Use Nuclear to Make a Change

Otilia Militaru, PhD
TRACTEBEL Engineering - Brussels

In a changing world …

My carrier in few lines …

Univ of Bucharest:
1989 - MSc in Technological Physics
1996 – 2000 PhD in Experimental Physics “Development of the CMS SM Tracker at CERN”

1996 – 2012 - Joined CERN as external collaborator

1996-2002 – INFN Pisa and Perugia, fellowships and postdoctoral fellow
2002-2012 – Catholic University of Louvain, Belgium

2012 – I left research and joined the ENGIE GROUP (former GDFSUEZ) in Brussels.

In a changing world …

My carrier in few lines …

- participated at the advancement of the design and tests of the CMS microstrips Silicon Tracker;

- Member of the program for the development of radiation-resistant silicon detectors used for the CMS Tracker and other groups like RD50 and RD39;

- Designer and software developer of remote controlled dedicated instrumentation systems and control devices for silicon detector tests in different laboratories of the Collaboration;

- Participated between 2005-2006 at the installation and first tests of the CMS Tracker End-Caps (petals).

In a changing world …

Currently, my position is:

Senior Nuclear I&C (Instrumentation and Control) engineer

Where:

TRACTEBEL Engineering – Brussels (ENGIE), leading industrial groups in Belgium and a reference in the energy sector.

Since 2015, Expat at owner’s engineer for the design and construction the new nuclear reactor in PETTEN - The Netherlands, called PALLAS, meant mainly for the production of medical radioisotopes.

More than ever your partner, offering engineering solutions in energy transition and innovation, hydropower and nuclear power

ENERGY

- Renewables
- Energy System Consulting
- Digital & Decentralized Energy Solutions
- Hydropower
- Nuclear
- Thermal Energy
- Transmission & Distribution
- Gas & LNG

WATER

- Coasts & Estuaries
- Reservoirs & Dams
- Flood Protection
- Water Transfer
- Water Treatment and Supply
- Irrigation
- Dredging Consultancy
- Offshore Infrastructures

INFRA

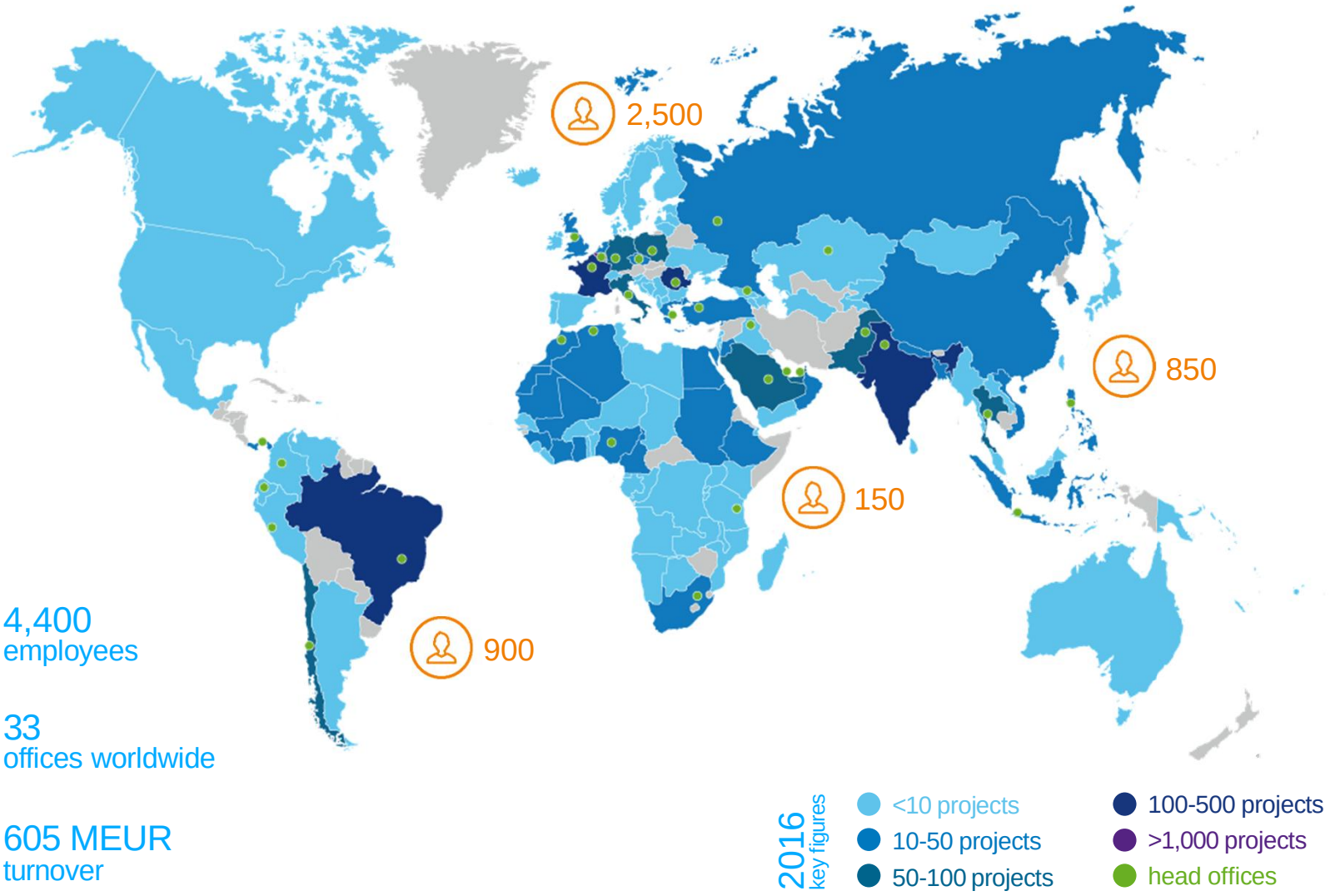
- Smart & Complex Buildings
- Transport & Mobility
- Urban Design & Master Planning
- Energy Efficiency
- Environmental, Sanitation & Social Programs

Shaping our world

Together with our clients it’s our mission to shape the world of tomorrow. Backed by 150 years of experience in energy, water and infra, we can provide **engineering, consultancy and project management services** and be your partner in innovative solutions, the energy transition & digital transformation.

Daniel Develay, CEO

Wherever you are located



Key Figures in Nuclear

850
Employees

€180
million revenues

22
countries in which we have recent project references

> 60
years of experience

Services across the full lifecycle of nuclear facilities

Advanced Technologies

- Fusion, Gen IV, SMR, Research Reactors
- Feasibility Studies & Conceptual Design
- Research & Development Projects
- EUR Compliance
- Compliance to Emerging Regulations
- Nuclear Medical Applications
- Advanced Expertise e.g. Fracture Mechanics

New Build

- Roadmap to Nuclear
- Capacity Building
- Technology Selection
- Nuclear Fuel Cycle Strategy
- Civil Engineering
- Licensing & Permitting
- Site Selection & Site Characterisation
- Engineering & Construction Oversight

Plant Operation Support

- Plant Modifications & Modernisation
- Plant Life Extension
- Ageing Management
- Safety Assessment
- Equipment Reliability
- Core & Fuel Studies
- Licensing and Safety related studies
- In-service and pre-service inspection programming

Radwaste, Decontamination & Decommissioning

- Waste Radiological Characterization
- Waste Treatment and Conditioning
- Waste Storage and Disposal
- Radiation Protection, ALARA Studies
- Decommissioning Scenarios & Plans
- Waste Management facility for decom waste
- Decom cost & schedule Optimization

Supporting you in managing your radioactive waste and spent fuel storage safely

- Waste Radiological Characterization and Minimization
- Radiation Protection Studies (e.g. ALARA studies, including shielding calculations and dosimetry analyses)
- Design of treatment, conditioning and storage facilities related to all types of radioactive waste
- Development of processes and systems for the treatment and conditioning of liquid and gaseous effluents as well as solid waste
- Design of interim storage facilities for all types of radioactive waste (low-, medium- and high-level waste, alpha-bearing waste)
- Design of final disposal sites for radioactive waste, both for surface and underground repositories
- Design of spent fuel dry and wet storage facilities
- Technical support for spent fuel cask licensing process

Advanced technologies, taking research one step further

- Fusion Technology (ITER)
- Gen IV (ASTRID - sodium-fast cooled reactor prototype, 600 MW)
- Small Modular Reactors
- Research Reactors (PALLAS reactor, Jules Horowitz reactor, …)
- Nuclear Medical Applications (IBA, ...)

Ensuring Uncompromising Levels of Nuclear Service



OE of new nuclear reactor Pallas, in Netherlands

PALLAS is a nuclear multi-purpose research reactor to produce medical isotopes and to supply a wide range of irradiation services.

CLIENT Pallas

LOCATION The Netherlands

PERIOD 2015-2024

SERVICES PROVIDED

Owner's Engineer

Organization of the Tendering process for Nuclear Island Designer

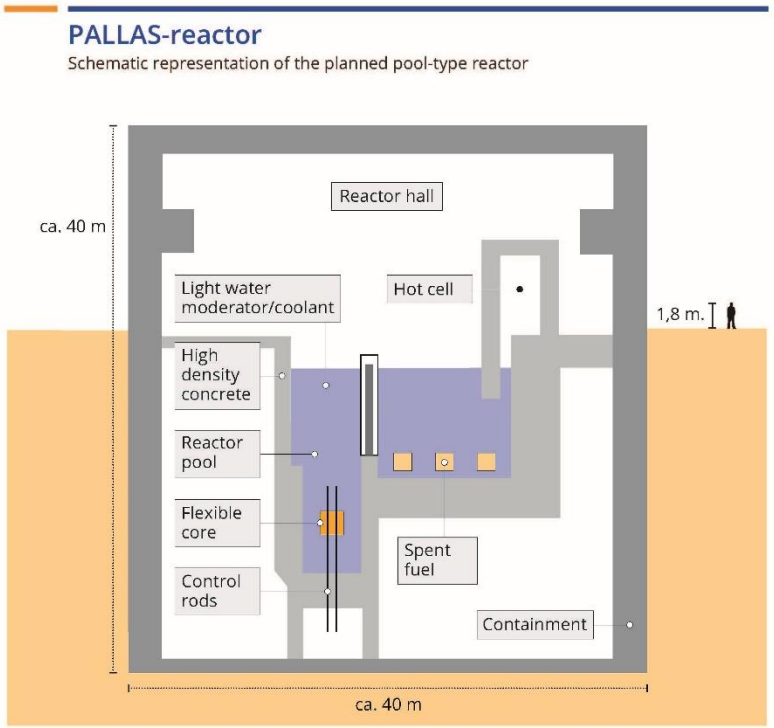
- Development of Safety Approach
- Development of Functional and Safety Breakdown Structure
- Review of Site Characterization Study
- Organization of Vendor's Conference
- Completion Bid Invitation Specification (BIS)
- Bids Assessment
- Contract Negotiation

Preparation of Design

Licensing

Construction Management

Commissioning Management



Pallas Reactor- Netherlands

The Pallas project aims to provide mainly MEDICAL radioisotopes for DIAGNOSTIC and THERAPEUTIC procedures

80% diagnoses with Nuclear Medical Imaging
-30 millions investigations worldwide per year
-Diagnoses and radiotherapy of cancers

Main RADIOISOTOPE for Nuclear Diagnosis is Technetium-99 (Tc-99)

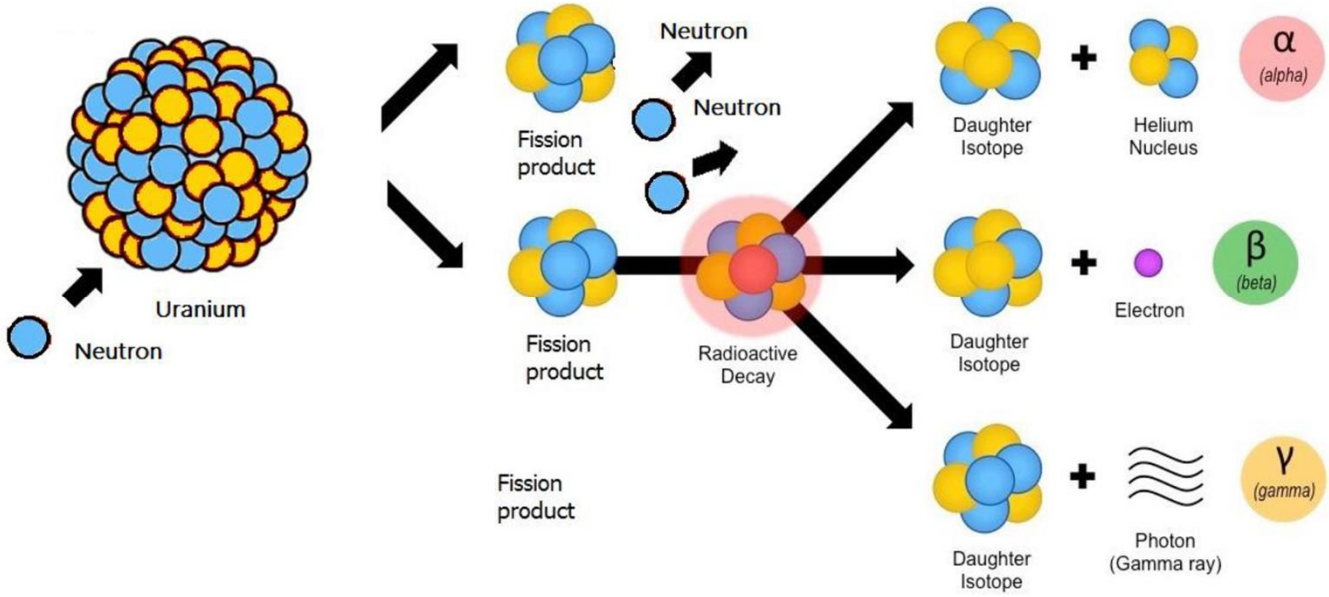
-90% diagnosis procedure worldwide

-80% all nuclear medicine procedures

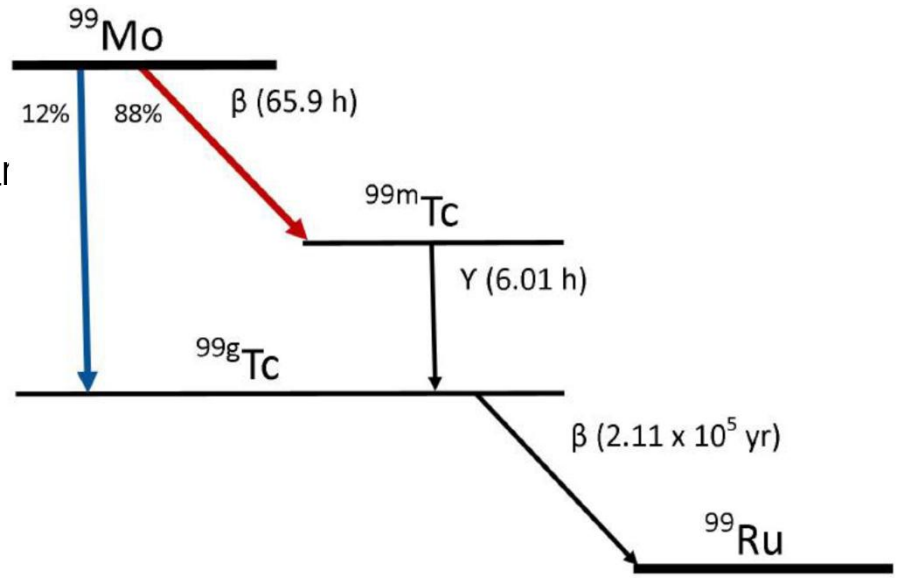
-Medical use grows 3-5% per year

-Huge market in developing countries

Why Technetium-99?



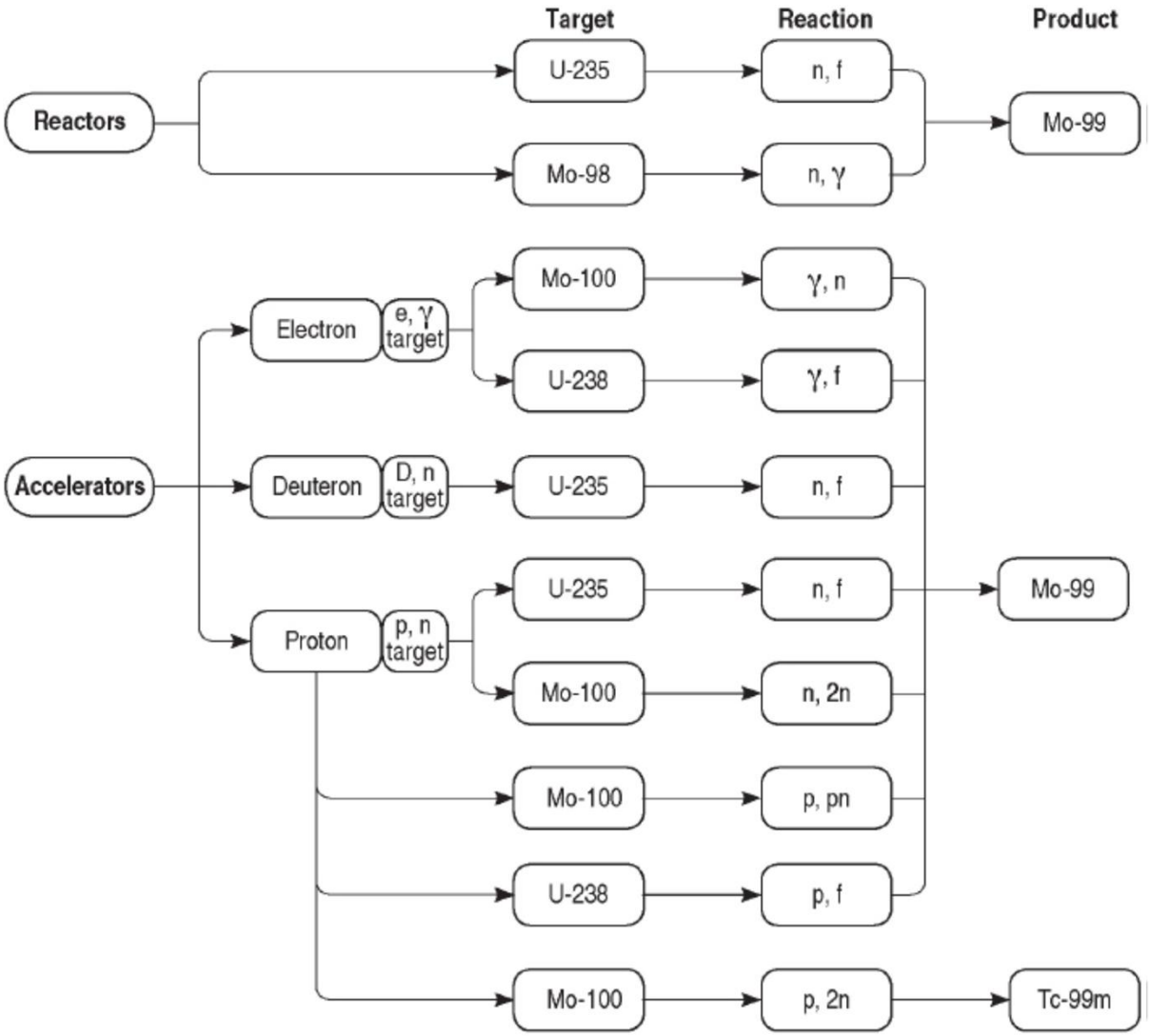
a) Obtained by decay of Molybdenum-99
Mo-99 half life = 66 h (~ 3 days) good for transportation
b) half life = 6 h -perfect for Medical use: low radiation dose
c) 140 keV photons
d) high quality images (tomography)
e) versatile to attach to different chemical substar
diseases: **bones, brain, kidneys, liver, lungs**

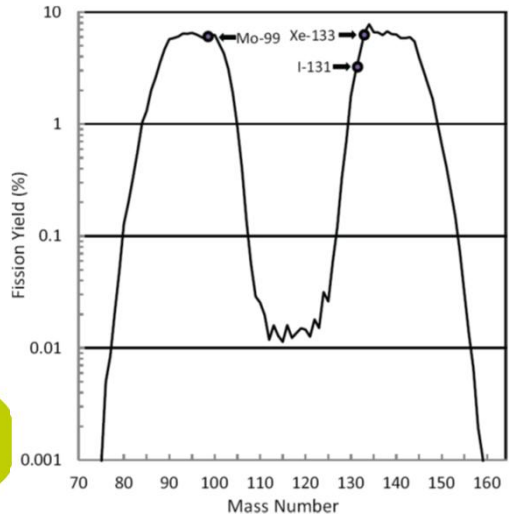


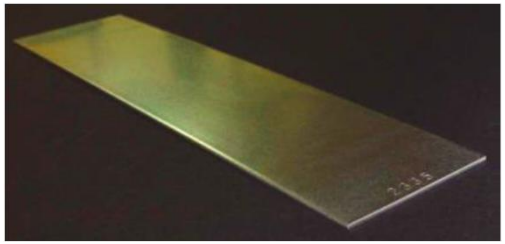
Why nuclear reactor?

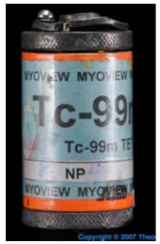
95% of the Mo-99 produced by fission of Uranium-235 contained in target plates

Other methods (cyclotrons, synchrotrons) **not** commercially attractive on global scale









Why the necessity of a new nuclear reactor?

- No reactor in the world built *only* for Radioisotope production
- 90% production with reactors more than 50 years old ➔ all **government subsidized**

Country	Name, age	Thermal power in MW	Reactor operation License expiration	Thermal neutron Flux n/s/cm²	Target type	Maximum annual operation, days	Typical share of production %
Canada	NRU (60, **Stopped**)	135	2014	4.0e14	HEU	280	40
Netherlands	HFR (56)	45	2024	2.7e14	HEU	266	30
Belgium	BR-2 (56)	100	2026	1.0e15	HEU	190	10-15
South Africa	Safari-1 (50)	20	2030	2.4e14	HEU	305	10-15
France	Osiris (51, **stopped**)	70	2015	1.7e14	HEU	220	0
Australia	OPAL (10)	20	2055	3.0e14	LEU	300	8
Other (USA, Germany, Poland)	MURR, FRM-II, MARIA		2028-2030			200-210	0-10

Why the necessity of a new nuclear reactor?

Scope of the reactor

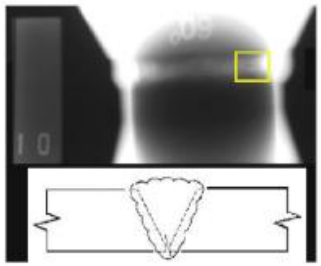
- Actual demand Tc-99 ➔ 9000 6 days Ci per week
- Global market Tc-99 ➔ 12000 6 days Ci per week

- Replace HFR ➔ become reference reactor in Europe
- Association with processing facility

- **Other RI as by products of Moly**
  - Iodine 131 (Therapeutics)
  - Xenon 133 (Diagnosis)

- **Industrial application**
  - Welds radiography (Iridium)
  - Defect detection (Selenium)

- **Nuclear Research**



PALLAS

Lutetium-177			Beta radiation therapy
Lu-176	3%	(n,gamma)	reactor
Yb-176	13%	(n,gamma)	reactor
Holmium-166			Alpha Radiation Therapy
Ho-165	100%	(n,gamma)	reactor, thermal flux
Iridium-192			Brachyterapy + Checking Industrial Welds
Ir-191	37%	(n,gamma)	reactor
Yttrium-90			Beta radiation therapy
Y-89	100%	(n,gamma)	reactor
Strontium-89			Beta radiation therapy
Sr-88	83%	(n,gamma)	reactor
Iodine-125			Brachyterapy
Xe-124	1%	(n,gamma)	reactor
Iodine-131			Beta radiation therapy
Te	100%	(n,gamma)	reactor

In a changing world …

Closing this presentation with few remarks …

- Working at CERN for so many years has been a great and unique experience that developed me as an engineer;

- There are an increasing number of opportunities for continuing the high-level research also in private industry in different domains, very well financed, that need people like you;

- Look for and seize the opportunities …

Let’s keep in touch

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THANK YOU !

Shaping our world

tractebel-engie.com