Notes for Group Talk

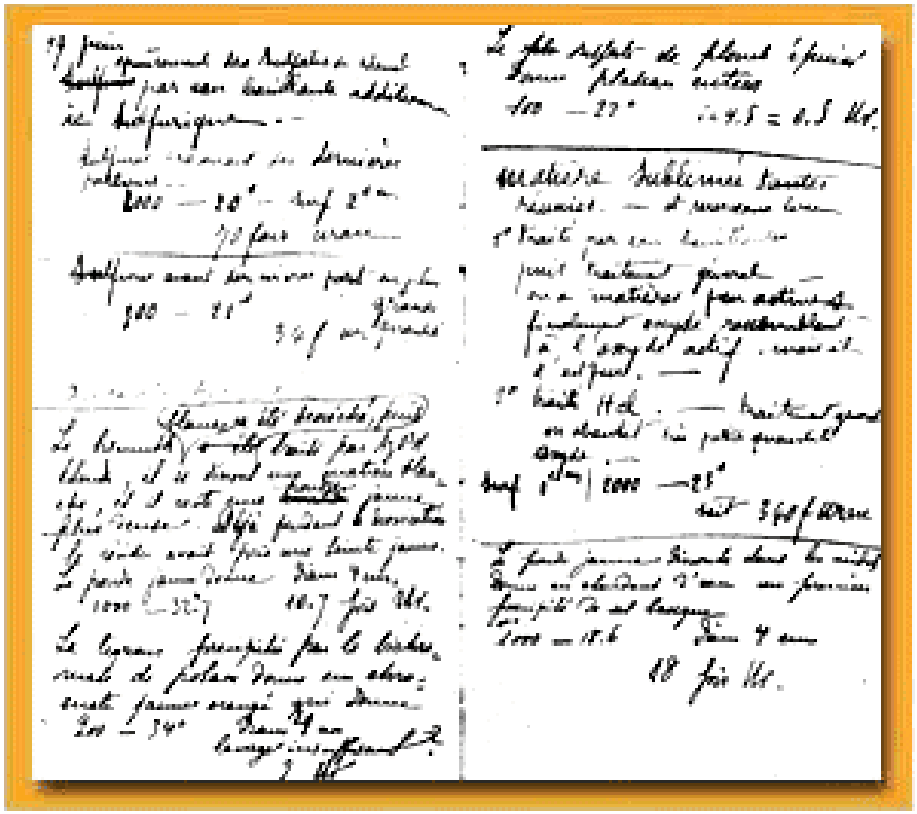
~~8~~ 15th May 2013

R. Collé

Radioactivity Group

NIST Physics Measurement Lab

^{209}Po News

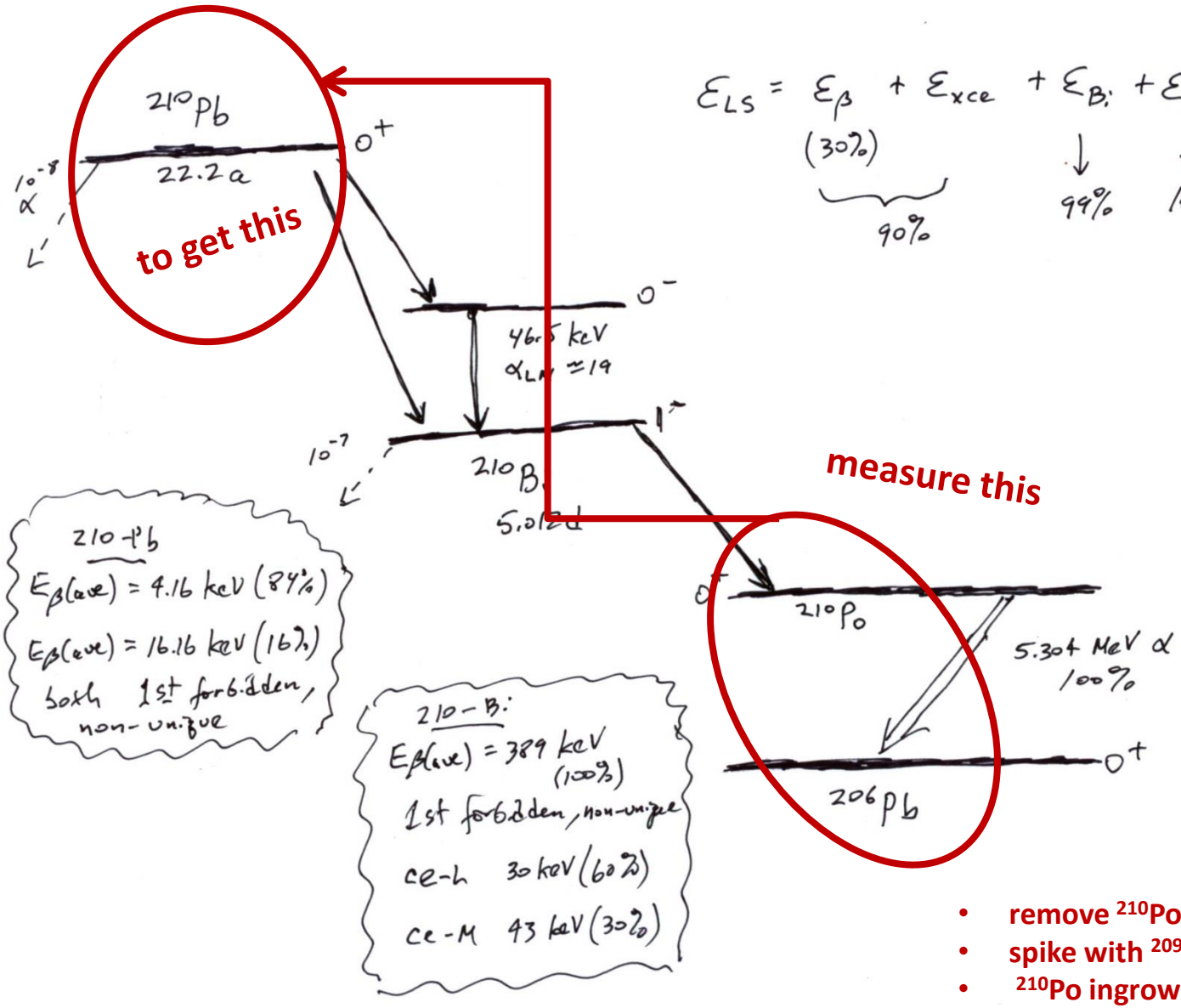


Pages from the laboratory notebooks of the Curies (June, 1898). Experiments made shortly before the publication of the discovery of polonium, written alternately by Marie and Pierre Curie.

World needs a Po tracer standard !

^{210}Po	0.4 a	5.3 MeV α
^{208}Po	2.9 a	5.1 MeV α
^{209}Po	~~102 a~~ ?	4.9 MeV α + *junk*

^{210}Pb assay



- remove ^{210}Po
- spike with ^{209} Po for yield
- ^{210}Po ingrowth & measure both

< 1990

208Po

210Po

PAPER

1991

Long-Term Stability of Carrier-Free Polonium Solution Standards

1993-94

Preparation and Calibration of Carrier-Free ^{209}Po Solution Standards

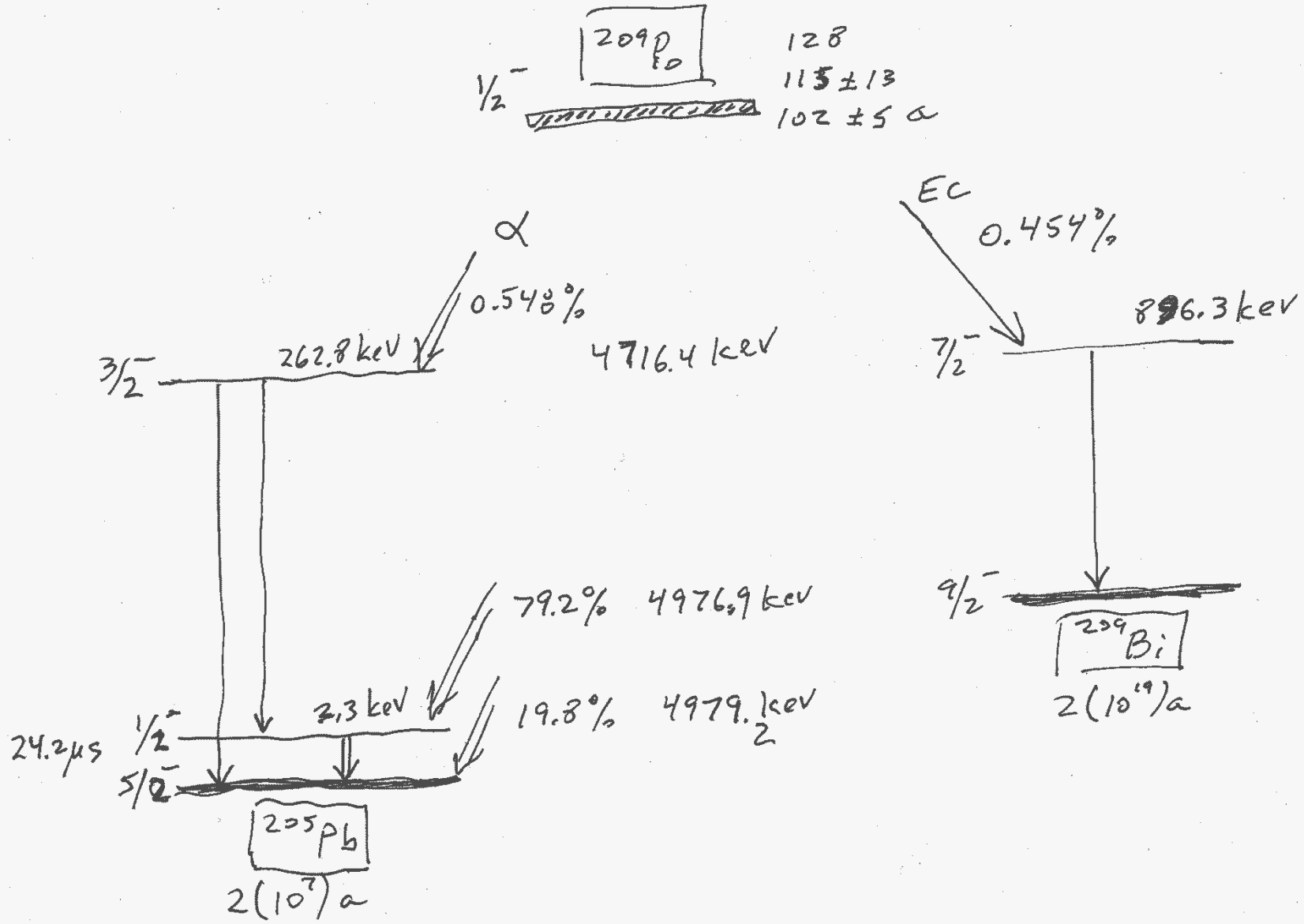
2005

ScienceDirect

A note on the half-life of ^{209}Po

NPL 2011-2012

NOW!


209Po
1/2−
128
115 ± 13
102 ± 5 a
α
0.54 8 %
262.8 keV
4716.4 kev
3/2−
EC
0.454 %
896.3 kev
7/2−
79.2 %
4976.9 kev
19.8 %
4979.1 kev
2
9/2−
209Bi
2(10^19)a
24.2 μs
1/2−
2.3 kev
5/2−
205Pb
2(10^7)a

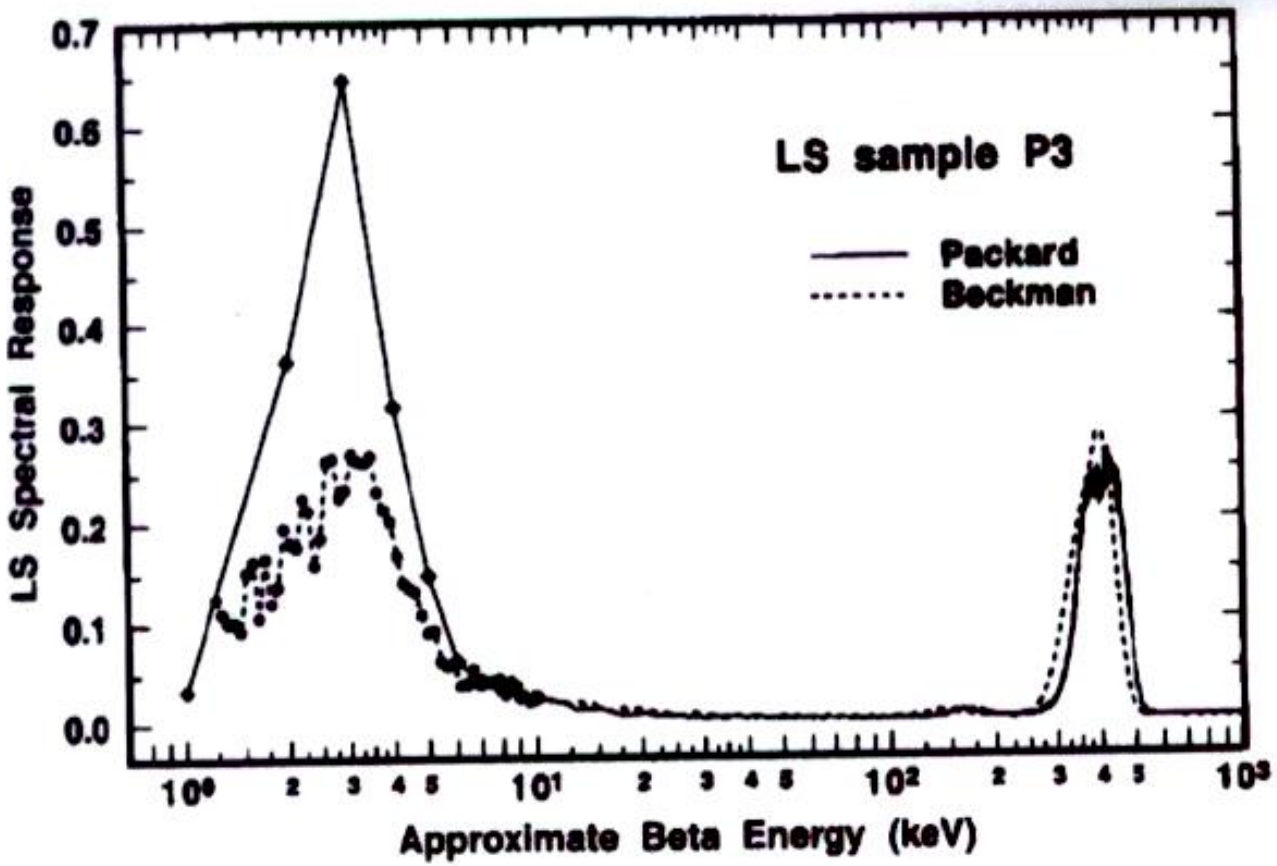


Fig. 6. Comparison of the ^{210}Po LS spectra obtained with the Beckman and Packard instruments

1995

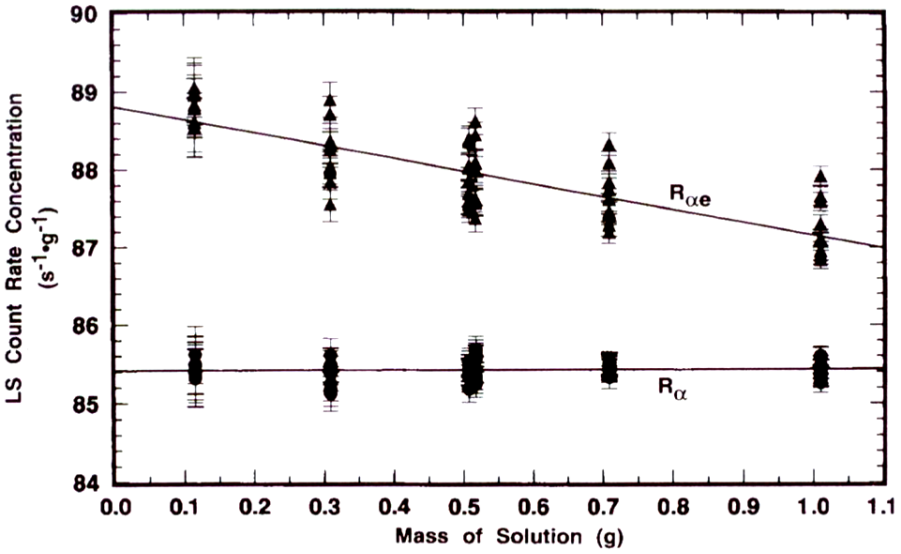


Fig. 12. LS counting rate concentrations $R_{\alpha e}$ and R_{α} as a function of m_s (analogous to that of Fig. 11) as obtained with the Packard instrument.

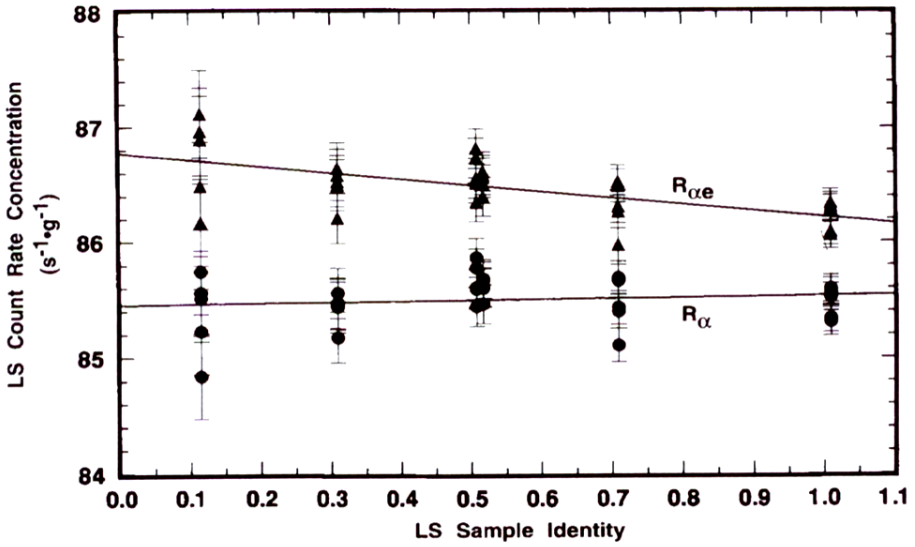


Fig. 11. LS counting rate concentrations $R_{\alpha e}$ (closed triangles) and R_{α} (closed circles) obtained with the Beckman instrument for the N series samples as a function of m_s (and sample quenching). The solid lines are linear regressions fitted to the data.

Same
in 2005

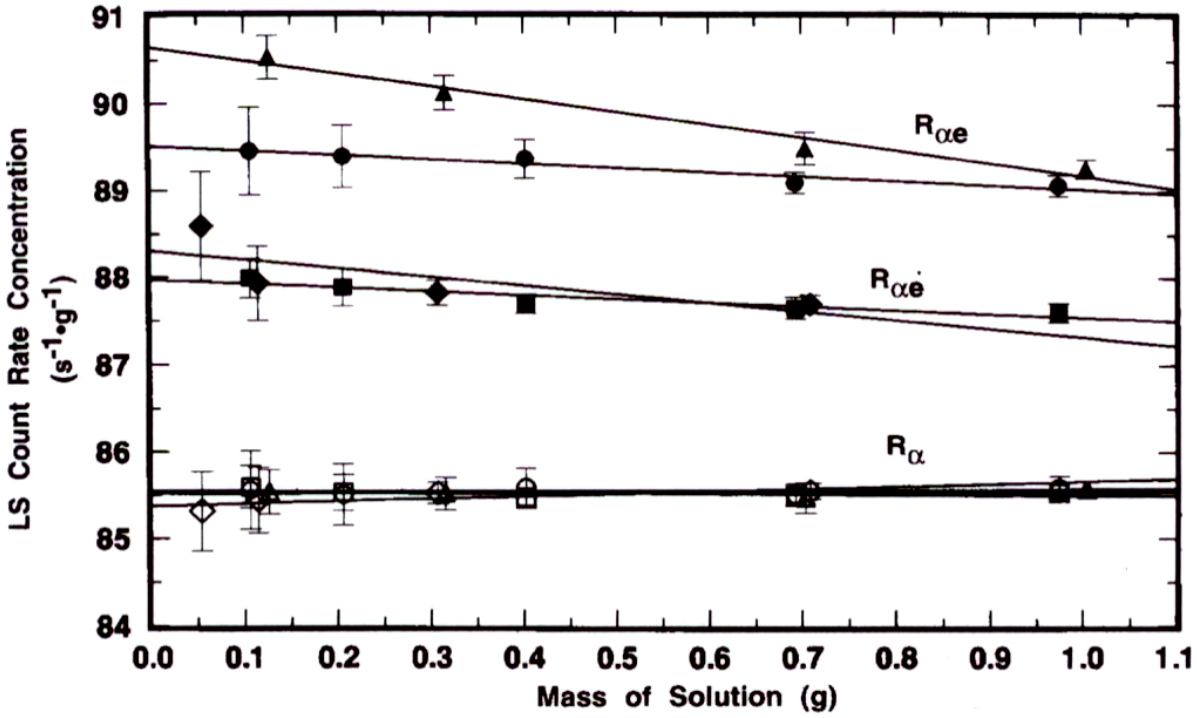


Fig. 13. LS counting rate concentrations $R_{\alpha e}$ and R_{α} obtained with the two LS systems for the P and Q series samples in 1994. Closed squares ($R_{\alpha e}$) and open squares (R_{α}) represent the mean values for samples Q5 through Q8 with the Packard; closed and open triangles represent $R_{\alpha e}$ and R_{α}, respectively, for samples P1 through P5 with the Packard; closed and open triangles ($R_{\alpha e}$ and R_{α}) are for samples Q1 through Q4 with the Beckman; and closed and open circles ($R_{\alpha e}$ and R_{α}) are for samples P1 through P5 with the Beckman. Each plotted value corresponds to the mean of 5 to 18 replicate measurements on each sample. The error bars represent standard deviation uncertainty intervals on the means. The solid lines are unweighted linear fits to the data. Although the $R_{\alpha e}$ values vary with the instrument used to perform the measurements (Packard or Beckman) and with sample compositions, all of the R_{α} values are statistically equivalent and invariant.

from 2005

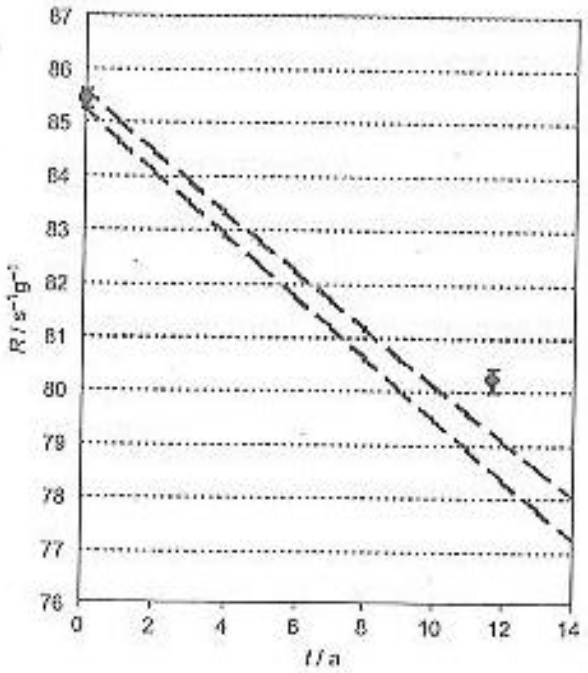


Fig. 1. The massic alpha particle emission rate R (in units of alphas per second per gram) for the standardized ^{209}Po solution standard as a function of time t (in years). The two data points are from the primary standardizations conducted 11.7 years apart and exhibit an apparent half-life of about 128 years. The error bars show the combined standard uncertainty intervals on the two measurements. The broken curves correspond to the upper and lower uncertainty bounds (for the combined standard uncertainty) on the decay of the 1994 value of R using a half-life of (102 ± 5) a. Refer to the text for additional detail.

Collé, Laureano-Perez, Outola

Appl. Radiat. Isot. 65, 728-730 (2007)

15 march 1994
R_α = (85.42 ± 0.18) $s^{-1}g^{-1}$

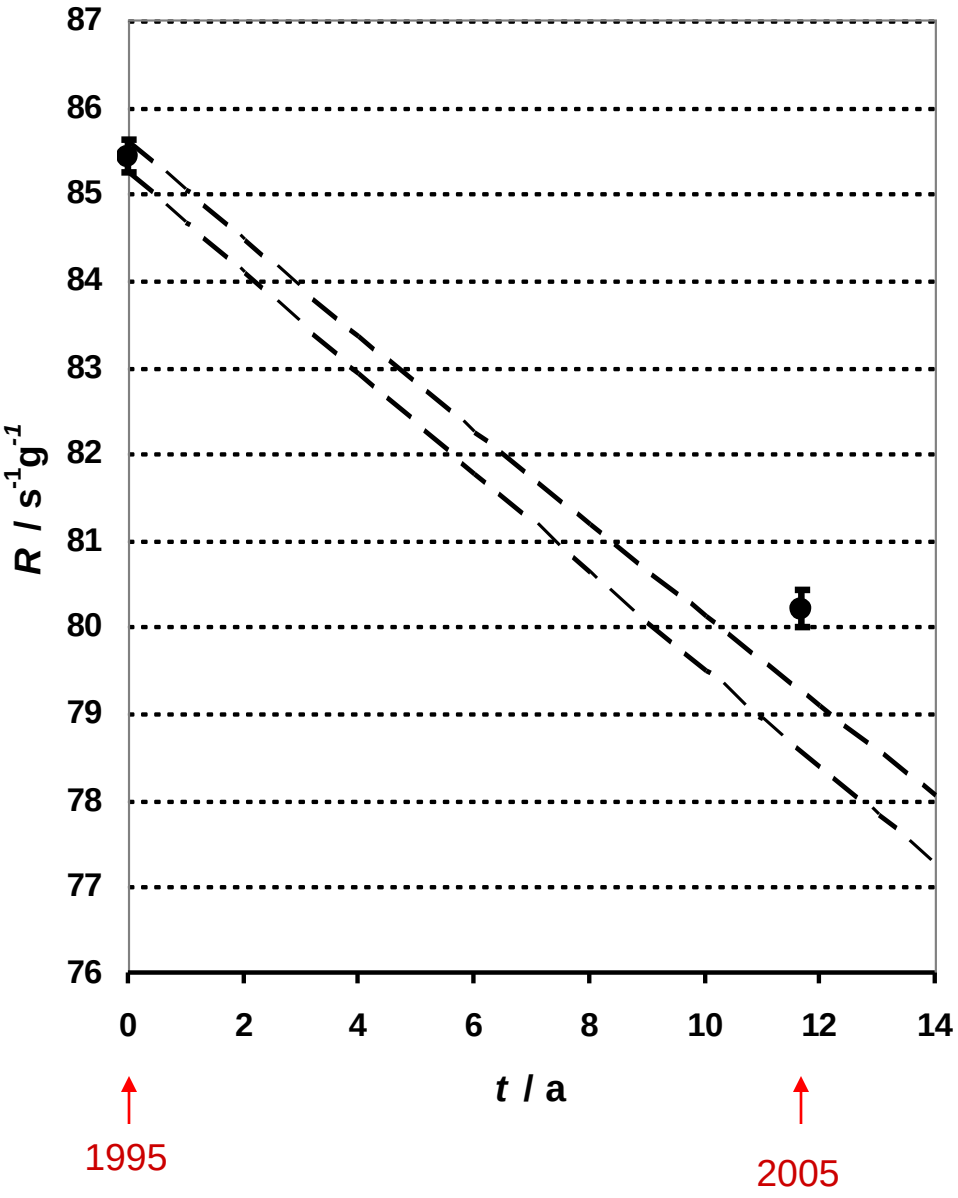
15 November 2005
R_α = (80.20 ± 0.22) s-1g-1

2 point fit gives

$T_{1/2}$ = 128 a

U = 5.5 % (7 a)

<u>Not</u> considered a new determination



Andre, Huizenga, et al. 1956 *Phys Rev.* 101, 645-651

^{208}Po/^{209}Po mass ratio 1.14 %

^{208}Po/^{209}Po activity ratios 5 %

} “private communication”

with $T_{1/2}(^{208}\text{Po}) = (2.93 \pm 0.03)$ a,

got $T_{1/2}(^{208}\text{Po}) = 103$ a

Compiler M. Martin,1991

must be wrong

with $T_{1/2}(^{208}\text{Po}) = 2.898 \pm 0.002$ a,

got $T_{1/2}(^{208}\text{Po}) = (102 \pm 5)$ a 4.9 %

^{209}Po half-life in error by 25 % !!

Result supported by work on ^{210}Pb – next story

Collé, Laureano, Outola, *Appl. Radiat. Isot.* **65**, 728-730 (2007)

New determination urgently needed

$$\frac{A}{N} = \lambda$$

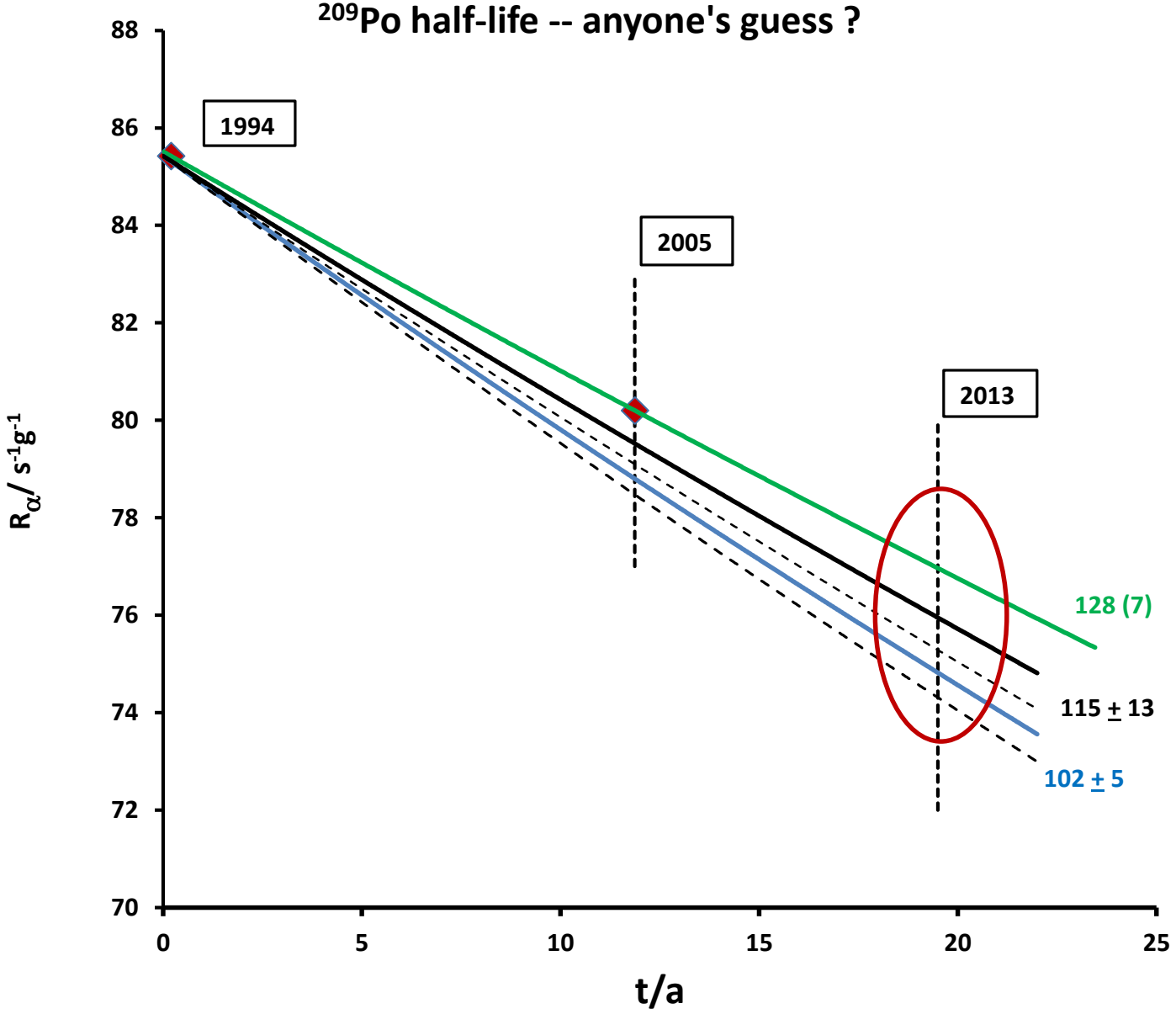
(link)

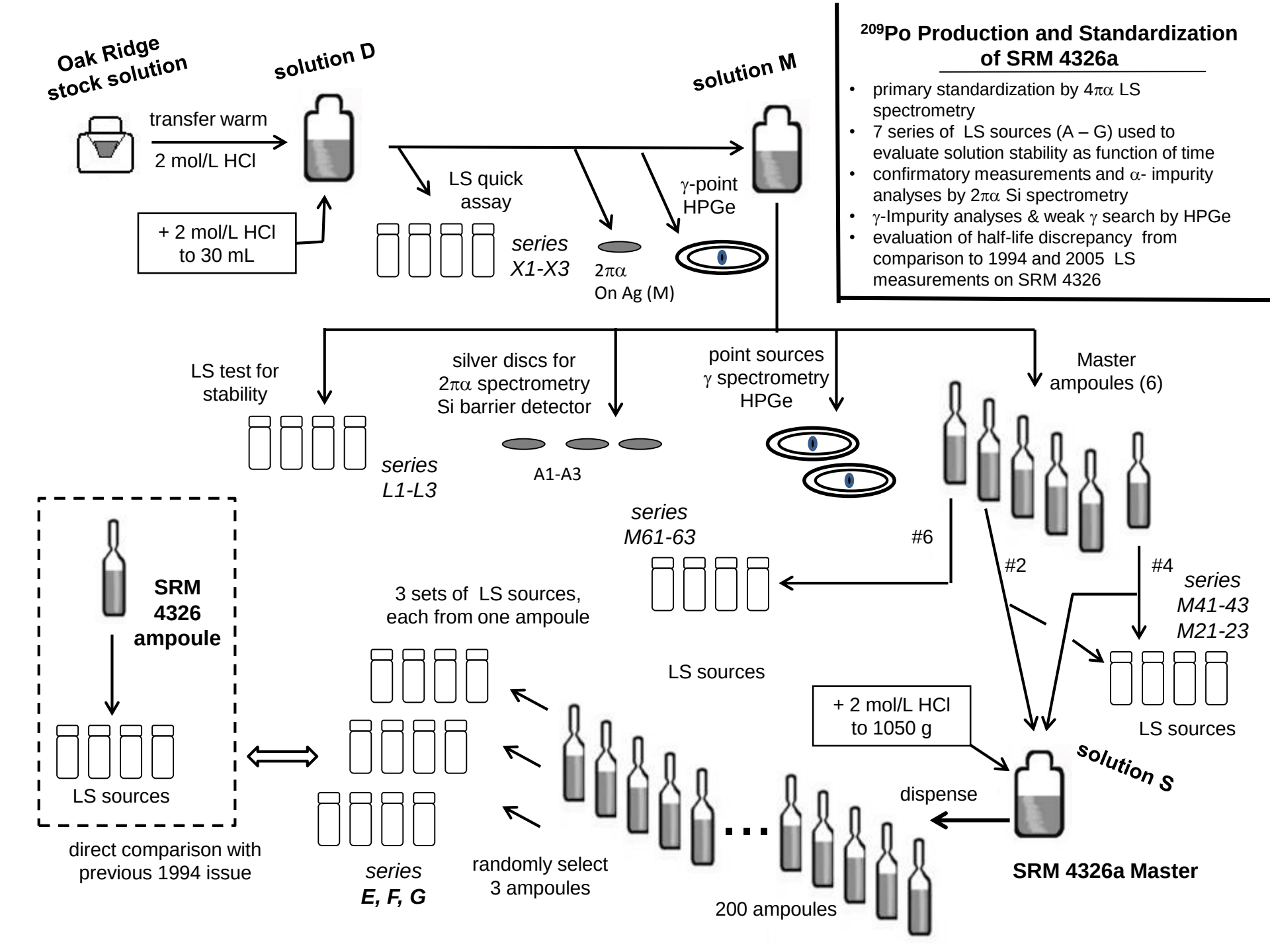
Collaboration with Polish Academy of Sciences labs

Institute of Nuclear Physics (Krakow)

Institute of Geological Sciences (Warsaw)

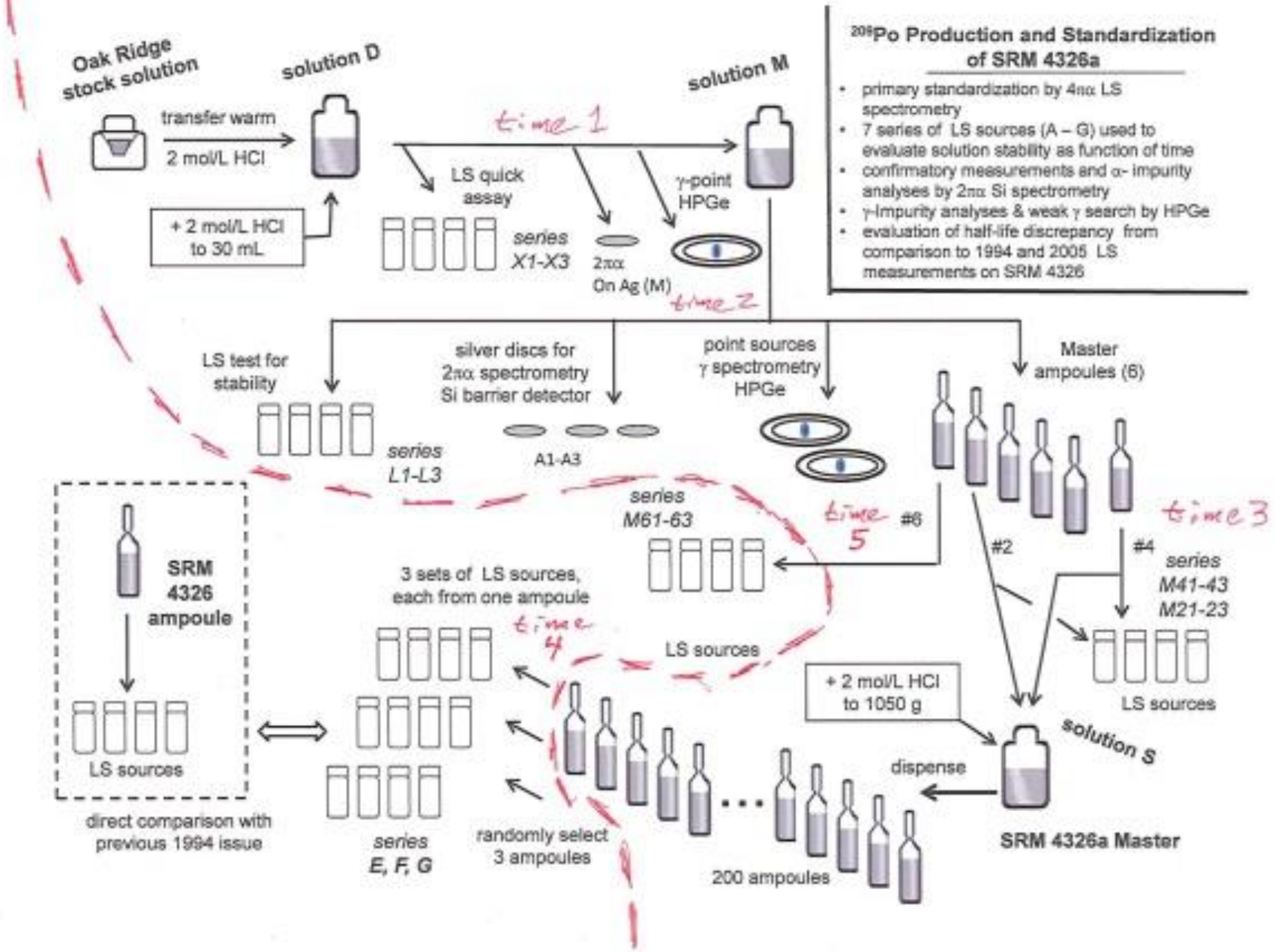
not going well ...


209Po half-life -- anyone's guess ?
1994
2005
2013
128 (7)
115 ± 13
102 ± 5
Rα / s-1g-1
t/a
88
86
84
82
80
78
76
74
72
70
0
5
10
15
20
25

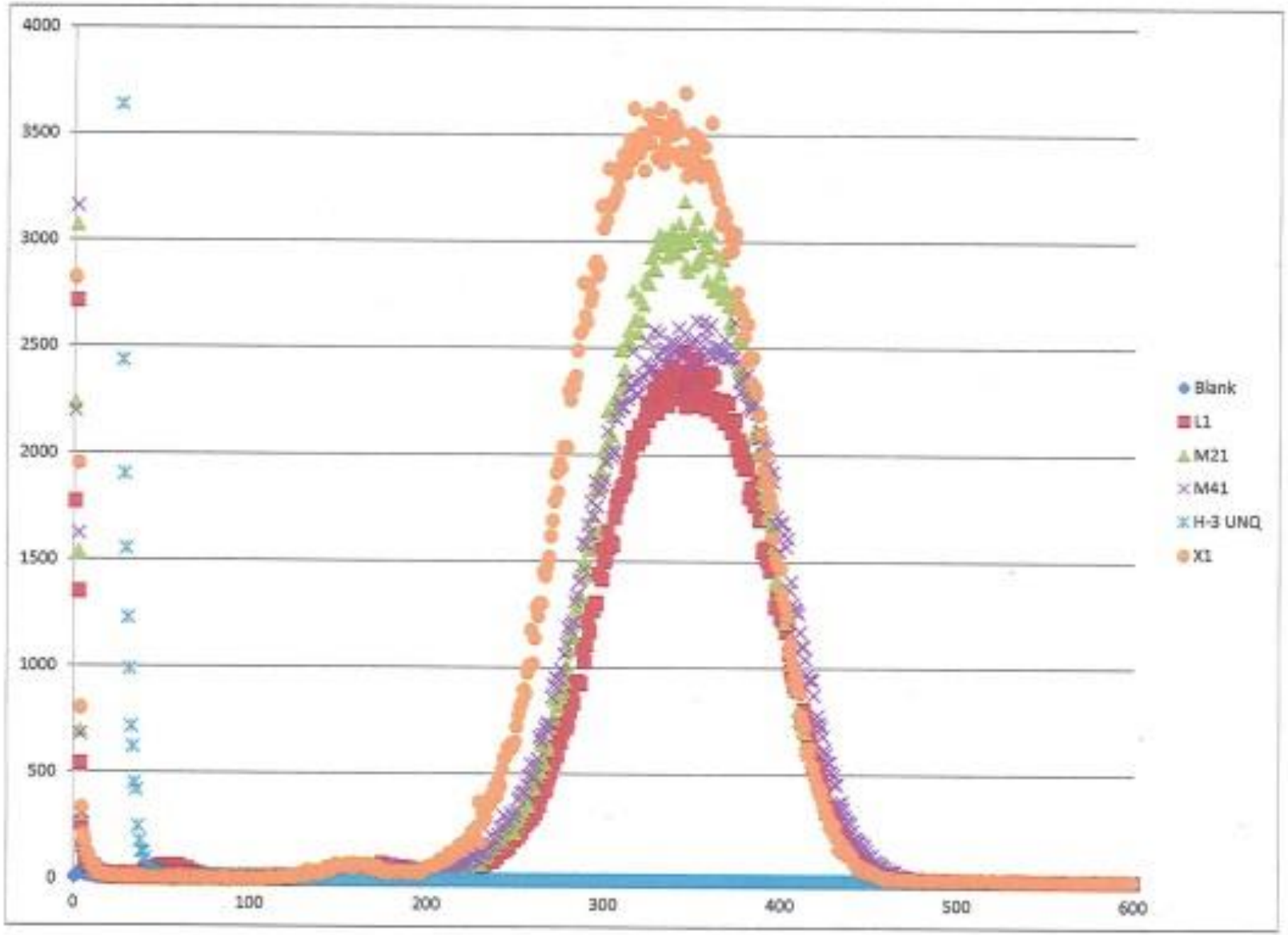


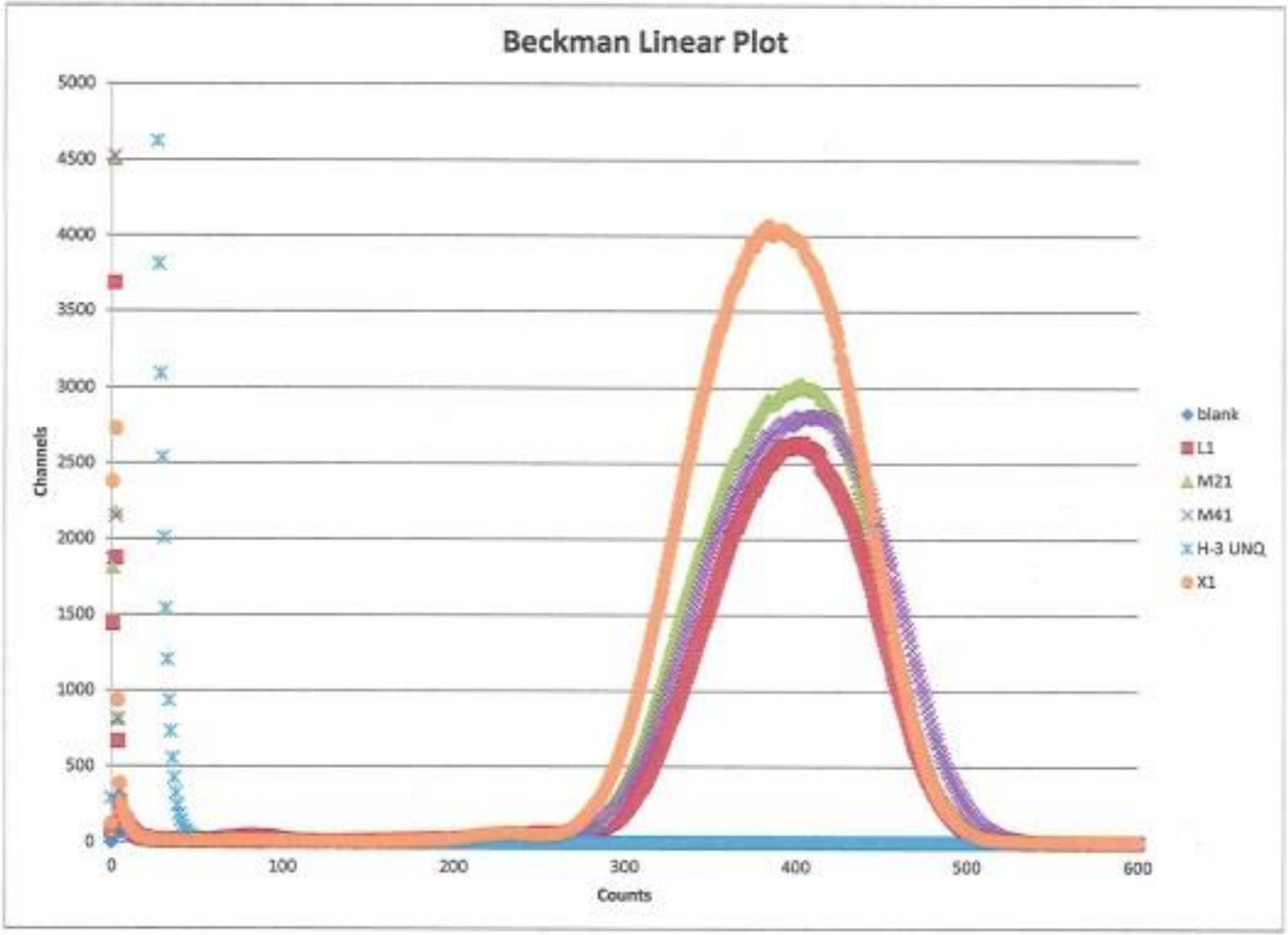
^{209}Po Production and Standardization of SRM 4326a

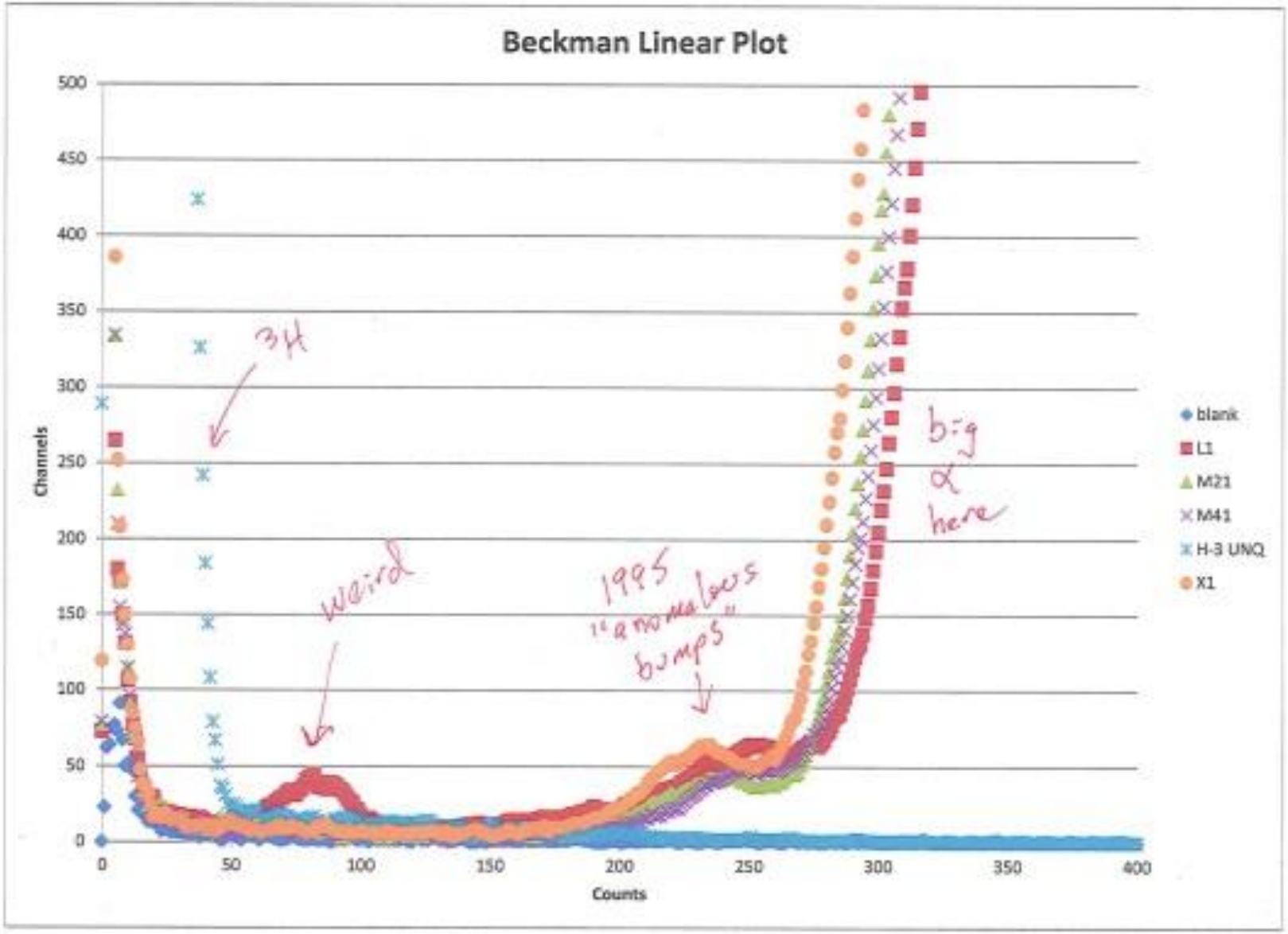
- primary standardization by 4πα LS spectrometry
- 7 series of LS sources (A – G) used to evaluate solution stability as function of time
- confirmatory measurements and α- impurity analyses by 2πα Si spectrometry
- γ-Impurity analyses & weak γ search by HPGe
- evaluation of half-life discrepancy from comparison to 1994 and 2005 LS measurements on SRM 4326


Oak Ridge stock solution
transfer warm
2 mol/L HCl
solution D
+ 2 mol/L HCl to 30 mL
time 1
LS quick assay
γ-point HPGe
series X1-X3
2πα On Ag (M)
solution M
time 2
LS test for stability
series L1-L3
silver discs for 2πα spectrometry Si barrier detector
A1-A3
point sources γ spectrometry HPGe
Master ampoules (6)
series M61-63
time 5
#6
#2
#4
time 3
series M41-43 M21-23
SRM 4326 ampoule
LS sources
direct comparison with previous 1994 issue
3 sets of LS sources, each from one ampoule
time 4
LS sources
series E, F, G
randomly select 3 ampoules
200 ampoules
+ 2 mol/L HCl to 1050 g
solution S
dispense
SRM 4326a Master
LS sources
208Po Production and Standardization of SRM 4326a
primary standardization by 4πα LS spectrometry
7 series of LS sources (A – G) used to evaluate solution stability as function of time
confirmatory measurements and α- impurity analyses by 2πα Si spectrometry
γ-Impurity analyses & weak γ search by HPGe
evaluation of half-life discrepancy from comparison to 1994 and 2005 LS measurements on SRM 4326

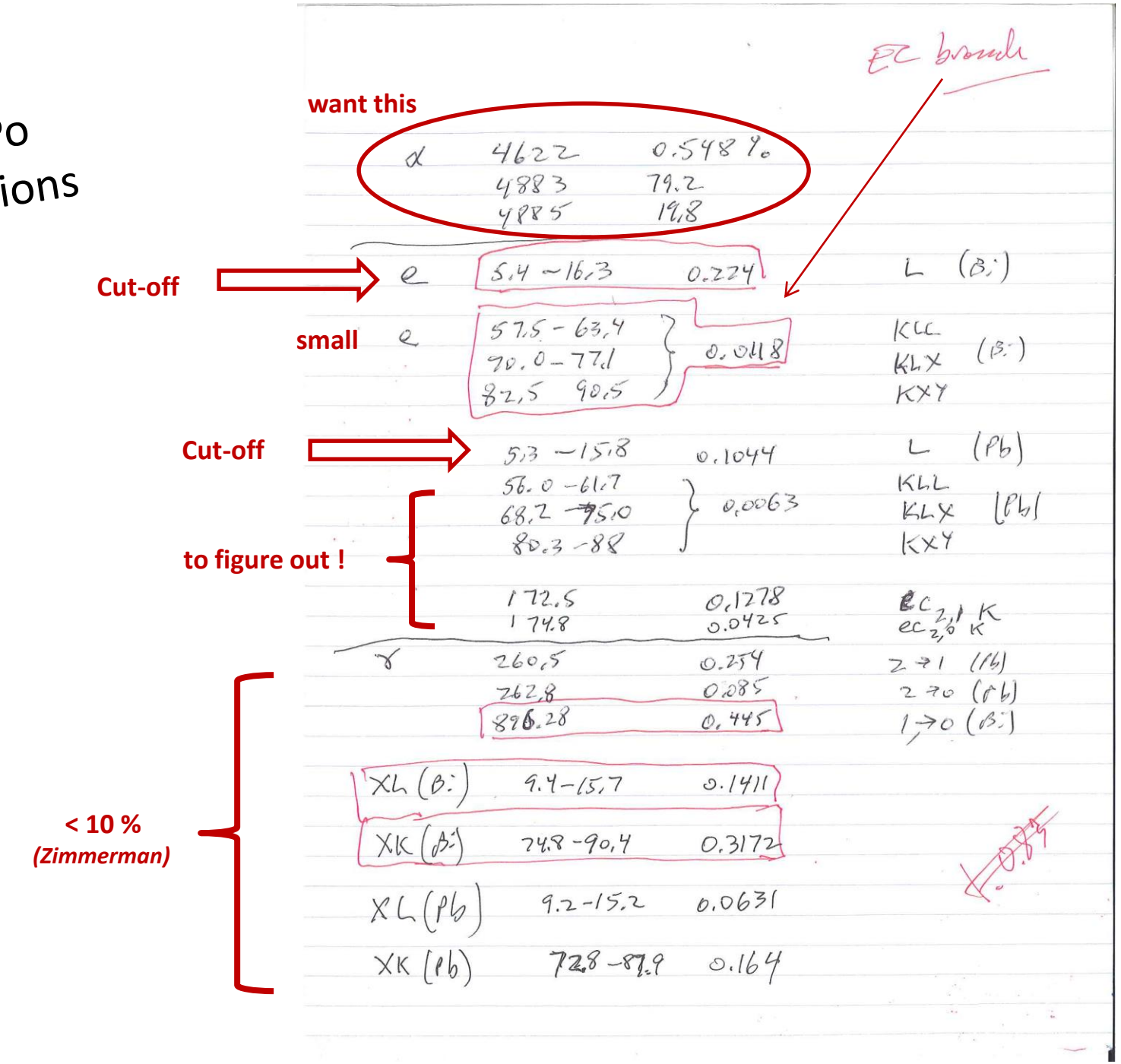
WALLAC

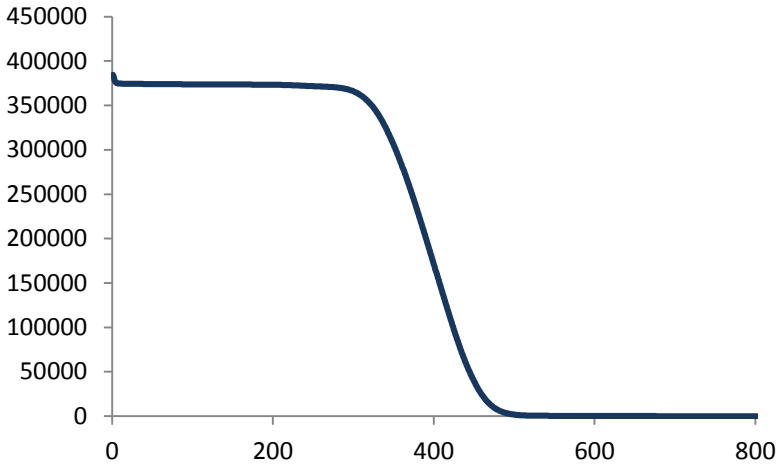

4000
3500
3000
2500
2000
1500
1000
500
0
0
100
200
300
400
500
600
Blank
L1
M21
M41
H-3 UNQ
X1


Beckman Linear Plot
Channels
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
100
200
300
400
500
600
Counts
blank
L1
M21
M41
H-3 UNQ
X1


Beckman Linear Plot
Channels
Counts
0
50
100
150
200
250
300
350
400
450
500
blank
L1
M21
M41
H-3 UNQ
X1
3H
weird
1995
"anomalous
bumps"
b:g
α
here

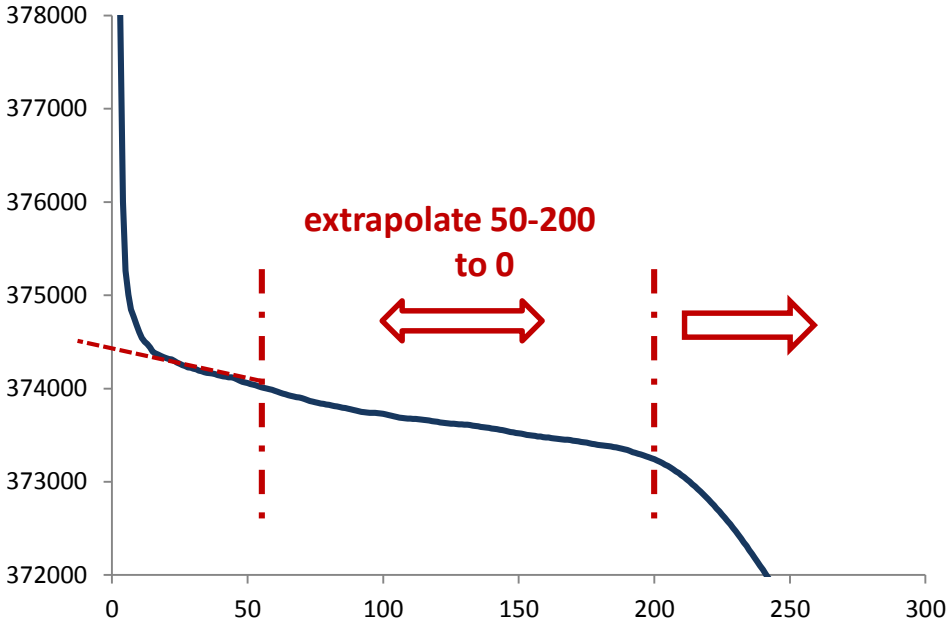
all ^{209}Po radiations

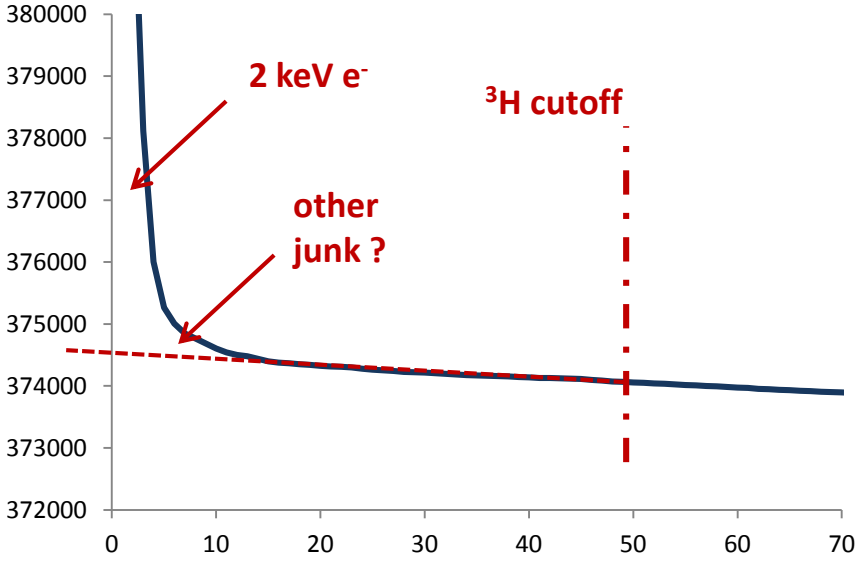




INTEGRAL LS SPECTRUM ^{209}Po

(M21 on Beckman)





2.7 % below 50

0.21 % in 50-200 region → + 0.28 % to 0

Fin

thanks

Lizbeth Laureano-Perez
principal worker bee

Ryan Fitzgerald
project's devil's advocate

Dan Golas
ampoule-sealer extraordinaire