High-precision studies on pure species using Penning traps

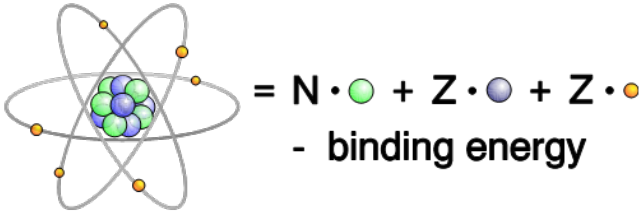
Magdalena Kowalska

CERN, PH-Dept., ISOLDE

On behalf of the
ISOLTRAP collaboration

High-precision mass studies

Mass of the nucleus => binding energy of the system:
Determines the energy released in decays and reactions:



Nuclear Structure:

shell closure, pairing, deformation, halos

$\delta m/m \leq 1 \cdot 10^{-7}$

4 Letters

Astrophysics:

Nucleosynthesis, r- and rp-process

$\delta m/m < 1 \cdot 10^{-7}$

ISOLTRAP, 2004-2009:
4 Letters

Weak Interaction:

symmetry tests, CKM unitarity (V_{ud})

$\delta m/m < 3 \cdot 10^{-8}$

2 Letters

**At ISOLDE, masses of exotic nuclei are investigated with ISOLTRAP:
the 'mother' of online Penning trap mass spectrometers,
where also decay-spectroscopy can be performed on purified samples**

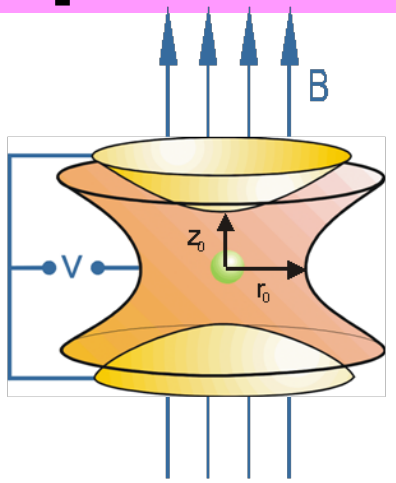
Unique: the beams available and the know-how at ISOLDE and ISOLTRAP

Masses and Penning traps

Mass determined from the ion cyclotron frequency:

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

Mass uncertainty decreases with the interaction time



Penning trap mass spectrometry achievements:

- ultra-high accuracy: better than 10^{-8} (e.g. ^{22}Mg)
- extreme resolving power: close to 10 million (Hg isotopes)
- isobaric separation (e.g rare-earth nuclides)
- isomer separation (e.g. Cu and Tl isotopes)
- single-ion sensitivity: production rates of 1 ion/s (^{252}No)
- high efficiency: half-lives down to 10 ms (^{11}Li)

But not all at the same time!

Limits: half-life and production rate, beam purity

Solution: increase the beam intensity and the charge state => planned within the HIE (High Intensity and Energy) ISOLDE project

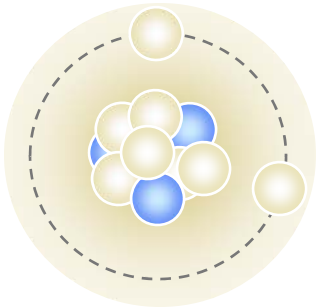
HIE-ISOLDE and mass studies

HIE-ISOLDE impact on ISOLTRAP:
- Increased beam intensity
- Better resolving power
- Highly-charged ions

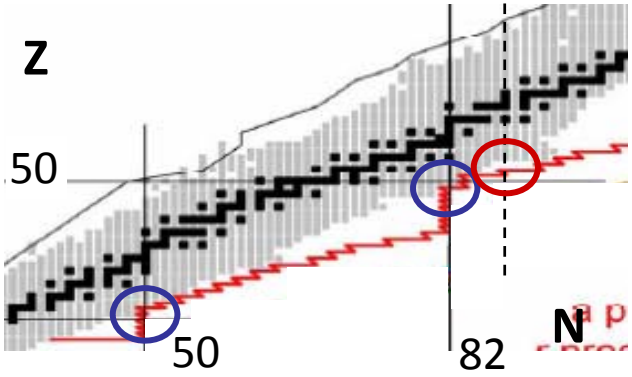
Push the limits of online mass studies:

Access to more exotic species	Access to species with high contamination	Higher precision

Halo nuclei:
^{12,14}Be, ^{11}Li



Astrophysics: ^{82}Zn, ^{132}Sn and ^{140}Te regions



Weak interaction: V_{ud} matrix element from mirror transitions, ^{21}Na,^{23}Mg