

European Collaboration in Airborne Trace Radionuclide Monitoring: The Ring of Five

The Chernobyl nuclear accident in April 1986 was a turning point in the history of environmental radioactivity because it highlighted the need for continuous monitoring of the environment and for greater international cooperation in the information exchange to ensure proper decision-making. It was the trigger for the development of environmental radioactivity monitoring programs at national level around Europe in the 1990s, which became part of the Ring of Five. This enlargement with laboratories of many countries has improved the possibility to resolve and identify detections by building a confident net covering most of the European continent.

Historical background

The first release of airborne fission products and other anthropogenic radionuclides took place in July 1945 during the Trinity Test. This was the dawn of the Atomic Age. During the following years, large amounts of radionuclides were dispersed through hundreds of atmospheric nuclear tests until the signature of the Partial Test Ban Treaty (PTBT) in 1963. Although some non-signatory countries kept carrying out such tests, airborne activity levels dropped continuously from that year on. The last atmospheric explosion was conducted by China in October 1980.

The interest to investigate the temporal and spatial distribution of anthropogenic and natural radionuclides in the air and the concern about their effects on the population soon drew the attention of the scientific community and some institutes started measuring the radioactivity in the air in those early years.

The development of the peaceful uses of nuclear technology worldwide ran parallel to that of detection techniques and the first environmental monitoring programs in the surrounding of nuclear power plants

were developed. At the atmospheric level, aerosol sampling and measurement technologies were regularly improved to cope with decreasing concentrations down to trace levels. In the early 1980s, man-made radionuclide

detections of both fission and activation products, occurred occasionally in Northern Europe and the events eventually caught the interest of the press. For a better understanding of the situation on a transboundary scale, **Lars-Erik de Geer** at the Swedish Defence Research Agency teamed the radiation protection authorities of five countries (Sweden, Germany, Finland, Norway, and Denmark) with the purpose of exchanging analytical data about unexpected detections of radionuclides. In the beginning, the exchange took place by ring calls on the phone, which led to the name Ring of Five (Ro5).

Ring of Five

Today, the Ro5 includes more than 60 members operating more than 200 stations and representing 31 countries and, although it is still mainly based in Europe, there are partners from Canada or the USA as well as

Measuring the radioactivity in the air



Fig. 1: A high-volume air sampler operated by IRSN (France)

some international bodies. Most members employ filters and high-volume air samplers (see Fig. 1) for aerosol particle sampling. The filters are routinely measured by low-level gamma-ray spectrometry and in addition may also go through radiochemistry to determine other relevant radionuclides such as ^{90}Sr or Pu isotopes.

Despite significant growth over the years and the streamlining of communication channels, the purpose of the Ro5 has remained unchanged: informal exchange of data and expertise amongst experts for airborne radionuclide releases for scientific insight. The measuring stations are managed according to the programs devised by national authorities. These programs have also established the reporting mechanisms to national authorities as well as to the European Commission.

The information exchange within the Ro5 remains unofficial and has another function. As soon as something unusual is observed, colleagues in different locations can be made aware of the detection and check their own measurements giving a clarification on the spread of radioactivity.

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This can be done on the basis of preliminary data of on-going measurement for the sake of quick response. The quick response combined with the wide extension of territory the Ro5 covers nowadays has also given the chance to go beyond the mere observation and help understanding some episodes in recent times, even when the release condition was not clear.

Major Ro5 detections

The network has contributed in understanding the transport and release of radionuclides on multiple occasions. One of the first unusual detections were increased concentrations of ^{137}Cs at multiple stations in June 1998. The source of this release was soon found to

Effektive Messung niedriger α/β Aktivitäten



LB 790-5L Low-Level Counter
Detektorsystem

LB 761 α/β Low-Level Counter
für 200 mm Schälchen

LB 790-UL
Ultra Low-Level Counter

Public interest

be a steelwork in Algeciras, Spain, that accidentally had melted a ^{137}Cs source. Much more public interest was put on the plume arriving from Japan after the Fukushima nuclear accident in 2011. The Ro5 collected invaluable data, primarily of ^{131}I and $^{134,137}\text{Cs}$ (1). This was the first time that data from large parts of the network were compiled and published. In January/February of 2017, ^{131}I was detected at a number of stations over Europe. Based on the application of meteorological models, it was found that multiple sources were likely responsible for these detections (2). This event was the first with a forensic approach because by combining the radiological data of the Ro5 with the meteorological models a solid hypothesis on the origin of the source was possible although no company admitted any releases. An unusual detection of ^{106}Ru occurred in September/October of 2017 (3). To this day, no one has declared a release that could explain the plume, which covered almost the entire European continent (Fig. 2).

Detection data from the Ro5 were used for meteorological analysis of a possible release source, and radiochemical analysis of air filters from this period allowed for a deeper understanding of the events that led to the accident. It was found that the Ru plume carried the chemical fingerprint that may point at nuclear fuel reprocessing (4) and that the stable Ru isotopes in the filter were consistent with the isotopic signature of VVER reactors (5).

In 2020, the Ro5 helped assess the situation in the Chernobyl exclusion zone during and after unprecedented wildfires in this area (6).

The collaboration within the Ro5 has also helped to understand local and regional detections and differentiate them from more global phenomena like the radionuclides resuspension episodes such as those due to wildfires in contaminated areas which were detected in various locations in Europe, or the Sahara desert dust intrusions across Europe.

Outlook

The Ro5 is dormant most of the time and some of the events that activated the network in early times are well known and need not necessarily be reported.

The Ro5 has proven its value on multiple occasions, and it still remains a valuable tool for the understanding of the evolution of radiological events. In recent years the group realized that these measurements can also give input to scientific development and contribute to making radiological surveillance evolve.

However, its performance is limited by the areas currently covered with sta-

tions. An expansion of the Ro5 would be helpful, especially in the South-Eastern part of Europe.

The experience along many years can also contribute to critical discussion of the work being

carried out. For example, ^{131}I is the artificial radionuclide most frequently detected in air and it is known that its gaseous retention on filters is not efficient (7). Currently a handful of samplers include a gaseous sampling line, which limits the capability of covering radioiodine releases in gaseous form. The revision of the monitoring programs to include more stations using charcoal filters that are capable of collecting gaseous iodine species would be an extremely valuable step up.

Olivier Masson,
Catharina Söderström,
Georg Steinhauser,
Daniel Zapata-García □

Performance is limited by the areas

Collaboration within the Ro5

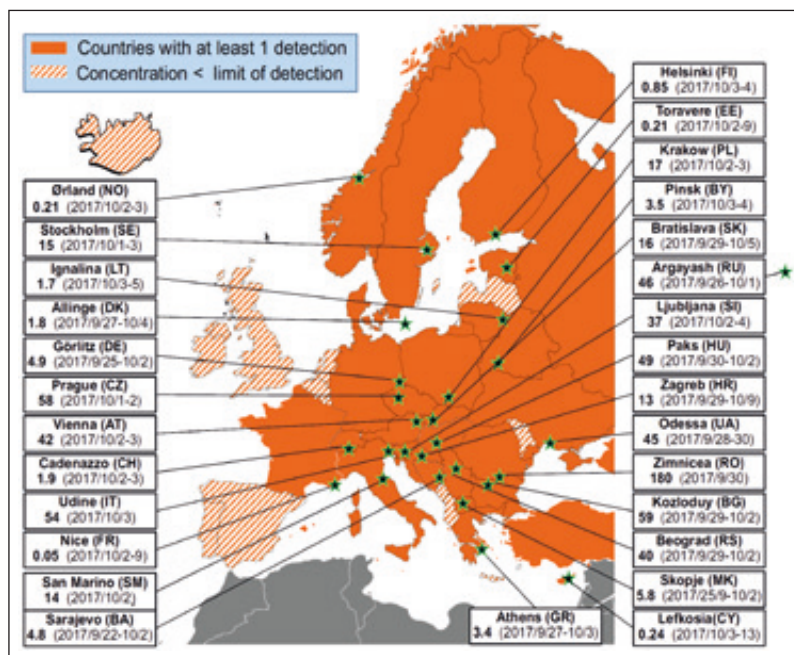


Fig. 2: Airborne activity concentrations of ^{106}Ru following the undeclared release in 2017.