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Alpha Spectrometric Measurements of Th and U in Acrylic

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In order to check on possible disequilibrium in the thorium and uranium families (i.e. the presence of short-lived daughters, unsupported by the parent isotopes ^{232}Th and ^{236}U), it is necessary to measure the last long-lived member of each chain, prior to the gamma emitter of interest. Alpha spectrometry is the only technique capable of detecting ^{226}Th and ^{226}Ra at the very low activities anticipated.

By adopting current ultra trace element analytical techniques (Class 100 acids, use of Teflon ware throughout, etc.) it has been possible to lower backgrounds in the relevant regions of interest of the spectra to 2 to 4 counts in a 20,000 minute period. Even so, in order to detect these radioisotopes at $<1 pg.g^{-1}$ Th or U equivalent, it has been necessary to ash 10 kg of acrylic and to count samples and blanks in excess of 10 days each to obtain statistically significant results.

Initially an electroplsted source was prepared directly from the dissolved ash without prior chemical separation, however the sources so obtained were thick and the spectra difficult to analyze. A step for thorium purification was first introduced, and subsequent to Jan.'88 a minimum number of analytical procedures have been added to purify and electroplate U,Th and Ra separately. Recoveries by this method, measured on spiked 200g samples of acrylic, are as follows:

U	38.8,40.0	average 39.4%
	(flamed prior to electroplating	67.5%)
Th	59.8,65.4,72.9	" 66.0%
Ra	37.3,54.3	" 45.8%

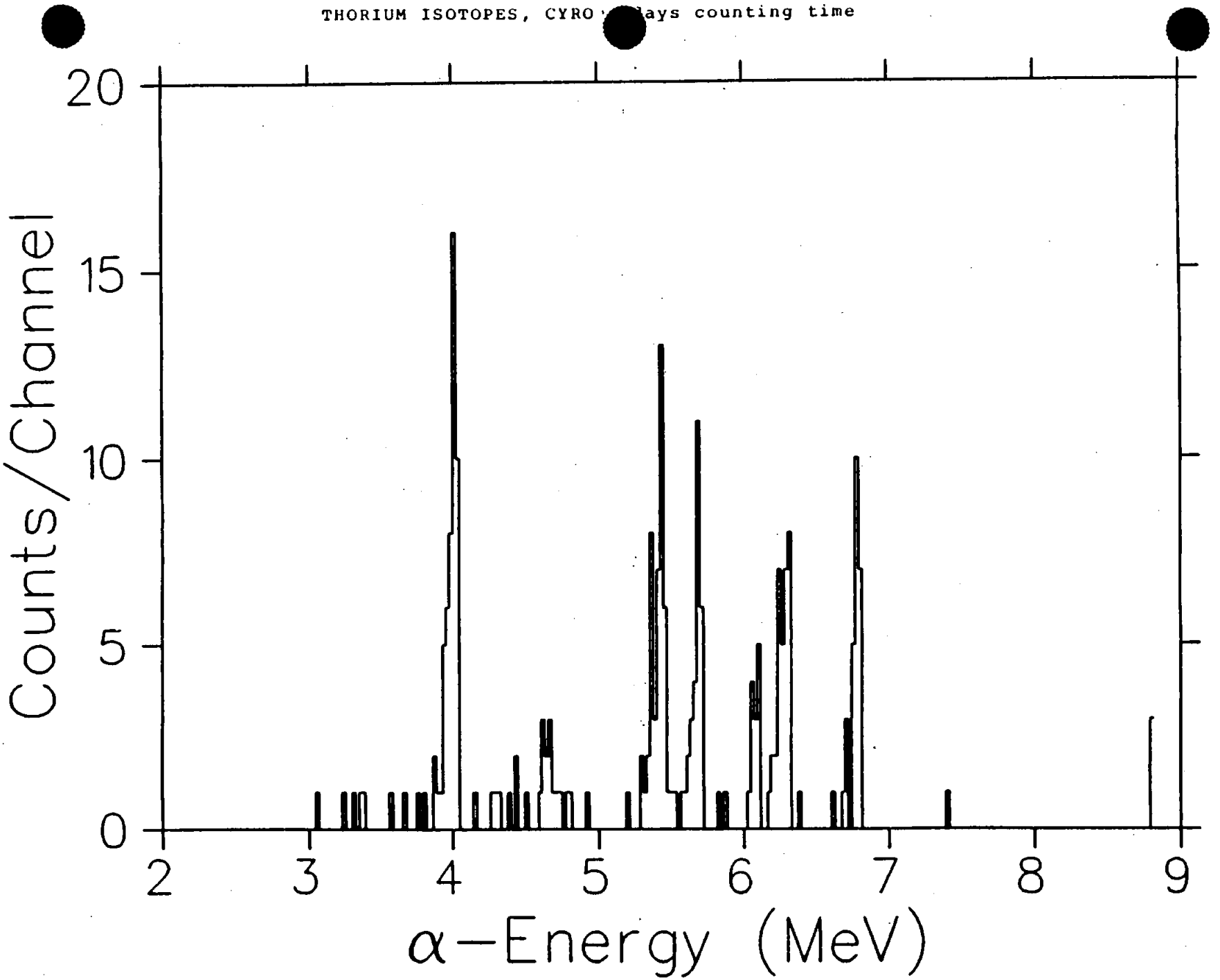
The lower than usual recoveries for U and Ra have been shown to result from our inability to volatilize trace residues prior to plating , when working in Teflon. In order to check for possible losses during the volatilization , chemical separation has been omitted for some of these spiked samples. Quantitative recoveries were observed following tube washout, utilizing methods such as counting dried sources, thermal ionization mass spectrometry, and , in the case of Ra, liquid scintillation counting. It must be recognized, however, that such checks, while encouraging, do not rule out the possibility of increased losses at this stage if the radioisotopes have been bound into the organic matrix at the time of polymerization.

Preliminary measurements in monomer, crosslinker and polymer, prior to application of separation techniques, have provided useful information on the sources of U and Th contamination, and identified other radio and stable elements present (e.g. ^{210}Po, $^{239,240}Pu$, Fe and Ni).

Alpha Spectometric Analyses of Acrylic

Date	Material Analized	Weight (Kg) Vapourized	Th ($pg.g^{-1}$)		U ($pg.g^{-1}$)	
			α Spec	*Mass Spec	α Spec	*Mass Spec
Mar'87	polymer	10.96	^{228}Th 5.1 ± 1.0	4.5 ± 0.08	^{230}Th 1.0 ± 0.22	0.9 ± 0.08
Dec'87	polycast	11.6	^{232}Th 4.3 ± 0.80 ^{228}Th 3.7 ± 0.80	3.7 ± 1.8	^{230}Th 0.8 ± 0.20	1.1 ± 0.10
April'88	polycast	10.6	^{232}Th 2.0 ± 1.0 ^{228}Th 2.2 ± 1.0		^{238}U 0.3 ± 0.20 ^{230}Th 0.8 ± 0.30	
July'88	polycast	9.8	^{232}Th 2.6 ± 0.60 ^{228}Th 3.9 ± 0.80	4.9	^{238}U 2.1 ± 0.80 ^{230}Th 0.8 ± 0.20 ^{226}Ra 1.2 ± 0.80	1.1
July'89	Rohm	8.72	^{232}Th 0.35 ± 0.29 ^{228}Th 0.83 ± 0.35	1.0	^{238}U 0.30 ± 0.13 ^{230}Th 0.08 ± 0.07 ^{226}Ra below LLD	0.3
Dec'89	Cyro	15.5	^{232}Th 6.7 ± 1.0 ^{228}Th 6.7 ± 1.0	7.2	^{238}U 7.0 ± 0.75 ^{230}Th 0.5 ± .15	7.3

*Analysis of similar material by mass spectroscopy; samples for two methods vapourized separately.


THORIUM ISOTOPES, CYRO
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Counts/Channel
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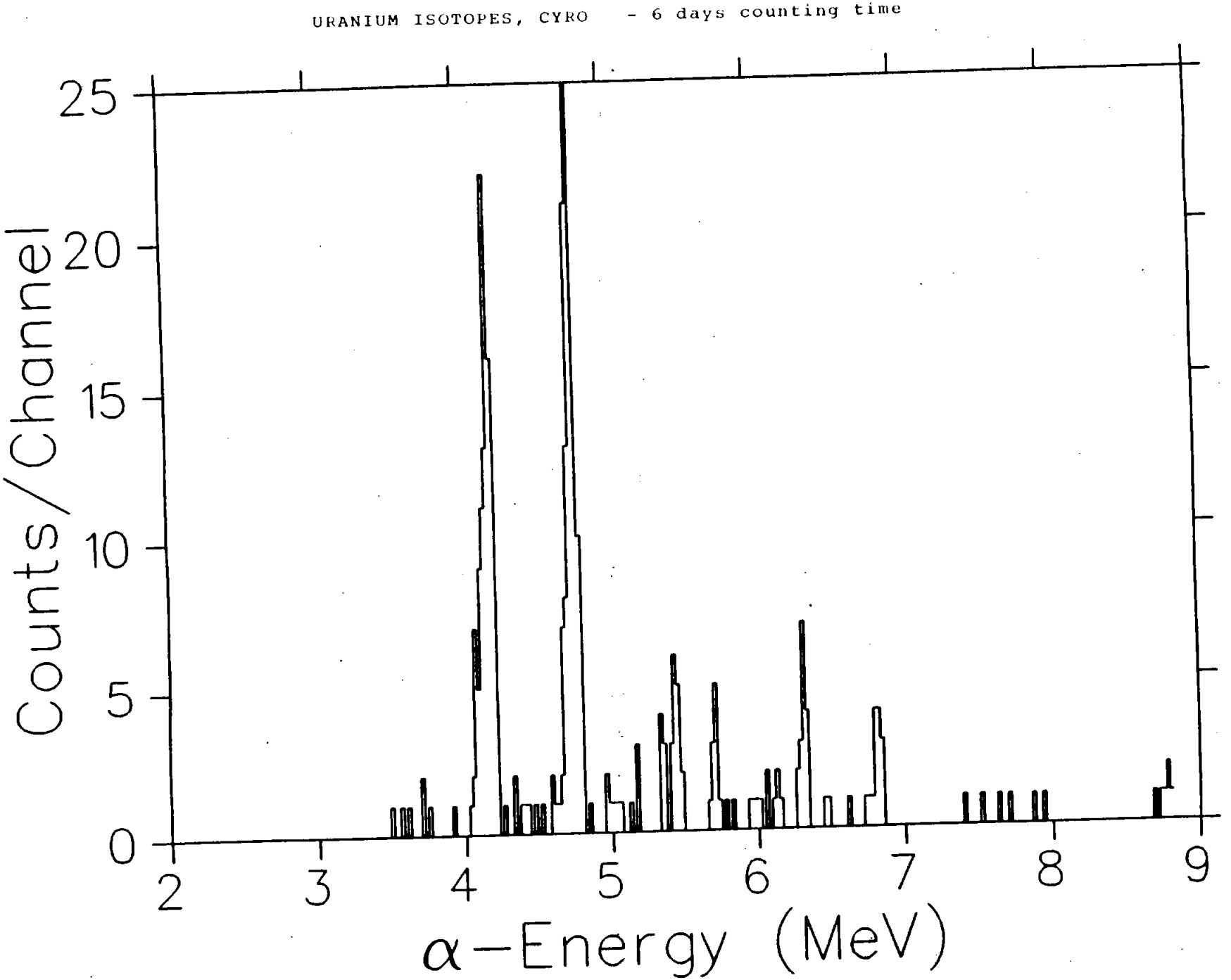
α−Energy (MeV)


URANIUM ISOTOPES, CYRO - 6 days counting time
Counts/Channel
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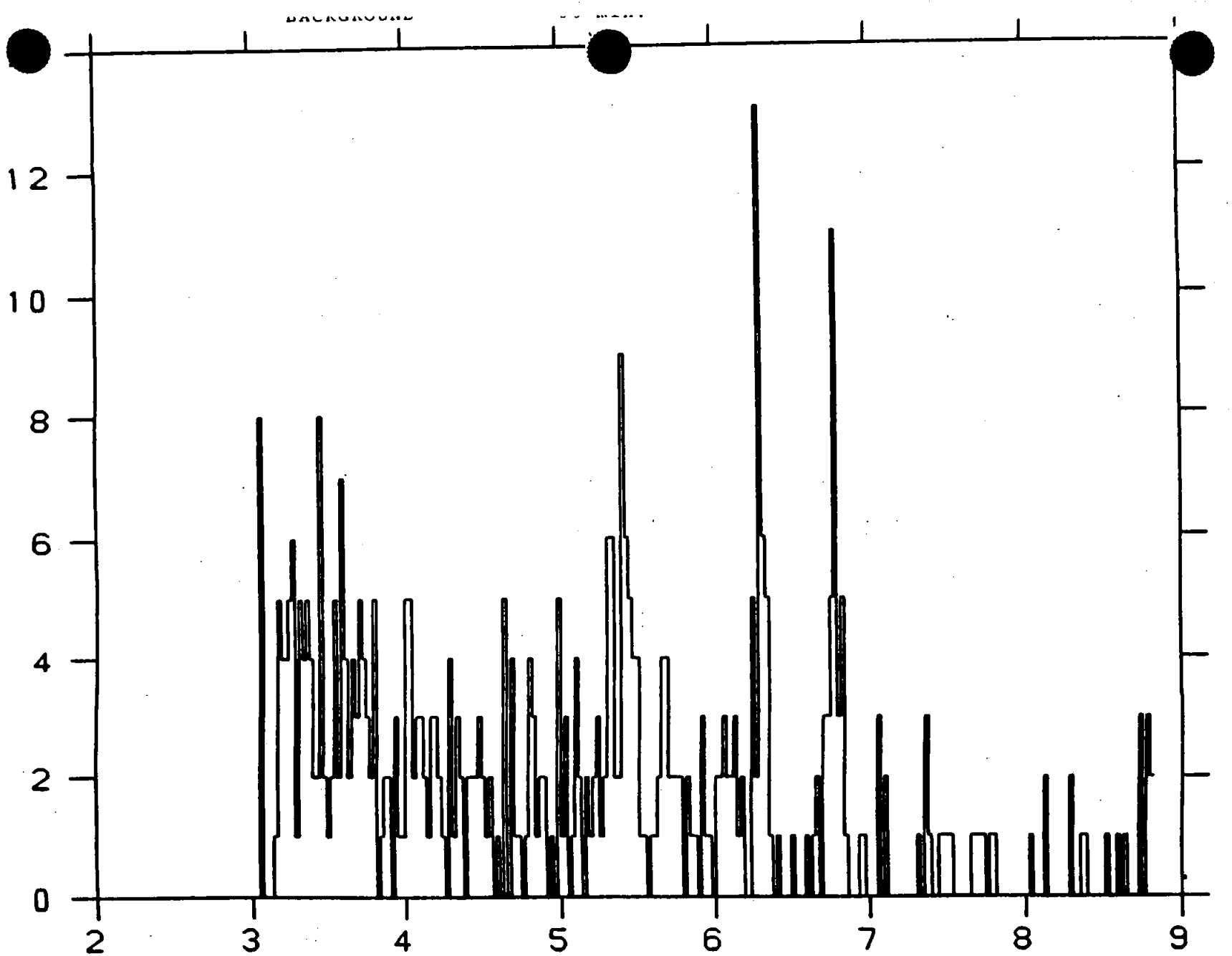
α-Energy (MeV)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