Linear regression for Gamma-Ray spectrum

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Linear Regression for Gamma-Ray Spectrum

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Abstract: The radiation emitted from nuclear decay is subject to a certain degree of statistical variability. These inherent fluctuations represent an inevitable source of uncertainty in all nuclear measurements and often they can be the predominant source of inaccuracy or error. So we used programming and statistical tests to study the spectrum of the Cesium-137 source. We analyzed the spectrum areas from the total area of the spectrum, photopeak, and others, and found through the analysis that the samples mean do not obey the normal distribution and this was proved by using a T-test. The distribution of the values was observed randomly around the rate by using the linear regression test. and there were few differences between the mean values and the statistical variation of the single assumed random models by using the statistical models.

INTRODUCTION

Nuclear decay is a quantum transition process obeying the statistical laws. so, for any radionuclide, decay time of occurrence is entirely accidental and cannot be expected [1]. It is an important way of understanding the nucleus where the exponential decay of radionuclides as a function time is a cornerstone of nuclear physics and radionuclide metrology [2]. Theoretical derivations of the exponential law can be achieved from probabilistic and quantum mechanical points of view [3].

The nature of statistical radiation resulting from uncertainty in the energy level of the nucleus is unstable and the possibility of the decay of the number of cores within a certain period of time based on the statistical relationship derived by Rutherford and Soddy so, we try use the laws of statistics and statistical distributions software to try to understand the random statistical nature of the dissolution of gamma rays and their interaction with the material. which that three kinds of rays are included during the release process of nuclear decay, i.e., (i) α-ray which has the two-charge number and four mass number. (ii) β-ray, negatively charged electron (iii) gamma -ray which is a very high energy [4]. The unstable nuclei emit radiation from radioactive decay to another less energy nuclear decay, and these decays are obey to the laws of energy and charge conservation. [5]. The exponential decay of radionuclides as a function of time is a cornerstone of nuclear physics and radionuclide metrology. Theoretical derivations of the exponential law can be achieved from probabilistic and quantum mechanical points of view. [1,2]. There is continuing interest in statistical models of multifragmentation which are relevant only for the description of the ultimate stage of the reaction but which, by variation of initial conditions (excitation energy, nucleon density), may exhibit behavior which is characteristic of a phase transition. Generally speaking, these models are highly successful in reproducing results of experiments [5,6].

EXPERIMENTAL METHODS

An electronic counting and analysis system was used by using NaI (Tl) sodium iodide crystal detector with size (3 "x 3") cm was measured based on the high penetration strength of the gamma ray in the materials by , the equipped by a company (Spectrum Tachniques LLC), the nuclear measurements and analysis were done by a computer program called UCS_30.

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The UCS30 Advanced Spectrometer System contain 4096 channel MCA with internal preamplifier, high voltage (0-2048V), upper and lower-level discriminators and multichannel scaling for half-life and decay studied. [7]. Figure (1) shows Nuclear counting NaI(Tl) detector in present study.

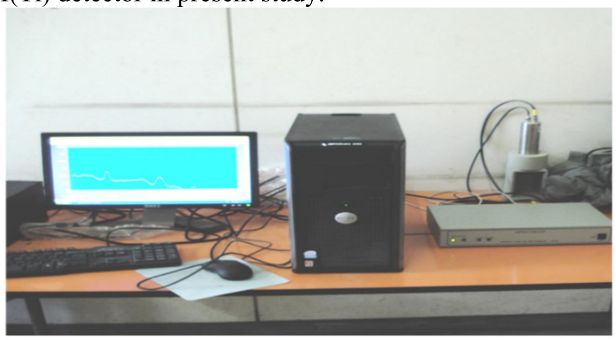


FIGURE 1. Nuclear detection system: NaI(Tl).

Radiation detector (NaI(Tl) scintillation counter) is a pulses of light produced in a transparent material by the passage of a particle . [8]. The iodine provides most of the stopping power in sodium iodide. These crystalline scintillators are characterized by high density, high atomic number, its efficiency and the high precision and counting rates are a consequence of the extremely short duration of the light flashes, from about 10-9 to 10-6 sec, that are possible and pulse decay times of approximately (1 μsec). Scintillation exhibits high efficiency for detection of gamma rays and are capable of handling high count rates. [10].

In general, a scintillation detector consists of:

Scintillator. A scintillator generates photons in response to incident radiation.

Photodetector. A sensitive photodetector which converts the light to electrical signal and electronics to process this signal. [11].

scintillation counters can be used to determine the energy, as well as the number, of the exciting particles (or gamma photons). For gamma spectrometry, the most common detectors include sodium iodide (NaI) scintillation counters and high-purity germanium detectors. [12].

Caesium-137(^{137}Cs) is a radioactive isotope of cesium is half-life of 30.07 years which is consider as one of the more common fission products by the nuclear fission of ^{235}U [7]. 94.6% decays by beta emission to a metastable nuclear isomer barium-137m(1^{37m}Ba) . Metastable barium has a half-life of about 153 seconds, and is responsible for all of the gamma ray emissions in samples of ^{137}Cs. ^{137m}Ba decays to the ground state by emission of photons having energy 0.662 MeV.[13] A total of 85.1% of ^{137}Cs decays lead to gamma ray emission in this way. as the Figure (2).

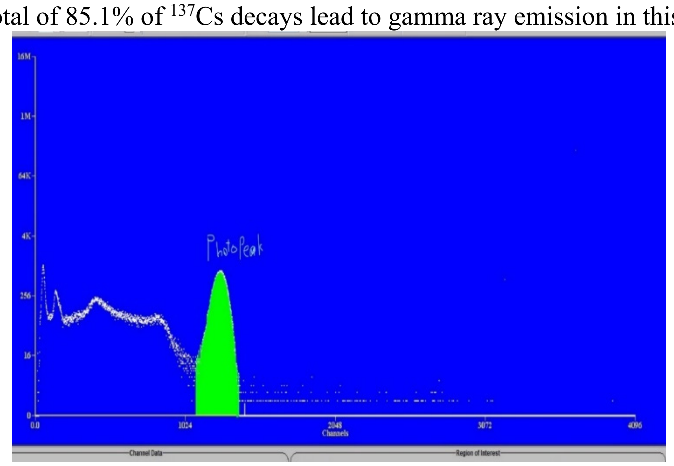


FIGURE 2. ^{137}Cs Spectrum, Note the single γ emission at 0.662MeV.

The spectrum produced by the emission of these photons has a single photopeak. Two hundred readings gathered. The cesium spectrum and the collection time of each spectrum is (200 sec) and the distance is (7cm) between the radioactive source and the detector.

Studied the statistical distribution of the irradiated ^{137}Cs spectrum regions by using R program and statistical treatments.

The R Programming Environment: is a program that allows the construction of statistical programs and applications. There are many specialized packages that can be protected on the program so that they can be used. These packages cover most statistical methods and in a very specialized and accurate manner. [14]. R is implementing a large of statistical and graphical techniques, including linear and nonlinear modeling, classical statistical tests, time-series analysis, classification. R is easily extensible through functions and extensions, and is noted for its active contributions in terms of packages. Many of R's standard functions are written by R itself [15].

THEORETICAL PART

There is interest in statistical models of multifragmentation w for the description of the ultimate stage of the reaction these. So, may be used to extract the densities and excitation energies which best experimental data sets. The statistical models is two kinds: discrete distribution, such Binomial and the Poisson, and two types of continuous distribution, the Uniform and the Exponential depending on the context, as well as the normal distribution. these types of random distribution may useful as theoretical models of the uncertainty associated with the outcome of a measurement.

Binomial distribution: The number of successes among n repeats of independent trials with a probability p(x) of success in each trial. and the probability of its failure is q =1-p. The distribution is marked as Binomial (n, p) as Eq.1 [16].

$$E(X) = np \quad , Var(X) = np(1 - p) \tag{1}$$

Where E(X) is referred to Expectation value of mean data and Var(X) refers to Variance of the mean data.

Poisson distribution: An approximation to the number of occurrences of a special event, when the expected number of events is λ. The distribution parameter is marked as (λ), as Eq. 2 [17]

$$E(X) = Var(X) = \lambda \tag{2}$$

Uniform distribution: Model for a measurement with equally likely outcomes over an interval [a, b]. This distribution shown in Eq. 3 [16].

$$E(X) = (a + b)/2 \quad , \quad Var(X) = (b - a) \tag{3}$$

where, a is the lowest value , b is the highest value

Exponential distribution: Model for times between events. This distribution shown in Eq. 4 [18]

$$E(X) = 1/\lambda \quad \& \; Var(X) = 1/\lambda^2 \tag{4}$$

Where λ is the rate of the distribution

Kolmogorov-Smirnov Test

The hypothesis test is used as Eq.5 [17].

$$H_0: X \sim N(\mu, \sigma^2)$$

Opposite

$$H_1: X \neq N(\mu, \sigma^2) \tag{5}$$

Shapiro-Wilk Test

It also uses the same Eq.5. If P <05.0 then data are distributed according to a normal distribution [17,18].

RESULTS AND DISCUSSION

In this paper, the total area of the spectrum was calculated (i.e., the area from the first point at the spectrum to the last point), and was also calculated the net area of the photopeak spectrum as shown in Table.1. Where it indicates; Net is the net area peak, Gross: the spectrum confined from the beginning to the end of the peak, FWHM: refer Full Width Half Maximum, P.P: The Centroid of the peak.

TABLE 1. ^{137}Cs spectrum

sample	Total Are(C/s)				Photopeak (C/s)				sample	Total Area(C/s)				Photopeak (C/s)			
	Net	Cross	F.W. H.M	P.P	Net	Cross	F.W. H.M	P.P		Net	Cross	F.W. H.M	P.P	Net	Cross	F.W. H.M	P.P
1	203,438	206,978	17	741.6	78,002	79,623	88	1257	101	187,126	208,621	15	735	77,939	79,578	87	1253
2	191,660	207,549	17	740	77,460	79,627	88	1258	102	208,842	208,843	15	734	77,270	79,524	90	1254
3	197,983	207,657	17	740	78,162	79,540	87	1259	103	181,782	208,047	15	735	77,817	79,409	89	1254
4	199,835	208,142	17	737	77,670	79,235	86	1259	104	207,213	208,904	16	737	77,432	79,795	87	1255
5	201,593	208,124	17	741	78,049	80,066	91	1260	105	206,225	208,147	15	737	77,942	79,606	90	1255
6	204,273	208,037	16	740	77,552	79,611	93	1260	106	186,041	207,846	15	735	76,605	79,316	90	1255
7	197,510	207,870	17	740	77,503	79,499	98	1261	107	189,086	208,312	15	738	77,946	79,958	87	1256
8	197,881	208,060	18	741	77,619	79,551	88	1262	108	190,885	208,378	15	740	78,673	80,225	87	1257
9	198,237	208,078	14	742	78,214	79,852	86	1262	109	194,532	208,529	15	738	76,665	79,706	86	1258
10	204,606	208,684	17	743	78,832	80,143	90	1263	110	194,818	209,026	15	739	77,506	79,869	86	1258
11	203,376	208,324	17	742	78,395	79,980	93	1263	111	204,719	208,763	15	741	78,318	79,779	91	1259
12	204,775	208,285	17	243	76,926	79,384	88	1265	112	194,638	208,219	15	741	77,999	79,548	87	1259
13	201,441	208,470	17	742	77,383	79,522	92	1266	113	198,425	208,439	15	740	77,587	79,643	90	1260
14	206,619	208,395	17	753	78,639	79,936	91	1281	114	206,455	208,284	15	740	78,166	79,409	89	1260
15	202,036	207,995	18	747	77,642	79,995	90	1266	115	194,230	208,155	15	740	77,924	79,802	89	1261
16	200,482	208,027	18	744	77,800	79,529	91	1267	116	198,334	208,460	15	742	77,596	79,600	87	1262
17	206,804	208,619	16	745	77,803	79,793	89	1268	117	195,609	208,850	15	742	77,592	79,951	86	1263
18	206,301	208,262	17	743	77,803	79,471	88	1268	118	196,862	208,230	15	742	77,800	79,719	88	1263
19	206,920	280,591	17	745	78,279	80,224	90	1268	119	199,926	208,452	15	740	77,208	79,330	88	1263
20	198,153	208,375	17	744	78,162	79,573	90	1270	120	198,283	208,451	15	740	76,758	79,280	88	1263
21	194,456	208,298	17	747	78,395	80,106	91	1270	121	199,741	208,447	15	740	76,775	79,323	86	1264
22	204,635	208,010	17	749	78,572	80,148	92	1272	122	202,034	208,035	14	744	78,144	79,729	88	1265
23	202,578	208,618	17	746	77,707	79,696	89	1272	123	198,821	208,617	15	744	77,622	79,781	90	1266
24	206,026	208,012	18	747	78,035	79,461	91	1273	124	184,505	208,662	14	743	77,342	79,527	91	1265
25	203,593	208,703	16	750	78,560	80,061	92	1273	125	193,543	208,622	15	742	77,900	79,557	91	1266
26	207,140	208,789	18	748	78,875	80,088	92	1273	126	194,864	208,300	14	743	77,886	79,840	88	1266
27	195,525	208,325	17	747	77,626	79,244	91	1274	127	208,190	208,191	15	743	77,511	79,657	91	1266
28	189,827	207,162	17	739	77,786	79,551	87	1257	128	195,369	207,781	15	744	77,190	79,316	87	1267
29	175,199	205,372	17	732	76,371	78,007	87	1250	129	196,260	208,135	15	745	77,678	79,772	87	1246
30	182,765	207,687	16	733	77,658	79,717	87	1248	130	196,311	207,955	14	744	76,874	79,145	89	1268
31	191,759	207,875	18	734	77,685	79,786	85	1247	131	201,133	208,232	15	745	77,996	80,013	87	1267
32	201,148	207,212	18	736	77,536	79,935	91	1247	132	197,721	208,156	15	744	77,305	79,406	90	1268
33	201,976	208,551	18	731	78,094	79,679	88	1247	133	197,468	208,899	14	743	77,234	79,260	92	1268

34	196,406	208,326	18	734	76,932	79,482	88	1248	134	192,630	208,356	14	745	78,595	79,852	92	1269
35	203,395	206,806	18	734	77,738	79,689	88	1247	135	197,087	208,413	15	744	77,196	79,477	91	1268
36	204,960	208,930	18	733	77,777	80,130	90	1248	136	199,776	208,199	14	746	77,964	80,103	86	1269
37	200,220	208,332	18	732	78,078	79,687	88	1248	137	198,501	208,936	14	745	78,240	79,636	91	1269
38	196,099	208,295	18	734	77,957	79,592	93	1249	138	197,950	207,971	15	745	76,995	79,453	86	1269
39	196,408	208,442	16	733	77,747	79,977	92	1249	139	202,751	208,361	15	745	78,372	79,908	90	1269
40	201,860	207,807	18	736	78,021	79,840	86	1250	140	202,873	207,518	15	743	76,975	78,979	84	1269
41	202,638	208,600	18	735	78,043	79,975	89	1250	141	197,497	209,150	15	746	78,029	79,918	91	1270
42	199,666	208,517	18	737	77,508	80,055	86	1251	142	202,968	208,093	15	745	77,886	79,681	92	1270
43	198,852	208,703	19	733	76,968	79,375	90	1251	143	132,546	208,792	14	746	78,514	79,925	92	1270
44	203,787	207,829	19	735	77,629	79,292	90	1252	144	198,372	208,096	15	746	77,348	79,810	89	1270
sample	Total Are(C/s)								sample	Total Area(C/s)				Photopeak (C/s)			
	Net	Cross	F.W. H.M	P.P	Net	Cross	F.W. H.M	P.P		Net	Cross	F.W. H.M	P.P	Net	Cross	F.W. H.M	P.P
45	201,847	207,914	18	736	77,585	79,825	84	1251	145	199,578	208,074	16	747	77,824	79,883	88	1270
46	195,382	208,768	14	732	78,038	79,455	89	1251	146	203,413	208,307	15	745	77,604	79,453	89	1271
47	202,927	208,172	15	735	78,163	79,748	85	1252	147	176,233	195,879	17	746	77,310	79,800	91	1238
48	206,852	208,516	15	738	77,546	79,800	85	1253	148	204,638	207,869	18	731	77,010	79,269	89	1244
49	174,339	208,586	14	737	78,254	79,795	87	1254	149	197,821	207,755	17	729	77,735	79,542	87	1240
50	200,115	208,026	18	729	77,099	79,456	88	1243	150	199,531	207,620	17	729	77,573	79,475	88	1240
51	196,229	207,444	19	729	77,152	79,526	91	1242	151	200,716	208,091	17	730	77,152	79,472	82	1240
52	199,006	207,427	18	728	77,248	79,188	85	1241	152	196,378	208,280	17	730	77,905	79,916	88	1240
53	202,532	208,404	18	731	77,982	79,943	88	1241	153	196,378	208,280	17	730	78,064	79,768	88	1241
54	198,290	208,318	18	730	77,973	79,604	89	1241	154	199,940	207,845	17	731	77,619	79,822	87	1241
55	198,324	208,057	20	728	77,954	79,827	91	1241	155	203,955	207,729	17	729	76,606	79,424	90	1242
56	199,927	207,892	18	730	78,375	79,619	90	1241	156	204,279	207,756	18	728	77,602	79,463	92	1242
57	196,674	206,983	18	729	77,719	79,021	88	1242	157	204,472	270,809	16	731	77,509	79,631	90	1245
58	191,221	207,506	18	731	77,723	79,505	88	1242	158	204,158	207,875	17	731	77,305	79,522	78	1246
59	199,883	208,354	18	731	78,669	80,194	83	1242	159	202,020	208,096	17	731	77,626	79,723	90	1244
60	201,004	209,059	17	731	78,631	80,305	87	1242	160	192,089	206,985	17	734	76,755	79,087	85	1248
61	175,050	207,946	14	730	77,690	79,672	87	1242	161	203,009	207,876	17	733	77,616	79,360	85	1250
62	173,973	208,236	14	730	77,966	79,807	90	1243	162	197,864	208,104	16	734	77,337	79,718	91	1249
63	177,412	208,925	14	731	78,002	79,769	88	1243	163	204,605	208,641	15	746	77,270	79,701	91	1271
64	181,918	208,559	14	730	77,785	79,864	88	1243	164	198,448	208,360	16	734	77,660	79,717	88	1249
65	181,282	208,363	14	731	77,922	79,567	89	1244	165	202,443	208,311	15	747	77,640	79,377	88	1273
66	182,809	207,874	14	730	76,854	79,344	85	1245	166	200,841	208,912	16	747	77,957	79,910	91	1270
67	177,264	209,089	14	731	78,469	80,076	89	1245	167	203,038	208,967	16	746	77,841	80,055	86	1269

68	178,396	207,808	14	735	78,534	80,094	85	1246	168	204,499	208,558	16	747	78,482	80,032	91	1270
69	179,717	208,870	14	732	77,882	79,509	90	1247	169	205,725	208,968	17	746	77,572	79,976	89	1271
70	187,108	207,977	14	732	77,261	79,043	88	1247	170	204,346	207,998	17	746	77,252	79,233	91	1272
71	201,194	207,027	17	727	77,337	79,530	59	1235	171	206,351	208,199	16	748	77,564	79,590	92	1272
72	191,341	207,302	18	727	77,914	79,490	90	1235	172	196,271	207,786	16	747	77,564	79,476	87	1273
73	202,072	207,658	18	724	76,999	79,383	88	1234	173	207,608	207,609	15	747	77,125	79,502	91	1272
74	204,558	208,083	18	726	77,092	80,041	87	1234	174	200,118	207,943	16	746	77,087	79,091	87	1273
75	199,733	207,762	19	726	77,707	79,673	88	1234	175	201,131	208,668	16	748	77,866	79,982	86	1273
76	200,056	208,133	18	726	77,452	79,597	92	1235	176	204,585	208,390	16	748	77,115	79,437	90	1273
77	185,960	207,477	18	726	77,913	79,504	86	1235	177	198,466	208,599	16	748	77,530	79,744	89	1274
78	200,877	208,294	18	727	76,402	79,653	85	1236	178	197,495	208,530	16	747	77,723	79,479	91	1275
79	201,528	208,253	17	723	76,596	78,878	89	1236	179	198,641	208,767	17	747	77,068	79,805	90	1275
80	200,045	208,654	17	726	77,840	79,832	88	1235	180	202,153	208,832	16	751	78,564	80,311	89	1275
81	204,871	208,171	17	727	77,589	79,710	90	1236	181	201,012	208,917	16	749	77,939	79,736	88	1276
82	204,553	208,534	16	728	77,552	79,885	90	1238	182	206,000	207,939	16	749	77,884	79,523	92	1276
83	203,429	208,323	16	726	76,630	79,372	90	1238	183	201,310	208,363	16	750	77,911	79,784	92	1277
84	182,428	207,292	15	728	77,747	79,465	86	1238	184	204,297	208,345	17	748	77,688	79,435	89	1277
85	201,813	207,871	16	731	77,640	79,622	89	1241	185	200,603	208,639	17	751	77,558	79,719	90	1278
86	184,508	208,899	15	729	77,752	79,878	88	1241	186	207,269	209,067	17	751	78,023	79,998	90	1278
87	189,153	208,258	15	730	78,123	79,754	86	1242	187	204,208	207,575	17	749	77,740	79,433	91	1278
88	181,180	208,600	15	731	78,306	79,833	89	1243	188	202,354	208,199	17	751	77,382	79,431	91	1279
89	189,763	208,178	14	730	77,127	79,409	85	1244	189	206,052	207,893	16	752	77,551	79,784	94	1279
sample	Total Are(C/s)								sample	Total Area(C/s)				Photopeak (C/s)			
	Net	Cross	F.W. H.M	P.P	Net	Cross	F.W. H.M	P.P		Net	Cross	F.W. H.M	P.P	Net	Cross	F.W. H.M	P.P
90	188,798	209,820	15	733	77,554	80,245	84	1245	190	205,042	208,646	17	752	77,943	80,059	89	1280
91	193,139	208,404	15	733	77,423	79,702	89	1245	191	197,979	207,988	17	745	77,501	79,848	91	1280
92	182,274	207,619	15	731	76,820	79,127	89	1246	192	201,392	207,392	17	753	77,606	79,518	89	1280
93	178,923	208,669	15	434	77,911	79,503	85	1251	193	205,411	207,396	17	753	78,033	79,551	89	1280
94	207,069	208,710	14	731	77,747	79,708	90	1247	194	201,849	207,847	17	752	77,390	79,461	92	1280
95	205,994	207,953	14	434	77,808	79,752	85	1248	195	203,808	208,786	17	751	77,850	79,702	91	1280
96	202,842	207,826	15	734	77,491	79,720	93	1248	196	199,297	208,163	16	753	77,972	79,646	86	1281
97	204,873	208,725	16	733	77,031	79,592	92	1249	197	204,579	208,594	17	752	77,056	79,514	88	1281
98	207,555	209,173	16	733	77,599	80,089	90	1250	198	206,245	208,153	18	751	77,464	79,313	91	1281
99	206,962	208,898	15	734	77,544	79,670	87	1251	199	205,653	207,645	15	752	77,463	79,417	90	1281
100	194,237	210,968	18	728	78,881	80,737	90	1239	200	207,177	208,886	17	755	77,574	79,350	90	1292

Table. 1 show the measurement of 200 spectra of the radioactive cesium source, where the table was divided into two parts (for the large size of the table), and the total area and the photopeak area of the cesium spectrum were calculated. This table was abbreviated in Table 2.

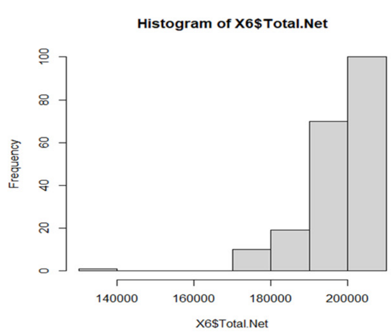
TABLE 2. Summary (^{137}Cs) spectrum

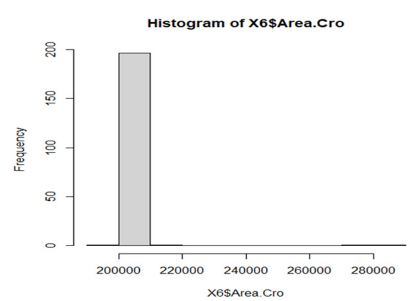
data	Total.Net	Area.Cro	Photo.Net	peak. Cro
Min.	132546	195879	76371	78007
1st Qu	195977	207933	77415	79474
Median	199993	208271	77682	79664
Mean	197869	208845	77680	79659
3rd Qu	203792	208600	77965	79840
Max.	208842	280591	78881	80737
IQR	7815	667	550	336
EX	197868.8	208844.5	77680.35	198238.5
var	82986233	46688034	239283.5	94108.6
sd	9109.678	6832.864	489.1662	306.7713
X6.bar	198238.5	208830	77627.51	79634.13

Table .2 shows a summary of the Cesium spectrum areas, where the data refers to the studied work environment (samples) , **Total.Net** refer to the net total area of the spectrum, Total, Area.Cro is Gross total spectrum , Photo.Net refer to the Net photopeak and peak. Cro refer to Gross photopeak spectrum. The table also shows the min (minimum) and Max(maximum) value For each sample, there is also IQR is the inter-quartile range which is the distance between the third quartile 3rd Qu an account and the first quarter 1st Qu of the data and EX refer to mean value , var is the variance and sd is the standard deviation.

STATISTICAL ANALYSIS

The Figures (3and 4) shows the statistical distributions on the studied environment samples, which is a histogram that shows the graphical relationship of the rate between the frequency of the sample and the mean of the spectrum. And the boxplot of Total Area of spectrum and Photopeak Area.





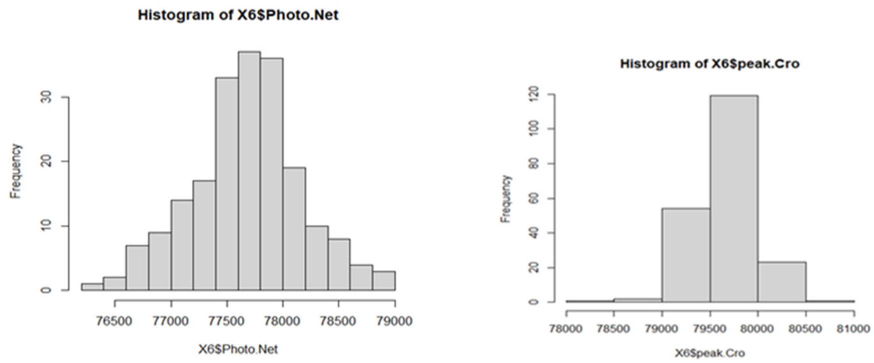


FIGURE 3. show the histogram between frequency and Area (Net & Cross).

A histogram has two axis, a horizontal axis represent total area and a vertical axis is represent the data (Frequency). By the notes of histogram, we can estimate the shape of the data, the center, and the spread of the data, also we note the x-axis dividing into equal intervals and the height of each box represents the count of the number of observations that fall within the interval of average.

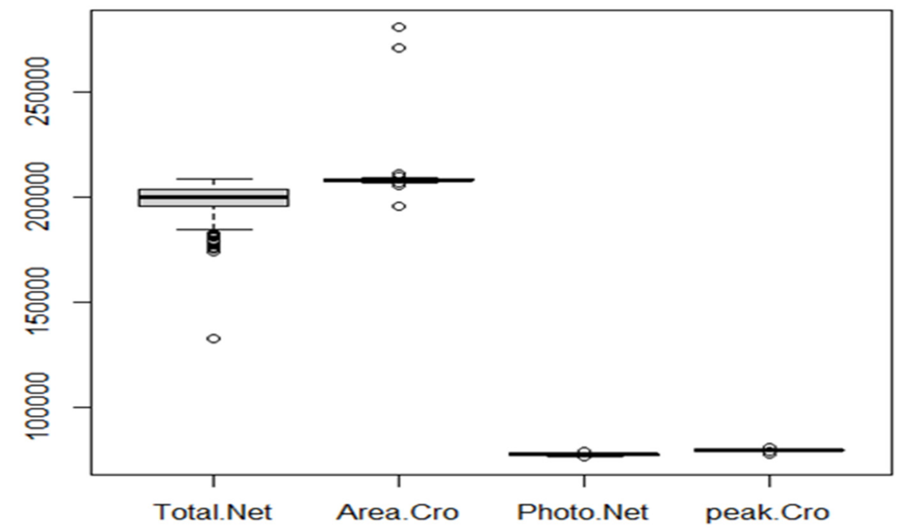
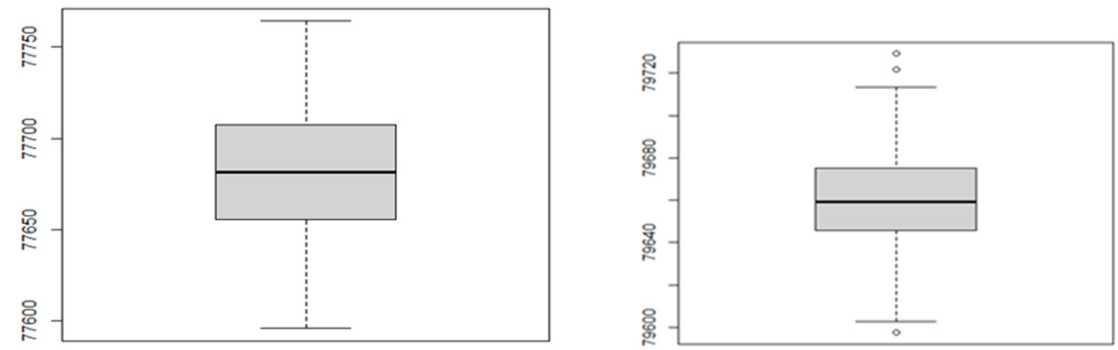


FIGURE 4. boxplot of Total Area of spectrum and Photopeak Area.

Figure 4 presents individually studied data , The box chart was created five values: the minimum value, 1st Qu, the median, 3rd Qu , and the maximum value. Where about 50% of the data is collected inside the box, while the rest of the data is distributed between the upper and lower halves, i.e. between the highest and the lowest value.

Figures (5and 6) shows the statistical distributions on the studied random sample environment, which is a histogram that shows the relationship of the rate between the frequency of the sample and the standard mean of the spectrum. And the boxplot of Total Area of spectrum and Photopeak Area.



a b

FIGURE 5. boxplot of spectrum Standard mean Area (a-Net and b- Gross).

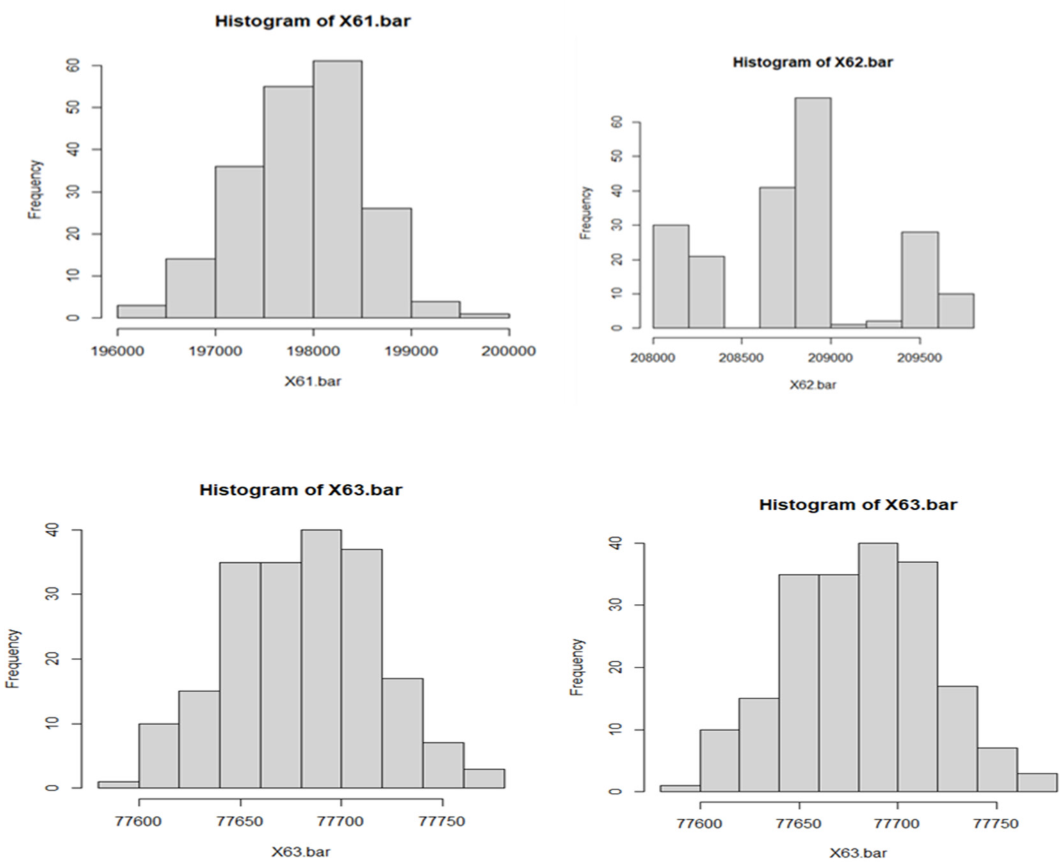


FIGURE 6. show the histogram between frequency and standard mean Area (Net & Gross).

A random sample consisting of 168 spectra was taken and a statistical analysis was performed on it, as shown in Table .1 and Figures 5 & 6, for the total area and photopeak area which are distinctly different from Figures 3and 4, and the reason for this is our selection of the random sample to represent the population, and random sampling mean is considered a standard sample subject to normal distribution. Here, we find that the two lines are similar to the shape of a bell, unlike the Figures 3and 4.

Compare The Mean Between The Total Net Area And Phot Net Area Mean Using The R Programming Language Using Shapiro.Test And T-Test.

Mean can be compared to two sets of data or two samples X , Y Independent using a t-test test based on this test is based on assumption that this data represents a community following normal distribution. As Figure (7,8,9and 10)
where
X11<-pop.6$Total.Net
X21<-pop.6$Photo.Net

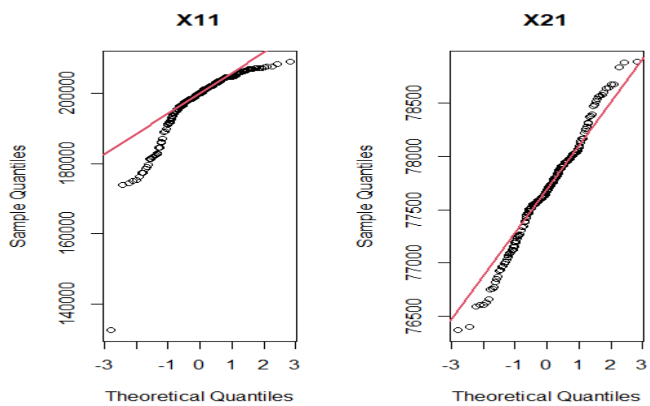


FIGURE 7. The graphic shows that the data of X (or pho.Net) and the data for X.bar standard are follow the normal distribution.

shapiro.test(X11) shapiro.test(X21)
W = 0.78341, p-value = $6.401e^{-16}$ W = 0.98926, p-value = 0.1392
For both groups p-value is greater than 0.05 and therefore the data can be said to follow the normal distribution
t.test(X11,X21)
p-value < $2.2e^{-16}$
Since p-value is above the significance level of 0.05 and therefore the final decision has not changed using both methods and two groups are right equal for the Mean.

Compare The Mean Between The Total Gross And Phot Cross Mean .

where
Y11<-pop.6$Area.Cro , Y21<-pop.6$peak.Cro

shapiro.test(Y11)
W = 0.13617, **p-value < $2.2e^{-16}$**

shapiro.test(Y21)
W = 0.96093, **p-value = $2.498e^{-05}$**

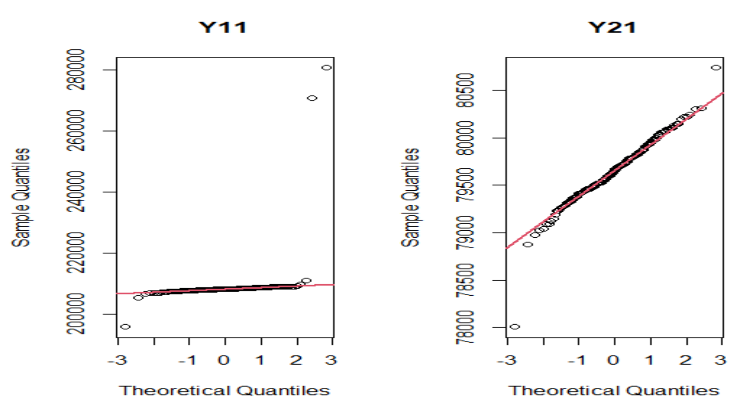


FIGURE 8. The graphic shows that Total Gross area and the X.bar (mean standard) are follow the normal distribution.

For both groups p-value are greater than 0.05 and therefore the data can be said to follow the normal distribution.
t.test(Y11,Y21)
p-value < $2.2e^{-16}$
Since p-value is above the significance level of 0.05 and therefore the final decision has not changed using both methods and two groups are right equal for the Mean.

Compare the mean between the Total Net mean and Total Net x.bar

where
x11<X61.bar (Total Net) , x21<-X63.bar (Total Net x.bar)

shapiro.test(X11)
W = 0.78341, p-value = $6.401e^{-16}$

shapiro.test(x11)
W = 0.99544, p-value = 0.8129

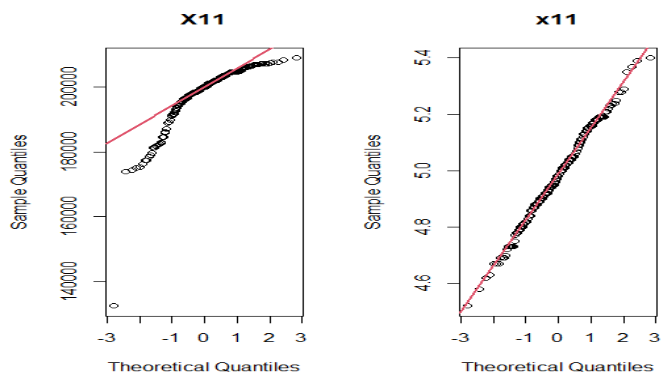


FIGURE 9. The graphic shows that Total Net Area and the Total Net Area standard are follow the normal distribution.

For both groups p-value are greater than 0.05 and therefore the data can be said to follow the normal distribution.
t.test (X11,x11)
p-value < $2.2e^{-16}$
Since p-value is above the significance level of 0.05 and therefore the final decision has not changed using both methods and two groups are right equal for the Mean.

Compare The Mean Between The Total Cross And Total Cross X.Bar Mean

shapiro.test(Y21)
W = 0.96093, p-value = $2.498e^{-05}$

shapiro.test(y21)
W = 0.99612, p-value = 0.8954

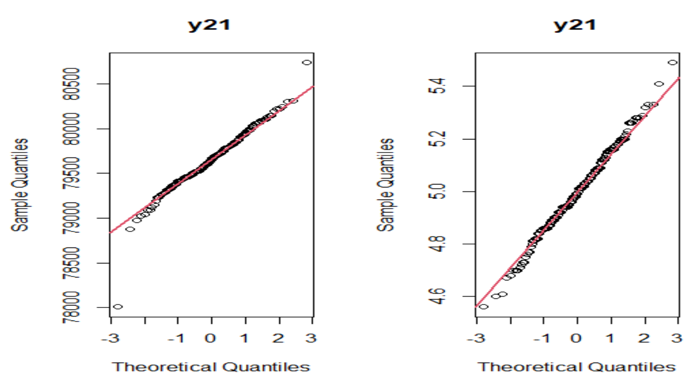


FIGURE 10. The graphic shows that Total Cross Area and the Total Cross Area standard are follow the normal distribution.

For both groups **p-value** is greater than 0.05, therefore the data can be said to follow the normal distribution.

t.test(Y21,y11)

p-value < $2.2e^{-16}$

Since p-value is above the significance level of 0.05 and therefore the final decision has not changed using both methods and two groups are right equal for the Mean.

Compare Between The Frequency (Samples) And Area Spectrum Using The Linear Regression

where, fit is the code name needed to draw a linear regression in R program, and fit1 is refer to relation between (sample $Total.Net), as Figures (11,12,13 and 14).

fit1 <- sample $Total.Net

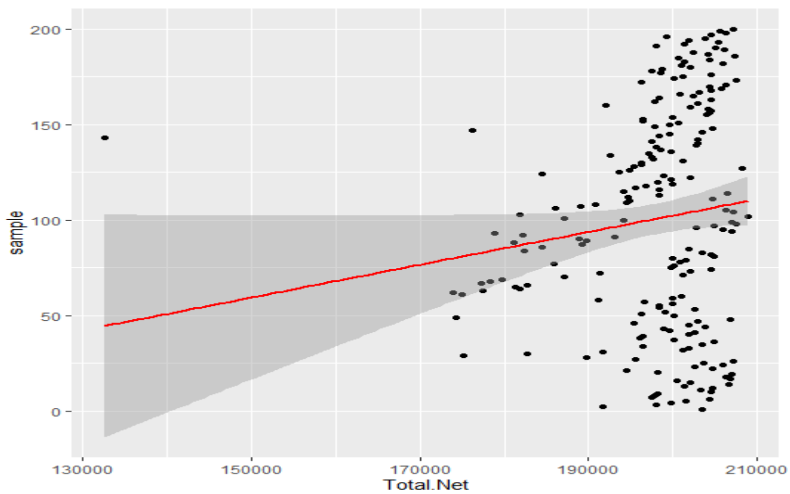


FIGURE 11. Linear Regression between the samples and Total Net Area.

p value is **0.05638** this mean the relationship between the frequency of samples and the total area is a strong statistical relationship.

fit2<- (sample $Area.Cro)

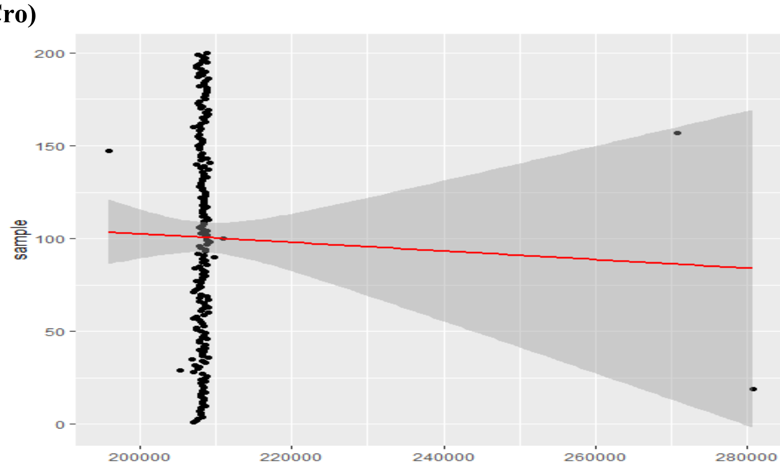


FIGURE 12. Linear regression between the samples and Total Cross Area.

p-value: **0.7006** the relationship between sampling frequency and the total spectrum area is statistically not firm.

fit3 <- (sample $Photo.Net)

p-value**: 0.076** is greater than 0.0.5 (Significance level), this mean the relationship between sampling frequency and the total spectrum area is statistically not firm. As the Figure 12.

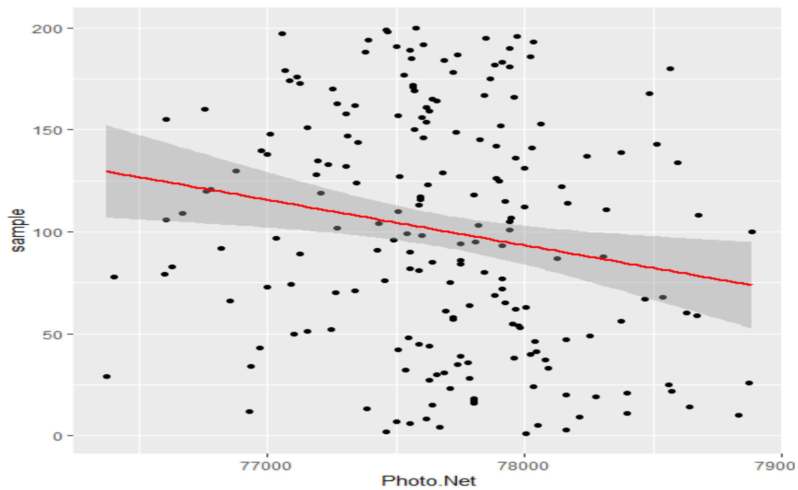


FIGURE 13. Linear regression between the samples and photopeak Net.

fit4<- (sample/$peak. Gro)

p-value**: 0.2451** is greater than 0.0.5 (Significance level) , this mean the relationship between sampling frequency and the total spectrum area is statistically not firm. As the Figure 13.

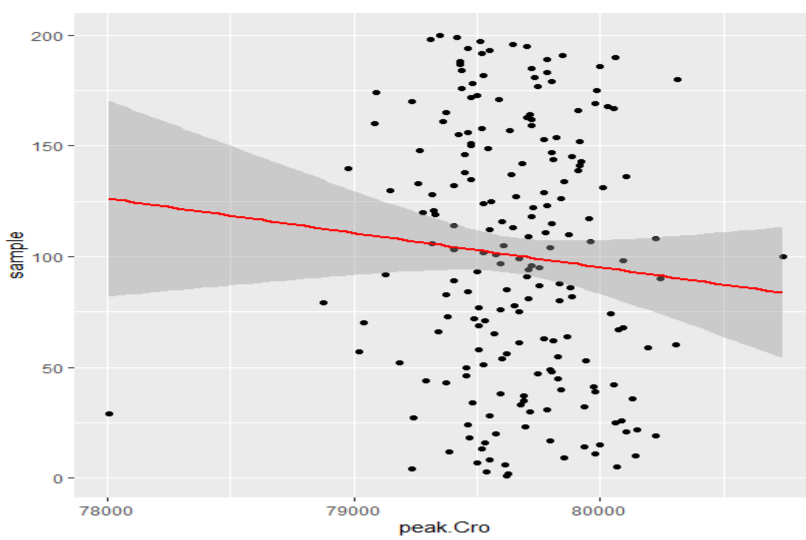


FIGURE 14. Linear regression between the samples and photopeak Gross.

CONCLUSIONS

In this paper we note through the use of statistical distributions (normal, exponential, binomial and the Poisson distribution the (random sampling mean) is follow to the normal distribution. so, there is a slight difference between the sample mean and the standard mean for the same samples using the same statistical distribution.

and by using linear regression test, we found that there is no strong statistical relationship between the studied random variables.

while by using T-test, we found that the studied samples (Total Net Area, Total Gross Area, Photopeak Net Area, Photopeak Gross Area) do not follow the normal distribution compared while the same random sampling standard that follow the normal distribution.

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