Chance Favors the Prepared Mind, The Founding of Eichrom

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Summer 1939

Founder of Eichrom

Phil (Age 9) on his homemade stilts.

Celebrating 25 Years ★ 1990-2015 ★
25th Anniversary
eichrom TECHNOLOGIES

1980: Technology Innovation Act &

1986: Federal Technology Transfer Act

These two federal laws allow private industry to obtain exclusive license to patents from government labs

1986: ARCH Development Corporation was Formed by Argonne National Laboratory and the University of Chicago. ARCH was a wholly owned subsidiary of the University of Chicago

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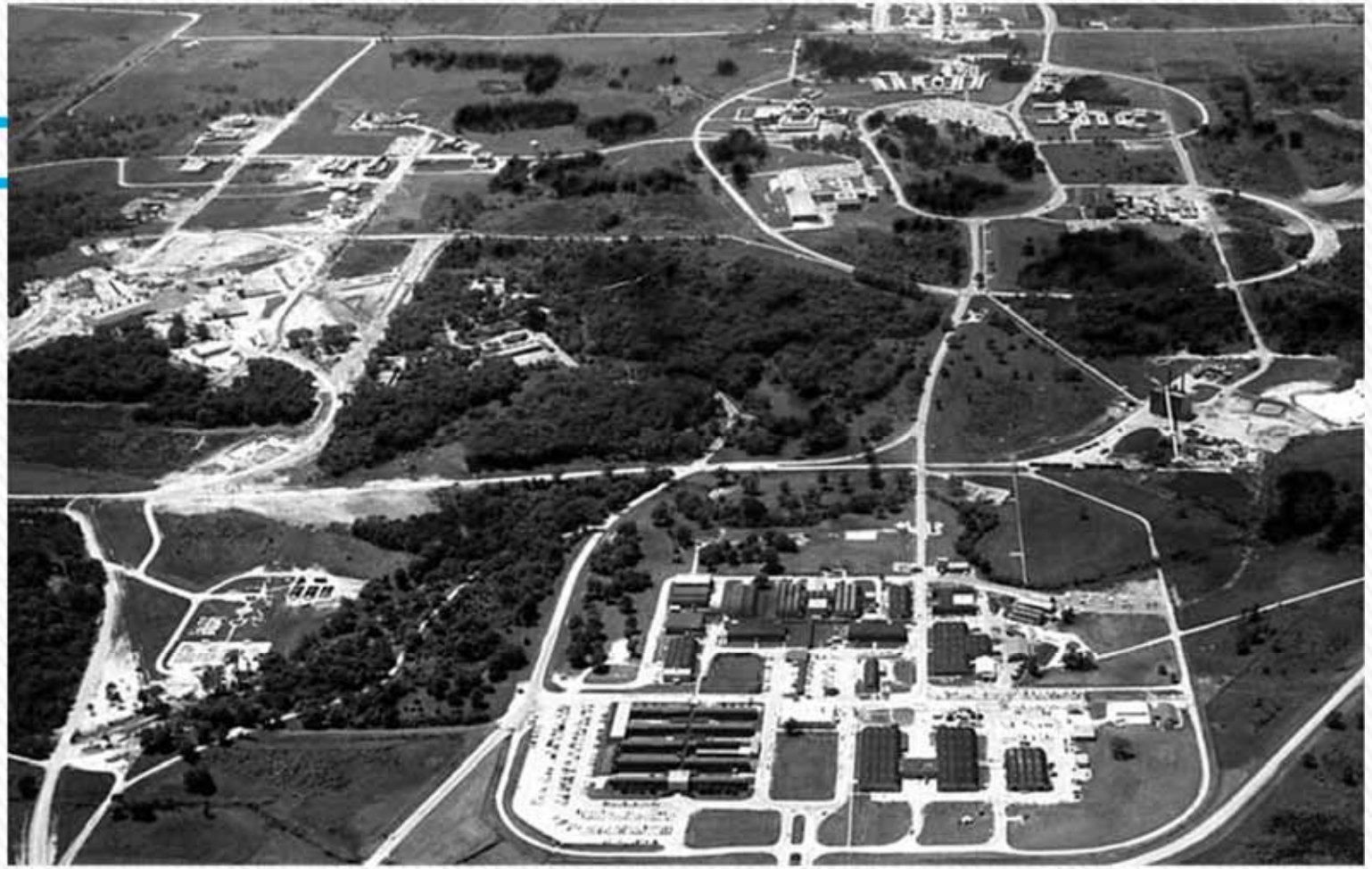
Started work at Argonne National Laboratory

Nov ‘59



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» The basic technology involved in the founding of Eichrom largely emerged from the following programs:

1. Trans-Plutonium Element Production
2. Search for Superheavy Elements
3. Hanford Tank Waste

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April 1962

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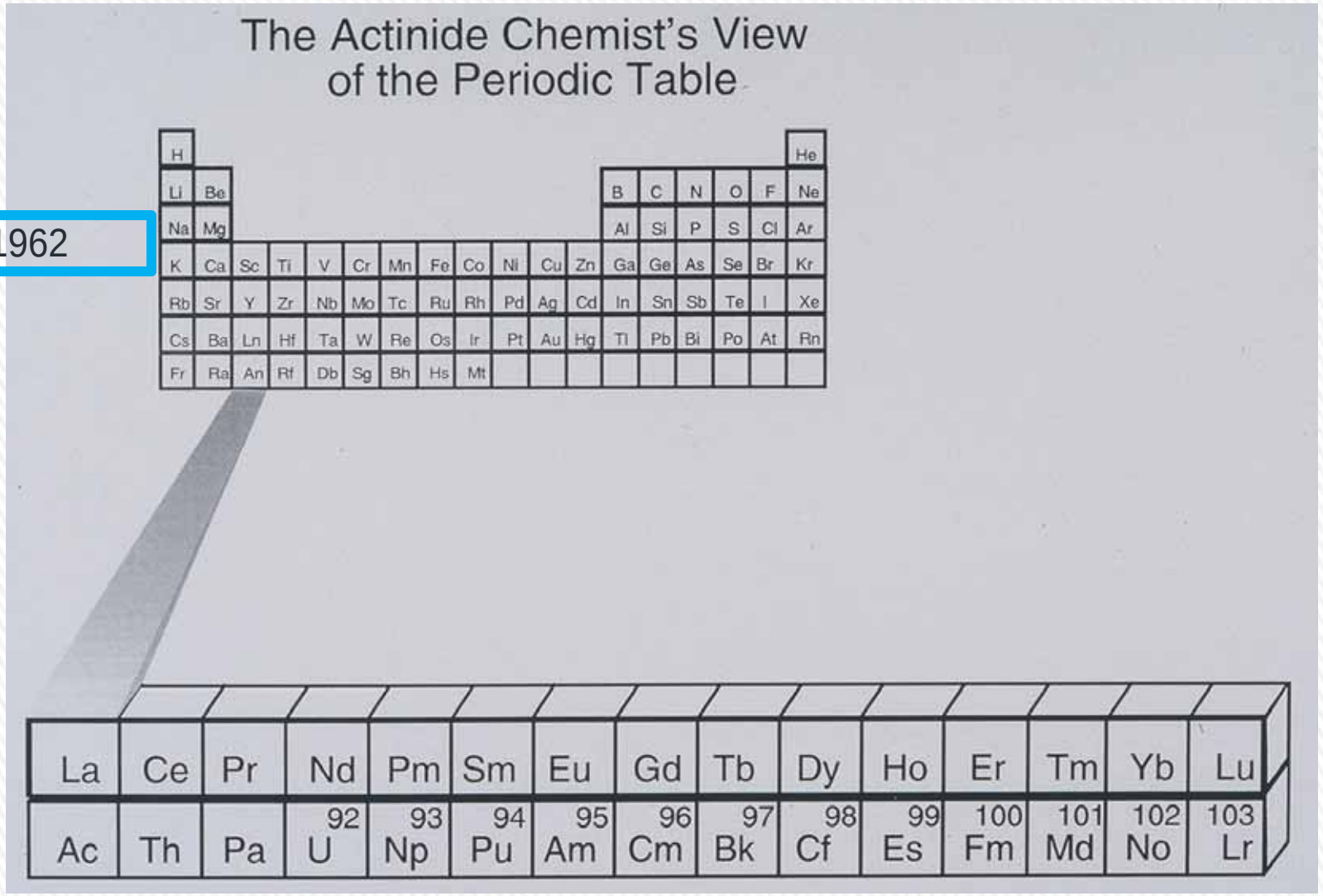
Phil moves to heavy element research



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April 1962

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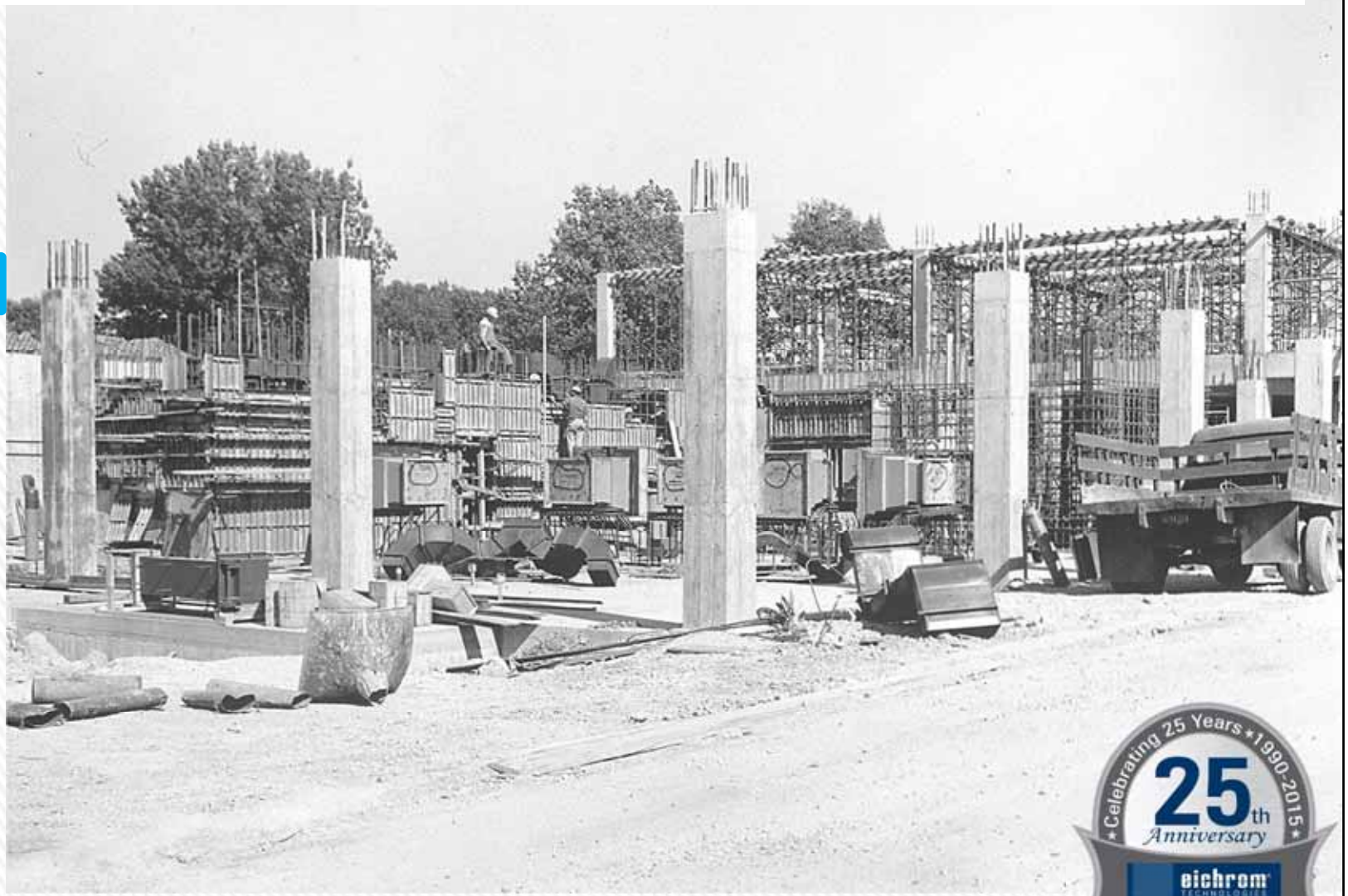
New Hot Lab under construction for Chemistry Division



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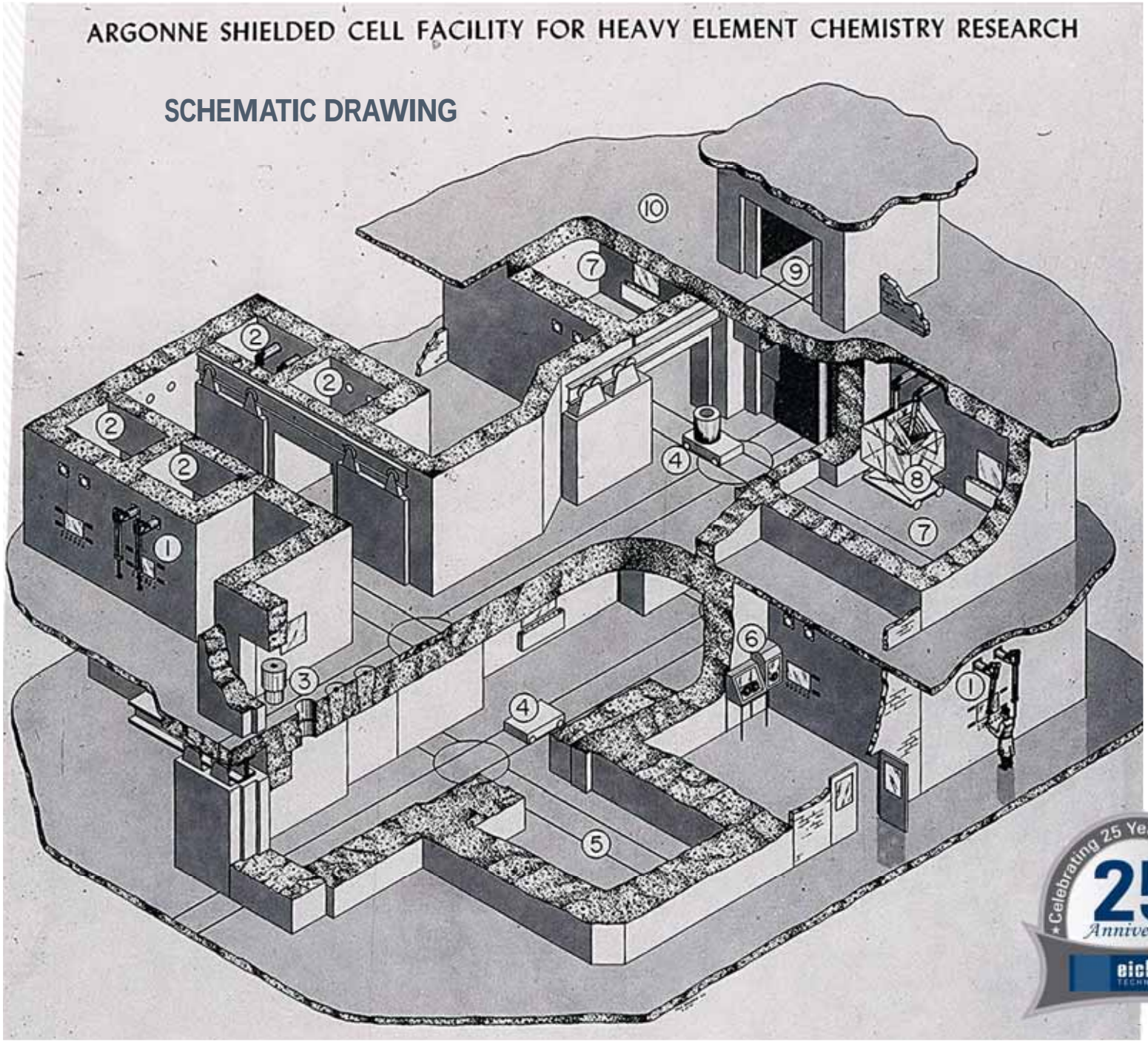
SCHEMATIC DRAWING



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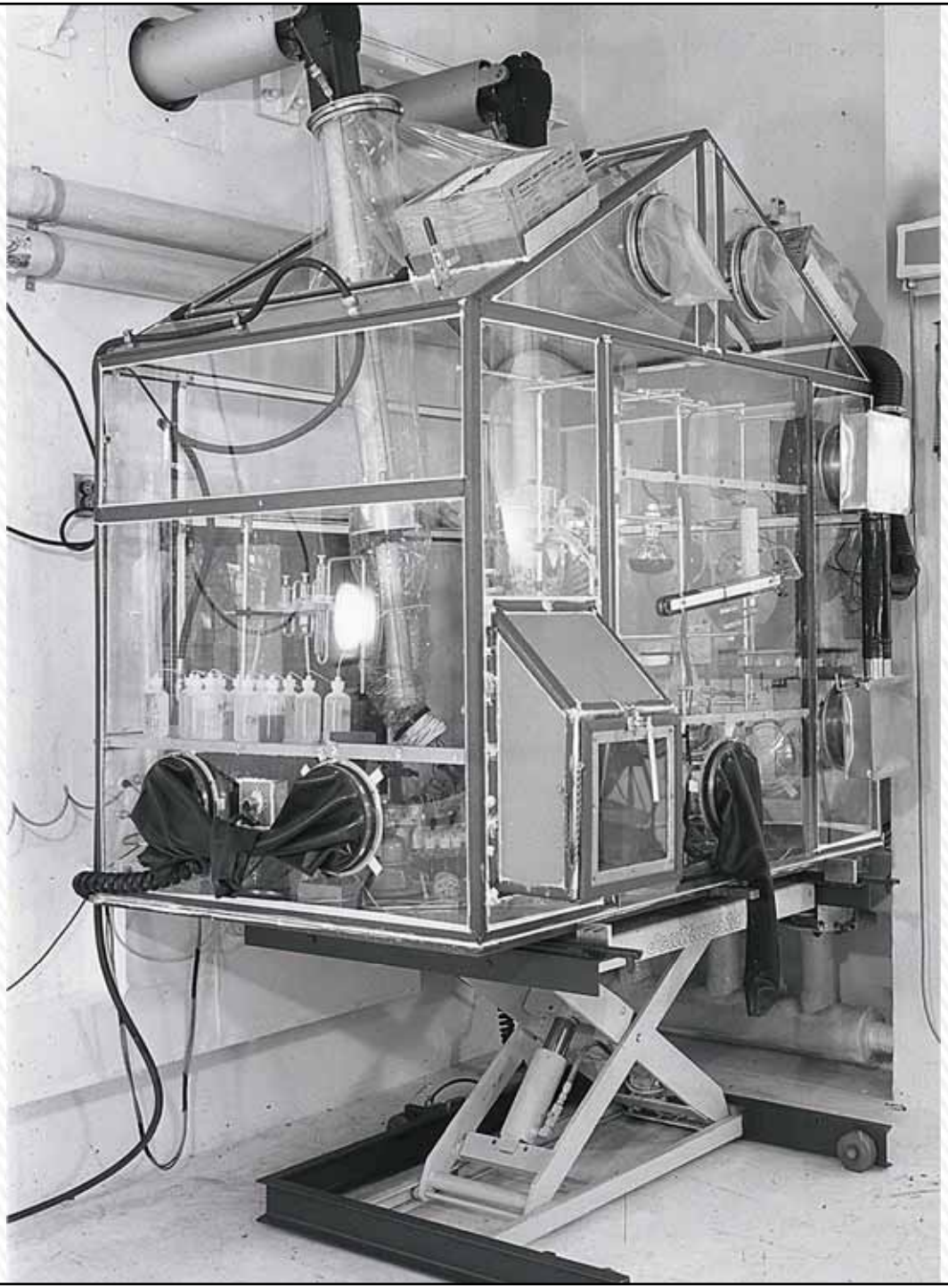

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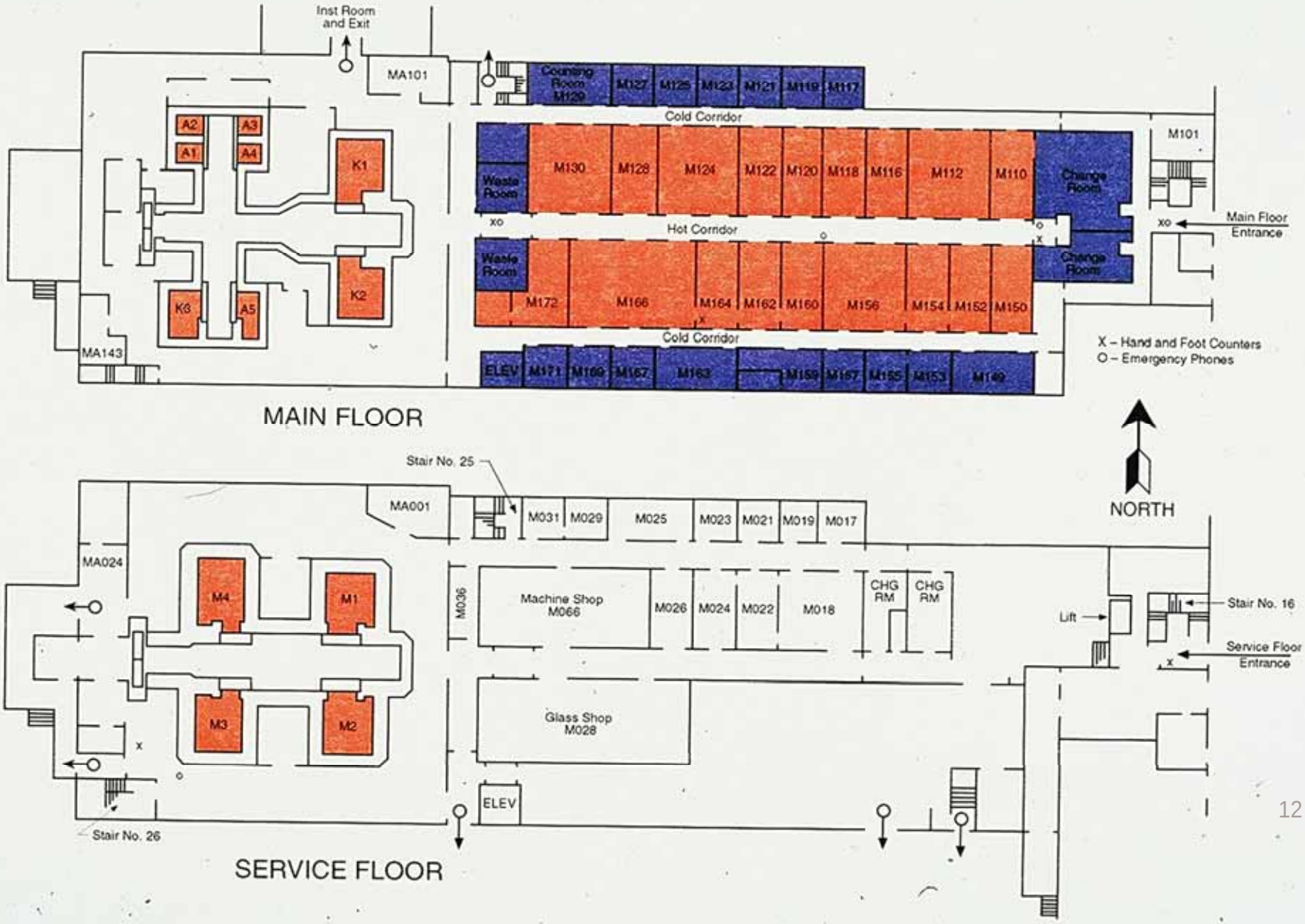
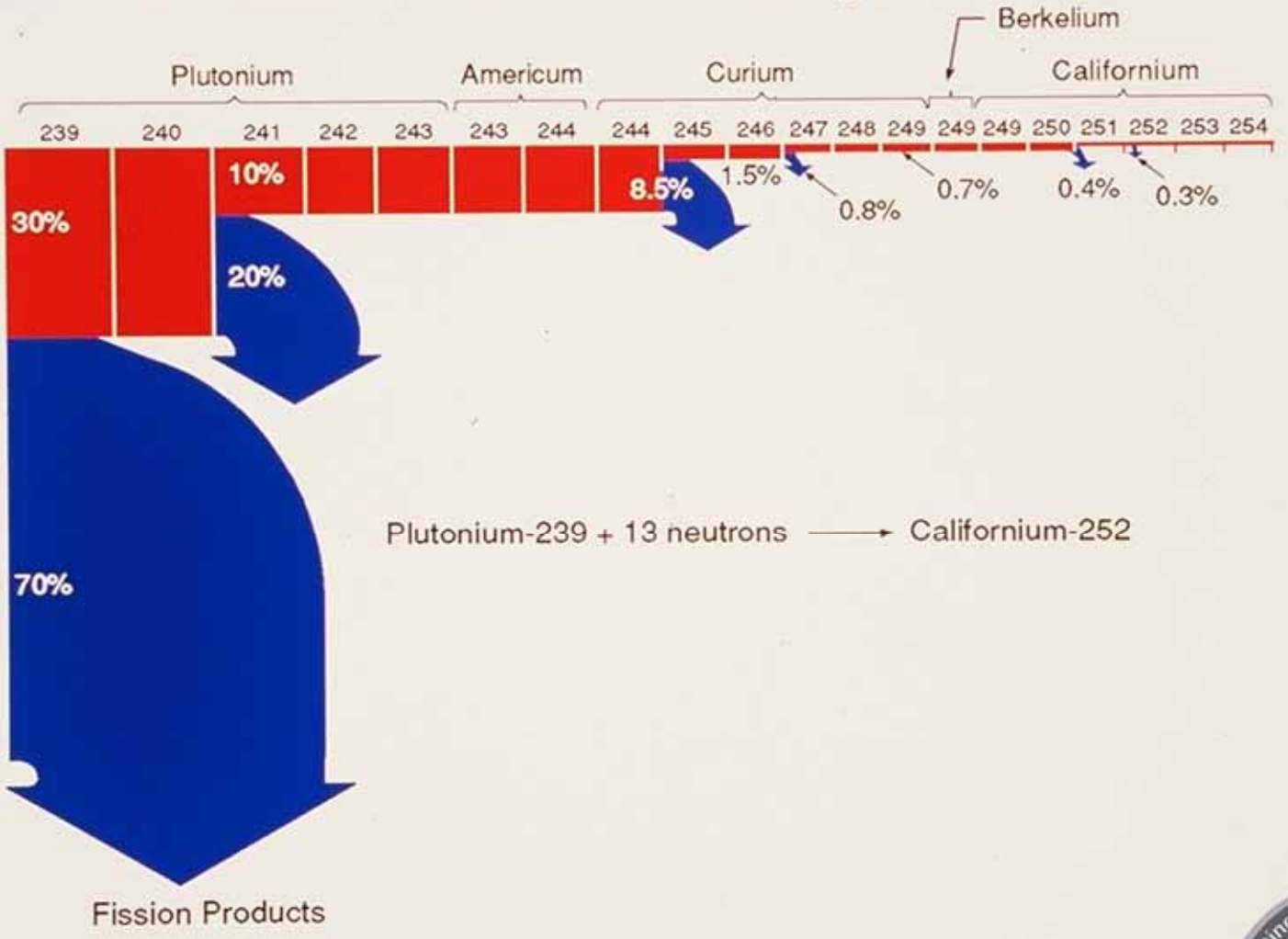
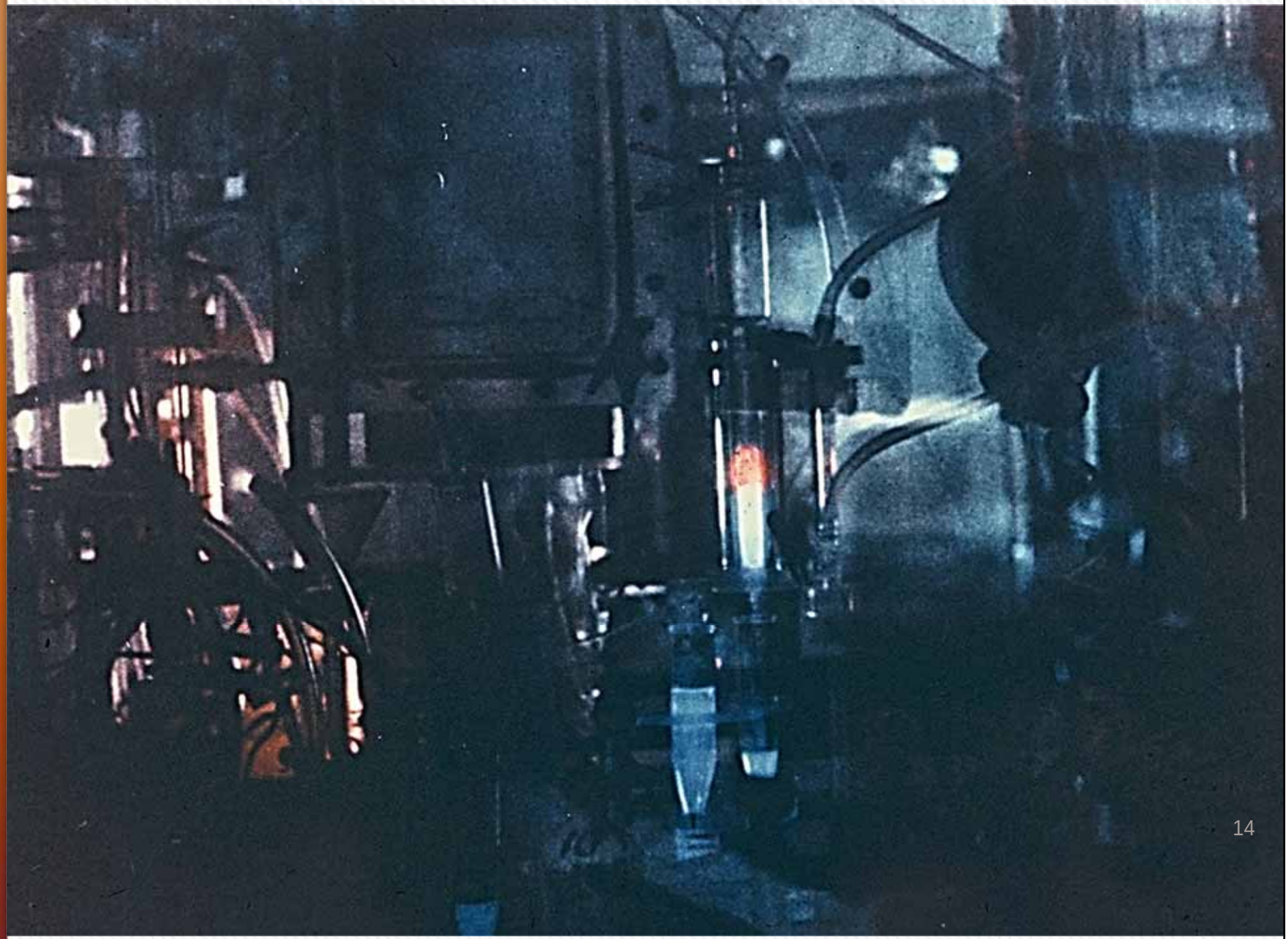
Argonne Chemistry Division Hot Laboratory



Program for the Production of Transplutonium Elements



From Man-Made Transuranium Elements
G. T. Seaborg
Prentice-Hall, Inc.



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Preparation of $^{242}_{96}Cm$ ($t_{1/2}$ = 162.5 days)

Neutron capture of ^{241}Am

$$^{241}_{95}Am\ (n,\gamma)\ ^{242}_{95}Am \xrightarrow{84\%} {}^{242}_{96}Cm + \beta$$

$$^{242}_{95}Am \xrightarrow{16\%\ E.C.} {}^{242}_{94}Pu$$

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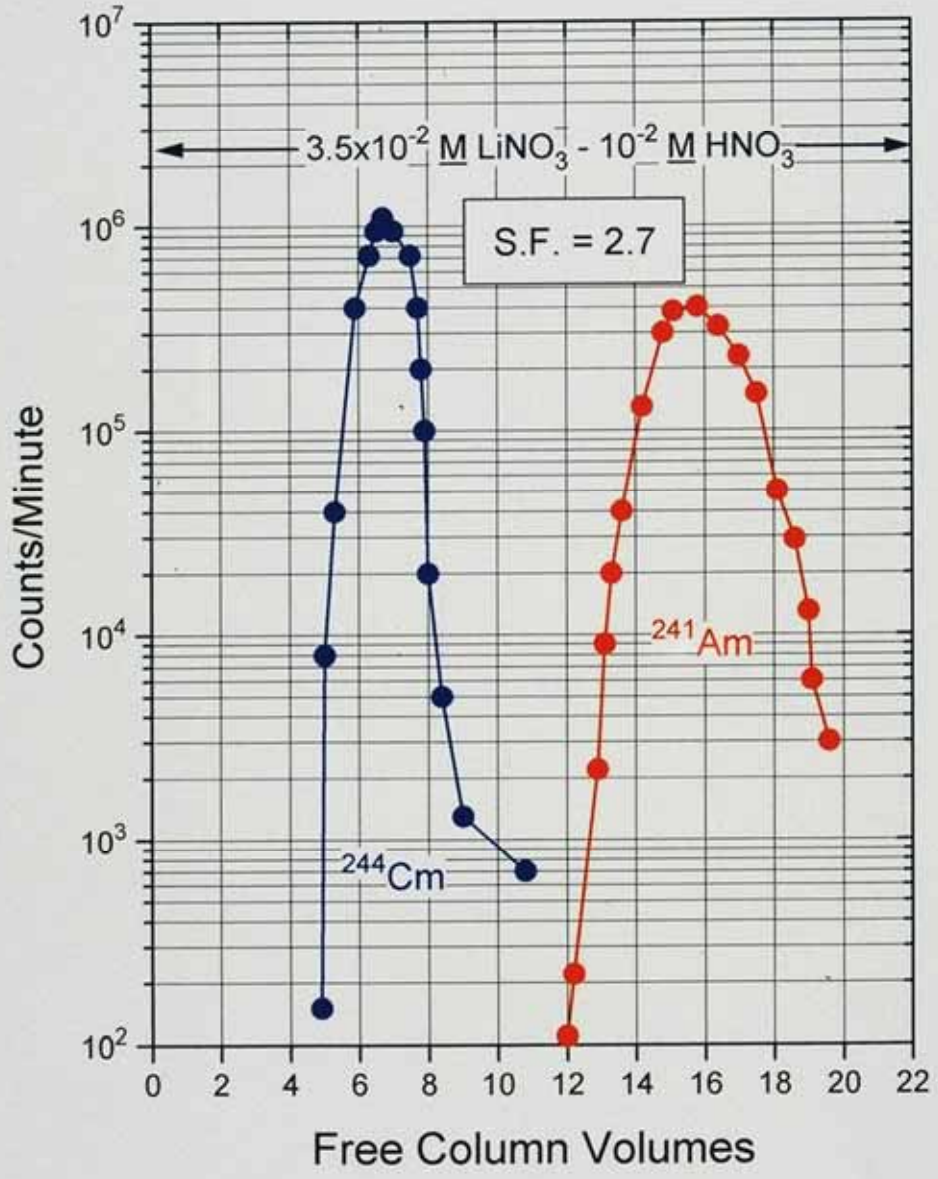
Tracer-Scale Separation of $^{244}Cm(III)$ from $^{241}Am(III)$ by Extraction Chromatography

Stationary Phase : TCMA·NO_3 ; FCV : 0.48 mL ; Room Temperature



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1965-1967
Lunar Program

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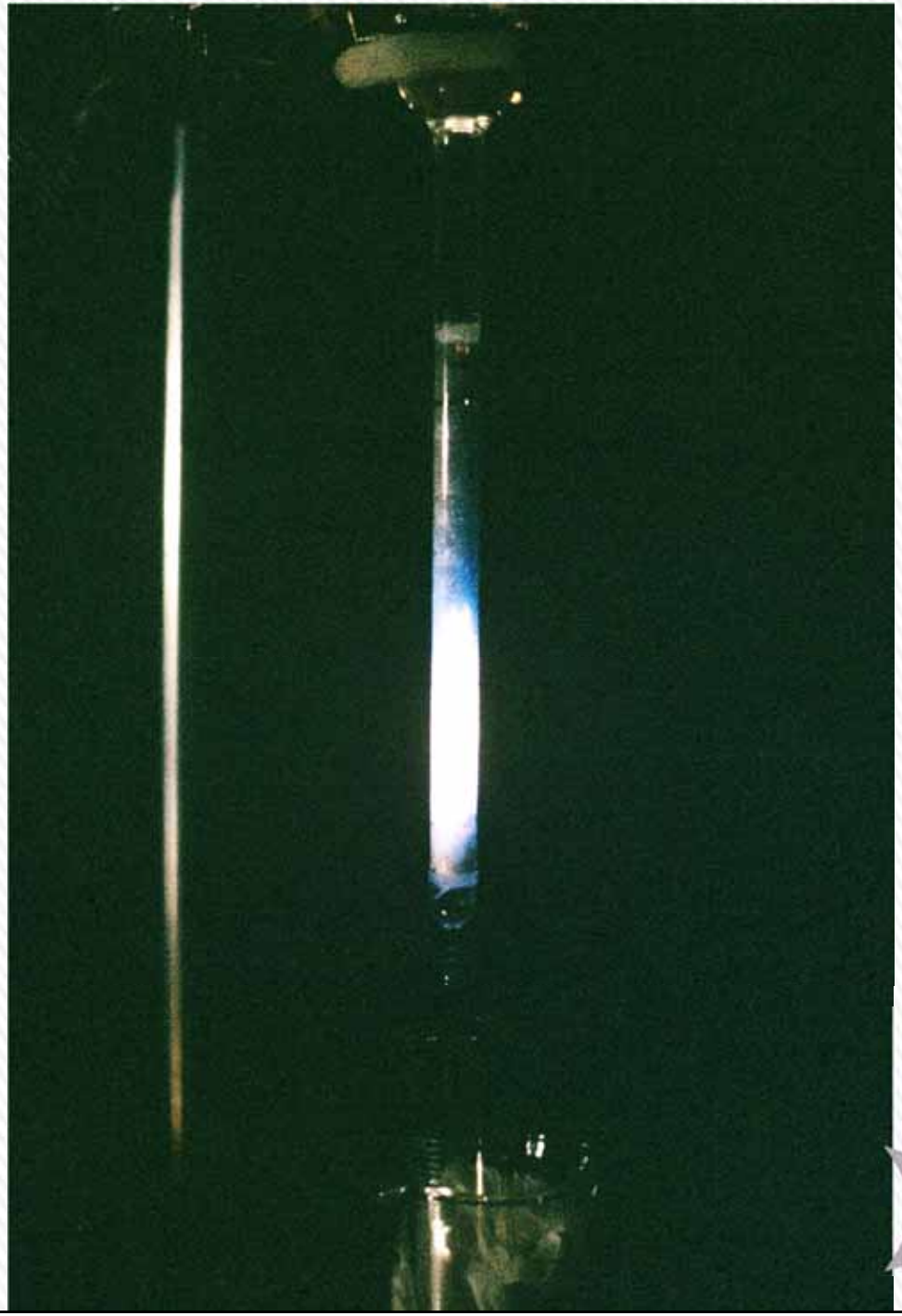

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Purity of ^{242}Cm for Use in NASA Surveyor Lunar Program 1963 – 1967

7 – 8 mg ^{242}Cm Stock
(23 to 26 curies)

Fission Products	>	10^6 decontamination
Na, Ca, Al and Fe	<	0.1 wt. %
Am	~	100 ppm

Alpha activity ratio ^{242}Cm / $^{241}Am = 10^7$

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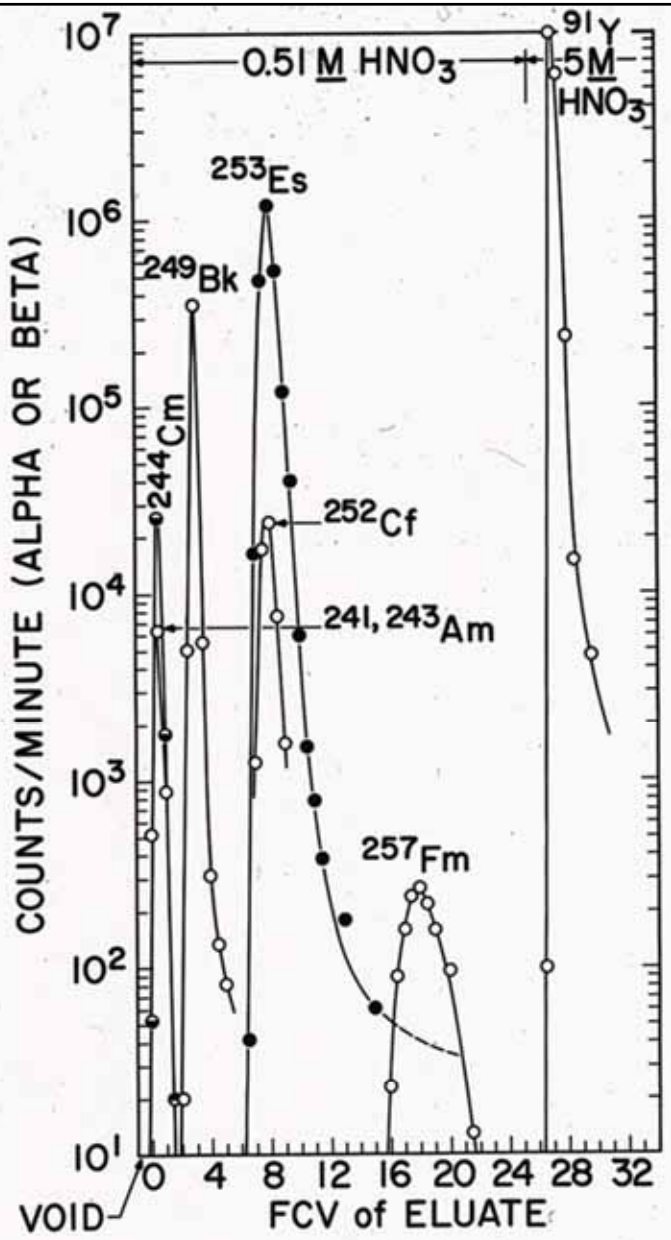
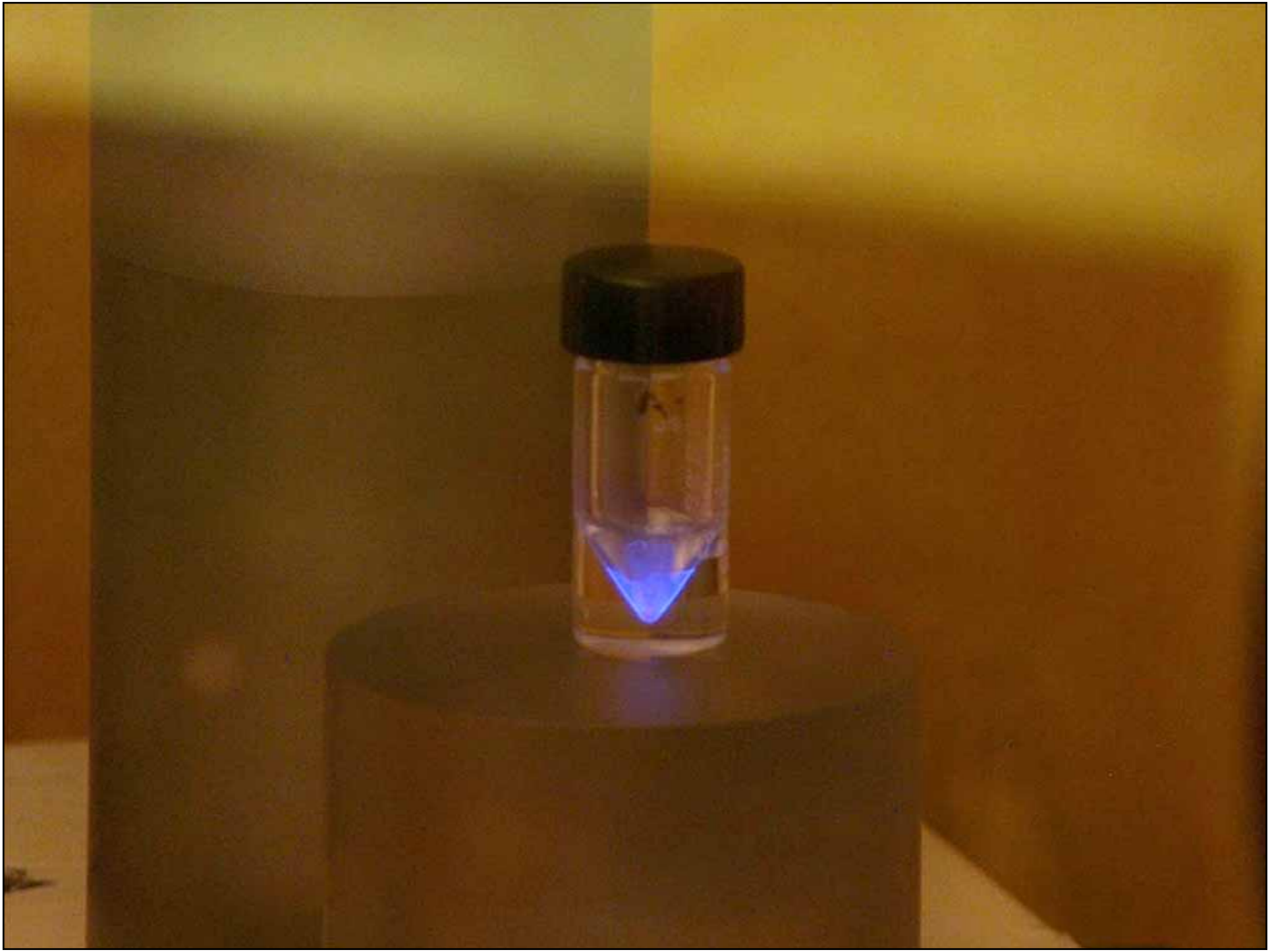


Purification of 4×10^8 atoms of $^{257}_{100}Fm$ (100 days) using 2cm long column. T=50°C. 25 w/o of 1.5E HDEHP in dodecane on 5μm Zorbax-SIL.



The Search For Superheavy Elements

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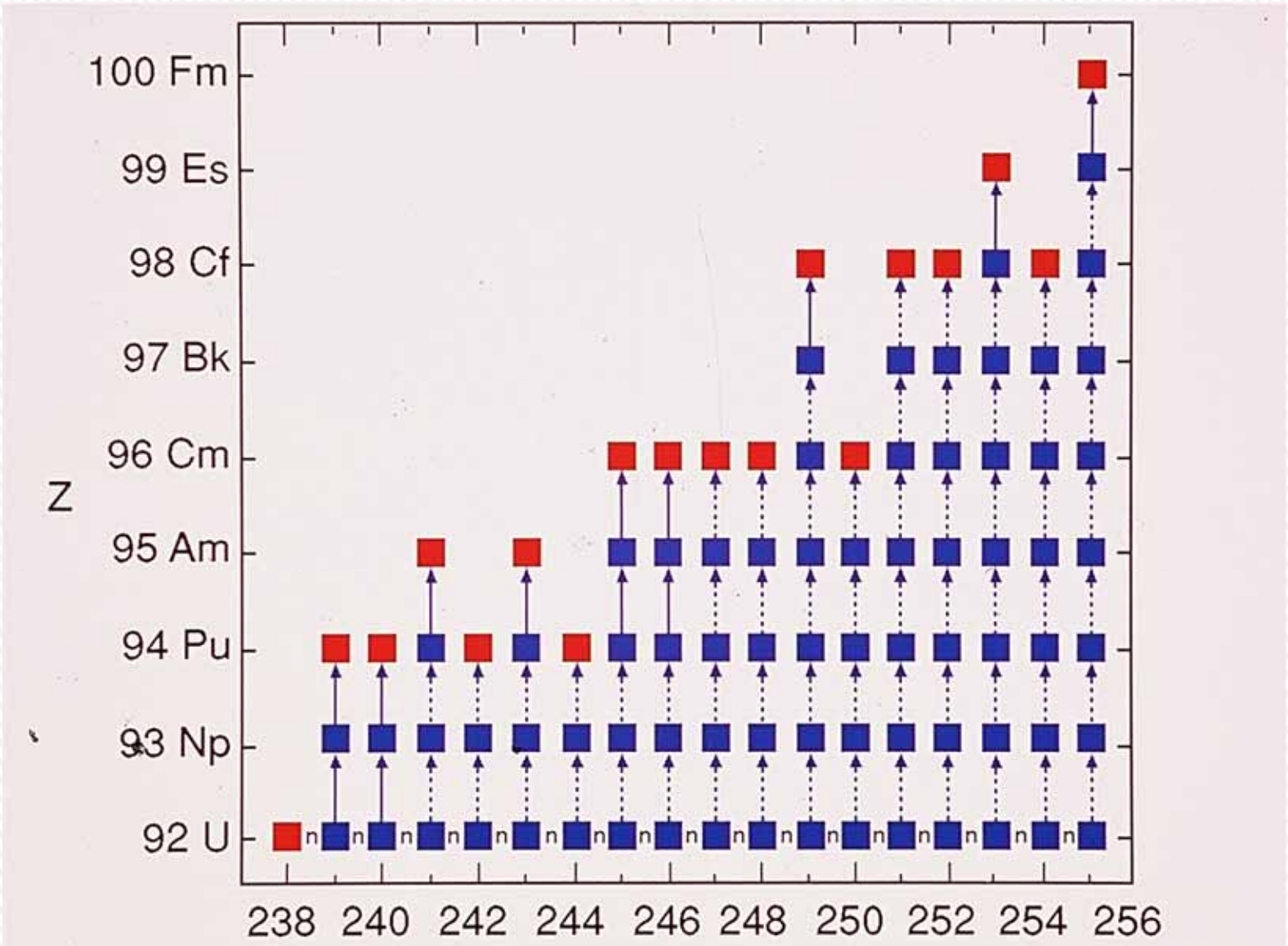
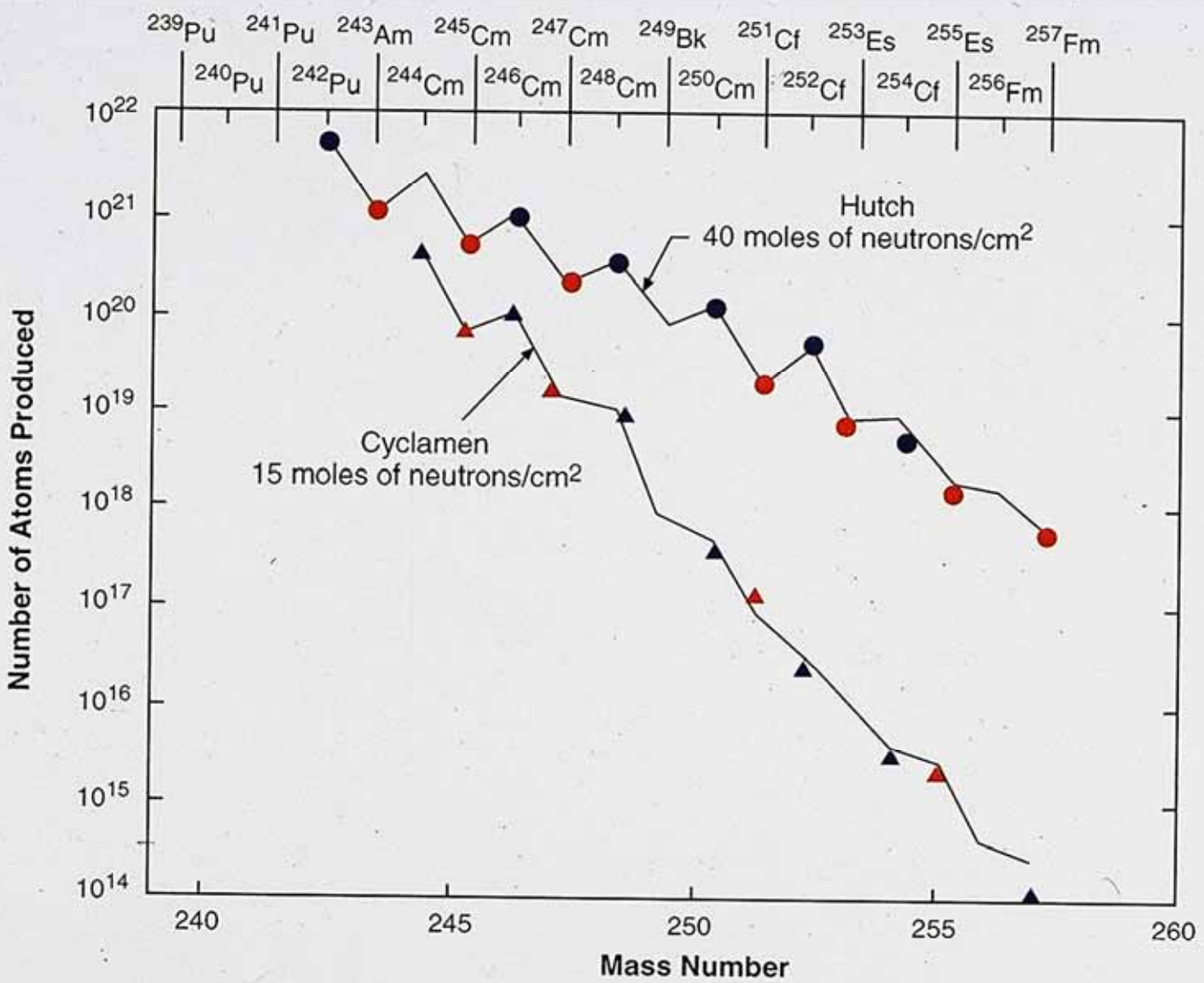
Examples of Possible Reactions to Produce Superheavy Elements

1. Thermonuclear Event
2. Secondary Reactions Induced by GeV Protons



Production of heavy element isotopes in thermonuclear events. ■ beta unstable nuclide. ■ beta stable nuclide.



Mass Yield Curves in the Hutch and Cyclamen Nuclear Explosions.
From UCRL-81566

Examples of Possible Reactions to Produce Superheavy Elements

1. Secondary reactions induced by GeV protons

$$^{238}_{92}\text{U (beam stop)} + {}^{1}_{1}\text{H} \xrightarrow{12\ \text{GeV}} \text{Spallation Products}$$

$$\text{Spallation Products} + {}^{238}_{92}\text{U} \longrightarrow {}^{290}_{110} \qquad {}^{298}_{114}$$

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1978 to 1984
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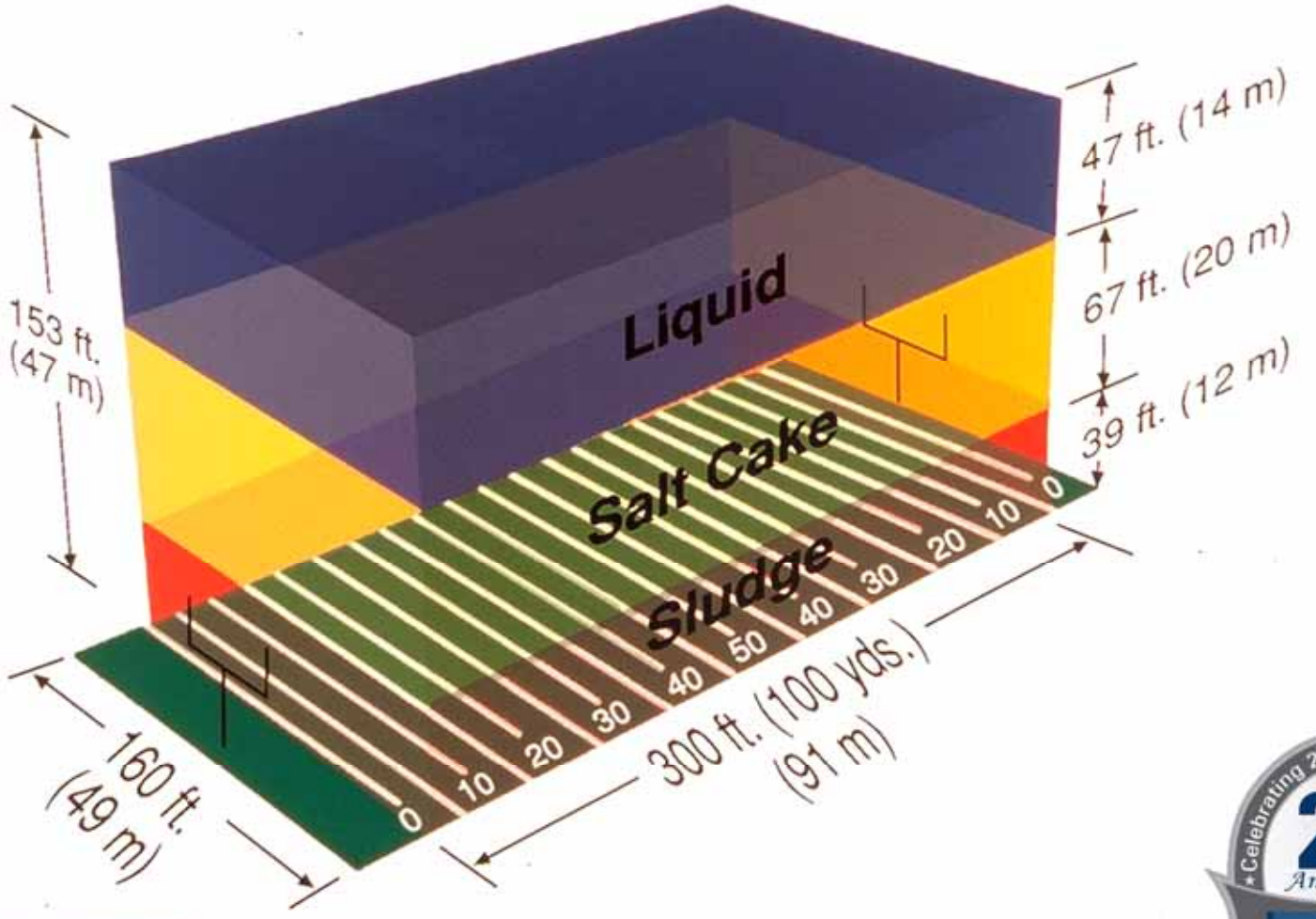
Began interaction with Hanford on Tank Waste

The 55 million gallons (208 x 10^3 cubic meters) of radioactive waste in Hanford's underground storage tanks would fill a football field to a height of about 150 feet.



From PNL-10773

DSW - Waste Feed Solutions

Acids	Conc., M	Actinides	Conc., M
HNO_3 $H_2C_2O_4$	1.0 0.2	Am (U, Np, Pu)	1.7e-4 3.4e-4
Non-Fission Cations		**Anions**	
Fe Al Na (Cr, Ni, Be, Ca, Cu, Mg, Si, Ti)	0.15 0.046 0.15 0.031	NO_3^- F^- (SO_4^{2-}, PO_4^{3-})	1.9 0.008 0.012
Fission Products		**Fission Products Rare Earths**	
Zr Mo Y Ru Pd Tc (Cd, Nb, Se, Rb, Sr, Rh, Ag, Sn, Sb, Te, Cs, Ba)	5.6e-3 1.8e-4 7.3e-4 2.1e-3 5.4e-4 0.0 3.6e-3	La Ce Pr Nd (Pm, Sm, Eu, Gd)	1.0e-3 2.4e-3 9.2e-4 2.7e-6 7.4e-4

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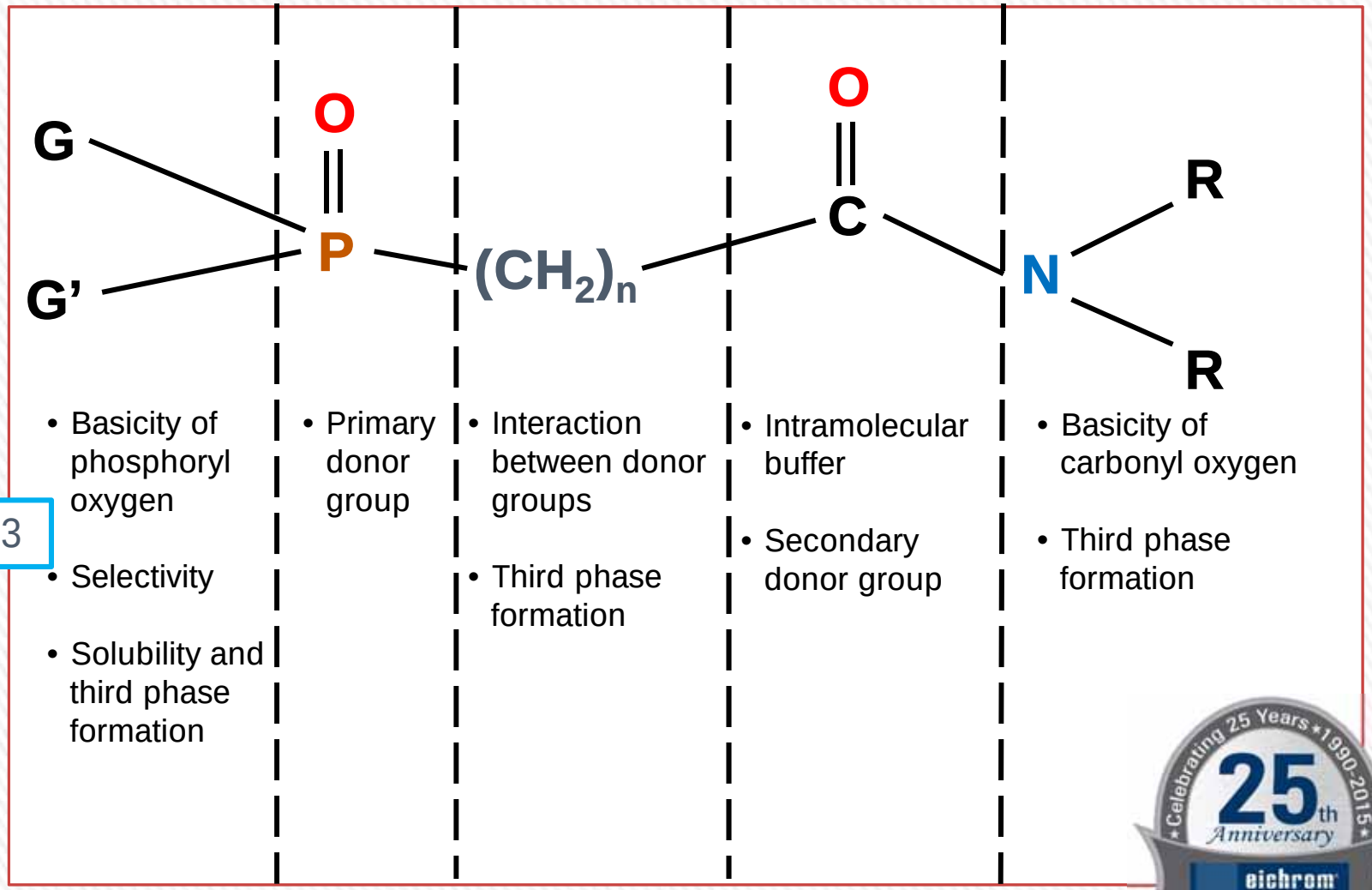
Invention of CMPO



1983

- Basicity of phosphoryl oxygen
- Selectivity
- Solubility and third phase formation

- Primary donor group

- Interaction between donor groups
- Third phase formation

- Intramolecular buffer
- Secondary donor group

- Basicity of carbonyl oxygen
- Third phase formation

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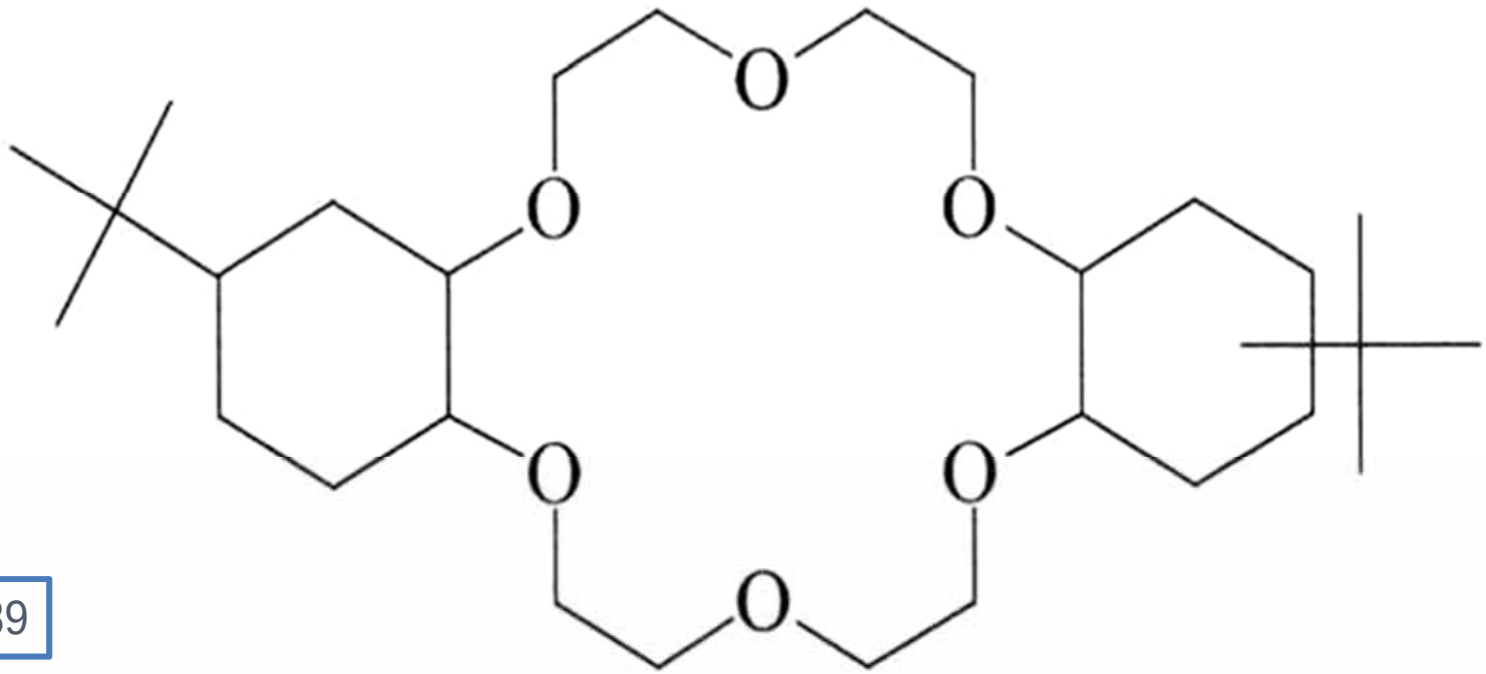
Invented SREX process



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Major Bioassay Incident

1930
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1985

1989

TRU Resin

Sr Resin

TEVA Resin

UTEVA Resin

1930

1940

1950

1960

1970

1980

1990

2000

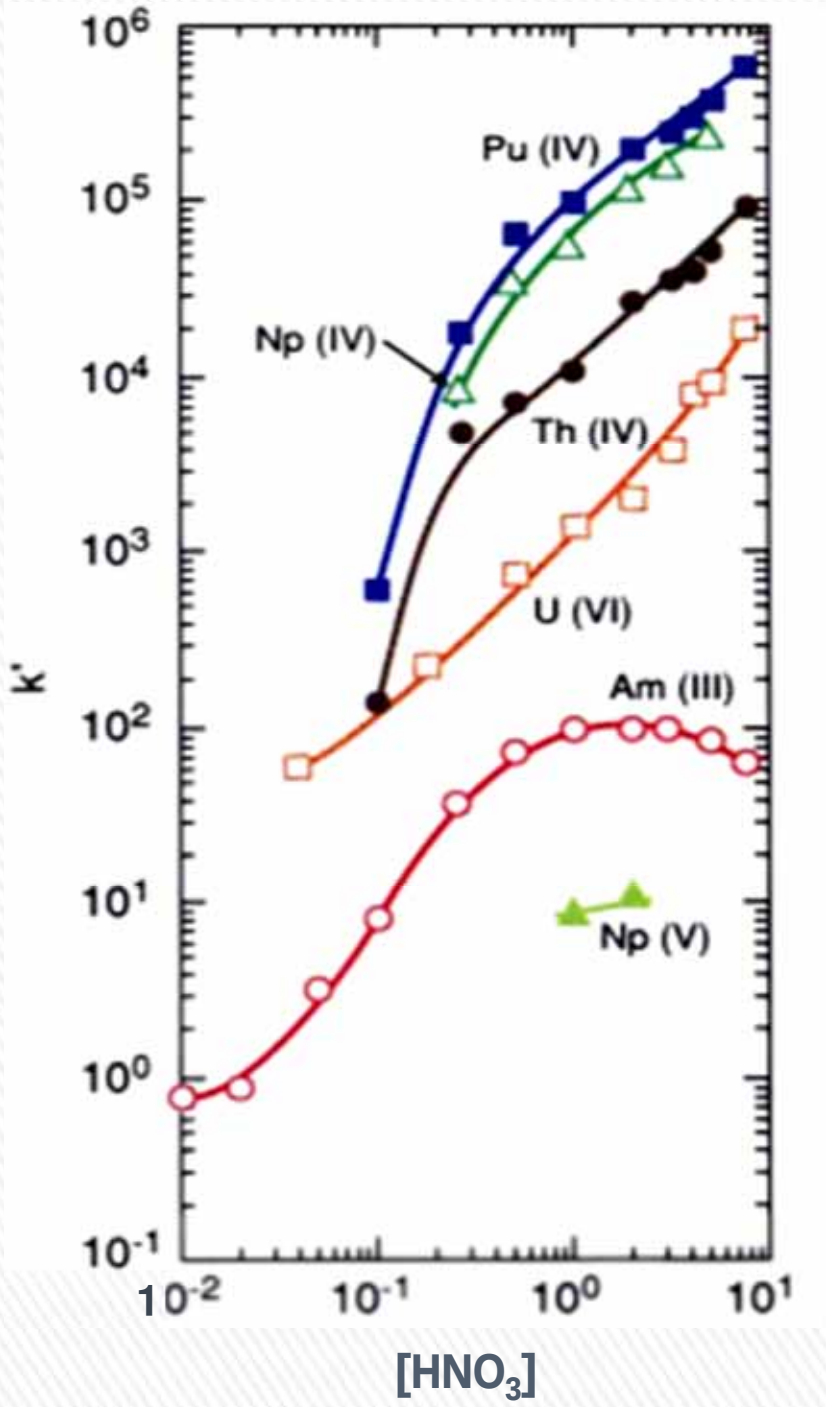
2010

TRU Resin

CMPO in TBP

United State Patent
Horwitz et al.
Patent Number 4,8235,107

Horwitz, E. Philip, et al. "Separation and preconcentration of actinides from acidic media by extraction chromatography." *Analytica Chimica Acta* 281.2 (1993): 361-372.



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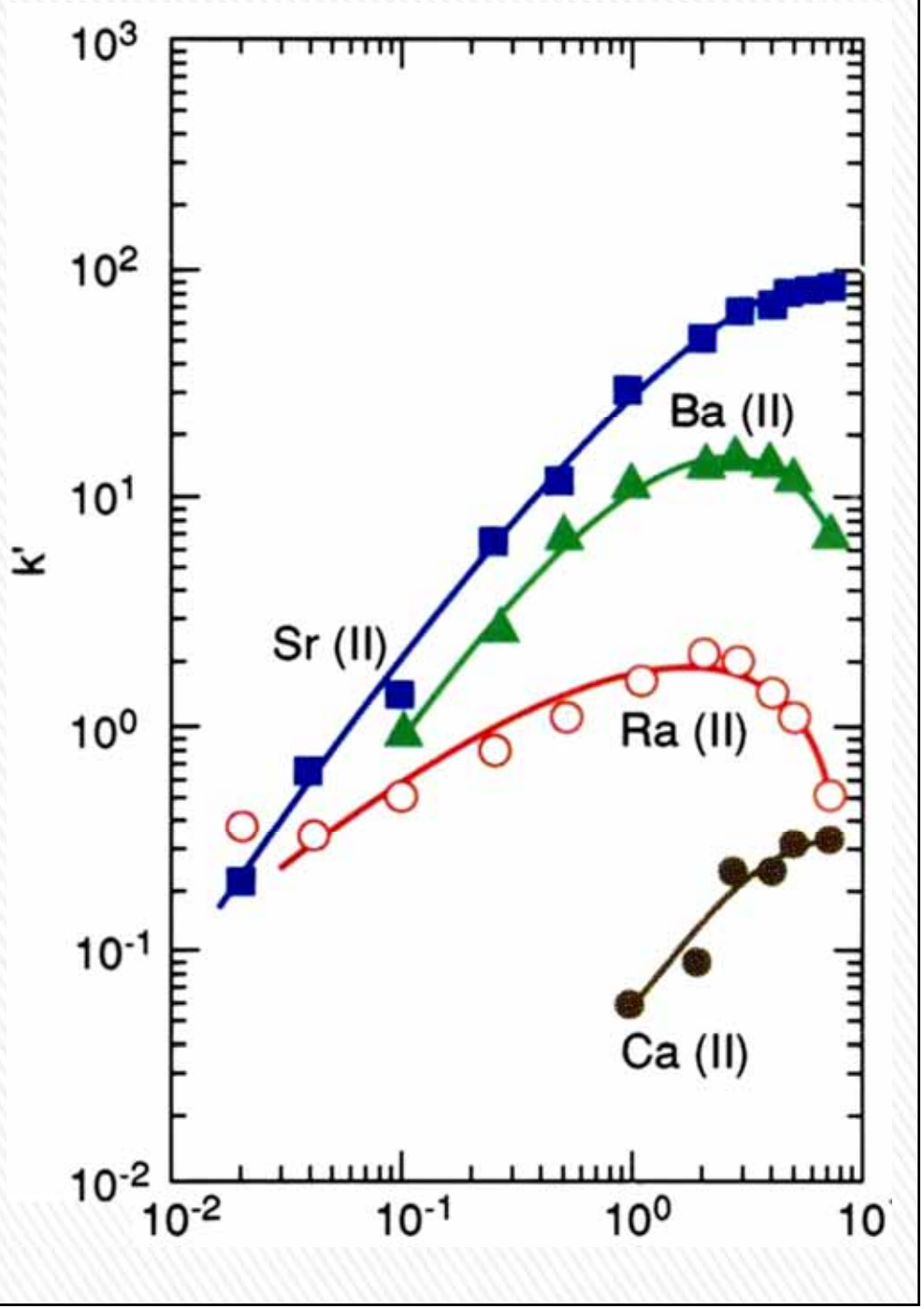
Sr Resin

di-t-butylcyclohexano crown ether in 1-octanol

United State Patent
Horwitz et al.
Patent Number 5,110,474

Horwitz, E. Philip, et al. “A Novel Strontium-Selective Extraction Chromatographic Resin." *Solvent Extraction and Ion Exchange* 10.2 (1992): 313-336.



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Phil and ARCH

2/90

Eichrom Industries

1992

ARCH
49%

GCI
51%

1998

GCI

1930

1940

1950

1960

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2000

2010

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No amount of careful planning will ever replace dumb luck.

Don Peppard
Senior Scientist at ANL 1953-1976

1930

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