 SNO-STR-92-080

Background and Rope Sample Test Update
Low Level γ-ray Spectrometer
SNO Research Station
4600 ft level, Creighton Mine
October 1, 1992

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Introduction

Shielding and radon exclusion measures have recently been improved for the 50% germanium γ-ray spectrometer (PGT) installed in June 1992 in the SNO underground research station. In this repcrt, representative background spectra, including uranium (U) & thorium (Th) peak counts, are compared, for the original and current shield configurations. γ-ray spectra for two U/Th standard samples (MnO and "brazil nuts") are also presented to determine the detector efficiencies (counts/day.(μg U or Th). Spectra for Vectran rope filament samples measured before and after the shielding change are compared. An estimate of current minimum detection limits for U and Th in the rope samples is also given.

Sample and Shielding Configurations

The PGT germanium detector has an electroformed copper cover and endcap over the 210 cm^3 germanium crystal. Efficiencies averaging 51% (vs standard NaI efficiency) were measured when the detector was installed. One litre Marinelli beaker acrylic containers 15 cm in diameter and 10 cm high, are used for samples. Copper and lead shielding blocks (2 in x 4 in x 8 in) were used in a rectangular castle with Cu (inner) and Pb (outer) shielding thicknesses as indicated in Table 1. Initially a heavy (6 mil) polyethylene sheet was used to keep airborne radon and its decay products from the detector region. In this configuration, nitrogen boil-off gases from the pressurized 150 L storage dewar were used to flush the detector volume. In the changes made in September 1992, a 3/8 in thick box was constructed (using heat-welded seams) from hard polyvinyl chloride (PVC). With approximate dimensions of a 30 in x 30 in base and 40 in height, the box can contain the detector and a maximum of 10 in (25 cm) Pb and 2 in (5 cm) Cu shielding as shown in Figure 1. The box is sealed around the detector cold finger (with silicone seal) and has a removable lid and inlet and outlet vents for nitrogen flushing. In measurements made this week, nitrogen boil-off gas from the storage dewar was used to flush the box interior. In the lowest background measurement (of the 'sand' Vectran filament) just made, the air inside the box was partially evacuated with a vacuum pump, and nitrogen boil-off gas added in several cycles. A high flush rate was used through the measurement period.

Results

a) Background Comparisons

Table 1: Backgrounds (counts/day) at U/Th peak energies for typical shielding configurations and radon isolation.

Peak (keV)	Unshielded Background	Shielded background before PVC box	Shielded background PVC box in
186	17460	8	1
238	88160	7	6
242	22000	76	84
295	56029	108	177
352	106023	223	304
583	65438	-3	-1
609	123438	175	262
911	56041	6	-2
1001	2266	-2	1
1461	352058	7	11
1764	38775	25	48
2614	77331	6	5

** The higher values in the background with the PVC box installed can be accounted due to the fact that the lead castle was previously built before flushing with nitrogen gas began and also the air in the box was not evacuated .

b) Standard Spectra and Detector Efficiencies

Table 2: MnO and brazil nut standard calibrations (shield configuration 5 cm Cu, 15 cm Pb, polyethylene wrap).

Peak (keV)	Standards	
	MnO (counts/24 hrs)	Brazil Nuts (counts/24 hrs)
186	14960	5548
238	43370	33616
242	16689	5214
295	39737	13647
352	71732	24665
583	18130	14789
609	59116	19456
911	13665	11034
1001	940	109
1461	60321	13456
1764	12132	3678
2614	8025	5734

Table 3: Detector Efficiencies (as per report July 29/92 by P.Jagam) in counts/day for 10^{-6} g U or Th per 1 kg sample(data from June 24/92 MnO count)

E_γ (keV) Std.	Counts $/10^{-6}$ g.day MnO	E_γ (keV)	Counts $/10^{-6}$ g/day MnO
Thorium		Uranium	
239	3.27	186	1.76
583	1.34	352	8.53
911	1.02	609	7.05
2614	0.61	1001	0.11
		1764	1.45
Potassium			
1461	2.61×10^{-3}		

The brazil nut standard has a matrix attenuation more similar (organic) to that of the Vectran rope than that for the MnO (silica and alumina). A comparison of MnO and brazil nut spectra indicates that, for example, at 2614 keV, the counts for a 500 ppt 1 kg Vectran sample may be enhanced by 20 % from the 0.3 counts per day expected from Table 3.

c) Comparison of Vectran Rope Filament Spectra

Table 4: Vectran sample spectra at U/Th and potassium peak positions.

Peak (keV)	Sand Vectran Filament	
	Before PVC box (counts/24 hrs)	PVC box installed (counts/24 hrs)
186	4	18
238	12	12
242	45	13
295	109	33
352	182	81
583	-2	0
609	156	60
911	1	1
1001	2	-2
1461	113	91
1764	33	13
2614	4	5

Conclusions:

Significant progress has been made in radon and radon decay product suppression in the shield and sample region of the detector. Currently, a practical detection limit of at least 0.5 ppb for U and for Th appears to be achievable for rope samples. Additional Pb shielding to obtain 25 cm thickness everywhere is still preferable, and will be installed as soon as possible. A regulated flushing system using dry nitrogen from a compressed gas cylinder is now being installed to further minimize radon backgrounds.

Figure 1

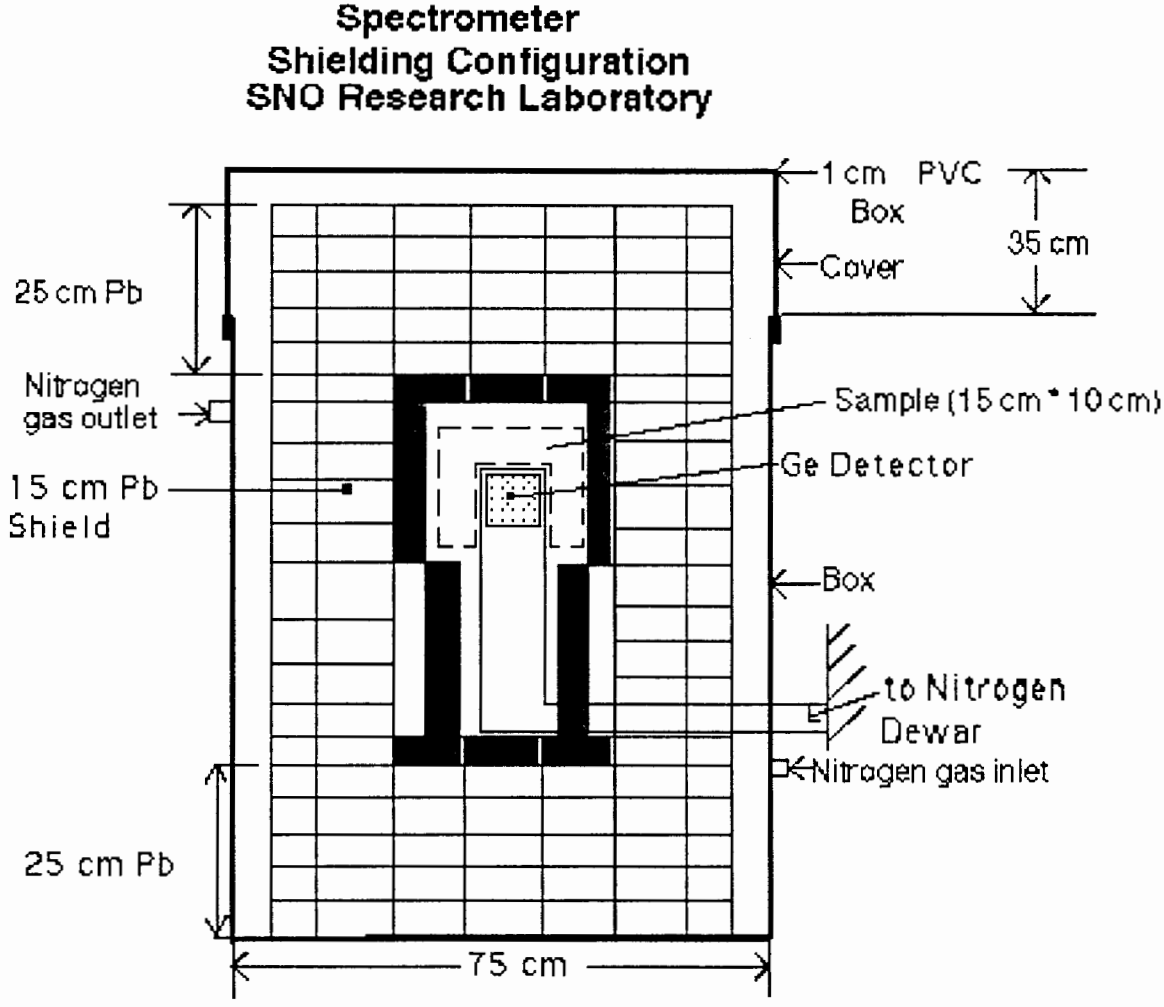


Figure 2

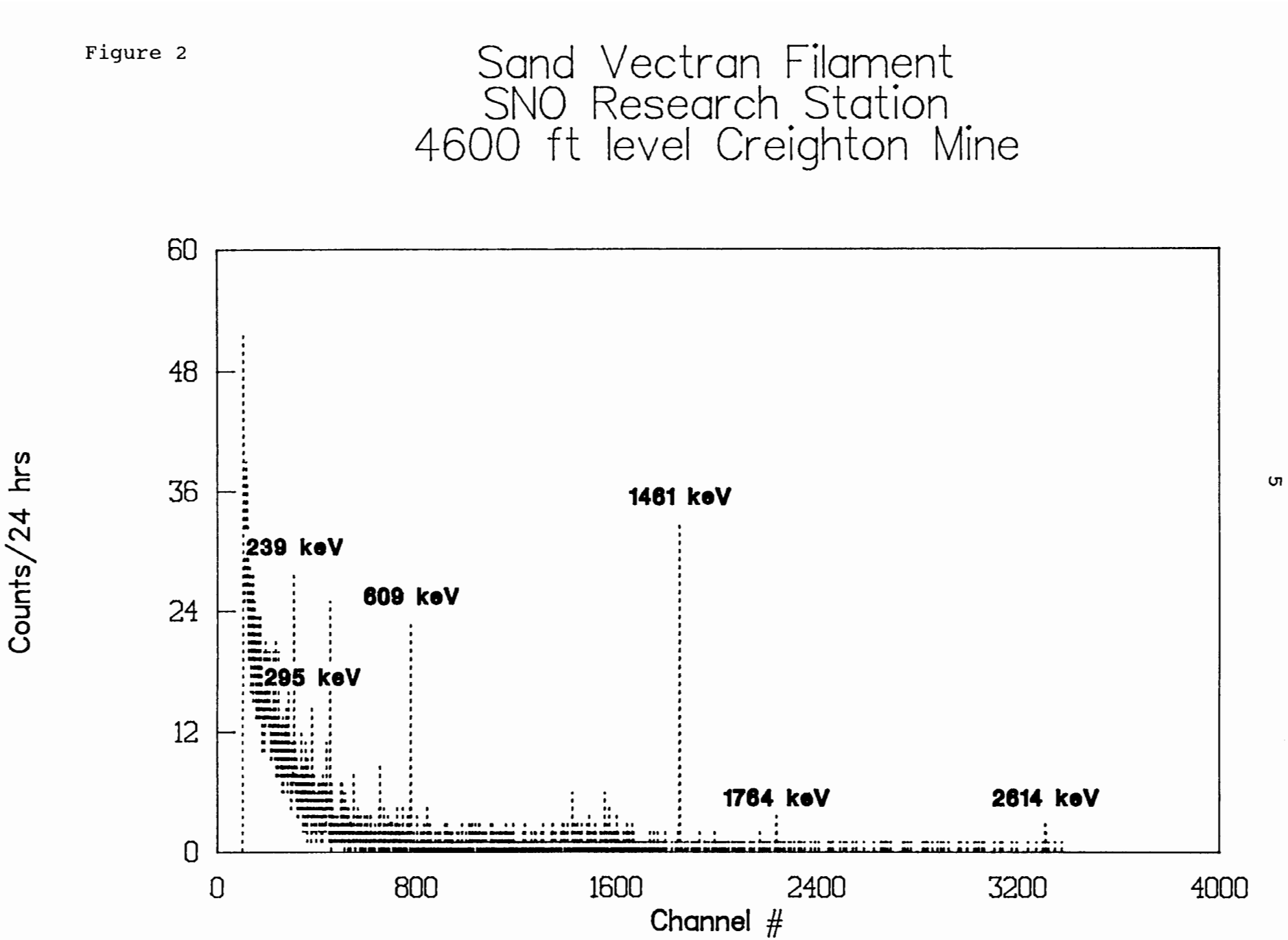
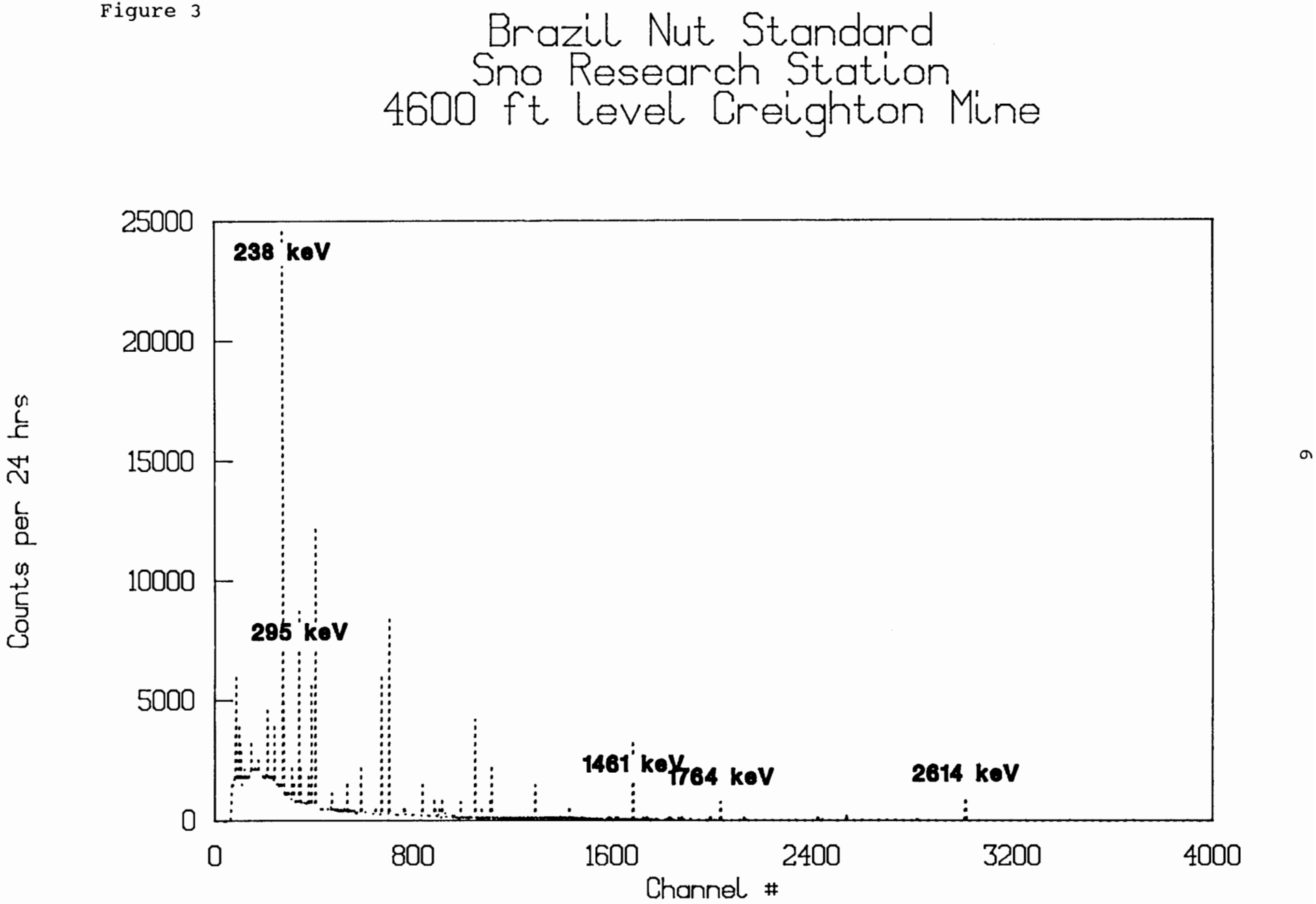

Sand Vectran Filament
SNO Research Station
4600 ft level Creighton Mine
Counts/24 hrs
60
48
36
24
12
0
239 keV
295 keV
609 keV
1461 keV
1764 keV
2614 keV
0
800
1600
2400
3200
4000
Channel #

Figure 3


Brazil Nut Standard
Sno Research Station
4600 ft level Creighton Mine
Counts per 24 hrs
25000
20000
15000
10000
5000
0
238 keV
295 keV
1461 keV
1764 keV
2614 keV
0
800
1600
2400
3200
4000
Channel #