^{20}Ne on ^{244}Pu – first preliminary results

R. Dressler[1], B. Eichler[1], R. Eichler[1,2], A. Laube[1], J. Neuhausen[1], D. Piquet[1] , H.W. Gäggeler[1,2], F. Haenssler[2], S. Soverna[2], Qin Zhi[2] , M. Schädel[3], E. Schimpf[3] , K. Eberhardt[4], P. Thörle[4], N. Trautmann[4]

[1]PSI, Switzerland; [2]University Bern, Switzerland; [3]GSI, Germany; [4]University Mainz, Germany

The isotope ^{259}Rf was firstly investigated in [1] in the 5n channel of the reaction ^{22}Ne on ^{242}Pu. Additionally, the low energy part of the excitation function of ^{256}No, which is produced in the α4n channel, was reported. Later, only a few experiments have been carried out aiming investigation of nuclear reactions based on Pu and Ne e.g.[2]. We continue our investigation of xn and αxn reactions in the region of Rf and No, which we started already in [3]. The goal is to study the formation and decay properties of ^{259}Rf and ^{256}No produced in the reactions ^{244}Pu(^{20}Ne, 5n) and ^{244}Pu(^{20}Ne, α4n), respectively.

In the course of the experiment a Pu target (enriched 98.6% in ^{244}Pu) with a thickness of 0.55 mg/cm^2 on a Be-backing of 15 mm thickness was irradiated with ^{20}Ne^{6+}, at beam energy of 113 MeV in the middle of the target. Typically, the beam intensity was 0.15 - 0.20 pmA. Hence, during the 120 h experiment an overall beam dose of $4.7 \cdot 10^{17}$ particles have been accumulated on the target. The recoiling reaction products were transported using a He-KCl-gas-jet (flow rate 1 l/min) to the PSI Tape System within 3 s (estimated transport yield 30%). The aerosols are impacted in vacuum on the tape during 3.8 s and subsequently the samples are moved within 0.4 s in front of 4 consecutive α-PIPS-detectors (450 mm^2 active area, 40% detection efficiency for α-particles). The MIDAS data acquisition system was used for the event-by-event recording [4]. During the entire experiment 17 spontaneous fission (SF) events were detected at an expected background of 1.9. The SF decay data are compiled in Table 1. The sum of the measured α-spectra of detector 2, 3, and 4 are presented in Figure 1. The first detector is omitted, because of the high ^{8}Be/^{8}B background in this detector. The daughter isotopes of ^{259}Rf and ^{256}No (^{255}No and ^{152}Fm, respectively) are too long-lived in order to observe unambiguous time correlated decay chains. kommt jetzt der eigentliche Text.

Table 1: Observed SF energy (E_{SF}) and live time (τ).

Det.No.	E_{SF} [MeV]	τ [s]	Det.No.	E_{SF} [MeV]	τ [s]
1	80.1	3.85	2	70.6	5.60
1	89.4	3.26	2	42.8	5.61
1	99.1	3.38	2	58.0	4.92
1	76.6	0.87	2	54.6	6.45
1	30.9	4.03	2	73.7	5.99
1	30.4	1.26	2	94.4	5.70
1	69.9	1.30			
4	82.3	14.3	4	102.3	16.5
4	58.0	13.4	4	98.6	15.1

Based on the number of measured α– α correlations and single α-events attributed to interfering nuclides, a background in the α-decay energy region of ^{259}Rf and ^{256}No has been estimated (BG). The data are compiled in Table 2. Unfortunately, this first experiment was not sensitive enough to detect the α-decay of ^{256}No or ^{259}Rf. The origin of the SF-events remains open. Their distribution in all 4 detectors did not allow, a statement about an evident short-lived SF activity attributed to ^{259}Rf.In order to get statistically more significant estimations of interfering long-lived background activities, the number of detectors will be extended up to 8 in future experiments. Furthermore, a daughter mode will be included in order to observe unambiguous α-α-correlations of the ^{259}Rf-^{255}No($T_{1/2}$ = 3.1min) decays.

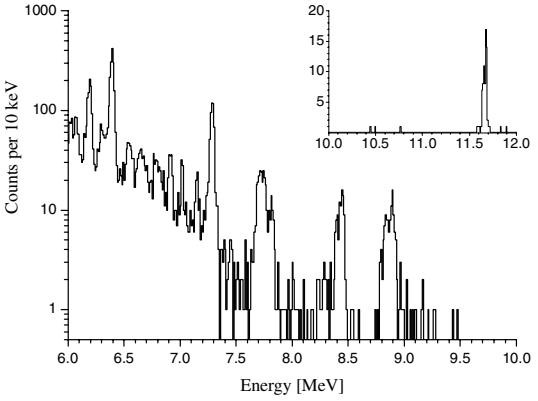

Fig. 1: α-spectra of detector 2, 3, and 4.

Table 2: Observed events in the ^{259}Rf and ^{256}No region, and interfering by-products (BG)

Mother (MeV)	Daughter (MeV)	Events	BG (MeV)
^{221}Ra (6.6–6.8)	^{217}Rn (7.6–7.8)	14	88 (8.4–8.6)
^{221}Ra (6.6–6.8)	^{213}Po (8.2–8.4)	58	145 (8.4–8.6)
^{222}Ac (6.8–7.1)	^{218}Fr (7.4-7.9)	6	15 (8.7–8.9)
^{211}Po (7.2-7.3)		550	60 (8.7–8.9)
^{213}Po (pile up)		28	112 (8.7–8.9)
Mother (MeV)		Events	BG
(^{256}No) (8.4 – 8.6)		248	233
(^{259}Rf) (8.7 – 8.9)		184	172

References

[1] G.N. Flerov, et al., Phys. Lett 13, 73 (1964).

[2] Yu.A. Lazarev, et al., Phys. Rev. C 62, 064307 (2000).

[3] R. Dressler, PhD Thesis Uni. Bern (1999).

[4] R. Dressler, PSI Scientific Report 2002, 68 (2003).