2ND JOINT WORKSHOP ON INITIATIVES OF LOW-DOSE RESEARCH CO-ORDINATION

Washington, D.C. 23–24 June 2026

WASHINGTON STATE UNIVERSITY
College of Pharmacy and Pharmaceutical Sciences

Learning from Plutonium and Uranium Workers

The story of human-based actinide research



Sergey Y. Tolmachev, Ph.D.

Professor and Director · United States Transuranium and Uranium Registries

College of Pharmacy and Pharmaceutical Sciences · Washington State University · Richland, WA

WITH GRATITUDE

To our **Registrants** – whose foresight and generosity built the scientific foundation of the USTUR and continue to inform radiation protection today.

HISTORY

United States Transuranium and Uranium Registries (USTUR)


Rocky Flats, July 25-26, 1966

1949 Hanford autopsy tissue study

1966 U.S. Atomic Energy Commission ‘Plutonium in Man’ meeting – the idea of a registry

1967 7th Annual Hanford Biology Symposium – the registry proposed

1968

Plutonium Registry **established**

Hanford Environmental Health Foundation ***contract***

1970

Renamed U.S. Transuranium Registry (USTR)

Scope broadened ***beyond plutonium***

1978

U.S. Uranium Registry (USUR) **established**

Administratively ***separate*** registry

1992

USTR + USUR = USTUR **consolidated**

Moved to Washington State University ***research grant***

Analytical and management support: HEHF, Los Alamos Scientific Laboratory, Pacific Northwest Laboratory, Rocky Flats

HISTORY

Mission

THEN · 1968

To protect the interests of workers, employees, and the public by … the acquisition and provision of the latest and most precise information about the **effects of the transuranic elements on man**.

By the end of the 1970s, the mission moved away from epidemiology.

NOW · 2026

To follow up occupationally exposed workers by studying the **biokinetics and tissue dosimetry of the actinides** – refining dose-assessment methods that support epidemiology, risk assessment, and regulatory standards.

FOUNDATIONS

Why human data matters

Biokinetic models can be built on four kinds of evidence. The USTUR provides **the strongest** – **H1**: humans, exposed to the element of interest.

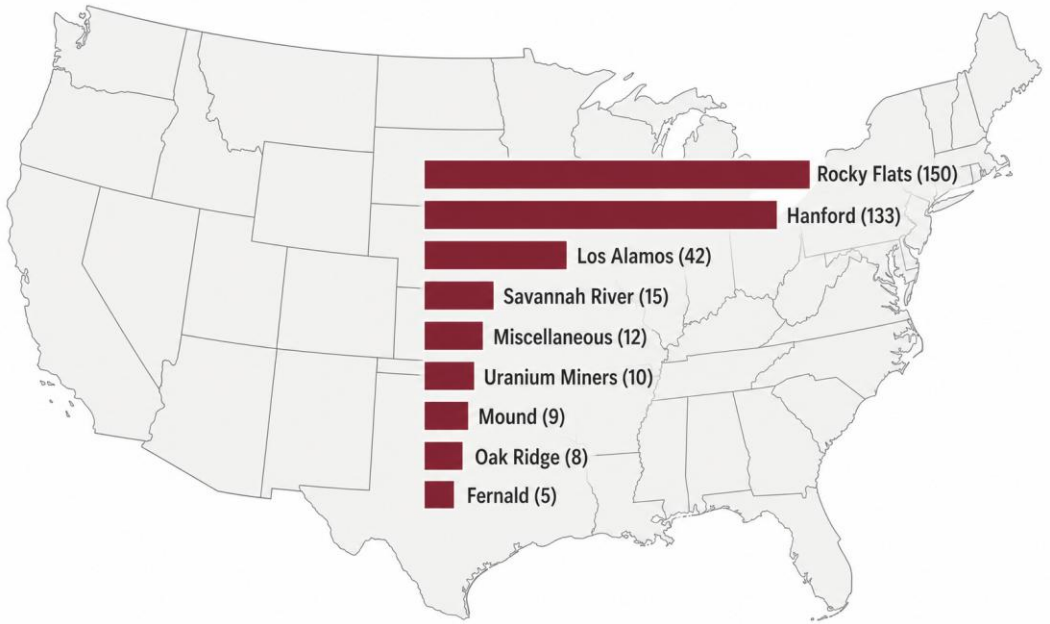
> *"Greater confidence can be placed in a biokinetic model based on H1 data than on H2, A1, and/or A2."*

Leggett, R. W., Bouville, A., & Eckerman, K. F. (1998). Reliability of the ICRP's Systemic Biokinetic Models. Radiation Protection Dosimetry, 79(1-4), 335–342.



THE RESOURCE

The Registrants



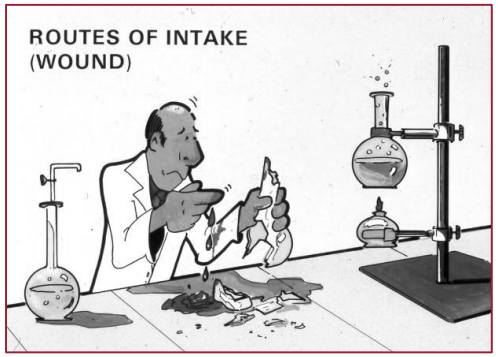
Mainly DOE-site nuclear workers with a **documented** history of **exposure to actinides** and with internal deposition of **≥74 Bq** (2 nCi).

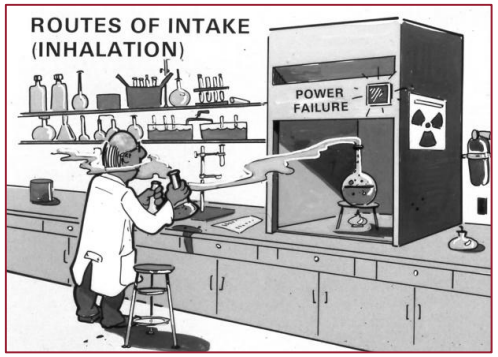
Voluntary, posthumous whole-body or partial-body **tissue donors.**

384 Enrolled

52 Whole body

332 Partial body





^{239}Pu | ^{238}Pu | ^{241}Am | U-nat | HEU | DU | ^{244}Cm | ^{237}Np

THE RESOURCE

THE MOST FAMOUS REGISTRANT

"The Atomic Man"

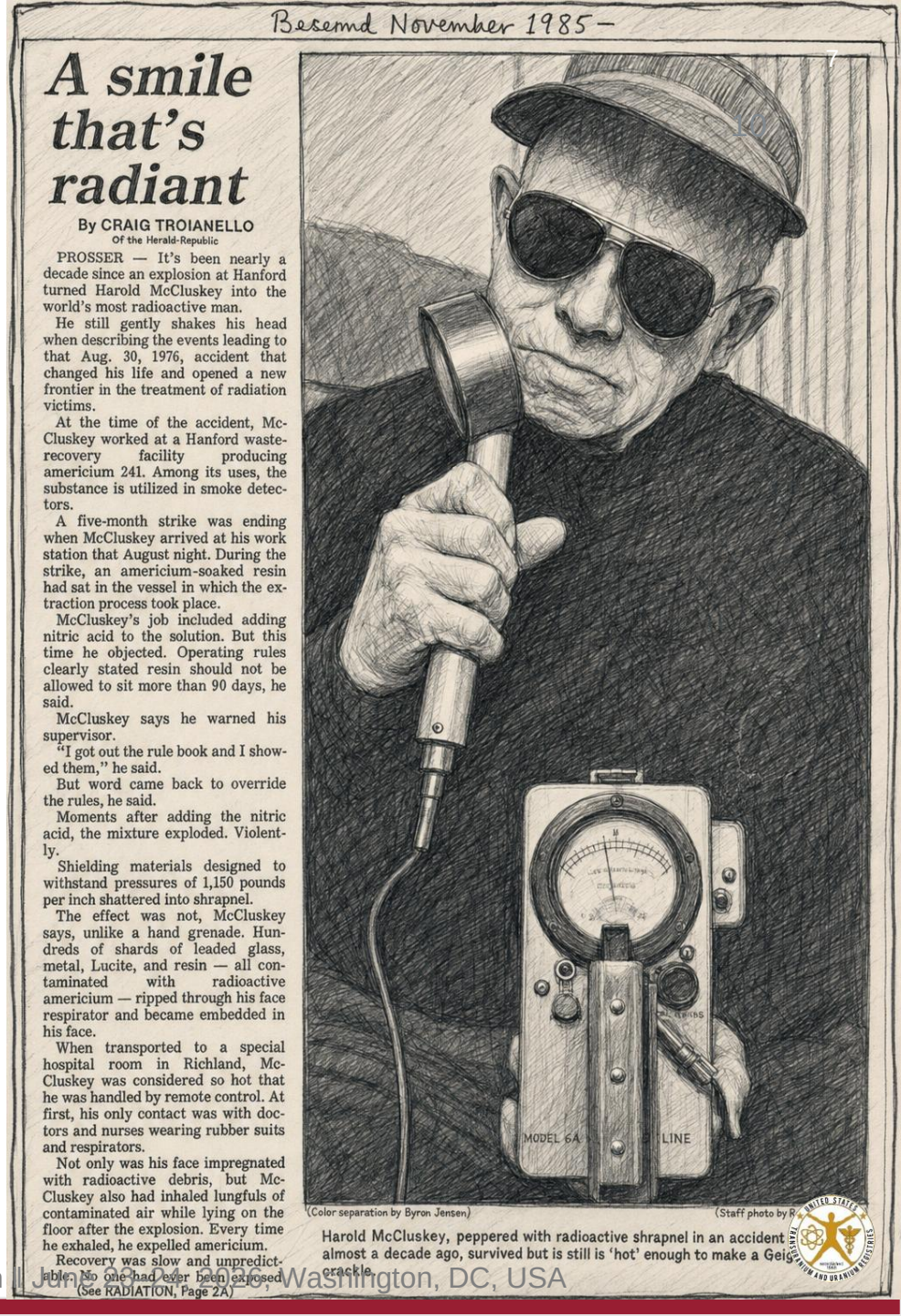
The largest recorded americium intake: the 1976 Hanford ion-exchange column explosion released ~100 g of ^{241}Am.

ESTIMATED UPTAKE

>40 MBq

→ Extensive Ca/Zn-DTPA chelation therapy

→ Systemic deposition after treatment **≈0.5 MBq**



Besemd November 1985–

A smile that's radiant

By CRAIG TROIANELLO
Of the Herald-Republic

PROSSER — It's been nearly a decade since an explosion at Hanford turned Harold McCluskey into the world's most radioactive man.

He still gently shakes his head when describing the events leading to that Aug. 30, 1976, accident that changed his life and opened a new frontier in the treatment of radiation victims.

At the time of the accident, McCluskey worked at a Hanford waste-recovery facility producing americium 241. Among its uses, the substance is utilized in smoke detectors.

A five-month strike was ending when McCluskey arrived at his work station that August night. During the strike, an americium-soaked resin had sat in the vessel in which the extraction process took place.

McCluskey's job included adding nitric acid to the solution. But this time he objected. Operating rules clearly stated resin should not be allowed to sit more than 90 days, he said.

McCluskey says he warned his supervisor.

"I got out the rule book and I showed them," he said.

But word came back to override the rules, he said.

Moments after adding the nitric acid, the mixture exploded. Violently.

Shielding materials designed to withstand pressures of 1,150 pounds per inch shattered into shrapnel.

The effect was not, McCluskey says, unlike a hand grenade. Hundreds of shards of leaded glass, metal, Lucite, and resin — all contaminated with radioactive americium — ripped through his face respirator and became embedded in his face.

When transported to a special hospital room in Richland, McCluskey was considered so hot that he was handled by remote control. At first, his only contact was with doctors and nurses wearing rubber suits and respirators.

Not only was his face impregnated with radioactive debris, but McCluskey also had inhaled lungfuls of contaminated air while lying on the floor after the explosion. Every time he exhaled, he expelled americium.

Recovery was slow and unpredictable. No one had ever been exposed

(See RADIATION, Page 2A)

(Color separation by Byron Jensen)

(Staff photo by R

Harold McCluskey, peppered with radioactive shrapnel in an accident almost a decade ago, survived but is still is 'hot' enough to make a Geig crackle.

THE RESOURCE

A unique material and data resource

Two linked repositories allow *exposure records*, *bioassay data*, *work histories*, *medical records*, and post-mortem ***tissue measurement results*** to be connected for the same individual.



Health Physics Database

Decades of bioassay results, work and exposure histories, and dosimetry and medical records – the documentary record paired with each donor's tissues.

Work history · exposure records · bioassay

National Human Radiobiology Tissue Repository (NHRTR)

The NHRTR preserves whole-body and organ tissues from donor Registrants – a physical archive available for analysis and re-analysis as methods advance.

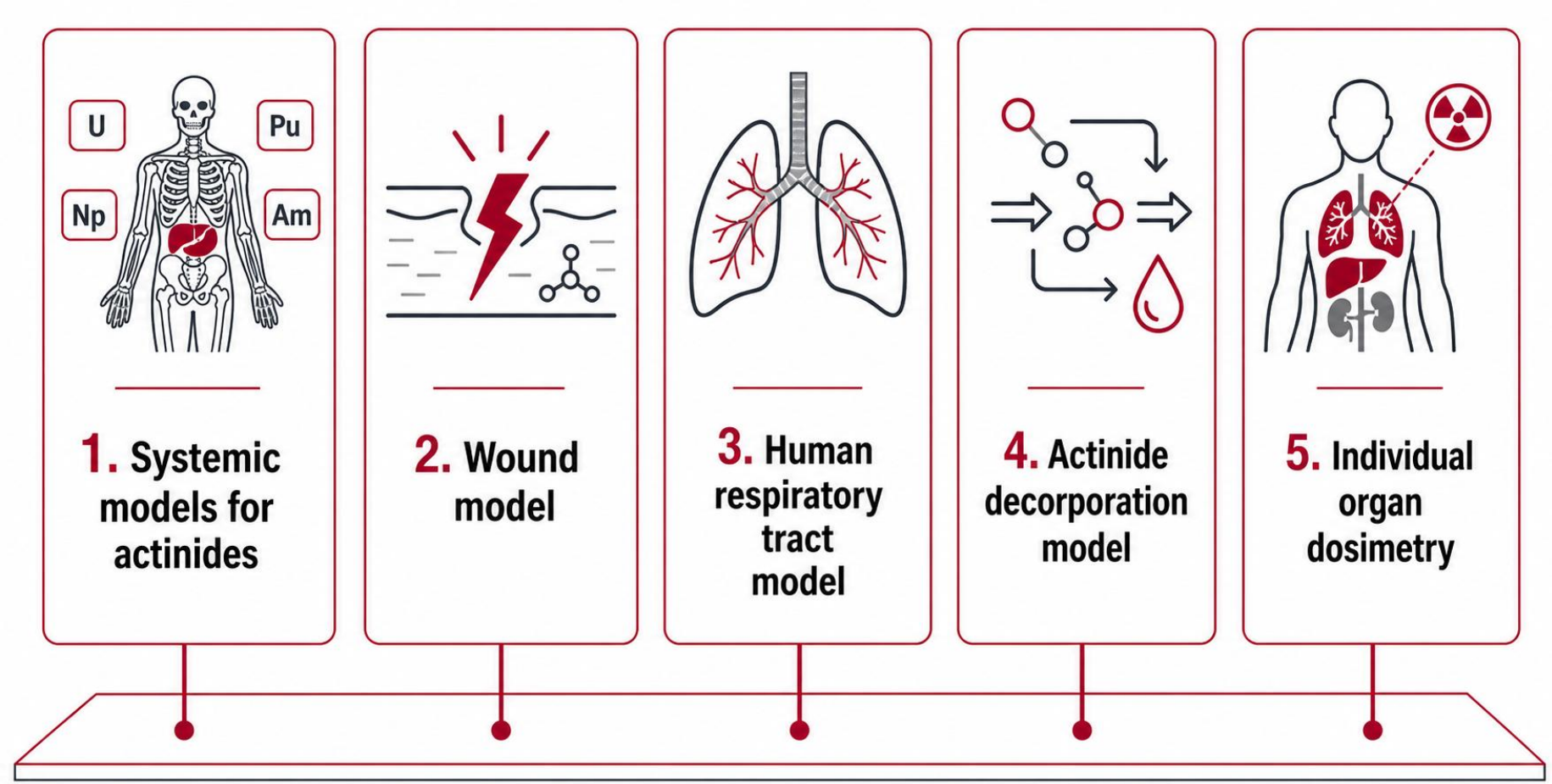
Frozen tissues · pathology slides



RESEARCH

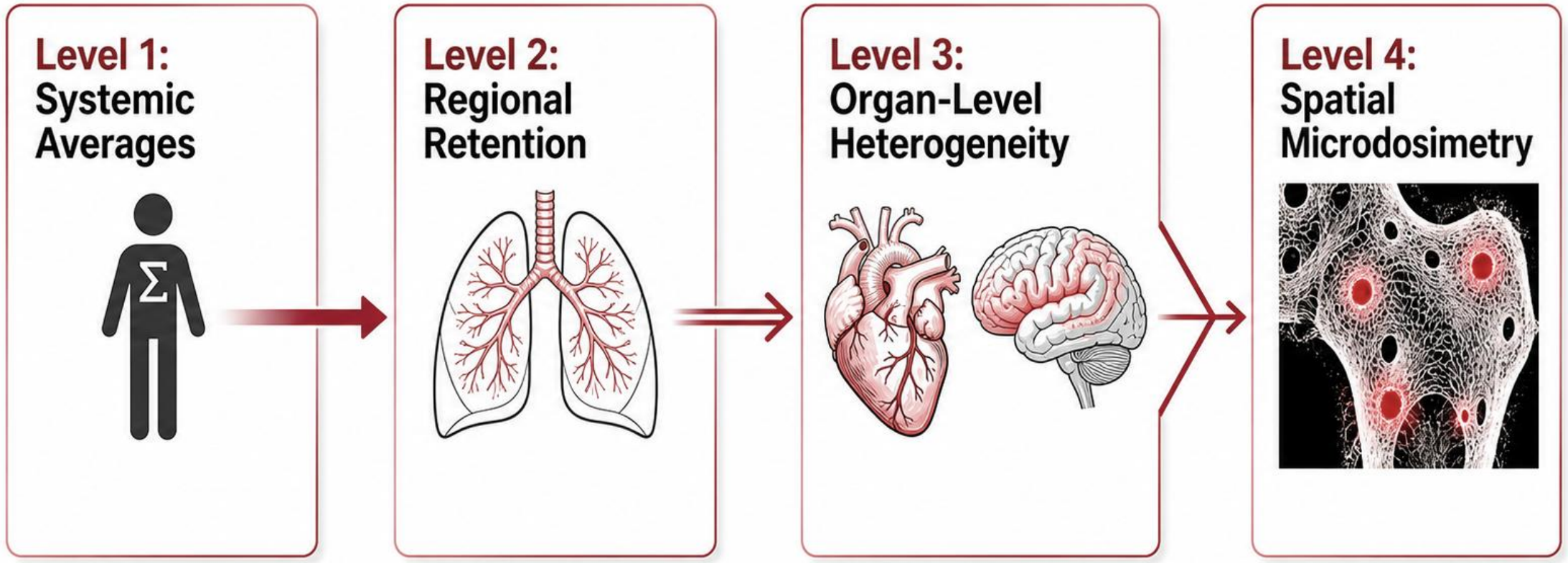
Primary research: actinide dosimetry

Developing, testing, improving, and parameterizing actinide biokinetic models



RESEARCH

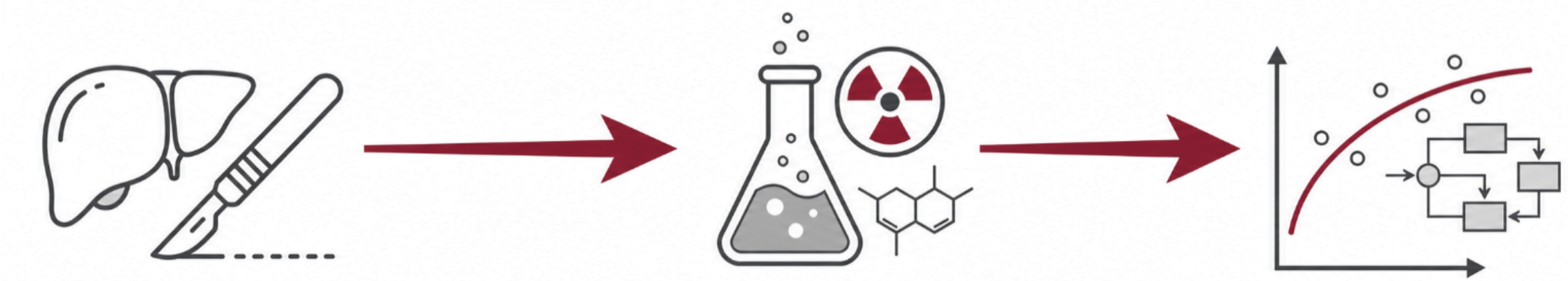
Actinide dosimetry from macro to micro and nano



The closer we look, the less adequate historical averages become.
Precise radiation protection requires biological reality at every scale.

THE OPERATIONS

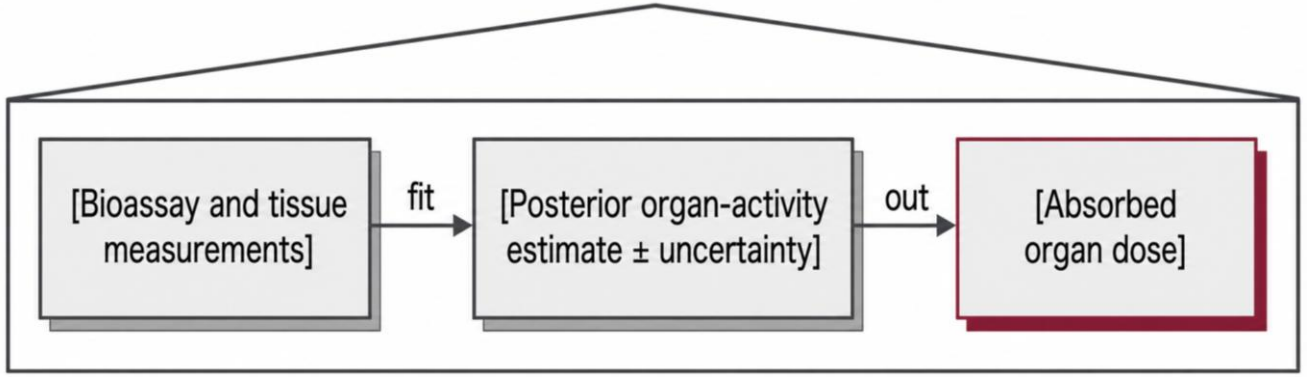
From autopsy to dose estimation



Tissue collection
Storage at the NHRTR

Radiochemical analysis
Tissue activity measurement

Biokinetic modeling
Intake and dose estimation



*Every step carries **uncertainty** that **must be quantified**, not hidden.*

THE SCIENCE

Site-specific uncertainty: material type

Different production processes produced plutonium of different physical form – and therefore different absorption behavior in the human body.

Hanford

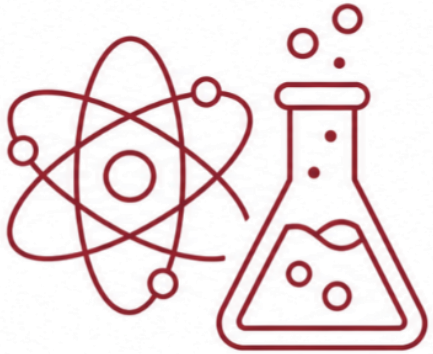
1943–1989



Large-scale plutonium **production** for nuclear weapons during the Manhattan Project

Los Alamos

1943–present



Plutonium **research** and **processing** supporting nuclear weapons and scientific applications

Rocky Flats

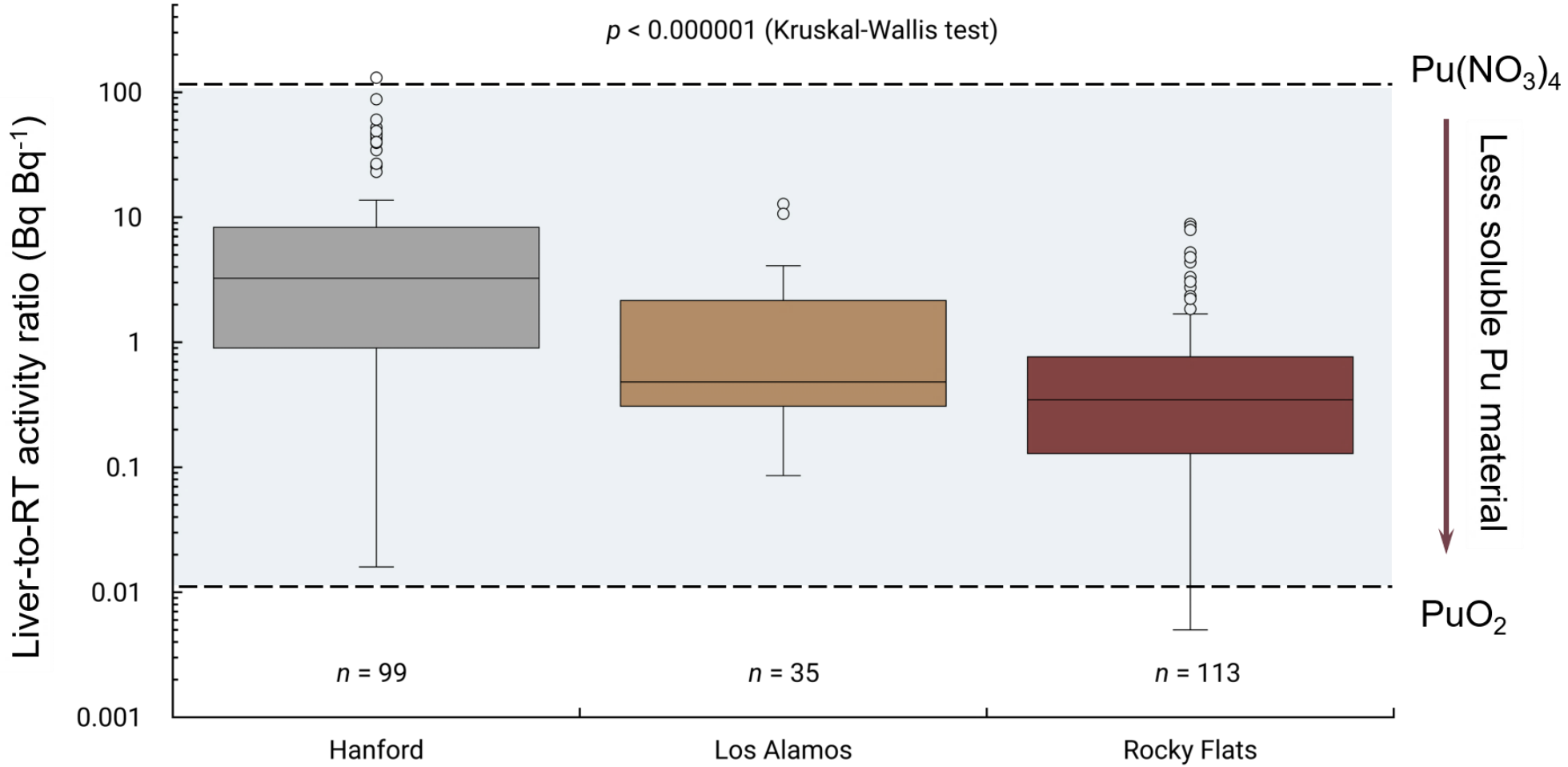
1952–1992



Trigger production and plutonium **recovery** with distinctive material chemistry

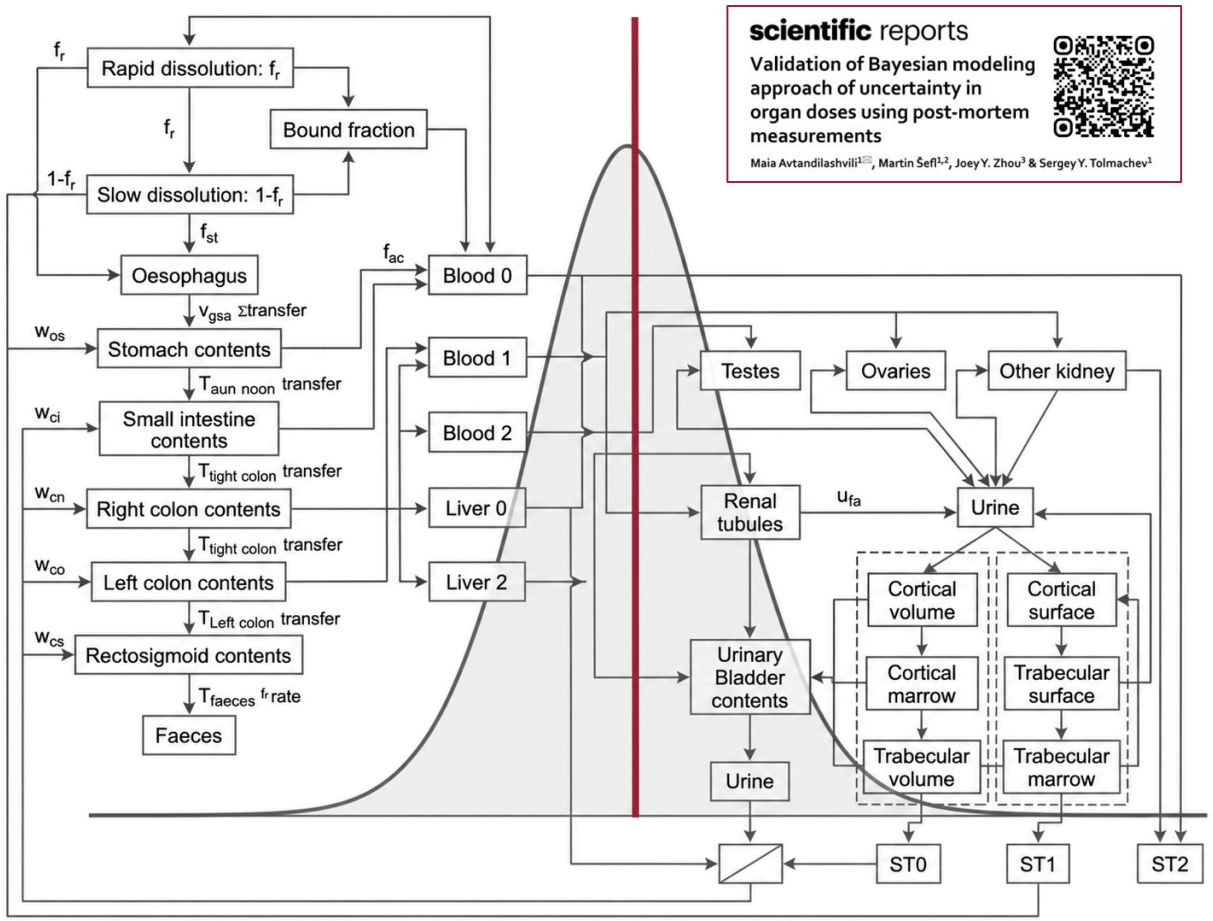
THE SCIENCE

Defining site-specific plutonium solubility



THE SCIENCE

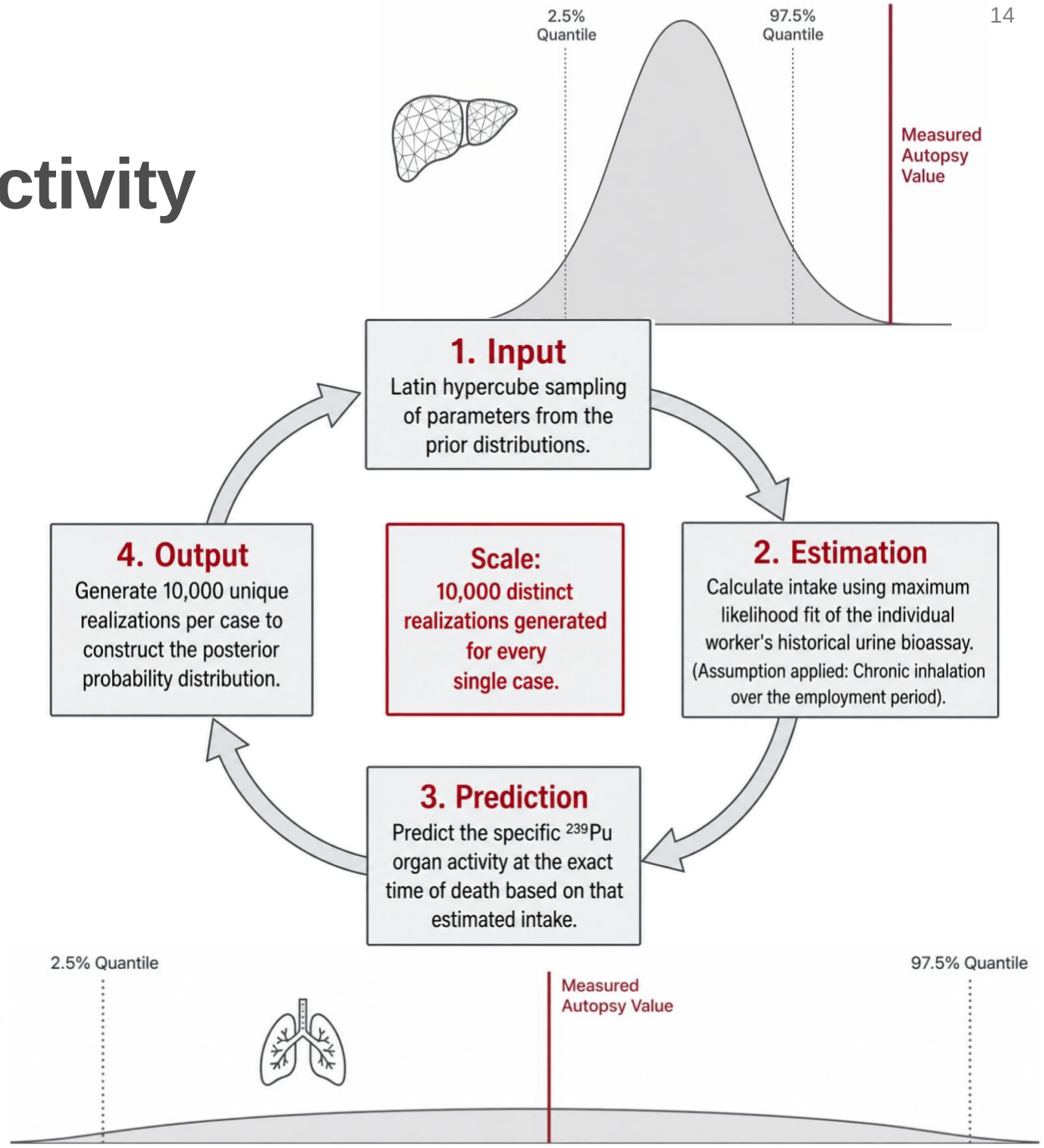
Model uncertainties: organ activity as a proxy for radiation dose



scientific reports

Validation of Bayesian modeling approach of uncertainty in organ doses using post-mortem measurements

Maia Avtandilashvili[1✉], Martin Šefl[1,2], Joey Y. Zhou[3] & Sergey Y. Tolmachev[1]



NEXT STEP

AI agent as a supervised coworker

Implementation of supervised AI agents to enhance the reproducibility of research (Anthropic released *Claude Managed Agent* to the public in April 2026).

01 Organized materials; reviewed source documents and code

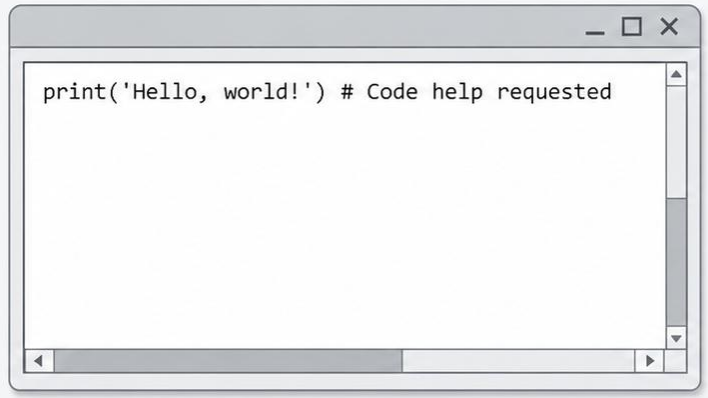
02 Developed Python analysis scripts

03 Executed model runs and summarized outputs

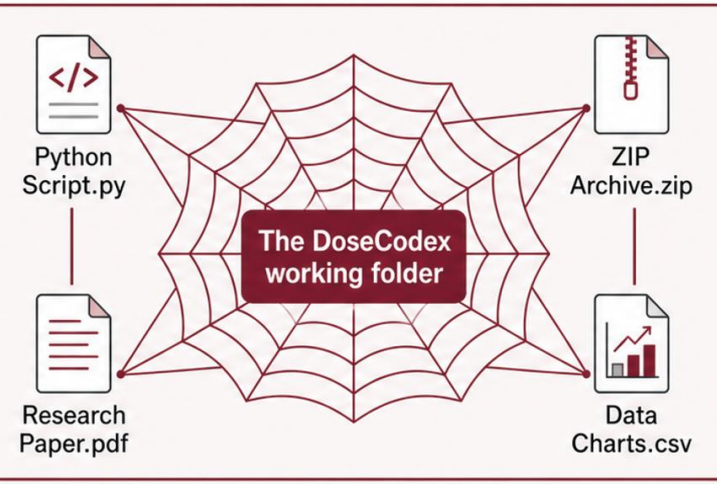
04 Compared results across analysis scenarios

05 Drafted reports and manuscript text for review

Investigators retained responsibility for the final scientific conclusions.



Traditional AI Assistance: Prompting for isolated code help.



Agentic Coworker: Supervising a project coworker across entire research environment.

scientific reports
Validation of Bayesian modeling approach of uncertainty in organ doses using post-mortem measurements
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THE QUESTION

Study reproduction: conceptual framework

Can a supervised AI coding agent provide reliable support for an internal dosimetry workflow?

Metric	Published Study (USTUR-iRAD)	Independent Reproduction (DoseCodex)
Respiratory tract within 95% interval	10/20	12/20
Liver within 95% interval	5/20	4/20
Skeleton within 95% interval	2/20	0/20
Respiratory-tract median error	250%	214%
Liver + skeleton median error	36%	40%

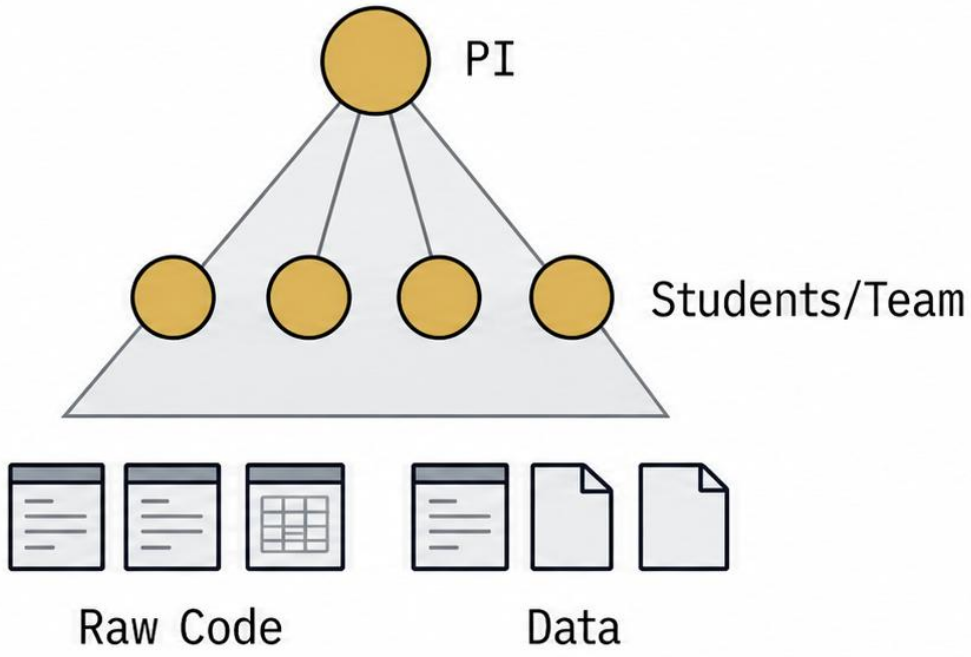


The difference was in the methods, not the conclusion. The goal was to assess consistency of findings, not exact numerical equivalence.

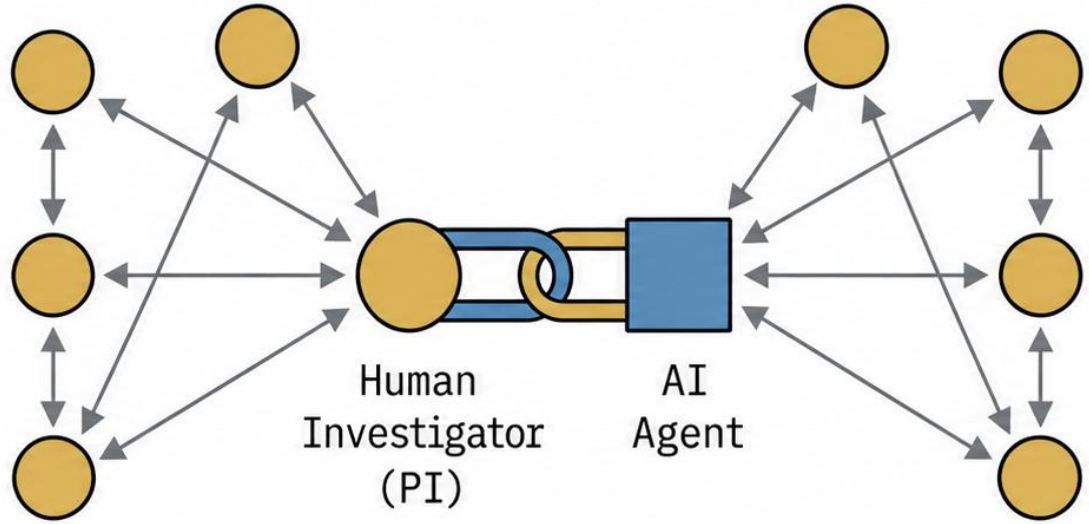
THE FUTURE

Changing the way research is conducted

TRADITIONAL MODEL



AI-AGENT-ASSISTED MODEL



When AI agents allow one principal investigator to do the work of an entire team, how must our models of collaboration, supervision, and training change?

IN CLOSING

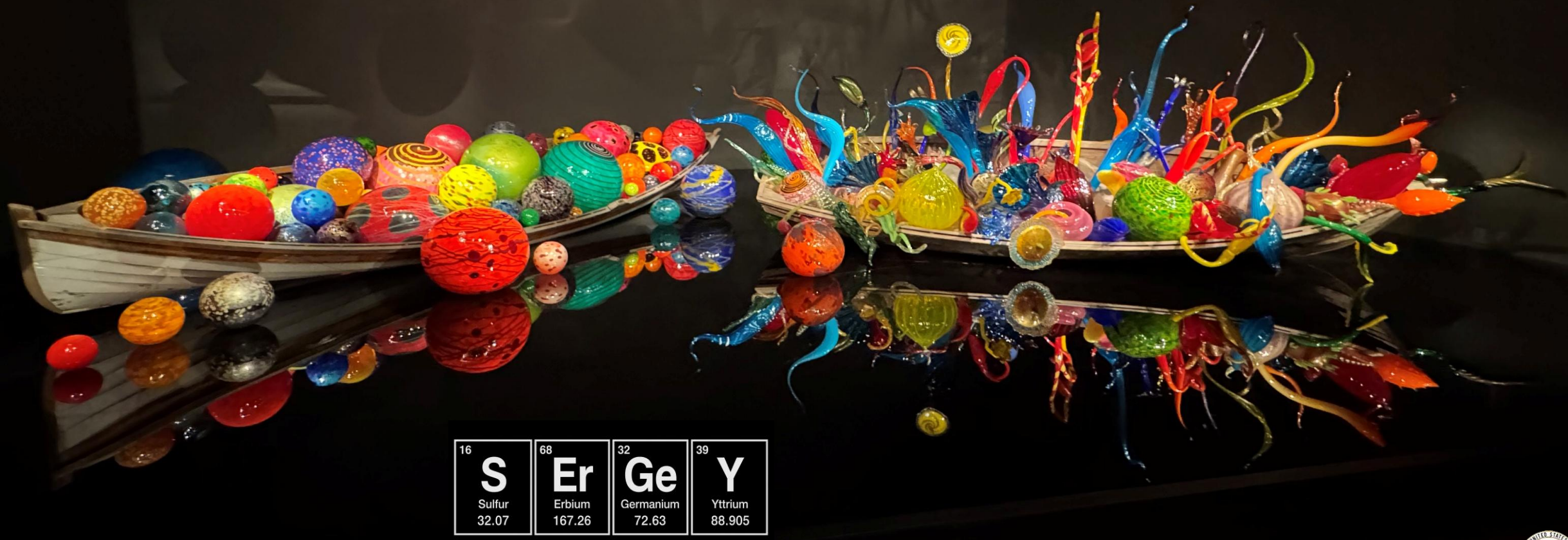
Takeaway message

The USTUR is a **unique worldwide resource** for the comprehensive study of **actinide elements** in the human body.

It continues to provide the scientific evidence needed to ensure **safety standards remain adequate** for these radioactive elements.

With **AI-driven modernization**, the USTUR will serve as a foundation for the **next generation of actinide research and beyond**.

Thank you for your attention!



Chihuly Garden and Glass Exhibit, Seattle, Washington, USA