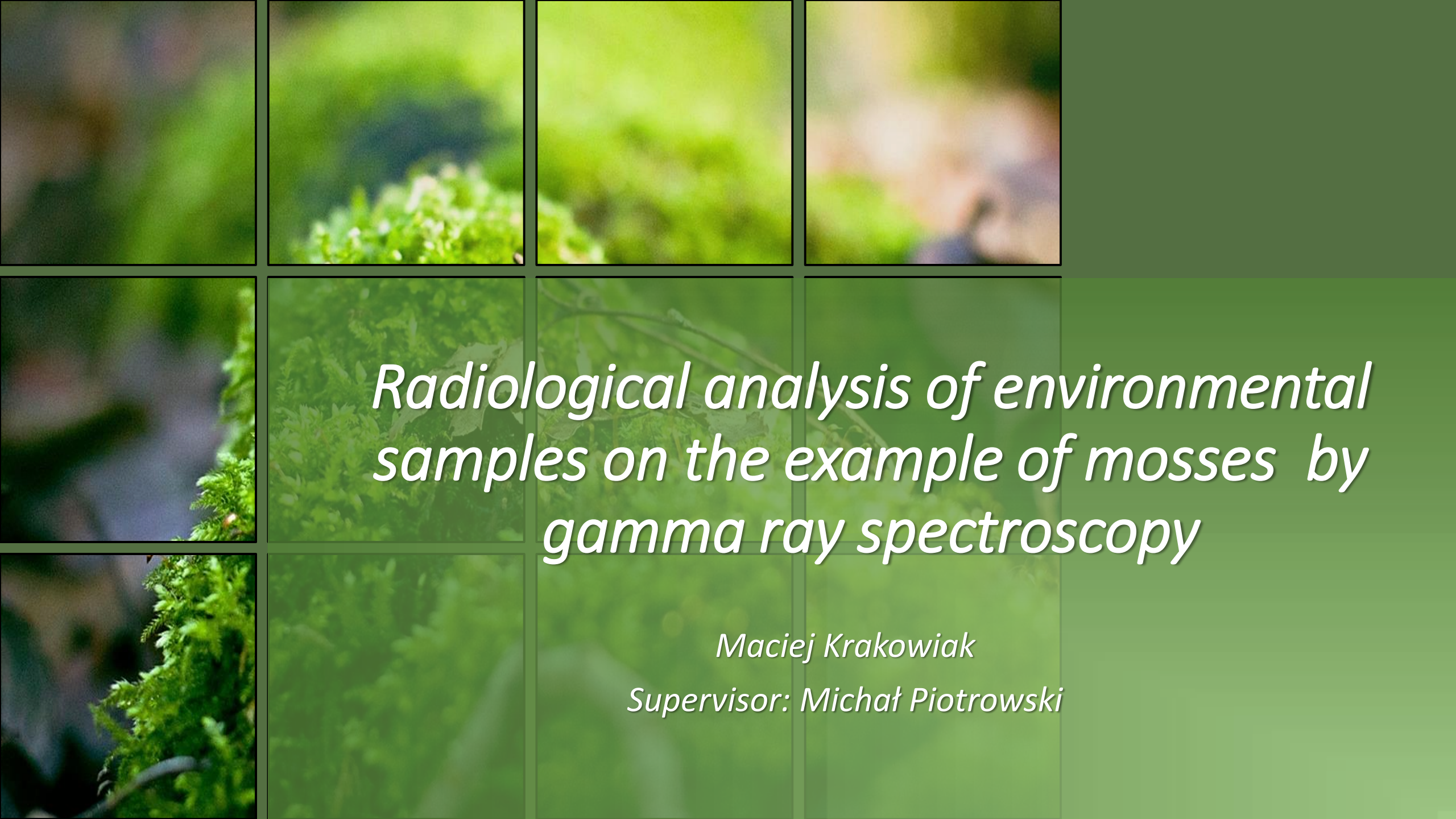

Radiological analysis of environmental samples on the example of mosses by gamma ray spectroscopy

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Supervisor: Michał Piotrowski

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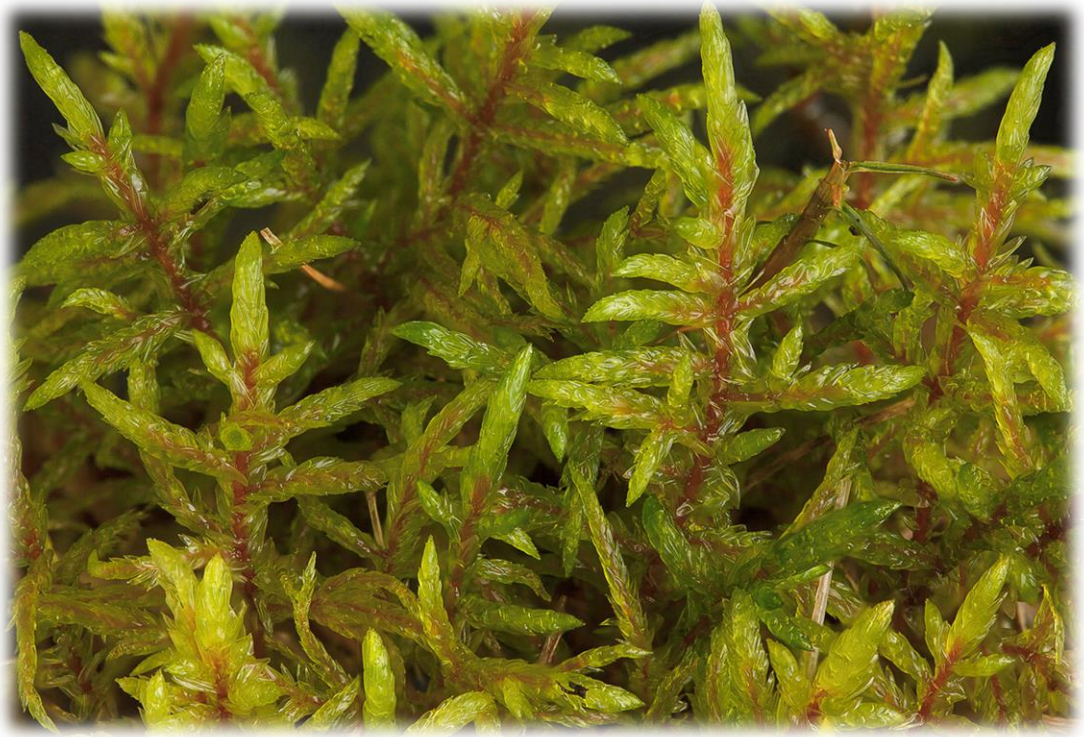
Introduction

- Mosses are small flowerless plants that typically grow in dense green clumps or mats, often in damp or shady locations.
- Mosses do not have seeds and after fertilisation develop sporophytes with unbranched stalks topped with single capsules containing spores.
- They are typically 0.2–10 cm (0.1–3.9 in) tall, though some species are much larger.

Bryoandersonia illecebra

Dicranum scoparium mat

Pleurozium schreber



Pleurozium schreber

- Pleurozium schreber is a moss with a loose growth pattern. The root name pleuro comes from the Latin for ribs, possibly describing how the parts branch from the stem.
- The species occurs on the floor of the boreal forests of Canada, Scandinavia and northern Russia.

Why mosses are important ?

- Natural air filters

- No roots

- they retain impurities in their tissue

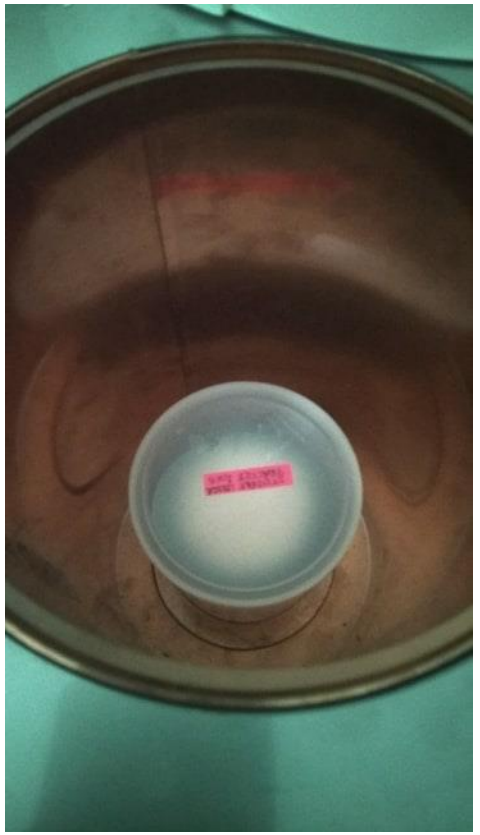
- Common occurrence

Sampling


Reka Chernaya
Dachnaya Ulitsa
Limonad
Лимонад
Teplichnoye
Садовый центр
Тепличное
Pamyatnik Iv Kurchatovu
Памятник И.
В. Курчатову
Torgovyy Dom Dubna
Торговый дом Дубна
JINR
ОИЯИ
Dixy
Дикси

Preparing sample and measurements

- Collect moss
- Clean and dry the sample
- Put into plastic bag
- Cut off brown parts
- Prepare sample in Marinelli
- 48h measurements



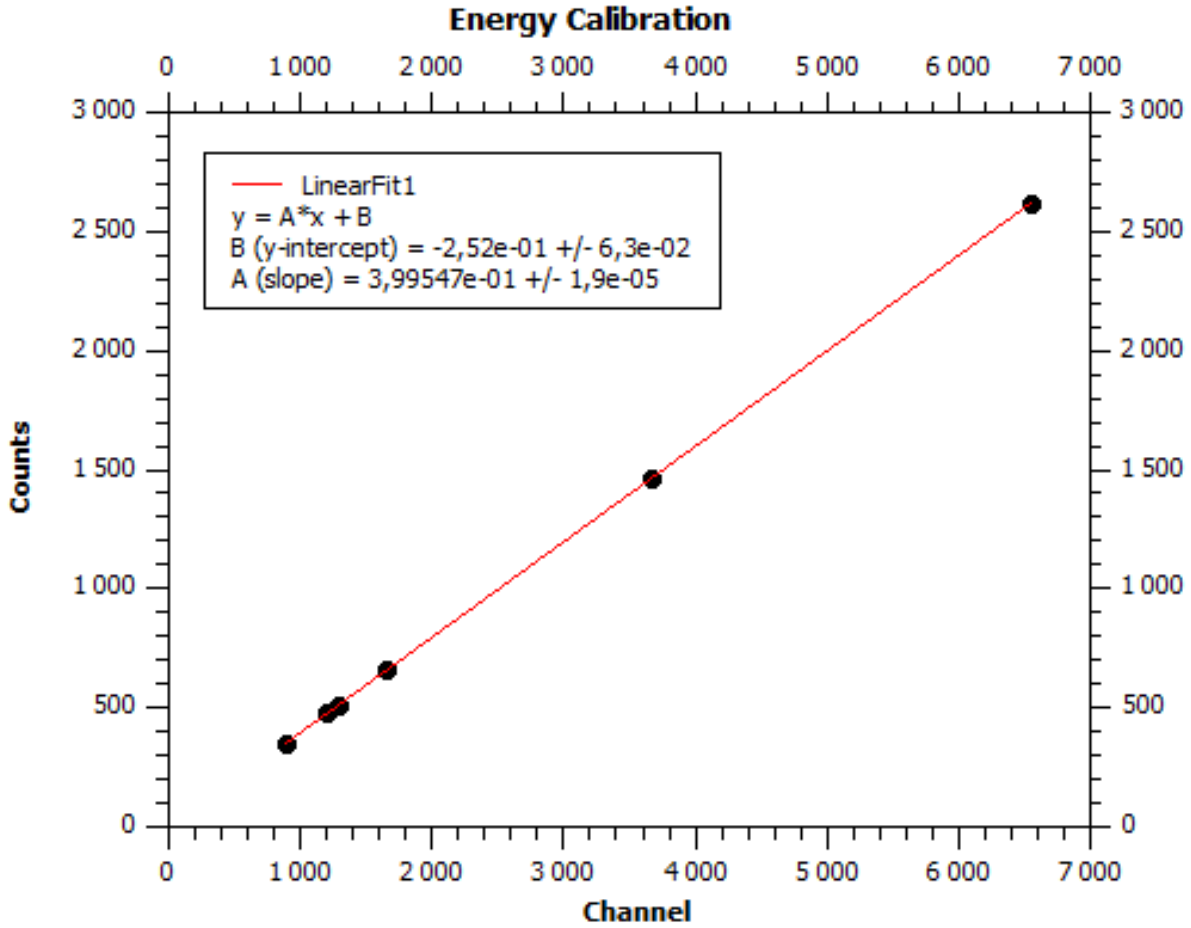
HPGe detector

Well HPGe canberra detector

- Semiconductor detector
- Impurities in the crystal (HPGe(Li))
- Lower efficiancy higher resolution
- Liquid nitrogen required

HPGe Canberra detector with dewar

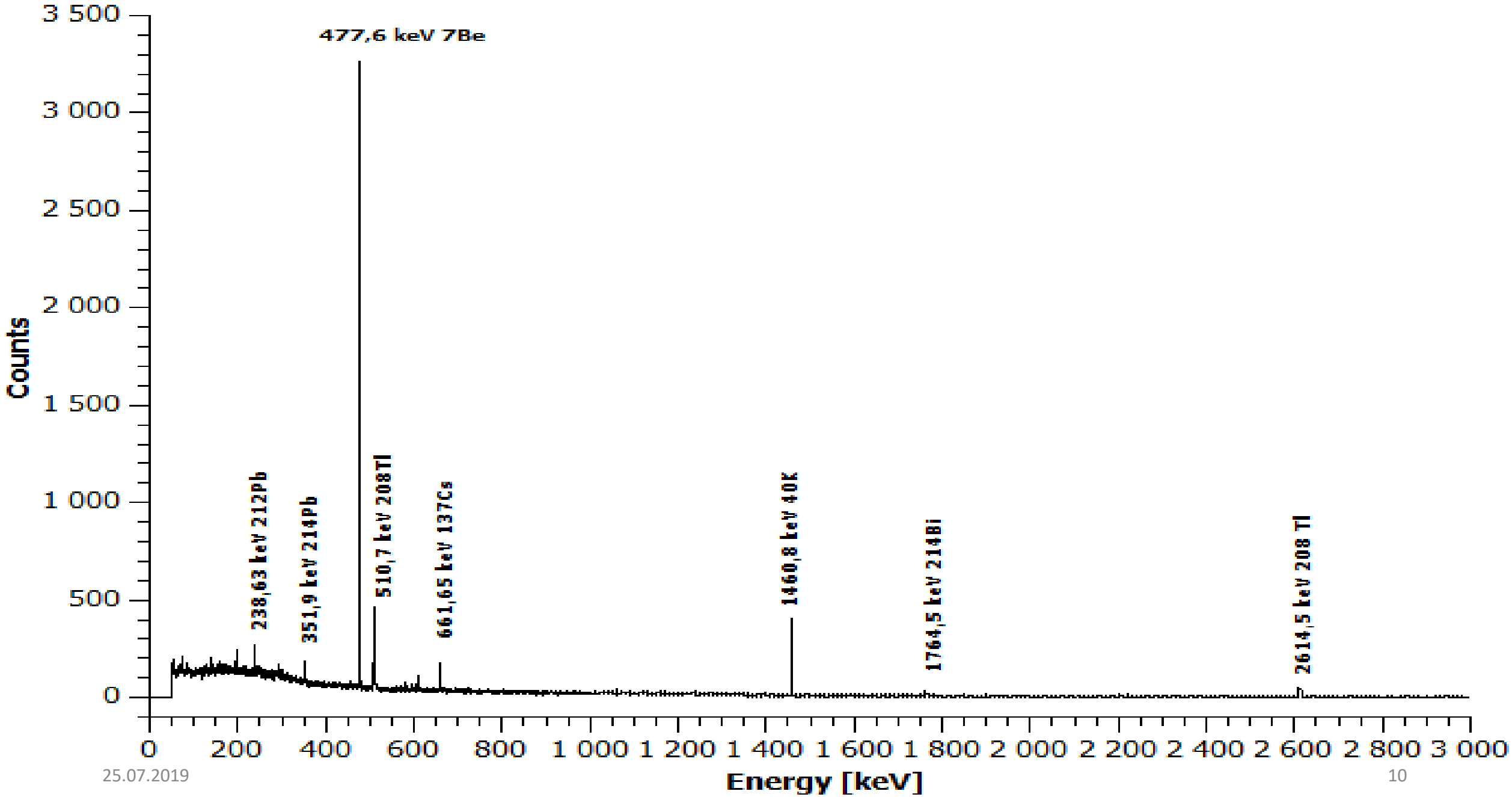
Energy Calibration

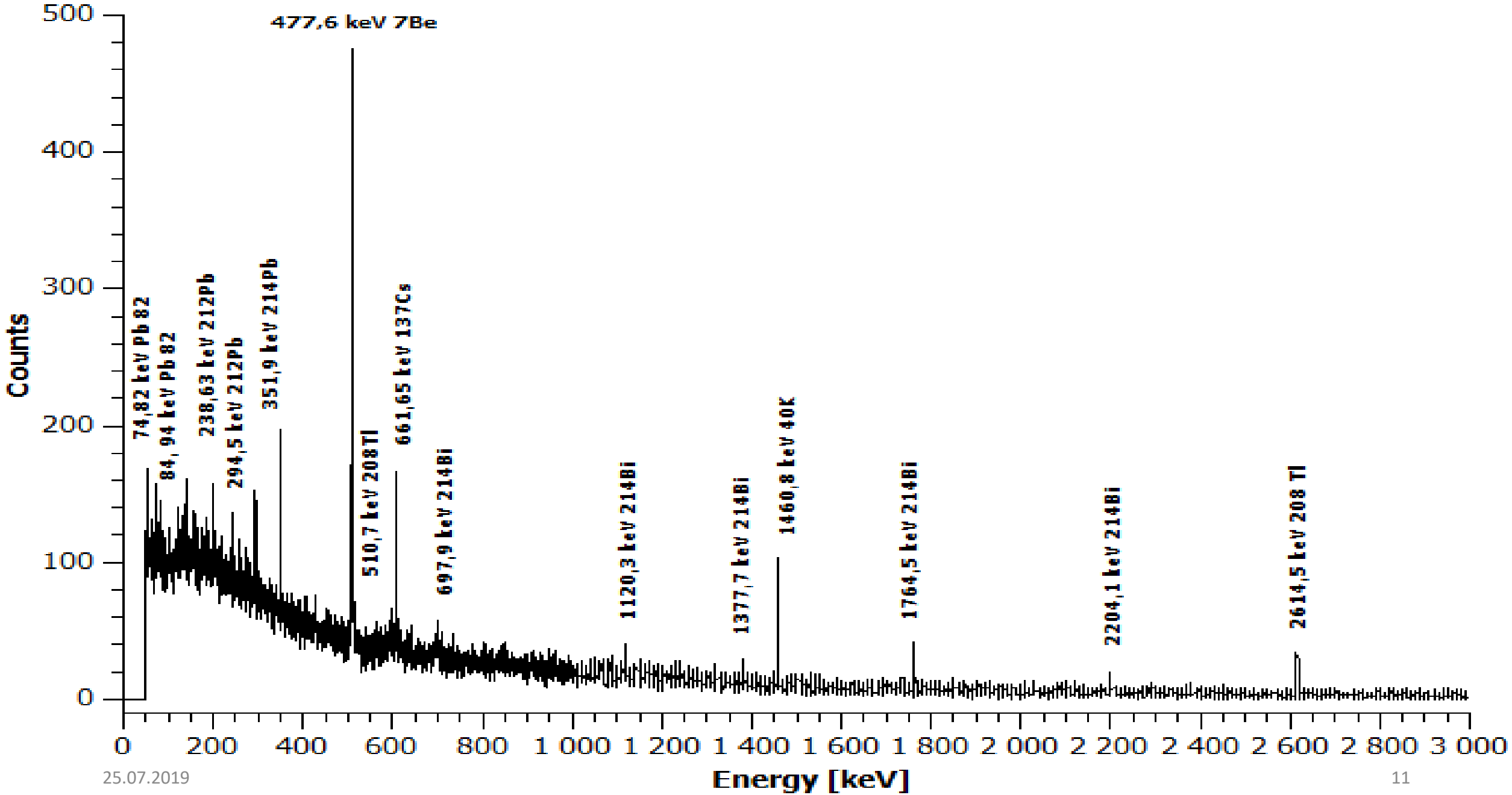


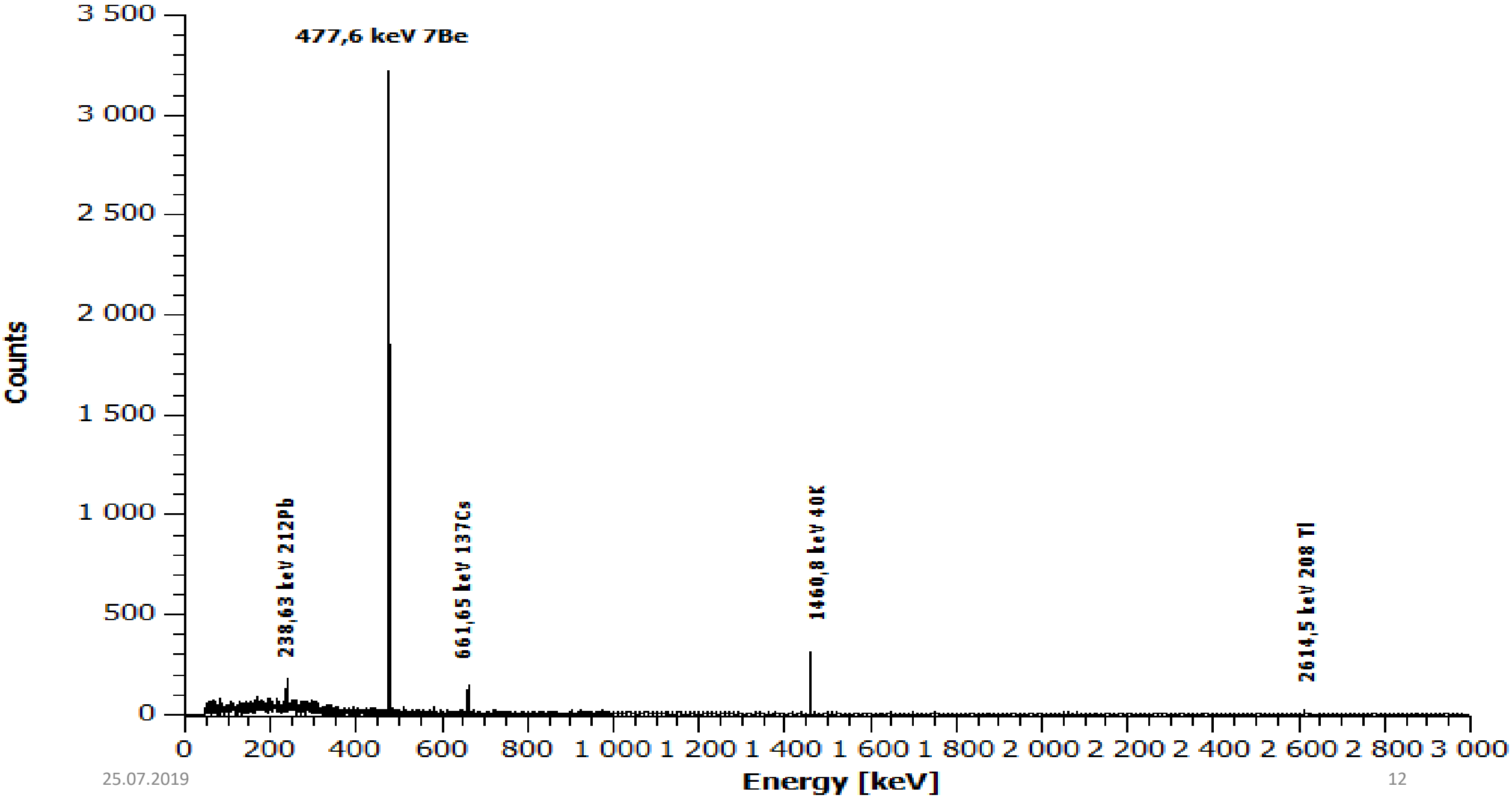
Energy calibration is needed to change channels into energy [eV].

It was theoretical calibration in special software „Geomety Composer”.

Fitting curve was linear.


3 500
3 000
2 500
2 000
1 500
1 000
500
0
Counts
477,6 keV 7Be
238,63 keV 212Pb
351,9 keV 214Pb
510,7 keV 208Tl
661,65 keV 137Cs
1460,8 keV 40K
1764,5 keV 214Bi
2614,5 keV 208 Tl
0 200 400 600 800 1 000 1 200 1 400 1 600 1 800 2 000 2 200 2 400 2 600 2 800 3 000
Energy [keV]

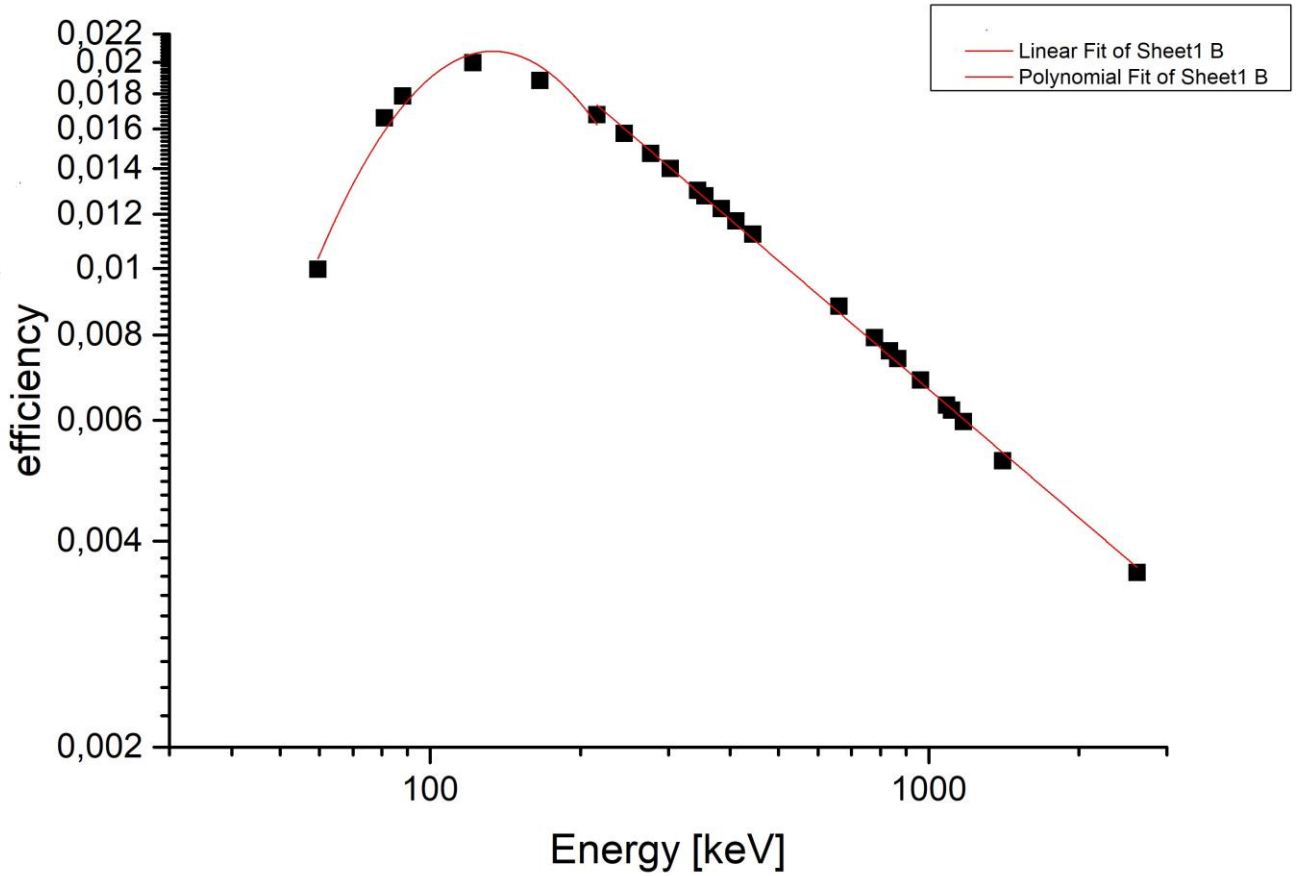

477,6 keV 7Be
74,82 keV Pb 82
84, 94 keV Pb 82
238,63 keV 212Pb
294,5 keV 212Pb
351,9 keV 214Pb
510,7 keV 208Tl
661,65 keV 137Cs
697,9 keV 214Bi
1120,3 keV 214Bi
1377,7 keV 214Bi
1460,8 keV 40K
1764,5 keV 214Bi
2204,1 keV 214Bi
2614,5 keV 208 Tl
Counts
Energy [keV]
0
100
200
300
400
500
0
200
400
600
800
1 000
1 200
1 400
1 600
1 800
2 000
2 200
2 400
2 600
2 800
3 000


477,6 keV 7Be
238,63 keV 212Pb
661,65 keV 137Cs
1460,8 keV 40K
2614,5 keV 208 Tl
Counts
Energy [keV]
3 500
3 000
2 500
2 000
1 500
1 000
500
0
0 200 400 600 800 1 000 1 200 1 400 1 600 1 800 2 000 2 200 2 400 2 600 2 800 3 000

Efficiency curve

Efficiency curve was made in „Geometry Composer”

It is needed to approximate energy efficiency



Analysis of data

- Lower limit of detection(LLD) is the lowest quantity of a substance that can be distinguished from the absence of that substance:

$$LLD = 2,71 + 3,66\sqrt{n_b}$$

- Minimum Detectable Activity (MDA) represents the smallest quantity of a radioisotope which can be detected:

$$MDA = \frac{LLD}{c \cdot \gamma \cdot t}$$

- Determination limit (LQ) is how many counts would I have to have to achieve a particulary statistic uncertaincy.

$$LQ = 3,7\sqrt{n_b}$$

Analysis of data

Isotope	Energy [keV]	Area	LC	LLD	LQ	MDA	Activity [Bg]	Activity [Bq/g]	Origin
^{212}Pb	238,63	104,33	48,30	110 (26)	109 (25)	0,093 (42)	0,088 (78)	0,0033 (29)	UT
^{7}Be	447,61	4463,68	43,12	99 (23)	97 (23)	0,49 (11)	22 (8)	0,82 (28)	cosmogonic
^{137}Cs	661,66	270,6103	31,98	74 (16)	72 (16)	0,057 (18)	0,209 (61)	0,0078 (23)	anthropogenic
^{40}K	1460,82	651,1689	31,21	72 (15)	70 (14)	0,75 (29)	7 (2)	0,251 (76)	Natural
^{208}Tl	2614,51	32,30251	37,84	87 (19)	85 (18)	0,140 (31)	0,052 (14)	0,00193 (58)	UT

UT – Thorium series

Cosmogonic - produced in the Earth's atmosphere and surface, through reactions induced by highly energetic cosmic rays

Antropogenic – nuclear incidents and test nuclear weapon

What I've learned

- What environmental measurements are.
- Why are they important
- How to gather and prepare samples of mosses.
- How to measure environmental samples using gamma spectroscopy.
- How to analyze the received data and identify the isotopes found in the sample.


Thank you for your attention