MR-TOF at ISOLDE

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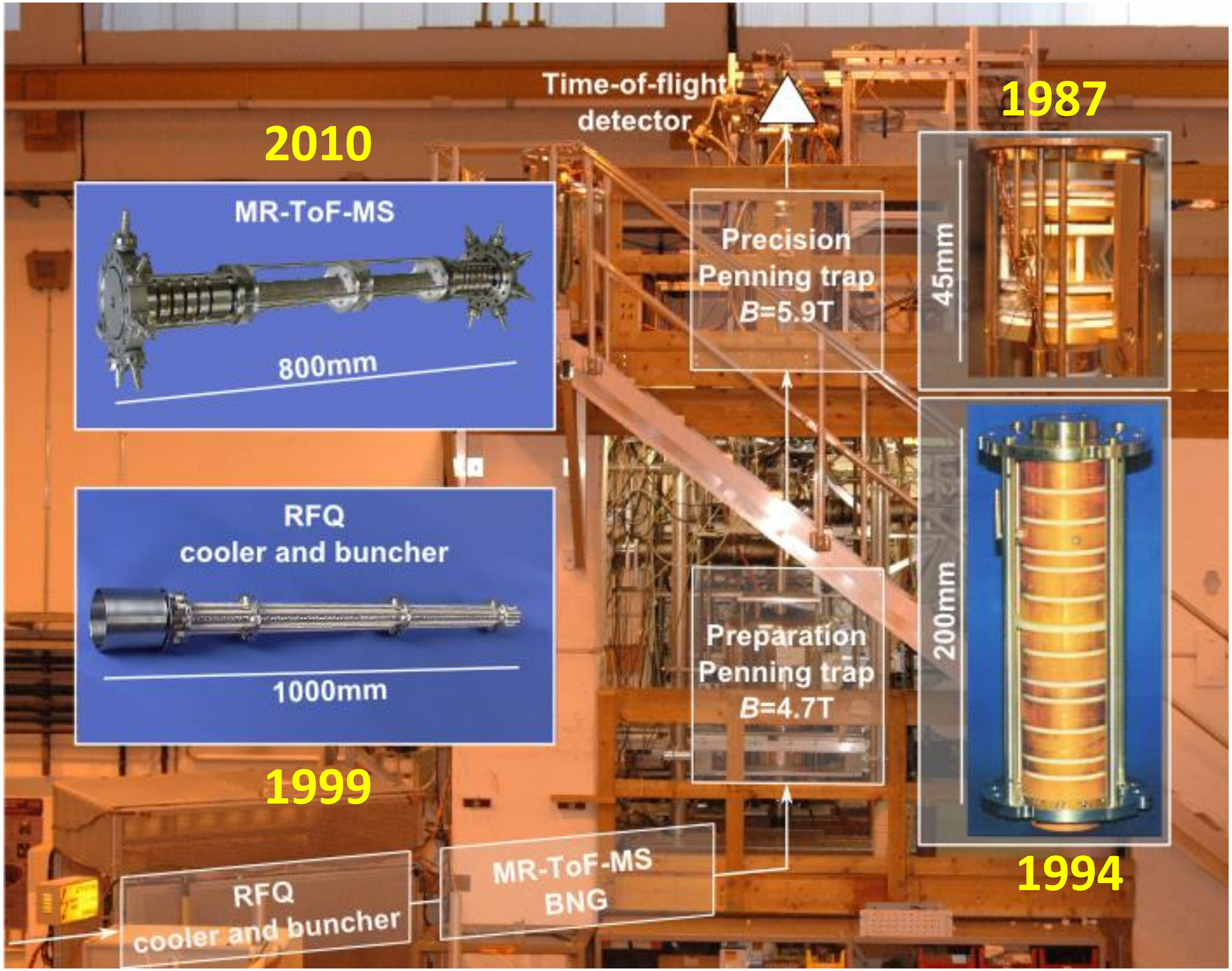
ISOLTRAP overview

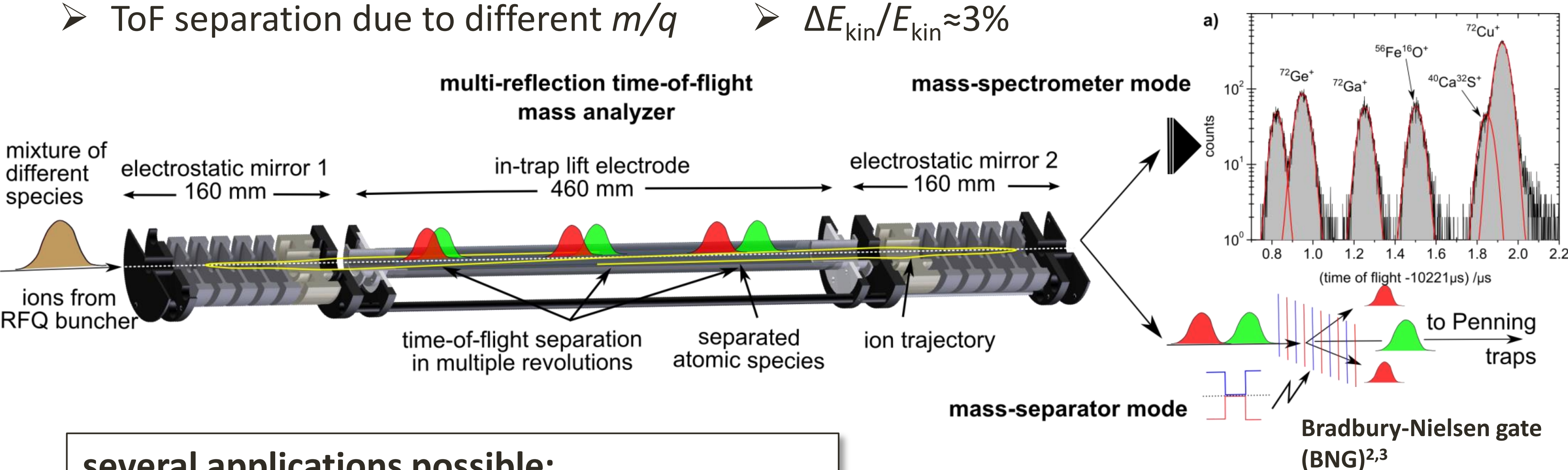
ISOLTRAP uncertainty: $\frac{\delta m}{m} \approx 10^{-8}$; >500 short-lived nuclides investigated



ISOLTRAP overview: MR-ToF-MS[1]

- mean kinetic energy E_{kin}=2.1keV
- ToF separation due to different m/q

RFQ:
- Δt≈100ns
- $\Delta E_{kin}/E_{kin}$≈3%



several applications possible:

- high-resolution mass separation with Bradbury-Nielsen gate for subsequent experiments
- observing and gating on separated ion-of-interest to perform further studies
- high-precision mass measurements with reference masses

MR-ToF-MS

mass resolving power (FWHM)
$m/\Delta m$=100 000 at 12ms
$m/\Delta m$=200 000 at 30ms

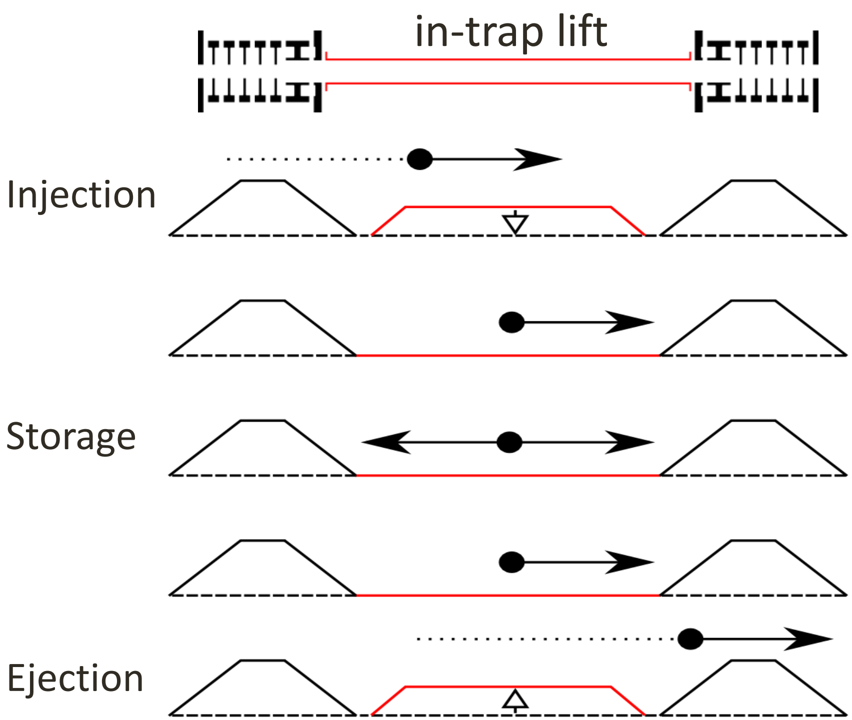
transmission
≈50% at 30ms

ion capacity
≈1000 per cycle
≈100 000 per second

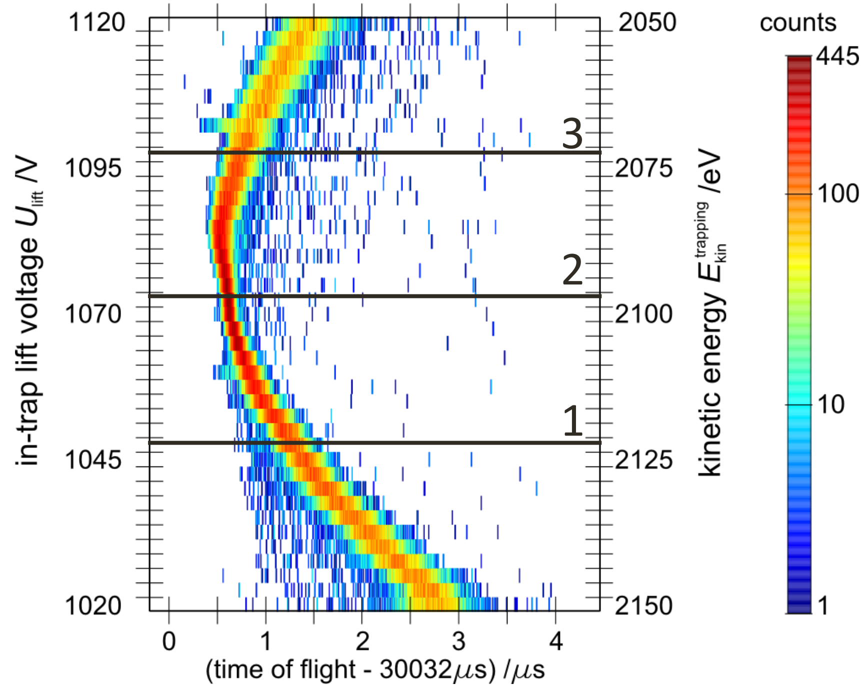
1: Wollnik & Przewloka, Int. J. Mass Spectrom. Ion Proc. 96, 267 (1990); 2: Bradbury & Nielsen, Phys. Rev. 49, 388 (1936); 3: Plass *et al.*, NIM B 266, 4560 (2008)
Wolf *et al.*, IJMS **313**, 8 (2012); Wolf *et al.*, IJMS 349-350, 123 (2013);

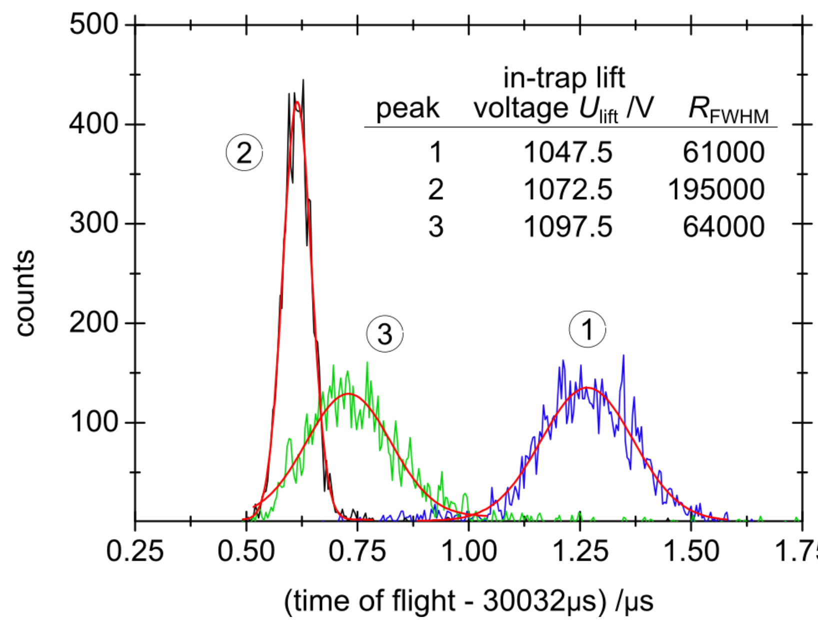
MR-ToF-MS at ISOLTRAP: in-trap lift

- 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**



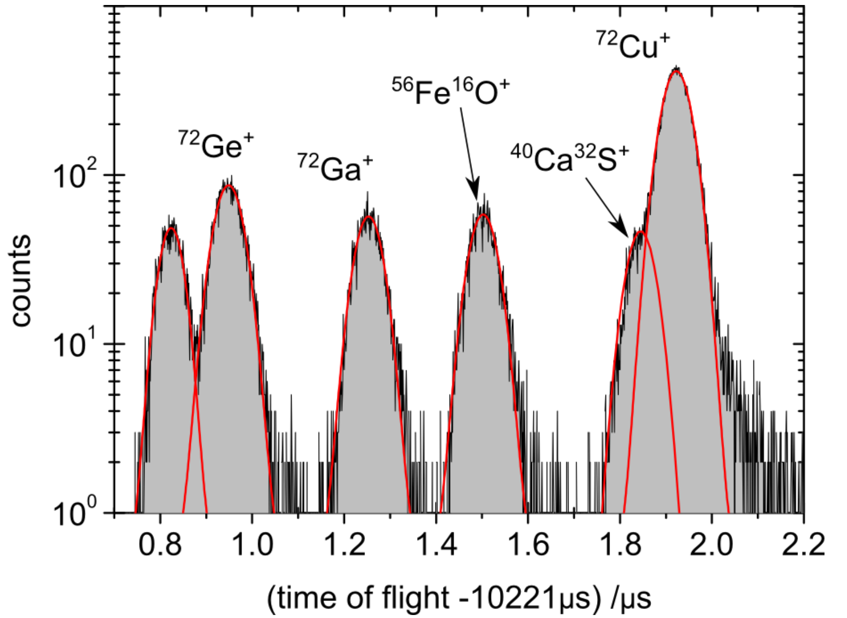


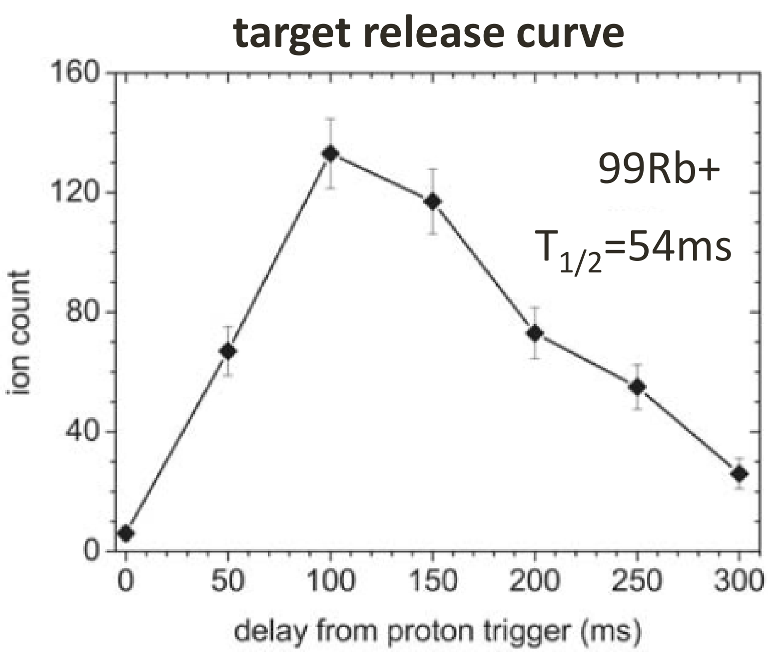
Wolf *et al.*, IJMS 313, 8 (2012)

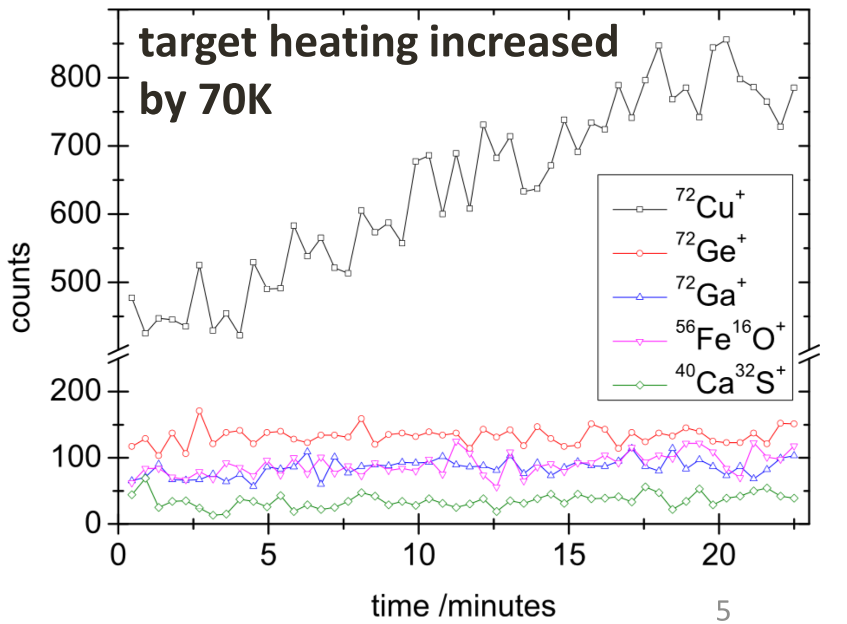
MR-ToF ion-beam analysis

Ion-beam composition analysis

- direct feedback for target/line optimization
- sampling of release curve possible
- single ion sensitivity to detect lowest yields
- no upper limit on half-life as with decay station
- not hindered by decay branching ratio

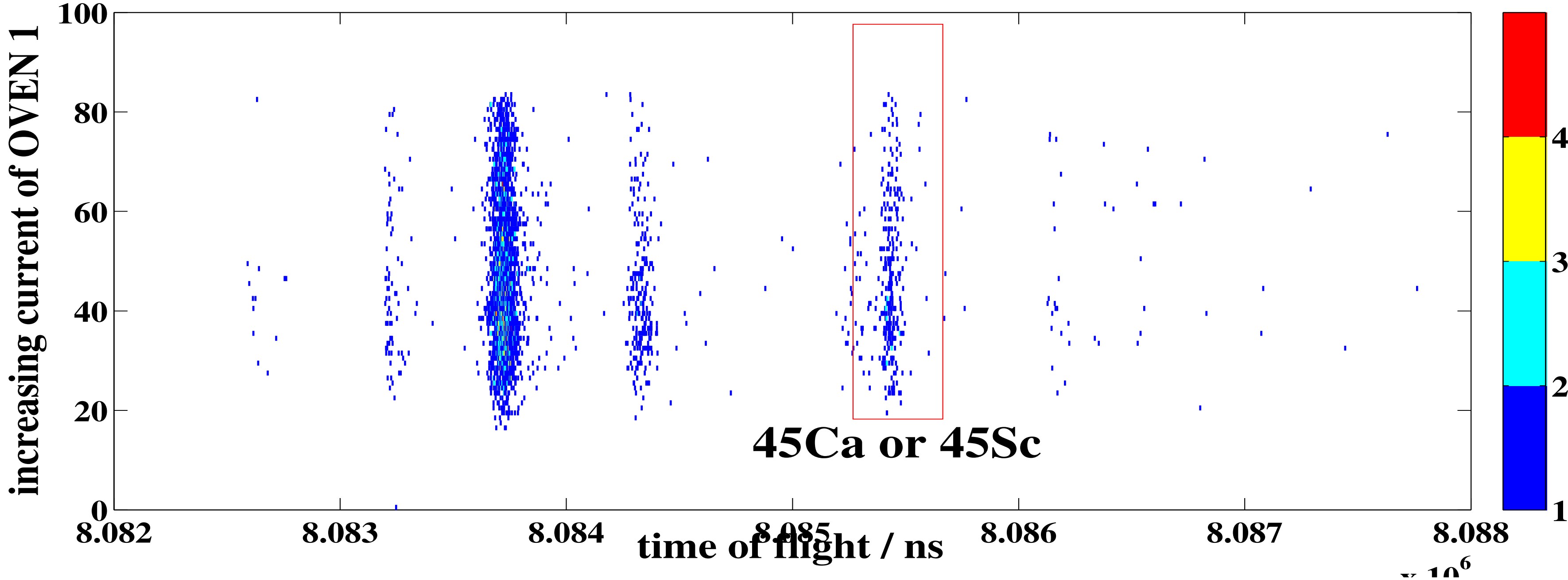


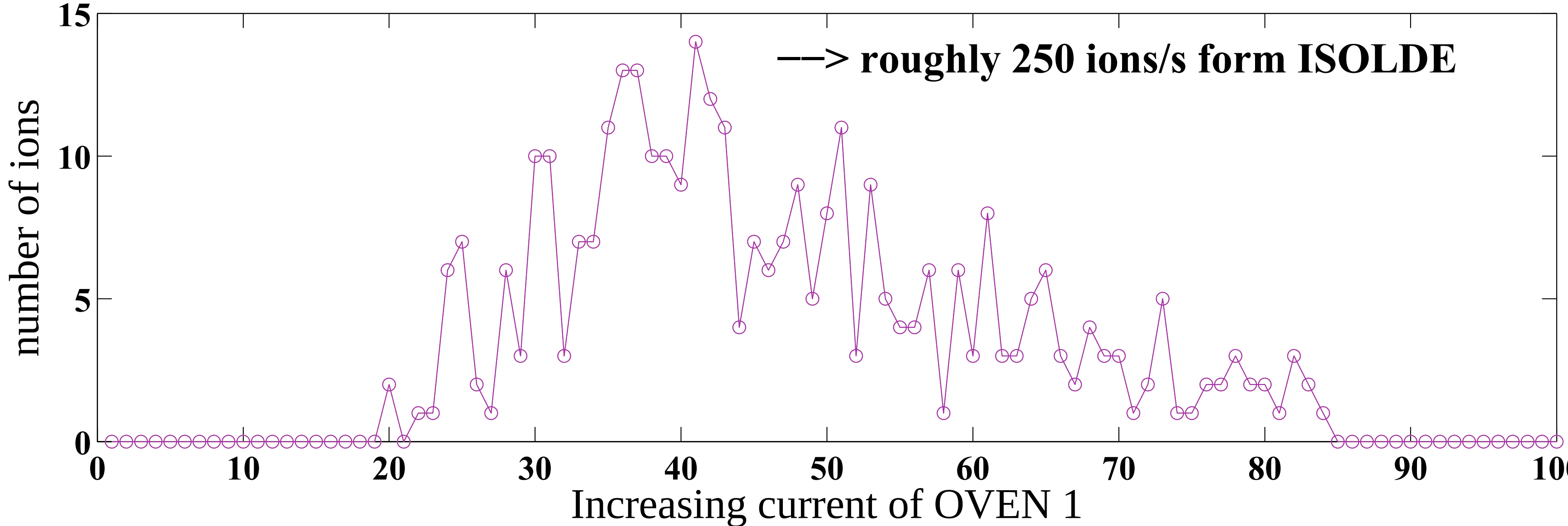




Wolf *et al.*, IJMS 349-350, 123 (2013); Kreim *et al.*, NIM B, accepted for publication (2013)

MR-ToF ion-beam analysis

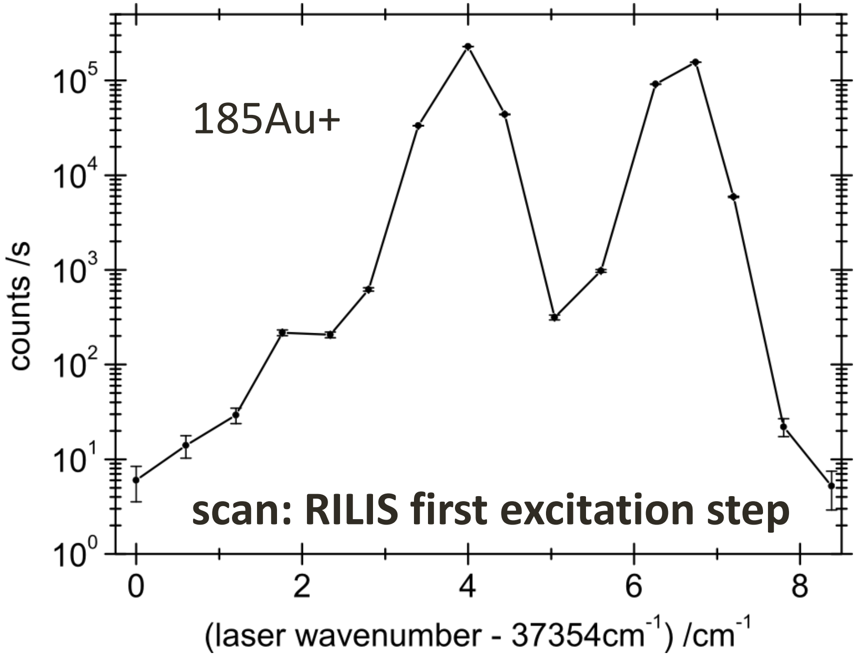


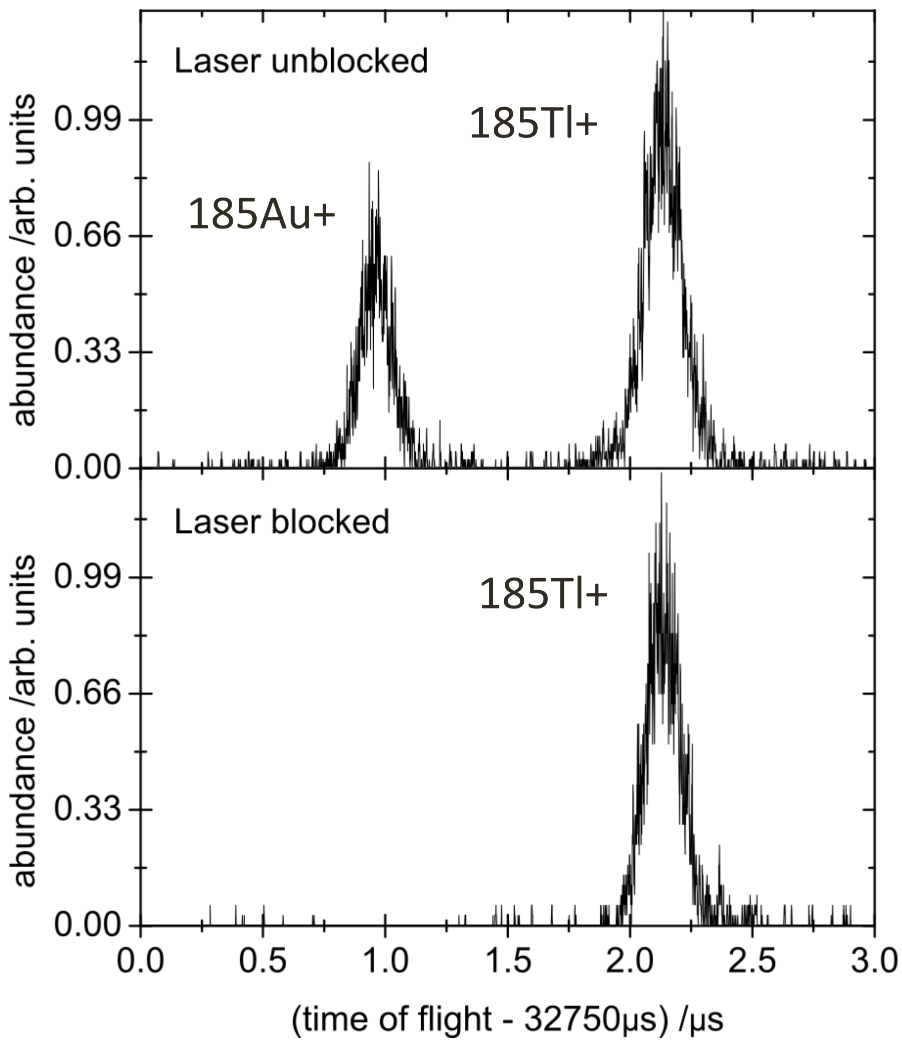


MR-ToF ←→ RILIS yield optimization

MR-ToF analyzer to investigate resonant laser ionization of nuclides far from stability

- fast, sensitive tool to improve ionization eff.
- high dynamic range: 1-10e5 counts/s
- counts free from background contamination
- not limited by decay branching ratio
- help to provide isomerically pure beams

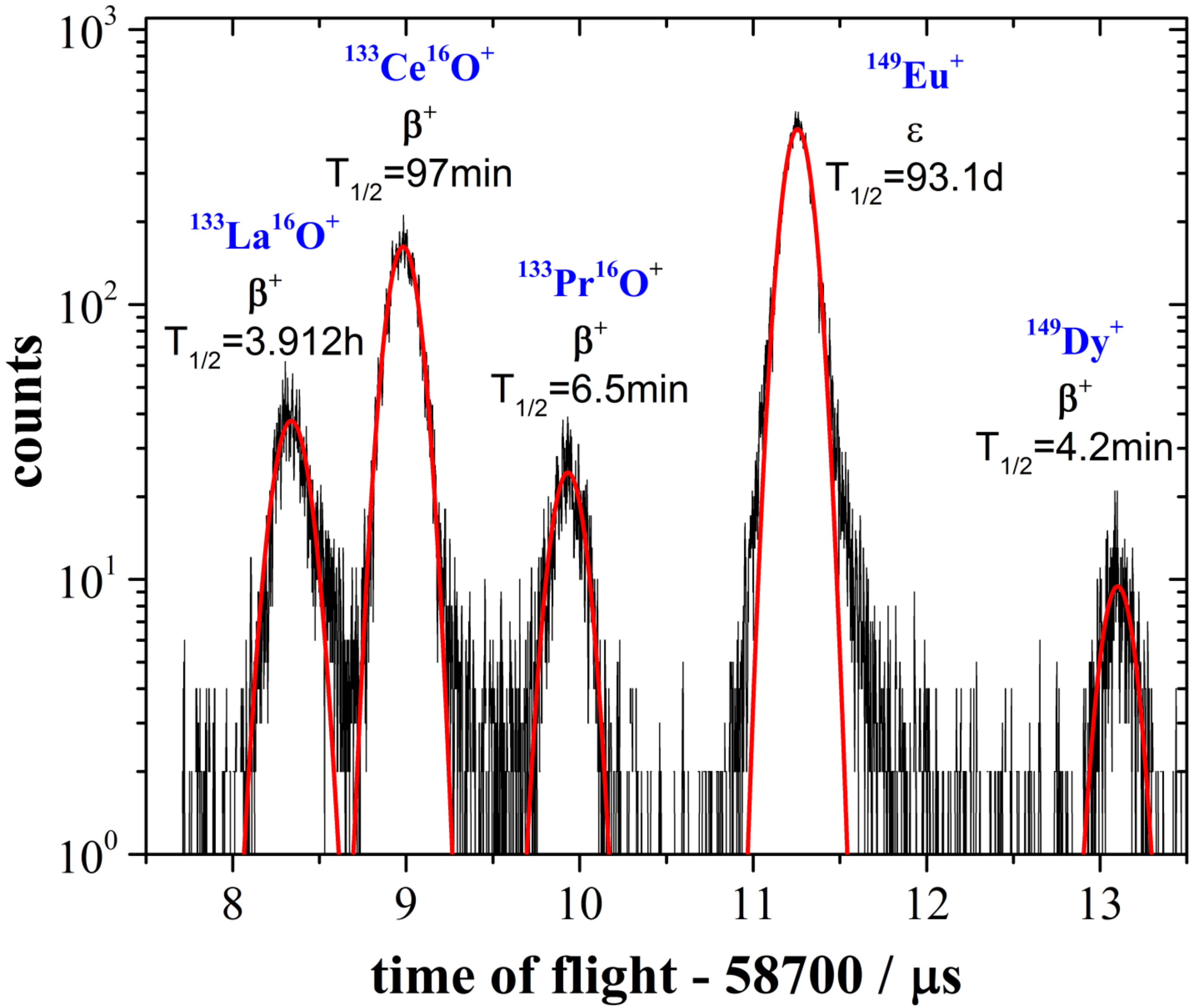




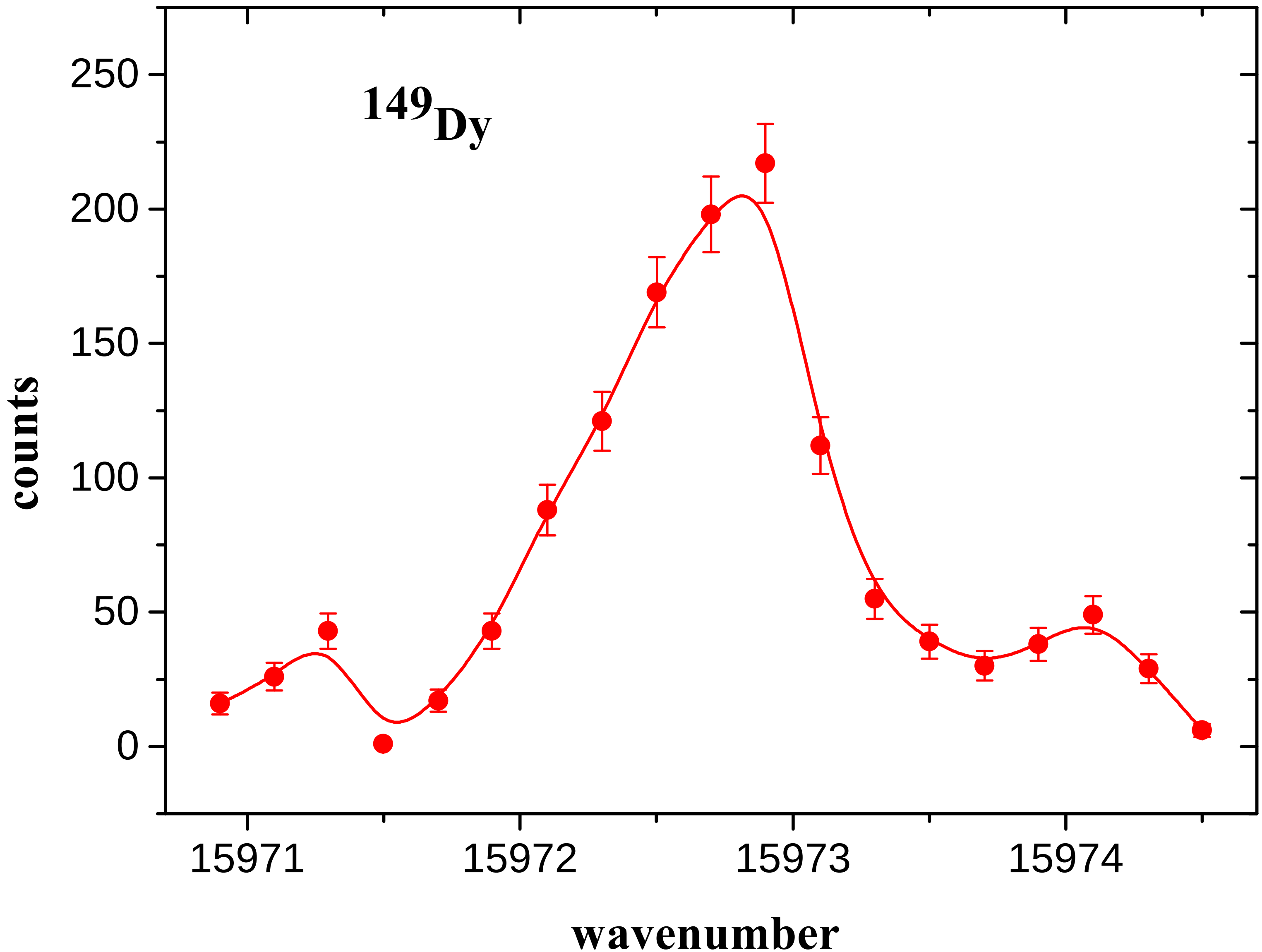
Wolf *et al.*, IJMS 349-350, 123 (2013); Kreim *et al.*, NIM B, accepted for publication (2013)

MR-ToF <--> laser scans of hyperfine structure

(Total counts - ^{149}Dy) / ^{149}Dy ≈ 70

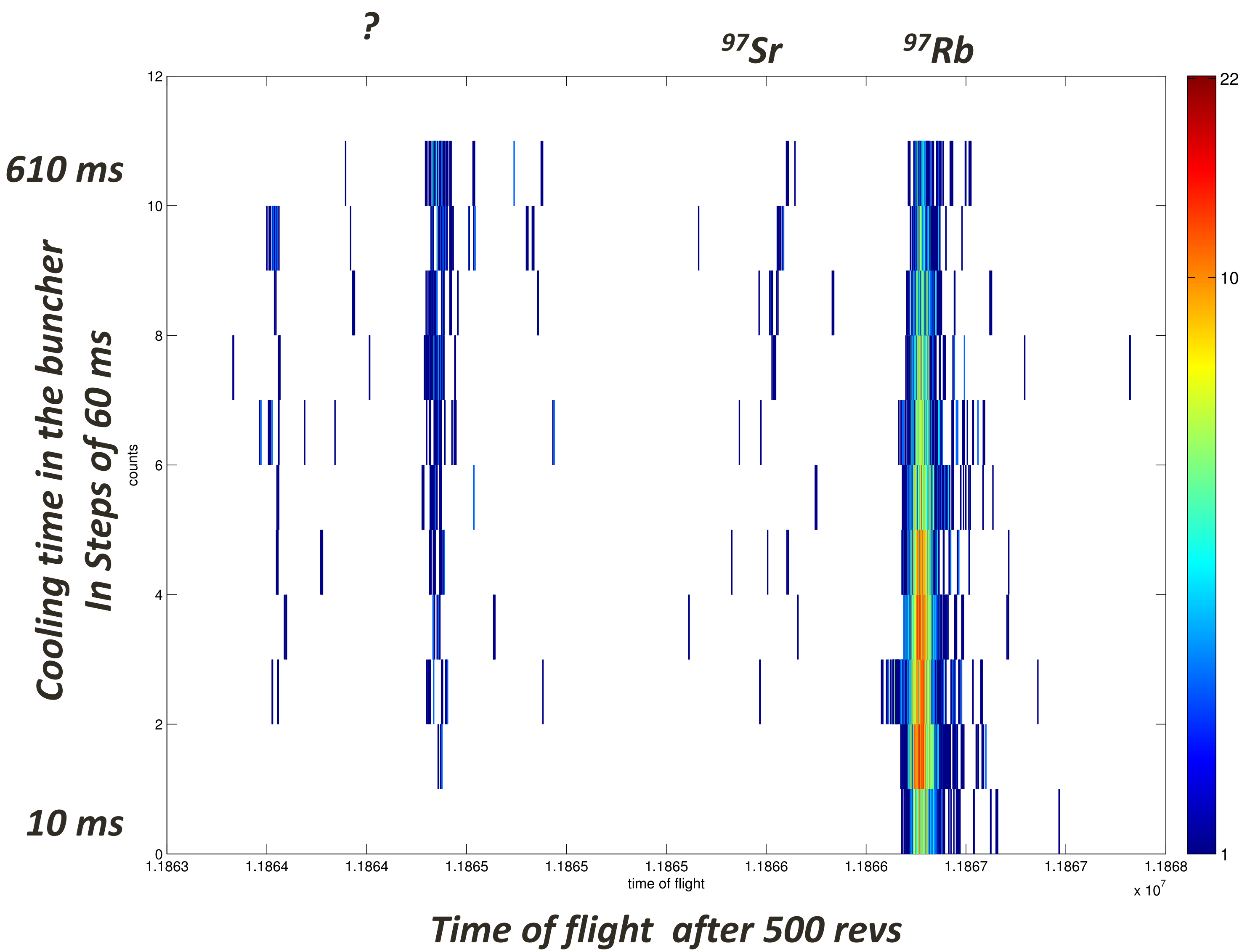


MR-ToF <--> laser scans of hyperfine structure

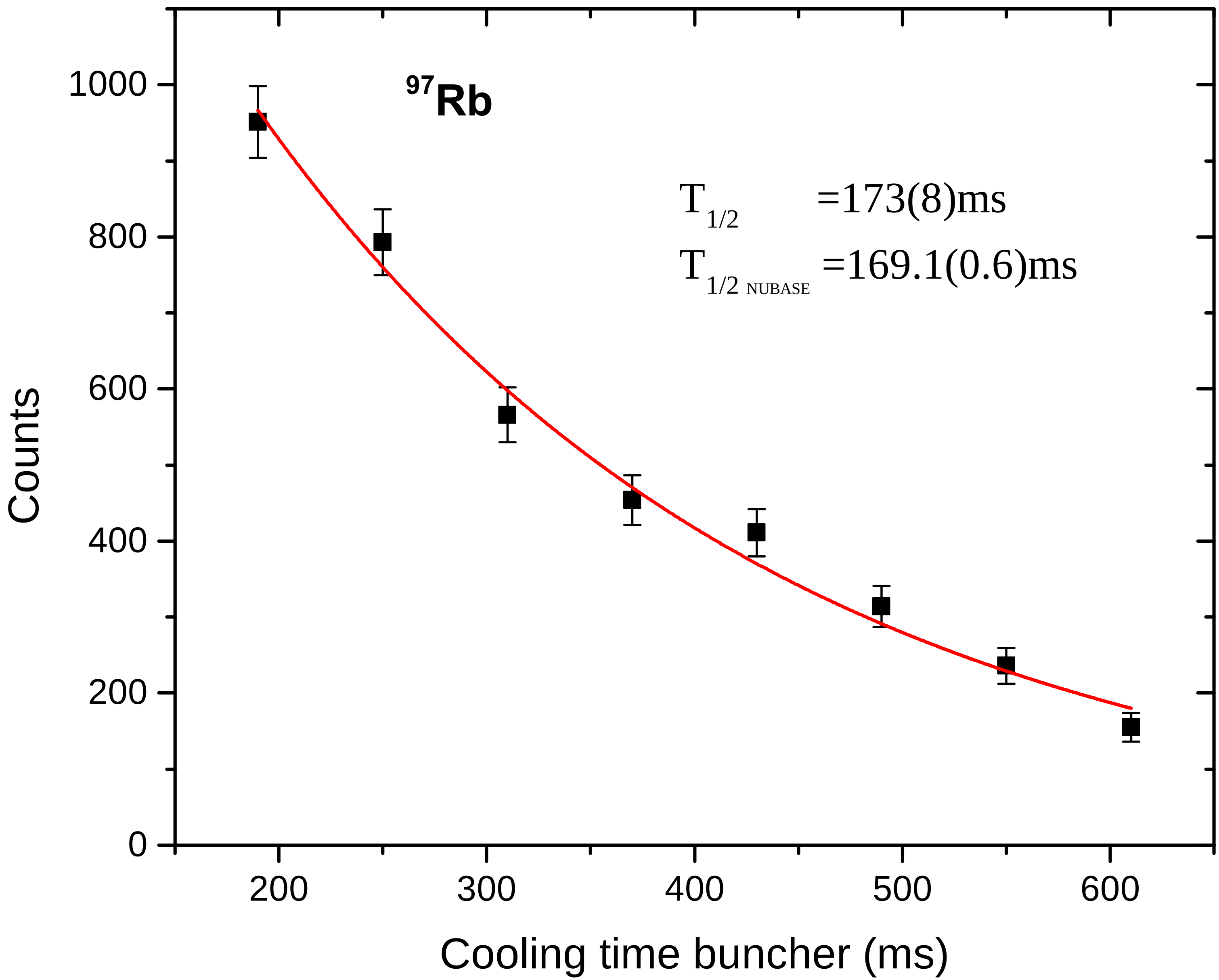


MR-ToF half life measurements

A=97



MR-ToF half life measurements



Possible applications @ ISOLDE

- Versatile tool for beam analysis especially for ion yields which are not detectable by FCs or accessible by decay spectroscopy
  - Continues observation of the beam composition possible

- Beam optimisation
  - Varying different target parameters
  - Beam line optimisation (transport)
  - Fast response to laser on/off or protons on/off
  - Laser frequency optimisation

- Delivery of highly pure beams for experiments with such needs

- Beam purification for REX-Trap and EBIS
  - Fast stacking in the Penning trap possible

Thanks to…

ERNST MORITZ ARNDT UNIVERSITÄT GREIFSWALD

S. George, **M. Rosenbusch**, **R.N. Wolf**, L. Schweikhard

MAX-PLANCK-GESELLSCHAFT — MAX-PLANCK-INSTITUT FÜR KERNPHYSIK

P. Ascher, **D. Atanasov**, Ch. Böhm, Ch. Borgmann, R. B. Cakirli,
S. Eliseev, T. Eronen, **D. Kissler**, S. Naimi, K. Blaum

GSI

D. Beck, F. Herfurth, A. Herlert, E. Minaya-Ramirez, D. Neidherr, Y. Litvinov

CSNSM — UNIVERSITÉ PARIS-SUD 11

G. Audi, **V. Manea**, M. Wang, D. Lunney

ISOLDE

M. Kowalska, S. Kreim, J. Kurcewicz

TECHNISCHE UNIVERSITÄT DRESDEN

J. Stanja, A. Welker, K. Zuber

MANCHESTER 1824 — The University of Manchester

N. Althubiti, T. Cocolios

KATHOLIEKE UNIVERSITEIT LEUVEN

M. Breitenfeldt

SPONSORED BY THE
Federal Ministry of Education and Research
Grants No.:
05P12HGCI1
05P12HGFNE

ISOL TRAP

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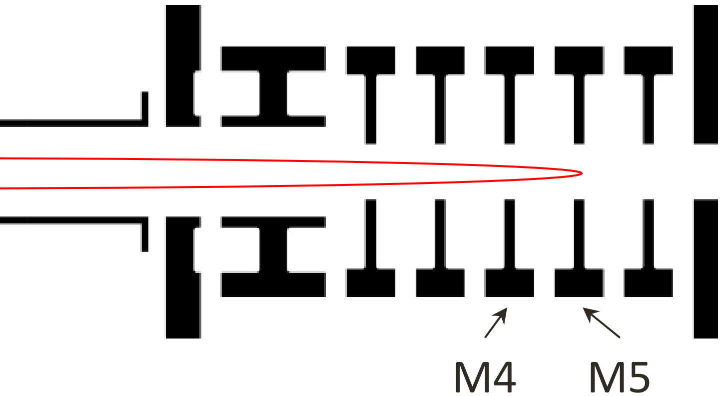
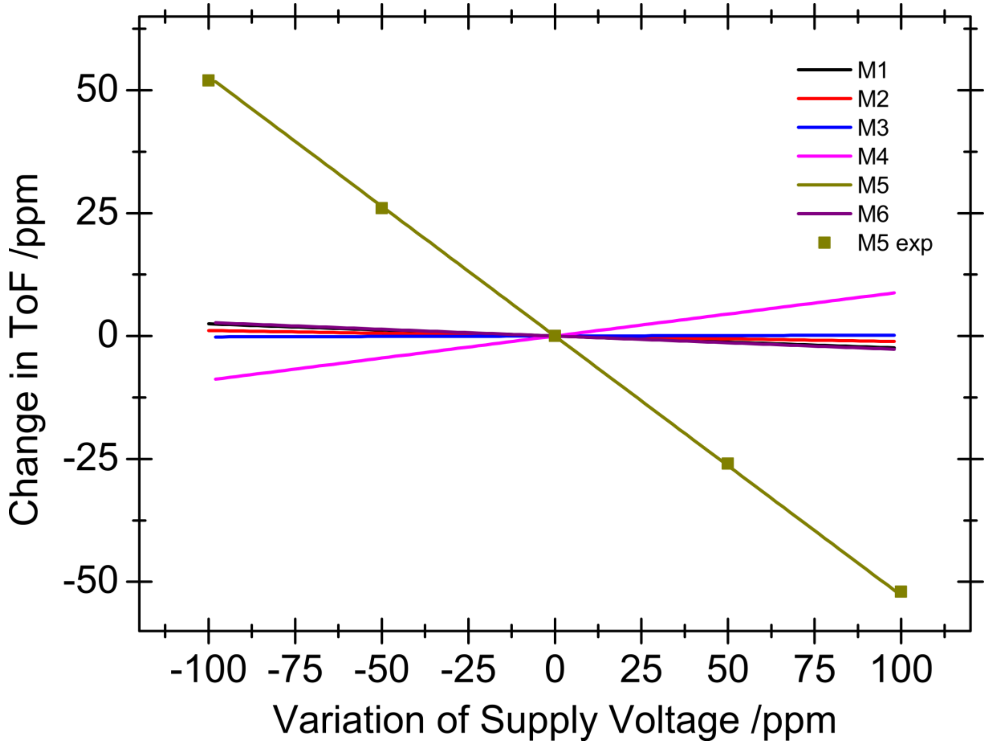
MR-ToF-MS: voltage stability

mirror electrode 5: turn-around point

$$\text{center drift} \approx \frac{0.5\,\text{ppm(ToF)}}{1\,\text{ppm(V)}}$$

- limiting long-term stability
- mass resolving power





- Temperature stabilization of supply voltages to <100mK
- ToF temperature coefficient:

$$\text{center drift} \approx \frac{20\,\text{ppm(ToF)}}{1\,\text{K}}$$

Wolf *et al.*, NIM A 686, 82 (2012)