Chemical Identification of Hassium (Hs, Z=108) and Prospects for Future Studies

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for the Hassium Collaboration

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The Hassium - Collaboration

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Outline

Introduction

The Periodic Table

Thermochromatography

Present

The Hassium-Experiment

Setup: IVO & COLD

Chemistry:

Classification of Hs in the PTE

Volatility of HsO_4

Physics:

Confirmation of E112-discovery

Evidence for ^{270}Hs

Future?

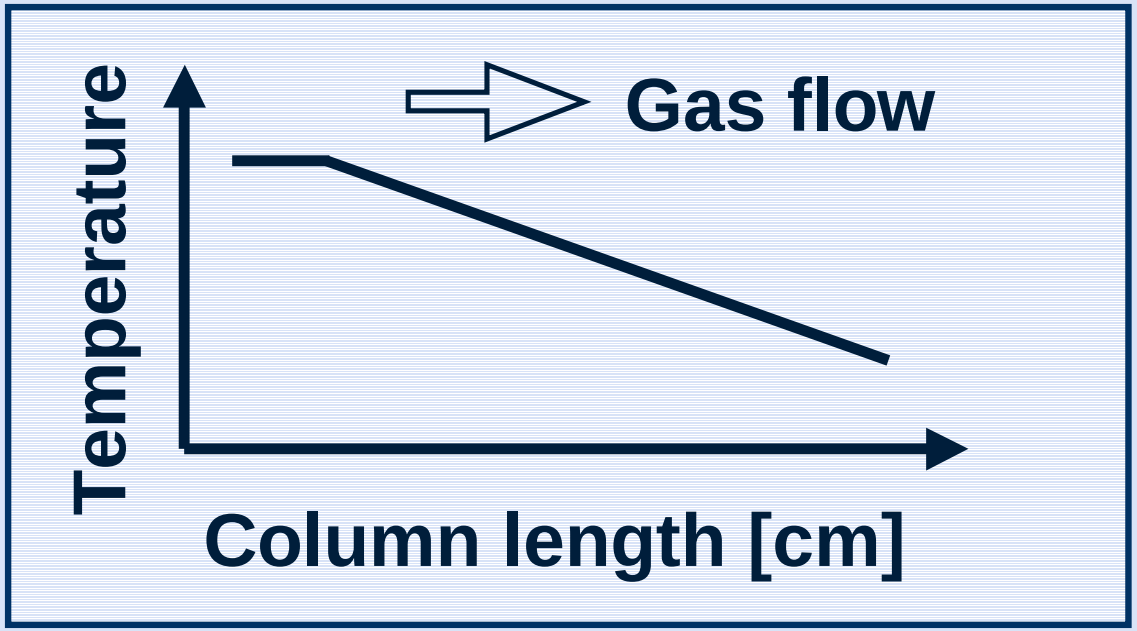
Organometallic Hs Compounds?

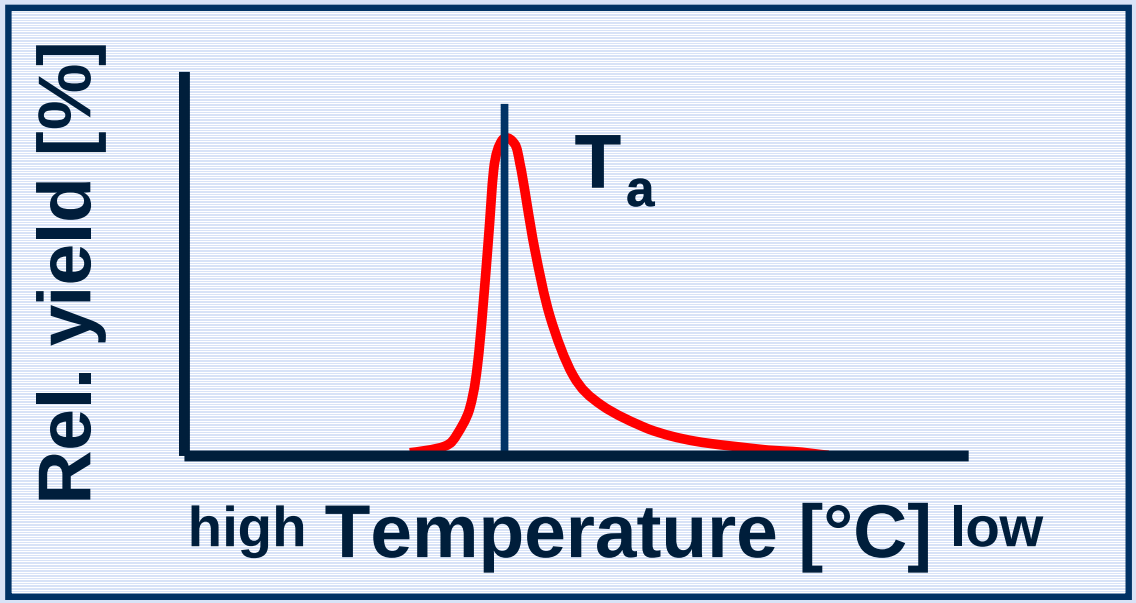
The Periodic Table of the Elements

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 Uun	111 Uuu	112 Uub		114 Uuq		116 Uuh		

*	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

Thermochromatography

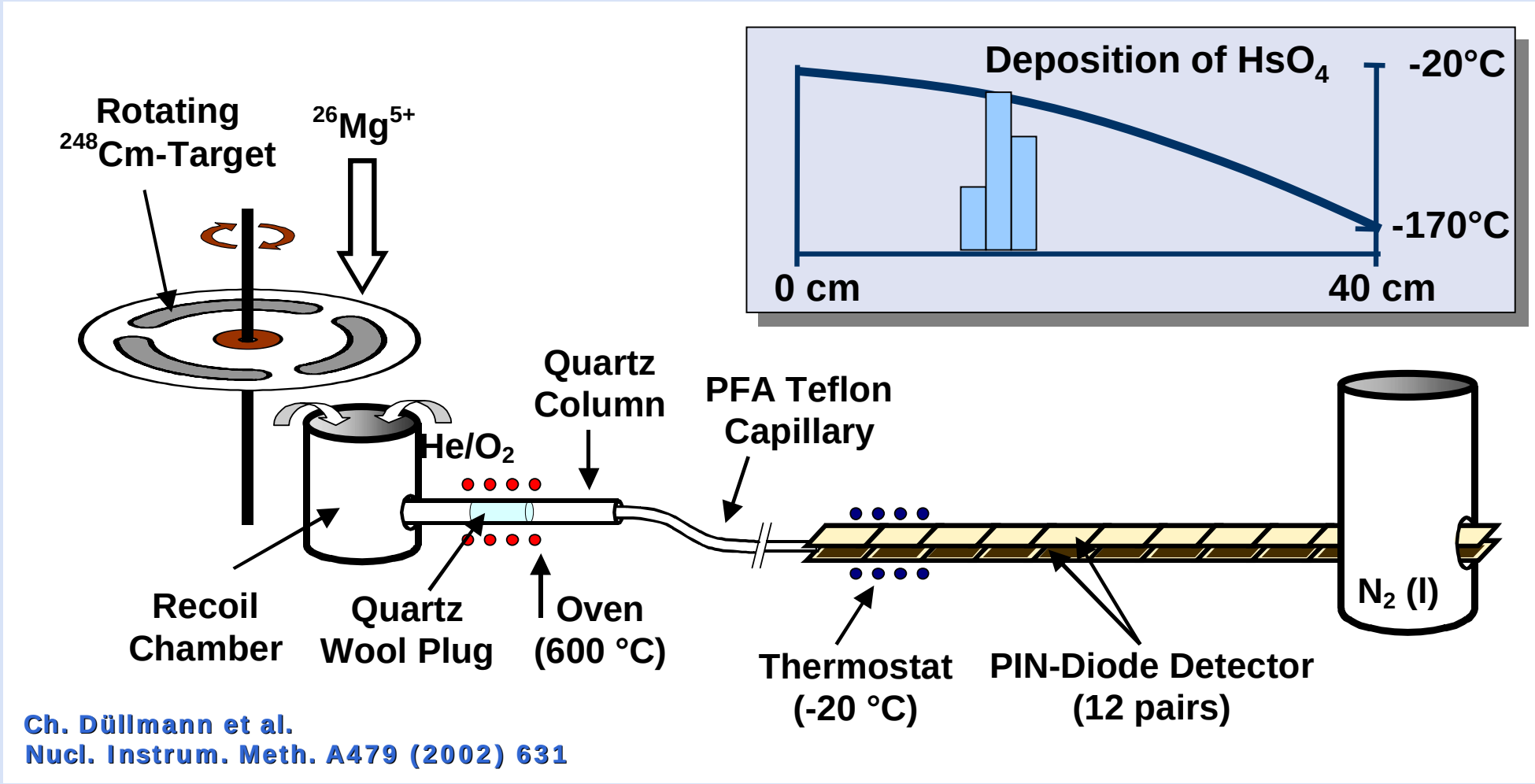




IVO + COLD:

In situ Volatilization and On-line detection apparatus

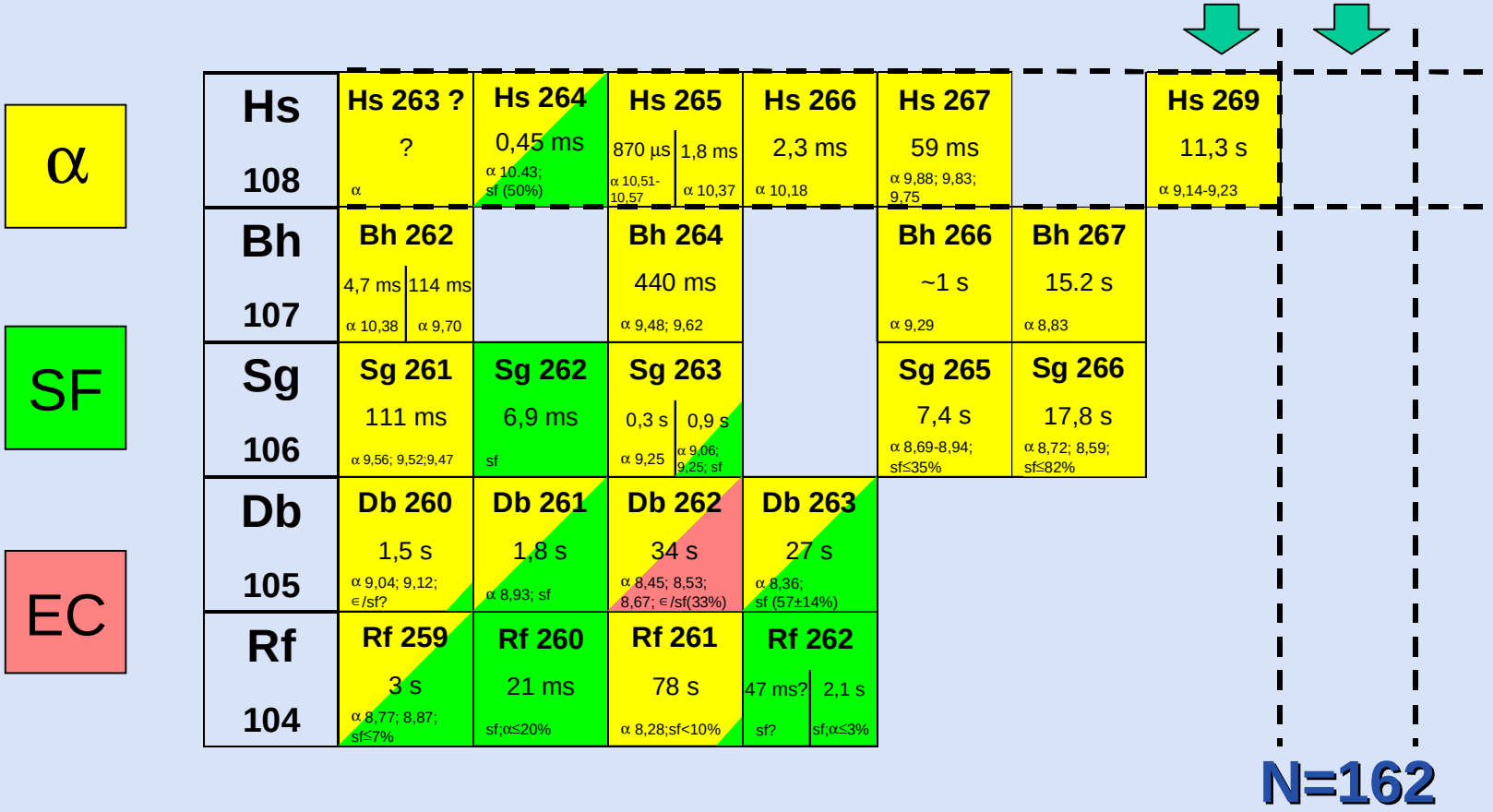
Cryo-On-Line Detector



Ch. Düllmann et al.
Nucl. Instrum. Meth. A479 (2002) 631

Cut out of the chart of nuclides

$^{248}Cm(^{26}Mg;5,4n)^{269}Hs,^{270}Hs$



Experiment Facts

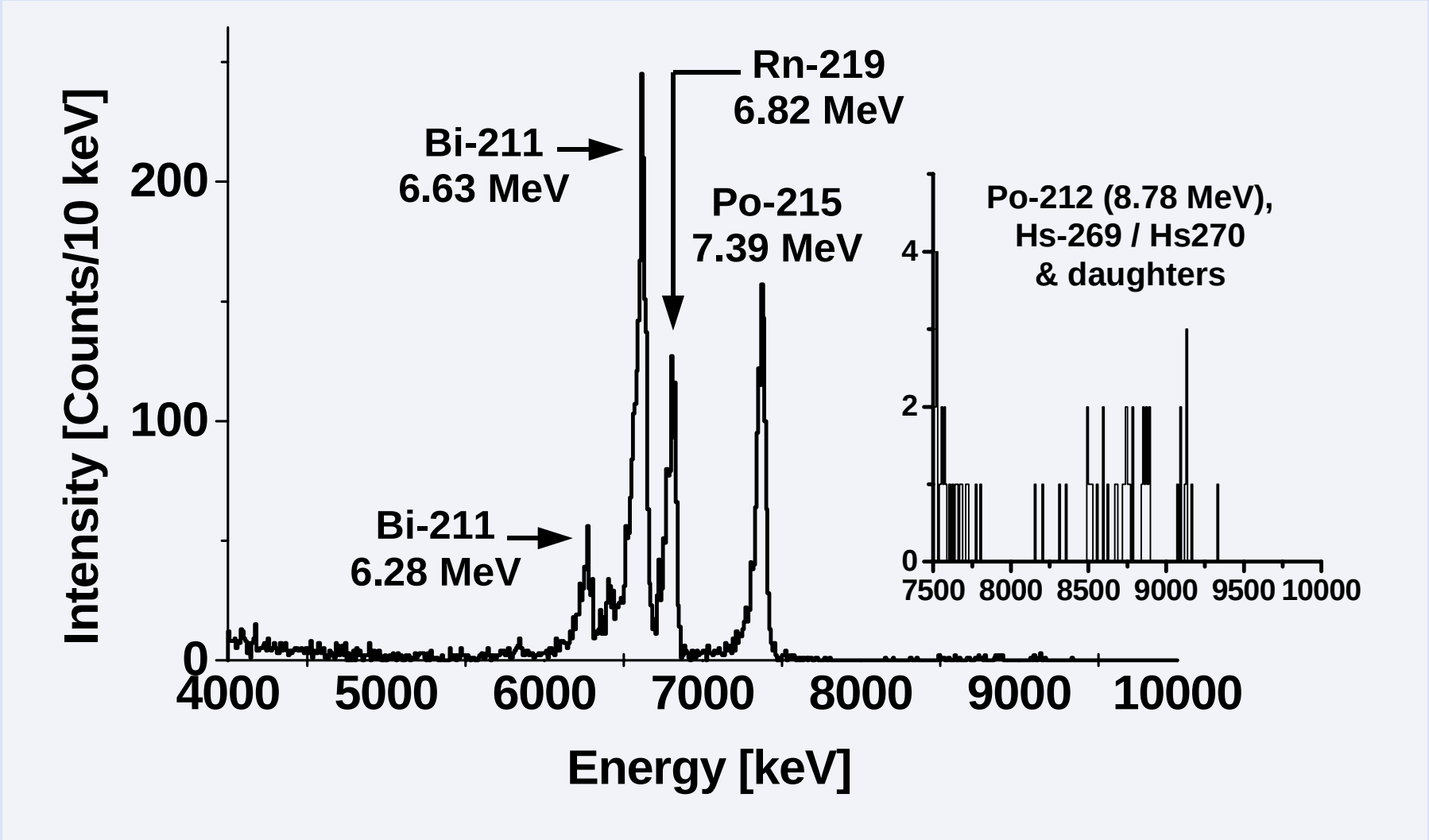
OsO_4: Formation and transport out of the chamber	60-90%
Transport time to the detection system	~2-3 sec
Geometrical efficiency for detection of an α:	77%
Prob. to detect at least 3 α's of a 4α decay chain:	66.6%

Overall Efficiency:	**30-50%**

Average beam intensity:	700 p·nA
Target thickness:	550 μg/cm^2
Expected production cross section (HIVAP):	5-10 pb

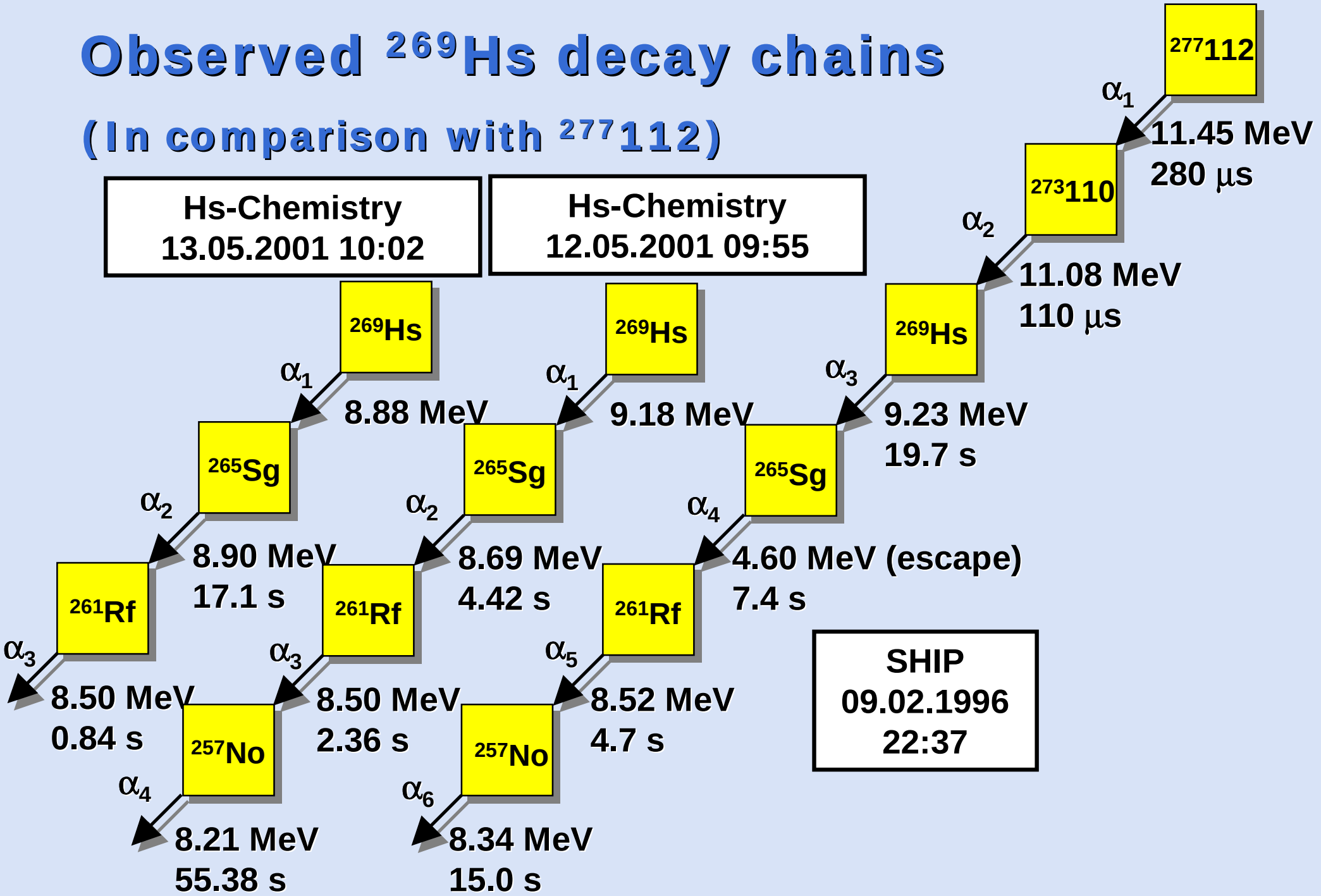
Expectation:	**1-2 α-α-α correlations/day**

Cumulative α-Spectrum of Dets. +3 and -3 of the Hs Experiment (Dose: $1.0 \cdot 10^{18}$ ^{26}Mg-particles)



Observed ^{269}Hs decay chains

(In comparison with ^{277}112)



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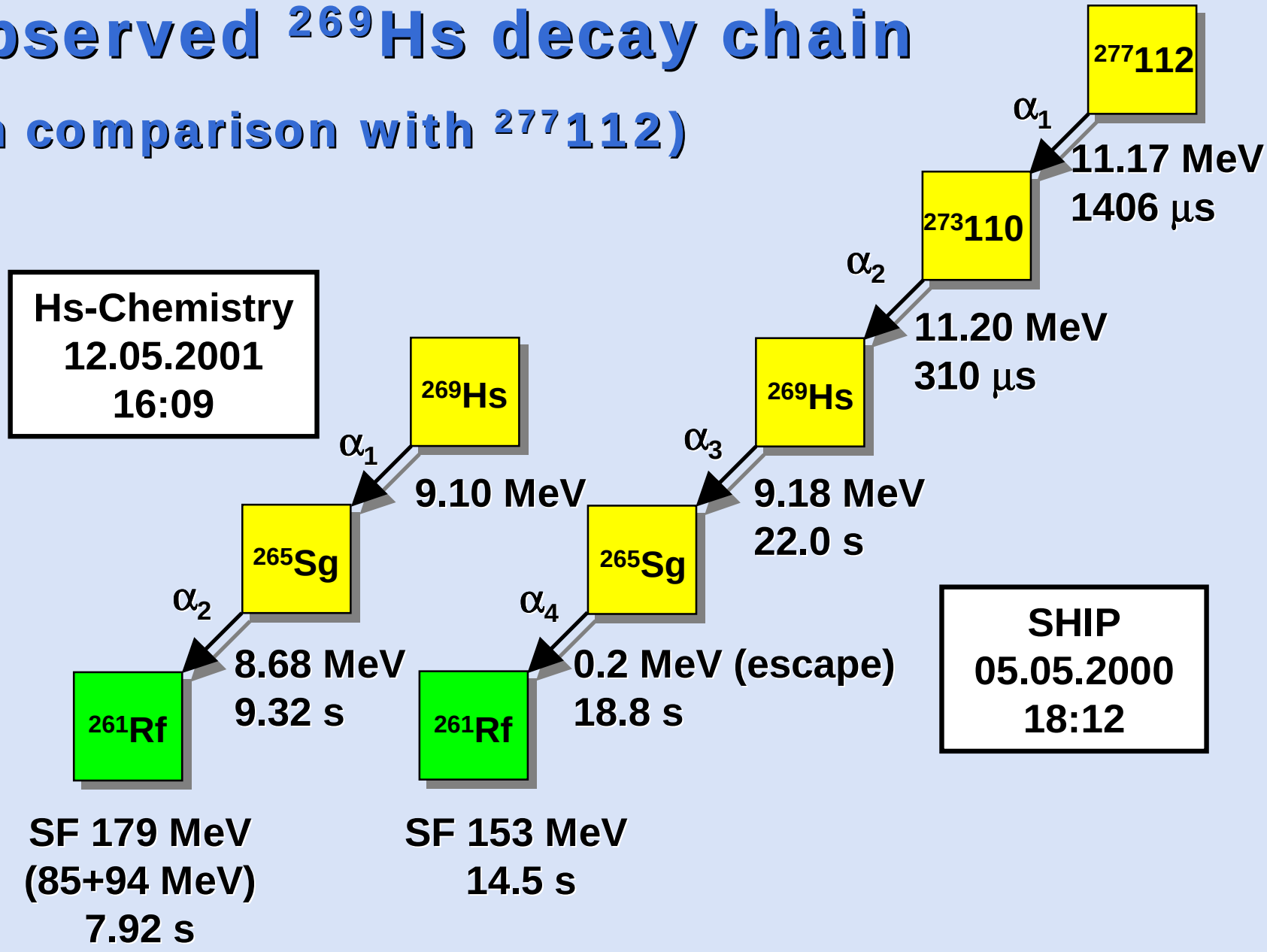
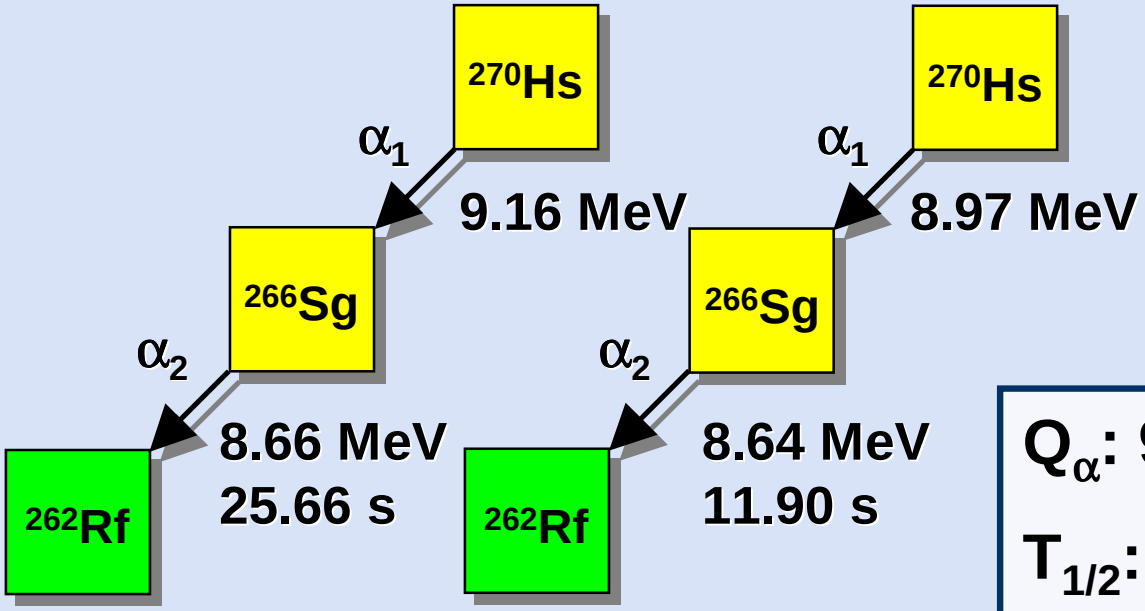


Evidence for the new isotope ^{270}Hs

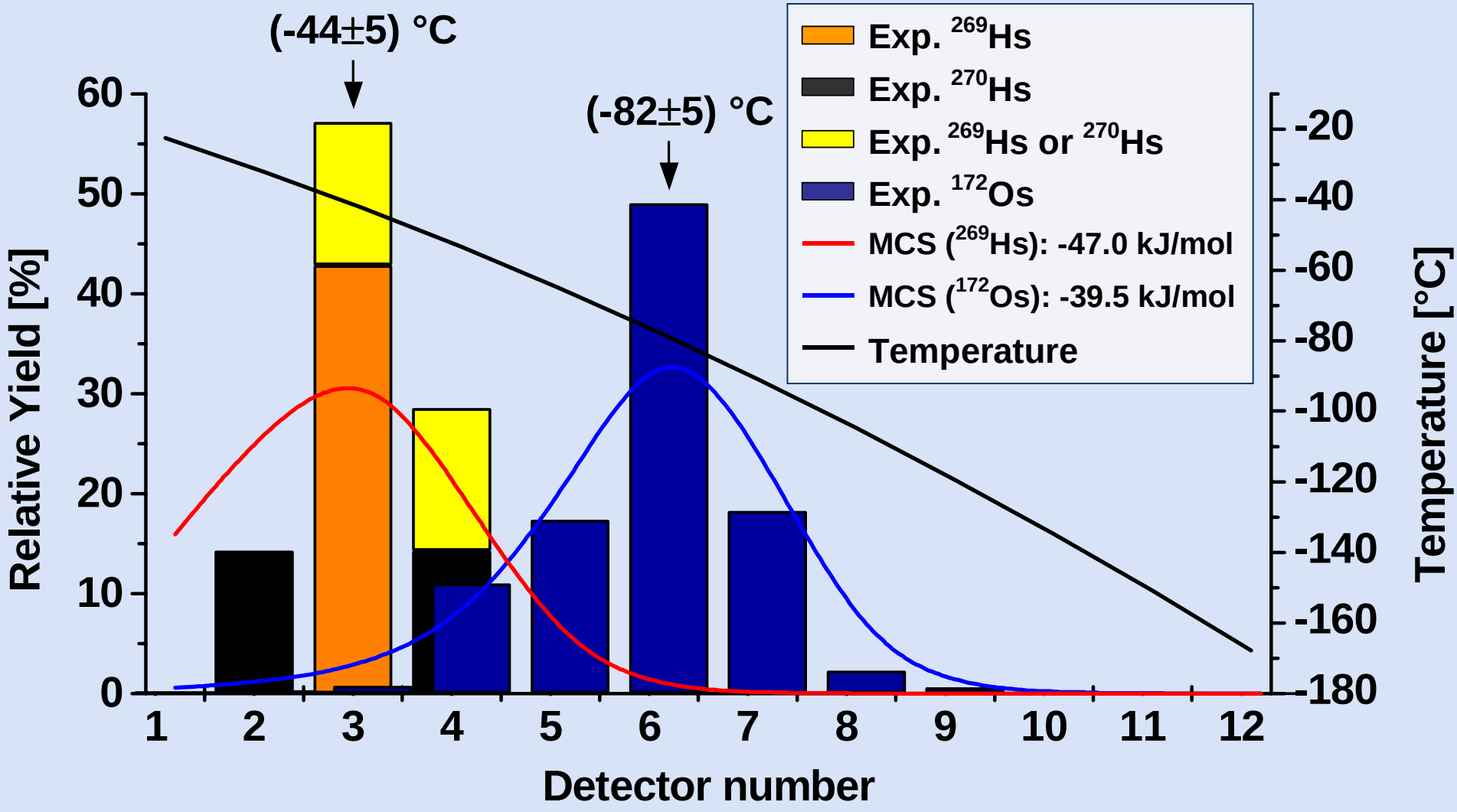


Q_α: 9.31 MeV

$T_{1/2}$: 3.62 s

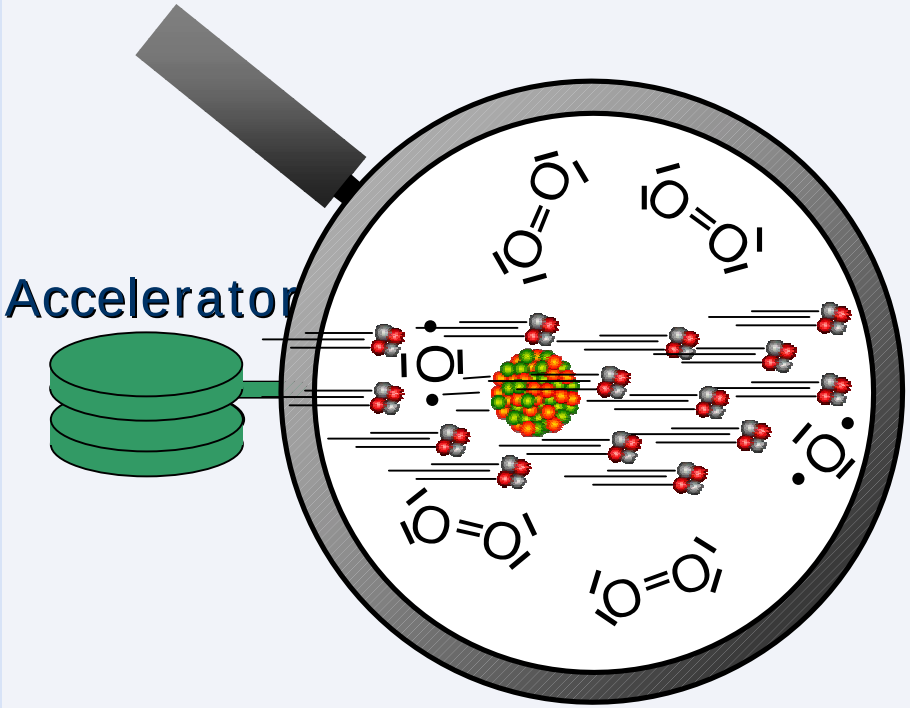
B.Buck et al.,
J. Phys. G 18 (1992) 143

Thermochromatogram of HsO_4 and OsO_4

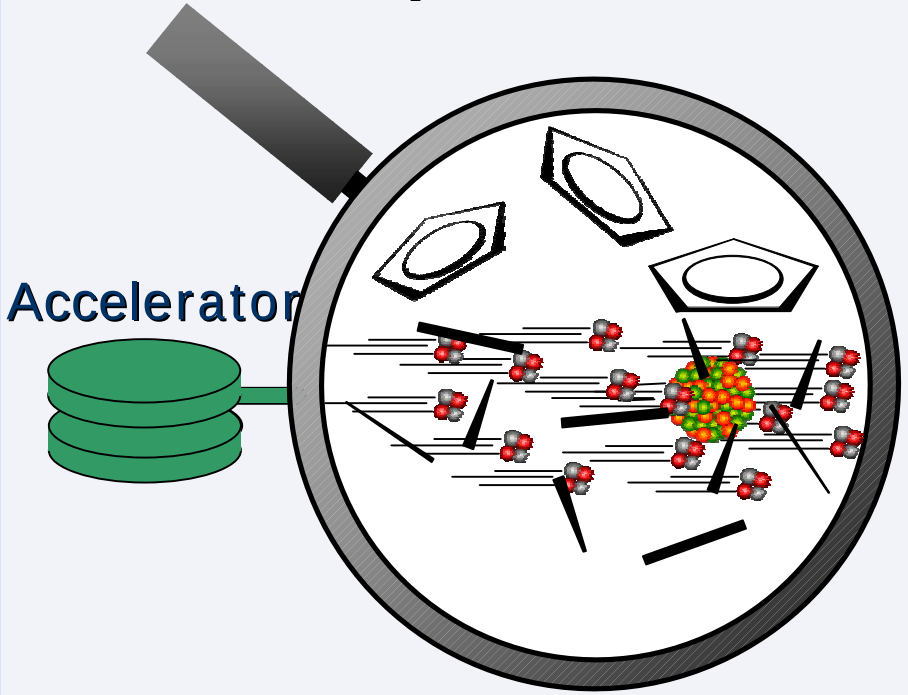


Gas Phase Chemistry: Present

Simple inorganic compounds: e.g. HsO_4

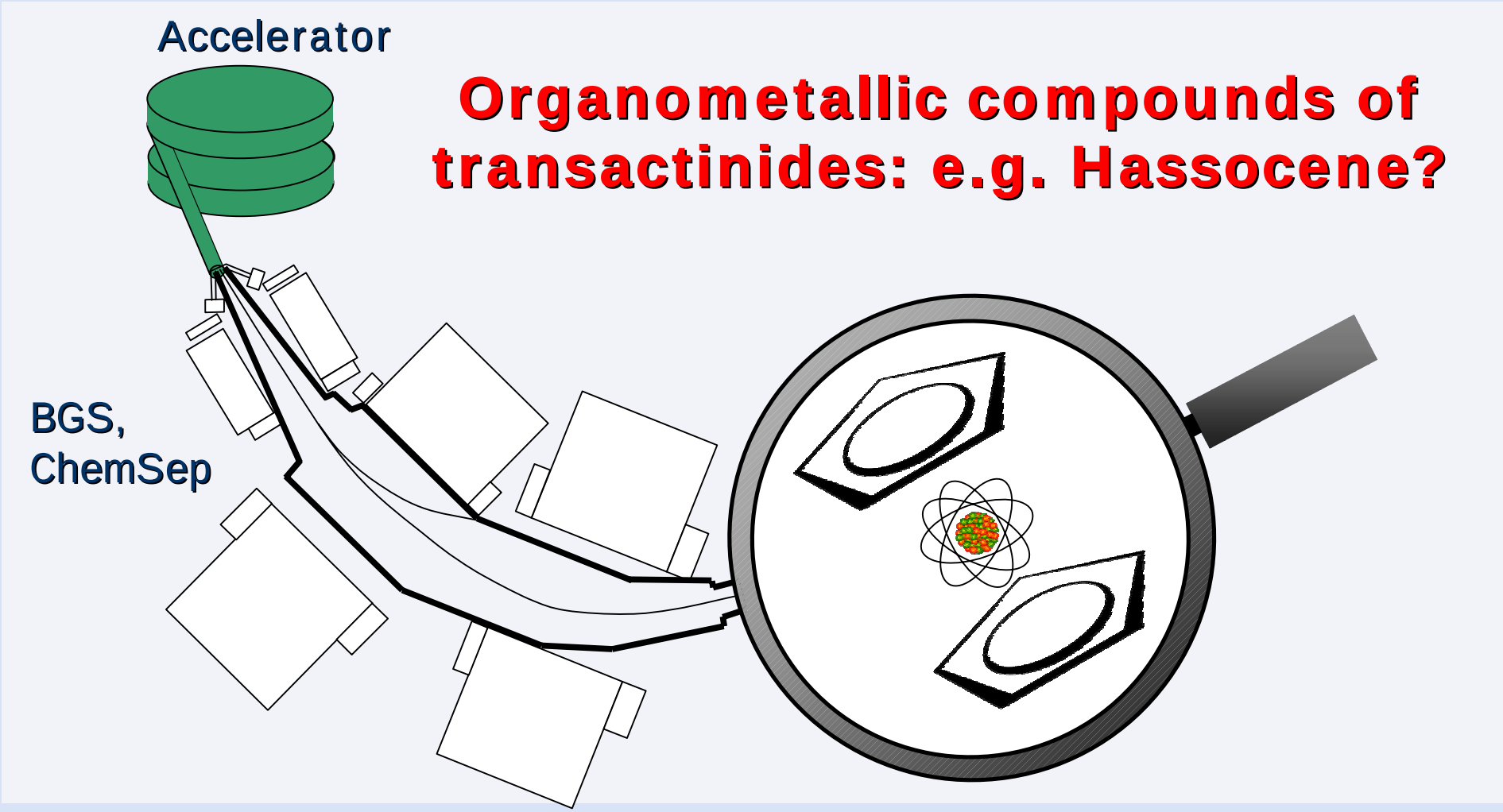


Organometallic compounds



Behind the target: Plasma (caused by the intense beam) destroys organic ligands

Gas Phase Chemistry: Future ?



No beam behind the target!! Separation @ BGS/ChemSep

Volatile Compounds in Group 8 Organometallic Chemistry

Metallocenes $M(cp)_2$

Observed in solid phase: $Fe(cp)_2 + U(n,f)Ru \rightarrow Ru(cp)_2$

(Baumgärtner et al. Z. Naturforsch. 16a (1961) 374)

$Ru(n,\gamma) + Fe(cp)_2 \rightarrow Ru(cp)_2$

(Baumgärtner et al. in: Chemical effects of nuclear transformations, IAEA Vienna 1961, p.319)

Dpm complexes (dpm=dipivaloylmethane)

Investigated with IC using carrier-free Ru from ^{252}Cf

(Ono et al. Abstract ASR2001)

Pentacarbonyles $M(CO)_5$

Well-known, stable (18 e^-)

Summary

Present

- First chemistry experiment with Hs. Cross-section level of a few pb. Seven correlated chains observed in 64 h of beam-time.
- Decay properties of ^{269}Hs are in agreement with SHIP results, confirming the discovery of element 112 by Hofmann et al. Evidence for ^{270}Hs was obtained
- Hs forms a volatile tetroxide. It behaves similar to Os and is a member of group 8 of the periodic table. $\Delta H_a(HsO_4)=(-47\pm2)$ kJ/mol.

Future

- Availability of a pre-separator (BGS, ChemSep) allows in principle the in-situ synthesis of less robuts compounds, e.g. organometallic ones.
- Promising systems in group 8 are the metallocenes, the pentacarbonyles and the dpm (=dipivaloylmethane) system, respectively.

Thank you!

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