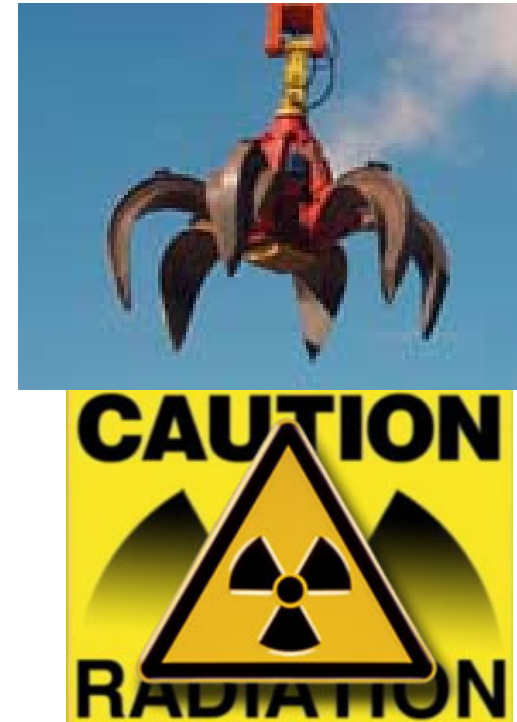


Beyond Detection: Tracing the Origin of Radioactive and Nuclear Material



Questions:

1. How did the material get there?
2. Origin of the material ?
3. Intended use of the material?
4. Age of the material?

Atomic Detectives at Work: Providing Clues on the Origin of Seized Nuclear Material



Klaus Mayer, Maria Wallenius, Erich Hrncek, Thierry Wiss
Institute for Transuranium Elements (ITU)
Karlsruhe, Germany

<http://itu.jrc.cec.eu.int>

<http://www.jrc.cec.eu.int>

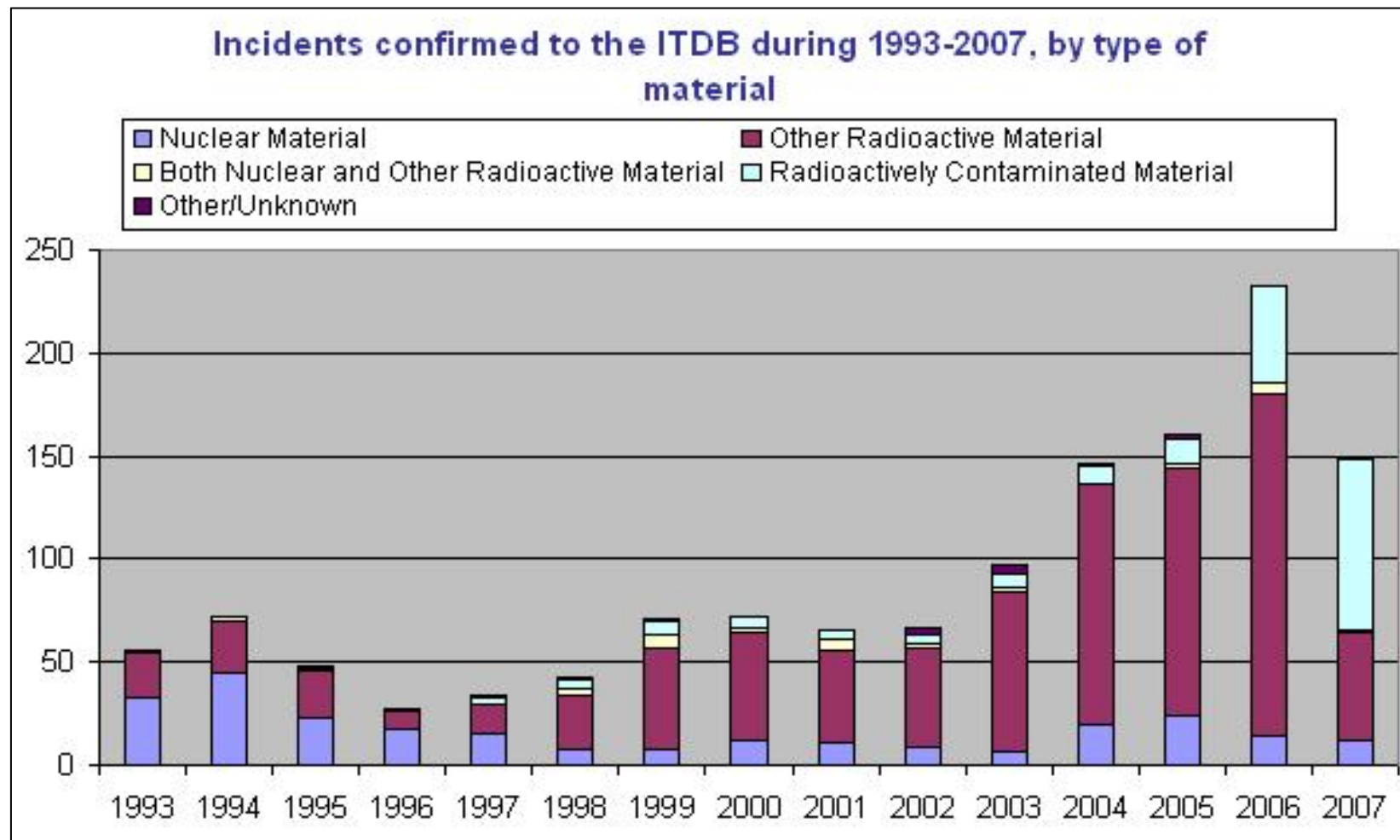
Klaus.Mayer@ec.europa.eu



- Introduction
- Response
- Examples
 - Uranium detected at Rotterdam
 - Uranium from the German nuclear program during WW II
- Sustainability in Nuclear Security
 - Training
 - International Cooperation

Illicit Trafficking (all types) incidents 1993-2007

(source: IAEA)



Detection



Detection equipment,
intelligence



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

Categorization



Nuclear Forensics

Source Attribution





- Oct./Nov. 2008 Material detected in two incidents
- Mid Jan. 2009 Preliminary enrichment measurement
- 23 January 2009 Secondary analysis in national lab.
- 04 February 2009 Sampling under IAEA/ITU supervision
- 16 February 2009 Sample arrival at ITU

First results confirm ^{235}U enrichments of 4% and 16%
Investigation ongoing

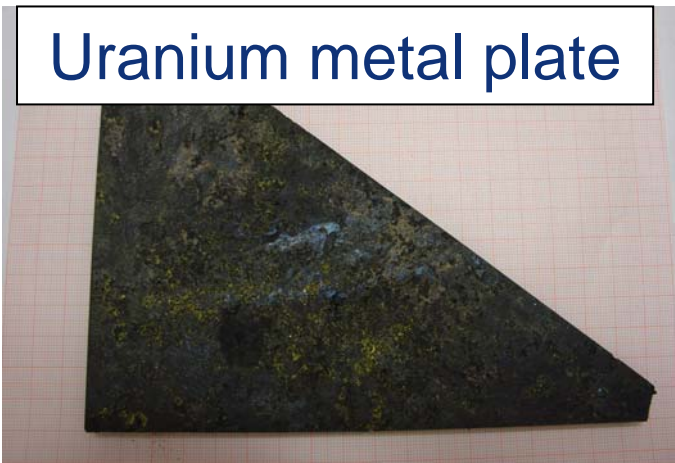
Uranium metal cube

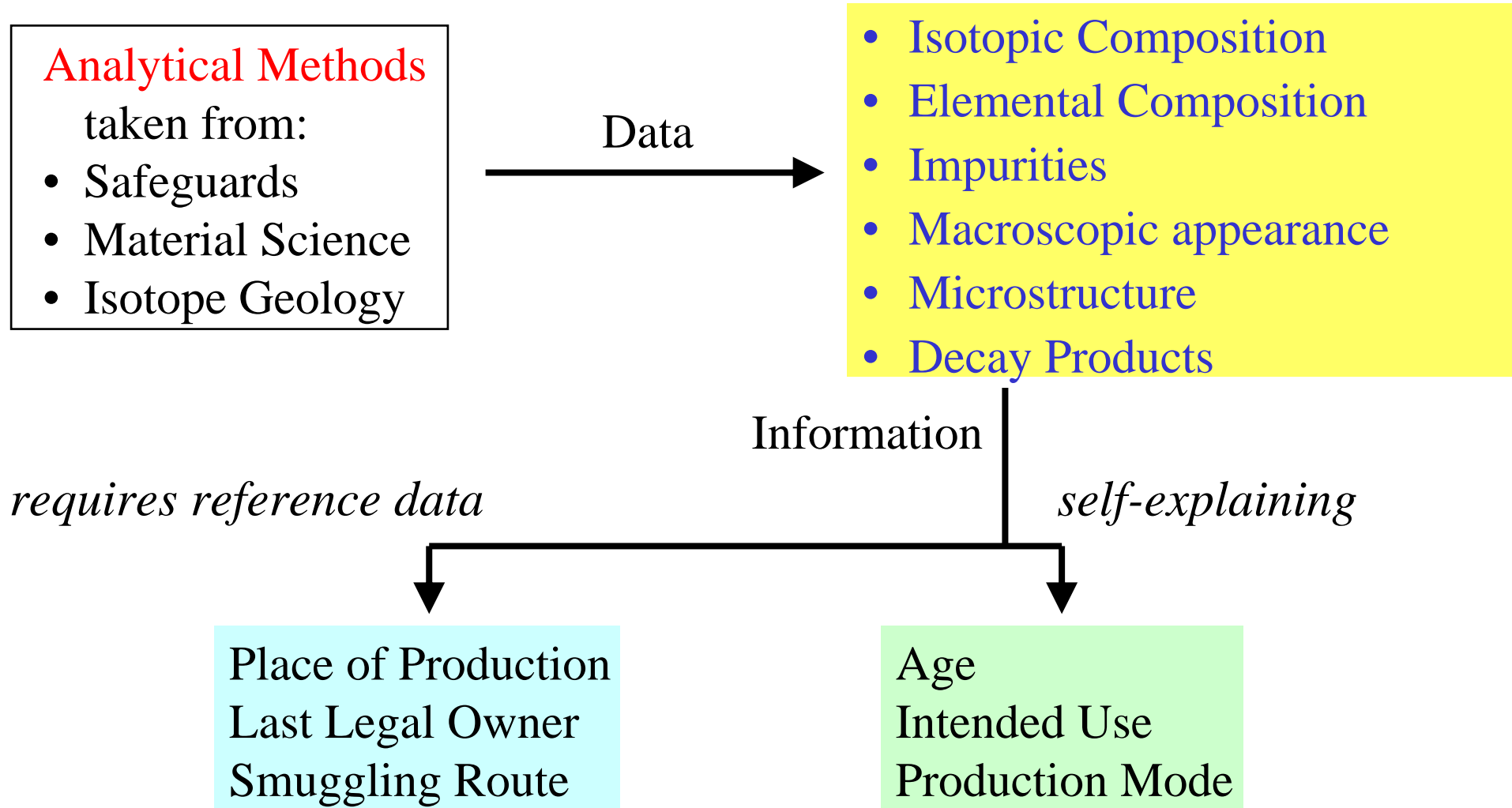


What information
does the material contain ?

- Production date
- Production Process
- Intended use
- Material history

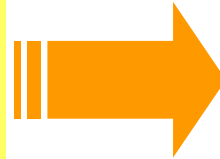
Uranium metal plate





Parameters Investigated

- Isotopic Composition
- Elemental Composition
- Impurities
- Geometry
- Decay Products



Information Obtained

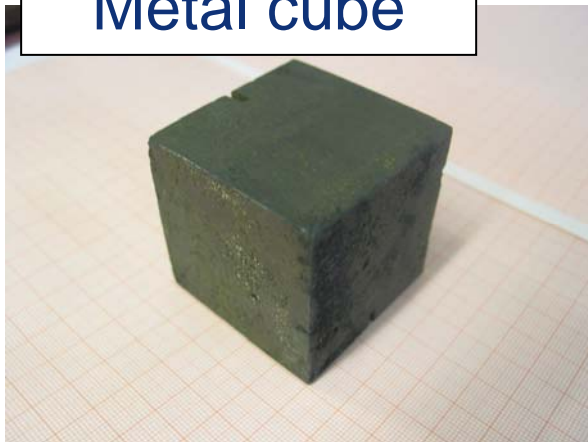
- Geographic origin
- Irradiation History
- Production Process
- Reactor Design
- Production Date



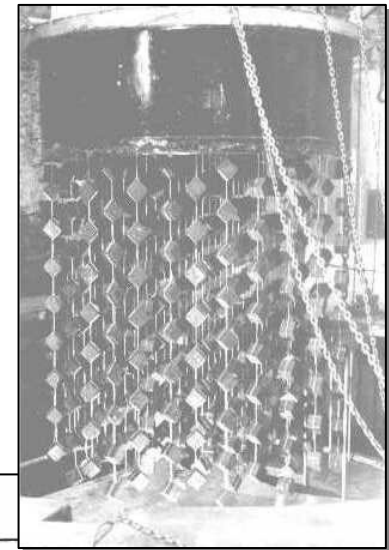
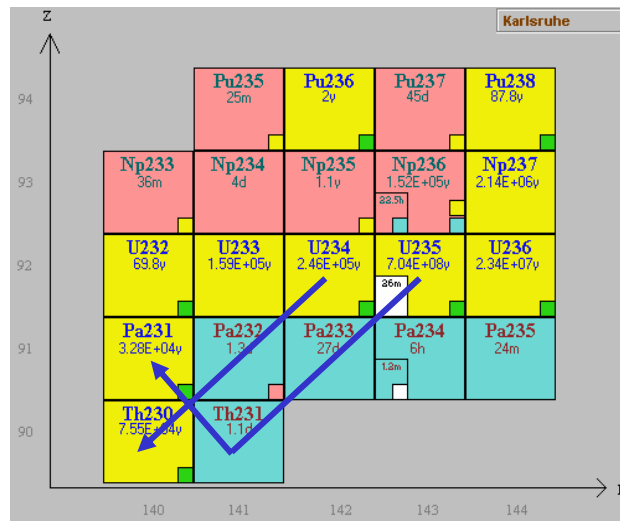
Production Date

Reactor Design

Metal cube



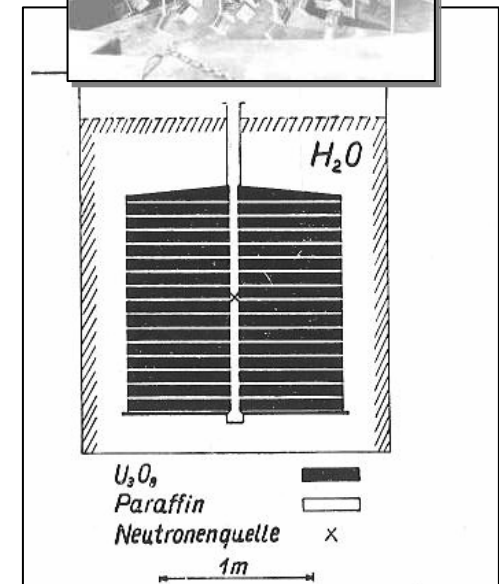
September 1943



Metal plate

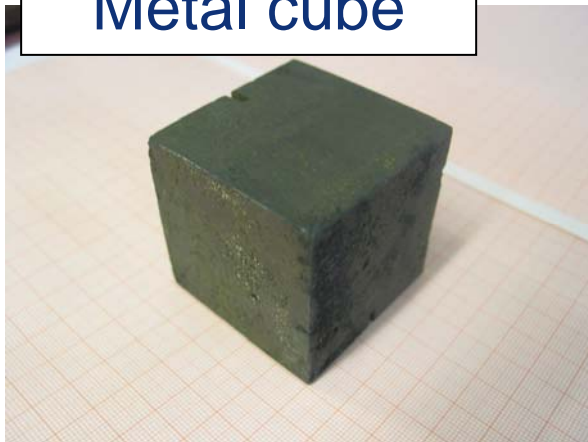


August 1940



Production Process Irradiation History

Metal cube



Metal plate

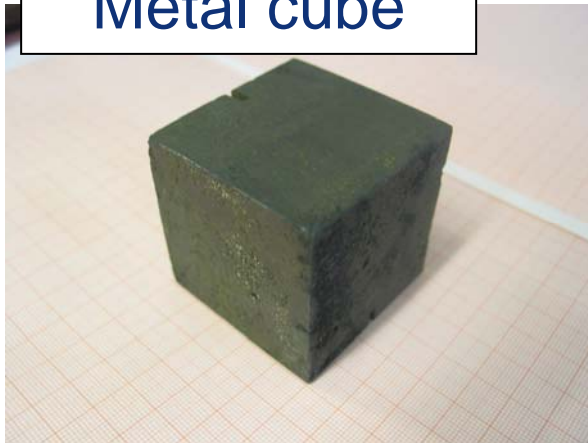


High **calcium impurities**
point at reduction of
oxide to metal using
calcium

Impurities suggest the
use of Joachimsthal
ore as base material

Natural uranium
**No detectable
fission products**
suggest small
number of
fissions during
the experiments

Metal cube



Metal plate



- Illustration of Nuclear Forensics Methodology
- Experimental Evidence from authentic material of Germany's WW II nuclear program

Training

- Increasing awareness
- Helping preparedness



Establishing a European Nuclear Security Training Centre

Based on experience and recognizing
the needs

- Dissemination of security culture
- major investment
- Based at ITU (Karlsruhe)
and IPSC (Ispra)



Nuclear forensics methodologies applied in

- Combating illicit trafficking
- Non-proliferation
- Fighting nuclear terrorism

International Cooperation in Nuclear Security

- Cooperation Agreement JRC - CEA (signed 20.01.2009)
- Cooperation Agreement ITU - LLNL (to be signed spring 2009)
- Cooperation Agreement JRC - IAEA (to be signed 2009)

Nuclear forensics

- Discipline between science, law enforcement,
- Uses systematic approach for analysis and attribution
- Provides clues on the origin of the material
- Assures sustainability in combating illicit trafficking
- Calls for International Co-operation