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Source Term Analysis of Xenon (STAX) – Exploring Methods for Understanding Radioxenon Civilian Terms

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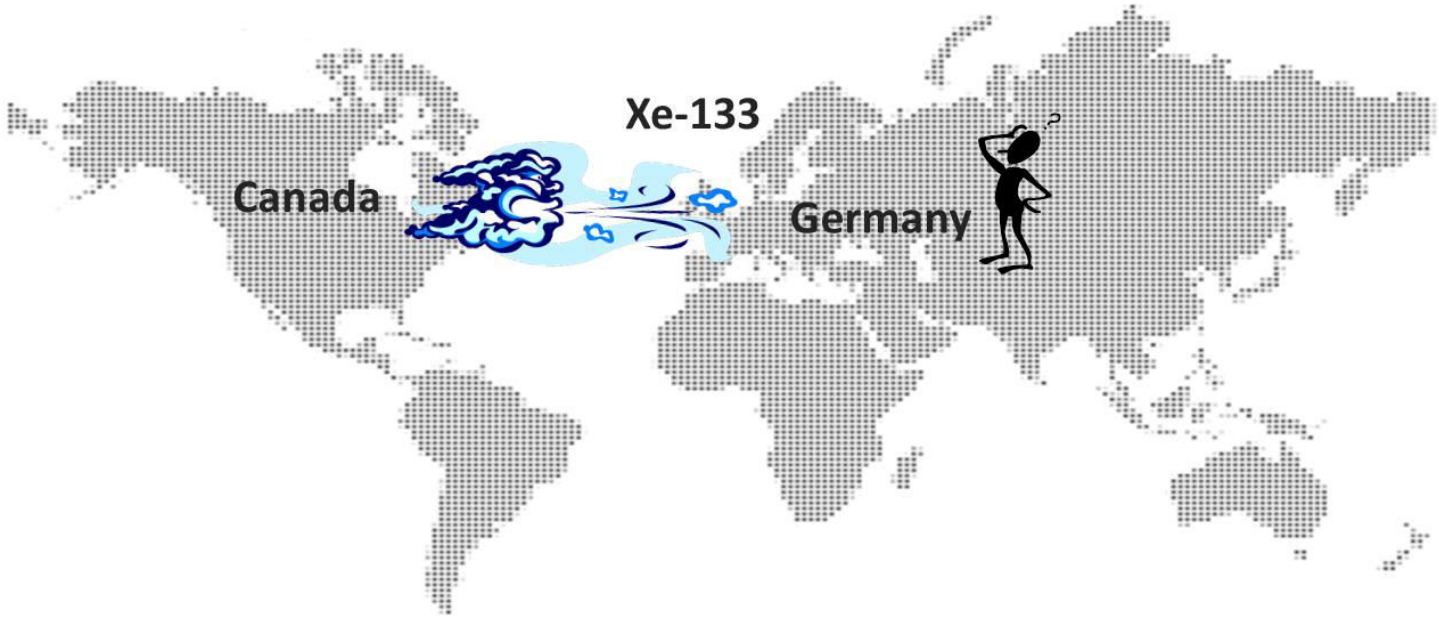
Outline

- Introduction to the problem
- Data Upload Experiment
- STAX project
- Summary

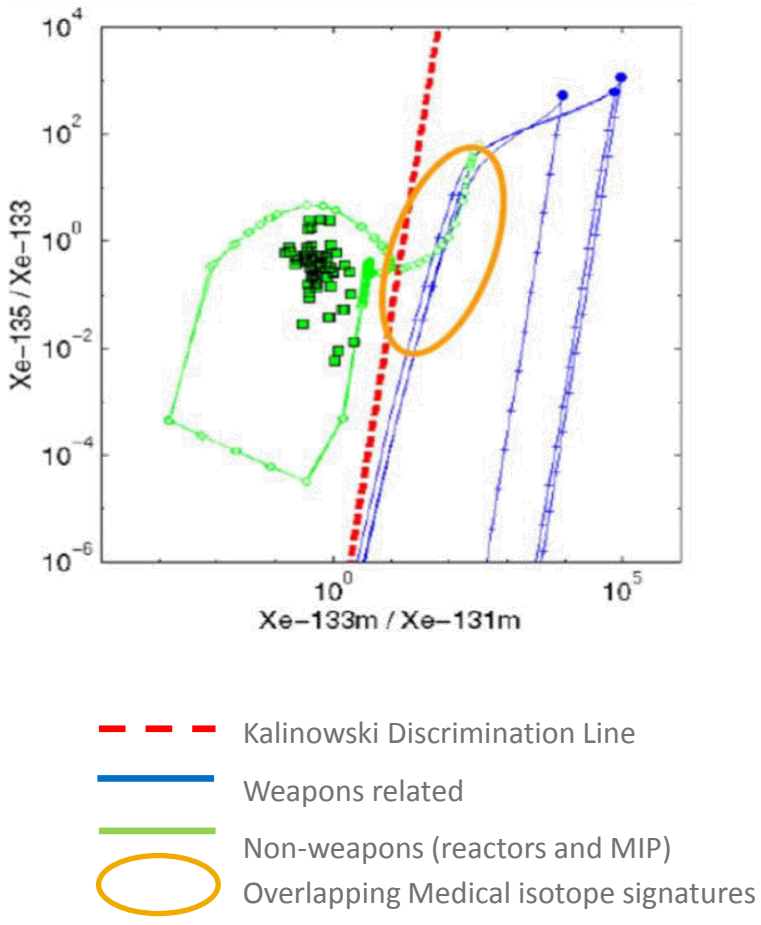
The Problem: Fission Based Medical Isotope Production Interferes with IMS Detection



- Background from medical isotope production (MIP) is routinely detected by the International Monitoring System (IMS). For example, xenon from the Chalk River Canada MIP facility has been detected at the Schauinsland Mountain station in Germany. This background decreases sensitivity of IMS and makes distinguishing nuclear explosions more difficult.[1]
- Because of this interference, MIP has been investigated to learn more about the effect of their emissions on the IMS.
- For a more comprehensive explanation of the IMS see the CTBTO PrepCom website www.ctbto.org.

[1]Saey et. al., The influence on the radioxenon background during the temporary suspension of operations of three major medical isotope production facilities in the Northern Hemisphere and during the start-up of another facility in the Southern Hemisphere, Journal of Environmental Radioactivity, 101, 2010.

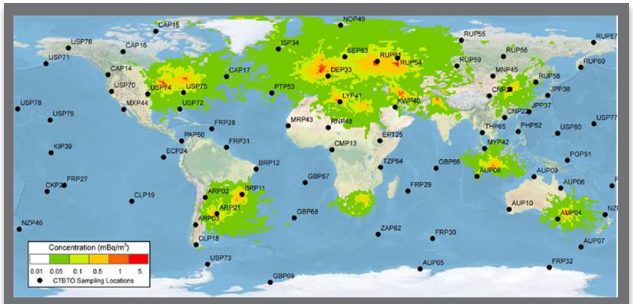
Signatures of Medical Isotope Production



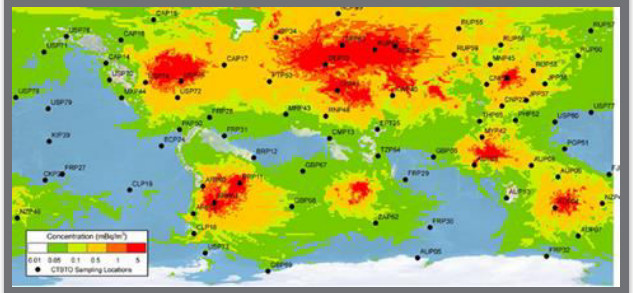
- Some medical isotope production facilities produce xenon emission signatures similar to that of nuclear weapons.
- The Kalinowski plot uses ratios of radioxenon isotopes to distinguish weapons related activities from peaceful nuclear activities. Xenon signatures of weapons related activities are located to the right of the Kalinowski discrimination line while those from nuclear power plants fall to the left of this line.
- Signatures of MIP overlap the discrimination line and can be difficult to clearly separate from weapons related activities.
- Therefore, xenon backgrounds from MIP reduce the IMS xenon monitoring sensitivity and ability to clearly discriminate between peaceful and rogue activities.

20. M Mathews, et. al. Workshop on Signatures of Medical and Industrial Isotope Production—A Review. PNNL-19294. 2010.

^{133}Xe Background from MIP



Top – theoretical background of ^{133}Xe for a scenario in which all fission based MIP release of 5×10^9 Bq/day ^{133}Xe



Bottom – theoretical background of ^{133}Xe assuming MIP facilities release 1×10^{12} Bq/day ^{133}Xe from each facility.

- A global background of radioxenon is created from peaceful industrial releases.
- This background has the potential to effectively decrease the ability of the IMS to discriminate a nuclear explosion.
  - The sensitivity for ^{133}Xe is approximately 300 microBq/m^3.
- Abatement of ^{133}Xe is the best solution, but not practical for all situations
- Sharing radioxenon stack release data with the CTBTO PrepCom has been discussed as a tool to be used to discriminate between radioxenon released from MIP and nuclear explosions.

Sensitive Xenon Detection Systems

The SAUNA xenon monitoring system uses adsorbent separation along with beta-gamma detection

The SPALAX xenon monitoring system uses membrane separation along with germanium gamma spectroscopy

- Xenon monitoring is a relatively 'new' technology. Several automatic sampler-analyzer systems have been developed since the mid 1990s.
- Four isotopes of xenon are used for IMS monitoring:
  - ^{133}Xe $T_{1/2}$ = 5.3 d
  - ^{133m}Xe $T_{1/2}$ = 2.2 d
  - ^{131m}Xe $T_{1/2}$ = 11.9 d
  - ^{135}Xe $T_{1/2}$ = 9.1 h
- The sensitivity for ^{133}Xe is approximately 300 microBq/m^3 or 5000 atoms.

IMS Monitoring Stations

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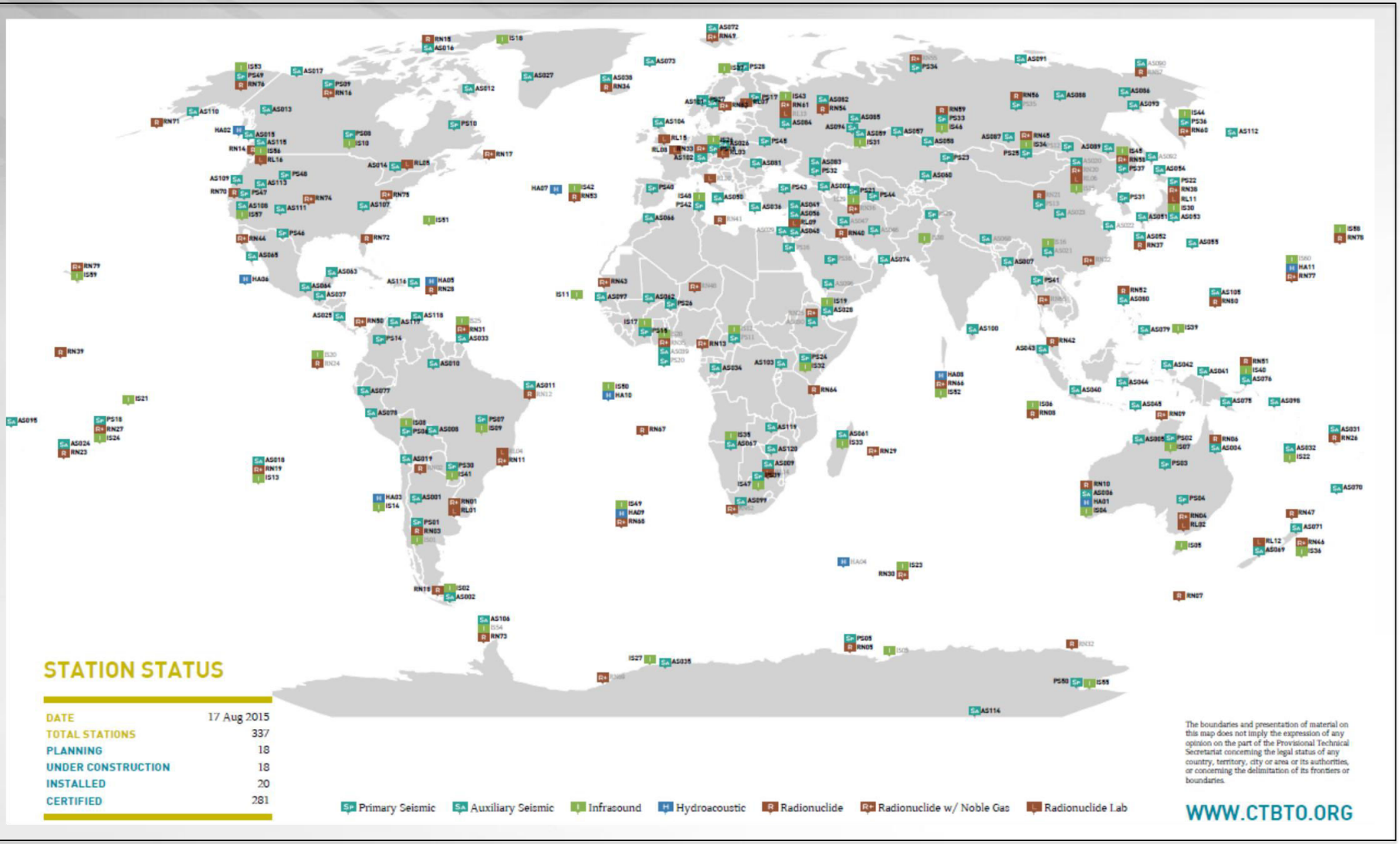


WOSMIP VI
Workshop on Signatures of
Man-Made Isotope Production
28th November | 2nd December 2016
Bariloche | Patagonia | Argentina
CTBTO
PNNL
INVAP

Stack Data Upload Experiment

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- Conducted by working group formed in 2015 following WOSMIP V
  - Many producers expressed willingness to share stack release data
  - CTBTO PrepCom agreed to start accepting stack data on an experimental basis
  - Working group
    - Producer Team: ANSTO, IRE, INUKI
    - Data Team: CTBTO PrepCom, PNNL
    - Software Team: TBD, will include members from the producer and data teams

- This experiment was initiated to:
  - Help develop the methods required for near real time data sharing
  - Identify gaps and issues so that a successful program of transferring data sets for scientific studies could be established.

CTBTO preparatory commission for the comprehensive nuclear-test-ban treaty organization
PREPARATORY COMMISSION

ansto

IRE

INUKI
Industri Nuklir Indonesia

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Use of Stack Release Data to Better Understand the Global Radioxenon Background

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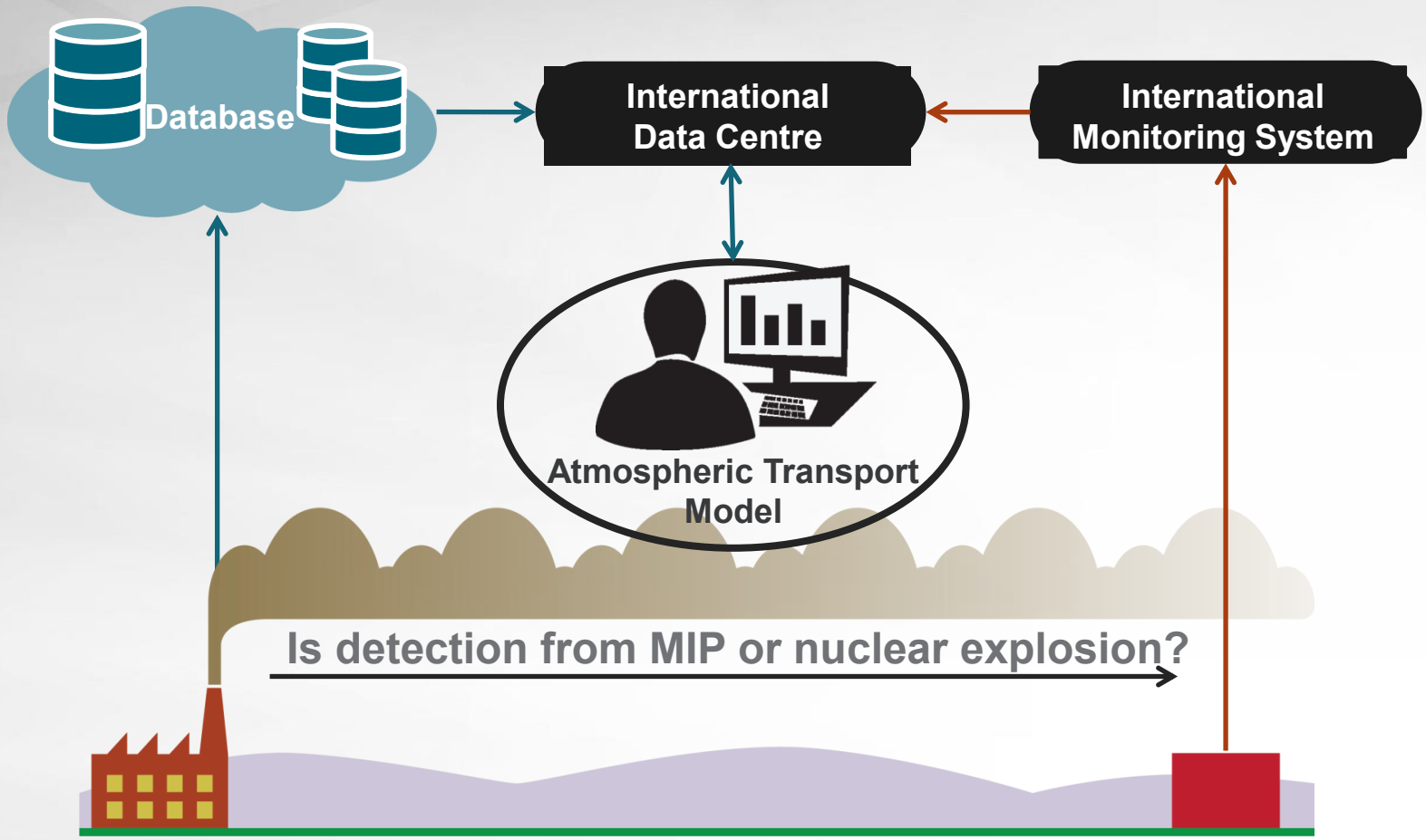
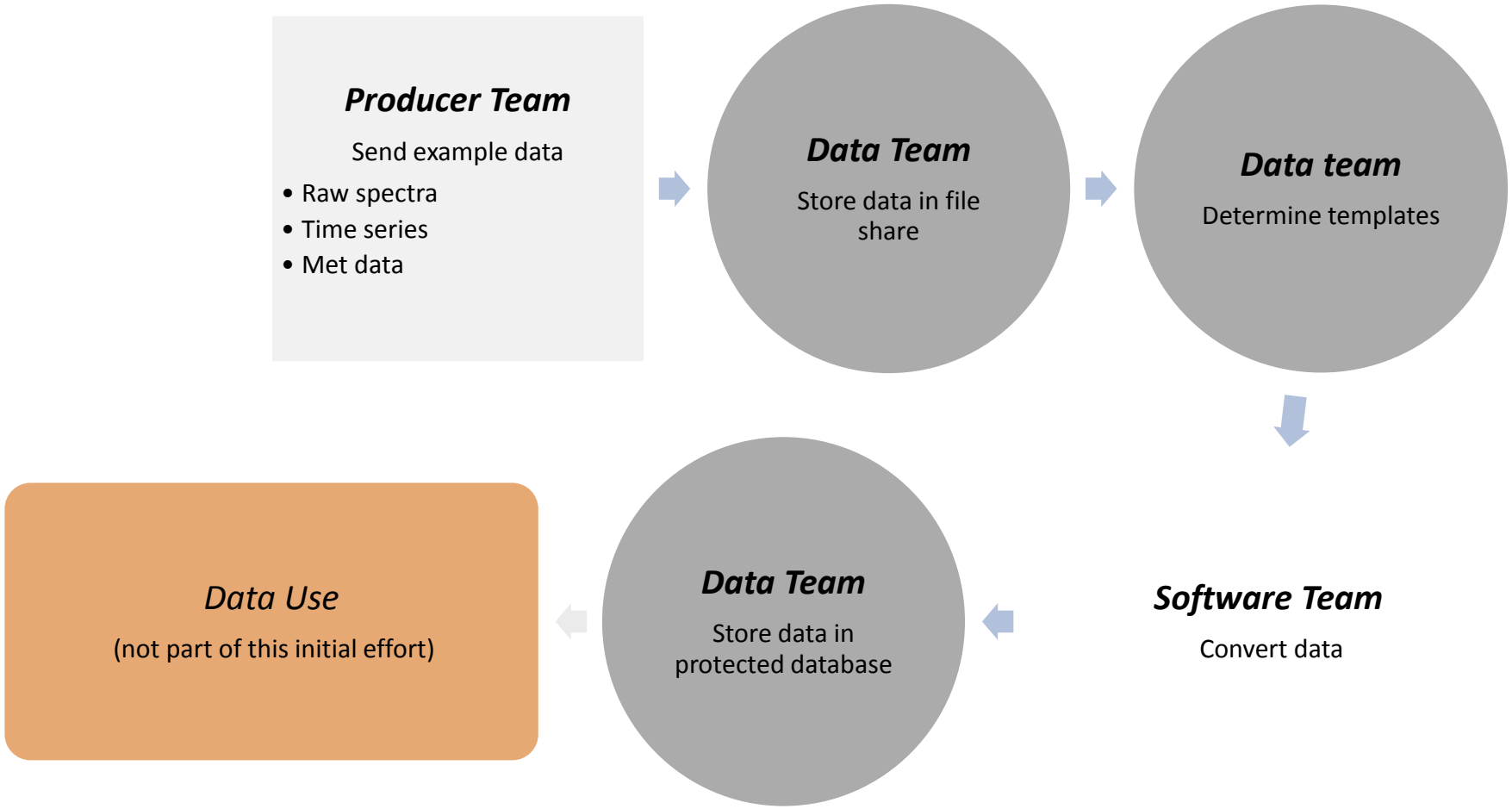


Objectives

- Establish a experimental data repository demonstrating that the data can be handled in a confidential manner
- Conduct an experiment to send test data to a repository while demonstrating that the data can be handled in a confidential manner
- Produce experimental database architecture and software implementation that is usable by the CTBTO PrepCom

Experimental Outline



Experimental Progress

- A stack release data software requirements specification document was created by the CTBTO PrepCom
- A data repository has been established
  - Cloud Computing by creating an AWS S3 (Amazon Simple Storage Service) file system, Cloudberry Explorer
  - Scalable platform - easily integrated with AWS computing, database, and other cloud services as the demand grows.
- Example data has been uploaded to the repository by INUKI, ANSTO and IRE. Types of data received include:
  - Raw spectra
  - Processed data
  - Concentration and air volume data
  - Meteorological data

Stack Release Data Software Requirements Spefications

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- Initial draft CTBTO PrepCom software requirements documents (version 0.4)

Requirements

1. Data Input
2. Data Processing
3. Data Storage
4. Data Viewing and Reporting
5. Data Output
6. Formal Requirements

What is STAX?
(Source Term Analysis of Xenon)

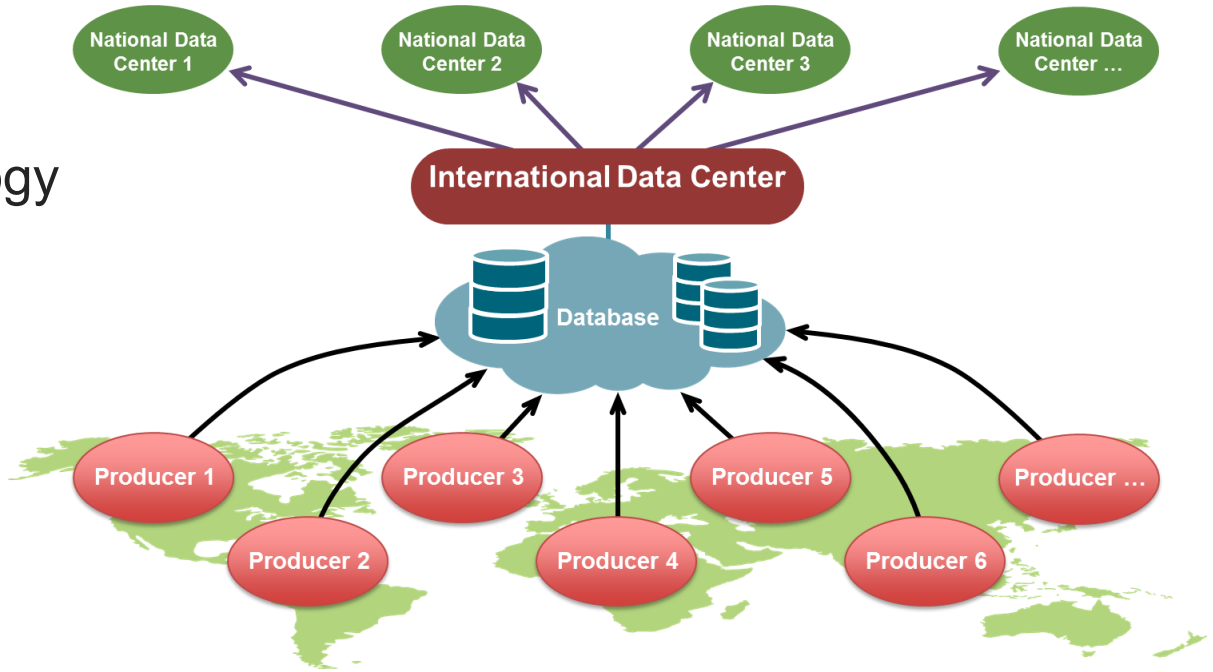
- A project that would develop methods, tools, and technology for the use of Medical Isotope Production (MIP) radioxenon emissions for CTBT PrepCom verification.

- Develop technical solutions for:
  - Stack data collection (technology)
  - Stack data transfer (to Vienna)
  - Stack data security (confidentiality of data)
  - Stack data use (by the IDC and NDCs)

STAX Project

- Determine data format specifications based on available data from the producers
- Develop methods for conversion of data to a standard format
- Determine the most efficient means to transfer data between organizations

- If successful, technology developed in this experiment could be implemented into a global stack data network



How STAX Could Work

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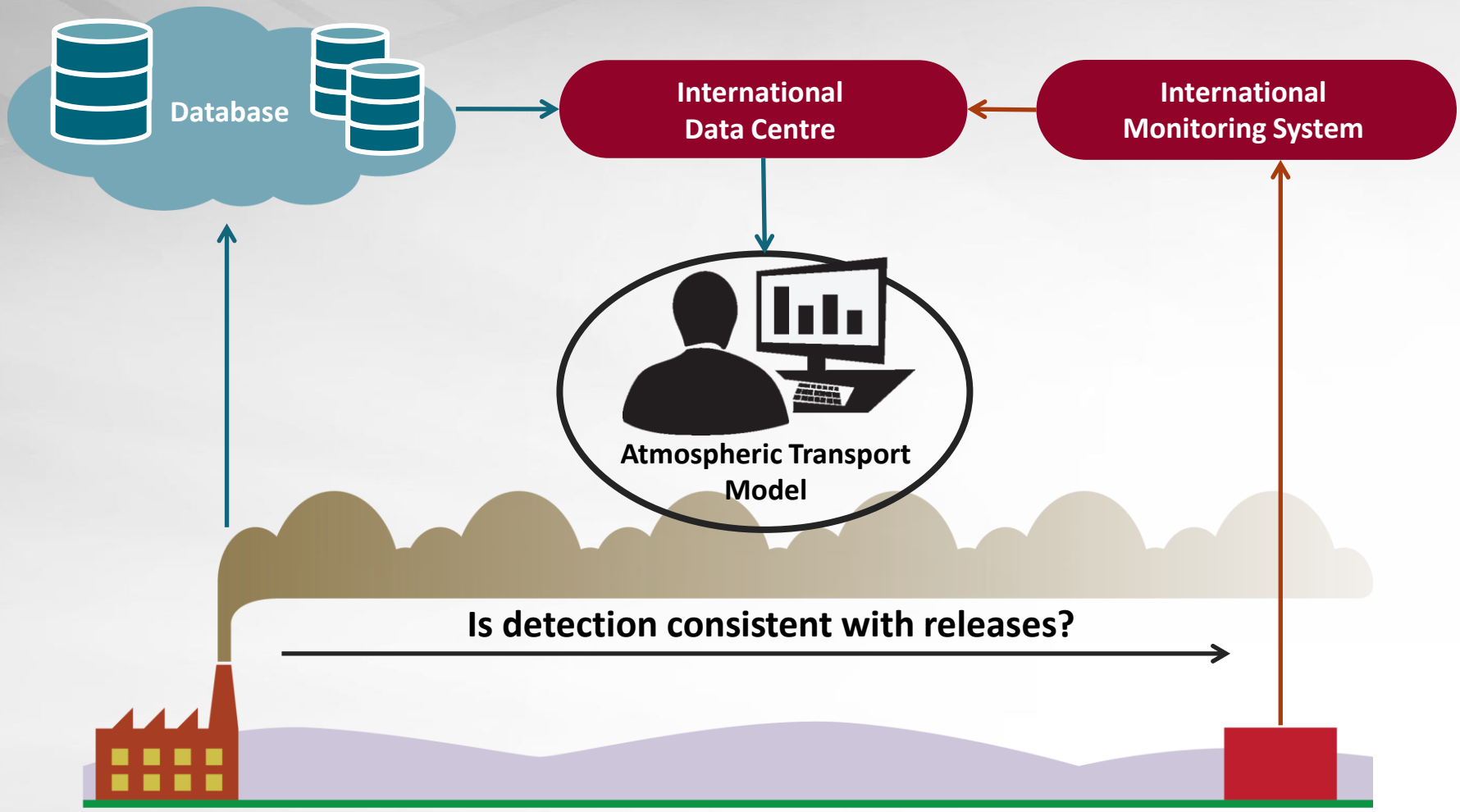

How Would STAX be Implemented?

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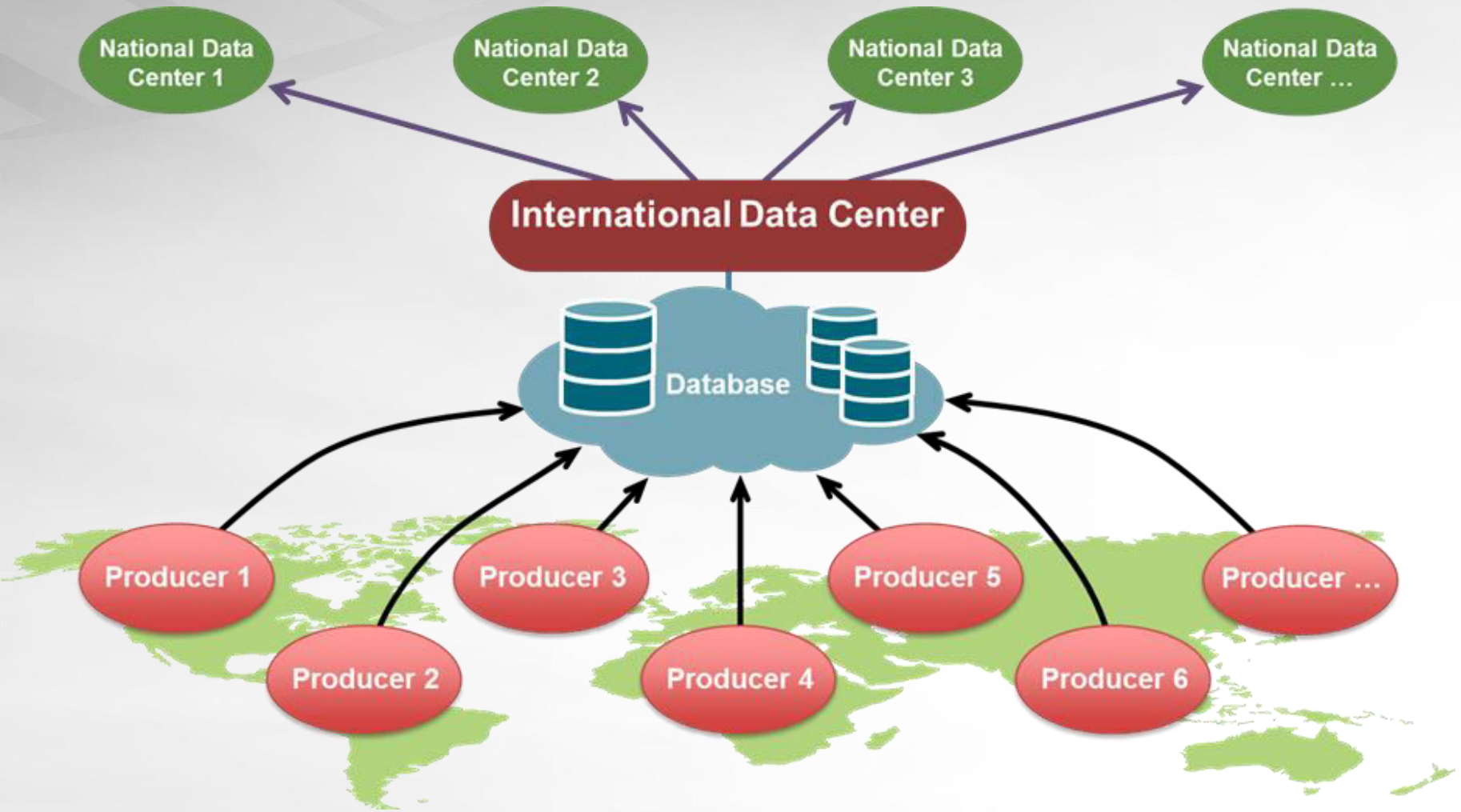

STAX Data Requirements

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General Types of Data

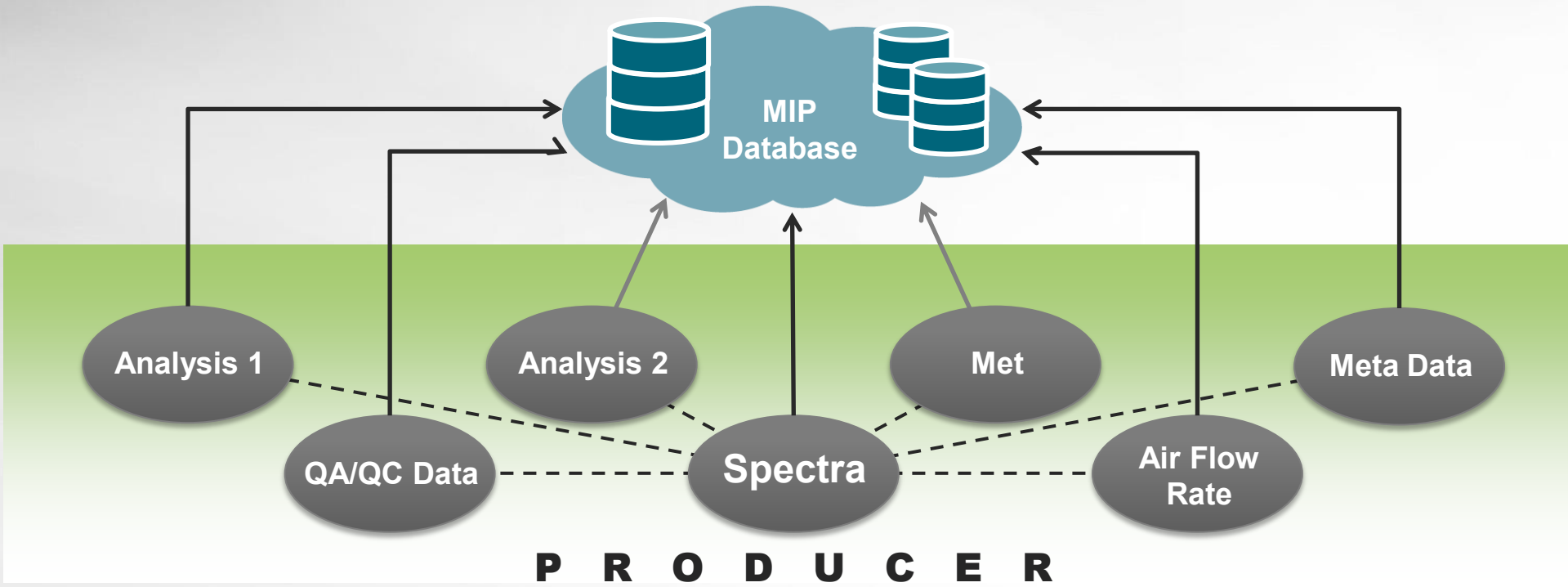
- Gamma Spectra
- Air Flow rates
  - Detector air
  - Stack air
- State of Health (SOH)
- QA/QC calibration data

General Requirements

- Four Xe isotopes
  - In the presence of inferences
  - 10% uncertainty
- 1GBq to10 TBq dynamic range
- Other IMS relevant radionuclides

Different Options for Stack Data Sharing

- Likely, not a “one size fits all” solution



Detector Technology

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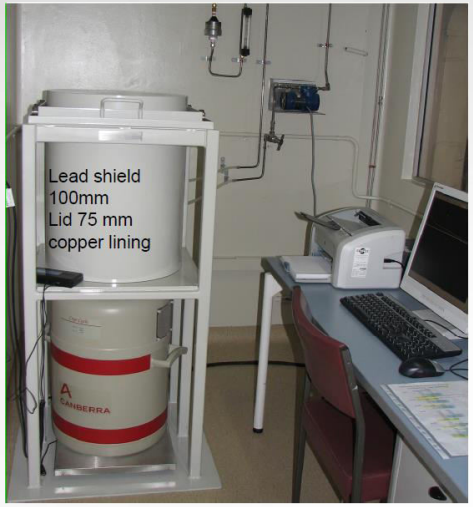
- Hardware needs to be able to meet the data requirements

Stack Monitor in Batan Indonesia



Stack Monitor at ANSTO

*WOSMIP 2012 Presentation by Hoffman

Stack Monitor at IRE

*WOSMIP 2012 presentation by Deconnick

Stack Monitor by INVAP

*2012 WOSMIP presentation by Di Tada

STAX conclusion

- Stack Data has been shown to be of value to the monitoring community in understanding detections

- If a STAX project were to be implemented…
  - Agreed framework for stack data needed
  - Standardized technology and data processing needed
  - Data confidentially needs to be implemented