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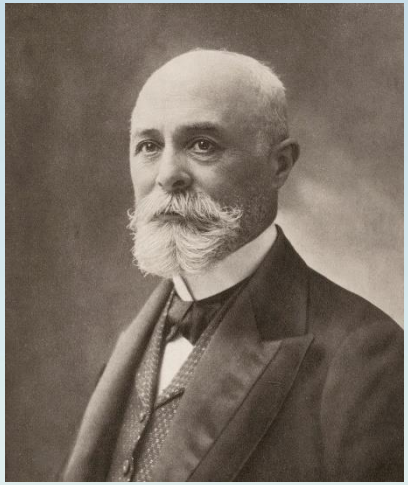
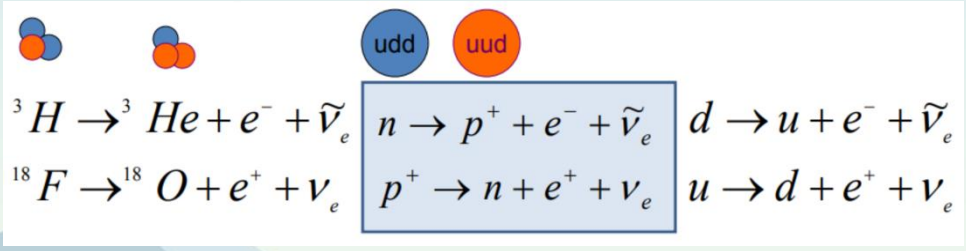
Radioactive Waste Disposal

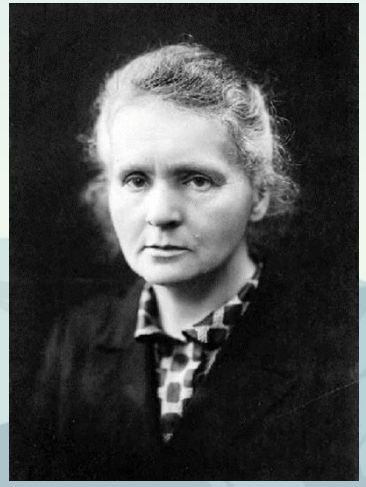
2020.02.26.

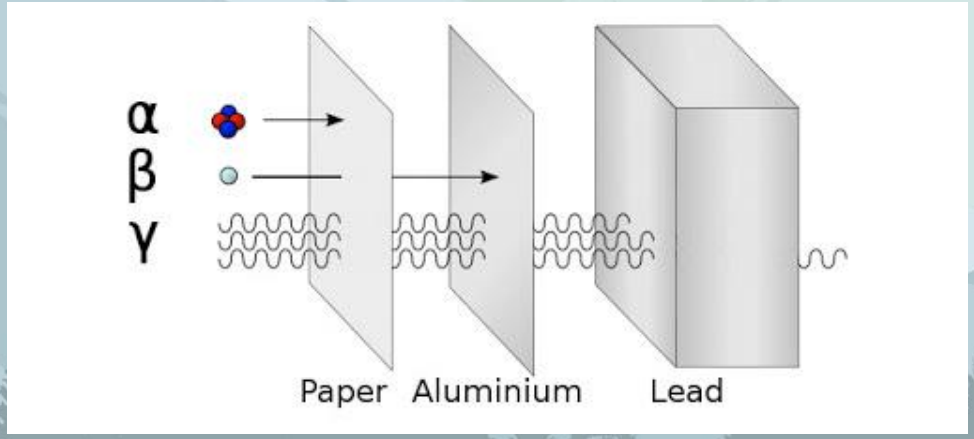
Radioactivity



- 1896 – Henri Becquerel
- Marie and Pierre Curie – Radium, Polonium
- α, β, γ radiation





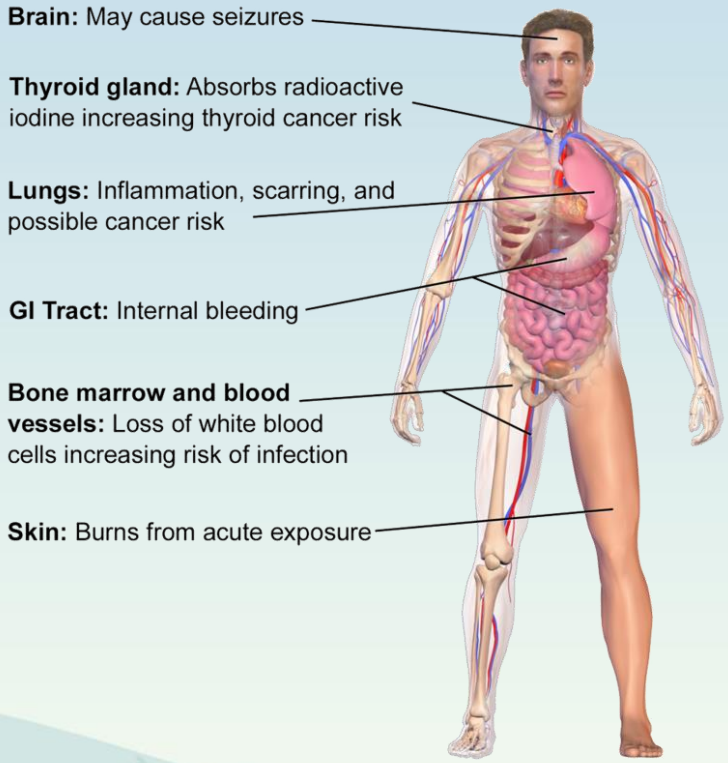


Absorbed dose

- Radiation poisoning causes cellular degredation
- Serious health risks

$$D = \frac{dW}{dm} = \frac{1}{\rho}\frac{dW}{dV}$$

$$[D] = \frac{J}{kg} = Gy$$



Selected Risks from Radiation Sickness

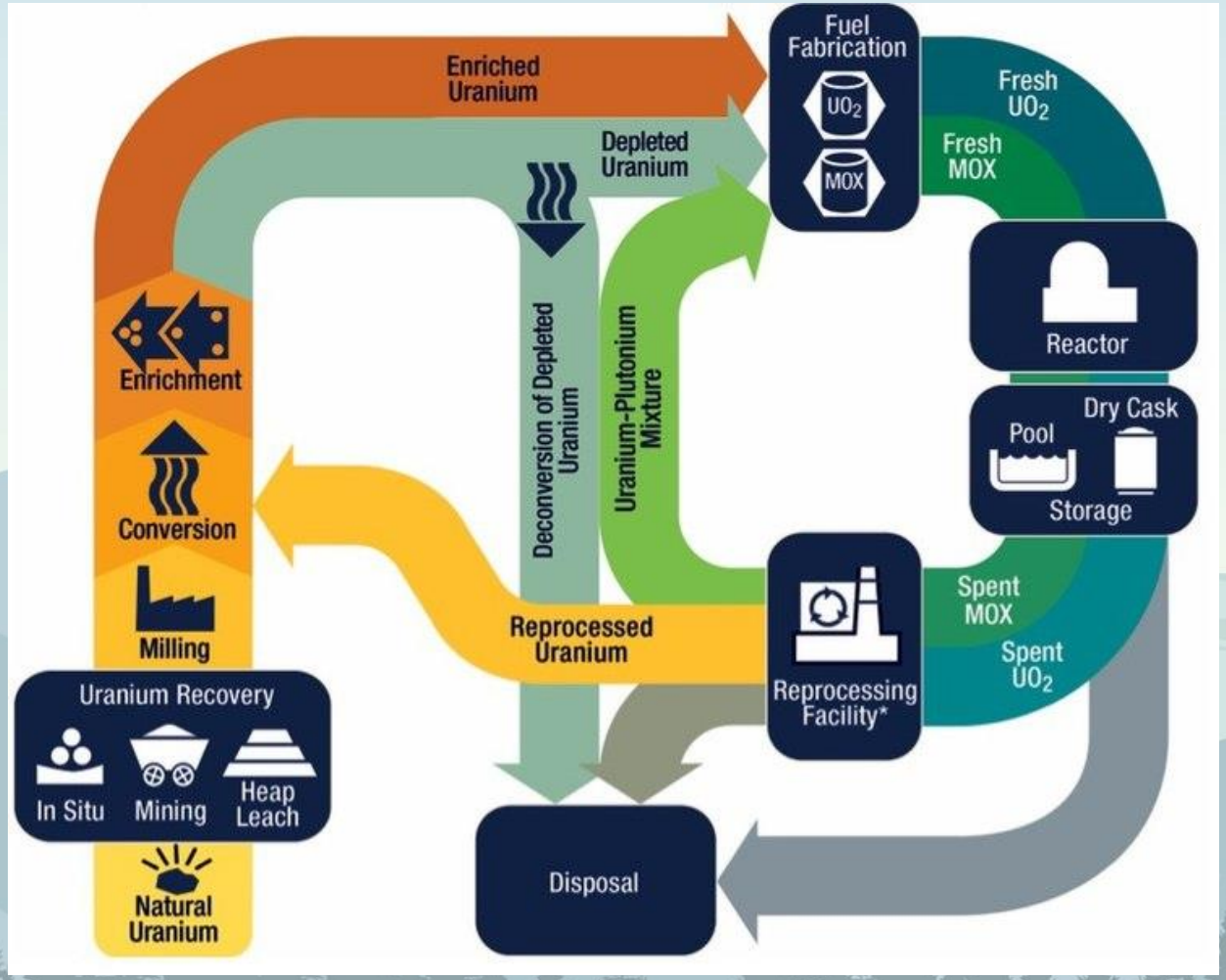
Symptom	Properties	1-2 Gy	2-6 Gy	6-8 Gy	8-30 Gy	>30 Gy
Nausea, Vomiting	Percentage	5-50%	50-100%	75-100%	90-100%	100%
	Time of onset	2-6h	1-2h	10-60 min	<10 min	minutes
Headache	Intensity	Slight	Mild to Moderate	Moderate	Severe	Extreme
	Time of onset	-	4-24h	3-4h	1-2h	<1h
Fever	None	Slight	Moderate	Severe	Extreme	
	Time of onset	-	1-3h	<1h	<1h	<1h
Morality	Without care	0-5%	5-95%	95-100%	100%	100%
	With care	0-5%	5-50%	50-100%	99-100%	100%
	Death	6-8 weeks	4-6 weeks	2-4 weeks	2days-2weeks	1-2 days

Nuclear fuel cycle

This is where most of the radioactive waste comes from

1. **Front end:** Exploration, Mining, Milling, Uranium conversion
    - Geophysical techniques
    - U-238 (99.28%), U-235 (0.71%), U-234 (0.001%)
    - Uranium Oxide – U_3O_8
2. **Service period:** Transport, different kinds of applications
3. **Back end:** Safe management, containment, reprocess, disposal

Nuclear fuel cycle



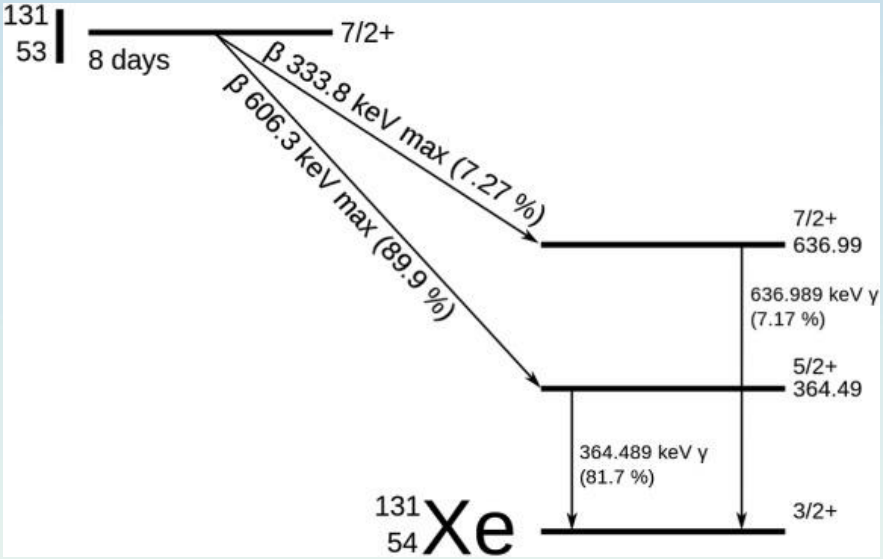
Radioactive waste

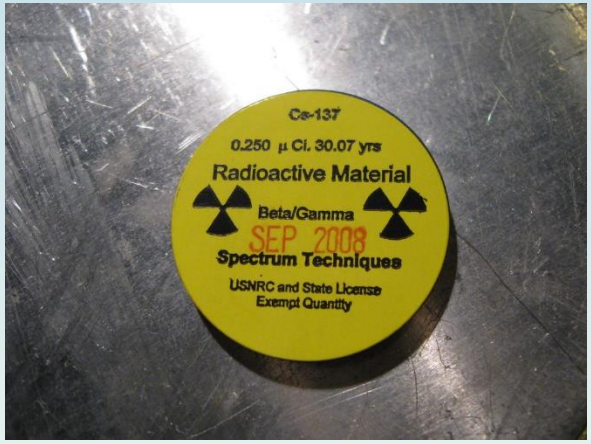
1. Contaminated / contains radionuclides
2. Concentration / activity is greater than clearance levels
3. No use is foreseen

Nuclear power plants, Nuclear fuel treatment plants, Nuclear armament, Medical use, NORM

- Radioactivity level, decay time
- Energy, type of radiation

type of radiation	nuclide	half-life
	uranium—238	4.5×10^{9} years
α	thorium—234	24.5 days
β	protactinium—234	1.14 minutes
β	uranium—234	2.33×10^{5} years
α	thorium—230	8.3×10^{4} years
α	radium—226	1590 years
α	radon—222	3.825 days
α	polonium—218	3.05 minutes
α	lead—214	26.8 minutes
β	bismuth—214	19.7 minutes
β	polonium—214	1.5×10^{-4} seconds
α	lead—210	22 years
β	bismuth—210	5 days
β	polonium—210	140 days
α	lead—206	stable



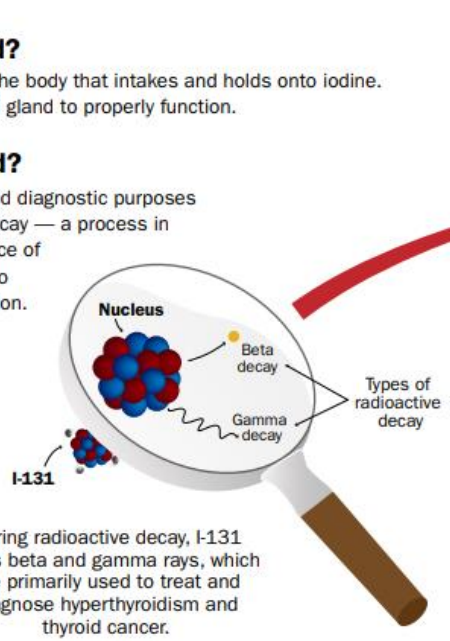


Why is Iodine-131 used?

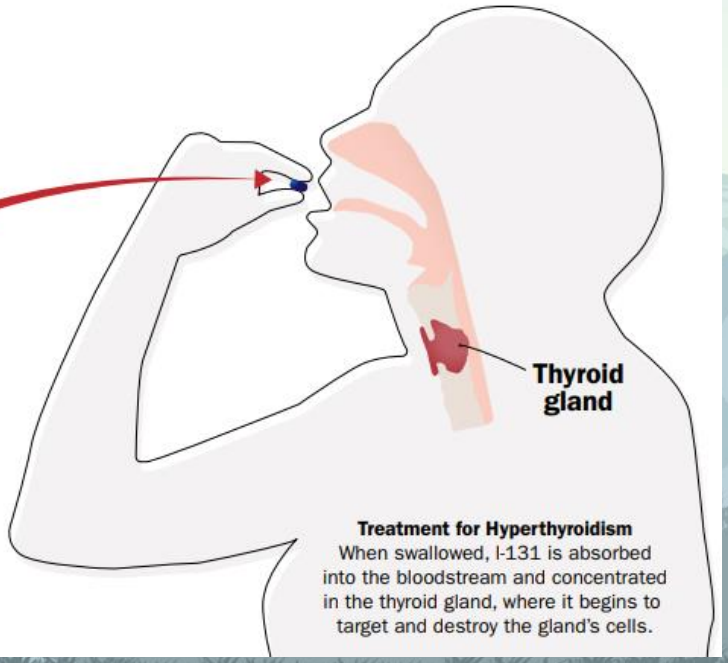
The thyroid is the only tissue in the body that intakes and holds onto iodine. Iodine is essential for the thyroid gland to properly function.

How is Iodine-131 used?

I-131 is useful for therapeutic and diagnostic purposes as it goes through radioactive decay — a process in which a nucleus with an imbalance of protons and neutrons attempts to stabilize again by emitting radiation.



During radioactive decay, I-131 emits beta and gamma rays, which are primarily used to treat and diagnose hyperthyroidism and thyroid cancer.



Treatment for Hyperthyroidism

When swallowed, I-131 is absorbed into the bloodstream and concentrated in the thyroid gland, where it begins to target and destroy the gland's cells.

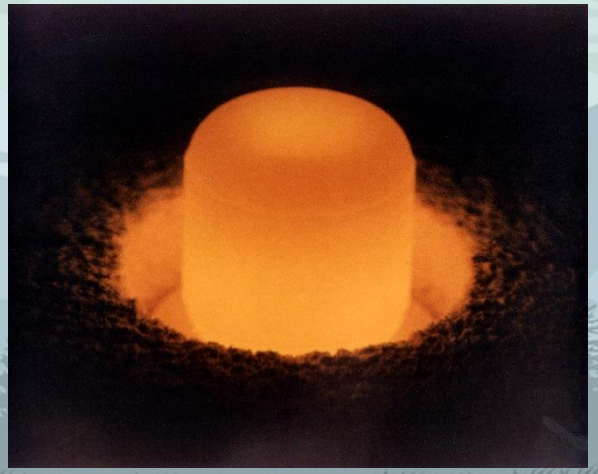
Waste from the nuclear cycle

1: Front end:

- Extraction of uranium
- Depleted uranium
- MOX

2: Back end:

- Spent fuel rods
- U-234: $T_{1/2}$ = 245.000 years
- Np-237: $T_{1/2}$ = 2.1 M years
- Pu-238: $T_{1/2}$ = 87.7 years
- Am-241: $T_{1/2}$ = 432 years
- Cf-251: $T_{1/2}$ = 898 years



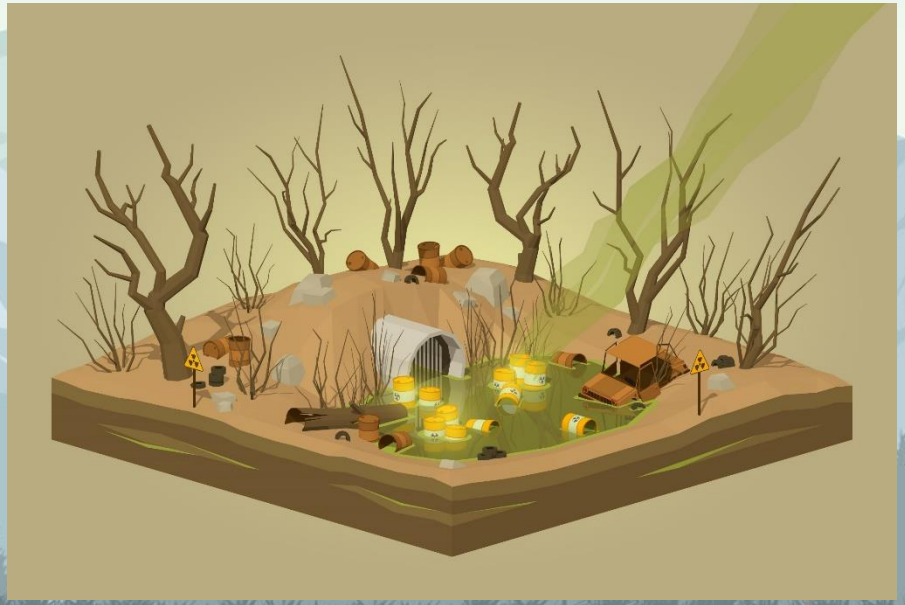
Waste Disposal

1: Low-level Radioactive waste:

- Contains small amounts of radiation
- Short-lived radionuclides from active areas
- Class A, B, C
- Deposited near / on the surface

2: Intermediate-level Radioactive waste

- Shielding
- No cooling
- Chemical sludge, metals, contaminated materials



Waste Disposal

1: High-level Radioactive waste:

- Fuel roads, fission products, Cs-137, Sr-90, Plutonium
- Increasing by 12.000 tons/year
- 250.000 tons in total

Two fundamental requirements to store HLW: Stable geological formation, stable human institutions

1983: Review of the Swedish radioactive waste disposal program: it may require up to a million year for the nuclear waste not to be harmful anymore -loose enough activity.

Yucca Mountain waste repository

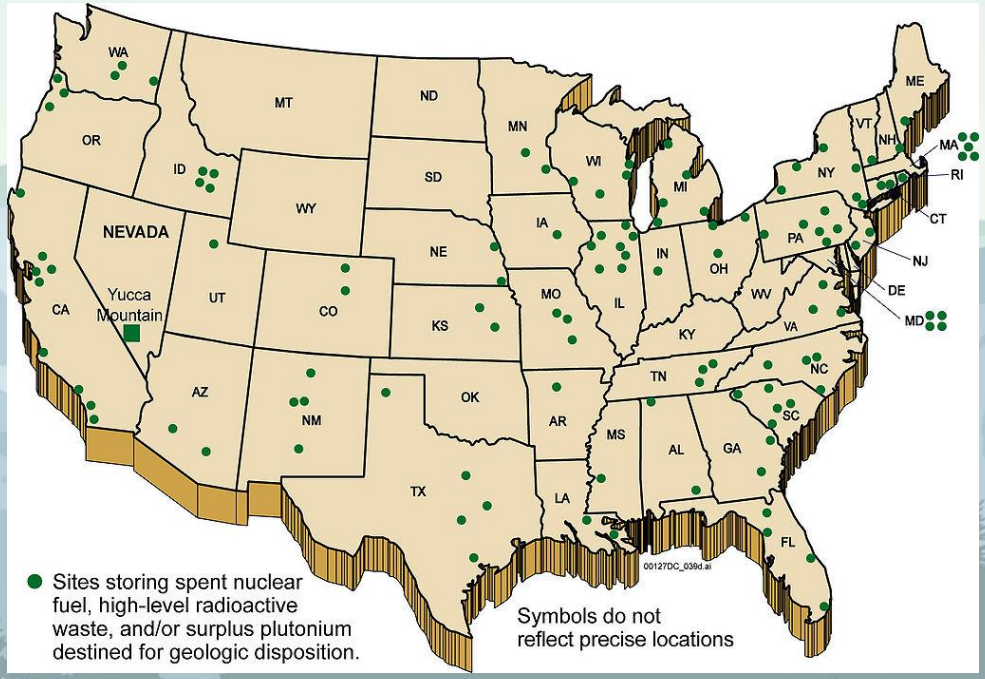
- Deep geological storage in the USA
- 85,000 tons
- 64 km of tunnels
- 8.0 km long and 7.6 m wide
- 9 billion dollars

Why here?

- Low populated area
- Dry weather
- No ground water
- Guarded area
- No other purpose

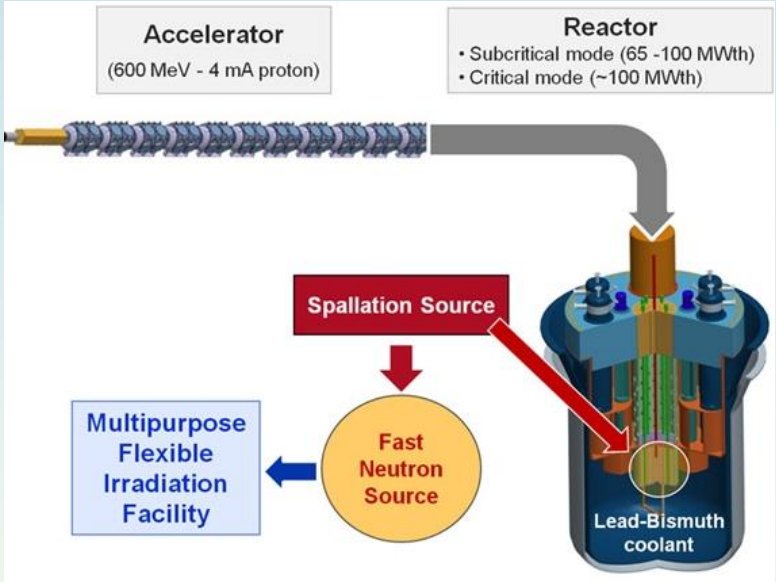
Waste Repository at Boda

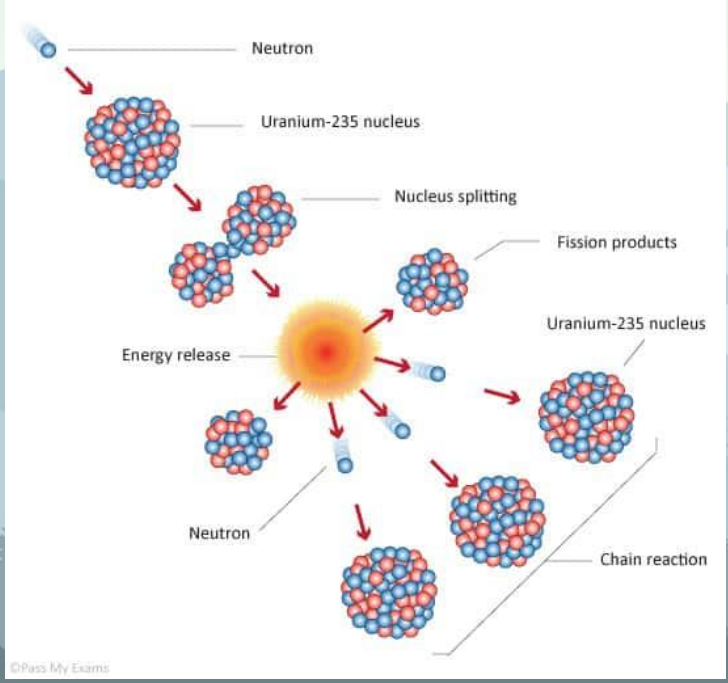
- Paks nuclear waste
- 1.8 billion forints
- Construction starts in 2055
- 2083
- Gábor Tímár

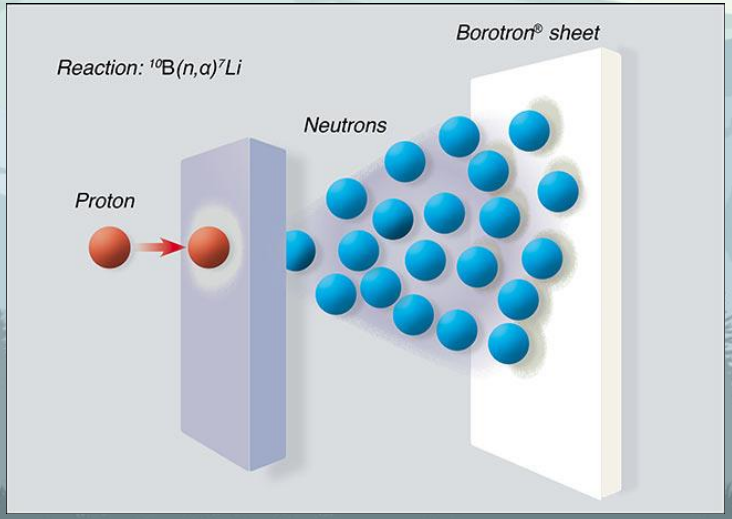


Nuclear Transmutation

- Conversion of an element to another
- Half life un der 30 years
- TRU – Transuranium Elements
- LLFP – Long Lived Fission Products
- Sr-90, Cs-137
- Intense neutron source







Hope this presentation was the bomb!

Thank you for your attention