



# Radon indoor measurements a way to approach the students to scientific culture: the Italian experience



Flavia Groppi, Simone Manenti

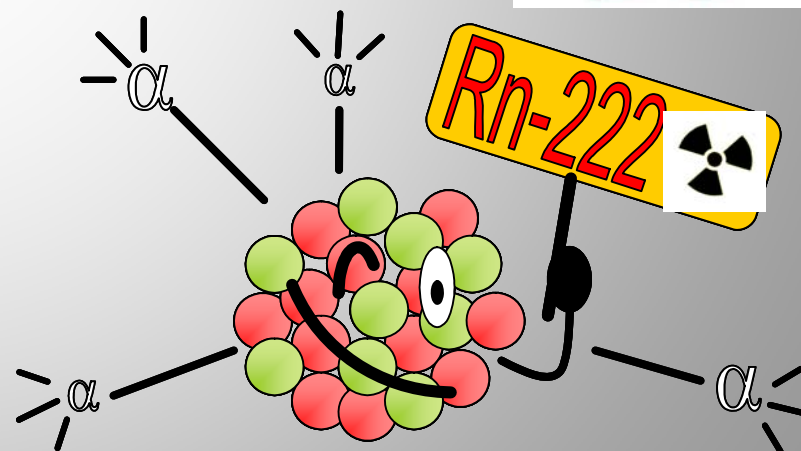
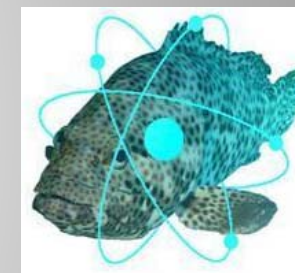
*Lab. Acceleratori e Superconduttività Applicata – L.A.S.A., Segrate (MI), Italy*

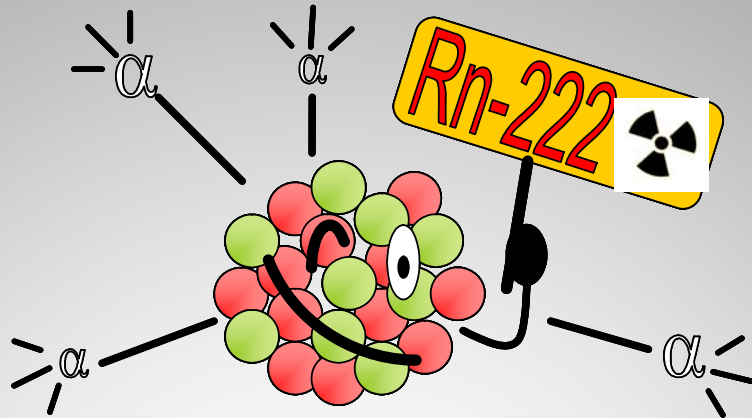
Anna Bazzocchi

*Istituto d'Istruzione Superiore – I.I.S. Mattei, San Donato Milanese (MI), Italy*

Paolo Maggioli

*Liceo Scientifico Gandini, Lodi (LO), Italy*





The Project is inserted in the **Education and Outreach programme of UNIMI;**

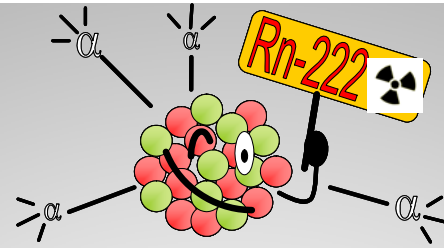
- it is addressed to students of **High Schools and their teachers;**
- it involves several of the 21 Italian Regions since 2004.

### **1. National Project “Lauree Scientifiche”**

Italian Ministry of Education, University and Scientific Research

### **2. Projects LABORAD, SPLASH, ENVIRAD-SPLASH, RADIOLAB**

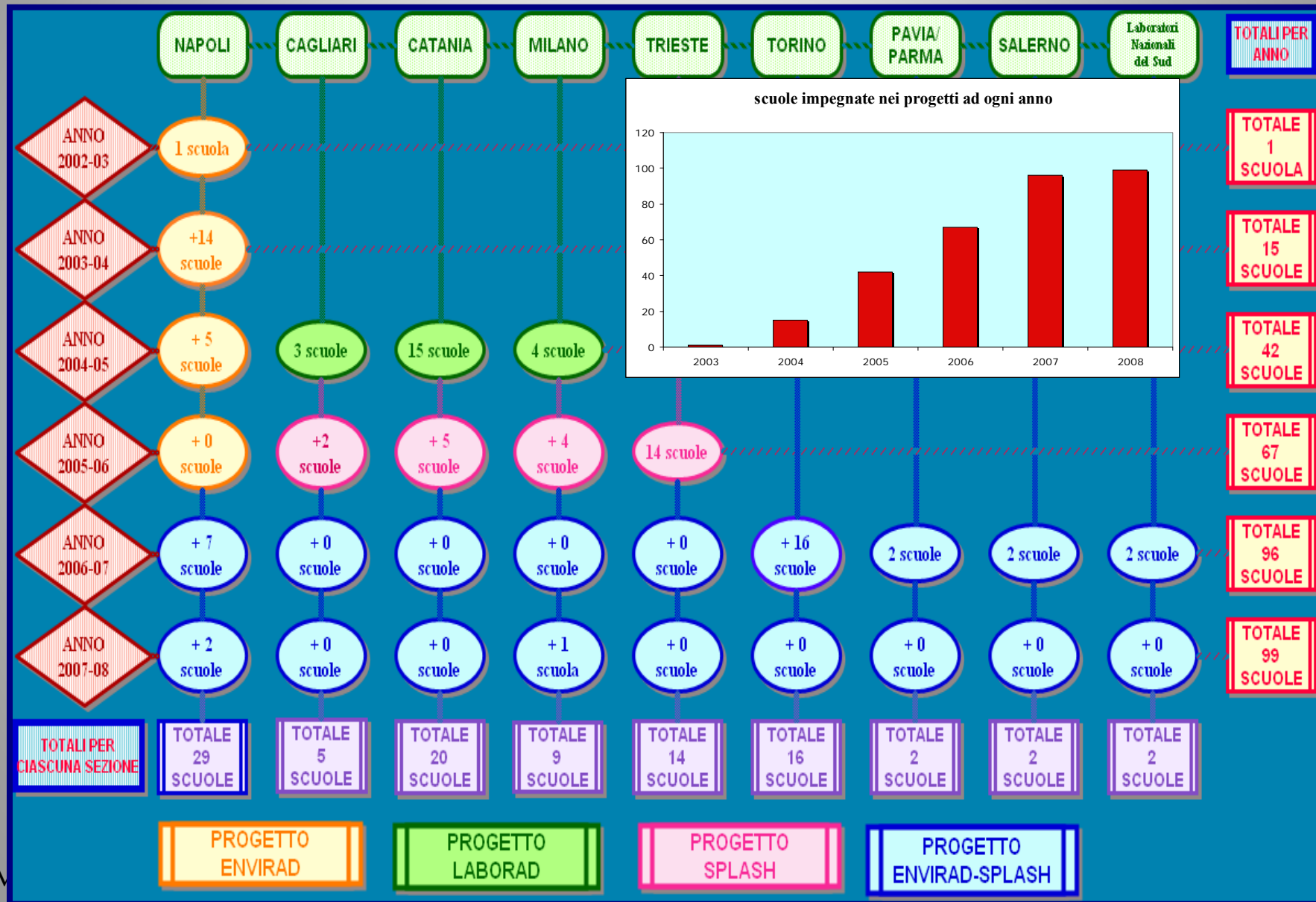
Nat. Inst. Nucl. Phys., INFN, Istituto Nazionale di Fisica Nucleare, -  
GR V – Multidisciplinary and Applied Physics, Research



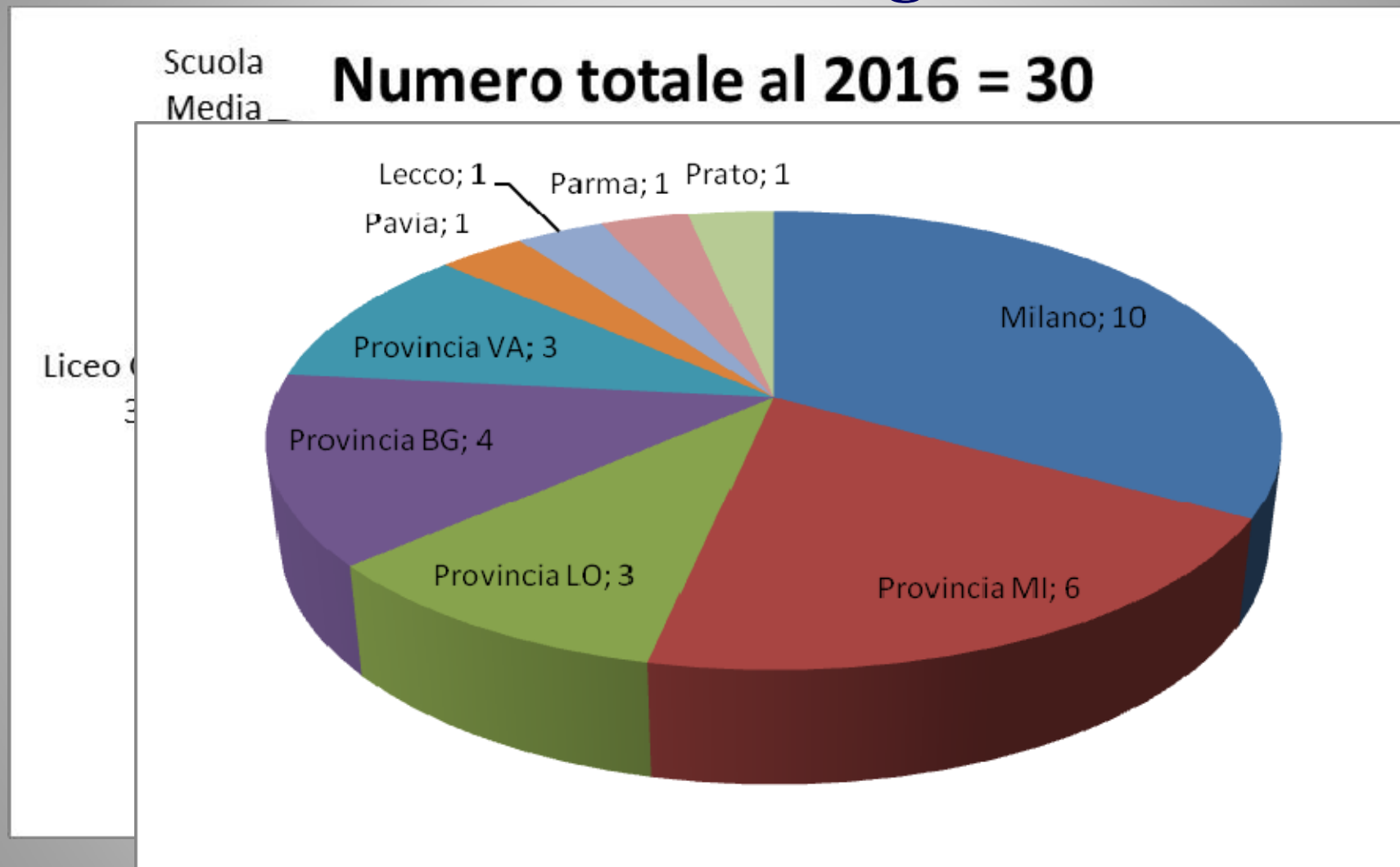
# The main Italian Regions NOW Involved



# The project involves a very high numbers of schools all around Italy



# Schools involved in the Project – Lombardia Region



**n. of students involved up to now  $\approx$  1300**

# The aim of the Project

- × The **subjective perception (sensation)** of the risk doesn't correspond very often to the **objective and real risk** of an human activity, and natural events as well.
- × The **radioactivity** theme is misleading because it is almost unknown and the public links this concept only to nuclear weapons and to its usage in unsafe way to produce energy in the nuclear power plants, NPPs.



Dissemination of scientific culture

a correct knowledge and information about this subject, permits a discussion and debate in a more objective way and to build up a personal understanding through the population.

# The aim of the Project

The High School students have to develop an experiment along all its phases:

- × the research theme,
- × the build up of their own laboratory at their school,
- × to understand the modality of how to do the measurements,
- × the choice of the instrumentation more suitable, depending of the type of measurements chosen,
- × data analysis,
- × presentation and discussion of the results.

# The aim of the Project

This process is applied to the measurement of the radioactivity starting from the natural component that is a part of our environment:

- a) the measurement of the  $^{222}\text{Rn}$  concentration is particularly suited and, nowadays, is up-to-date;
- b) there are different types of radiations, and ionizing radiations are just a particular type of radiation;
- c) ionizing radiations can be measured;
- d) to prove the fun a student can derive from discovery and detection of ionizing radiation.



# Points of strenght of the project

- The real **experimental** approach.
- It is a **no an occasional** experiment: it requires 2 years, giving the possibility to the students to gain a more deep thinking over and acquisition of the theme.
- It allows the **study of the environment** outside the school too.
- The high **multidisciplinary approach** of this matter, permits to link the knowledge of different subjects.
- The development of the **communication ability** and debate between student and their relatives on these topics.
- A final spin-off is the **training and refreshment** for the teachers.

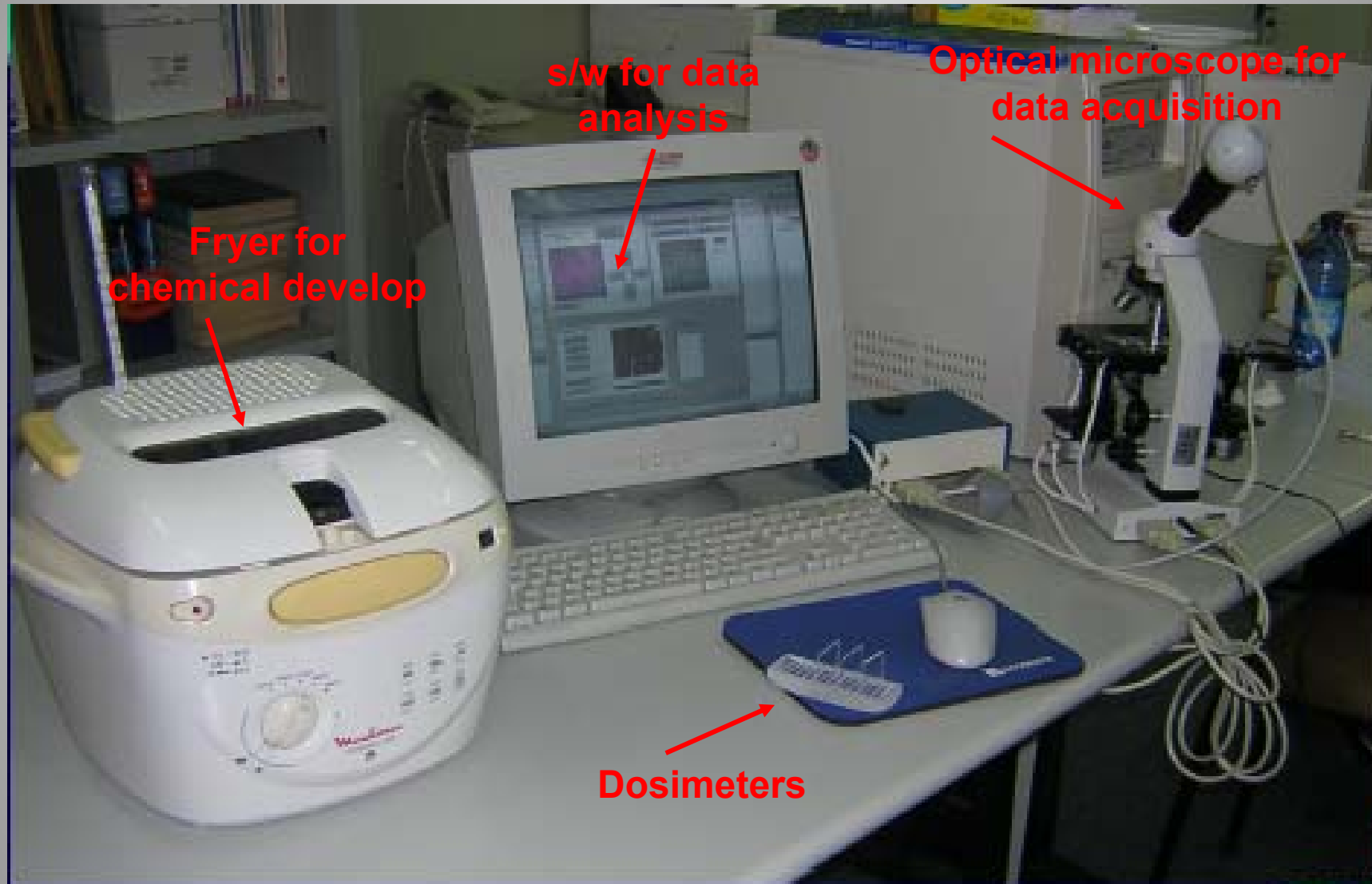
# The idea is that:

- × An “assembly box” – school receives a kit
- × with instructions (given by teachers or university experts)
- × *“I construct the instrumentation ...”*
- × *“I build up my laboratory ...”*



- dosimeters - CR39
- plastic box - diffusion chamber
- fryer - as thermostatic bath
- a cheap optical microscope
- a simple webcam

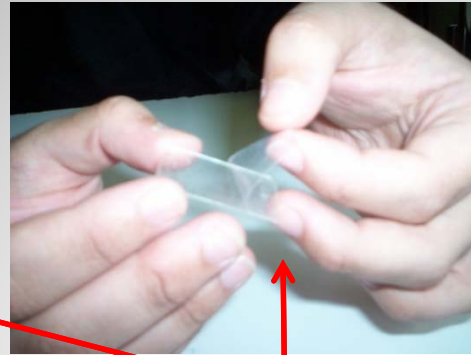
# Experiment



# Experiment – selection of the sites



# Experiment



**Preparation of the dosimeters**

**Exposition of the dosimeters**

**Development procedure of the dosimeters**

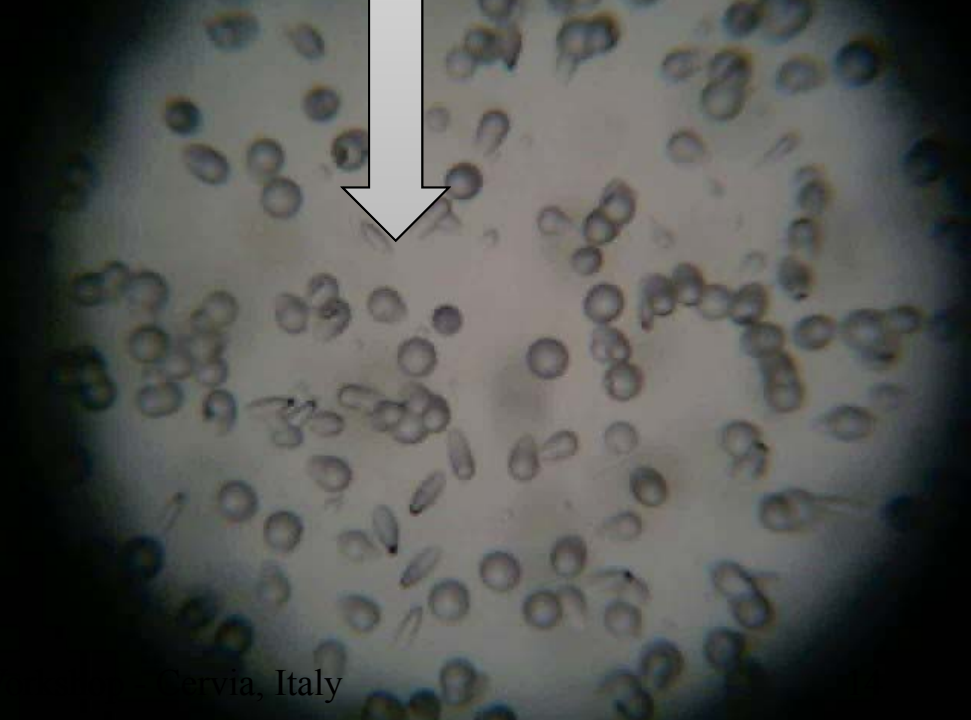
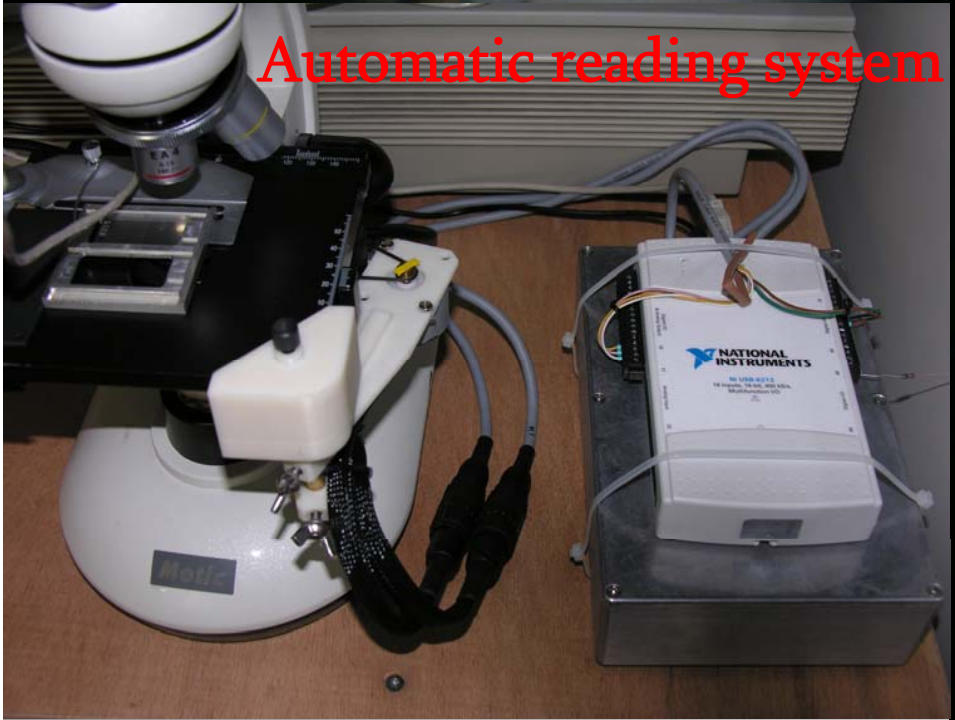
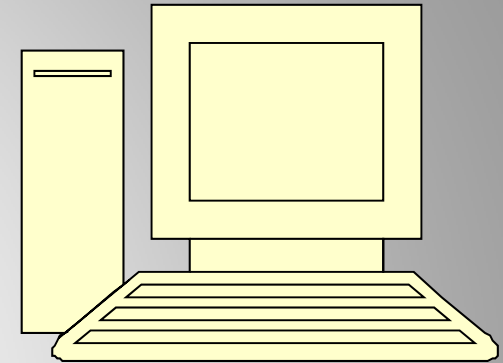


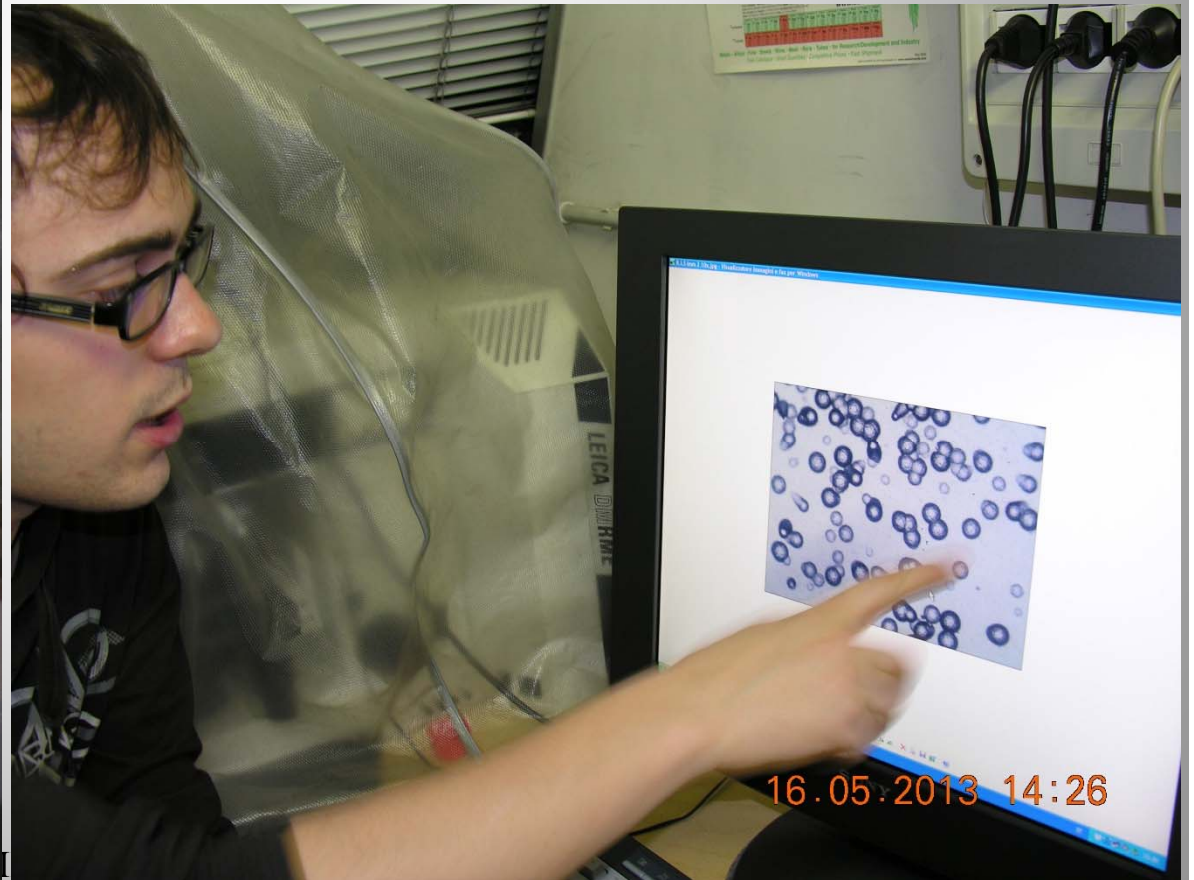
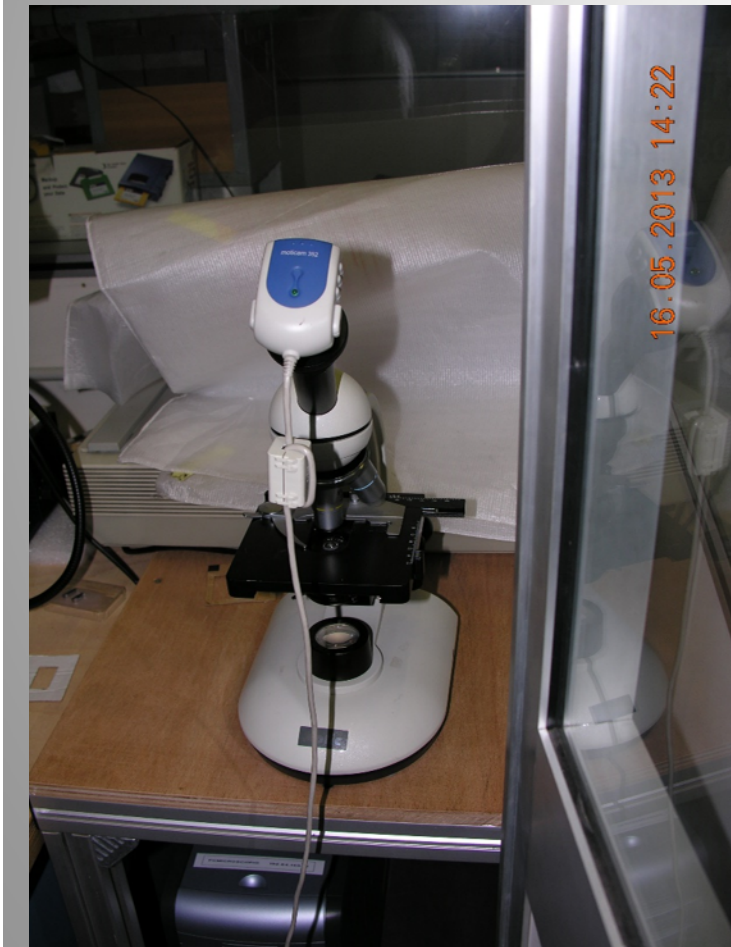
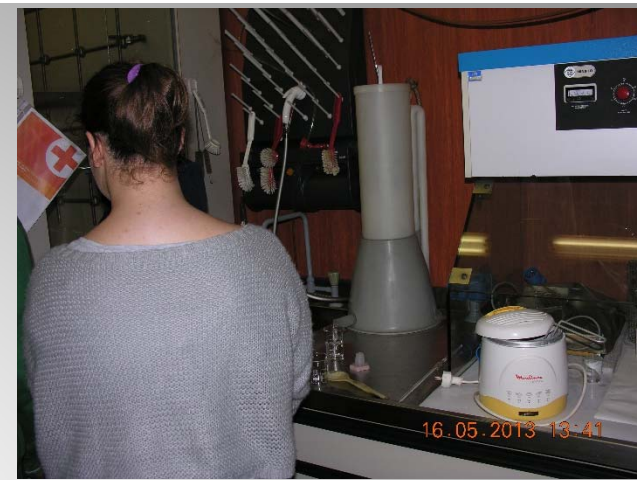
May 2016

CHE



# Counting of the alpha tracks







BERGAMOSCIENZA2007







BERGAMOSCIENZA2007



YEARS

2007

- 
- 
- 

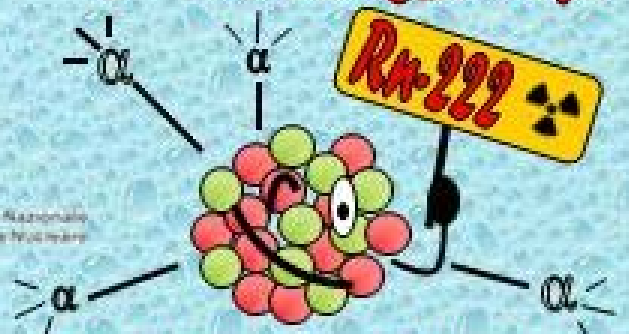
2013

May 2016


Progetto ENVIRAD - SPLASH INFN - Sezione di Milano  
& Progetto Laurea Scientifica Università degli studi di Milano

# SPLASH: un tuffo nella radioattività naturale

## 4° Workshop



**INFN**  
Istituto Nazionale di Fisica Nucleare



**Giovedì 03 marzo 2011 ore 14.45**  
**Aula A, Dipartimento di Fisica, via Celoria 16, Milano**  
**Saluti**

*Prof. Francesco Ragusa, Direttore Dipartimento di Fisica - UNIMI*  
*Prof. Pier Francesco Tortignon, Presidente CCD, Dipartimento di Fisica - UNIMI*

### Presentazioni

**The activity size distribution of radioactive <sup>210</sup>Be aerosols in different environments in Italy**  
*Prof.ssa Alexandra Ioannidou, Dipartimento di Fisica Università di Salonicco, Grecia*

**Applicazioni dell'energia del nucleo in campo biomedico ed ambientale**  
*Prof. Mauro Bonardi, Dipartimento di Fisica di UNIMI e Coord. Sr. V. Sez. INFN di Milano*

### Interventi degli studenti delle scuole partecipanti

### Discussione e consegna dei lavori

**Segreteria e Organizzazione**  
Ambra Gianola [ambra.gianola@unimi.it](mailto:ambra.gianola@unimi.it)  
tel. 02 503 17218  
[luigi.gm@mi.infn.it](mailto:luigi.gm@mi.infn.it)

**Coordinatori dell'intervento**  
Comitato Scientifico  
Prof.ssa Flavia Grappi  
Prof.ssa Anna Bassocchi  
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# Some Results

Indoor Radon concentration measured by the students

	School Rooms	Houses in the same zone of schools	Cellars of the same zone of the schools
“V. Sereni” Luino	23 -163 Bq•m <sup>-3</sup>	54-553 Bq•m <sup>-3</sup>	19-1160 Bq•m <sup>-3</sup>
“E. Mattei” San Donato Mil.	12 - 65 Bq•m <sup>-3</sup>	15 - 58 Bq•m <sup>-3</sup>	NO
“G. Gandini” Lodi	48 -169 Bq•m <sup>-3</sup>	48-169 Bq•m <sup>-3</sup>	NO
“G. Galilei” Caravaggio	4 - 18 Bq•m <sup>-3</sup>	NO	NO

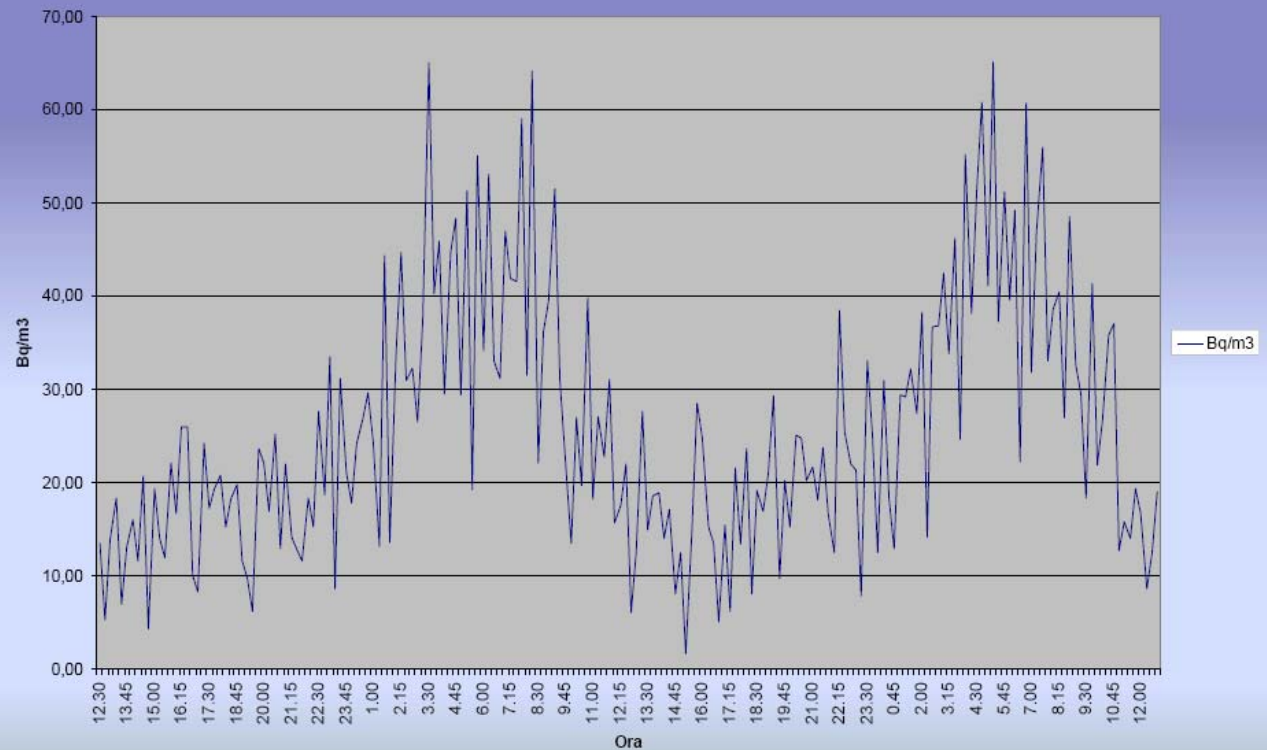
# IIS "ENRICO MATTEI" SAN DONATO MILANESE

Camera a scintillazione



## Grafico delle misurazioni

Concentrazione Radon

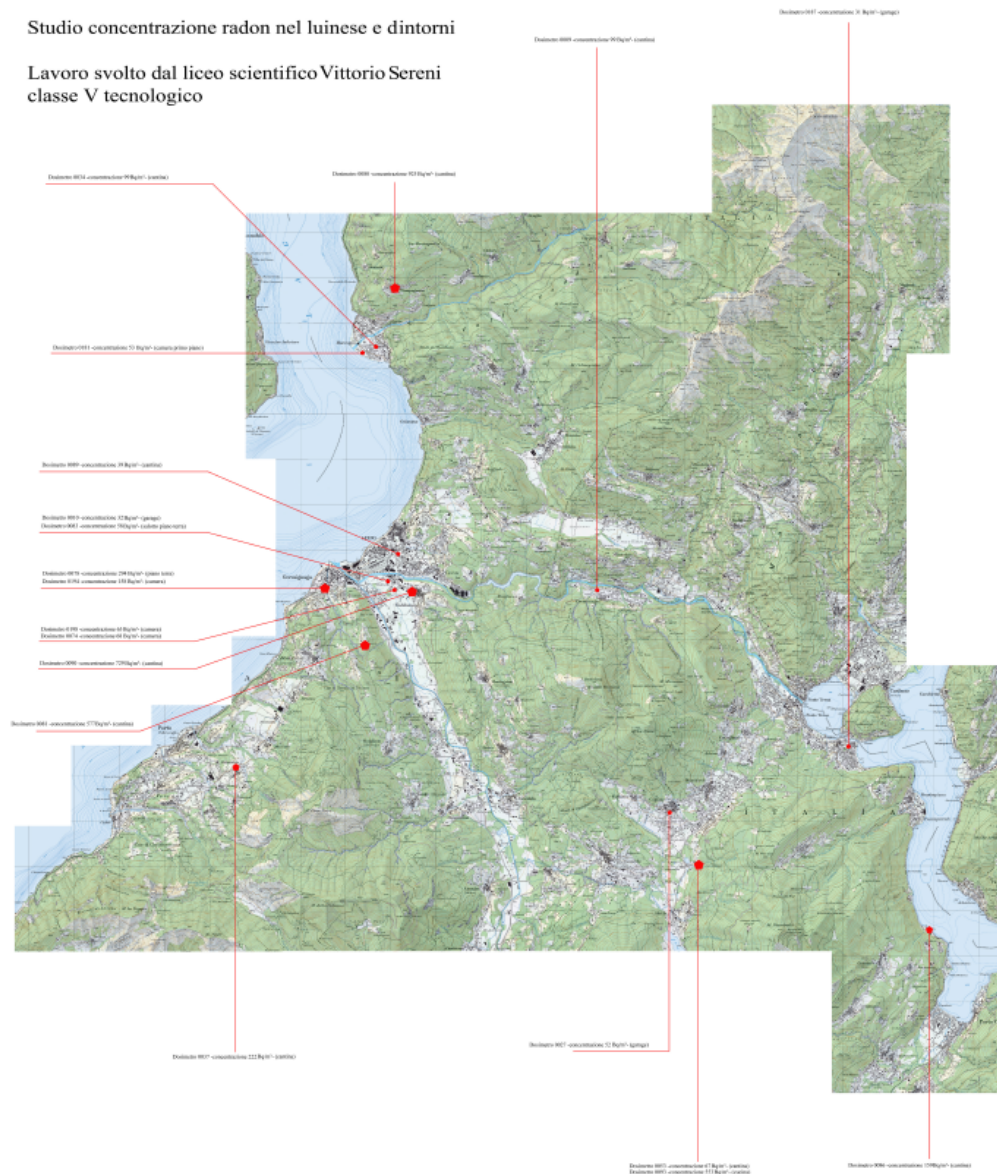


May 2016

# PROGETTO LABORAD

Studio concentrazione radon nel luinese e dintorni

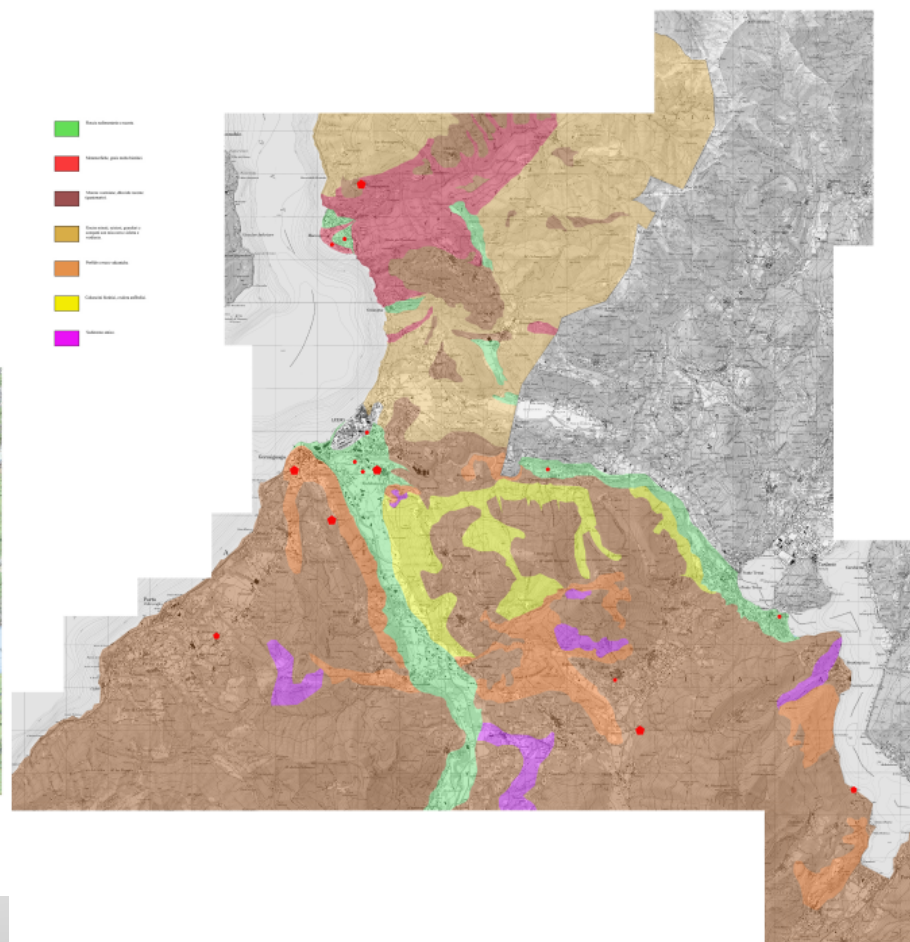
Lavoro svolto dal liceo scientifico Vittorio Sereni  
classe V tecnologico



# PROGETTO LABORAD

Studio concentrazione radon nel luinese e dintorni

Lavoro svolto dal liceo scientifico Vittorio Sereni  
classe V tecnologico





# IL RADON IN GROTTA: UN PROBLEMA INTERESSANTE



GROTTA	Periodo esposizione e nro giorni	Concentrazione (Bq/m <sup>3</sup> )	Deviazione standard (Bq/m <sup>3</sup> )	Errore % ale	Concentraz media (5 SITI DIVERSI) (Bq/m <sup>3</sup> )
Antro delle Gallerie (induno olona)	14 Settembre 11 gennaio 119 gg	3911	218	6	2222
		4024	298	7	
		1345	176	13	
		412	56	14	
		1417	557	39	
Frassino (campo dei fiori) ( <i>dosimetri umidi</i> )	13 luglio 12 ottobre 86 gg	4535	288	6	3960
		2986	200	7	
		4360	208	5	
		300 DOSIMETRO ROVINATO	58	19	Dato scartato
Frassino (campo dei fiori) ( <i>dosimetri asciutti</i> )	12 ottobre 25 gennaio 105 gg	924	198	21	881
		1166	130	11	
		1059	52	5	
		648	129	20	
		610	94	15	
Marelli (campo dei fiori)	30 novembre 15 marzo 105 gg	3697	364	10	5775
		6608	180	3	
		6250	205	3	
		6415	365	6	
		5903	298	5	



### **Grotta del Frassino**

Terreno: Calcari selciferi stratificati  
Tempo di esposizione: 86 gg (luglio-ottobre)  
Concentrazione: 3960 Bq/m<sup>3</sup>(dosimetro umido)

Tempo di esposizione: 105 gg(ottobre-gennaio)  
Concentrazione: 880Bq/m<sup>3</sup>( dosimetro asciutto)

### **Antro delle gallerie**

Terreno: Granofiro  
Tempo di esposizione: 119gg(settembre-gennaio)  
Concentrazione: 2222 Bq/m<sup>3</sup>

### **Grotta Marelli**

Terreno: Calcari selciferi stratificati  
Tempo di esposizione: 105gg(novembre-marzo)  
Concentrazione: 5775 Bq/m<sup>3</sup>



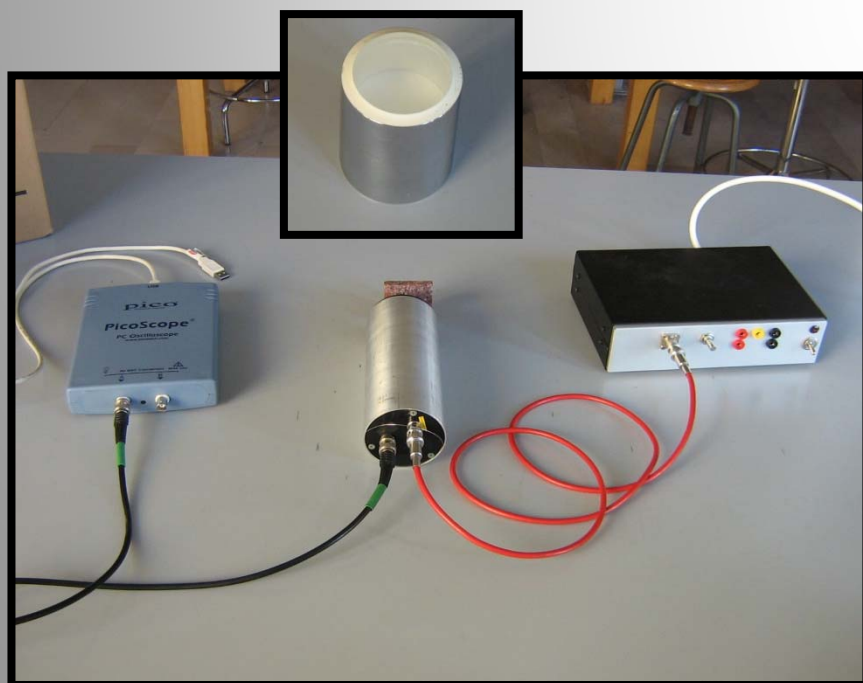
# SOME RESULTS

- built-in acquisition system for gamma and alpha spectrometry
- Radiobiological applications

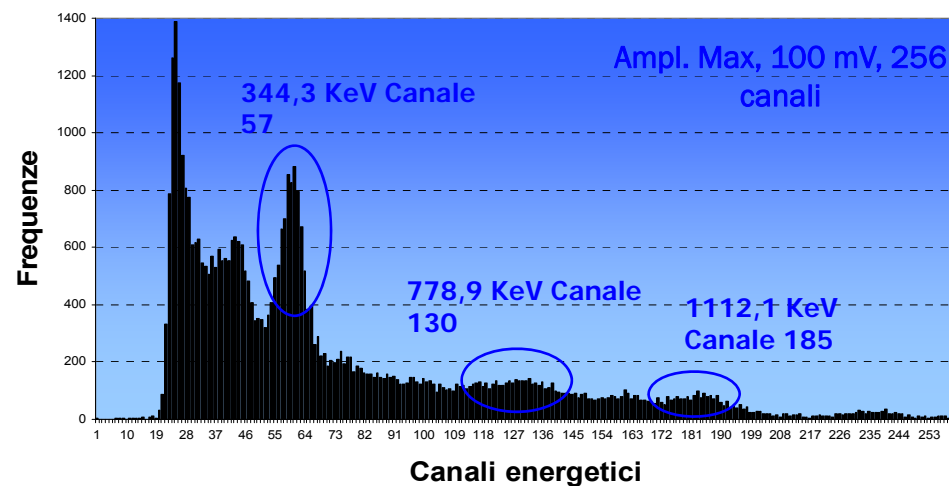
Conta delle colonie



Batteri del latte



Spettro Europio-152



# Ravenna

	Domus of stone carpets	home	cellar
Time of exposure [d]	69	70	70
n. of dosimeters	6	2	2
Rn concentration [ $\text{Bq m}^{-3}$ ]	$177 \pm 14$	$56 \pm 17$	$73 \pm$



# RadioLab 2013/2014 INFN-Catania

## PARTICIPANTS

- 13 High Schools
- 140 Students
- 5 municipalities (Catania, Siracusa, Ragusa, Enna, Caltanissetta)

## ACTIVITIES

- Introduction to fundamentals on Nuclear Physics, Radioactivity and Radon
- Preparation of dosimeters (electretes and nuclear track dosimeters-CR39)
- Indoor Radon survey: exposition of 150 electretes and about 200 CR-39



- Selection of suitable sites through geological and tectonic mapping (in figure: Scordia village)



# *RadioLab-Catania 2013/2014*

## **RELATED ACTIVITIES**

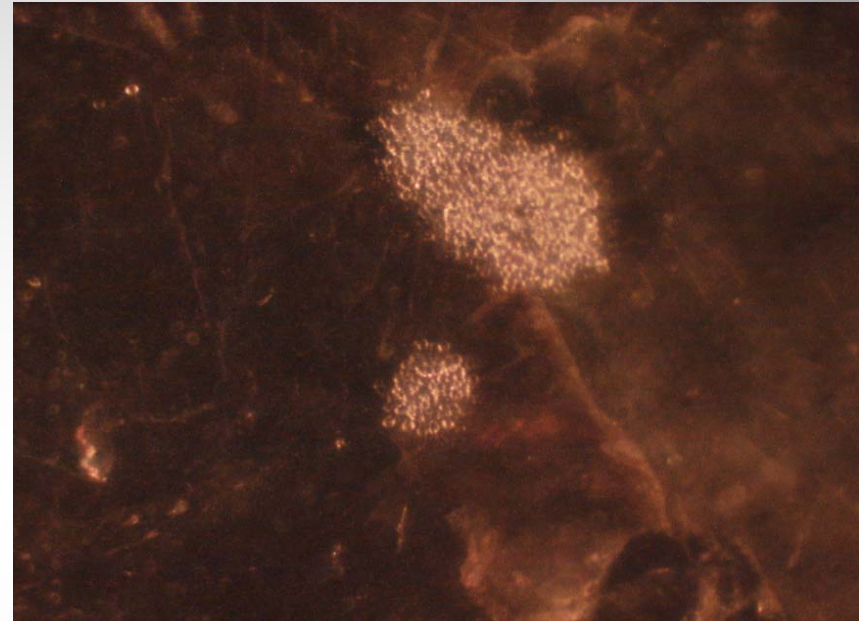
- Study of various aspects related to the radon problem: production and transport, biological effects and detection techniques
- In soil Radon measurements close to active tectonic structures (faults)
- RadioLab final Meeting at Department of Physics and Astronomy – University of Catania



### Particular activity:

Radon concentration measurements at the “Salinelle” site (near Paternò village), where secondary vulcanism events happen due to mount Etna activity.

The younger students measure some granitic rocks utilizing the autoradiographic technique.



- The CR39 dosimeters are posed on the sample for one week;
- are developed;
- are read by the microscope, placed on the sample in the same position of the exposure in order to observe the radioactive zones;
- they have to recognize if all the samples are granites.

# Conclusions

- this kind of activities upper excites a strong interest and the desire to understand more deeply a subject that in general is unusual,
- the beginning from the measurement of natural radioactivity is a good way for the students to approach the nuclear theme on a more rationale basis,
- an experimental activity is a good way to provide for an adequate scientific background,
- through this project also the teachers carry out a training or refresher course on these subjects,
- the measurements are made in accordance to Italian radioprotection law, so the data collected will be used for the radon concentration mapping of the school buildings, as required.

# Thank you for your kind attention!



**info and/or documentation**  
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# GOTHENBURG INVITE

INCC -5 Conference, 27 Aug. – 1 Sept. 2017

Gothenburg



# General Aim and Scope of the Society

**The general aim** is to build a bridge between individuals, institutions, and commercial companies and to establish close cooperation between them worldwide.

**The scope:** It is expected to be a large umbrella which covers all scientists dealing with chemical studies and applications of ionizing radiations with the understanding that Nuclear Chemistry is a branch which covers all kinds of subjects related to radioactive materials and nuclear radiation and to their applications in different fields of science and technology.

# Main Goals of the Society

1. Organization of International Nuclear Chemistry Congresses;
2. Organization of summer schools, and international courses for training, education, and motivation of young generation;
3. Supporting international collaborations and successful young scientists;
4. Supporting the activities of national, regional, and local organizations and societies related to nuclear science and technology, and their applications;
5. Forcing the conditions for rapidly increasing the number of young scientists in the nuclear field in the following decades;
6. Establishment of grants for research and development;
7. Publication of an International Nuclear Chemistry Journal;
8. Publication of an electronic INCS bulletin;
9. Establishment of close collaboration with other scientific organizations such as NAMLS, NRC, MARC, and MTAA;
10. Supporting all kinds of peaceful applications of nuclear science and technology; and
11. Creation of an International Nuclear Chemistry Research and Training Center.