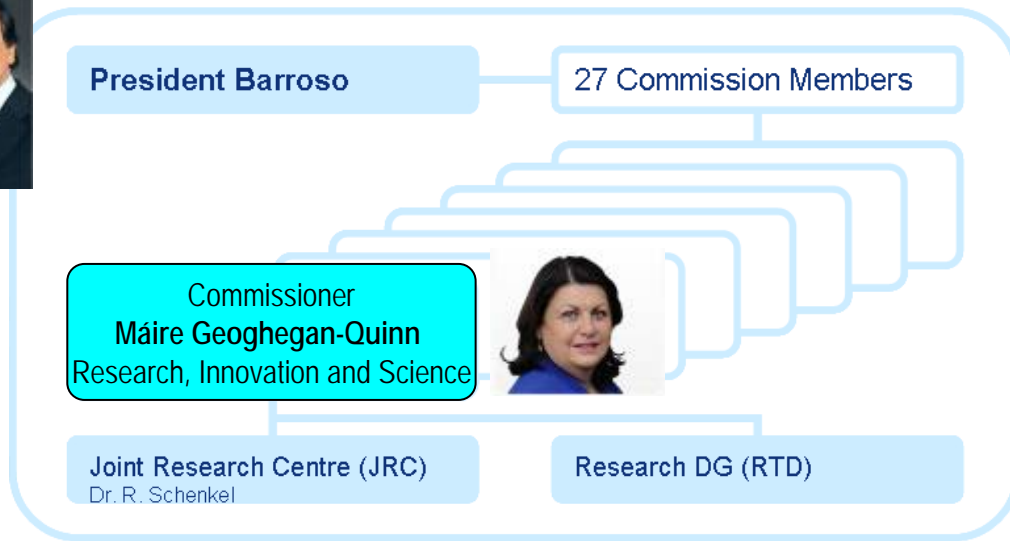
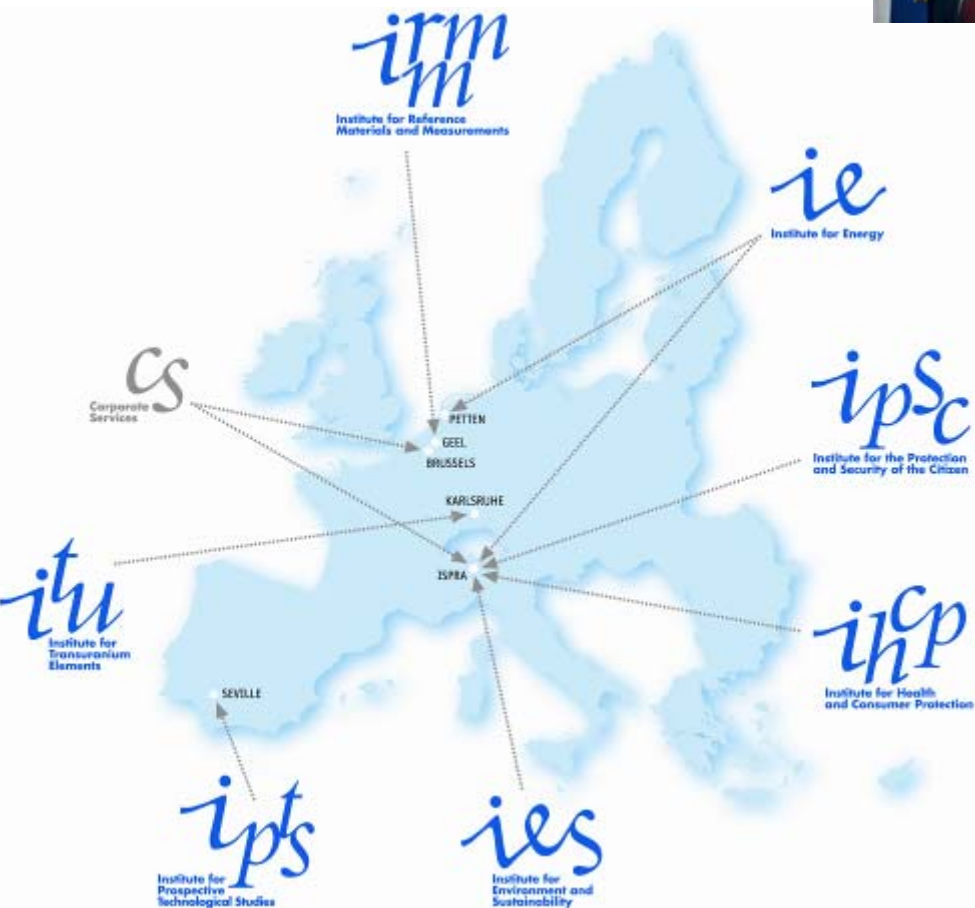




Nuclear Research at the JRC-Institute for Transuranium Elements, Karlsruhe

Prof. Dr. Thomas FANGHÄNEL
Director

7 Research Institutes in 5 EU countries



JOINT RESEARCH CENTRE *Robust Science for Policy Making*

As a Directorate-General of the European Commission, The JRC provides customer-driven scientific and technical support to Community policy making

As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union.

Specific programme "JRC direct actions"
2007-2013 1,751 M€

EURATOM programme "JRC direct actions"
2007-2011 517 M€

FP7 indirect actions

Nuclear waste management and Environmental Impact:

- Spent fuel characterisation
- Partitioning, transmutation, conditioning
- Radioactivity in the environment

Nuclear safety:

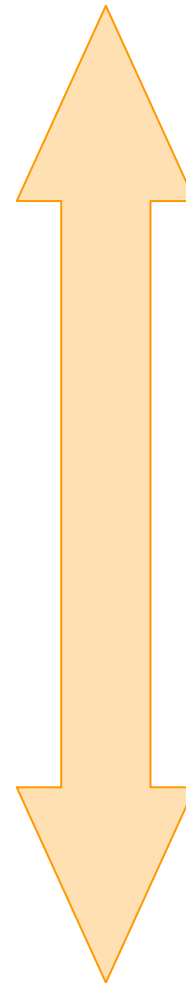
- Safety of nuclear installations
- Nuclear fuel safety
- Advanced nuclear energy systems

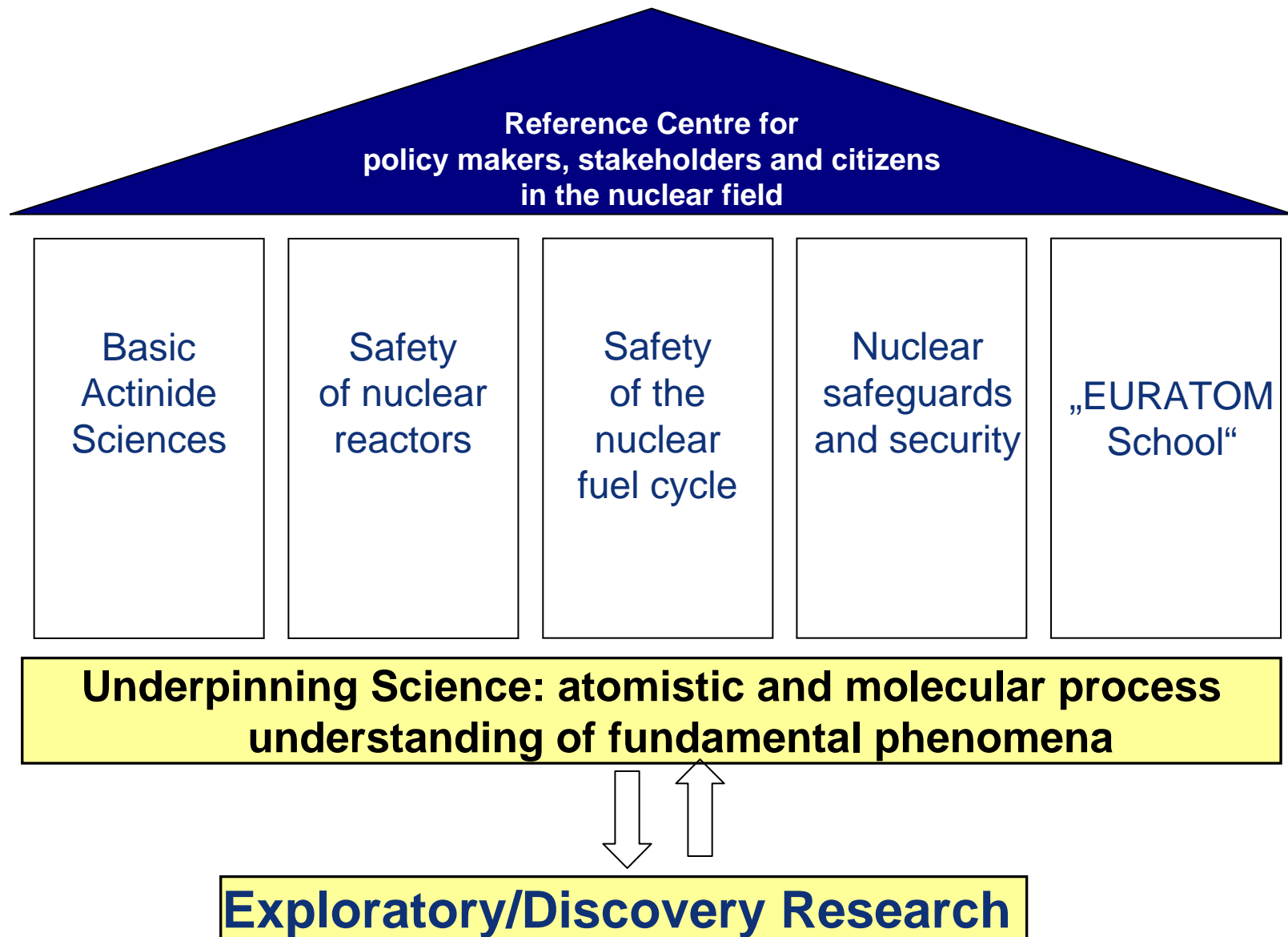
Nuclear security:

- Nuclear safeguards, non-proliferation
- Combating illicit trafficking
- Open source information

Key cross-cutting activities:


- Actinide sciences
- Education & training
- Networking
- Medical Applications





1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg		113	114	115	116	117	118
119	120	121	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168

Lanthanides	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Actinides	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr


Transuranium Elements

Superactinides	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153
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The mission of ITU is to provide the scientific foundation for the protection of the European citizen against risks associated with the handling and storage of highly radioactive material.



*ISO 14001:2004
standard for environmental
management*

*OHSAS 18001
(Occupational Health and
Safety Standard)*

*ISO 9001:2000
quality management standard
(since 1994)*

*EFQM Excellence Model
as basis for an
integrated business processes
implementation*

*ISO 17025
Accredited Laboratory*

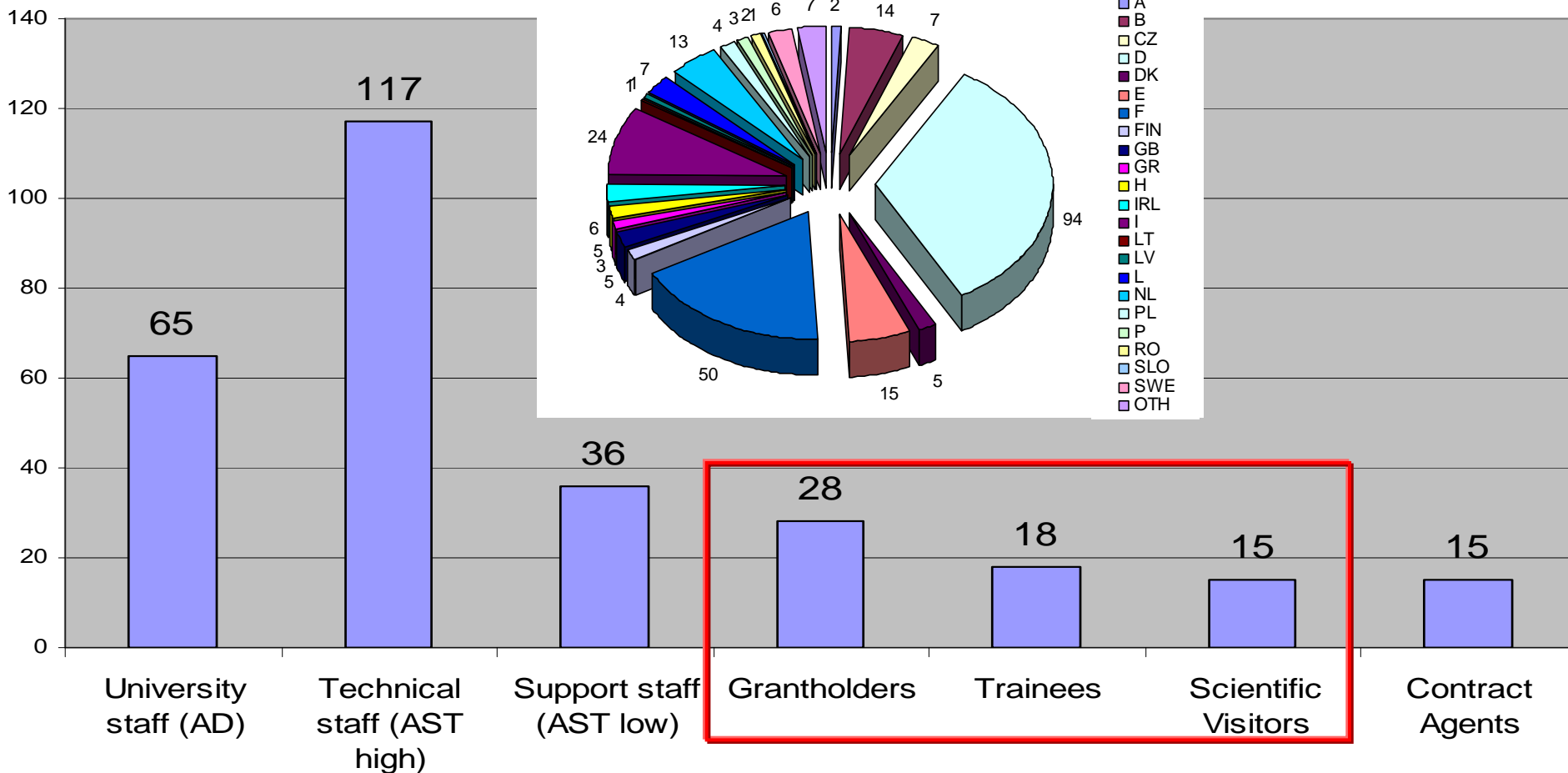
ITU's prime objectives are

- to serve as a reference centre for basic actinide research,*
- to contribute to an effective safety and safeguards system for the nuclear fuel cycle, and*
- to study technological and medical applications of transuranium elements.*

Staff ~ 300 (+ externals)
More than 24 nationalities

Institutional Budget about 40 M€

Competitive activities
6-8 M€, about 15% of budget

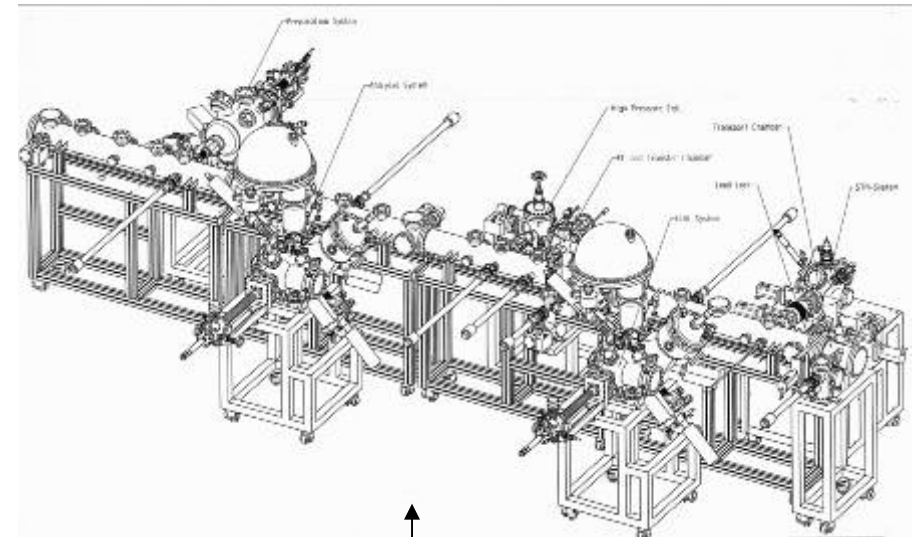


- 24 hot cells with capacities up to 1 Mio Curies and some 400 glove boxes in 30 alpha-laboratories.
- Minor Actinide Lab for preparing irradiation targets containing amounts of actinides for transmutation experiments
- ARTINA category 10-100 Clean Lab for safeguards and nuclear forensic applications
- Destructive and non-destructive analyses
 - Advanced mass spectrometers, laboratory robots, ...
- Basic materials science investigations
 - Materials studies down to 1 K and up to 8000 K and 60 GPa
 - Photo-electron spectroscopy,
 - Crystallographic investigations,
 - Solid-state studies (X-ray diffraction, electrical resistance and optical properties) on highly radioactive samples,
 - Mössbauer spectroscopy at normal and elevated pressures
 - High-resolution electron microscopes,
 - Shielded microprobes,

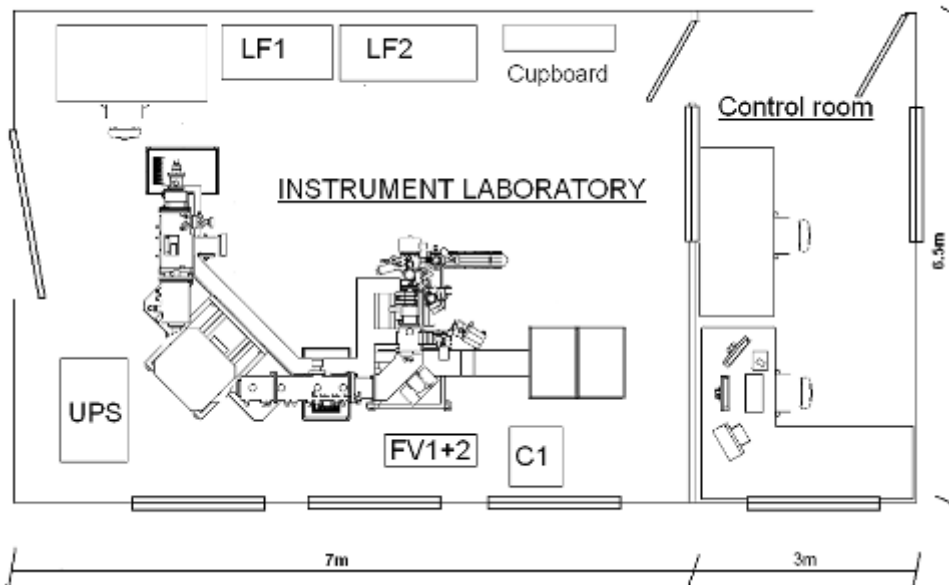


New facilities 2008-2010

- "EURACT-NMR – European Radioactive Nuclear Magnetic Resonance"
(workshop in Karlsruhe 27-29 January, 2010)
- New Transmission Electron Microscope (TEM)
- Raman spectrometer




Large Geometry - SIMS laboratory



- Instrumentation: Surface Science Spectroscopies (XPS)
- Large Geometry SIMS laboratory




**Basic actinides
science
and
applications**



**Safety of the nuclear fuel
cycle**



**Safeguards
and
nuclear
forensics**

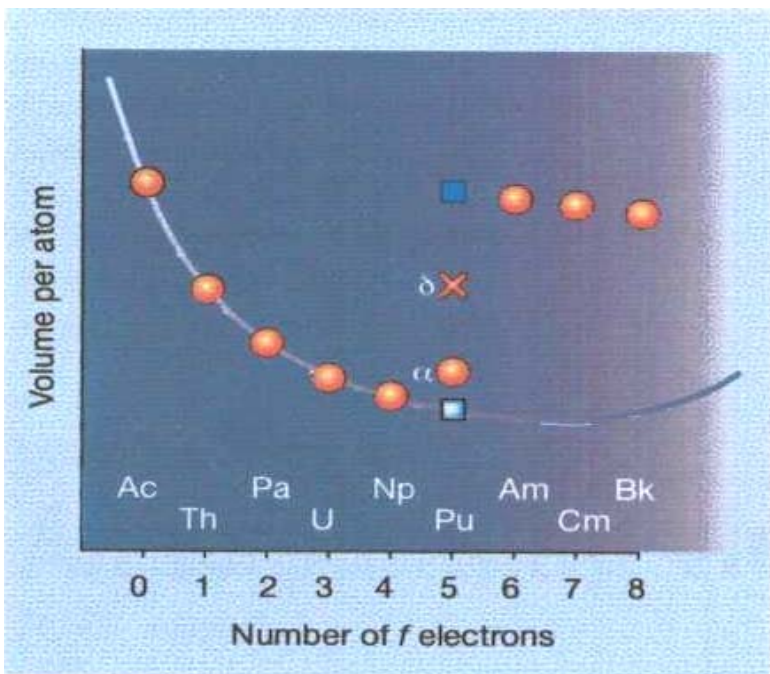
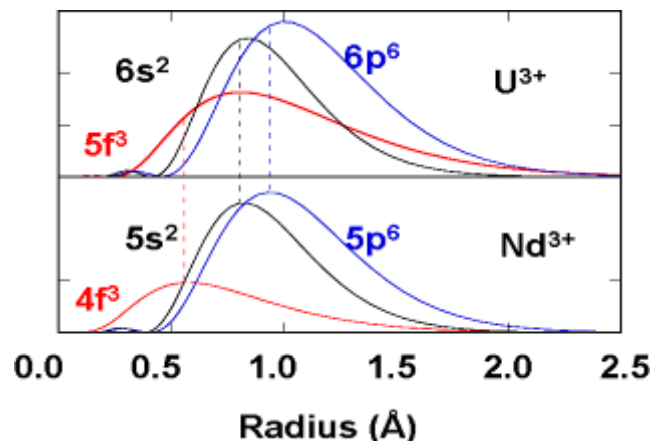


Education, Training

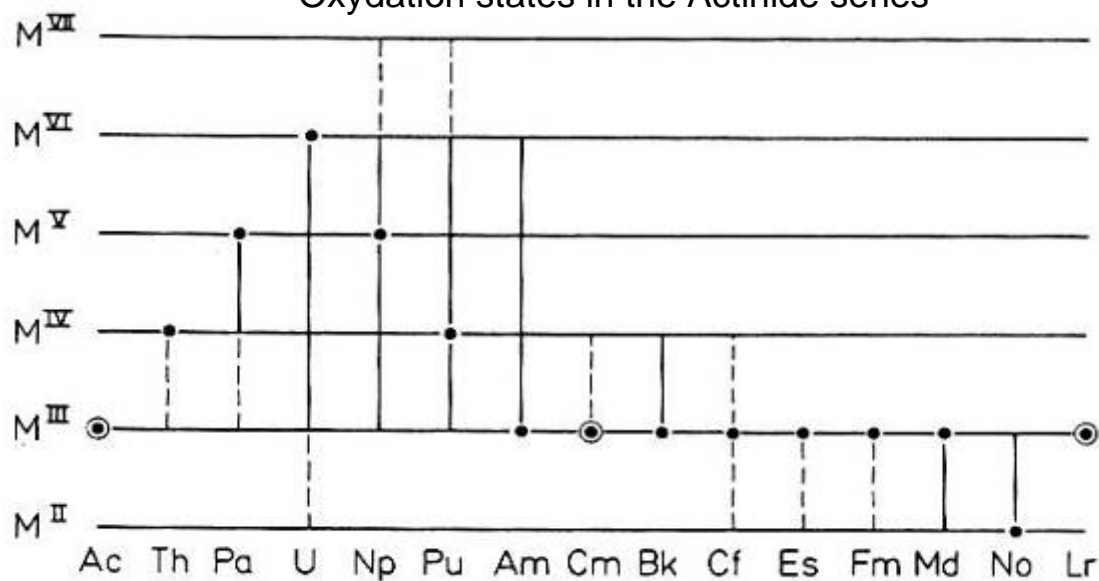
and user facilities/networking

The actinides are among the most complex of the long-lived elements, and in the solid state, they display some of the most unusual behaviours of any series in the periodic table

Radial-Distribution of the valence electrons in trivalent Lanthanide and Actinide



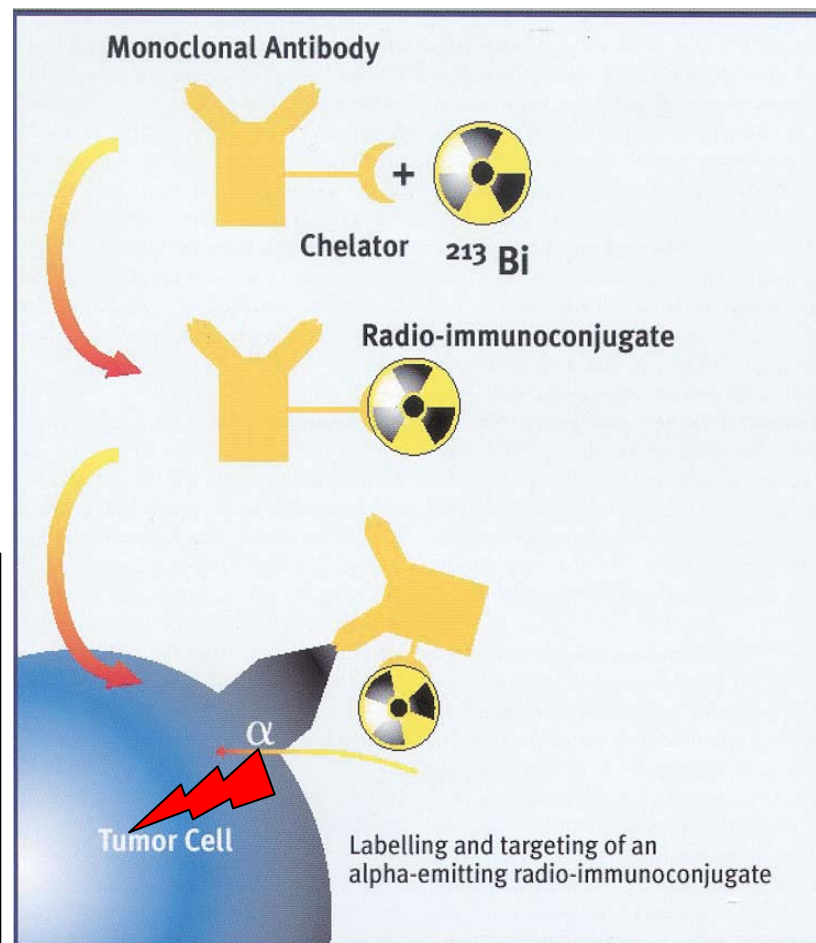
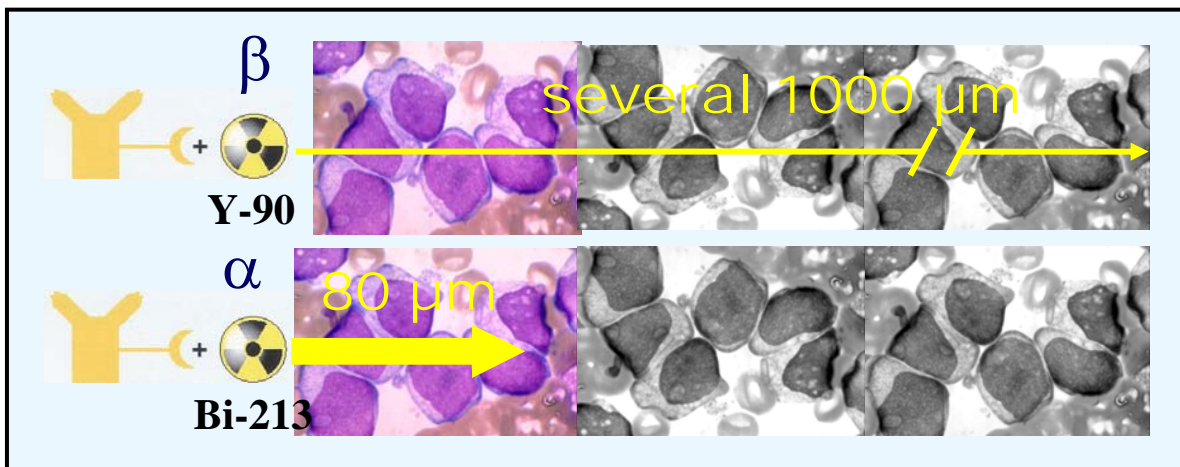
Oxydation states in the Actinide series



Alpha-ImmunoTherapy

- *production of radionuclides*
- *radiolabelling of biomolecules*
- *radiobiology and pre-clinical studies*
- *production of radionuclides and set-up of adapted reprocessing*
- *Further diversification of applications*
- *Radiobiology for Th-226 and U230*
- *In vivo studies*

Principle of Alpha-ImmunoTherapy

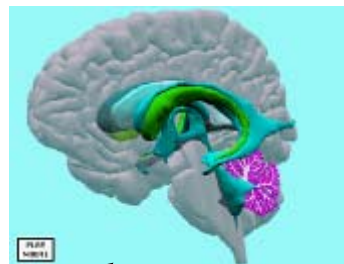


*Alternative alpha-emitters and chelates
Increase pre-clinical and clinical studies
diversify applications*

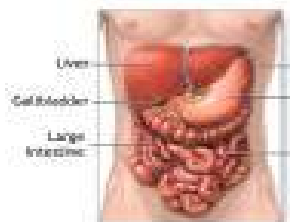


*CT image of patient #4
after injection of 17.4 mCi
²¹³Bi-DOTA-Substance P*

*Malignant melanoma
(Phase I), + pre-
clinical (Sydney)*



*Brain tumours (Phase I)
Prostate cancer
(Basel)*



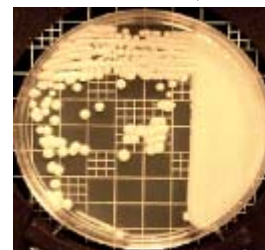
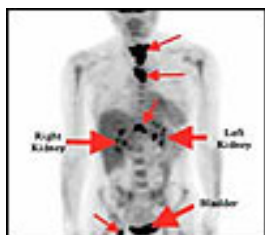
*Gastric, bladder,
ovarian cancer
(Munich)*

ITU
*α-emitting
isotopes*



*Multiple myeloma
(Nantes)*

*Breast Cancer
(Baltimore)*

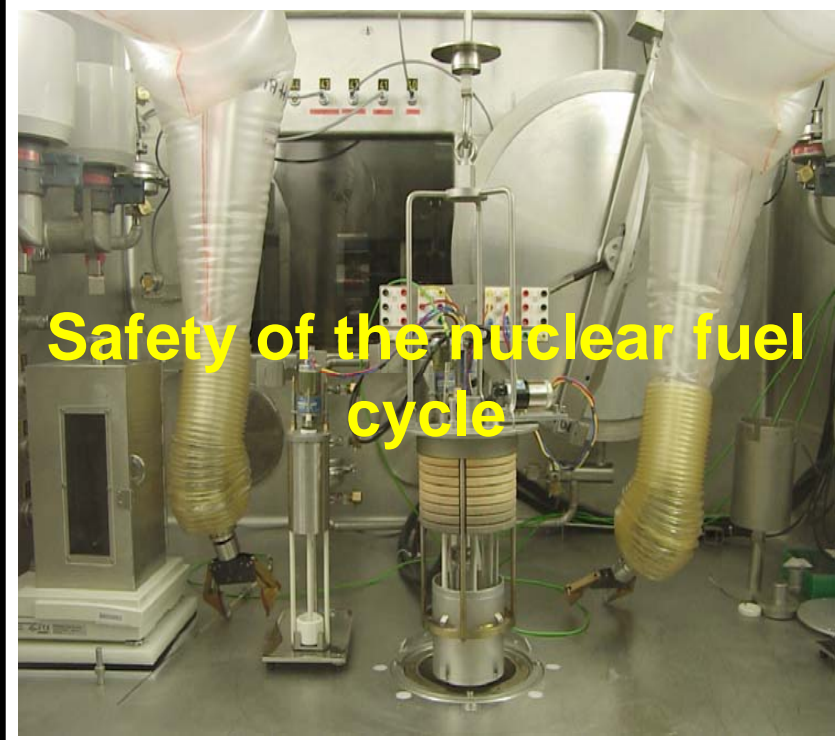


*Infectious diseases
HIV Phase I
(New York)*





Basic actinides
science
and
applications



Safety of the nuclear fuel
cycle



Safeguards
and
nuclear
forensics



Education, Training
and user facilities/networking

First Reactors



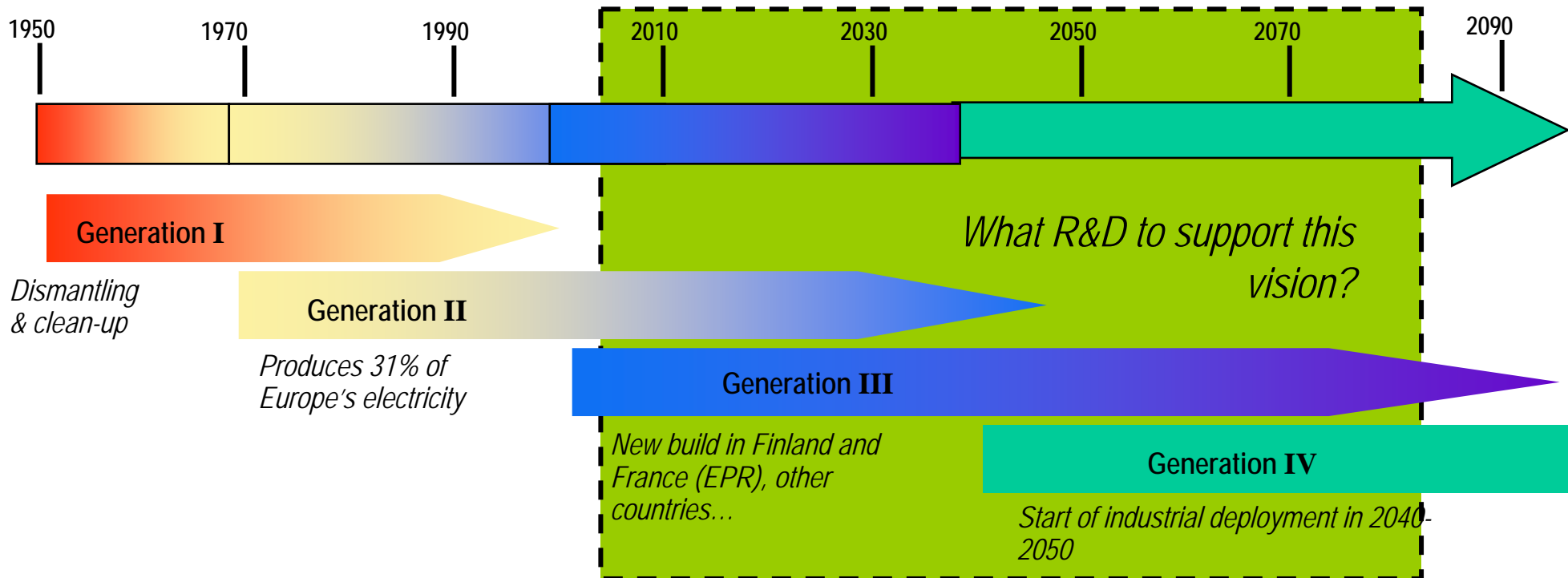
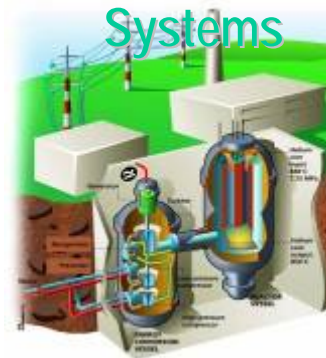
Current Reactors

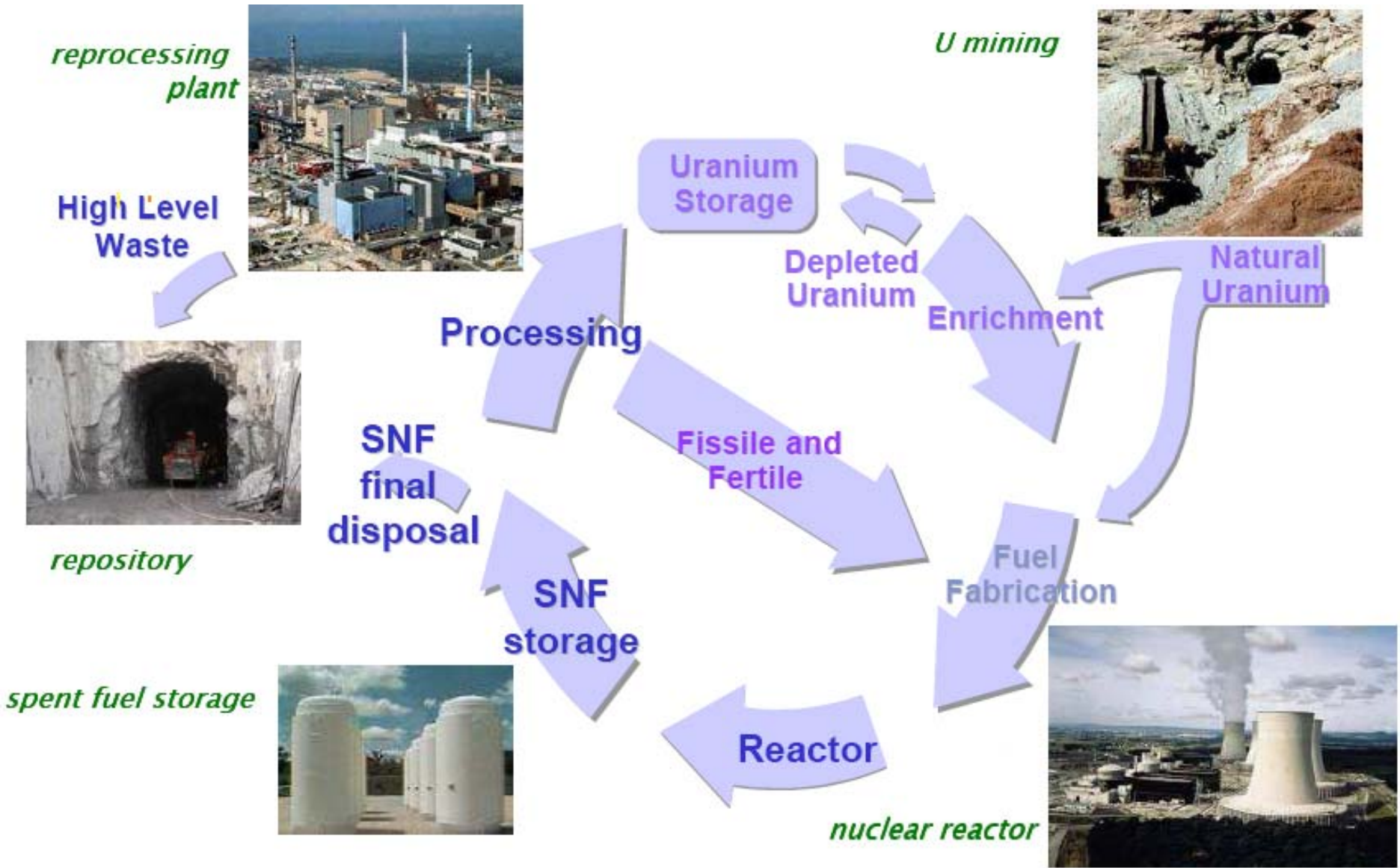


Advanced Reactors



Future Systems







SNE-TP



Safety of Advanced Nuclear Fuels:

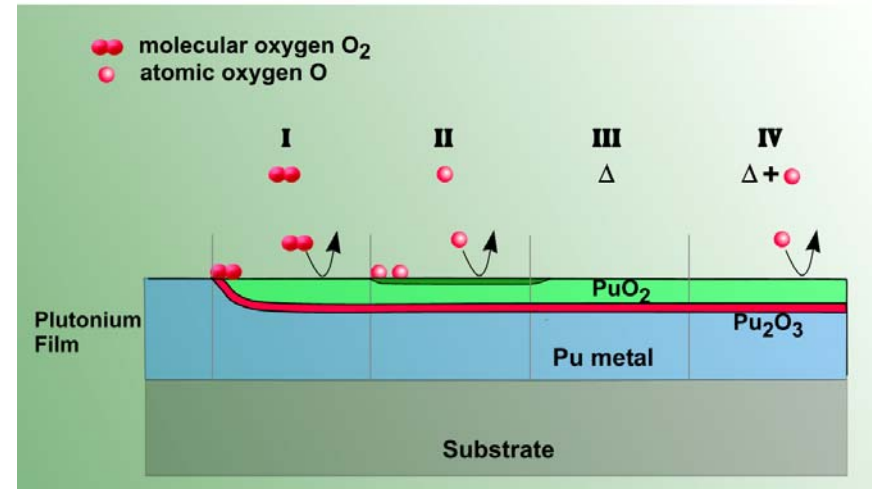
- advanced sustainable fuels
- EURATOM contribution to Gen IV
- International Forum (GIF).

Safety of Conventional Nuclear Fuels

- in-pile behaviour of nuclear fuel at extended burn-up
- Code and Modeling: **Transuranus**



ITU FUTURIX pellets



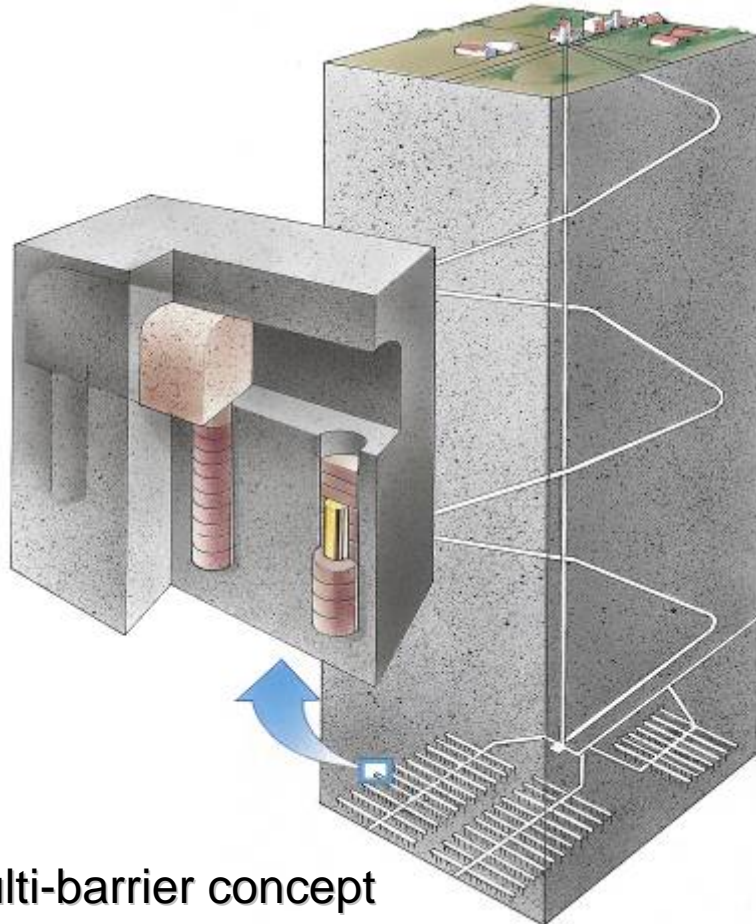
Nuclear Waste Disposal

- studies on unirradiated wastefoms
- advanced characterisation methods
- corrosion studies on irradiated fuels
- conditioning matrices for minor actinides

Alternative Fuel Cycles

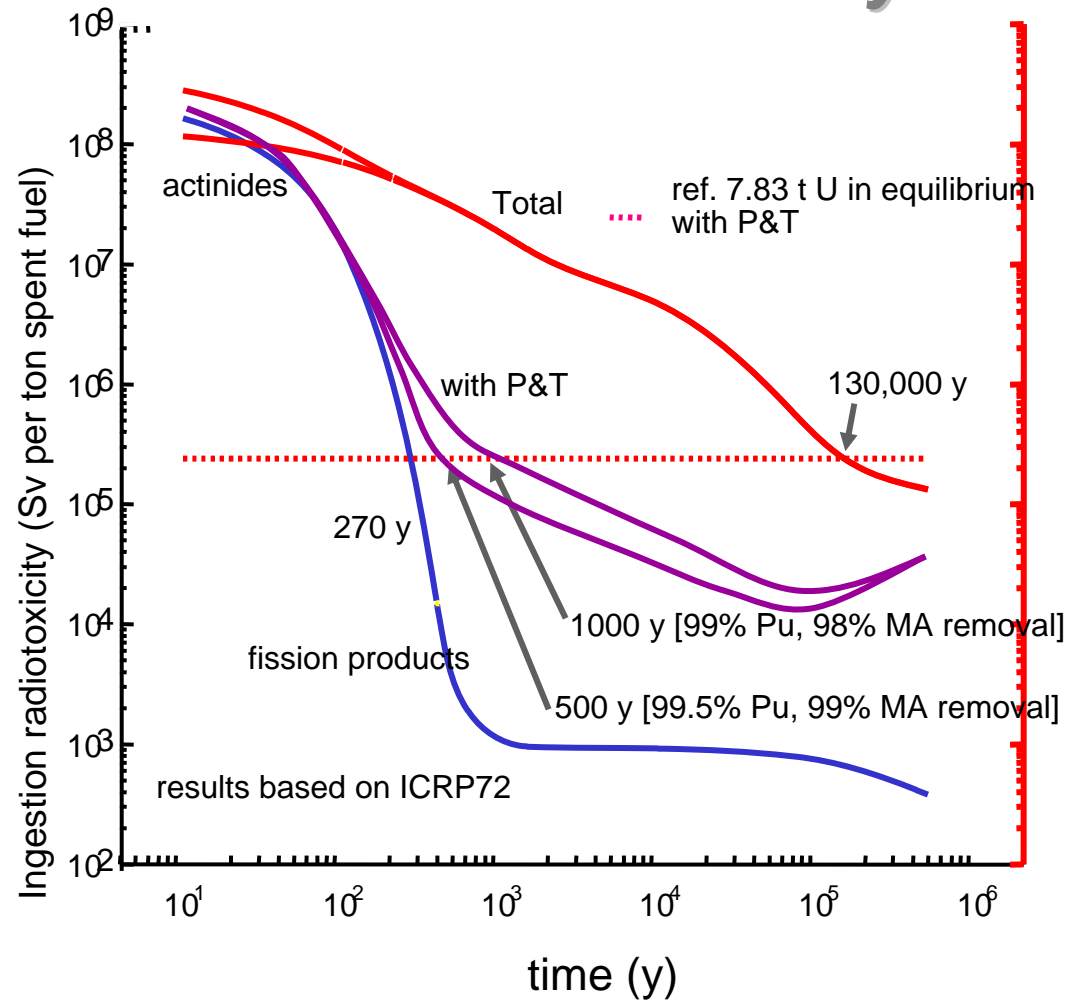
- advanced aqueous partitioning
- pyro-reprocessing technologies
- head-end conversion processes

Nuclear Waste Disposal



Multi-barrier concept
 Retrievability, Reducing conditions
 Source-term
Fuel corrosion

Waste Radiotoxicity





Education, Training
and user facilities/networking

Non-Proliferation is a policy objective of the EU, ITU provides scientific/technical support to Member States, Euratom and IAEA

Traditional Safeguards

- Nuclear material accountancy (owner)
- Independent verification (Euratom, IAEA,...)

Isotope & Element Assay



Strengthened Safeguards

- Absence of undeclared activities (Add. Protocol)

Environmental Analysis

Illicit trafficking and nuclear forensics

- Detection
- Source attribution

Chemical Analysis

Macroscopic Parameters

Microscopic Parameters

Reference Data



Radiological Dispersal Event (RDE)



OSL Sellafield (1999+)

Robotised glovebox for sample preparation and alpha spectrometry

Diluted spent fuel and product samples



LSS La Hague (2000+)

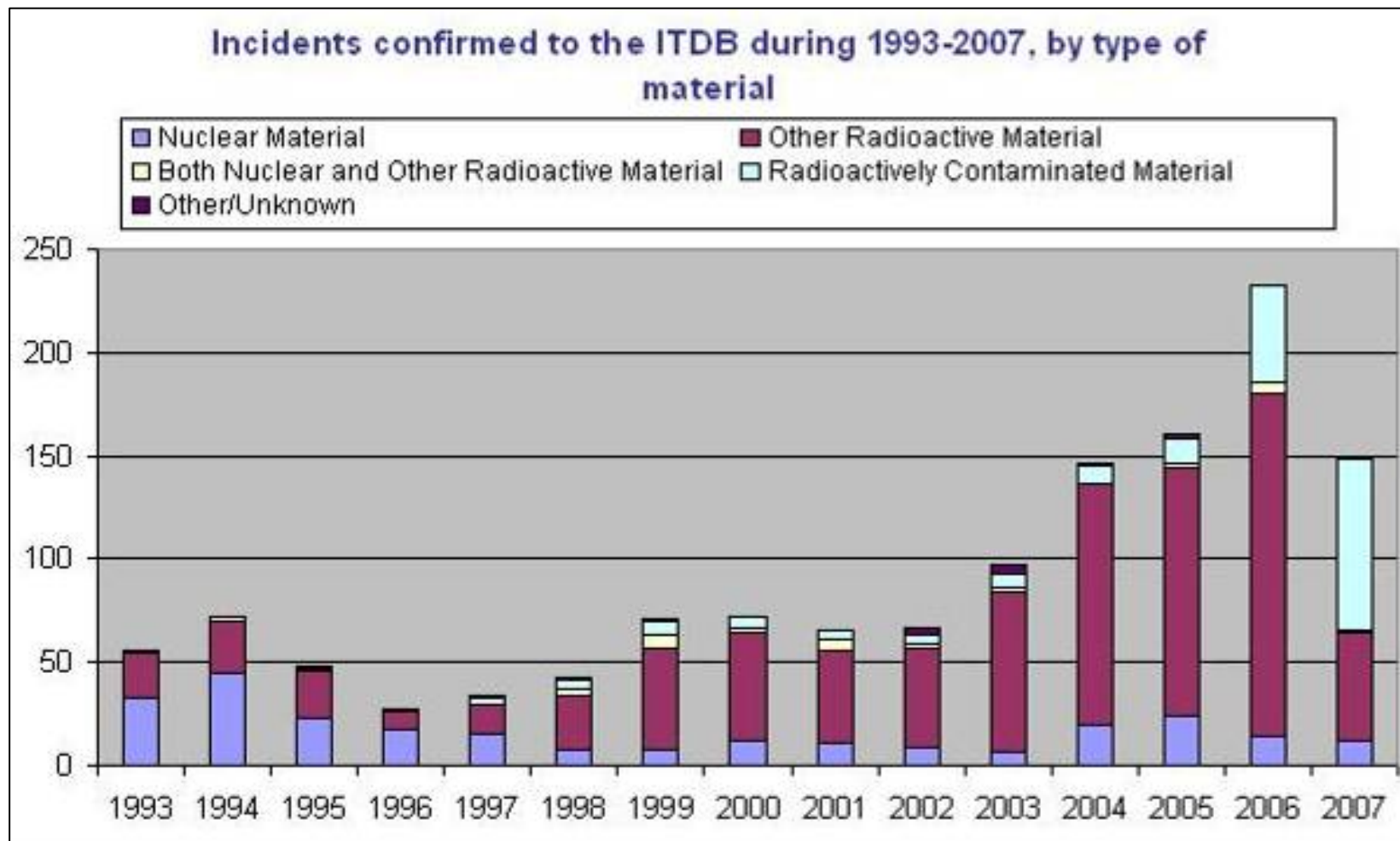
Hot cells for handling and analysing dissolved spent fuel

Undiluted spent fuel and product samples



Illicit Trafficking (all types) incidents 1993-2007

(source: IAEA)

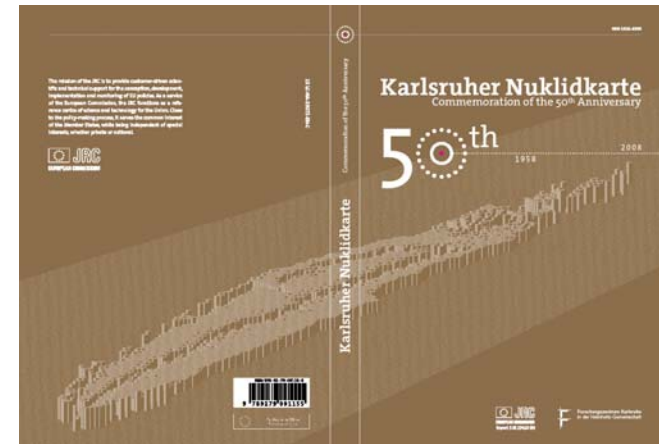
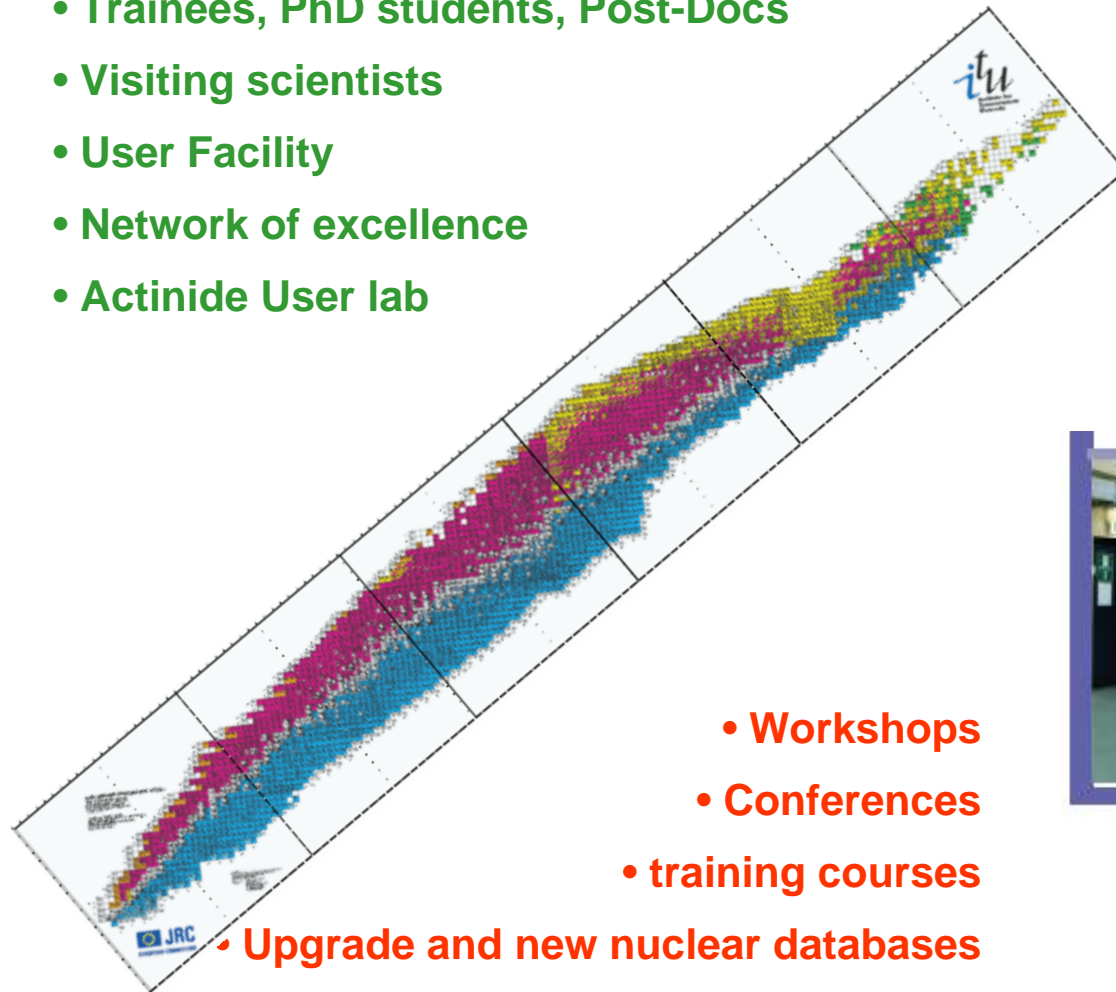




Education, Training
and user facilities/networking

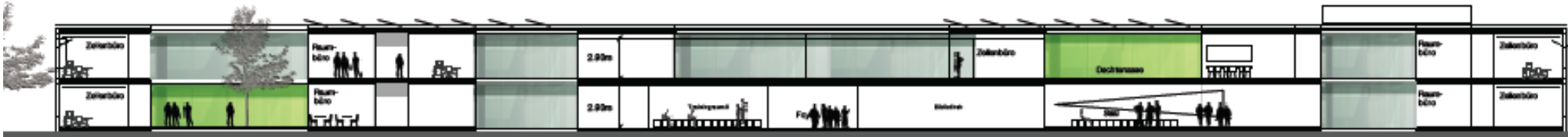
- Summer Schools
- Trainees, PhD students, Post-Docs
- Visiting scientists
- User Facility
- Network of excellence
- Actinide User lab

Information portals www.nucleonica.net

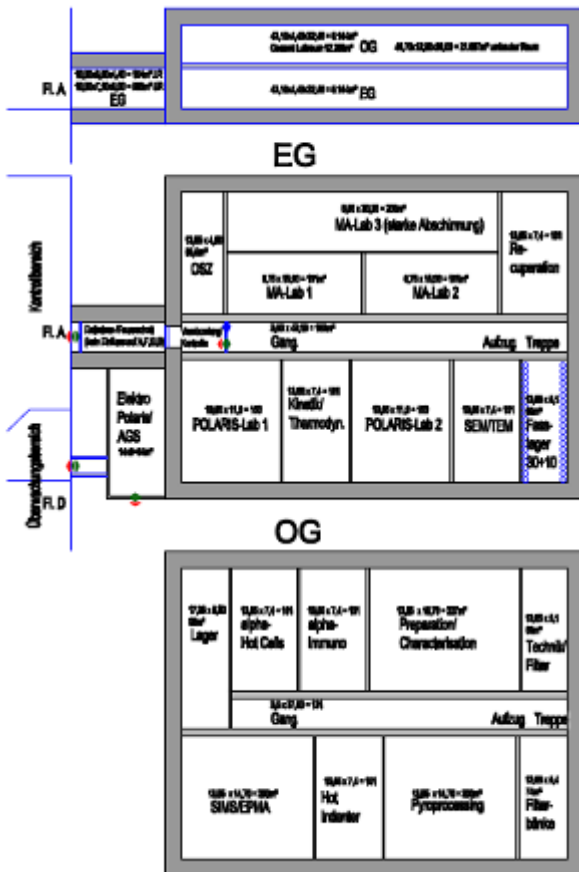


- Workshops
- Conferences
- training courses
- Upgrade and new nuclear databases





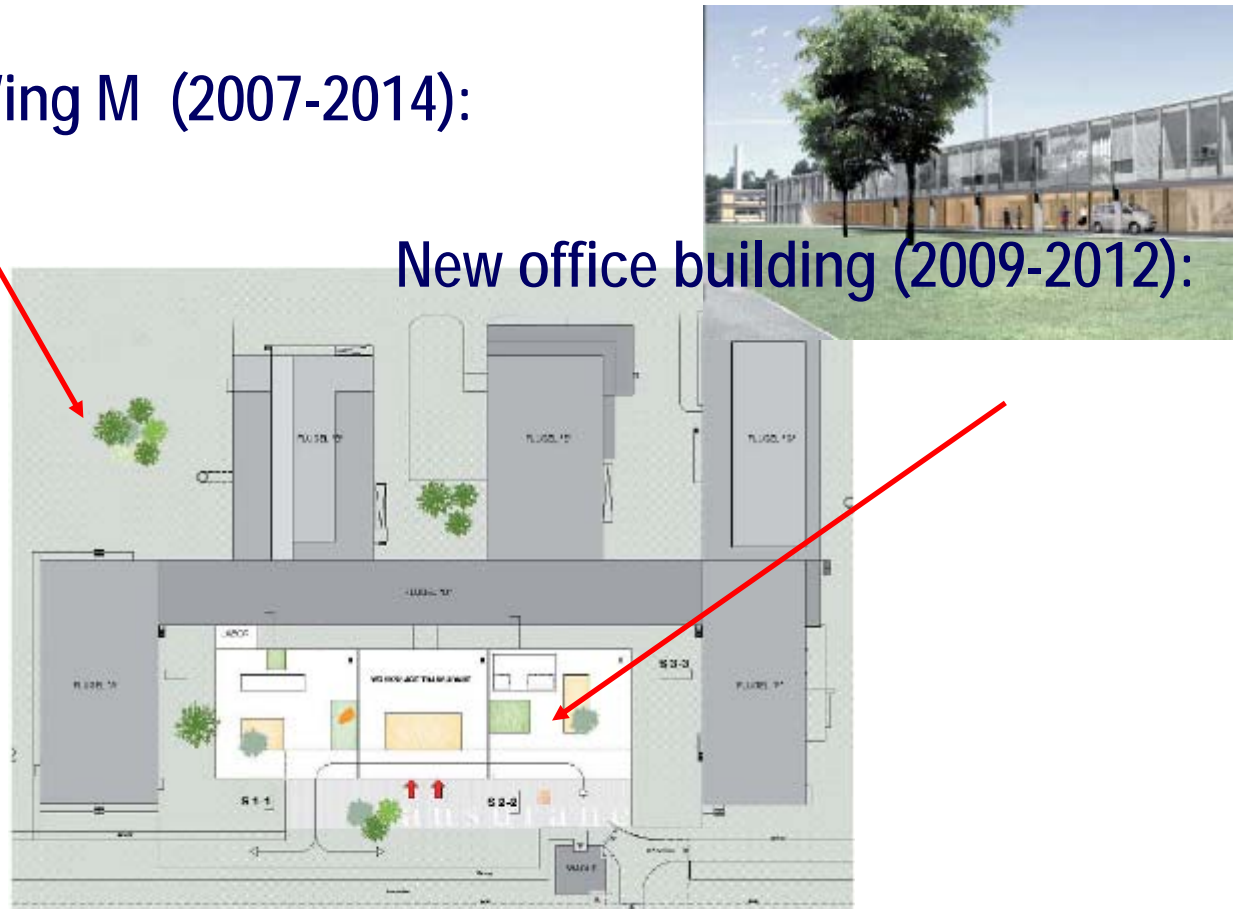
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Wing M (2007-2014):

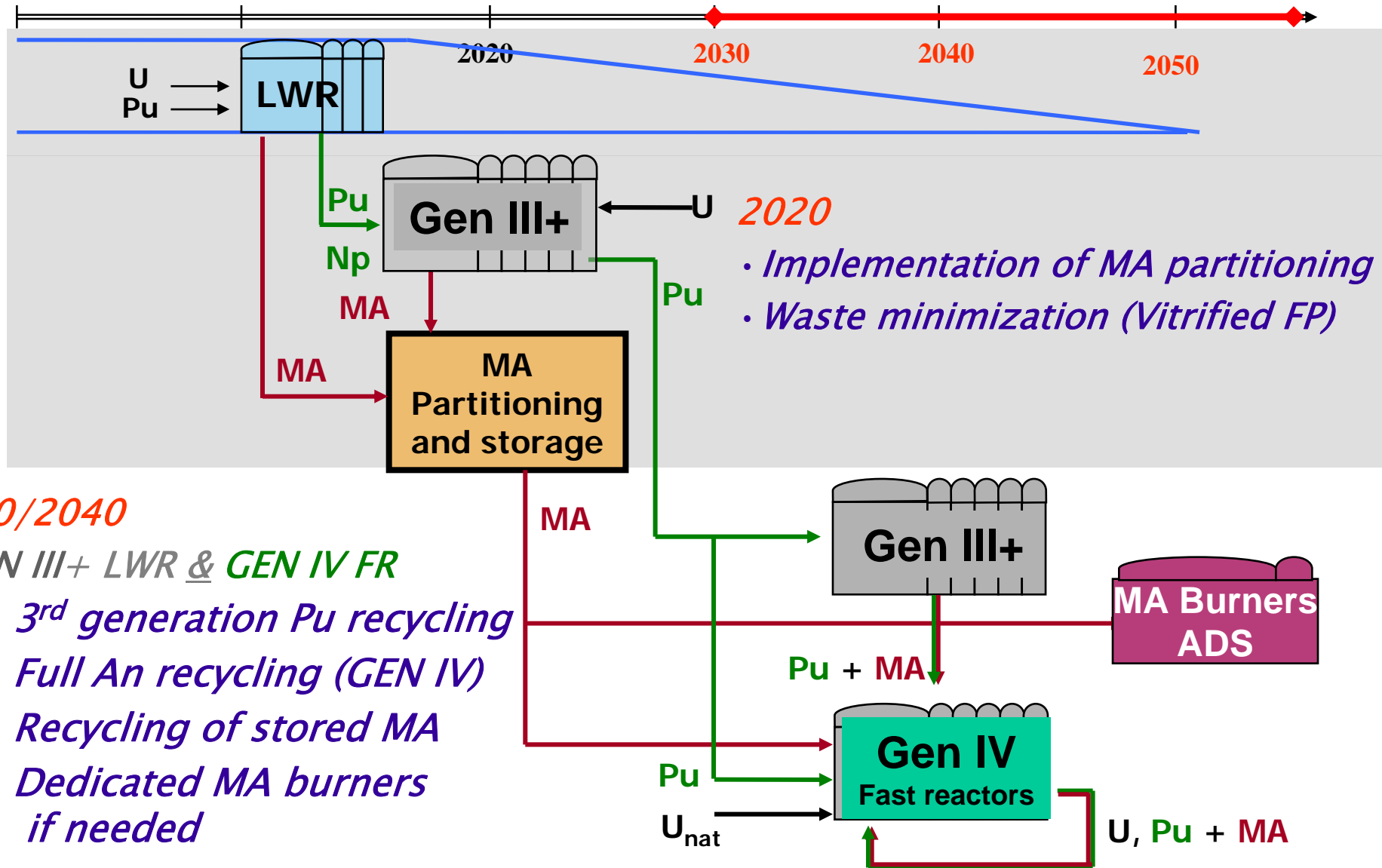
New office building (2009-2012):

Lösung ohne warmen Bereich





Many thanks for your attention
and your visit



- Implementation of MA partitioning
- Waste minimization (Vitrified FP)

2030/2040

- GEN III+ LWR & GEN IV FR
 - 3rd generation Pu recycling
 - Full An recycling (GEN IV)
 - Recycling of stored MA
 - Dedicated MA burners if needed

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

