Procedures in nuclear and radiological emergencies

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Summary

1. Nuclear and radiological emergencies in the Italian regulatory system
2. The Italian emergency plan
3. The ARPA Piemonte procedures

Nuclear and radiological emergencies in the Italian regulatory system

- Many human activities, in different fields (industrial, medical, pharmaceutical) deal with the problem of nuclear or radiological risk
- In this matter, it is common to distinguish the nuclear risk from the radiological risk: this separation is clearly stated both in the technical documents and the legislation
- The first (the nuclear risk) is mainly related to the nuclear power plant and all the other nuclear installations belonging to the nuclear industry (fuel fabrication, reprocessing plants, etc.)
- The latter is related to all the other human activities in which the use of a radiation source can lead to a substantial increase of exposure to workers or the public

The Italian Emergency Plan

- Italy has no Nuclear Power Plant in operation now: in 1987, after a referendum, the Government decided to stop all the nuclear activities related to electric power production

- Of course, this situation affected in a substantial way the Italian approach to the emergency Plan: without a NPP in operation the probability of the occurence of a severe nuclear/radiological accident is low

- However, we have still some important nuclear installation: Italy, after WWII, at the beginning of the Sixties, was one of the leading country in the development of a nuclear industry. 4 NPPs were constructed:

a) Latina, GCR da 153 MWe (1964-1987)

b) Garigliano (CE), BWR da 150 MWe (1964-1978)

c) Trino Vercellese (VC), PWR da 270 MWe (1965-1990)

d) Caorso, PWR da 860 MWe (PC) (1981-1990)

- Besides these NPPs, were constructed also two other important nuclear installations:

a) Nuclear Fuel Factory (FN, Bosco Marengo, in Northern - Piemonte)

b) Experimental Fuel Reprocessing Plants, for the treatment of the irradiated nuclear fuel (ENEA-EUREX, Saluggia, in Piemonte (VC) and ENEA-ITREC, Trisaia in Southern Italy)

- For that reason at the ENEA-EUREX Plant is still stored the major part of the Italian Nuclear Wastes
- They are highly radioactive liquids: mainly fission products (Cs-137, Sr-90), but also transuranic such as Plutonium e Americium
- These Wastes must be conditioned (solidified) before being removed and the definitive disposal: a new conditioning Plant (CEMEX) is now under construction for this purpose

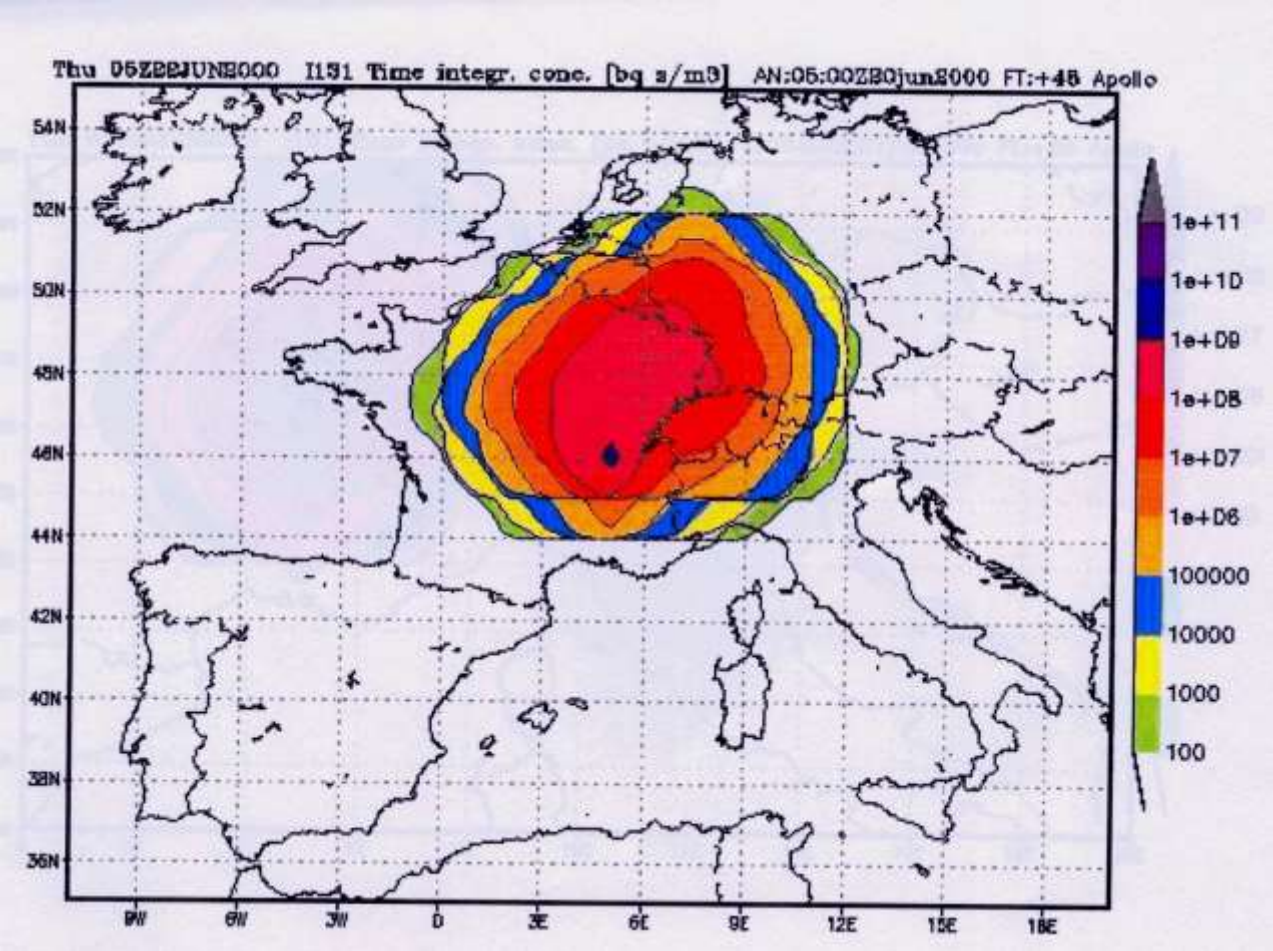
The Italian Emergency Plan

- The Italian nuclear and radiological emergency plan is based on a scenario involving a severe nuclear accident to a NPP near the border (in particular in French or in Slovenja)
- The reference accident assumed as a technical basis for the Plan is a INES 6 accident (corresponding to the emission in atmosphere of about 10^{17} Bq of ^{131}I equivalent)

The IAEA INES Scale

Nuclear Power Plants in Europe: (in blue those wiht a distance from the Italian border < 200 km)

Software simulation of the radioacive release following a sever accident (Level 6 IAEA INES scale) to a French nuclear power plant



- An accident of this kind can have some important consequences in the some parts of Italian territories
- Of course, the effects strongly depend on the meteorological condition
- The estimate for a worst case scenario gives doses for the population in the range 10 – 20 mSv

- These doses are not very high: extreme countermeasures (evacuation) are excluded but, following the Italian legislation (based on the general radioprotection *ALARA* principle: *all the exposures shall be kept As Low As Reasonable Achievable*), there is the need of implementing actions in order to reduce the doses to the population
- Typical countermeasures that can be implemented in this case are the following:

- 1) Restrictions on the consumption of foodstuffs and forages, potentially contaminated by the radioactive fallout: for the implementation of this countermeasure there is a need of comprehensive radioactivity monitoring program of the radioactive contamination of the foodstuffs and of the environment: this monitoring program is one of the main ARPA task during an emergency of this kind

- For less severe accidents, where the contamination of a significant part of the national territory is not expected, a local pianification applies
- This pianification is leaded at local level by the Prefects (we have about 100 Prefectures in Italy). We have in these cases two main technical bodies involved:

1. Fire Fighters (Safety and Security)
2. ARPA (Measurements)

The derived limits: limits established for foodstuffs (Bq/kg, activity concentration instead of dose). In no emergency situations, the following limits apply:

FOODSTUFFS

- ^{134}Cs + ^{137}Cs: **600 Bq/kg**

- For all the artificial radionuclides: is established the effective dose limit of

1 mSv/anno

$$H\ (Sv) = A\ (Bq/kg) \cdot C(kg) \cdot h(g)\ (Sv/Bq)$$

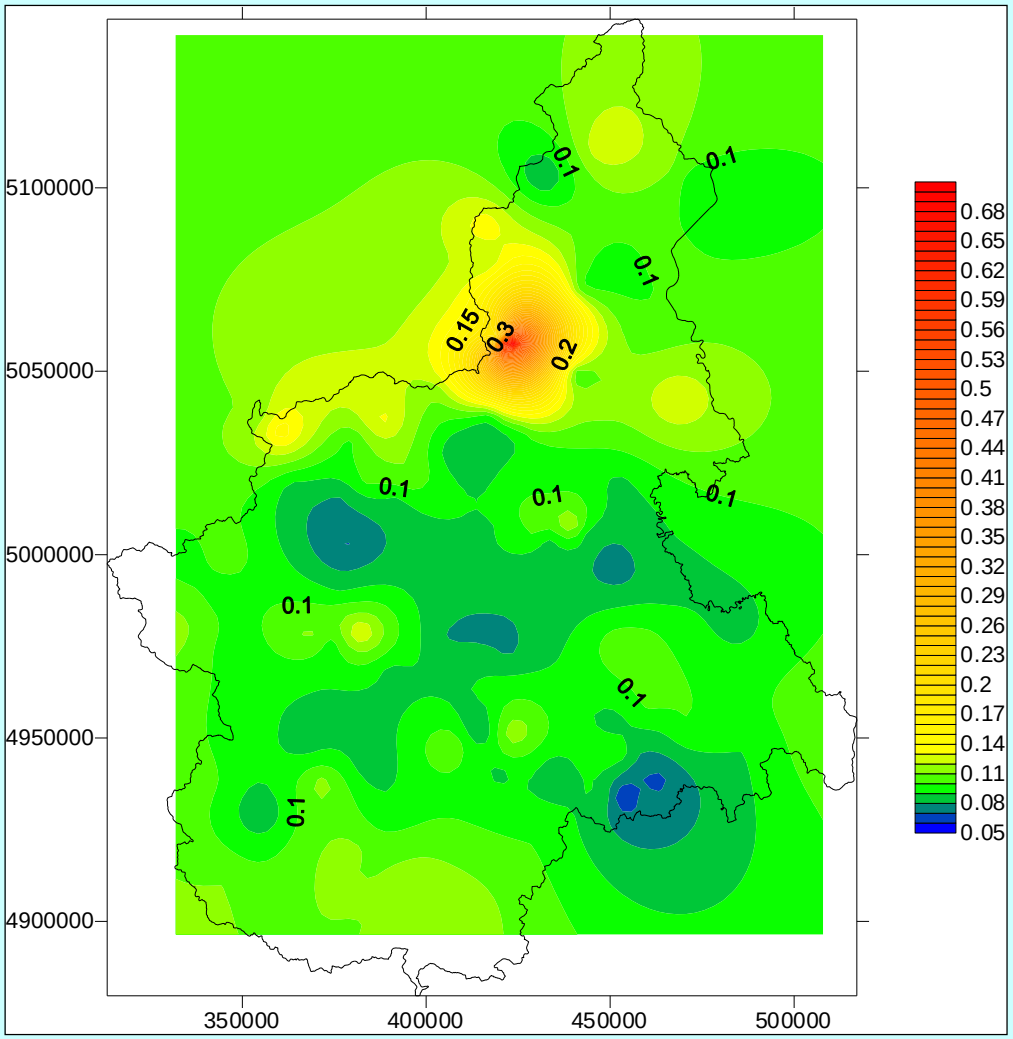
The limits can change if an accident occurs!!

	Strontium isotopes (^{90}Sr) (Bq/kg)	Iodine Isotopes, (^{131}I) (Bq/kg)	Transuranic (Bq/kg)	Others radionuclides (Bq/kg)
Foodstuffs for infants	75	150	1	400
Milk and cheese	125	500	20	1000
Other foodstuffs	750	2000	80	1250
Liquid foodstuffs	125	500	20	1000
Pork forages	-	-	-	1250
Forages for chicken, beefs and sheeps	-	-	-	2500
Other forages	-	-	-	5000

The ARPA Piemonte γ dose rate emergency network

- It is based on the measurement of the γ radiation; more precisely, the γ dose rate: it is the simplest measurement method and the most reliable
- The γ dose rate can be measured using quite simple instrumentation (for example: Geiger-Mueller counters) and therefore is used as the main tool for the discovery of radiation anomalies

Average backgrond γ dose rate in Piemonte



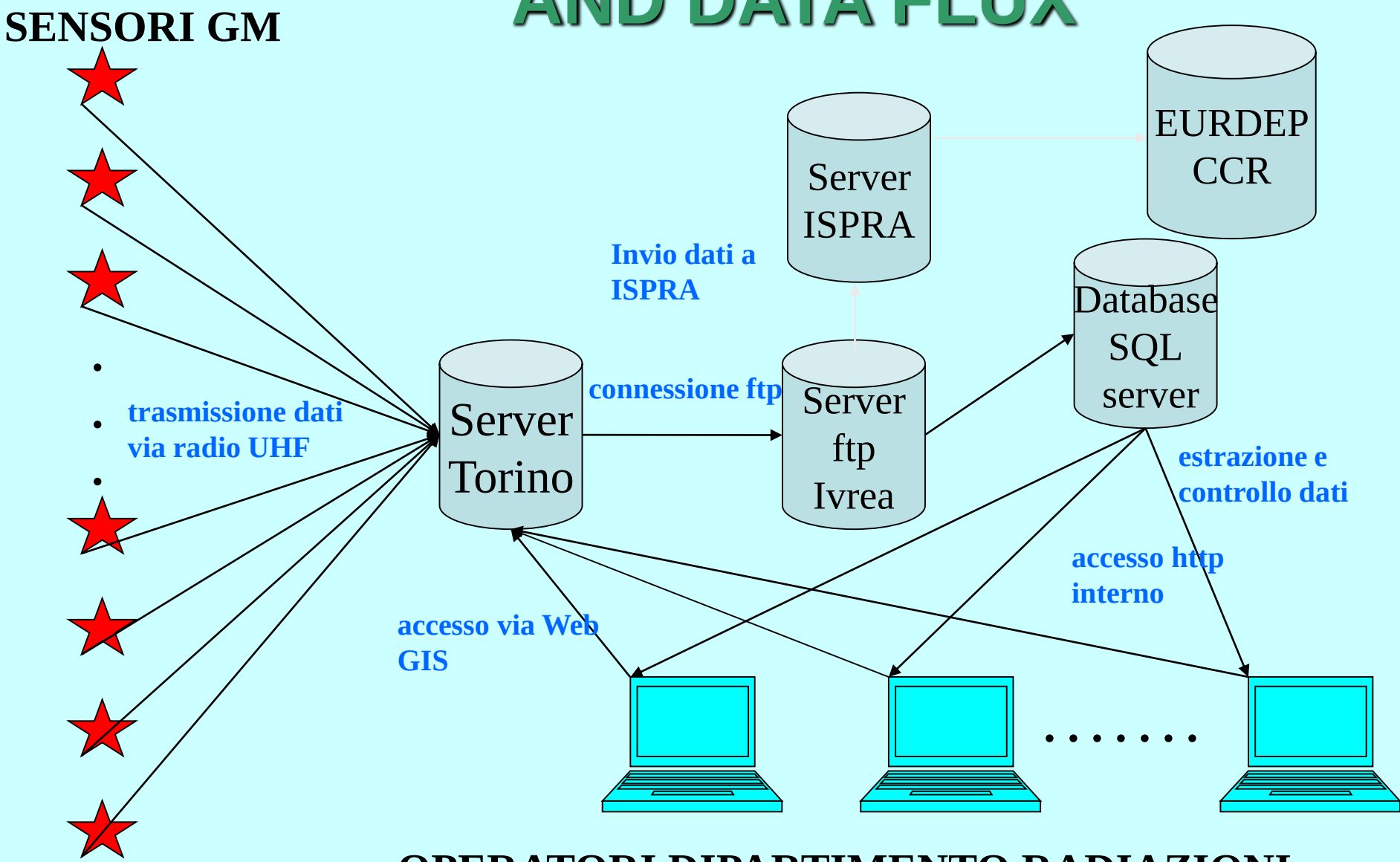
- Average data calculated from the knowledge of the activity concentration of the radionuclides in solis + the cosmic rays contribution

  μGy/h

- In red a radiation anomaly (Cervo Valley) due rock with high level of uranium)

The γ emergency

STRUCTURE OF THE NETWORK AND DATA FLUX



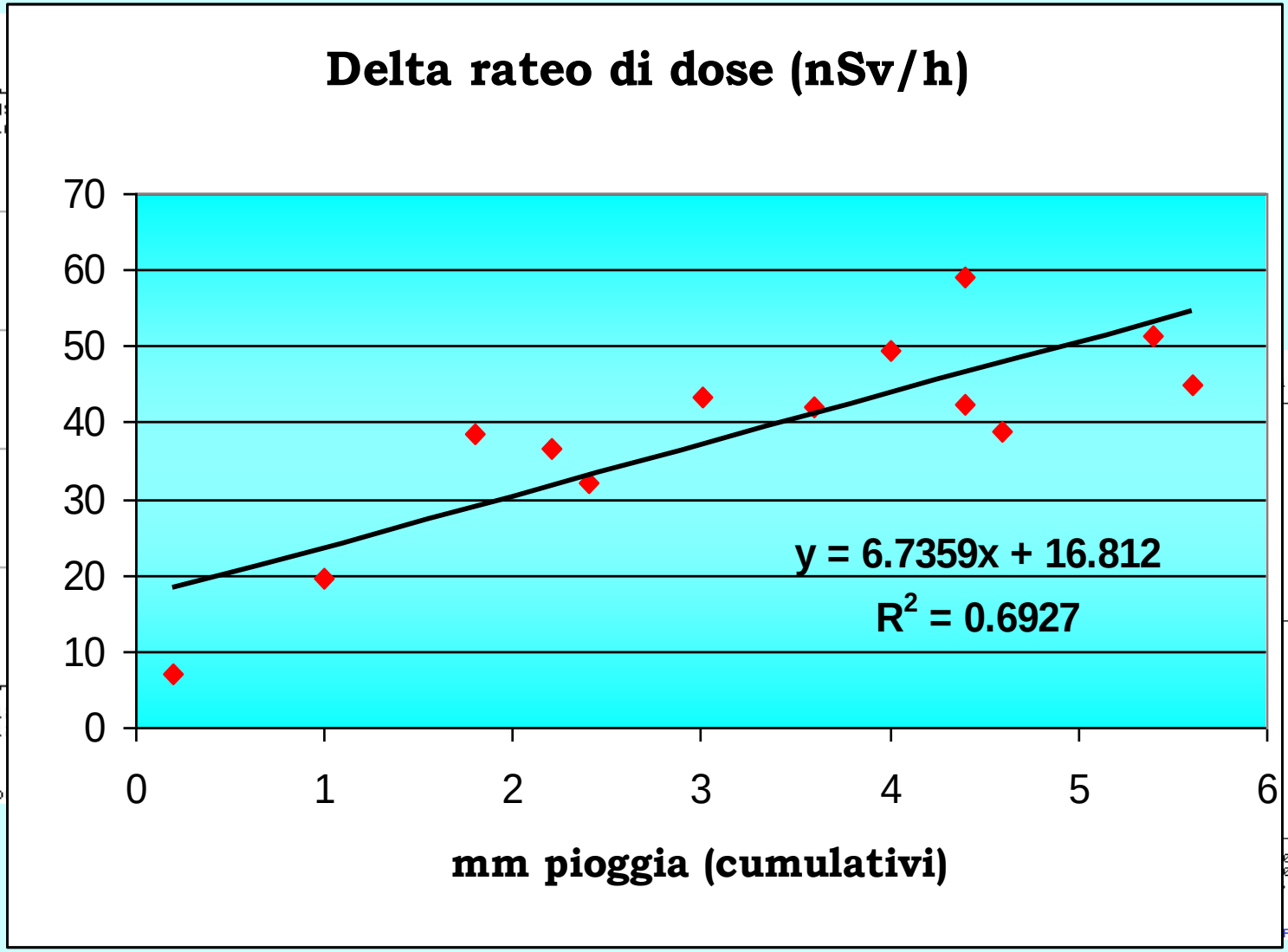
- The Geiger-Mueller detectors take the γ dose rate data every 10 minutes
- An automatic check of the data is automatically performed by a “validator”, a software procedure that ensures that the dose rate data are normal (below a given threshold) and nothing is going wrong
- If some anomalous data are detected, an automatic warning is sent to ARPA personals by means of an SMS message and e-mail

- A “human control” is made at 2 different stage:

1. The first control is made by our colleagues in Turin, after the collection of the data from the 29 stations: the operator checks for the coherence of all the data set and also for the presence of some anomalous data

2. The second check is performed at national level, in Rome, at ISPRA (National Istitute for the Protection of the Environment), before the final deliver of the data at European level to the EURDEP Platform

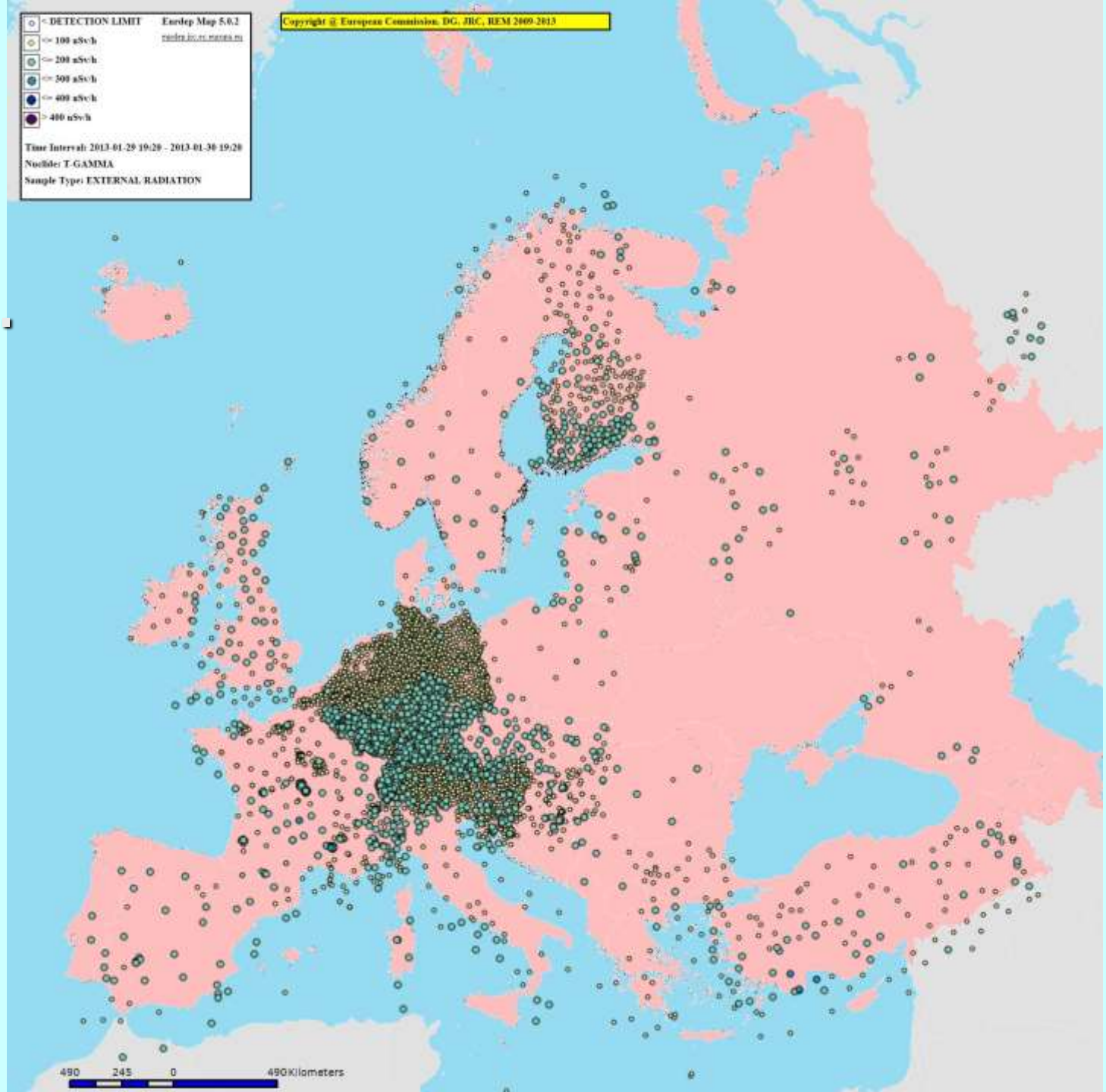
The γ alarm network



The EURDEP project

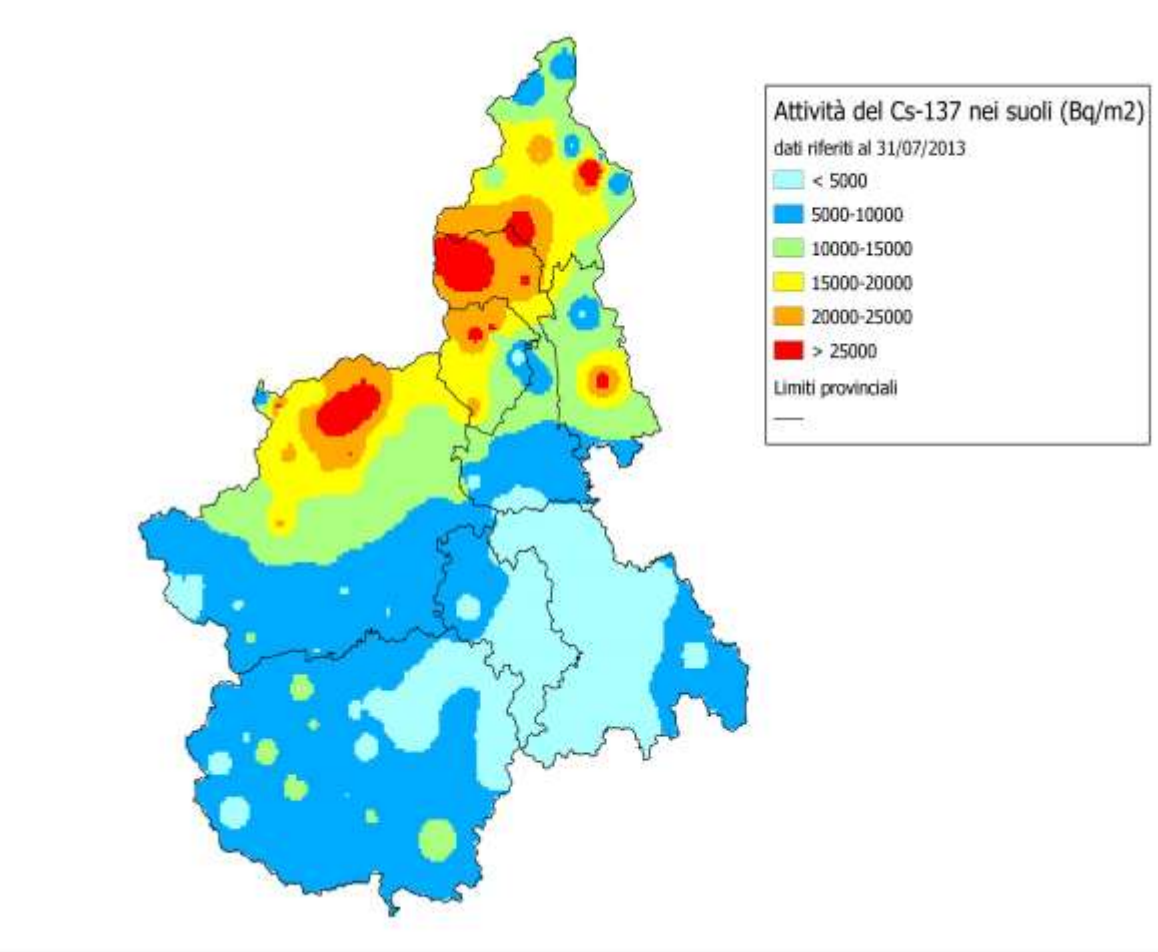
- The γ dose rate data from all the European Networks are collected and displayed in free access European platform, called EURDEP
- All the data (aggregated in 4 dose rate categories) can be viewed by the public after some delay established by the national authorities

- http://eurdep.jrc.ec.europa.eu/Basic/Pages/Public/Home/Default.aspx


< DETECTION LIMIT
<= 100 nSv/h
<= 200 nSv/h
<= 300 nSv/h
<= 400 nSv/h
> 400 nSv/h
Eurdep Map 5.0.2
Time Interval: 2013-01-29 19:20 - 2013-01-30 19:20
Nuclide: T-GAMMA
Sample Type: EXTERNAL RADIATION
Copyright © European Commission, DG, JRC, REM 2009-2013
490 245 0 490 Kilometers

Measuring and monitoring environmental radioactivity

- Besides the alarm network, there is also a regional-based radioactivity monitoring network (RESORAD) measuring low-level radioactivity in environmental matrices (soils, water bodies, sediments) and foodstuff
- This network is coordinated at national level by ISPRA



Measuring and monitoring environmental radioactivity

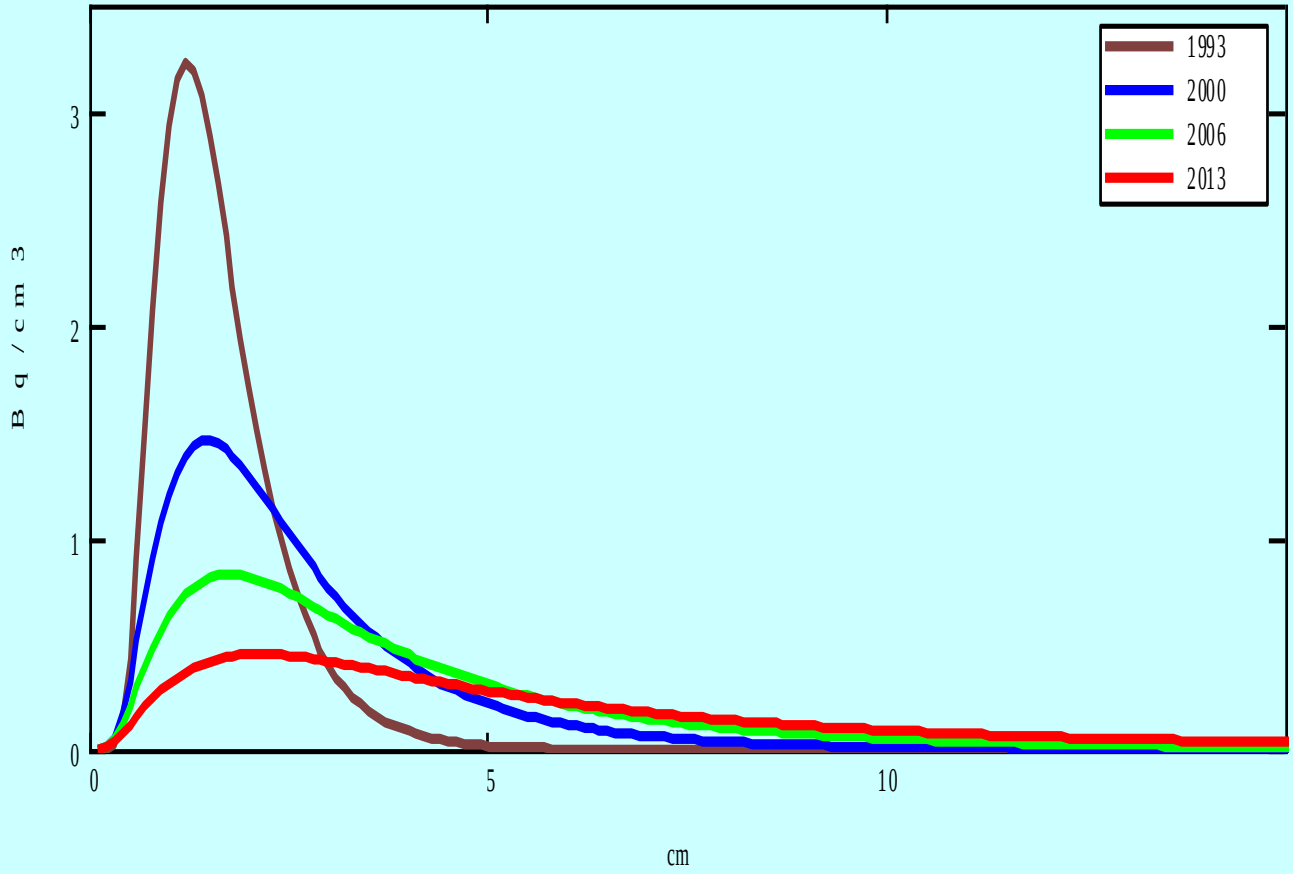
- Environmental sampling: water sampling in Maggiore Lake, near Verbania

Measuring and monitoring environmental radioactivity

- Environmental sampling:
soil sampling in cultivated and undisturbed soils

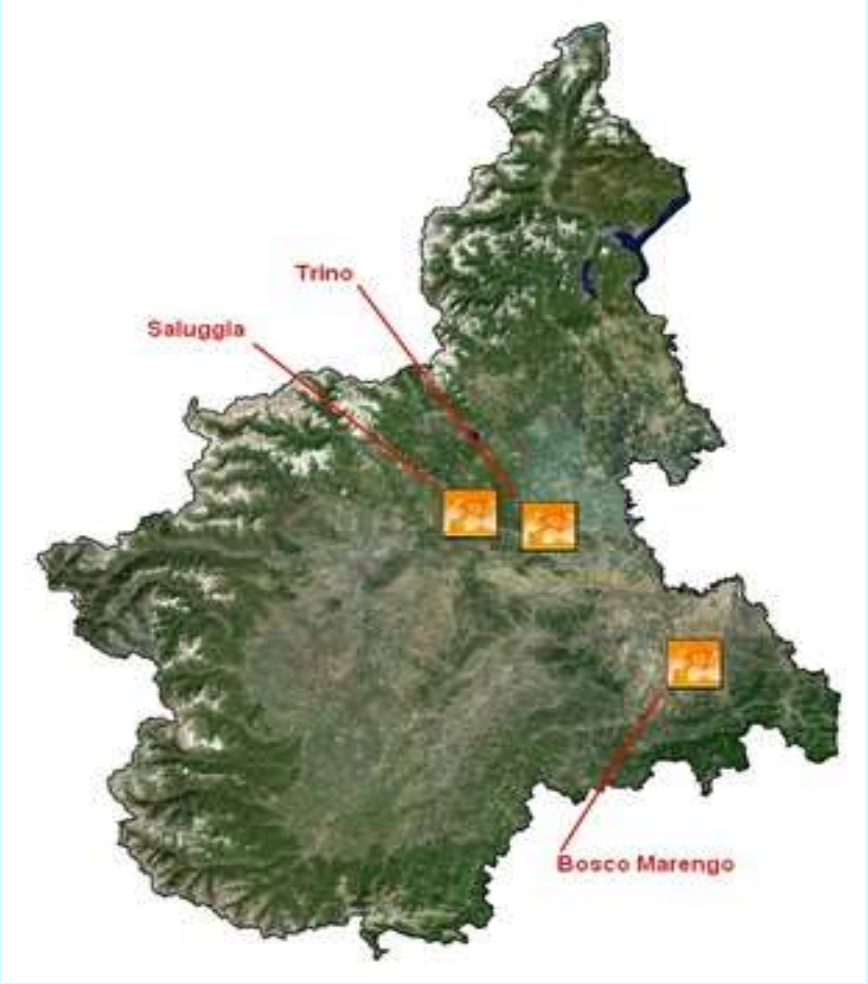
Measuring and monitoring environmental radioactivity

- Radioecological studies:
^{137}Cs migration in soils



Measuring and monitoring ionising radiation

- In Italy we have no Nuclear Power Plant in operation: all the nuclear installations are at a *decommissioning* stage
- However, we have also locally based monitoring networks around the nuclear facilities of Piemonte:
  - Bosco Marengo, former nuclear fuel factory;
  -Trino, PWR power plant;
  -Saluggia, reprocessing plant



Monitoring radiation during nuclear transports

- The transfer of the spent fuel stored in the Italian nuclear facitilies to the La Hague reprocessing plant (France) is supervised and monitored by Arpa Piemonte

In the field radiation maesurements

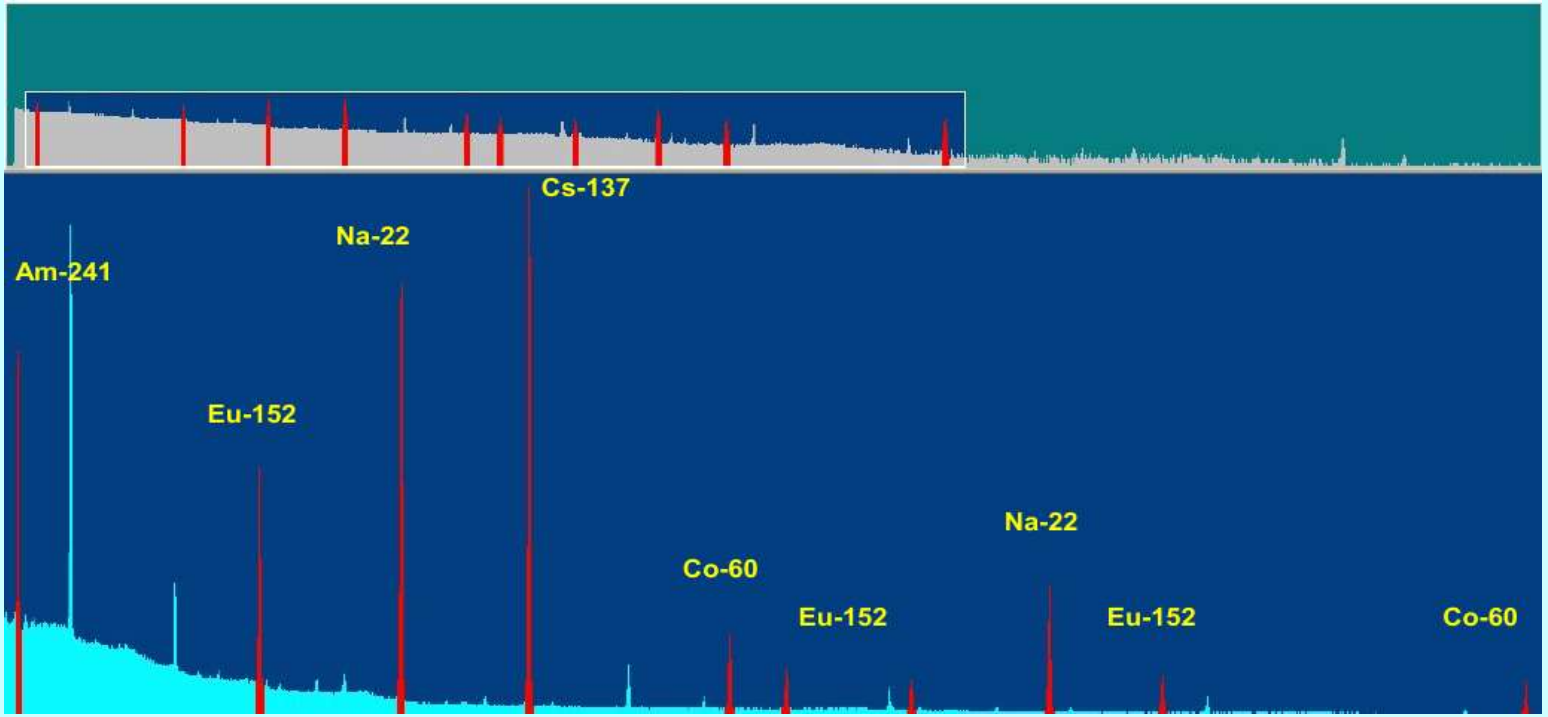
- For emergency situation due to *In situ* gamma spectrometry with HPGe detectors

In field radiation maesurements

- Gamma dose rate measurements and *in situ* gamma spectrometry with LaBr detector

In the field radiation maesurements

- ISIGAMMA 2011 International Exercise (Davos, Switzerland)



Searching for radiation sources in metal scraps

Checking the radiation levels and searching for buried sources

Main Measurements Techniques use in the RESORAD Network

(most of them complying with ISO 17025 standards)

- Gamma spectrometry with Hyperpure Germanium detectors,
- Low level alpha/beta/gamma measurements in atmosphere

- Low-level alpha/beta scintillation counting in water

- Radiochemical analysis (Uranium isotopes, $^{239+240}Pu$, ^{238}Pu, ^{90}Sr, ^{3}H, ^{210}Po, etc.)

Thank you for your kind attention !

Ivrea, 16th March 2014