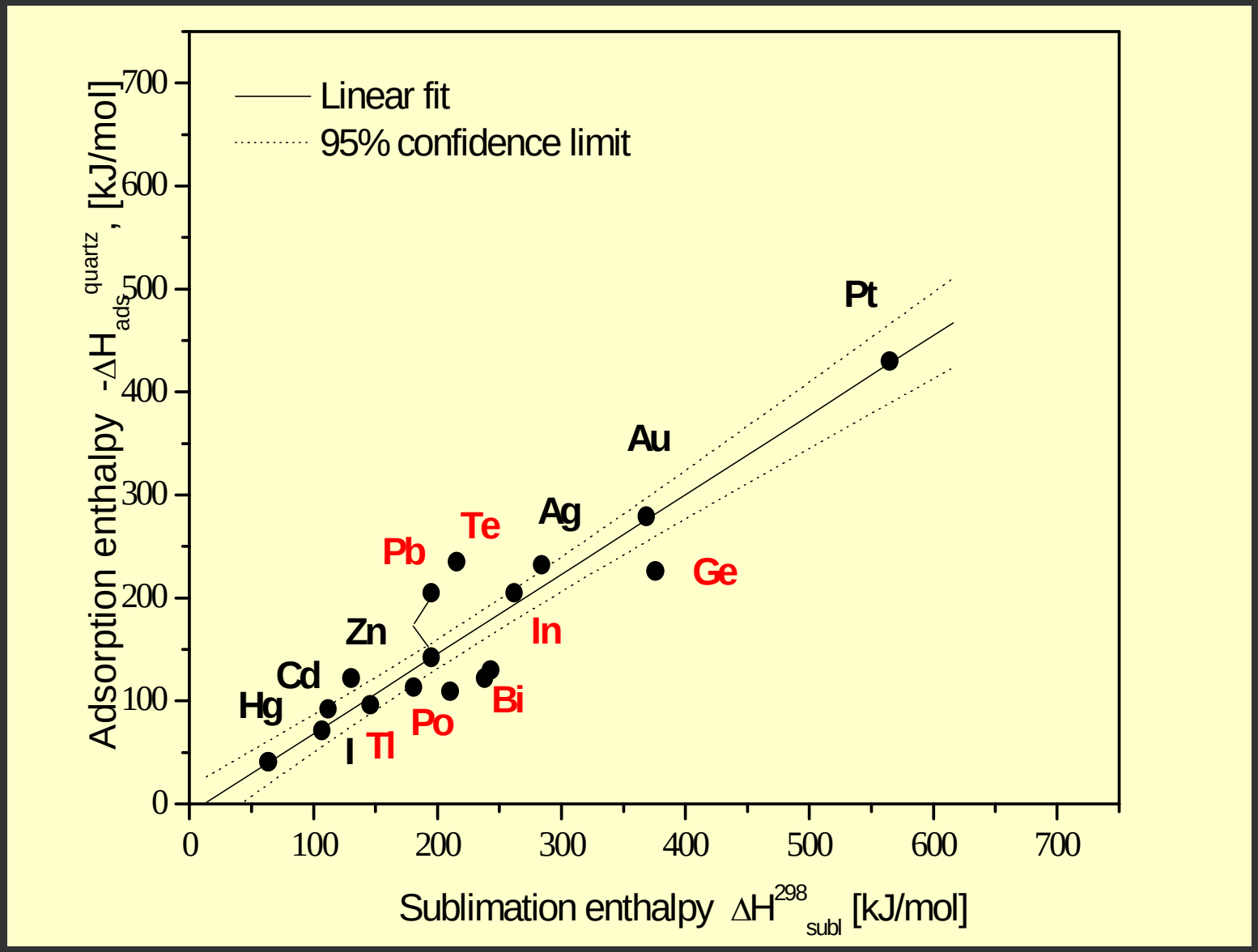
Theory

Adsorption of elements 112 and 114 on inert surfaces — J. Chem. Phys. **128**, 024707 (2008)

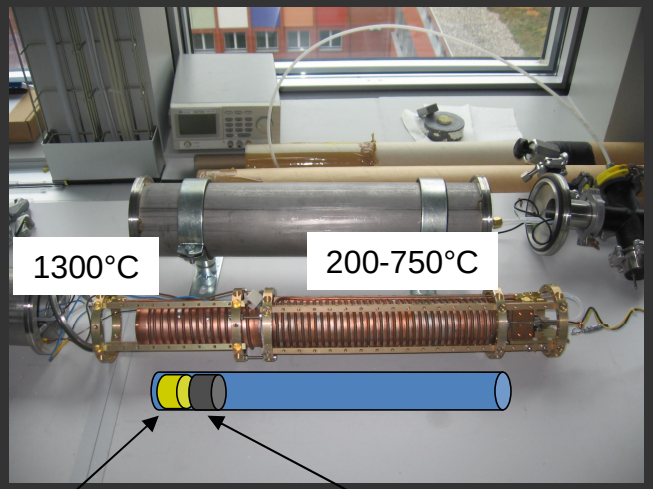
TABLE VI. Radii of the maximum charge density of the $np_{1/2}$ AOs, $R_{max}(np_{1/2})$ (in a.u.), van der Waals radii R_{vdW} (in a.u.), polarizabilities α (in a.u.), and adsorption enthalpies $-\Delta H_{ads}$ (in kJ/mol) of group 14 elements on inert surfaces.

Radius	C	Si	Ge	Sn	Pb	114
$R_{max}(np_{1/2})$	1.217	2.174	2.233	2.540	2.471	2.251
R_{vdW}	3.21	3.968[a]	3.921[b]	4.1[a]	4.062[b]	3.94[b]
			4.61[c]		3.82[a]	
α	11.877	36.31	40.96	51.96	45.89	29.52[d]
$-\Delta H_{ads}$ (quartz)	18.15	24.57	28.19	29.92	27.34	20.97
$-\Delta H_{ads}$ (ice)	17.56	23.65	27.13	28.76	26.29	20.20
$-\Delta H_{ads}$ (Teflon)	8.91	12.22	14.04	14.94	13.65	10.41

[a]Reference 26.
[b]This work via correlation (Fig. 5).
[c]Reference 35.
[d]Corrected for the difference with experiment for Pb.

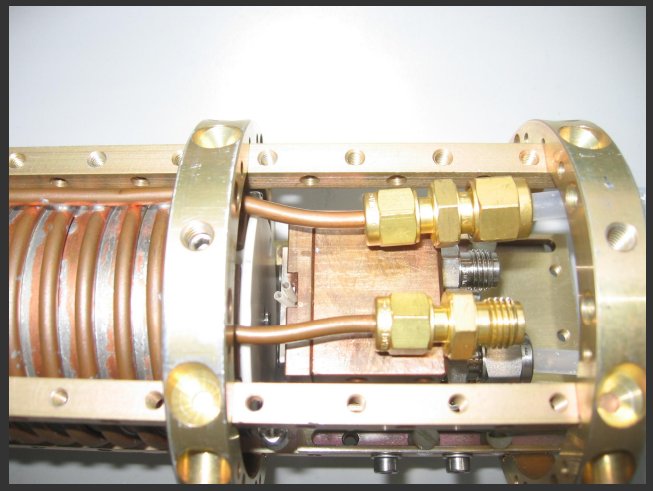

Linear fit
95% confidence limit
Adsorption enthalpy -ΔH$_{ads}^{quartz}$, [kJ/mol]
Sublimation enthalpy ΔH$^{298}_{subl}$ [kJ/mol]
0
100
200
300
400
500
600
700
Pt
Au
Ag
Te
Pb
Ge
In
Zn
Cd
Hg
Bi
Po
Tl
I

Vacuumchromatography of elemental Pb IVAC 2009

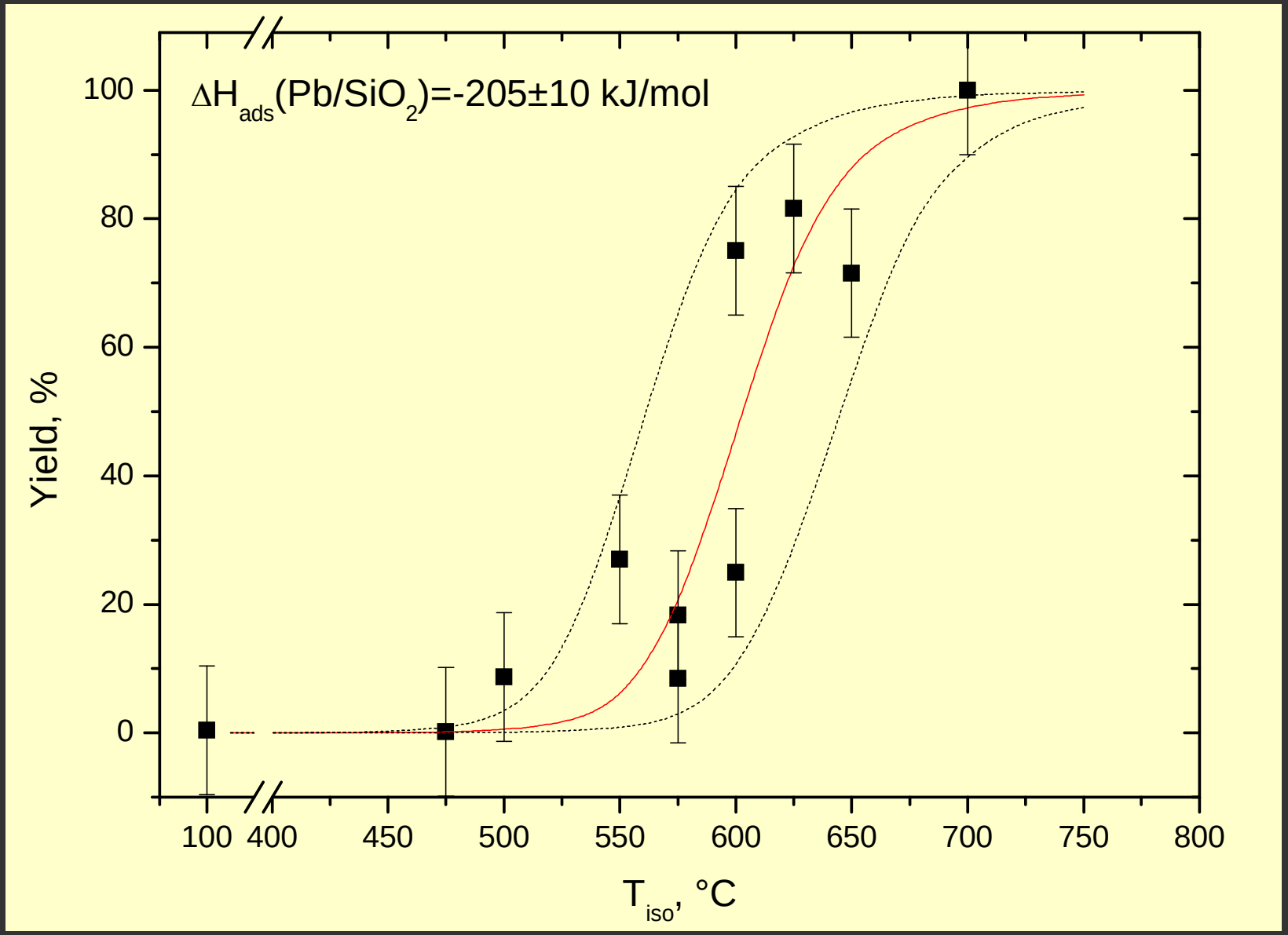


$^{227}Ac \rightarrow \rightarrow \rightarrow ^{211}Pb$ **Ta**

10^{-6} mbar



Vacuum chromatography of elemental Pb



Chemical investigation of element 114

R. Eichler

for a PSI-University of Bern-FLNR-LLNL-FZD-ITE collaboration

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PSI and University Bern

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Yu.V. Lobanov, O.N. Malyshev, Yu.Ts. Oganessian, O.V. Petrushkin,
A.N. Polyakov, A.G. Popeko, R.N. Sagaidak, I.V. Shirokovsky, S.V. Shishkin,
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FLNR Dubna

R.A. Henderson, A.M. Johnsen, J.M.Kenneally, K.J. Moody,
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LLNL Livermore

S. Hübener
FZD Rossendorf

M.Wegrzecki
ITE Warzaw

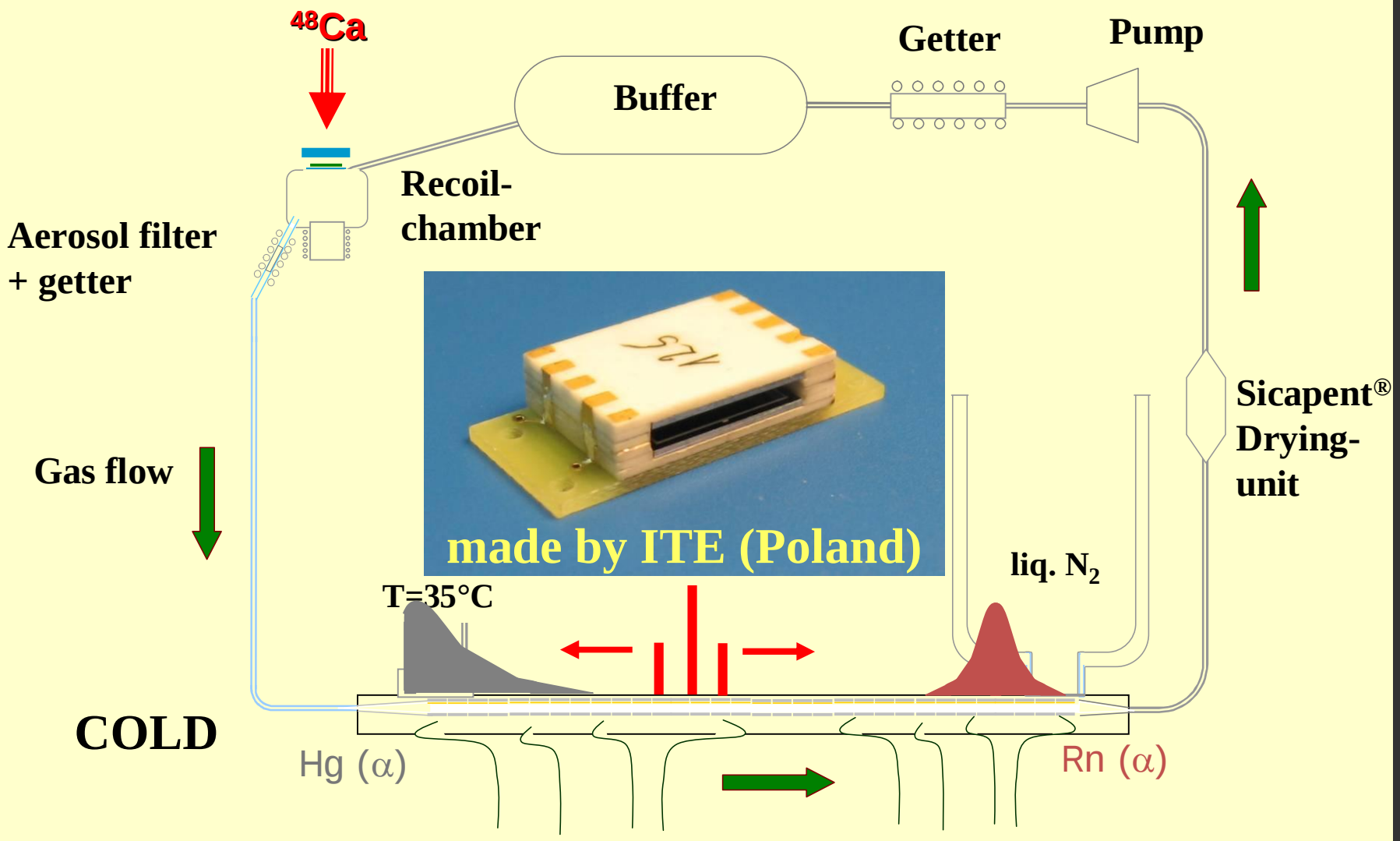
Chemistry of Transactinides

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac**	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	112	113	114	115	116		118

Closed shell atoms???

*	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
**	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

Thermochromatography with SHE



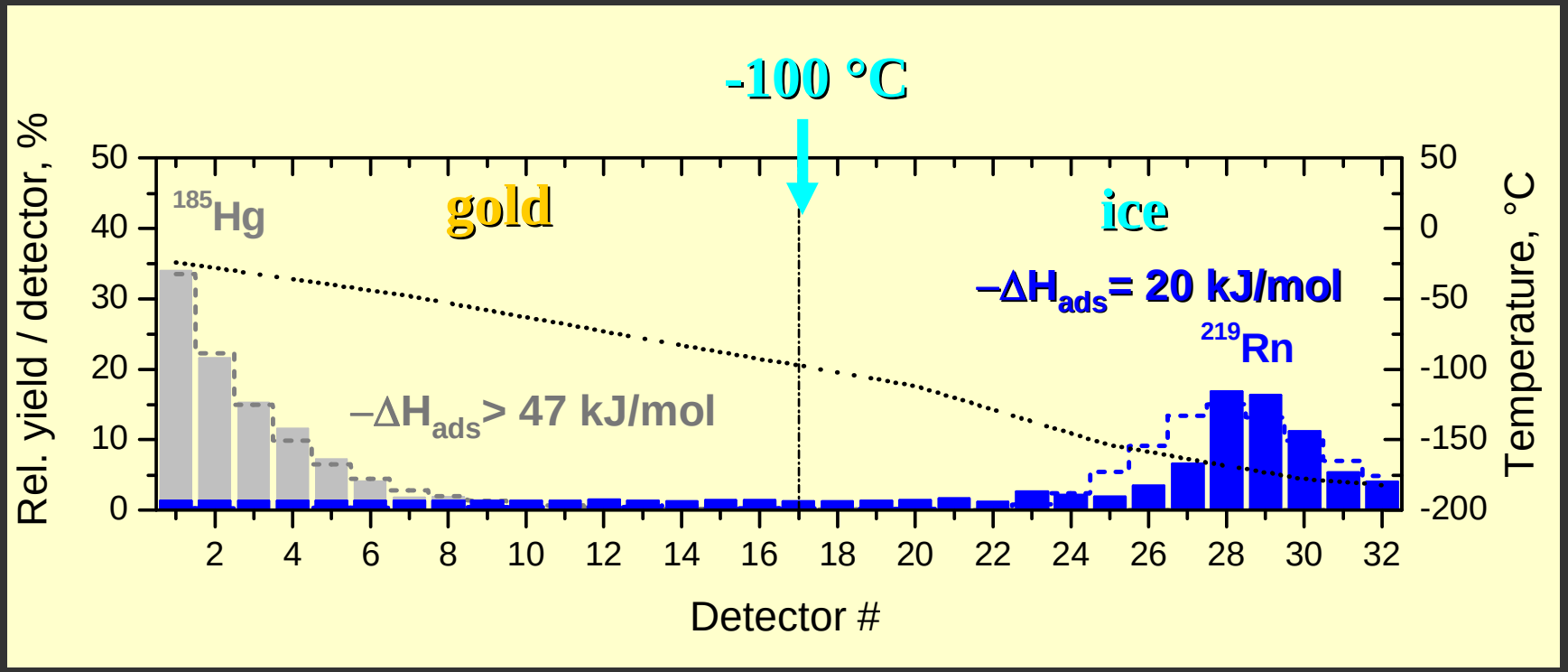
Hg and Rn ?

Deposition of ^{185}Hg and ^{219}Rn along COLD

^{142}Nd(^{48}Ca,5n)^{185}Hg

admixture ^{nat}Nd (50μg/cm^2)

From multinucleon transfer reactions



The Observation of ^{283}Cn @ FLNR 2006/2007

Reported at FLNR:

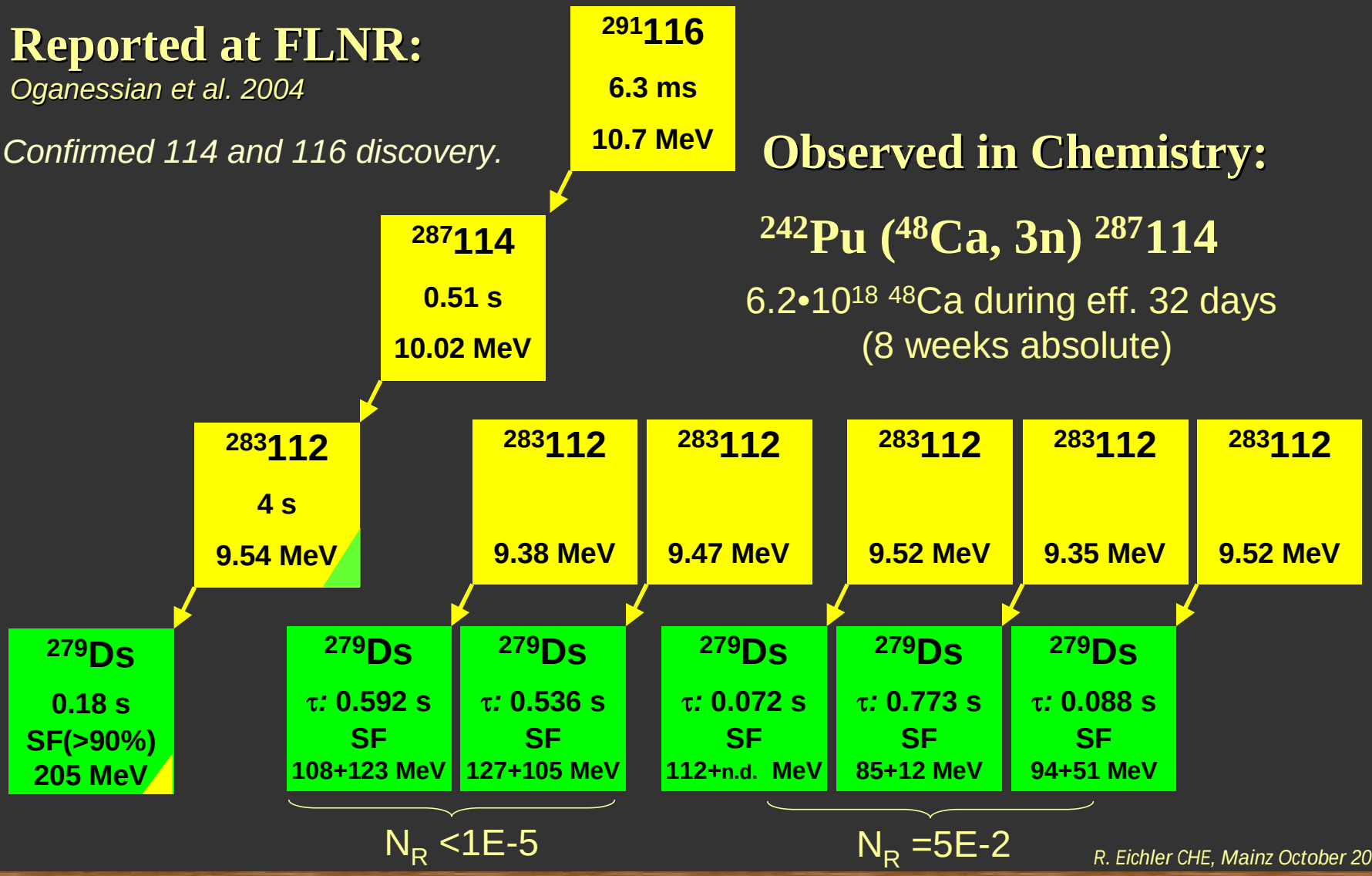
Oganessian et al. 2004

Confirmed 114 and 116 discovery.

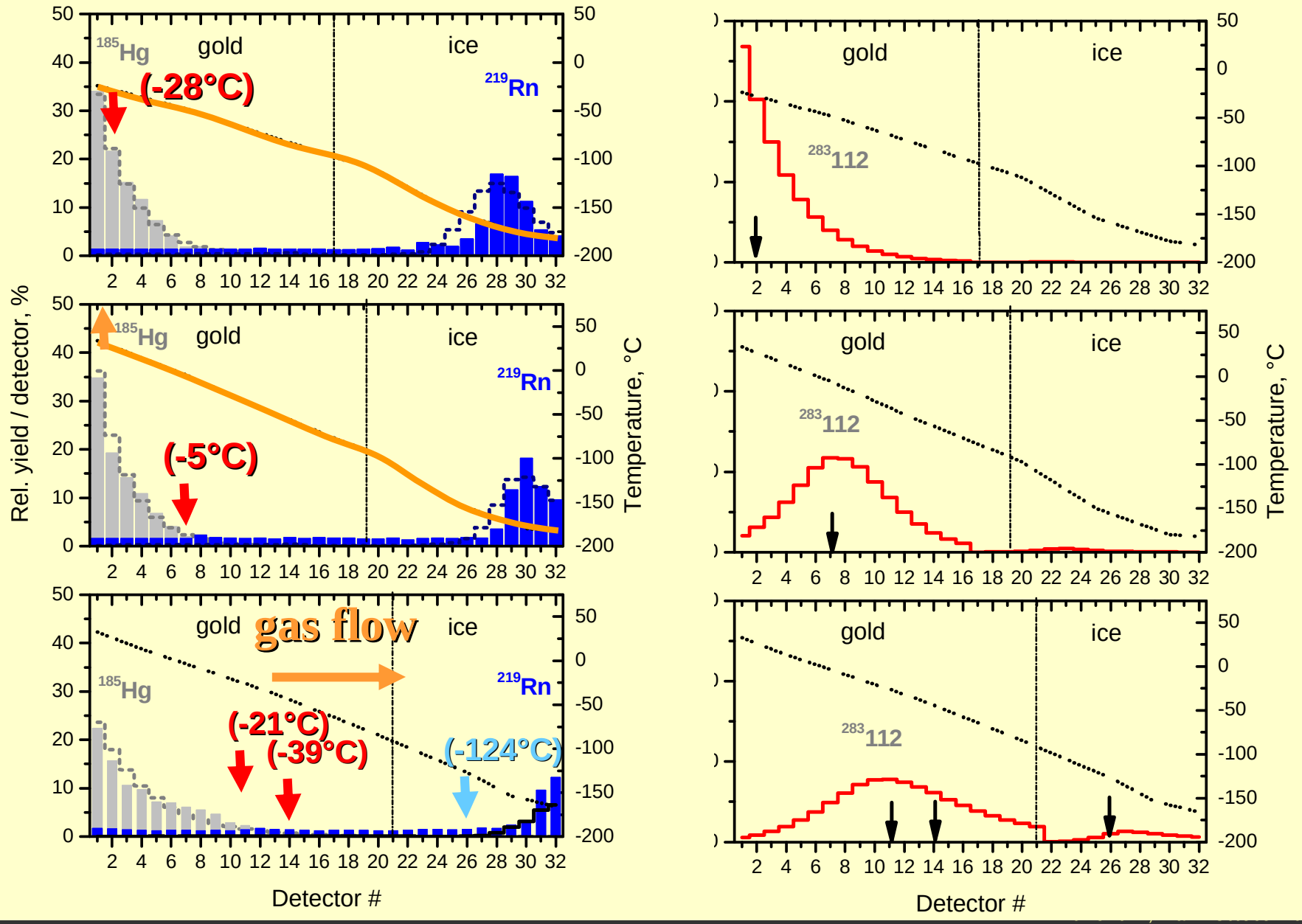
Observed in Chemistry:

^{242}Pu (^{48}Ca, 3n) ^{287}114

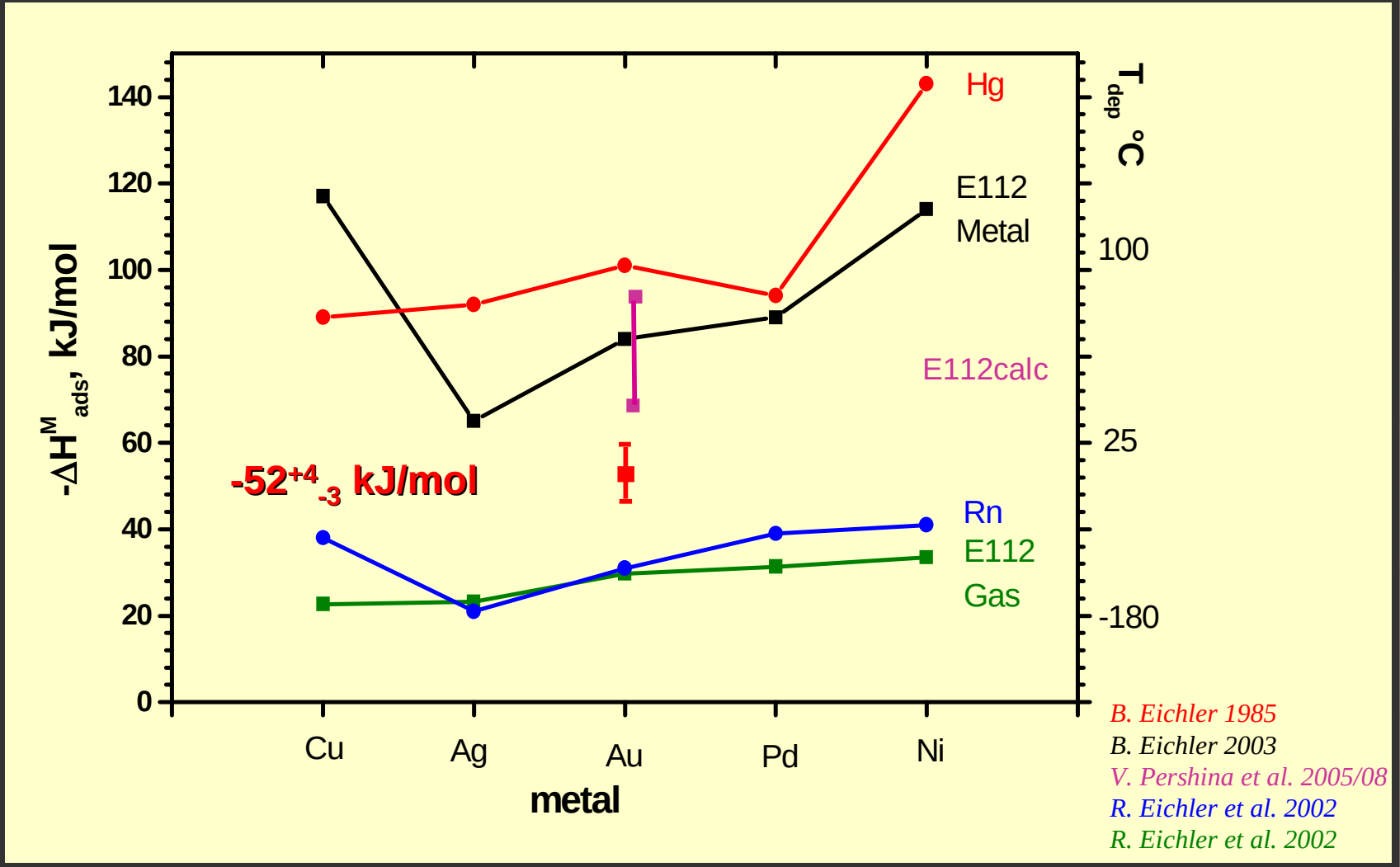
6.2•10^{18} ^{48}Ca during eff. 32 days
(8 weeks absolute)



Experiment *Results* Simulation

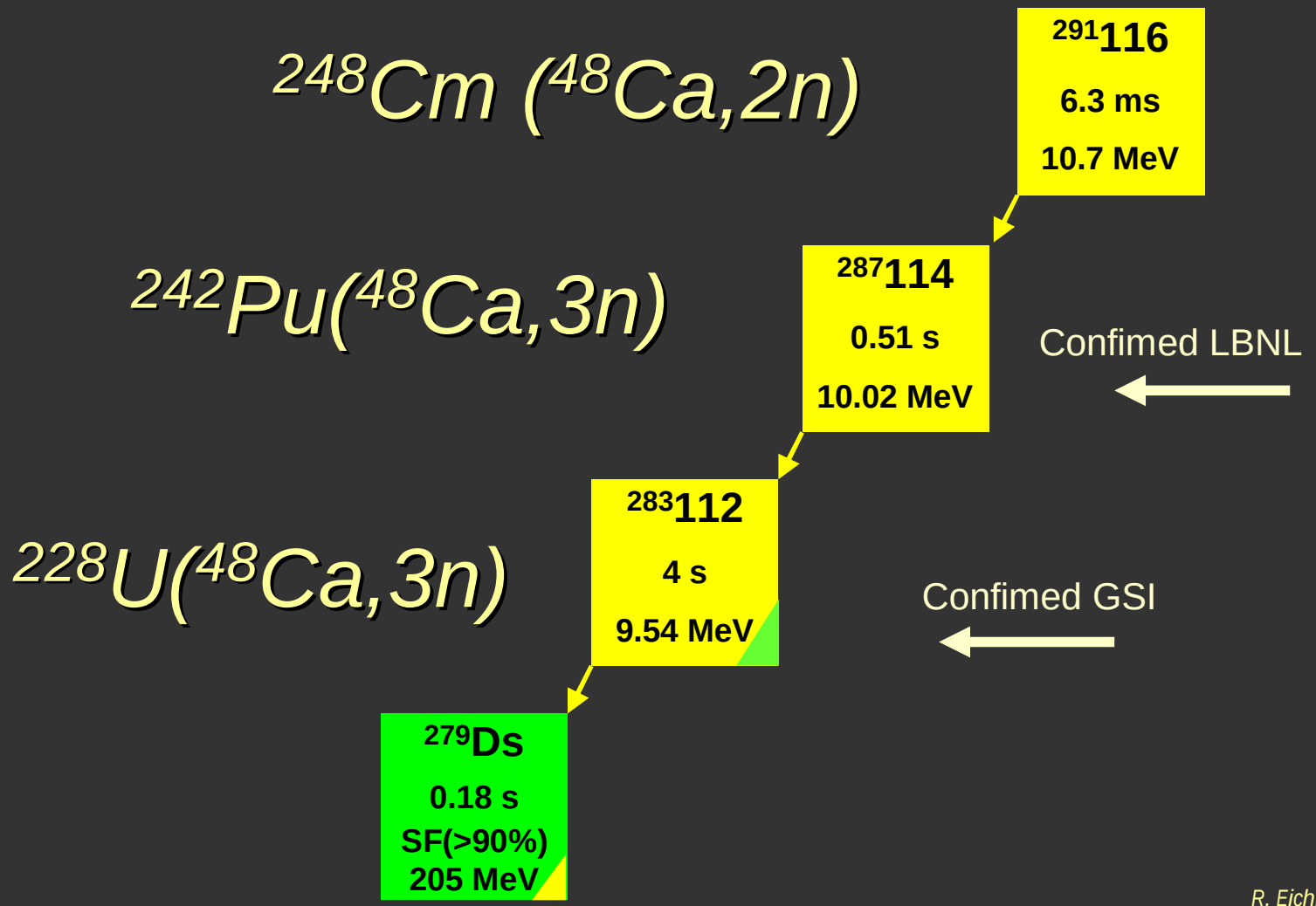


The Adsorption on Gold



Result was used to improve the prediction models.

The Observation @ FLNR 2001-2004



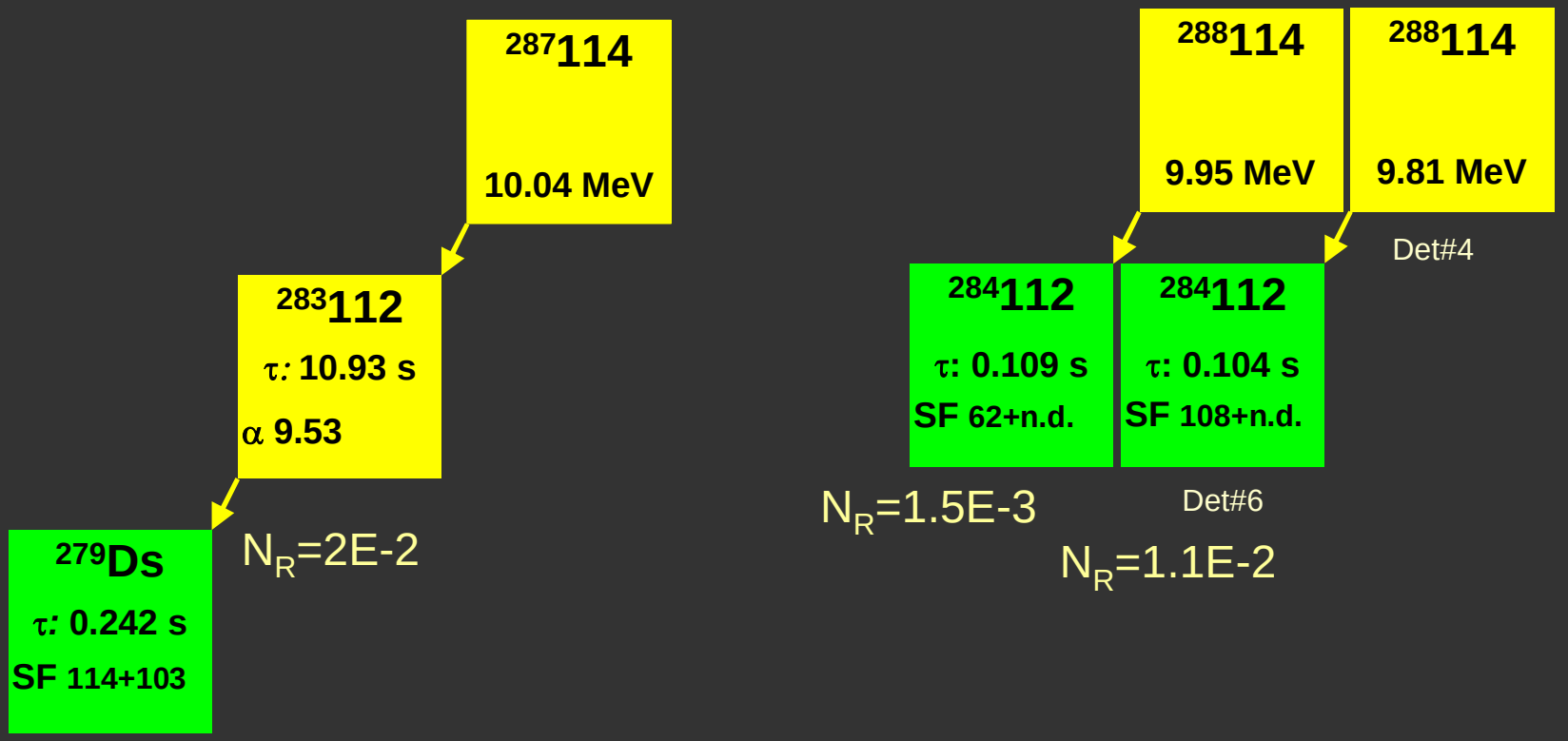
Preliminary Results with Element 114

Dubna 2007

^{242}Pu (^{48}Ca, 3n) ^{287}114 ⟹ **^{244}Pu$_{LLNL}$ (^{48}Ca, 3-4n) $^{288\text{-}289}$114**

3.1•10^{18} ^{48}Ca during 16 days

3.2 •10^{18} ^{48}Ca during 16 days



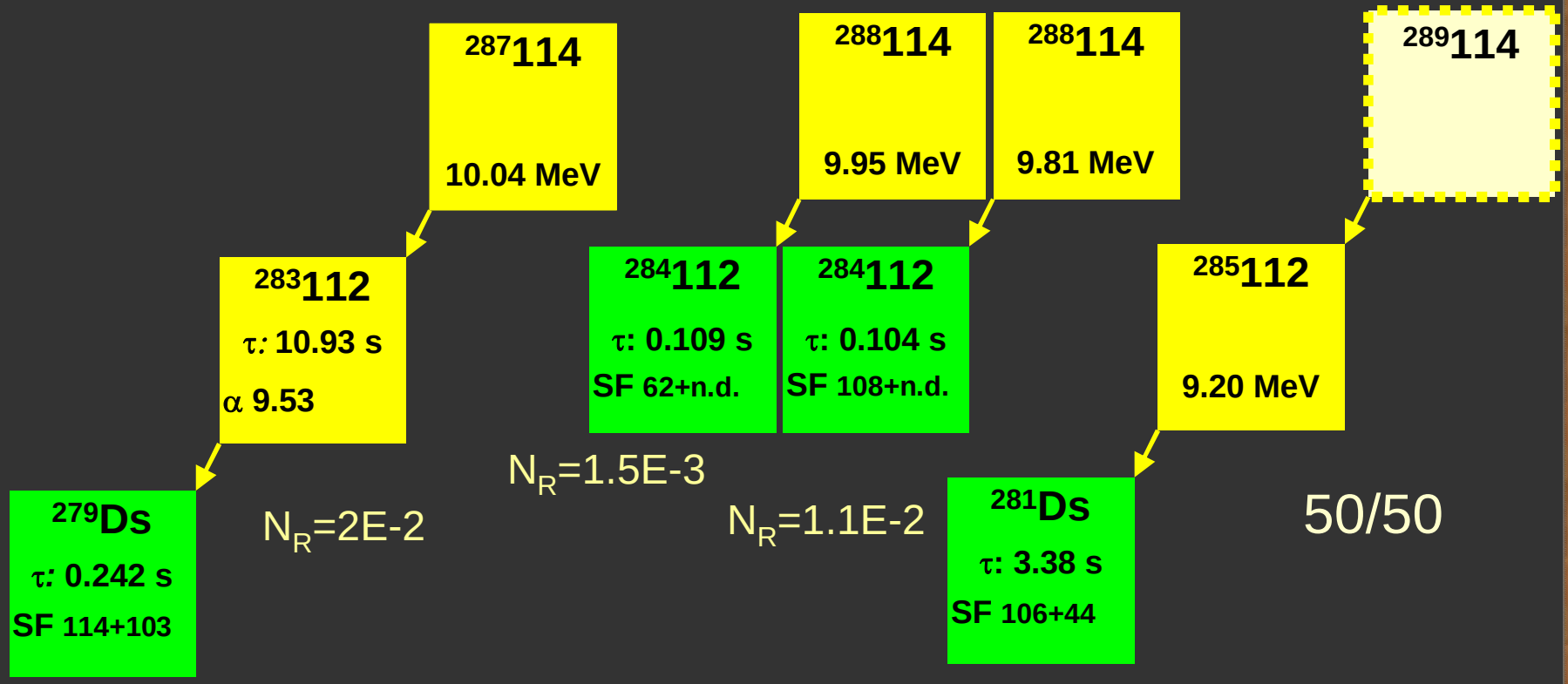
Preliminary Results

Dubna 2007/2008

^{242}Pu (^{48}Ca, 3n) ^{287}114 ⟹ **^{244}Pu (^{48}Ca, 3-4n) $^{288\text{-}289}$114**

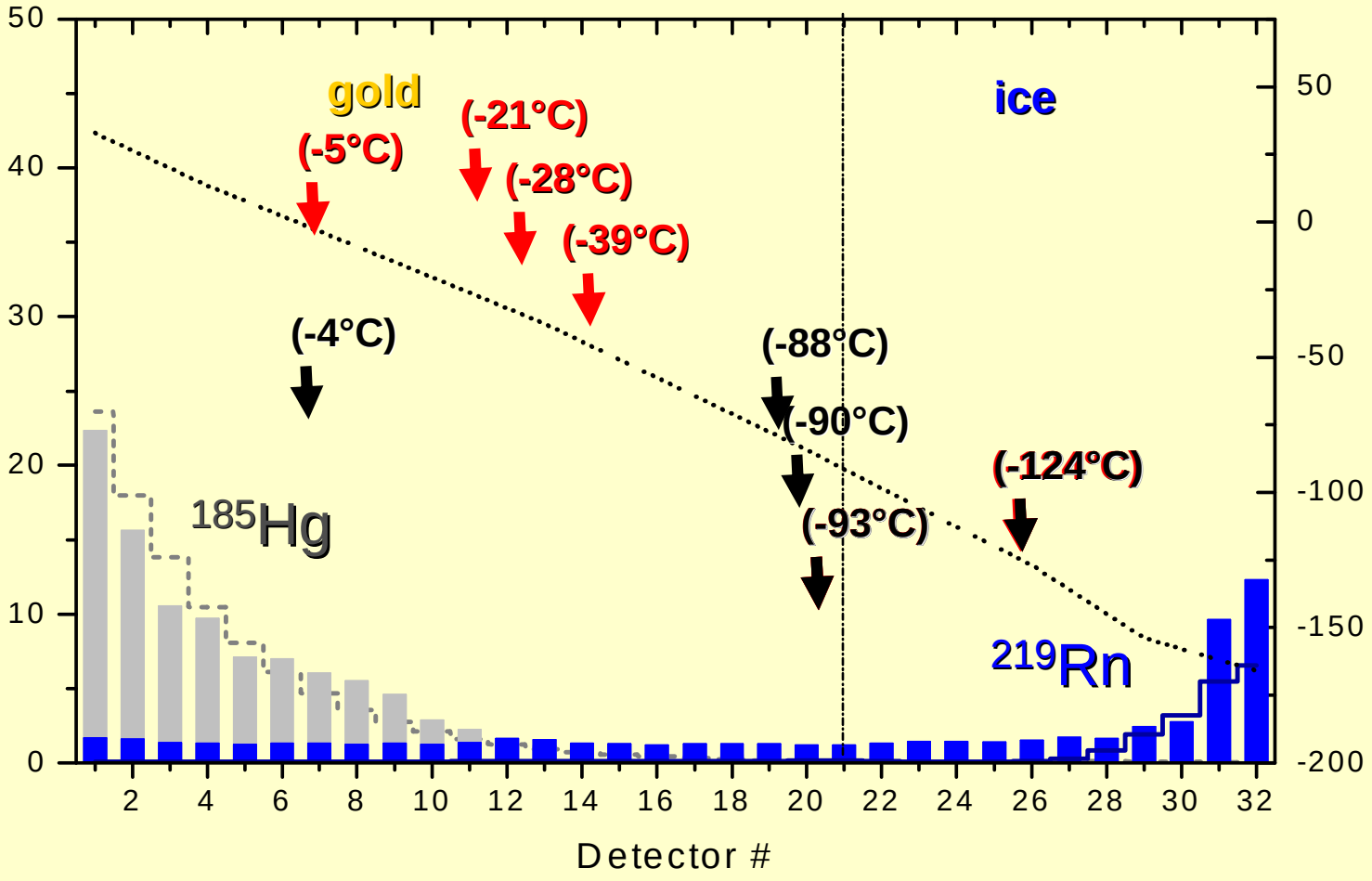
3.1•10^{18} ^{48}Ca during 16 days

1.43•10^{19} ^{48}Ca during 51 days

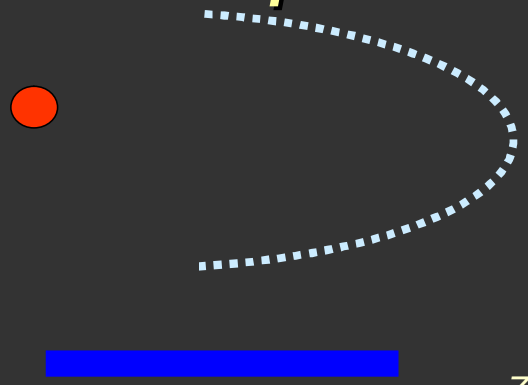


D. Wittwer et al. Gas Phase Chemical Studies of Superheavy Elements Using the Dubna Gas-filled Recoil Separator- Stopping Range Determination. NIM B 2009 accepted

Preliminary results (2007/2008)



Kinetic model of linear gas adsorption chromatography



Zvara, I., Radiochim. Acta 38, 95 (1985).

Frenkel-type adsorption kinetics:
$\tau_a = \tau_o * \exp(-\Delta H_{ads}/RT)$
phonon frequency of the surface material : τ_o

gas transport through tubes: laminar flow, kinetic gas theory

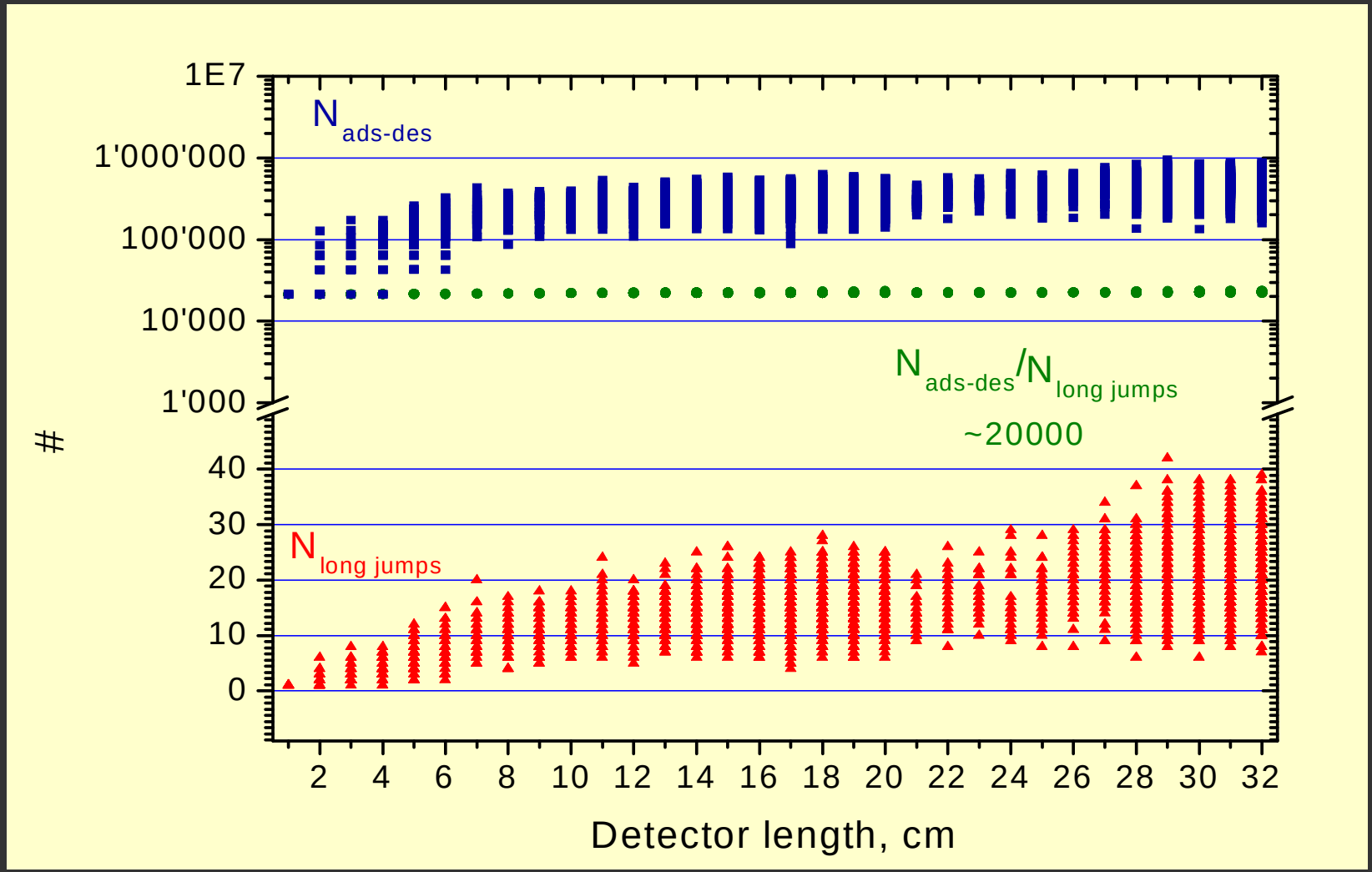
ΔH_{ads}

diffusion in the carrier gas Gilliland eqn.

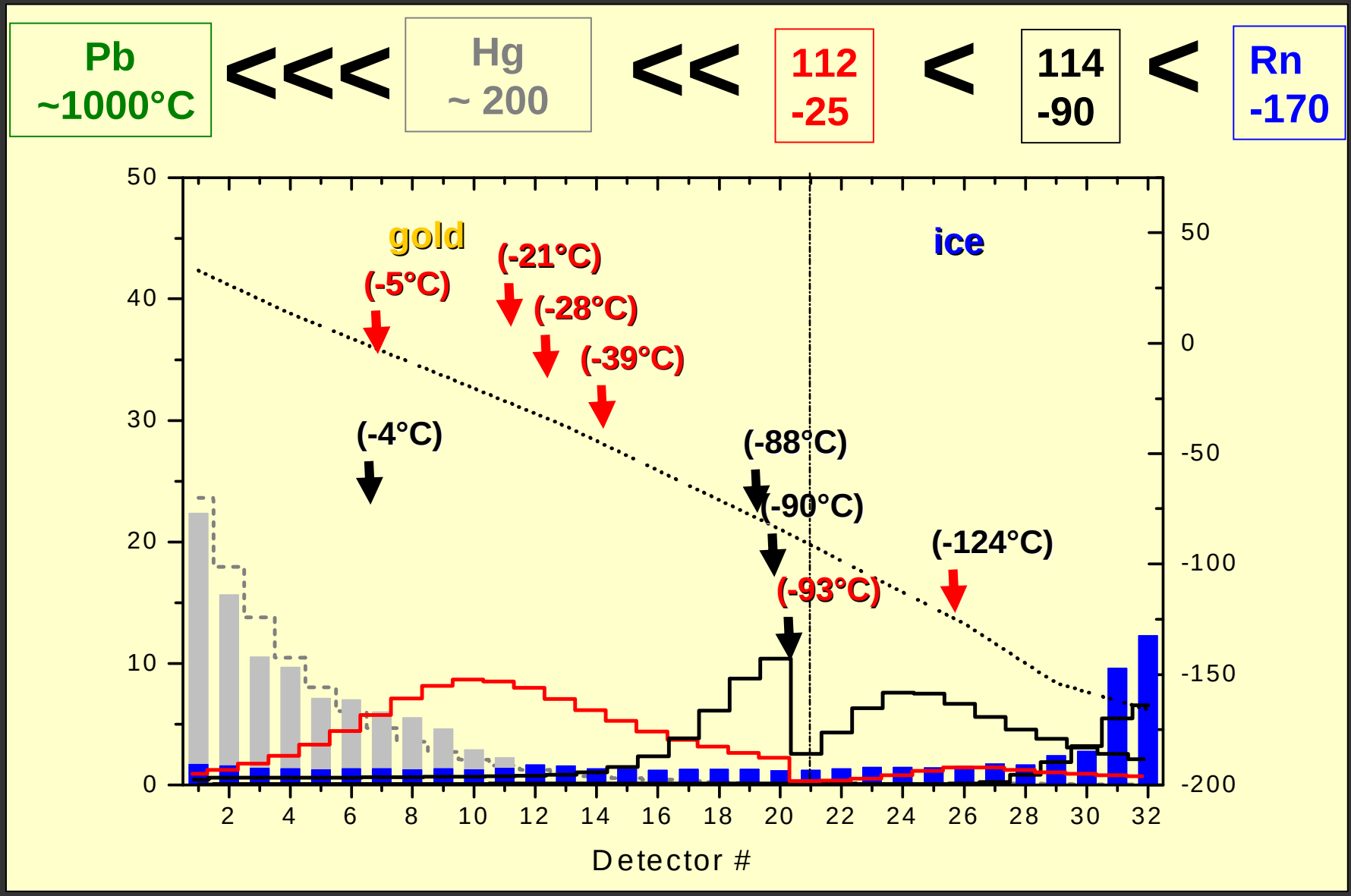
for short-lived isotopes radioactive decay: $t_{1/2}/\ln(2)$ else: t_{exp}

Monte Carlo Simulation

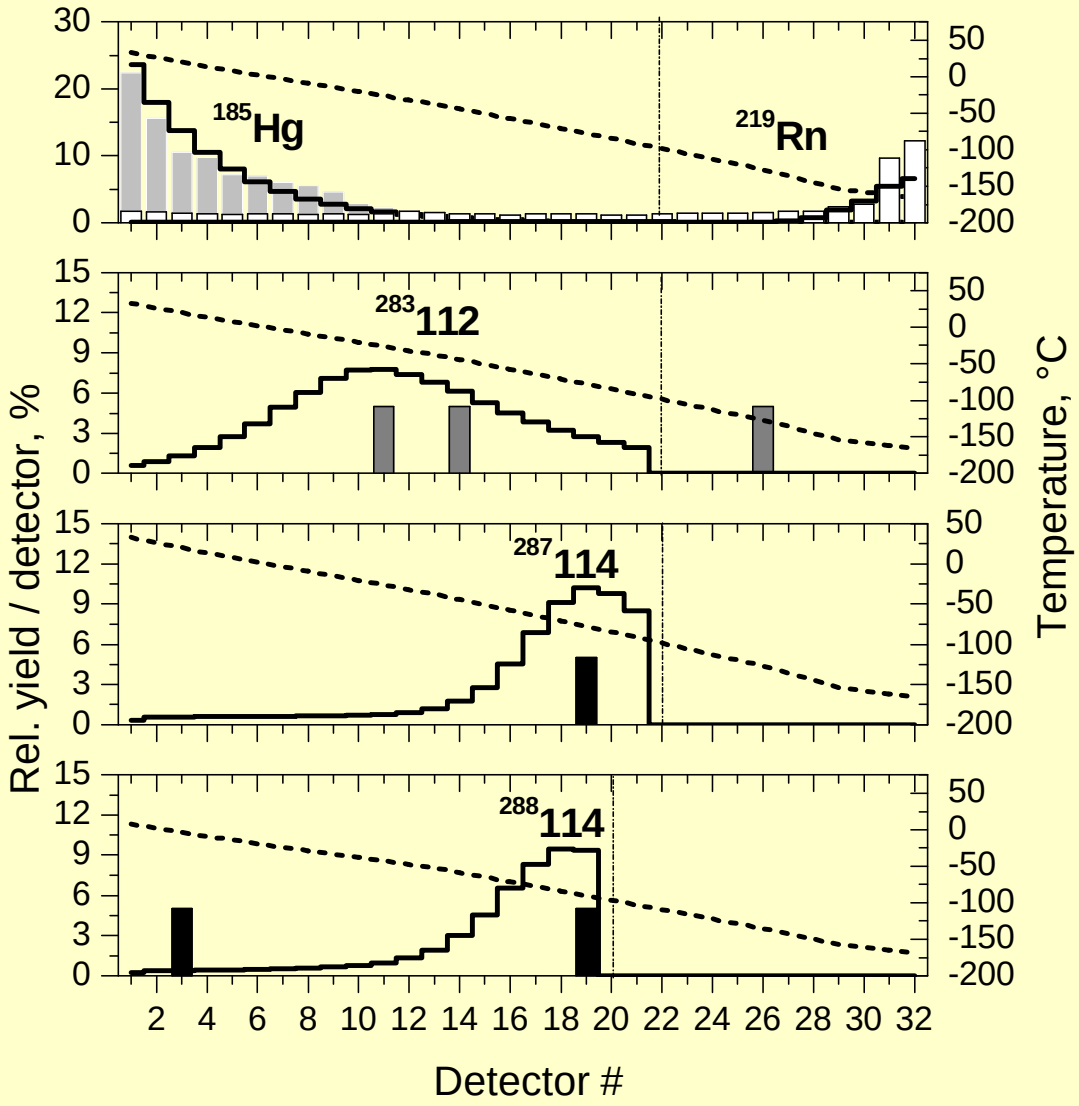
Kinetic model of linear gas adsorption chromatography



Results (2007/2008)

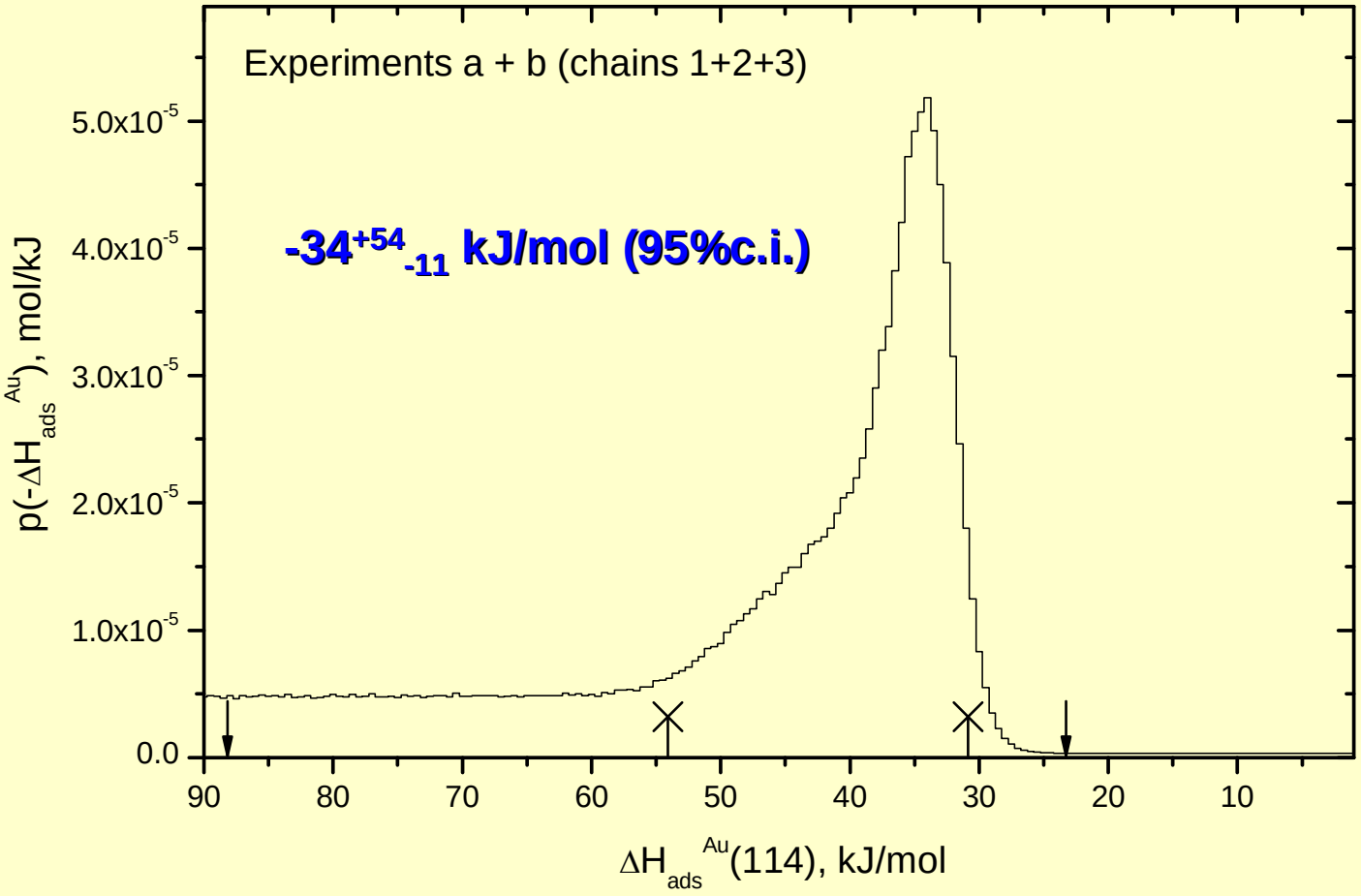


Summary chemisty results (2007)

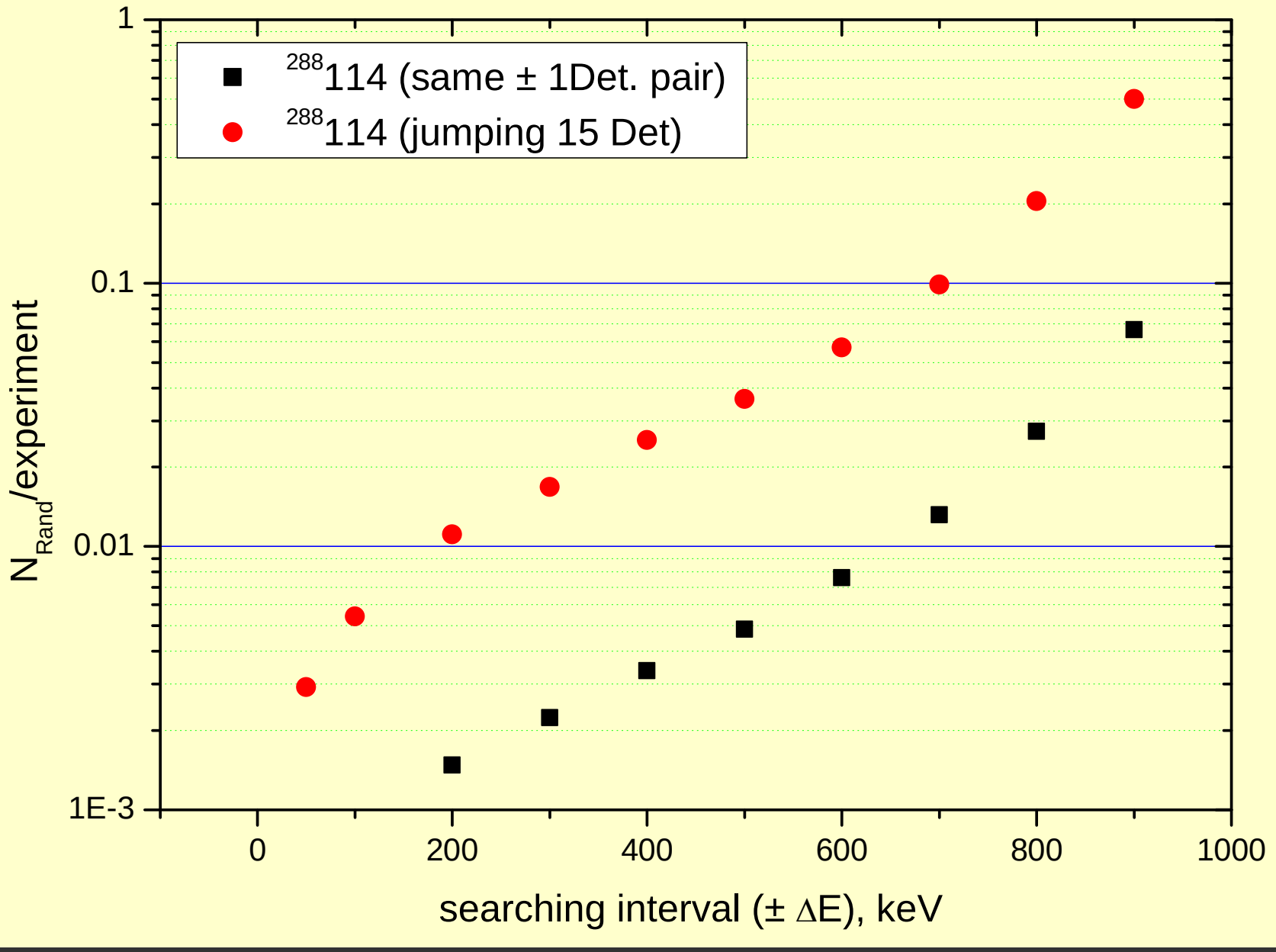


Simultaneously measured!!!

Preliminary results (2007/2008)



R. Eichler et al. Radiochimica Acta 2009 resubmitted



See also Talk by R. Dressler

Dubna 2009

^{242}Pu, ^{243}Am
1.5 μm Rh backing (no Ti)

^{48}Ca

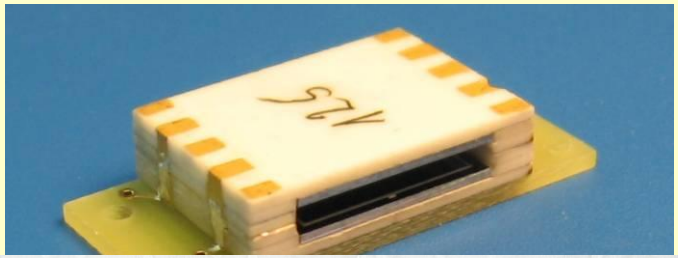
Getter

Pump

Buffer

Recoil-
chamber

Aerosol filter
+ getter



RT Au –filter
and heated to 100°C

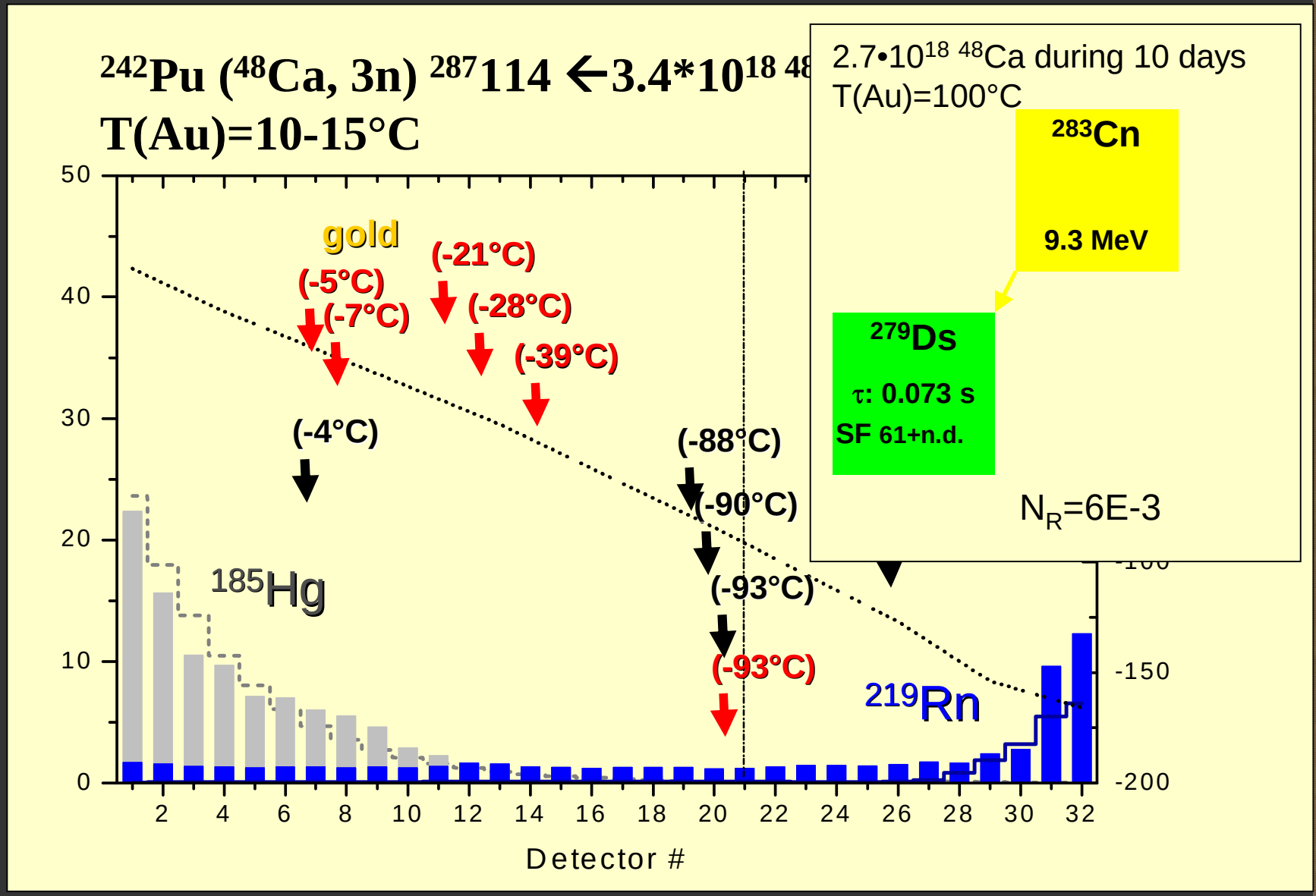
Gas flow

Sicapent®
Drying-
unit

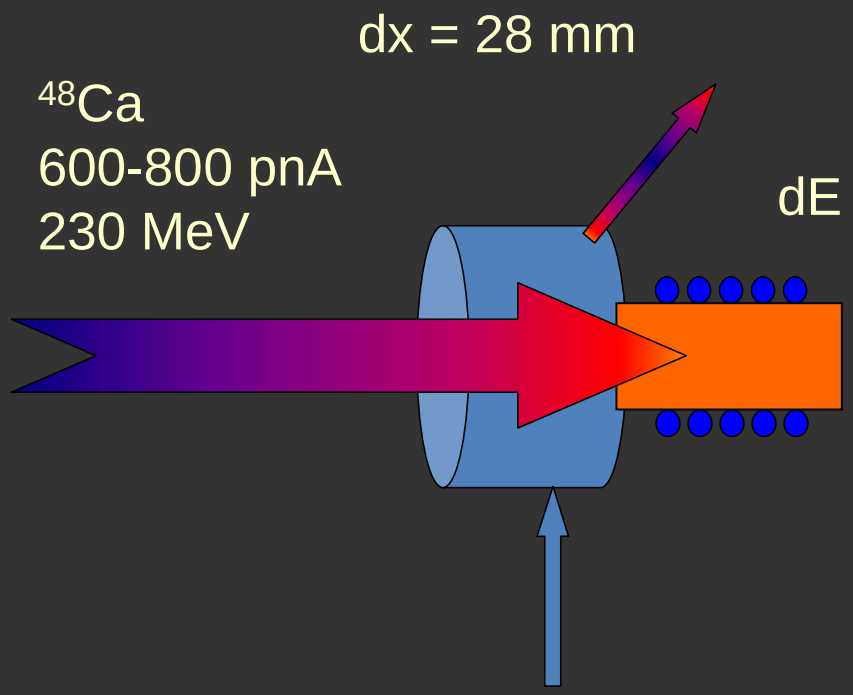
COLD

Rebuilt irradiation channel and the COLD arrangement decreased the transport time to 0.8 s.

Results (2007-2009)



Preliminary results (2009)

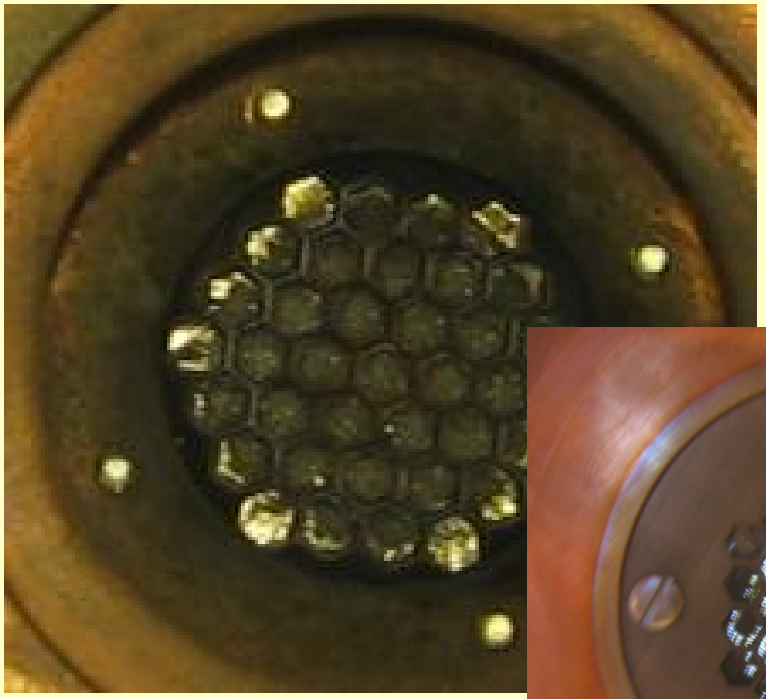


→ ΔT = 600-800 K

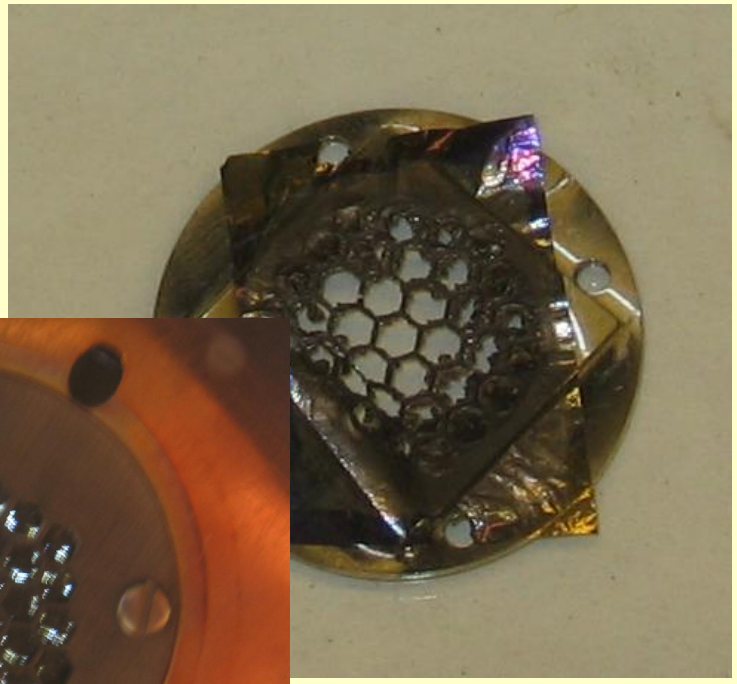
→ factor of ~3 more range for products

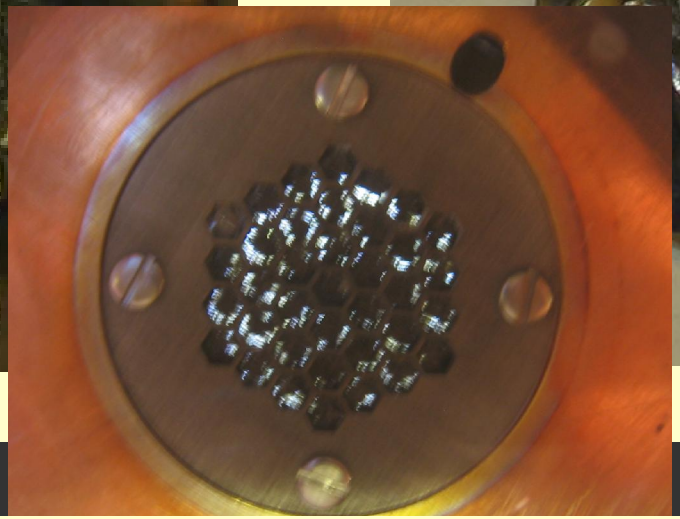
Dubna 2009

Target on 1.7 μm Rh backing
$3*10^{18}$ ^{48}Ca



Target on 1.5 μm Ti backing
$1*10^{18}$ ^{48}Ca





Target on 1.7 μm Rh backing
$6*10^{18}$ ^{48}Ca

Acknowledgements

Accelerator and ECR crews:

U400, Philips cyclotron

LMN, Electronics group @ PSI

Tech-shops @ University Bern, PSI, FLNR

US Department of Energy (^{244}Pu)

U$ Department of Energy

Ru$$ian Foundation for Ba$ic Re$earch

$wi$$ National $cience Foundation