



**The Abdus Salam
International Centre for Theoretical Physics**



1833-9

**Workshop on Understanding and Evaluating Radioanalytical
Measurement Uncertainty**

5 - 16 November 2007

The Romanian underground laboratory

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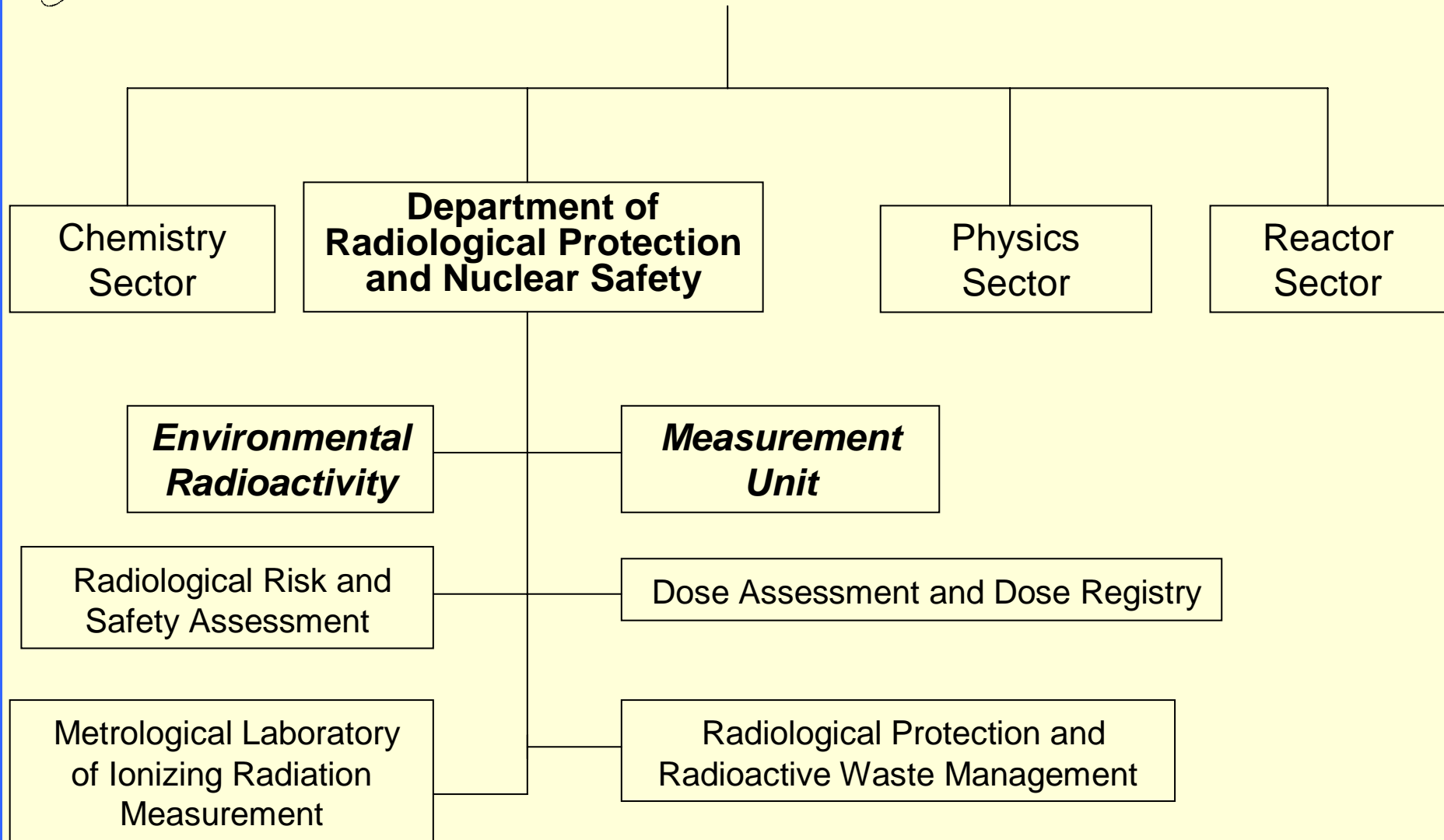
PORTUGAL ACTIVITIES FOR THE ROUTINE ENVIRONMENTAL MEASUREMENTS

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Nuclear Safety
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Nuclear and Technological Institute





Environmental Radioactivity and Measurement Units

Main Activities:

- To perform the Environmental Radioactivity Monitoring in Portugal, following the Recommendations (2000/473) of the EURATOM Treaty, Article 35. This programme has been legally created in the Portuguese legislation in 2005 (Dec. Law 138/05);
- To support economical activities lending services to national and private enterprises;
- To develop and implement new analytical methods;
- To develop and collaborate in research projects;
- Training and education of students



Environmental Radioactivity and Measurement Units

Main Activities:

- To implement Quality Control Programmes;
- To elaborate technical procedures for laboratories accreditation according to the ISO/IEC 17025 standard;
- To participate in national and international intercomparison exercises;



Environmental Radioactivity Monitoring

Aerosols

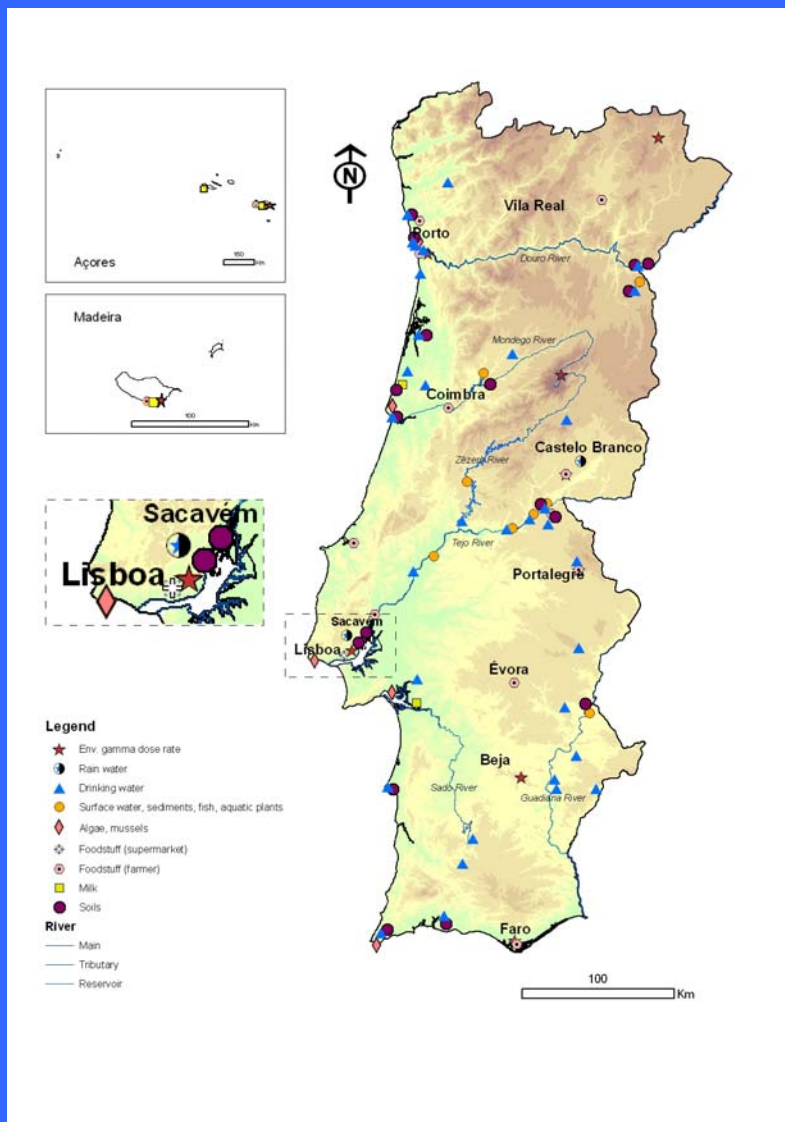
^{137}Cs , ^7Be , ^{210}Pb

Rain water

^{90}Sr , ^{137}Cs , ^3H ,
global alpha/beta

Env. gamma dose rate
(active detectors)

Env. gamma dose rate
(TLD passive detectors)



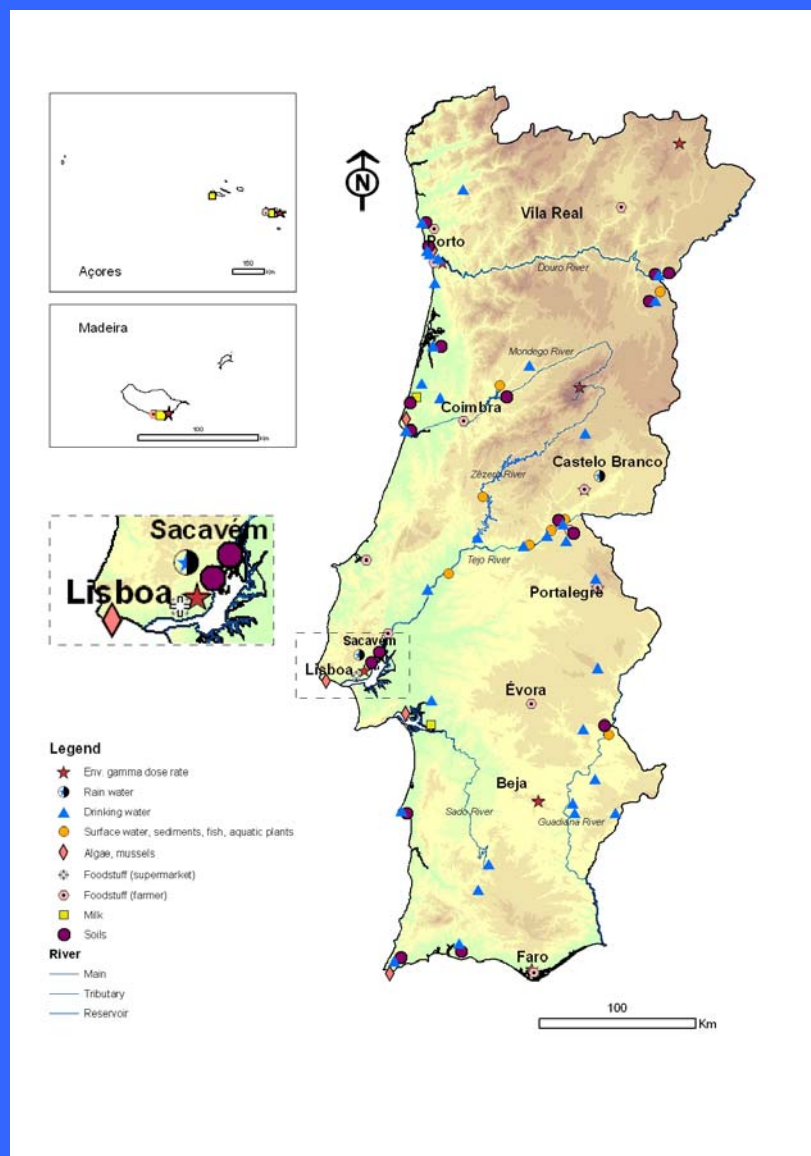


Environmental Radioactivity Monitoring

Marine samples
(algae, mussels)
NA Radionuclides
*gamma emitters, ^{238}Pu ,
 $^{239+240}\text{Pu}$*

Drinking water

*^{90}Sr , ^{137}Cs , ^3H ,
global alpha/beta*



River Samples

Surface Waters

*^{90}Sr , ^{137}Cs , ^3H , global
beta, residual beta*

**Sediments, fish,
aquatic plants**

*NA Radionuclides
gamma emitters*



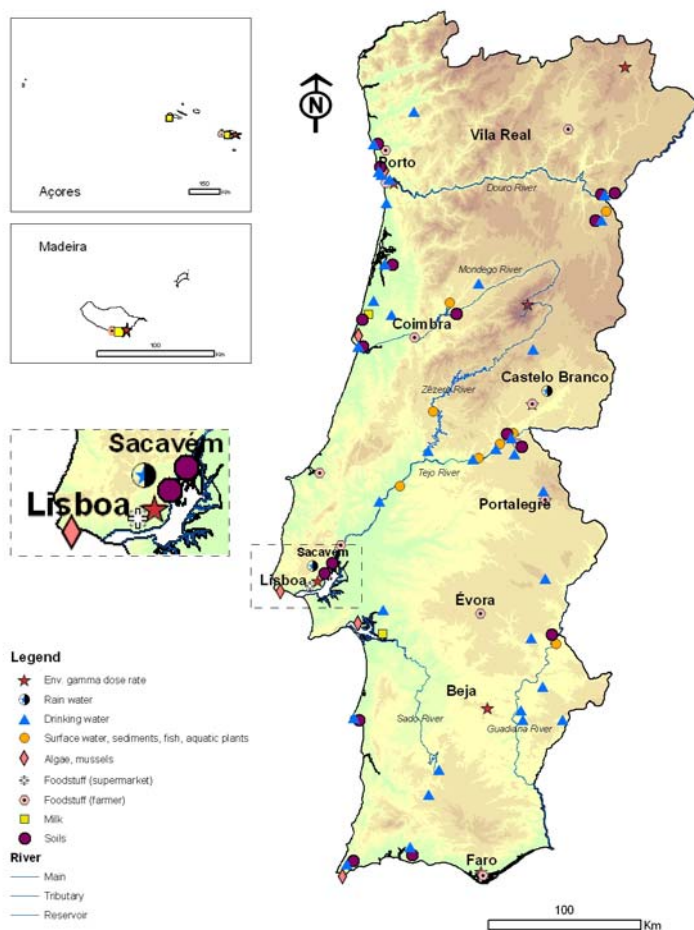
Environmental Radioactivity Monitoring

**Foodstuff
(individual
components)**

^{137}Cs , ^{40}K

**Mixed diet
(complete meals)**

^{137}Cs , ^{40}K



Milk

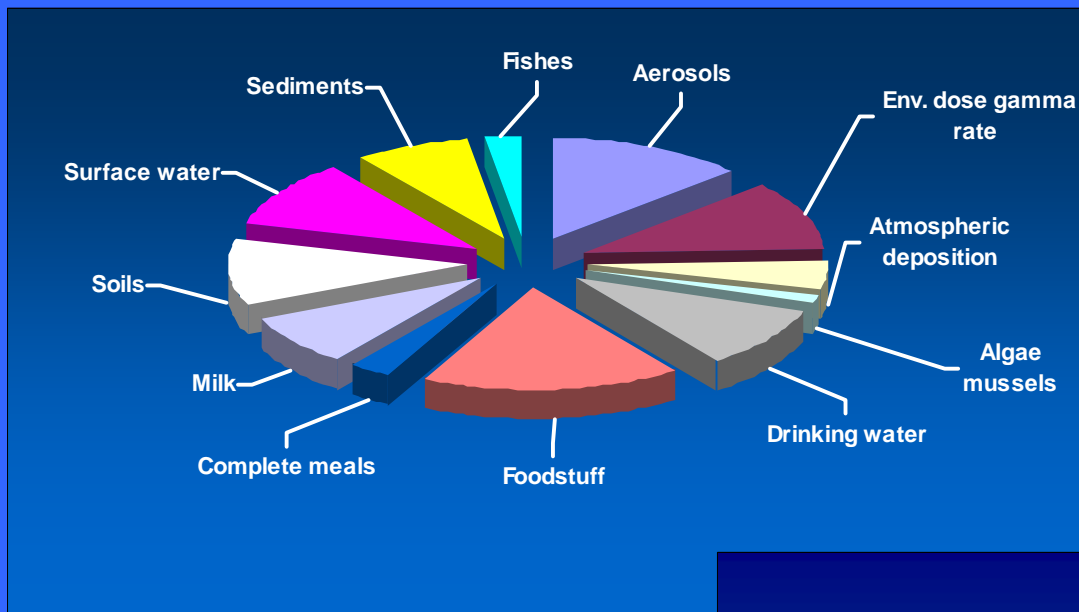
^{90}Sr , ^{137}Cs , ^{40}K

Soils

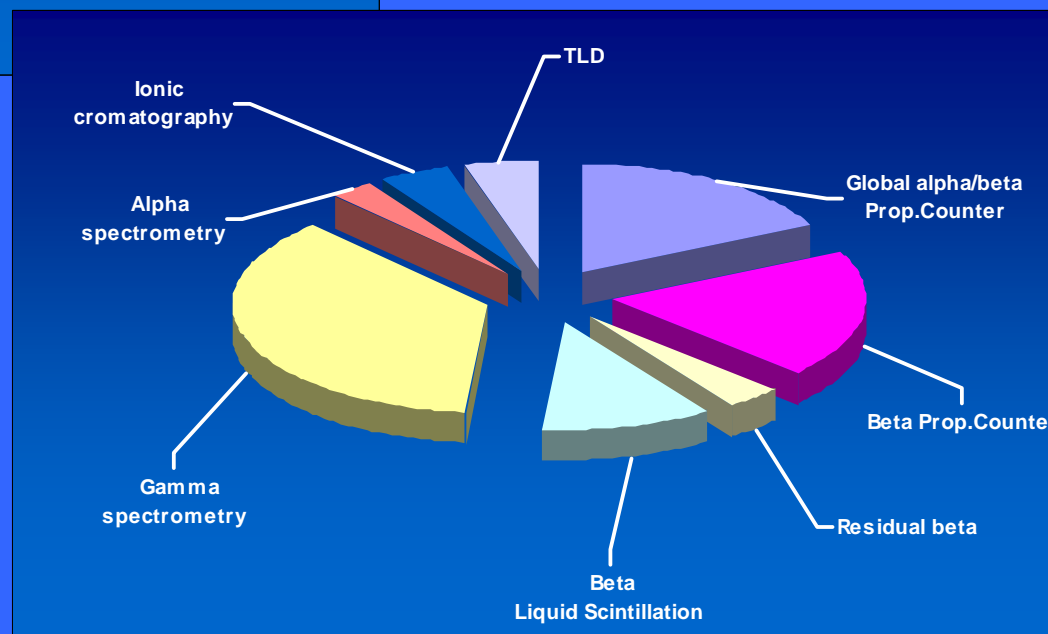
*NA Radionuclides
gamma emitters*



≈ 450 samples collected



≈ 1000 analyses

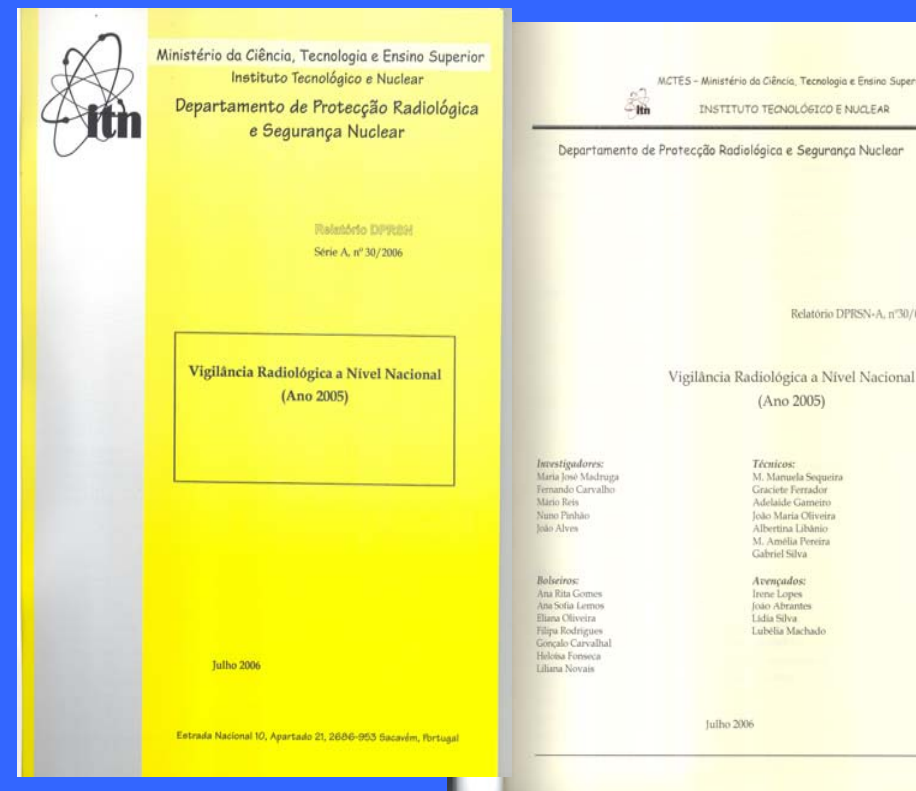




Delivering of Environmental Monitoring Data

- European Data Base (REM) located at JRC (Ispra, Itália)
- Annual ITN Technical Report

➤ website-<http://www.itn.pt/>





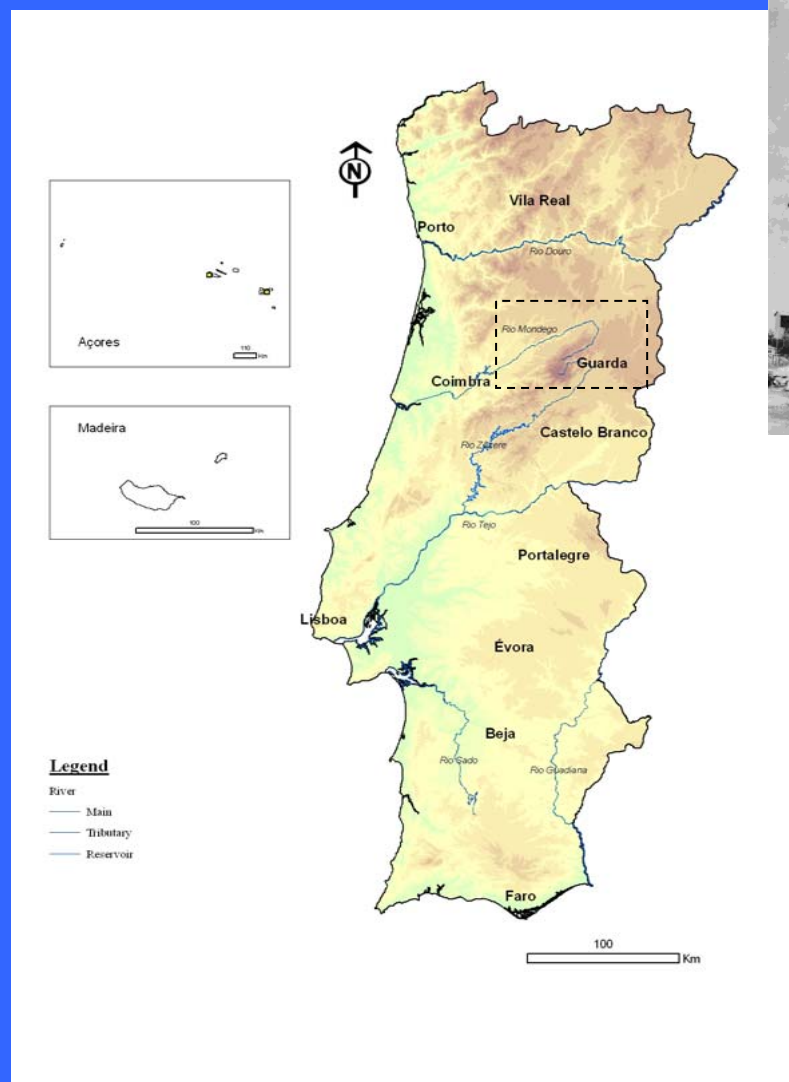
Environmental Radioactivity Monitoring Around Old Uranium mines and Milling Tailings

U and Th isotopes:

- Aerosols
- Drinking water
- Surface water
- Sediments
- Agriculture products
- Soils

Radon monitoring

Around 200 samples analysed





Services for governamental and private enterprises

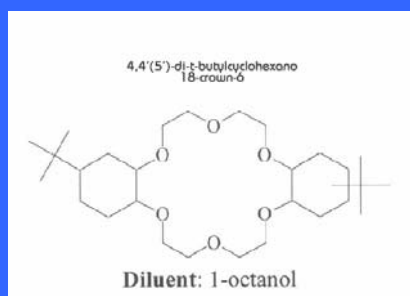
- Measurements of alpha/beta, ^3H , U and Th isotopes in drinking waters;
- Measurements of indoor radon;
- Measurements of gamma emitters in samples mainly foodstuff to be exported;
- Measurements of gamma emitters in building materials;
- etc.

Around 400 samples analysed

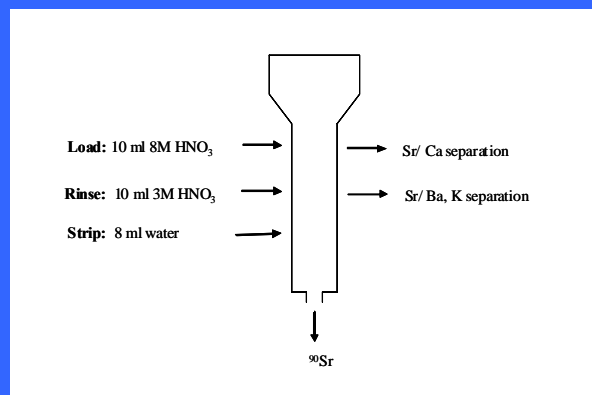


Development and implementation of new methodology for ^{90}Sr determination in milk and foodstuff

Sr-Spec EICHROM resin



Chromatographic extraction



Tri-Carb 3170 TR/SL Packard



Equipment Capabilities



HV Particulate Sampler ASS-500
(800 m³/h)



HV Particulate Sampler 3000
(70 m³/h)



Gamma monitoring network
(GAMMANET)



Equipment Capabilities

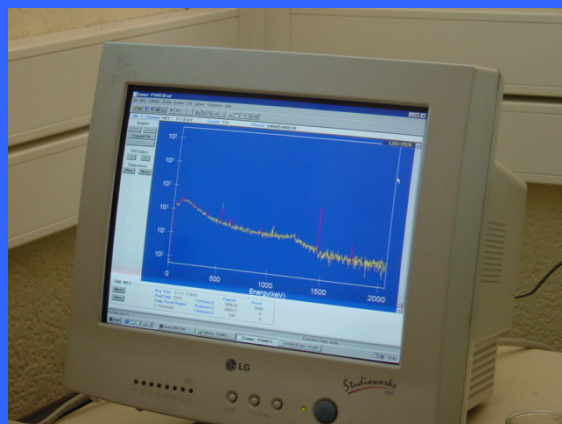


2- GAS PROPORTIONAL COUNTERS
(low background alpha/beta counters)

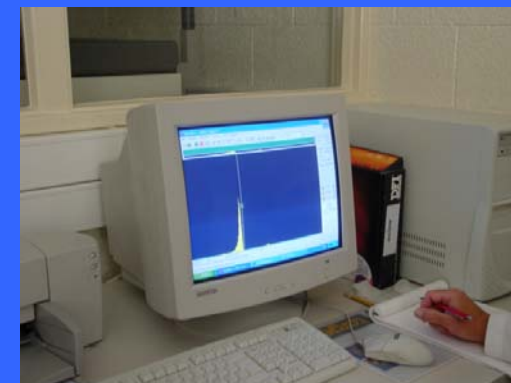
2- LIQUID SCINTILLATION
COUNTERS



Equipment Capabilities



GAMMA SPECTROMETRY
6 HpGe (low background) Canberra



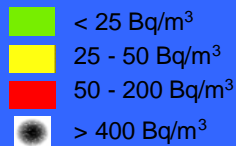
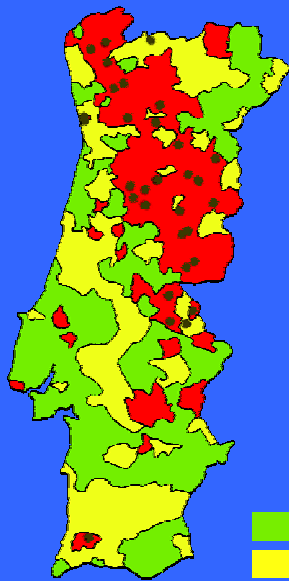
ALPHA SPECTROMETRY
40 PIPS, Ortec



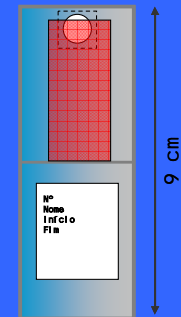
Equipment Capabilities

Radon Laboratory

Indoor Radon



Solid State Nuclear Track Detectors (LR115)





Quality Control Programme

Internal :

- Repeatability and reproducibility tests;
- Replicate samples;
- Instrumentation calibration and verification using internal standards and reference materials;
- Accurate measurements of background levels;
- Implementation of procedures to eliminate gamma-X-ray sums and matrix effects in gamma spectrometry;
- Development of a data reporting software application to allow the reporting of the upper limit of activity in gamma spectrometry;



Quality Control Programme

Internal :

- **Environmental Database** including the sample identifier, the analytical techniques and the results of the analysis;
- **The implementation of international standards for data reporting (ISO GUM) and evaluation of the uncertainty budget;**



Quality Control Programme

According with ISO/IEC 17025:

- Procedures for sampling, sample preparation and analytical methods;
- Procedures for operation and maintenance of all the equipments, for quality control of the measurements and for data analysis;



Quality Control Programme

External :

Participation in Intercomparison Exercises and Proficiency Tests

- IAEA
- ALMERA/IAEA Network
- European Commission
- FAO/WHO
- Consejo de Seguridad Nuclear (CSN)



IAEA Intercomparison exercises

Sample type	Analyse Technique	Radionuclides Analysed	Z score (a)
Fish (lyophilised) IAEA-414*	Gamma spectrometry	^{137}Cs	$ Z \leq 2$
		^{40}K	$ Z \leq 2$
	Alpha spectrometry	$^{239+240}\text{Pu}$	$ Z \leq 2$
		^{210}Pb (^{210}Po)	$ Z \leq 2$
		^{234}U	$ Z \leq 2$
		^{235}U	$ Z \leq 2$
		^{238}U	$ Z \leq 2$
^{226}Ra	$ Z \leq 2$		
Irish sea sediment IAEA-385**	Gamma spectrometry	^{137}Cs	$ Z > 2$
		^{40}K	$ Z > 2$
		^{241}Am	$ Z > 2$
		^{228}Ra	$ Z > 2$
		^{226}Ra	$ Z > 2$
	Alpha spectrometry	$^{239+240}\text{Pu}$	$ Z \leq 2$
		^{238}Pu	$ Z \leq 2$
		^{210}Pb	$ Z \leq 2$
		^{210}Po	$ Z \leq 2$
		^{232}Th	$ Z > 2$
^{230}Th	$ Z > 2$		
Mediterranean mussel IAEA-437***	Gamma Spectrometry	^{40}K ; ^{228}Ra ; ^{226}Ra	$ Z \leq 2$
	Alpha spectrometry	^{238}U ; ^{234}U ; ^{235}U ; ^{232}Th ; ^{226}Ra	exception for ^{238}U ; ^{234}U where $ Z > 2$

* Pham, M.K. et al., Radionuclides in mixed fish from Irish sea and the North sea, IAEA, 2004;

** Pham, M.K. et al., Radionuclides in Irish Sea sediment, IAEA, 2005;

*** Pham, M.K. and J.A. Sanchez-Cabeza, Radionuclides in Mediterranean Mussel, IAEA, 2007

(a)- $|Z| \leq 2$ acceptable; $|Z| > 2$ outlier



IAEA-ALMERA intercomparison exercises

Sample type	Analyse Technique	Radionuclides Analysed	Performance
Soil*	Alpha spectrometry	$^{239+240}\text{Pu}$	passed
		^{238}Pu	passed
Soil, Water and grass **	Gamma spectrometry	^{54}Mn ; ^{60}Co ; ^{65}Zn ; ^{109}Cd ; ^{134}Cs ; ^{137}Cs ; ^{210}Pb ; ^{241}Am ; ^{40}K	
IAEA-CU-2006-03			Acceptable, exception for ^{54}Mn ; ^{65}Zn ; ^{210}Pb ; ^{241}Am in soils
IAEA-CU-2006-04			Acceptable, exception for ^{54}Mn ; ^{65}Zn ; ^{210}Pb ; ^{241}Am in soils and ^{134}Cs ; ^{210}Pb in water

Water***	Alpha spectrometry	^{210}Po	Acceptable
IAEA-CU-2007-09			

* Shakhashiro, A. et al., Final report on the proficiency of the analytical laboratories for the measurement of environmental radioactivity (ALMERA) Network, IAEA/AL/152, 2005;

** Shakhashiro A., Sansone U., Trinkl A., Makarewicz M., Yonezawa C., Kim C.K., Kis-Benedek G., Benesch T., Schorn R. (2007). Report on the IAEA-CU-2006-03 World-Wide Open Proficiency Tests on the Determination of Gamma Emitting Radionuclides. IAEA/AL/171, April 2007;

*** Individual evaluation report, 2007/05/10



EC- EURATOM Treaty intercomparison exercises

Sample type	Analyse Technique	Radionuclides Analysed	DPRSN Results	Reference Values	Performance
Drinking water**	Liquid Scintillation	³ H	16.3 ± 5.0	15.3 ± 2.1	Compatible
	Solid scintillation	Global alpha	0.033 ± 0.123	0.057 ± 0.008	Compatible
	Proportional counter	Global beta	0.522 ± 0.100	0.520 ± 0.047	Compatible
	Ionic chromatography	Potassium	14.5 ± 0.14	13.5 ± 1.0	Compatible
Aerosols**	Gamma spectrometry	¹³⁷ Cs	1.18	0.65-1.35	Acceptable
Milk powder***	Gamma spectrometry	¹³⁷ Cs	1480± 110	1232± 81	E ≤ 1 Unsatisfactory
	Gamma spectrometry	⁴⁰ K	540± 40	513± 71	E > 1 Satisfactory
	Proportional counter	⁹⁰ Sr	4.9± 0.4	4.0± 1.1	E > 1 Satisfactory

* IRC, Note n°50, 2002;

** Watjen U., Szántó Zs., Altitzoglou T., Sibbens G., Keightley J., Hult M. (2006). EC intercomparison for Laboratories Monitoring Environmental Radioactivity. Appl. Radiat. Isot., 64, 1108-1113,

*** Watjen, U, 2006, IRMM, personnel communication, Report not available yet (Article 35-36 of Euratom Treaty);



Consejo de Seguridad Nuclear (CSN) intercomparison exercises

Sample type	Analyse Technique	Radionuclides Analysed	Z score (a)
Drinking water*	Solid scintillation	Global alpha	$ Z \leq 2$
	Proportional counter	Global beta	$ Z \leq 2$
	Liquid Scintillation	Global alpha	$2 < Z < 3$
	Liquid Scintillation	Global beta	$ Z \leq 2$
	Liquid Scintillation	^3H	$2 < Z < 3$
	Proportional counter	^{90}Sr	$ Z \leq 2$
	Proportional counter	^{137}Cs	$2 < Z < 3$
	Gamma spectrometry	^{137}Cs	$ Z \leq 2$
Vegetable ash**	Gamma spectrometry	^{210}Pb	$ Z \leq 2$
		^{238}U	$ Z \leq 2$
		^{226}Ra	$ Z \leq 2$
		^{40}K	$ Z \leq 2$
		^{228}Ra	$ Z \leq 2$
		^{137}Cs	$ Z \leq 2$
		^{60}Co	$ Z \leq 2$
	Alpha spectrometry	^{238}U	$ Z \leq 2$
		^{238}Pu	$ Z \geq 3$

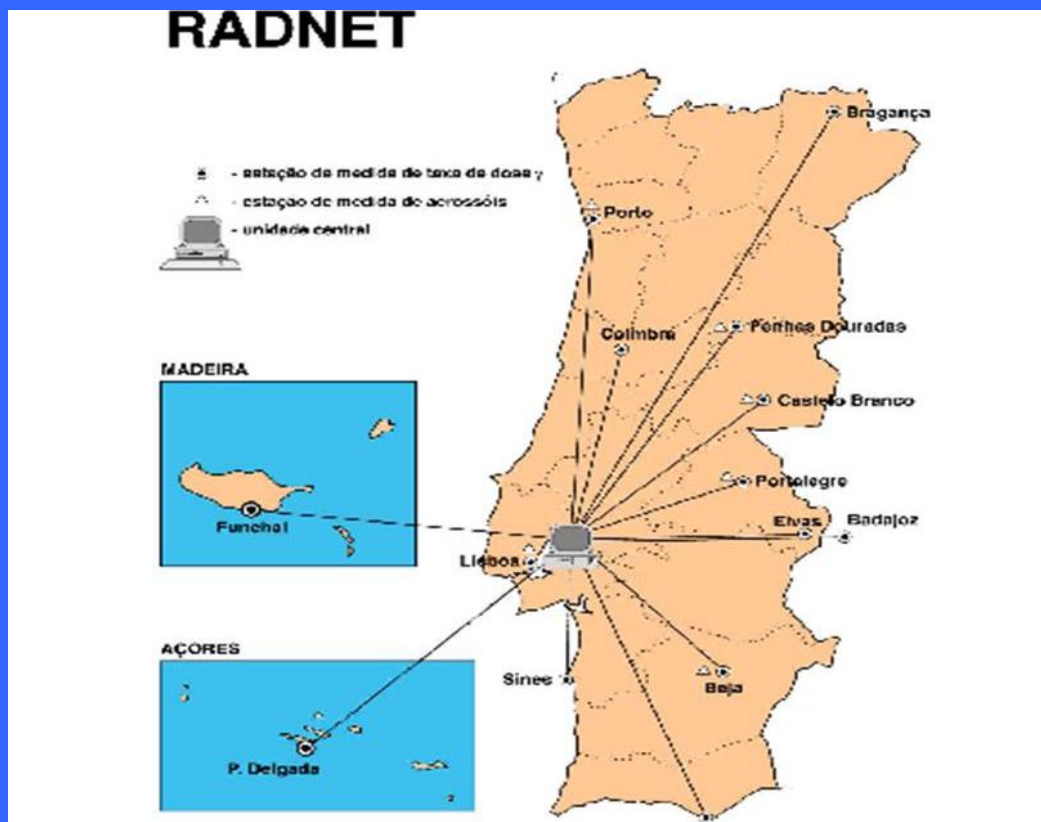
* González and Izquierdo, Consejo de Seguridad Nuclear, Spain, 2004;

** González and Izquierdo, Consejo de Seguridad Nuclear, Spain, 2006;

(a) $|Z| \leq 2$ satisfactory; $2 < |Z| < 3$ acceptable; $|Z| \geq 3$ unsatisfactory



Environmental Monitoring in Emergency Situations



EURDEP
Continuous Monitoring Network

Ministry of the Environment
Agency Portuguese for the Environment



Environmental Monitoring in Emergency Situations

The environmental monitoring of air, soils, water, vegetation, etc.
(under the responsibility of ITN)

Laboratory Capabilities:

- Gamma spectrometry (HpGe);
- Gamma spectrometry NaI (TI);
- Gross alpha/beta (water samples);
- ^3H (water samples);
- TRU by alpha spectrometry



THANK YOU FOR YOUR ATTENTION

