An EC-branch in the decay of 27-s ^{263}Db: Evidence for the new isotope ^{263}Rf

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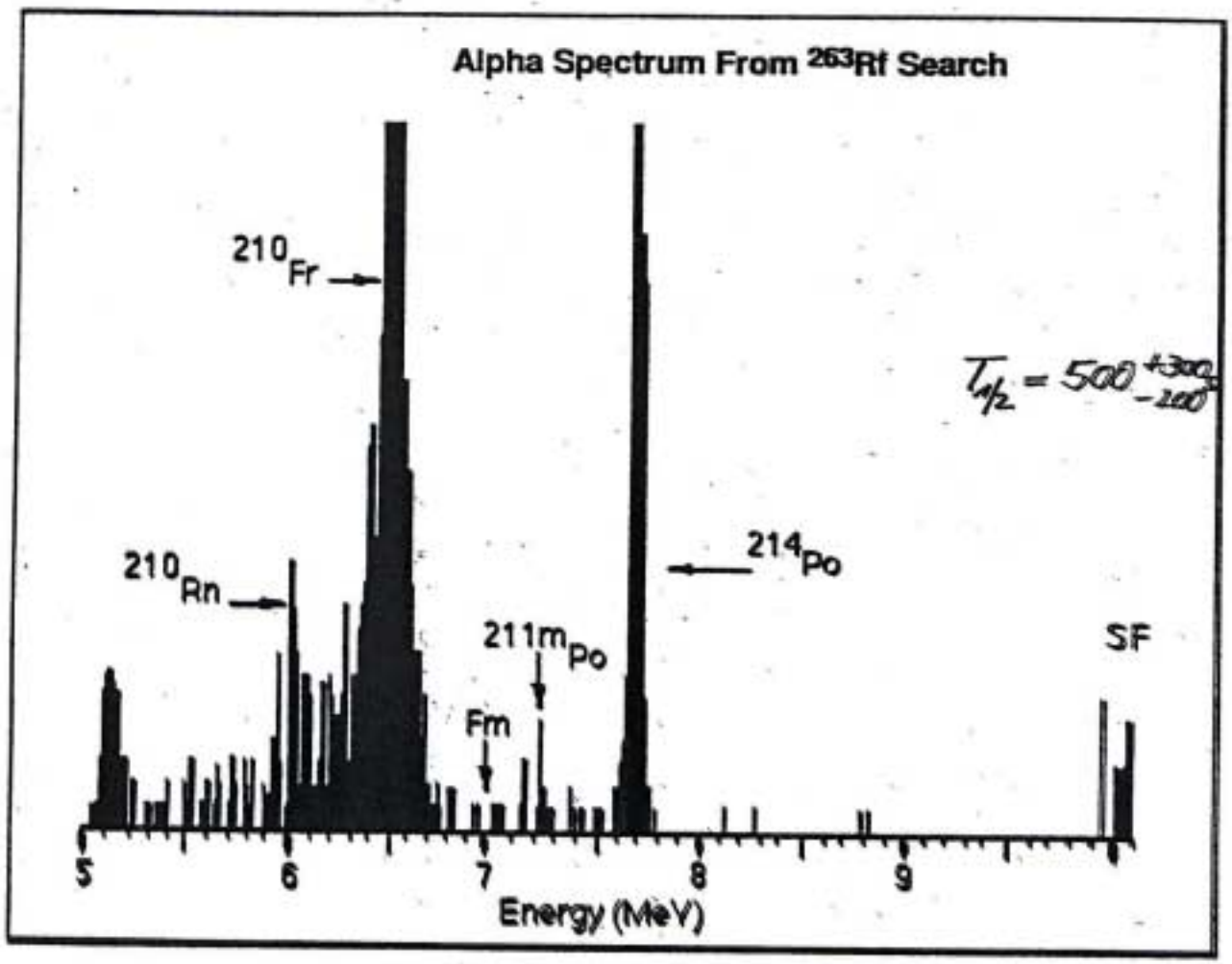
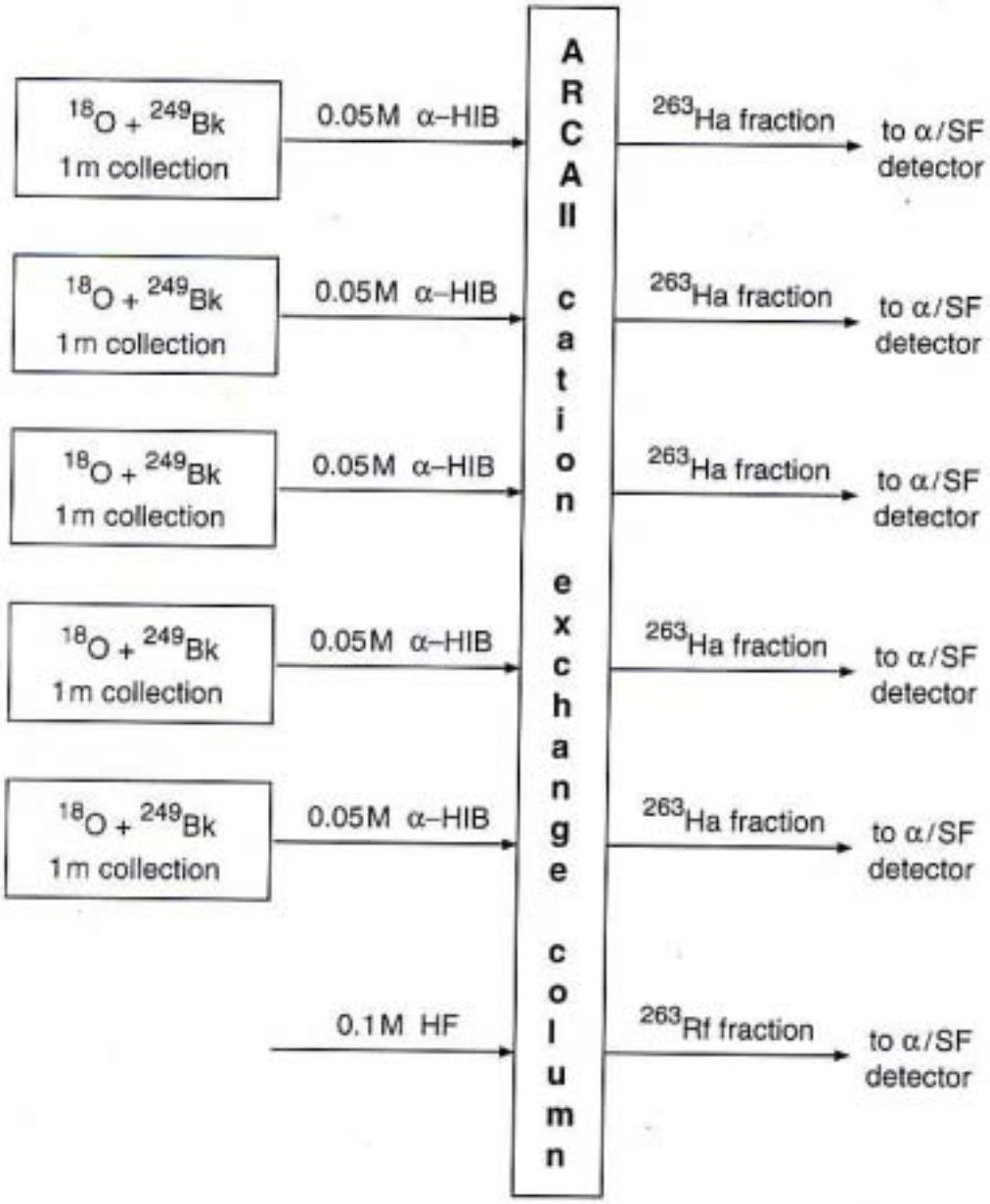
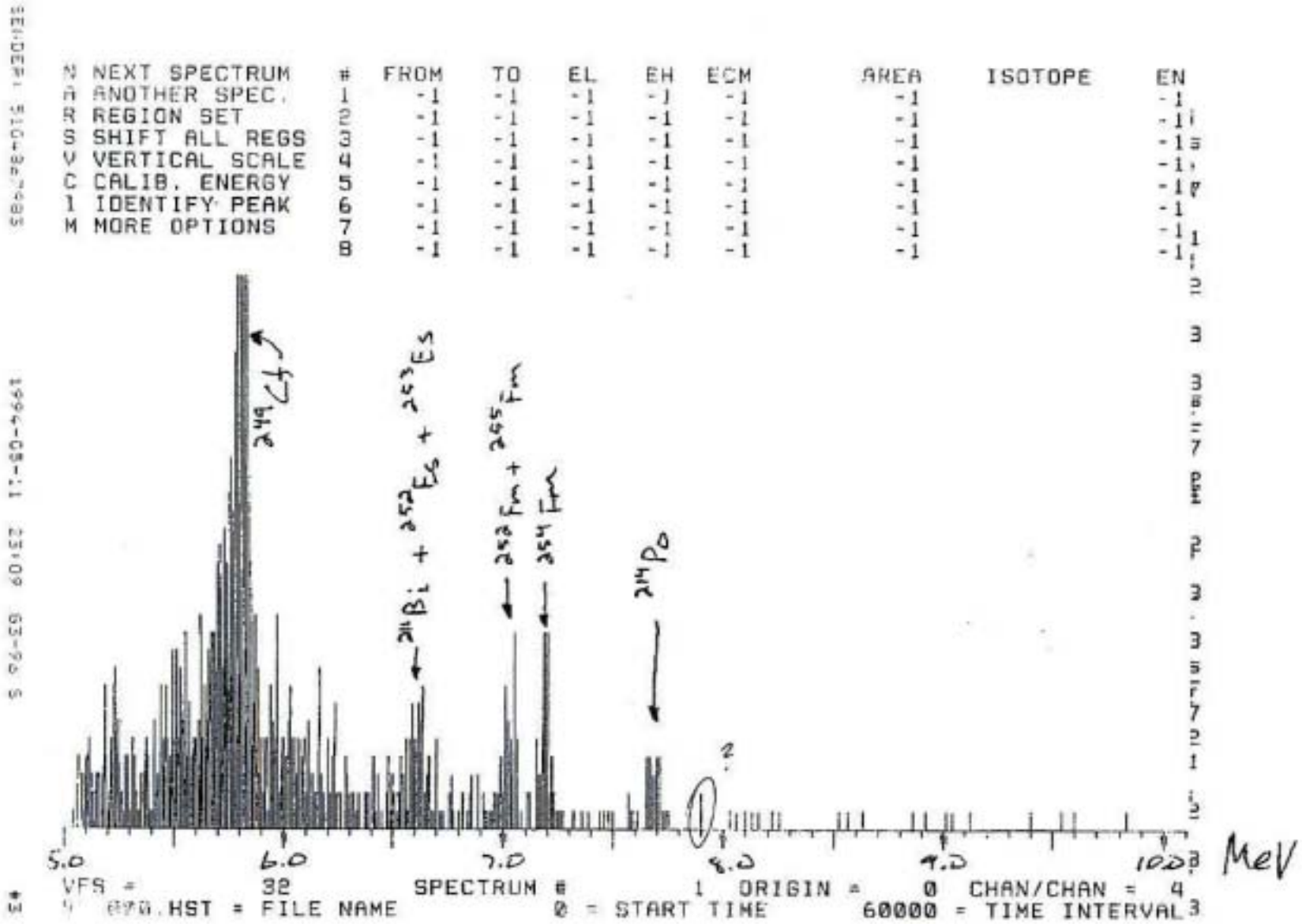
K.R. Czerwinski, LBL-32 233

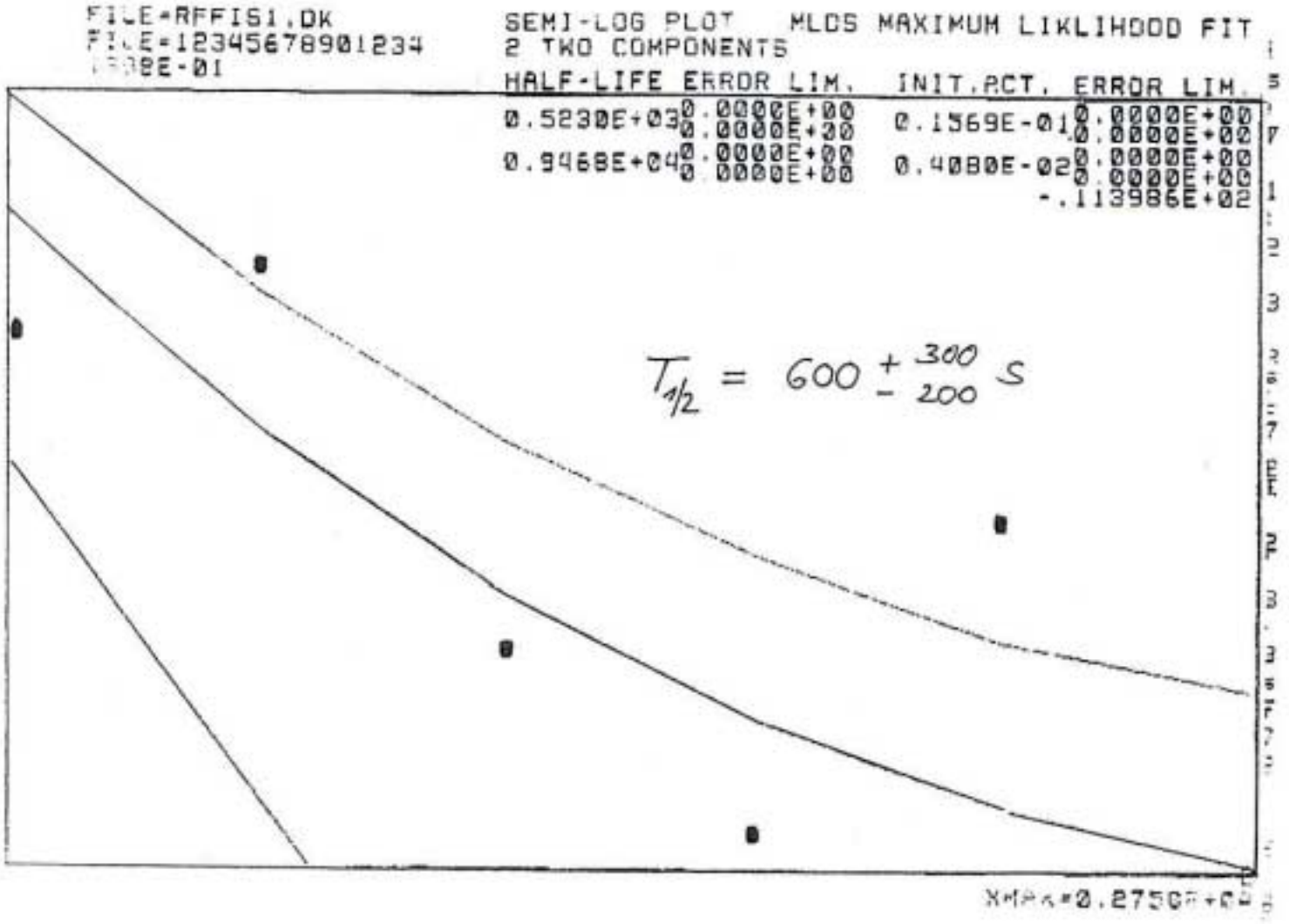
$^{248}Cm(^{18}O, 3n)$





Search for an EC branch in the decay of ^{263}Db
K.E. Gregorich, GSI 95-1, p. 14

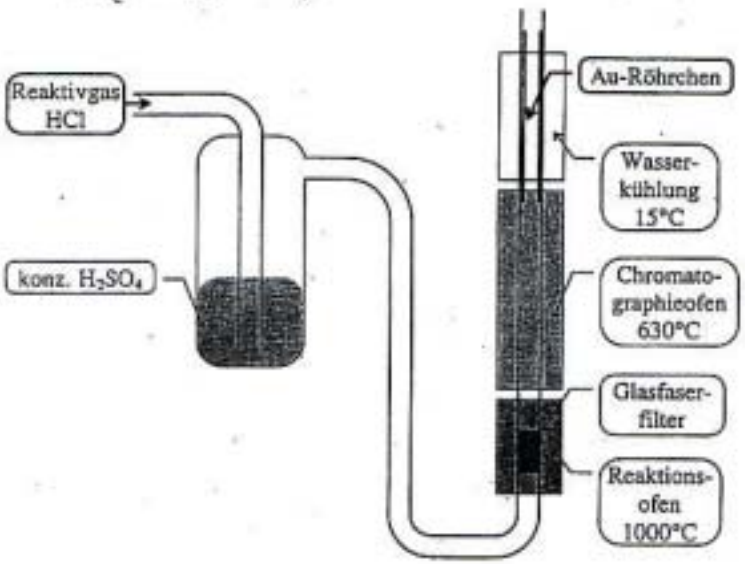

N NEXT SPECTRUM
A ANOTHER SPEC.
R REGION SET
S SHIFT ALL REGS
V VERTICAL SCALE
C CALIB. ENERGY
I IDENTIFY PEAK
M MORE OPTIONS
FROM TO EL EH ECM AREA ISOTOPE EN
1 -1 -1 -1 -1 -1 -1 -1
2 -1 -1 -1 -1 -1 -1 -1
3 -1 -1 -1 -1 -1 -1 -1
4 -1 -1 -1 -1 -1 -1 -1
5 -1 -1 -1 -1 -1 -1 -1
6 -1 -1 -1 -1 -1 -1 -1
7 -1 -1 -1 -1 -1 -1 -1
8 -1 -1 -1 -1 -1 -1 -1
249 Cf
211 Bi + 252 Es + 253 Es
253 Fm + 255 Fm
254 Fm
214 Po
?
5.0
6.0
7.0
8.0
9.0
10.0
MeV
VFS = 32 SPECTRUM # 1 ORIGIN = 0 CHAN/CHAN = 4
.HST = FILE NAME 0 = START TIME 60000 = TIME INTERVAL



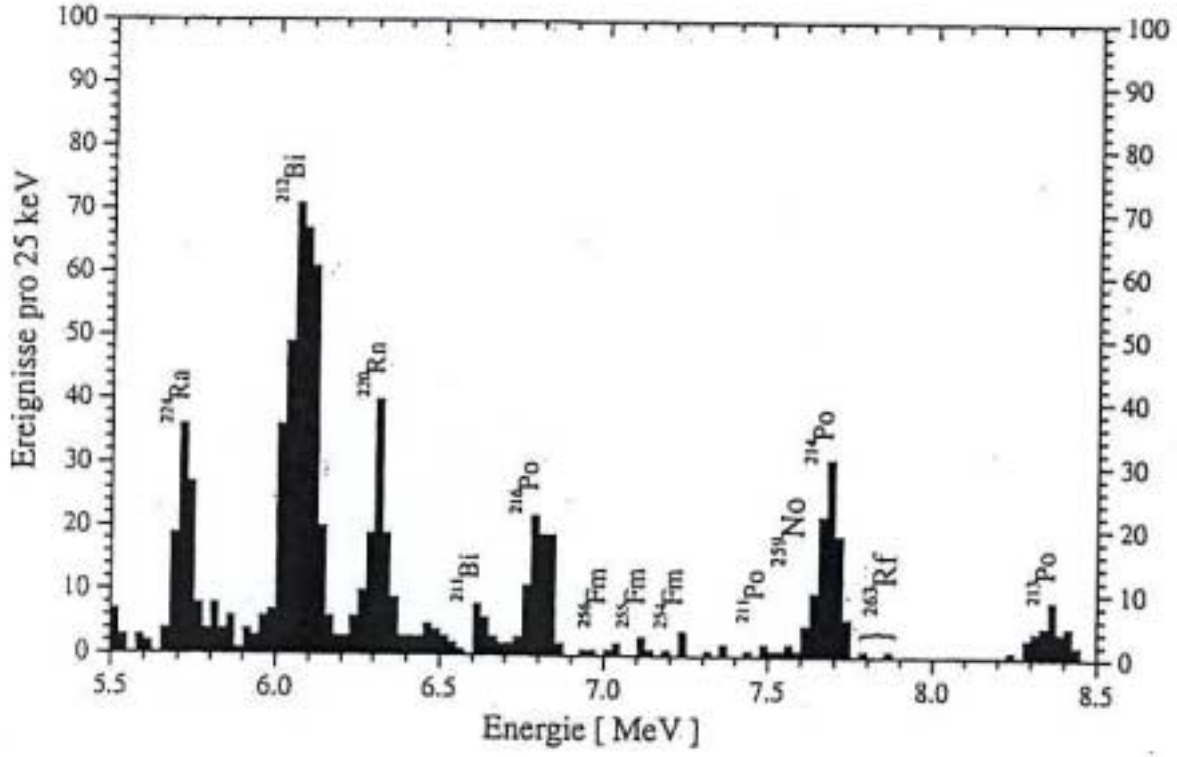
EC branch in ^{263}Db $\approx 5\%$

R. Dressler 1999

$^{248}Cm(^{22}Ne, \alpha 3n)$



Nr.	Typ	E_α [MeV]	Zeit [s]
1	α	7.791	5
2	α	7.873	1058
3	SF		4348
4	SF		17378
5	SF		18817
6	SF		49647



SEARCH FOR ^{263}Rf IN AQUEOUS SOLUTION

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The reaction ^{248}Cm(^{22}Ne, α3n) was used to produce the nuclide ^{263}Rf. A Rf fraction was isolated using cation exchange chromatography. Two events were found which could probably be attributed to the α-particle decay of ^{263}Rf.

1 INTRODUCTION

The development of heavy element research within the last years clearly shows evidence for the existence of relatively long-lived neutron-rich nuclei in the region Z=108 and *N*=162, but also for the newly discovered most neutron-rich isotopes of superheavy elements with Z=108-114 [1]. Isotopes of heavy elements with half-lives longer than one hour are very interesting, especially for studies of their chemical behaviour in aqueous solution. Unfortunately, these long-lived nuclei are not accessible by hot fusion neutron evaporation reactions. One alternative to produce such very neutron-rich isotopes is the use of (HI,αxn) reactions [2]. Several studies of the nuclear reaction ^{22}Ne + ^{248}Cm showed evidence for the formation of ^{263}Rf in the α3n reaction channel, see e.g. [2]. Predictions of the decay properties of ^{263}Rf indicate that this nuclide may decay by α-particle emission with a half-life of the order of one hour [3]. Preliminary studies with model nuclides as well as with short-lived Hf isotopes [4,5] showed that ion exchange on strongly acidic cation exchangers with 0.5 M HF solution as eluent is suitable for the separation of Rf both from all unwanted contaminants like Bi, At and Pb isotopes as well as from its α-decay product No.

2 EXPERIMENTAL

A Cm target (0.73 mg/cm^2 ^{248}Cm electrodeposited on 2.34 mg/cm^2 Be, 95.7 % ^{248}Cm, 4.2 % ^{246}Cm, 0.1 % other Cm-isotopes) was bombarded with an integral beam dose of 1.03×10^{17} ^{22}Ne particles. The beam energy in the middle of the target was 122±1 MeV. The reaction products were transported from the target chamber to the laboratory with a KCl aerosol gas-jet system with an average yield of 55 % and collected on a Nucleopore filter for one hour. Then, the activity was washed from the filter with 0.8-1.0 ml 0.5 M HF solution and passed through a cation exchange column (DOWEX 50Wx8, 200-400 mesh, 300 mg) with a flow rate of about 75 ml per minute. The eluate, containing the Rf fraction, was evaporated to dryness in a quartz vessel and diluted in about 150 ml of a solution containing 40 % ethanol, 1 M HCl, 0.5 M HF and 5 Bq/ml ^{241}Am tracer as inner standard. The chemical procedure, from washing the filter till the beginning of measurement, lasted about 25 min. Samples suitable for 4π α-measurements were prepared by evaporating the final solution on thin polypropylene foils (40 μg/cm^2). These foils were measured in 6 α-counting chambers. With a collection time of one hour a measuring time of about 6 hours for each sample was obtained. 36 samples were prepared and measured within an experiment time of 1929 min.

3 RESULTS

In Fig. 1 the sum of all α-particle spectra from all detectors is shown. Although the separation from Bi and Fm/Md is better than in earlier experiments using gas-phase chemistry [2], there is still ^{211}Po at 7.68 MeV, which interferes with the detection of both the expected α-decay of ^{263}Rf (7.8-8.0 MeV) and, especially, its α-decay daughter ^{259}No.

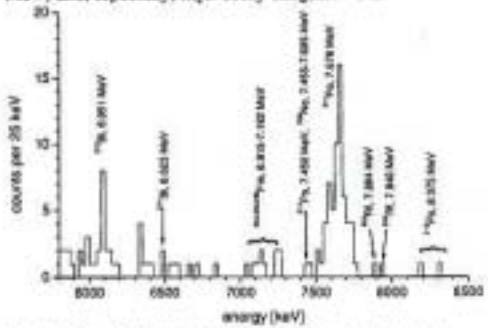

Fig. 1: Sum of all α-particle spectra from all detectors.

Table 1 shows the measured decay data of the two events which can possibly by attributed to ^{263}Rf along with the data of an earlier gas-phase chemistry search experiment.

Table 1: Possible α-decay events of ^{263}Rf.

	α-energy [MeV]	life-time [s]	
1	7.883	25'868	this work
2	7.939	5'749	this work
3	7.791	5	Ref. [2]
4	7.873	1'058	Ref. [2]

The measured life-times lead to a half-life of 1.6 h for ^{263}Rf. Further experiments including improvements of the purification from Po are necessary to confirm this result.

ACKNOWLEDGMENTS

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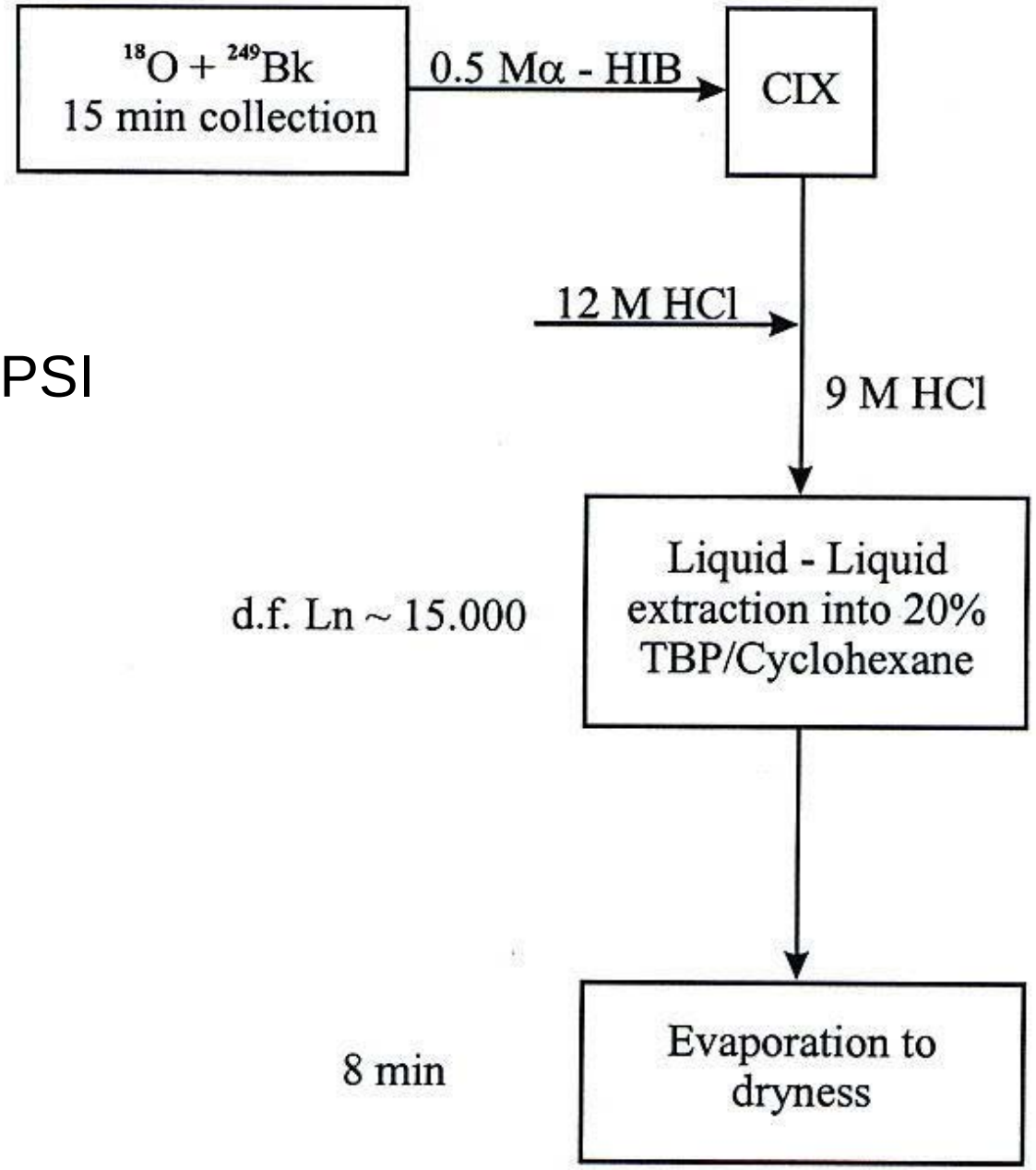
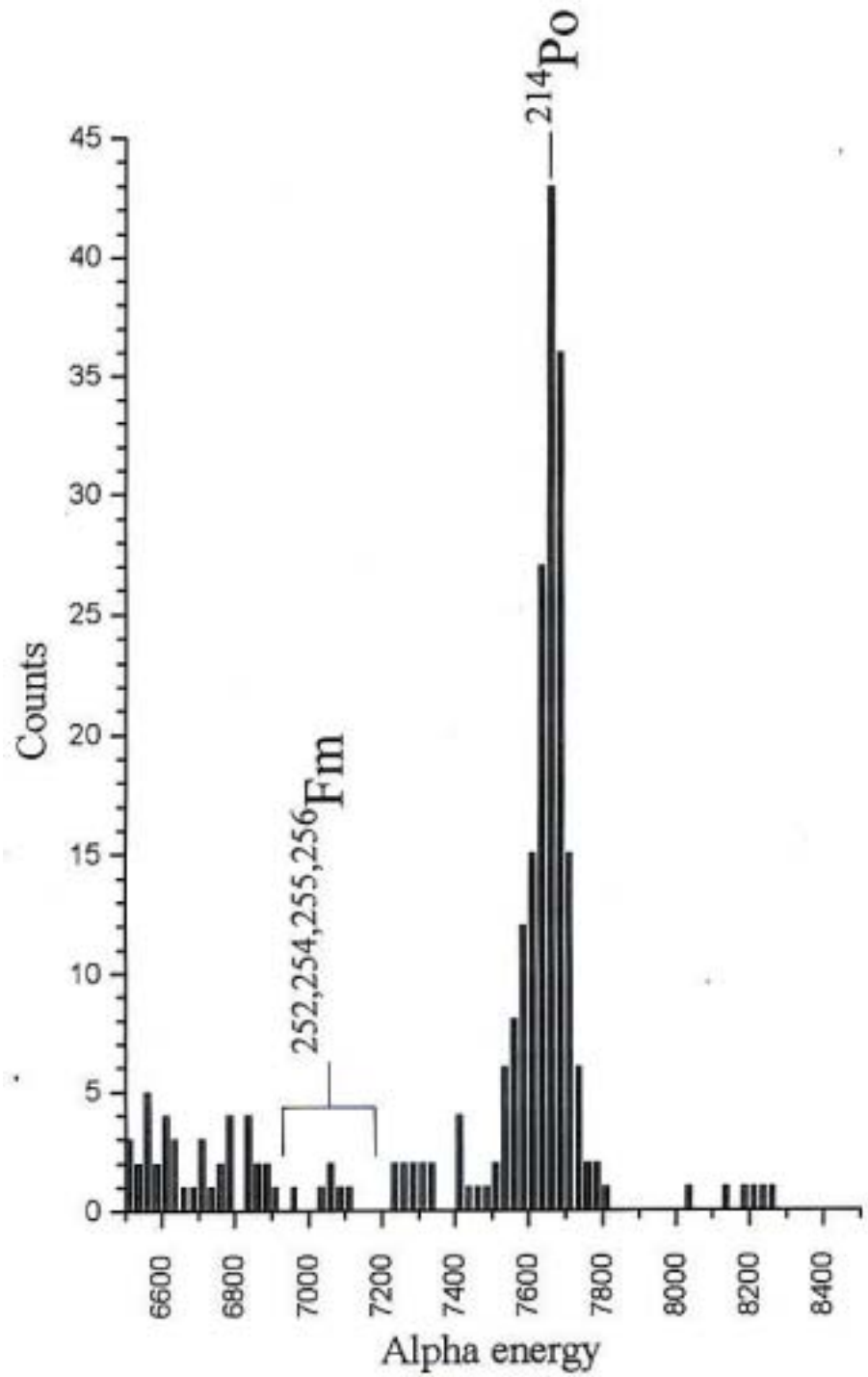
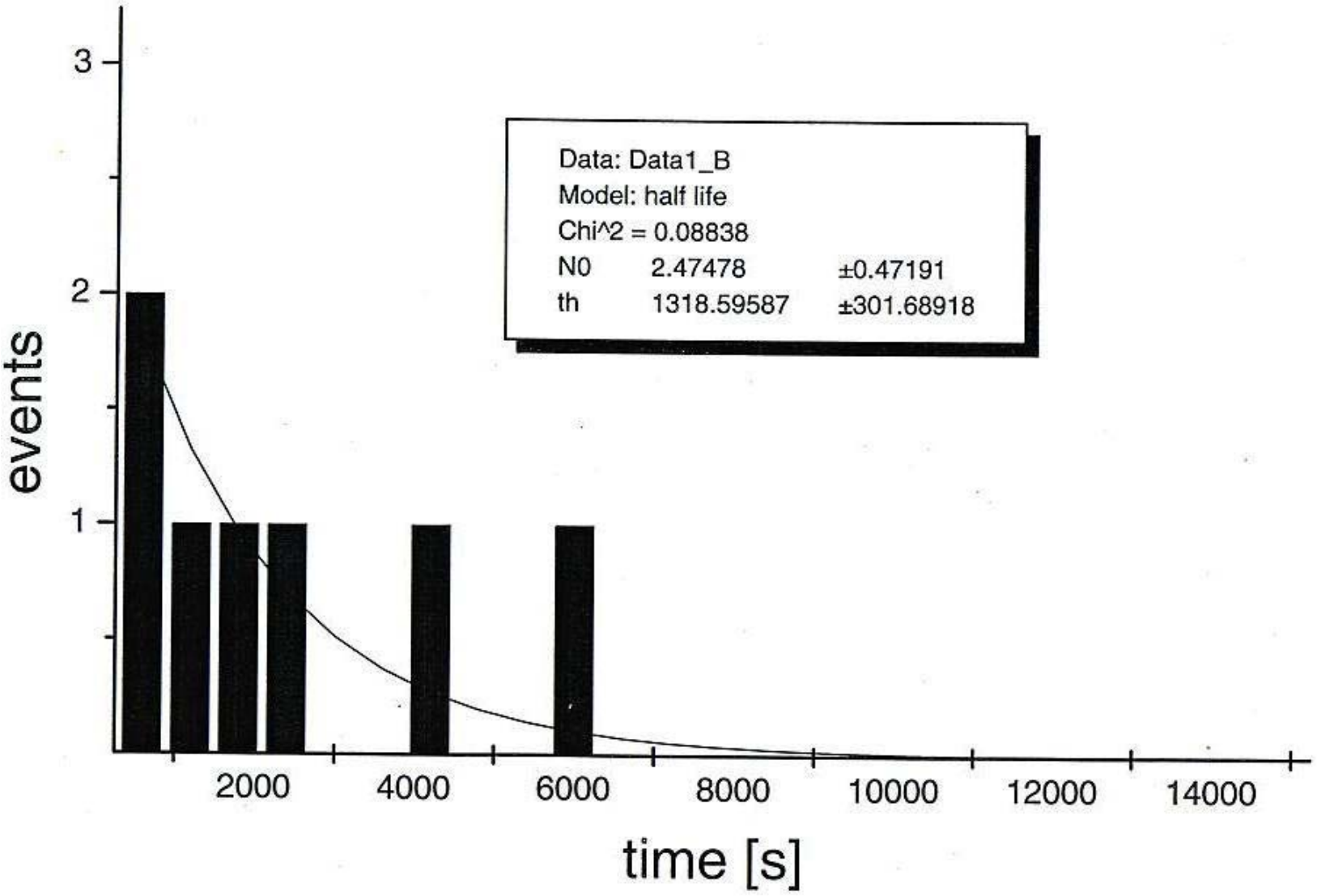
REFERENCES

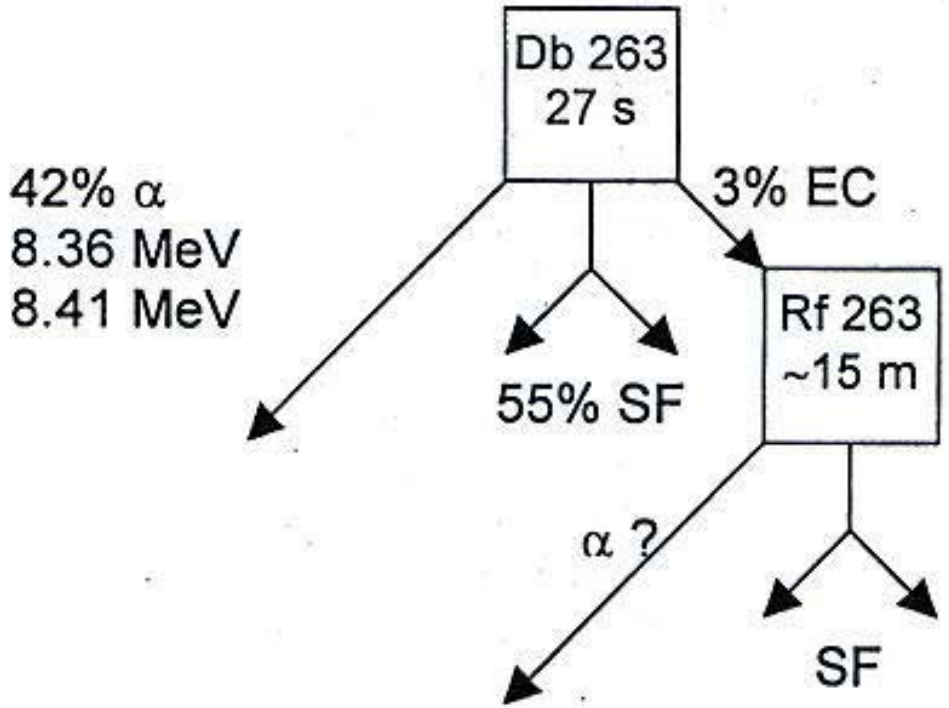
[1] Yu. T. Oganessian et.al., Nature **400**, 242 (1999).
[2] R. Dressler, PhD thesis, Universität Bern (1998).
[3] S. Cwiok et al., Nucl. Phys. A573, 356 (1994).
[4] D. Schumann et.al., PSI Scientific Report 1998/I 128.
[5] D. Schumann et.al., PSI Scientific Report 1998/I 129.

December 2000, PSI




^{214}Po
45
40
35
30
25
20
15
10
5
0
Counts
^{252,254,255,256}Fm
6600
6800
7000
7200
7400
7600
7800
8000
8200
8400
Alpha energy


Data: Data1_B
Model: half life
Chi^2 = 0.08838
N0 2.47478 ±0.47191
th 1318.59587 ±301.68918
events
3
2
1
2000
4000
6000
8000
10000
12000
14000
time [s]



Decay scheme for ^{263}Db and ^{263}Rf

α decay branch 7.9 MeV $< 12\%$; $T_{1/2}(\alpha) \sim 4h$
incompatible with α energy – α half-life systematics

$E_\alpha \leq 7.8$ MeV ; $T_{1/2}(\alpha) > 4000$ s ; $< 30\%$

Collaboration:

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W. Brüchle, M. Schädel, B. Schausten, A. Türler,
H. Gäggeler, C. Laue, R. Sudowe, P.A. Wilk