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# USTUR Whole-body Case 0680: 53-year Follow-up of a Manhattan Project Worker

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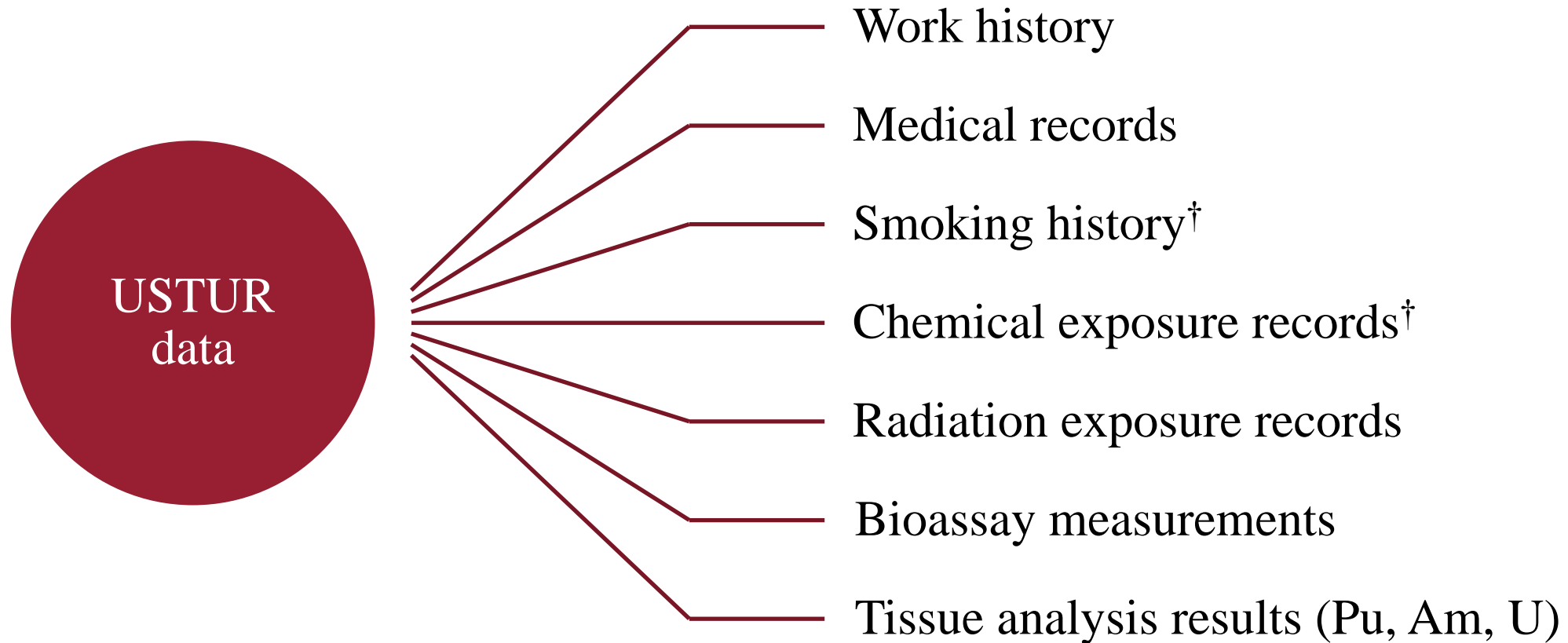
United States Transuranium and Uranium Registries, College of Pharmacy and  
Pharmaceutical Sciences, Washington State University, Richland, Washington





# Unique Data Resource

- Registrant acceptance:  $\geq 74$  Bq (2 nCi) systemic content



<sup>†</sup> - self-reported data



## USTUR Case 0680

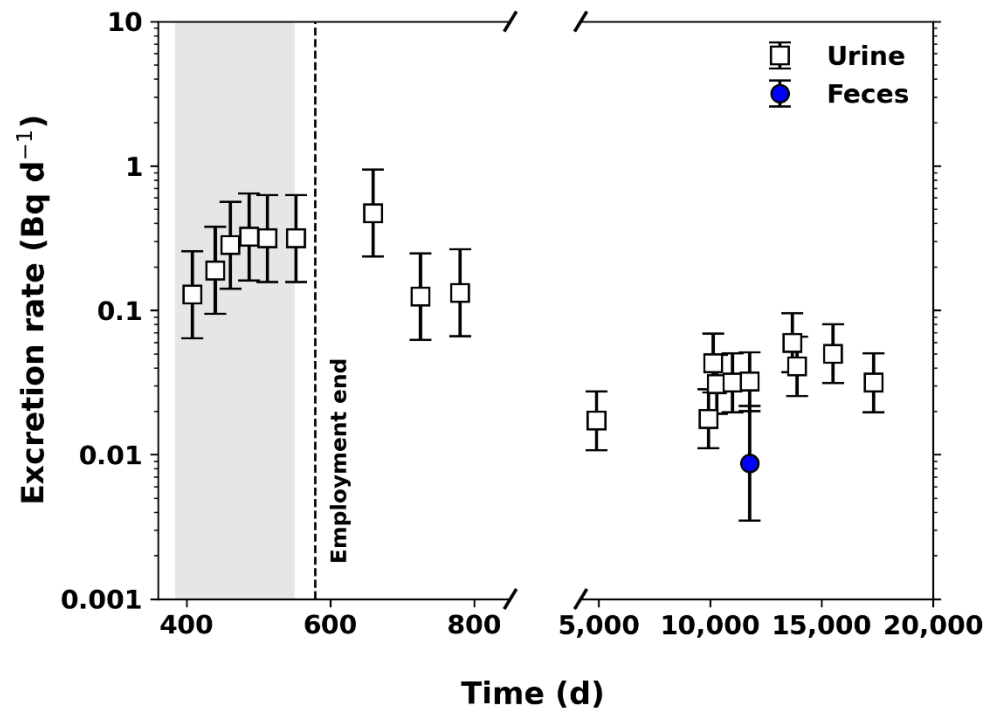
- One of 26 Manhattan Project plutonium workers selected for medical follow-up “*on the basis of the amount of plutonium excreted in the urine assayed by methods available before 1950.*”
- Worked as a chemist on plutonium recovery for 18 months in 1940s
- Died 53 years after exposure at age 90+
- Whole-body tissue donor to the USTUR





# Data: Bioassay Measurements

- 19 urine samples
- 1 fecal sample
- 1 blood sample
- 212 nasal swipes
- 14 chest counts < MDA





## Data: Post-mortem Tissue Analyses

- Tissues analyzed: 82 bone samples and 13 soft tissues
- Total body:  $1,765 \pm 12$  Bq

Systemic		Respiratory
		Lungs: $181 \pm 3$ Bq
	Liver: $661 \pm 11$ Bq	LNTH: $101 \pm 1$ Bq
Skeleton: $700 \pm 3$ Bq	Other Soft Tissues: $120 \pm 4$ Bq	



# Methods: Taurus Internal Dosimetry Software

Taurus

File Preferences User guide Notebook Refresh screen About



**Input**

Reference  
0680

Nuclide  
Pu-239 2.411E+4y

**Deposition parameters**  
☒ ICRP OIR series defaults  
Light work  
0.3 microns AMAD  
(for aerosols only)

**Absorption parameters**  
☒ ICRP OIR series defaults  
☐ User-defined form

**Systemic biokinetics**  
☒ ICRP OIR series defaults

**Alimentary tract**  
☒ ICRP OIR series defaults

**Respiratory tract**  
☒ ICRP OIR series defaults

**Intake regimes**  
Number of intake regimes (max. 20)  
2

	Form	Route	Mode	Start	End	Intake	fA	fr	sr	ss	fb	sb
1	PUN034	INH	Chronic	385	548	1.5247E+02	1.00E-04	0.2000	0.4000	2.0000E-03	2.0000E-03	0.000
2	PU02	INH	Chronic	385	548	4.2107E+01	2.00E-06	4.0000E-03	0.4000	1.0000E-05	2.0000E-03	0.000

**Bioassay quantities**

Whole body ☐

Urine ☒

Lungs ☒

Blood ☒

Faeces ☒

Thyroid ☐

Kidneys ☐

Liver ☒

Skeleton ☒

**Calculations**

☐ Quick dose and bioassay  
☐ Prospective calculation  
☒ Retrospective calculation (data fitting)

Progress

**Results**

Total effective dose, Sv

**Report**  
☒ short ☐ long

**Licence information**

This copy of Taurus is registered to USTUR-W/SU for 5 users. It will expire on 07/10/2021.

Public Health England, UK



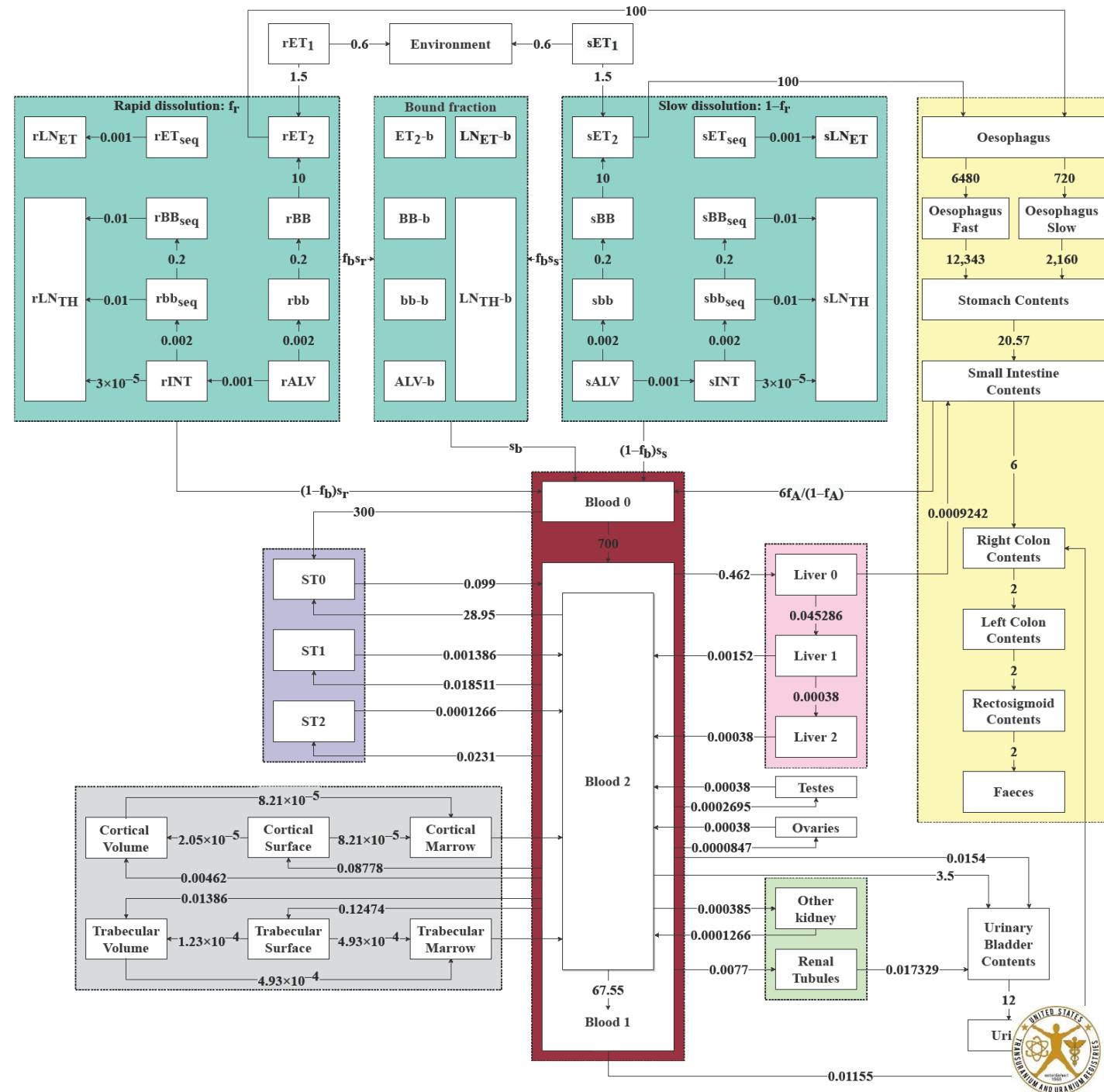
# Methods: Intake Scenario

## Chronic inhalation

- Pu-nitrate
- $\text{PuO}_2$

## ICRP models

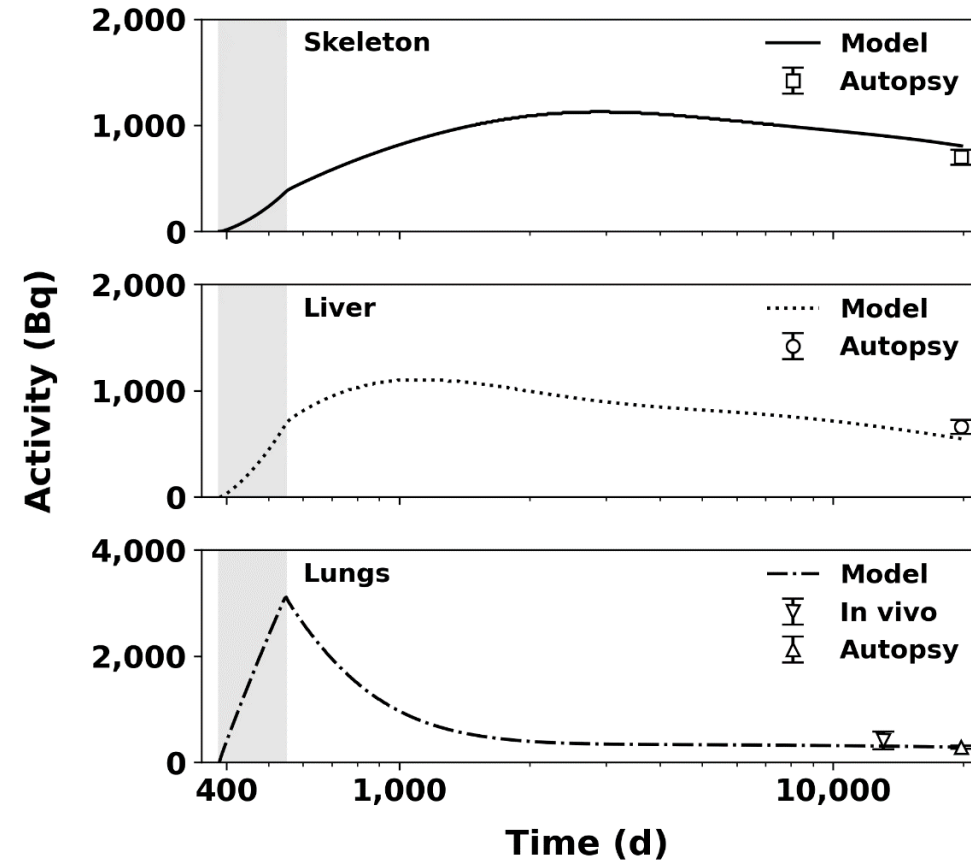
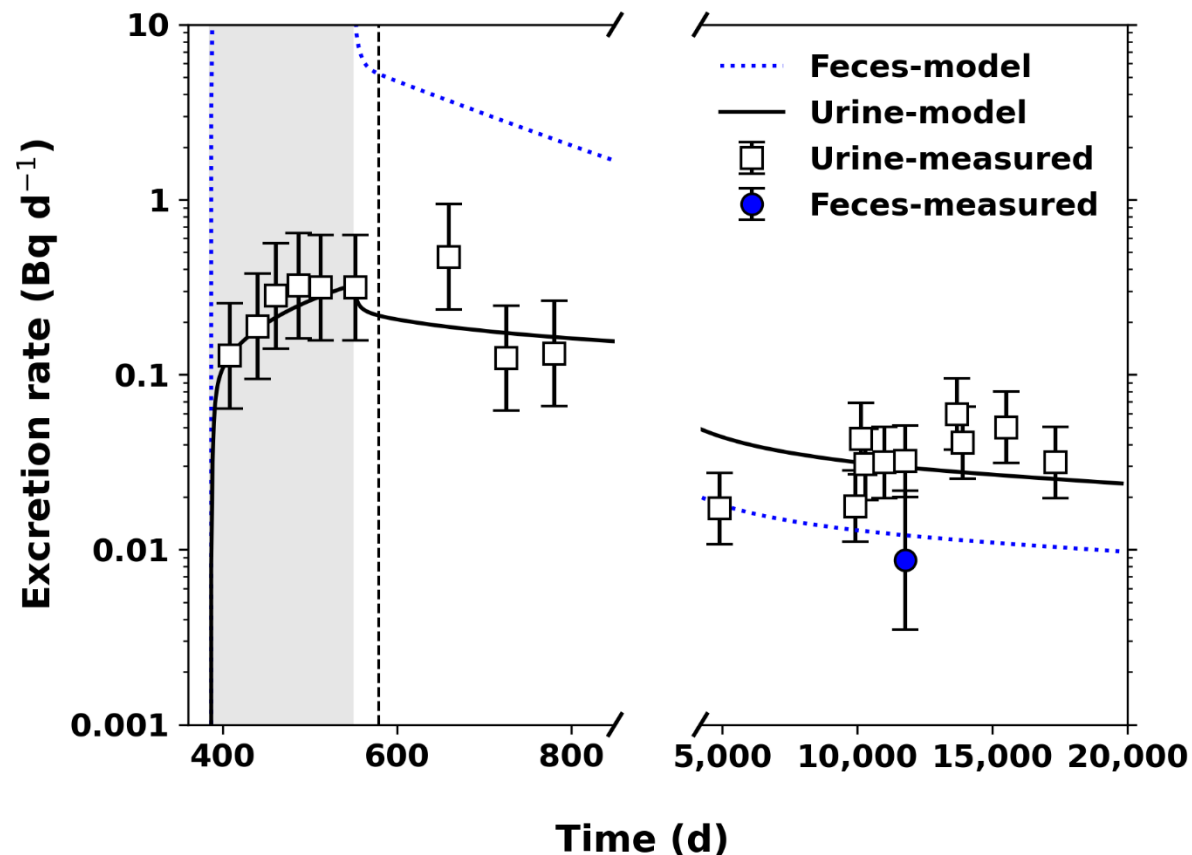
- 130 Human Respiratory Tract
- 100 Human Alimentary Tract
- 141 Plutonium Systemic





# Results: Estimated Intake

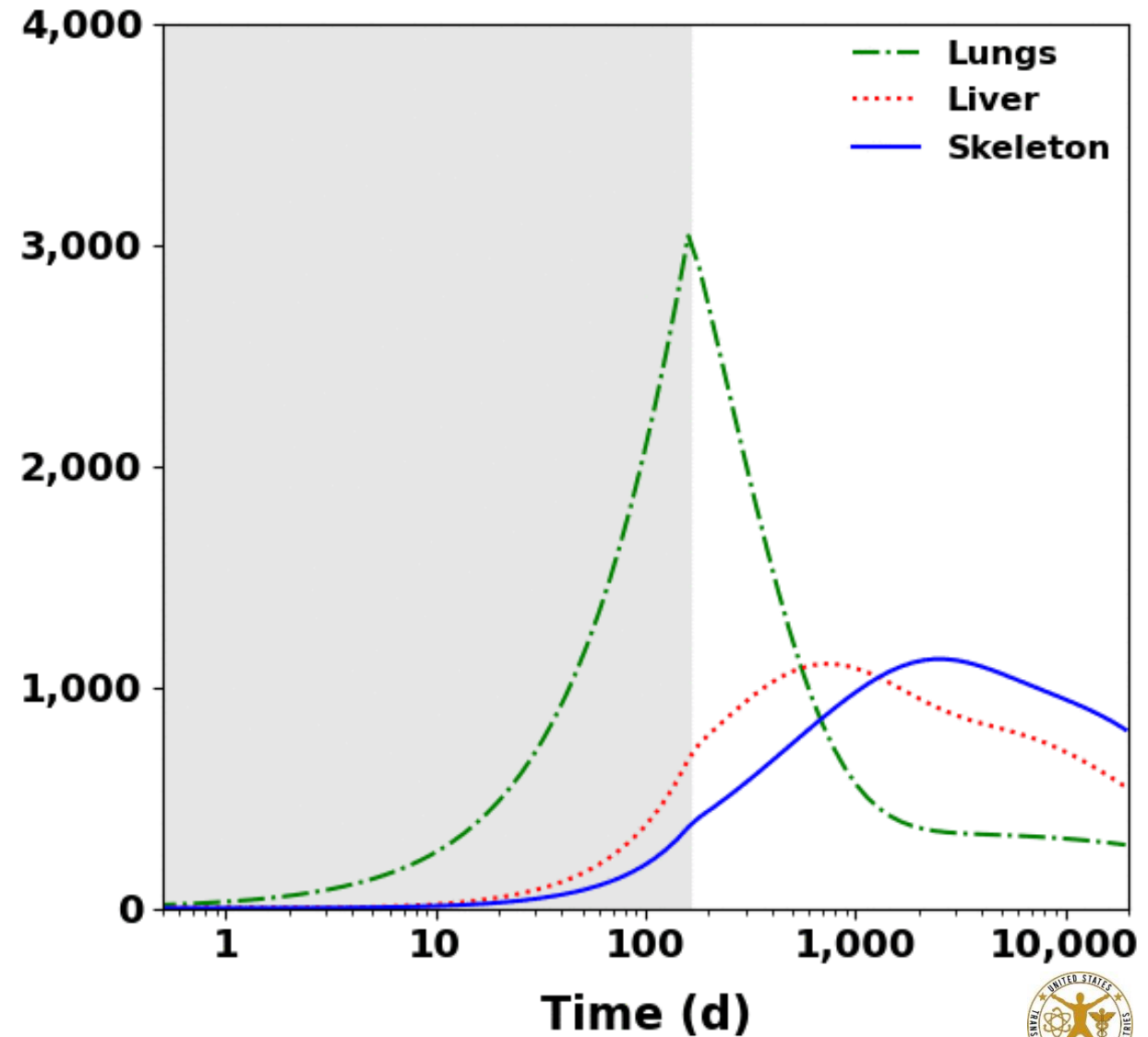
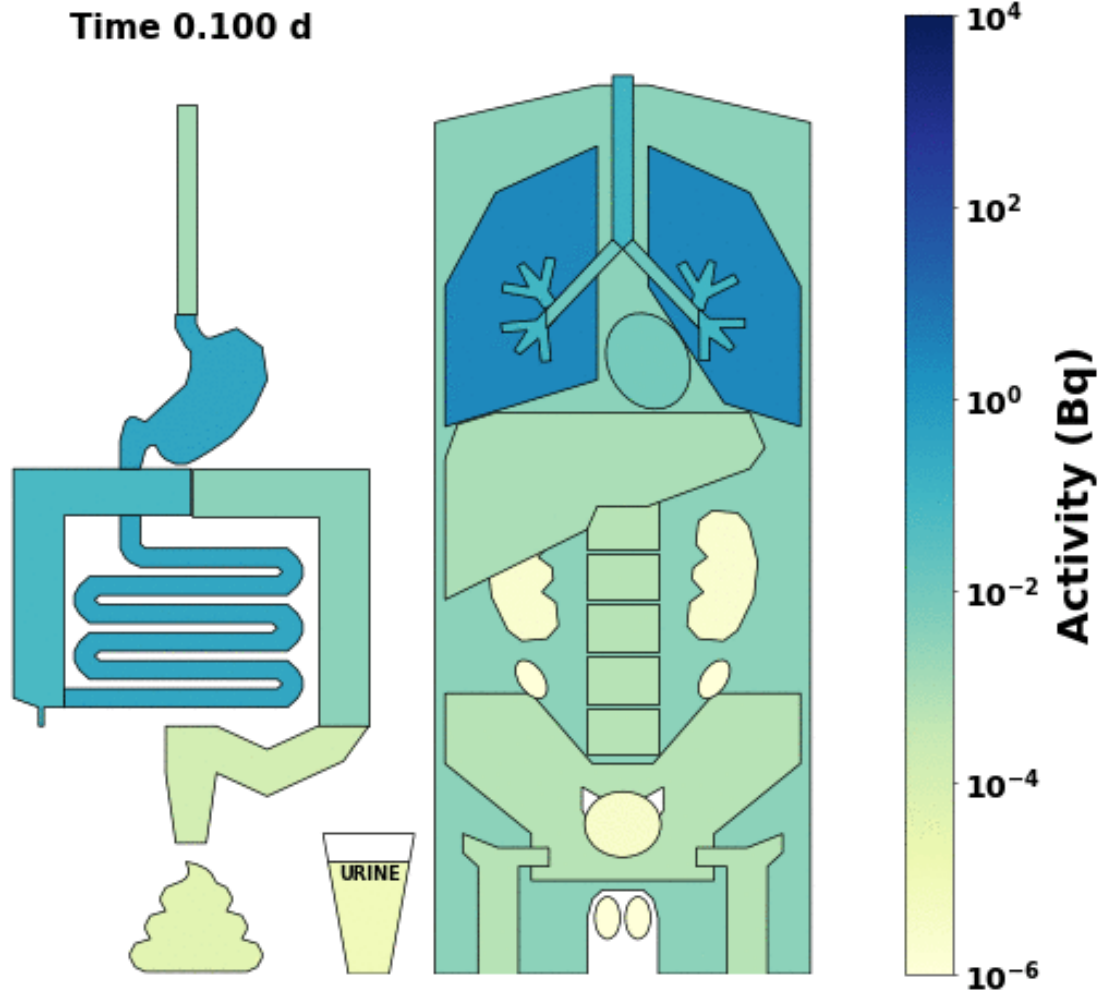
Days	Material	Intake		Goodness of fit $\chi^2$ <i>p</i> -value
		Rate (Bq d <sup>-1</sup> )	Cumulative (Bq)	
385 – 548	Pu-nitrate	152.5	25,570	0.808
	PuO <sub>2</sub>	42.1	9,485	





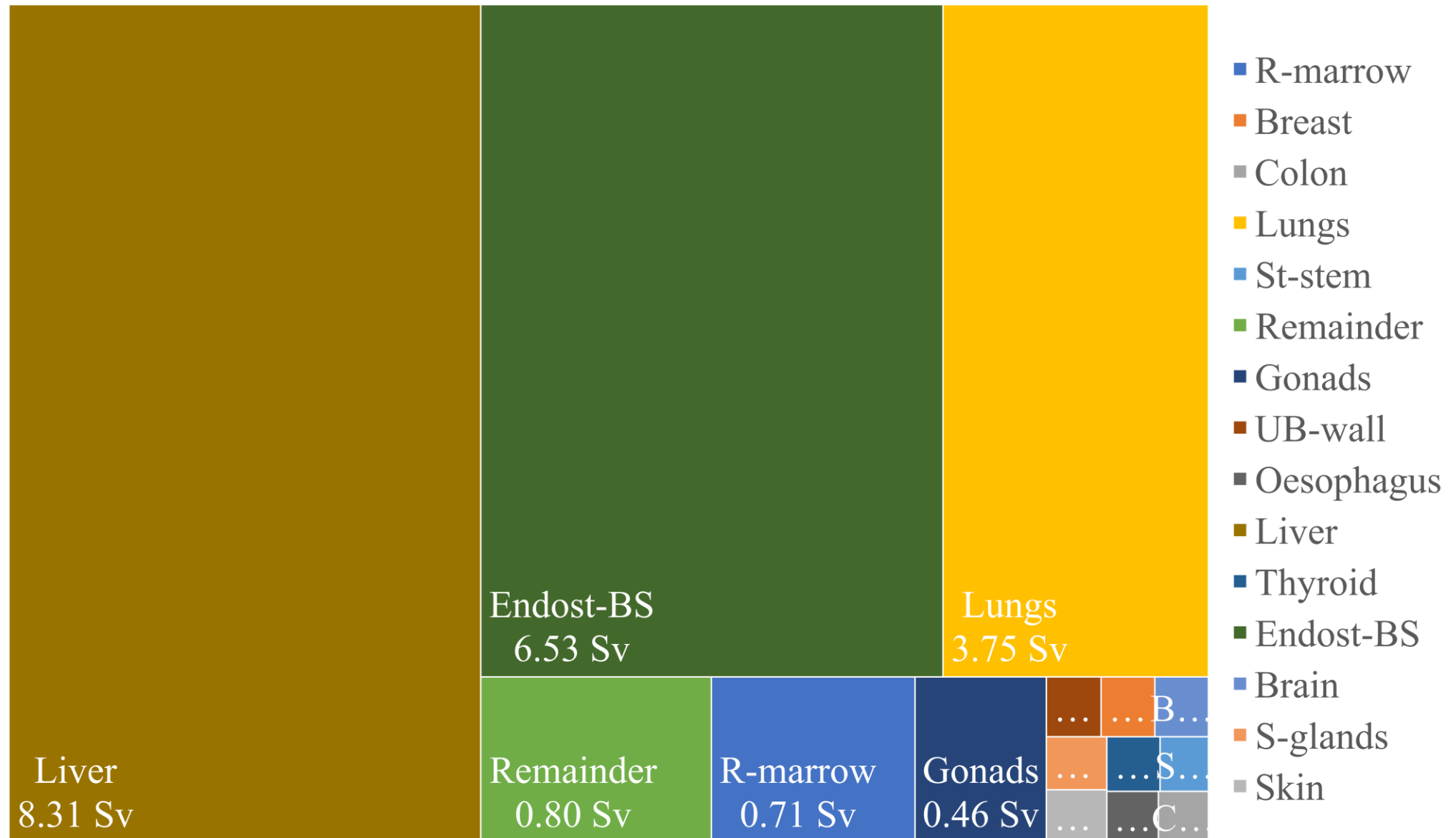


# Results: Plutonium Organ Distribution over Time





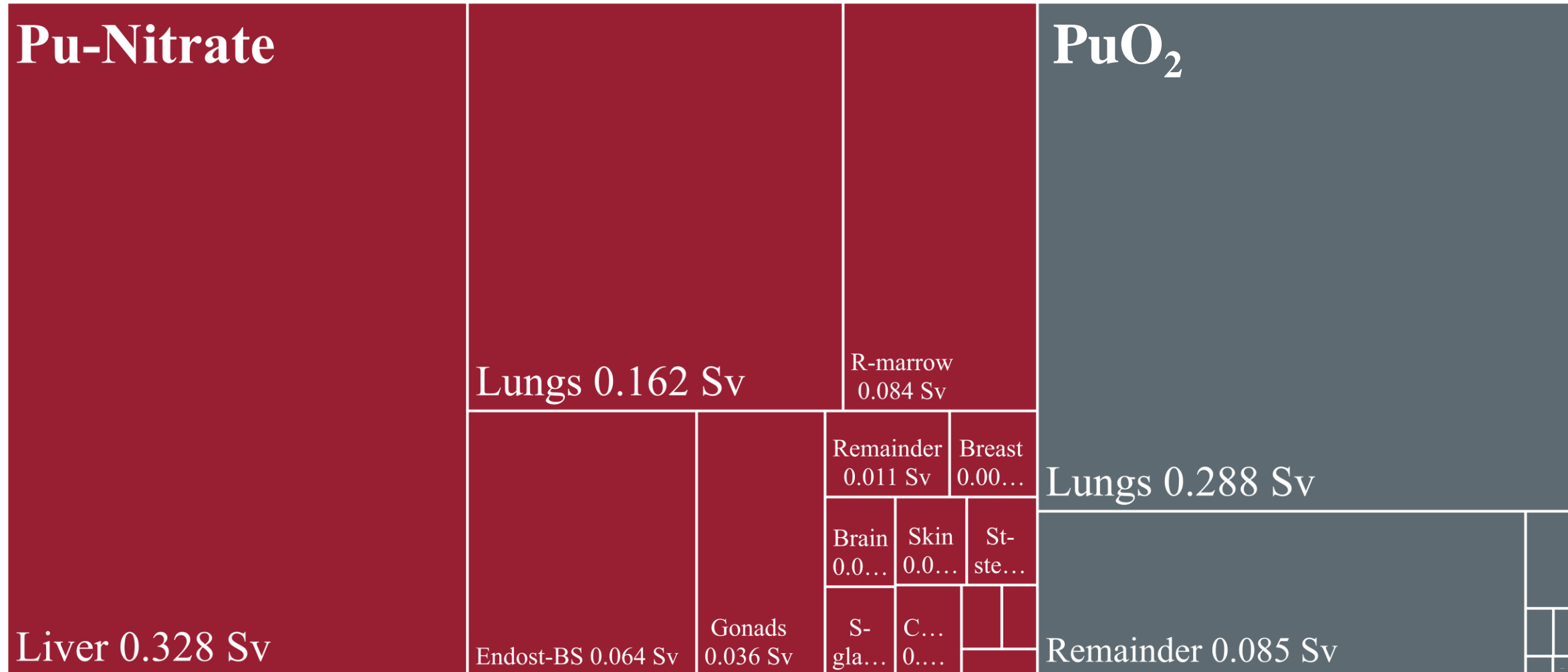
# Results: Organ Equivalent Doses





# Results: Organ Contributions to Effective Dose

- Committed effective dose: 1.22 Sv





## Summary

- ICRP reference biokinetic models adequately described the long-term plutonium retention and excretion for this individual
- Chronic inhalation of 78% Pu-Nitrate and 22% PuO<sub>2</sub>
- 53 years post intake total body activity: 1,765 Bq
- Total body distribution: systemic organs 84%, respiratory tract 16%
- Systemic distribution: skeleton 47%, liver 45%, other 8%

Šefl, M, Avtandilashvili, M, Tolmachev, SY. Inhalation of Soluble Plutonium: 53-year Follow-up of Manhattan Project Worker, Health Physics 2021:120(6); 661-670.





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# Thank you!

