ISCC 2017-02-07

MR-ToF MS prototype for ISOLDE

- What is an MR-ToF MS and why do we want one?
- Current performance and possible improvements
- Constrains at ISOLDE
- Test with ISCOOL and ISOLTRAP

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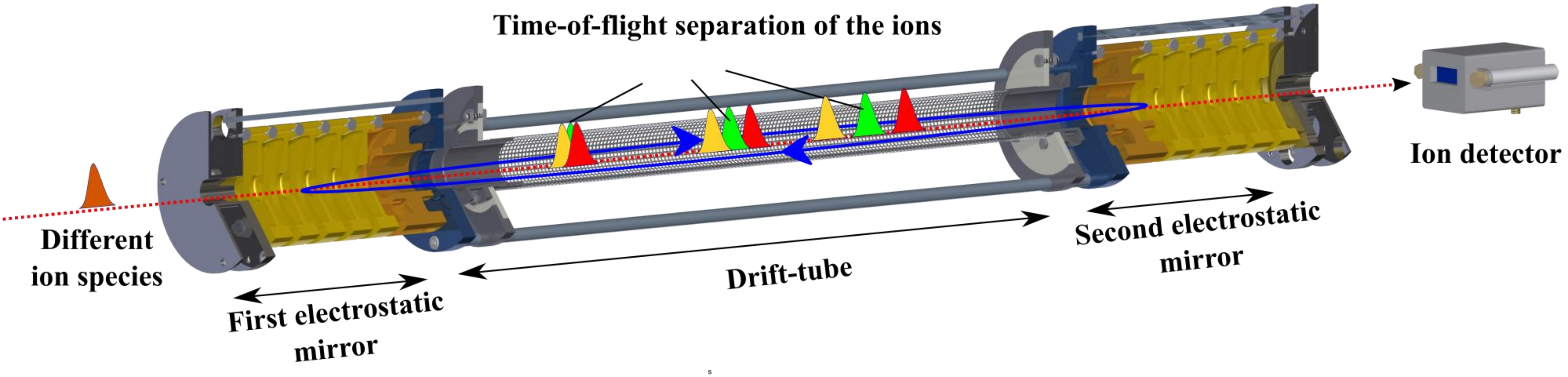
What is a Multi-reflection time-of-flight Mass spectrometer and why do we want one?

ISOLTRAP’s MR-ToF MS



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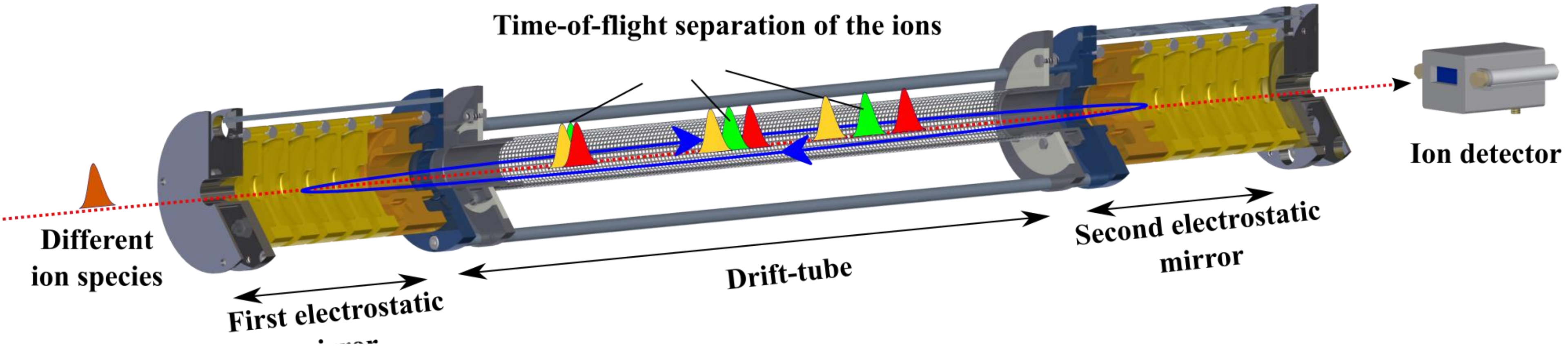
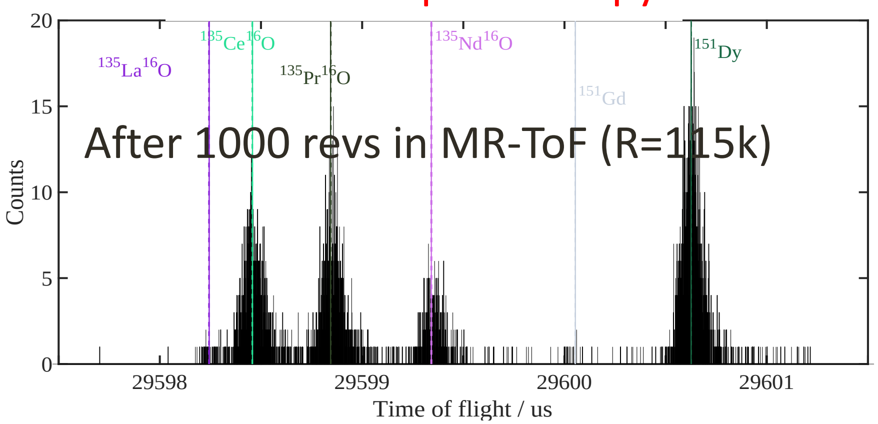


Mößbauer spectroscopy



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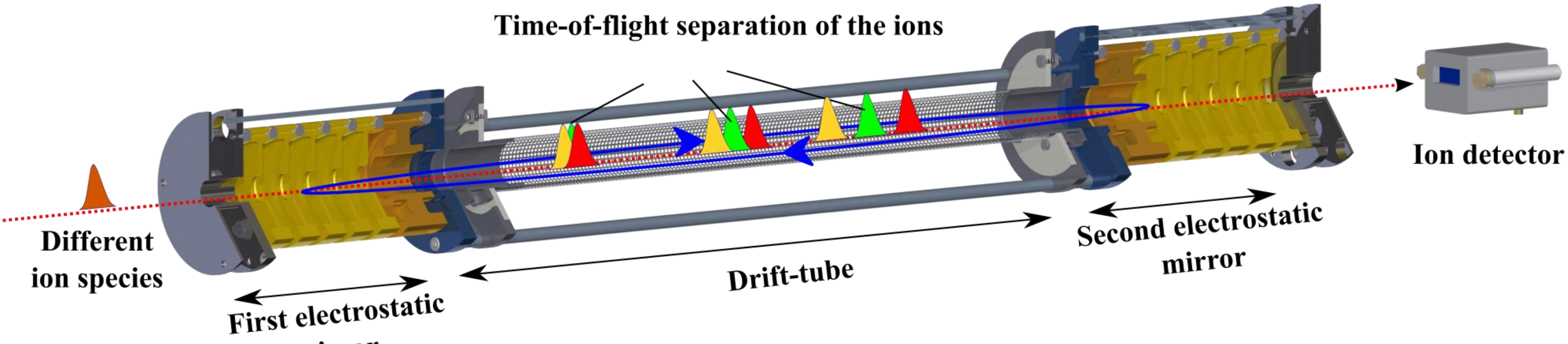

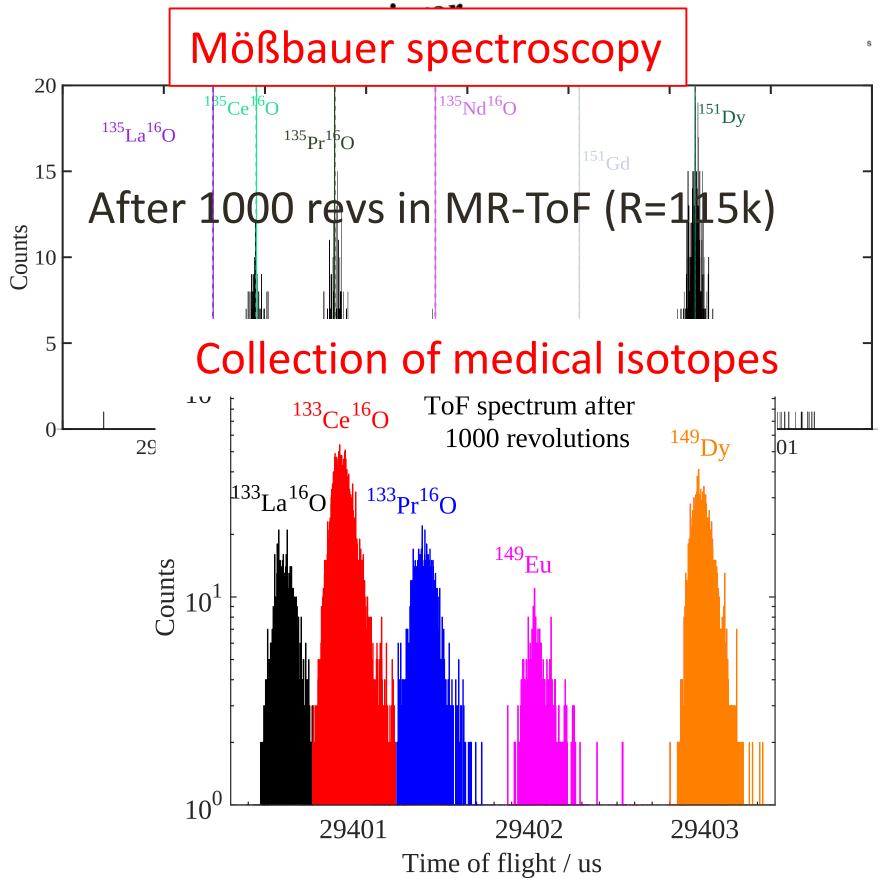

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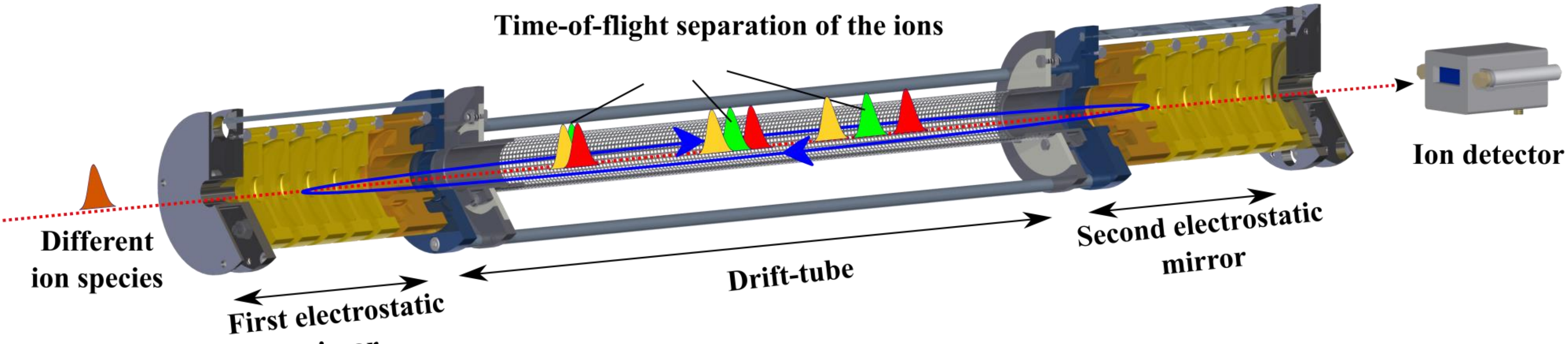
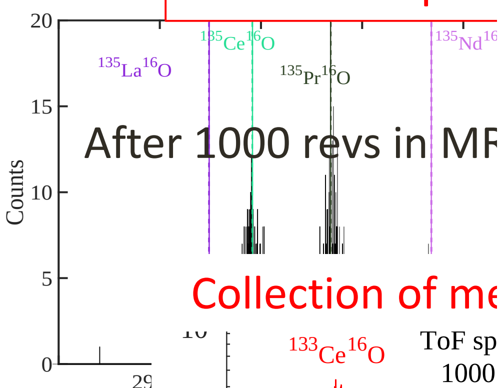
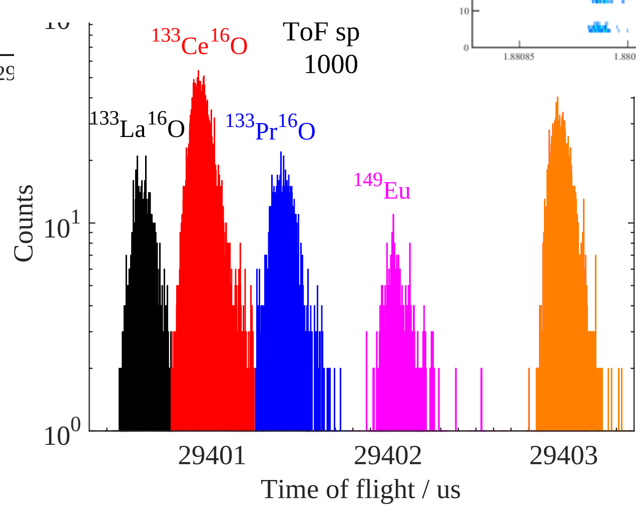


Mößbauer spect

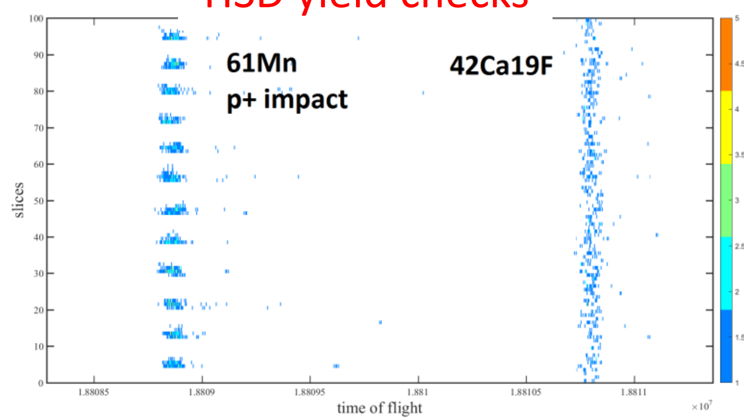


After 1000 revs in MF

Collection of me



TISD yield checks



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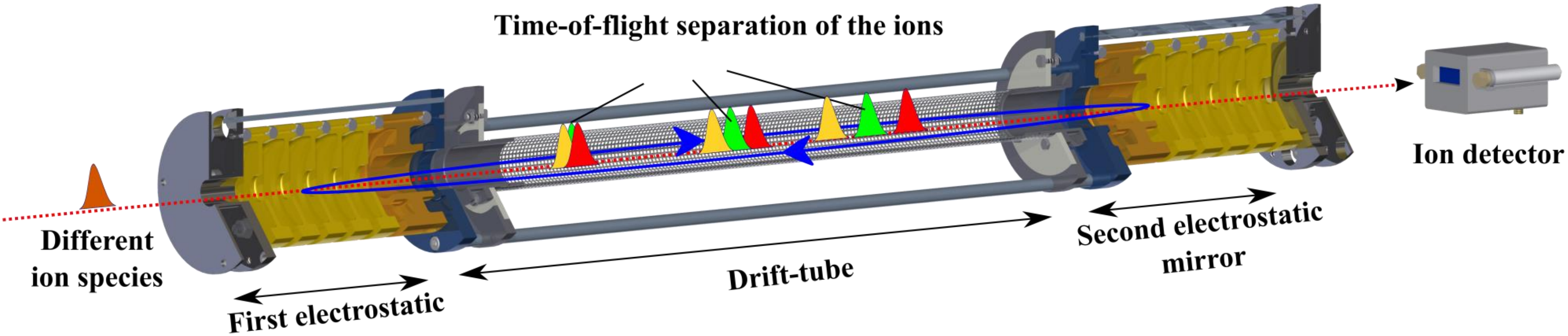
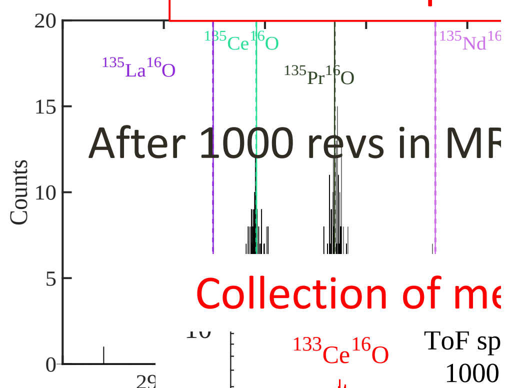


Mößbauer spect



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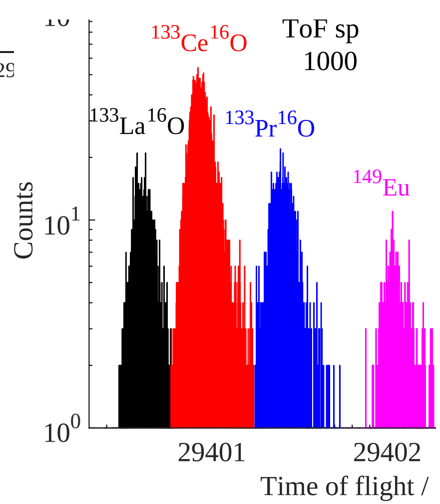

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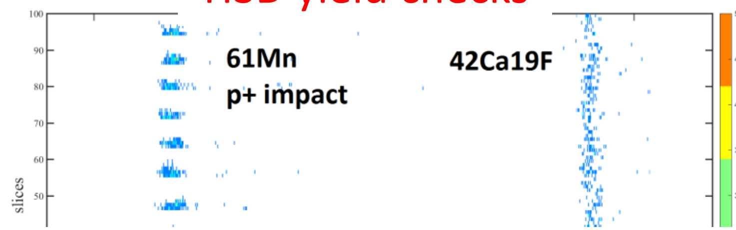
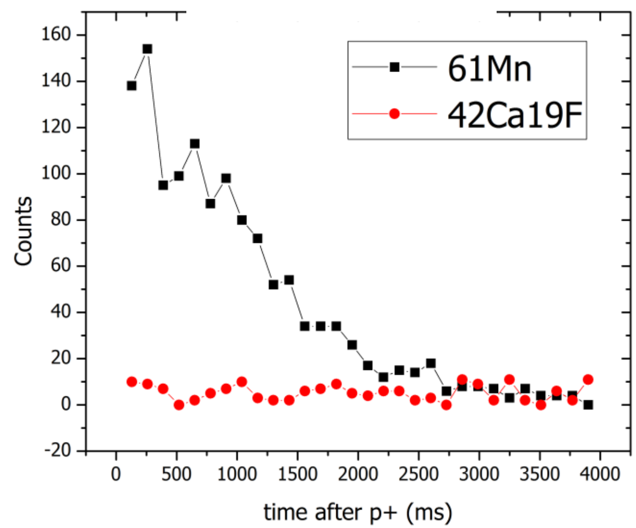


Release curve



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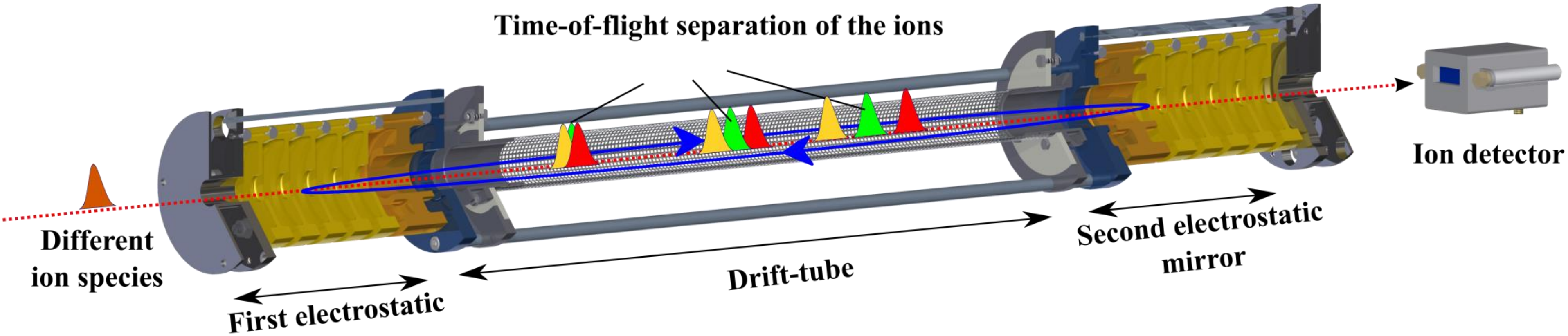
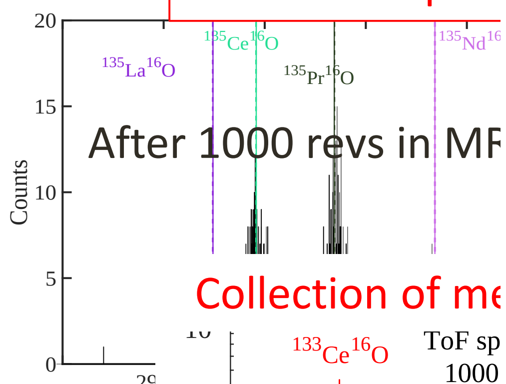


Mößbauer spect



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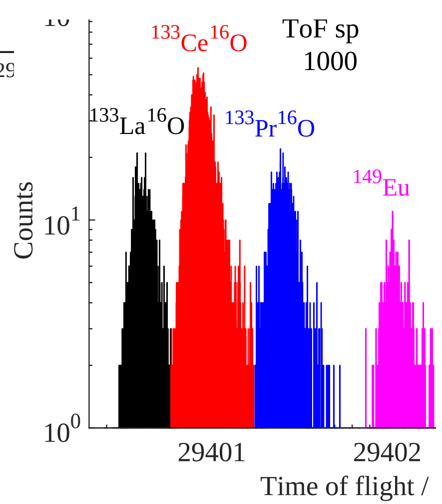

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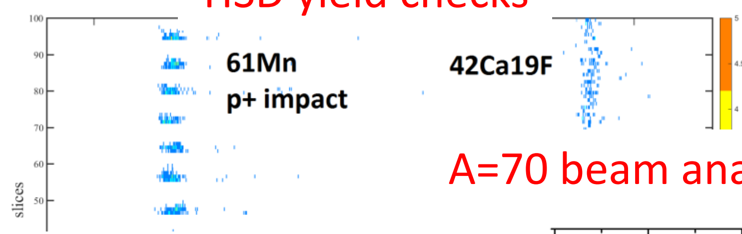
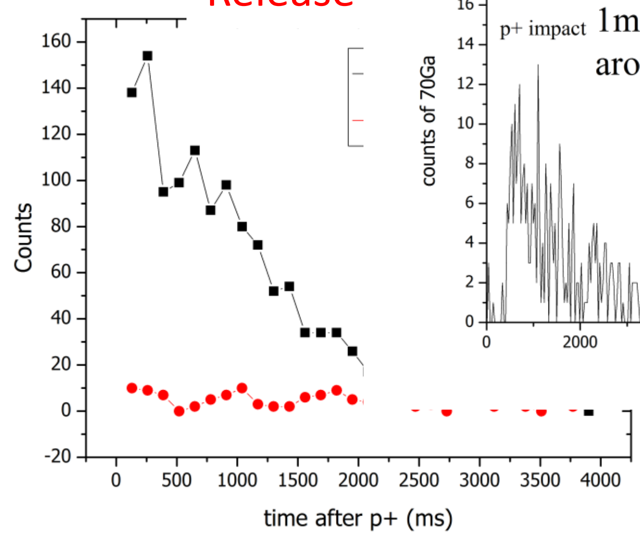
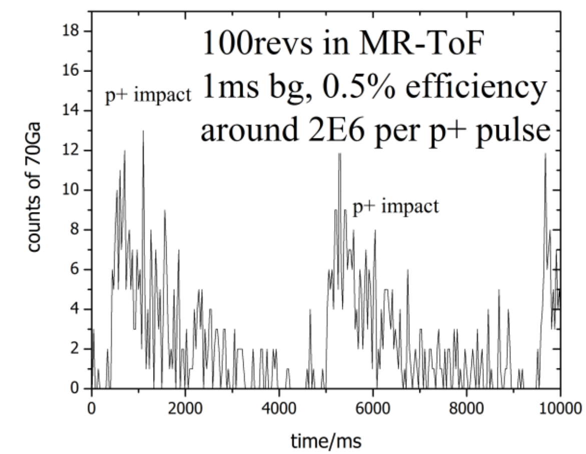


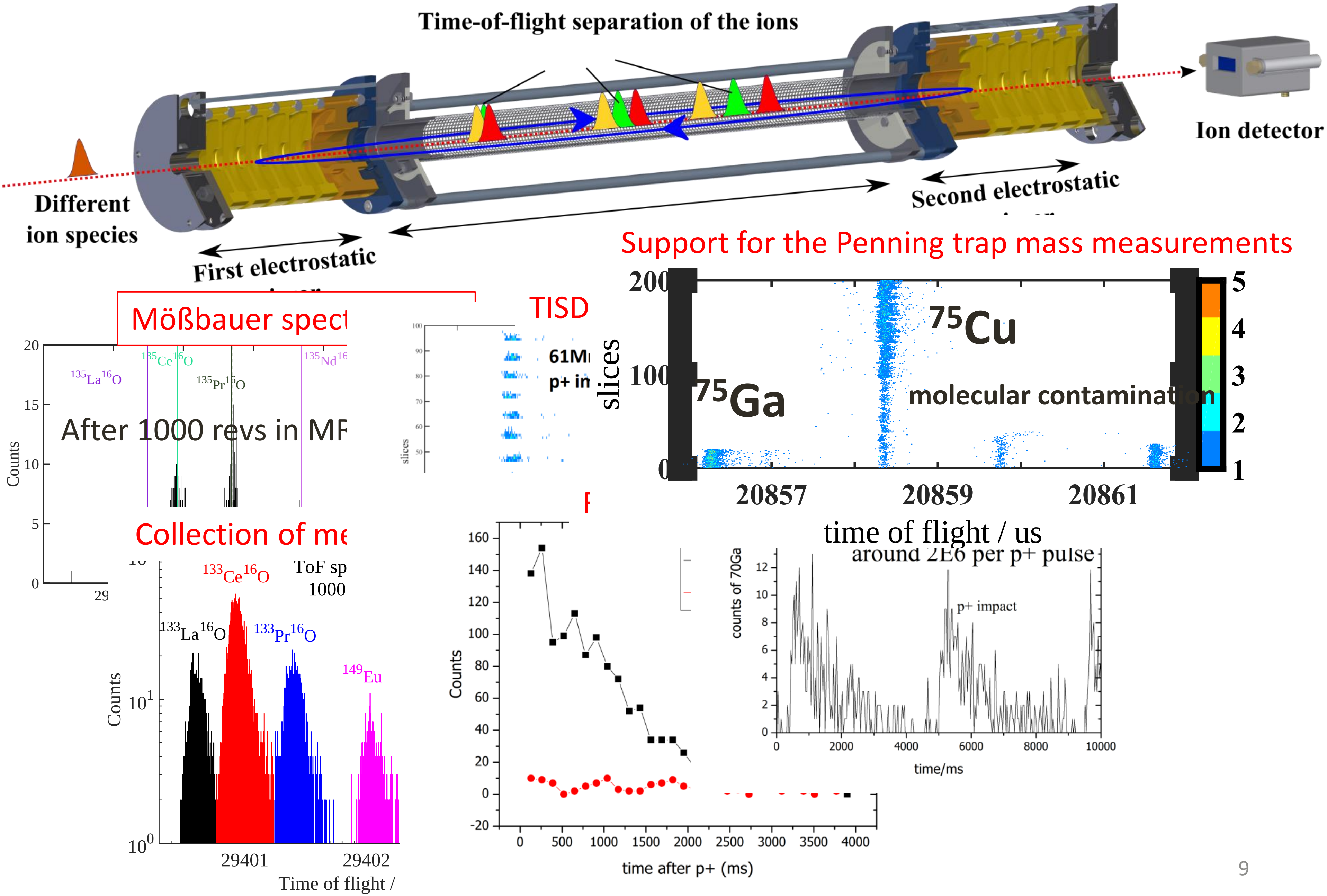
A=70 beam analyses – 70Ni Collaps

Release





ISOLTRAP’s MR-ToF MS



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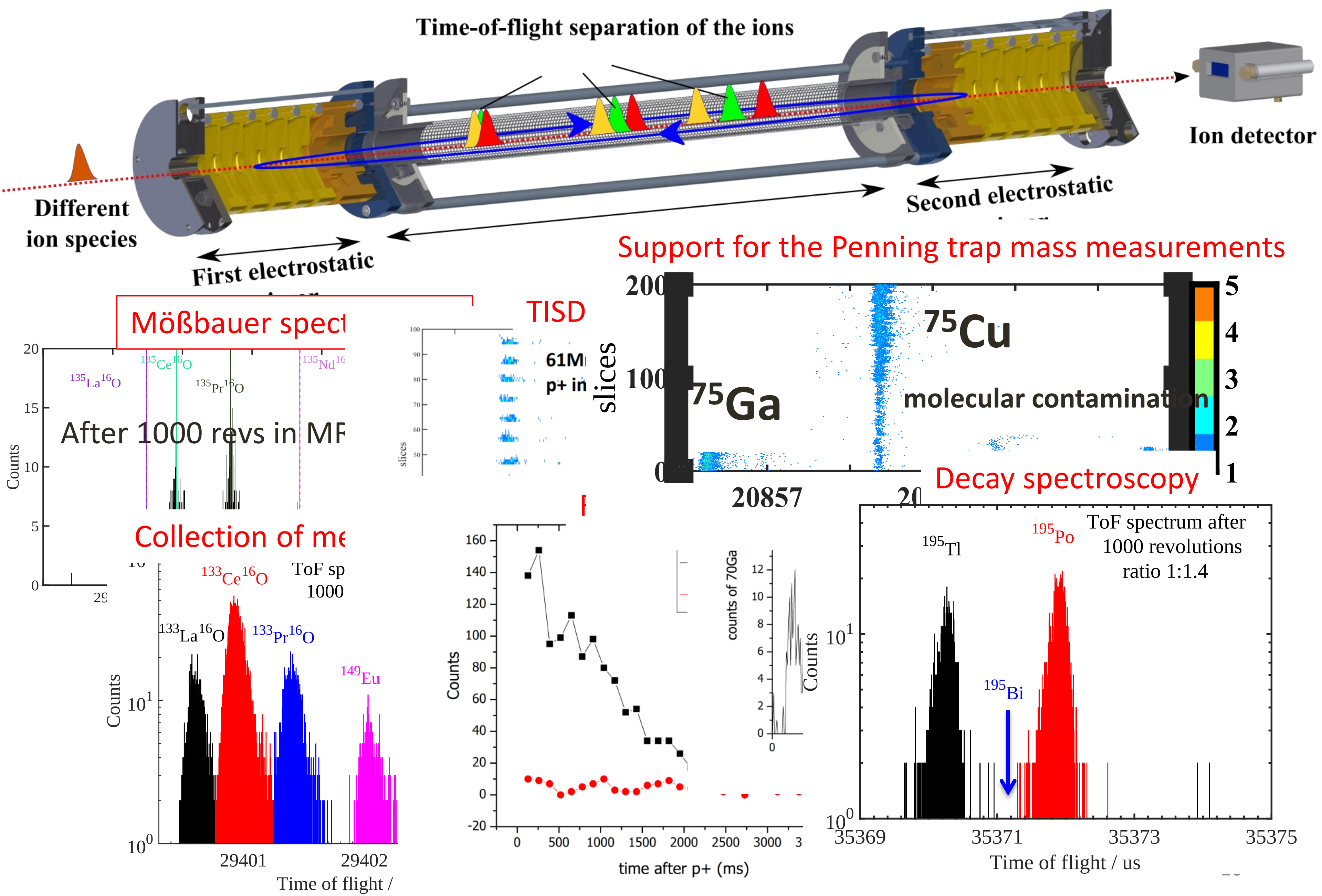
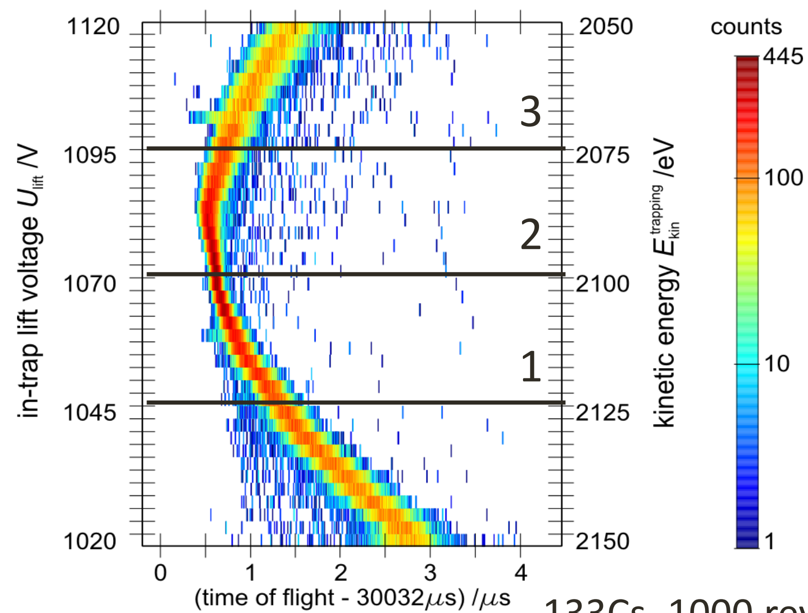


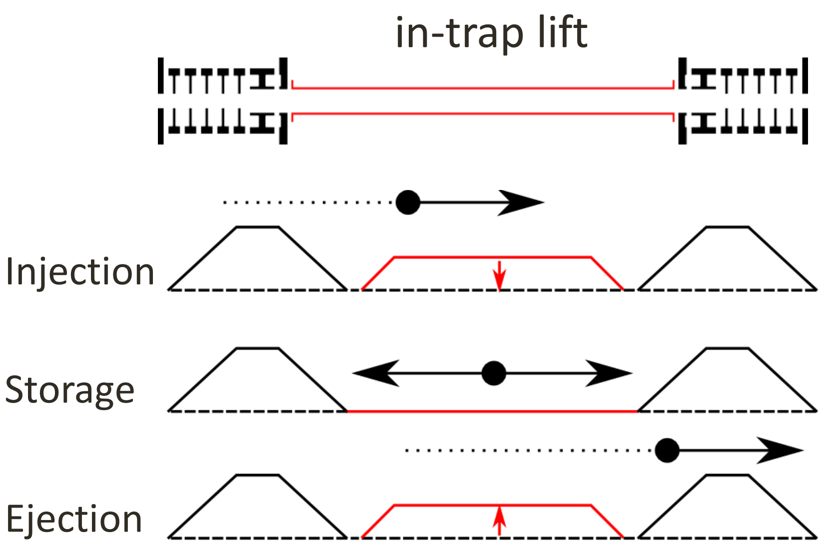
The MR-ToF-MS at ISOLTRAP

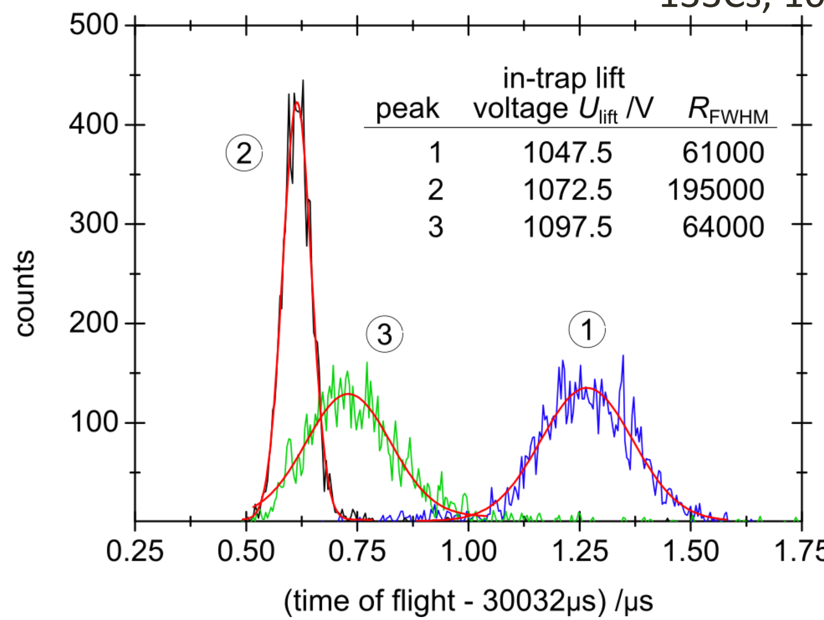
- capture and ejection with one electrode
  ➔ **simple technique, stable mirror potentials**
- decouple MR-ToF-MS and adjacent beamline
  ➔ **independent optimization**
- adjust ions' kinetic energy
  ➔ **ToF focusing, max. mass resolving power**

➔ **only one parameter to adjust**



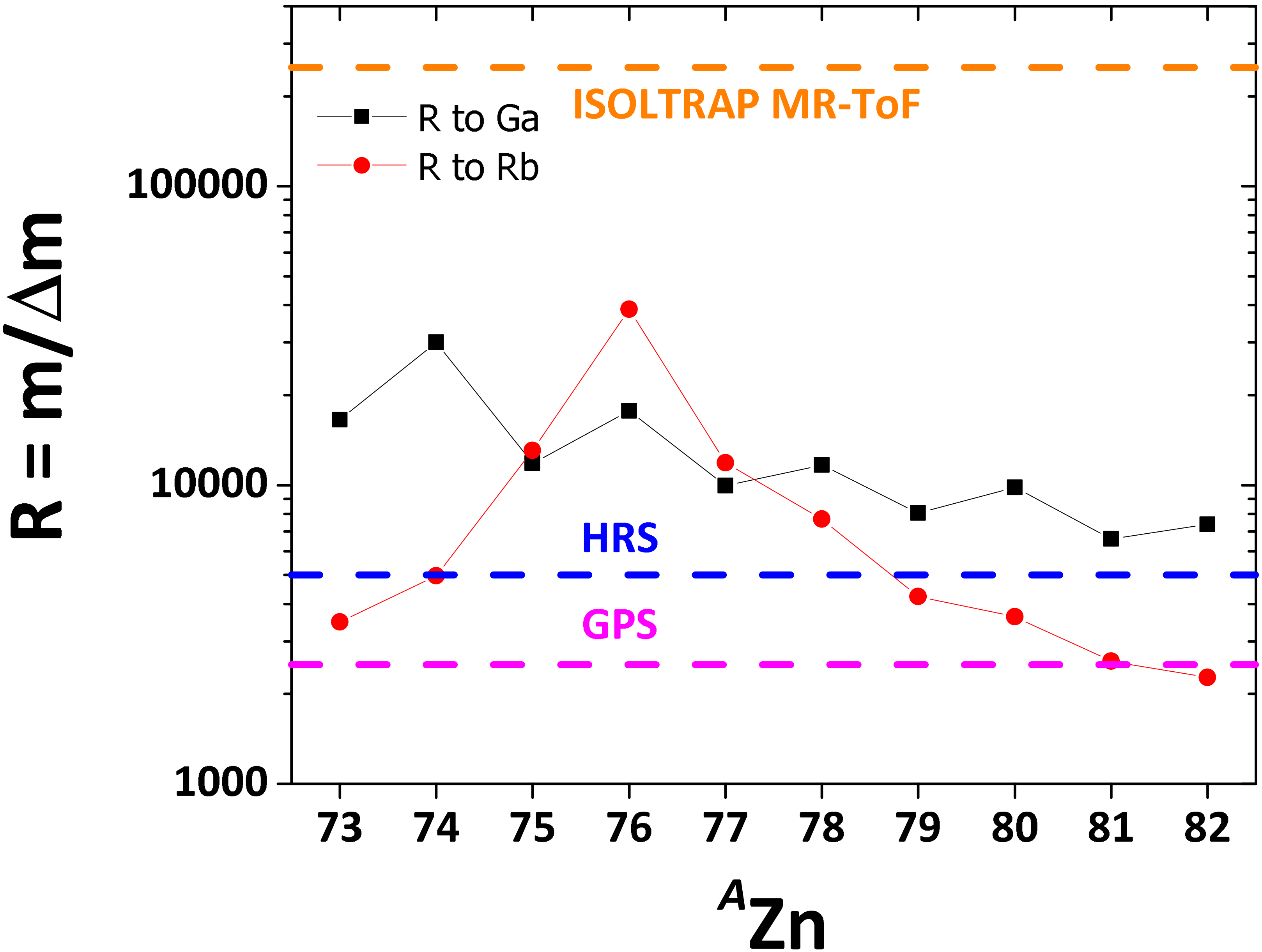
133Cs, 1000 rev.





Wolf *et al.*, IJMS 313, 8 (2012)

Necessary mass resolving power for separation of n-rich Zn beams



The MR-ToF-MS at ISOLTRAP - Performance

Ion energy: 2.1keV
Max. mirror potential: 4kV
Pressure: 5E-9mbar
Longitudinal emittance: 100nseV
Transversal emittance: 5π mm mrad

mass resolving power (FWHM)
 $m/\Delta m$=100 000 at 18ms
 $m/\Delta m$=300 000 at 35ms

transmission
 ≈50% at 30ms

ion capacity for multiple species
≈100 000 per second

contamination suppression (BNG)
 4 orders of magnitude

operation and tuning
 only one parameter to adjust

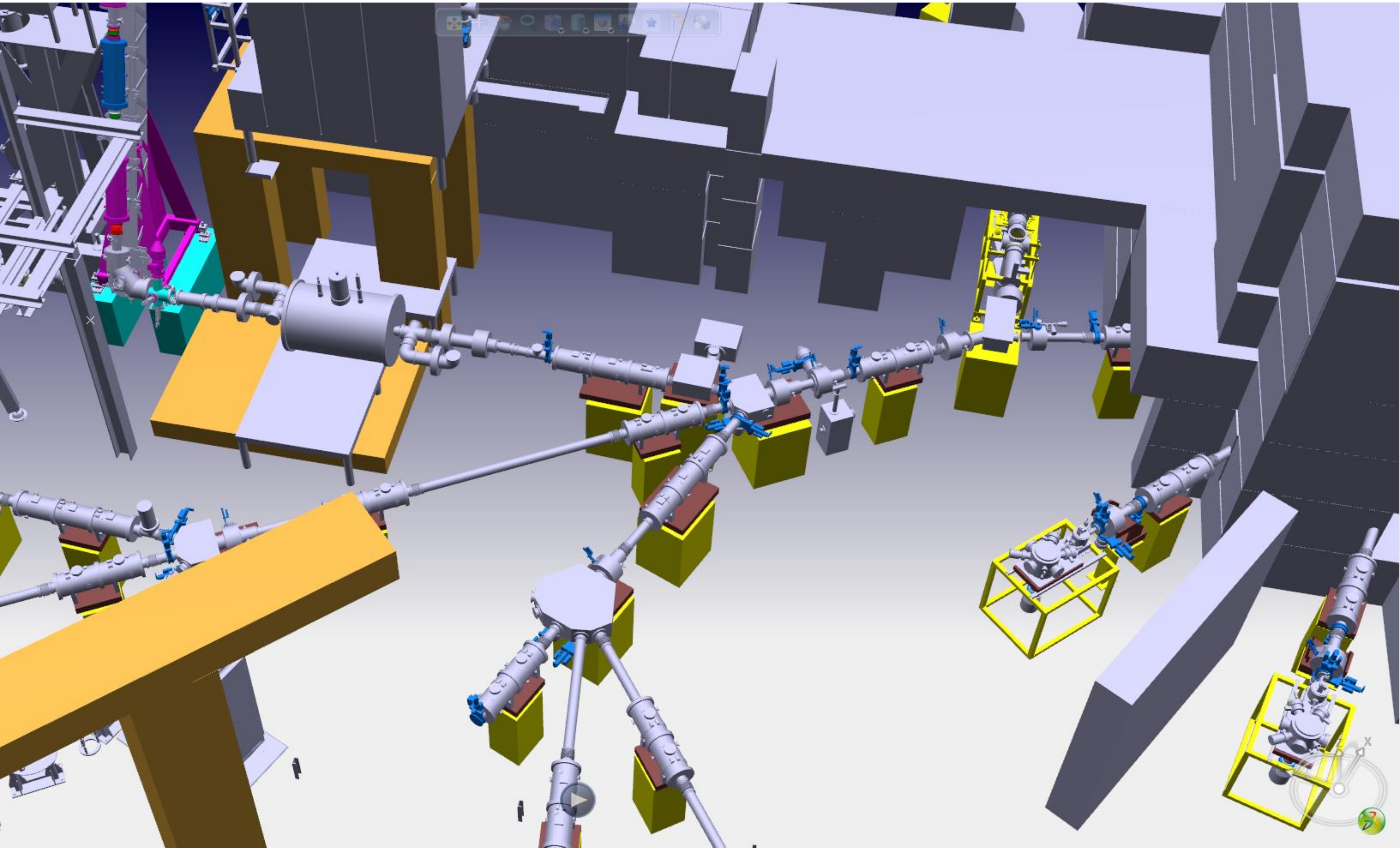
→ simple operation

Ion energy: 30keV
Max. mirror potential: 60kV
Pressure: 1E-8mbar
Bunching with ISCOOL:
Longitudinal emittance: 500nseV
Transversal emittance: 2-4 *π mm mrad*
Chopping: *has to be tested*

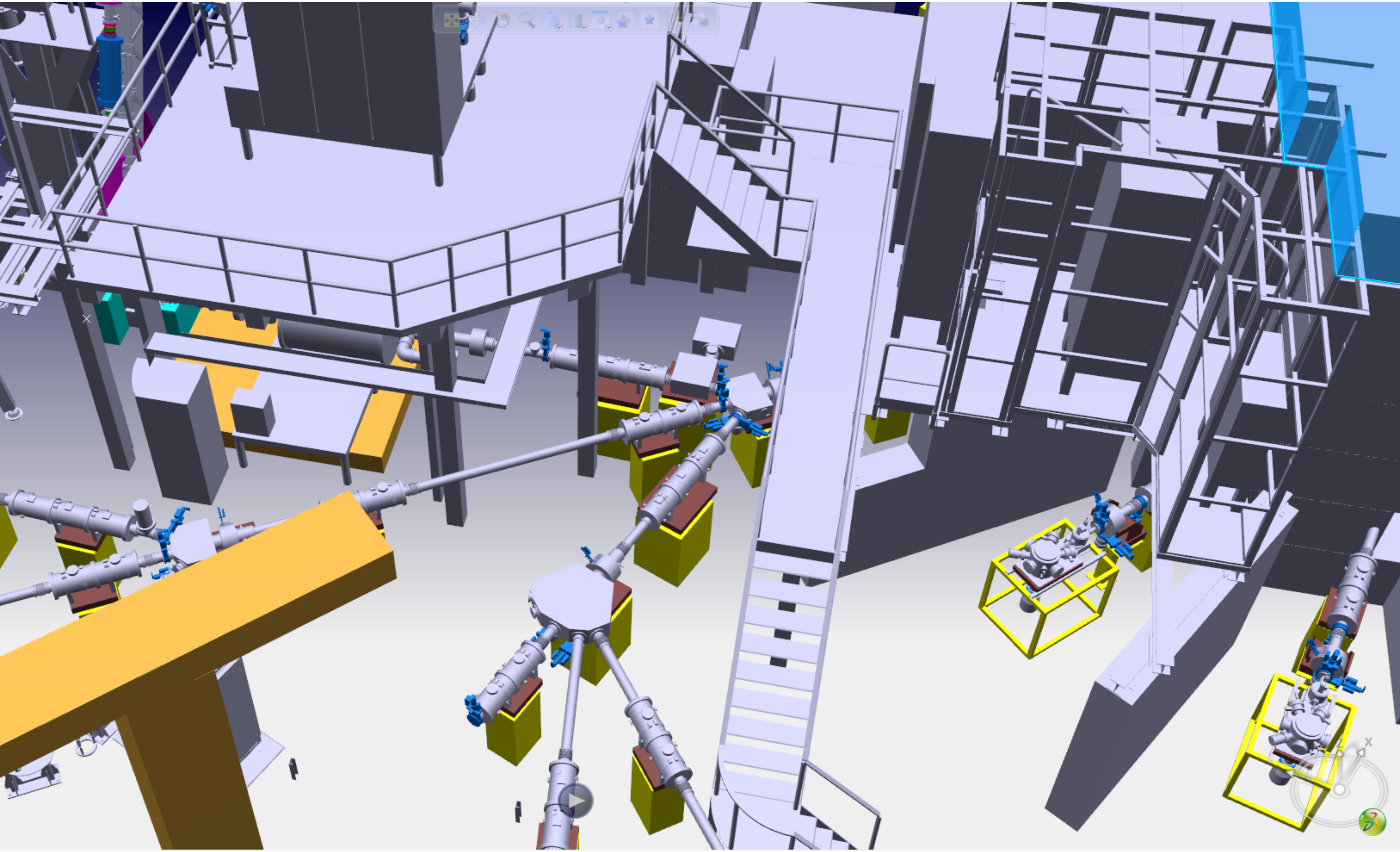
Decrease time needed for separation by about factor 4
→ Transmission should be improved

→ Optimize mirror electrodes and ion optics for large transversal emittance
→ Increase ion capacity

ISOLDE MR-ToF-MS



ISOLDE MR-ToF-MS



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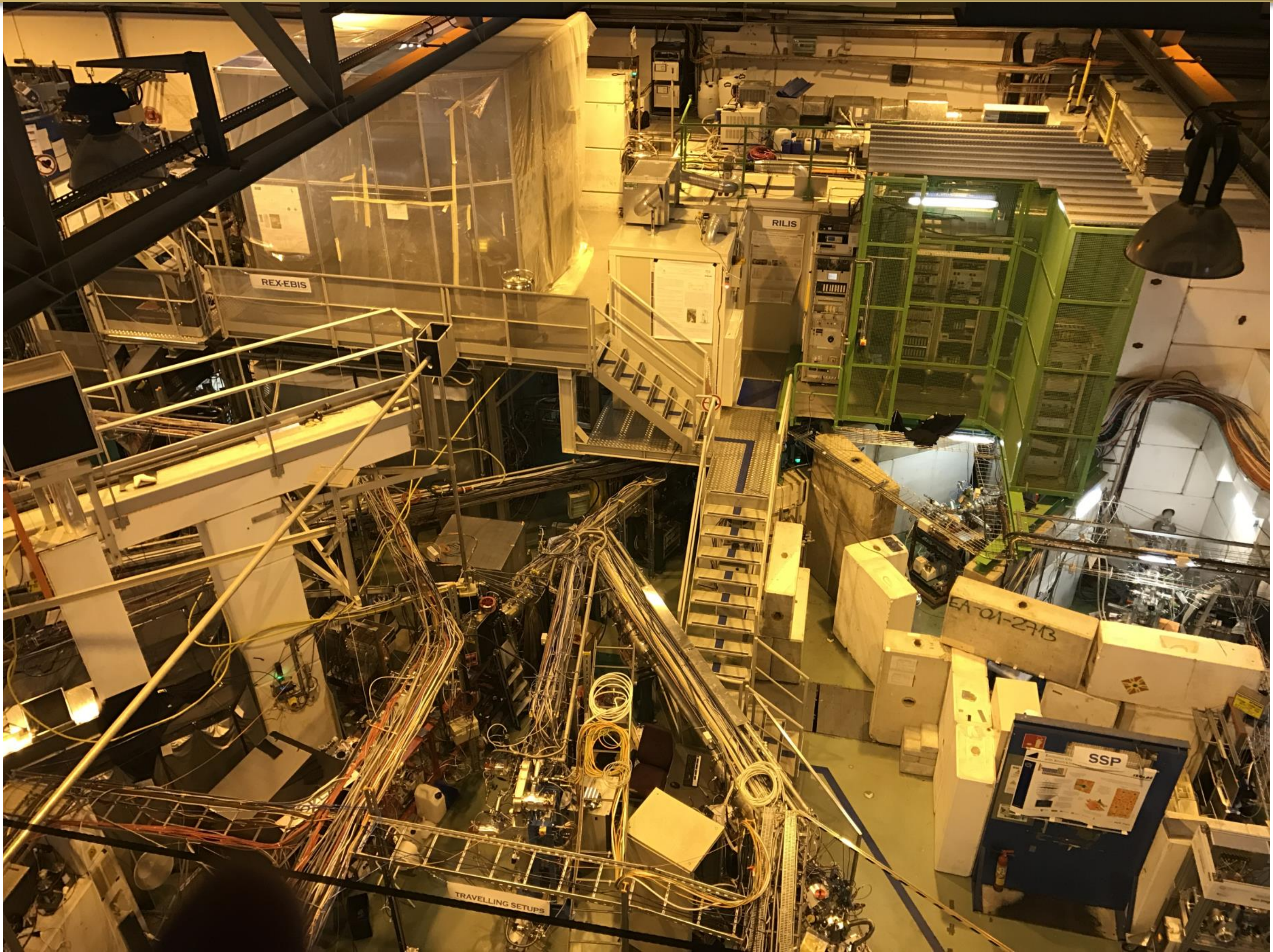
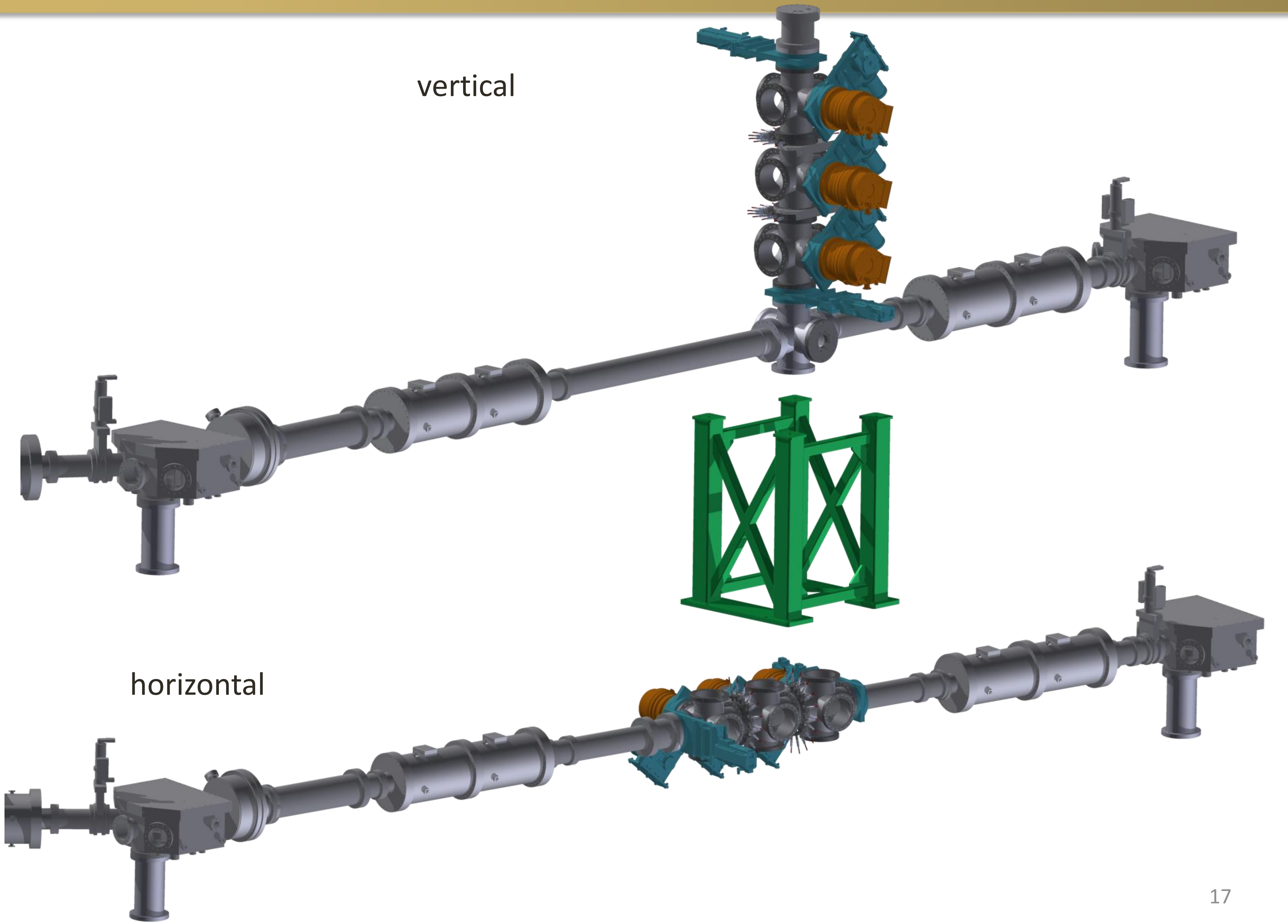


ISOLDE MR-ToF-MS



Tests with the ISCOOL and ISOLTRAP

- Shoot the ISCOOL beam through the ISOLTRAP buncher (transmission mode)

- Perform beam diagnostic with ISOLTRAP's tools
  - Minimal longitudinal emittance / ToF peak width?
  - Investigate fast ions?

- Determine the transmission
  - through ISCOOL → 50%?
  - through ISOTLRAP buncher?
  - through MR-ToF MS?

- Inject ISOOL bunches directly into the MR-ToF MS
  - Time scale?
  - Maximal R?
  - Mirror retune?
  - Efficiency of the hole process?

Acknowledgements

N. Althubiti, P. Ascher, G. Audi, **D. Atanasov**, D. Beck, K. Blaum, G. Bollen, Ch. Borgmann, M. Breitenfeldt, R. B. Cakirli, T. Cocolios, S. Eliseev, T. Eronen, S. George, F. Herfurth, A. Herlert, D. Kisler, M. Kowalska, S. Kreim, J. Kluge, Yu. A. Litvinov, D. Lunney, **M. Mougeot**, **V. Manea**, E. Minaya-Ramirez, S. Naimi, D. Neidherr, M. Rosenbusch, A. de Roubin, L. Schweikhard, F. Wienholtz, M. Wang, **A. Welker**, R. Wolf, K. Zuber, S. Schwarz

IS534 and IS598 Collaboration

Max-Planck-Institut für Kernphysik

ERNST MORITZ ARNDT UNIVERSITÄT GREIFSWALD

Federal Ministry of Education and Research

Grants No.: 05P12HGCI1 05P12HGFNE

ISOLDE Target and Technical Group

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Ulli Köster

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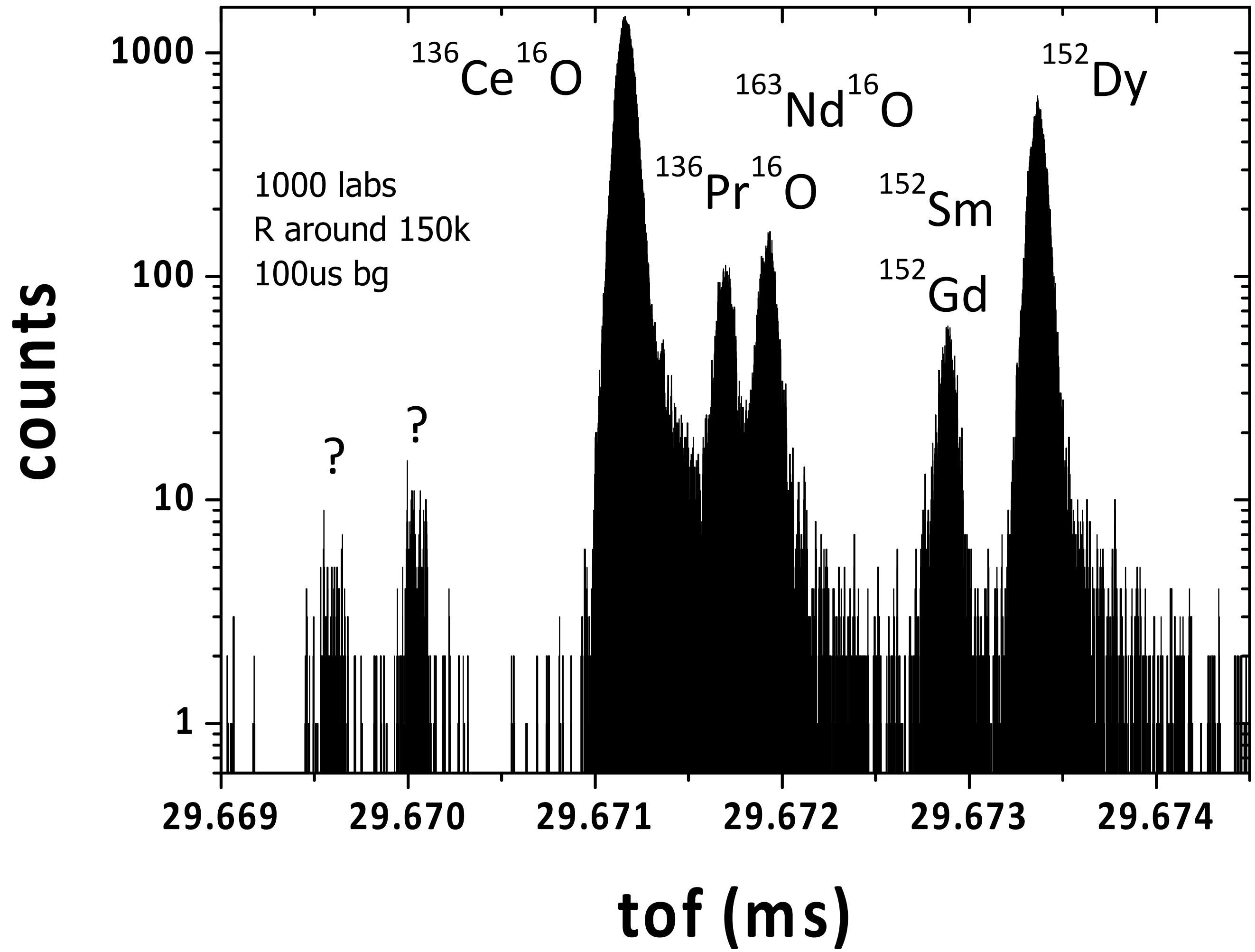
Limitations – peak coalescence

The MR-ToF-MS at ISOLTRAP – peak coalescence

- "Many" ions in one bunch can lead to peak coalescence due to Coulomb interaction
  - ToF mass measurements difficult BUT separation still possible
- Example: **A=152** beam



MCP voltage 2kV

- Around 26 ions/shot

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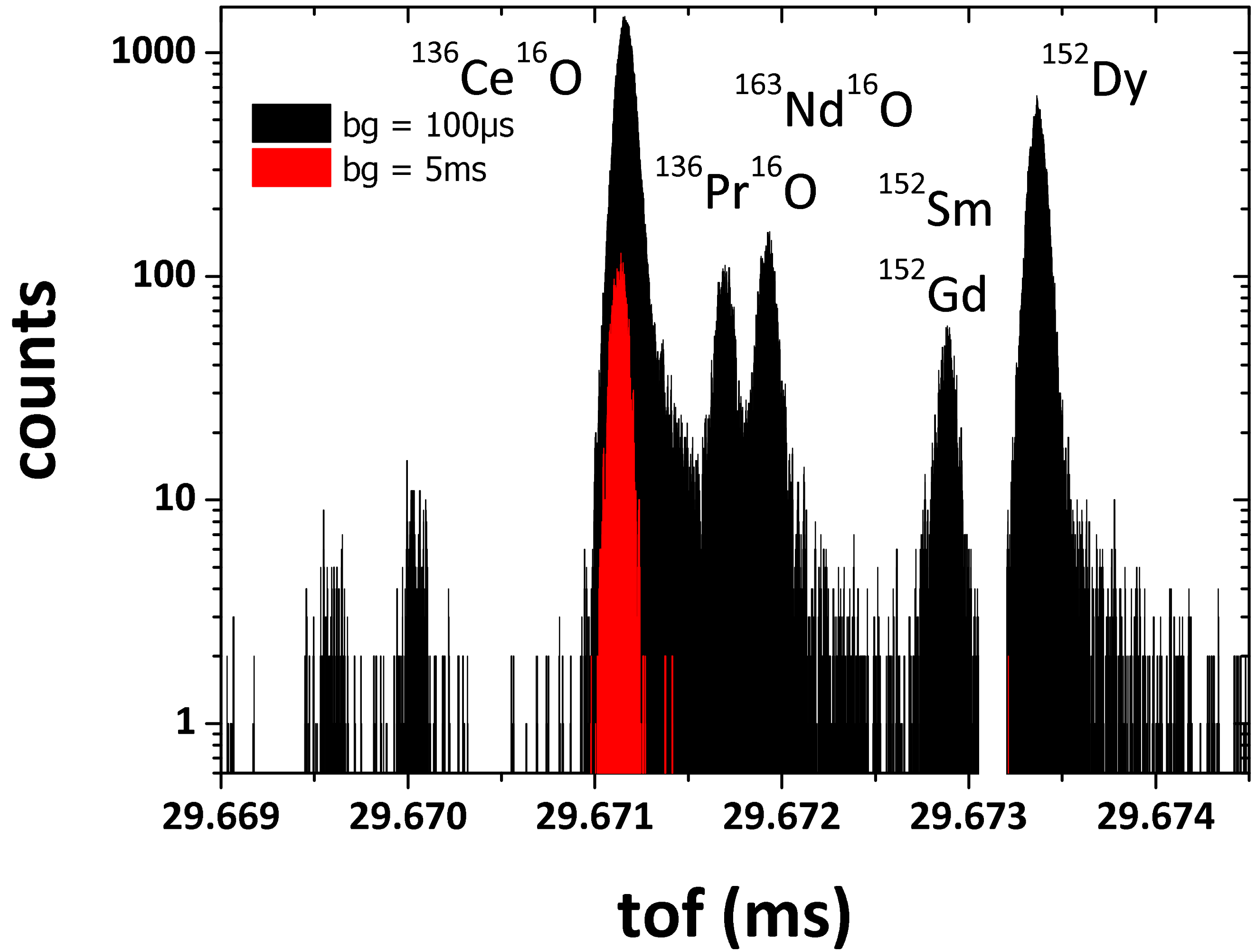

MCP voltage 2kV

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MCP voltage to 1.8kV

- Increase bg by x50

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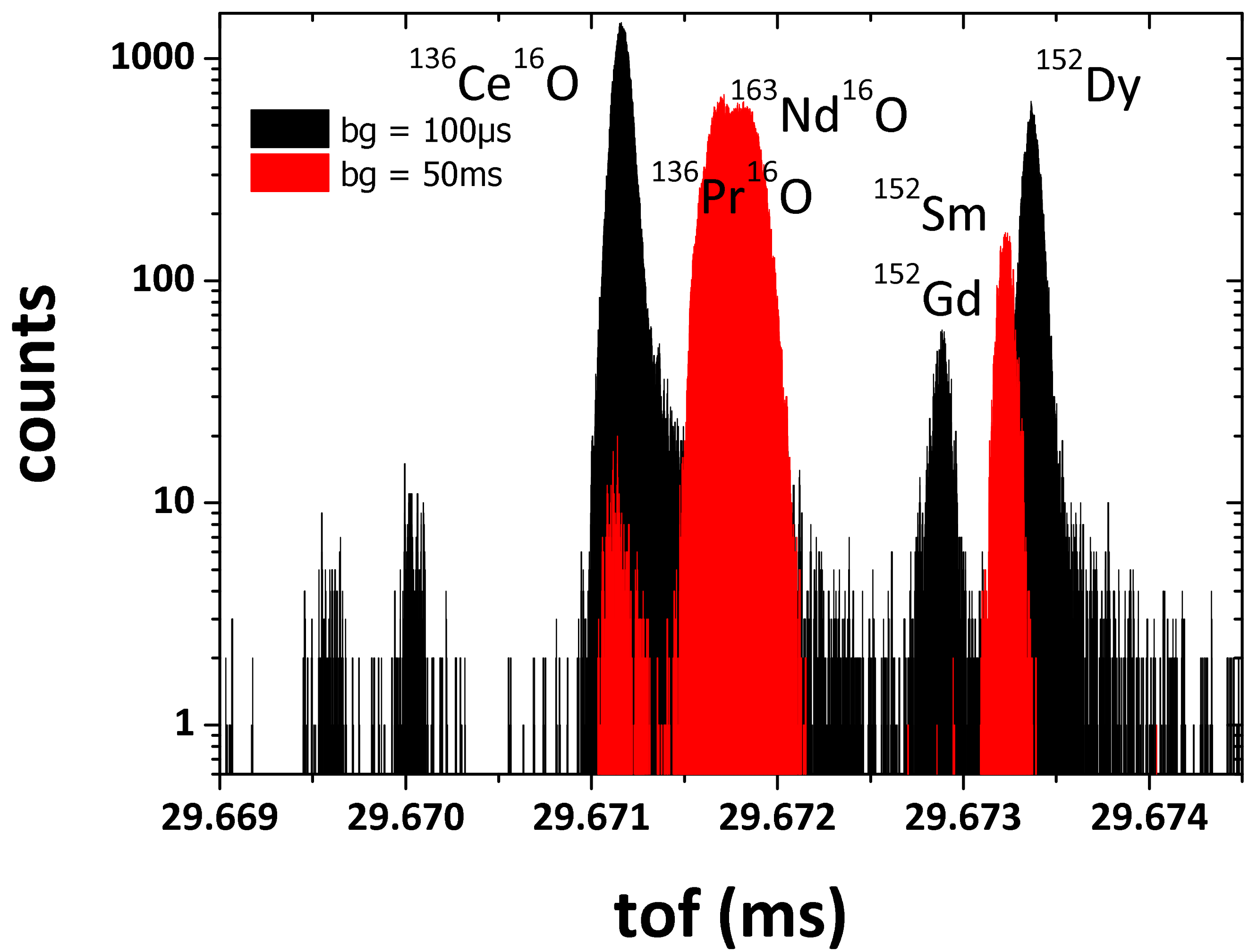

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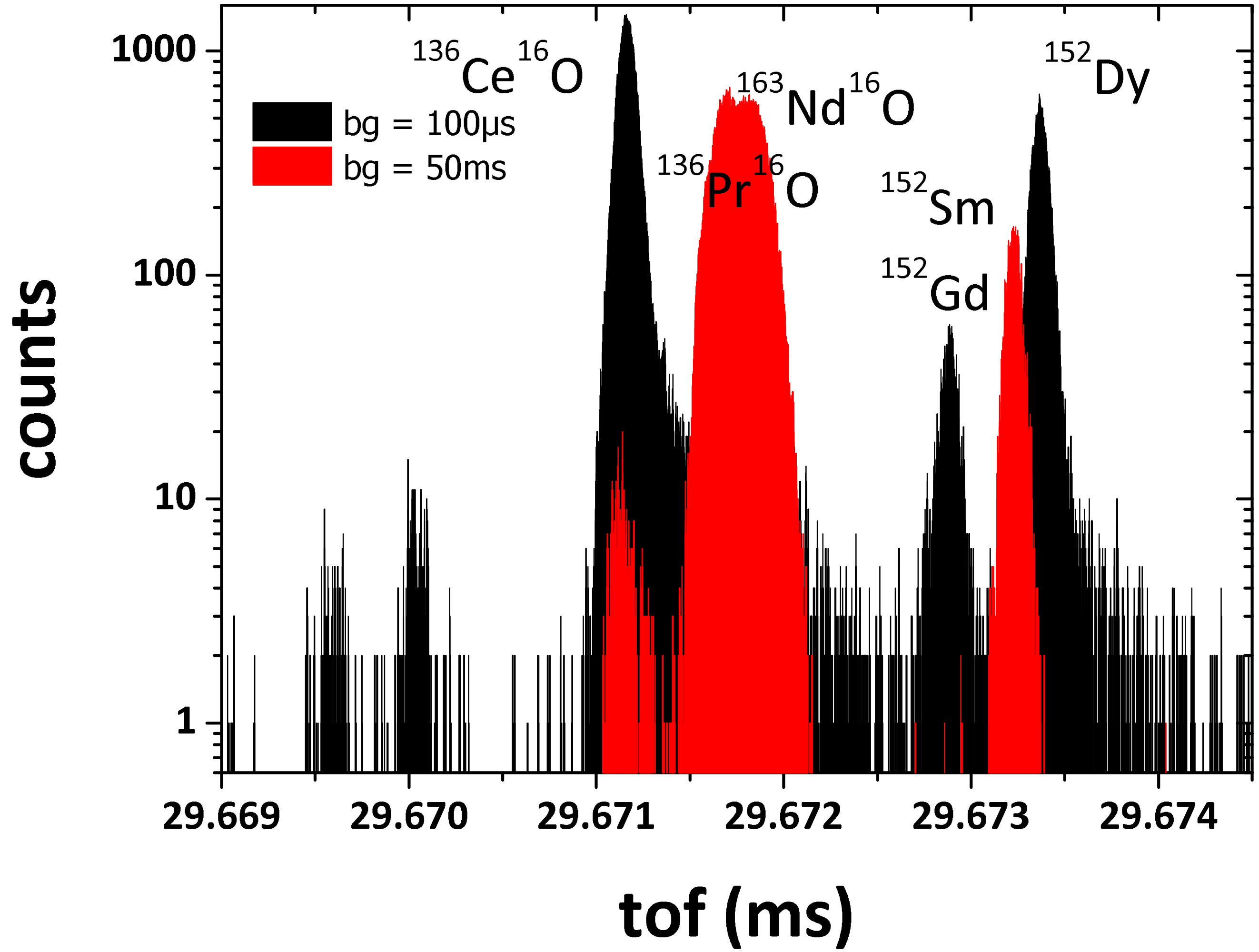


MCP voltage 2kV

- Around 26 ions/shot

MCP voltage to 1.8kV

- Increase bg by x50
- Increase bg by x500

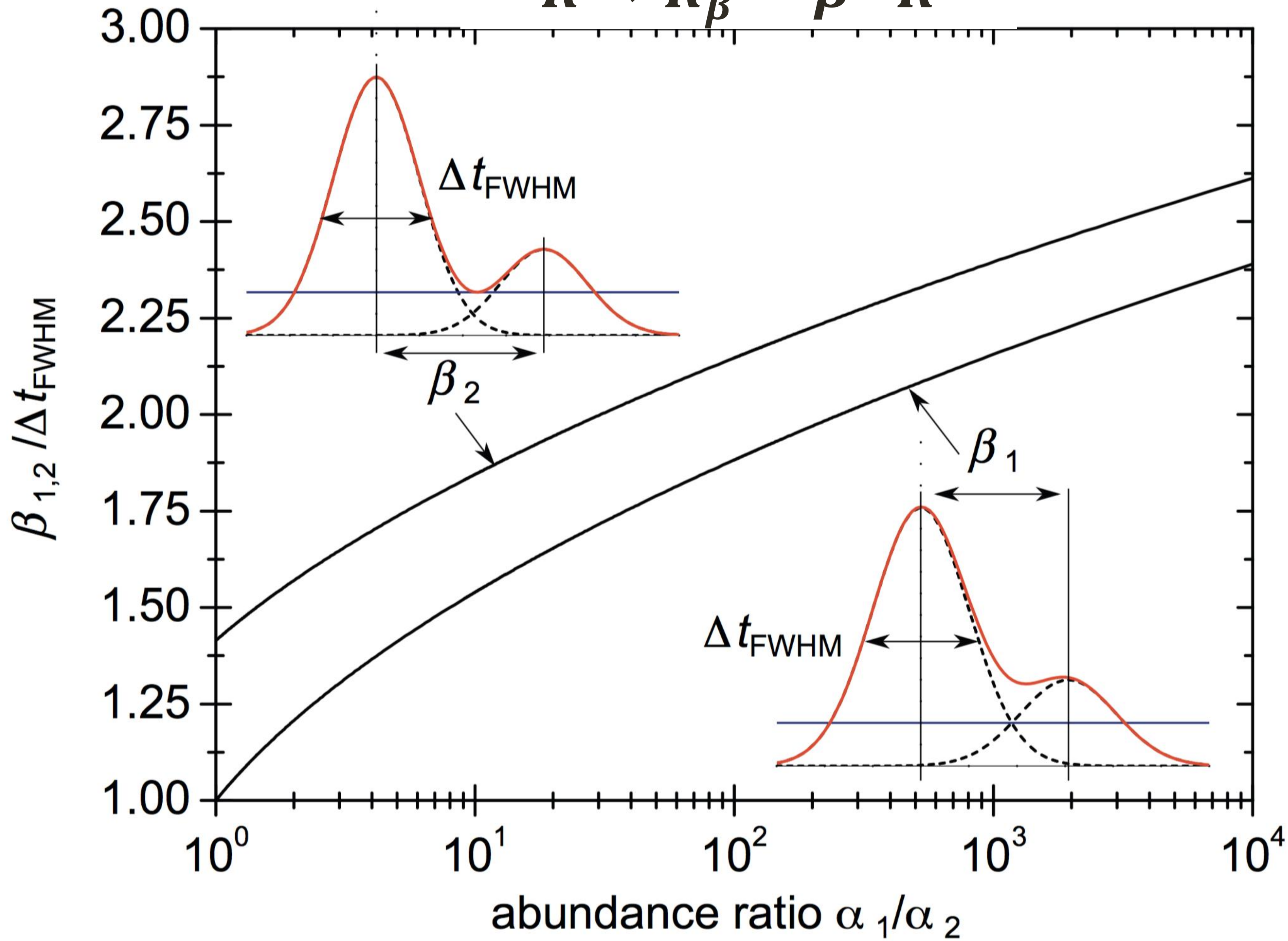
→ Separation still possible

→ Allows cleaning with higher throughput

Resolving power <-> cleaning of the Zn-beam

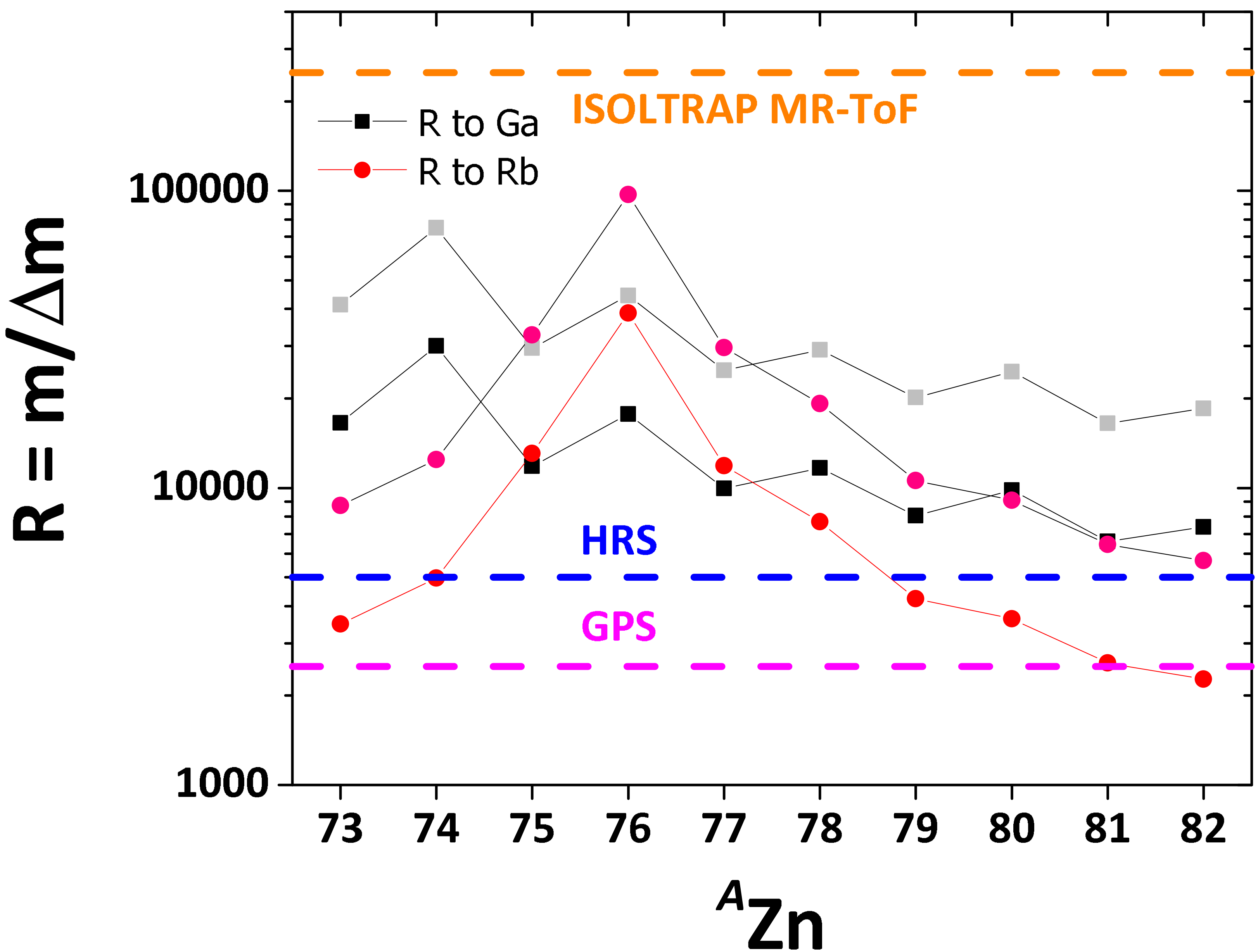
Mass resolving power – neutron rich Zn beams

$$R \rightarrow R_\beta = \beta \cdot R$$

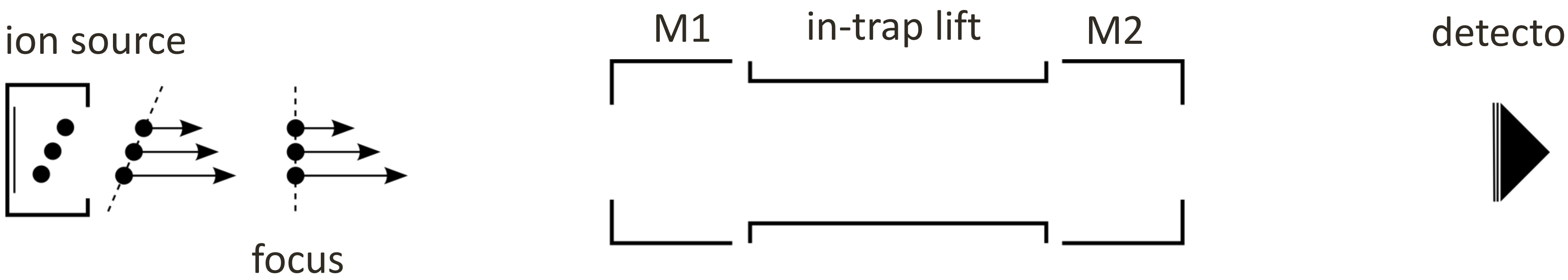


Wolf *et al.*, IJMS 349-350, 123 (2013);

Mass resolving power – neutron rich Zn beams



In-trap potential lift time focussing



Wolf *et al.*, IJMS **313**, 8 (2012)

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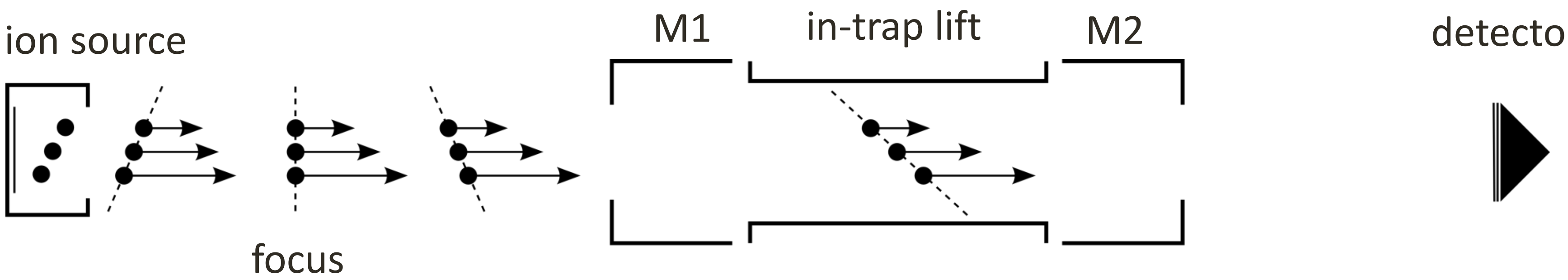

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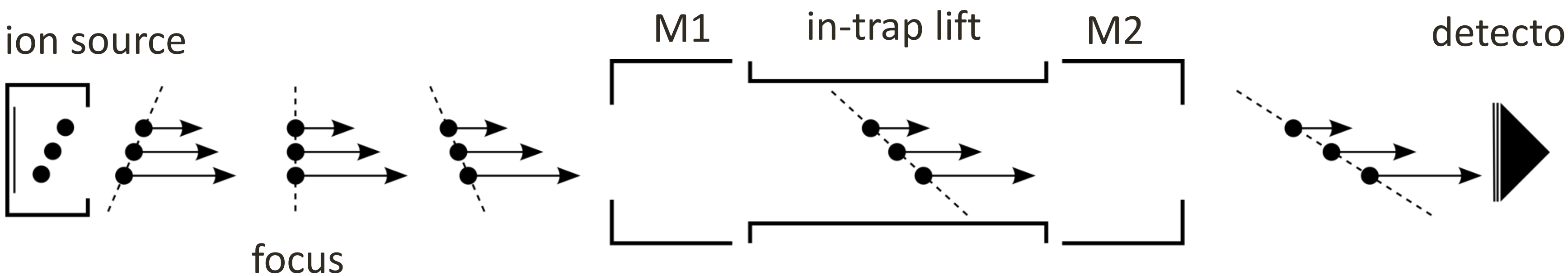

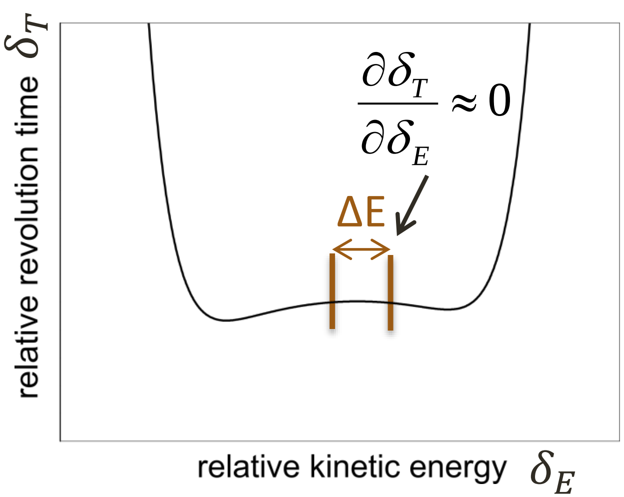

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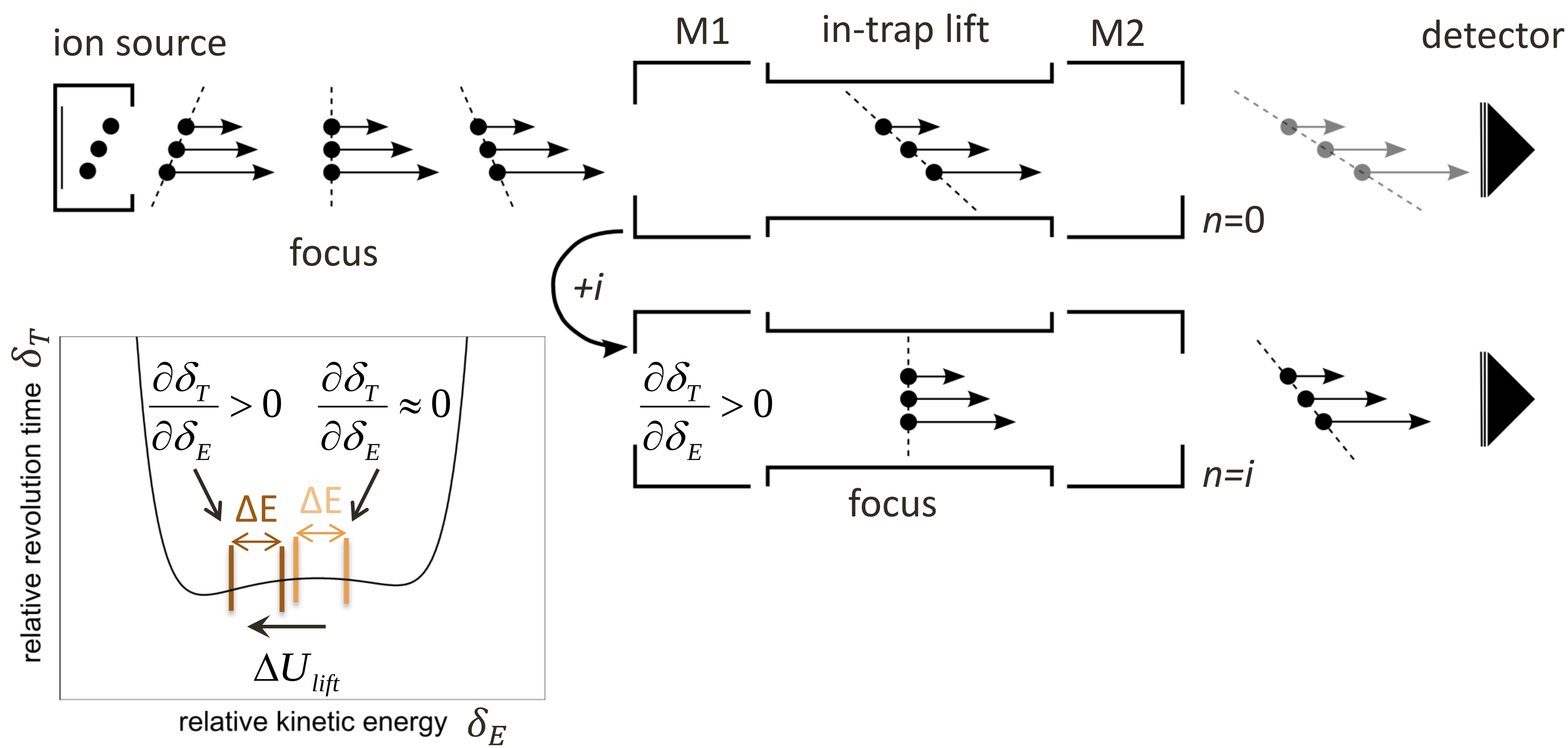

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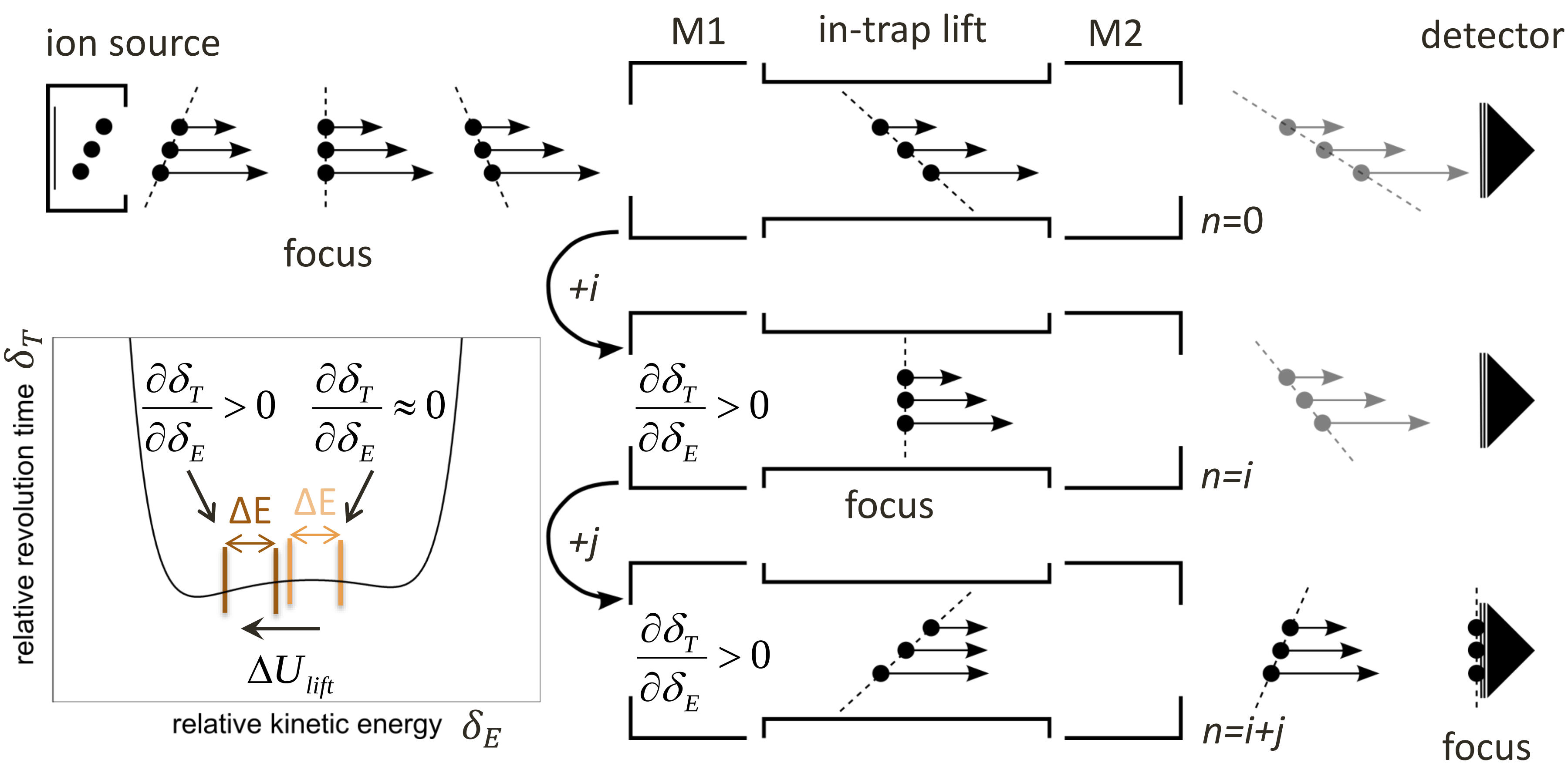

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