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Title: Aqueous Chloride Operations Overview: Plutonium and Americium Purification/Recovery

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Aqueous Chloride Operations Overview: Plutonium and Americium Purification/Recovery

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Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

Aqueous (Chloride) Operations: The Basics

We take things like *this*

Salt mixture, variable Pu content

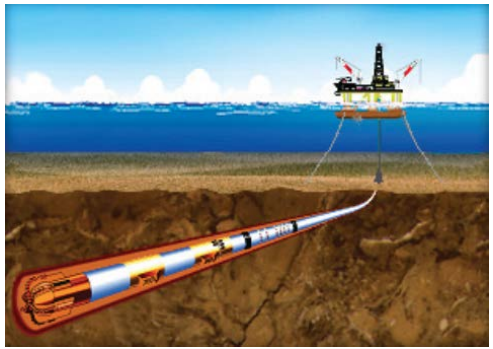
Purify it to *this*

Pu/Am Oxalate, high Pu/Am purity

And convert it to *this*

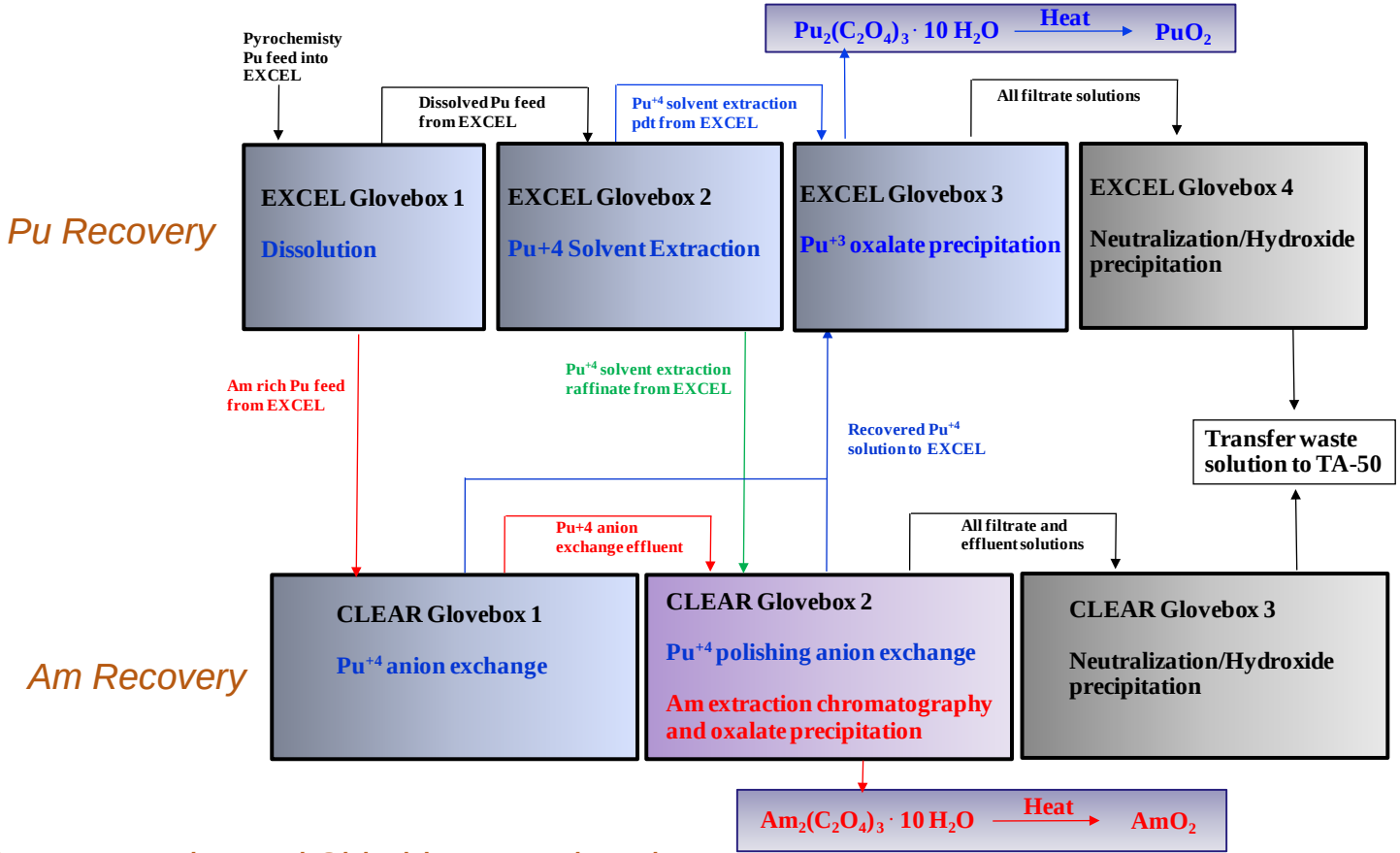
Pu/Am Oxide, high Pu/Am purity, highly stable/storable

Americium neutron source used for oil and gas exploration



So it can be used to do things like *this*

Aqueous Chloride and Americium Flowsheet



EXCEL = Experimental Chloride Extraction Line
CLEAR = Chloride Extraction and Actinide Recovery Line

Americium

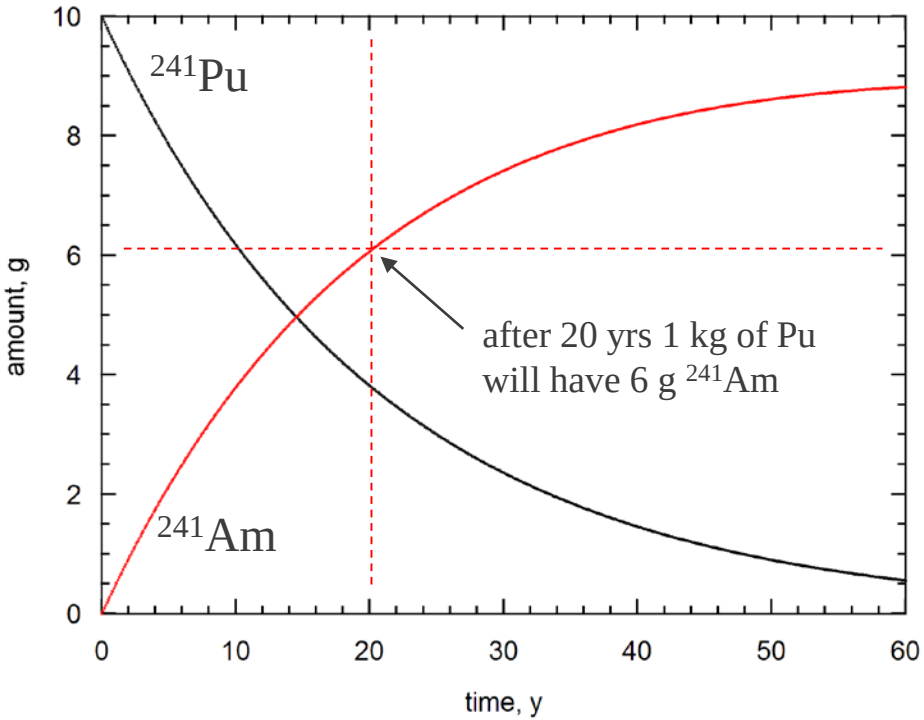
- **Where does it come from? From the plutonium**
  - ^{241}Pu decays to ^{241}Am over time (always a little ^{241}Pu in ^{239}Pu supply)

- **Where do we have it now?**
  - Old pyrochemistry residues
  - Solvent extraction raffinate

$$^{241}Pu \xrightarrow{t_{1/2}=14.4\,years} {}^{241}Am + \beta^-$$

$$^{241}Am \xrightarrow{t_{1/2}=432\,years} {}^{237}Np + \alpha + \gamma(59.5keV)$$

Dose!



First, Manage the Feed: Size Reduction

Block of feed (simulant), harder to remove Pu

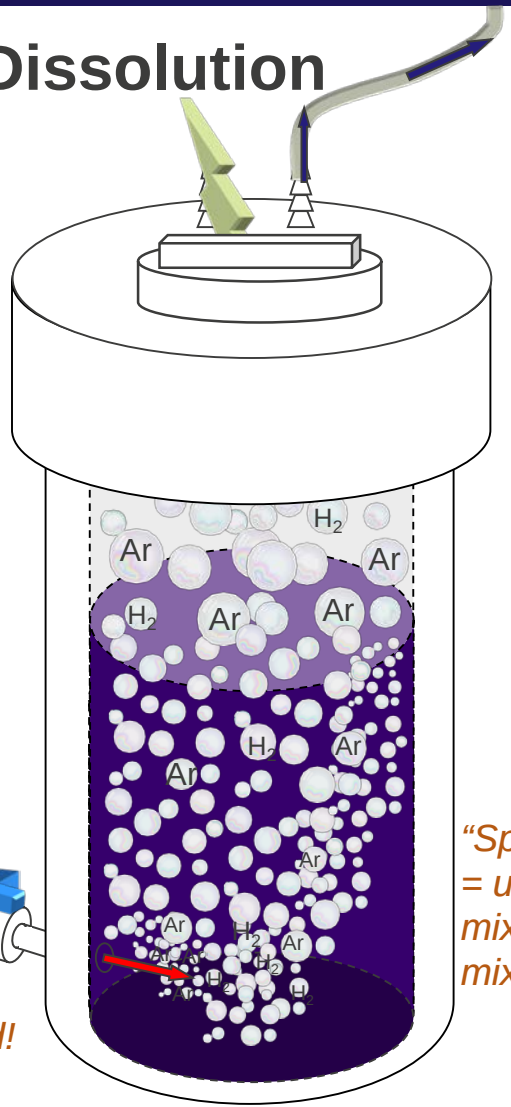
Crushed feed, plenty of surface area, ready for dissolution

Process Begins: Dissolution

Argon gas

12M HCl

Water

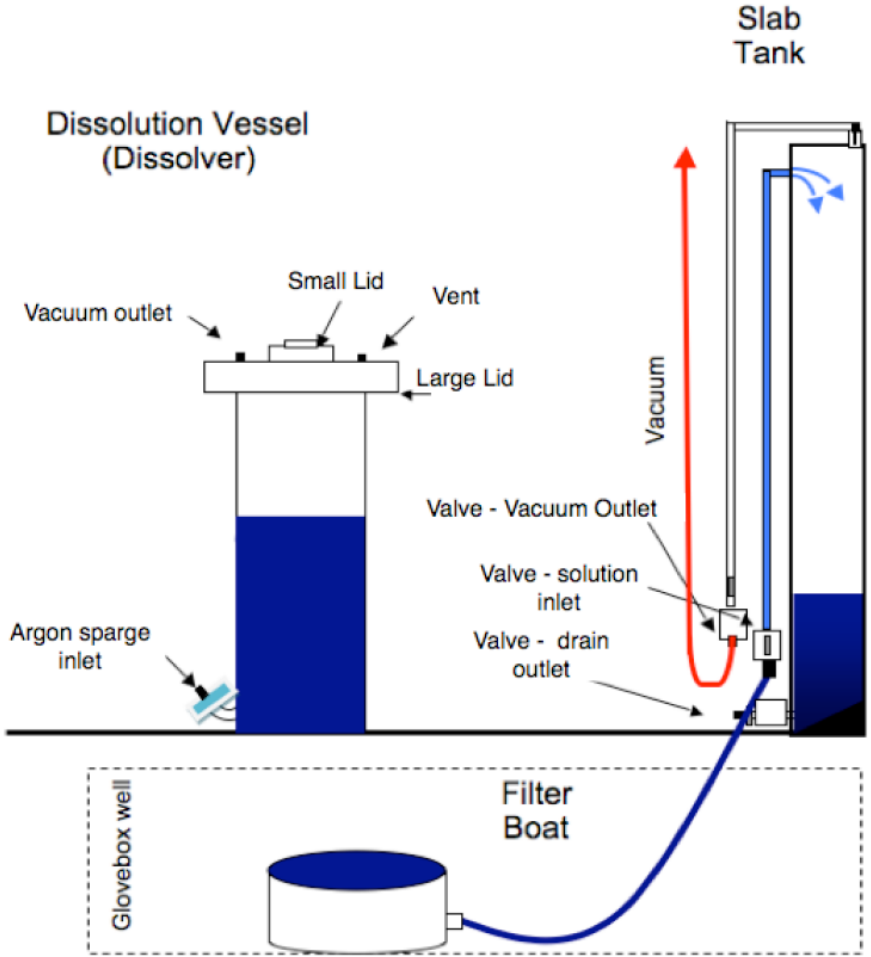


No heating required!

"Sparging" = using gas to mix/agitate the mixture

Looks like plastic? Kynar lined. Why?

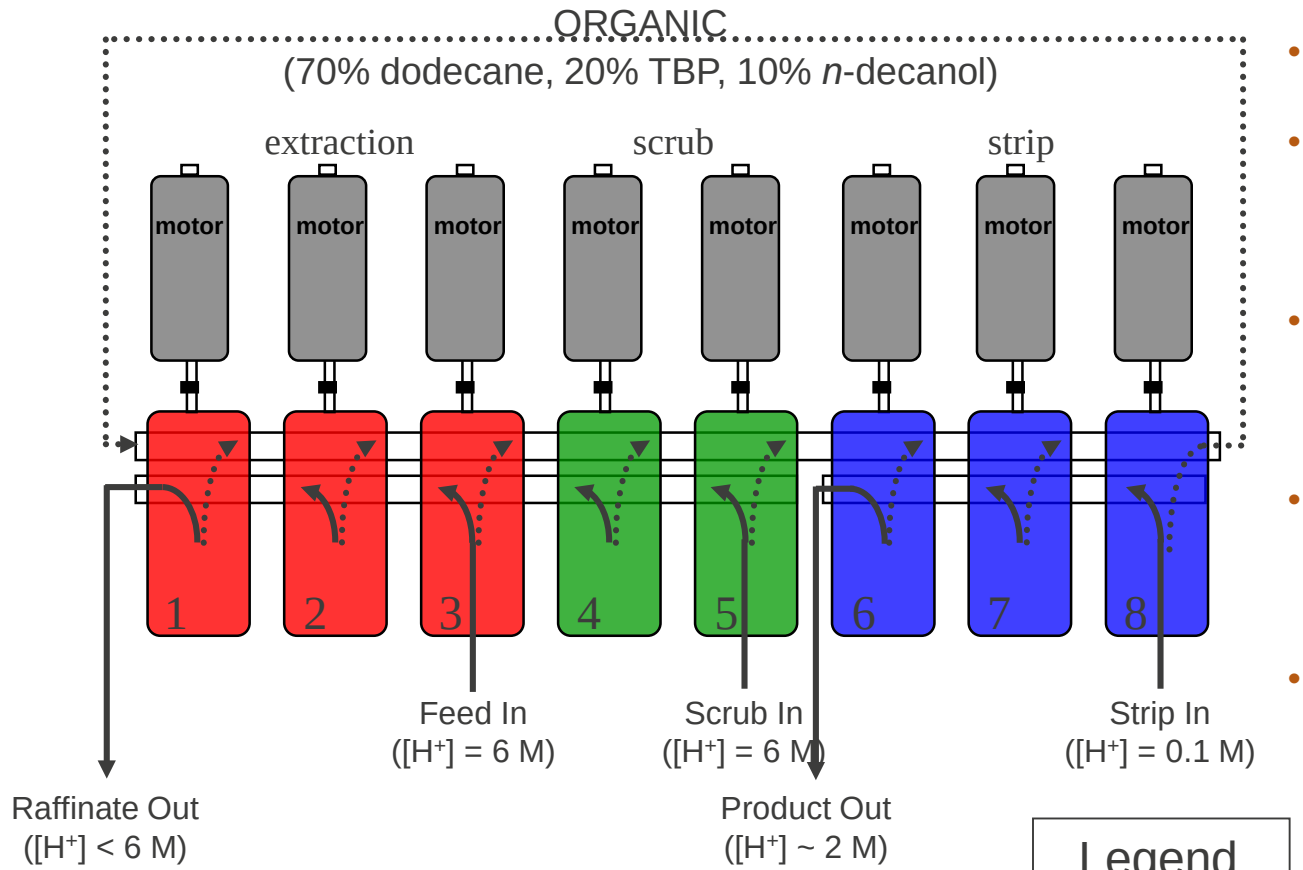
Dissolution, Continued…



Vacuum filter the dissolved material into a Kynar slab tank

Slab tank is “skinny” (~4” thick). Why? So those neutrons can leak!

Begin Purification: Solvent Extraction



"Raffinate" – remember this for later

Legend
aqueous
organic

- *Solvent Extraction: a liquid-liquid separation method*
- *Pu(+4) is pulled into the organic phase from the higher acid concentration (~6 M), aqueous phase*
- *Organic phase, containing the desired Pu, is washed, again with higher acid concentration* aqueous solution
- *Pu is removed from the organic phase with lower acid concentration (~0.5 M) aqueous solution.*
- *"Contactors" are specially designed chambers that mix and separate the phases, allowing separation to be "automated", with continuous flow.*

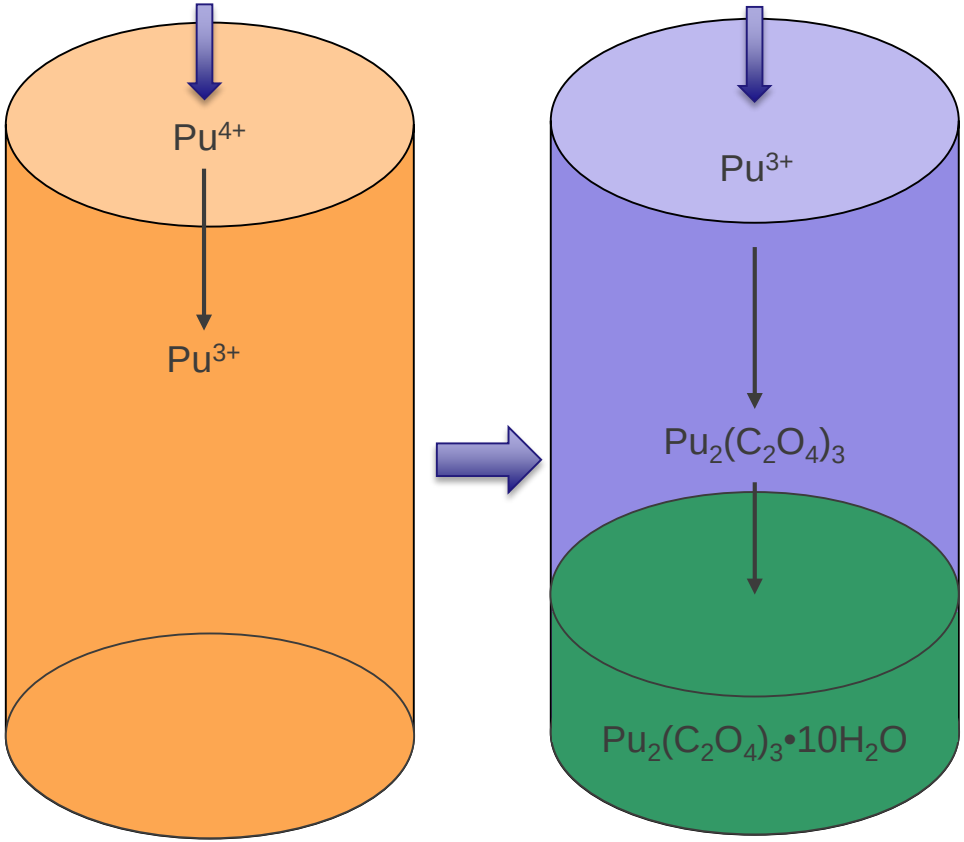
Purification, Continued: Oxalate Precipitation

$NH_2OH•HCl$

(hydroxylamine hydrochloride)

$H_2C_2O_4•2H_2O$

(oxalic acid)

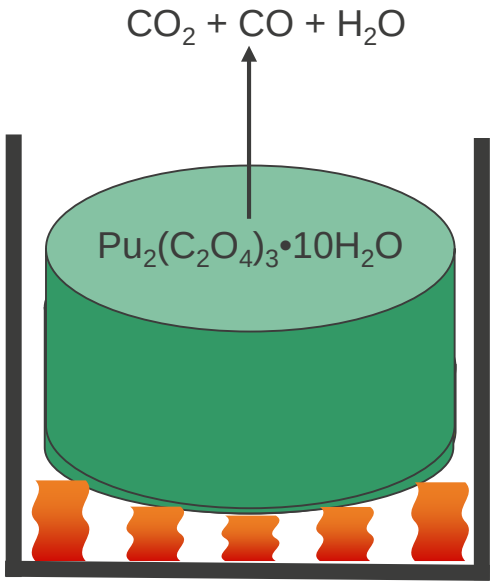


Precipitation, Filtration

Pu^{3+} makes a MUCH nicer oxalate precipitate than Pu^{4+}

Endgame: Calcination

Purified oxalate cake



Oxidize = heat in an oven at high temp (aka "calcination")

Purified, stable Pu oxide product

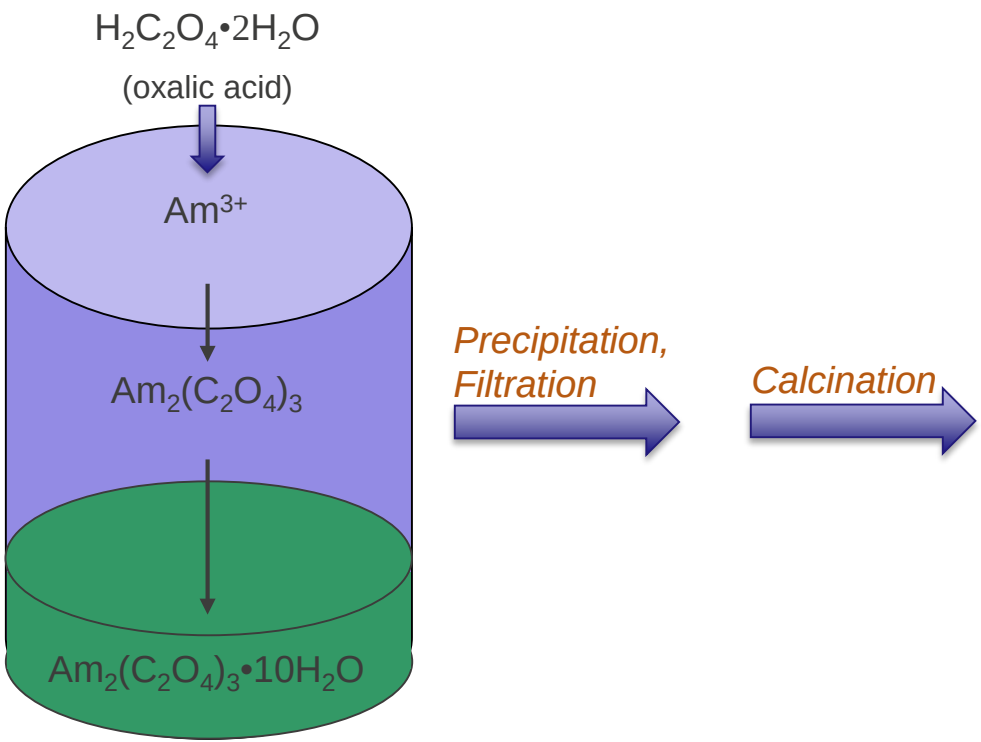
Pu oxide packaged for storage, use

Americium Recovery: CLEAR Line

- **CLEAR: Chloride Extraction and Actinide Recovery Line**
- **Key methods: Pu anion exchange and extraction chromatography**
  - Pu and Am are separated on resin columns
  - Pu and Am “stick” to different solid “resin” material, while waste products do not (flow right through)
  - Recover each separately

Americium Recovery: Oxalate Precipitation and Calcination

- **Americium is precipitated similarly to Pu (easier, no reduction needed!)**
- **Calcination of americium is also analogous to Pu calcination (just a different furnace)**



Americium calcination is a MUCH smaller scale operation than Pu calcination. Why?
1. DOSE 2. Am is generated slowly (^{241}Pu decay)

LANL in the News: Americium Recovery

Physics Today 2015, 68(10), 20.

issues and events

Isotope program expands activities

To meet the growing demand for isotopes and lessen dependence on foreign sources, the Department of Energy has been realigning its capabilities and connecting with universities.

The US isotope program gets a healthy dose of kudos in a recent report by the Nuclear Science Advisory Committee Isotopes Subcommittee (NSACI). A key change in the program since it moved six years ago within DOE from the Office of Nuclear Energy to the nuclear physics program in the Office of Science is that it now has a research component. The report, *Meeting Isotope Needs and Capturing Opportunities*, recommends that the program's mission includes developing new and better ways to produce more types and larger quantities of isotopes. Another goal is to train young scientists to do R&D on isotopes.

Filling a gap

At DOE national laboratories, isotope production is largely parasitic on machines that have other missions. The isotope program oversees production at

plete
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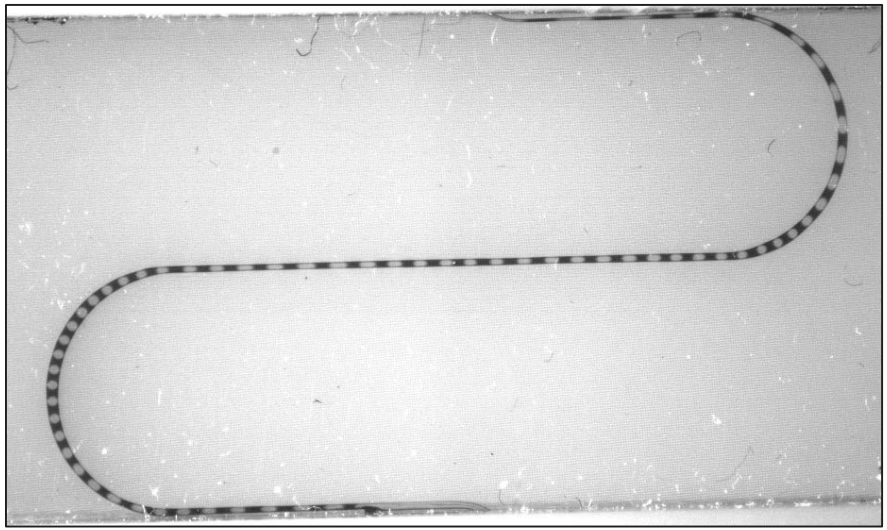
"Russia is the only supplier of americium-241, which is used in well logging to identify sites for drilling oil and gas. An industry consortium 'has provided the isotope program with money to develop a method of producing americium-241 here [in the US]. We're developing it at Los Alamos.'"

Research and Development – Microfluidic Processing

- **Smaller quantities – inherent safety**
  - Decreased exposure, decreased combustibles, decreased criticality concerns
- **Reduce footprint – save valuable floor space**
- **Decreased waste**



Questions?

“What’s this thing?”