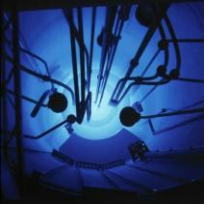

Coupling of the gas-filled recoil separator TASCA to chemistry and spectroscopy devices with a gas-jet

Julia Even

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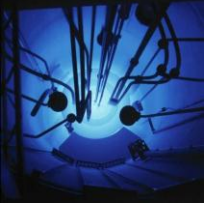
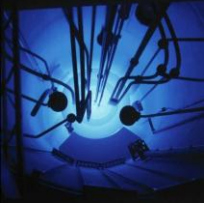


Outline

- Gas-jet transport
- TASCA
- The Recoil Transfer Chamber @ TASCA
- Chemistry @ SHIP
- Summary

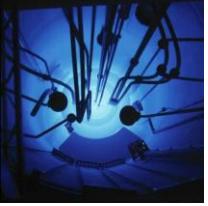


Gas-jet transport

- Cluster jet: Transport of none-volatile elements attached to aerosol clusters (e.g. KCl, C, MoO_3…) in an inert gas stream

- Inert gas jet: Transport of volatile elements in pure He, Ar, N_2…

- Reactive gas jet: In-situ formation of volatile compounds with the reactive gas and transport of these compounds in the gas stream

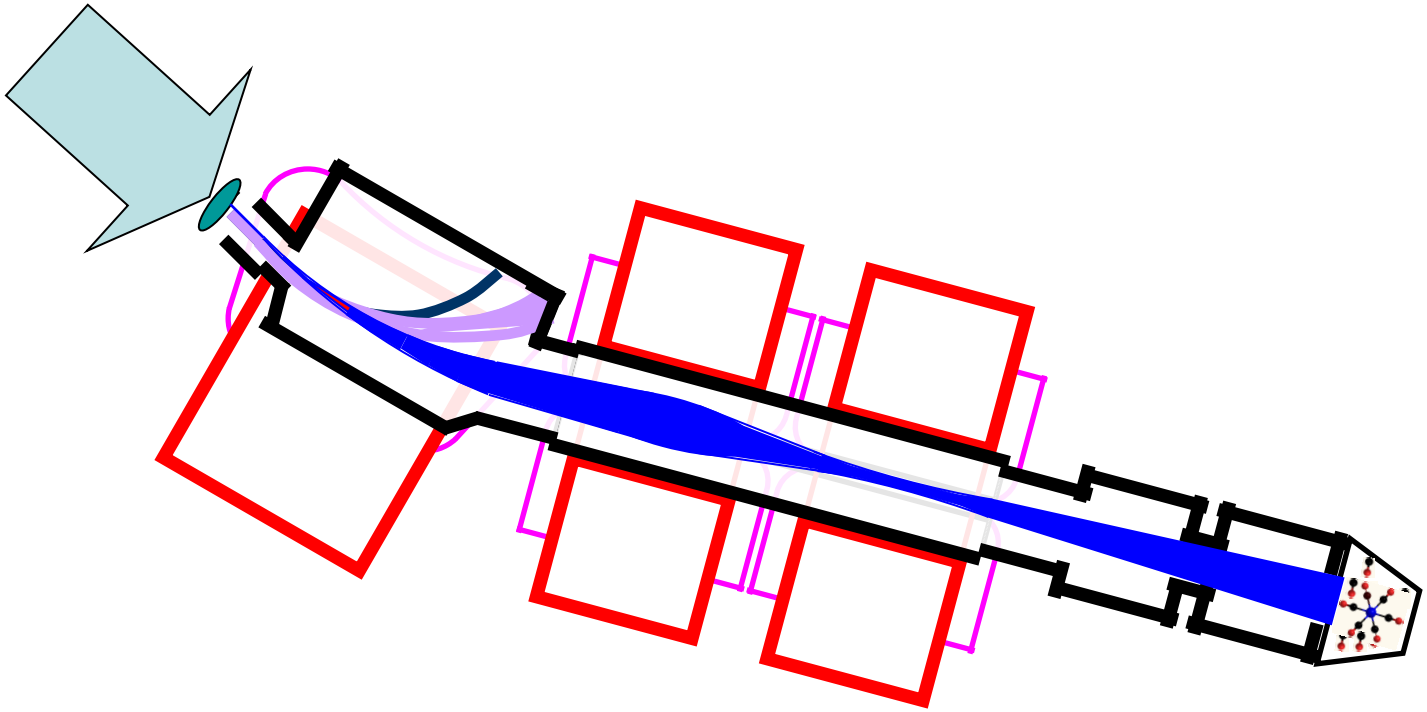


Gas-jet transport of superheavy elements and their lighter homologs

1																	18
1 H	2											13	14	15	16	17	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	3	4	5	6	7	8	9	10	11	12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57+* La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89+" Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 ---	114 Fl	115 ---	116 Lv	117 ---	118 ---

*	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
"	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

TASCA – as a preseparator

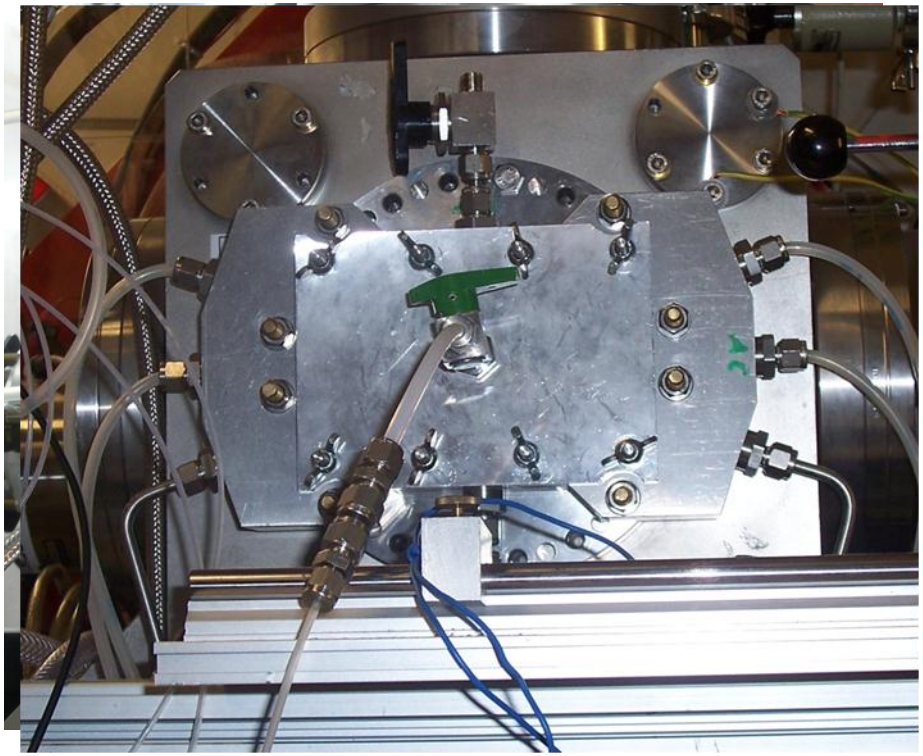


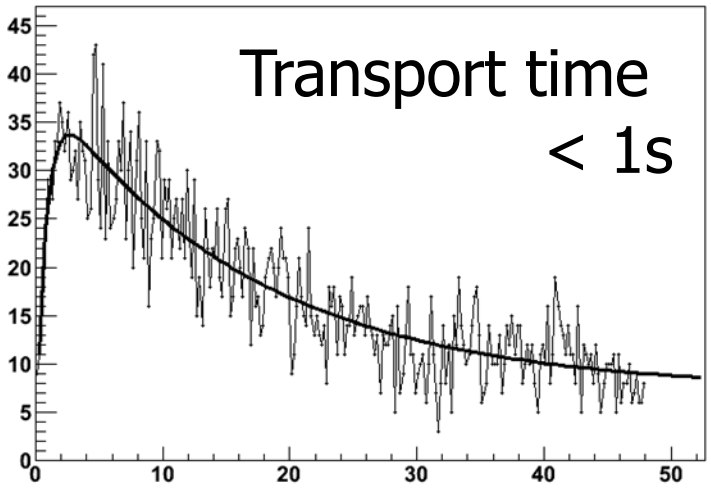
TASCA @ GSI

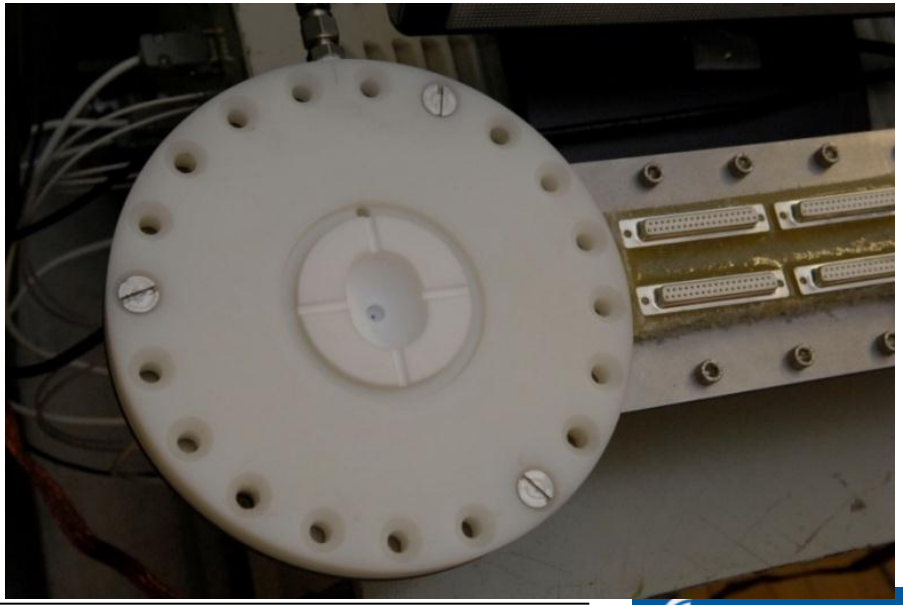
TransActinide Separator and Chemistry Apparatus

J. Even et al., NIMA 638 (2011) 157
A. Semchenkov et al., NIMB 266 (2008) 4153
Ch.E. Düllmann et al., NIMA 551 (2005) 528
M. Schädel, Eur. Phys. J. D 45 (2007) 67

The TASCA-Chemistry-Interface: The Recoil Transfer Chamber - RTC





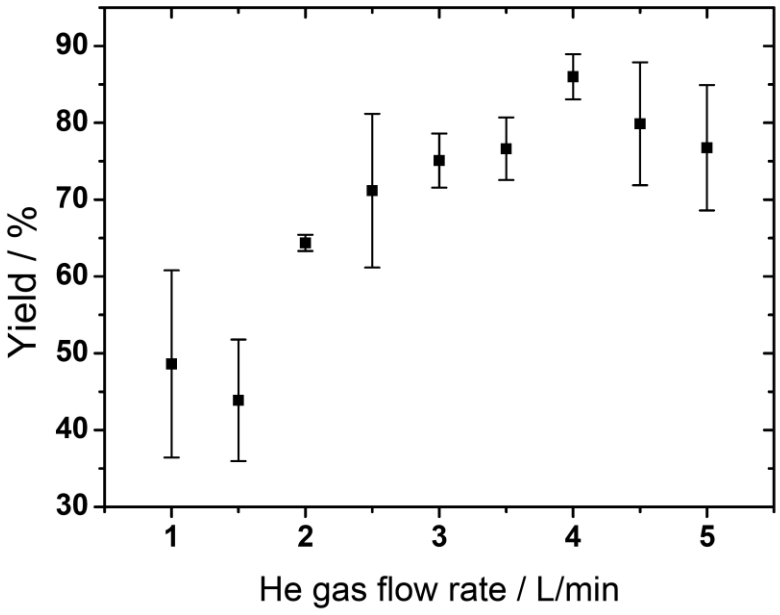


High Transmission Mode
HTM

Small Image Mode SIM

ROMA

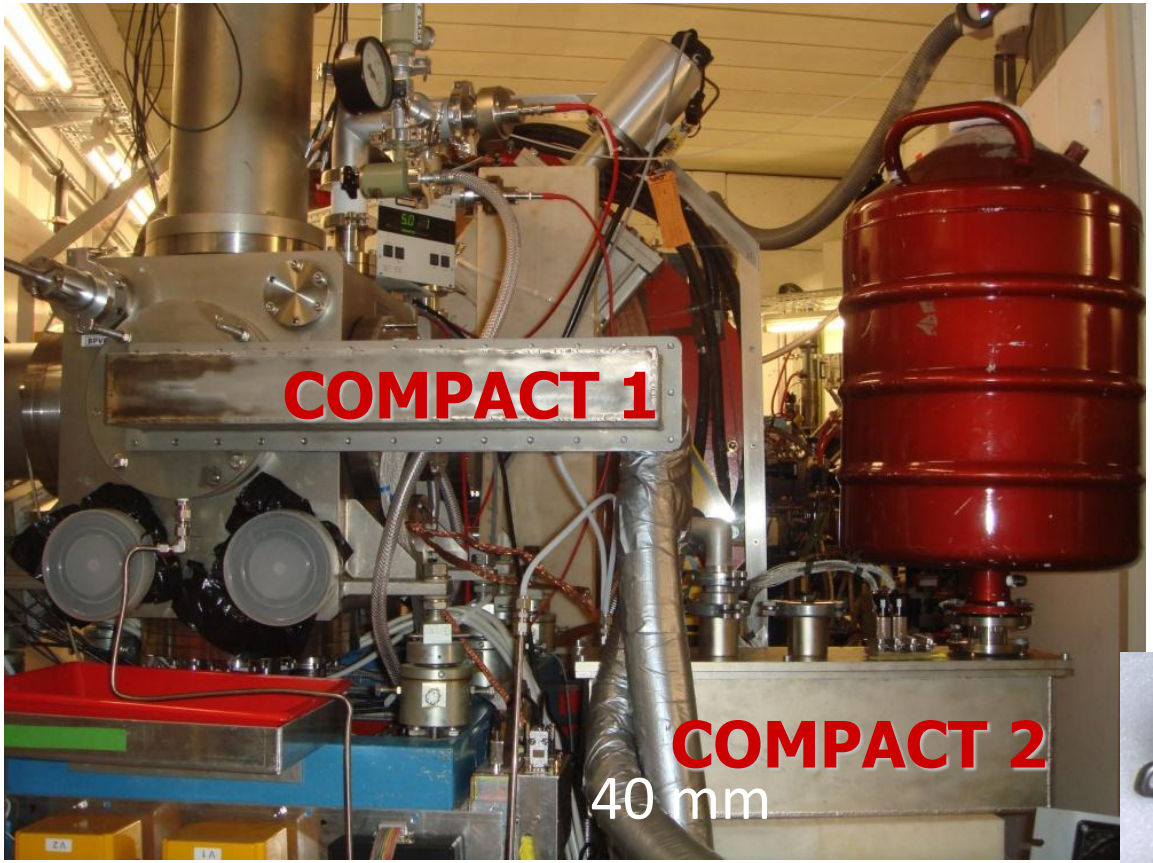
HTM-RTC:
up to 80%
gas jet yield



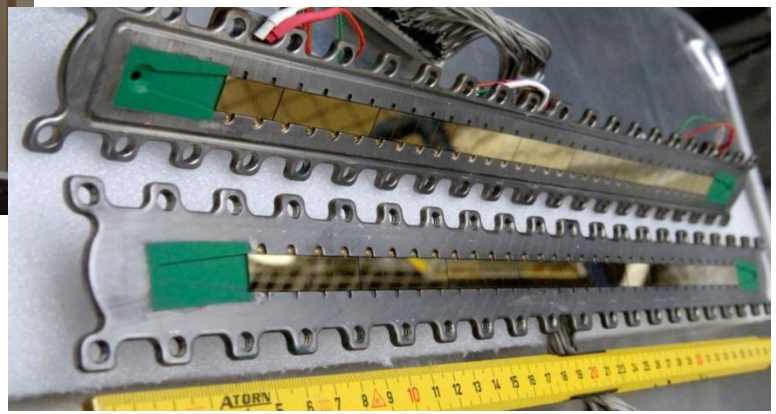
Chemistry

J. Even et al.,
NIMA 638 (2011) 157

TASCA – COMPACT coupling for Fl (114) studies



Pb
Hg
Rn
Cn (E112)
Fl (E114)



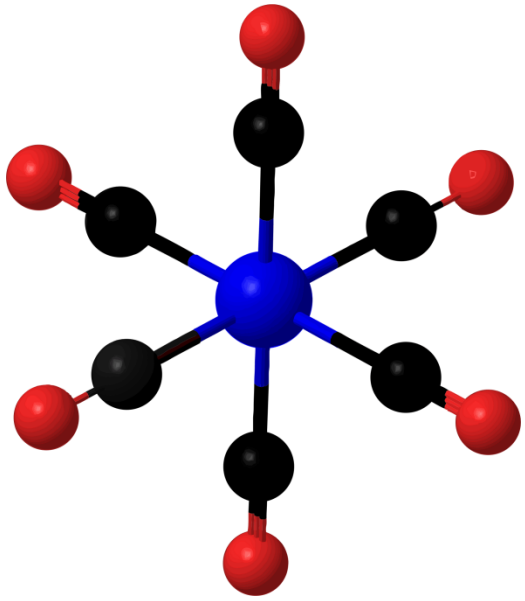
Cryo **O**n-line **M**ultidetector for **P**hysics
And **C**hemistry of **T**ransactinides

A. Yakushev et al.

HELMHOLTZ GEMEINSCHAFT
Helmholtz-Institut Mainz

Metall-carbonyl complexes

5	6	7	8	9	10
$V(CO)_6$	$Cr(CO)_6$	$Mn_2(CO)_{10}$	$Fe(CO)_5$	$Co_2(CO)_8$	$Ni(CO)_4$
	$Mo(CO)_6$	$Tc_2(CO)_{10}$	$Ru(CO)_5$	$Rh_2(CO)_8$	
	$W(CO)_6$	$Re_2(CO)_{10}$	$Os(CO)_5$	$Ir_4(CO)_{12}$	



Highly symmetric
VOLATILE
complexes

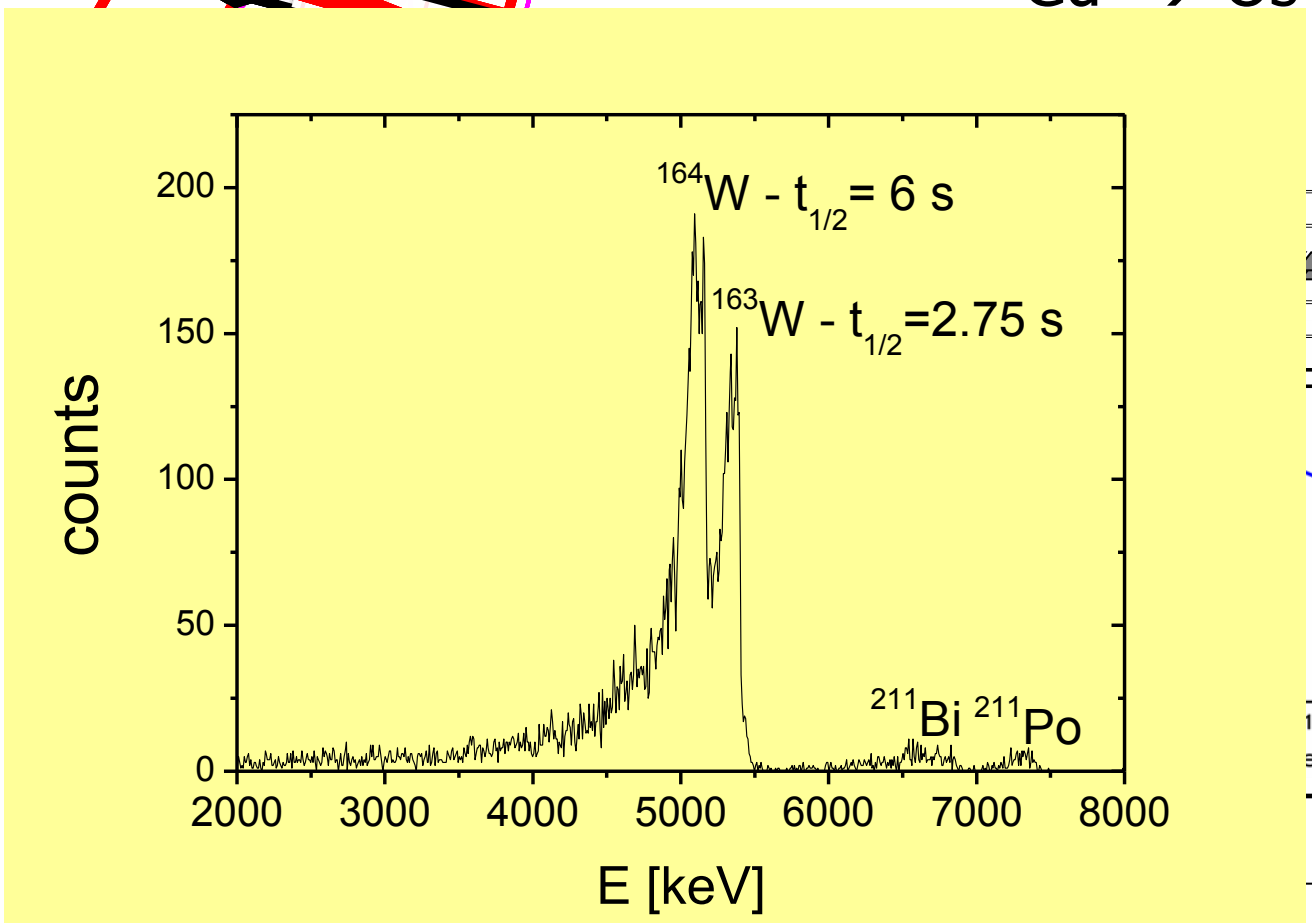
But thermal instable

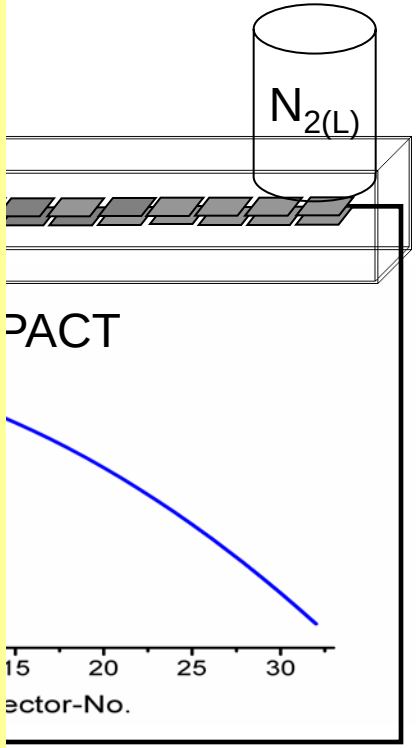
In-Situ synthesis of transitionmetall carbonyl complexes @ TASCA

$^{24}Mg + {}^{144}Sm \rightarrow W$

$^{nat}Eu \rightarrow Re$

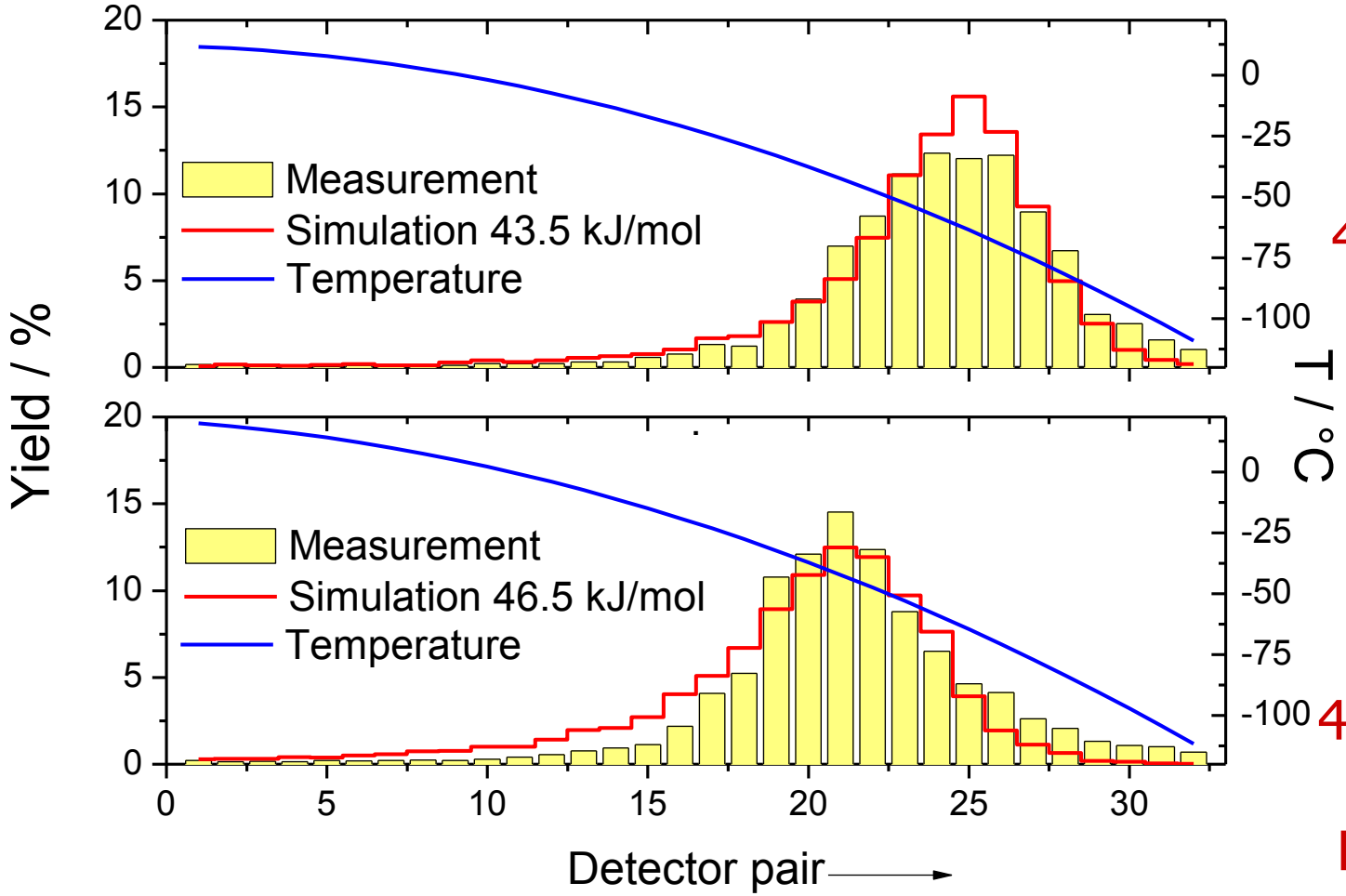
$^{152}Gd \rightarrow Os$





J. Even et al. Inorg. Chem. 51 (2012) 6431-6433.

SHE homologs studies @ TASCA



$Os(CO)_5$

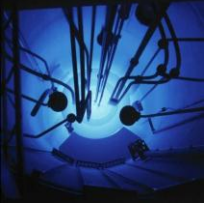
$-\Delta H_{ads}$: $43.5^{+2.5}_{-3.5}$ kJ/mol

$W(CO)_6$

$-\Delta H_{ads}$: 46.5 ± 2.5 kJ/mol

Physisorption

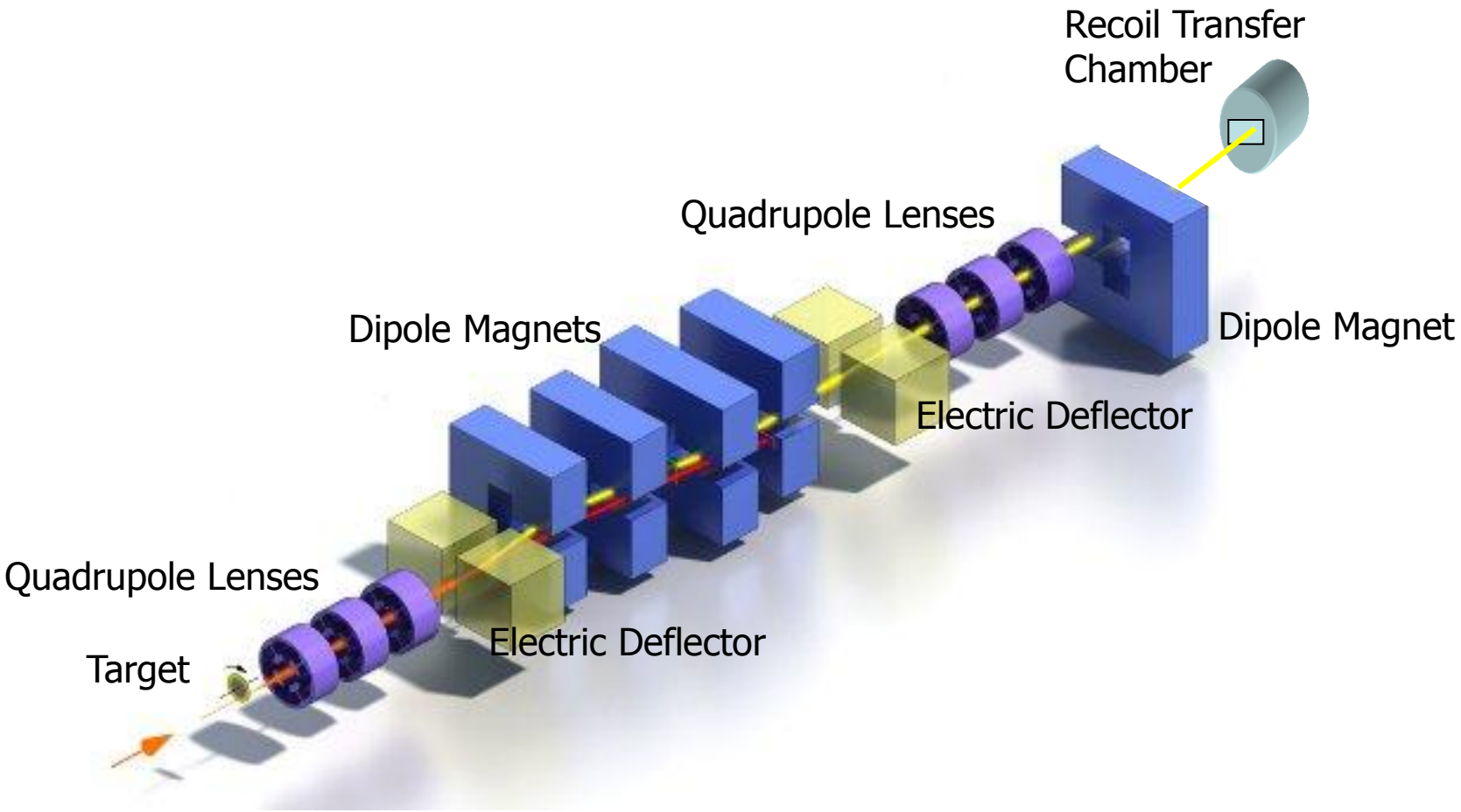
J. Even et al. Inorg. Chem. 51 (2012) 6431-6433.



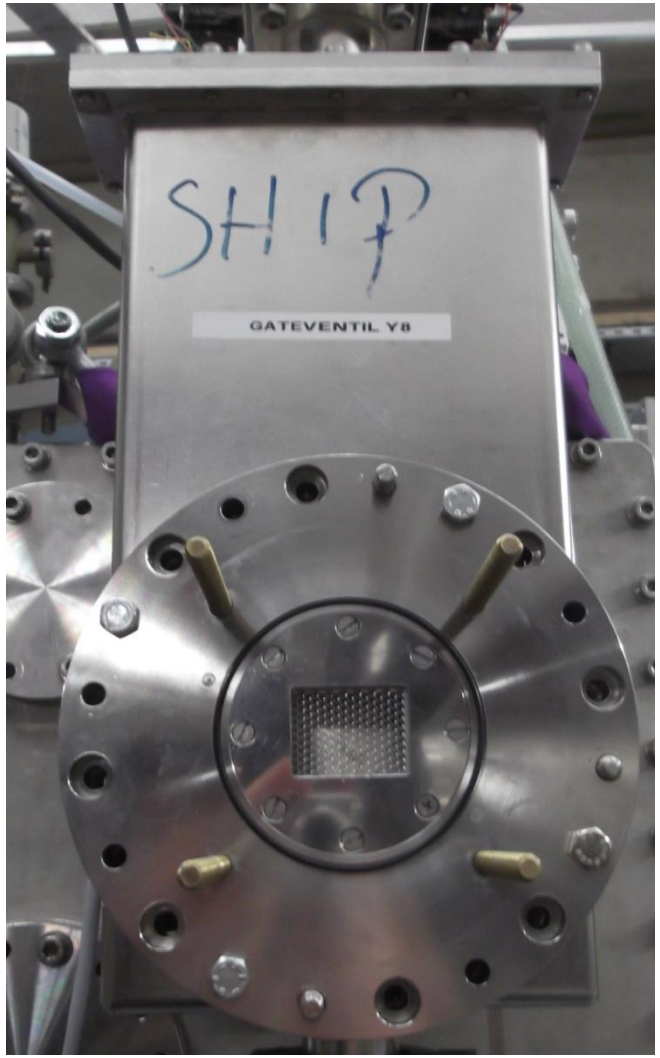
Next step $Sg(CO)_6$

- Combination of the gas-filled separator GARIS with COMPACT
- 11 days of beamtime approved @ RIKEN

The velocity separator -SHIP

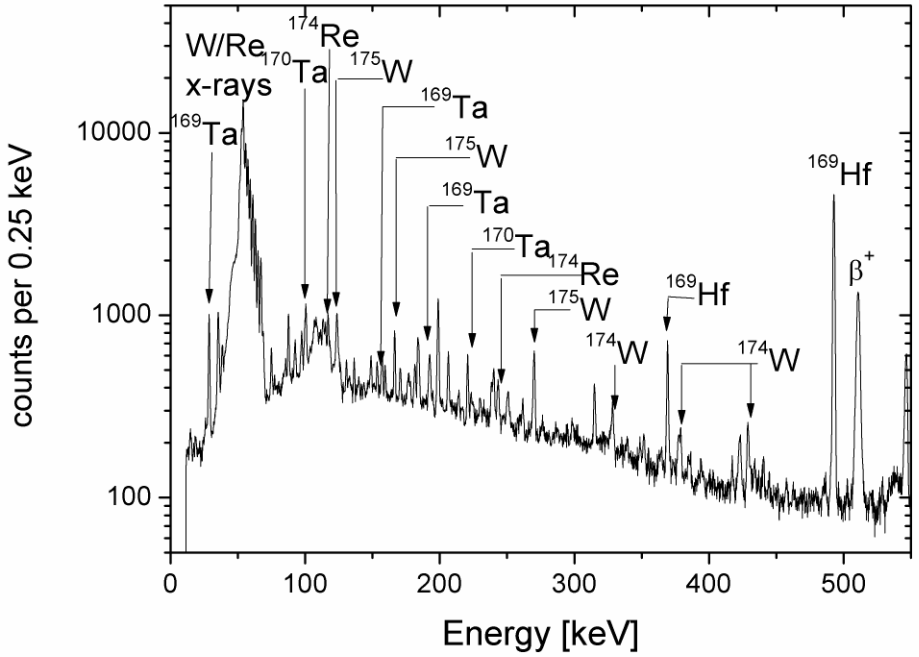


First test experiments at SHIP

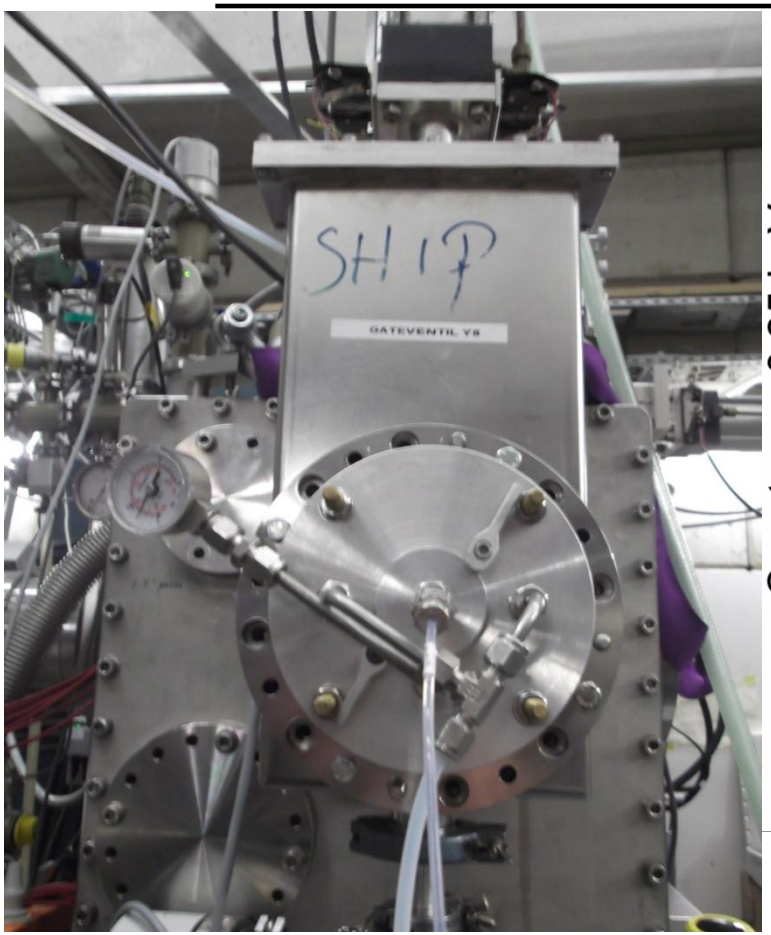


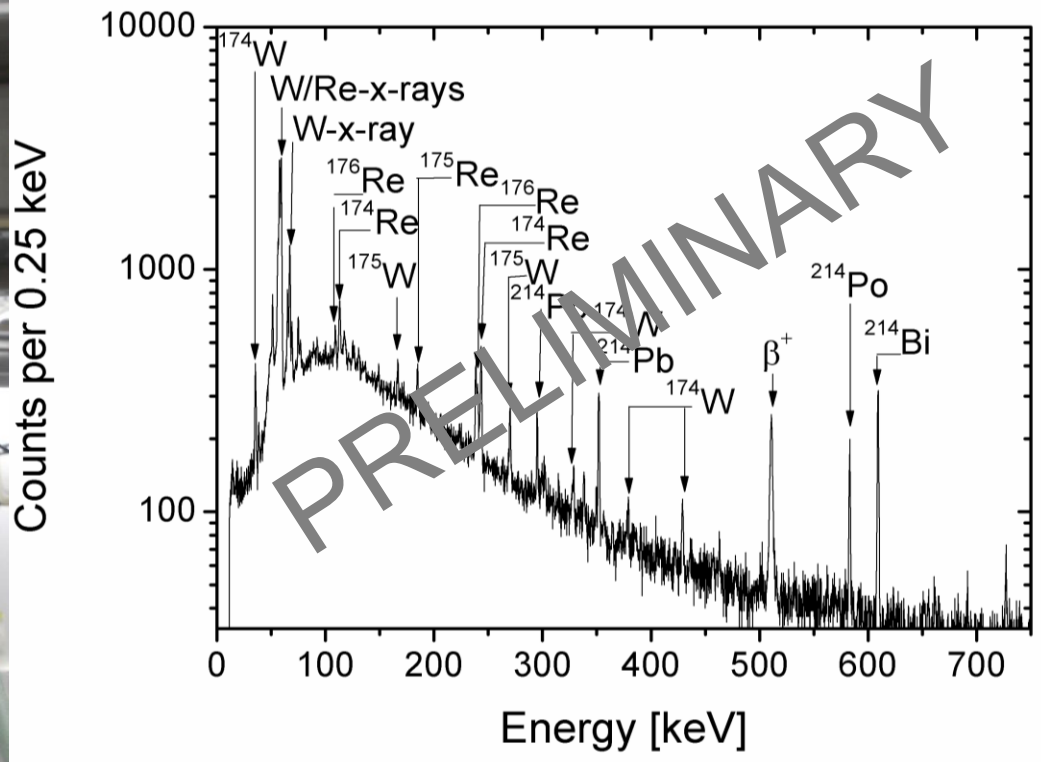
$^{133}Cs^{127}I(^{48}Ca,xn)$

Ta, Hf, W and Re



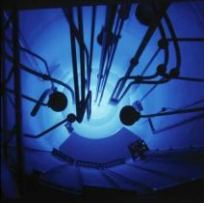
CO-transport behind SHIP





Transport of Re and W in pure CO
No transport of Ta!

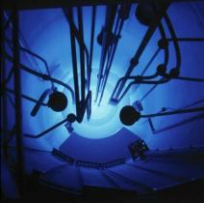
→ Gas-jet technique can also be applied at SHIP
→ Chemistry as a second separation step, Z-selective



Summary and outlook

- RTC is an established technique at TASCA
- High efficient transport with cluster jet
- Transport and detection of volatile elements – including Cn and Fl
- Carbonyl complexes of W, Re, Os and Ir were in-situ synthesized @ TASCA
- First successful gas-phase chemistry behind SHIP

- First transactinide carbonyl complex $Sg(CO)_6$ will be studied @ RIKEN next spring



Acknowledgments

- The Superheavy elements groups @ GSI, HIM and Uni Mainz

- The TASCA collaboration
- The CO-collaboration
- The mechanical and electronics workshops at the Institute for Nuclear Chemistry, Uni. Mainz
- UNILAC operators, Experiment electronic and Target lab @ GSI
- Funding: BMBF and HIM

Thank you for your attention!