Separation of Transfer and Fusion Products

Sophie Heinz

- Results from SHIP experiments
- Kinematics and cross-sections
- Separation criteria
- Separator concept
- High-resolution final stage

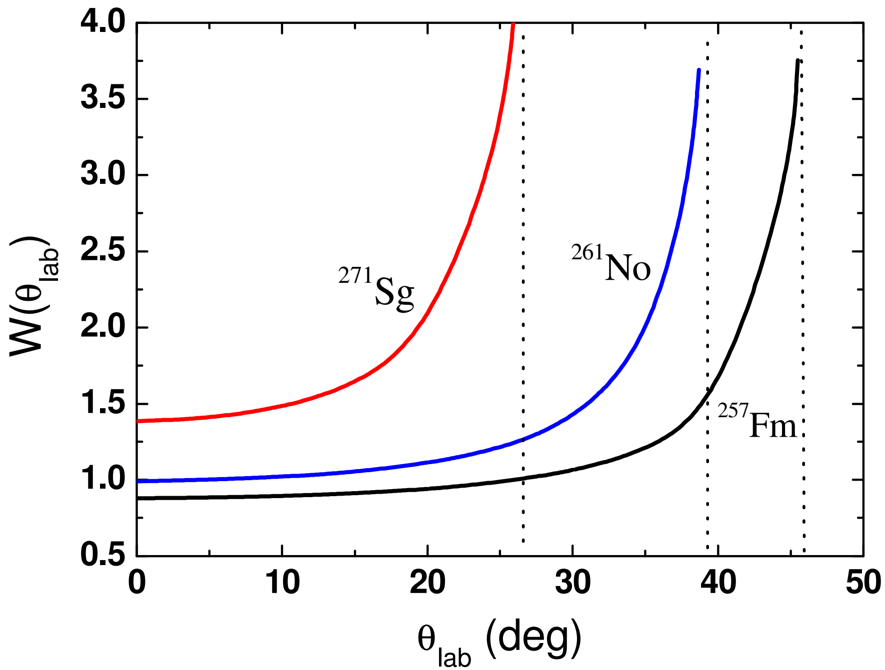
Iris workshop, November 19, 2010

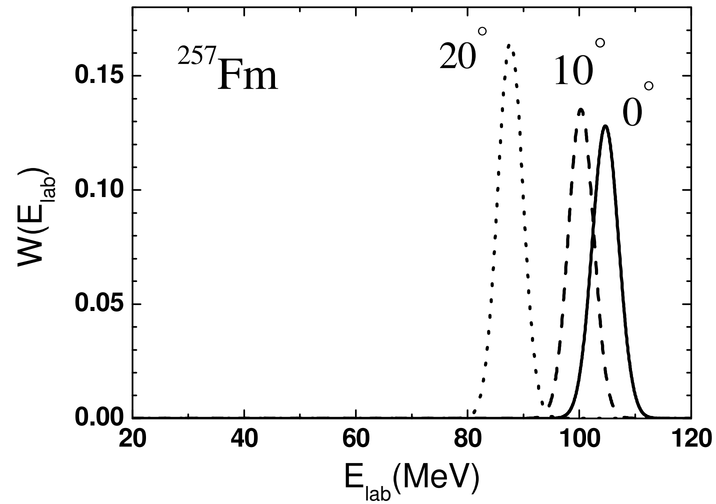
Kinematics of heavy transfer products

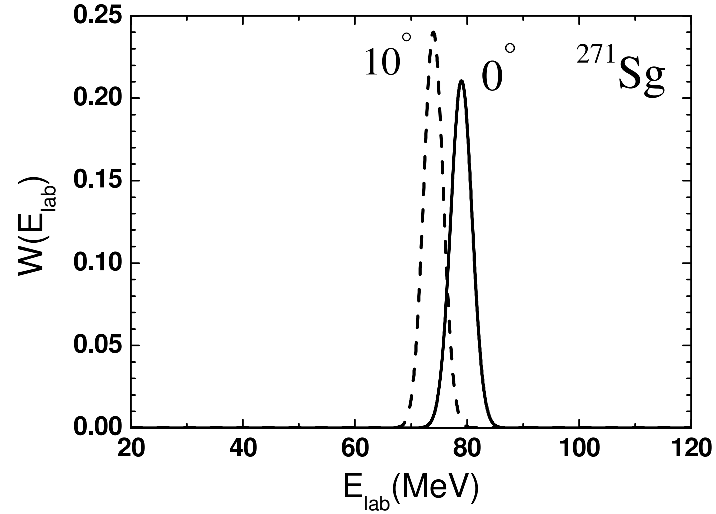
<u>Angular and energy distributions of n–rich heavy transfer products</u>

→ *<u>calculations</u> (G. Adamian and N. Antonenko, Dubna)*

$^{48}Ca + ^{248}Cm$, E_{cm} = 209 MeV





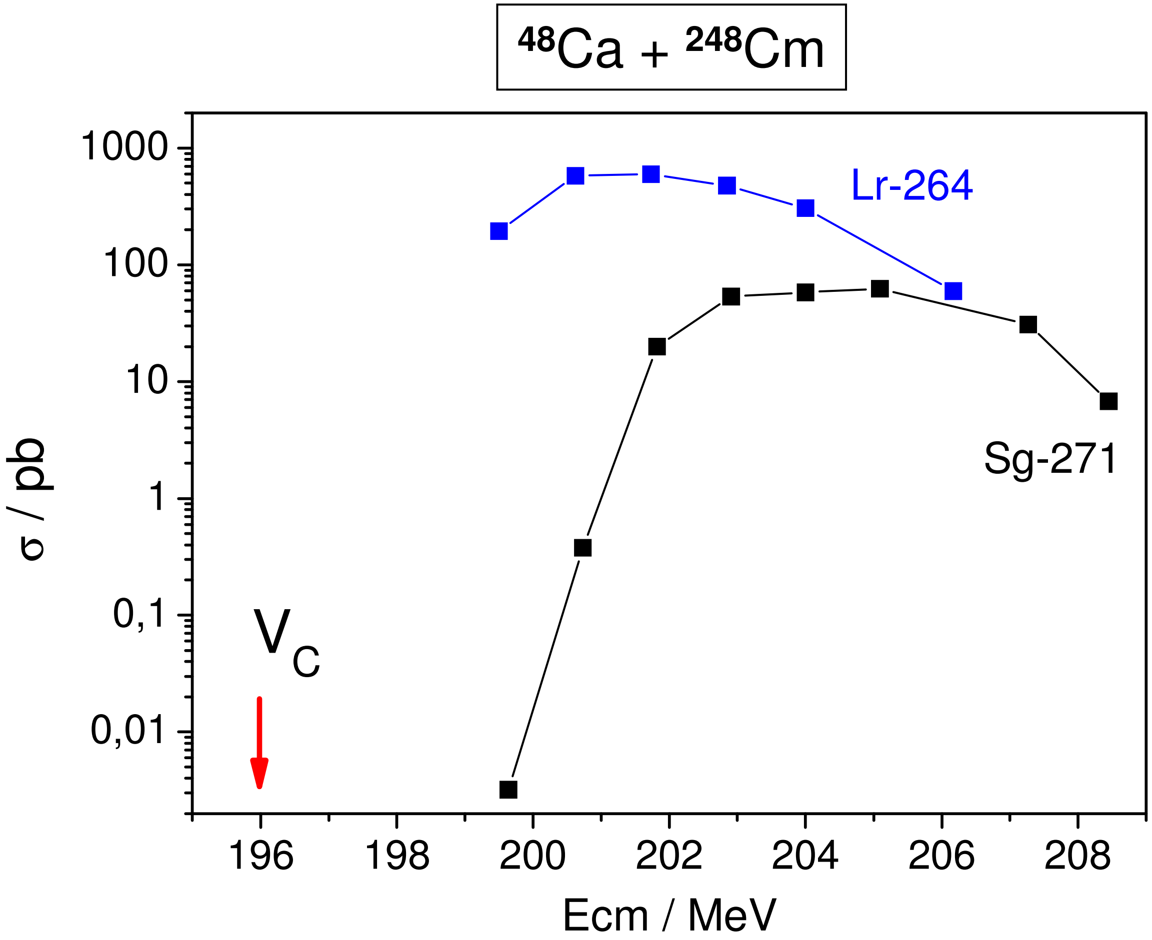


isotropic angular distributions in the cm-system
(deep-inelastic transfer)

Excitation functions

Calculated excitation functions for Lr-264 and Sg-271

(G. Adamian and N. Antonenko, Dubna)



σ_{max} (Lr-264) = 600 pb

σ_{max} (Sg-271) = 62.5 pb

Velocity filter – Performance for transfer products

- Starting point: SHIP

present acceptance: 10 msr

expected counting rates with present setup:

Lr-264 → $\varepsilon = 0.04$

σ_{max}(Lr-264) = 600 pb for E_{cm} = 202 MeV

N(Lr-264) = 9 / day (with 25 μA $^{48}Ca^{10+}$, 460 μg/cm^2 ^{248}Cm)

Sg-271 → $\varepsilon = 0.05$

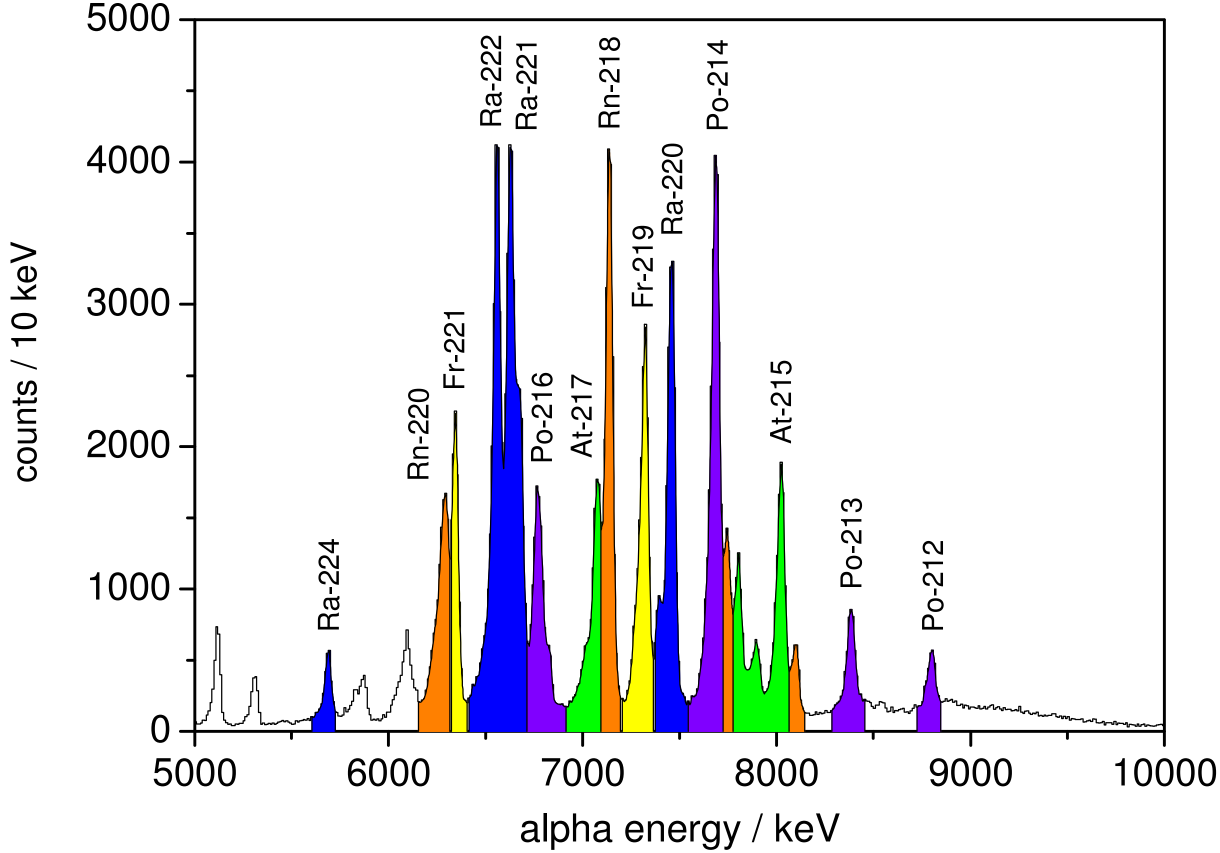
σ_{max}(Sg-271) = 62,5 pb for E_{cm} = 205 MeV

N(Sg-271) = 1 / day

Experimental results from SHIP

Transfer in ^{48}Ca + ^{248}Cm reactions at SHIP

- Transfer products with $Z < Z_{Cm}$ → Identification via (Re – α) correlations

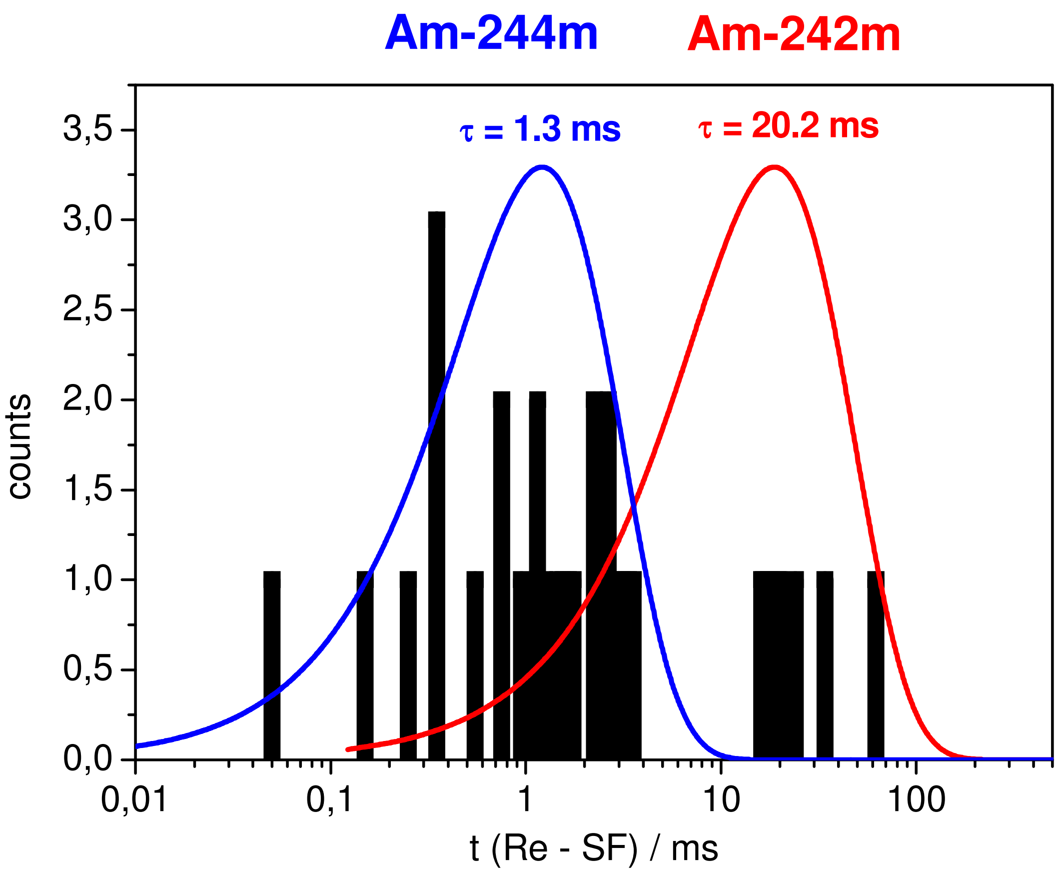


dσ/dΩ ≈ 100 – 500 nb/sr

Transfer in ^{48}Ca + ^{248}Cm reactions at SHIP

Fission events from short-living isotopes

- Identification of short-living fission events via (Re–SF) - correlations

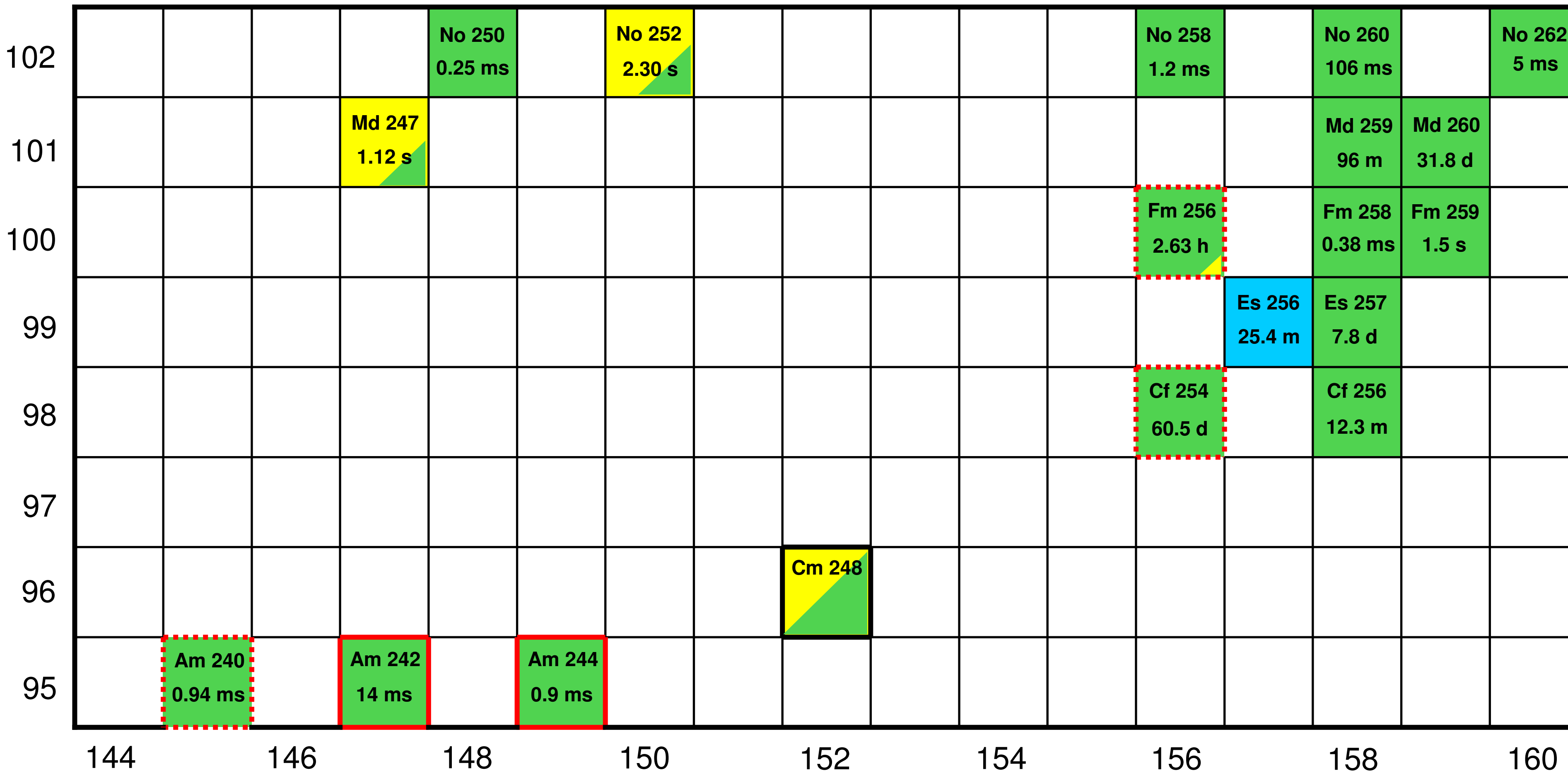


$d\sigma/d\Omega$ (^{242m}Am) = 100 pb/sr

$d\sigma/d\Omega$ (^{244m}Am) = 700 pb/sr

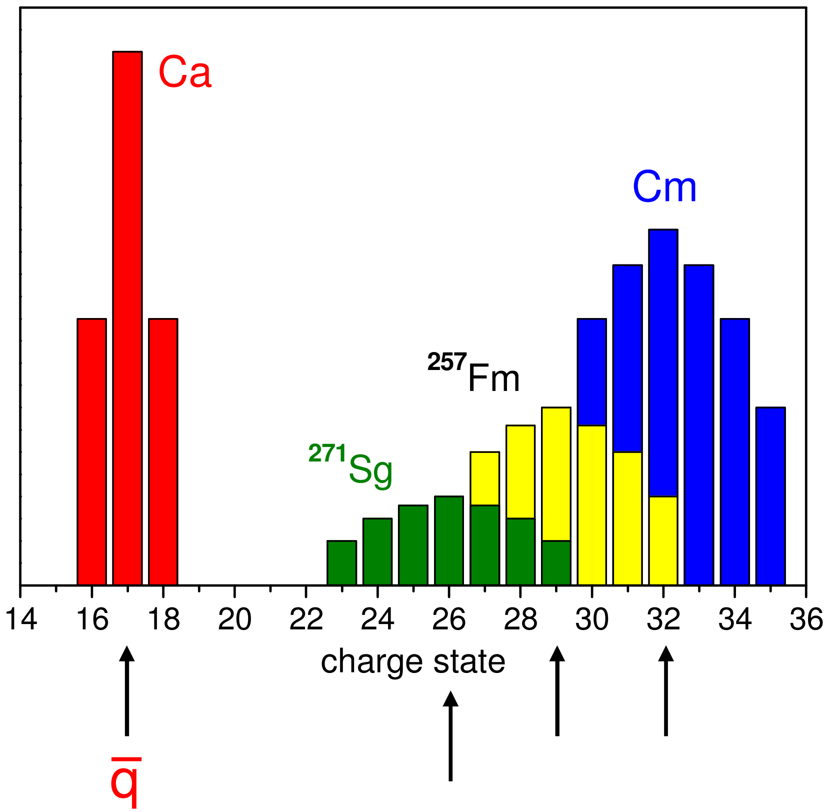
Transfer in ^{48}Ca + ^{248}Cm reactions

transfer products with $Z > Z_{Cm}$

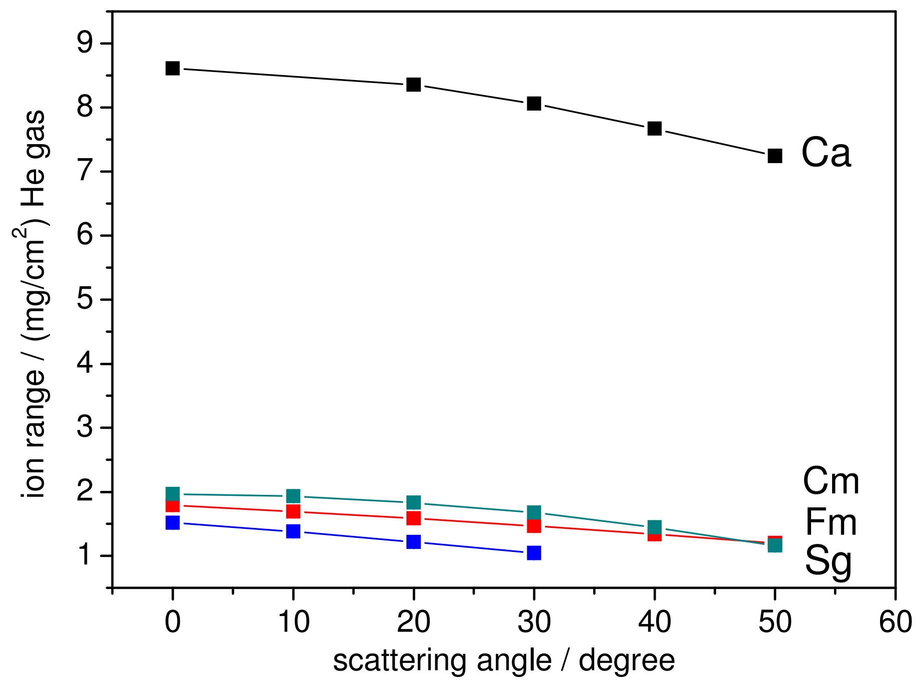


Separation criteria I

$^{48}Ca + ^{248}Cm$, E_{cm} = 209 MeV



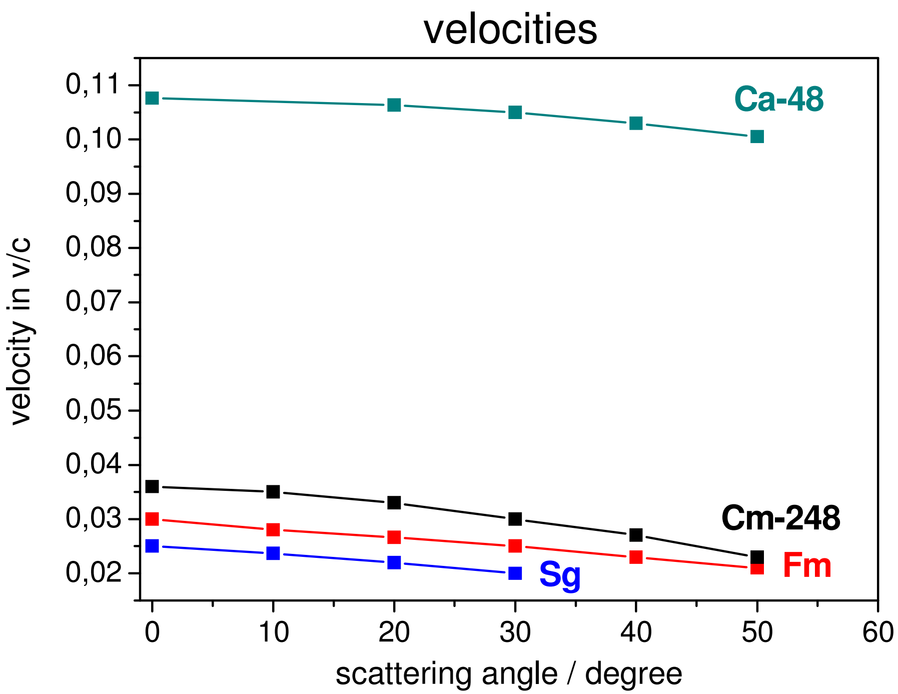
gas filled separator

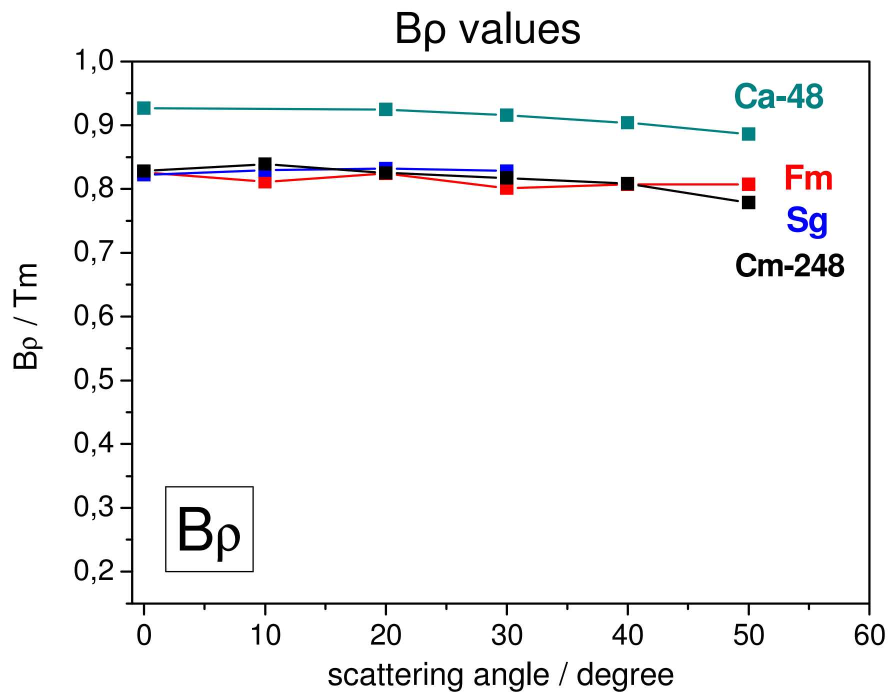


range separation

Separation criteria II

Ion velocities and magnetic rigidities in vacuum





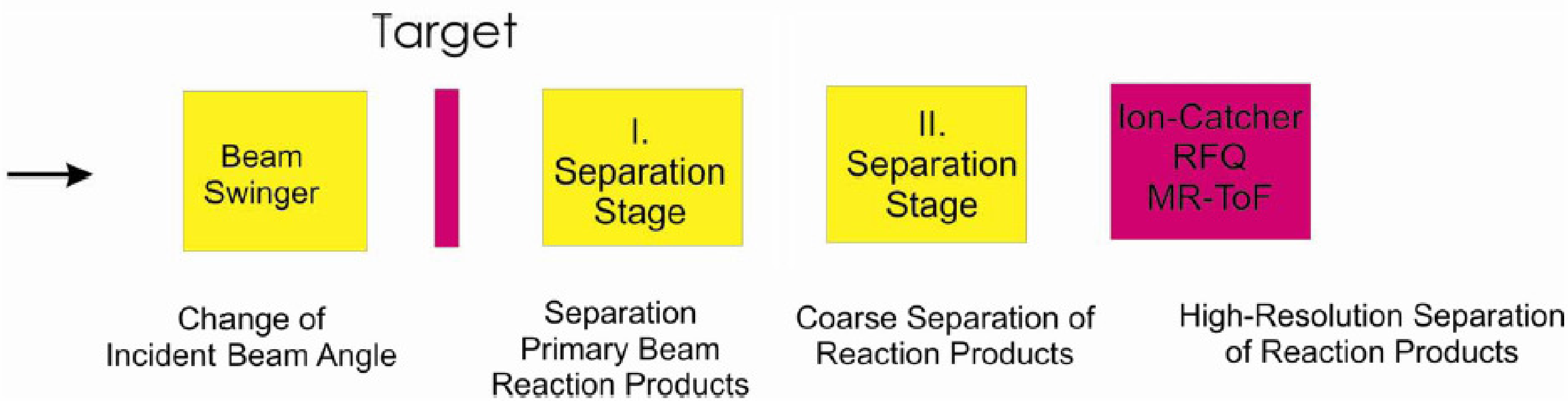
velocity filter

magnetic separation

Separation of Transfer- and Fusion Products

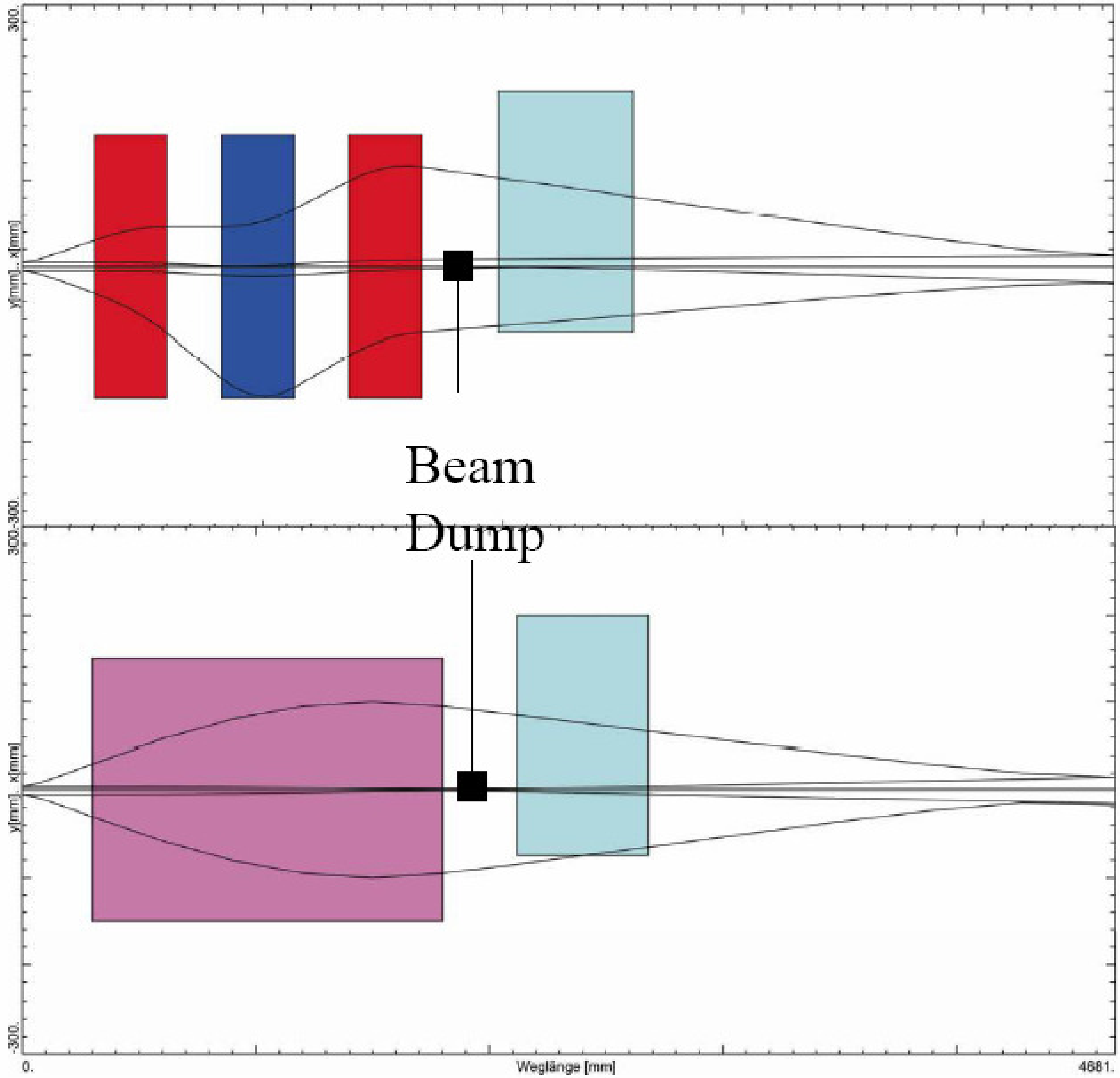
Goals: Primary Beam $I_{max} = 10^{(14\text{-}15)}$/s

$\sigma = 0.1$ pb, $T_{1/2} < 10$ ms



G. Münzenberg, H. Geissel, S. Heinz, H. Weick, M. Winkler

How to collect a large transverse phase space?



At the Entrance:

Superconducting Quadrupole Triplett

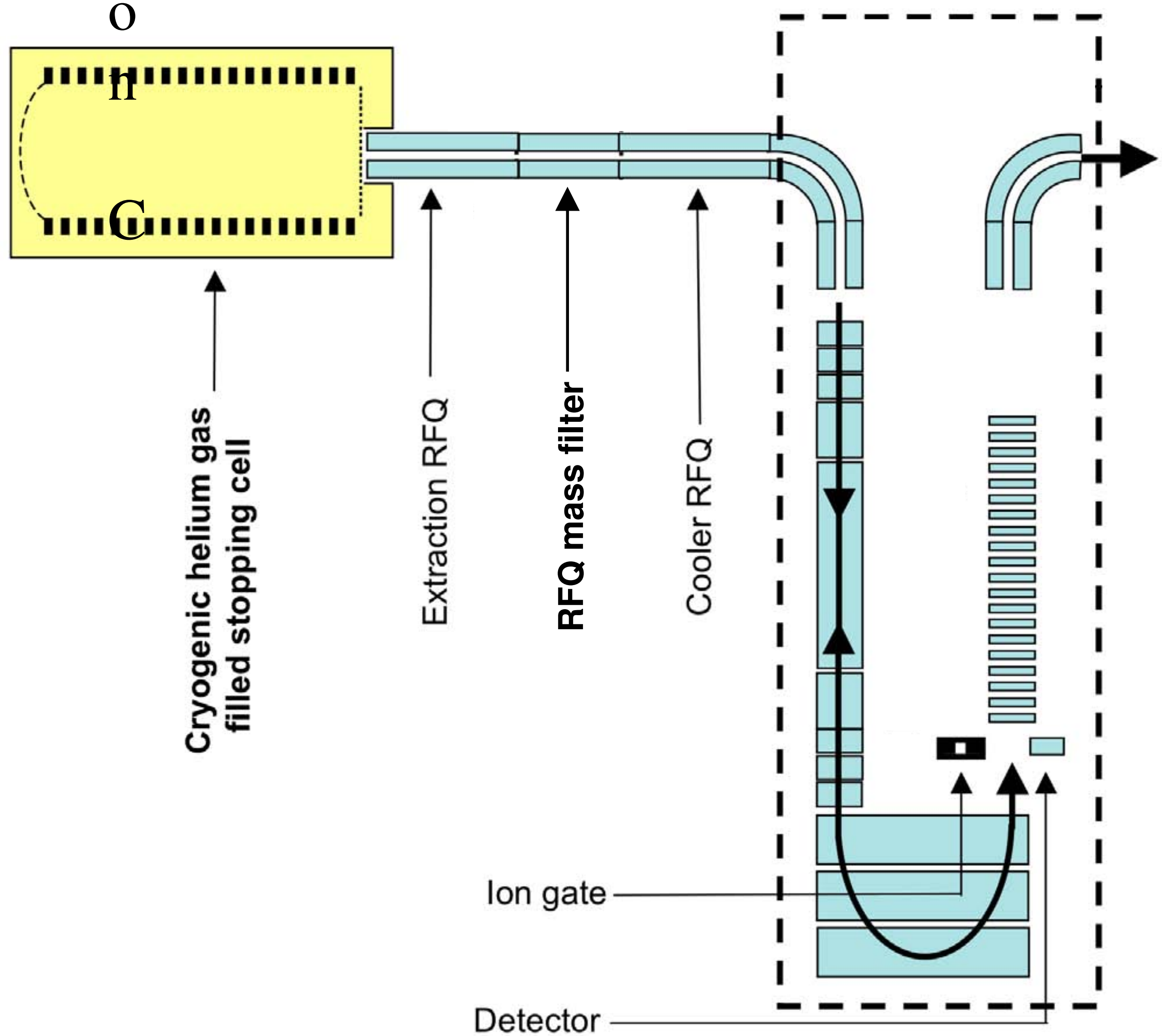
Superconducting Solenoid

Beam Dump is 40 times more efficient

Emittance: Primary Beam = 5 π mm mr   Reaction Products = 500 π mm mr

Ion-Catcher -- RFQ – MR-ToF

I
o
n
C



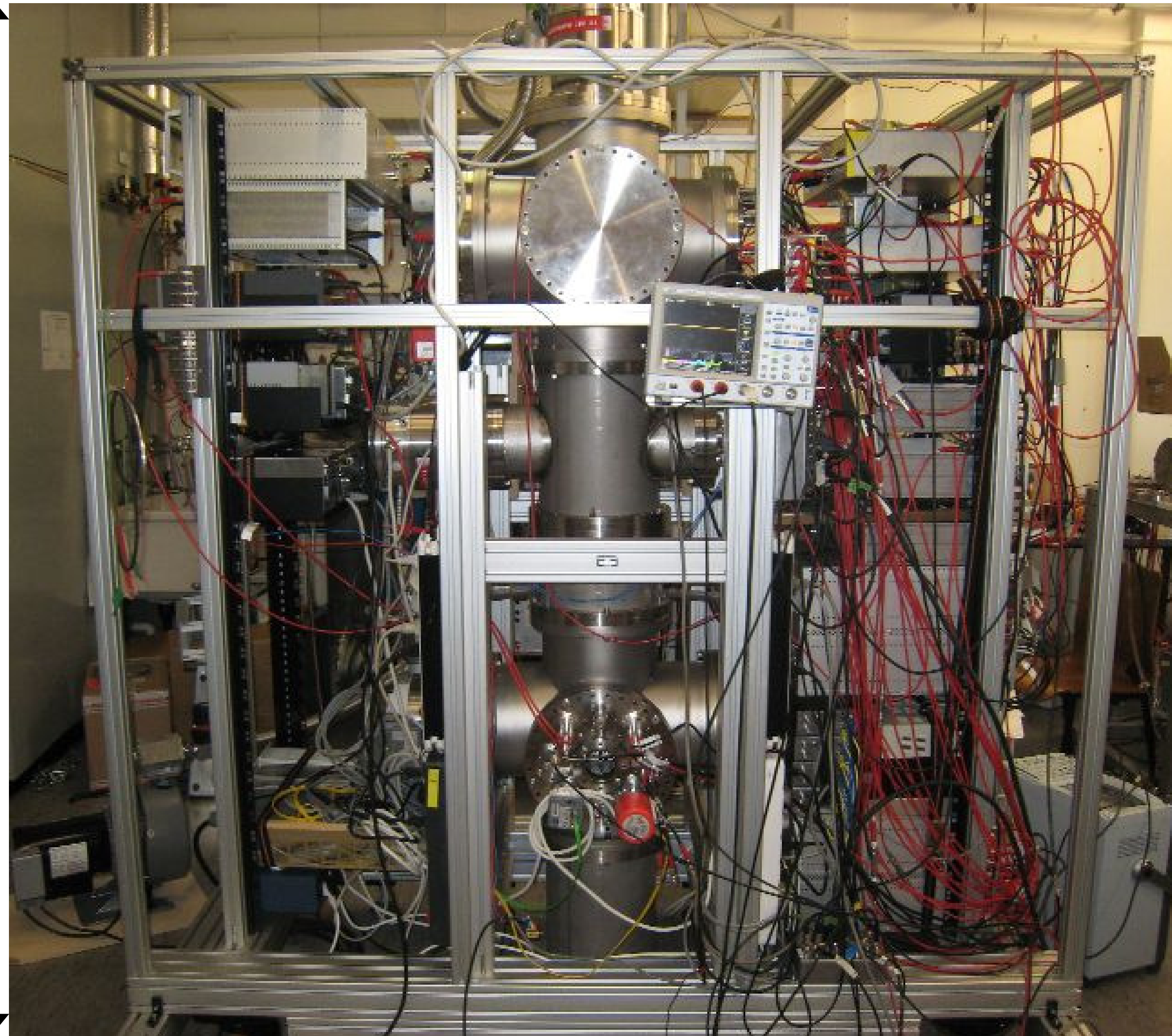
P. Dendooven, T. Dickel, W. Plass

Setup of the MR-TOF-MS

- Device including electronics mounted in one frame
- Easily transportable
- Variable entrance potential (~2kV)

→ Suitable to be employed at different facilities

2 m

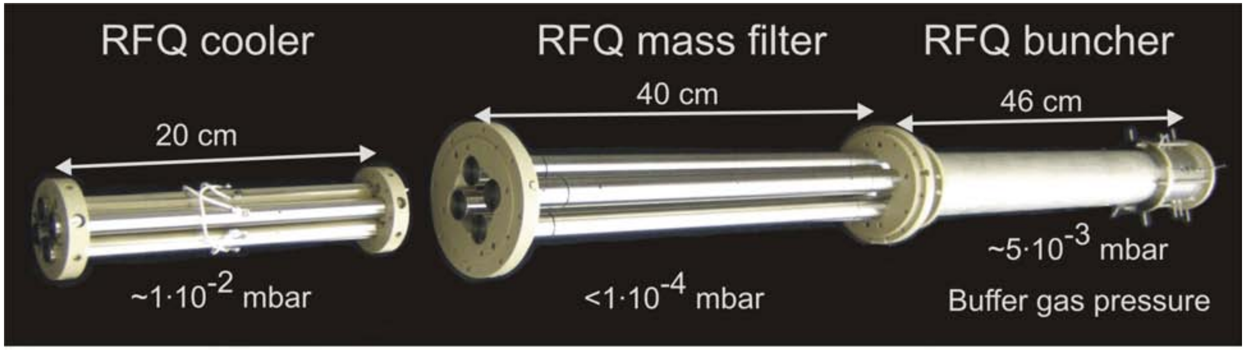


T. Dickel, W. Plass

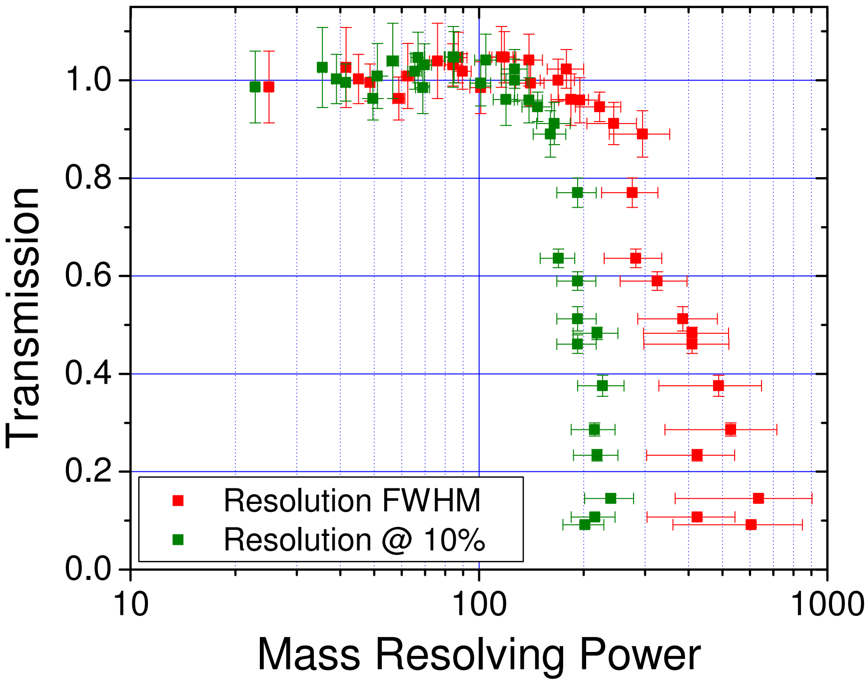
RFQ System for SHIPTRAP

Solution: Matched combination of cooling, mass separation and bunching

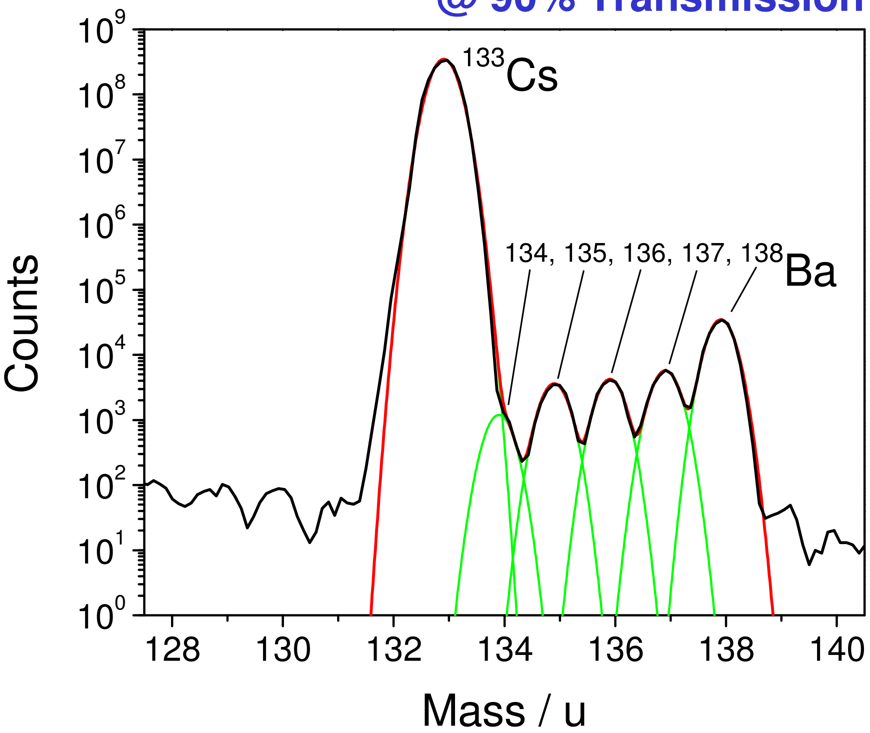
from Stopping cell



to Penning traps

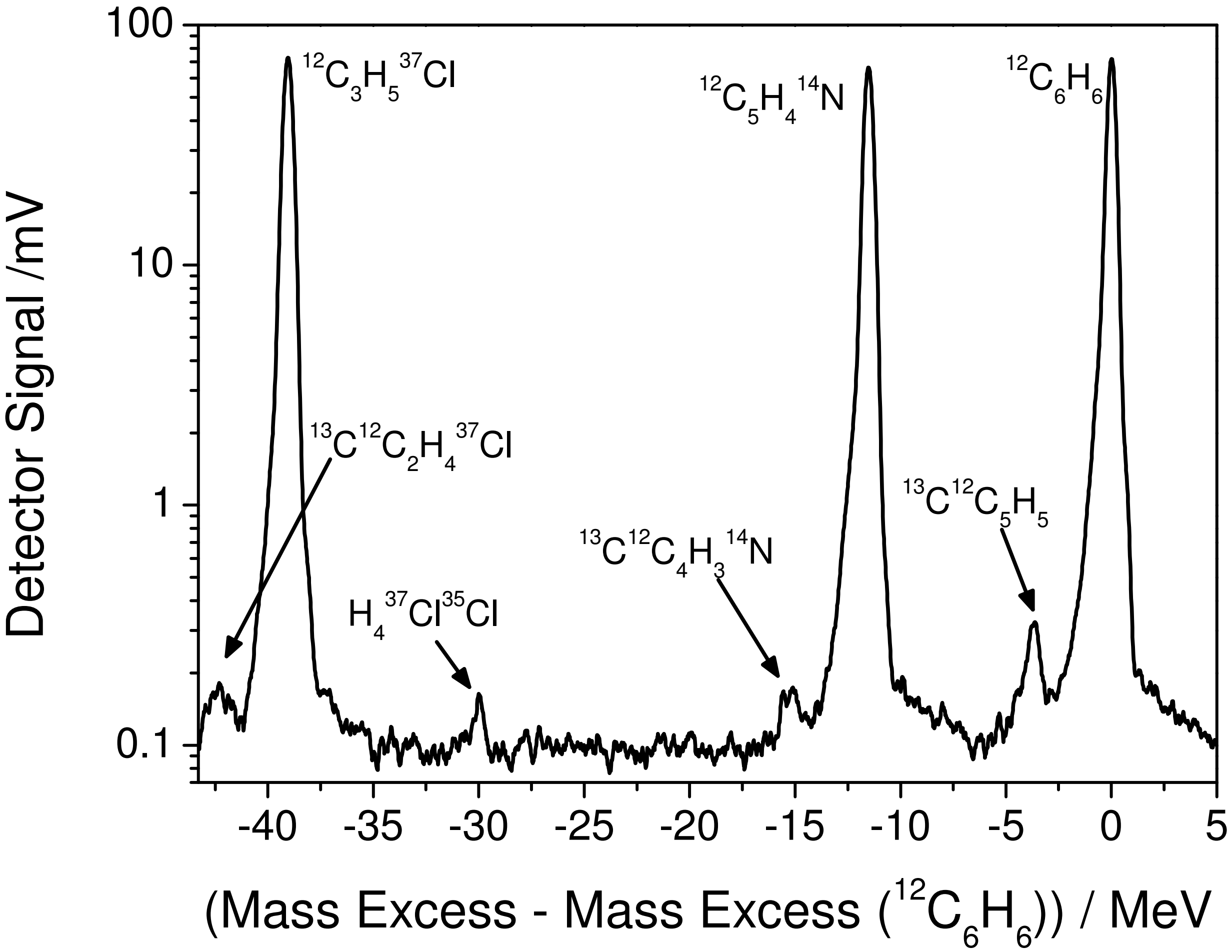


@ 90% Transmission



E. Haettner

MR-ToF Measured Spectra
T. Dickel, W. Plass



~ 275 detected ions / cycle

m/Δm: up to 600000 have been achieved

More than 10.000 ions/cycle

+

Repetition rate:
100 Hz

=

! **More than 10^6 ions/s can be proccessed** !

Summary and Conclusion

- Calculated transfer reactions open a new field
- First results from SHIP experiments are promising
- Separation criteria:
  velocity- and range selection: superior
  mean-charge state: very difficult
  brho: not appropriate
- Separator concept for high-intensity primary and small x-sections: Multi-stage separator
- A solenoid is a high-acceptance device for a coarse separation for the primary beam
- High-resolution final stage: of great importance