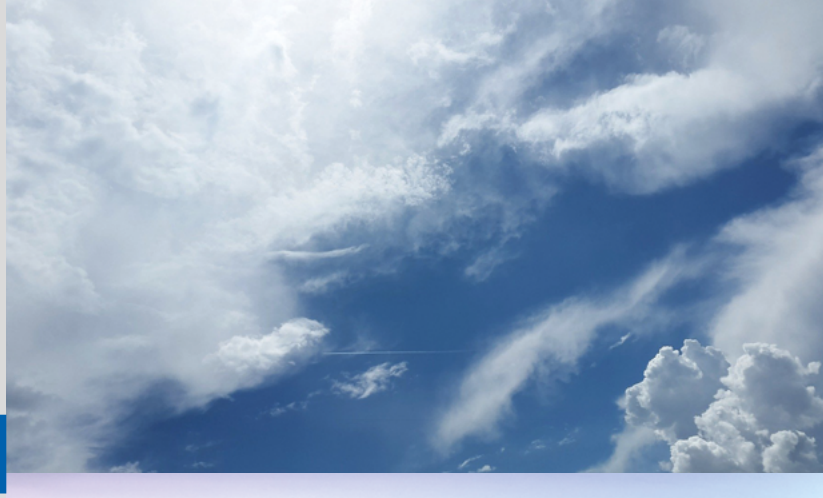
SAUNA QUBE







SAUNA QUBE – Radioactive Xenon Monitoring System

A change of perspective: stationed on own territory, QUBE monitors distant nuclear events. Radioxenon is the earliest indicator of irregularities in the operation of nuclear facilities. The isotope signature reveals the type of source and its condition, the array concept the point of origin.

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RADIOXENON MONITORING SYSTEM

SAUNA QUBE, the miniaturized, strong sister of SAUNA III, is a highly flexible, scalable radioxenon monitoring system. Its real power arises from the many: earliest warning and remote monitoring capabilities can easily be expanded by adding units to the QUBE array. If boundary conditions change, QUBE can swiftly be relocated to adjust the array dynamically.

FUNCTIONS

- Detection and identification of all four radioxenon isotopes with maximum confidence
- Powerful array concept:
  - Scalable from one to multiple units
  - Robust
- Accurate source localization and characterization
- State-of-health monitoring for all relevant components

FEATURES

- Low total cost of ownership: low power and gas consumption, nitrogen as carrier gas, low maintenance
- Small and compact, easily transportable – on wheels, can be moved by one person
- Plug-and-play installation
- Modular design for easy maintenance
- Exchange unit philosophy – quick and easy replacement
- Built-in, uninterruptible power supply with automatic shutdown
- Relaxed housing requirements: internal lead-shielded Cs-137 source (~1.5 kBq) for stabilization
- Calibrated at the factory

DESCRIPTION

SAUNA QUBE is the latest generation, fully automated system to measure the activity concentration of radioactive xenon in the atmosphere. QUBE uses a series of adsorption stages to extract xenon gas from the air. The volume of the xenon sample is measured and then transferred to a detector to measure the activity of the four relevant xenon isotopes using beta-gamma coincidence spectroscopy.

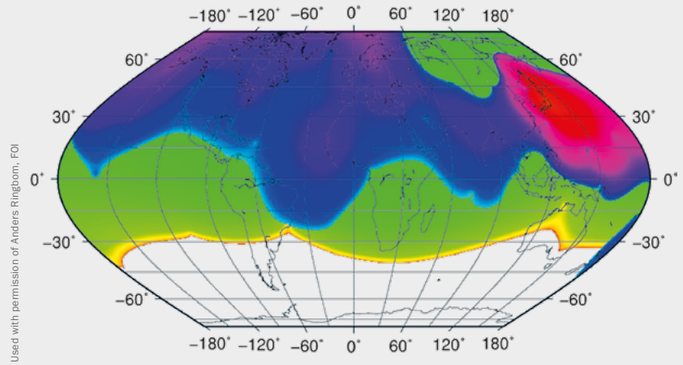
QUBE is highly scalable, operating as a single unit and in an array of multiple QUBE units spread over a larger geographic region. The array concept improves source localization and characterization. It also increases robustness compared to a single system as the array continues to function even if a single unit is down. Exchanging an individual unit is easy because of its transportability and plug-and-play design.

Great care was taken regarding the affordability and low total cost of ownership during QUBE development. Low nitrogen and power consumption as well as relaxed housing requirements form the basis, not to mention low maintenance efforts. QUBE is calibrated at the factory, its performance is verified on-site during the annual service.

MINIMUM DETECTABLE CONCENTRATIONS*

Isotope	Typical value
Xe-133	0.4 mBq/m³
Xe-133m	0.3 mBq/m³
Xe-131m	0.3 mBq/m³
Xe-135	1.0 mBq/m³

* Specified for a pure sample of the respective isotope in 12h sampling interval



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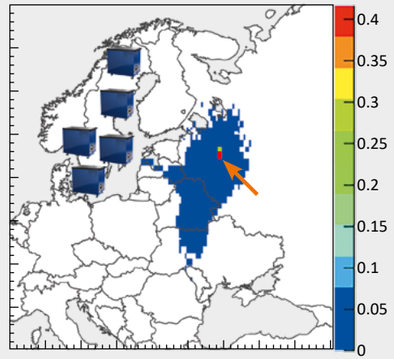
The radioxenon cloud from Fukushima Daiichi (green/yellow) can be detected earlier than Cs-137 (red/blue, same concentration scale): Xe travels further and is not washed out by precipitation



Precise and accurate localisation of radioxenon emissions with the array concept

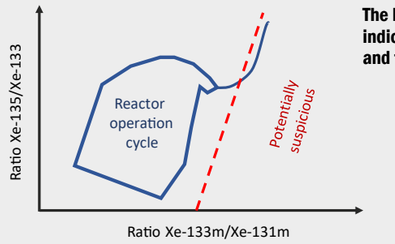
APPLICATIONS

- **Earliest warning**
  Radioactive xenon is the earliest remotely detectable precursor of nuclear events. Unusual radioxenon detections can indicate reactor operation outside of specifications.

- **Source localization**
  The larger the array, the more precisely the source of a radioxenon emission can be determined with atmospheric transport calculations.

- **Remote NPP monitoring**
  The xenon isotope ratios can contain information on the fuel cycle status of a specific NPP. The same holds true for concentration peaks or the absence of radioxenon under suitable wind conditions.

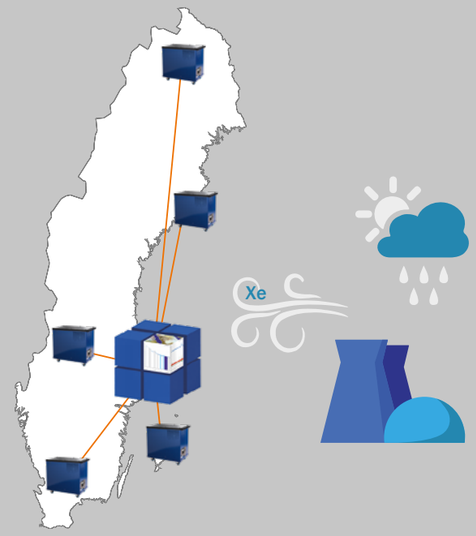
- **Nuclear weapons testing**
  Radioxenon isotope ratios can indicate whether the origin of an emission is an NPP, a medical isotope production facility, or a nuclear weapon test.



The Kalinowski diagram indicates origin and fuel conditions

ARRAY CONCEPT

The array concept improves geographic coverage and thus the earliest warning capability, compared to a single unit. It also improves source localization since individual detections are spread out in both time and space, especially when combined with atmospheric data and diffusion models.





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