CTBTO.ORG

CTBTO
PREPARATORY COMMISSION

COMPREHENSIVE
NUCLEAR-TEST-BAN
TREATY ORGANIZATION

The International Monitoring System

WOSMIP IX

Richard Britton, Guillaume Beziat
IMS Division, CTBTO

Santiago, Chile
December 4-7th 2023

Introduction

The International Monitoring System

OVERVIEW

- The Comprehensive Nuclear-Test-Ban Treaty (CTBT) bans nuclear explosions by everyone, everywhere: above ground, under water and underground
- The treaty opened for signature in 1996, currently signed by 187 states
- Part of a wider global non-proliferation and disarmament regime

MISSION

- The CTBTO exists to prepare for the Treaty's entry into force. It has two main tasks:
    - Promoting universal recognition of the Treaty
    - Building up the verification regime to ensure no nuclear explosion can go undetected

The International Monitoring System

HOW?

- The **International Monitoring System** (also International Data Centre, and On-Site Inspection, see other talks)

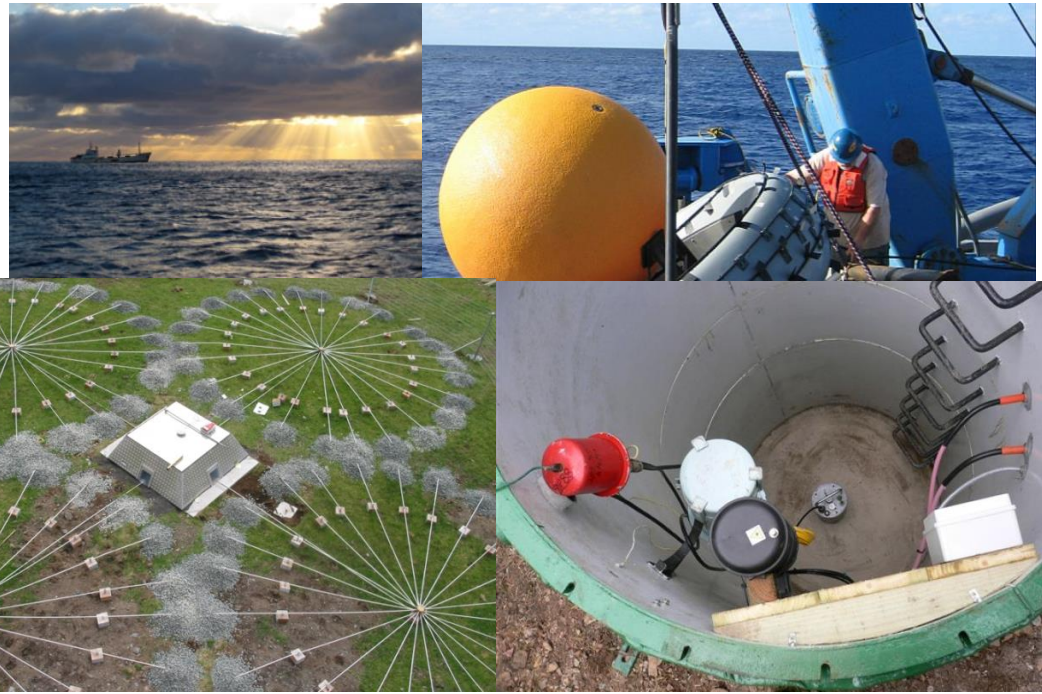
The International Monitoring System

IMS Stations

- 337 dedicated facilities
- 321 monitoring stations
- 16 laboratories

IMS Technologies

- ***Hydroacoustic***
- ***Seismic***
- ***Infrasound***
- Radionuclide



The International Monitoring System

IMS Stations

- 337 dedicated facilities
- 321 monitoring stations
- 16 laboratories

IMS Technologies

- Hydroacoustic
- Seismic
- Infrasound
- ***Radionuclide***

The International Monitoring System

IMS Technologies (Radionuclide)

- Particulate Monitoring
  - Manual and Automated systems
  - One sample per day
  - $\mu Bq.m^{-3}$ (10^{-6}) detection limits
- Noble Gas (NG) Monitoring
  - All systems fully automated
  - Multiple NG samples per day
  - $mBq.m^{-3}$ (10^{-3}) detection limits
- 24/7 monitoring, 80 station network design
  - 73 P & 26 NG stations currently certified

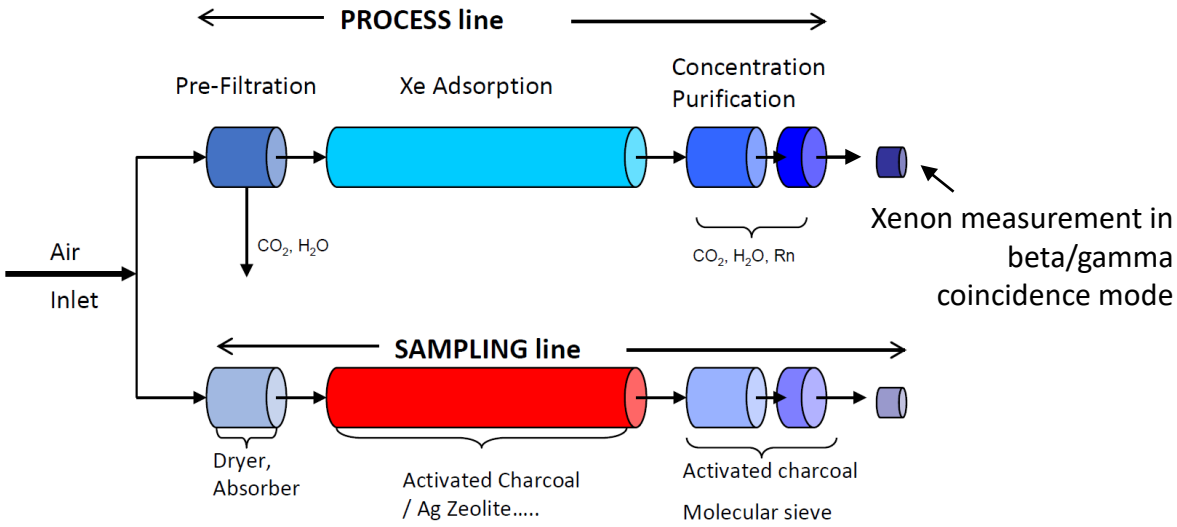
Detection Systems

(Next-generation) Xenon Systems in the IMS

CTBT/PC/II/1/Add.2
Page 49

Characteristics	*Minimum requirements*
Air flow	0.4 m^3/h
Total volume of sample	10 m^3
Collection time	≤ 24 h
Measurement time	≤ 24 h
Time before reporting	≤ 48 h
Reporting frequency	daily
Isotopes measured	^{131m}Xe, ^{133m}Xe, ^{133m}Xe, ^{135m}Xe
Measurement mode [23]	beta-gamma coincidence or high resolution gamma spectrometry
Minimum Detectable Concentration [24]	1 mBq/m^3 for ^{133}Xe
State of health	status data transmitted to IDC
Communication	two-way
Data availability [25]	95 %
Down time [25]	≤ 7 consecutive days ≤ 15 days annually

(Next-generation) Xenon Systems in the IMS



(Next-generation) Xenon Systems in the IMS

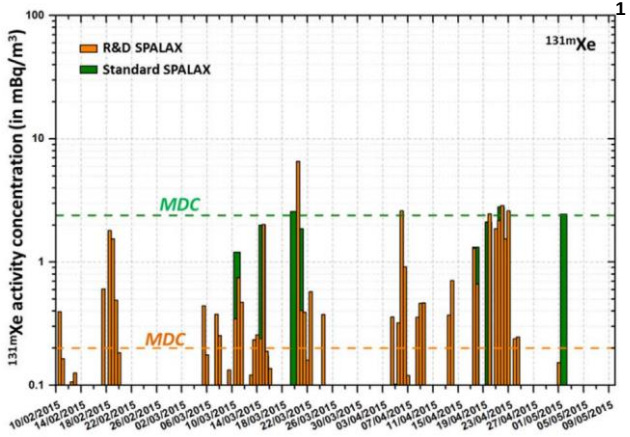
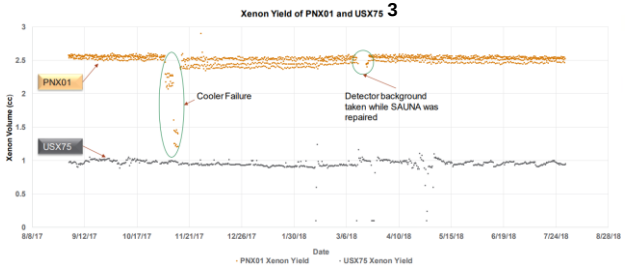


Table 1 2

Average minimum detectable concentrations in mBq/m^3 for the SAUNA II and SAUNA III systems in Stockholm 2017–2019.

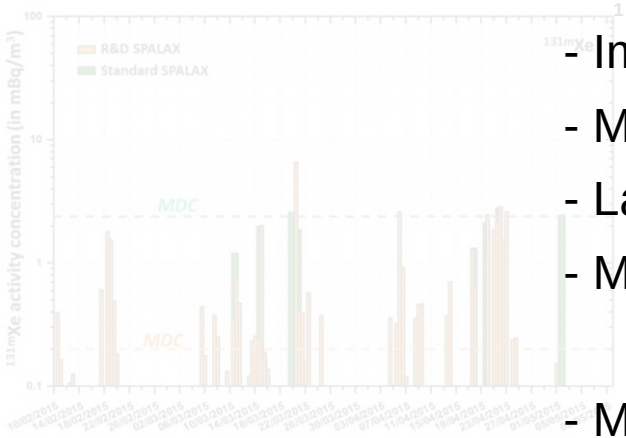
	SAUNA II	SAUNA III	SAUNA III no GASBK(*)
Air volume (m^3)	16	44	43
Xenon volume (sccm)	1.0	2.7	2.7
MDC ^{133}Xe (mBq/m^3)	0.43	0.15	0.07
MDC ^{131m}Xe (mBq/m^3)	0.27	0.15	0.07
MDC ^{133m}Xe (mBq/m^3)	0.23	0.15	0.08
MDC ^{135}Xe (mBq/m^3)	0.87	0.36	0.24

(*) Data from a nine-month period in 2020–2021 when the system was operated in the gas-background free-mode.



1. A. Cagniant, S. Topin, G. Le Petit, P. Gross, O. Delaune, T. Philippe, G. Douysset, SPALAX NG: A breakthrough in radioxenon field measurement, ARI 134 (2018) https://doi.org/10.1016/j.apradiso.2017.06.042
2. M. Aldener, A. Axelsson, T. Fritioff, J. Kastlander, A. Ringbom, SAUNA III - The next generation noble gas system for verification of nuclear explosions, JER 262 (2023) https://doi.org/10.1016/j.jenvrad.2023.107159
3. J. Hayes, Xenon International, WOSMIP Remote (2020), https://www.wosmip.org/sites/default/files/2020-07/Xenon_International_Hayes.pdf

(Next-generation) Xenon Systems in the IMS



- Improved detection limits
- More samples per day
- Larger Xenon yields
- More locations

- More detections!

1. A. Cagniant, S. Topin, G. Le Petit, P. Gross, O. Delaune, T. Philippe, G. Douysset, SPALAX NG: A breakthrough in radioxenon field measurement, ARI 134 (2018) https://doi.org/10.1016/j.apradiso.2017.06.042
2. M. Aldener, A. Axelsson, T. Fritioff, J. Kastlander, A. Ringbom, SAUNA III - The next generation noble gas system for verification of nuclear explosions, JER 262 (2023) https://doi.org/10.1016/j.jenvrad.2023.107159
3. J. Hayes, Xenon International, WOSMIP Remote (2020), https://www.wosmip.org/sites/default/files/2020-07/Xenon_International_Hayes.pdf

Rollout Plan

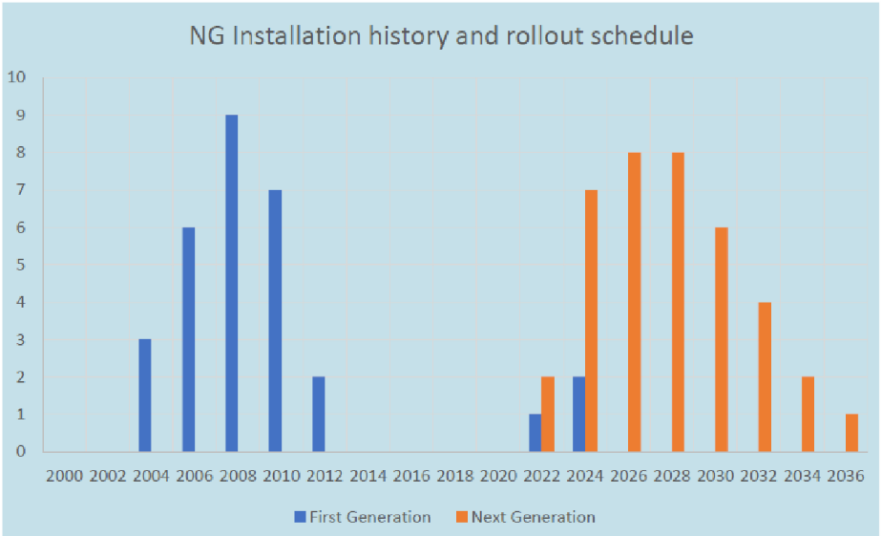
- An older plot, but illustrative of the systems likely to come on-line in the next 10 years

- Deployment will be a mixture of system types, including Xenon International, SPALAX-NG, SAUNA III and MIKS

- Total station coverage will also increase from 26 NG systems towards 40

- Eventual IMS configuration could approach 80 NG stations

- Station locations and numbers are limited by the Treaty



The International Monitoring System

Summary

- The International Monitoring System is growing
- The number of deployed xenon systems will increase
- The sensitivity and throughput of monitoring stations will increase

But

- There are many emitters, often clustered (on IMS scales)
- More emitters are coming online
- A complex and dynamic Radioxenon background will continue to dilute and mask releases from Treaty violations

Thank you!

CTBTO
PREPARATORY COMMISSION

Vienna International Centre, PO Box 1200
1400 Vienna, Austria
CTBTO.ORG