



BS-ERA.NET Pilot Joint Call 2010/2011

Project BSERANET7-041

Radiation background of Black Sea coastal environment (RACE)

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Parteners

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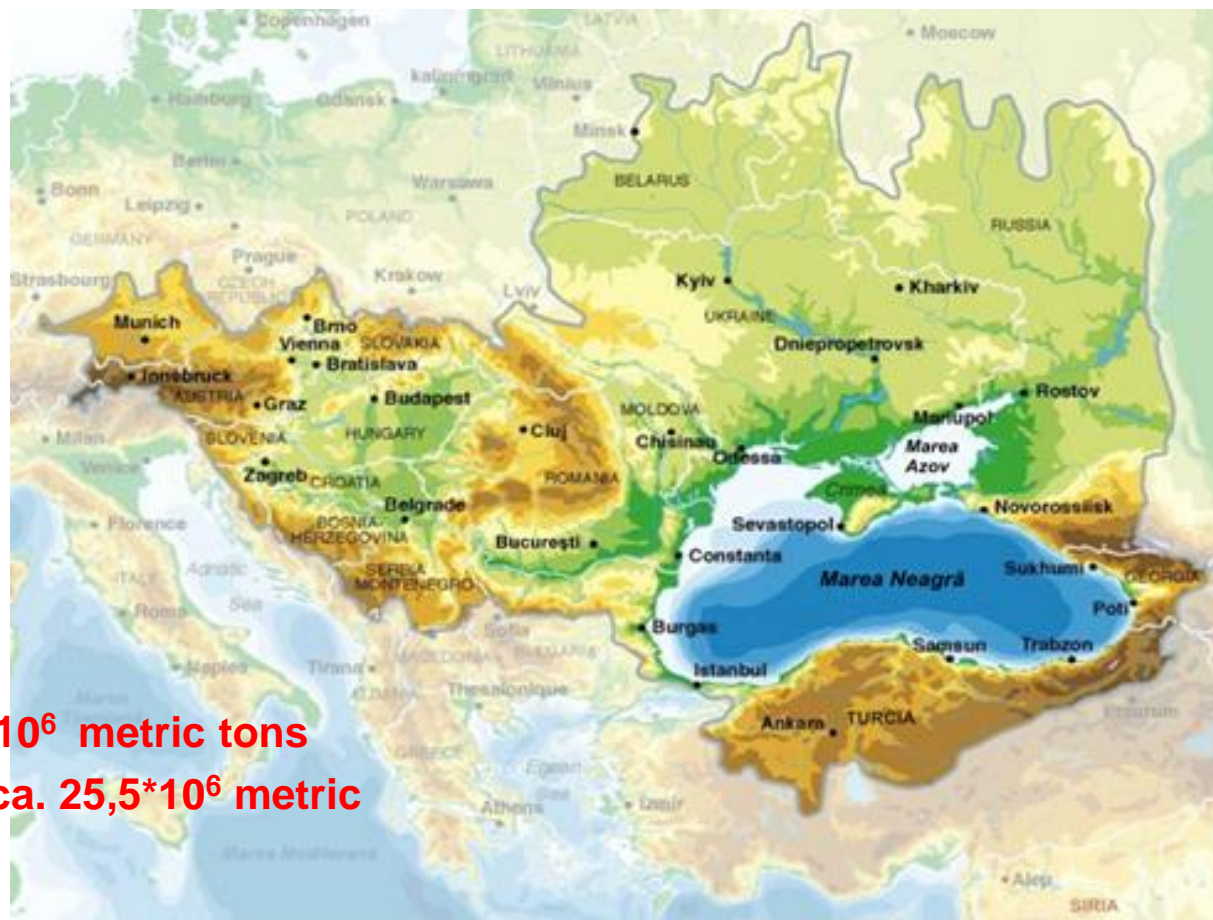
The main objective of the project is to establish the levels of radiation background and its sources in the Black Sea coastal environment.

The specific objectives are:

- collection, transport, storage and conditioning of marine samples
- measurement of gamma and beta emitting radionuclides and by photo-spectrometry of Uranium and Thorium in samples
- measurement of atmospheric muon flux on land and on sea
- optimization of the spatial sampling scheme



The greatest euxinic and meromitic basin in the world



Surface: 423,000 km²

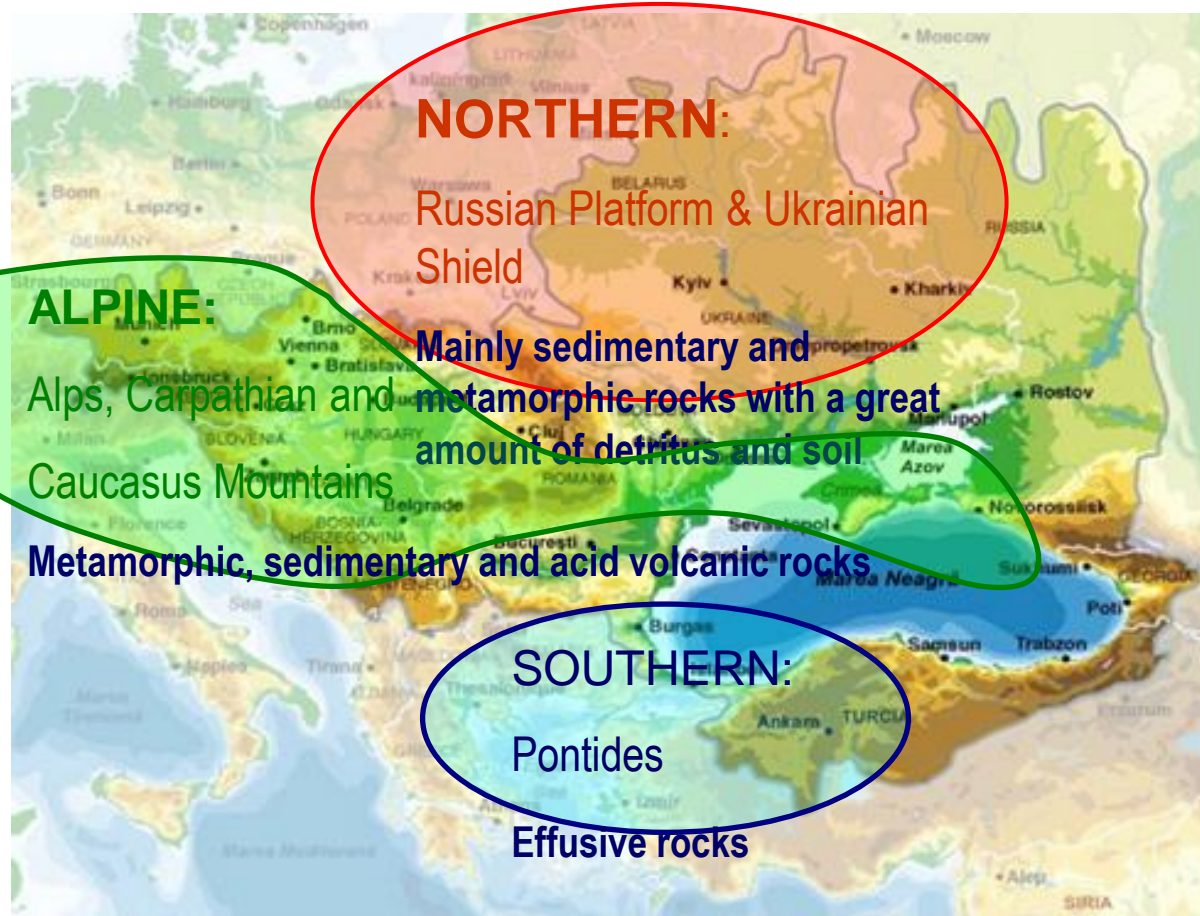
Volume: 547,000 km³

Catching area: 1,864,000 km²

Catching area/surface: 4,4

Annual debt of solid matter: 138*10⁶ metric tons

Annual debt of solvated matter cca. 25,5*10⁶ metric tons



Catching area - Three major units
Northern, Alpine and Southern



Sources of radiation background

The major components of radiation background at soil surface are coming from:

- natural and artificial radionuclides in environment
- primary and secondary cosmic radiation

The most abundant radionuclides of natural origin are ^{40}K and the members of the decay series of ^{232}Th , ^{235}U and ^{238}U

The significant artificial radionuclides in environment are ^{137}Cs , ^{60}Co , ^{90}Sr , ^{14}C and Tritium

Cosmic-rays contribution consists on protons (90%), He nuclei (7%) and other nuclei (3%) the primary cosmic ray originates from the extraterrestrial space (galactic and extragalactic).



Sources of radiation background, cont'd

The Black Sea receives important amounts of radionuclides from the rivers which cross contaminated areas by Chernobyl accident and, also from the nuclear reactors which are in its basin and from the global radioactive fallout.

The role played by the drainage basins of the Danube, Dniepr and Don rivers in transporting the Chernobyl radioactive fallout to the Black Sea is such that the effects of this major nuclear accident are still evident.

These rivers are known to influence ^{137}Cs concentrations from the Black Sea due to their large sediment fluvial inputs to the sea.

By the interaction of the primary cosmic rays, (CR), with the atmospheric nuclei a shower of secondary particles including neutrons is generated. A large number of gammas, electrons, neutrons and muon will reach the ground level.

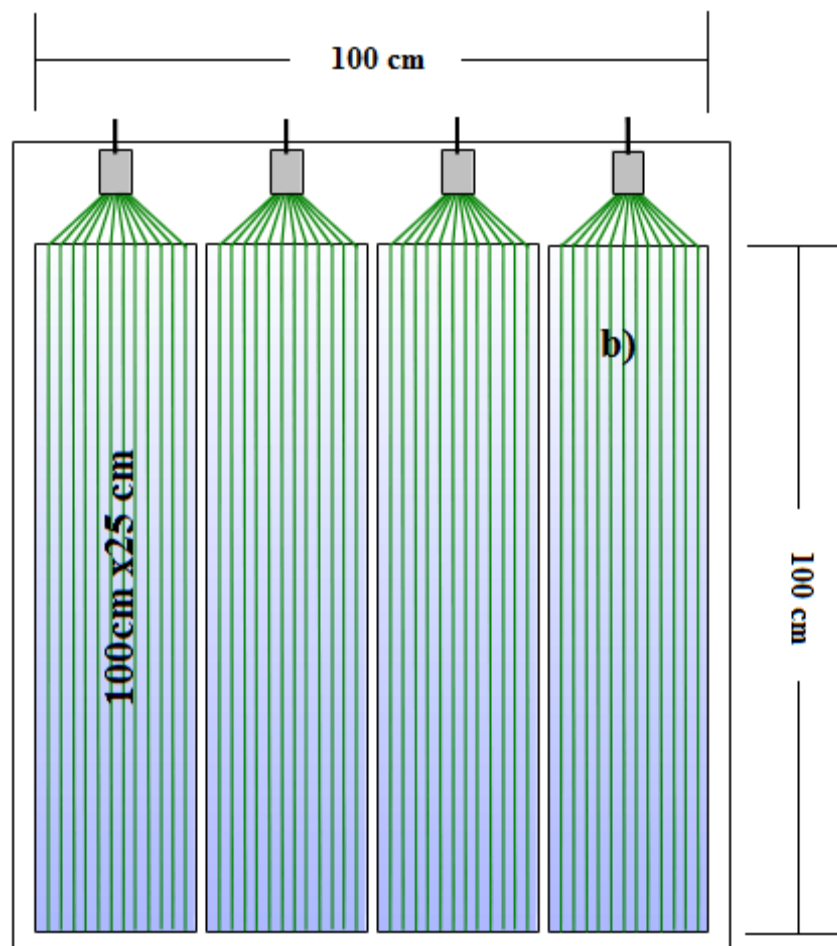


THE MOBILE DETECTOR



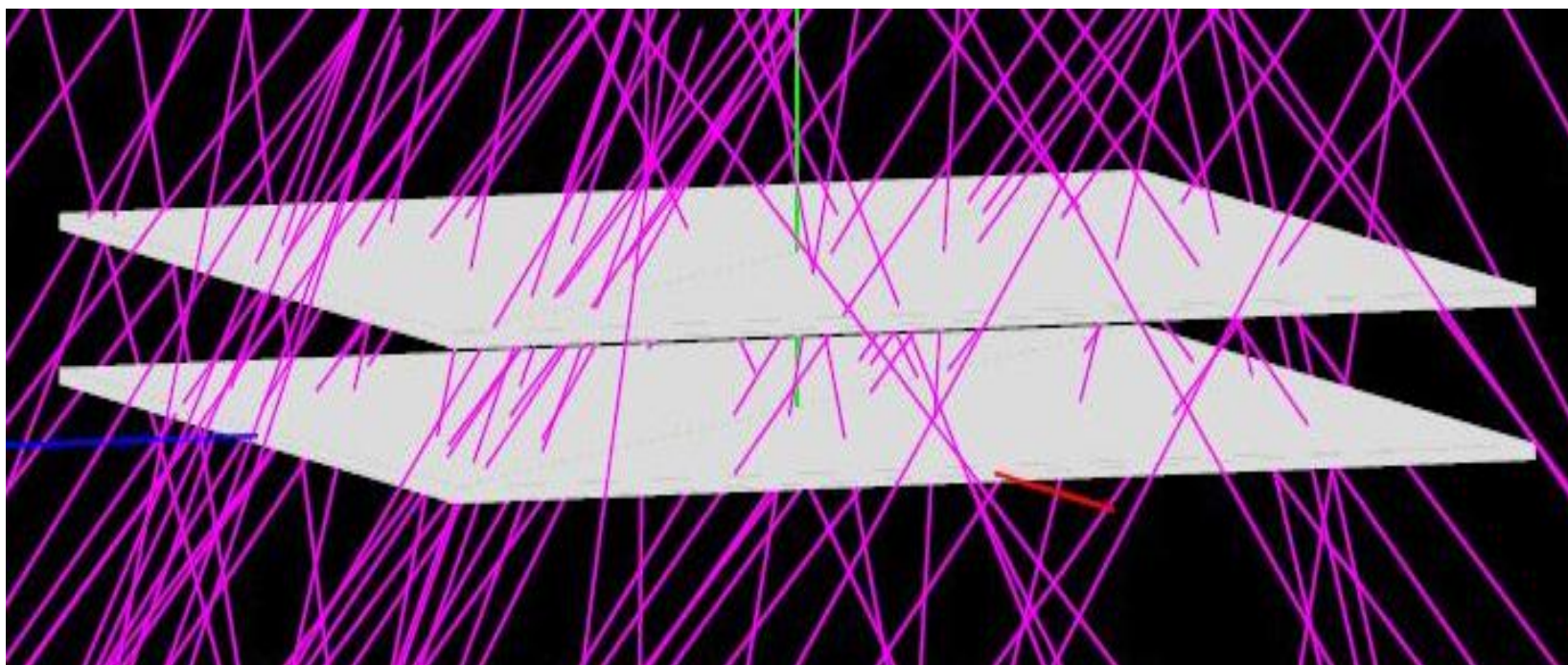


MUON DETECTORS



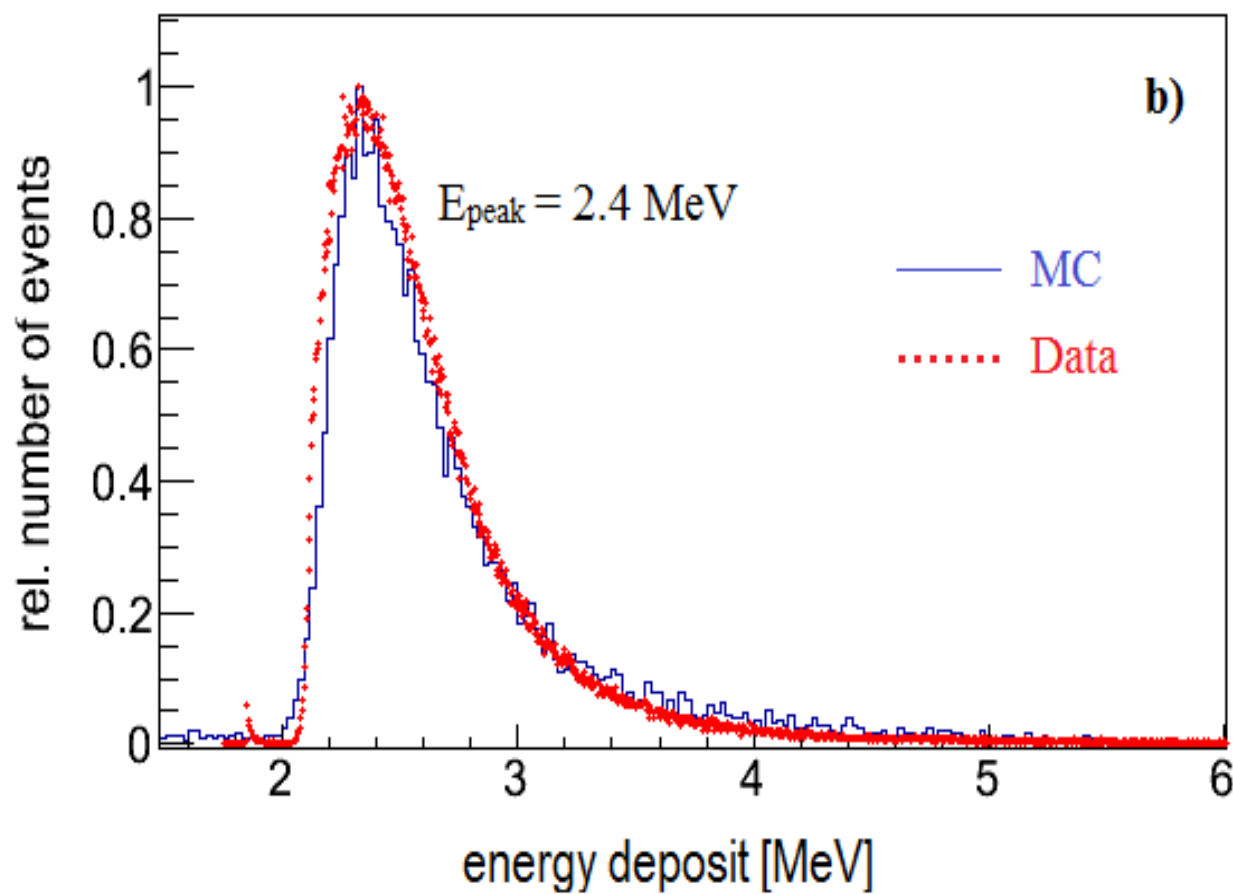


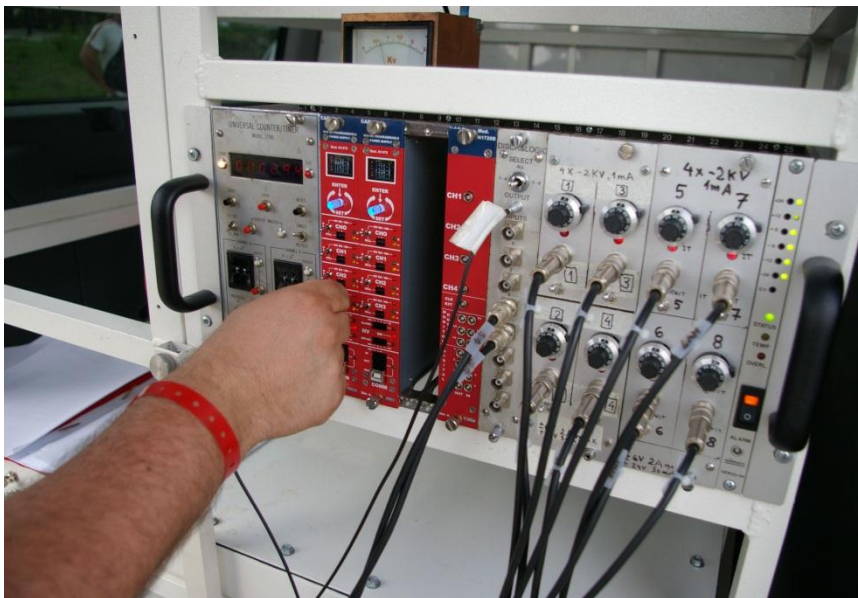
MONTE - CARLO

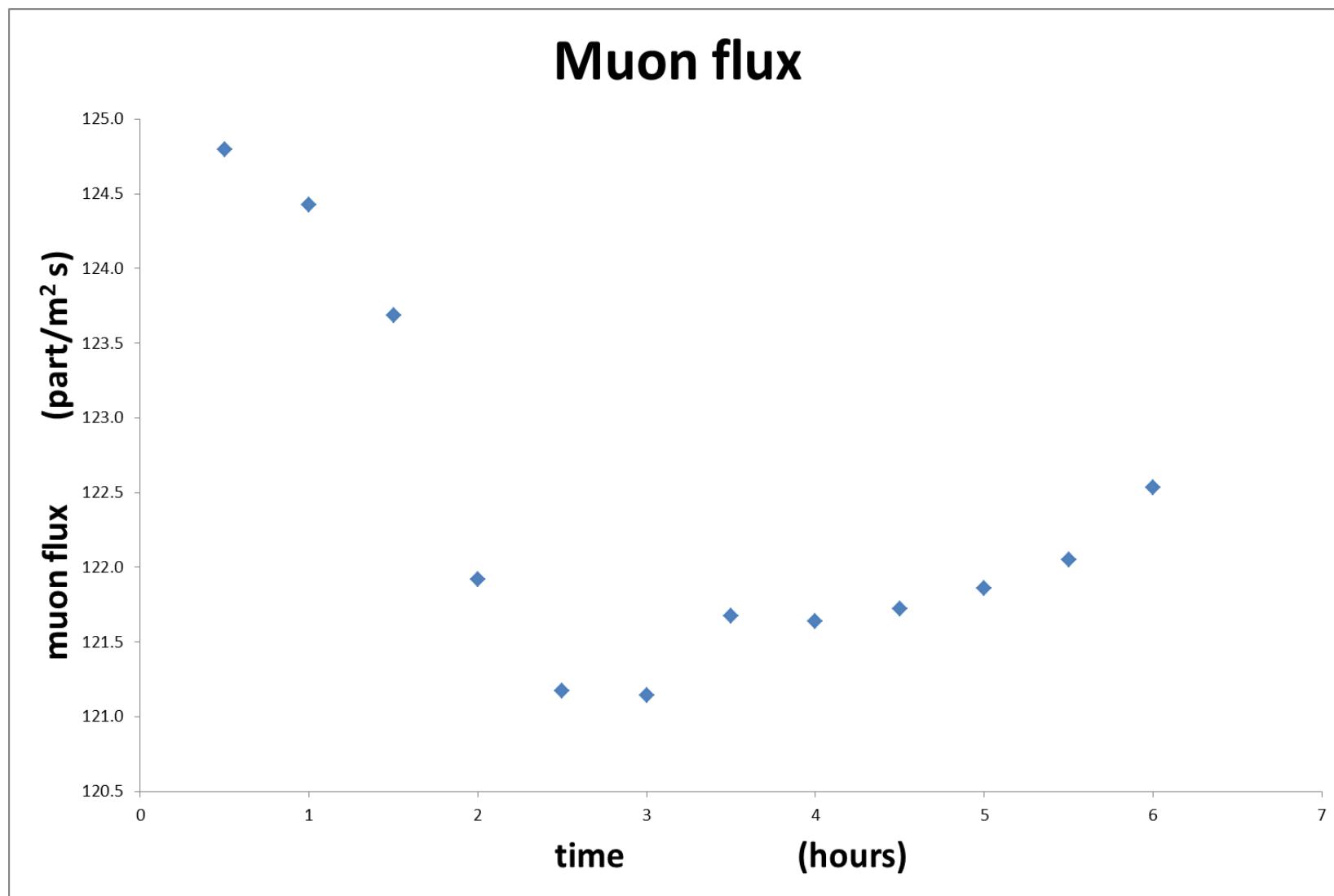




DETECTOR CALIBRATION







Each point represents an average value for 1800 s collecting time



Sampling and measurement campaign in Bulgaria

Samples for gamma spectrometry

Sand and soil

41 sampling points

Sediment

3 sampling points

Ambiental dose rate

near the sea and/or on the beach

16 places

Chernomorets beach

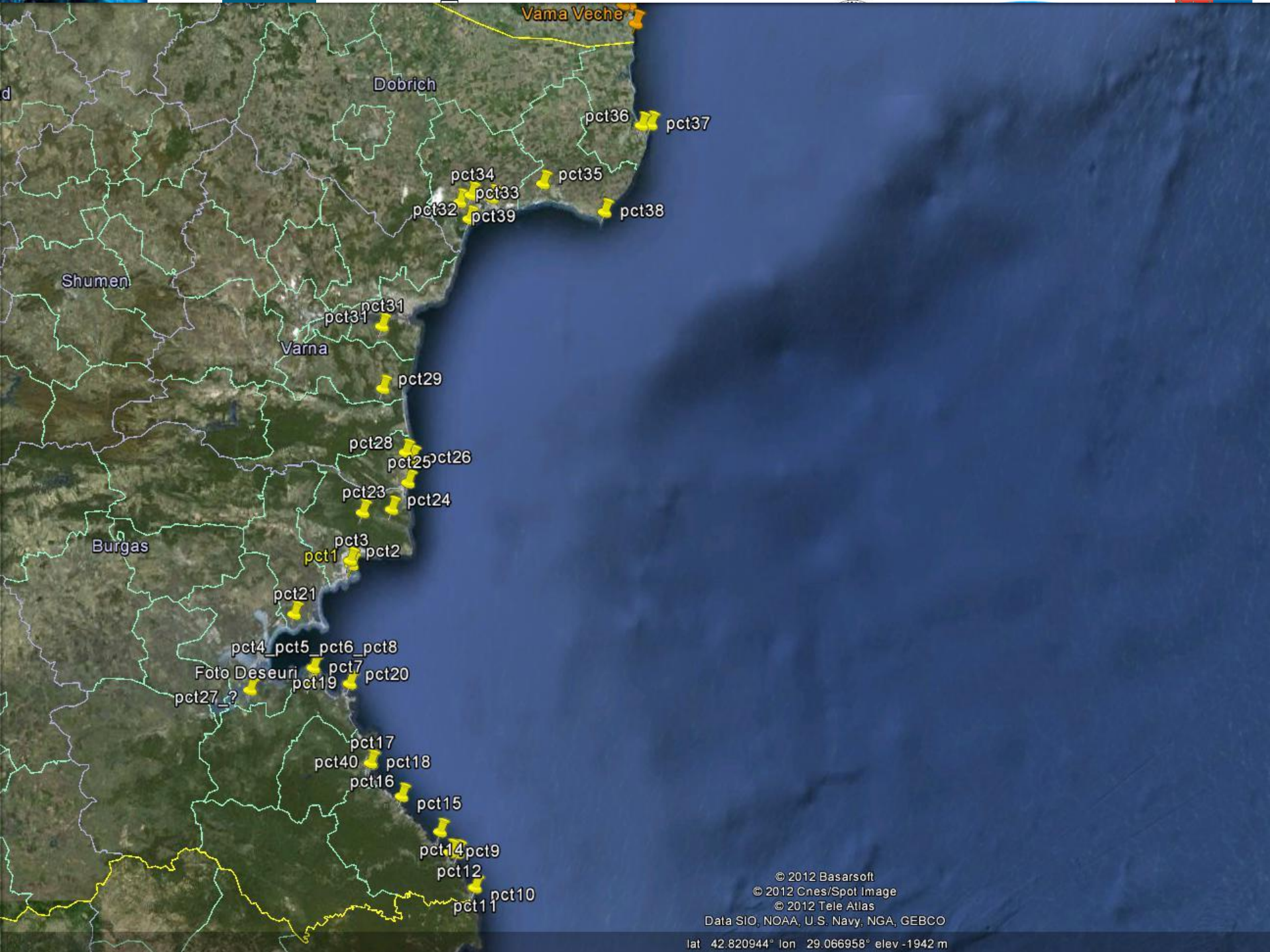
6 places

On the sea

13 measurements in 4 places

On land

10 places







Gamma dose rate in air in several places along Bulgarian sea shore June 2012

Place	Latitude North	Longitude	dose rate nSv/h	uncertainty nSv/h
		Eest		
Rezovo (10 m from the sea, on the beach)	42.056389	27.986944	54	8
Beach between Primorsko Kiten	42.247583	27.753610	52	6
Sozopol – New Town Beach	42.412472	27.701400	52	10
Nesebar (beach)	42.657160	27.717950	67	8
Sunny Beach (1)	42.666600	27.714420	64	7
Sunny Beach (2)	42.666600	27.714420	65	7
Obzor (beach)	42.823400	27.884170	71	5
Byala (beach)	42.873270	27.897700	60	5
Albena beach	43.362400	28.081290	63	9
Balcic (beach)	43.403760	28.149120	45	11
Balcic (concrete terace, ~10 m from the beach)	43.403974	28.148707	51	8
Shabla-Karia beach	43.542690	28.606490	38	10
Nesebar (point 1 – concrete alley at the cliff base)	42.657230	27.720015	144	7
Nesebar (point 3 – concrete alley at the cliff top)	42.657590	27.718250	132	5
Sunny Beach (on the cliff)	42.666090	27.714920	75	11
Sunny Beach (~30 m from the sea on the sand banck)	42.395970	27.425030	70	7



Gamma dose rate in air on the sea in Varna Bulgaria June 2012

Place	Latitude North	Longitude Est	dose rate nSv/h	uncertainty nSv/h
Black Sea_Varna (12 m depth); 10.35	43.209306	27.963333	32	10
Black Sea_Varna (12 m depth); 10.48	43.209306	27.963333	33	10
Black Sea_Varna (12 m depth); 10.52	43.209306	27.963333	32	9
Black Sea_Varna (12 m depth); 11.00	43.209306	27.963333	35	7
Black Sea_Varna (12 m depth); 11:10	43.209306	27.963333	34	8
Black Sea_Varna (12 m depth); 11.25	43.209306	27.963333	33	9
Black Sea_Varna, 11.58 h	43.209444	27.963056	37	9
Black Sea_Varna; 15.02 h	43.178210	27.930990	32	10
Black Sea_Varna; 15.18 h	43.178210	27.930990	33	11
Black Sea_Varna; 15.39 h	43.178210	27.930990	33	9
Black Sea_Varna; 15.50 h	43.178210	27.930990	33	9
Black Sea_Varna; 16.04 h	43.178210	27.930990	34	9



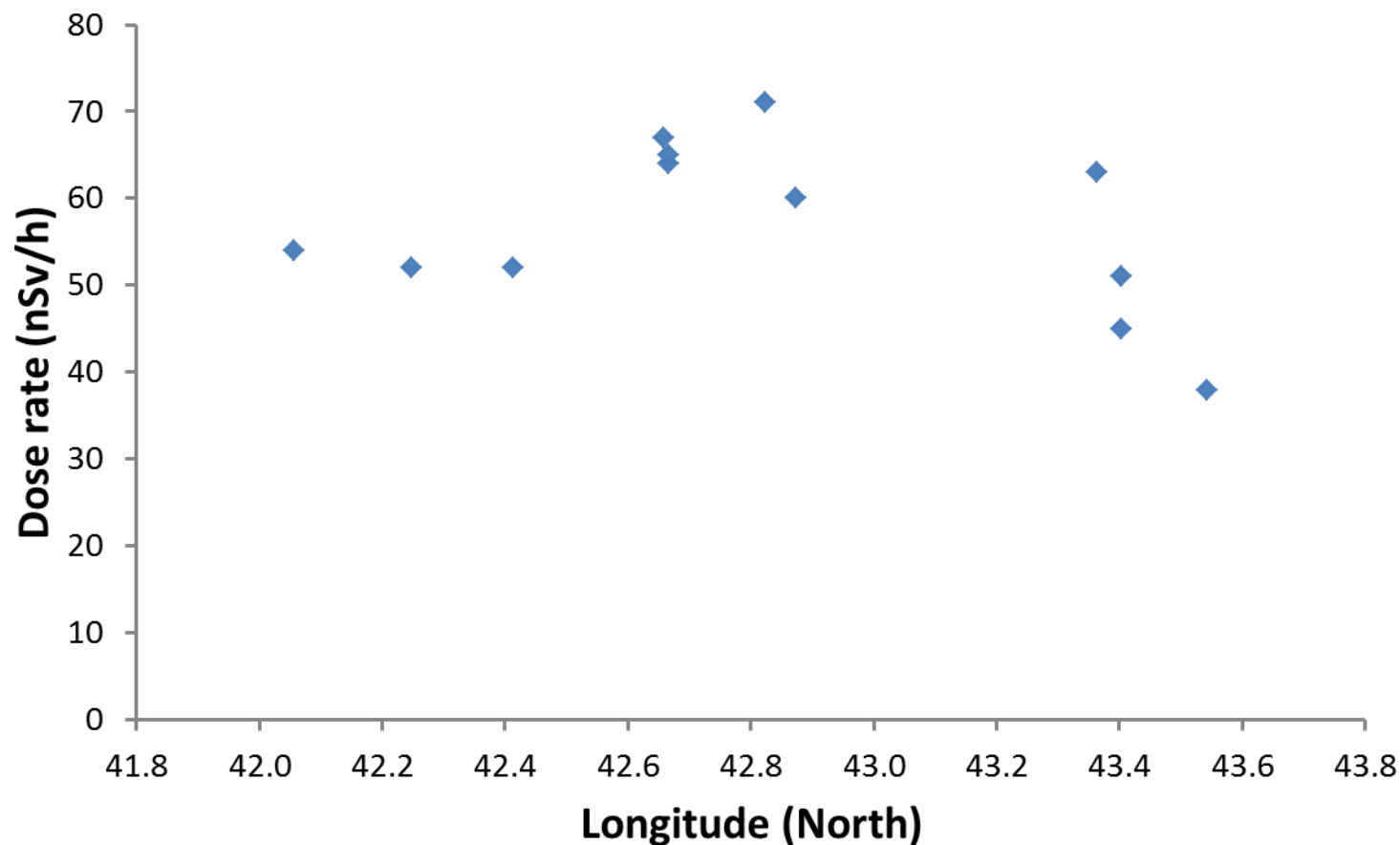
Gamma dose rate in air in several places in Vromos Bay, on sea shore

June 2012

Place	Latitude North	Longitude Est	dose rate nSv/h	uncertainty nSv/h
Chernomorets (1)	42.447765	27.600283	507	6
Chernomorets (2)	42.447765	27.600283	620	7
Chernomorets (3)	42.447090	27.60980	861	7
Chernomorets (4)	42.447090	27.60980	784	8
Chernomorets (5)	42.447090	27.60980	499	5
Chernomorets (6)	42.446980	27.60121	297	7



Dose rates on the Bulgarian beaches





Measurement places for
environmental dose rate in
2012 along Romania seashore

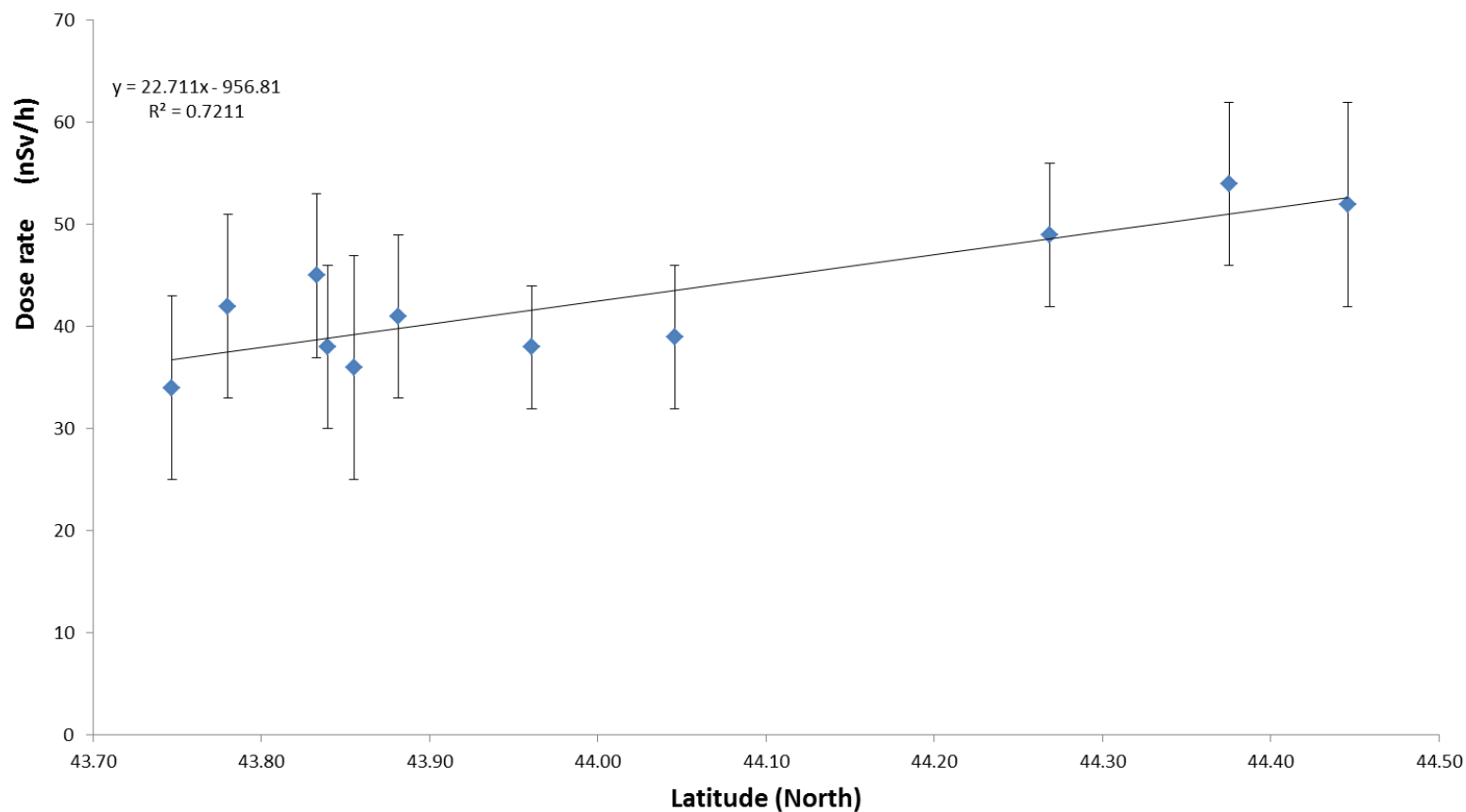


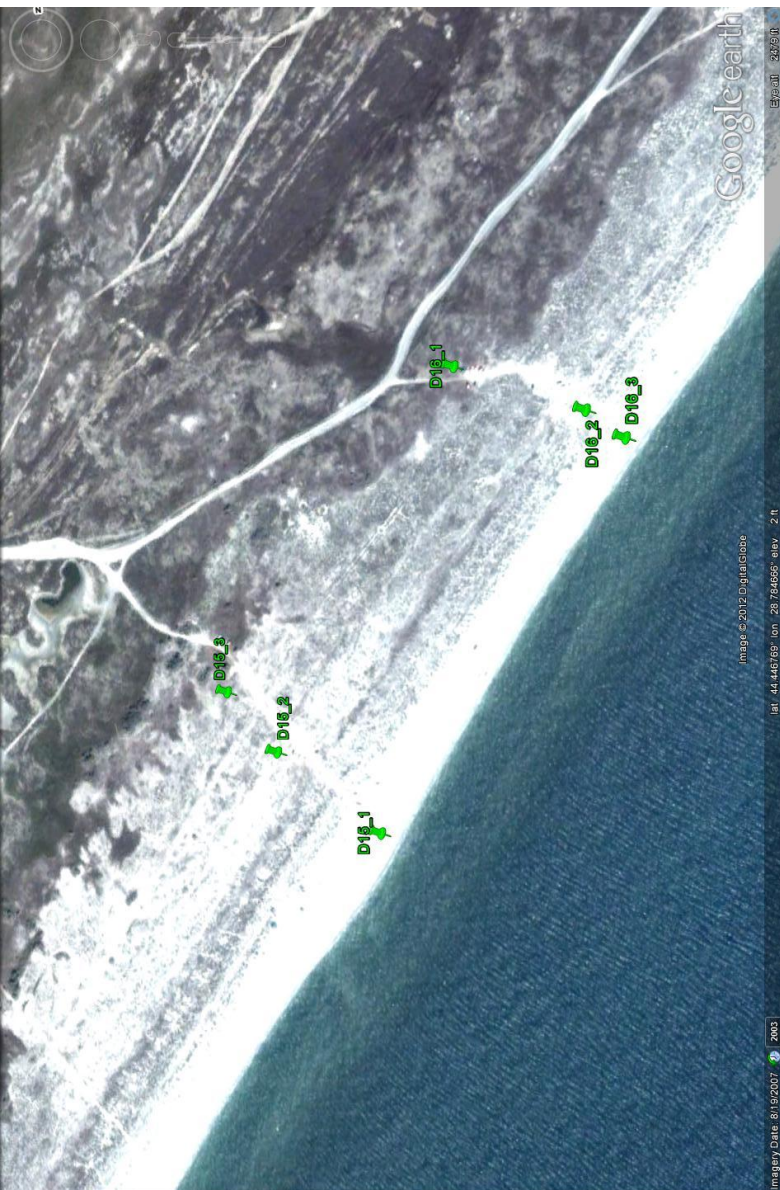
Gamma dose rate in air in several places Romanian along sea shore in 2012

Place (beach)	Latitude N	Longitude E	Dose rate nSv/h	Uncertainty nSv/h
Vama Veche	43.74696	28.57817	34	9
2 Mai	43.78018	28.58103	42	9
Saturn	43.83278	28.58945	45	8
Venus	43.83950	28.59038	38	8
Jupiter	43.85497	28.60768	36	11
Neptun	43.88141	28.60658	41	8
Costinesti	43.96082	28.64596	38	6
Azur	44.04571	28.64458	39	7
Mamaia	44.26857	28.62069	49	7
Corbu	44.37509	28.70895	54	8
Vadu	44.44568	28.78364	52	10



Dose rate from South to North along Romanian Black Sea shore

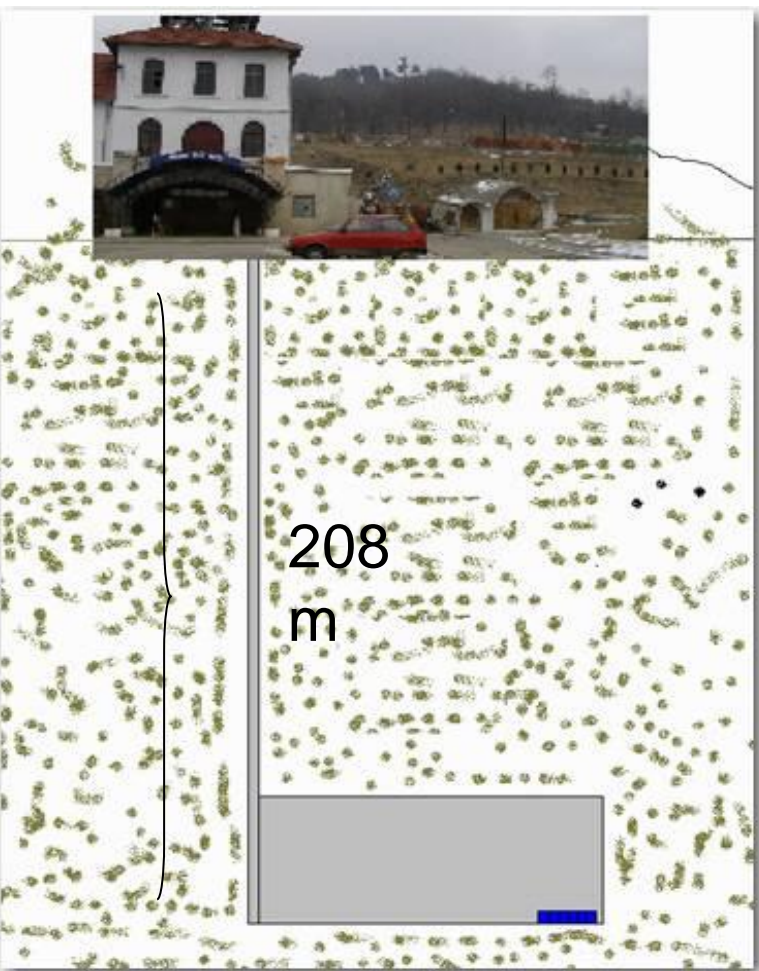




Vadu beach North traverse 1			
Latitude N	Longitude E	Dose rate nSv/h	Uncertainty nSv/h
44.44826	28.787087	52	10
44.44826	28.786762	108	7
44.44826	28.785580	60	8
Vadu beach South traverse 2			
Latitude N	Longitude E	Dose rate nSv/h	Uncertainty nSv/h
44.44463	28.78373	50	10
44.44463	28.78343	82	6
44.44463	28.78294	44	12



The Unirea salt mine Romanian underground laboratory



The salt mine environment:

temperature: 12.0 -13.0 °C

humidity: 65-70 %

excavated volume: 2.9 million m³

floor area: 70000 m²

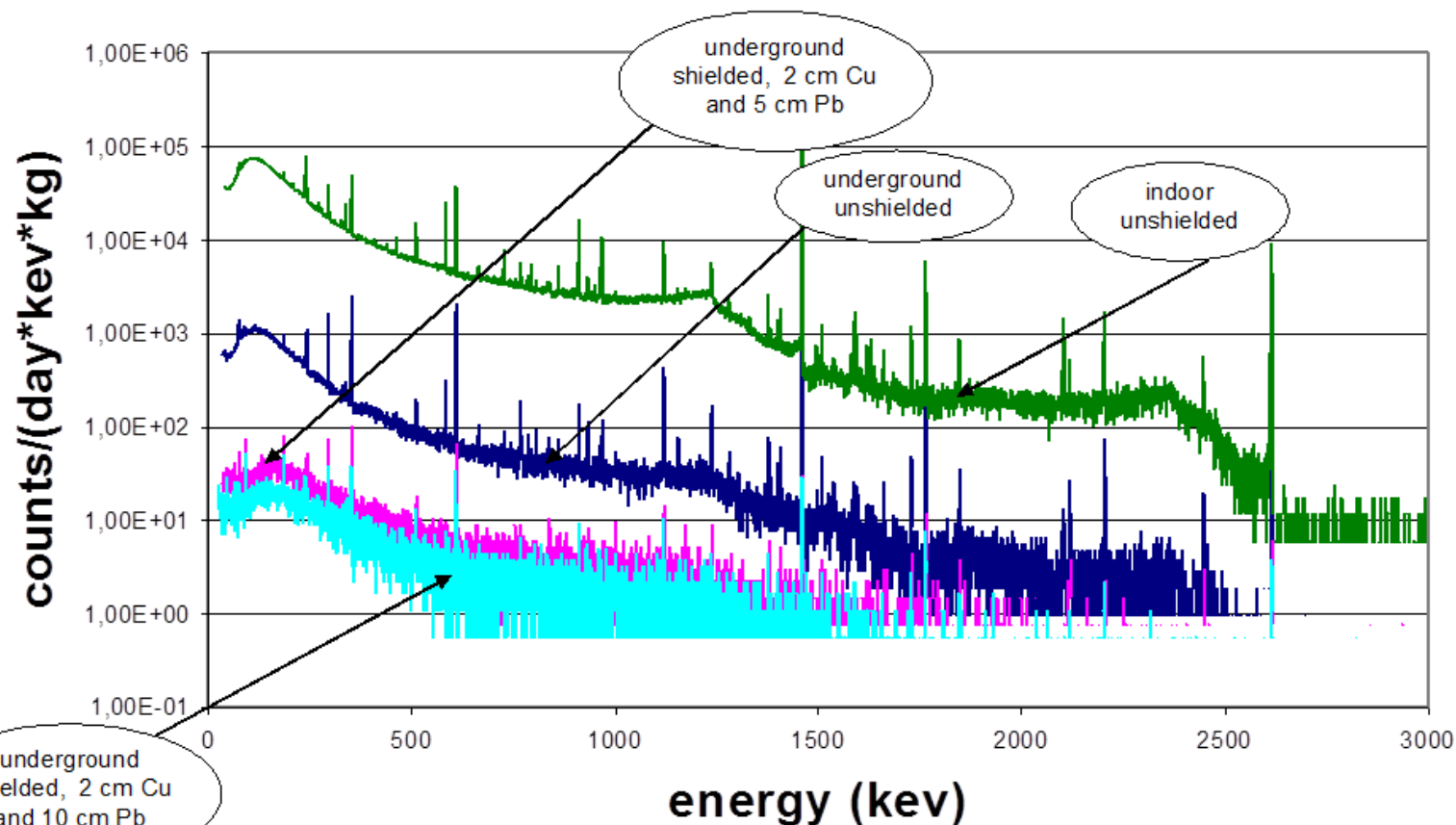
average high: 52-57 m

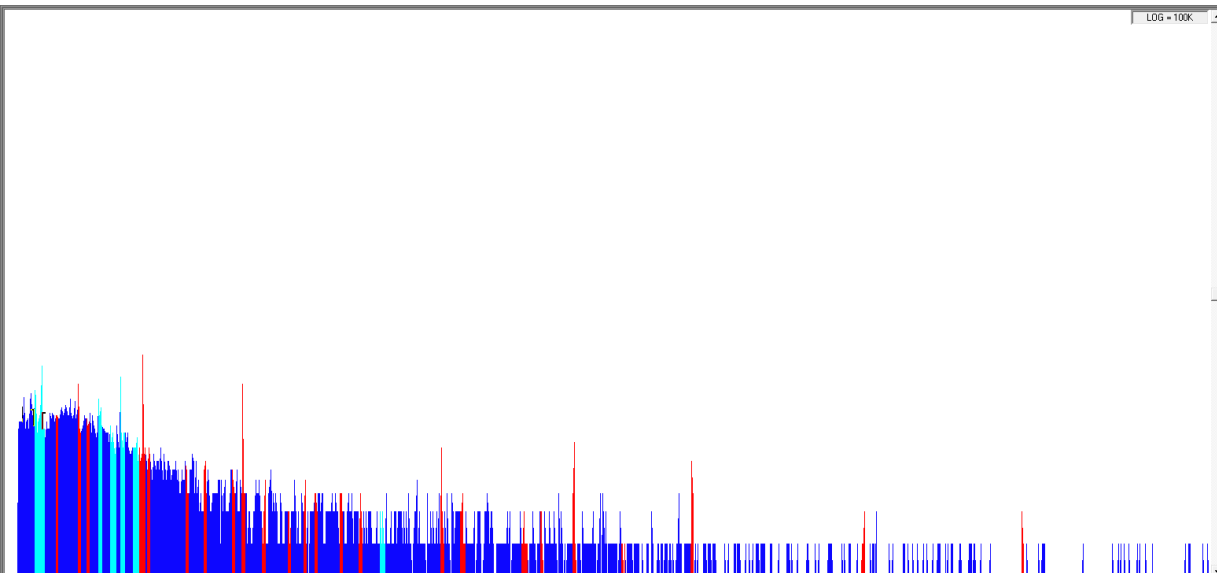


The underground laboratory



Background spectra collected with a CANBERRA GeHP detector with 22.8% rel. efficiency





***** GAMMA SPECTRUM ANALYSIS *****

Filename: DET01
Report Generated On : 10/16/2012 9:25:15 AM
Sample Title : Fond octombrie 2012
Sample Description : fond
Sample Identification : 2
Sample Type : fond
Sample Geometry : 0
Peak Locate Threshold : 3.00
Peak Locate Range (in channels) : 1 - 65535
Peak Area Range (in channels) : 1 - 65535
Identification Energy Tolerance : 1.000 keV
Sample Size : 0.000E+000 0
Sample Taken On :
Acquisition Started : 10/12/2012 10:51:29 AM
Live Time : 340360.6 seconds
Real Time : 340362.5 seconds
Dead Time : 0.00 %

***** PEAK ANALYSIS REPORT *****

Detector Name: DET01
Sample Title: Fond octombrie 2012
Peak Analysis Performed on: 10/25/2012 11:04:46 AM
Peak Analysis From Channel: 108
Peak Analysis To Channel: 8192

	Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
	1	163-	172	168.24	63.35	0.86	3.76E+001	15.53	8.94E+001
M	2	194-	211	198.40	74.73	0.84	4.18E+001	9.17	6.34E+001
m	3	194-	211	204.65	77.10	0.85	4.59E+001	9.46	7.00E+001
	4	241-	254	245.56	92.55	0.83	8.56E+001	21.65	1.37E+002
	5	485-	497	491.49	185.42	1.22	6.41E+001	21.42	1.50E+002
M	6	623-	646	631.21	238.19	1.43	6.19E+001	11.30	9.07E+001
m	7	623-	646	641.92	242.24	1.44	5.19E+001	10.41	7.33E+001
	8	774-	788	781.53	294.96	1.17	1.05E+002	18.79	8.63E+001
	9	926-	939	931.98	351.78	1.22	1.85E+002	19.38	6.91E+001
	10	1605-	1620	1612.54	608.81	1.47	1.24E+002	12.87	1.39E+001
	11	2959-	2973	2965.59	1119.80	0.96	3.84E+001	6.54	1.61E+000
	12	3860-	3873	3866.21	1459.94	0.47	2.60E+001	6.74	7.00E+000
	13	4664-	4679	4671.72	1764.15	0.65	2.02E+001	5.06	1.83E+000

Energy Calibration Used Done On : 6/21/2012
Efficiency Calibration Used Done On : ??????????
Efficiency ID :

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet



High resolution gamma ray spectrometric measurements of sea shore samples from Romania

Place	Activity (Bq/kg)			
	Cs137	K40	Ra226	Ac228
Vadu N 1	<0.2	212	14.9	13.5
Vadu N 2	1.4	128	102.2	104.8
Vadu N 3	0.9	226	15.1	11.5
Vadu 1	0.9	222	11.2	9.4
Vadu 2	1.1	135	61.7	64.5
Vadu 3	0.7	37.5	6.5	5
Vama Veche	0.4	9	3.4	1.2
Corbu	1.3	233	12.2	8.5
Plaja 2 Mai	0.7	52	8.6	4.8
Saturn	1.1	36	4.4	2.5
Venus	1.1	24	6.3	3.1
Jupiter	1.2	27	2.9	1.7
Neptun	0.9	11	3.1	1.2
Costinesti	0.9	21	5	2.7
Azur	1.1	22	7.7	3.1
Mamaia	1.7	282	14	6.8



					dose rate	(nGy/h)/ (Bq/kg)	(nGy/h)/ (Bq/kg)	(nGy/h)/ (Bq/kg)	Calculated Doserate Total
	Activity (Bq/kg)				measured	0.46	0.623	0.0414	nGy/h
Place	Cs137	K40	Ra226	Ac228	nSv/h	Ra226	Th232	K	
Vama Veche	0.4	9	3.4	1.2	34	1.6	0.7	0.4	34.4
Corbu	1.3	233	12.2	8.5	54	5.6	5.3	9.6	52.3
Plaja 2 Mai	0.7	52	8.6	4.8	42	4.0	3.0	2.2	40.8
Saturn	1.1	36	4.4	2.5	45	2.0	1.6	1.5	36.8
Venus	1.1	24	6.3	3.1	38.8	2.9	1.9	1.0	37.5
Jupiter	1.2	27	2.9	1.7	36	1.3	1.1	1.1	35.2
Neptun	0.9	11	3.1	1.2	41	1.4	0.7	0.5	34.3
Costinesti	0.9	21	5	2.7	38	2.3	1.7	0.9	36.6
Azur	1.1	22	7.7	3.1	39	3.5	1.9	0.9	38.1
Mamaia	1.7	282	14	6.8	49	6.4	4.2	11.7	54.1



					dose rate	(nGy/h)/ (Bq/kg)	(nGy/h)/ (Bq/kg)	(nGy/h)/ (Bq/kg)	Calculated Doserate Total
	Activity (Bq/kg)				measured				
Place	Cs137	K40	Ra226	Ac228	nSv/h	Ra226	Th232	K	
Vadu N 1	<0.2	212	14.9	13.5	60	6.9	8.4	8.8	55.7
Vadu N 2	1.4	128	102.2	104.8	108	47.0	65.3	5.3	149.3
Vadu N 3	0.9	226	15.1	11.5	52	6.9	7.2	9.4	55.2
Vadu 1	0.9	222	11.2	9.4	50	5.2	5.9	9.2	51.9
Vadu 2	1.1	135	61.7	64.5	82	28.4	40.2	5.6	105.9
Vadu 3	0.7	38	6.5	5.7	44	3.0	3.6	1.6	39.8



Conclusion remarks

The ambiental dose rates on the beaches on Romanian Black Sea shore:

- ❑ are much lower than those measured far from the sea, ranging from 36-54 nSv/h;
- ❑ seem to increase from South to North;
- ❑ varies locally, (see Vadu beach), with a factor of up to 3.

The ambiental dose rates on the beaches on Bulgarian Black Sea shore:

- ❑ are lower than those measured far from the sea, ranging from 38-71 nSv/h;
- ❑ are around 52 nSv/h in South, in central part about 65 nSv/h and decrease to North to 38 nSv/h
- ❑ are about 33.4 nSv/h on the sea

A more detailed measurement of ambiental dose rates on all the beaches is necessary

Thank you!

