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From Autopsies to Synchrotrons to Mars
- Why the Brain Matters -

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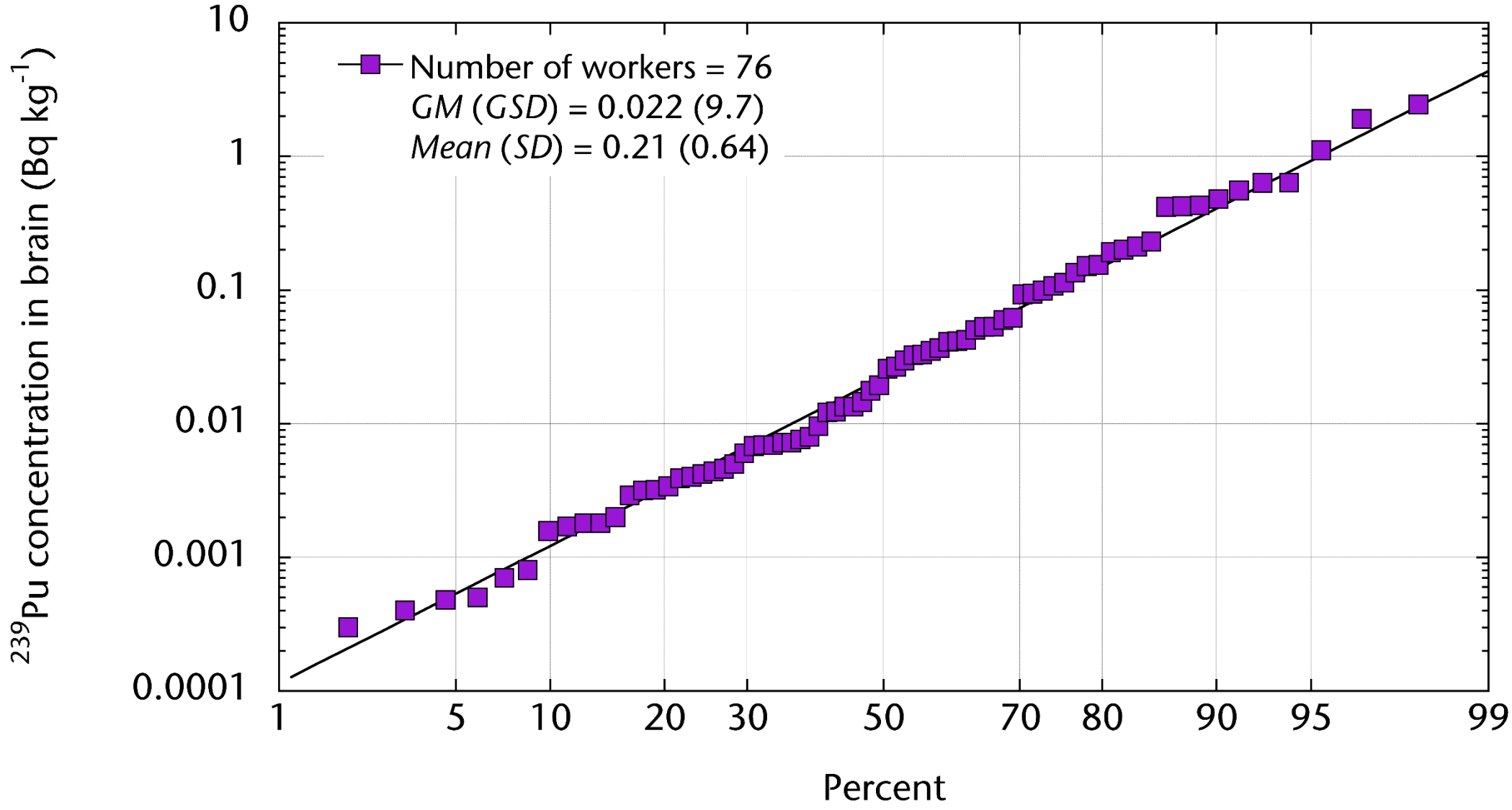
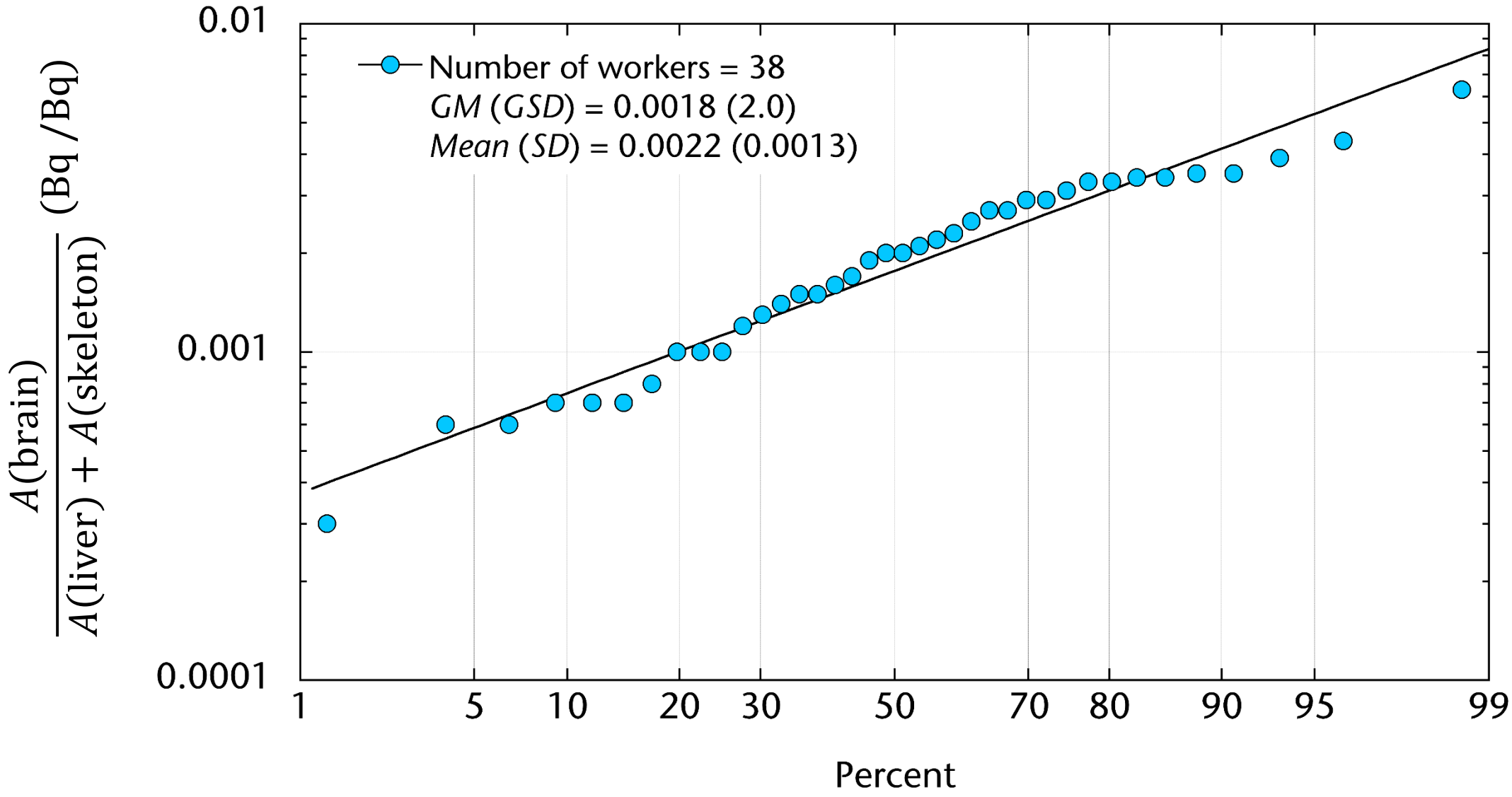
Growing Interest in Brain Dosimetry for Internal Emitters

- **U.S. Million Worker Study**: estimating brain doses and evaluating dementia, Alzheimer's, and other motor neuron diseases as possible adverse effects of radionuclide depositions in the brain
- **National Aeronautics and Space Administration**: interested in adverse effects of alpha dose on brain as a limited but perhaps informative analogy of behavioral and cognitive effects of galactic cosmic ray (high Z and high energy ions) exposure on astronauts
- **NCRP Scientific Committee 6-12**: Development of Models for Brain Dosimetry for Internally Deposited Radionuclides (2018 – 2020)

US Transuranium and Uranium Registries: Plutonium in Brain of Occupationally Exposed Individuals



Plutonium: How Much is in the Brain?



Distribution of Plutonium and Radium in Brain

The Bionanoprobe: Synchrotron-based Hard X-ray Fluorescence Microscopy for 2D/3D Trace Element Mapping

Si Chen[1,*], **Tatjana Paunesku**[2], **Ye Yuan**[2], **Qiaoling Jin**[3], **Benjamin Hornberger**[4], **Claus Flachenecker**[4], **Barry Lai**[1], **Keith Brister**[5], **Chris Jacobsen**[1,3,4,6], **Gayle Woloschak**[2], and **Stefan Vogt**[1,3]

Micros Today. 2015 May ; 23(3): 26–29.

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USTUR Case 0785

- Dumit *et al*. Health Physics 117: 156-167; 2019
- ^{239}Pu in brain = 1.9 ± 0.1 Bq kg^{-1}

Brain stem
Hippocampus (R)

Cortex (L)
Hippocampus (L)

Thalamus

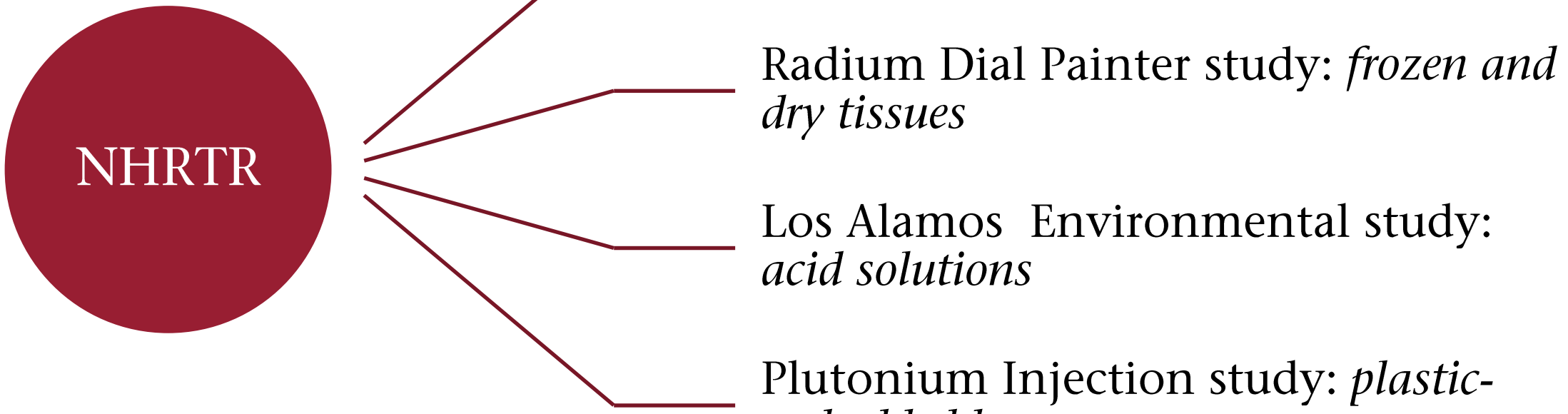
Internal
left capsule

Occipital

Parietal
Cortex (R)

Cerebellum

National Human Radiobiology Tissue Repository (NHRTR) at the US Transuranium and Uranium Registries (USTUR)



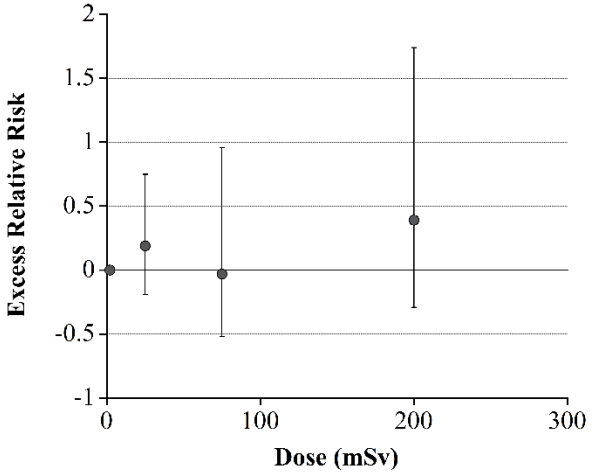
Radium Dial Painter: Case 03-551

Rowland (1993) Radium in Humans – A review of U.S. Studies

- ^{226}Ra intake = 261.7 μCi (μg)
- ^{226}Ra total body activity = 1.077 μCi (μg)

Current Relevance to the Million Person Study (I)

- **Mound Facility (Polonium intake)**: Brain dose from polonium deposition and alpha particle decay estimated for the first time and related to the occurrence of dementia, Alzeihmer's, Parkinson's and other Motor Neuron Disease (e.g. ALS)



Dose (mGy)	N Workers	N Deaths	RR	95% CI
<5	2,662	69	1.0	Ref
5 – <50	1,262	47	1.19	0.81 – 1.75
50 – <100	328	9	0.97	0.48 – 1.96
100+	324	10	1.39	0.71 – 2.74
p for the trend (two sided) 0.06 RR at 100 mGy (95% CI) 1.23 (0.99 – 1.54)				

- **Radium Dial Painter Study (Radium intakes)**: A new follow-up of 2,470 dial painters. Radium dose to brain, red bone marrow and lung will be assessed and incorporated into the new biokinetic models for the epidemiologic study

Current Relevance to the Million Person Study (II)

- **Rocky Flats Facility (Plutonium intakes):** Autopsy material is being used by Oak Ridge National Laboratory to assist in understanding the bioassay data (urine samples, chest counts) of over 700 workers with relatively high intakes of ^{239}Pu for accurate organ dose assessment
- The distribution of **beryllium**, a potential confounder, is to be examined for several autopsy cases and contrasted with radiation dose
- **Brain doses also have been estimated for workers at:** Los Alamos National Laboratory (^{238}Pu, ^{239}Pu), Malinckrodt Chemical Works (radium, uranium), Rocketdyne (uranium, plutonium, other) and will be for the Savannah River (plutonium) and Hanford (plutonium) sites

To Advance Knowledge the Future is the Integration of Biology (and Chemistry and Physics) with Epidemiology

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