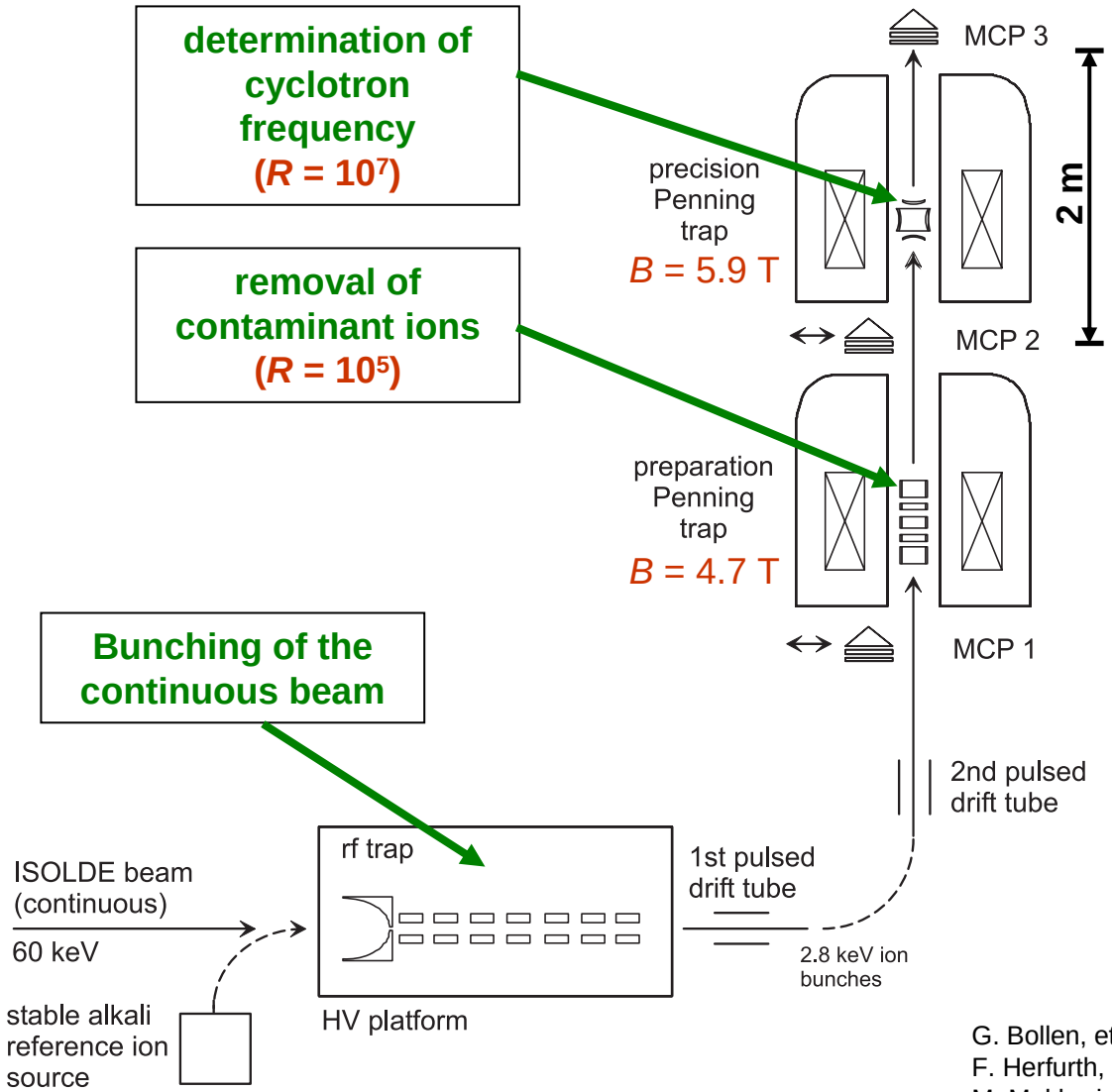
Nuclear mass measurements for nuclear synthesis studies

M. Breitenfeldt for the ISOLTRAP collaboration

Motivation

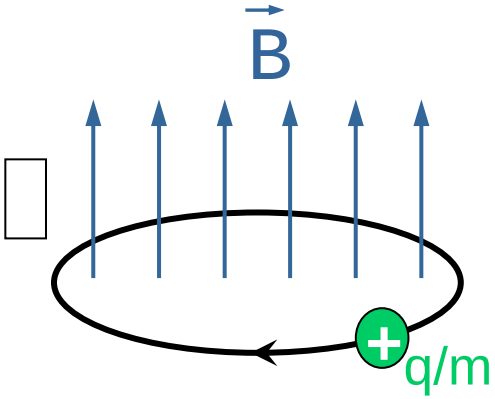
- Astrophysics:
  - r process (neutron rich nuclides)
    - Kr85-95 (P. Delahaye Phys. Rev. C 74 (2006) 034331)
    - Zn80 (waiting point, unpublished)
    - Cd130, Ag129 (waiting points, aim for this year)
  - rp process (neutron deficient nuclides)
    - Kr72 (D. Rodriguez Phys. Rev. Lett. 93 (2004) 161104)
    - Cd98 (aim for this year, shell closure n=50)

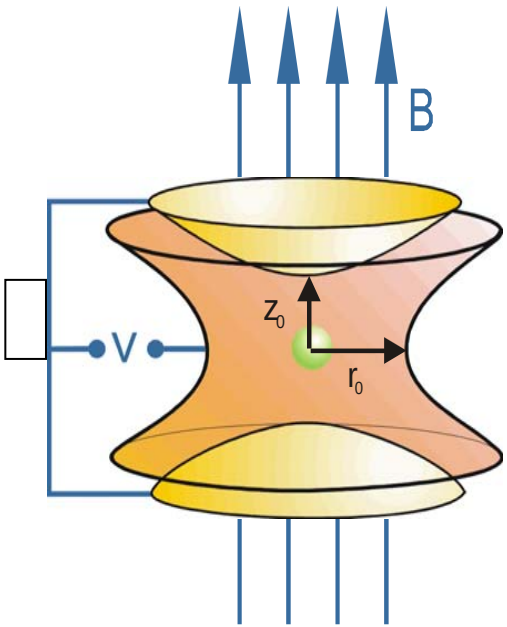
ISOLTRAP



G. Bollen, et al., NIM A 368, 675 (1996)
F. Herfurth, et al., NIM A 469, 264 (2001)
M. Mukherjee et al. EPJD submitted

Principle of mass determination

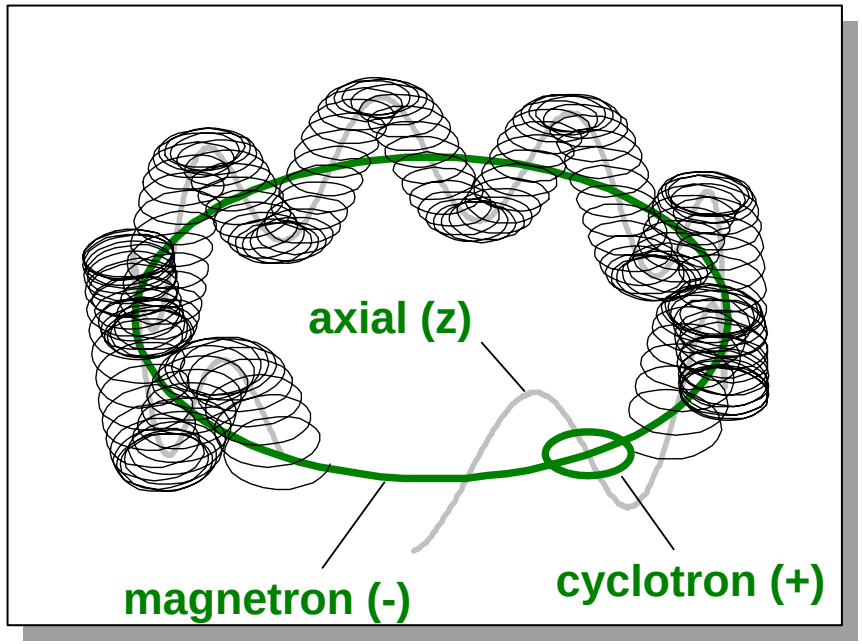




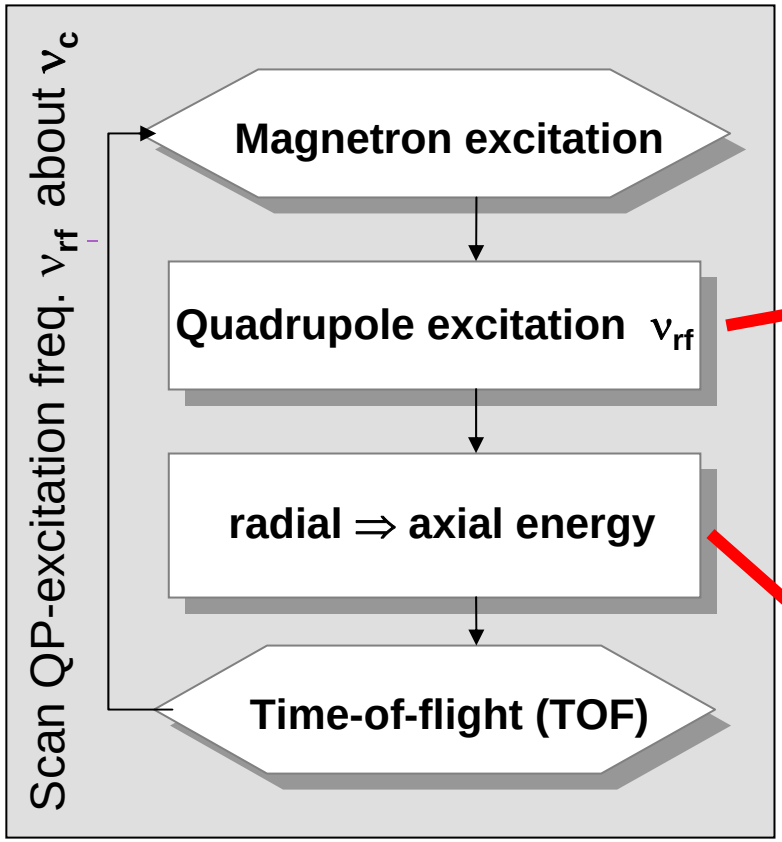
measurement of cyclotron frequency

$$\nu_+ + \nu_- = \nu_c = \frac{1}{2\pi}\frac{q}{m}B$$

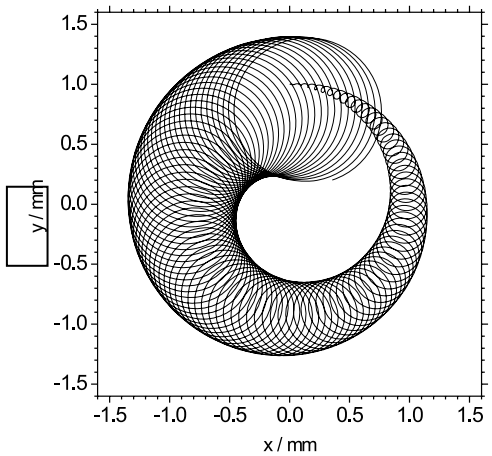
motional modes of ion stored in a Penning trap

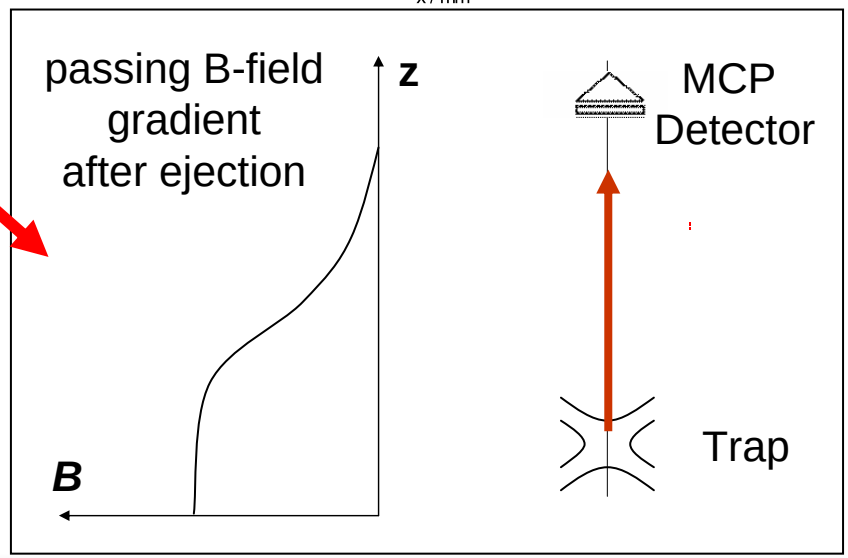


Principle of mass determination



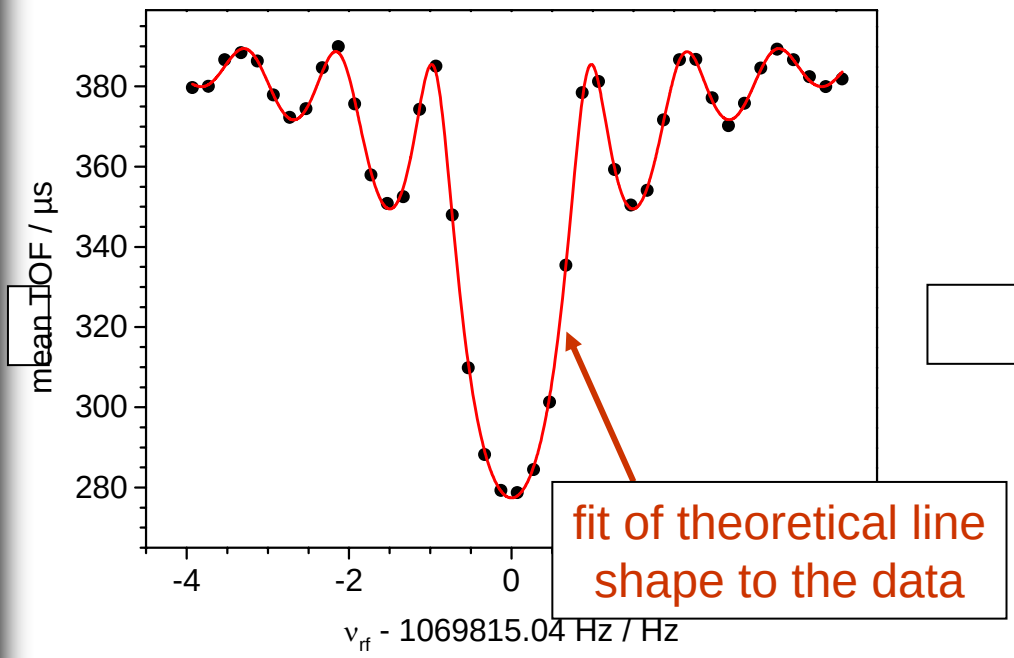
Conversion of magnetron into cyclotron motion



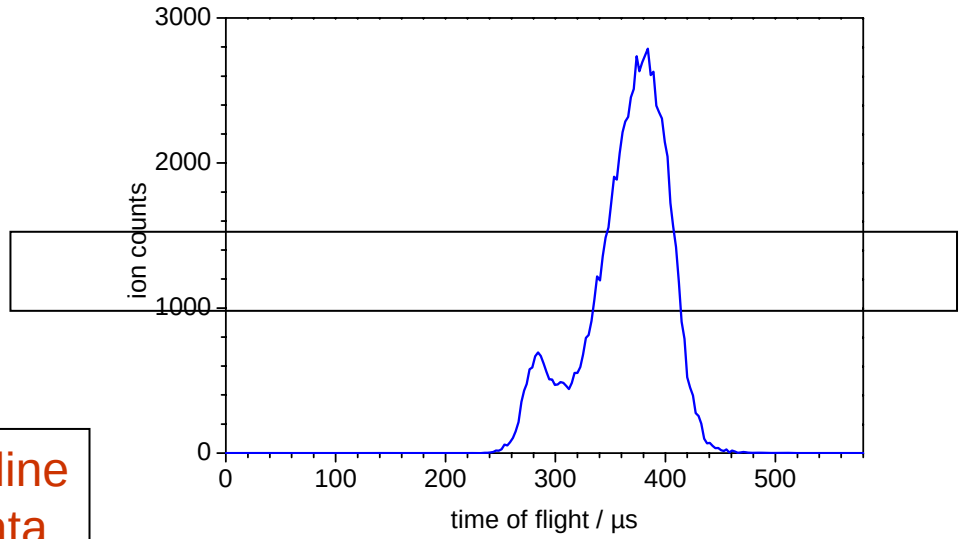


Principle of mass determination

mean TOF



TOF spectrum



Example: ^{85}Rb (900ms excitation duration)

Principle of mass determination

Sandwich:

measured

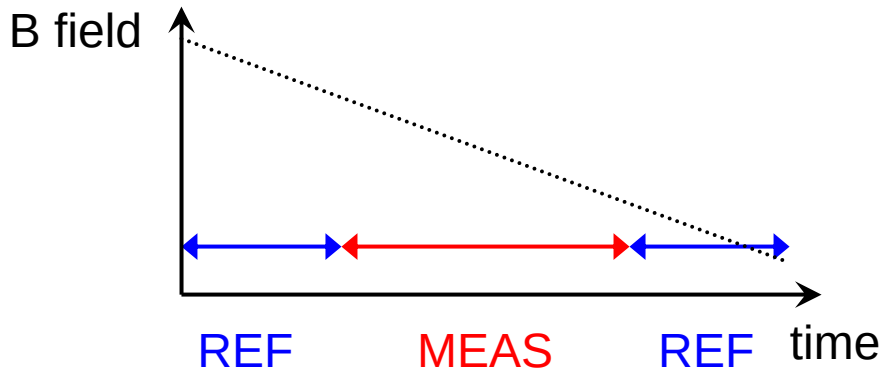
known

$$\nu_c = \frac{1}{2\pi}\frac{q}{m}B$$

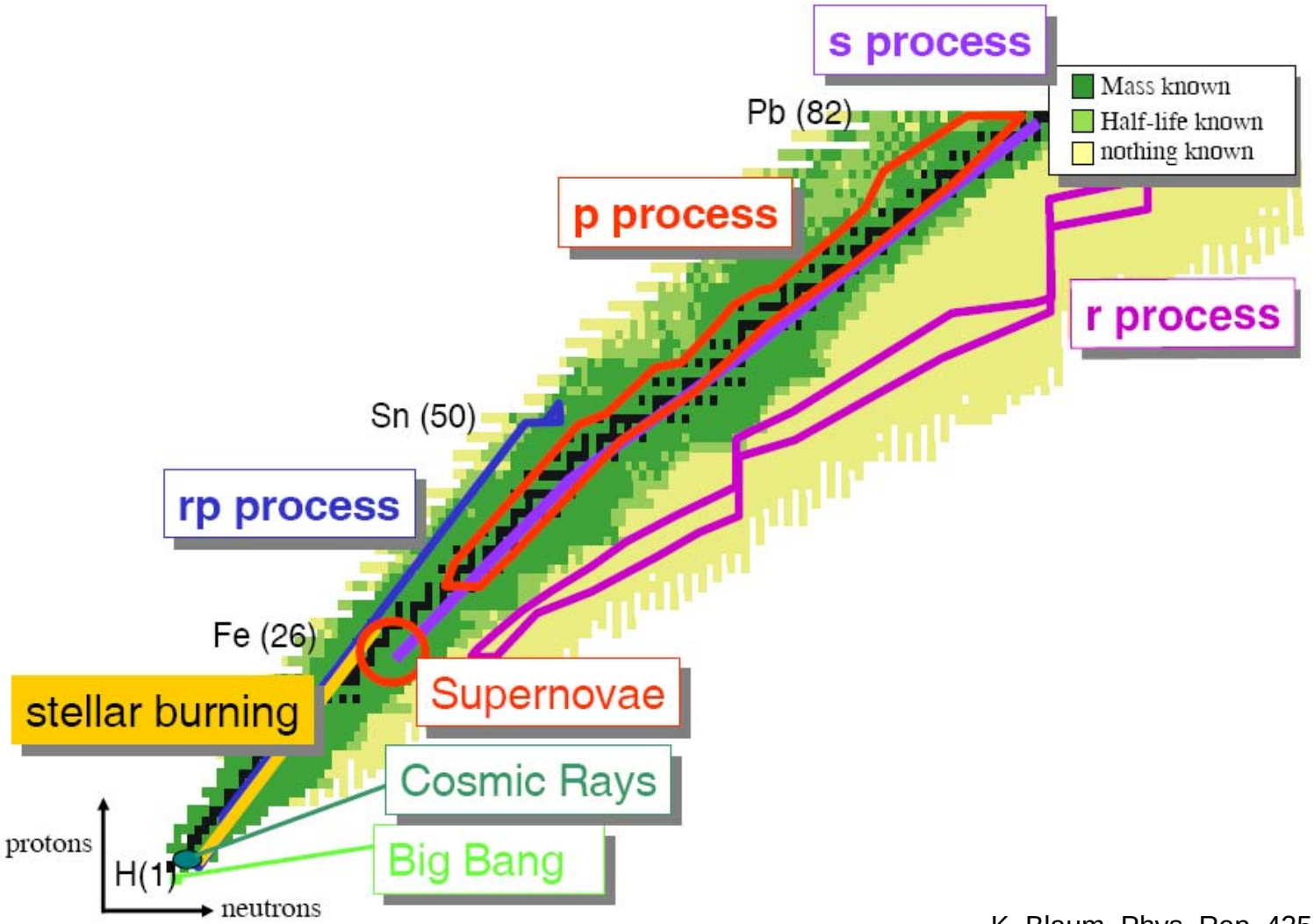
fluctuating & drifting

WANTED

$$m_{meas} = \frac{m_{ref}}{\nu_{ref}}\nu_{meas}$$



This year campaigns



K. Blaum, Phys. Rep. 425 (2006) 1

This year campaigns

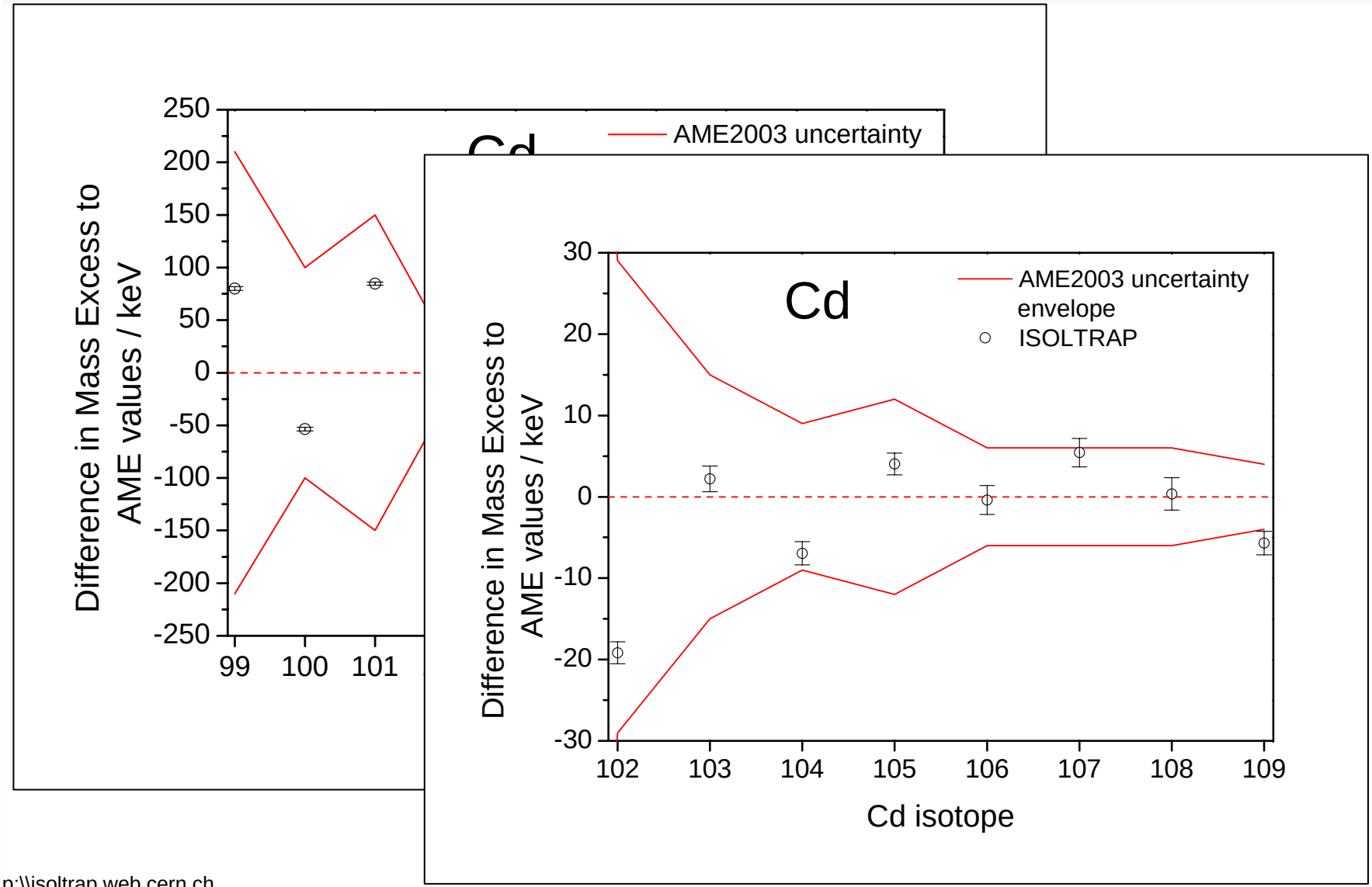
Cd: 99-109

close to the neutron shell closure of *N=50*
neutron rich Cd was not possible due to a broken RILIS window

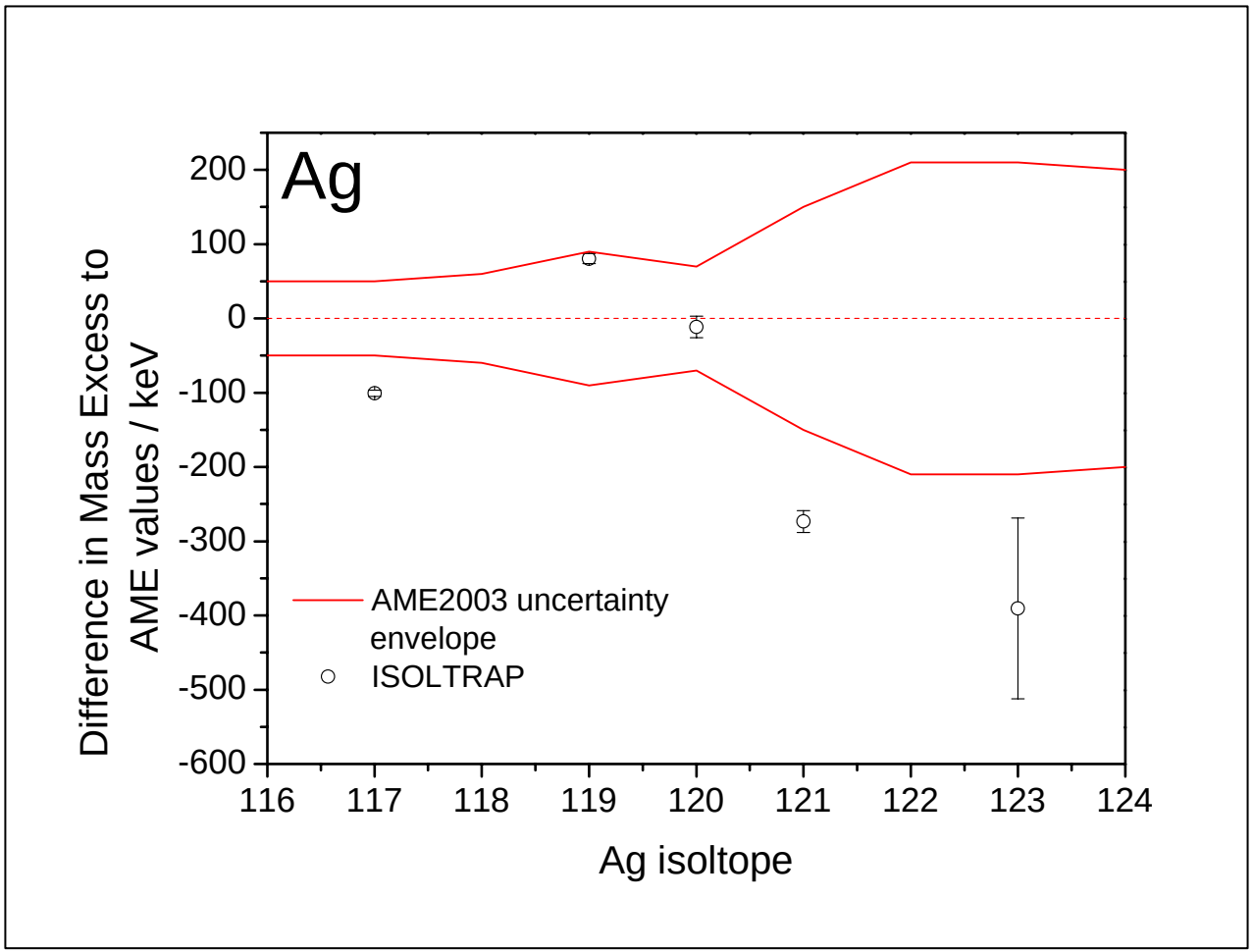
Ag: 117, 119-121, 123

aiming for the r-process (~Ag129), not possible because of too many contaminations

Preliminary results Cd



Preliminary results Ag



Summary this year

We measured about 20 nuclides this year:

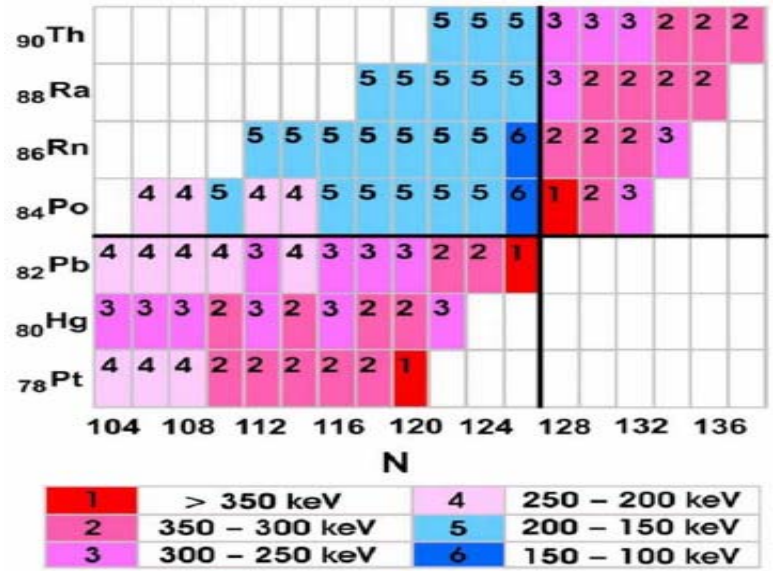
Ag	contaminations (indium)
Cd	neutron deficient: very nice
Cd	neutron rich: no RILIS
Pb	contaminations (measured Fr, Ra)

Outlook - Delta δV_{pn}

The average interaction of the last proton(s) with the last neutron(s) is given by:

$$\delta V_{pn}(N,Z) = \frac{1}{4}[\{B(Z,N)-B(Z,N-2)\} - \{B(Z-2,N)-B(Z-2,N-2)\}]$$

Development of configuration mixing
- Onset of collectivity
- Deformation in nuclei
- Changes in single particle energies and magic numbers
- Microscopic origins of phase transitional behavior



R. Casten, R.B. Carkili

Outlook - Delta δV_{pn}

- Measurements in IS461 on neutron rich Cd (122-130) for determining δV_{pn} (interaction of the last neutron with the last proton)
- Hg 207 – 210 for the symmetry of “above-below” and “below-above”

Thanks to:

ISOLTRAP Collaboration:
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Participating Institutes:
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MPI Heidelberg, MSU

δV_{pn}:
R. Casten, R.B. Carkili

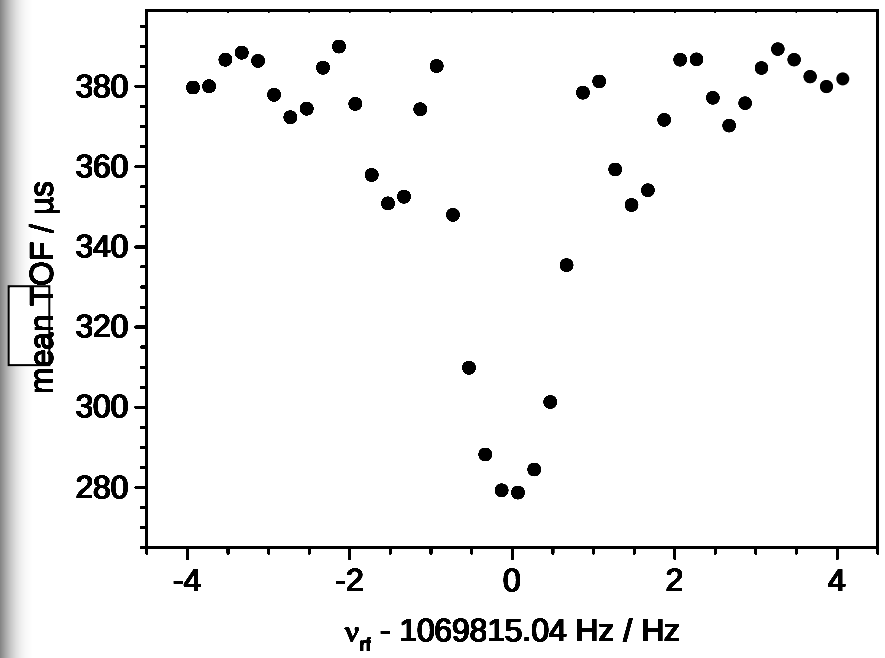
ISOLDE Team

~~€€€€€~~:
BMBF, EU, Helmholtz, DFG

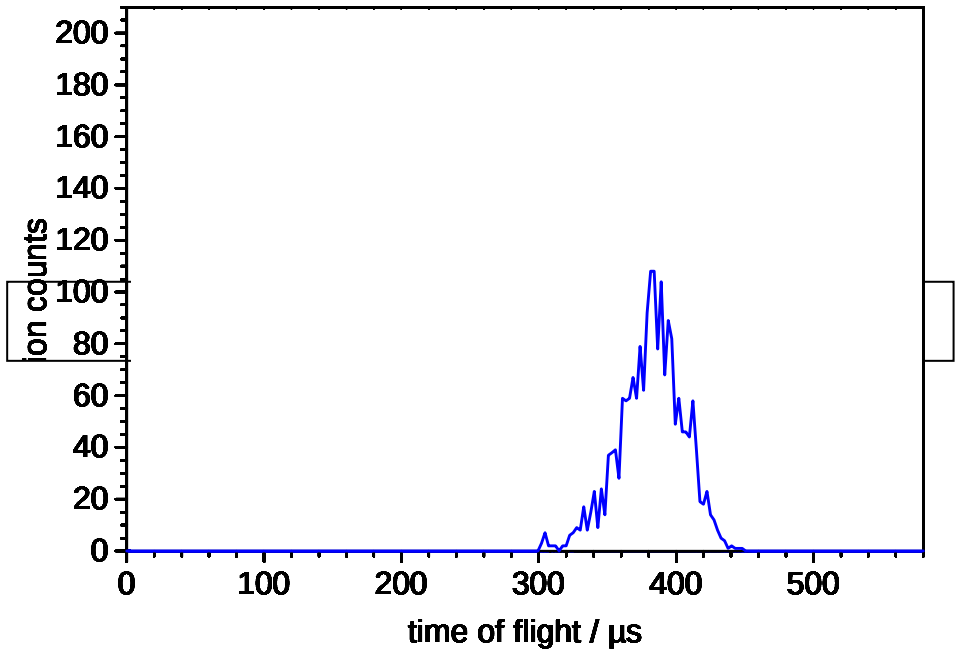

ISOL
TRAP

Principle of mass determination

mean TOF



TOF spectrum



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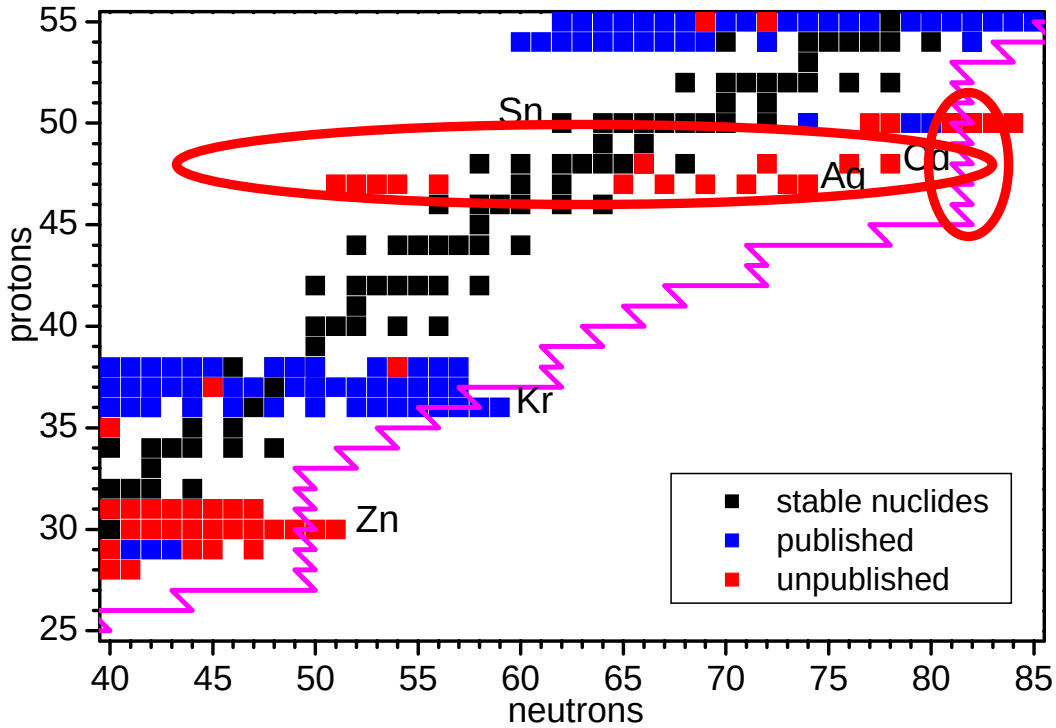
Motivation


protons
neutrons
Sn
Ag
Cd
Kr
Zn
stable nuclides
published
unpublished