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Effect of Cell Phone Emitted Radiation On the Operation of Nuclear Electronics

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Abstract: The debate regarding the health effects of low-intensity electromagnetic radiation from sources such as power lines, base stations, and cell phones has recently been reignited. In the present review, we studied the radiation effects of three types of hand phone on the performance of 70% HPGe X and Gamma-ray detector in the calling mode. The interference was found at energy range 20-1000 KeV. The measurement quality of the gamma-spectra can be corrected at a wide photon energy region. The results were obtained for Vodafone and Etesalat stations. The introduced measurement must be taken into account for other nuclear devices having the same interference effect. Simulation for the probability trends of the measured gamma rays corresponding to the measurements multiplicity was given.

Keywords: HPGe detector, interference of electromagnetic radiation, phone signals, cell phone waves, Cell phone; Electromagnetic radiation

Introduction `

Radiofrequency energy is a form of electromagnetic radiation. The frequency range lie between 0.3 to 300 GHz and wavelengths vary from 0.01 to 1 m the frequency emitted by mobile lie in the average of 900 MHz Mobil phones are in this frequency range [1,3,5]. *Electromagnetic radiation can be categorized into two types: ionizing (e.g., x-rays, radon, and cosmic rays) and non-ionizing (e.g., radiofrequency and extremely low-frequency or power frequency)*[2]. *Exposure to ionizing radiation, such as from radiation therapy, is known to increase the risk of cancer*[3,4] and also for childern.*[15] However, although many studies have examined the potential heat the effects of non-ionizing radiation from radar, microwave ovens, and other sources, there is currently no consistent evidence that non-ionizing radiation increases cancer risk. And other sources, there is currently no consistent evidence that non-ionizing radiation increases cancer risk* [*3,4*,11,12].

Also Hand phones or cell phones are form of radio transmitters emitting electromagnetic radiation. Once the connection is made the cell phone's encode packages of information representing your voice or text data. When the call is received *through a processor in the phone the digital information signal is converted into an analog signal so a voice can be heard. All this occurs in an average time of five seconds depending on the wave intensity and the distance from the tower. In the present experiments we studied the effect of the durations of different type of cell phone signals that are commonly used in Egypt, to the gamma- ray system during the dialing and alarm mode. The germanium detector [6,7] was exposed to each type of cell phone radiation in the forward and backward directions. The effect of different communications, Etesalat and Vodafone , vise the detector performance and its BG were also investigated. The effect of cell phones radiation intensities, at the same exposure durations, and the performance of HPGe[13,14] are shown and investigated in the study.*

Experimental design:

- ### Detection system

Single gamma-ray measurements were achieved, using a high resolution ORTEC hyper-pure germanium (HPGe) detector of efficiency 70 %. A cylindrical lead-shield of five cm thickness, which contains inner concentric thin cylinder of Cu with a thickness of 5 mm, was used to shield the detector and to reduce the effect of background fig (1). Standard gamma sources, of ^{241}Am, ^{22}Na, ^{60}Co, ^{133}Ba, ^{137}Cs and ^{152}Eu, were used for both energy and efficiency calibrations of the system [10].

The noise level was estimated, using the different gamma transitions and each cell phone was measured several times during receiving the dialing signal and the gamma spectra were analyzed, using different tables and computer programs [7-9].

- ### Experimental procedure:

Ten types of mobile phones were used in this investigation. The cell phone was located in every experiment at the top of the detector plastic cover (3 mm distance from the beryllium window). The noise level was measured for the following cases:

i) In the forward direction.
ii) In the backward direction.
iii) For the 3 common companies located in the Egyptian market.
iv) With and without charger mobile
v) Measurements were done at 50, 100,200 spectroscopic amplifier gain mode.

vi) Measurements were done in the non-charging mode

Results and discussion

Nowadays cell phones are often used at any place without any restrictions. The effective noise range, generated from hand phones, on the performance of HPGe (70% efficiency) were detected. Figure (2-5) represents the measured spectra of different hand phone types in the forward mode.

In several studies, some noise parameters were detected in the region of surrounding the cell phones. No one detect and fix with its influence during any nuclear measurements. In this study, as new results, we have measured the noise levels during the performance of HPGe 70% detector with a good heat energy and efficiency calibration and the intensity level of each were summarized in tables (1-3). It is a useful parameter for correcting the influence of noise generated during the calling mode.

Measurements show that all backward modes give minimum interference than other modes. And the maximum detected noise liens fall up to ^{129}Ba, ^{124}I, ^{118}Sb *and* ^{151}Tb.

The minimum detected noise were seen fall in the minimum energy range of ^{177}Lu, ^{240}Np, ^{155}Sm, ^{111}Pb, ^{241}Pu, ^{227}Ac, ^{104}Ag, ^{177}Ta, ^{201}Po, ^{201}Po, ^{251}Cf, ^{201}Po, ^{156}Eu, ^{74}Br, ^{123}Xe, ^{80}Br, ^{147}Pr, ^{97}Pd, ^{47}V, ^{173}Yb, ^{198}Ti, ^{256}Fm, ^{153}Sm, ^{230}Ac, ^{160}Hf *and* ^{130}Xe *nuclei.*

It should be mentioned that; using 1mm Al absorber can reflect the waves and minimize the phone interference and we could reach to a negligible level in the case of I phone.

Theoretical Approach

From figures (6-8) one can expect the multiplicity for the gamma energy as the influence of the cell phone waves. For magnification in the order 50-100% the HPGe measures maximum energy near to 800 KeV. For Magnification 200% the measured energy was near 1 MeV. Semi-empirical relations for these probabilities trends are given in equations (1-3).

For system magnification 50%

$$E_g = 1E\text{-}06x^6 - 7E\text{-}05x^5 + 0.0015x^4 + 0.0202x^3 - 0.8187x^2 + 10.804x + 4.8841 \qquad (1)$$

$R^2 = 0.9917$

For system magnification 100%

$$E_g = 1E\text{-}07x^6 - 3E\text{-}05x^5 + 0.0023x^4 - 0.0957x^3 + 1.8843x^2 - 11.496x + 29.304 \quad (2)$$

$R^2 = 0.9941$

For system magnification 200%

$$E_g = 0.0004x^6 - 0.0231x^5 + 0.4539x^4 - 3.5914x^3 + 11.478x^2 + 3.9221x + 5.5004 \quad (3)$$

$R^2 = 0.9872$

Where E_g represents the HPGe measured energy (KeV) , R^2 is the goodness of fitting and x represents any one of the measured experiment.

Conclusions

Cell phones except I Phone type produce high signals that can cause a huge noise affecting the performance of HPGe detector. The quality of gamma-ray measurements can be modified by taking into account this study. The measured spectra indicate that the noise range fall in X-ray region up 1000 KeV and the user can works in safe mode if using the analysis of this study.

The results show also the radiation intensities difference generated for different hand phone types and its communication companies. We must inform that, in the case of far distance from towers the noising signal has its maximum value.

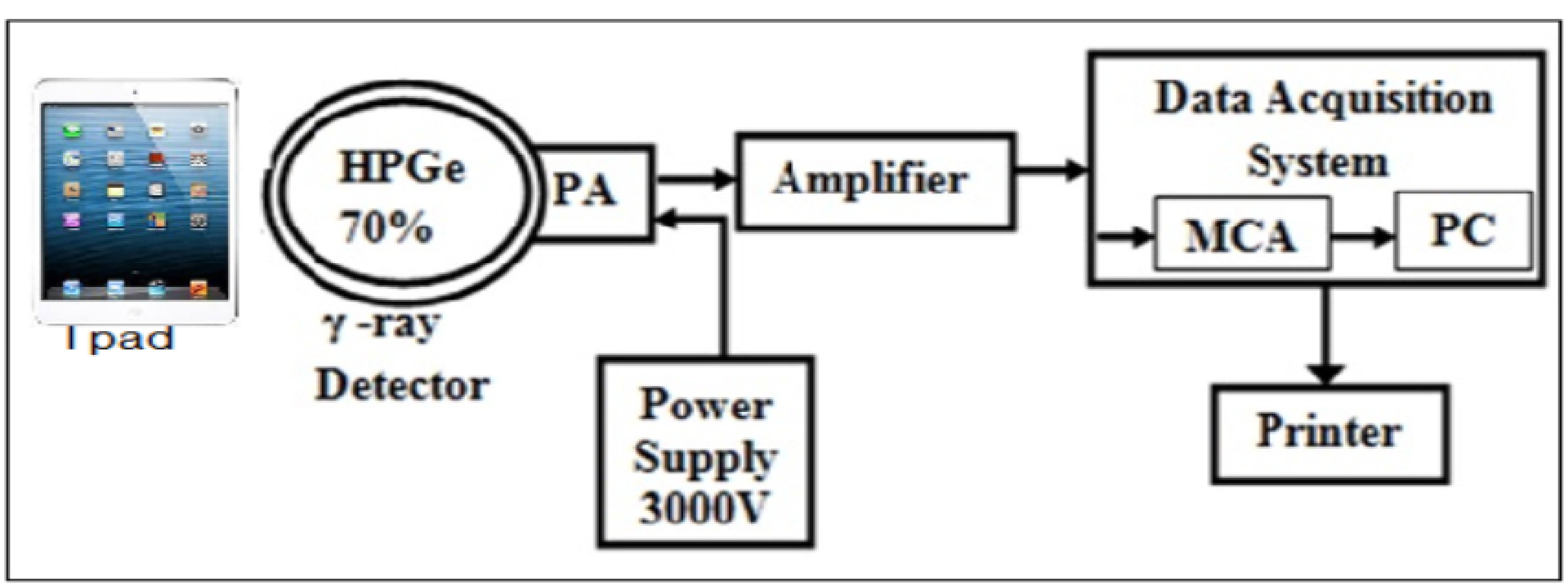


Fig. (1) Systematic diagram for the detection system used in the calling mode of each cell phone.

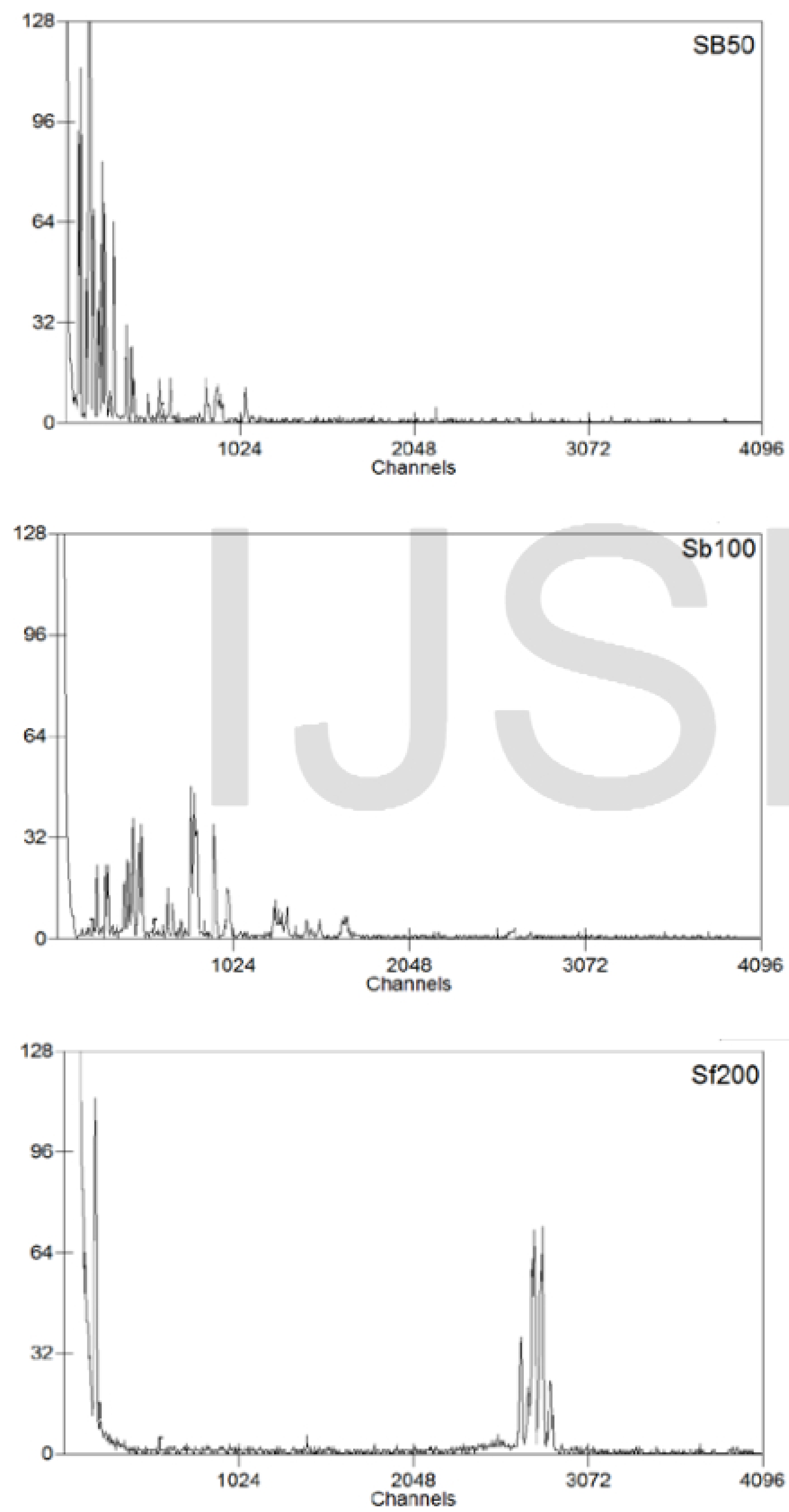


Fig. (2) Selected gamma spectra measured with the influence of I Phone (Model A1429) hand phone at 50, 100, 200 amplification mode

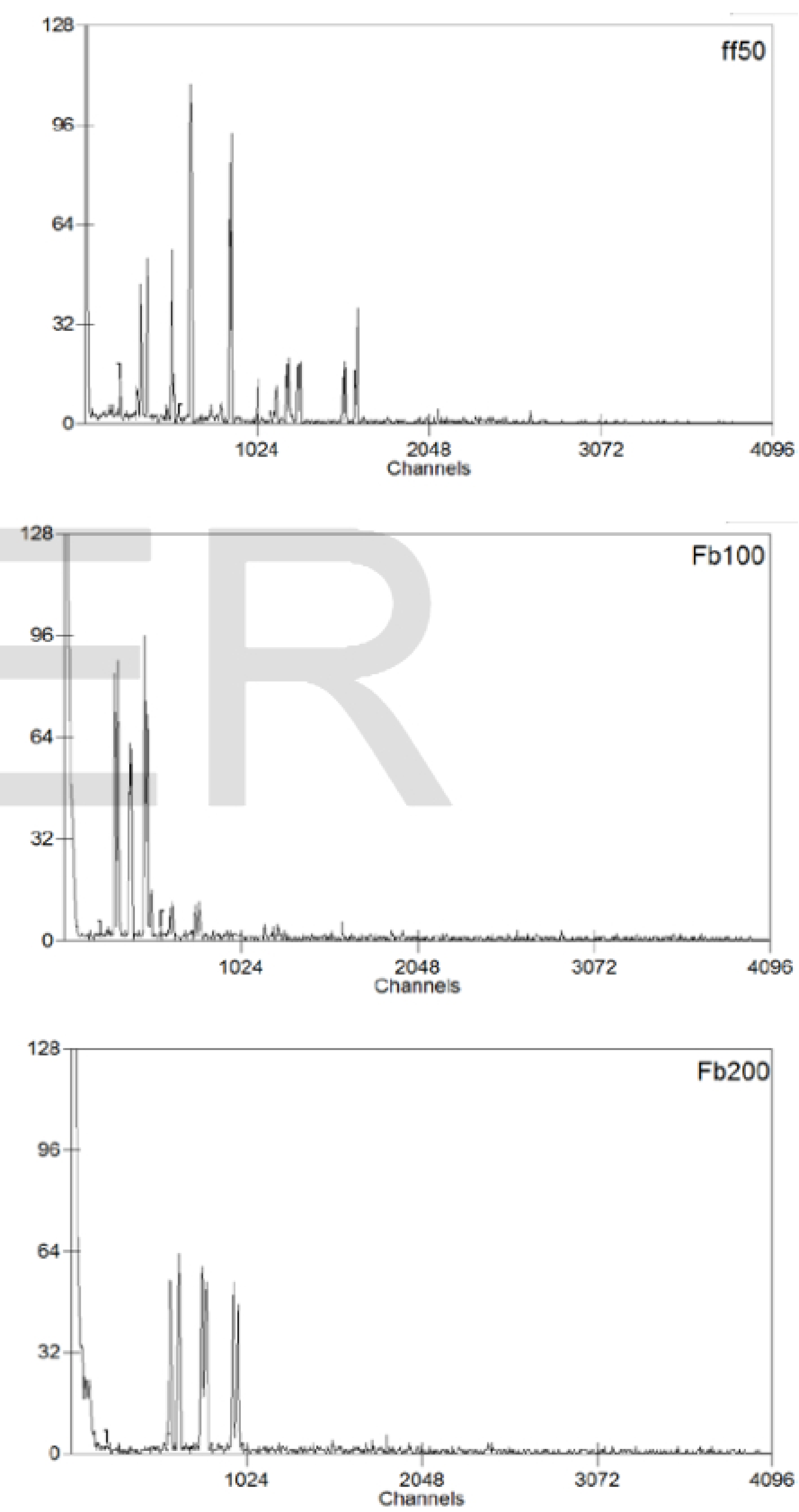
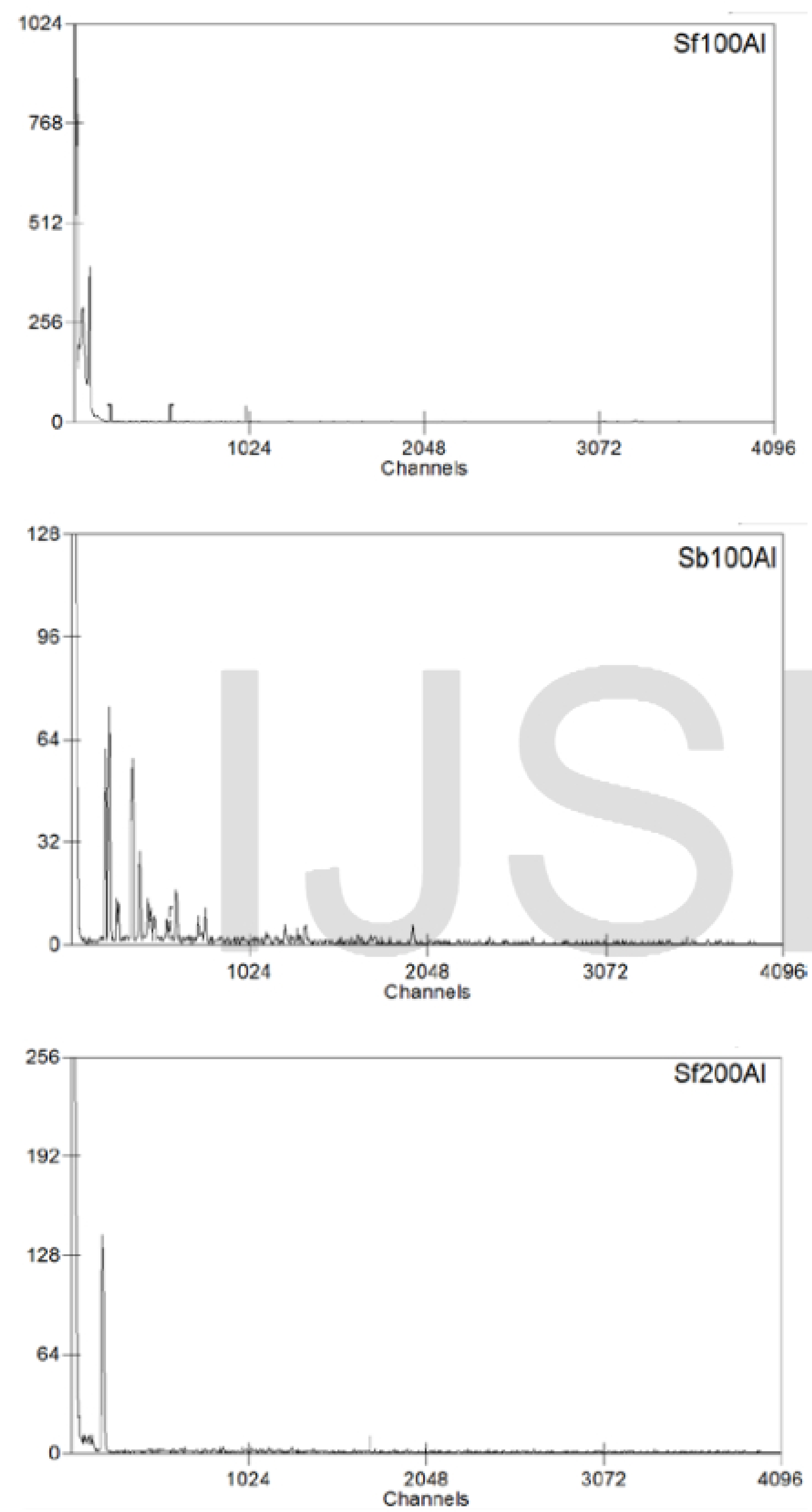


Fig. (3) Selected gamma spectra measured with the influence of Nokia model (X1-01) hand phone at 50, 100, 200 amplification mode

In the forward direction



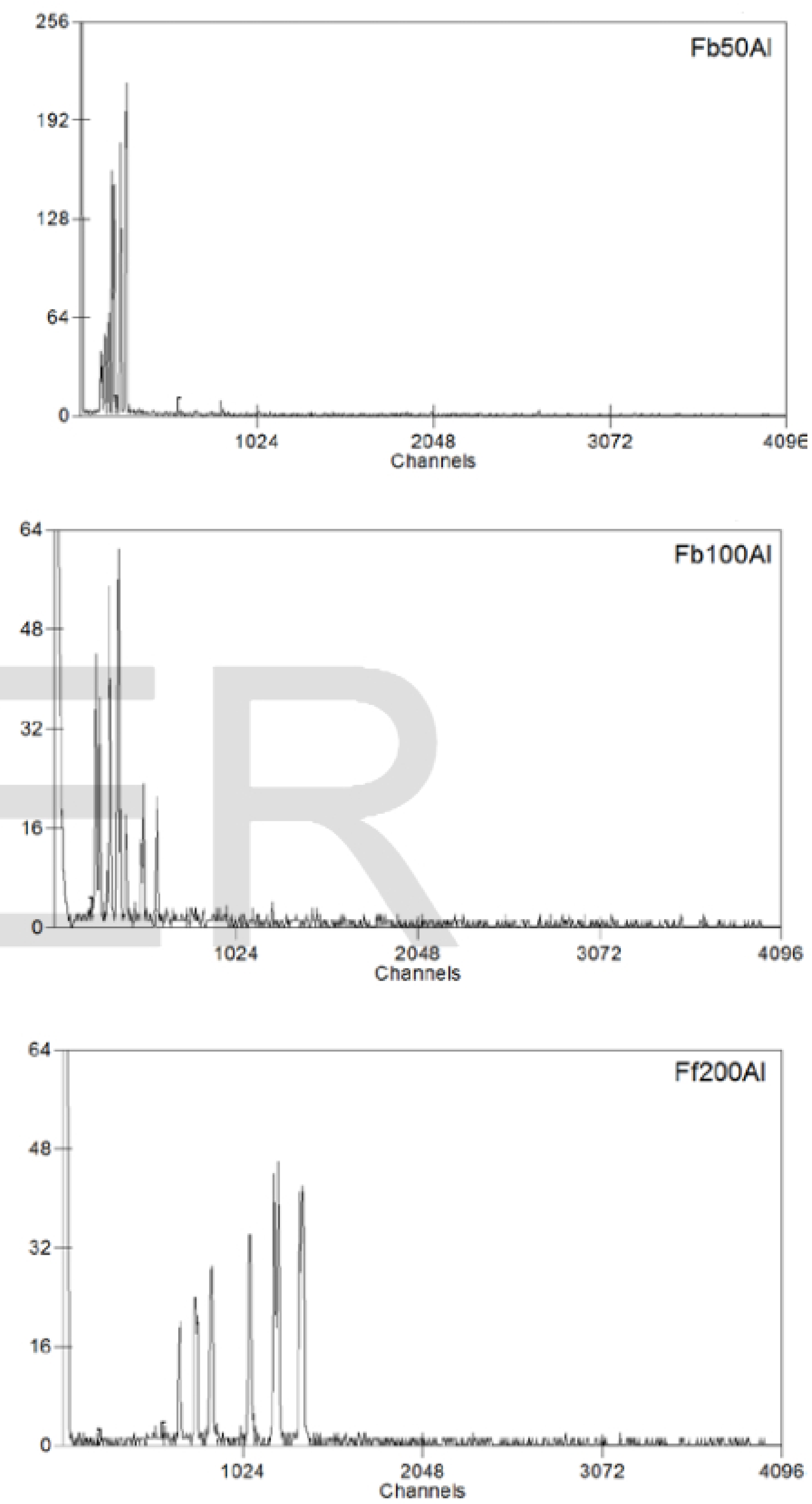


Fig. (4) Selected gamma spectra measured with the influence of I Phone (Model A1429) hand phone at 50, 100, 200 amplification mode using 1mm Al absorber.

Fig. (5) Selected gamma spectra measured with the influence of Nokia model (X1-01) hand phone at 50, 100, 200 amplification mode using 1mm Al absorber.

In the forward direction

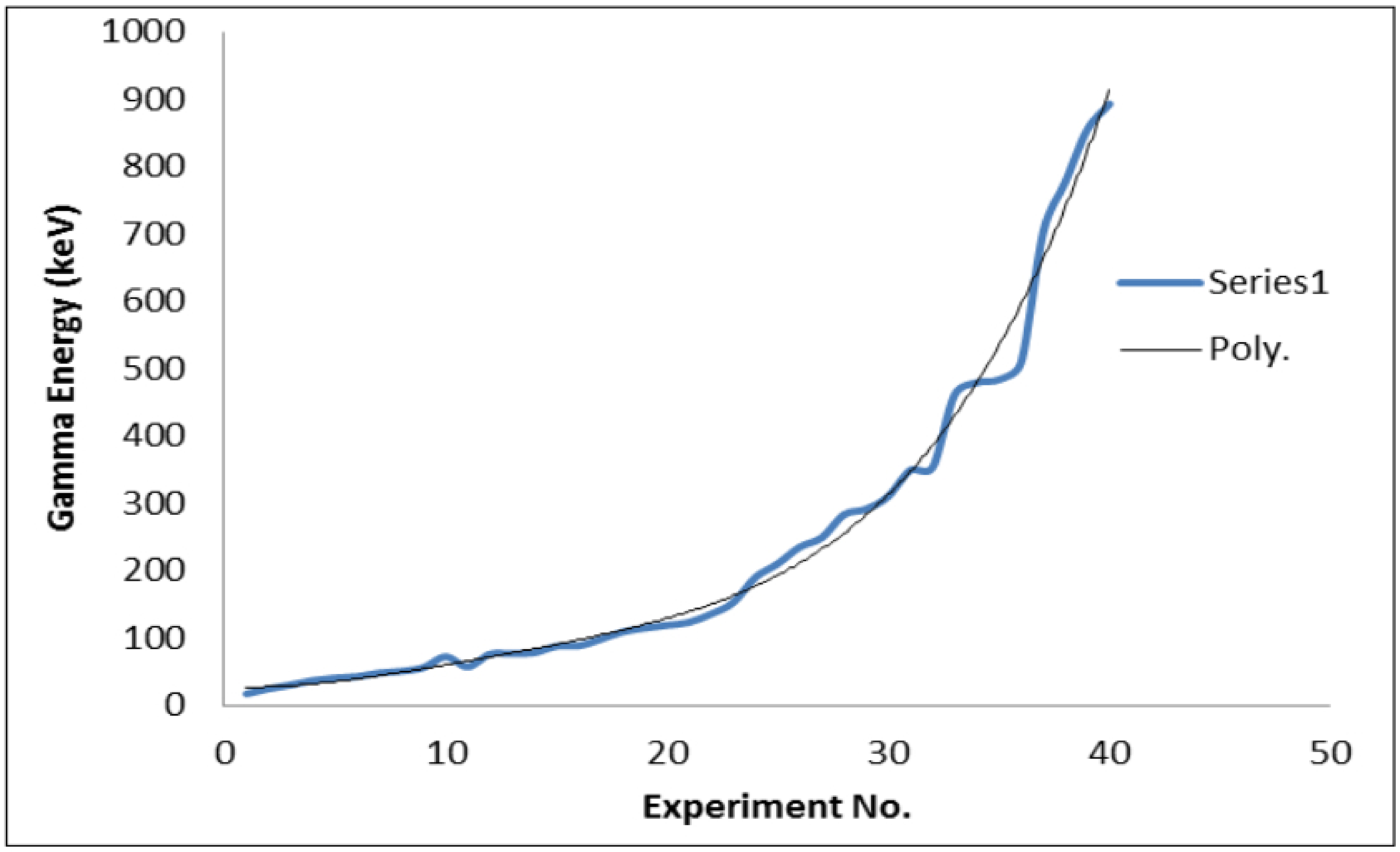


Fig. (6) Histogram represents the trends of gamma energy probability at 50 % amplification.

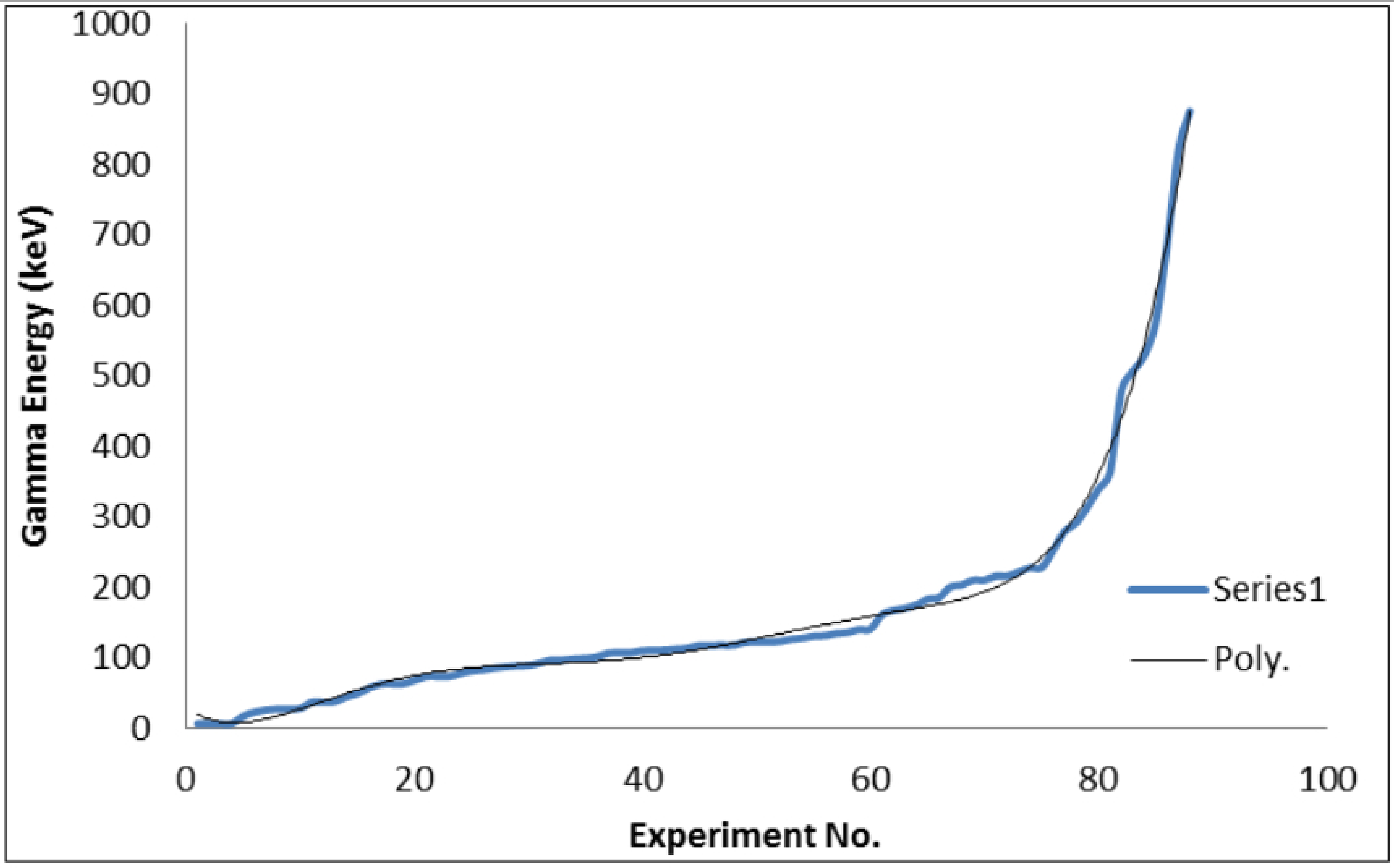


Fig. (7) Histogram represents the trends of gamma energy probability at 100 % amplification.

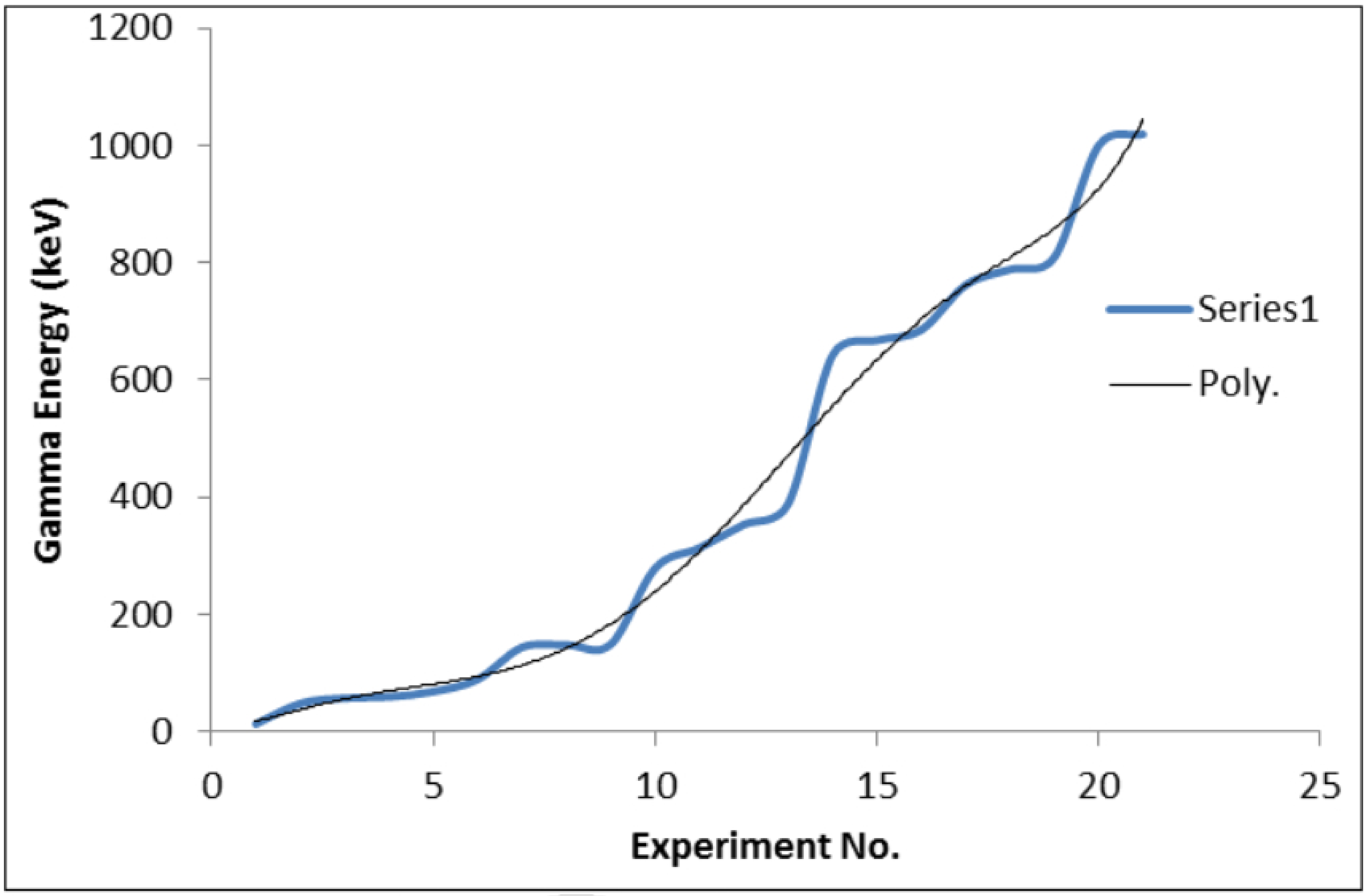


Fig. (8) **Histogram represents the trends of gamma energy probability at 200 % amplification.**

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Table (1) ***Represents the corresponding interfering nucleus A* for Nokia (f, m) and I Phone (s) at amplifier gain adjusted to 50. The second letter (f) represents the face mode and (b) the back mode and (al) represent using 1mm Al sheet as absorber.***

Telephone Code	Results & Identification									
fb50al	^{177}Lu	^{246}Pu	^{77}As	^{185}Pt	^{154}Eu	^{127}Ba	^{185}Ir	^{79}Sr		
ff50	^{240}Np	^{152}Eu	^{70}AS	^{231}Pa	^{223}Th	^{154}Eu				
ff50_1cm	^{155}Sm	^{152}Eu	^{154}Eu	^{45}Ti	^{144}La	^{232}U	$^{139}Cs.$			
Ff50 al	^{111}Pb	^{110}Sn	^{68}Ga	^{87}Zr	^{160}Yb	^{178}Os				
ff50	^{241}Pu	^{177}W	^{157}Dy	^{186}Au	^{99}Tc	^{64}Cu	^{151}Eu	^{89}Zr	^{170}W	^{129}Ba
sf50	^{227}Ac	^{226}Ra	^{237}Pu							

Table (2) ***Represents the corresponding interfering nucleus A* for Nokia (f, m) and I Phone (s) at amplifier gain adjusted to 100. The second letter (f) represents the face mode and (b) the back mode and (Al) represent using 1mm Al sheet as absorber.***

Telephone Code	Results & Identification									
fb100	^{104}Ag	^{152}Eu	^{154}Eu	^{171}Er	^{197}Hg	^{181}W	^{166}In	^{181}Pt	^{182}Re	^{124}I
fb100_1cm	^{177}Ta	^{231}Pa	^{233}Pa	^{107}Mo	^{116}In	^{115}In	^{163}Er	^{168}W	^{154}Er	
fb100al	^{201}Po	^{189}Ir	^{177}Ta	^{156}Eu	^{160}Tb	^{143}Eu	^{211}Po	^{125}Xe	^{222}Th	
ff100	^{201}Po	^{234}Pa	^{159}Gd	224Th	^{112}I	^{174}Lu	$^{204}P0$			
ff100_1cm	^{251}Cf	^{192}Hg	^{121}Sb	^{170}Lu	^{223}Fr					
ff100Al	^{201}Po	^{102}Nb	^{177}Re	^{174}Lu	^{102}Rh					
sb100_1cm	^{156}Eu	^{235}Np	^{150}Er	^{120}Sb	^{136}La	^{160}Gd	^{223}Ac	^{96}Tc	123Cs	^{118}Sb
sb100_1cm	^{74}Br	^{127}Te								
sb100al	^{123}Xe	^{169}Yb	^{106}Tc	^{185}Ir	^{107}W	^{192}Ti				
sf100	^{80}Br	^{124}I	^{176}Hf	^{147}Gd	^{143}Gd	^{160}Tb	^{64}Ge	^{160}Er	^{82}Sr	
sf100_1cm	^{147}Pr	^{181}Hf								
sf100Al	---	----	----							

***Table (3)** Represents the corresponding interfering nucleus A* for Nokia (f, m) and I Phone (s) at amplifier gain adjusted to 200. The second letter (f) represents the face mode and (b) the back mode and (Al) represent using 1mm Al sheet as absorber.*

Telephone Code	Results & Identification								
fbe200	^{97}Pd	^{115}I	^{232}U	^{128}Te	^{183}Pt	^{83}Zr			
ffe200	^{47}V	^{118}Sb							
sbe200	--	--	--						
sfe200	--	--	--						
fb200al	^{173}Yb	^{123}I	^{77}Br	$^{210}P0$	^{238}Pu	^{101}Mo	^{126}Sn		
ff200al	^{198}Ti	66Cu	^{102}Rh	^{101}Mo	^{145}Gd				
ffb200	^{256}Fm	^{239}Pu							
mb200	^{153}Sm	^{142}La	^{184}Au	^{114}Sb	^{169}Lu	^{147}Pm	^{146}Eu	^{193}Hg	^{151}Tb
mf200	^{230}Ac	^{124}I							
sb200	^{160}Hf	^{70}As	^{176}Yb						
sf200	^{130}Xe	^{85}Sr	^{141}La	^{79}Ga					
sf200al	----	----	----						

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