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19ENV01 traceRadon

PAST and FUTURE for the Ionising Radiation Metrology Laboratory (IFIN-HH) from the perspective of participating in traceRadon activities

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Background – past project

Between 2017 and 2020, the JRP 16ENV10 MetroRADON has been developed
Project overview and objectives
The overall objective of this project is to enable the SI traceable monitoring of radon (^{222}Rn) at low radon activity concentrations including calibration and radon mapping. These objectives include the investigation of the influence of thoron (^{220}Rn), the harmonisation of indoor and soil exhalation radon measurements and the development of new methodologies for the identification and characterisation of radon priority areas in Europe. The JRP contributes to the creation of a coordinated metrological infrastructure for radon monitoring in Europe.
The specific objectives of the project are:
1. To develop novel procedures for the traceable calibration of radon (^{222}Rn) measurement instruments at low activity concentrations (100 Bq/m^3 to 300 Bq/m^3) with relative uncertainties ≤ 5 % (k = 1). As part of this, to develop new radioactive reference sources with stable and known radon emanation rates.
2. To investigate and to reduce the influence of thoron (^{220}Rn) and its progeny on radon end-user measurements and radon calibrations.
3. To compare existing radon measurement procedures in different European countries and from the results optimise the consistency of indoor radon measurements and soil radon exhalation rate measurements across Europe.
4. To analyse and develop methodologies for the identification of radon priority areas (i.e. areas with high radon concentrations in soil, as defined in the EU-BSS) and investigate the relationship between soil radon exhalation rates and indoor radon concentrations.
5. To validate traceability of European radon calibration facilities, and publish guidelines and recommendations on metrologically sound calibration and measurement procedures.

The current project

IFIN-HH Activities as partner

Task 1. 1: The aim of this task is **to develop two new traceable low-level Rn-222 emanating sources** (below 100 Bq m-3). The sources will be validated via a comparison.

Task 1. 2: The aim of this task is **to develop a transfer standard (TS)** for the traceable calibration of atmospheric radon monitors **according to IEC 61577**, at atmospheric radon levels (below 100 Bq m-3).

Task 1. 3: The aim of this task is **to use the emanating Rn-222 sources** from Task 1.1 and **the transfer standard** from Task 1.2, **to enable the traceable calibration of environmental atmospheric radon measurement systems in the field**, with an hourly uncertainty below 15 % for k=1.

WP1	IFIN—HH Activities Partner/Leader/Month
Task 1.1	A1.1.2/PTB /12
	A1.1.3/PTB/13
	A1.1.5/CMI/15
	A1.1.6/CMI/22
Task 1.2	A1.2.1/UPC/3
	A1.2.3/SUJCHBO /14
Task 1.3	A1.3.4/UVSQ/24
	A1.3.5/UVSQ/26

IFIN-HH Activities as partner

Task 2. 1: The aim of this task is **to develop a continuous radon flux monitor for use as a transfer standard** to calibrate existing radon flux monitors under laboratory conditions. Furthermore, **to develop a radon exhalation reference system "exhalation bed"**, (as the starting point of the traceability chain to the SI) and use this to calibrate the continuous radon flux monitor with an hourly uncertainty of 10 % for k=1.

Task 2. 2: The aim of this task is **to use the radon flux monitoring capability developed** in Task 2.1 and **to harmonise existing radon flux methods and monitors under field conditions using intercomparison campaigns**.

Task 2. 3: The aim of this task is **to perform intense radon flux measurement campaigns in the field at AMNS or RMS** using the calibrated continuous radon flux monitors from Tasks 2.1 and 2.2.

WP2	IFIN—HH Activities Partner/Leader/Month
Task 2.1	A2.1.5/UPC/12
Task 2.2	A2.2.1/UC/15
	A2.2.2/UC/16
	A2.2.3/U/16
	A2.2.4/UC/17
	A2.2.5/UPC/20
	A2.2.6/UPC/22
Task 2.3	A2.3.1/NPL/18
	A2.3.5/UVSQ/31

A1.2.1/UPC/3

A1.2.1 Based on the results of the literature review, **UPC** and UVSQ will define a matrix of properties such as **environmental parameters, activity levels, stability, accuracy, achieved uncertainty and portability** for the field application of these radon monitors

MONITORS	Environmental parameters	Activity levels	Stability	Accuracy	Achieved uncertainty	Portability
RAD7	Temperature: 32° – 113°F (0° – 45° C) Humidity: 0% – 100%, non-condensing	0.1 – 20,000 pCi/L (4 – 750,000 Bq/m³)	-	5%	-	External 12V Power Adaptor
AlphaGUARD	No sensitivity to high air humidity	2 – 2,000,000 Bq/m³	Long-term stable calibration factor (guaranteed 5 years) (According to the producer)	3%	-	10 days (40 days with external battery)
SARAD	Rel. humidity: 0 …100%, accuracy ± 2% Temperature: -20 … 40°C, accuracy ± 0.5°C Bar. pressure 800 … 1200mbar, accuracy 0.5%	0…10 MBq/m³	-	5%	-	Internal 12V rechargeable battery, AC/DC wall adapter Option: additional connector for 12V car battery or solar power station
Pylon AB6	Operating Temperature Range: 0 to +40 °C (-32 to +122 °F) Storage Temperature Range: -20 to +60 °C (-4 to +140 °F) Relative Humidity Range: 0 to 90 % - Non-condensing	0.007 -10 000 cps	-	-	-	12 - 14.7 Vdc 4 A - 110/220 VAC adapter/charger included Integrated 12V gel cell Operating Time: 22 Hrs backlight off

The Pylon AB6 Portable Radiation Monitor is next generation laboratory-grade instrument for fast, accurate measurement of radon levels developed by Pylon Instruments

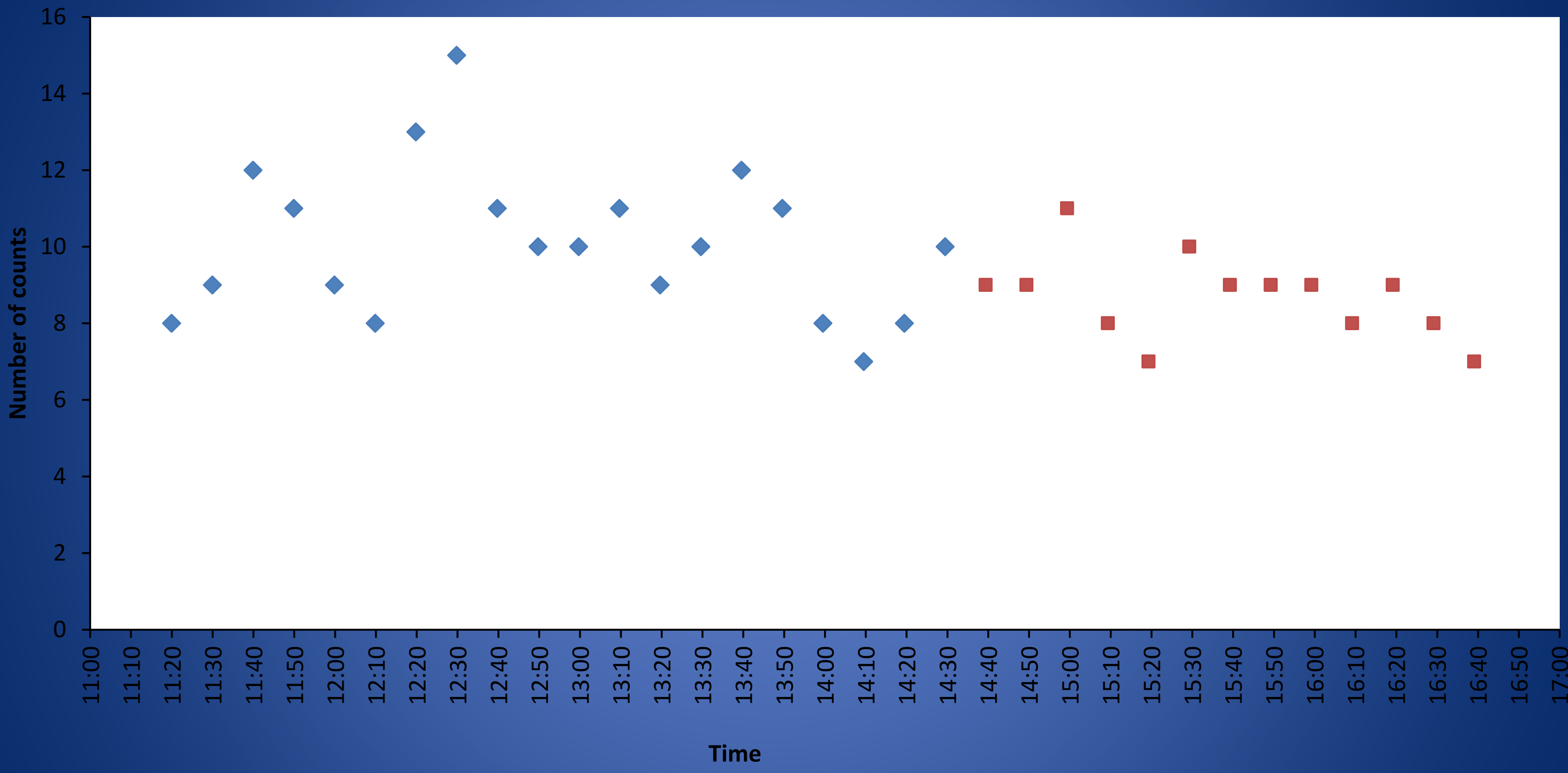
Modes of Operation (multiple)	**Sample & Count Periods: User programmable** **Maximum Counting Rate: 10,000 cps** **Electronic Background: < 0.4 cpm**
Pump	(sold separately and user installable) Pump Flow Rate: 0 to 2 lpm - User adjustable
Data Storage	Storage of time distribution
Principle of Operation/Detector	Active and passive Lucas type scintillation cells
Operating Ranges	Operating Temperature Range: 0 to +40 °C (-32 to +122 °F) Storage Temperature Range: -20 to +60 °C (-4 to +140 °F) Relative Humidity Range: 0 to 90 % - Non-condensing

Pylon AB-5

Recorded data by Pylon AB-5

AB-5	DATA	RECALL
SERIAL#:	1346	
RUN#:	2	
MODE:	CONTINUOUS	
INTERVAL	10	MIN.
START:	02/10/2008	
	11:10:26	
CYC.	INT.	COUNT
1	1	8
1	2	9
1	3	12
1	4	11
1	5	9
1	6	8
1	7	13
1	8	15
1	9	11
1	10	10
1	11	10
1	12	11
1	13	9
1	14	10
1	15	12
1	16	11
1	17	8
1	18	7
1	19	8
1	20	10

1	21	9
1	22	9
1	23	11
1	24	8
1	25	7
1	26	10
1	27	9
1	28	9
1	29	9
1	30	8
1	31	9
1	32	8
1	33	7



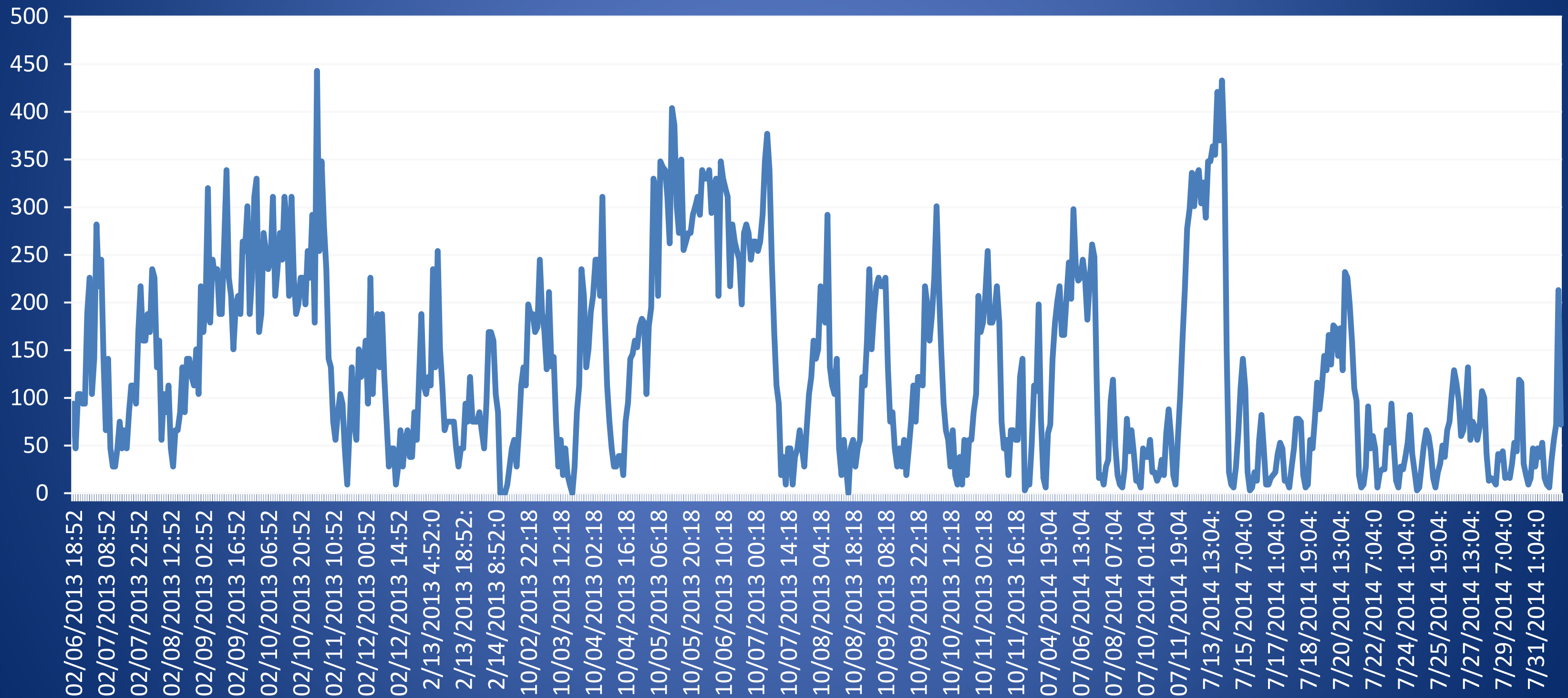
Mean number of counts = 9.0 ± 1.1

Radon Concentration = 16.6 ± 2.6 Bq/m^3

Recorded data by RADON SCOUT (SARAD)

Time	Radon	Error
	Bq/m3	%
02/06/2013 18:52	94	32
02/06/2013 19:52	47	45
02/06/2013 20:52	104	30
02/06/2013 21:52	104	30
02/06/2013 22:52	94	32
02/06/2013 23:52	94	32
02/07/2013 00:52	188	22
02/07/2013 01:52	226	20
02/07/2013 02:52	104	30
02/07/2013 03:52	141	26
02/07/2013 04:52	282	18
02/07/2013 05:52	217	21
02/07/2013 06:52	245	20
02/07/2013 07:52	141	26
02/07/2013 08:52	66	38
02/07/2013 09:52	141	26
02/07/2013 10:52	47	45
02/07/2013 11:52	28	58
02/07/2013 12:52	28	58
02/07/2013 13:52	47	45
02/07/2013 14:52	75	35
02/07/2013 15:52	47	45
02/07/2013 16:52	66	38
02/07/2013 17:52	47	45
02/07/2013 18:52	85	33
02/07/2013 19:52	113	29
02/07/2013 20:52	113	29
02/07/2013 21:52	94	32

Radon Bq/m^3

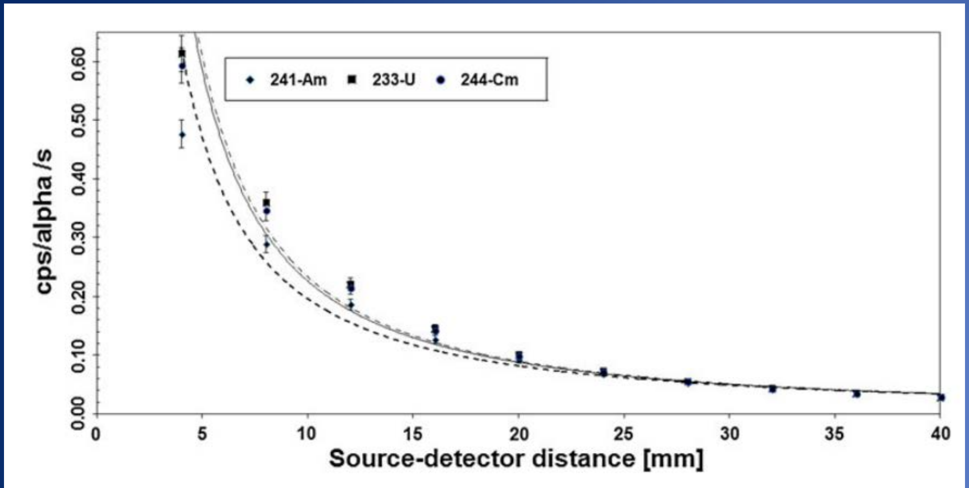


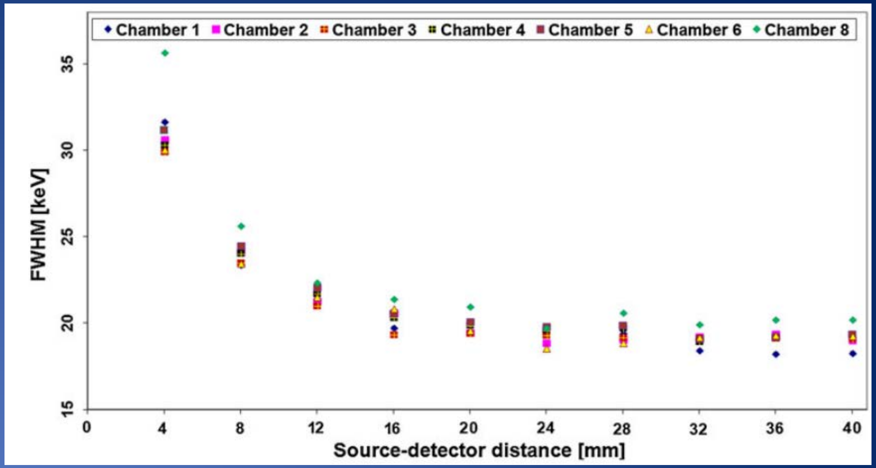
500
450
400
350
300
250
200
150
100
50
0
02/06/2013 18:52
02/07/2013 08:52
02/07/2013 22:52
02/08/2013 12:52
02/09/2013 02:52
02/09/2013 16:52
02/10/2013 06:52
02/10/2013 20:52
02/11/2013 10:52
02/12/2013 00:52
02/12/2013 14:52
2/13/2013 4:52:0
2/13/2013 18:52:
2/14/2013 8:52:0
10/02/2013 22:18
10/03/2013 12:18
10/04/2013 02:18
10/04/2013 16:18
10/05/2013 06:18
10/05/2013 20:18
10/06/2013 10:18
10/07/2013 00:18
10/07/2013 14:18
10/08/2013 04:18
10/08/2013 18:18
10/09/2013 08:18
10/09/2013 22:18
10/10/2013 12:18
10/11/2013 02:18
10/11/2013 16:18
07/04/2014 19:04
07/06/2014 13:04
07/08/2014 07:04
07/10/2014 01:04
07/11/2014 19:04
7/13/2014 13:04:
7/15/2014 7:04:0
7/17/2014 1:04:0
7/18/2014 19:04:
7/20/2014 13:04:
7/22/2014 7:04:0
7/24/2014 1:04:0
7/25/2014 19:04:
7/27/2014 13:04:
7/29/2014 7:04:0
7/31/2014 1:04:0

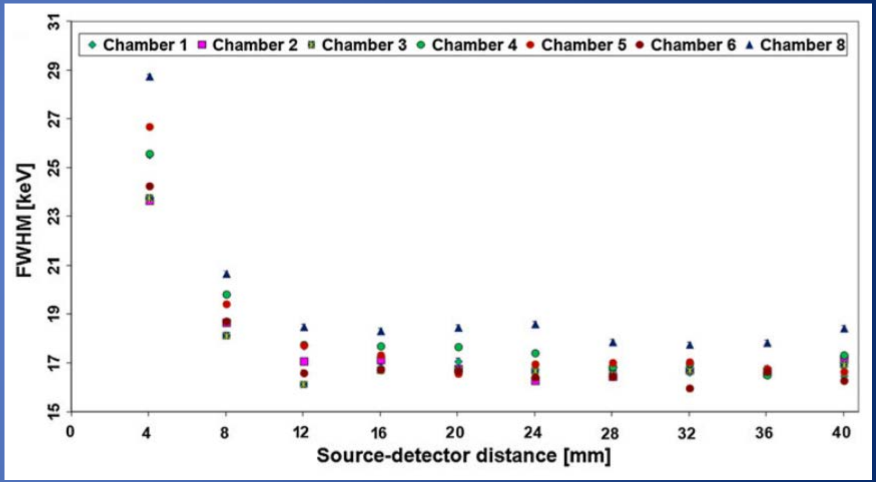
Alpha spectrometers

Octete Plus Alpha Spectrometer

Average efficiency for ^{241}Am, ^{233}U and ^{244}Cm sources for Octete Plus Alpha Spectrometer





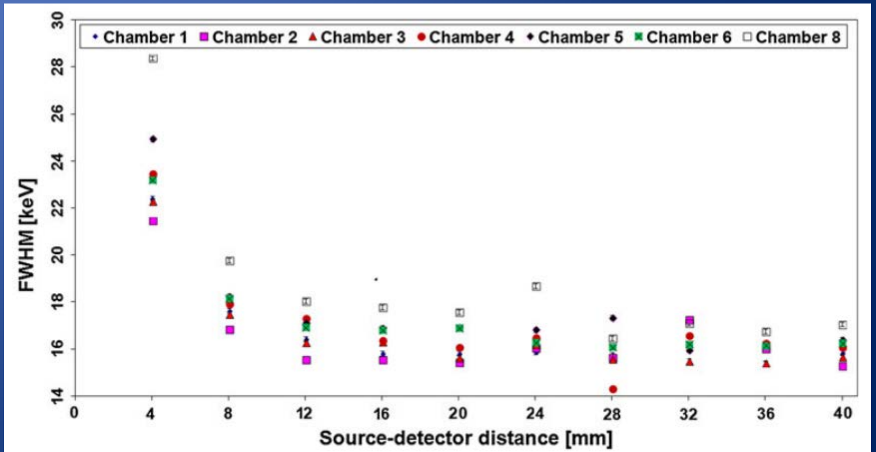


Detector FWHM at:

5.48 MeV for ^{241}Am

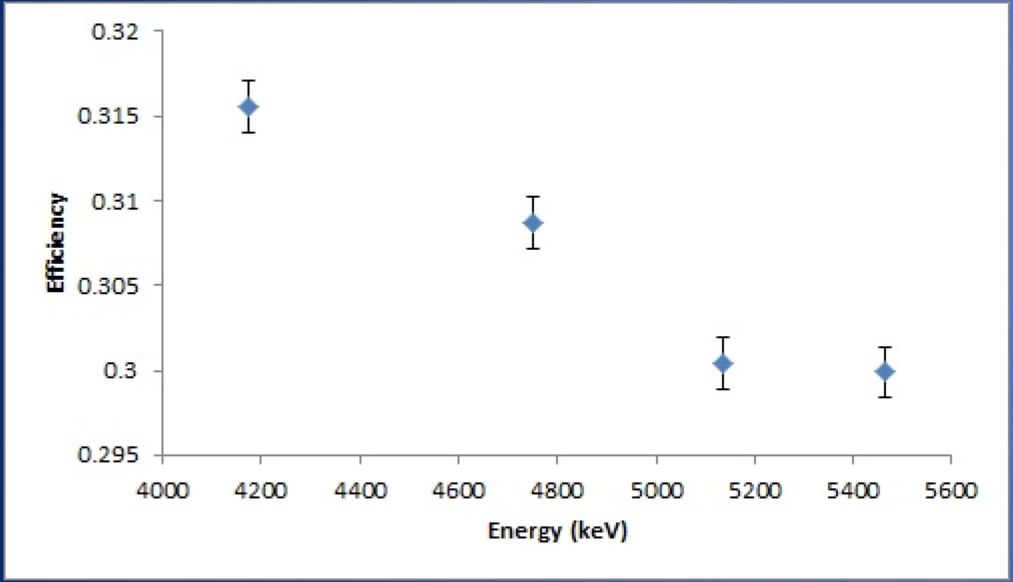
4.82 MeV for ^{233}U

5.80 MeV for ^{244}Cm



Efficiency as a function of energy for SOLOIST spectrometer

Measurements were performed only for level 1 (4 mm distance from the detector) of the spectrometer as the source was of 1.615 Bq 238U, 1.579 Bq 234U, 1.565 Bq 239Pu and 1.599 Bq 241Am.



The energy resolution was about 56 keV for 234U at 4774 keV.