

Nuclear Forensics as Border Crossing Support -Experience and Perspectives -



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Detection



Radiation Alarm
at a scrap metal yard in
Europe



Nuclear Material (U, Pu,
reactor or weapons grade) or
other radioactive material
(^{60}Co , ^{137}Cs , ^{192}Ir ,...)

Categorization



Nuclear Forensics

Source Attribution



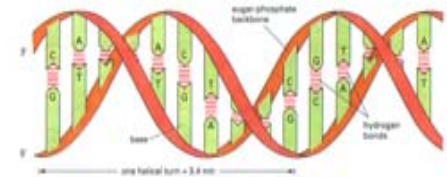
Nuclear Forensics

- provides clues on the history of nuclear material
 - production process
 - date of production
 - place of production
 - intended use
- provides information on nuclear material of immediate relevance to law enforcement

Aims at identifying suspect individual using information adherent to the pieces of evidence:

- Fingerprints
- “genetic fingerprint”
- Fibre
- Hair
- Residues of explosives

Objective



Solve criminal case and put criminal individual to jail

Aims at identifying origin and intended use using information inherent to the (nuclear) material:

- Isotopic Composition
- Elemental Composition
- Impurities
- Macroscopic appearance
- Microstructure
- Decay Products

Objective



Improve safeguards and physical protection measures at place of theft or diversion to prevent future thefts or diversions, supporting prosecution.

Nuclear Material



Nuclear Forensic Analysis

Characteristic Parameters



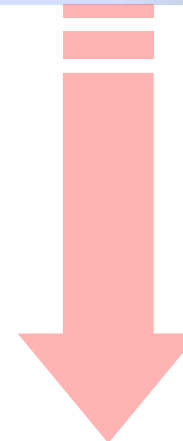
Material History



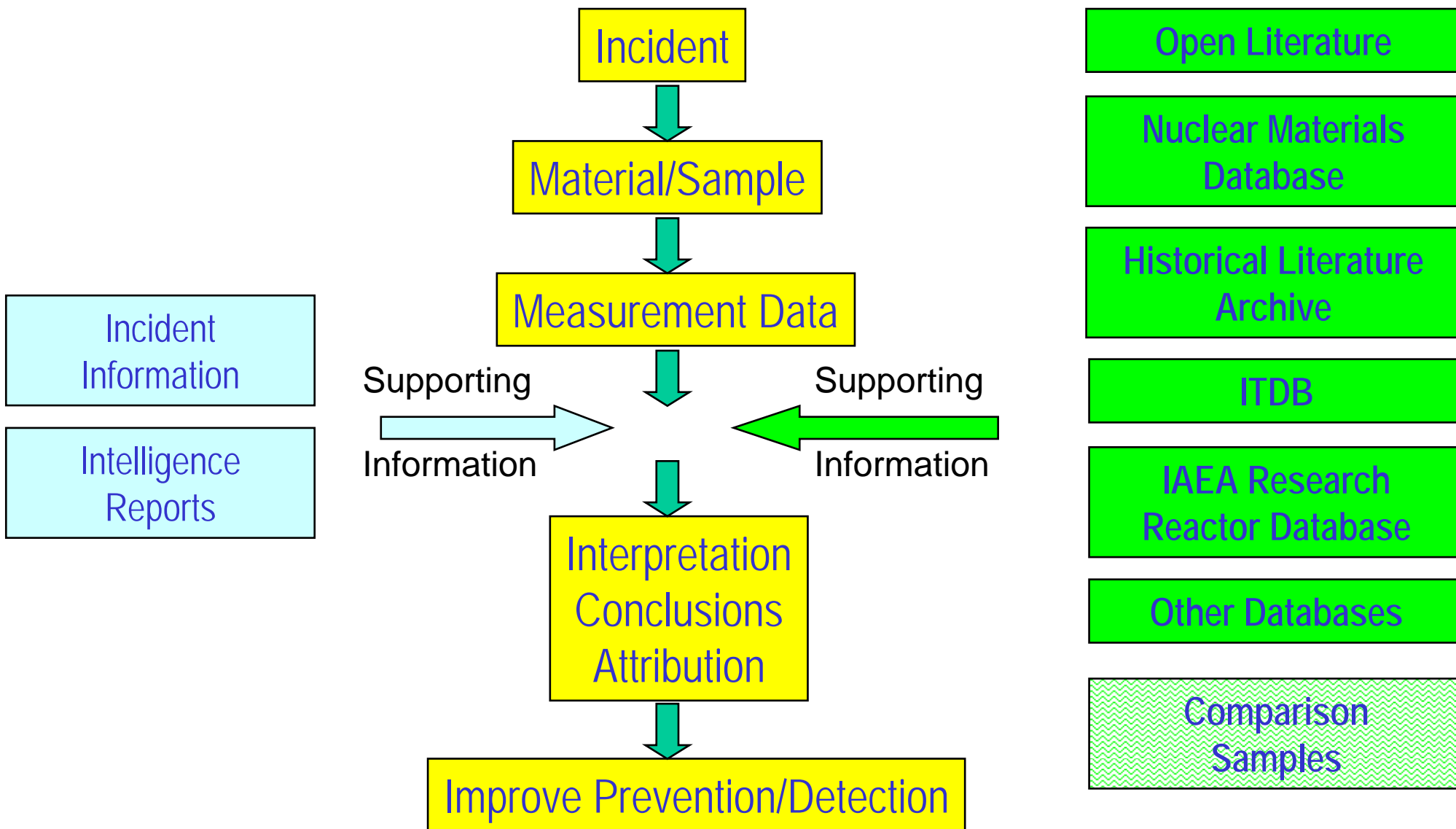
Production



Processing



Source Material



Nuclear Forensics Laboratory

Legal Basis

- Framework Agreement
- Collaboration Agreement

itu



- Specific Contract
- Exchange of Letters
- IAEA NSS No.2

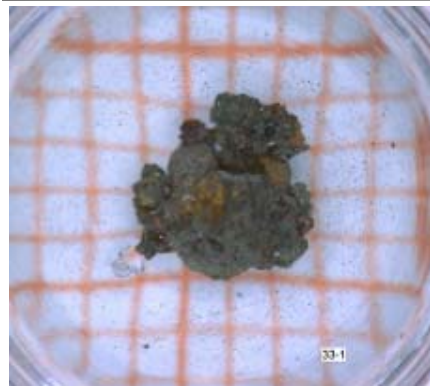
Requesting Parties

- EU Services
- EU Member States
- Other States
- IAEA

- Political level
(e.g. Ministry for the environment)
- Law enforcement
(e.g. police, prosecutor)
- Other Authority
(e.g. office for radiation protection)

- Three separate shipments of scrap metal received from the same seaport outside the EU
- Detected in July, August and October
- Representatives of the IAEA and I TU visited the scrap metal yard in October
- Four samples were received at I TU in December





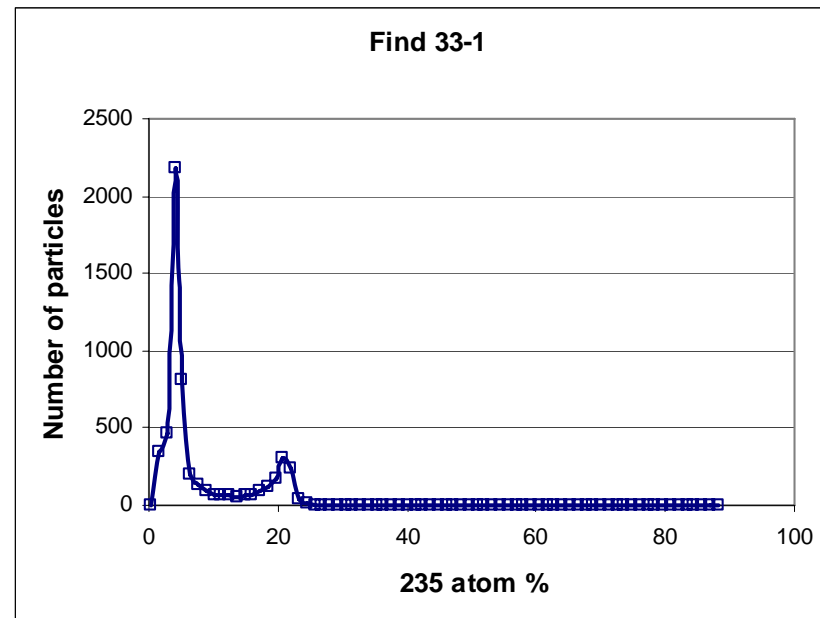
Isotopic Composition of the Uranium

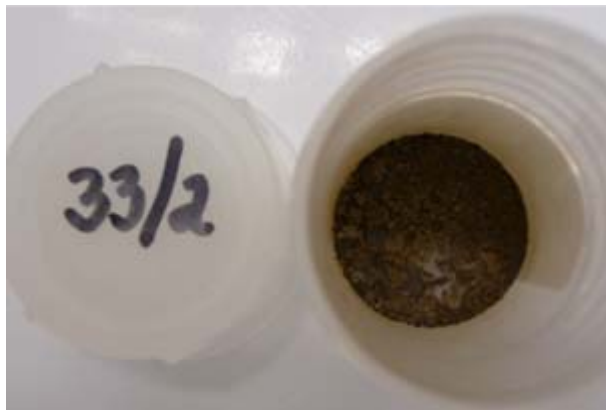
| F33/1 | ^{234}U | ^{235}U | ^{236}U | ^{238}U |
|-------|------------------|------------------|------------------|------------------|
| TIMS | 0.06700 (70) | 9.0333 (52) | 0.09040 (50) | 90.8093 (37) |

Uranium Content: 0.33 wt%

Production Date: April 1962 \pm 7 months

Particle analysis





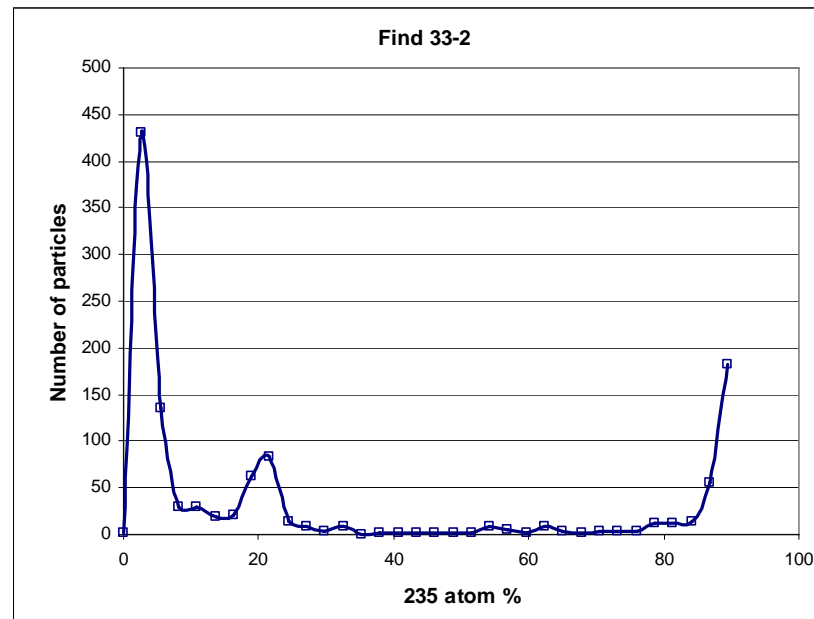
Isotopic Composition of the Uranium

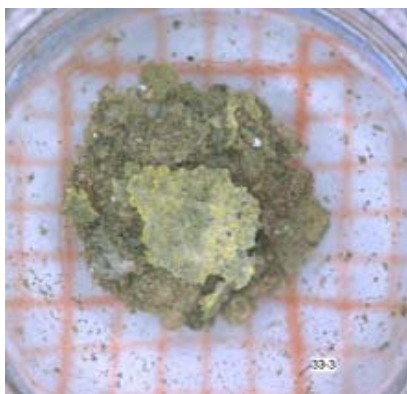
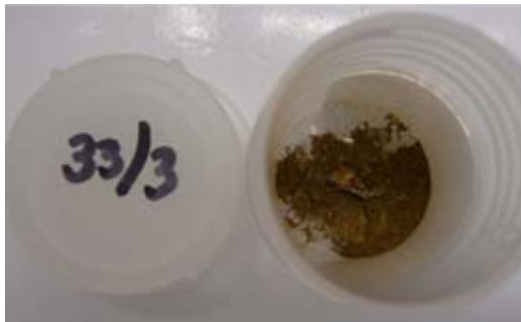
| F33/2 | ^{234}U | ^{235}U | ^{236}U | ^{238}U |
|-------|------------------|------------------|------------------|------------------|
| TIMS | 0.56430 (30) | 45.847 (17) | 0.12810 (60) | 53.461 (20) |

Uranium Content: 1.48 wt%

Production Date: June 1959 \pm 7 months

Particle analysis





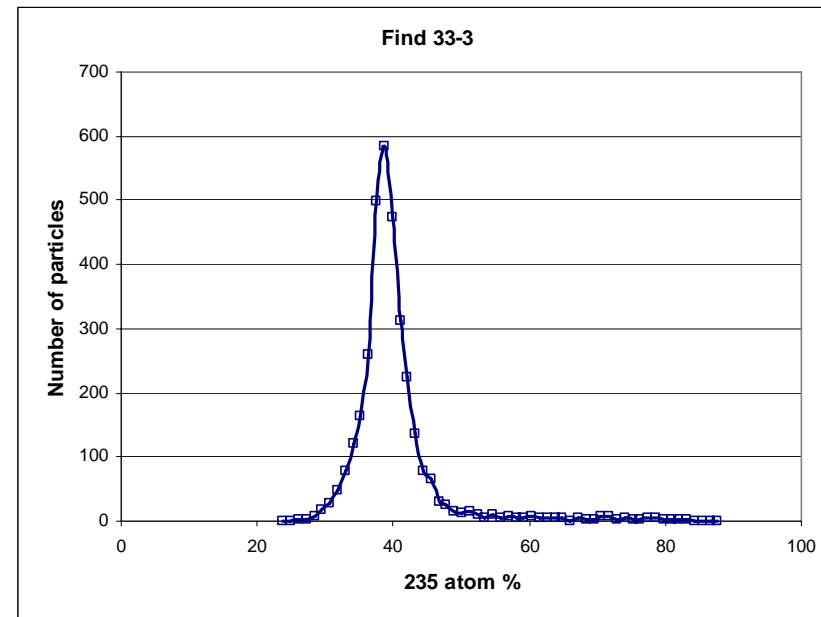
Isotopic Composition of the Uranium

| F33/3 | ^{234}U | ^{235}U | ^{236}U | ^{238}U |
|-------|------------------|------------------|--------------------|------------------|
| TIMS | 0.4092 (21) | 43.800 (16) | $0.72000 \pm (40)$ | 55.073 (20) |

Uranium Content: 3.41 wt%

Production Date: June 1972 \pm 6 months

Particle analysis





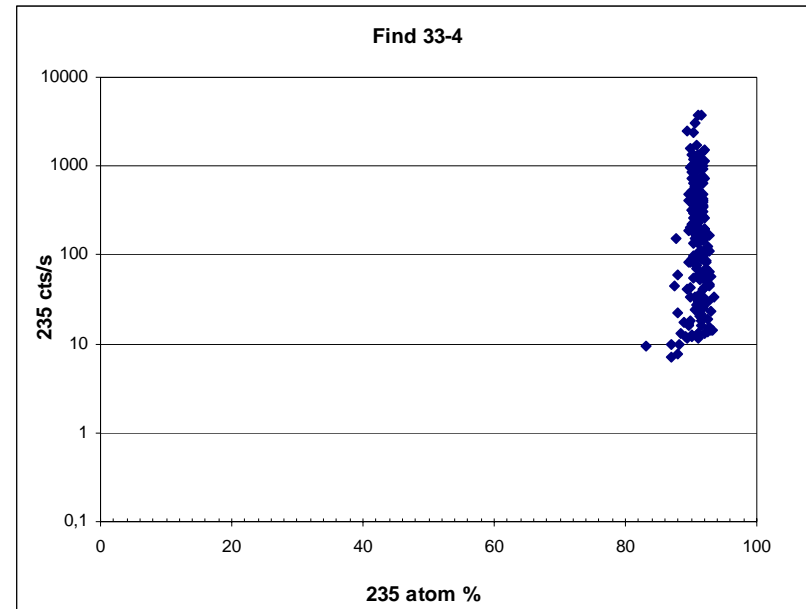
Isotopic Composition of the Uranium

| F33/4 | ^{234}U | ^{235}U | ^{236}U | ^{238}U |
|-------|------------------|------------------|------------------|------------------|
| TIMS | 0.97410 (60) | 89.730 (36) | 0.6981 (35) | 8.5867 (34) |

Uranium Content: 16.9 wt%

Production Date: October 1983 \pm 5 months

Particle Analysis



- Deposits on the scrap metal contain uranium at various degrees of chemical purity.
- Isotopic enrichment in U-235 measured after grinding the samples to fine powders shows distinct populations
 - VVER-type fuel – 3.6 and 4.4 %
 - Fast breeder reactor fuel BN-600 and BN-350 – 17, 21 and 26 % (and natural U in the breeding zone)
 - Submarine fuel- 21/45 %
 - Research reactor fuel – up to 90 %
- Production period of the material ranges from 1950's to the 1980's
- Information allowed to narrow the source of the material to two facilities.

- Examples of successful **border crossing support** in nuclear forensics within the European Union
- **Wealth of information** inherent to nuclear material
- Decrypting the information requires **sophisticated methodology**, subject matter expertise and reference data
- **Significant effort** (resources and time) needed for comprehensive analysis and data interpretation



- Nuclear forensics methodology opens new avenues in
 - ❖ Nuclear security
 - ❖ Non-Proliferation
 - ❖ Environmental issues
 - ❖ Illicit nuclear trafficking
 - ❖ Nuclear Safeguards
- Nuclear forensics will become even more effective by
 - ❖ Networking of laboratories
 - ❖ Data and information sharing



Thank you for your attention!

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