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Data Article

# Gamma-ray spectrometry dataset along the route of the research vessel Laura Bassi during the Antarctic campaign

Massimiliano Iurcev*, Alessio Trebbi, Behzad Salmassian, Maria Elena Musco, Franco Coren

*National Institute of Oceanography and Applied Geophysics (OGS), Centre for Management of Maritime Infrastructure (CGN), Borgo Grotta Gigante 42/C, Sgonico, 34010 Trieste, Italy*

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## ABSTRACT

Gamma-ray spectrometry is a key tool for monitoring environmental radioactivity and tracing radionuclide distributions in marine ecosystems. In this study, we present the first dataset acquired by a gamma-ray spectrometer permanently installed aboard the Italian research vessel Laura Bassi during its 2023–2024 Antarctic campaign. The spectrometer, an RS-250 Stationary Radiation Monitor by Radiation Solutions, was mounted on the vessel's upper deck and operated continuously during navigation from Italy to New Zealand and onward to Antarctica, acquiring over ten thousand gamma spectra at ten-minute intervals. Each spectrum was recorded in both N42 and CSV formats and later georeferenced using high-precision navigation data from the ship's GPS systems. The dataset, accessible via an ERDDAP server, supports future studies on radionuclide dynamics, inter-hemispheric comparisons, and oceanic currents. This work contributes to the global effort of marine radioactivity monitoring and open data sharing.



* Corresponding author.
*E-mail address:* miurcev@ogs.it (M. Iurcev).

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Specifications Table

| | |
|---|---|
| Subject | Earth & Environmental Sciences |
| Specific subject area | *Marine gamma-ray spectrometry for monitoring natural and anthropogenic radionuclides in seawater and sediments.* |
| Type of data | *CSV, Table, .n42 file* |
| Data collection | *Data were collected using a RS-250 radiation detection system (Radiation Solutions Inc.) equipped with a NaI(Tl) scintillation crystal and GPS. The instrument was operated aboard the RV Laura Bassi during the 2023–2024 Antarctic campaign. Gamma spectra were recorded every 10 min while navigating at constant speed. Count-rate data and signal-to-noise ratios for specific isotopes were logged in CSV files, and N42-format spectral files were generated every 10 min by the system's onboard software.* |
| Data source location | Data collected both ways on the ship path from Trieste Italy to Antarctica. Data are stored at OGS headquarters.<br>Available at: https://lbnode.ogs.it/erddap/files/rs250_pnra40/ |
| Data accessibility | Repository name: rs250_csv_pnra40<br>Data identification number: https://doi.org/10.13120/m64k-q375<br>Direct URL to data: https://lbnode.ogs.it/erddap/files/rs250_csv_pnra40/<br>Instructions for accessing these data: No registration or logging is required |
| Related research article | |

## 1. Value of the Data

- Provides underway gamma-ray spectrometry datasets collected continuously along a polar research vessel route, covering multiple oceanic regions including the Southern Ocean.
- Supports inter-hemispheric comparison of natural and anthropogenic radionuclide distributions in marine aerosols and background environments.
- Enhances environmental monitoring capabilities with a yearly frequency through oceanographic campaigns.
- Offers georeferenced, time-resolved gamma spectra suitable for multidisciplinary research including marine currents, climatology, geochemistry, and radiological baseline mapping.
- Facilitates integration with other environmental datasets via an open-access ERDDAP server, enabling broader use by the scientific community.

## 2. Background

Marine gamma-ray spectrometry is a well-established method for the measurement of natural and anthropogenic radioisotopes in seawater, sediments, and marine structures. Since its development in the 1950s, the method has been widely applied for environmental monitoring, nuclear site assessments, and oceanographic research [1,2]. Over the decades, several countries have contributed to the advancement of in situ gamma-ray spectrometry systems, leading to significant improvements in detector technology, data processing, and deployment strategies [3–5]. Polar sites are areas characterized by both upwelling from depth and sinking of surface waters. Reconstruction of the history of these processes in the past is important for understanding climate [6,7]. Application of 226Ra/Ba chronology to Southern Ocean sulphates and carbonates is one possible approach to better constrain variability in past Southern Ocean 14C reservoir ages [8]. Despite these advances, polar regions, especially those south of 60°S, are critically undersampled due to their remoteness and logistical constraints. To contribute fill this gap, the National Institute of Oceanography and Applied Geophysics (OGS) has initiated a gamma ray monitoring program to trace radionuclides aboard the Italian research vessel (R/V) Laura Bassi. The research vessel is a PC5-class A icebreaker owned by OGS and operated as part of the Italian Antarctic Program (PNRA). Each year, the vessel sails from Italy to New Zealand and onward to Antarctica, providing a unique opportunity to collect uninterrupted, trans-oceanic datasets during its long voyages. In 2023–2024, a stationary gamma-ray spectrometer (RS-250 Radiation Solutions) was installed on the vessel's monkey island, allowing for continuous acquisition of

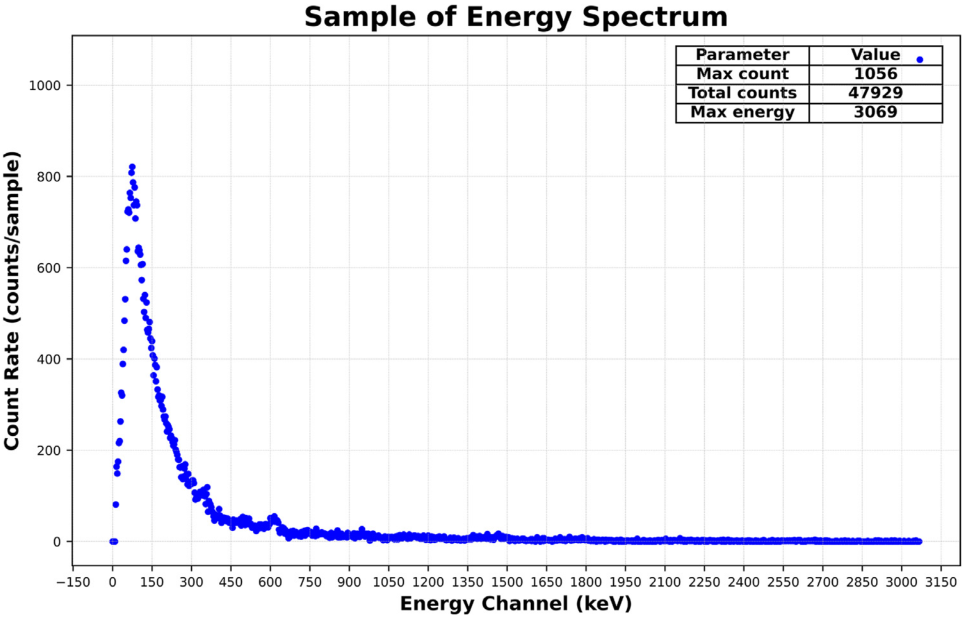


**Fig. 1.** Sample of recorded gamma spectrum. The spectrum shown corresponds to the total count rate measured over ten minutes for each sample. The horizontal axis (x-axis) represents the energy channels, while the vertical axis (y-axis) indicates the number of gamma-rays counted in each corresponding channel per sample.

gamma spectra during the entire Antarctic campaign. The scope of this article is to describe the gamma ray dataset collected in 2023–2024 PNRA Antarctic mission of R/V Laura Bassi. The data provided are valuable for hemispheric comparisons, fallout radionuclide analysis and for tracking marine currents. Ultimately, this initiative aims to contribute to open-access, high-frequency marine radioactivity datasets that support climatological, geochemical, and radiological research across disciplines.

## 3. Data Description

The RS-250 Detector Unit operates by collecting gamma count rate data continuously over a 10-minute interval. During this period, it records spectral and temporal information, which is then processed into a data stack. At the end of the acquisition cycle, the device generates an .n42 file, which encapsulates the collected raw spectra with related metadata Fig. 1. An N42 file is an XML-based data format primarily used to store and exchange information from radiation detection instruments.

Available at: https://lbnode.ogs.it/erddap/files/rs250_pnra40/

In addition, a CSV file is created that includes the total absorbed dose in nGy/h, the dose absorbed specifically for each isotope in nGy/h and signal-to-noise ratio for each identified isotope, providing a quick and accessible overview of detection quality and isotope-specific signal strength.

Available at: https://lbnode.ogs.it/erddap/files/rs250_csv_pnra40/

During the journey from Italy to New Zealand, from New Zealand to Antarctica, and the return trip, more than ten thousand samples were collected and reported. Initial analyses and spectra have demonstrated a typical oceanic background. As observed from the collected data, anomalies in the total count rates of the isotopes occur at different coordinates along the vessel track. indicate the necessity for further analyses to identify the underlying causes of these variations.

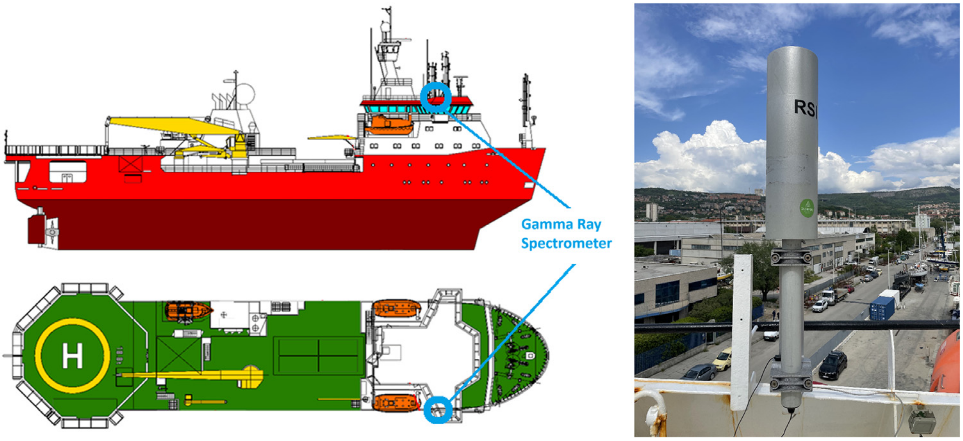


**Fig. 2.** Location of the gamma-ray spectrometer on the research vessel.

## 4. Experimental Design, Materials and Methods

### *4.1. Overview of gamma-ray spectrometer specifications*

The RS-250 is a portable gamma-ray spectrometry system equipped with RadAssist v6.2.83.0 and DgsAssist v1.7.9.0, commonly used for radionuclide identification and quantification [9]. Its primary function is to enable in-situ measurements of gamma-emitting isotopes across various environments. In our case, the RS-250 is employed for general monitoring, as well as the detection of anomalies and contamination.

The detector geometry consists of a thallium-doped sodium iodide (NaI(Tl)) scintillation crystal with dimensions of 3 × 3 inches, coupled to a photomultiplier tube (PMT). The system is installed on the upper deck of our research vessel, which causes partial shielding between the detector and ocean-sediment-associated radionuclides, depending on the angle of measurement.

Data are recorded in the ANSI N42.42 and CSV formats, standard for radiological data exchange. Measurements are reported in counts per second (cps) for activity and gray per hour (Gy/h) for dose rate.

The system provides an energy resolution of approximately 3 keV, with a Full Width at Half Maximum (FWHM) of about 7–10 % at 662 keV (corresponding to Cs-137). The spectrometer divides the energy spectrum into 1024 channels, each representing a discrete energy interval.

Calibration is routinely conducted using a Cs-137 source (typically 5–10 µCi), and K-40 is also utilized to verify FWHM, peak fitting quality, and energy gain. Novosal Hyposodic Salt with 28.5 % potassium is used for this application. Th-232 may additionally be used for calibration purposes. The system supports adjustable signal-to-noise ratios (SNRs), ranging from 3 (low) to 25 (high), depending on measurement conditions.

The instrument can record a maximum of 1000,000 gamma counts per sample as well as 50,000 counts per second, with data acquisition occurring every 10 min. GPS functionality is integrated into the RS-250 and is further synchronized with the vessel's GPS system for accurate spatial referencing.

### *4.2. Installation and data collection*

The mounting location of the gamma-ray spectrometer, shown in Fig. 2, is on the monkey island on the starboard side. Through an ethernet connection the device is connected to the ship's internal network. A specific computer is dedicated for the data collection with the related


**Fig. 3.** PC station to operate the gamma-ray spectrometer and store the data.

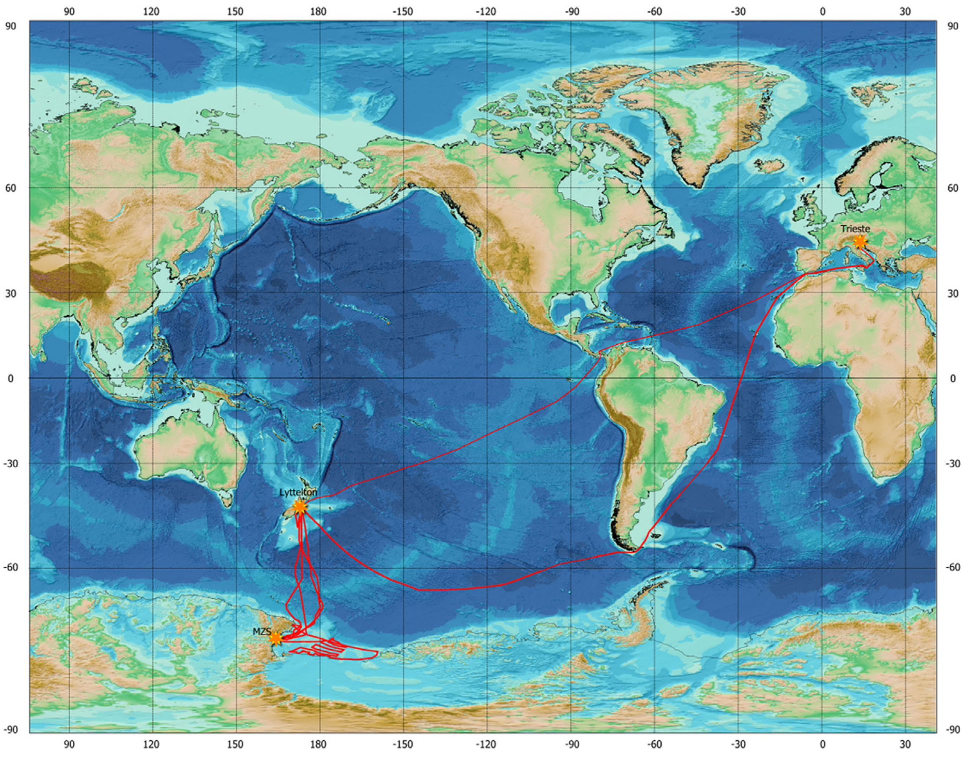


**Fig. 4.** Journey from Trieste, Italy to Lyttleton, New Zealand.

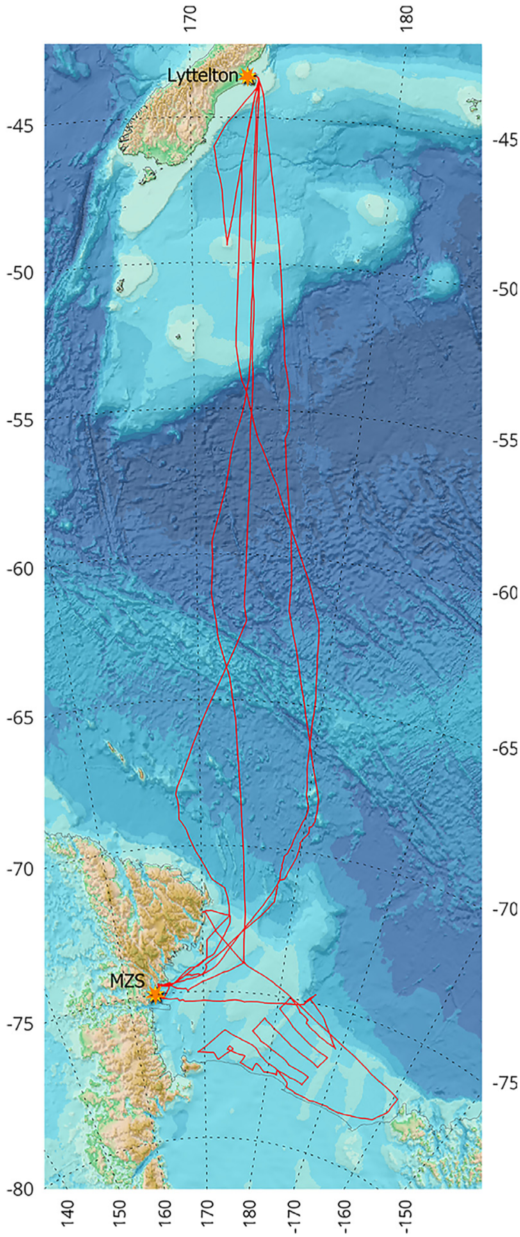


**Fig. 5.** The two legs from Lyttelton, New Zealand to the Italian Antarctic Base Mario Zucchelli Station.

software to operate the gamma-ray spectrometer Fig. 3. The computer was also accessible with AnyDesk to allow for remote access and data visualization.

For data validation, the obtained values were compared with those reported in the literature under similar measurement configurations at open sea, both for the total count rate and for the spectra [10,11].

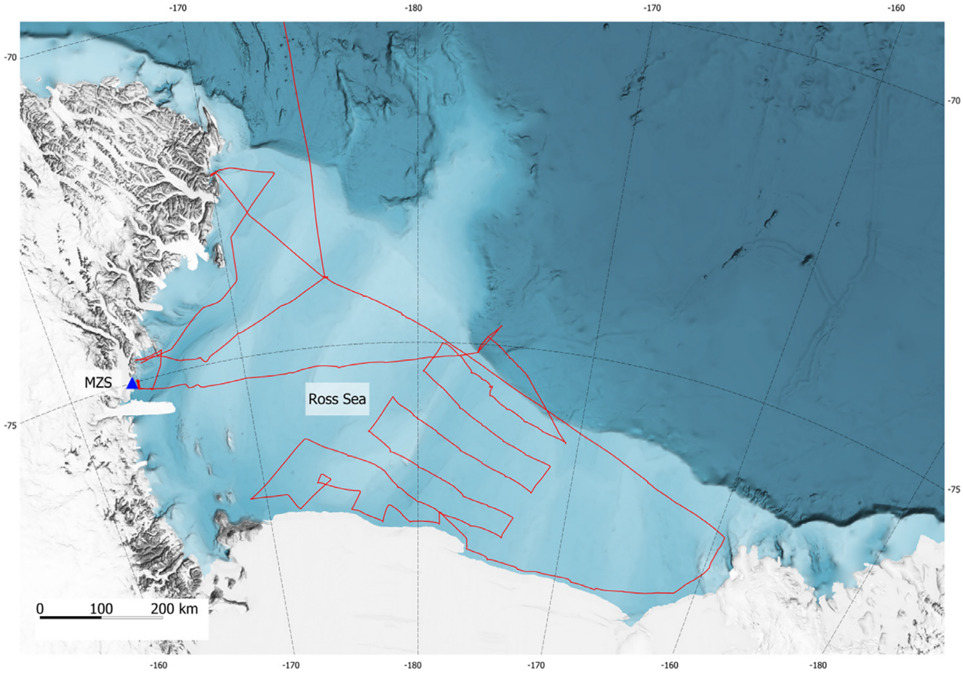


**Fig. 6.** Mapping bathymetry lines in the Ross Sea.

### *4.3. Georeferencing*

The RS-250 is also equipped with a compact GPS receiver. However, its georeferencing capability is limited to fixed measurement stations, where the position is set only once at the start of each acquisition process. Due to this design limitation, the latitude and longitude information in the CSV and N42 files is often incomplete or inaccurate.

To address this issue, locations were obtained from the vessel's scientific navigation system, specifically a Seapath 380–5+ [12] dual-antenna GPS (used for high-precision positioning during the campaign) and a Trimble GPS (used as a backup system). Navigation data were sampled every minute and stored in the Laura Bassi databases, both on board and at the OGS headquarters.

After post-processing, the synoptic CSV data was accurately georeferenced with high-quality latitude and longitude coordinates (WGS84). The N42 files, however, remained unmodified.

Fig. 4–6 show the path of the ship in the 2023–2024 Antarctic campaign. Firstly, the journey from Trieste, Italy to Littleton, New Zealand is shown. Secondly, the two legs from Littleton to the Italian Antarctic Base, Mario Zucchelli Station is reported. Finally, the mapping bathymetry lines in the Ross Sea are shown.

## Limitations

One limitation of the dataset arises from the installation location of the gamma-ray spectrometer on the R/V Laura Bassi. The instrument was mounted on the monkey island, a high and externally accessible part of the vessel, to ensure stability and continuous exposure to the environment. However, due to the surrounding ship structures and hull geometry, it is possible that some gamma radiation originating from the sea surface was partially shielded or attenuated.

## Ethics Statement

The authors have read and follow the ethical requirements for publication in Data in Brief and confirming that the current work does not involve human subjects, animal experiments, or any data collected from social media platforms.

## CRediT Author Statement

**F. Coren:** conceptualization, funding acquisition, project administration. **M. Iurcev:** supervision, methodology, writing – original draft. **M.E. Musco:** writing – original draft, review and editing. **B. Salmassian:** validation, writing – original draft. **A. Trebbi:** Methodology, data curation, Investigation, Software, Writing - Original Draft.

## Data Availability

rs250_csv_pnra40 (Original data) (Erdapp).

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## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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