Institut für Kernchemie

Coupling TASCA with SHIPTRAP

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2 UNIVERSITY OF HEIDELBERG

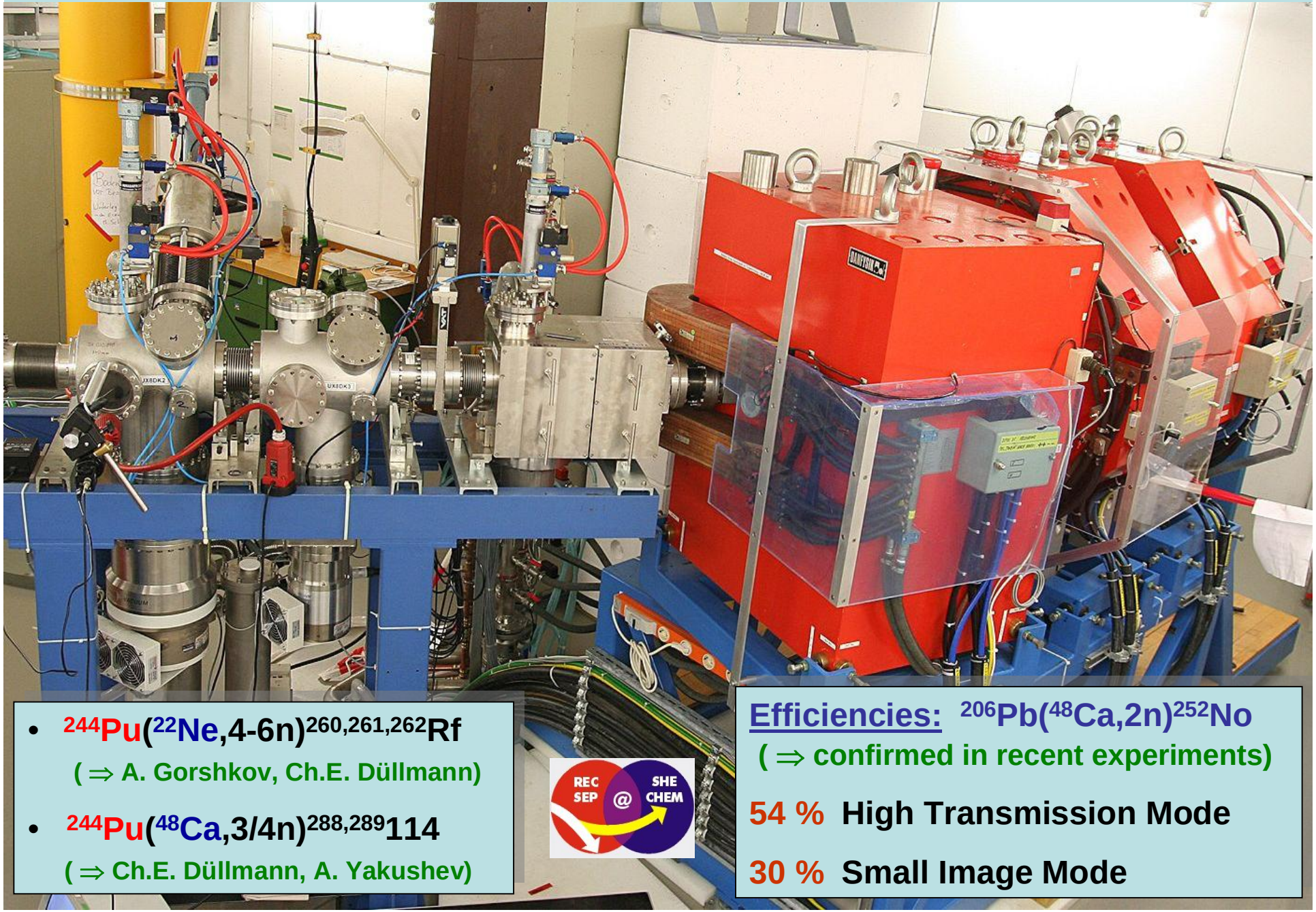
3 Max-Planck-Institut für Kernphysik

4 GSI HELMHOLTZ GEMEINSCHAFT

- TASCA-separator @ GSI
- TRIGA-SPEC experiment @ JOHANNES GUTENBERG UNIVERSITÄT MAINZ
- SHIPTRAP facility @ GSI
- Coupling of TASCA and SHIPTRAP

7th Workshop on the Chemistry of the Heaviest Elements, Mainz / 11-13.10.2009

TASCA separator



- $^{244}Pu(^{22}Ne,4\text{-}6n)^{260,261,262}Rf$
  (⇒ A. Gorshkov, Ch.E. Düllmann)
- $^{244}Pu(^{48}Ca,3/4n)^{288,289}114$
  (⇒ Ch.E. Düllmann, A. Yakushev)

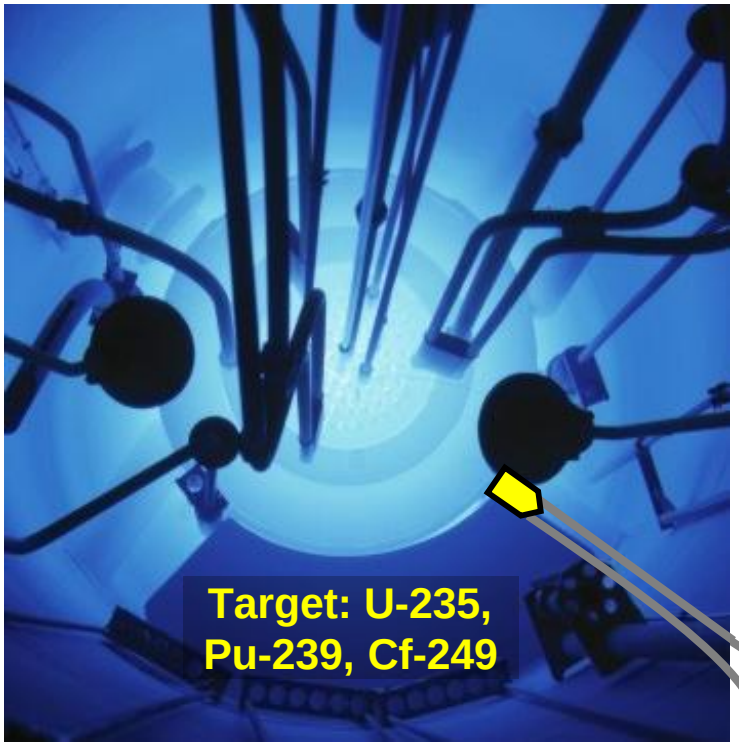
REC SEP @ SHE CHEM

Efficiencies: $^{206}Pb(^{48}Ca,2n)^{252}No$
(⇒ confirmed in recent experiments)

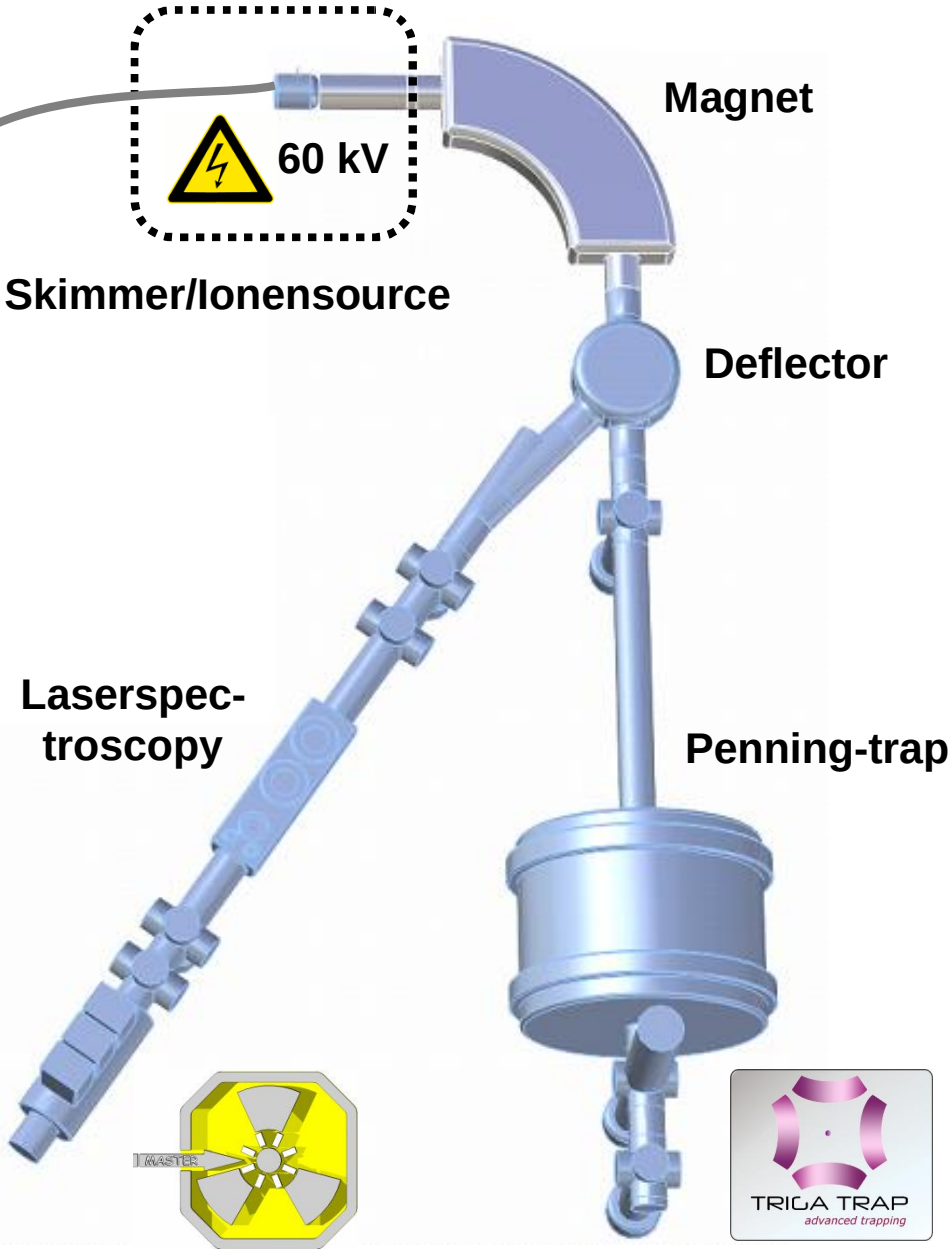
54 % High Transmission Mode

30 % Small Image Mode

TRIGA-SPEC experiment

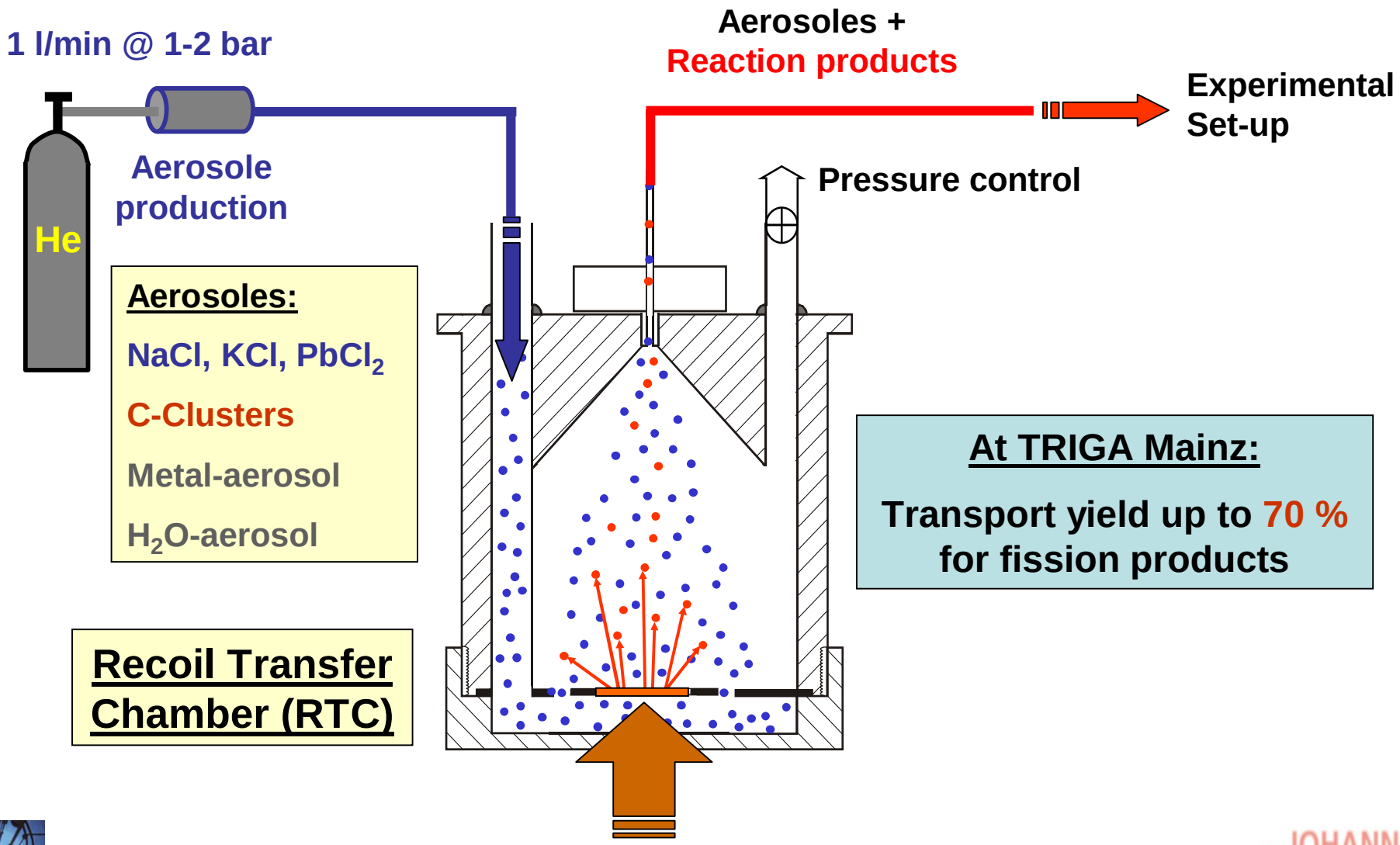


Gasjet-System
C-Aerosol

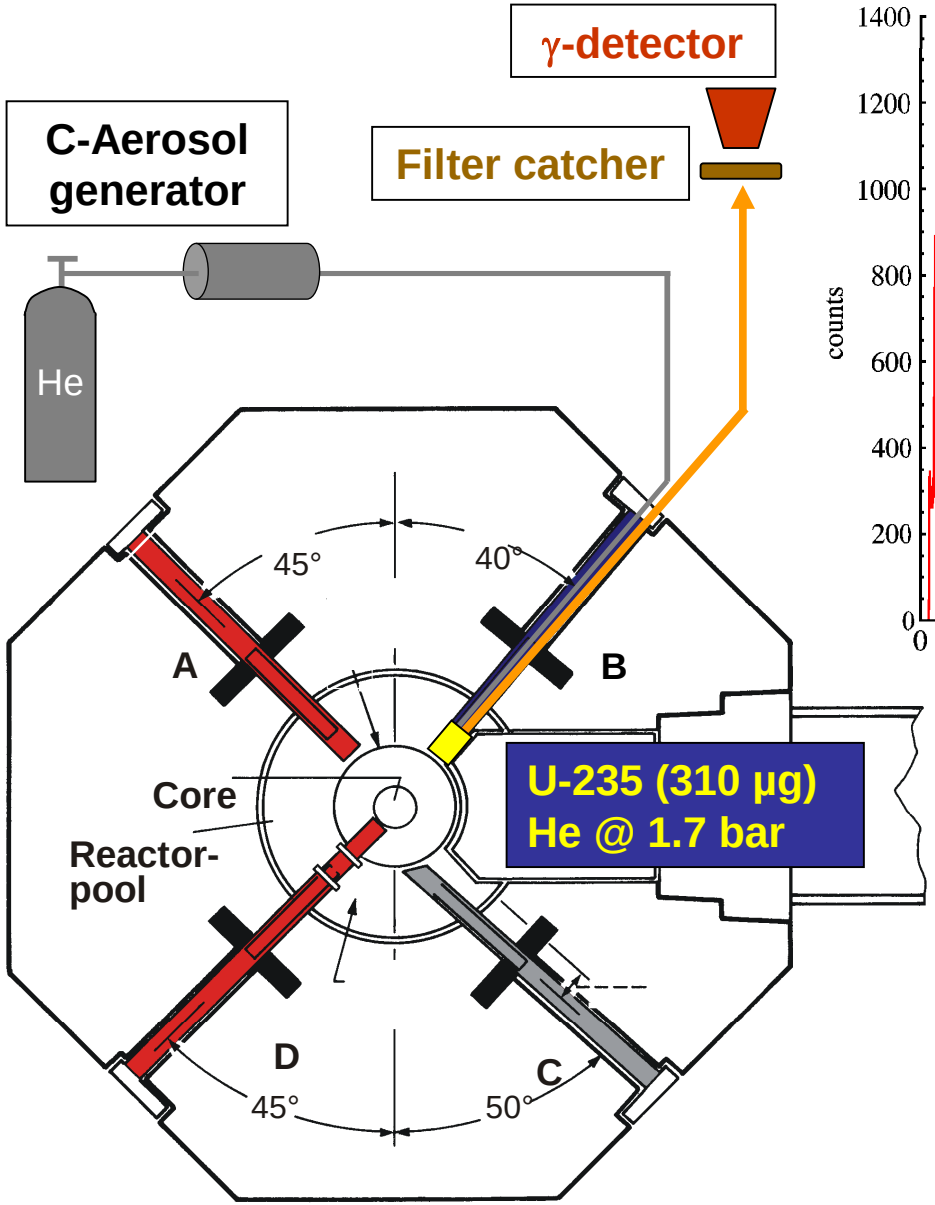


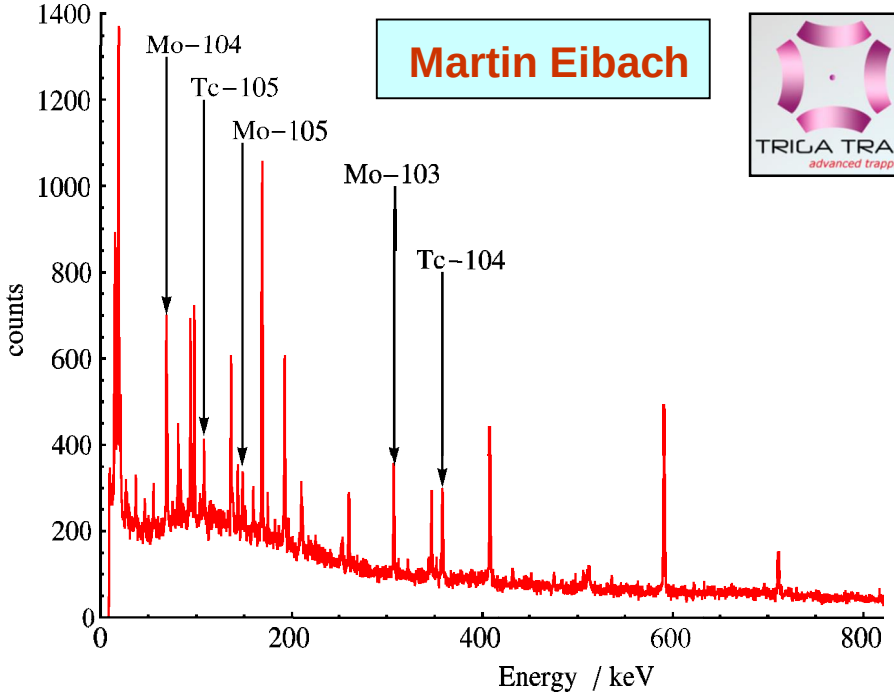
Gas-jet transport system

Transport of reaction products from the target site to experimental set-up



Gas-jet with carbon-aerosols @ TRIGA Mainz





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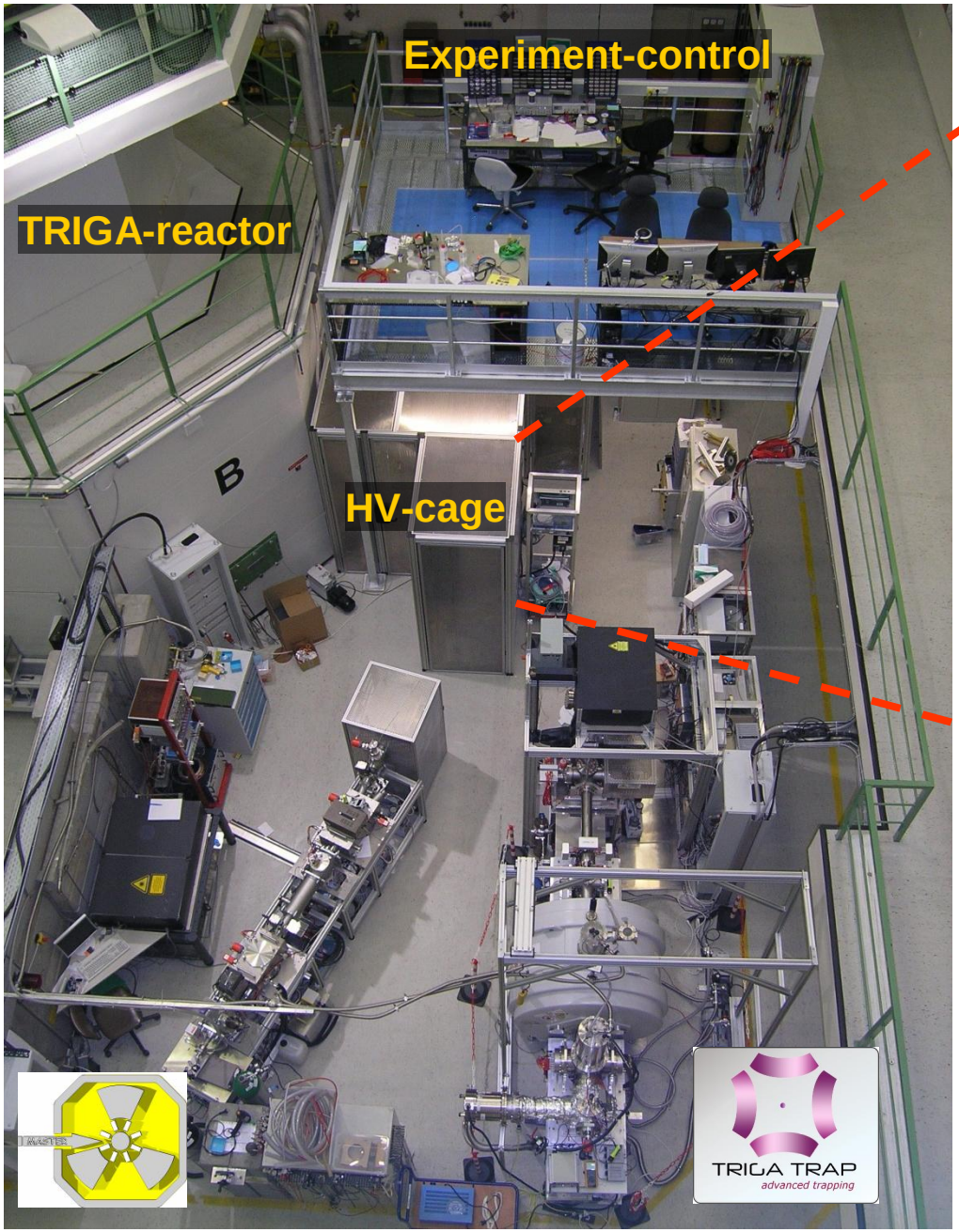
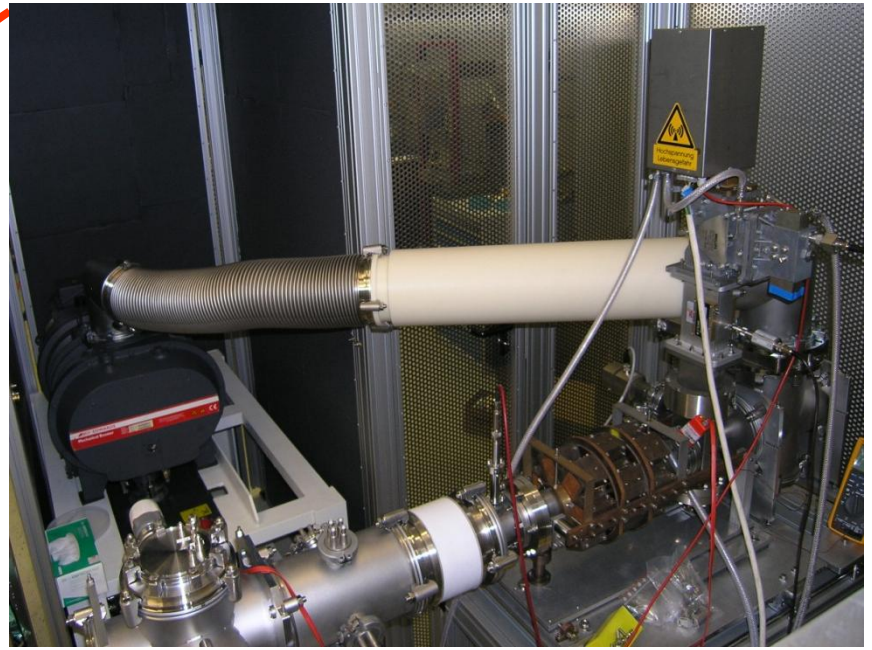
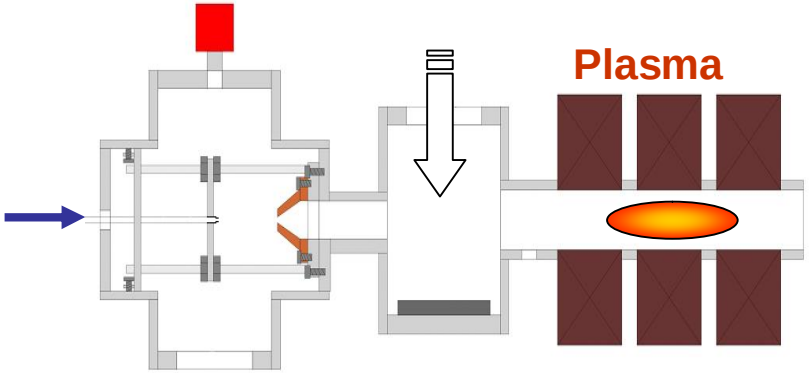
TRIGA-SPEC Experiment



Skimmer-Ionensource-unit at 60 kV



Skimmer MW-inlet ECR-magnet

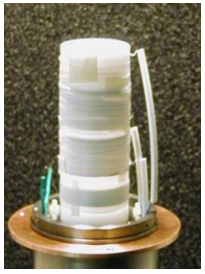


Current developments @ TRIGA-SPEC

- **Coupling of gas-jet with ECR-source**
  - **Skimmer-unit**
  - **Aerosol materials: carbon, metallic particles, water**
- **Off-line ion-source for actinides:**

U	Np	Pu	Am	Cm	Bk	Cf

- **Single-ion-detection with FT-ICR-detector: Pre-amplifier cooled with liq. He**



UNIVERSITY OF HEIDELBERG

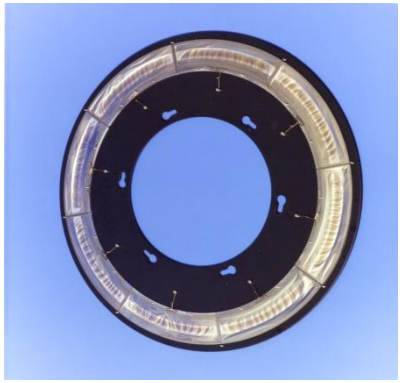
Klaus Blaum

Max-Planck-Institut für Kernphysik

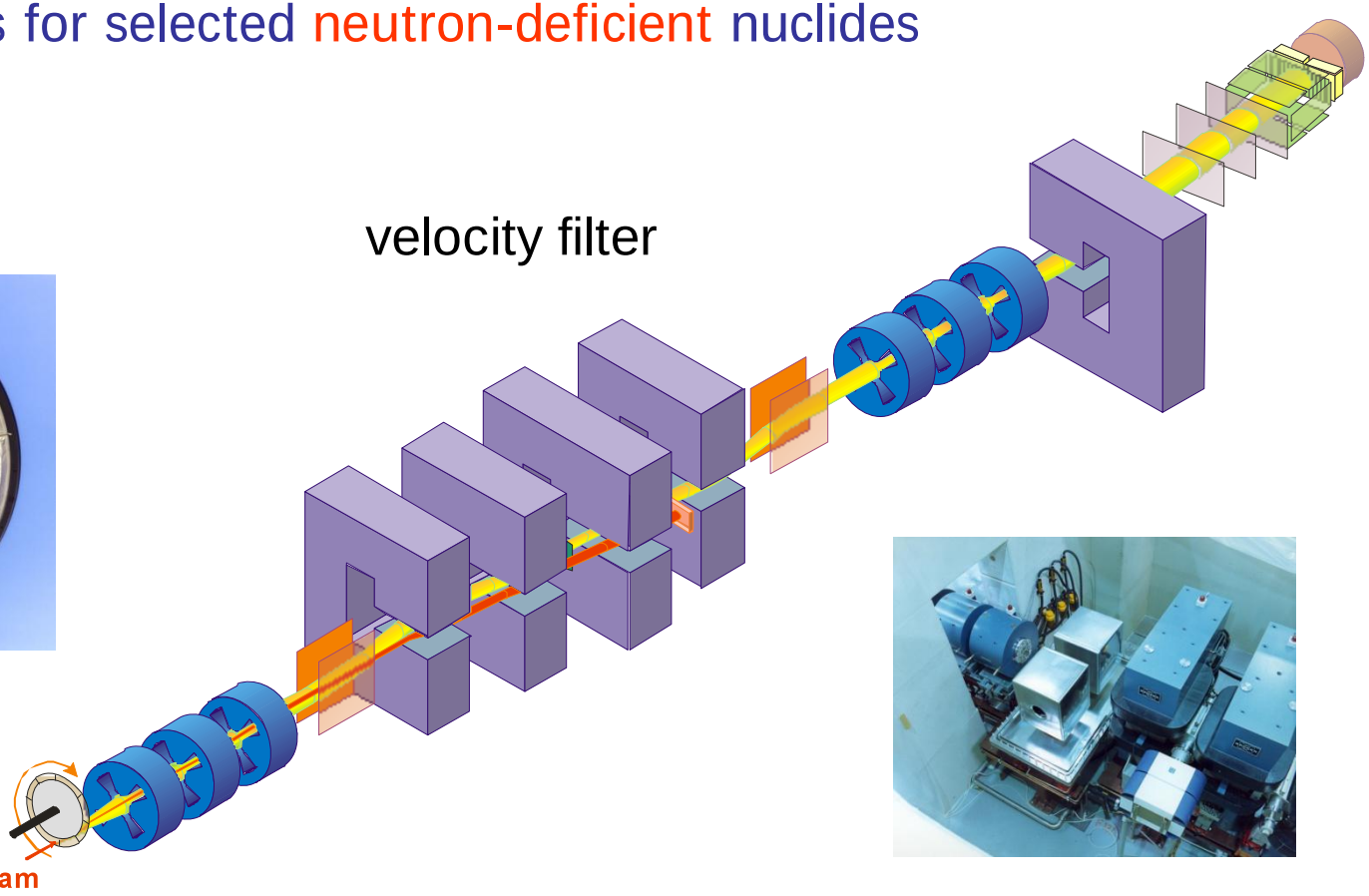
The Recoil Separator SHIP

- rare isotopes from fusion-evaporation reactions
- separation from the primary beam in-flight
- high yields for selected neutron-deficient nuclides

0.1-1 MeV/u

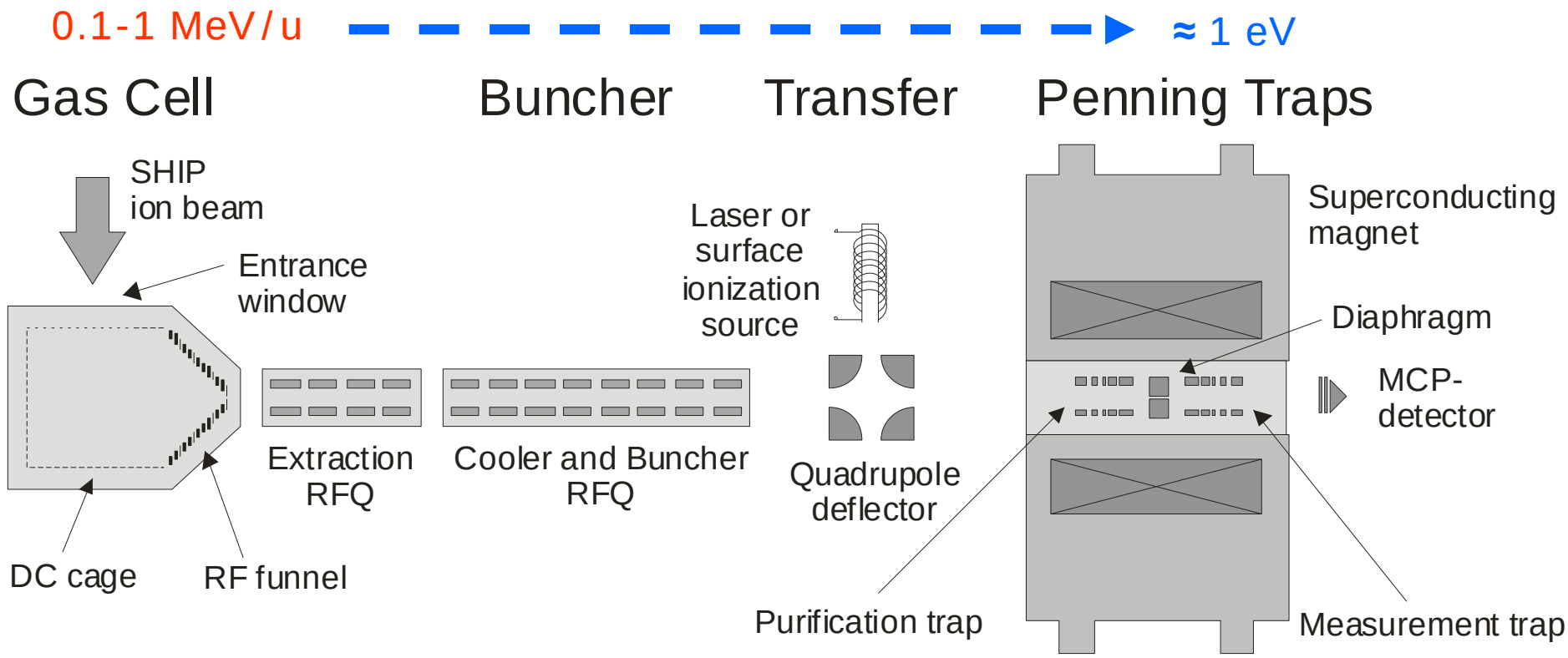


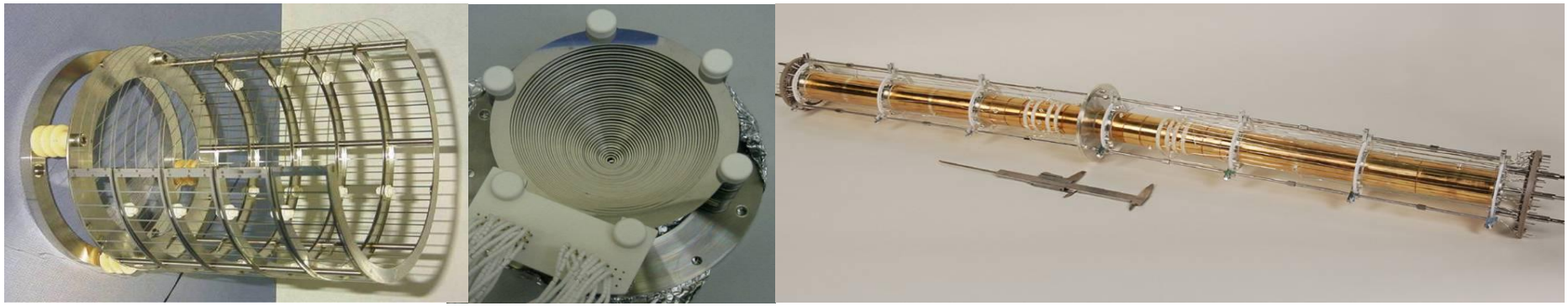
velocity filter



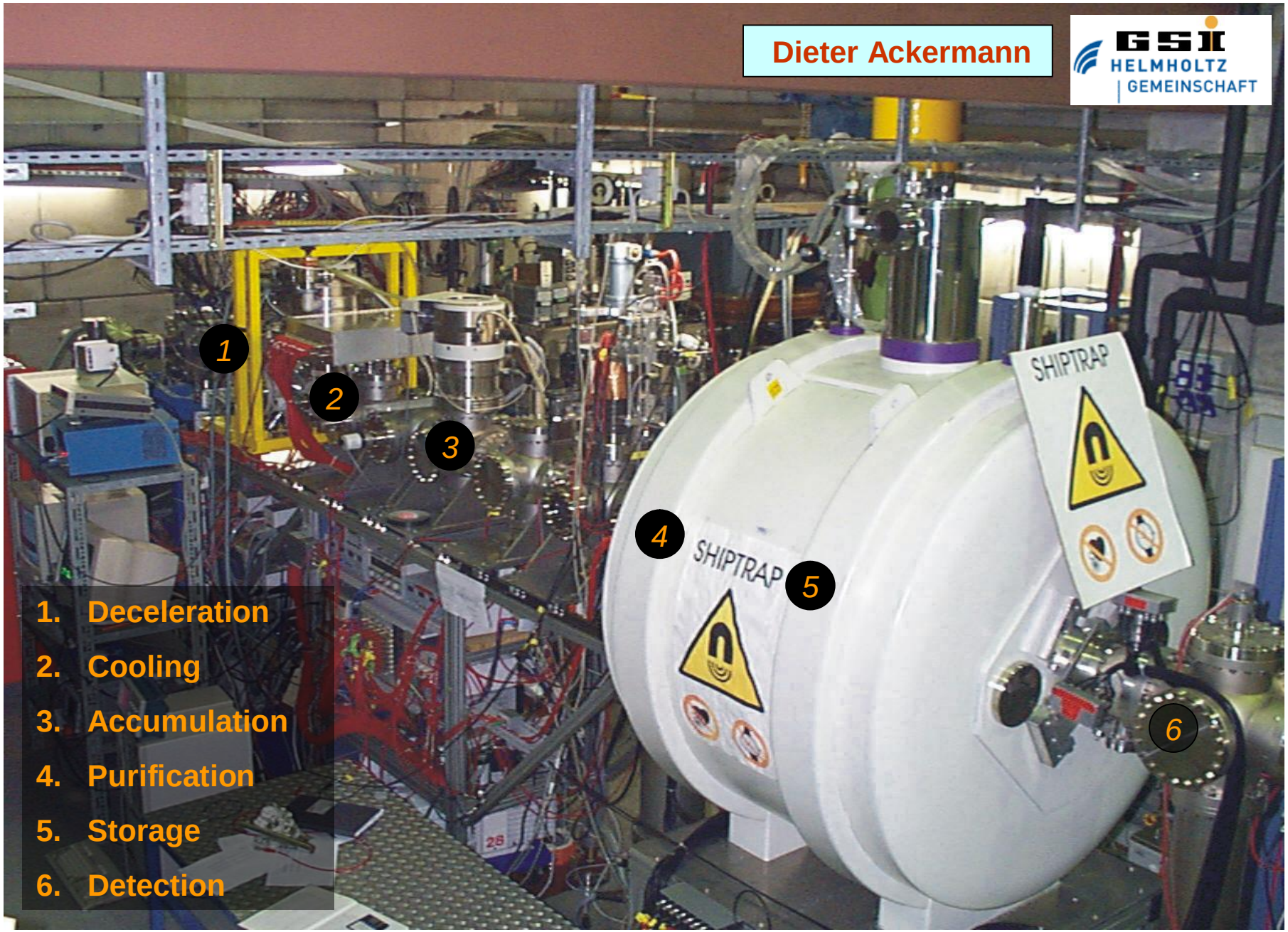
≈ 5 MeV/u

SHIPTRAP Setup

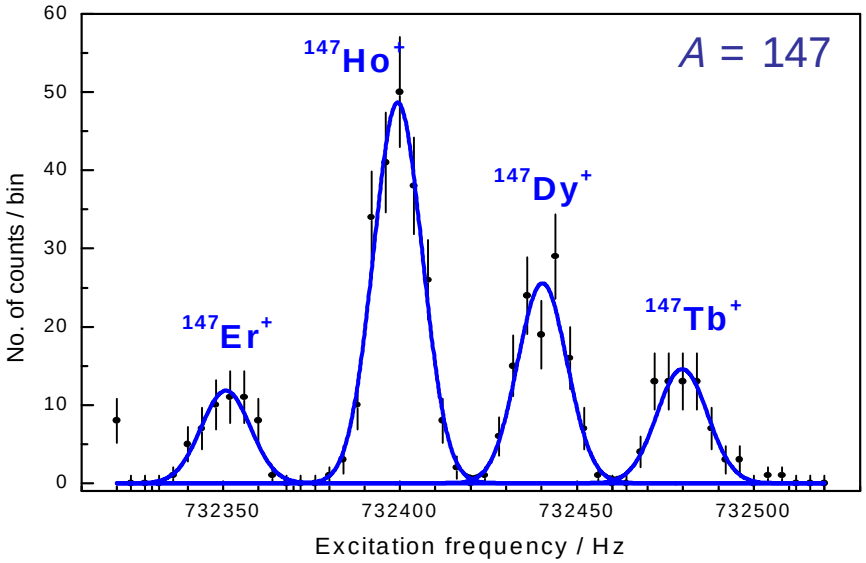




SHIPTRAP Setup

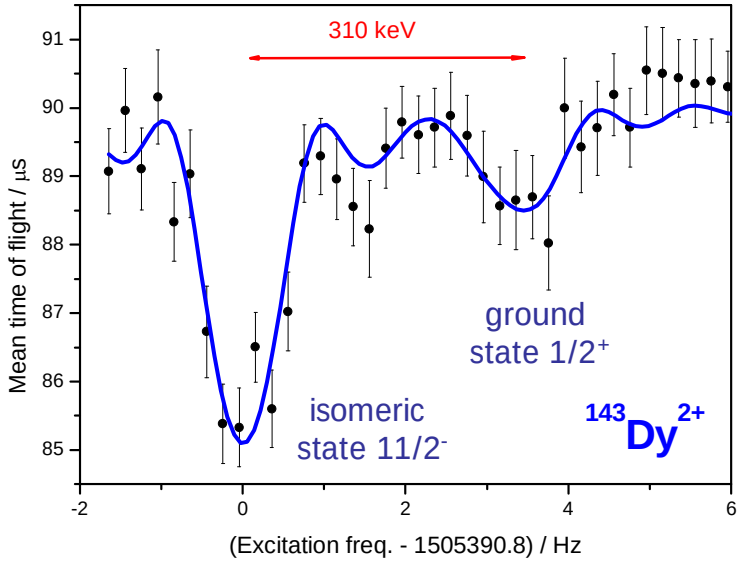


SHIPTRAP Performance



Mass resolving power of
$m/\delta m \approx 100{,}000$
in purification trap:

$\Rightarrow$ separation of isobars



Mass resolving power of
$m/\delta m \approx 1{,}000{,}000$
in measurement trap:

$\Rightarrow$ separation of isomers

Direct Mass Measurements above $Z = 100$

Requirements:

- energy matching of reaction products to trap's energy scale
- high efficiency to deal with very low production rates
  - 1 atom/s @ Z=102 ($\sigma \approx \mu$b)
  - 1 atom/week @ Z=112 ($\sigma \approx$ pb)
- high cleanliness for low background
- stable and reliable operation over extended time

Present reach of Penning Traps for RIBs

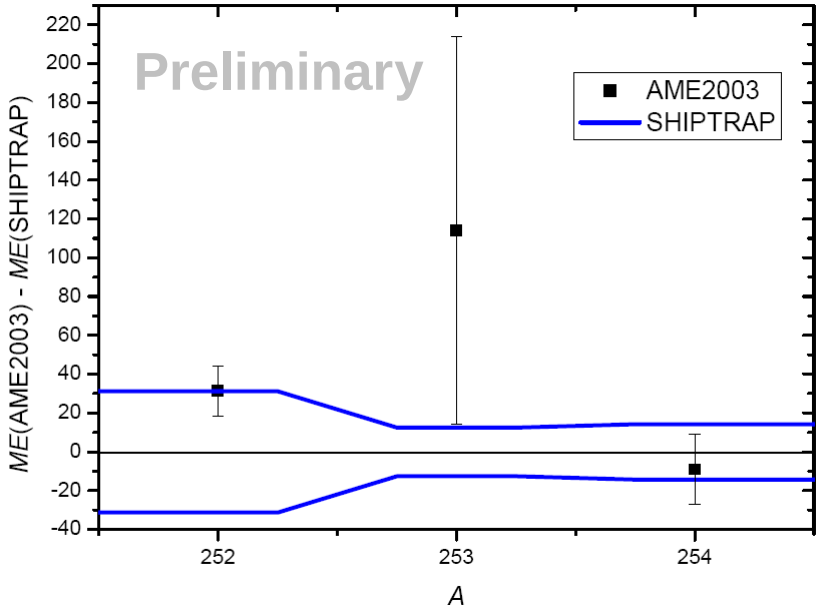
• Half-life	> 10 ms
• Rate of trapped ions	> 0.01 / s

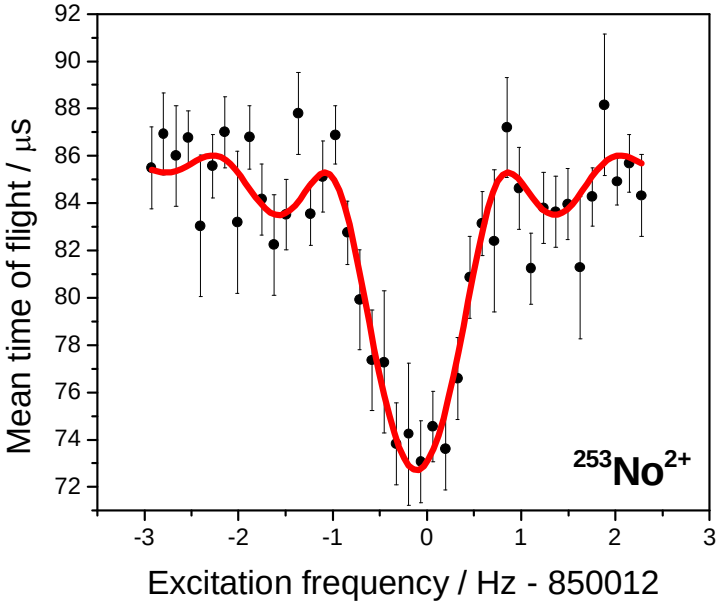
Direct Mass Measurements of $^{252\text{-}254}$No

August'08:

$^{206\text{-}208}$Pb(^{48}Ca,2n)$^{252\text{-}254}$No

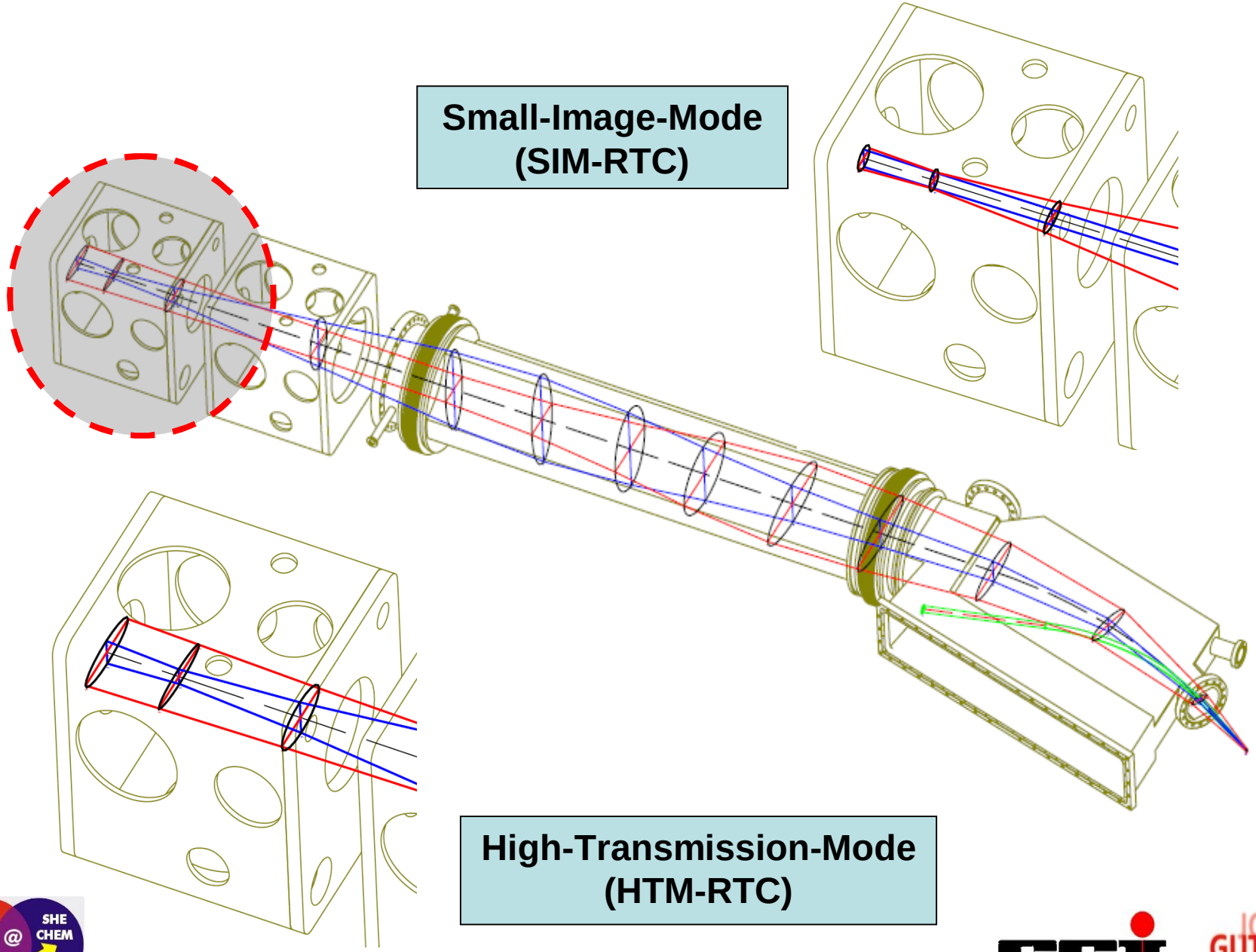
- doubly-charged nobelium ions extracted
- production rates ≈ 1 / s





First direct mass measurements in the region $Z > 100$

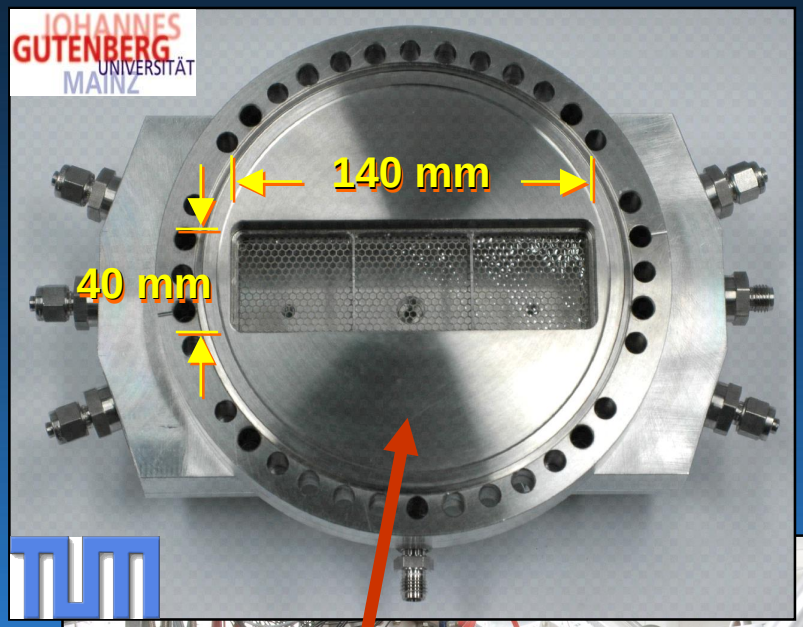
Coupling of TASCA and SHIPTRAP

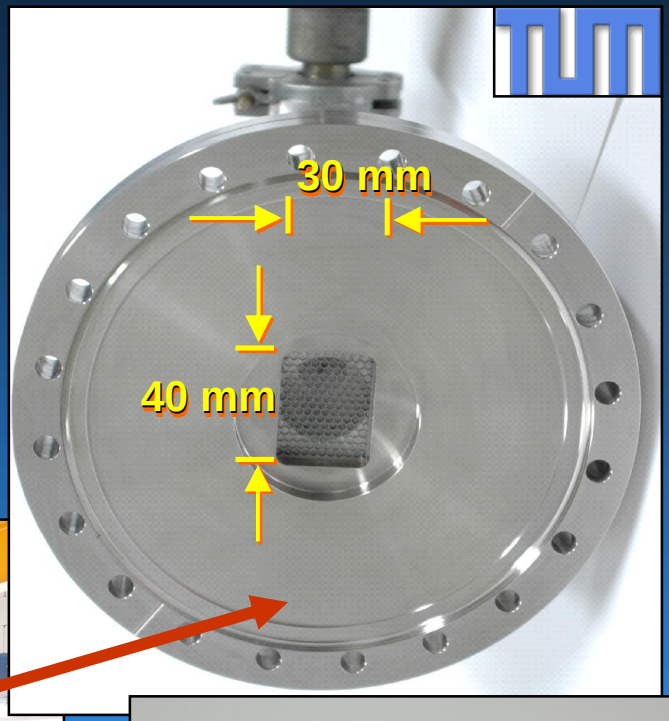


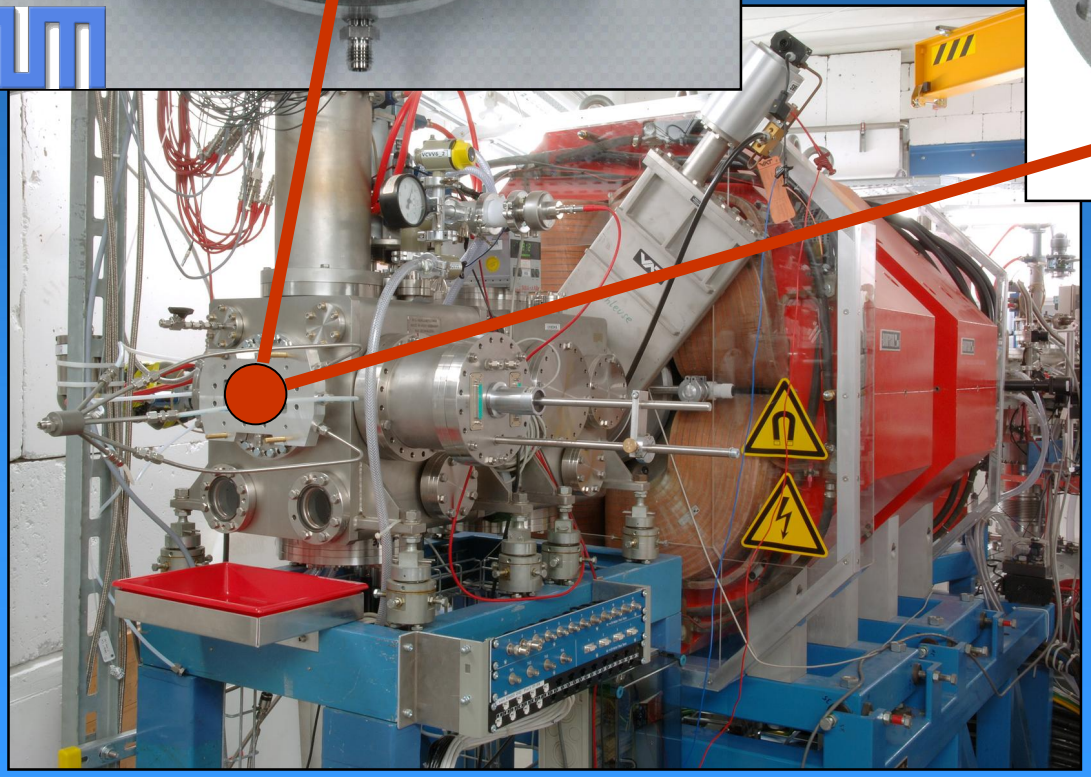
HTM RTC

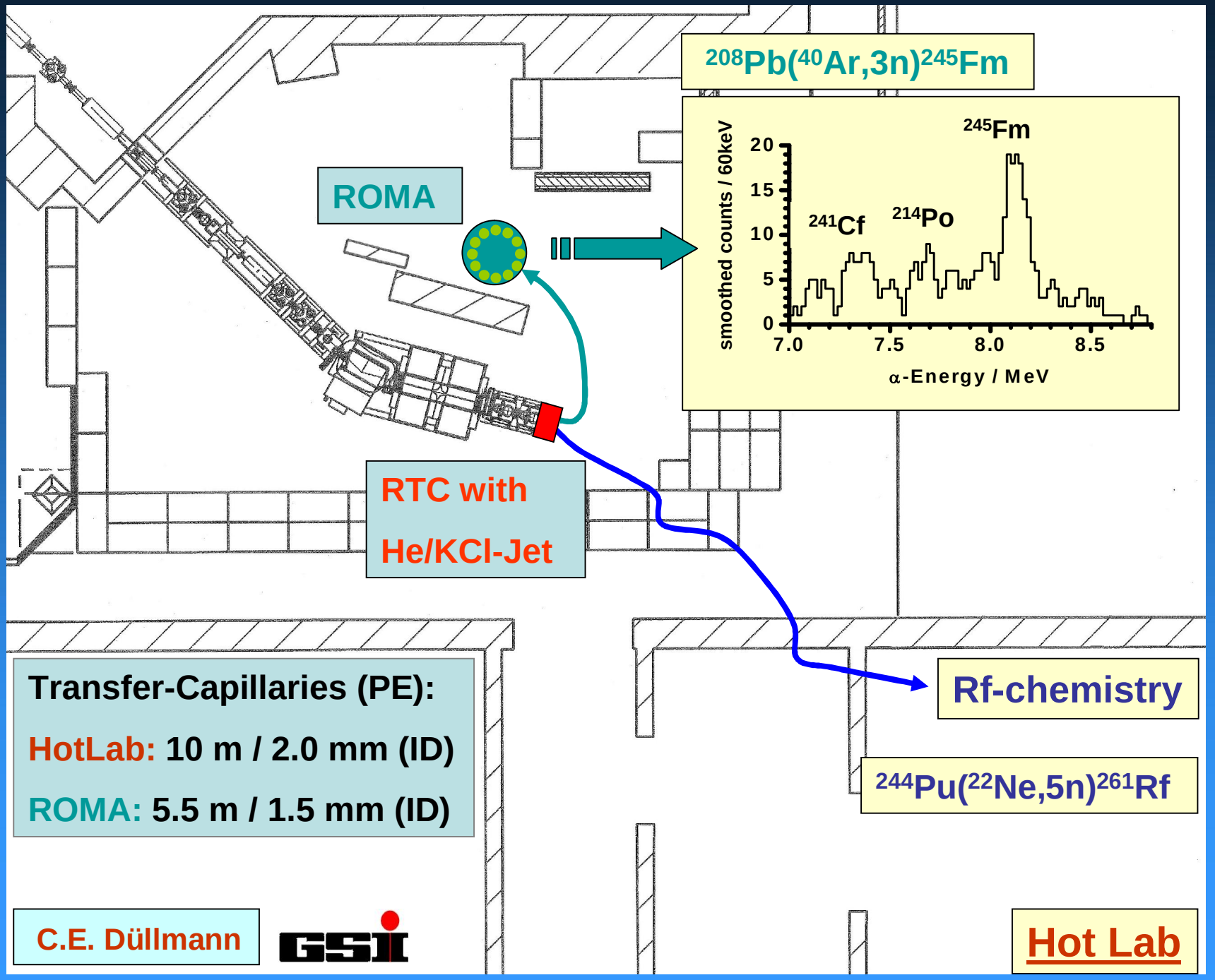
Ch.E. Düllmann

SIM RTC



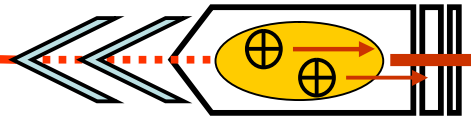




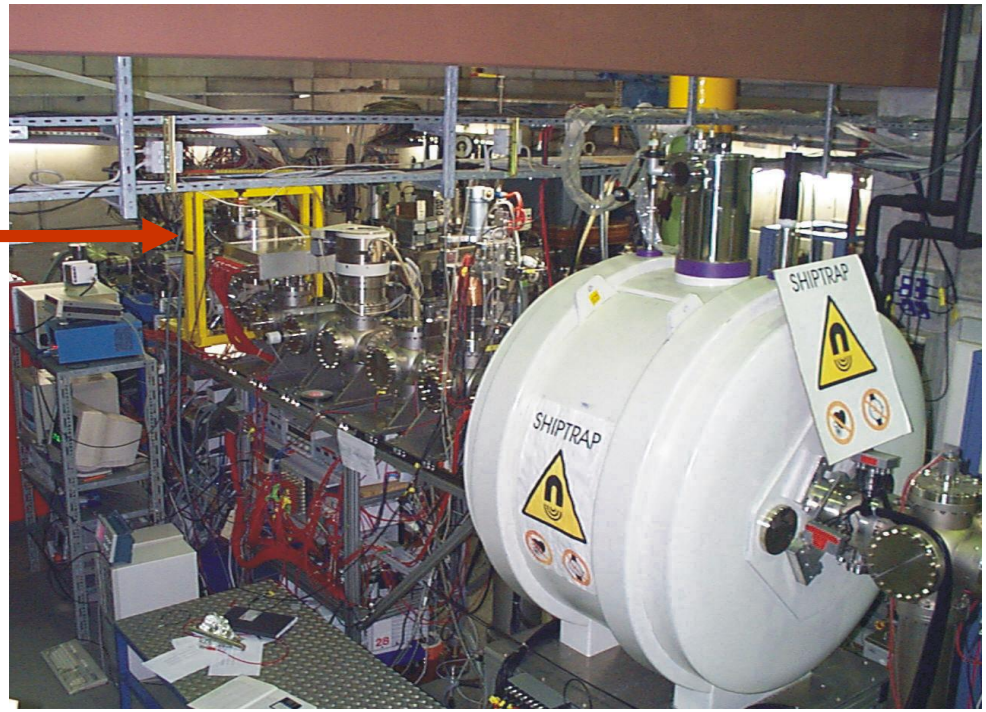

208Pb(40Ar,3n)245Fm
ROMA
245Fm
241Cf
214Po
smoothed counts / 60keV
20
15
10
5
0
7.0
7.5
8.0
8.5
α-Energy / MeV
RTC with
He/KCl-Jet
Rf-chemistry
244Pu(22Ne,5n)261Rf
Transfer-Capillaries (PE):
HotLab: 10 m / 2.0 mm (ID)
ROMA: 5.5 m / 1.5 mm (ID)
C.E. Düllmann
GSI
Hot Lab

Coupling of TASCA and SHIPTRAP

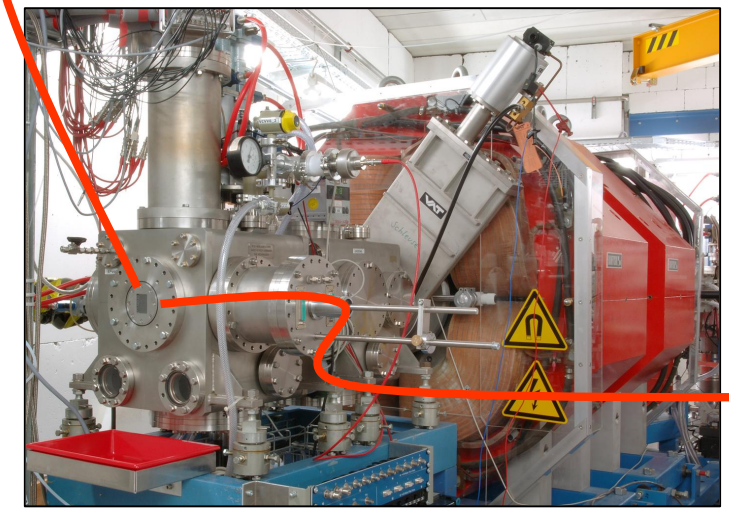
Skimmer + Ionsource



- ECR-source
- Laser ablation



SHIPTRAP ✓



TASCA ✓

Gas-jet

Aerosol:
- Carbon
- Metall
- Water

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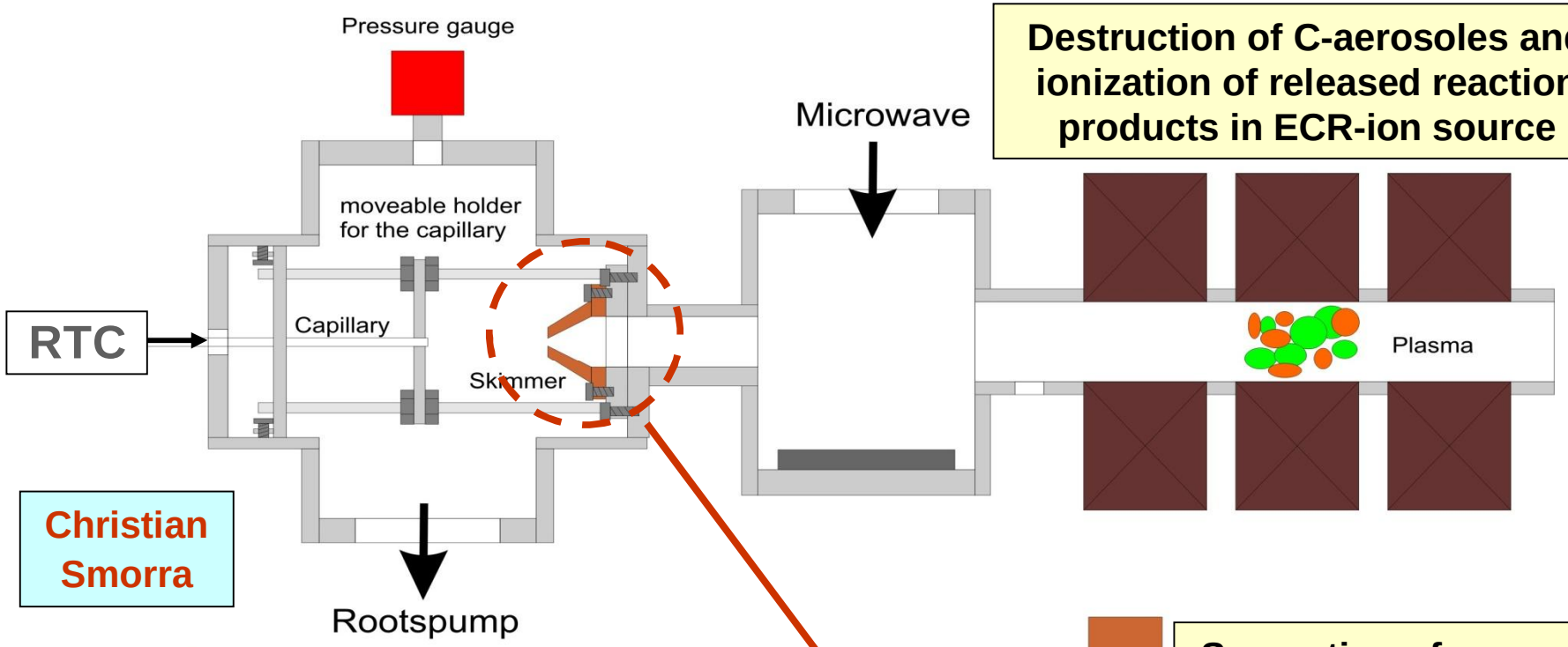
Coupling of TASCA and SHIPTRAP: Ion Source (I)

High-pressure ECR source ⇒ currently developed at TRIGA Mainz



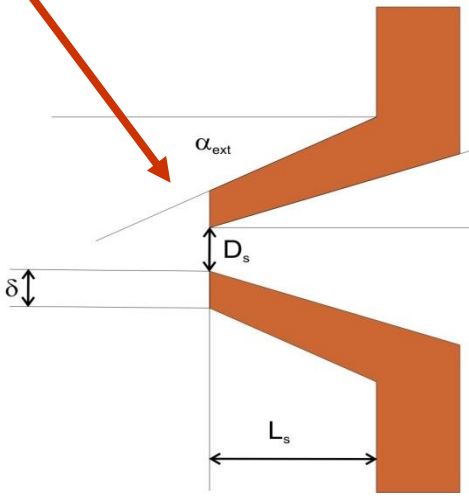
Destruction of C-aerosoles and ionization of released reaction products in ECR-ion source

Christian Smorra

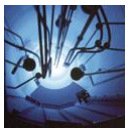
TRIGA TRAP
advanced trapping

skimmer parameters:

δ = 2 µm (as small as possible)
α_{int} = 45°
α_{ext} = 55°
L_s = 20 mm
D_s = ???



Separation of aerosol from transport gas with skimmer



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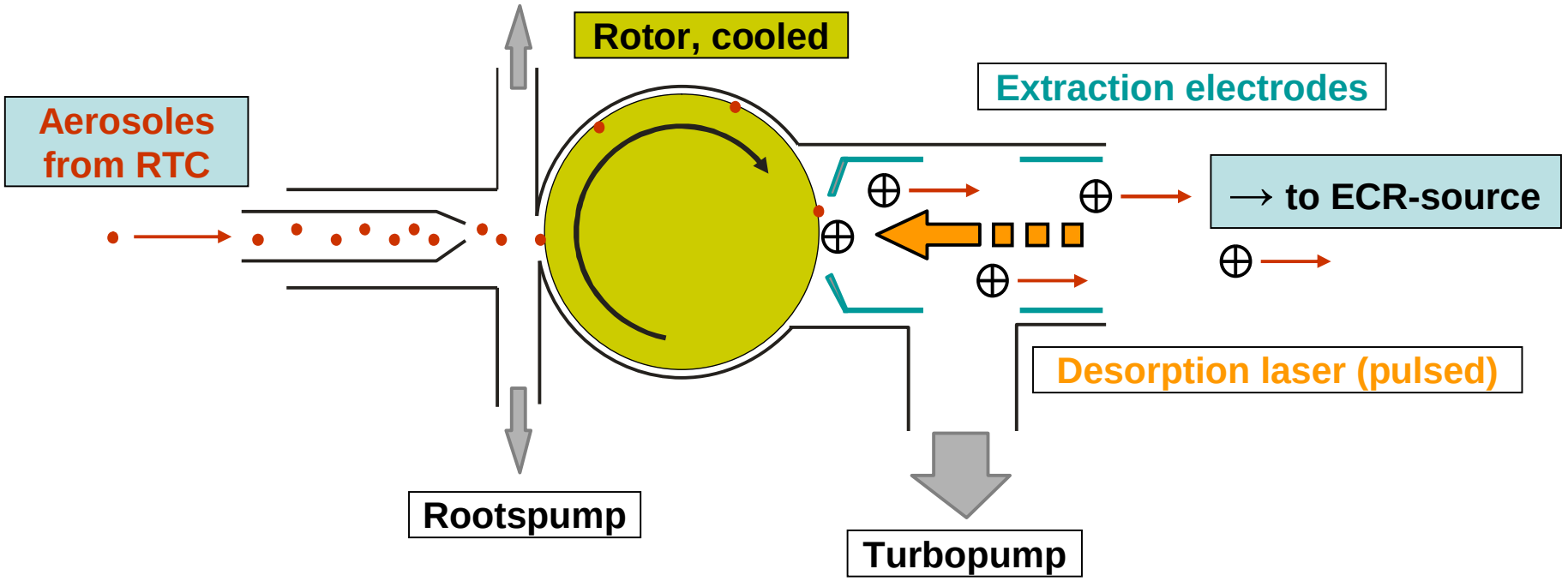
Coupling of TASCA and SHIPTRAP: Ion Source (II)

Alternative approach ⇒ Laser ablation



Application within the Frame of NuSTAR.de

Teilantrag

Entwicklung einer Ionenquelle zur Ankopplung von SHIPTRAP an TASCA

Kernstrukturuntersuchungen an schwersten Elementen durch Massenmessungen mit SHIPTRAP

Klaus Eberhardt, Jens Volker Kratz

120 k€ Investments

10 k€ Travel money

2 PhD-Positions (3 y)

BMBF Verbundforschung

NuSTAR.de

Max-Planck-Institut für Kernphysik

GSI

UNIVERSITY OF HEIDELBERG

TASCA-TRAP

REC SEP @ SHE CHEM

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Thanks to

Financial support from:

YOU for your attention