EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

Joint Research Centre

Combating Illicit Trafficking and Criminal Use of Radioactive and Nuclear Material

Activities of the Institute for Transuranium Elements

André von Zweidorf

European Commission, DG Joint Research Centre,
Institute for Transuranium Elements (ITU), Karlsruhe, Germany

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- Education and Culture
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- Enterprise and Industry
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- Infrastructures and Logistics - Brussels
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- Internal Audit Service
- Interpretation
- Legal Service
- Personnel and Administration
- Translation

The Joint Research Centre (JRC)

Directorate General (DG) of the European Commission

… to provide customer-driven scientific
and technical support for the conception, development,
implementation and
monitoring of EU policies …

…the JRC functions as a reference centre of science and technology for the EU, independent of private and national interests...

Structure of the JRC

7 Institutes in 5 Member States

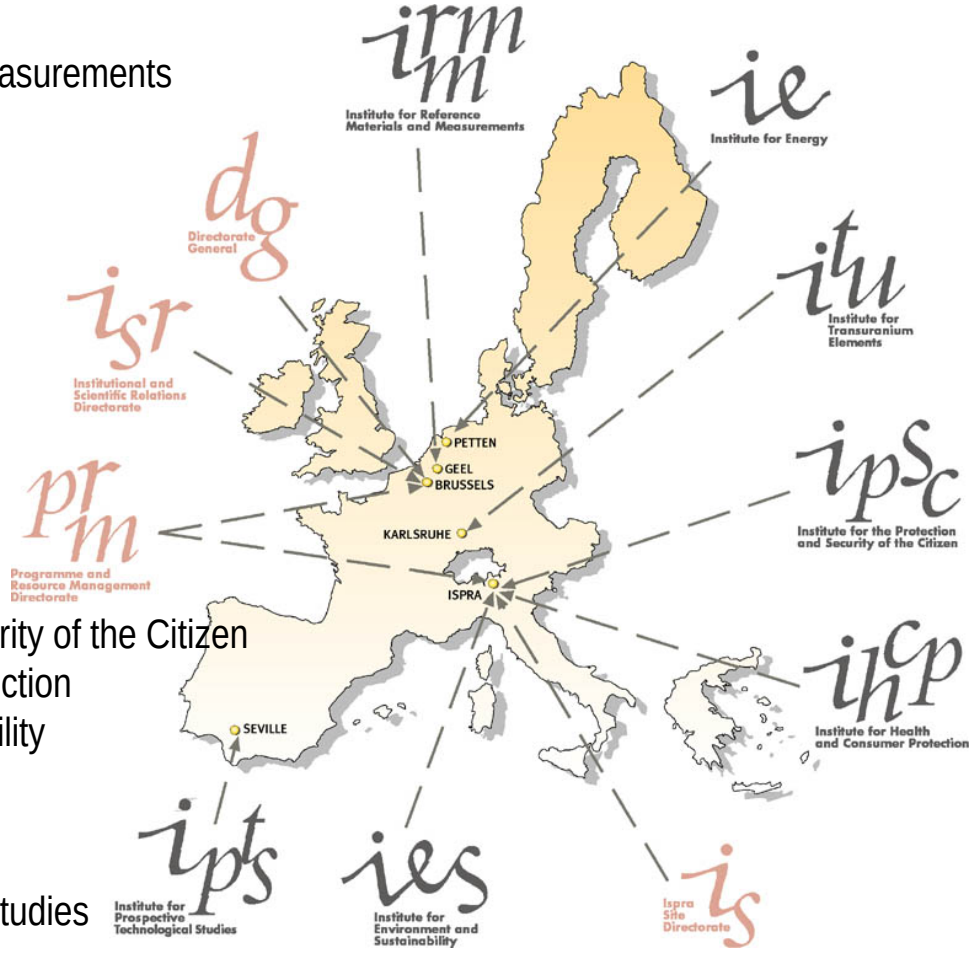
IRMM – Geel, Belgium
- Institute for Reference Materials and Measurements
Staff: ≅ 250

IE – Petten, The Netherlands
- Institute for Energy
Staff: ≅ *180*

ITU – Karlsruhe, Germany
- Institute for Transuranium elements
Staff: ≅ 250

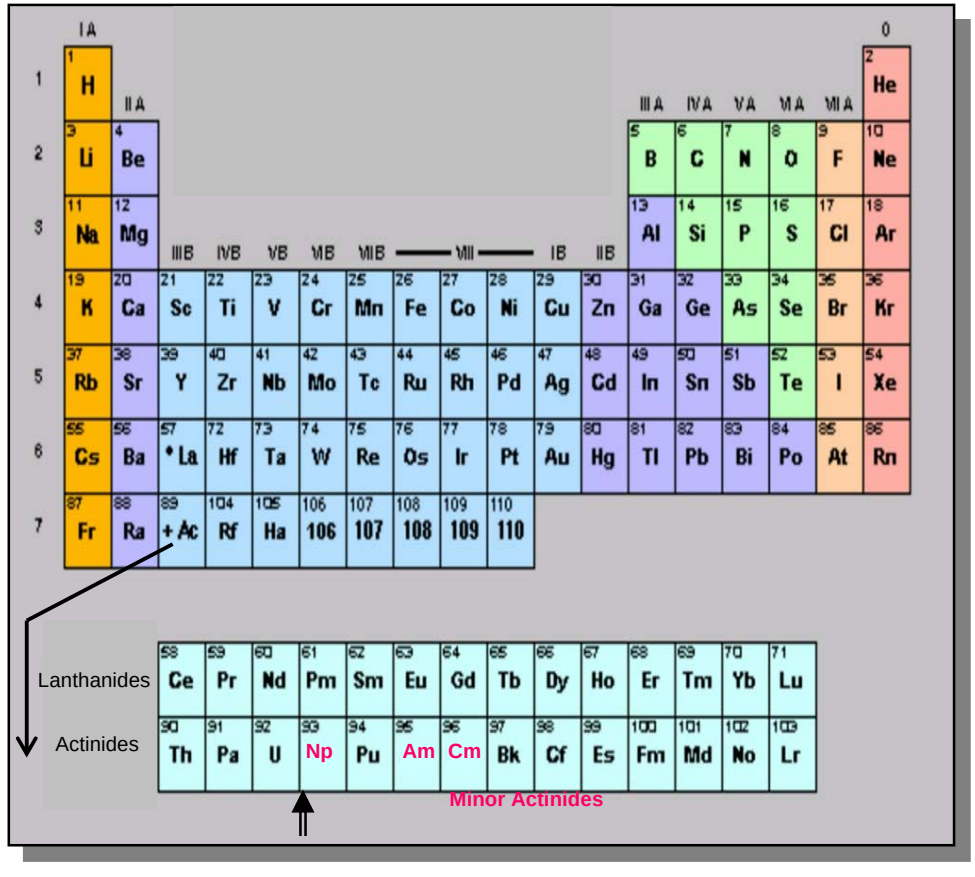
IPSC - IHCP - IES – Ispra, Italy
- Institute for the Protection and the Security of the Citizen
- Institute for Health and Consumer Protection
- Institute for Environment and Sustainability
Staff: ≅ 350, 250, 370

IPTS – Seville, Spain
- Institute for Prospective Technological Studies
Staff: ≅ 100



Total staff: ~ 2200 people

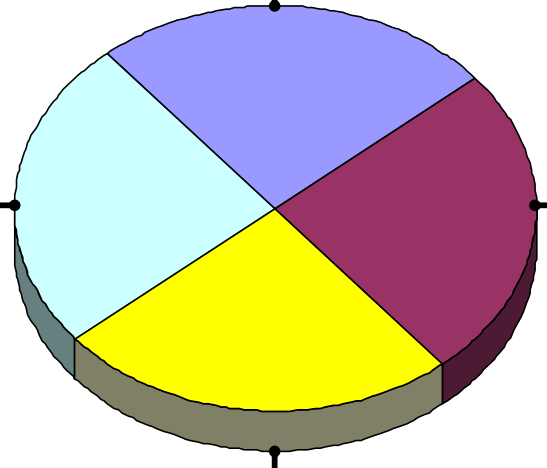
Institute for Transuranium Elements, Karlsruhe, Germany



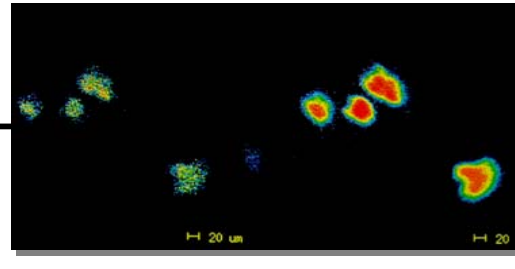
Transuranium Elements

ITU Core Competences 2003-2006

Basic Actinide Research



Safeguards



Safety of Nuclear Fuel Cycle

Work for third parties

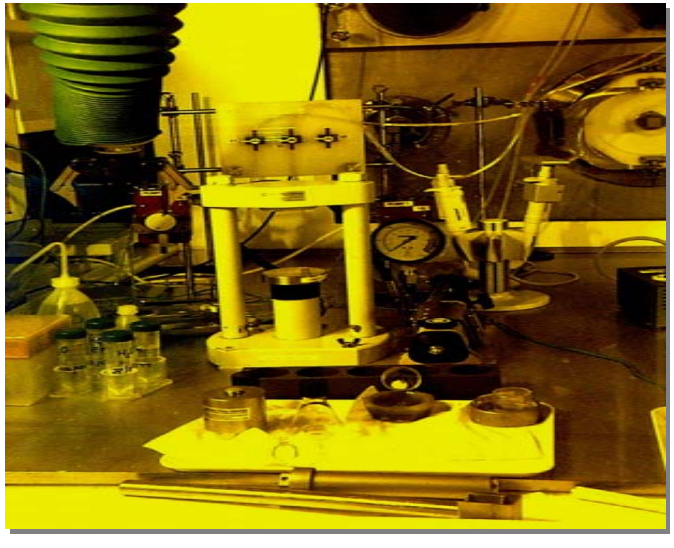
- Industry
- TACIS
- Experts reports
- Licensing authorities
- Research centres (networks)

ITU Facilities

Hot cells

Pyrometallurgy

Trace analyses



Radium 226 hot cell

Minor actinide laboratory

itu Mission Statement:

"The mission of ITU is to protect the European citizen against risks associated with the handling and storage of highly radioactive elements..... to contribute to an effective safety and safeguards system for the nuclear fuel cycle...."

View of ITU created with NASA Worldwind

- Fight against illicit trafficking of nuclear material in collaboration with IAEA, Europol, UNICRI*, OSCE, ITAWG‡ ...
- Nuclear Forensic analyses of seized samples in the Chemistry/Physics laboratories of ITU

* United Nations Interregional Crime and Justice Research Institute

‡ Illicit Trafficking Analysis Working Group

Combating Illicit Trafficking of Nuclear Material

Projects JRC/ITU with new EU and candidate countries

- Fact-finding missions
- Training sessions for law enforcement services and laboratory experts jointly with IAEA (2002) : New EU members and candidate countries
- TACIS projects with Russia and the Ukraine; further projects are in preparation
- RITNUM Handbook for the national Response to Illicit Trafficking of Nuclear Material (developed jointly with ITWG)
- Demonstration exercises (border Bulgaria/Turkey 2002, Poland/Belarus 2004)
- Workshop in Vilnius/Lithuania, Sept. 2004
- Methodological and metrological support for the categorisation of material

Combating Illicit Trafficking of Nuclear Material

Projects in preparation with the Russian Federation, the Ukraine, the Republic of Moldova, the Republic of Georgia, the Republic of Azerbaijan and the Republic of Kazakhstan

Technical Assistance to the Commonwealth of Independent States

Tacis programme of the European Union

What is Tacis?

EU assistance to

- promote the transition to a market economy
- reinforce democracy and the rule of law
- ensure the observance of democratic principles and human rights

The Tacis countries

Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Mongolia, Tajikistan, Russian Federation, Turkmenistan, Ukraine, Uzbekistan

N°13 - 06/2002

More details can be found at http://europa.eu.int/comm/europeaid/projects/tacis/publications_en.htm

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Regional TACIS project

The project will focus on combating illicit trafficking of nuclear and radioactive material and is centered on the following objectives:

- training of experts
- installation of hand-held and mobile equipment
- installation of stationary equipment
- implementation of the RITNUM handbook and creation of a Model Action Plan
- demonstration exercises
- workshop to strengthen regional co-operation
- Joint Analysis Agreement to analyze seized material
- Memorandum of Co-operation to jointly encounter terrorist threats (particularly with a “Dirty Bomb”)

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PECO projects

Past projects with New Member States

- Implementation of a national Model Action Plan for combating illicit trafficking
- Training and technical upgrade for Law Enforcement Services and Expert Laboratory
- Demonstration exercise at national and international levels
- Agreement on joint analysis at ITU including the use of the NM database for identification of seized material

Integrated response within EU

- Meeting in Brussels on April 15-16, 2003 with Member States
- Jointly organized with EUROPOL
- Enhanced collaboration and common response to nuclear threat

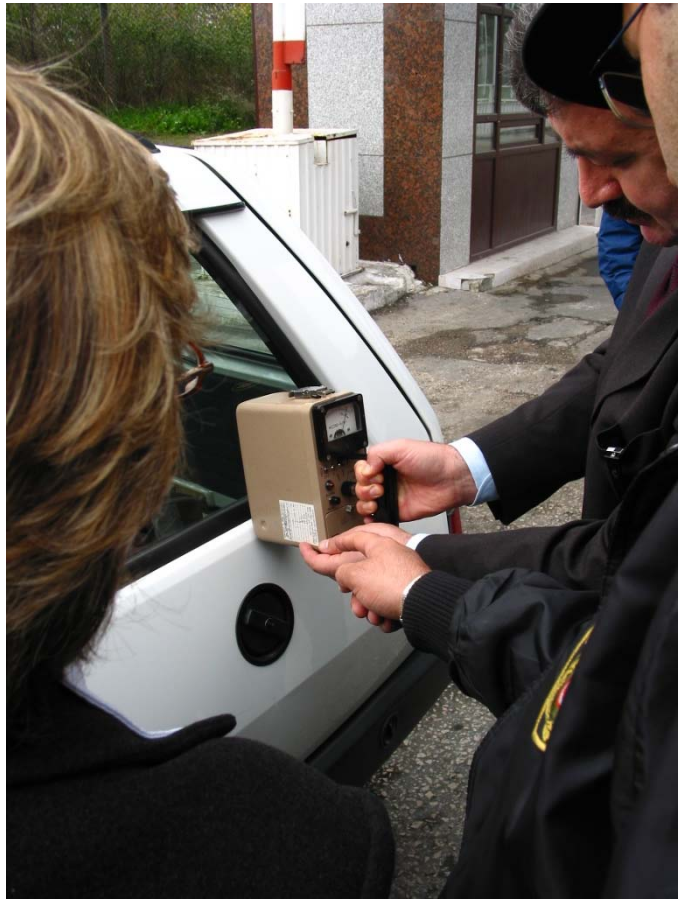
AvZ1 PECO: Pays d'Europe Centrale et Orientale

(Bulgaria, Cyprus, Czech Republic, Estonia, Hungaria, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia)

André von Zweidorf; 15.10.2004 r.

Combating illicit trafficking of nuclear materials

Demonstration Exercise: Border Bulgaria/Turkey - Kapikule (joint exercise): 14 - 15 October 2002



Activities: Demonstration exercises

Romania

18 July 2002

Particle Analysis for Safeguards

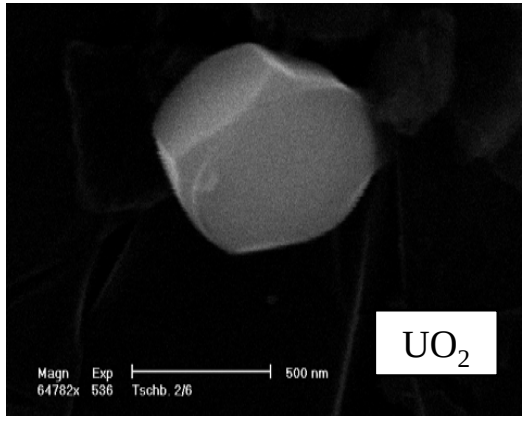
Safeguards objectives

- Enrichment plants
  - no enrichments higher than declared
  - no undeclared material
- Hot Cell Facilities
  - absence of undeclared operations
  - depending on the declared status of the facility:
    - Separation of Pu or HEU
    - Undeclared U and Pu metallurgy
- Forensic samples
  - determination of the history of confiscated nuclear materials

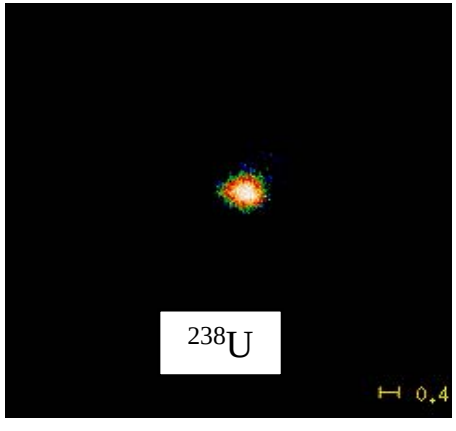
Precision positioning and picking up of individual particles by means of microtips (down to 100 nm)

Analysis of Radioactive Micro-particles

- Environmental sampling
  - samples taken from surface of equipment or buildings (cotton swipes)
  - air, soils, sediments and vegetation
- Characterisation of individual radioactive micro-particles by Secondary Ion Mass Spectrometry (SIMS)
  (10^9 atoms of uranium in 1 µm diameter particles of UO_2 weighing few picograms)
  - Main means for detecting *where, whether, what* nuclear activities are ongoing
- Typical particle sizes : few sub-microns up to 30 microns



Scanning Electron Microscopy (SEM)



SIMS imaging analysis

Application of the method for Routine Safeguards

High Performance Trace Analysis for the detection of U and Pu particles

Find a Needle in the Hay Stack

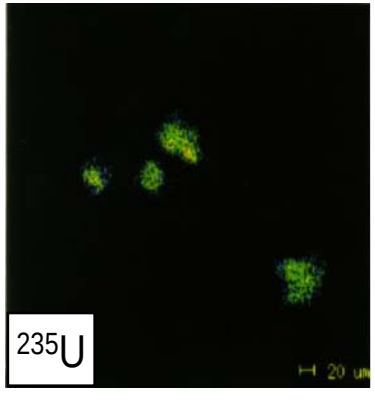
"swipe" sample: billions of dust particles

amongst them

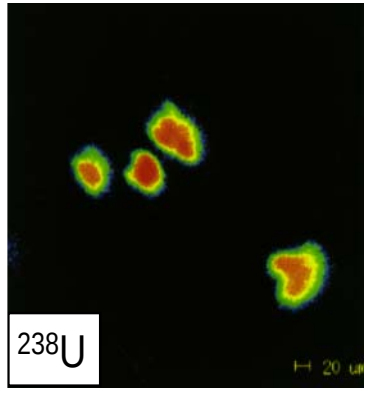
low enriched uranium particles

Secondary Ion Mass Spectrometry (SIMS)

- *Elemental Analysis*
- *Isotopic Composition*
- *Imaging Systems*
- *Line Scan and Depth Profile*
- *Mass and Energy Resolution*



U-235 SIMS image



U-238 SIMS image

Natural U, 0.72 wt % of U-235

Nuclear power production, 0.72-5 wt% of U-235

Weapons grade U, 20-90 wt % of U-235

Nuclear Forensic Science

Questions

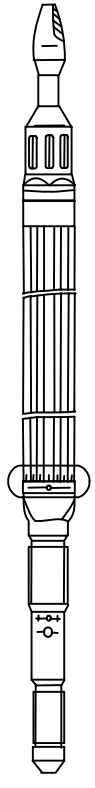
- **nature of the material**
- **age determination (When produced?)**
- **determination of origin**

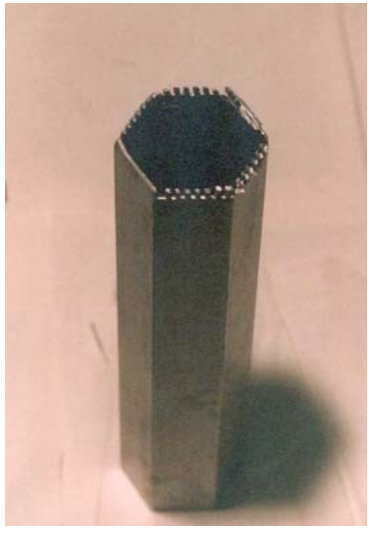
Chemical and physical properties, morphology

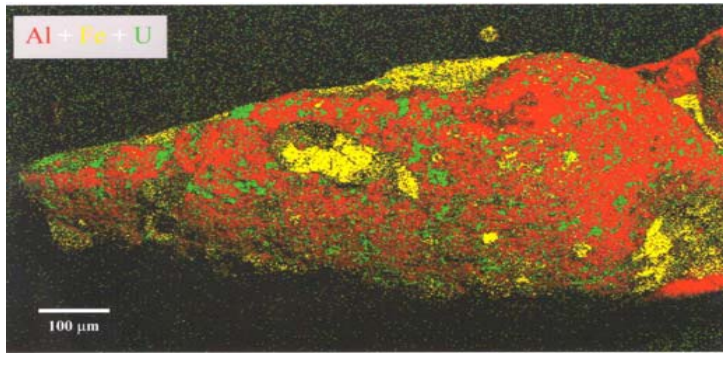
- bulk sample, micro-particles
- **isotopic composition** (enrichment)
- microstructure
- chemical impurities (mass sp.)
- maintenance of nuclear material database

Co-operation

- EUROPOL
- IAEA
- other laboratories and authorities





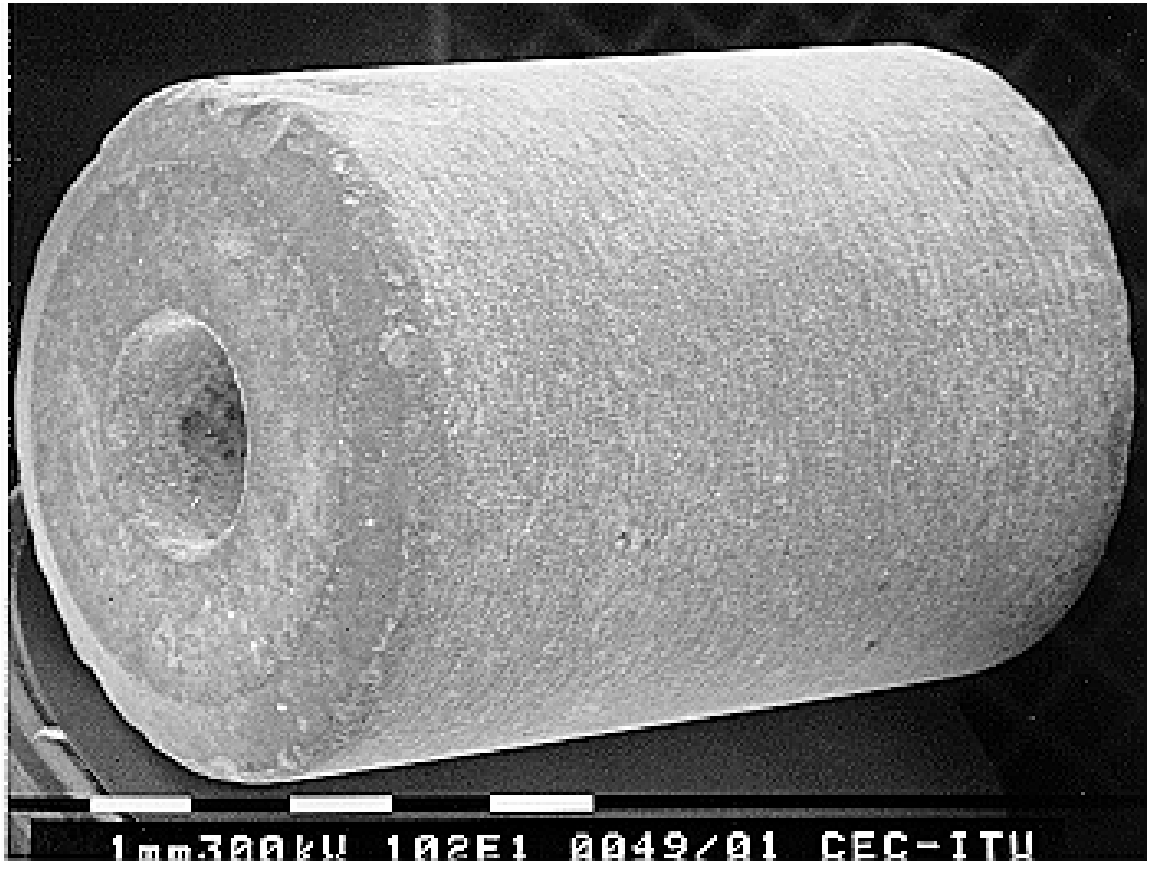


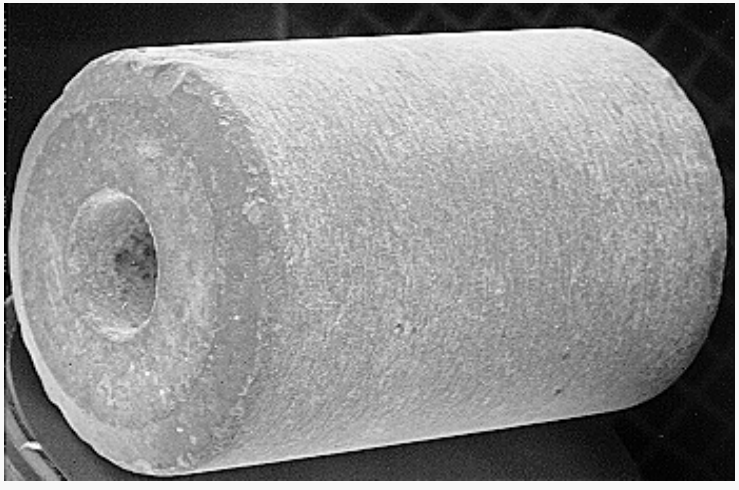
Nuclear Forensics: "Fund 22", Ulm/Germany

seized on May 29th 1996 (206 LEU pellets + U_{nat} powder)

Origin Determination

Pellet geometry, enrichment, impurities, surface roughness point at production facility





Pellets:

U-content 88 % ⟶ UO_2

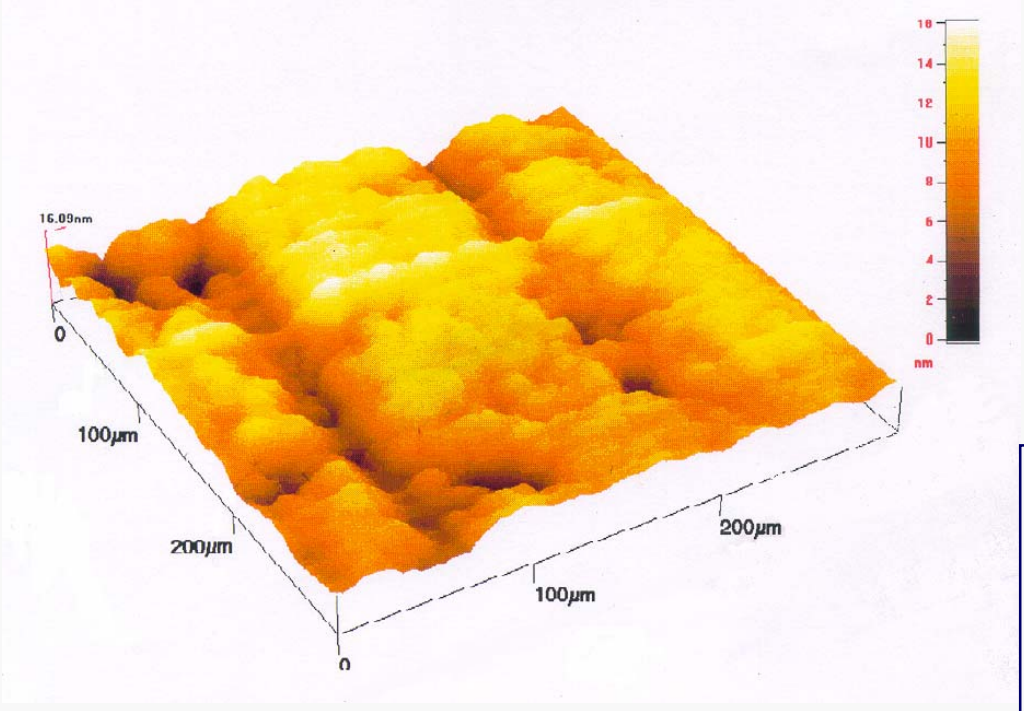
U	234	235	236	238
w-%	0.039	4.38	0.032	95.54

Diameter (mm)	Hole diameter (mm)	Heigh (mm)
7.55	2.43	10.5-12.3

Data Bank VVER-1000

Russia	Ukraine
Balakovo 1-4	Khmelnitski 1
Kalinin 1-2	Rovno 3
Novovoronezh 5	South Ukraine 2-3
	Zaporozhe 1-5

"Fund 22" – Ulm/Germany



Surface roughness

- UMP - wet grinding
  → smoother surface
- Electrostal-MZ - dry grinding
  → rougher surface

Measured surface roughness (µm)	
UMP – Kazakhstan	1.7 – 1.9
MZ – Russia	2.3 – 2.5
Pellet – "Fund 22"	1.87

Pellets were manufactured at the Ulba Metallurgical Plant, UMP

AvZ2 UMP: Ulba Metallurgical Plant
MZ: Electrostal Fuel Manufactory Plant
André von Zweidorf; 15.10.2004 г.

Strengthening International Collaboration

Workshops for Strengthening International Cooperation to Combat Illicit Trafficking and Criminal Use of CBRN* Substances and Weapons in 2004/2005
(held in Bucharest, Istanbul, Brussels, Turin)

*Chemical, Biological, Radiological and Nuclear

- coordination of the activities to combat illicit trafficking and criminal use of CBRN substances (UN resolution 1540 [April 2004])
- discussion of a scenario of an attack with a “Dirty Bomb” in a major city at the 2nd workshop
- more international co-operation will support the efficient use of the existing resources and of existing technology
- “Dirty Bombs” are a major concern of the international community
- scenarios can support decision-makers in the visualization of the threat of an RDD attack

Criminal use of radioactive substances for terrorist attacks: Radiological Dispersal Devices (RDD, “Dirty Bomb”)

- Radiological Dispersal Device (RDD): disperses radioactive substances with the help of conventional explosives
- Effects:
  - kills only few people as a result of the initial blast
  - creates panic and chaos (weapons of mass disruption/dislocation/effect)
  - radioactive material is transported attached onto aerosol particles
  - health damage of the population because of external radiation and inhalation
  - contamination of a large area can result in severe consequences for the infrastructure (buildings are not usable for a certain time)
  - consequences for the economy are significant (decontamination of a large area requires a huge amount of resources)

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Prediction of the consequences of a Radiological Dispersal Event (RDE)

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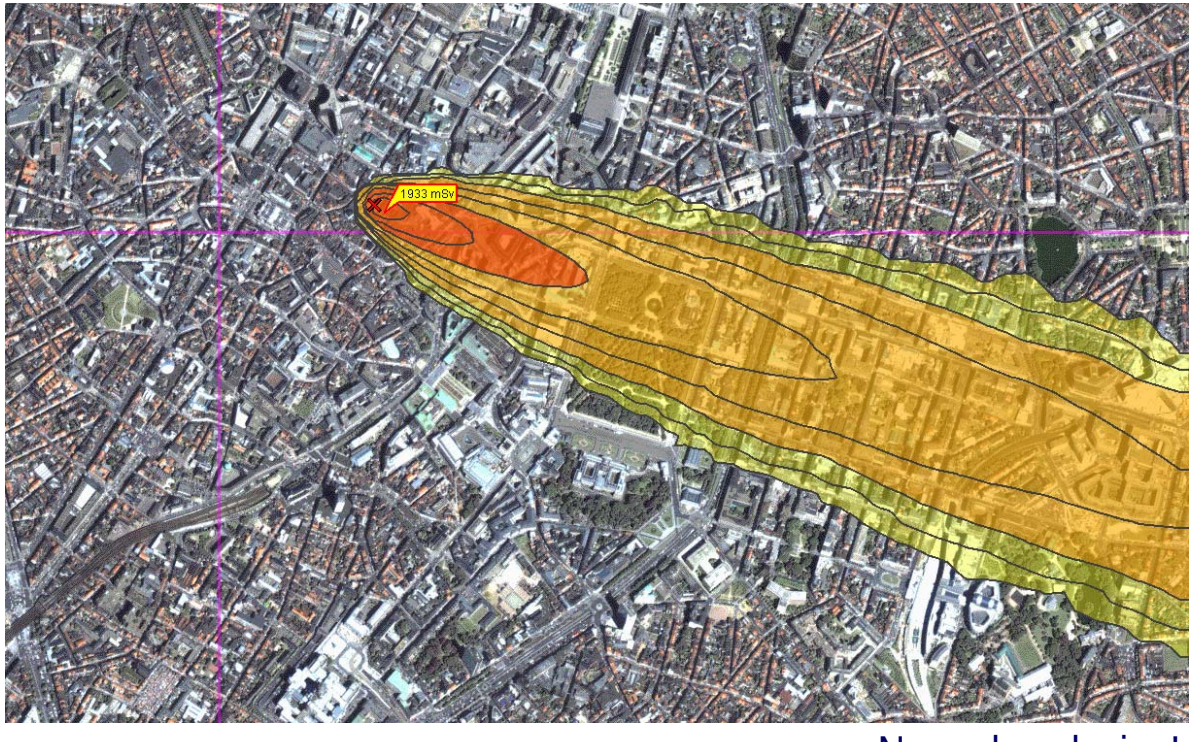
itu ipsc
Bundesamt für Strahlenschutz
LASAIR Collaboration

- ITU, IPSC (both JRC) and the German Federal Office for Radiation Protection (BfS) co-operate to improve the LASAIR software and to apply it onto European territory and beyond
- LASAIR: software to predict the effects of the dispersion developed by the BfS: simulates the transport of dispersed radioactive and nuclear substances attached onto aerosol particles



No real explosion!

Aim of LASAIR:

- better understanding of a RDE
- provision of scenarios to raise situation awareness
- support in an emergency situation

Scenario with 0.5 kg of conv. explosives, 2000 Ci ^{60}Co, scale 1:10,000 Digital Map Archive IKONOS satellite map (wind with 0.5 m/s from 290° north, weather conditions neutral/unstable), 3 hours propagation time

Joint Research Centre

Thank you for your attention!

Many thanks to:

K. Lützenkirchen, J. Magill, W. Wagner (JRC/ITU)

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