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PREPARATORY COMMISSION

COMPREHENSIVE
NUCLEAR-TEST-BAN
TREATY ORGANIZATION

History of the temporary radioxenon measurement campaigns

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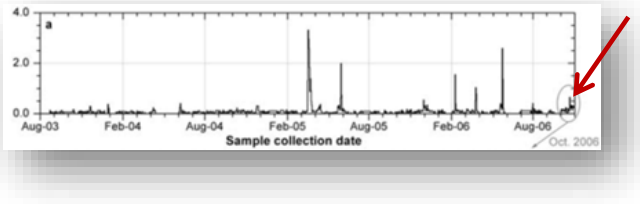
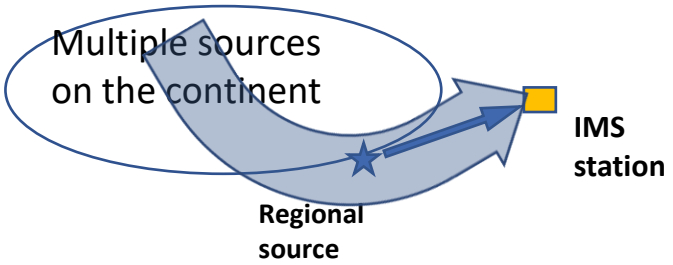
What are the problems that we are trying to solve?

- **Needle in a needle stack:** Xe-133 from nuclear explosion same as from civil facilities
- **Level C every day but still insufficient**: every Level B (10,000 per year!) might indicate a nuclear explosion and may still be above 1 mBq/m^3 = network design requirement
- **Blinding effect:** Small signal from a nuclear explosion may be covered up by large background from civilian sources
- **Hard to relate to a relevant SHI event:** Association with close-by source often inconclusive due to further downwind civil sources





How are we approaching this challenge?

The primary source of data for improving our understanding and for validating methods are the IMS NG systems of the CTBTO network.

In addition, **temporary radioxenon measurement campaigns** have been carried out by the PTS using **transportable noble gas (NG) systems** since 2008.

Technical / scientific aims of the campaigns:

- **Calibrating** the IMS verification system, i.e.
  - with focus on the four CTBT-relevant radioxenon isotopes (^{131m}Xe, ^{133m}Xe, ^{133}Xe, ^{135}Xe),
  - optimizing the capability of detecting signals from nuclear explosions against the standard background,
  - through event screening methodologies, specifically the categorization scheme with its abnormal threshold and screening flags.
- **Improving the performance** of the verification system, by evaluating / improving / developing / refining screening methods using metrics (applicable either to IMS stations or to the IMS network).

The overall goal is to **support States Signatories in making a judgment** regarding nuclear explosion monitoring by increasing the effectiveness in screening noble gas samples.

This **scientific project** is part of the progressive enhancement of the IDC technical capabilities, as experience is gained in the operation of the IMS and supplemented as needed by additional data collected with the temporary measurement campaigns.

Characteristics of the measurement campaigns

Framework of the measurement campaigns:

- The transportable NG systems are **not used for Treaty monitoring**,
- The systems are **always operating temporarily,**
- They support **scientific studies** related to atmospheric radioxenon background,
- They are **funded through voluntary contributions** from States Signatories.

The deployment of transportable NG systems also has the potential to support capacity building, cooperation and exchange among States Signatories, in particular for States who do not host IMS NG stations.

Technological developments on transportable noble gas systems are also relevant **to establishing temporary arrangements for IMS stations** (Article IV of the Treaty, paragraph 26).

Use of data collected during the campaigns:

- Data are used by PTS and SS to **develop and test scientific methods** relevant to nuclear explosion monitoring,
- Data are **processed in a non-operational database** of the IDC,
- **No IDC products** are generated.

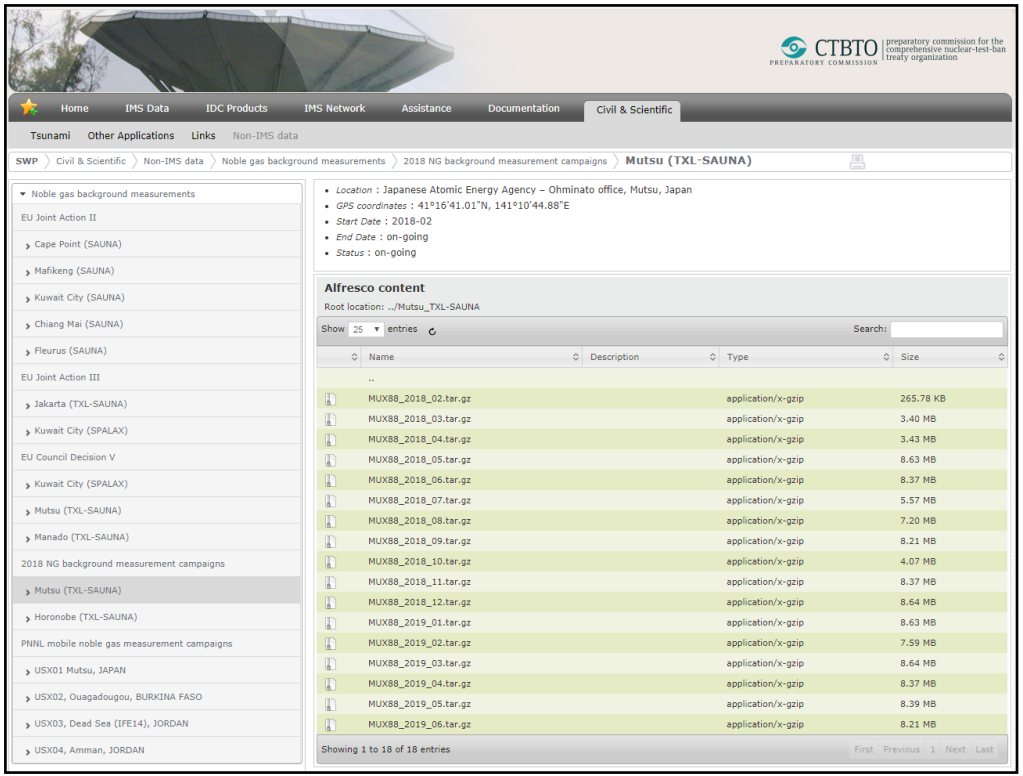
All data collected during the temporary measurement campaigns are made available on the Secured Web Portal of the IDC.

Availability of the NG background measurement data

Information about all temporary NG background measurement campaigns is available on the CTBTO Secure Web Portal (SWP). This includes the plans, the raw data, analysis results and conclusions.

Data are made available:

- for authorized users designated by States Signatories,
- for scientists who have signed a confidentiality agreement to access the virtual Data Exploitation (vDEC) platform.



Summary of past / ongoing radioxenon measurement campaigns

Site	Host country	Start	End
Fleurus	Belgium	2008-06-26	2008-07-16
Kuwait City	Kuwait	2008-09-11	2008-11-30
Mafikeng	South Africa	2008-11-17	2008-12-18
Cape Point	South Africa	2009-01-13	2009-02-02
Chiang Mai	Thailand	2009-02-26	2009-04-29
Isar-1	Germany	2009-03-02	2009-03-08
Jakarta	Indonesia	2012-03-01	2013-08-01
Kuwait City	Kuwait	2012-05-16	2018-02-01
Mutsu	Japan	2014-07-01	2014-10-19
Manado	Indonesia	2015-02-15	2017-09-30
Mutsu	Japan	2018-02-26	/
Horonobe	Japan	2018-01-18	/
Fukuoka	Japan	Planned	/
Mutsu	Japan	2012-04-02	2012-10-09
Ouagadougou	Burkina Faso	2013-06-27	2014-02-09
Dead Sea	Jordan	2014-11-08	2014-12-11
Amman	Jordan	2014-12-14	2015-03-10

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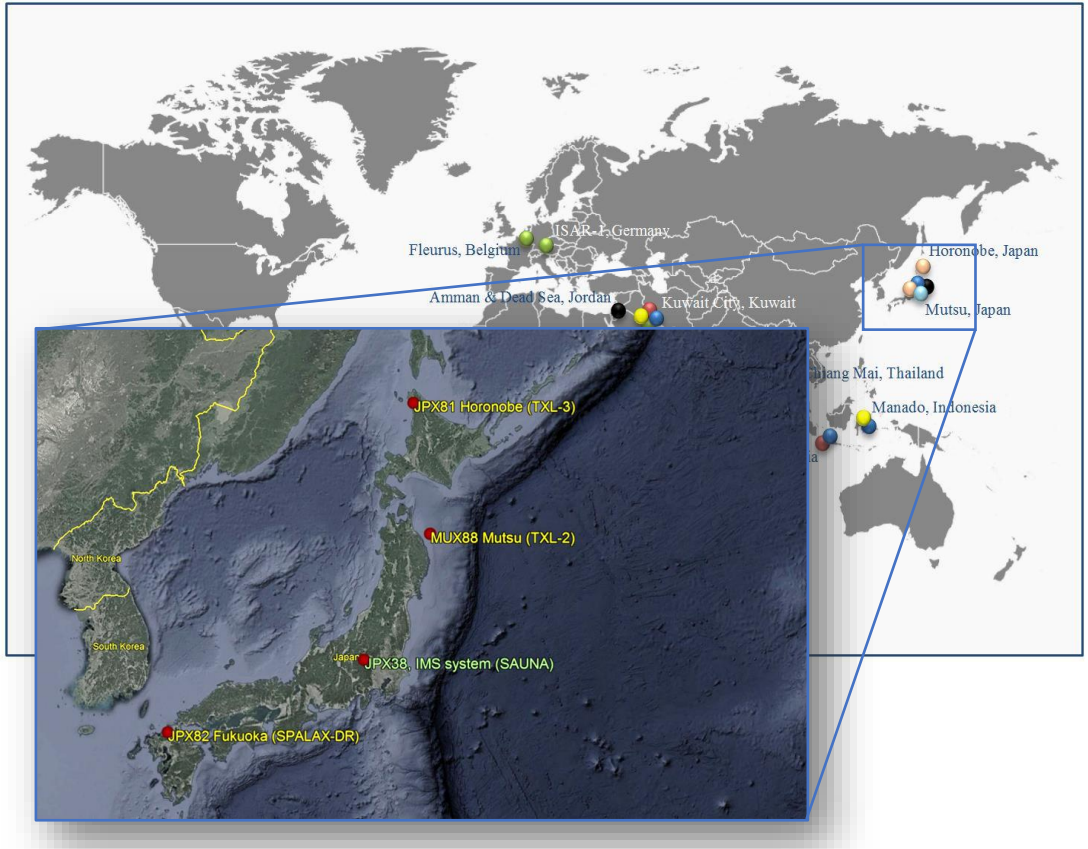
Summary of past / ongoing radioxenon measurement campaigns

Creation of a high-density network: to improve / optimize source location algorithms, allowing a better understanding of Level C episodes of the IMS network.



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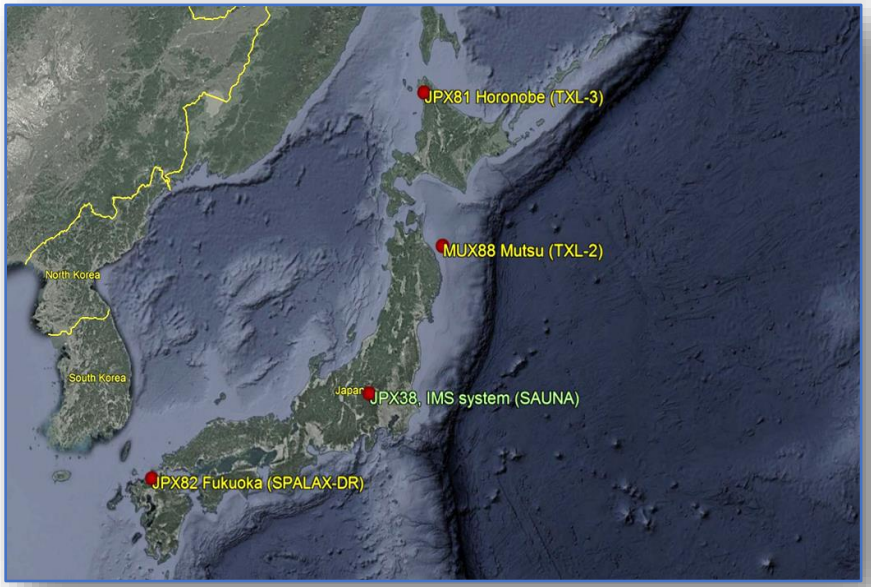
Ongoing measurement campaigns in Japan



Creation of a high-density network (around RN38, Takasaki) with transportable systems in:

- Horonobe: data transmission started in January 2018,
- Mutsu: data transmission started in March 2018,
- Fukuoka: installation pending PrepCom guidance.

Aim of this high-density network:

- Cross-validation of the systems,
- Cross-correlation of the detections,
- Development of small-scale high-resolution ATM models,
- Observation of the same release event at different locations.

Expected outcomes are improved / optimized source location algorithms, allowing a better understand of Level C episodes of the IMS network.

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Guiding principle for the deployment of transportable radioxenon systems

The **guiding principle** for selecting the locations of measurement campaigns with transportable radioxenon systems, complementary to IMS NG systems, is **to develop or to advance scientific** methods focused on calibration and performance of the verification system as described in the Treaty and in particular, among others, to:

1. **Fully implement the NG categorization scheme** as approved by WGB at its Thirty-Eighth Session CTBT/WGB-38/1, paragraph 71) that addresses the noise and background observed at IMS stations, in accordance with the Treaty. This is crucial for the IMS capability to detect and identify signals from nuclear explosions.

2. **Develop and test methods to determine which radionuclide samples are associated with the same radionuclide release event**. Such methods may have the potential to be used to add a missing component to the Standard Screened Radionuclide Event Bulletin (SSREB) as prescribed in the draft IDC Operational Manual (CTBT/WGB/TL-11,17/19/Rev.5).

3. **Develop and test methods for expert technical analysis to assist States Parties in identifying the source of an event** (Protocol to the Treaty, Part I, paragraph 20(c)).

The above mentioned scientific advances in various applications can only be partially achieved with the data being collected by the operational IMS noble gas systems. In fact owing to the **dynamic processes in the atmosphere**, the radioxenon background at IMS stations is caused by air that is continuously arriving from other regions through atmospheric transport. Significant benefit will be gained from experimental data collected at additional locations even for a limited time.

Conclusions

Temporary radioxenon measurement campaigns have been carried out by the PTS using **transportable noble gas (NG) systems** since 2008

Important results (shared in the companion presentation) in addition to what was learnt from IMS data:

- Xe135 has to be included in the categorization scheme,
- The categorization scheme is robust against strongly fluctuating background,
- Pure Xe131m can be observed, and bias isotopic ratios – caution is needed when using ratio screening flags.

Idea of future scientific proposals (shared in the companion presentation as reading material):

- Method for associating samples to the same release event
- Provide more accurate estimates of the possible location of the source of an event and test the different PSR options
- Developing the screening flag "ATM backtracking to known sources" for ARR and RRR
- Complex terrain
    - Mountains
    - Land-sea Breeze
- Use of isotopic ratio measurements for screening
- Others ideas and suggestions?

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Transportable NG systems

Transportable NG measurement systems :

- Are based on the two IMS NG measurement systems certified by the PTS,
- Have identical specifications as IMS systems and meet the same minimum requirements,
- Are integrated within standard ISO containers for transportation purpose,
- Have auxiliary generator and UPS integrated to provide power autonomy if needed,
- Provide near real-time data transmission by email.

The basic operating principle from air collection to activity measurement is as follows: