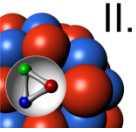

II. Physikalisches Institut

JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

EIGENSCHAFTEN UND STRUKTUR KURZLEBIGER KERNE
IONAS

GSI

HELMHOLTZ GEMEINSCHAFT

FRS Ion Catcher: Measurement of Isomers and Production of Isomerically Clean Beams

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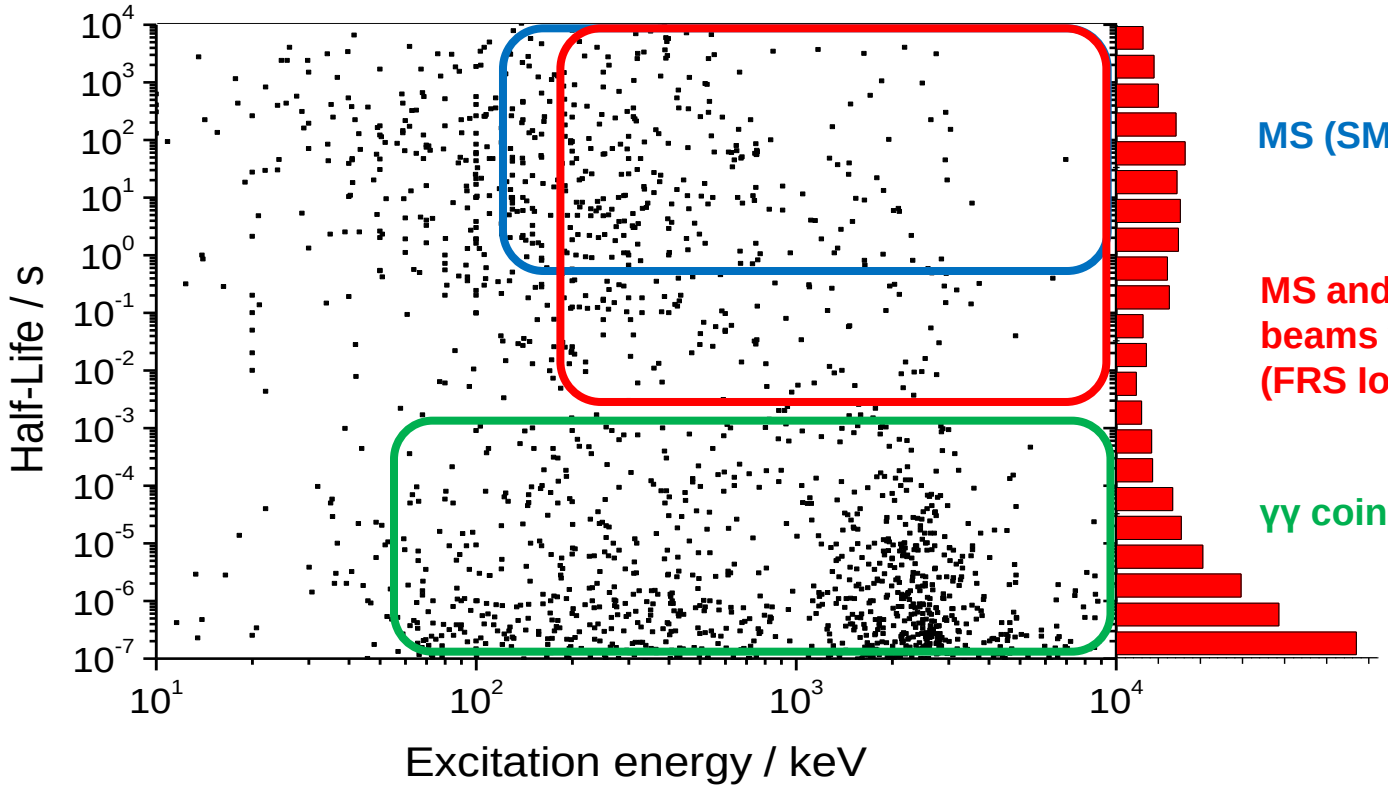
Why a new Method to Measure Isomers?

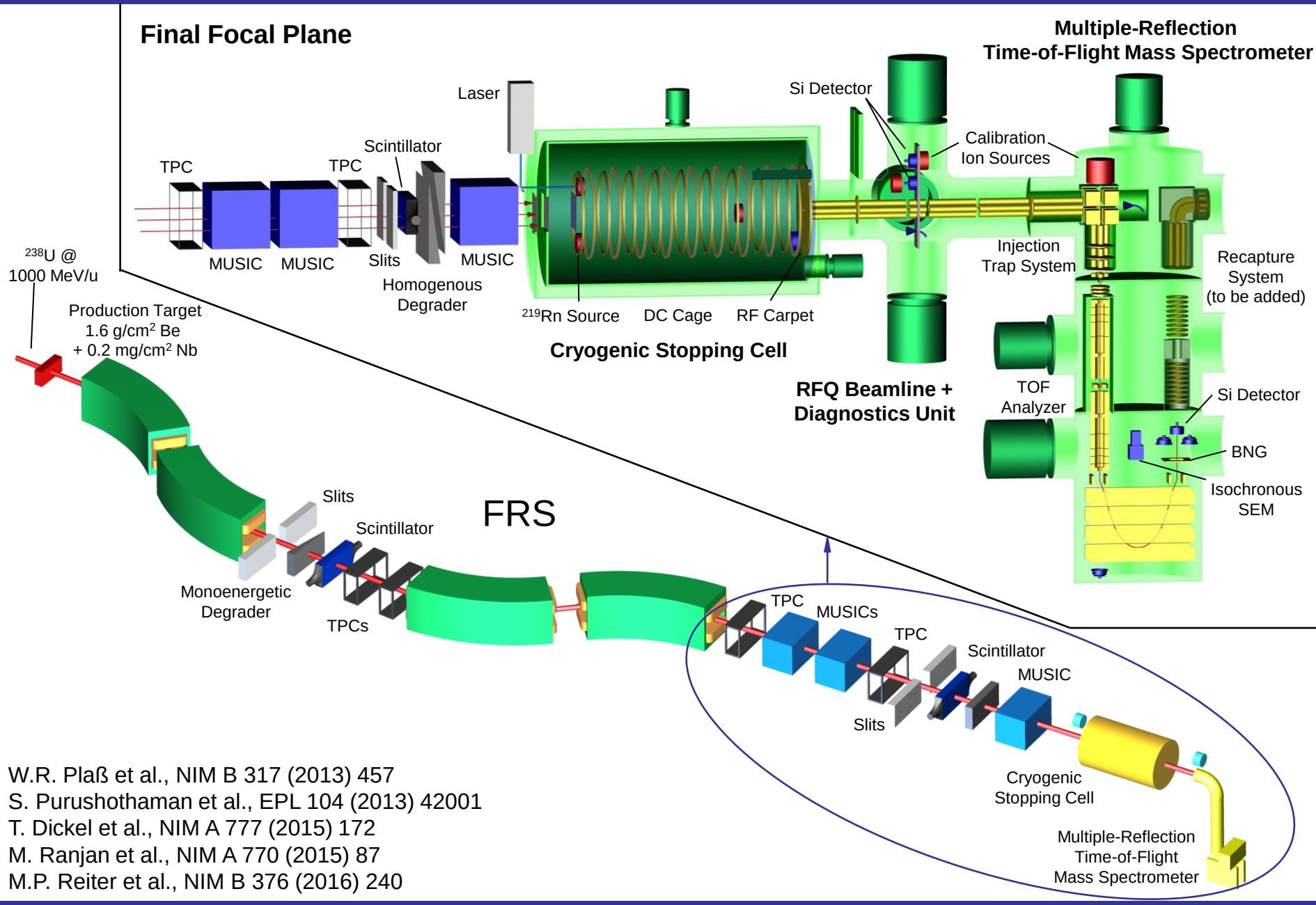
Nubase 2012



Requirements for system for isomere search:

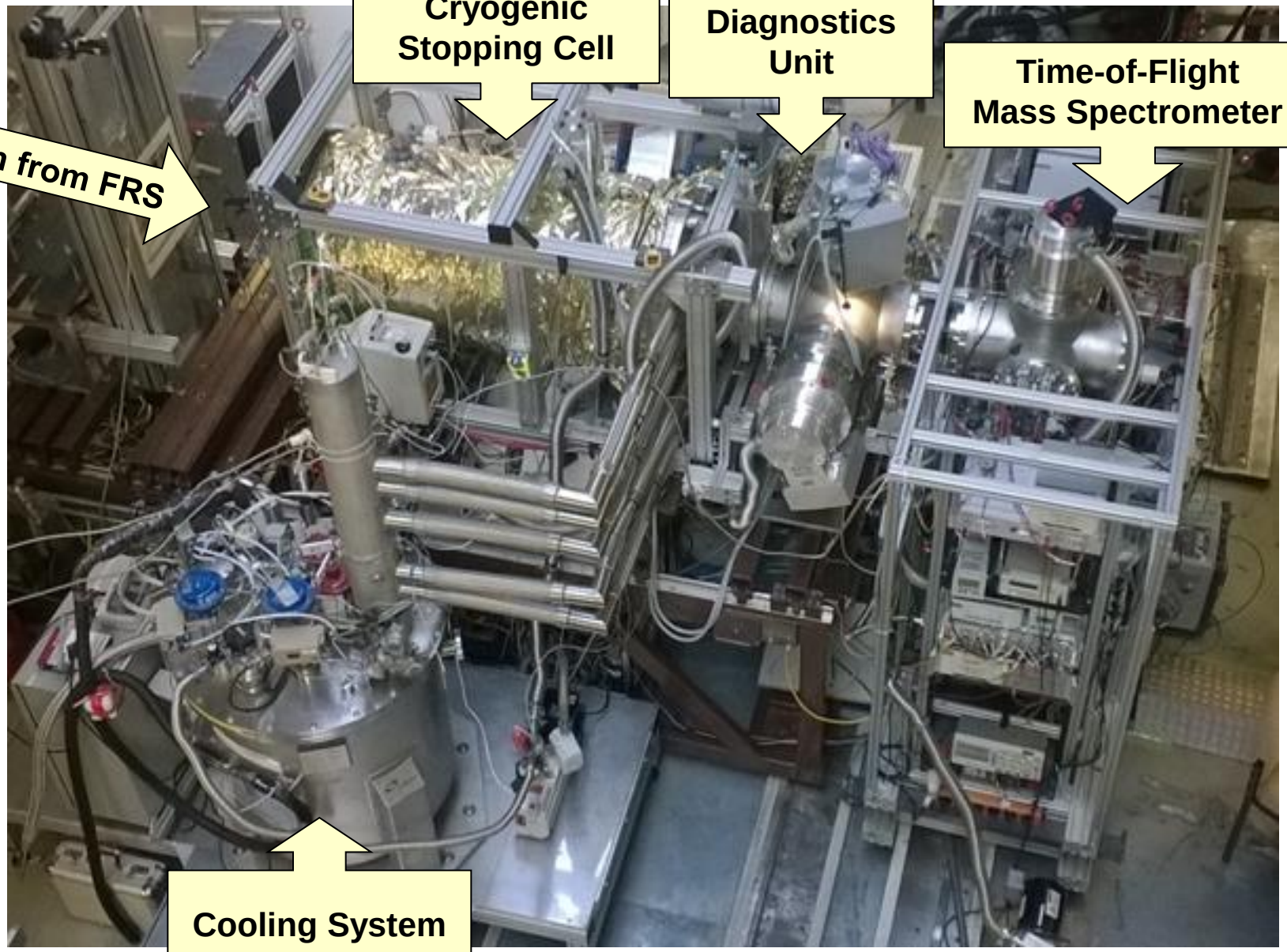
- Fast: ~ms
- Sensitive: Non-Scaning
- High Mass Resolving Power: >>10^5
- High Dynamic Range: > 10:1

FRS Ion Catcher



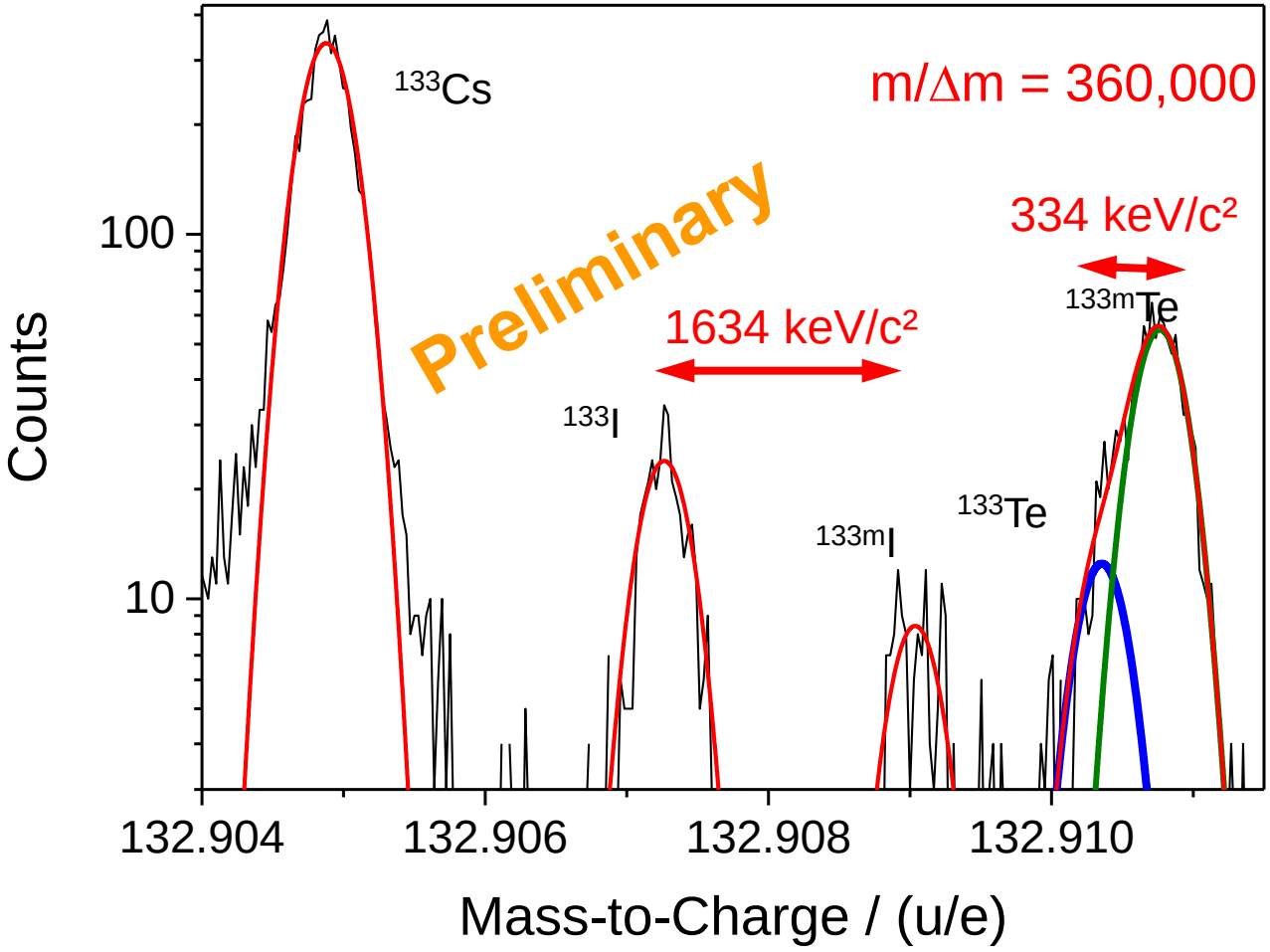
W.R. Plaß et al., NIM B 317 (2013) 457
S. Purushothaman et al., EPL 104 (2013) 42001
T. Dickel et al., NIM A 777 (2015) 172
M. Ranjan et al., NIM A 770 (2015) 87
M.P. Reiter et al., NIM B 376 (2016) 240

Setup at the FRS Ion Catcher at GSI



Uranium Fission Fragments

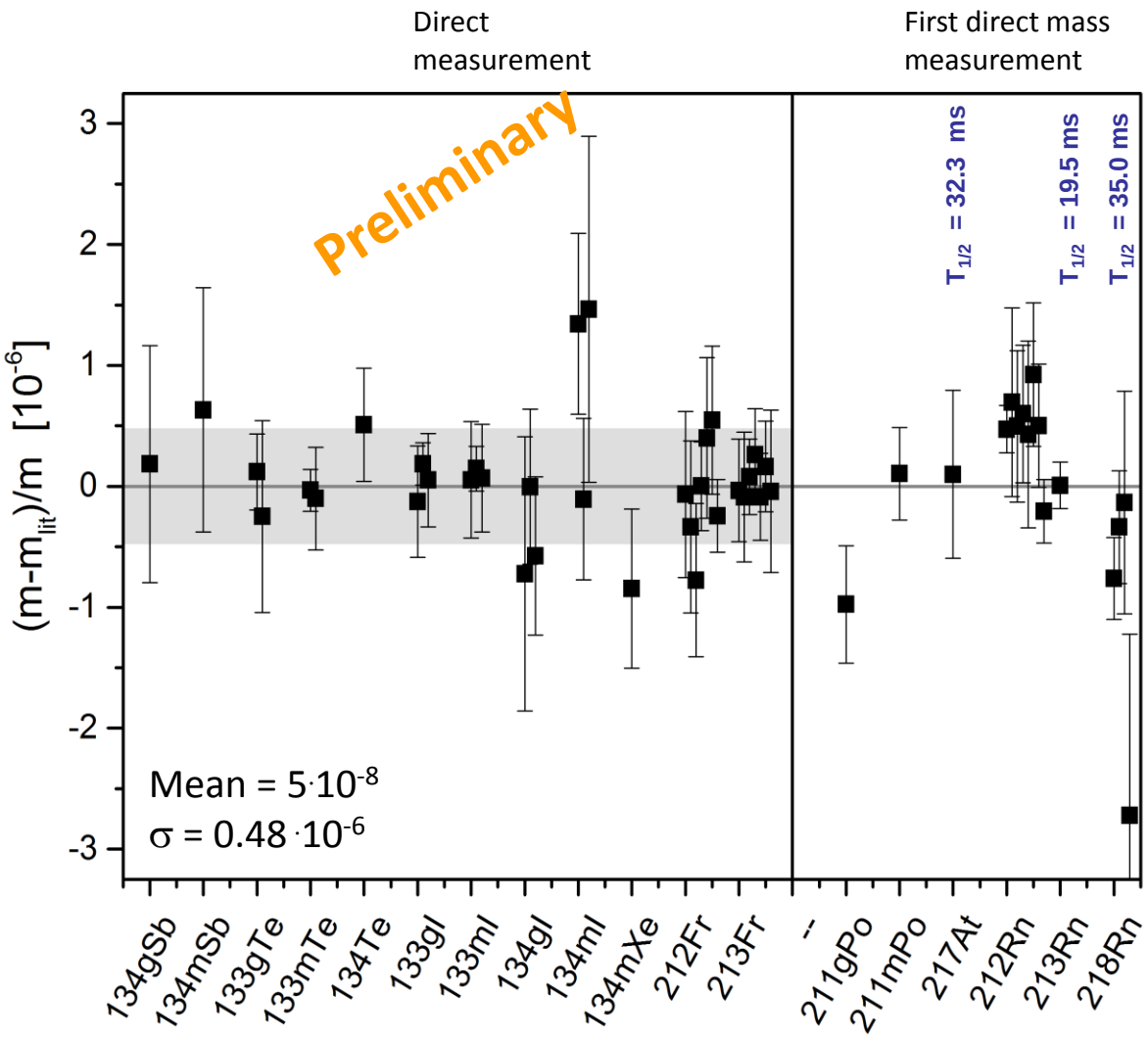
- Mass measurement of uranium fission products produced at 1000 MeV/u
- MR-TOF-MS will enable efficient search and measurement of new isotopes and isomers

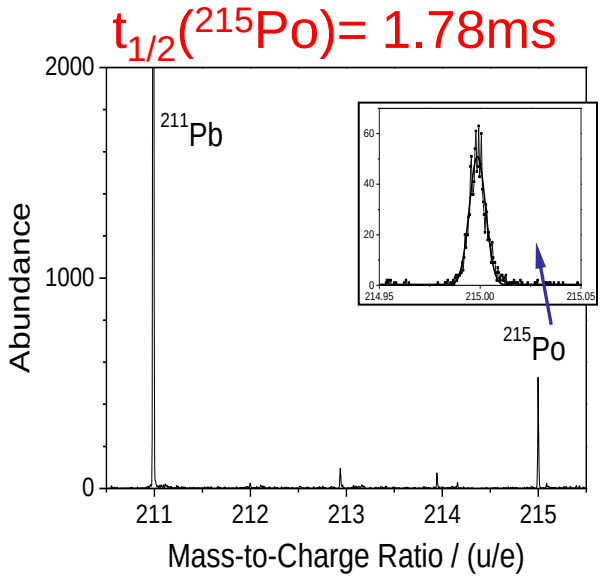


S. Ayet et al.

Mass Measurements

- Accuracy > $2 \cdot 10^{-7}$
- Half-life > few ms



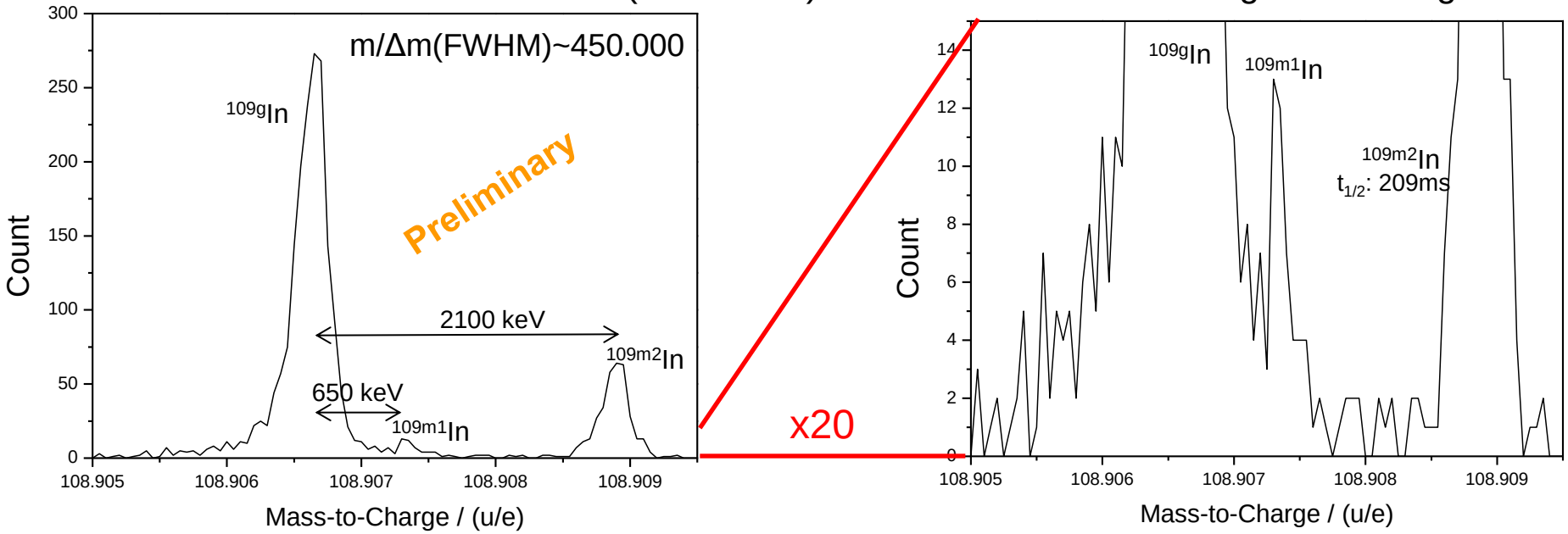


m(^{215}Po) accuracy: ~ 75 keV
Δm from AME2012: 85 keV

J Ebert, PhD Thesis, JLU Giessen, 2016
S. Purushothaman et al., IJMS (2017) in press
A.K. Rink PhD Thesis, JLU Giessen, 2017
C. Hornung, PhD Thesis, JLU Giessen, in prep.
S. Ayet, PhD Thesis, JLU Giessen, in prep.

Isomer Measurement with MR-TOF-MS

Results from the recent beamtime (June 2016): 600MeV/u ^{124}Xe on a 1.6g/cm² Be target



Requirements for system for isomere search:

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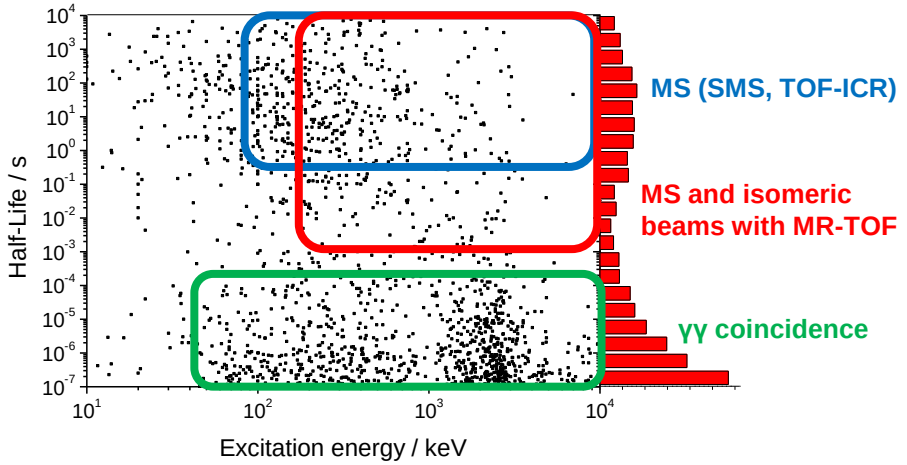
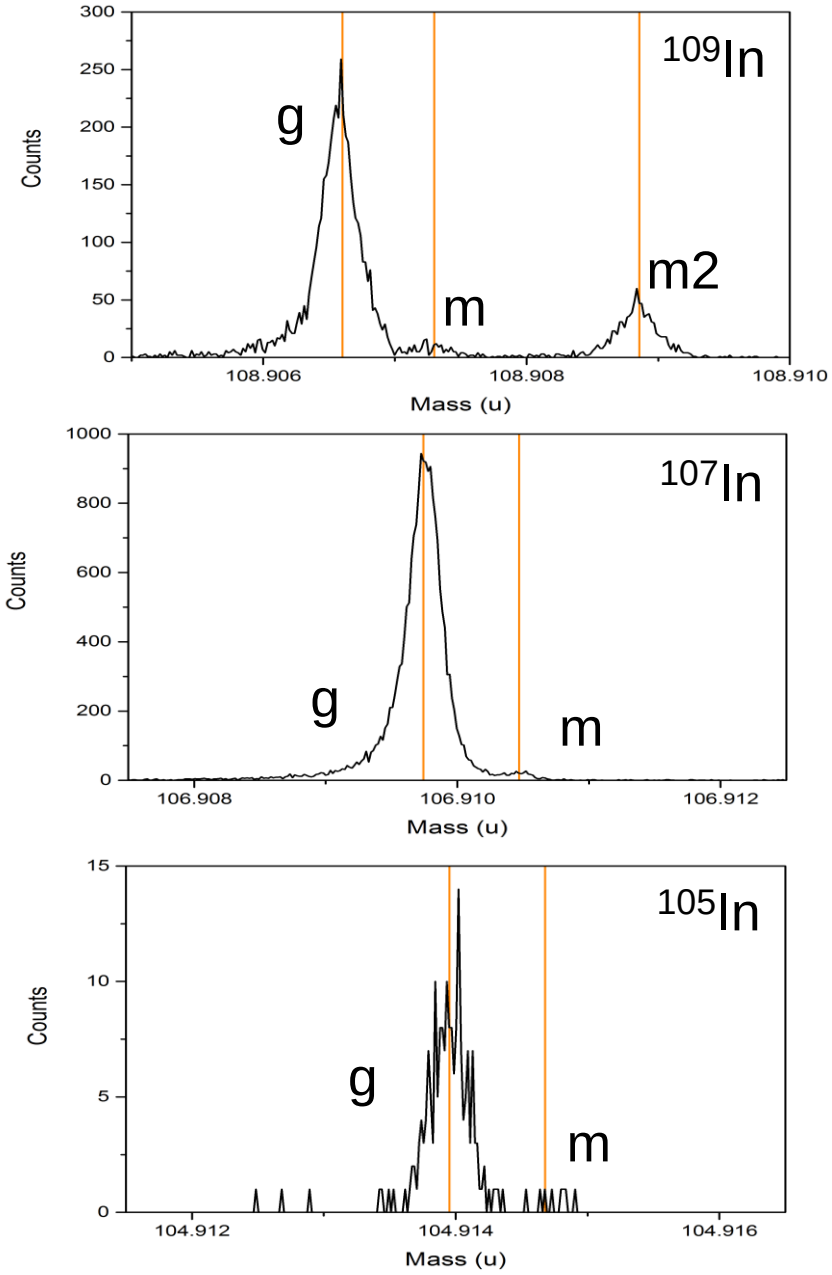
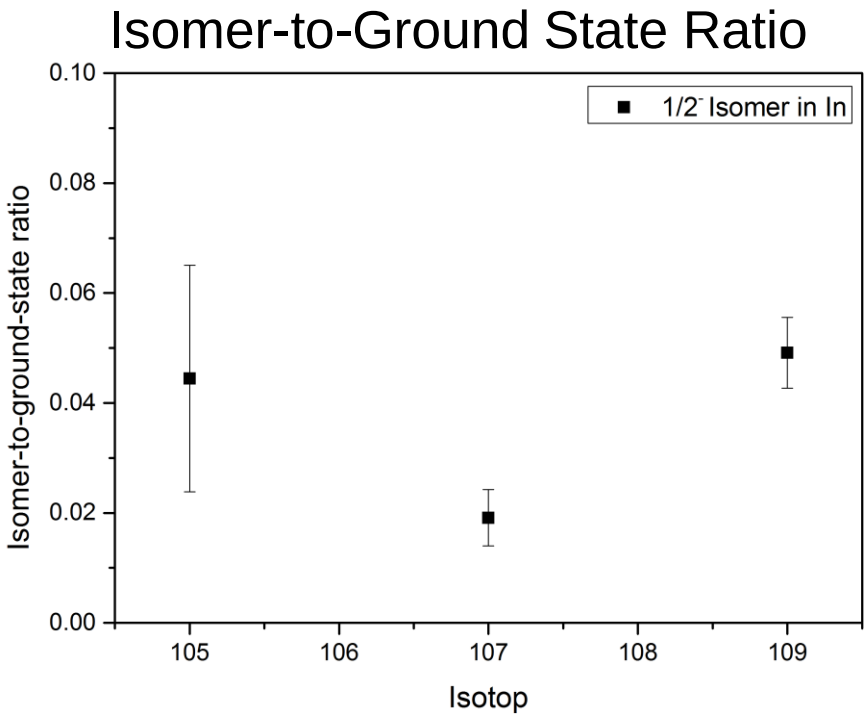


$1/2^-$ Isomers in proton rich In Isotopes



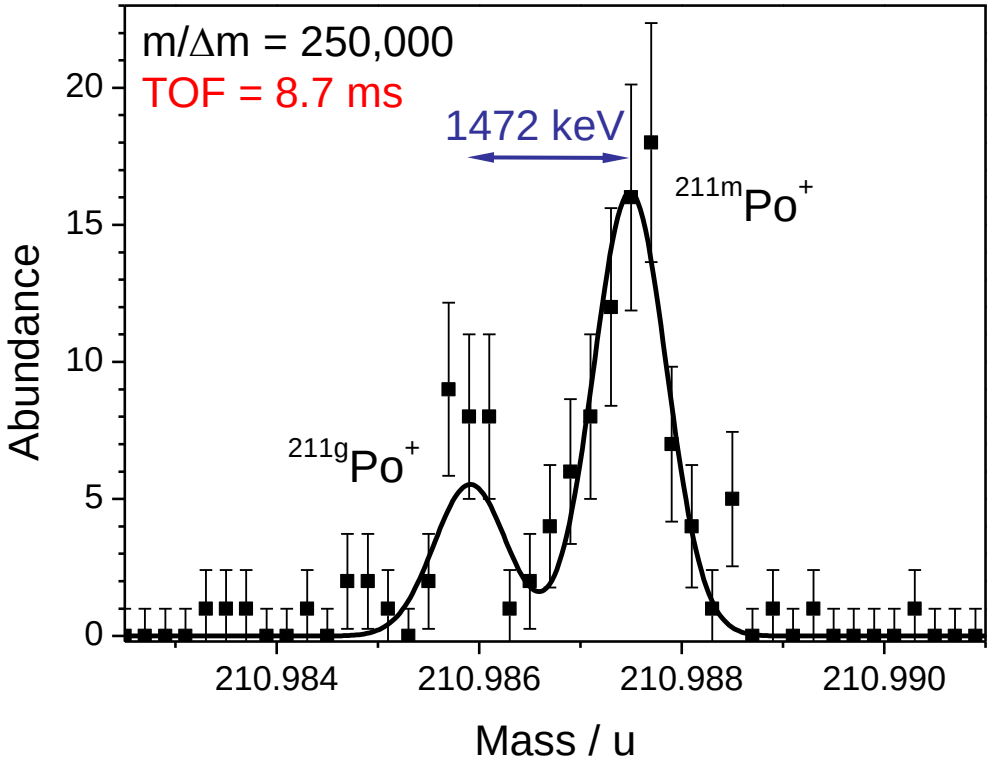


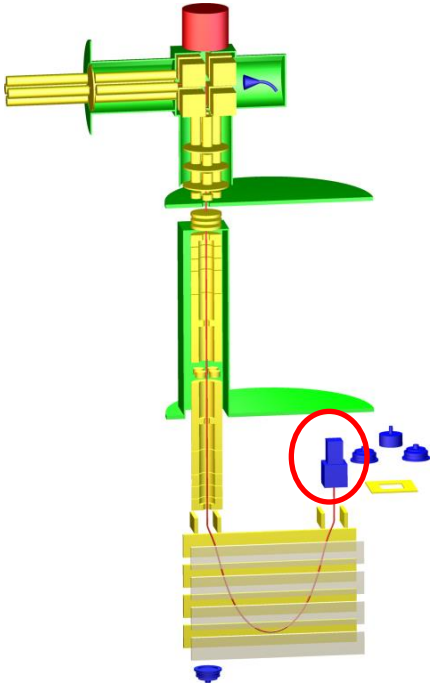
Systematics in Isomer-to-ground state ratio include information about nuclear structure and production mechanism

I. Miskun
C. Hornung

Measurement and Separation of Isomers

- Identification of ^{211g}Po and ^{211m}Po by using PID detectors in the FRS, by alpha decay on Si detector and by mass spectrometry
- Measurement of excitation energy:
  (1472 ± 120) keV Lit.: (1462 ± 5) keV





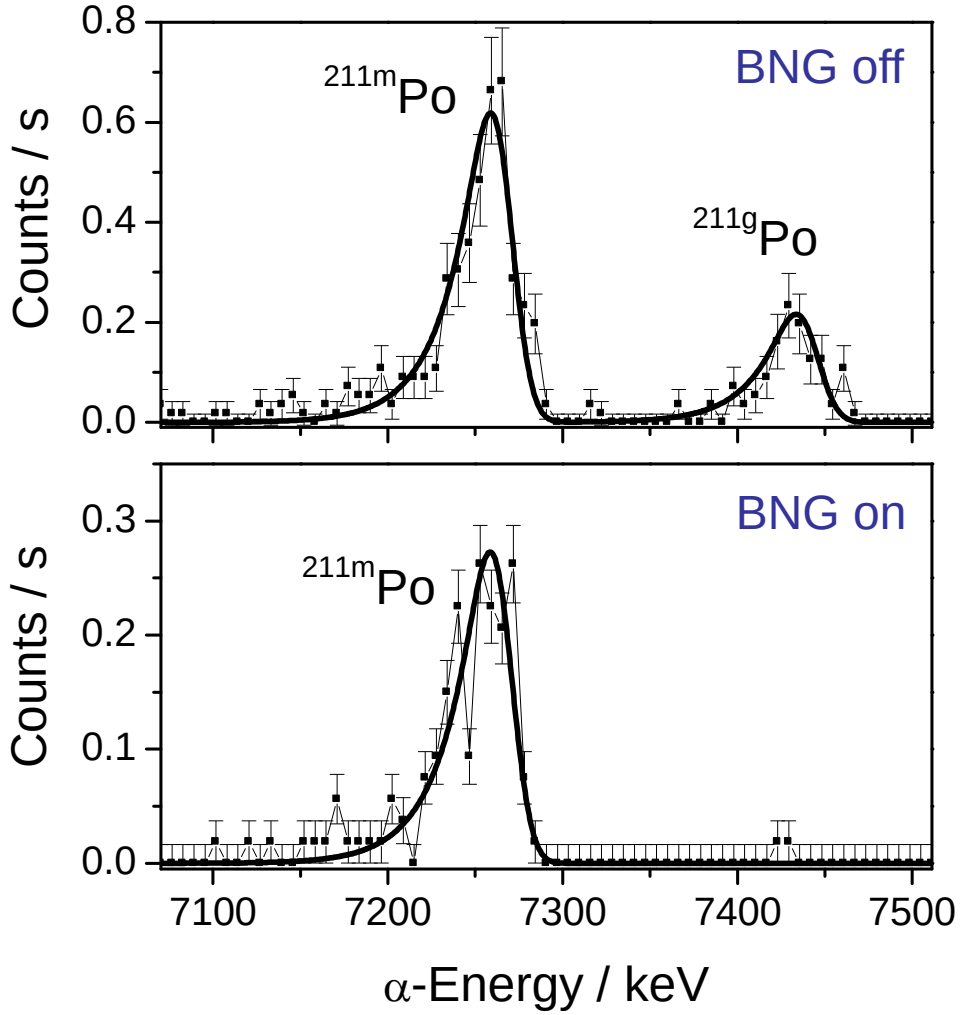
Measurement using the TOF detector

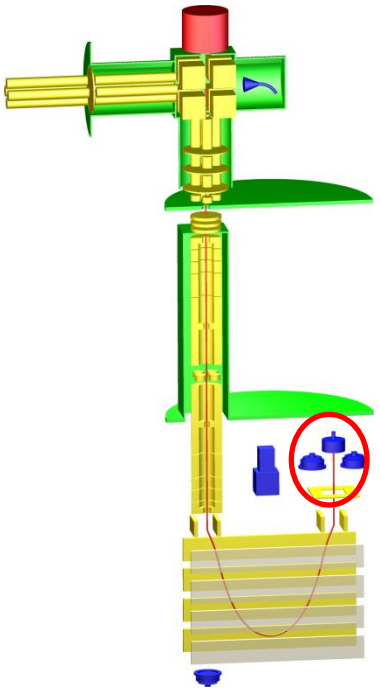
T. Dickel et al., Phys. Lett. B 744 (2015) 137

Measurement and Separation of Isomers

First spatial separation of ground state and isomeric state in an MR-TOF-MS

Proof-of-principle: production of isomerically clean beams by MR-TOF-MS



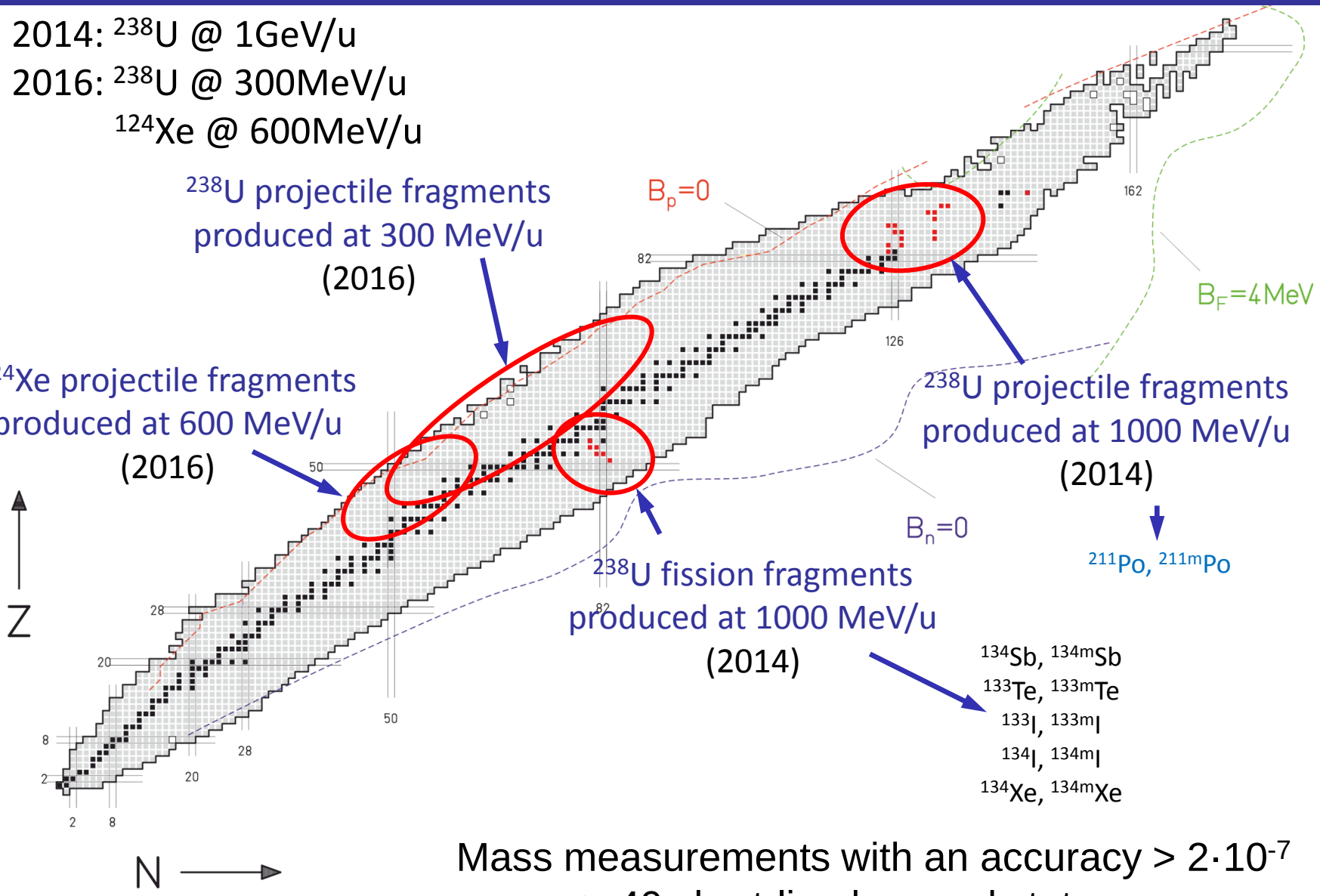


Separation using the Bradbury-Nielsen gate, measurement using the Si detector

T. Dickel et al., Phys. Lett. B 744 (2015) 137

Results From 2014 to 2016

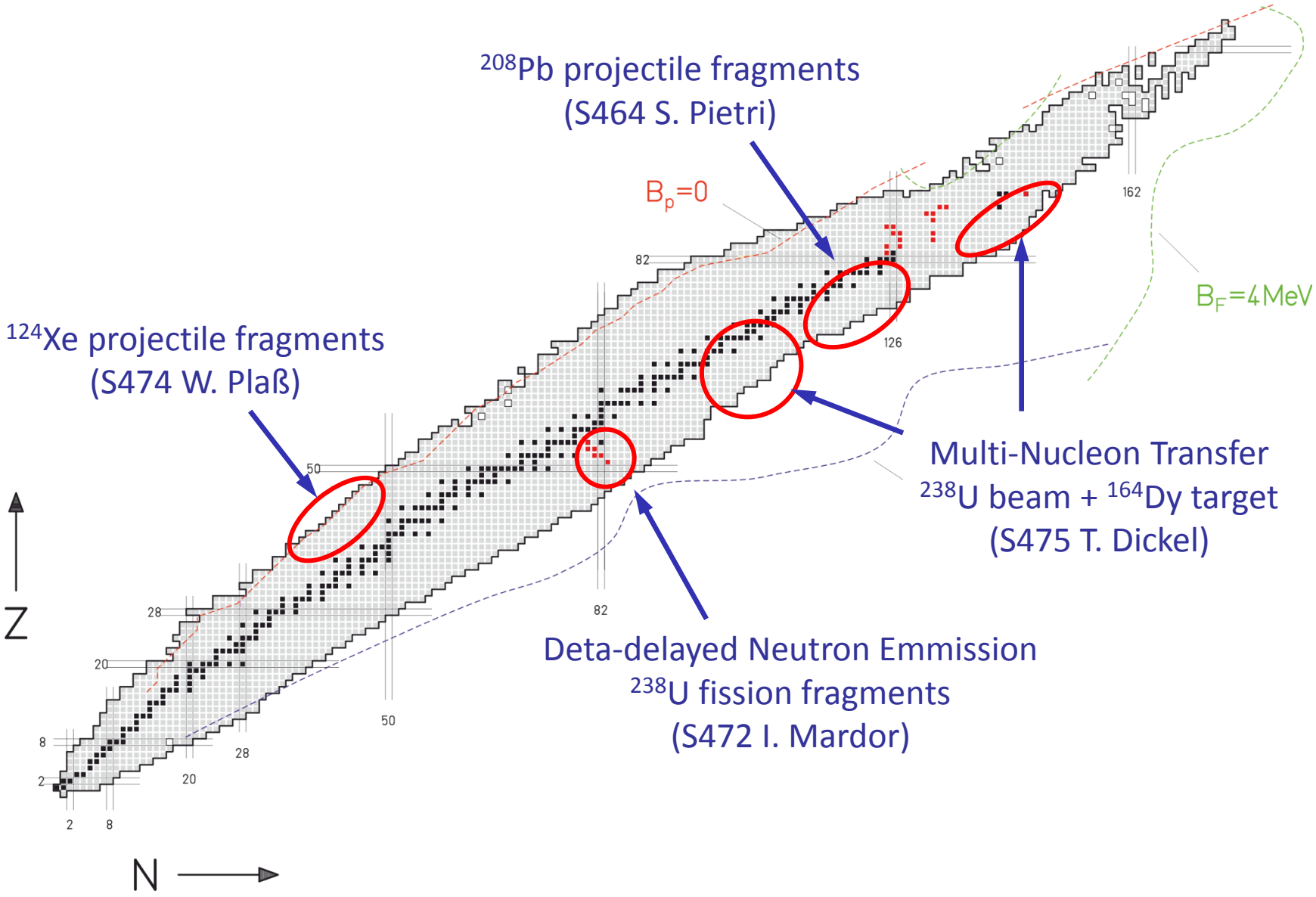
- 2014: ^{238}U @ 1GeV/u
- 2016: ^{238}U @ 300MeV/u
  ^{124}Xe @ 600MeV/u



Mass measurements with an accuracy > $2 \cdot 10^{-7}$

- > 40 short-lived ground states
- 15 isomers

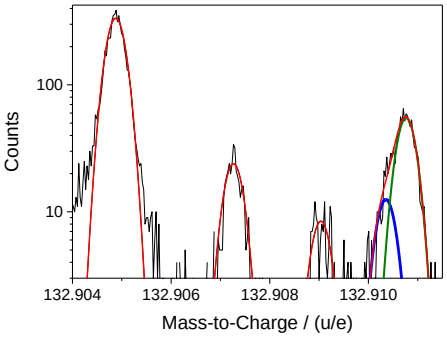
Approved Beamtimes for 2018/19

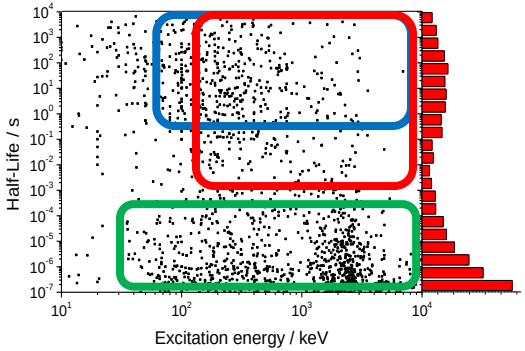


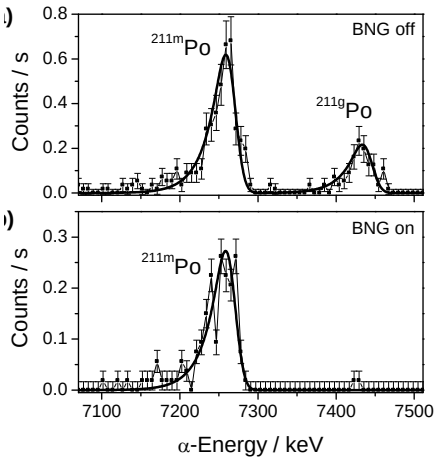
Conclusions and Outlook

The FRS Ion Catcher

- Unprecedented efficiencies for thermalized ions produced at relativistic energies
- Access to short life times (~ms)
- High-accuracy mass measurements: $2 \cdot 10^{-7}$
- Powerful tool for the measurement of isomers: Identification, excitation energies, isomeric ratios
- Isomerically clean beams

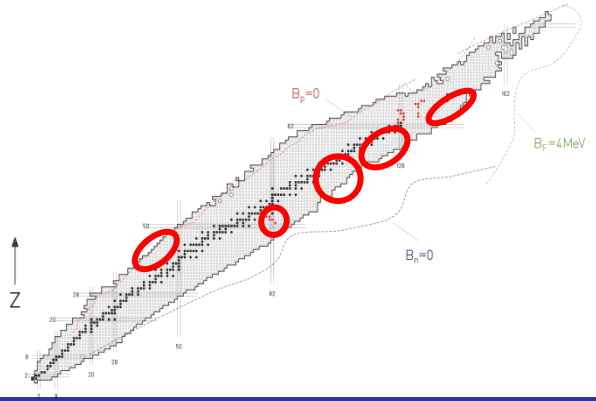






Beamtimes in 2018/19

- N=Z below ^{100}Sn
- N=126 below ^{208}Pb
- Multi-Nucleon Transfer; Target and Projectile-like Fragments (^{238}U → ^{164}Dy)
- PXN for Uranium Fission Fragments (A~140)



Acknowledgements

FRS Ion Catcher Collaboration

S. Ayet[1,2], B. Soumya[2,9], J. Bergmann[1], P. Constantin[6], T. Dickel[1,2], M. Diwisch[1], J. Ebert[1], A. Finley[7], H. Geissel[1,2], F. Greiner[1], E. Haettner[2], C.Hornung[1], S. Kaur[8], R. Knöbel[2], W.Lippert[1], I. Mardor[10,11], B. Mei[6], I. Miskun[1], I. Moore[3], J.-H. Otto[1], Z. Patyk[4], S. Pietri[2], A. Pikhtelev[8], W.R. Plaß[1,2], I. Pohjalainen[3], A. Prochazka[2], S. Purushothaman[2], C. Rappold[2], M.P. Reiter[1,7], A.-K. Rink[1], C. Scheidenberger[2], M. Takechi[2], Y. Tanaka[2], H. Toernquist[2], H. Weick[2], J.S. Winfield[2], X.Xu[1,2], M.I. Yavor[5]

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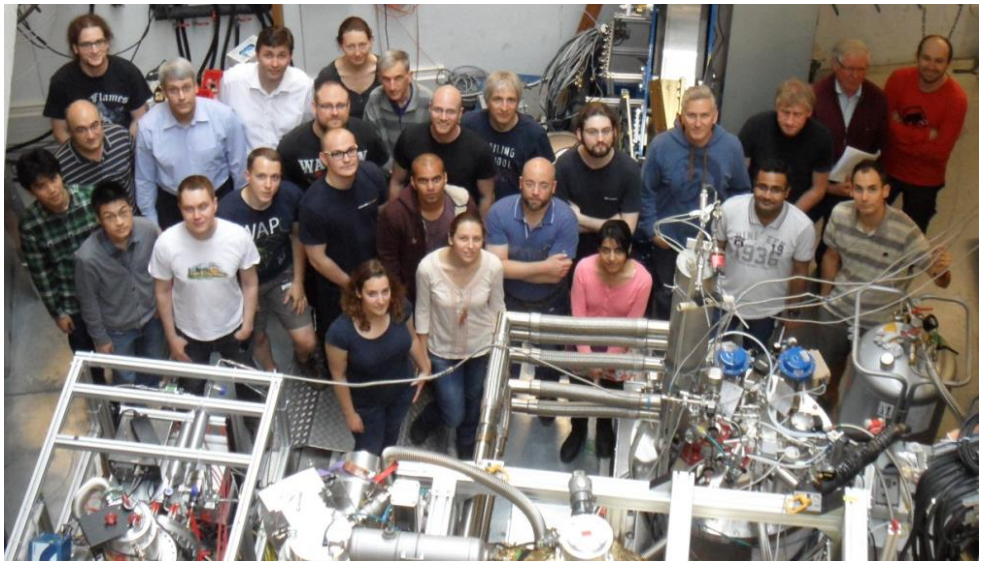

Funding:
BMBF (05P12RGFN8, 05P16RGFN1), **State of Hesse** (HMWK) (LOEWE Center HICforFAIR), **HGS-HIRe**, **JLU Giessen** and **GSI** (JLU-GSI strategic Helmholtz partnership agreement)