SnT 2025
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE
8 SEPTEMBER ONLINE DAY
9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE

T3.6-700

What's new in the German Radioxenon Network

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INTRODUCTION AND MAIN RESULTS

Bundesamt für Strahlenschutz (BfS) has been operating a network with weekly sample collection at 6-8 locations in Germany with sampling starting in 1977. Since 2024, this network is complemented by the automatic xenon system Sauna Qb with a sampling period of 12h followed by automatic radioxenon analysis. The shorter sampling periods of the Sauna Qb promise a much better ability to characterize known emitters, evaluate ATM performance and localize unknown emitters. Here, we present data from the operation of a Sauna Qb at two different locations in Bavaria. We compare the measured data with modelled radioxenon activity concentrations expected at the sites from forward and backward ATM. In order to localize unknown emitters detects and non-detects at several stations within reasonable proximity can be combined. The Qb is thus an ideal supplement of the existing networks, both nationally and internationally. We therefore carefully consider the location of additional Sauna Qbs in Germany. We suggest to establish a common data sharing structure among Qb users.

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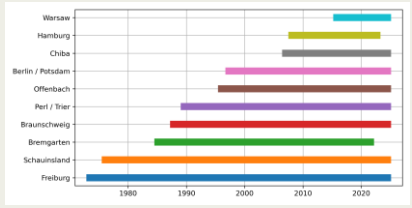
Weekly Xenon monitoring

Bundesamt für Strahlenschutz (BfS) has been operating a network with weekly sample collection at 6-8 locations in Germany with sampling starting in 1977.



BfS Noble Gas laboratory

Samples are shipped to the BfS lab in Freiburg and analyzed in 1 of 2 β-γ coincidence detection systems (SAUNA). The lab is support laboratory to the CTBTO and accredited according to DIN EN ISO/IEC 17025.

MDA Xe-133 (2 m^3 air, 24 h aq.): ≈ 1 mBq
Analysis of βγ-data with openSpex

Sauna Qb

The SAUNA Qb system is a compact, fully automated platform for measuring radioxenon in the atmosphere with a sampling period of 12h and ideally complements the weekly network.

The first Qb was initially installed in Munich / Neuherberg (July 2024) and then moved in May 2025 to be co-located with PS19 at GERES station in the Bavarian forest. A second Qb was installed in Freiburg in August 2025.

Sample re-analysis

Both Qbs were modified to allow for sample re-analysis after measurement by the system. Samples are re-analyzed in the BfS lab in Freiburg. Regular re-analysis is planned for both Qbs.

Measurement data

Initial data from the first three months of operation at GERES station shows several interesting detections, including multi-isotope detections.

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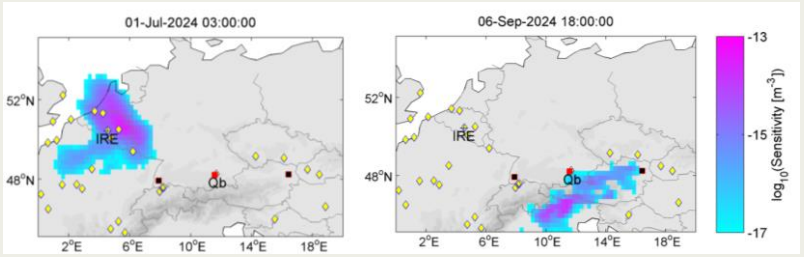
Atmospheric transport modelling

model: HYSPLIT v5.2.3 (NOAA-ARL)
meteorological data: NCEP GFS 0.25°
grid resolution: 0.25° x 0.25°
output interval: 3 h
simulated time: 240 h / 168 h (forward/backward)
model particles: 480.000 / 360.000 (fwd/bw)
vertical layers: 0-200 200-800 800-1600 1600-5000 m AGL / 0-500 m AGL (fwd/bw)

Backwards ATM for single detections

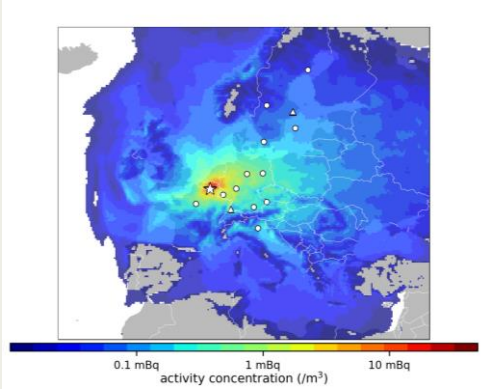
Backwards ATM was calculated for the samples from the Sauna Qb operation in Munich/Neuherberg. Here, we show snapshots from the backwards ATM from one sample with elevated AC of Xe-135 (left) and one with elevated Xe-133m AC (right). The 2.22 mBq/m3 of Xe-135 in the sample with collection start 2.7.2024 12:14 likely originate in Fleurus, Belgium. The provenance of the 0.15 mBq/m^3 Xe-133m in the sample with collection start 7.9.2024 18:00 cannot be attributed to a single emitting facility.

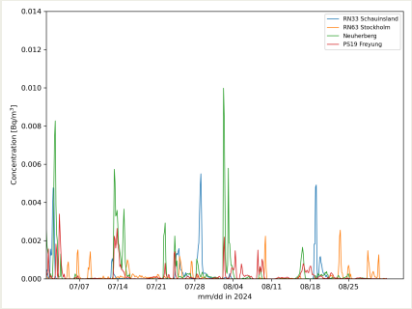


Radioxenon background from IRE Fleurus

The isotope production facility IRE in Fleurus, Belgium is the main radioxenon emitter in central Europe. PNNL has installed a STAX monitor at IRE Fleurus, providing valuable live data on radioxenon emissions from the facility.

Here we generated an averaged weekly emission time series and input it to 6 months of forward ATM (Mar - Aug 2024) to simulate the expected background from Fleurus at different potential locations.





GERES (PS19) was identified as a suitable location for a Sauna Qb due to its low expected influence of IRE Fleurus on Xe-133 activity concentrations.

Conclusion

- The German radioxenon network has been in operation for almost 50 years. The analysis is done in an accredited laboratory, but source localization is often a challenge for these weekly samples. The Sauna Qb offers a valuable supplement to this network, but needs automatic data processing pipelines and extensive atmospheric transport modelling.
- 2 Sauna Qbs are now in operation in Germany, in the Bavarian forest and in Freiburg.
- Sample re-analysis for quality assurance of Sauna Qb data.

Challenges & Outlook

- Sample association (including continued background modelling)
- Combination of detection and non-detection patterns
- Data sharing and integration of data from other European Qbs
- Systematic uncertainties of ATM remain a challenge
- Use of the special inversion weather situation in Freiburg / Schauinsland to investigate sources of Xe-131m, in light of the upcoming installation of a SPALAX NG on mount Schauinsland in 2026.

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