Status of the IAEA-led project on Decay Data Library For Monitoring Applications

F.G. Kondev on behalf of J. Chen, V. Dimitriou, T. Kibedi, S. Lalkovski, A. Negret, A. Nichols, S. Pascu, B. Singh, J. Tuli & M. Verpelli

Introduction

⇒ monitoring applications: associated with detecting of nuclear explosions

⇒ four different monitoring technologies are used:

- seismic: seismic events
- hydro-acoustic: acoustic waves in oceans
- infra-sound: very low-frequency sound waves
- ☞ radionuclide monitoring: radioactivity in atmosphere

Nuclear test, Upshot-Knothole, Event Badger, 18 April 1953, Nevada test Site, USA

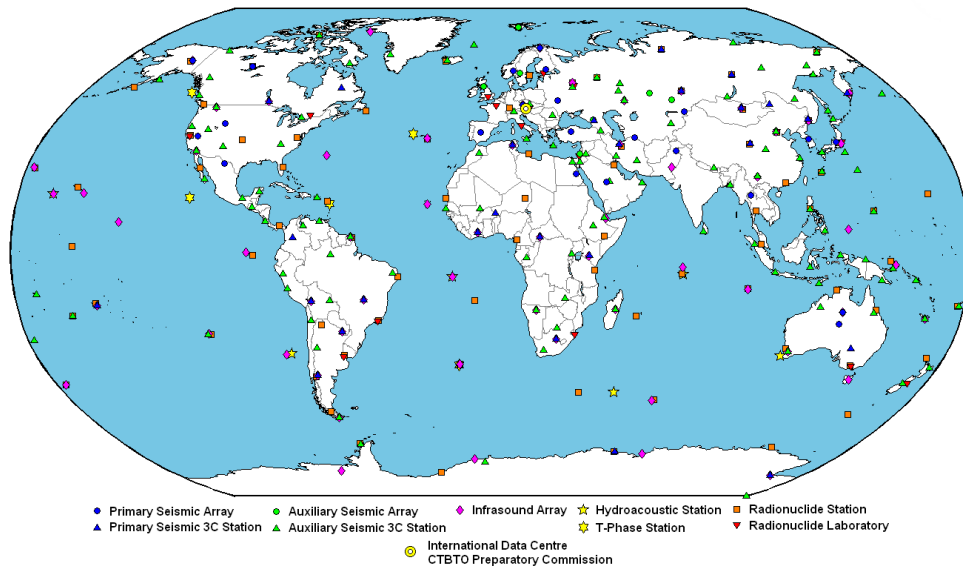Crater from Castle Bravo test seen from space

Able test, 1951, Nevada test Site, USA

Images from the CTBTO website

Who, Where & How

CTBTO: Comprehensive Nuclear-Test-Ban Treaty Organization
~300 staff from >90 countries & $130M annual budget

- **120** seismic stations
- **11** hydro-acoustic stations
- **60** infra-sound stations

- **80** radionuclide stations
  - ▶ air samples & noble gas purification
  - ▶ gamma- and beta-ray detections
- **16** laboratories – assist in the analysis of radioactive samples

INTERNATIONAL MONITORING SYSTEM

- ● Primary Seismic Array
- ▲ Primary Seismic 3C Station
- ● Auxiliary Seismic Array
- ▲ Auxiliary Seismic 3C Station
- ◆ Infrasound Array
- ★ T-Phase Station
- ★ Hydroacoustic Station
- ■ Radionuclide Station
- ▼ Radionuclide Laboratory
- ◎ International Data Centre CTBTO Preparatory Commission

International Data Center @ CTBTO
Provisional Technical Secretariat

Monitoring 7 days a week / 24 hours a day

data from the CTBTO website

Nuclear Data Needs

⇒ for gamma-ray spectra analysis – ND for radionuclides in the fission product region with half-lives of a few hours to several days, including noble gases and specifically ^{133,133m,135}Xe

- half-lives
- absolute γ-ray emission probabilities of the strongest gamma lines
- X-rays data - in a case there is only g.s. to g.s. decay, e.g. ^{106}Ru

⇒ for detector development & data analysis (Monte Carlo codes)

- complete decay schemes
- absolute beta (β^-, β^+ & EC) emission probabilities & beta spectra
- absolute atomic radiation data and spectra

⇒ currently

- data retrieved from ENSDF & DDEP; software are developed in house

IAEA project (2019 -2025)

⇒ **Objective:** Create a decay data library with up-to-date recommended data for radionuclide used in monitoring applications

⇒ **How?**

- establish evaluation policies and procedures → comprehensive decay data evaluation methodology was adopted by the participants
- evaluate the decay data sets from "scratch" – not blindly copying from ENSDF or DDEP
- review process (by participants) and final editorial review (by the coordinator)

⇒ **Where?**

- Complete data library at IAEA-NDS (online) and CTBTO & publication

⇒ **Who?**

- Technical coordinator: F. Kondev (ANL)
- Evaluators: J. Chen (FRIB/MSU), V. Dimitiou (IAEA), T. Kibedi (ANU), F. Kondev (ANL), S. Lalkovski (U. Sofia), A. Negret (IFIN-HH), A. Nichols (U. Surrey), S. Pascu (IFIN-HH), B. Singh (deceased), J. Tuli (retired)
- Codes: J. Chen (FRIB/MSU), T. Kibedi (ANU), M. Verpelli (IAEA)
- Collaboration with CTBTO IDC staff

Work program

⇒ **31 priority radionuclides – in consultation with CTBTO staff**

⇒ **Decay data evaluation:**

- Parent: E_x, $J\pi$, $T_{1/2}$ and Q value
- Daughter:
  - → Levels: E_x, $J\pi$, and $T_{1/2}$
  - → Gammas: $E\gamma$, $I\gamma$ (absolute), Mult, δ, and α_T
  - → Beta/EC properties: absolute emission probabilities
  - → Beta/EC derived properties (log ft, E_{ave} & spectra): calculated using the BETASHAPE code (X. Mougeot, LHNB-CEA-Saclay)
  - → Atomic radiation data and spectra derived properties (energies, intensities & spectra for X rays & conversion and Auger e-): calculated using the BrIccEmis code (T. Kibedi, ANU)

⇒ **Format:**

- ENSDF
- CTBTO-specific

⇒ **Dissemination:**

- ENSDF-formatted files
- Atomic and nuclear radiation spectra - in separate files
- Dedicated Website (IAEA-NDS) and journal publication

Status – release plan

⇒ Completed (including editorial reviews):

- 14 radionuclides

⇒ Under review:

- 4 radionuclides

⇒ Under evaluation:

- 13 radionuclides

⇒ All evaluations, including reviews and post-review revisions, are envisioned to be completed by the end of 2024

⇒ Completed library will be available in early 2025

⇒ Publication in EPJ is envisioned in the second half of 2025

⇒ Library is not only relevant to radionuclide monitoring, but can be used in other applications, i.e. nonproliferation, nuclear reactor monitoring, medical applications, etc.