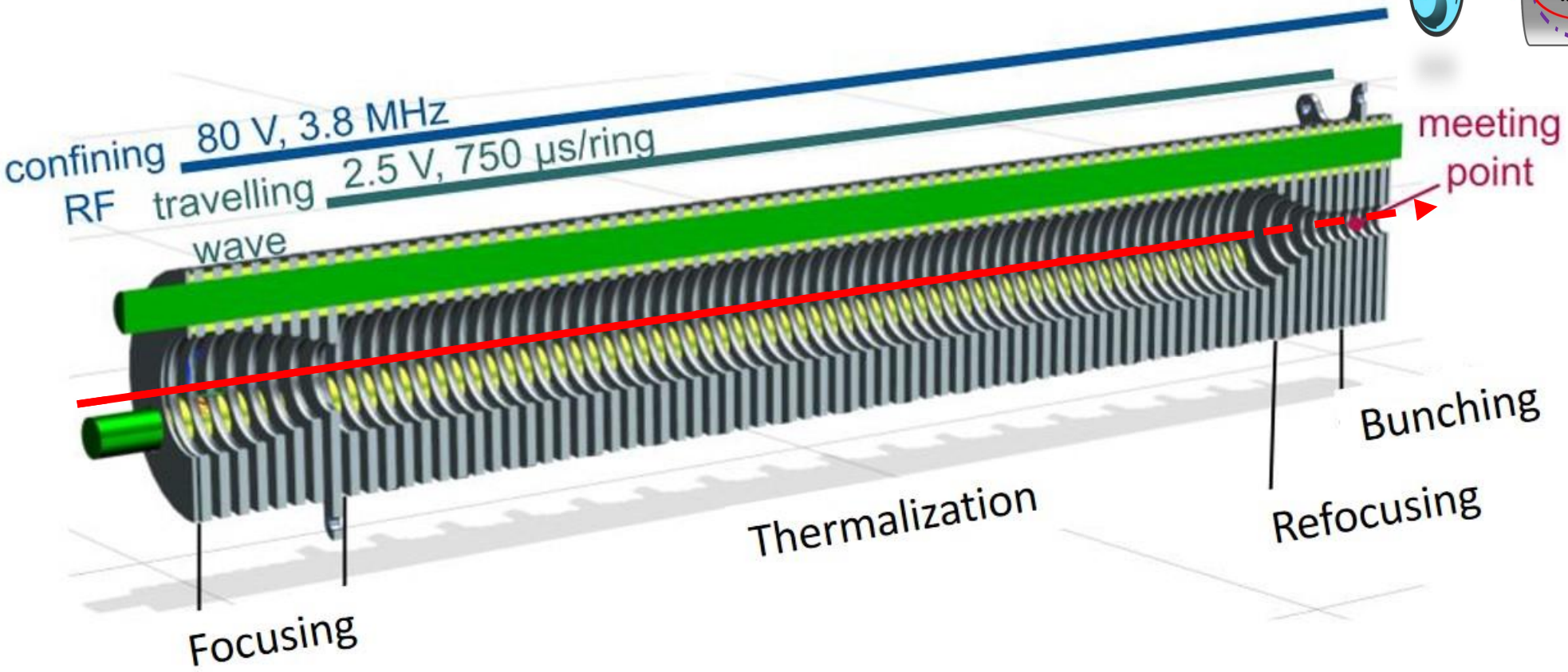
- Continuous beam
- 34° divergence
- 100 mbar

- Large acceptance
- Cooling
- Bunching
- 10^{-3} mbar

- Bunched beam
- Well focused
- 10^{-9} mbar

Ion Guide



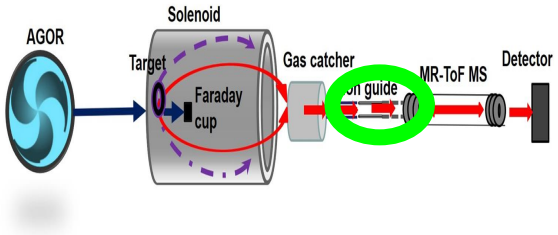


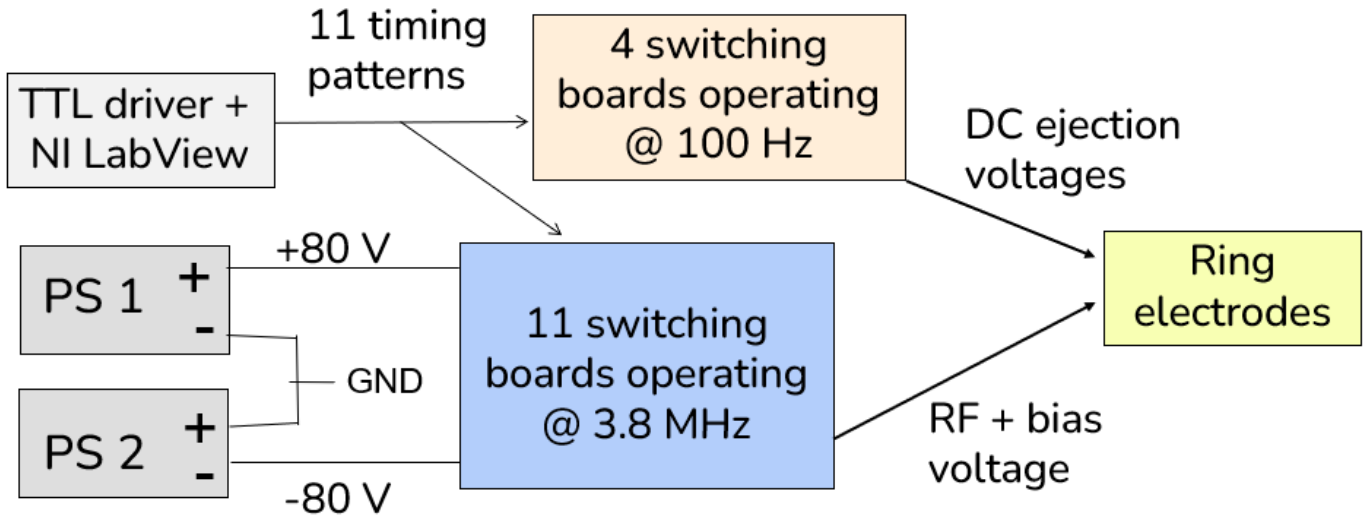
Expected…

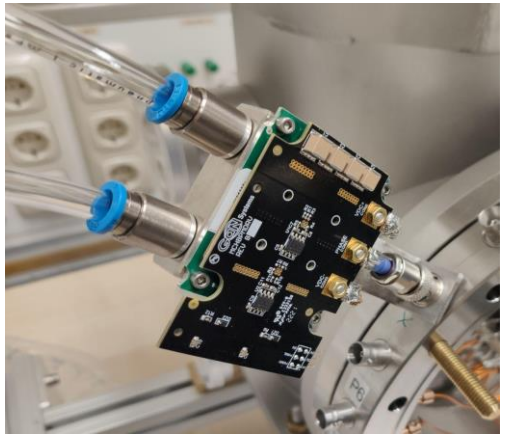
Transmission efficiency: 82%
Bunch ToF width: 100 ns

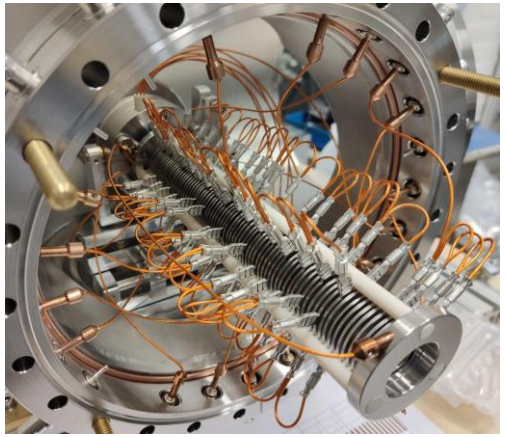
X. Chen et al., *Int. J. Mass Spectrom.* 477 (2022) 116856

Ion Guide





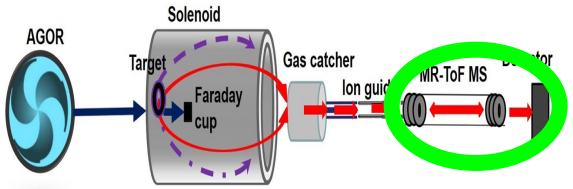


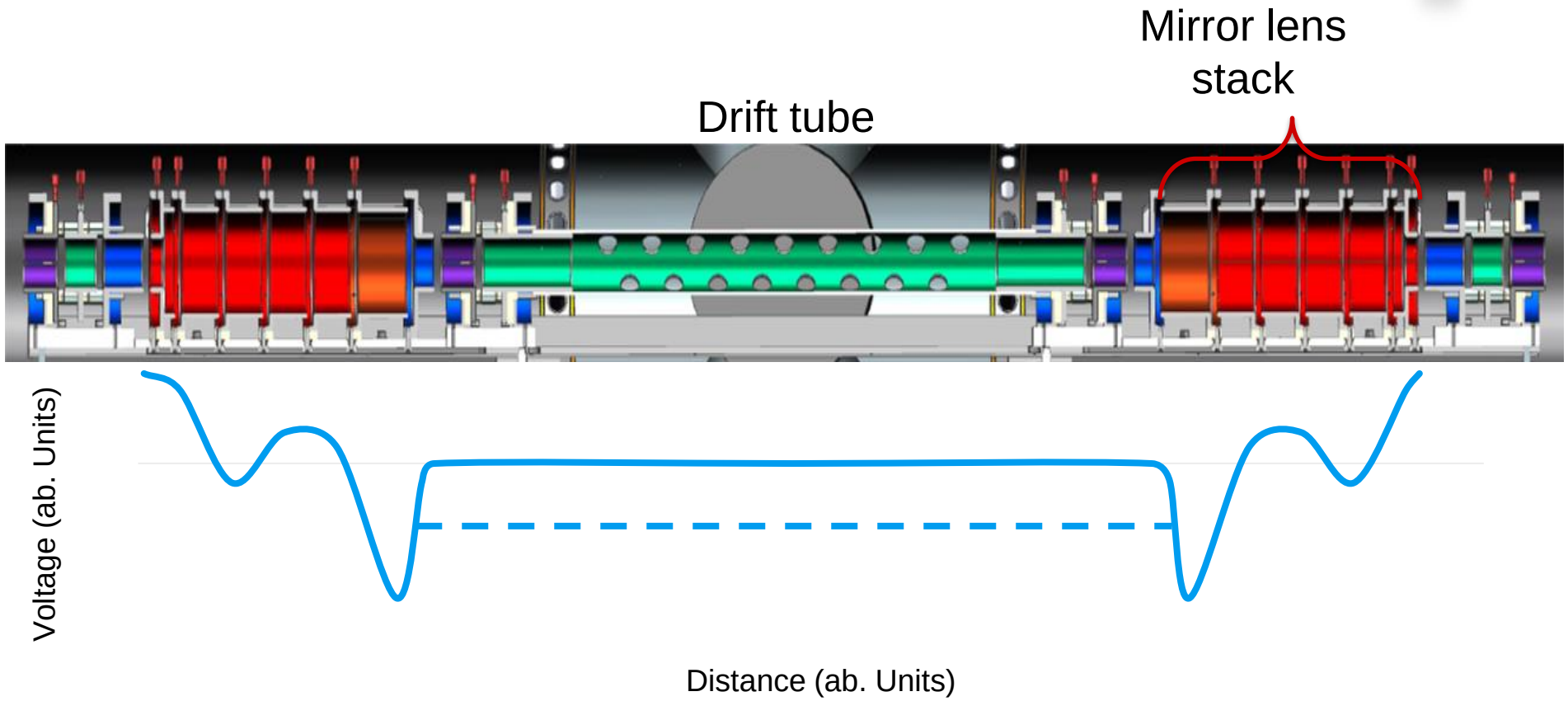


Study…

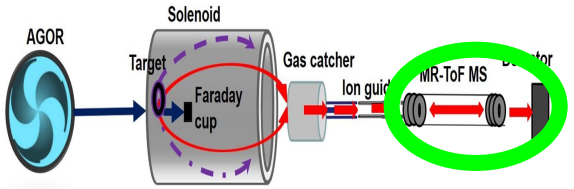
Transmission efficiency.
Bunching efficiency.

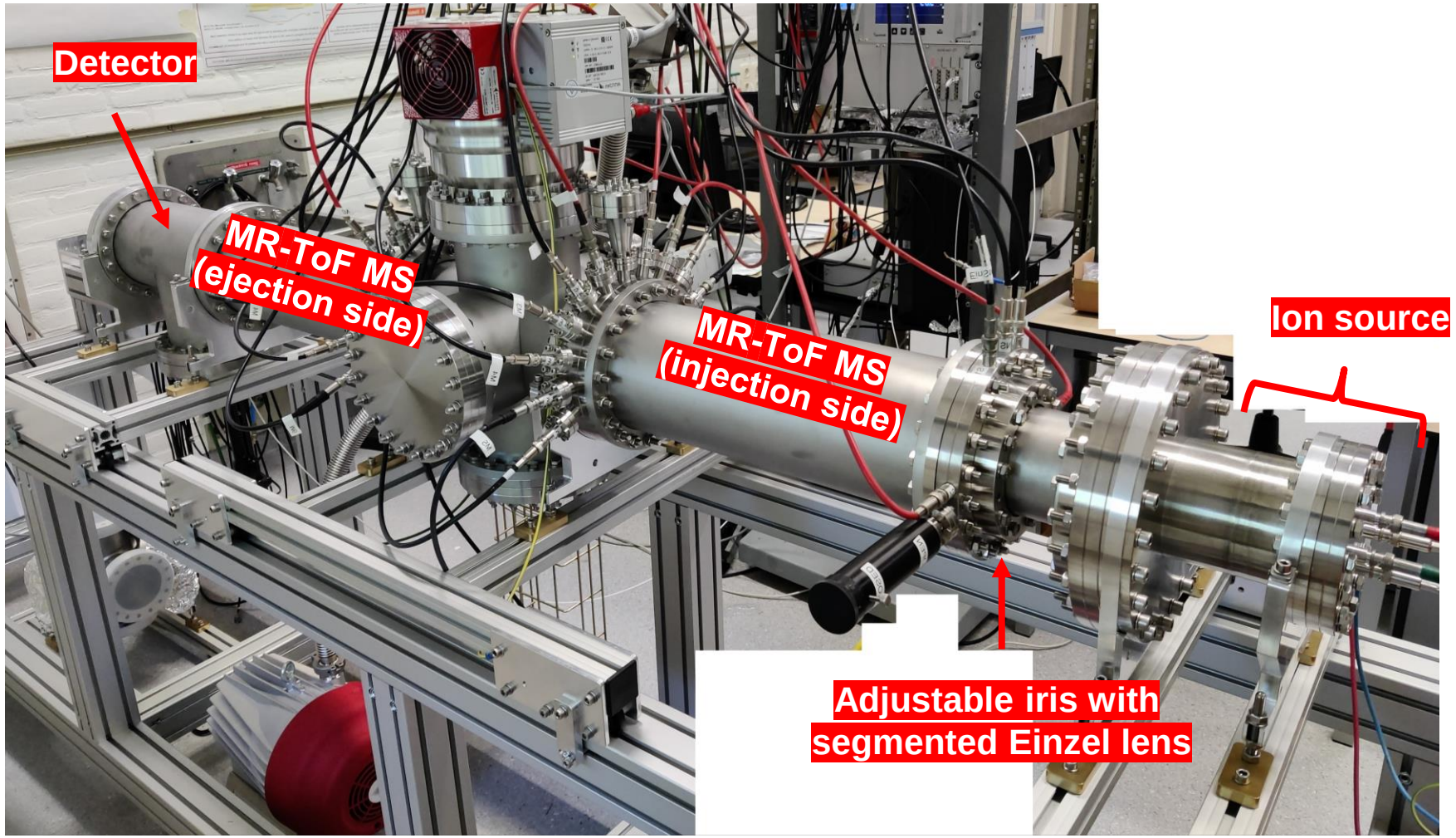
MR-TOF MS


AGOR
Solenoid
Target
Faraday cup
Gas catcher
Ion guide
MR-ToF MS

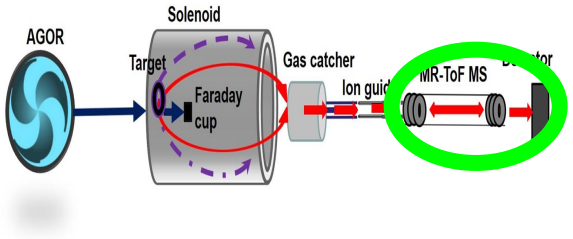

Mirror lens stack
Drift tube
Voltage (ab. Units)
Distance (ab. Units)

MR-TOF MS

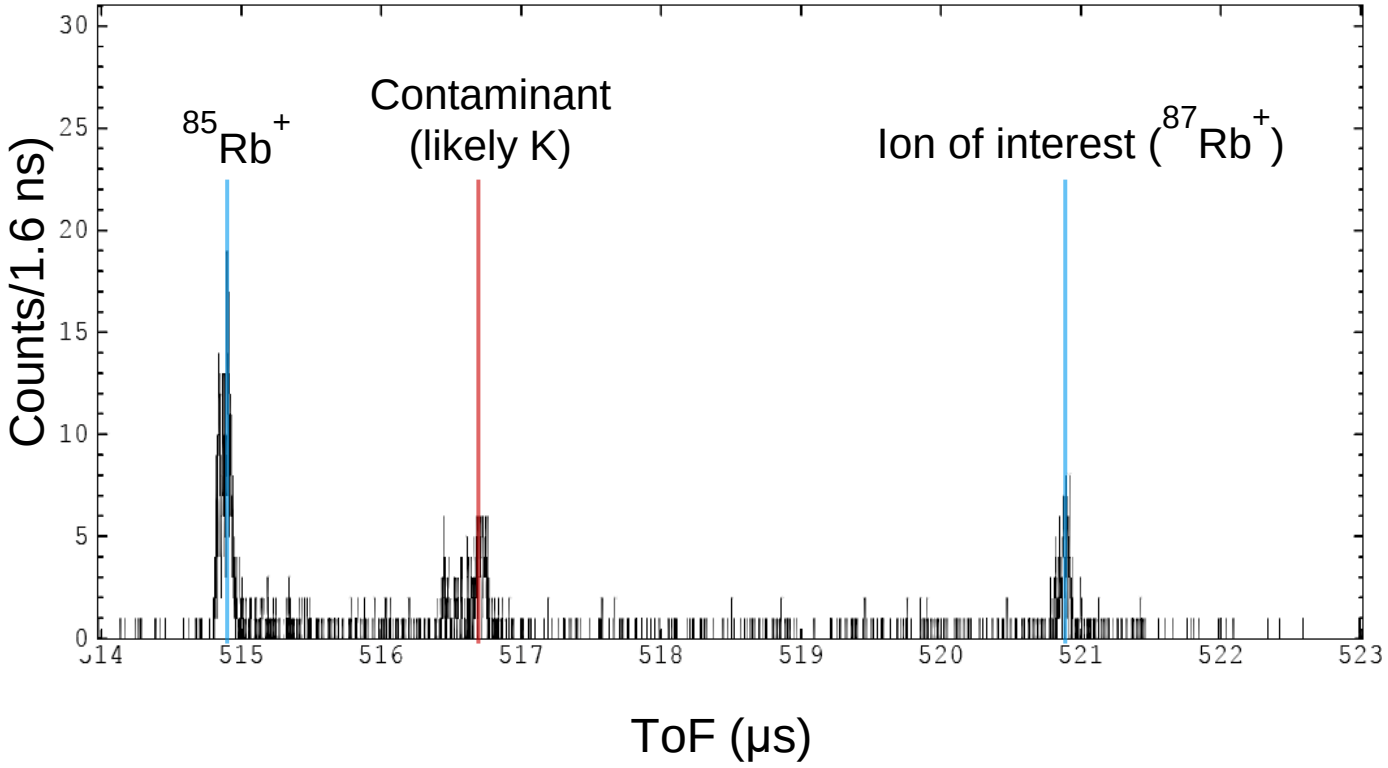

AGOR
Solenoid
Target
Faraday cup
Gas catcher
MR-ToF MS


Detector
MR-ToF MS (ejection side)
MR-ToF MS (injection side)
Ion source
Adjustable iris with segmented Einzel lens

MR-TOF MS



$$\frac{2\Delta t}{t} = \frac{\Delta m}{m}$$



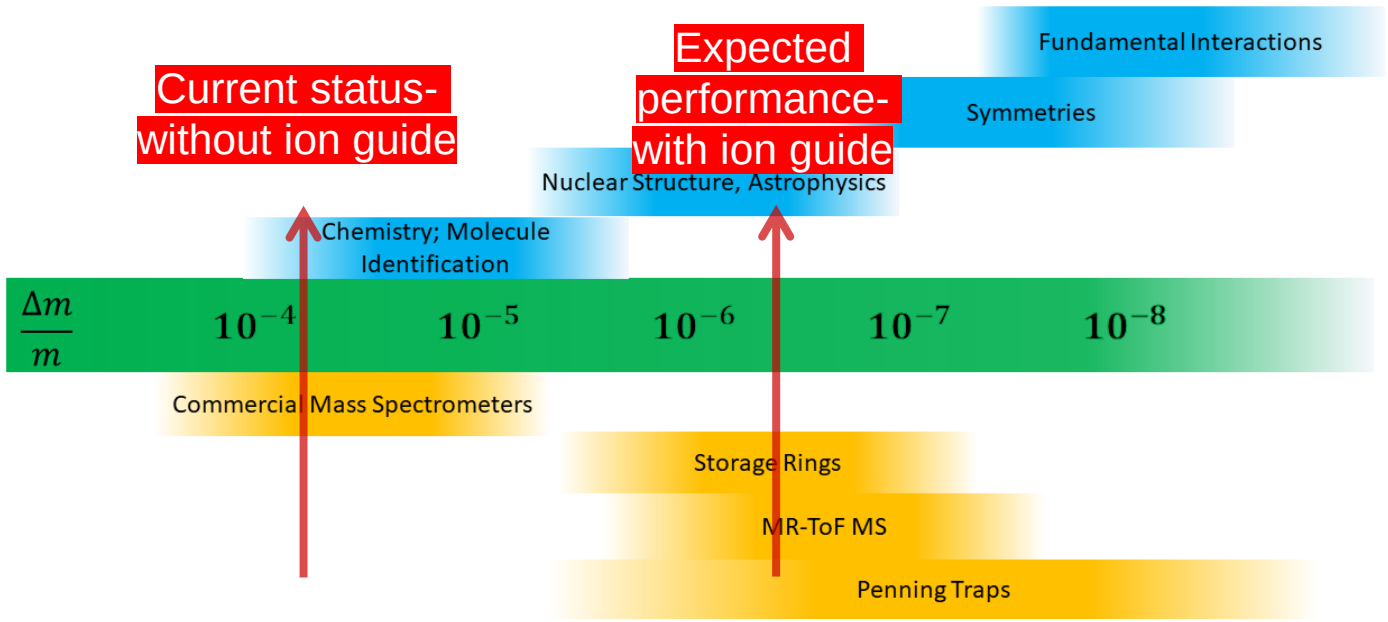
B.D. Hartigan, Master's thesis, RUG (2023)

$\frac{\Delta m}{m} \approx 10^{-4}$ after 18 revolutions.

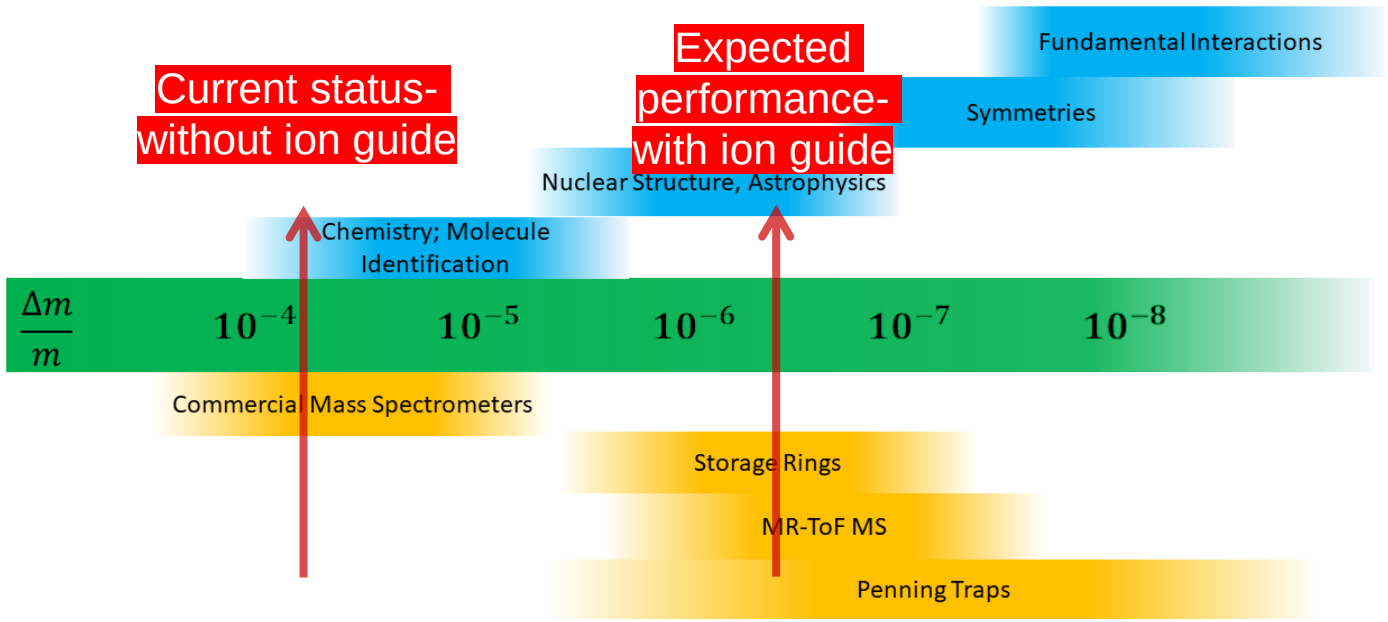
Bunching method limits storage time.

Ion guide will give better precision.

The NEXT Steps



The NEXT Steps



- Investigate transmission efficiency and ion bunch characteristics of ion guide.
- Commission total set-up offline and benchmark mass resolution.
- Move set-up to downstream of beamline

Thanks to….

Research group: Julia Even, Marko Brajković, Xiangcheng Chen, Arif Soylu, Jennifer B. Cipagauta, Nathan Moorrees, Niels Landsman, Puck Planje

And to

Our collaborators: Lutz Schweikhard (U. Greifswald), Moritz Schlaich (TU Darmstadt), Frank Wienholtz (TU Darmstadt), Jan Sáren (U. Jyväskylä), Juha Uusitalo (U. Jyväskylä), Thomas Schlathölter (RuG)