

NASA needs Pu-238 now. The Medical Community needs isotopes now.

NASA is effectively out of Pu-238, the power source for all deep space probes. They can launch no more deep space missions until they get more. There is none available in the world.

Successful cancer research has been halted for a lack of medical isotopes.

We are about to destroy the very rare and valuable solution to both of these needs.

The U.S. Has contracted to destroy the stockpile of Uranium 233.

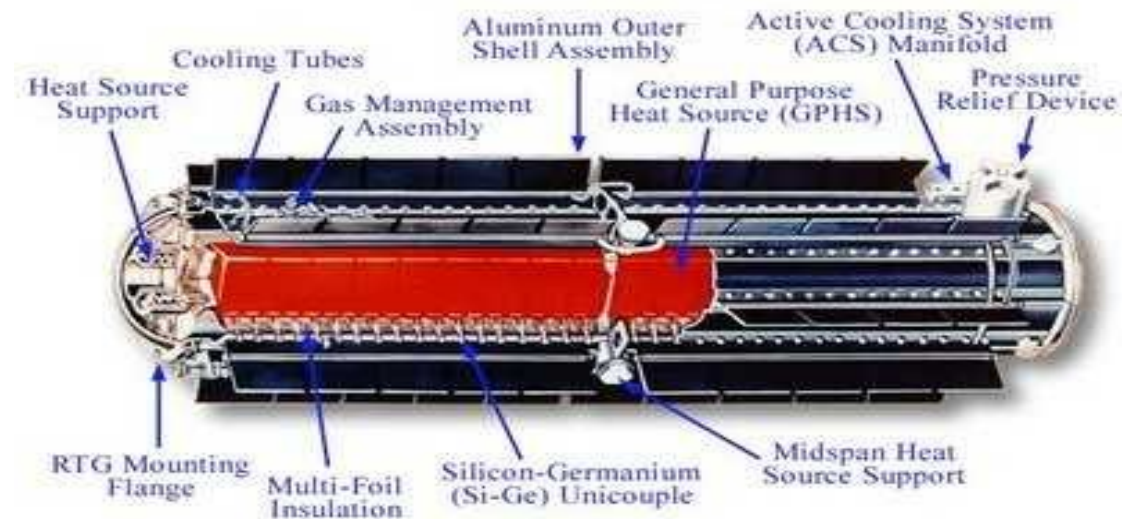
This stockpile could be the starting material for a Thorium reactor. The Thorium reactor is the best and cleanest way to produce pure Pu-238 and the rare medical isotopes that can be used in novel cures for Cancer.

There is \$350 million of \$500 million left in the budget to denature the U233. NASA has budgeted \$150 million to acquire Pu238.

These financial funds can be redirected to our project to produce these desperately needed materials in the safest known manner possible.



GPHS-RTG



Radioisotope Thermoelectric Generator Basics

Radioisotope thermoelectric generators (RTG) are slugs of radioisotopes (usually plutonium-238 in the form of plutonium oxide) that heat up due to nuclear decay, and surrounded by thermocouples to turn the heat into electricity. There are engineering reasons that make it impractical to design an individual RTG that produces more than one kilowatt.

Nuclear weapons-grade plutonium cannot be used in RTGs. The MSR is one of the best ways to create Pu-238. Plutonium-238 has a half life of 85 years, i.e., the power output will drop to one half after 85 years. To calculate power decay:

$$P1 = P0 * 0.9919^Y$$

where:

- * P1 = current power output (watts)
- * P0 = power output when RTG was constructed (watts)
- * Y = years since RTG was constructed.

Example: If a new RTG outputs 470 watts, in 23 years it will output $470 \times 0.9919^{23} = 470 \times 0.83 = 390$ watts

Wolfgang Weisselberg points out that this equation just measures the drop in the power output of the slug of plutonium. In the real world, the thermocouples will deteriorate under the constant radioactive bombardment, which will reduce the actual electrical power output even further. Looking at the RTGs on NASA's Voyager space probe, it appears that the thermocouples deteriorate at roughly the same rate as the plutonium.

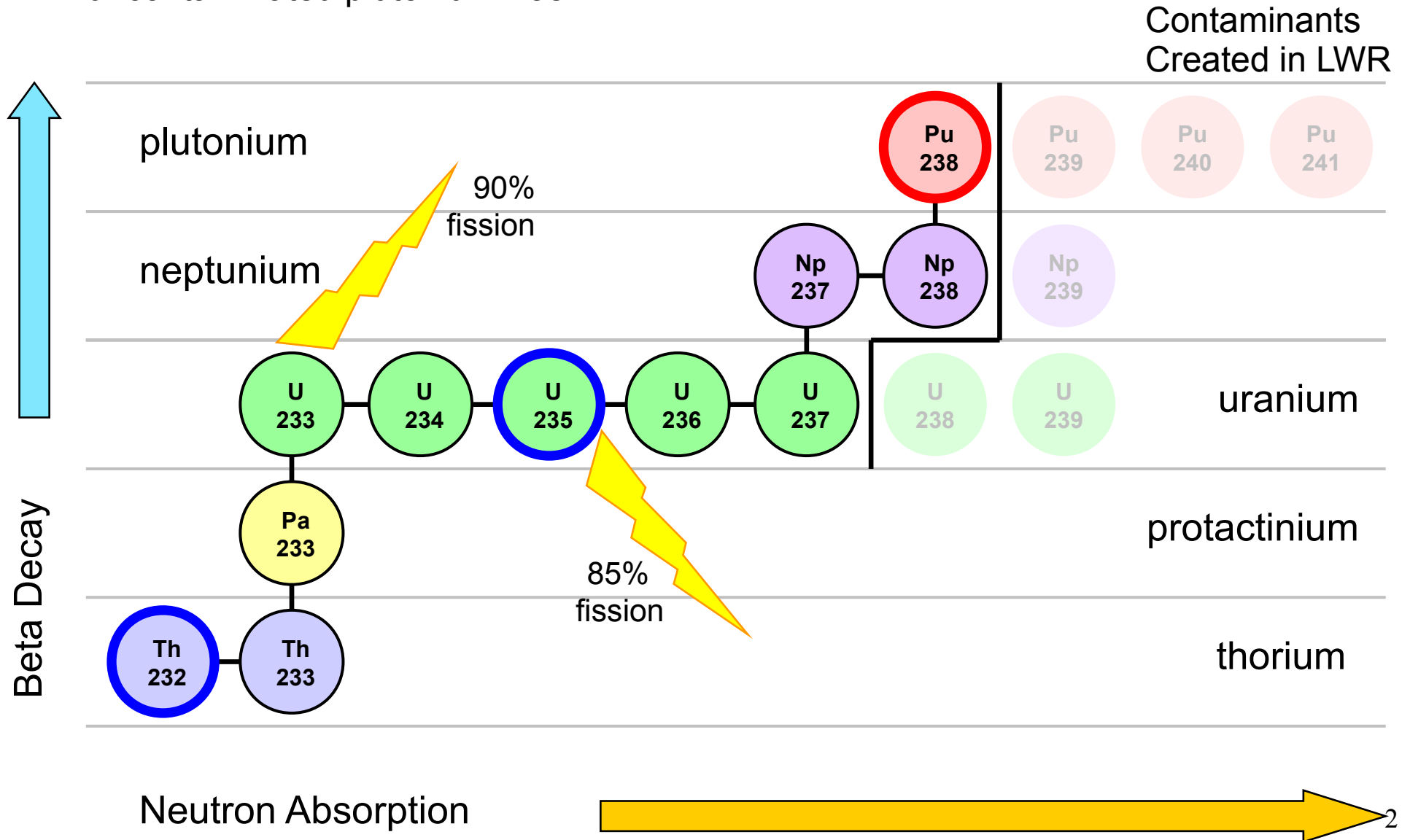
Plutonium-238 has a specific power of 0.56 watts/gm or 560 watts per kilogram, so in theory all you would need is $470 / 560 = 0.84$ kilograms. Alas, the thermoelectric generator which converts the thermal energy to electric energy has an efficiency of only a few percent. If the thermoelectric efficiency is 5%, the plutonium RTG has an effective specific power of $560 \times 0.05 = 28$ watts per kilogram (0.036 kilogram per watt or 36 kg/kW). This means you will need an entire 17 kilos of plutonium to produce 470 watts.

Currently RTGs have an alpha of about 200 kg/kW (though there is a design on the drawing board that should get about 100 kg/kW). So an RTG with the theoretical maximum output of 1 kilowatt would obviously mass 200 kilograms.

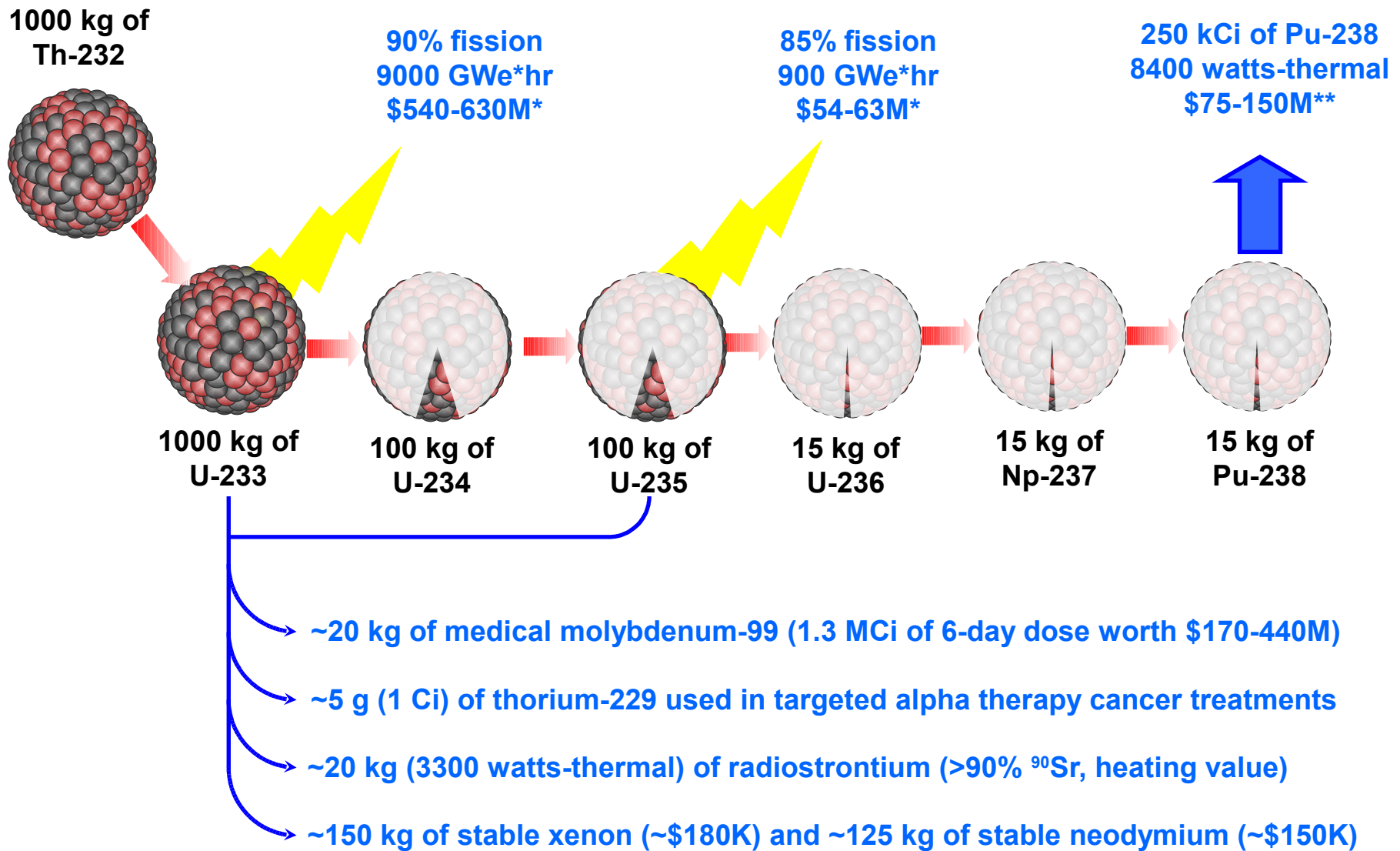
Plutonium-238 needs less than 2.5 mm of shielding, and in many cases no shielding is needed as the casing itself is adequate.

Pu-238 can be made in thorium reactors...in isolation

Using uranium-233 to start a thorium reactor makes it possible to produce uncontaminated plutonium-238!



Electricity and Isotope Production from LFTR (once started, these processes will be self funding)



*At wholesale electrical prices of \$60-70/MWe*hr in the Oak Ridge/Knoxville region.

**Pu-238 specific activity is 17 kCi/kg; decay produces 560 Wt/kg, estimated "price" of \$5-10M/kg

***Mo-99 specific activity is 480 kCi/g; 14% remains after 8 days; \$125-325 per "6-day curie" in NAS report

Ac-225 and Bi-213 are currently derived from purified Th-229 extracted from U-233 at ORNL. **The only practical way at present is to derive these isotopes from the natural decay of Th-229. Th-229 is produced by the natural decay of U-233.** Ac-225 is the product being shipped to medical facilities. Bi-213 is separated from the Ac-225 at the hospital and combined with the targeting agent.

“Bi-213 appears to be very potent, so only a very minute quantity may be needed to treat a patient...on the order of a billionth of a gram.”

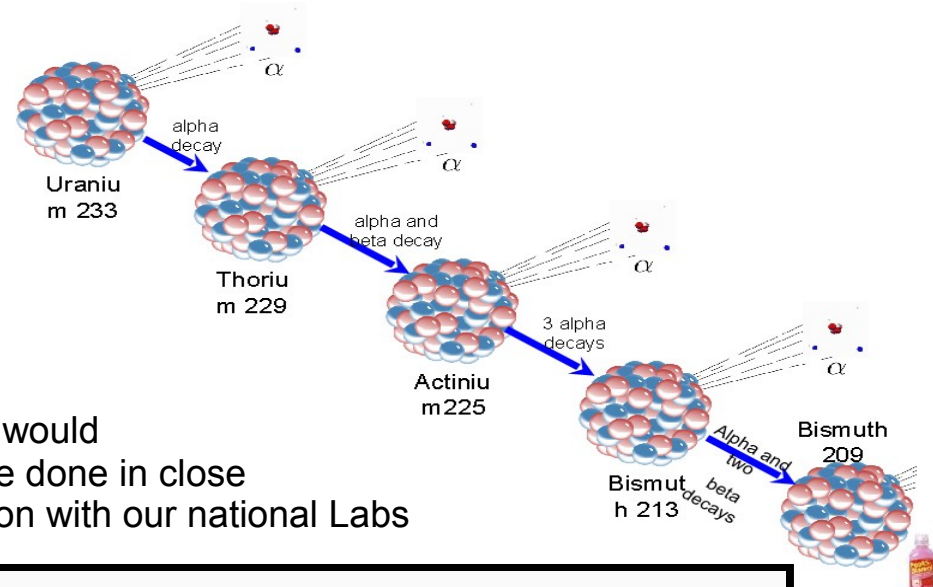
Conclusion:

There is great need and available resources both material and financial to make a dramatic difference in general science, health care and Deep Space Exploration.

There is vast I.P. Potential in the specifics involved in the production and processing of these critical materials and the systems that create them.

This work would pay for itself both economically and in the great good will that will be generated in the Scientific and Health Research communities.

Credits:
NASA, N.P.R, Kirk -Teledyne, N.I.H.
D.O.E., Thorium Energy Alliance



This work would
Need to be done in close
Cooperation with our national Labs

Report to Congress on the Extraction of Medical Isotopes From Uranium-233

**U.S. Department of Energy
Office of Nuclear Energy, Science and Technology
Office of Isotopes for Medicine and Science**

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