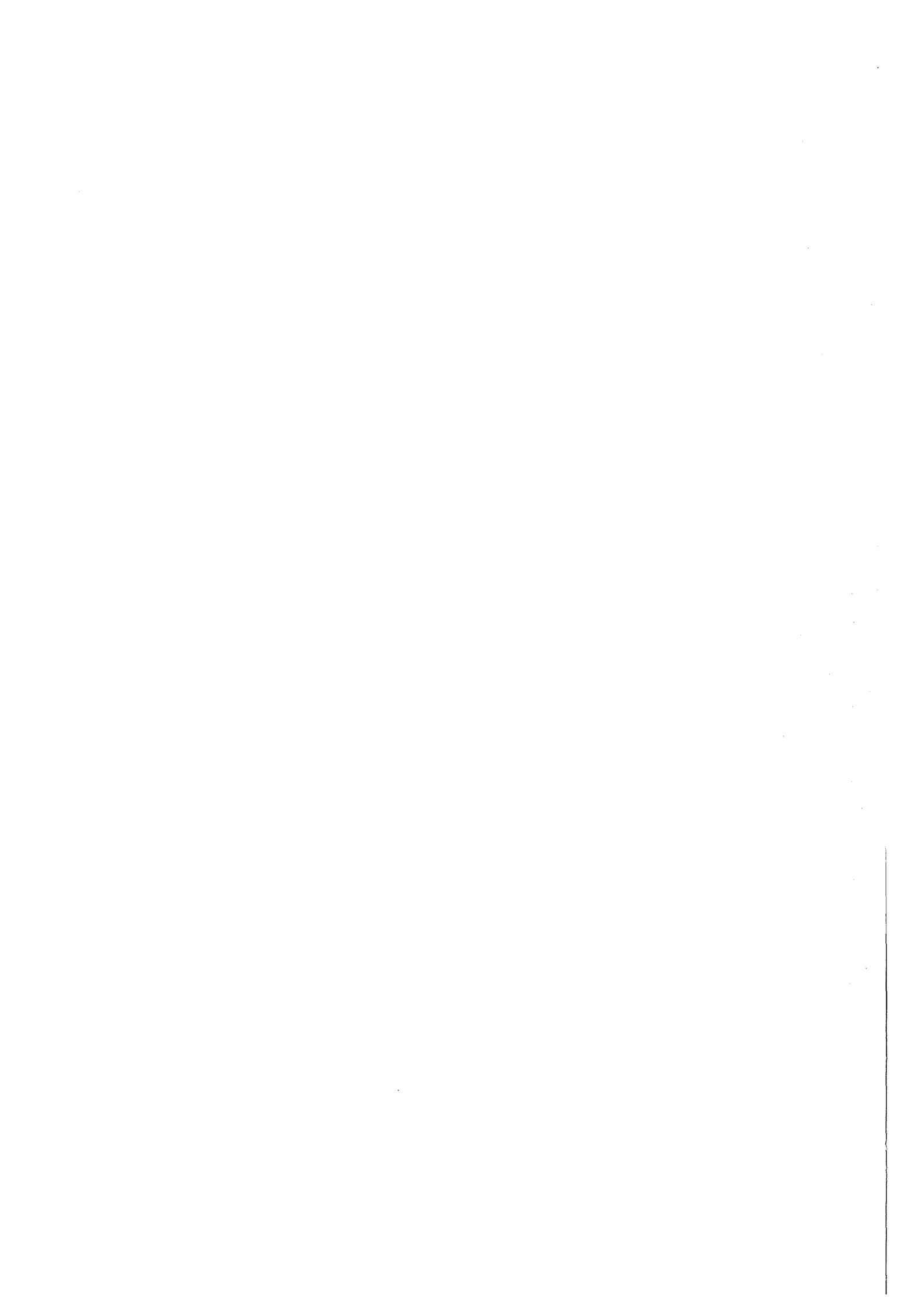


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Experience Gained from the Operation of Two α -Monitors in "PUTE"

**P. Groll, M. Persohn, L. Röder, J. Römer, B. Schuler
Institut für Heiße Chemie
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Kernforschungszentrum Karlsruhe



K E R N F O R S C H U N G S Z E N T R U M K A R L S R U H E

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Kernforschungszentrum Karlsruhe GmbH, Karlsruhe

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Abstract

The operation of two α -monitors of the 'drum-cell'-type in the plutonium facility "PUTE" is described. The instruments were installed in the AW- and the BW-stream. After a short description of the monitor, the different operating modes and of installation details, the experience gained from two weeks of continuous operation is described. The advantages of the use of in-line-instruments compared with laboratory analyses of samples are discussed. The instruments were available for 97 or 94 % of the time.

Zusammenfassung

Erfahrungen im Betrieb von zwei Trommelmeßzellen in "PUTE".

Es wird der Betrieb von zwei Trommelmeßzellen in der Plutoniumtestanlage "PUTE" beschrieben, die im AW- und BW-Strom eingesetzt waren. Nach einer kurzen Beschreibung des Monitors, der Betriebsarten und der Einbaugegebenheiten wird über die Erfahrung während eines 14-tägigen Dauerbetriebes berichtet und die Vorteile der In-line-Instrumentierung an Hand konkreter Beispiele beschrieben. Die Verfügbarkeit im vorliegenden Betriebszeitraum war 97 bzw. 94%.

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1. INTRODUCTION

Two α -monitors of the drum-cell type have been installed in the plutonium test facility PUTE to test these instruments and for process control. By switching over the three-way valve V31-06 one of the monitors can be operated alternatively in the organic waste stream of extraction column K03 (BW-stream) or of extraction column K02 (BW-stream) (figure 1). The column K03 is an electrolytic reduction column ("ELKE"). The second α -monitor (instrument 2) analyses the concentration of α -nuclides in the raffinate of extraction column K01 (AW-stream). For the interpretation of the measured data it is important to note that under normal operation conditions americium-241 is directed into the AW-stream from the feed. During the first throughput of the plutonium the content of americium-241 was the highest.

	Half-life years	Spec. act. Bq/g	Isot.fract. %	Act.in 1g Pu Bq/g	Act.fract. %
Pu-238	87,75	$6,3378 \cdot 10^{11}$	$0,38 \pm 0,04$	$2,4084 \cdot 10^9$	1,4
Pu-239	24390	$2,2706 \cdot 10^9$	$66,4 \pm 0,06$	$1,5077 \cdot 10^9$	0,9
Pu-240	6537	$8,4366 \cdot 10^9$	$26,6 \pm 0,13$	$2,2441 \cdot 10^9$	1,3
Pu-241	14,89	$3,6885 \cdot 10^{12}$	$4,45 \pm 0,02$	$1,6414 \cdot 10^{11}$	96,4
Pu-242	387000	$1,4133 \cdot 10^8$	$2,22 \pm 0,04$	$3,1375 \cdot 10^6$	<0,01

Table 1: Radiometric properties of used plutonium.

Average specific activity of the plutonium: $1,7030 \cdot 10^{11}$ Bq/g.

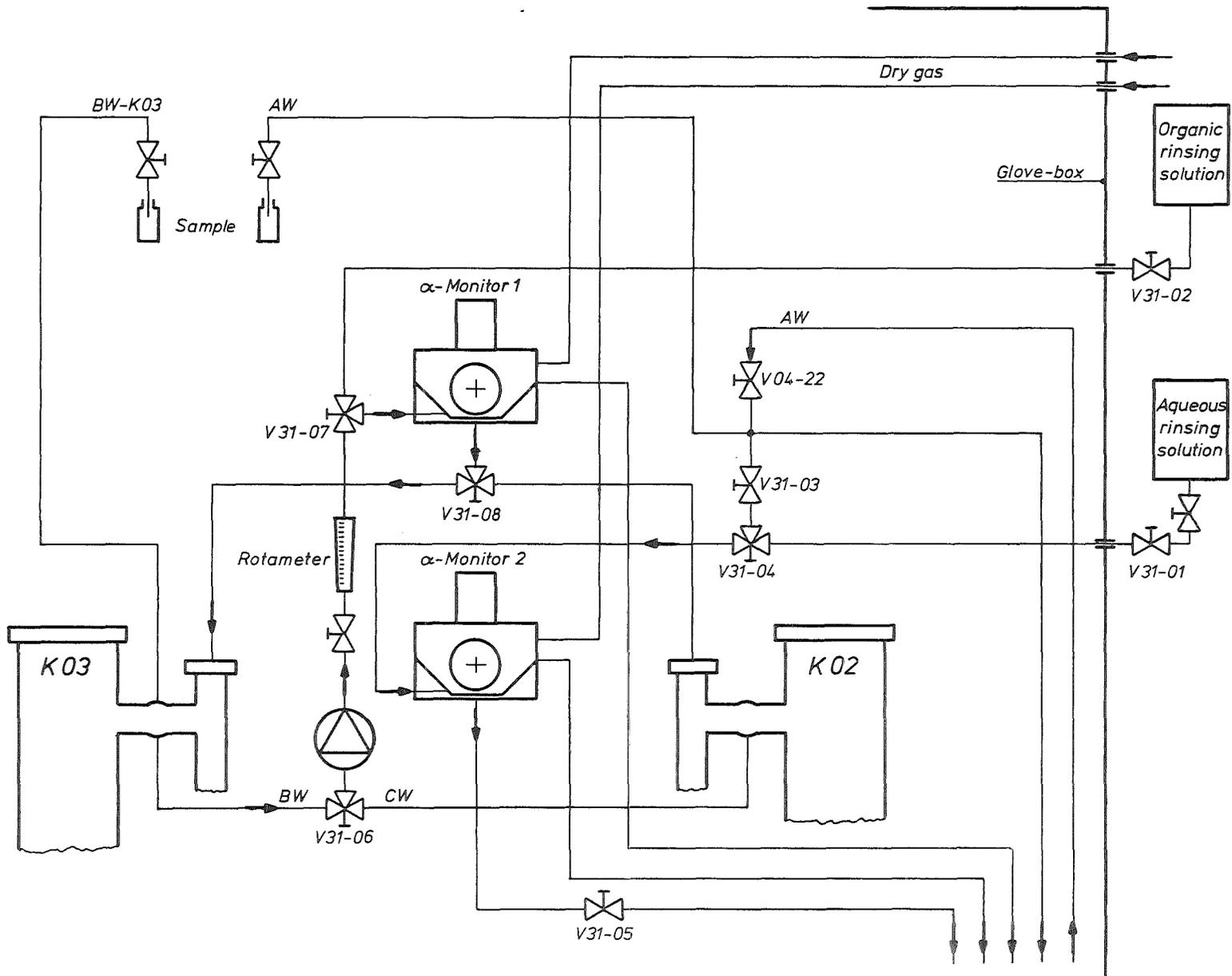


Figure 1: Installation of the α -monitors at the top floor of box 8.
(Schematic).

2. INSTALLATION

The installation at the top floor of process-glove-box 8 is shown in figure 1. The instrument 1 was located higher than the level of liquid in the top decanter of K02 and K03. A pump was used for the flow of the process-stream to the instrument. The flow-rate could be measured by a rotameter. It could be adjusted by a needle-valve, integrated in the rotameter. The outflow of the instrument was guaranteed by gravity.

The sampling point of instrument 2 was located after the sampling station for single samples. No pumping was necessary for the flow of the process stream to be analysed due to gravity. The flow-rate could be adjusted by the needle-valve V31-03 in front of the instrument. The outflow of the instrument was also due to gravity. The sampling point at the bottom decanter of the column was not used for the installation of the α -monitor for security purposes. We suggested that it should not be possible to cause unintentional flooding of the instrument. Therefore the location of the instrument above the column top has been chosen. The disadvantage of this installation mode is the longer piping. But that has been taken into account for safety reasons.

Prior to measuring the background, the rotating drum has to be rinsed to clean it from process solution. The container for these rinsing solutions was placed outside the box above the level of the instruments. Also with this installation technique no additional pumping was necessary. Using both three-way valves V31-04 and V31-07 the instruments could be switched from process-stream to rinsing solution. This rinsing solution was 1,5M nitric acid or 30% TBP in dodecane. By closing the two valves V31-05 or V31-08 in the effluent pipe of the two instruments the solution could be retained. This was necessary during the rinsing operation.

3. CONTROL OF THE INSTRUMENTS

The α -monitor is described in detail in [2]. A schematic diagram is given in figure 2. Both installed instruments can be operated in three modes:

- background measurement
- standardizing measurement
- process solution measurement

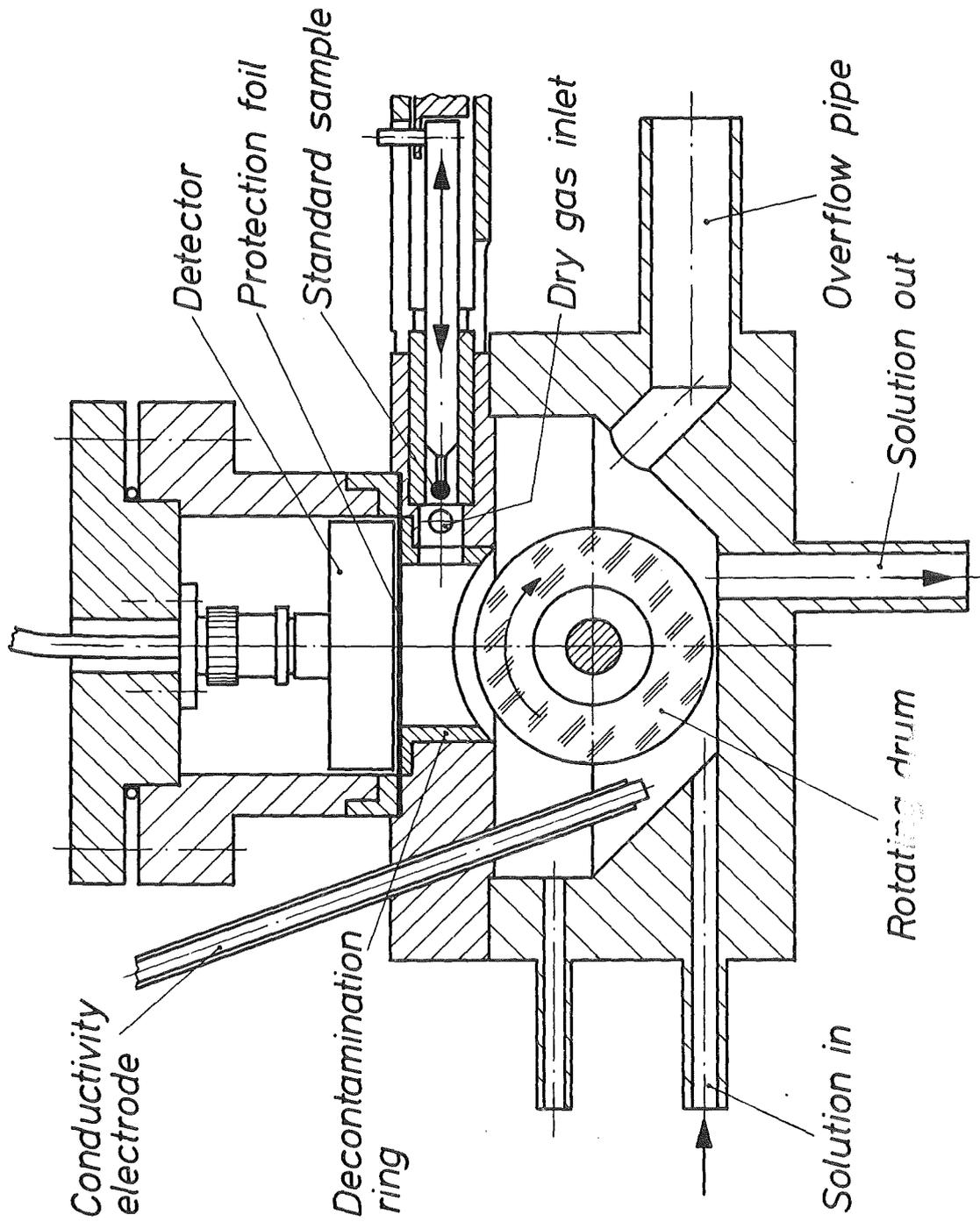
The valves and the introduction of the standard sample was done manually. The instruments have been kept very simple to reduce the necessary investment. For this simplicity it was necessary to control the instruments for correct operation conditions. To avoid condensation of water vapour on the polymer foil and on the standard sample, a continuous gas stream of dry and oil-free air or nitrogen passed the instrument. The flow rate of the gas-streams for the two instruments of 10 l/h has been measured by two rotameters.

3.1. Background measurement

The contamination of the surfaces in the measurement chamber, which are not in contact with the process solution, is characterized by the background measurement.

3.1.1. Rinsing

The measurement of the background was preceded by rinsing the instrument. The organic extractant or nitric acid was used for rinsing, both in concentrations similar to that of the process solution to be analyzed. Mostly the rinsing was repeated 3 times (6 times at maximum). For one rinsing operation 50 ml was necessary. The level of the rinsing solution in the instrument 2 was controlled by a conductivity electrode. The level of the organic rinsing solution could not be controlled by this electrode because of lack of



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Figure 2: Cross-section of the α -monitor.

conductivity. The amount of solution used for rinsing was controlled by the decrease of the level in the rinsing solution vessel. Flooding of the monitor was not possible because of the overflow pipe. After each rinsing step the solution was drained out to the process stream. This was possible because rinsing solution and process stream were quite similar in composition. The rinsing solution of the last rinsing step remained in the monitor until the measurement of the background and of the standard sample was finished.

3.1.2. Measurement

Once the background was measured the last portion of the rinsing solution remained in the monitor. This solution should have no α -activity and thus shields the drum. It is contaminated however, but no α -particle can pass the liquid layer on its surface. The background correction on the ratemeter was then adjusted to the measured value. Each measurement during the process was thus automatically corrected. The correction was done by hardware.

Due to the construction of the measuring chamber the following surfaces could be contaminated:

- the protection foil of the detector
- the decontamination ring and
- the drum.

If the entire surface of the drum is covered with the solution to be analyzed, no α -particle can escape from the surface and pass the liquid layer and reach the detector. By α -spectroscopy (figure 3) it is possible to distinguish between the contamination of the protection foil of the detector and the contamination of the decontamination ring. The energy spectrum is characteristic for the contamination because each one has a characteristic maximum energy of the α -particles. It is higher for α -particles coming from the foil than that of α -particles from the decontamination ring due to the shorter distance to the detector.

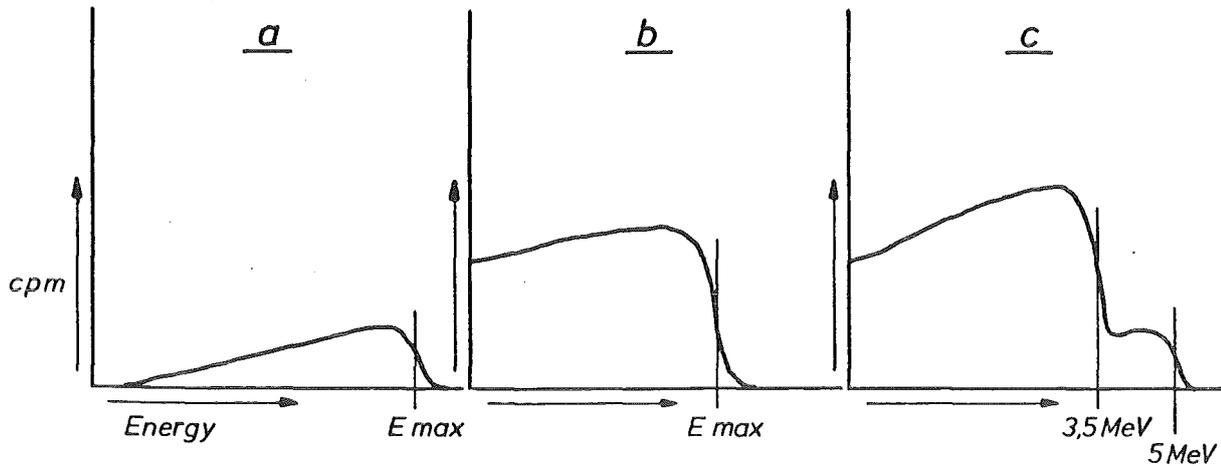


Figure 3: α -Spectrum of
 a) contaminated foil,
 b) contaminated decontamination ring,
 c) contaminated foil and decontamination ring.

If the contamination of the foil becomes too high, it can be exchanged without changing the detector. If this is carefully done in a glove-box where the contamination level is not very high, it is possible to exchange the foil without larger contamination of the detector surface. However, if the detector is contaminated anyhow, it has to be exchanged for a new one. If the decontamination ring is contaminated it can easily be exchanged for a new one after lifting the assembly of detector and protection foil.

3.2. Standardizing measurement

After finishing the background measurement the standard sample was introduced into the measuring chamber. With this sample in position a rapid check of the correct working of the measuring electronics was possible. After finishing the standardizing measurement the rinsing solution still remaining in the monitor was drained out to the process solution.

3.3. Process solution measurement

After switching over the corresponding valve the measurement of the process solution was started.

4. EXPERIENCES GAINED DURING OPERATION OF PUTE.

Both α -monitors were operated during the run of PUTE with plutonium from 15.9.1982 until 30.9.1982. The operation of PUTE is summarized in [3]. The availability of the instruments has been 96,7% for instrument 1 and 93,6% for instrument 2. 12 hours lack of operation time has been due to maloperation of the high voltage supply. The additional outage of 9 hours was due to the search for the cause of increasing contamination of the detector foil. It was found that the outlet pipe of the detector had not been correctly installed. The situation is given in detail in figure 4. After shutting off the flow of the process solution or the rinsing solution to the monitor, the pipe from the monitor to valve V31-05 was filled with air. When the α -monitor was then filled again with the rinsing solution, a more or less large air bubble remained in the pipe. This air bubble rose and reached the monitor after more than 20 seconds. By leaving the liquid in the monitor droplets were dispersed and also reached the protection foil of the detector and the decontamination ring. After enlarging the slope of the drain pipe and diminishing the flow rate of the rinsing solution, the contamination was avoided.

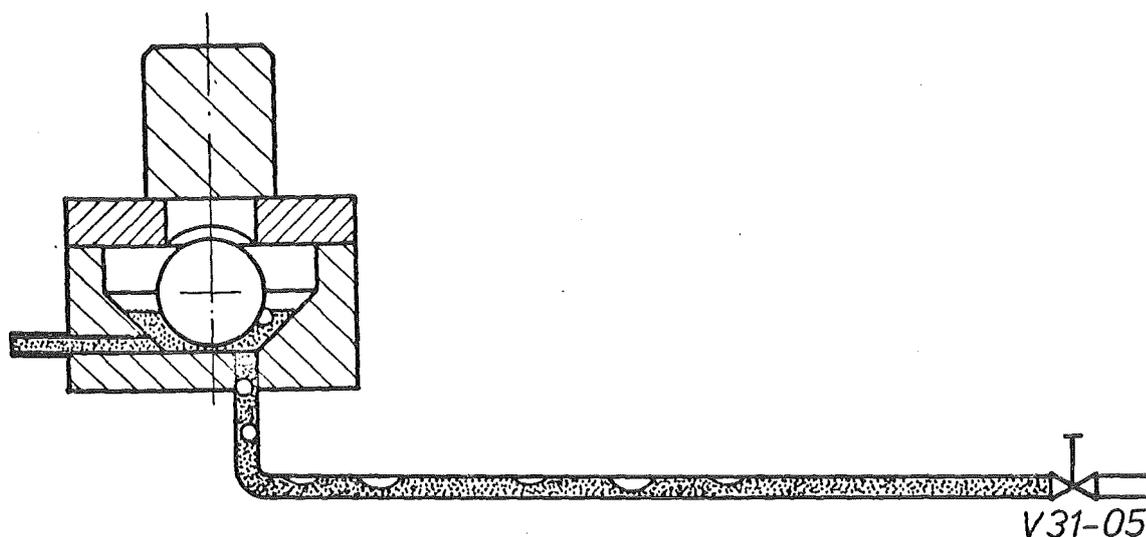


Figure 4: Installation of α -monitor 2.

In the following section the measurement results of both instruments are discussed. They are compared with the results of the analytical laboratory.

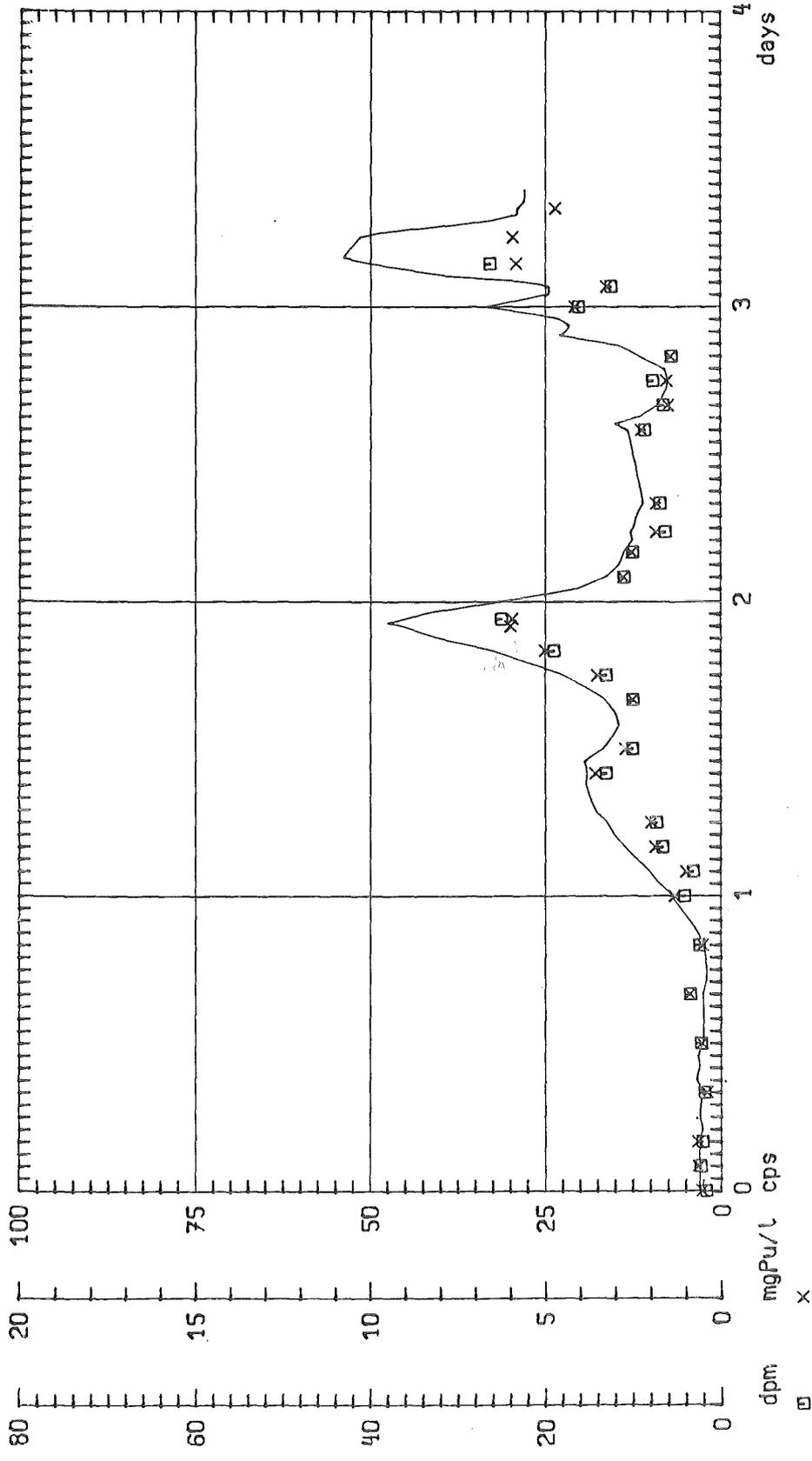
4.1. Measurement results of 'monitor 1' (BW-stream)

During the whole operation time the concentration of plutonium in the organic stream was less than 0,01 mg Pu/l to 10,8 mg Pu/l. The sampling interval was generally two hours. The reading of the instrument was adjusted with the help of the analytical results of the first samples. During the first and second day of operation the results were found to be significantly below 0,1 mg Pu/l. The writing of the recorder nearly reached the zero-level. After 22.9. the concentration of plutonium was between 0,07 mg Pu/l and 10,8 mg Pu/l according to the laboratory analysis. During 27.9. there were few deviations of the plutonium-concentration. From 25.9. until 30.9. the change in plutonium-concentration was rapid and remarkable. The usefulness of the "BW-monitor" will be discussed in the following paragraph.

4.2. Discussion of the record of 'monitor 1' (BW-stream)

4.2.1. General discussion

The recorded data from 27.9. to 30.9. are shown in compact form in figure 5. The daily charts are given in figure 6a - figure 6d. A table of the analyzed results is given in table 2 of the annex. In figure 5 and figure 6a - figure 6d the results of laboratory analysis of samples for plutonium are also plotted. To enable a direct comparison, the disintegrations per minute per milliliter evaluated by the analytical laboratory for single samples are also listed. In the BW-stream no other α -emitting material than plutonium was expected. Therefore the reading of the instrument and the measured dpm/ml of the analytical laboratory should have the same shape. But the difference



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Fig.5: CHART OF α -MONITOR 1 (BW-STREAM) AT 27.09.82 - 30.09.82

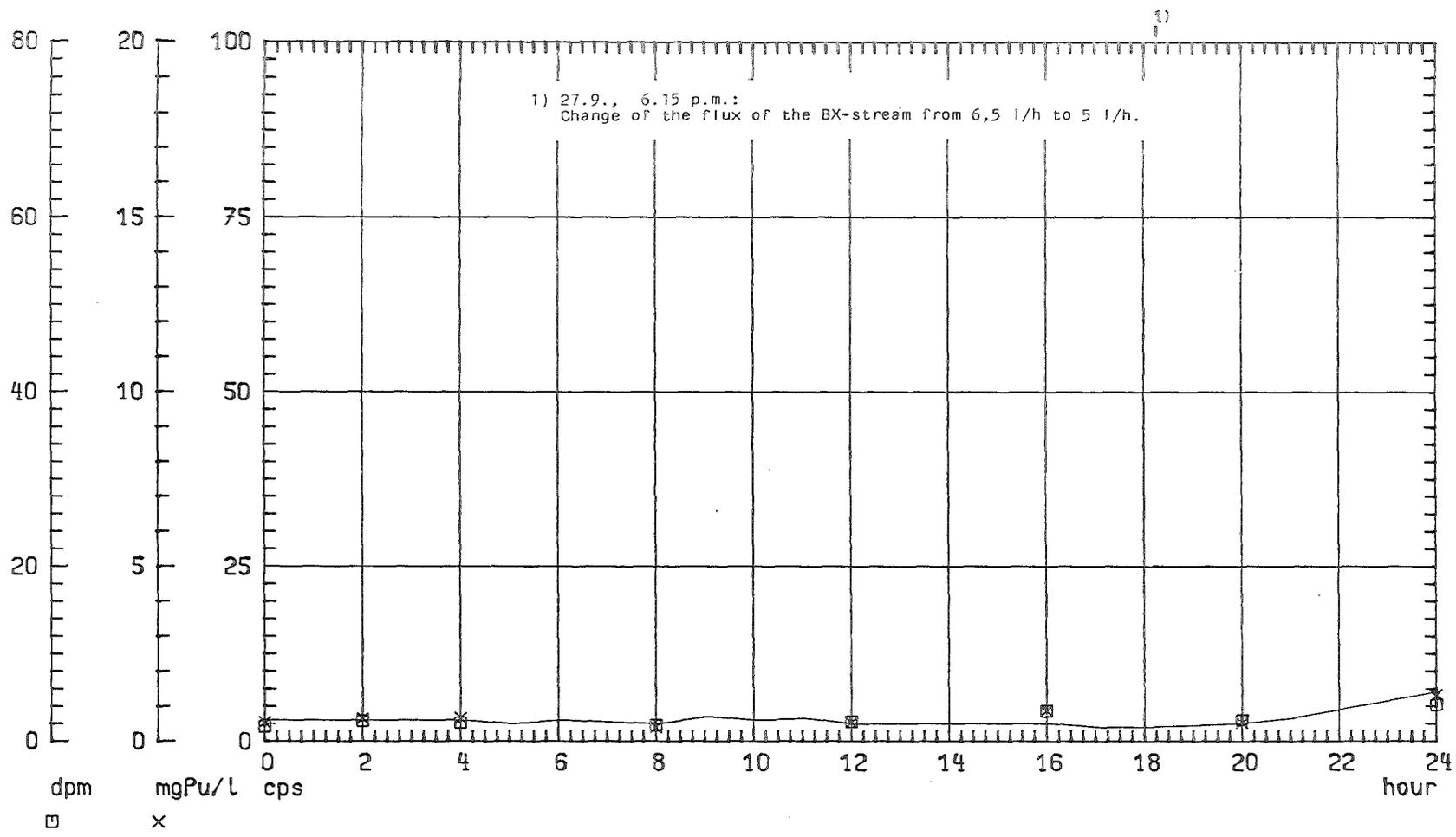


Fig.6a: CHART OF α-MONITOR 1 (BW-STREAM) AT 27.09.82

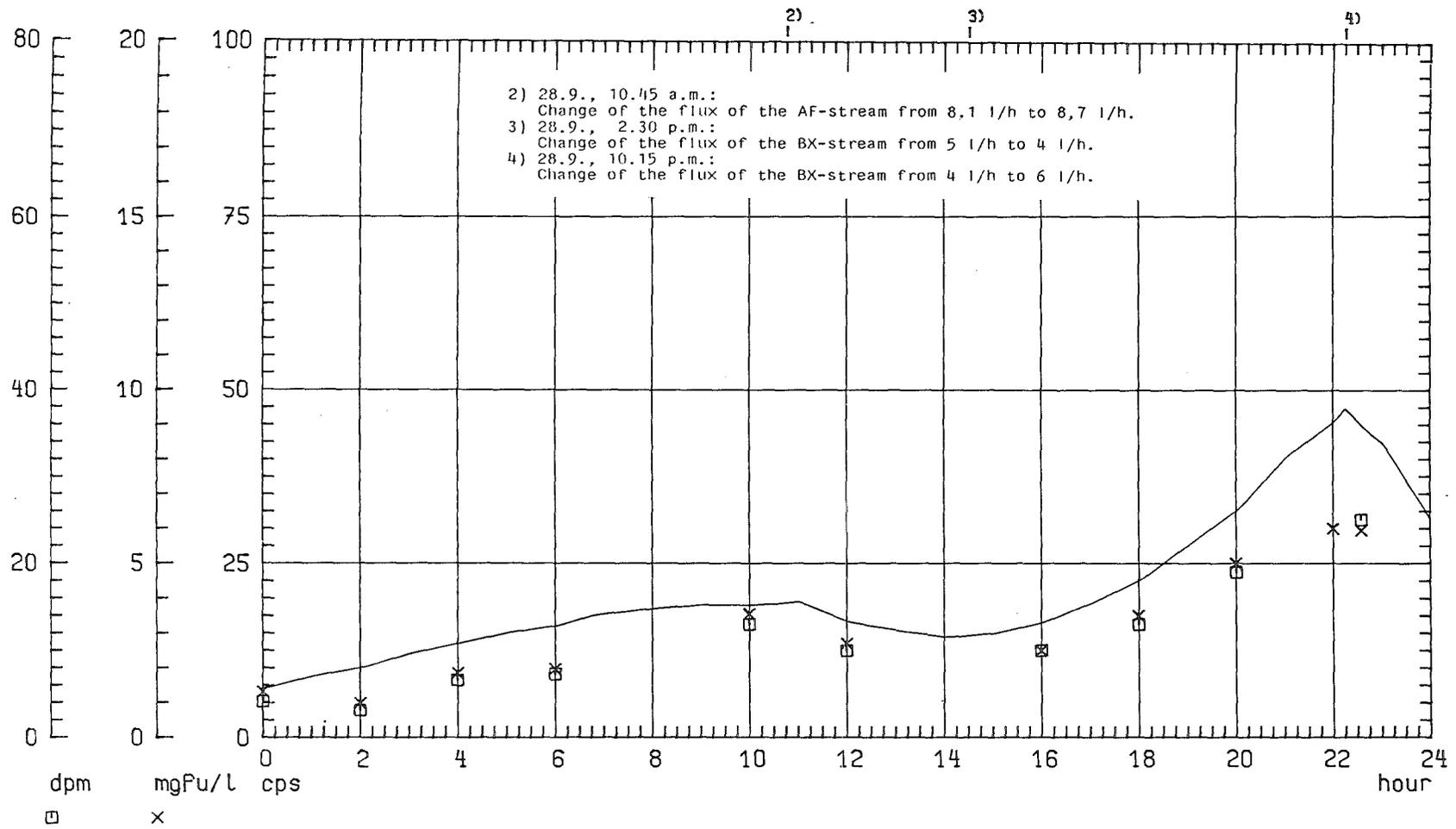


Fig.6b: CHART OF α -MONITOR 1 (BW-STREAM) AT 28.09.82

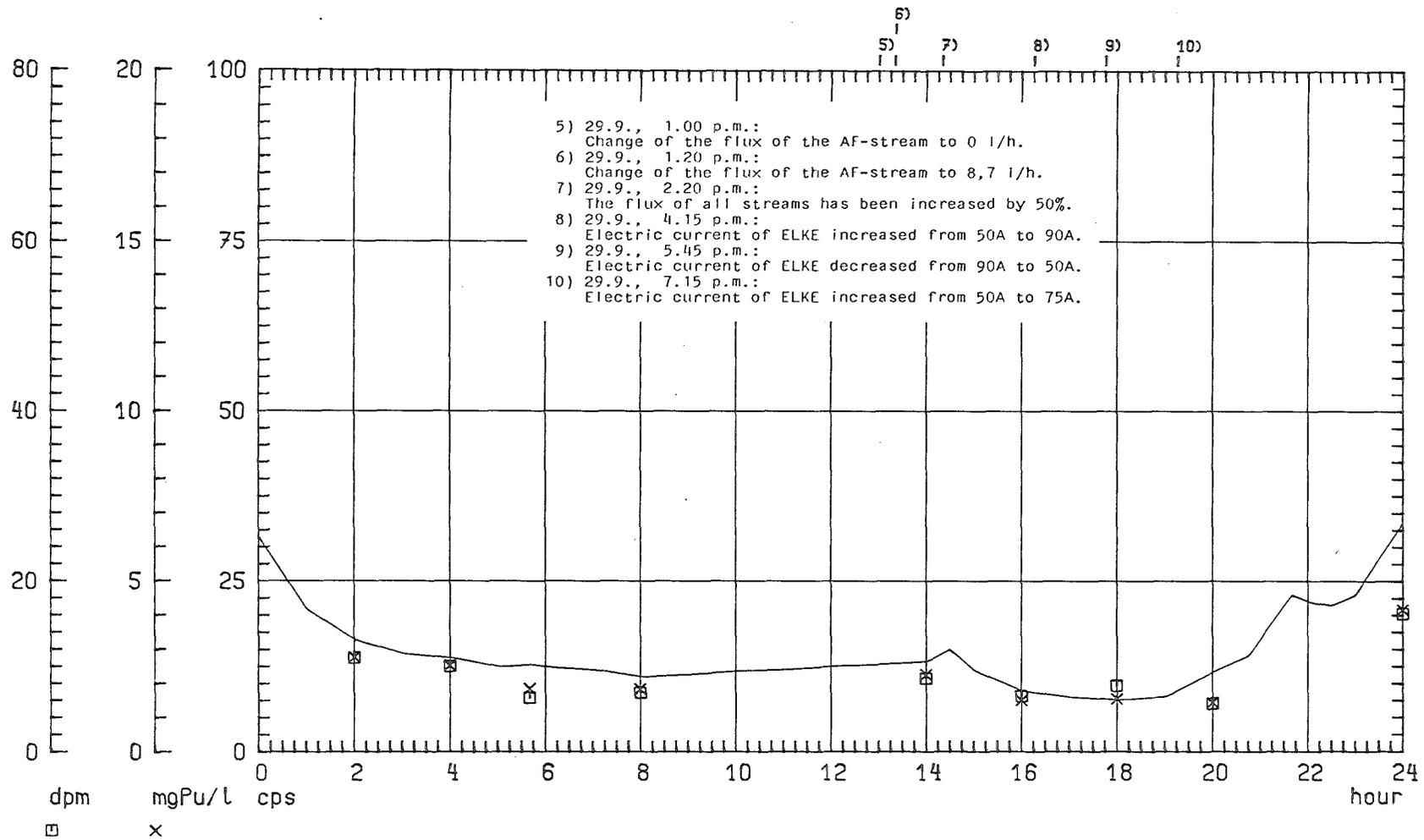


Fig. 6c: CHART OF α -MONITOR 1 (BW-STREAM) AT 29.09.82

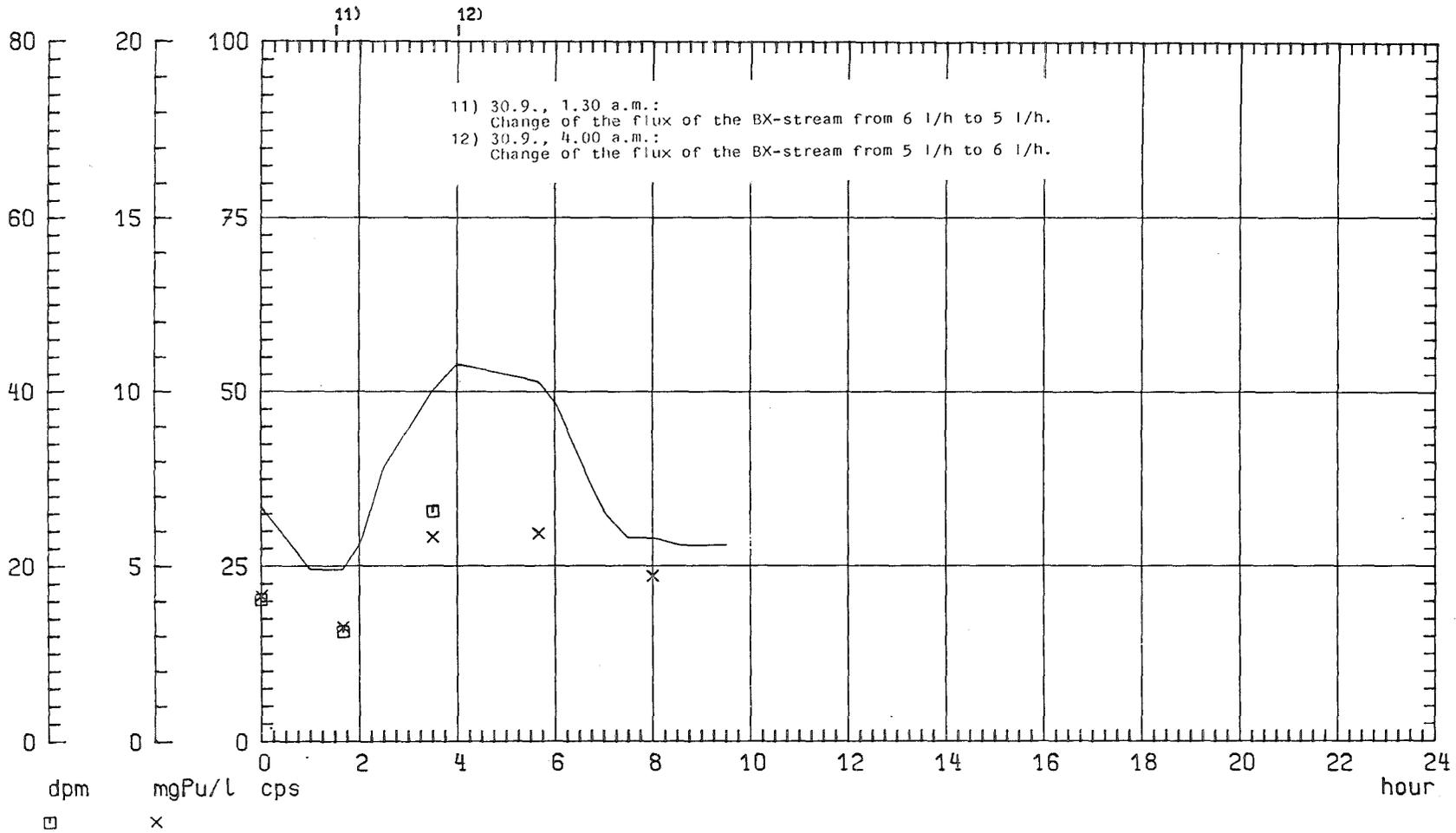


Fig.6d: CHART OF α -MONITOR 1 (BW-STREAM) AT 30.09.82

of the analytical laboratory results and the monitor readings is significant when the concentration exceeded 1 mg Pu/l. The difference can be 70% of the monitor reading. The reason for this is not known, but one possibility could be that plutonium has been stripped in the analytical procedure from the organic to the aqueous phase not 100% efficiently.

4.2.2. Problems of the single sample analysis

The decrease of the plutonium concentration on 28.9. at 2⁰⁰, found with single sample analysis was not recorded on the α -monitor. Another disadvantage of the analysis in the laboratory is also shown in figure 5. On 29.9. at 20⁰⁰ a sample was drawn. In general 60 - 90 minutes after sampling the laboratory result was ready. No indication for a change in the plutonium concentration could be seen from the analytical result. Nevertheless in gradient of the recorder can be observed. This was also confirmed by the result of the next single sample analysis. But it is important to note that four hours had passed in which the concentration changed and the shape of the plutonium concentration curve can only be roughly seen. A similar situation occurred on 30.9. at 1³⁰.

4.2.3. Influences on the behaviour of the concentration by alterations of the process

At 27.9. 18¹⁵ the flux of the BX-stream was changed from 6,5 l/h to 5 l/h. This alteration caused the increase of the concentration of plutonium starting at 10⁰⁰. At 28.9. 10⁴⁵ the flux of the AF was increased from 8,1 l/h to 8,7 l/h after the increase of the concentration of plutonium to nearly 4 mg Pu/l. At 14⁰⁰ the concentration of plutonium decreased again. By diminishing the flux of BX-stream from 5 l/h to 4 l/h at 14³⁰ the plutonium concentration increased once more. At 22⁰⁰ the maximum was reached. At 22¹⁰ the flux of the BX-stream was again increased to 6 l/h. Thereby the plutonium concentration became normal again.

On 29.9. from 12⁵⁰ until about 13²⁰ the flux of the AF-stream

was zero. After a delay of about 40 minutes an increase of the plutonium concentration was observed. The increase of the flux of all streams (except AS) was followed by a change in the plutonium concentration as from about 20⁰⁰. At 14¹⁵ the electric current of "ELKE" was changed to 75 ampere. This was followed by a decrease in plutonium concentration on 30.9. after 0⁰⁰. The decrease of the flux of the BX-stream to 5 l/h at 1³⁰ resulted in a concentration peak of plutonium at about 4⁰⁰. The decrease of the plutonium concentration after 4⁰⁰ was caused by an alteration of the flux of the BX-stream to 6 l/h.

4.3. Discussion of the record of 'monitor 2' (AW-stream)

The used plutonium had a relatively high concentration of americium which had accumulated during the storage period since the last purification process of the plutonium. It had grown as a radioactive daughter-product of plutonium-241. The α -activity of the Am-241 cannot be distinguished from the α -activity of plutonium by an α -monitor because the monitor measures in infinite thickness of solution. After the separation of the americium during the following 24 hours sufficient americium grows again to raise the α -activity of the plutonium by 5%. The americium was separated after the A-column in the AW-stream. Therefore the monitor 2 started operation on 17.9. (third day of process). At that time the whole plutonium had processed once. During the whole operation time the plutonium concentration in this stream was between 7 and 580 mg/l. It was mainly about 15mg Pu/l. The sampling interval for the analytical laboratory was 4 hours. Additional samples were only taken if necessary to control the reading of the α -monitor.

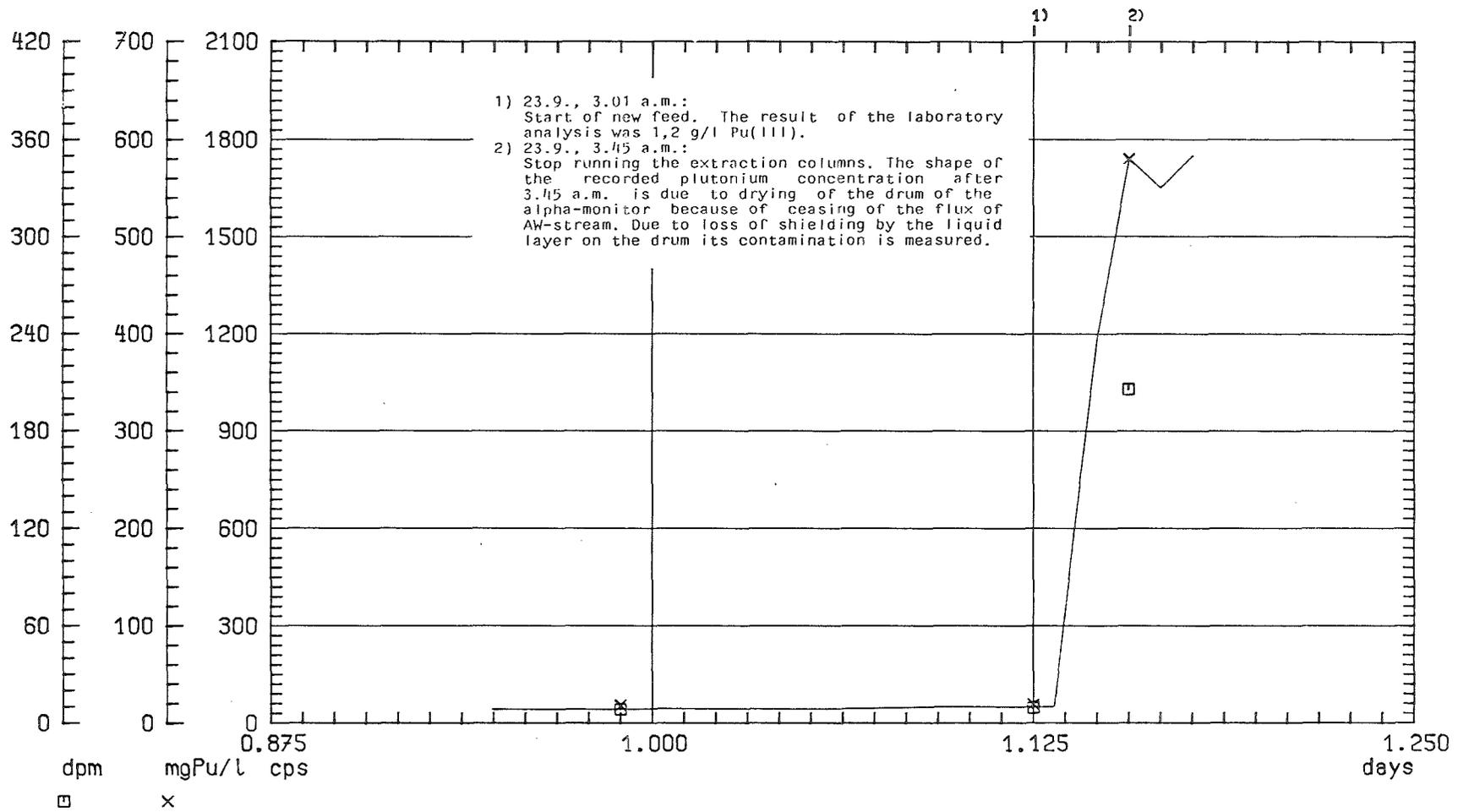


Fig.7: CHART OF α-MONITOR 2 (AW-STREAM) AT 22.09.82 - 23.09.82

4.4. Measurement results of 'monitor 2' (AW-stream)

The recorded data between 22.9. 22³⁰ and 23.9. 4¹⁵ are shown in summarized form in figure 7. A table of the analyzed results is given in table 3 of the annex. In figure 7 the results of laboratory analysis of samples for plutonium are plotted, as well as the disintegrations per minute measured on single samples. Figure 7 shows a breakthrough of plutonium of the A-column. In this example it can be seen that the results of the single sample analysis are too late to observe it. Therefore it is not possible without in-line instrumentation to minimize the amount of material out of specification. The recording was constantly increased until 3¹⁰ from 42 cps to 50 cps. At 3⁰⁰ the concentration of plutonium was found by single sample analysis to be 19,2 mgPu/l, 3,25 earlier the value was 17,97 mgPu/l (total number of disintegrations $9,38 \cdot 10^6$ at 3⁰⁰ and $8,25 \cdot 10^6$ at 23⁴⁵). At that time the sampling interval was 3 hours. There was no sign of a breakthrough at 3⁰⁰. The bulk amount of plutonium reached the α -monitor after 3¹⁰. The concentration increased between 3¹⁰ and 3⁴⁵ from 20mg Pu/l to 580mg Pu/l. At that time the operation of the column had been stopped. Due to lack of process solution the drum of the monitor later became dry (3⁴⁵ until 4¹⁵).

Due to the recording of the α -monitor a sample was drawn at 3⁴⁵. The analytical result was probably not available before 4³⁰. At that time the breakthrough could also be detected by the change of colour of the AW-stream which was significantly blue due to Pu^{3+} . The volume of AW with high plutonium concentration would have been twice as big if it has detected at 4³⁰. Running the original sampling procedure the detection of the breakthrough would have been possible three hours later. This is a good example of the advantages of using in-line instrumentation for process control.

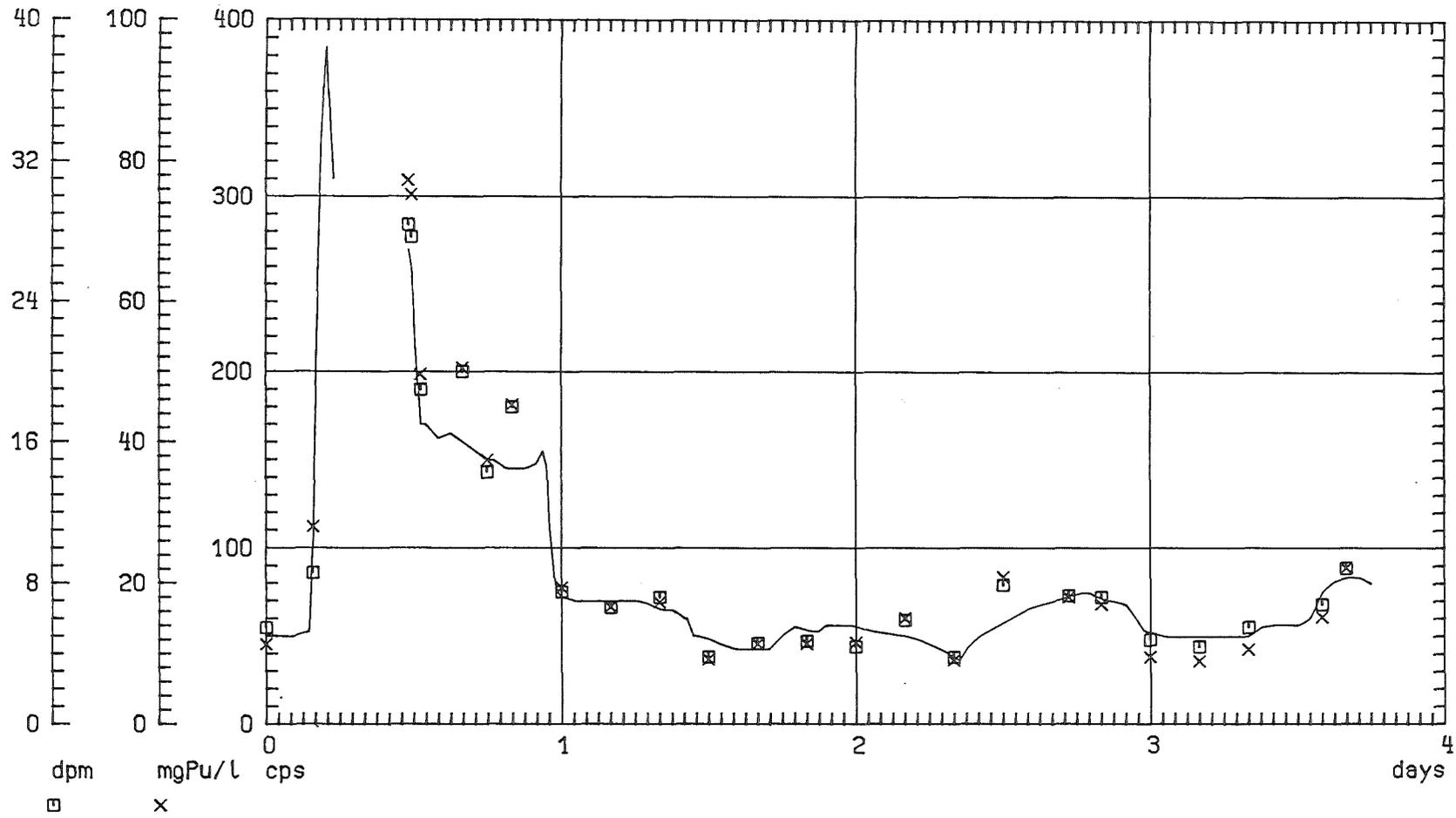


Fig.8: CHART OF α -MONITOR 2 (AW-STREAM) AT 26.09.82 - 29.09.82

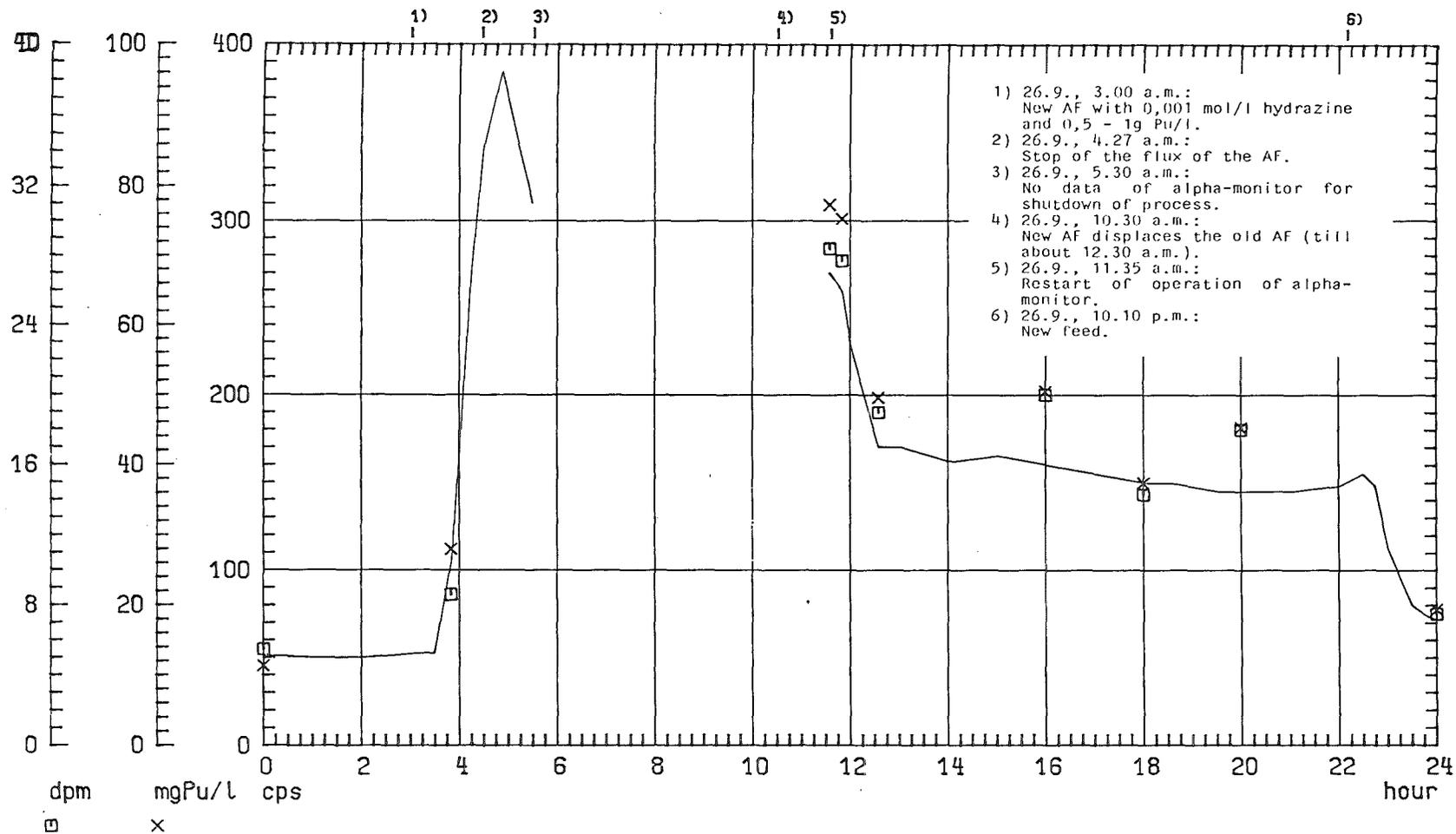


Fig.9a: CHART OF α -MONITOR 2 (AW-STREAM) AT 26.09.82

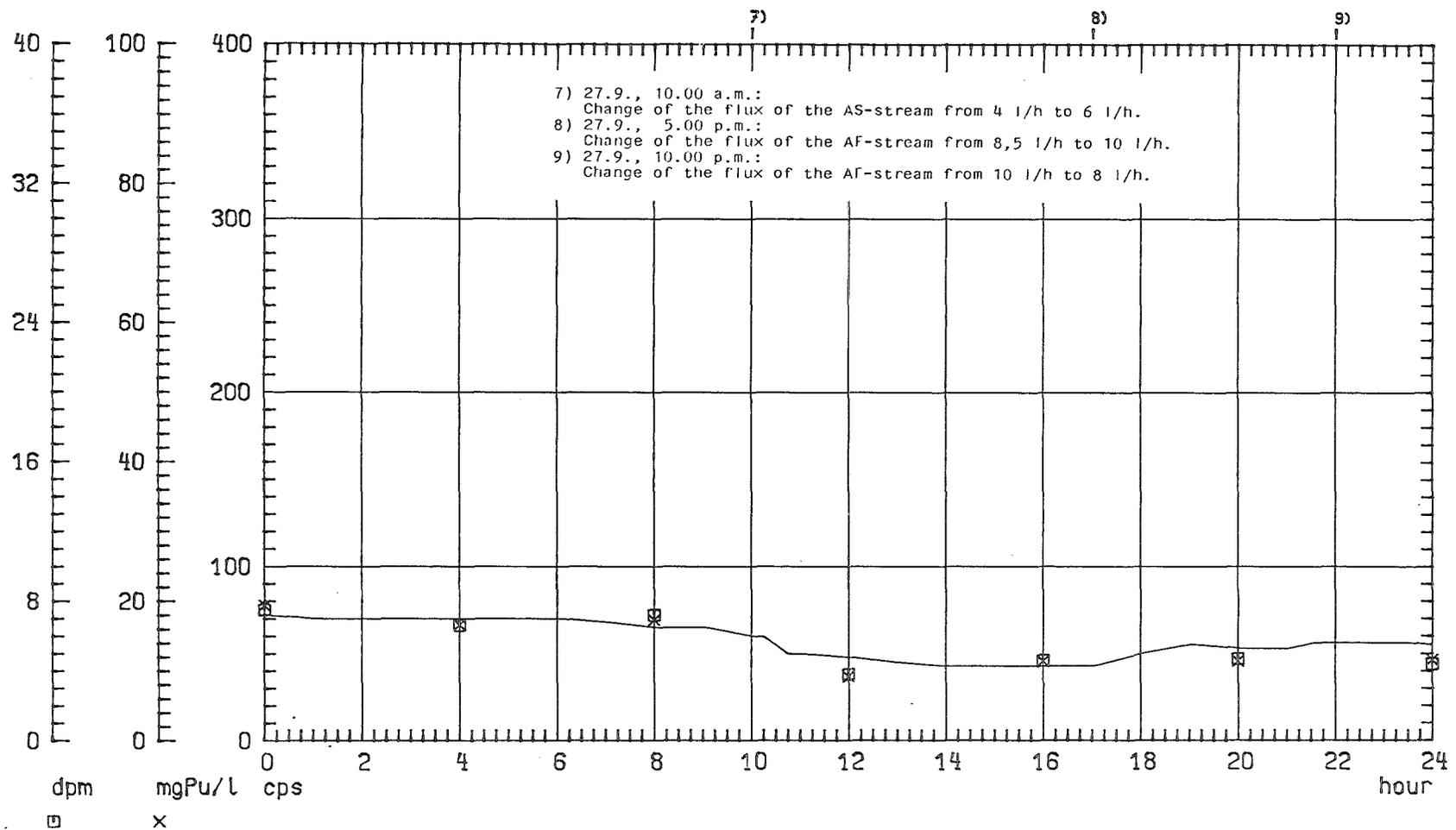


Fig.9b: CHART OF α -MONITOR 2 (AW-STREAM) AT 27.09.82

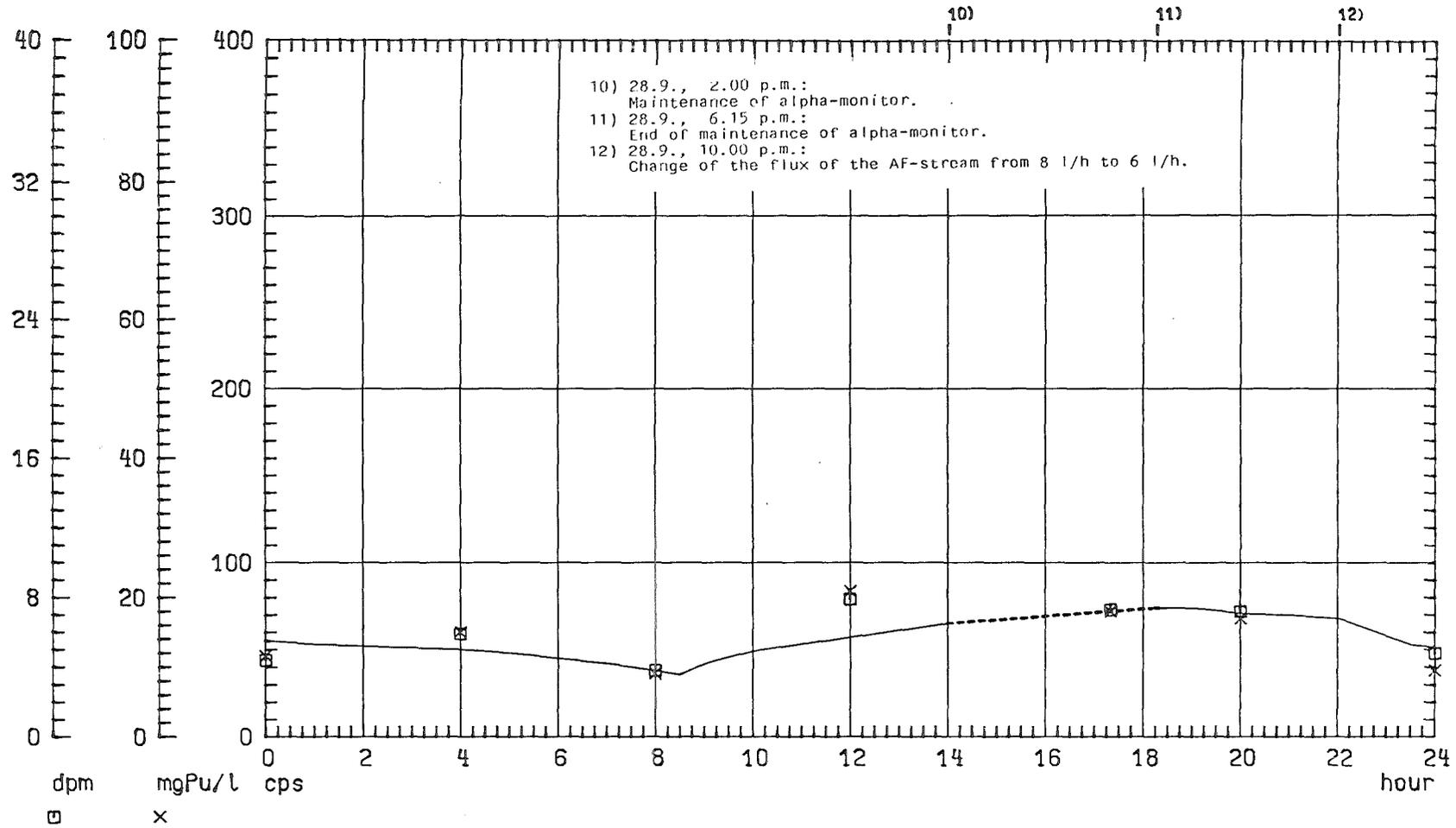


Fig.9c: CHART OF α -MONITOR 2 (AW-STREAM) AT 28.09.82

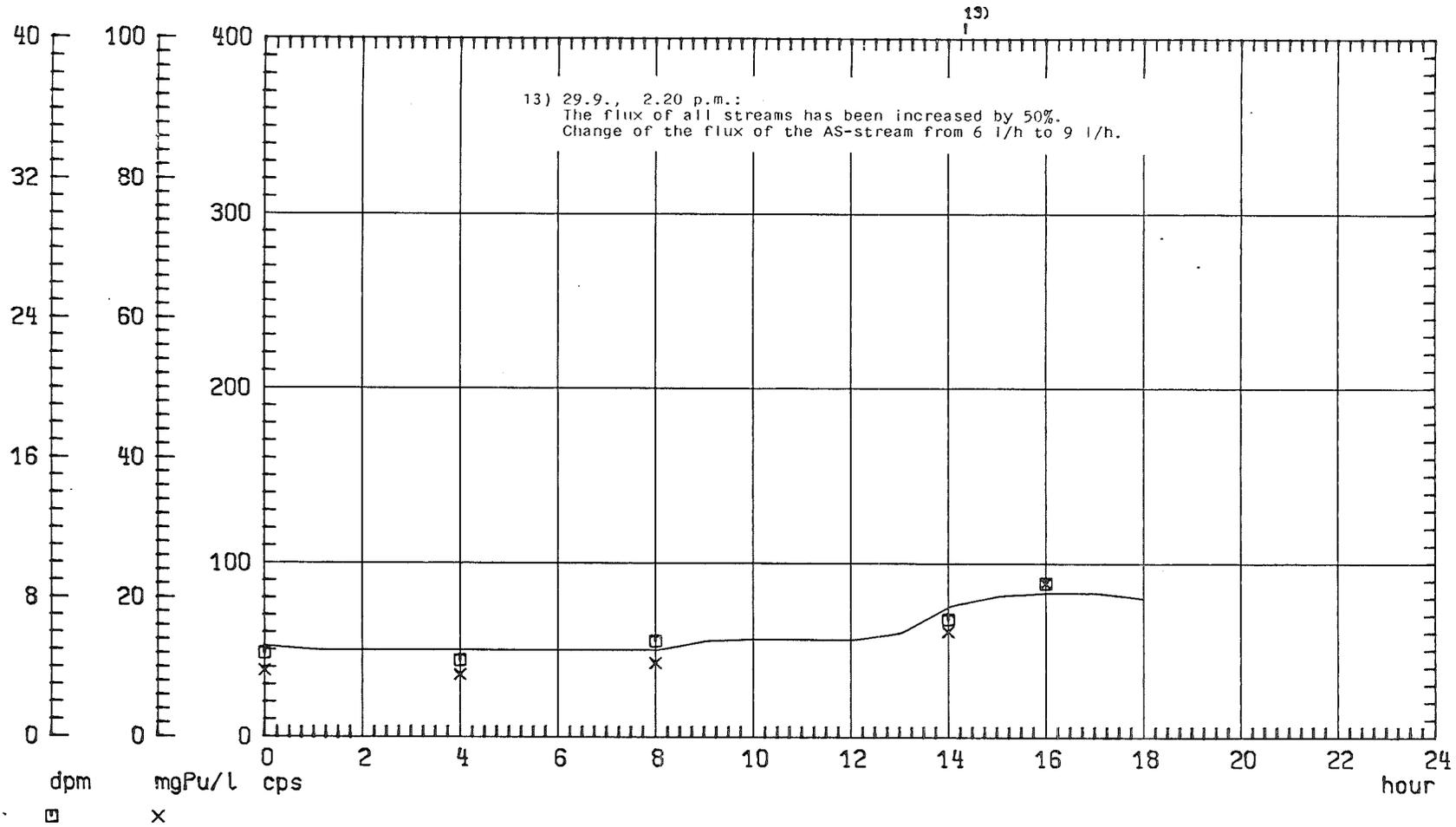


Fig.9d: CHART OF α -MONITOR 2 (AW-STREAM) AT 29.09.82

4.5. Second example of the measuring results of 'monitor 2'

The recorded data between 26.9. and 29.9. are shown in summarized form in figure 8. The daily charts are given in figure 9a - figure 9d. A table of the analyzed results is given in table 4 of the annex. In figure 8 and figure 9a - figure 9d, the results of the laboratory analysis of samples for plutonium are also plotted. To enable a direct comparison the disintegrations per minute per milliliter evaluated by the analytical laboratory for single samples are also listed.

In figure 9a a sudden increase of the plutonium concentration starting at about 3³⁰ can be observed. This increase was preceded by a change of the AF. The concentration of hydrazine was then 10^{-3} mol/l, the concentration of plutonium was less than 1g/l Pu³⁺. This is roughly the analytical detection limit. The Pu(III) could be observed at 4²³ by a pale blue colour in the ground decanter of K01. This colour corresponds to roughly little more than 0,5g/l Pu(III). Therefore the AF was stopped until about 10³⁰. After starting the feed again the piping between the feed container and the column still contained the old feed. Therefore the decrease of the concentration of plutonium in the product lasted until about 12³⁰.

A further decrease of the plutonium concentration occurred after 22³⁰. At 22¹⁵ a new AF was started, with a similar plutonium concentration, but the concentration of hydrazine was less than $1,7 \cdot 10^{-4}$ mol/l (detection limit). Therefore this feed contained no Pu³⁺. After 27.9. 0⁰⁰ the plutonium concentration was between 7 and 20 mg/l Pu. The good relation of the recorded data of the α -monitor and the analytical results can be observed very well in this section. The decrease of the plutonium concentration at 10³⁰ can be explained by the change of the flux of the AF-stream from 4 l/h to 6 l/h.

From 14⁰⁰ until 18⁰⁰ on 28.9. the α -monitor was maintained. During this maintenance period the cause for the contamination of the detector foil and of the decontamination ring was found (s.S.8).

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Private communication 1983.

ANNEX
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Table 2: Recorded data BW-stream
from 27.9., 0⁰⁰ till 30.9., 10⁰⁰.

Date	Hour	Anal.- res. mgPu/l	Anal.- res. x5,0	Integr. dpm x10 ⁵	Integr. dpm x1,26.10 ⁵	Recorded data cps
27.9.	0 ⁰⁰	0,53	2,65	1,65	2,08	3,00
	1 ⁰⁰					3,00
	2 ⁰⁰	0,64	3,20	2,30	2,90	3,00
	3 ⁰⁰					3,00
	4 ⁰⁰	0,65	3,25	2,09	2,63	3,00
	5 ⁰⁰					2,50
	6 ⁰⁰					3,00
	7 ⁰⁰					2,75
	8 ⁰⁰	0,39	1,95	1,81	2,28	2,50
	9 ⁰⁰					3,50
	10 ⁰⁰					3,00
	11 ⁰⁰					3,25
	12 ⁰⁰	0,53	2,65	2,22	2,80	2,50
	13 ⁰⁰					2,50
	14 ⁰⁰					2,50
	15 ⁰⁰					2,50
	16 ⁰⁰	0,87	4,35	3,43	4,32	2,50
	17 ⁰⁰					2,00
	18 ⁰⁰					2,00
	19 ⁰⁰					2,25
	20 ⁰⁰	0,51	2,55	2,40	3,02	2,50
	21 ⁰⁰					3,25
	22 ⁰⁰					4,50
	23 ⁰⁰					5,75
28.9.	0 ⁰⁰	1,31	6,55	4,10	5,17	7,00
	1 ⁰⁰					8,75
	2 ⁰⁰	0,98	4,90	3,10	3,91	10,00
	3 ⁰⁰					12,00
	4 ⁰⁰	1,85	9,25	6,60	8,32	13,50
	5 ⁰⁰					15,00

Date	Hour	Anal.- res. mgPu/l	Anal.- res. x5,0	Integr. dpm x10 ⁵	Integr. dpm x1,26.10 ⁵	Recorded data cps	
28.9.	6 ⁰⁰	1,97	9,85	7,30	9,20	16,00	
	6 ⁴⁵					17,50	
	8 ⁰⁰					18,50	
	9 ⁰⁰					19,00	
	10 ⁰⁰	3,55	17,75	13,0	16,38	19,00	
	11 ⁰⁰					19,50	
	12 ⁰⁰	2,70	13,50	10,0	12,60	16,75	
	13 ⁰⁰					15,50	
	14 ⁰⁰					14,50	
	15 ⁰⁰					15,00	
	16 ⁰⁰	2,50	12,50	10,0	12,60	16,50	
	17 ⁰⁰					19,25	
	18 ⁰⁰	3,50	17,50	13,0	16,38	22,50	
	19 ⁰⁰					27,50	
	20 ⁰⁰	5,00	25,00	19,0	23,94	32,50	
	21 ⁰⁰					40,00	
	22 ⁰⁰	6,00	30,00			45,25	
	22 ¹⁵					47,50	
	22 ³⁵	5,94	29,70	25,0	31,50	45,00	
	23 ⁰⁰					42,50	
	29.9.	0 ⁰⁰					31,5
		1 ⁰⁰					21,0
2 ⁰⁰		2,77	13,85	11,0	13,86	16,5	
3 ⁰⁰						14,5	
4 ⁰⁰		2,52	12,60	10,0	12,60	13,8	
5 ⁰⁰						12,5	
5 ⁴⁰		1,84	9,20	6,3	7,94	12,8	
6 ⁰⁰						12,4	
7 ⁰⁰						12,0	
8 ⁰⁰		1,83	9,15	6,9	8,69	11,0	
9 ⁰⁰						11,3	
10 ⁰⁰						11,8	
11 ⁰⁰					12,0		
12 ⁰⁰					12,5		

Date	Hour	Anal.- res. mgPu/l	Anal.- res. x5,0	Integr. dpm x10 ⁵	Integr. dpm x1,26.10 ⁵	Recorded data cps
29.9.	13 ⁰⁰					12,8
	14 ⁰⁰	2,25	11,25	8,6	10,84	13,2
	14 ³⁰					15,0
	15 ⁰⁰					12,0
	16 ⁰⁰	1,50	7,50	6,5	8,19	9,0
	17 ⁰⁰					8,0
	18 ⁰⁰	1,54	7,70	7,7	9,70	7,6
	19 ⁰⁰					8,0
	20 ⁰⁰	1,43	7,15	5,63	7,09	11,6
	20 ⁴⁵					14,0
	21 ⁴⁰					23,0
	22 ⁰⁰					22,0
	22 ³⁰					21,5
	23 ⁰⁰					23,0
30.9.	0 ⁰⁰	4,16	20,80	16,2	20,41	33,5
	1 ⁰⁰					24,5
	1 ⁴⁰	3,26	16,30	12,5	15,75	24,5
	2 ⁰⁰					28,0
	2 ³⁰					39,0
	3 ⁰⁰					44,5
	3 ³⁰	5,83	29,15	26,3	33,14	50,0
	4 ⁰⁰					54,0
	5 ⁰⁰					52,5
	5 ⁴⁰	5,93	29,65			51,5
	6 ⁰⁰					48,5
	6 ⁴⁵					36,5
	7 ⁰⁰					33,0
	7 ³⁰					29,0
	8 ⁰⁰	4,72	23,60			29,0
	8 ³⁰					28,0
	9 ⁰⁰					28,0
	9 ³⁰					28,0

Table 3: Recorded data AW-stream
from 22.9., 22³⁰ till 23.9., 4¹⁵.

Demonstration of the break-through of plutonium in AW.

Date	Hour	Anal.- res. mgPu/l	Anal.- res. x5,0	Integr. dpm x10 ⁵	Integr. dpm x1,26.10 ⁵	Recorded data cps
22.9.	22 ⁴⁵					42,00
	23 ⁰⁰					42,00
	23 ³⁰					42,00
	23 ⁴⁵	17,97	53,91	8,25	41,25	42,00
23.9.	0 ⁰⁰					44,0
	0 ⁴⁵					44,0
	1 ⁰⁰					43,0
	1 ³⁰					44,0
	2 ¹⁵					50,0
	2 ³⁰					50,0
	3 ⁰⁰	19,20	57,60	9,38	46,90	50,0
	3 ¹⁰					50,0
	3 ²⁰					635,0
	3 ³⁰					1180,0
	3 ⁴⁵	580,0	1740,0	206,0	1030,0	1740,0
	4 ⁰⁰					1650,0
	4 ¹⁵					1750,0

No more data, because of shut down of the extraction process.

Table 4: Recorded data AW-stream
from 26.9., 0⁰⁰ till 29.9., 18⁰⁰.

Date	Hour	Anal.- res. mgPu/l	Anal.- res. x5,0	Integr. dpm x10 ⁵	Integr. dpm x1,26.10 ⁵	Recorded data cps
26.9.	0 ⁰⁰	11,3	45,2	5,47	54,7	51,00
	1 ⁰⁰					50,00
	2 ⁰⁰ a					50,00
	2 ⁰⁰ b					50,00
	3 ⁰⁰					52,00
	3 ³⁰					52,50
	3 ⁵⁰	22,4	112,0	8,60	86,0	104,00
	4 ⁰⁰					164,00
	4 ¹⁵					270,00
	4 ³⁰					340,00
	4 ⁴⁵					370,00
	4 ⁵²					385,00
	5 ⁰⁰	102,0				370,00
	5 ³⁰					310,00
	No feed till 10 ³⁰ .					
	11 ³⁵	77,3	309,2	28,40	284,0	270,00
	11 ⁵⁰	75,3	301,2	27,70	277,0	260,00
	12 ⁰⁰					230,00
	12 ³⁵	49,6	198,4	19,00	190,0	170,00
	13 ⁰⁰					170,00
	14 ⁰⁰					162,00
	15 ⁰⁰					165,00
	16 ⁰⁰	50,5	202,0	20,00	200,0	160,00
	17 ⁰⁰					155,00
	18 ⁰⁰	37,4	149,6	14,30	143,0	150,00
	18 ³⁰					150,00
	19 ³⁰					145,00
	20 ⁰⁰	45,3	181,2	18,00	180,0	145,00
	21 ⁰⁰					145,00
	22 ⁰⁰					148,00

Date	Hour	Anal.- res. mgPu/l	Anal.- res. x5,0	Integr. dpm x10 ⁵	Integr. dpm x1,26.10 ⁵	Recorded data cps
26.9.	22 ³⁰					155,00
	22 ⁴⁵					148,00
	23 ⁰⁰					114,00
	23 ³⁰					80,00
	23 ⁴⁵					75,00
27.9.	0 ⁰⁰	19,4	77,6	7,5	75,0	72,00
	0 ³⁰					71,00
	1 ⁰⁰					70,00
	2 ⁰⁰					70,00
	3 ⁰⁰					70,00
	4 ⁰⁰	16,6	66,4	6,6	66,0	70,00
	5 ⁰⁰					70,00
	6 ⁰⁰					70,00
	7 ⁰⁰					68,00
	8 ⁰⁰	17,3	69,2	7,2	72,0	65,00
	9 ⁰⁰					65,00
	10 ⁰⁰					60,00
	10 ¹⁵					60,00
	10 ⁴⁵					50,00
	11 ⁰⁰					50,00
	12 ⁰⁰	9,2	36,8	3,8	38,0	48,00
	13 ⁰⁰					45,00
	14 ⁰⁰					43,00
	15 ⁰⁰					43,00
	16 ⁰⁰	11,4	45,6	4,6	46,0	43,00
	17 ⁰⁰					43,00
	18 ⁰⁰					50,00
	19 ⁰⁰					55,00
	20 ⁰⁰	11,4	45,6	4,7	47,0	53,00
	21 ⁰⁰					53,00
	21 ³⁰					56,00
	22 ⁰⁰					56,00
	23 ⁰⁰					56,00
	23 ³⁰					56,00

Date	Hour	Anal.- res. mgPu/l	Anal.- res. x5,0	Integr. dpm x10 ⁵	Integr. dpm x1,26.10 ⁵	Recorded data cps
27.9.	23 ³⁰					56,00
28.9.	0 ⁰⁰	11,6	46,4	4,4	44,0	55,00
	1 ⁰⁰					53,00
	2 ⁰⁰					52,00
	3 ⁰⁰					51,00
	4 ⁰⁰	15,0	60,0	5,9	59,0	50,00
	5 ⁰⁰					48,00
	6 ⁰⁰					45,00
	7 ⁰⁰					42,00
	8 ⁰⁰	9,1	36,4	3,8	38,0	38,00
	8 ³⁰					36,00
	9 ⁰⁰					42,00
	10 ⁰⁰					49,00
	11 ⁰⁰					53,00
	12 ⁰⁰	20,9	83,6	7,9	79,0	57,00
	13 ⁰⁰					61,00
	14 ⁰⁰					65,00
	15 ⁰⁰	No data for maintenance of α -monitor till 18 ⁰⁰ .				
	17 ²⁰	18,0	72,0	7,3	73,0	
	18 ¹⁵					74,00
	19 ⁰⁰					71,00
	20 ⁰⁰	17,0	68,0	7,2	72,0	70,00
	21 ⁰⁰					68,00
	22 ⁰⁰					58,00
	23 ⁰⁰					53,00
	23 ³⁰					55,00
29.9.	0 ⁰⁰	9,53	38,1	4,8	48,0	52,00
	1 ⁰⁰					50,00
	2 ⁰⁰					50,00
	3 ⁰⁰					50,00
	4 ⁰⁰	8,95	35,8	4,4	44,0	50,00
	5 ⁰⁰					50,00
	6 ⁰⁰					50,00
	7 ⁰⁰					50,00

Date	Hour	Anal.- res. mgPu/l	Anal.- res. x5,0	Integr. dpm x10 ⁵	Integr. dpm x1,26.10 ⁵	Recorded data cps
29.9.	8 ⁰⁰	10,6	42,4	5,5	55,0	50,00
	9 ⁰⁰					55,00
	10 ⁰⁰					56,00
	11 ⁰⁰					56,00
	12 ⁰⁰					56,00
	13 ⁰⁰					60,00
	14 ⁰⁰	15,2	60,8	6,8	68,0	75,00
	15 ⁰⁰					81,00
	16 ⁰⁰	22,2	88,8	8,87	88,7	83,00
	17 ⁰⁰					83,00
	18 ⁰⁰					80,00