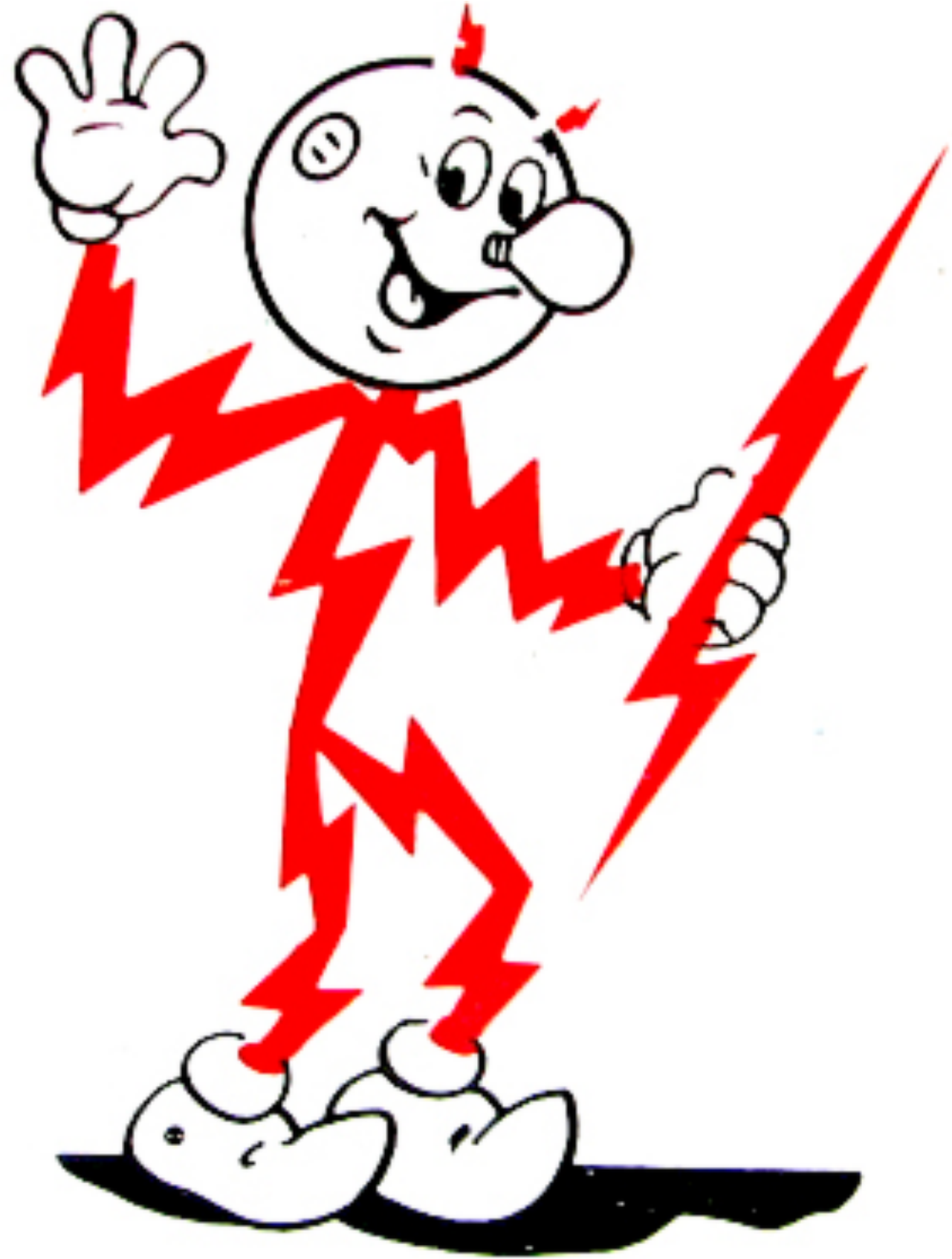


8 Radiophobia



Fission is in Fashion

Fear sells

Fission power safest

Metabolism

DNA, cellular repair

Evidence, ignored by authorities

Deadly evacuations unnecessary

Radiophobia policy, NRC, EPA

Educational video, book

Confounders, controls, p-hunting

Unfounded radiation fear is the ignored elephant in the room.



New York Times prints radiation scares. We Are Giving Ourselves Cancer

By RITA F. REDBERG and REBECCA SMITH-BINDMAN JAN. 30, 2014

“a 2009 study from the National Cancer Institute estimates that CT scans conducted in 2007 will cause a projected 29,000 excess cancer cases and **14,500 excess deaths** over the lifetime of those exposed.”



New York Times ignores the evidence.

Nghi Phan 2011 PhD thesis

BIOLOGICAL EFFECTS AND CANCER RISK OF COMPUTED TOMOGRAPHY

Results from this research found that low-dose diagnostic CT scans do not increase risk and can, in fact, induce protective effects. ...

...CT scans can increase longevity and reduce cancer risk

Radiation dose is the energy transferred to body tissue.



Example dose

X-ray mammography

2 mSv (millisievert)

= 0.002 Sievert

= 0.002 Gray (for X-rays)

= 0.002 joule per kilogram

= 0.002 watt-second per kg

Natural background radiation dose rates are 1-10 mSv/year.

Sources

Radon

Cosmic rays

Food

Granite

Places

Ave dose rate

US

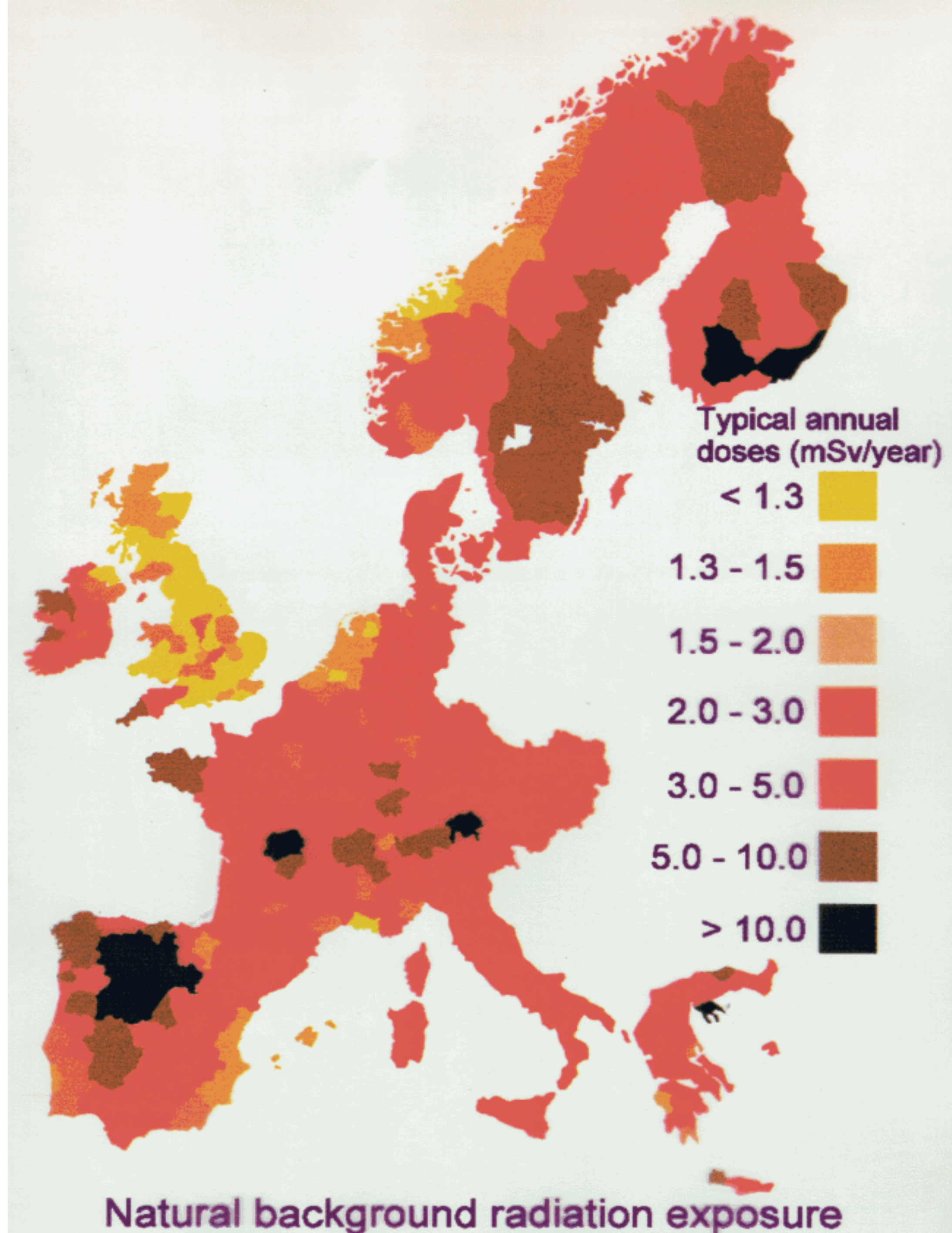
3 mSv/y

Denver

4

Finland

7





Guarapari, Brazil

Radiation 45-175 mSv/a

Known locally as "Health City"

Tourists visit for "medicinal sands"



Ramsar, Iran

Radiation 250-260 mSv/a

Hot springs known as "health spas"

Low rates of lung cancer



Yangjiang, China

Radiation 5-6 mSv/a

City of 2,500,000

Lower than average rates of cancer



Cornwall, England

Radiation 6-8 mSv/a

Hotspot for holidays and surfing

Known for pasties and clotted cream



Kollam, India

Radiation 20-35 mSv/a

Occupied since ancient times

Population 45,000



Chernobyl, Ukraine

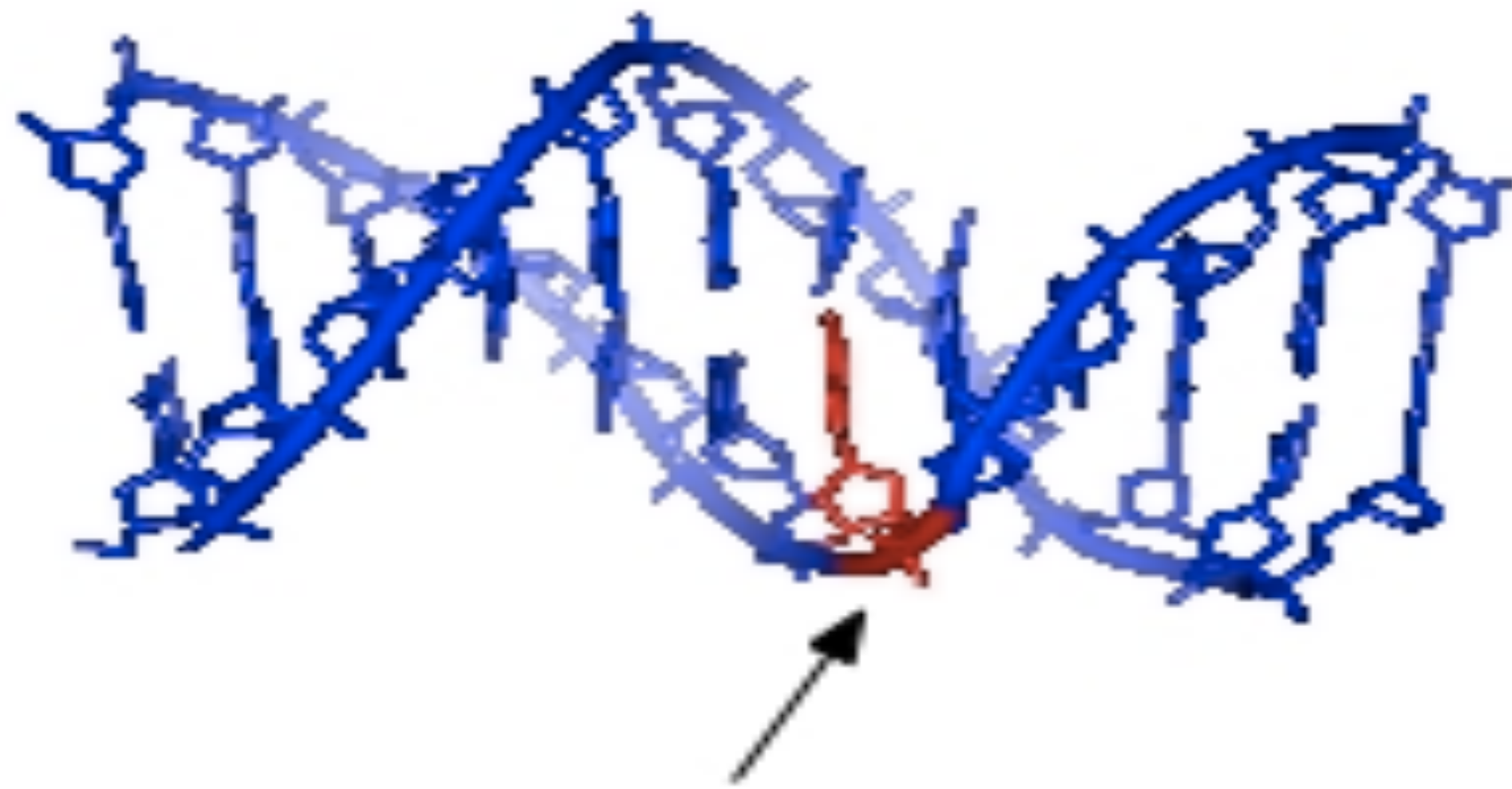
Radiation 2-8 mSv/a

"Dangerous and toxic wasteland"

"Uninhabitable for centuries"

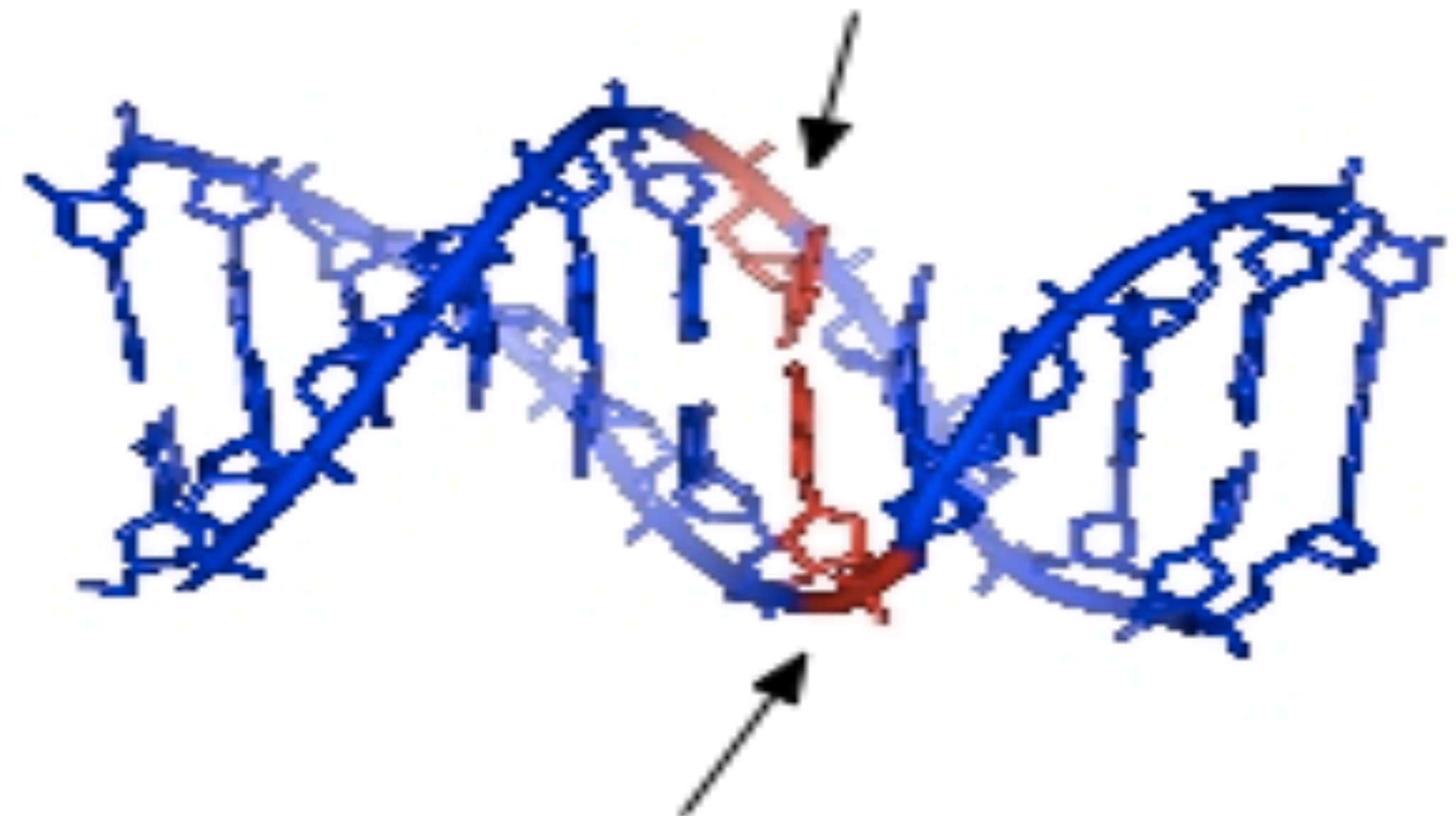
Population 500

DNA strand breaks occur frequently, by ionized oxygen molecules from metabolism.



Single strand breaks occur **10,000 times per day per cell.**

100 mSv/y radiation adds 12 per day.

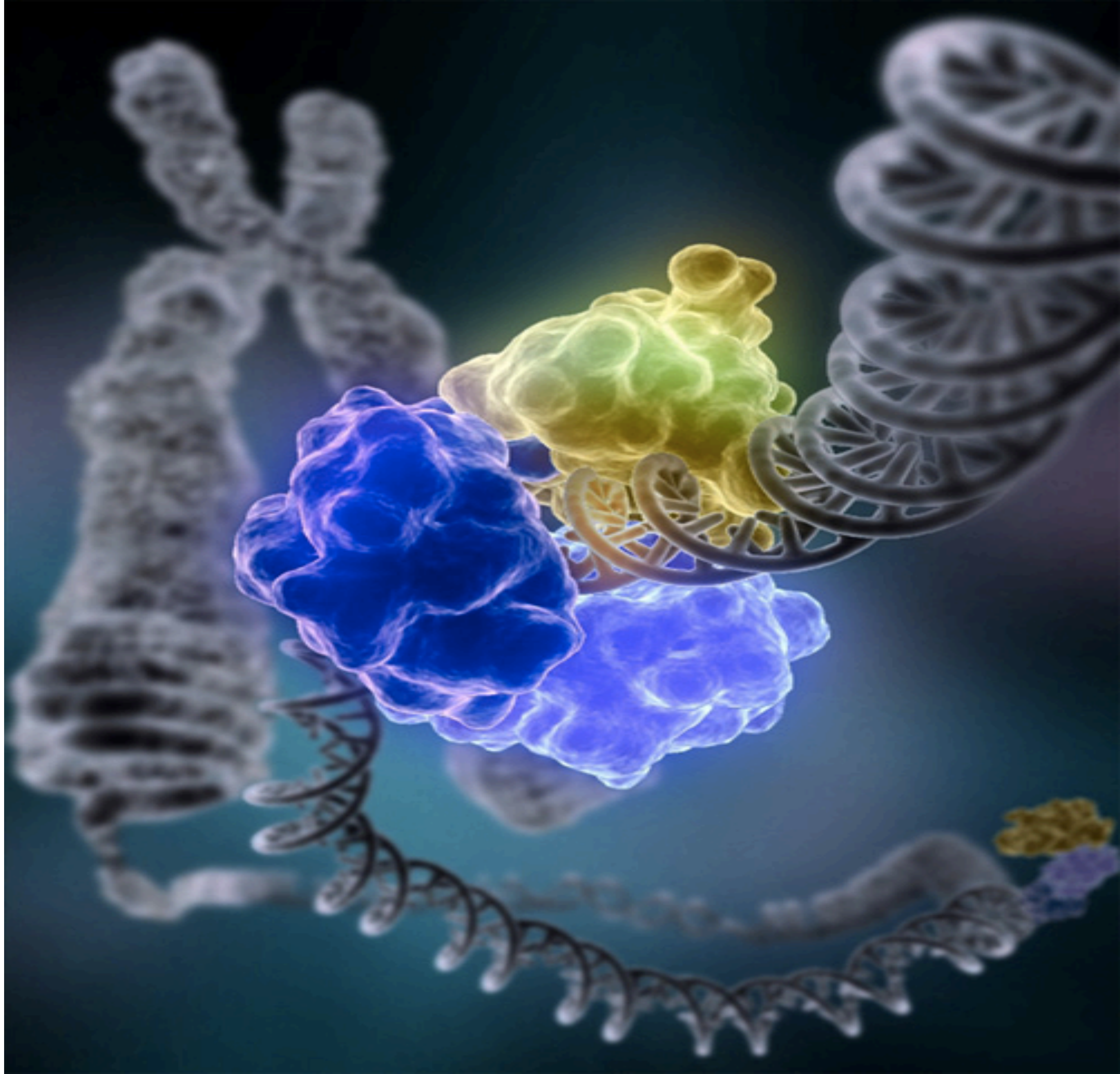


Double strand breaks occur **10 times per day per cell.**

100 mSv/y radiation adds 1 per year.

DNA is repaired.

Special enzyme DNA ligase encircles the double helix to repair a broken strand of DNA.



2015 Nobel Prize: How DNA is repaired.

Nobelpriset i kemi 2015 The Nobel Prize in Chemistry 2015

Nobelpriset i kemi 2015 KUNGL. VETENSKAPS- AKADEMIEN THE ROYAL SWEDISH ACADEMY OF SCIENCES



Tomas Lindahl
Francis Crick Institute and
Clare Hall Laboratory,
Hertfordshire, UK



Paul Modrich
Howard Hughes Medical
Institute and Duke University
School of Medicine, Durham,
NC, USA



Aziz Sancar
University of North Carolina,
Chapel Hill, NC, USA

"för mekanistiska studier av DNA-reparation"
"for mechanistic studies of DNA repair"

Lindahl: excision *repair* — the cellular mechanism that repairs damaged DNA during the cell cycle.

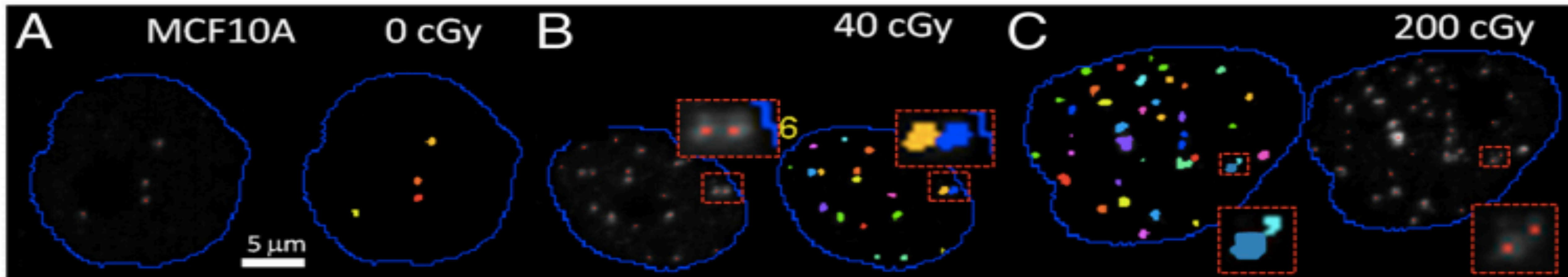
Modrich: how cells *correct errors* that occur when DNA is replicated during cell division.

Sancar: mapping the mechanism cells use to *repair* ultraviolet damage to DNA.

DNA repair times are ~ 1 hour.

Evidence for formation of DNA repair centers and dose-response nonlinearity in human cells

Teresa Neumaier^a, Joel Swenson^{b,c}, Christopher Pham^d, Aris Polyzos^d, Alvin T. Lo^d, PoAn Yang^d, Jane Dyball^d, Aroumougame Asaithamby^e, David J. Chen^e, Mina J. Bissell^{d,1}, Stefan Thalhammer^a, and Sylvain V. Costes^{d,1}

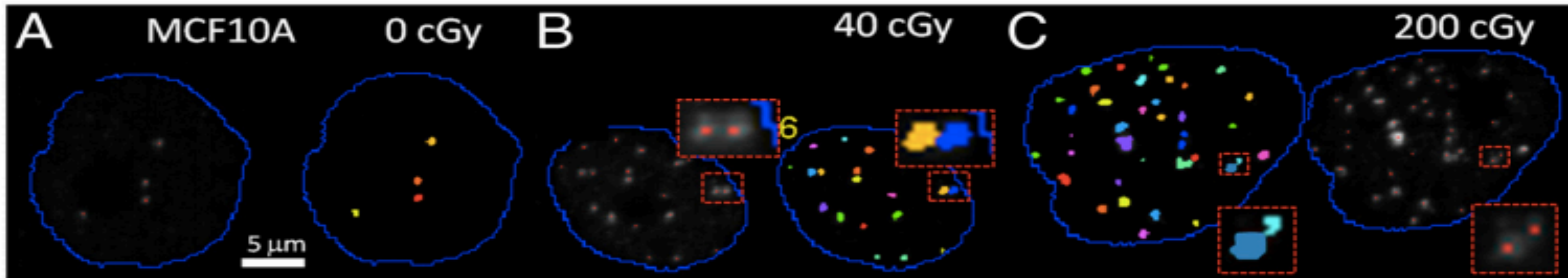


UC Berkeley pictures of DSB repair process

<https://www.pnas.org/doi/10.1073/pnas.1117849108>

- Bright spots are RIF's, Radiation Induced Foci, clusters of damage sensing/repair proteins.
- RIFs are repair centers for Double Strand Breaks (DSBs).

Each RIF can accurately repair ~ 1 DSB.



Observe/expect ~ 25-40 DSBs per Gy.

Study reveals RIF/Gy, repairability, decreases with radiation exposure:

100 mGy: 73 RIF/Gy

1000 mGy: 28 RIF/Gy

@ 100 mGy, get 7.3/4 RIF/Gy, >1, so repairability OK.

@1000 mGy, get 28/40 RIF/Gy, <1, so repair system overwhelmed.

Repairs are nonlinear with dose rate.

Fukushima evacuation killed 2,000 citizens.

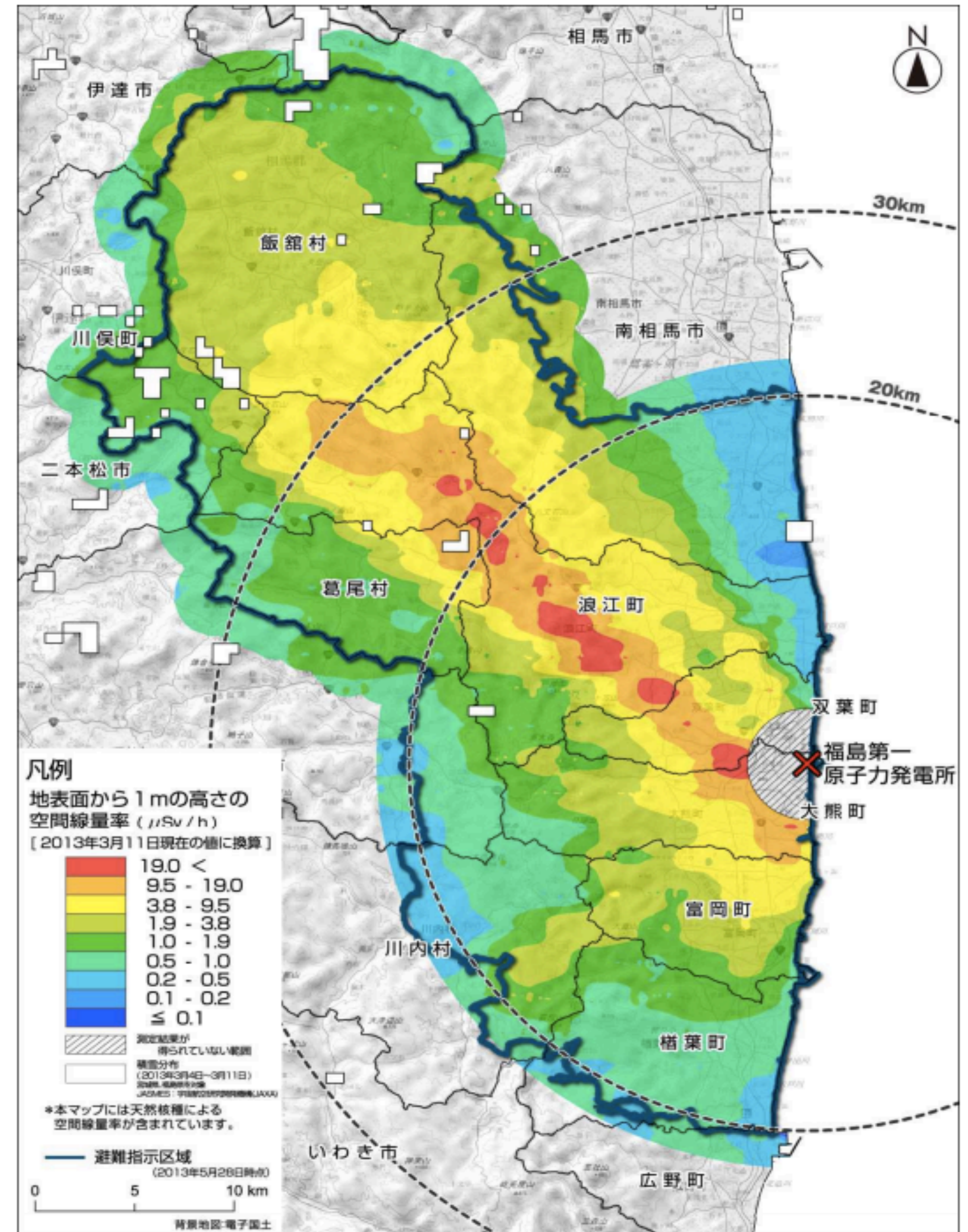
Japan evacuated the black-lined area.

IAEA published recommendation: evacuate the **red** area.

Evacuation was unnecessary anywhere.

No one died from radiation.

20,000 died from the tsunami.



Tritium in Fukushima water release is harmless.

1. Tritium is hydrogen with 2 neutrons.
2. Decays to He-3, releasing electron.
3. Each electron releases: **6,000 eV**, average.
4. Decay half-life: **12 years**.
5. Biological excretion half-life: **10 days**.
6. Cosmic rays make **$15e16$ Bq** per year.
7. Fukushima water: **$1,000,000$ Bq/L x $1e9$ L**
8. Lethal dose: **$8e15$ Bq/kg** (in ~35g mouse).
9. Safe continuous ingestion: **$4,000,000$ Bq/L**.
10. US drinking water limit: **740 Bq/kg**



Tanks storing treated groundwater flowing through destroyed fission power plants at Fukushima

‘No One Died From Radiation At Fukushima’: IAEA Boss Met With Laughter At COP26

“No one died from radiation at Fukushima,” Grossi said, provoking laughter from the audience.

“I don’t know why you’re laughing, it’s a fact. Thousands of people died because of the tsunami but there were no deaths attributable to exposure to radiation. People died also because of the evacuation, it was very traumatic,” he continued.

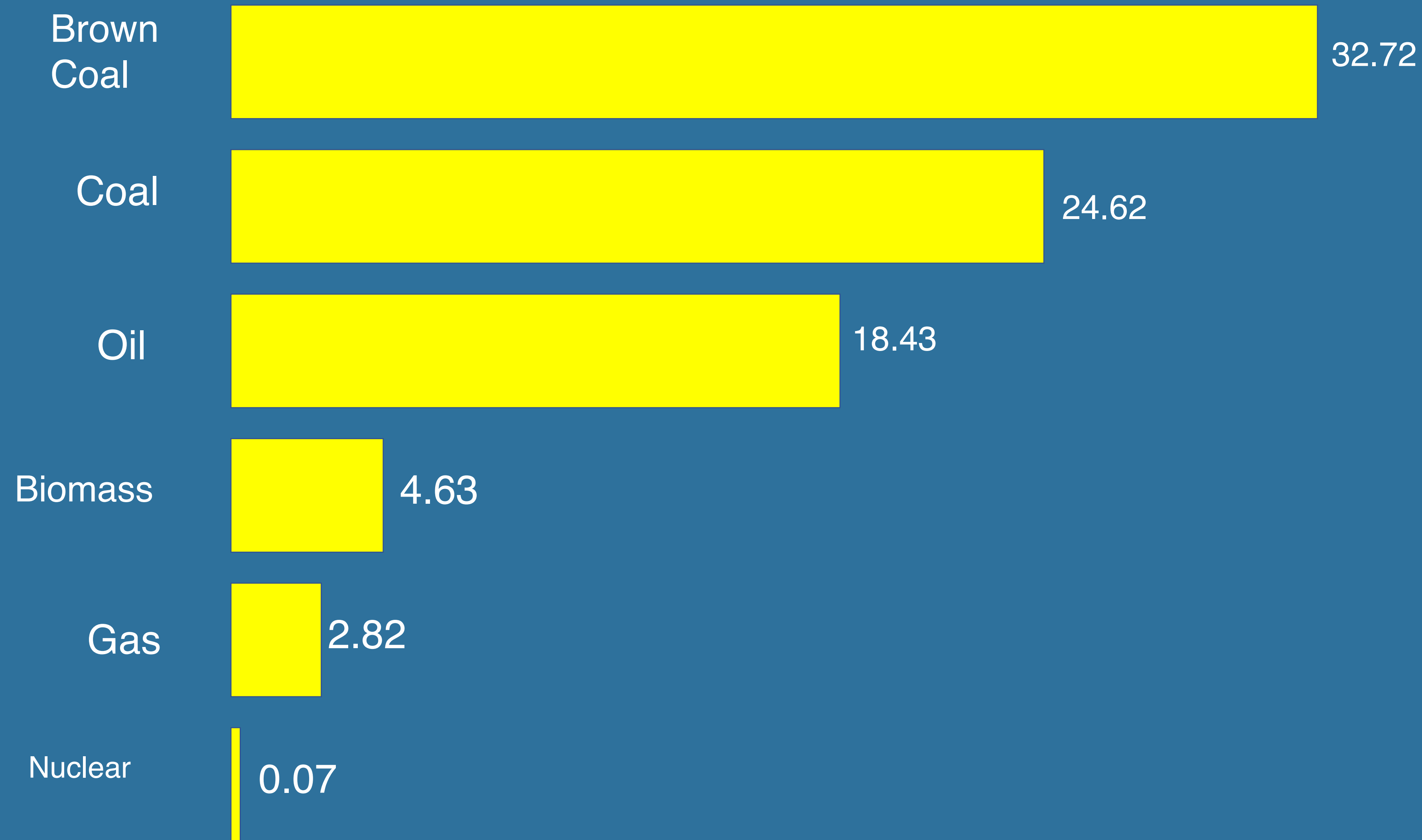
IPCC scientists’ ignorance is appalling.

How Much Radiation Is Too Much?

Regulators have set exposure limits far too low, inspiring irrational fear of a cheap, clean energy source.

...The Dirty Harry atomic bomb test in 1953 dropped **two to three times as much radioactive fallout** on the residents of St. George, Utah, than people near Fukushima were exposed to. There was no evacuation in Utah. People were asked to stay indoors that day; there was **no increase in cancer rates.** ...

Fission power is the safest energy source.



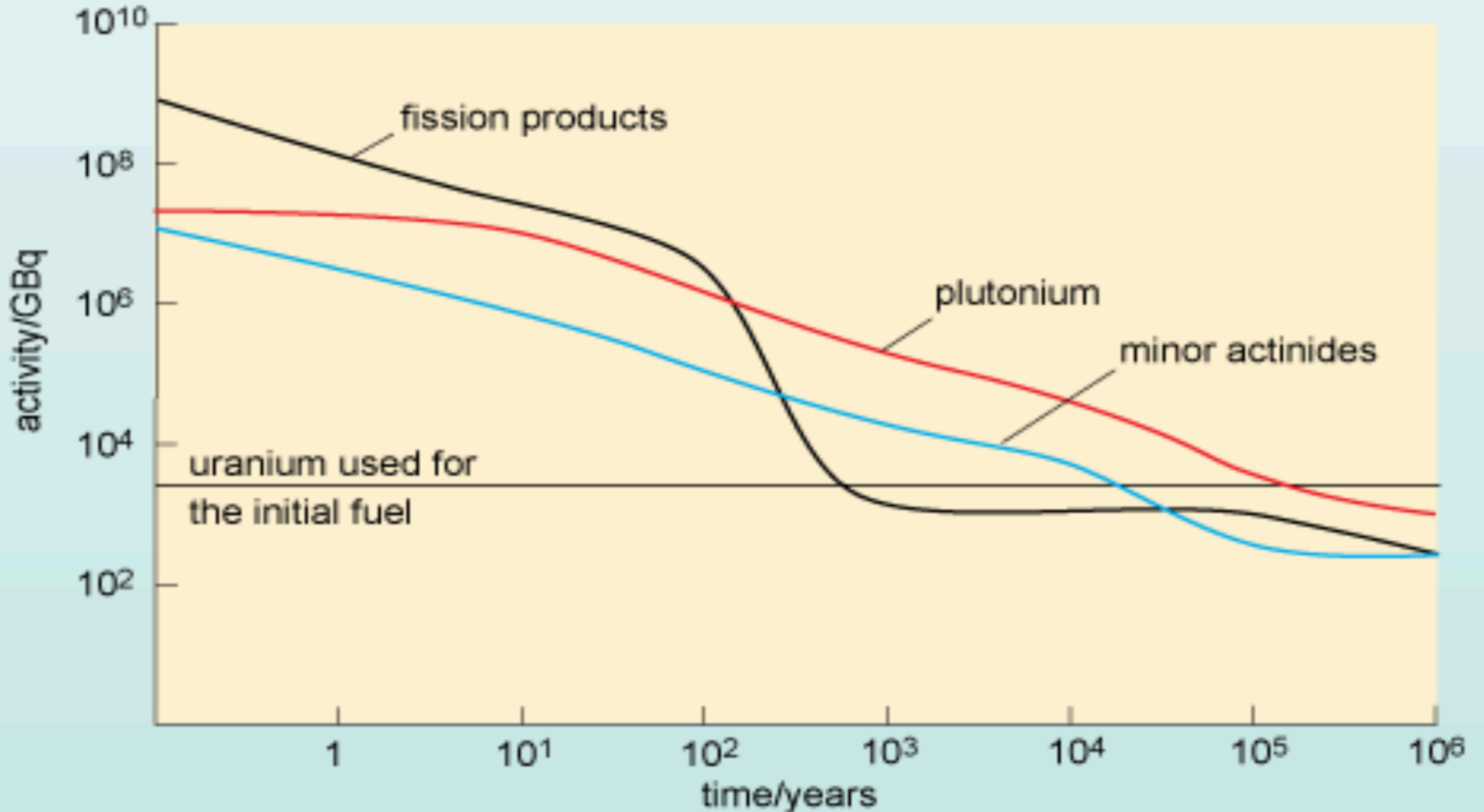
Deaths per thousand gigawatt hours

Small amount of waste is easily stored.

- Dry cask storage for 28 years of 620 MW Connecticut Yankee.
- 80 GW-yrs may be stored in casks on pad for ThorCon fission energy.
- 80 GW-yrs of coal ash on that pad would reach one mile high.
- 80 GW-yrs of end-of-life solar panels on that pad would reach one mile high.



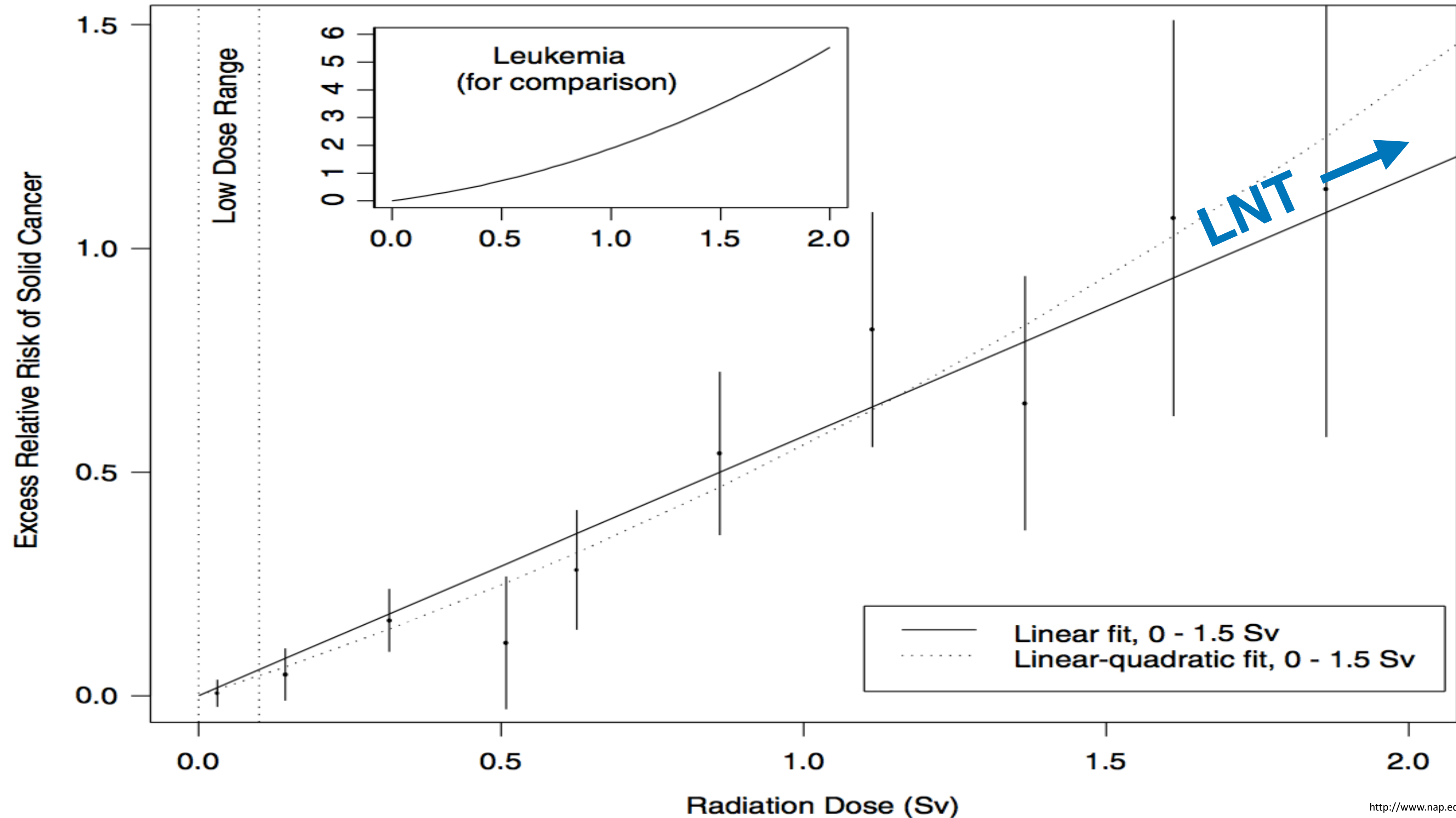
Used fuel radioactivity drops 10,000X in a few hundred years.



Jim Conca: CalTech, NASA, PNNL, WSU, LANL, ANS, Forbes...

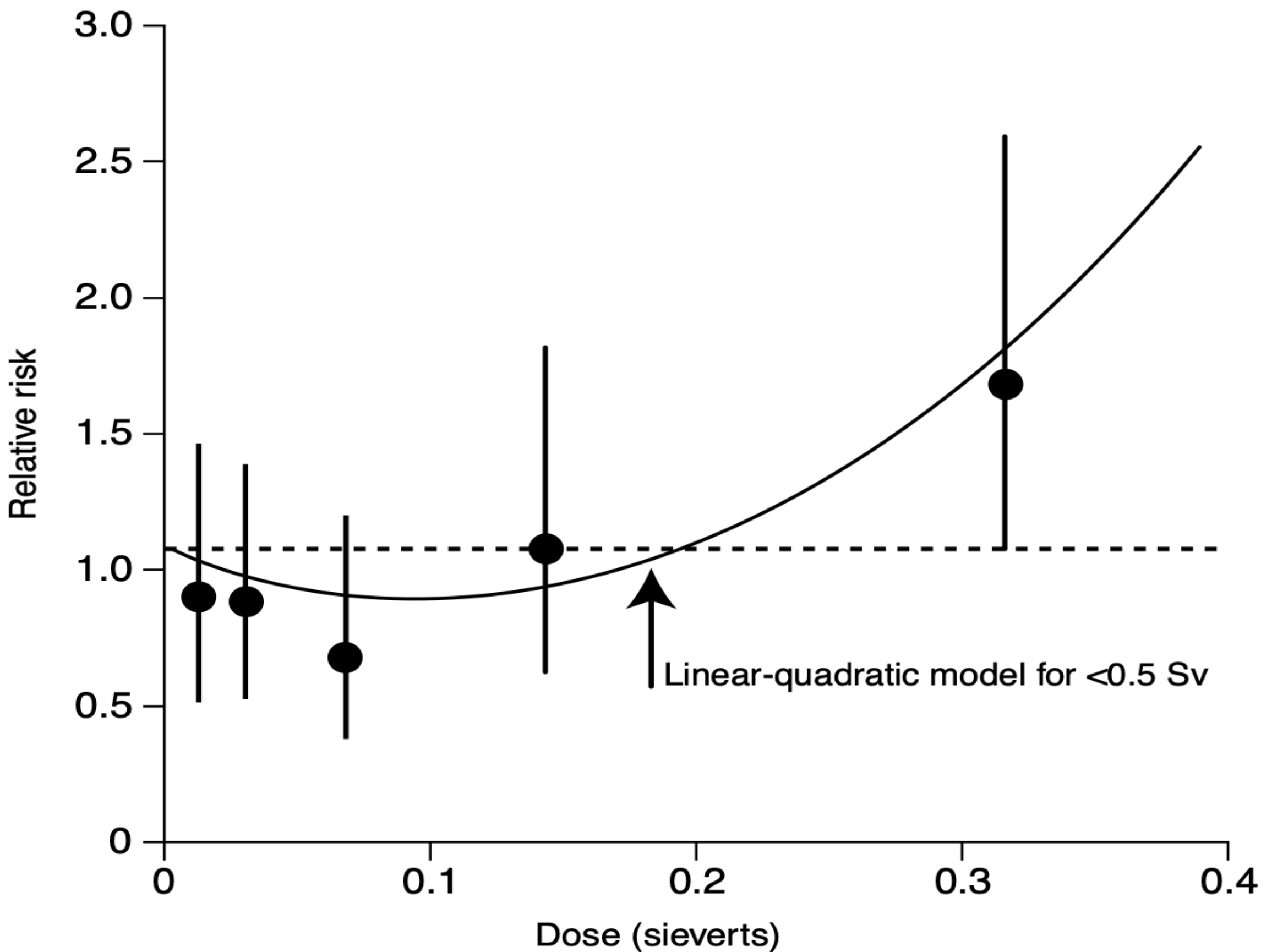


National Academy report said cancer risk is proportional to radiation dose (Linear No Threshold).



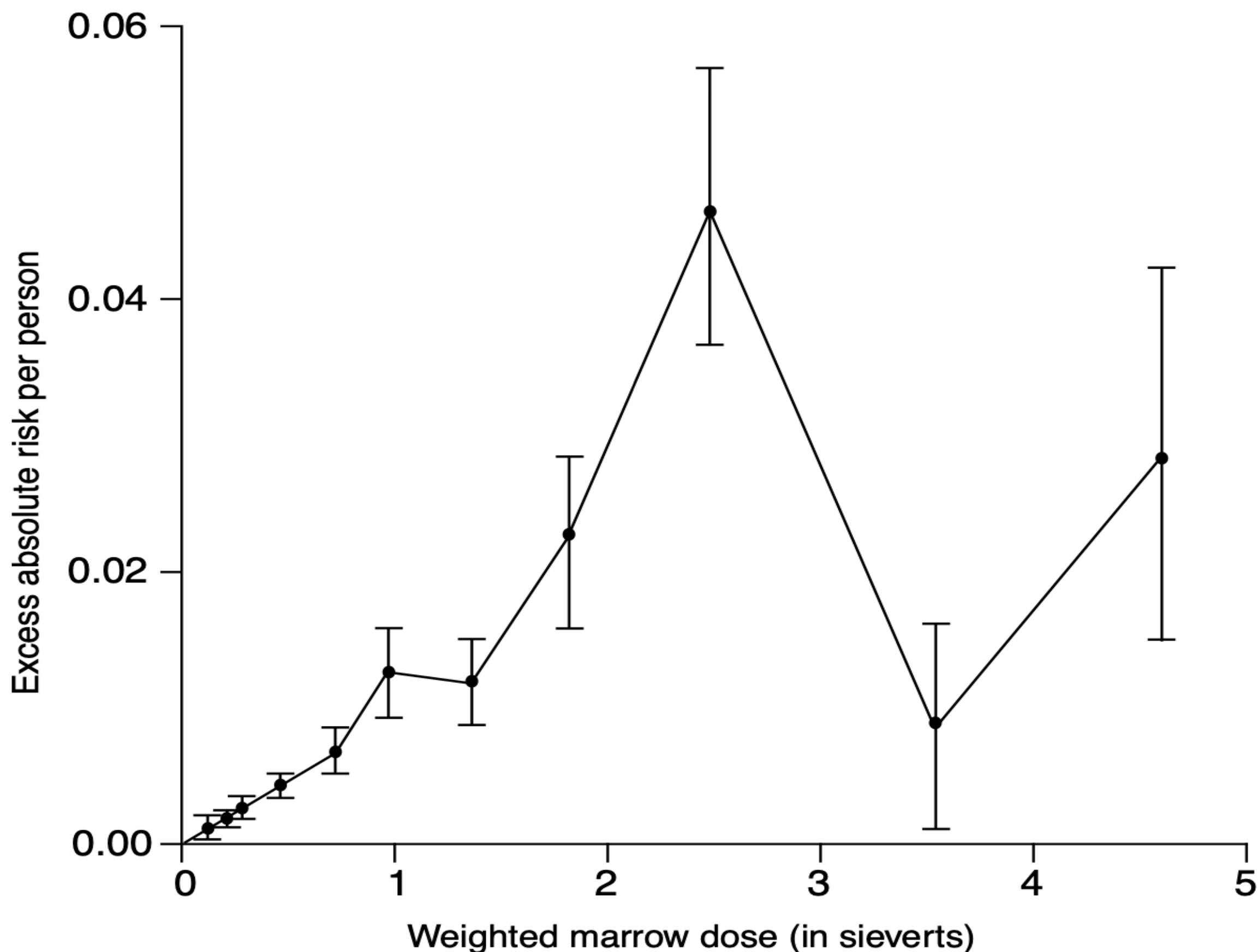
National Council on Radiation Protection hides data.

FIGURE 1a
Mortality from Leukemia in Hiroshima and Nagasaki—Data as Presented by UNSCEAR



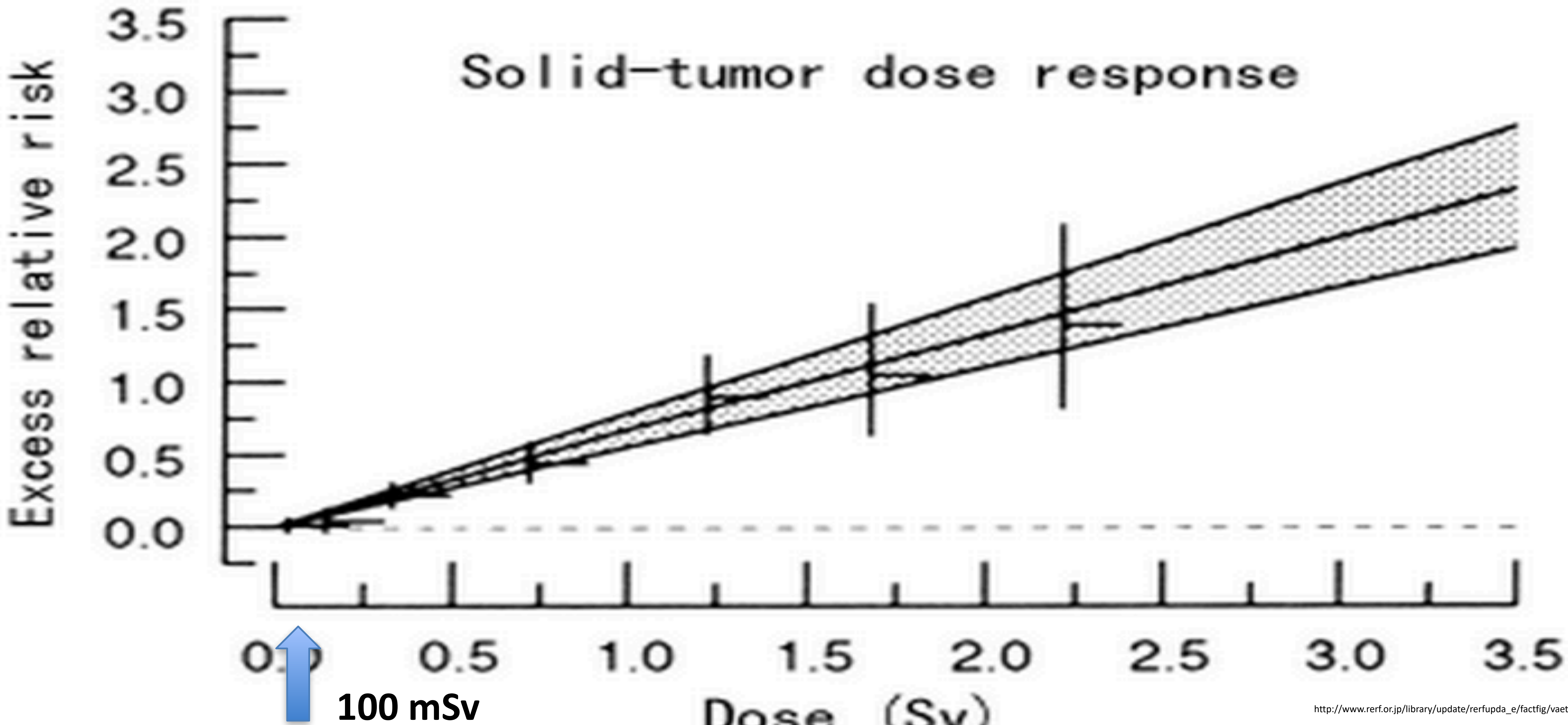
Source: UNSCEAR 1994, p. 257.

FIGURE 1b
Mortality from Leukemia in Hiroshima and Nagasaki—NCRP Version of the Same Data



Source: NCRP Report No. 136, p. 146.

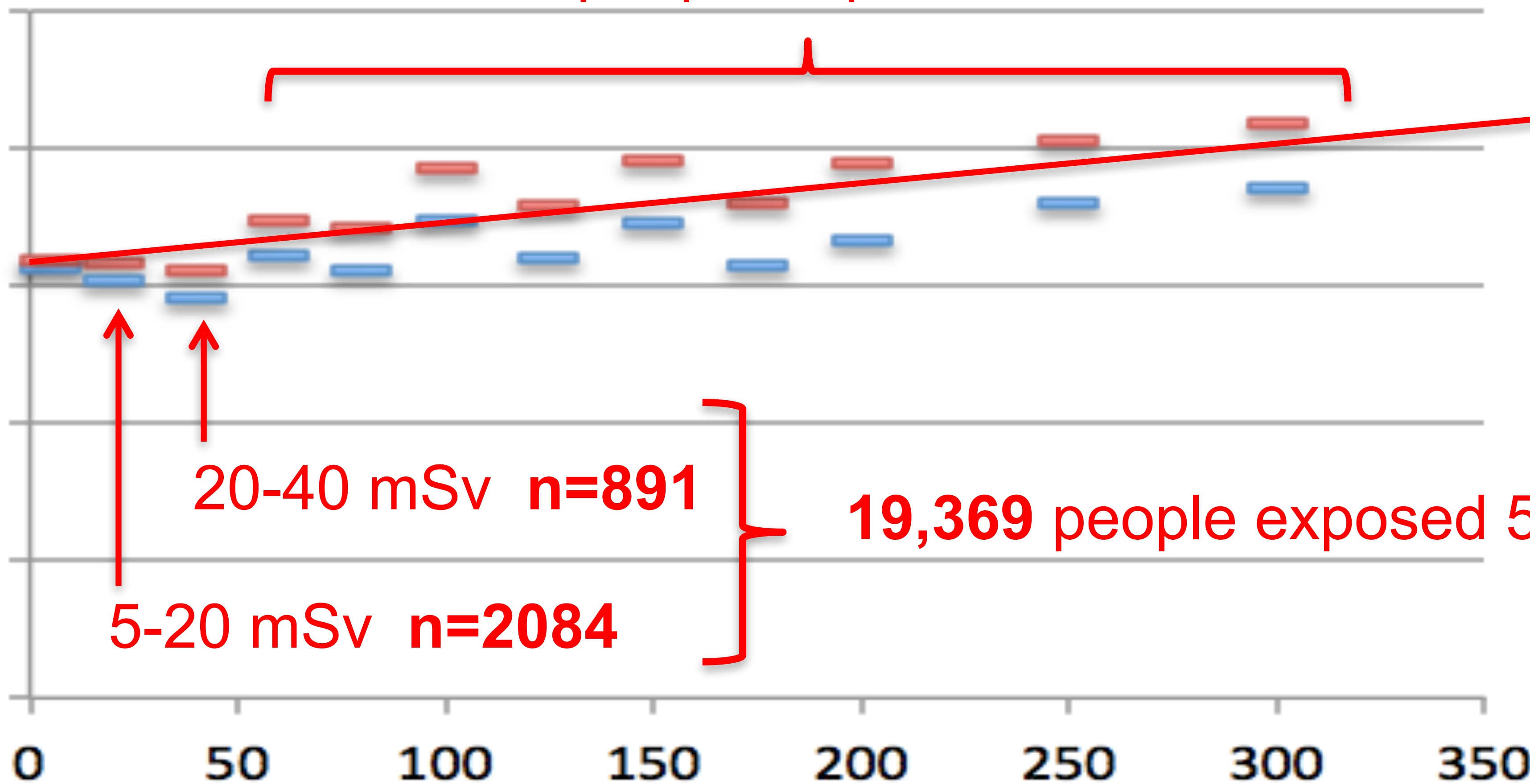
Atomic bomb survivor publications do not show the details of doses < 100 mSv.



Yet the decrease in cancers below 40 mSv dose is significant.

Cancer rate

0.250
0.200
0.150
0.100
0.050
0.000



6,411 people exposed to >40 mSv

20-40 mSv n=891

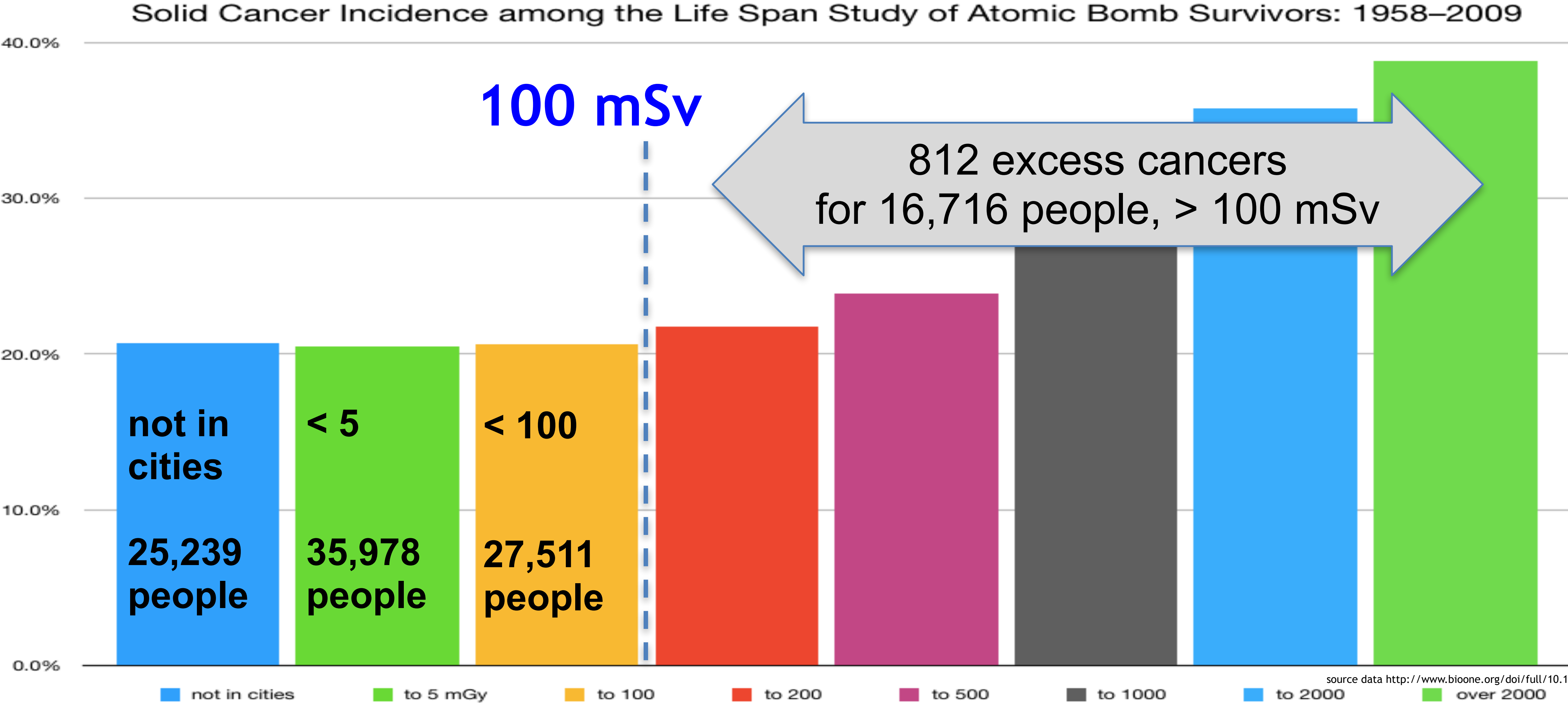
5-20 mSv n=2084

19,369 people exposed 5-40 mSv

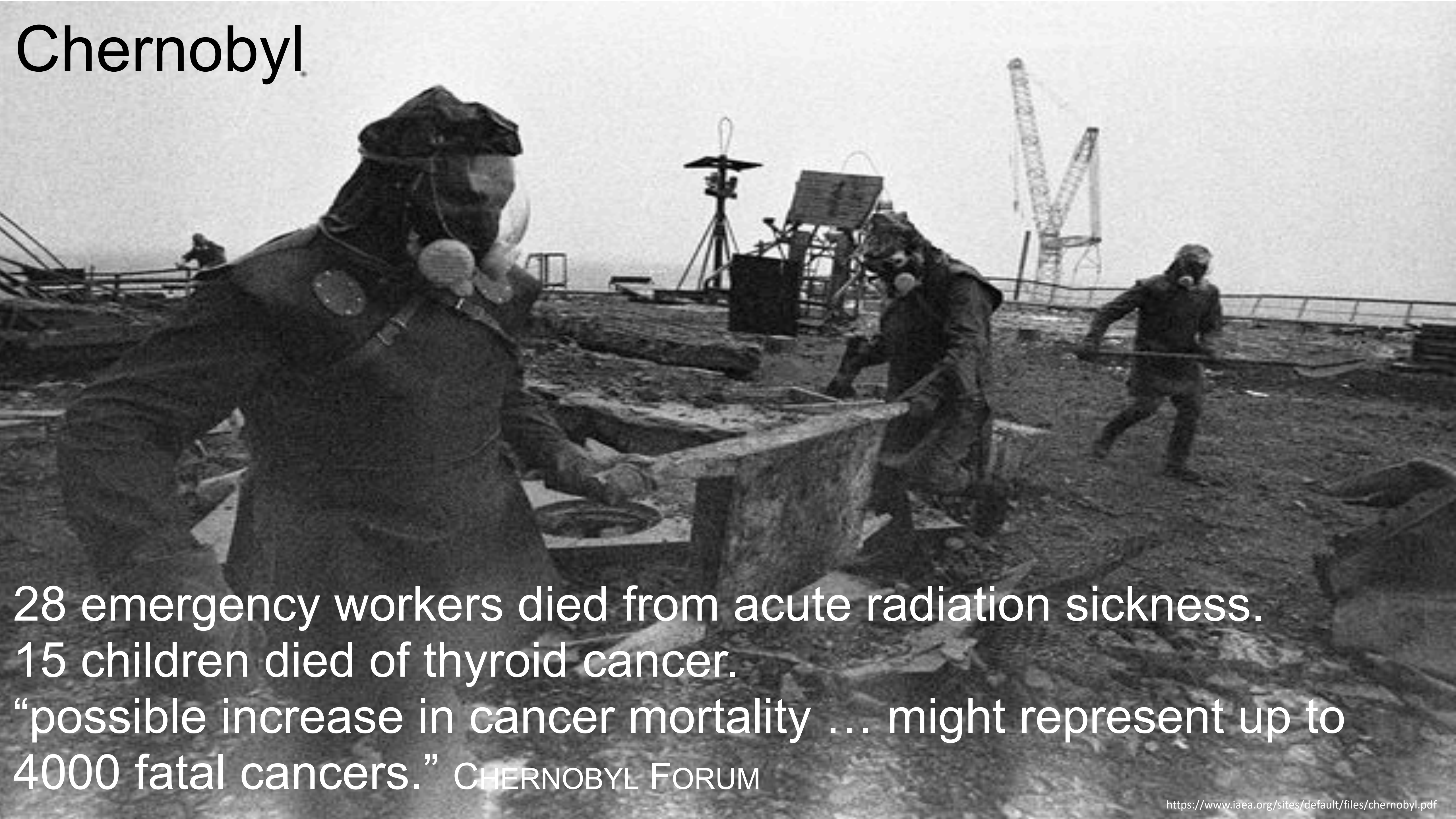
LNT

Radiation exposure (mSv)

Atom bomb survivors exposures < 100 mSv caused no observed excess cancers.



Chernobyl

A black and white photograph showing several workers in full-body protective suits and respirators working at the Chernobyl site. They are positioned around a large concrete structure, possibly a containment vessel. In the background, there are cranes and other industrial equipment under a hazy sky.

28 emergency workers died from acute radiation sickness.
15 children died of thyroid cancer.
“possible increase in cancer mortality ... might represent up to
4000 fatal cancers.” CHERNOBYL FORUM

A rotating X-ray beam focused on cancer tissue delivers up to 80,000 mSv.

To minimize the small risk of causing cancer in nearby tissue

- radiologists divide the radiation dose into fractions
- administered daily rather than all at once

giving healthy tissue time to recover. (3 million therapies/yr)



**If LNT were true,
fractionated radiation
therapy wouldn't work.**

**28,000 nuclear shipyard workers exposed to ~8 mSv
had a 24% lower death rate.**

- **Controls - age-matched
- job-matched**



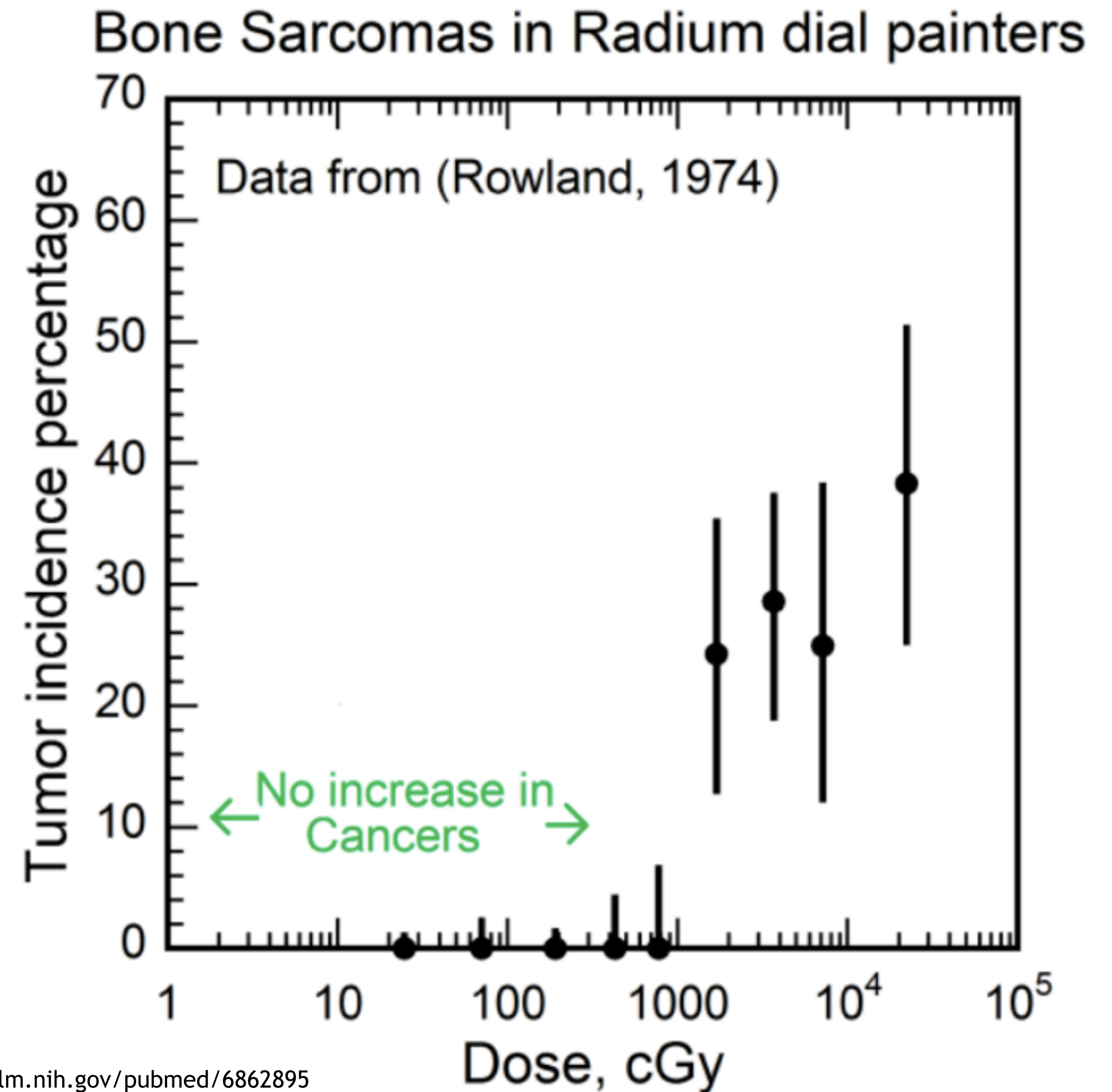
7,271 Taiwan apartment dwellers exposed to ~48 mSv had 55 fewer cancers than 150 predicted by LNT.

<http://www.ncbi.nlm.nih.gov/pubmed/17178625>
<http://taiwan-apt-cancer-data-analysis.blogspot.com/>
<http://www.ncbi.nlm.nih.gov/pubmed/18666807>

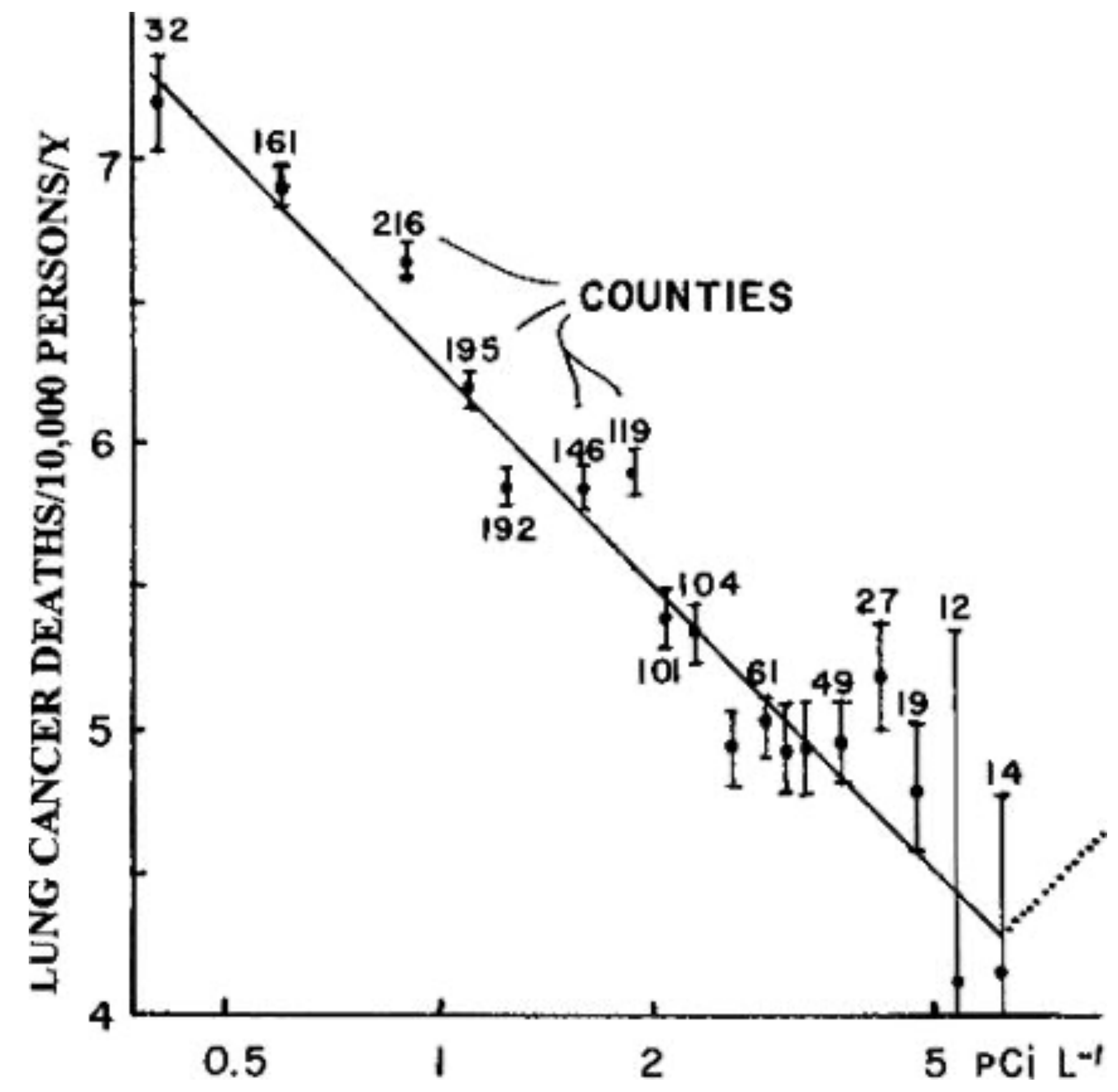
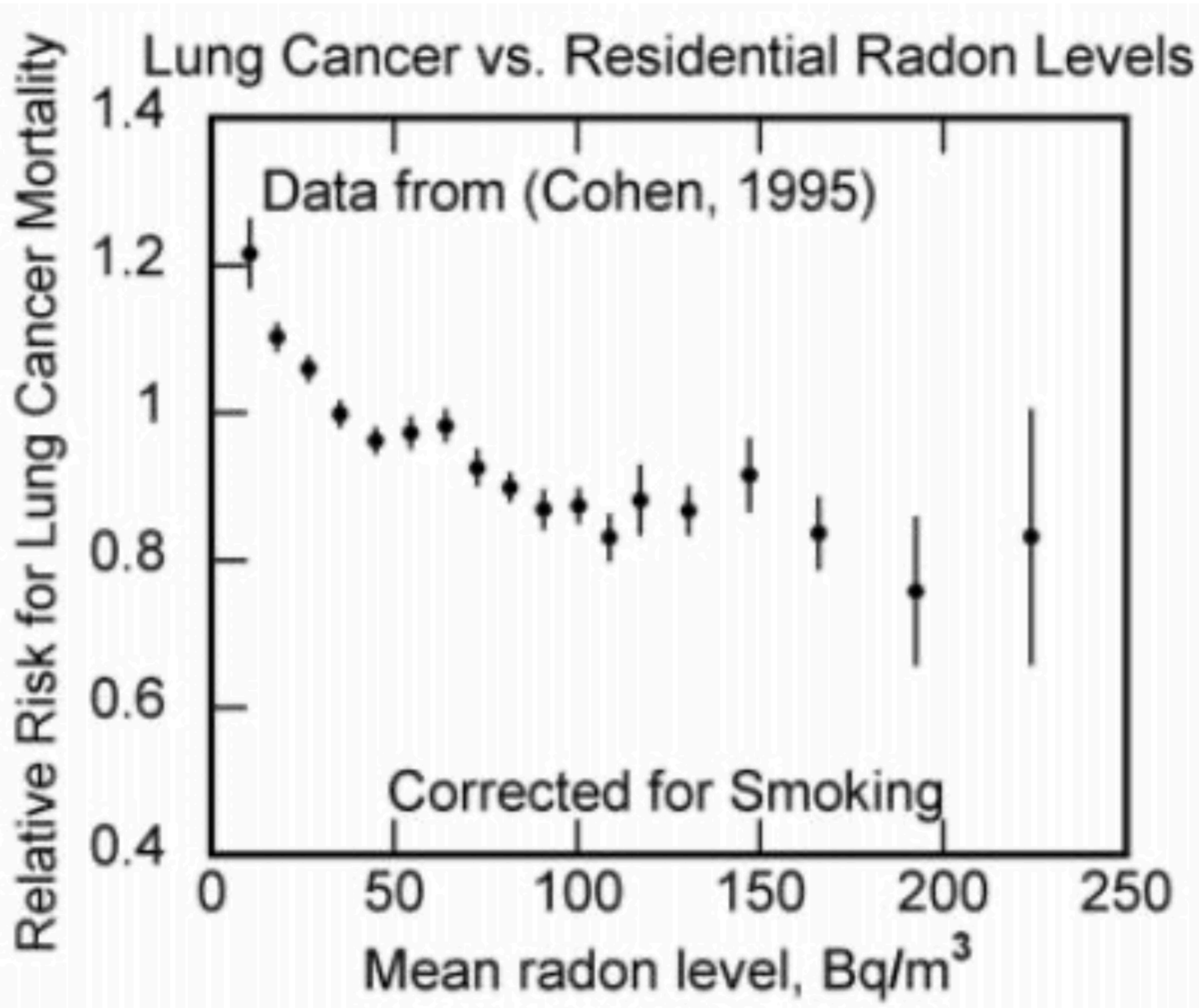
Cancer site	Men			Women			All		
	Observed	Expected	SIR (95% CI)	Observed	Expected	SIR (95% CI)	Observed	Expected	SIR (95% CI)
All cancers	42	53.8	0.8 (0.5, 1.0)	53	60.9	0.9 (0.7, 1.1)	95	114.9	0.8 [†] (0.7, 1.0)
All cancers except Leukemia	36	52.0	0.7 [‡] (0.5, 0.9)	52	59.3	0.9 (0.7, 1.2)	88	111.6	0.8 [‡] (0.6, 0.9)
Solid cancers	32	50.9	0.6 [‡] (0.4, 0.8)	50	58.5	0.9 (0.6, 1.1)	82	109.5	0.7 [‡] (0.6, 0.9)



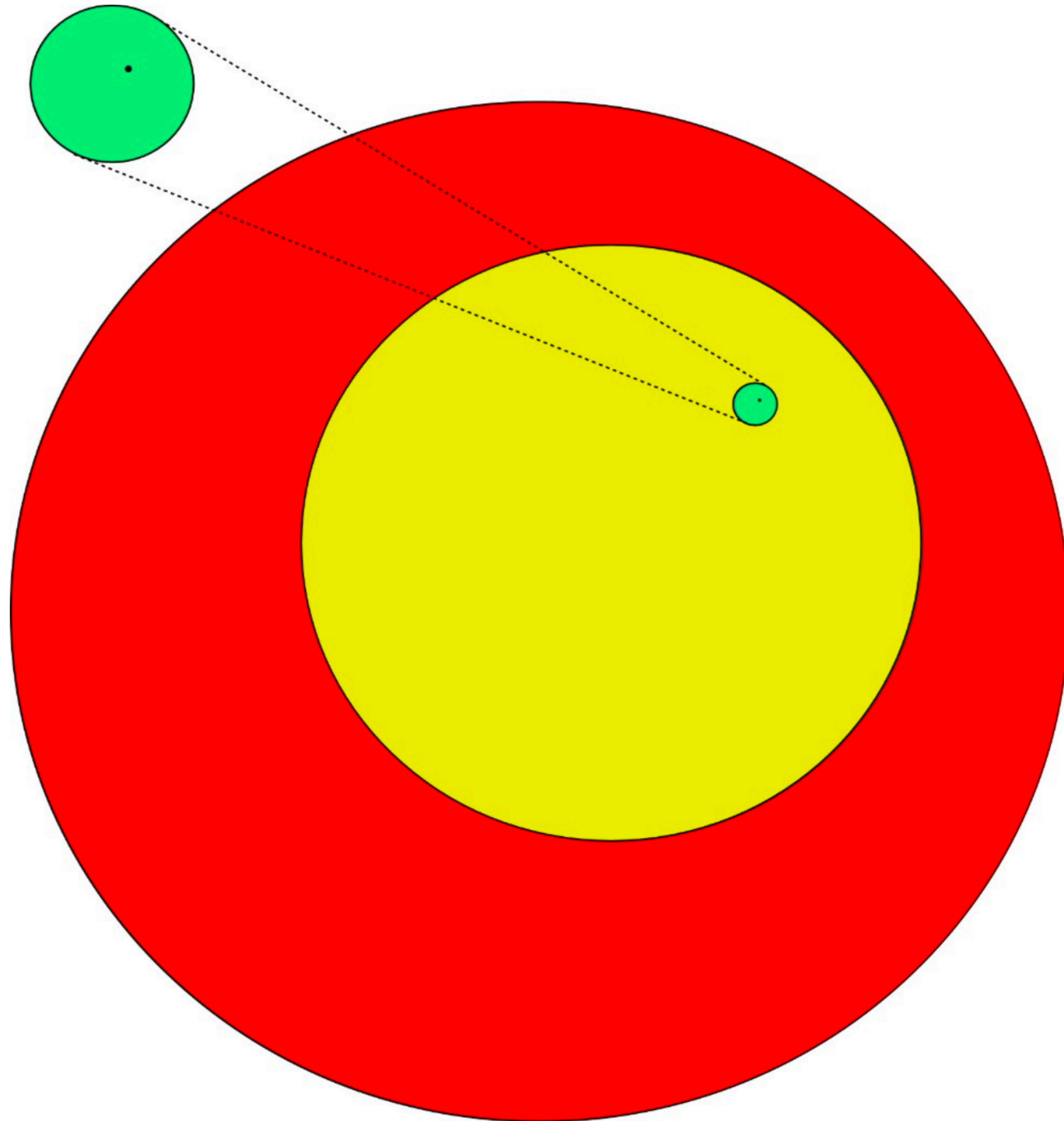
56 radium dial painters' bone sarcomas occurred at a threshold over ~ 10,000 mGy. (1412 unharmed)



Lung cancer rates decrease with increasing residential radon levels.



What radiation exposure is safe? 100 mGy per month



Red: 80,000 mGy/mo
- deadly to cancer tumors

Yellow: 30,000 mGy/mo
- healthy tissue recovers, rarely causing second cancer

Green: 100 mGy/mo
- harmless

Black dot: < 0.08 mGy/mo
- ICRP, EPA, NRC public limit

French Academy of Sciences accepts safe threshold.

At US NRC, policy trumps science. No threshold! ALARA!

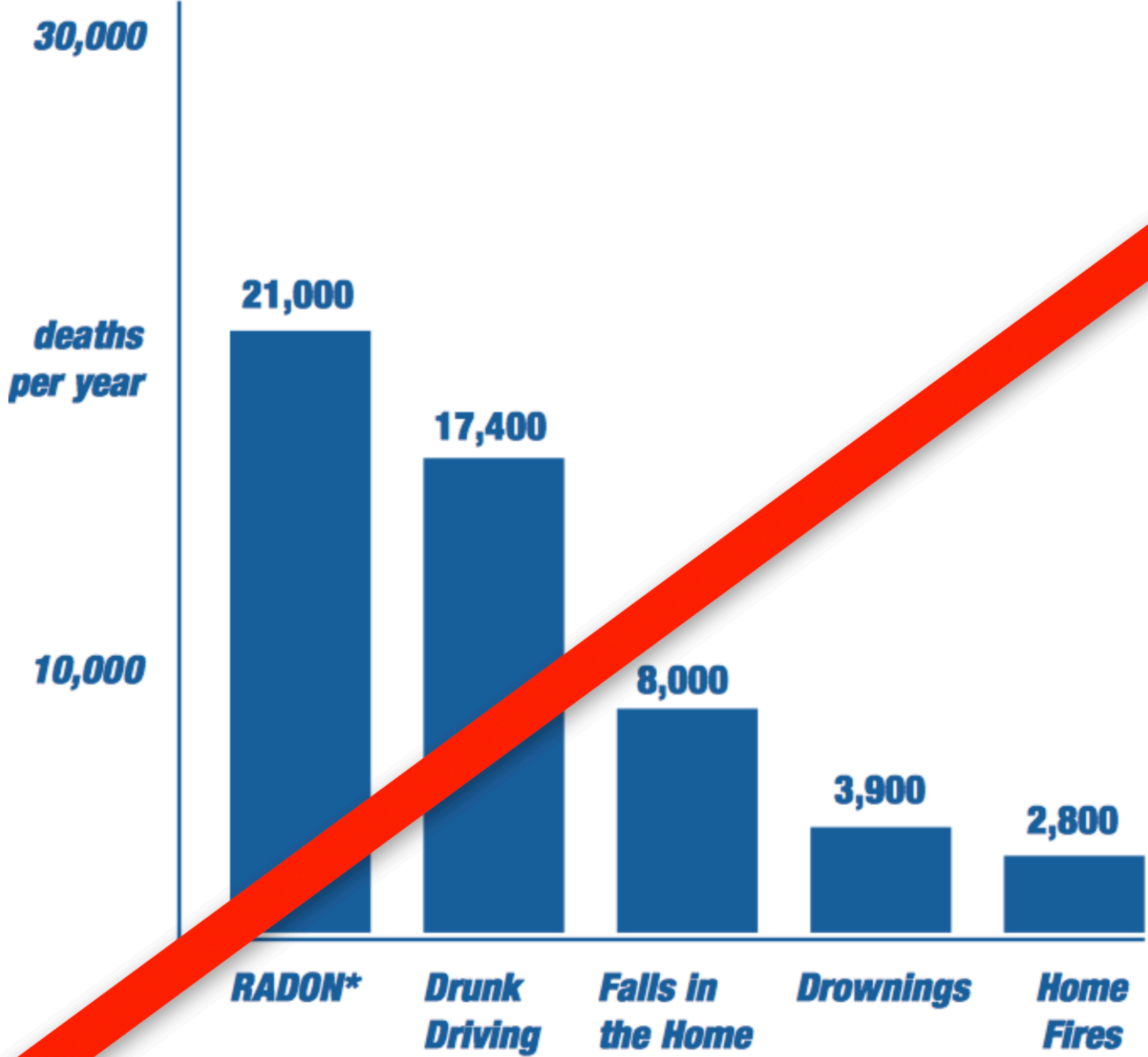
SUBJECT: REPORT OF THE FRENCH ACADEMY OF SCIENCES, “THE DOSE-EFFECT RELATIONSHIP AND ESTIMATING THE CARCINOGENIC EFFECTS OF LOW DOSES OF IONIZING RADIATION”

1. The French Academy of Sciences report focuses on the radiobiological science and does not try to interpret these results in a policy context. In contrast, the BEIR VII report
3. The French Academy report, based on current data, raises doubts about the validity of using the LNT theory to estimate carcinogenic risks at doses less than 10 rem (< 100 mSv) and is even more skeptical of such estimates at doses less than 1 rem (< 10 mSv).



UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, DC 20555 - 0001

Ignoring science, with no observed evidence, EPA claims radon deaths exceed those from drunk driving.



EPA recommends radon testing and remediation if radioactivity exceeds 4 pico-curies per liter of air.
= 0.15 Bq/liter, 20 mSv/yr
1 Bq = 1 decay/sec

Note: humans are naturally slightly radioactive at about 2,700 pico-curies per liter.
= 100 Bq/liter

<https://www.epa.gov/sites/production/files/2015-05/documents/hmbuygud.pdf>

<https://hps.org/publicinformation/ate/q11963.html>

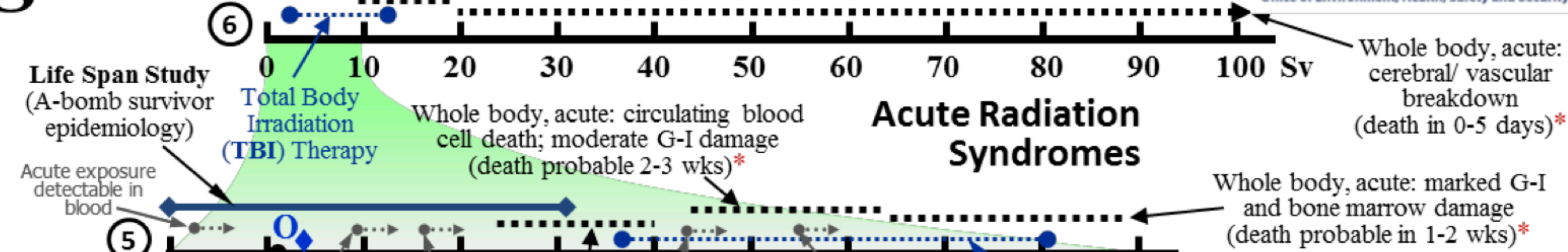
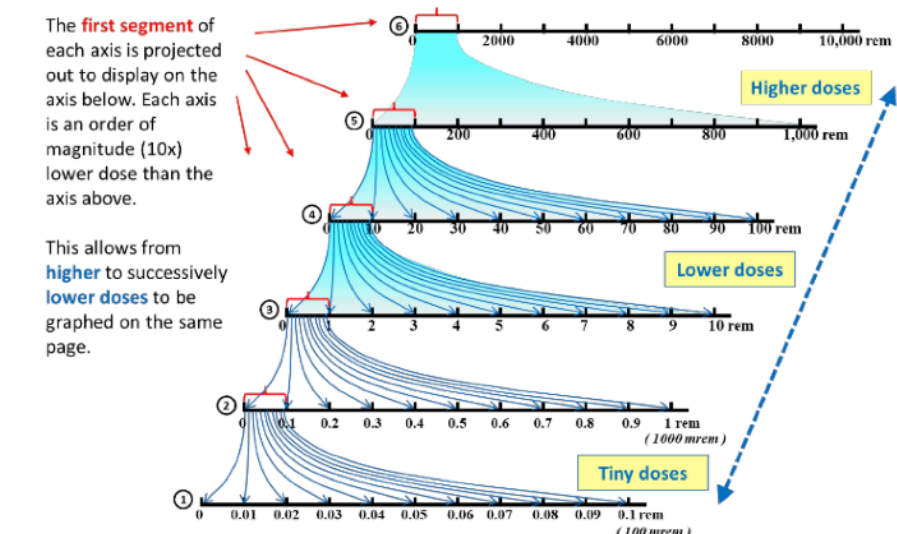
Ionizing Radiation Dose Ranges (Sievert)



FIGURE 6.

Whole body, acute: G-I destruction; lung damage; cognitive dysfunction (death certain in 5 to 12 days)*

Cancer Radiotherapy
total doses to tumor



Solar Particle Event (SPE; Solar flare)
dose on **lunar surface**, no shielding

Estimated dose for 3-year Mars mission
(current shielding, no SPE)

Temporary epilation (3 wk onset) at 4 Sv
Main erythema reaction (10 day onset) at 6 Sv
Permanent epilation (3 wk onset) at 8 Sv
Human LD_{50/30} range acute exposure* at 10 Sv
Human LD_{50/30} range acute exposure with medical intervention at 10 Sv

***Note:** Whole body acute prognoses assume **no** medical intervention (G-I = gastrointestinal)

Evidence is weak and inconsistent for excess human cancers from exposures below 100 mSv acute or 300 mSv chronic (acute exposure in seconds/minutes; chronic exposure in days/months/years)

Cancer Epidemiology
Ramsar, Iran high natural bkg/y
DHS emergency guideline to save a life: 250 mSv
Acute exposure detectable in blood at 600 mSv
Interplanetary Space natural bkg/y; no SPE
DOE Low Dose Research Program

Medical Diagnostics mGy (Estimated maximum organ dose ◆)	
X-ray films	
A – Chest (PA & Lat)	0.1 - 0.23
B – Dental Panoramic	0.7
C – Lumbar Spine	0.7-1.9
D – Mammogram	0.6 - 2.9
Radiotracer Imaging	
E – Heart Stress (Tc-99m)	6 – 12
F – Bone (Tc-99m)	4 – 15
G – Dual Isotope Stress Test	40 – 45
H – PET: F-18 FDG (bladder)	55 – 80
CT Scans (X-ray) (multiple scan average dose)	
I – Chest CT	20 – 30
J – Head CT	30 – 50
K – Abdominal CT	22 – 60
L – Full Body CT	50 – 100
Fluoroscopy/Procedures	
M – Barium Contrast G.I.	10 – 22
N – Cardiac Catheterization	12 – 40
O – TIPS Procedure	400 – 1400

Typical mission doses on International Space Station (ISS; no SPE)

Kerala coast, India high natural bkg/y
DHS emergency guideline for public relocation: 20 mSv/y (2 rem/y)
Guarapari, Brazil high natural bkg/y
DOE, NRC dose limit for workers: 50 mSv/y (5 rem/y)
Lunar mission ~ 88 d (no SPE)

Typical added annual dose for commercial airline flight crews

Medical Diagnostics (A-O)
see chart >>
Yangjiang, China high natural bkg/y

Airport x-ray whole body scanner: 0.00007 mSv/scan (Limit = 0.25 mSv/y ~ 4000 scans/y)

Regulations & Guidelines
DOE facility releases
Natural background, USA average of 3.1 mSv/y
EPA dose limit public drinking water systems: 0.04 mSv/y
EPA dose limit from release in air: 0.1 mSv/y
NRC cleanup criteria for site decommissioning / unrestricted use: 0.25 mSv/y
DOE, NRC dose limit for the public: 1 mSv/y (100 mrem/y) (ICRP, NCRP)

Round-trip Los Angeles – New York (~ 0.037 mSv)

DOE, NRC dose limit for the public: 1 mSv/y (100 mrem/y) (ICRP, NCRP)

LD_{50/30} = Lethal Dose 50/30 is the whole body dose that results in lethality to 50% of exposed individuals in 30 days

6 orders of magnitude of ionizing radiation effects

Excerpts from 2015 petition to end LNT *2022: denied!*

There has **never been scientifically valid support for this LNT hypothesis** since its use was recommended by the U.S. National Academy of Sciences Committee on Biological Effects of Atomic Radiation (BEAR I)/Genetics Panel in 1956. The **costs of complying with these LNT-based regulations are enormous**. Prof. Dr. Gunnar Walinder has summed it up: **“The LNT is the greatest scientific scandal of the 20th century.”**

Regulators use the LNT assumption because nationally and internationally respected bodies recommend and advocate it. NCRP, ICRP, IAEA, and NAS-NRC’s BEIR Committee come to mind. However, they appear to have lost their sheen of expertise and appear mostly committed to maintaining the status quo. **An army of regulators at NRC, EPA, FDA, as well as DOE, would be unbudgeted if the LNT disappeared.** In addition, there are politicians whose anti-nuclear stand gets them votes.

I am not talking about a few **scientific papers that show that the LNT model is in error**. We are **talking about thousands**. There are a couple of textbooks in this field, and journals that publish scientific findings that refute the LNT model. This is a **whole field of science that regulators pretend does not exist**. The attitude of today’s regulators is reminiscent of the Catholic Church at the time of Galileo.

Consequence: US NRC certification of an advanced reactor design costs \$1 billion.

GAO

United States Government Accountability Office
Center for Science, Technology, and Engineering
Natural Resources and Environment

Report to the Ranking Member, Subcommittee on Energy and
Water Development, Committee on Appropriations, U.S. Senate

July 2015

TECHNOLOGY ASSESSMENT

Nuclear Reactors

Status and challenges in development
and deployment of new commercial concepts

“It is a multi-decade process, with costs up to \$1 billion to \$2 billion, to design and certify or license the reactor design, ...”

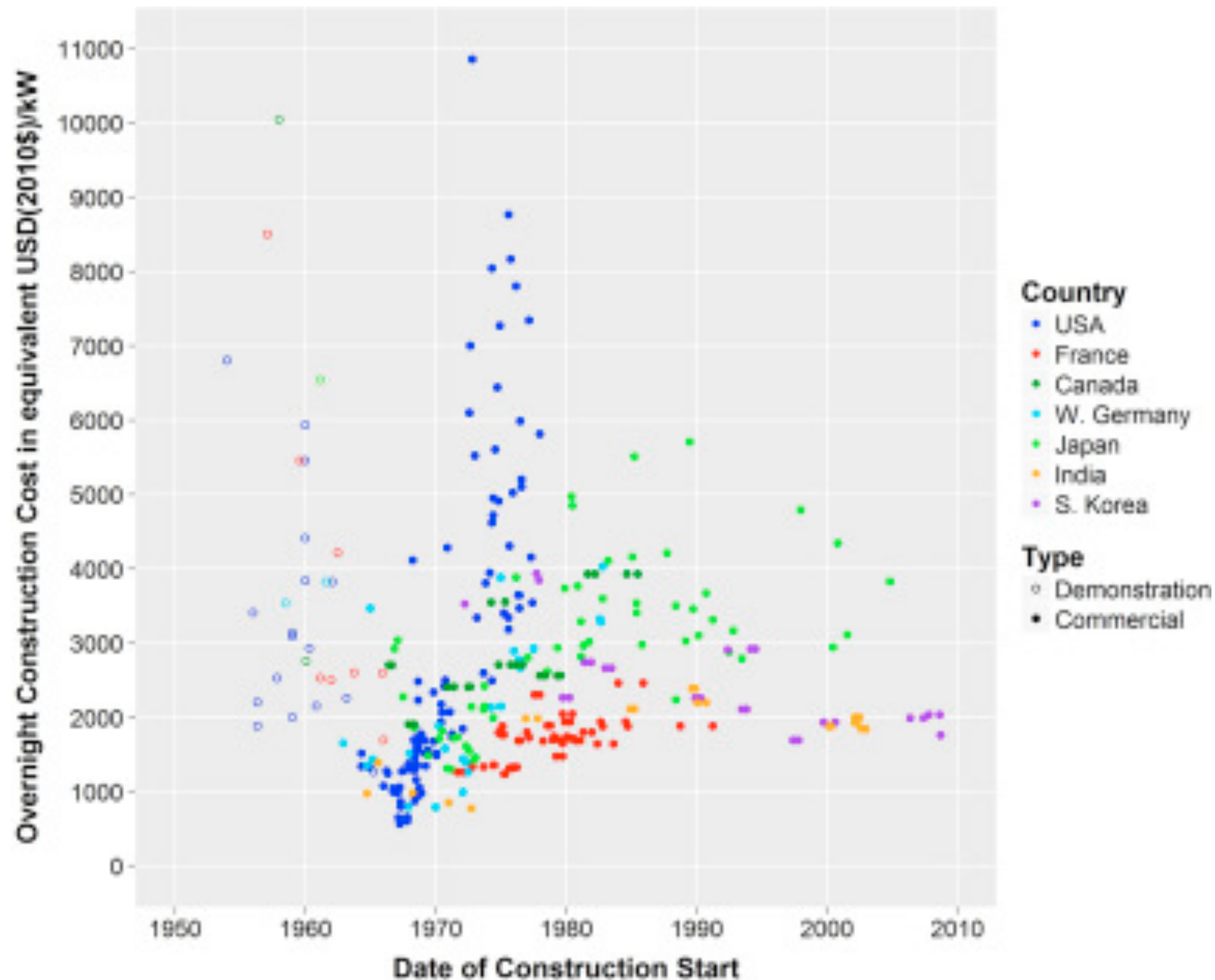
GAO, July 2015

...and then you may be allowed to build and test it.

Consequence:
Fission power plants became too expensive in the US.

\$2/W --> \$11/W

- regulation
- inexperience
- delays



Bad science is decried by editors.

“The case against science is straightforward: **much of the scientific literature, perhaps half, may simply be untrue.** Afflicted by studies with small sample sizes, tiny effects, invalid exploratory analyses, and flagrant conflicts of interest, together with an obsession for pursuing fashionable trends of dubious importance, science has taken a turn towards darkness.”

Richard Horton, Lancet editor

“It is simply **no longer possible to believe much of the clinical research that is published,** or to rely on the judgment of trusted physicians or authoritative medical guidelines. I take no pleasure in this conclusion, which I reached slowly and reluctantly over my two decades as an editor of the New England Journal of Medicine”

Marcia Angell, New England Journal of Medicine editor



For the **great enemy of the truth** is very often not the lie—deliberate, contrived, and dishonest—but the myth—persistent, persuasive, and unrealistic. Too often we hold fast to the clichés of our forebears. We subject all facts to a prefabricated set of interpretations. We enjoy the comfort of opinion without the discomfort of thought. (1966)

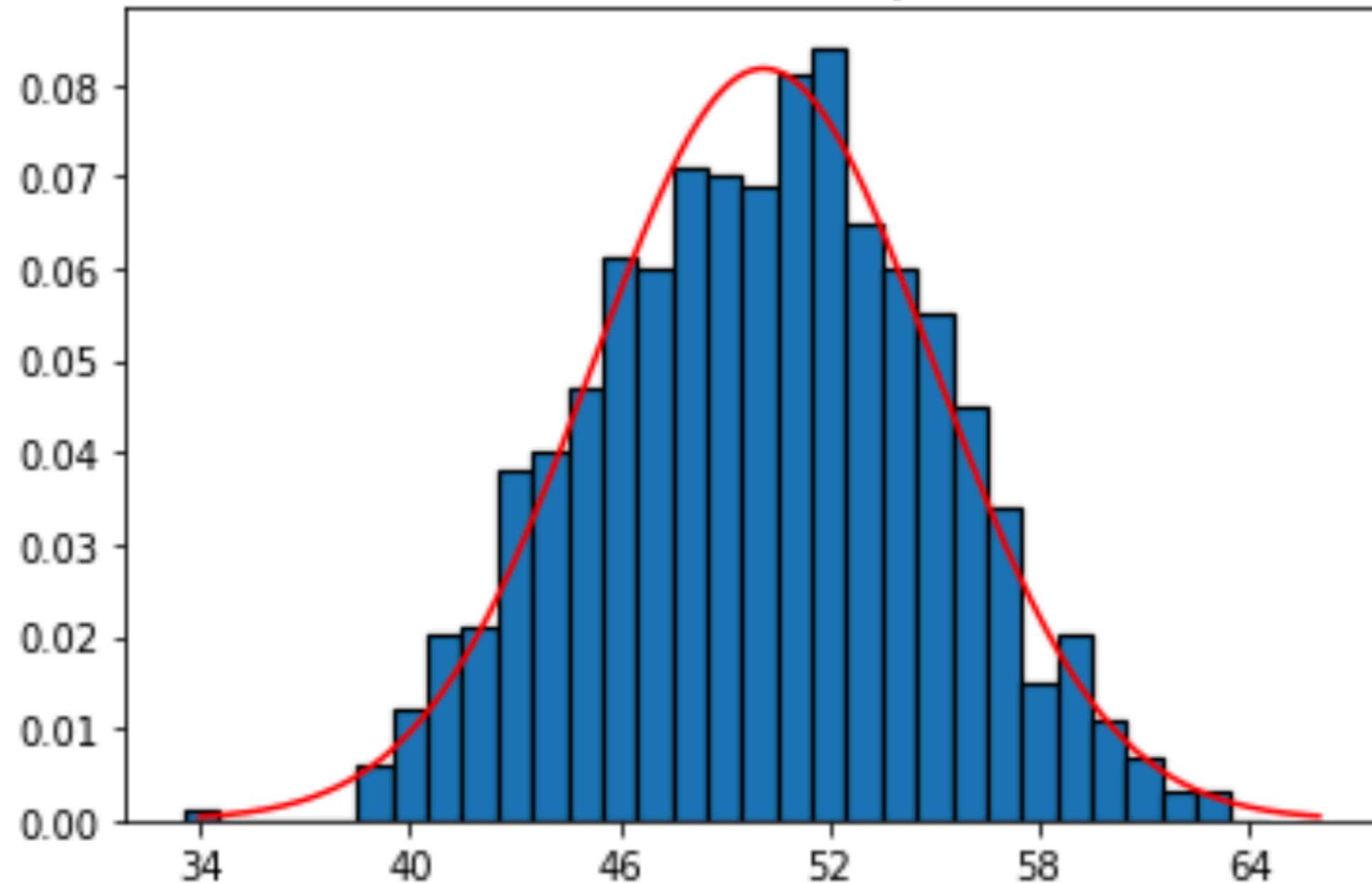
What's a p-value?

Null hypothesis: Every day is equally lucky.
My Hypothesis: Friday-the-13ths are lucky days.
I observed 66 heads on Friday the 13th! I'm right!

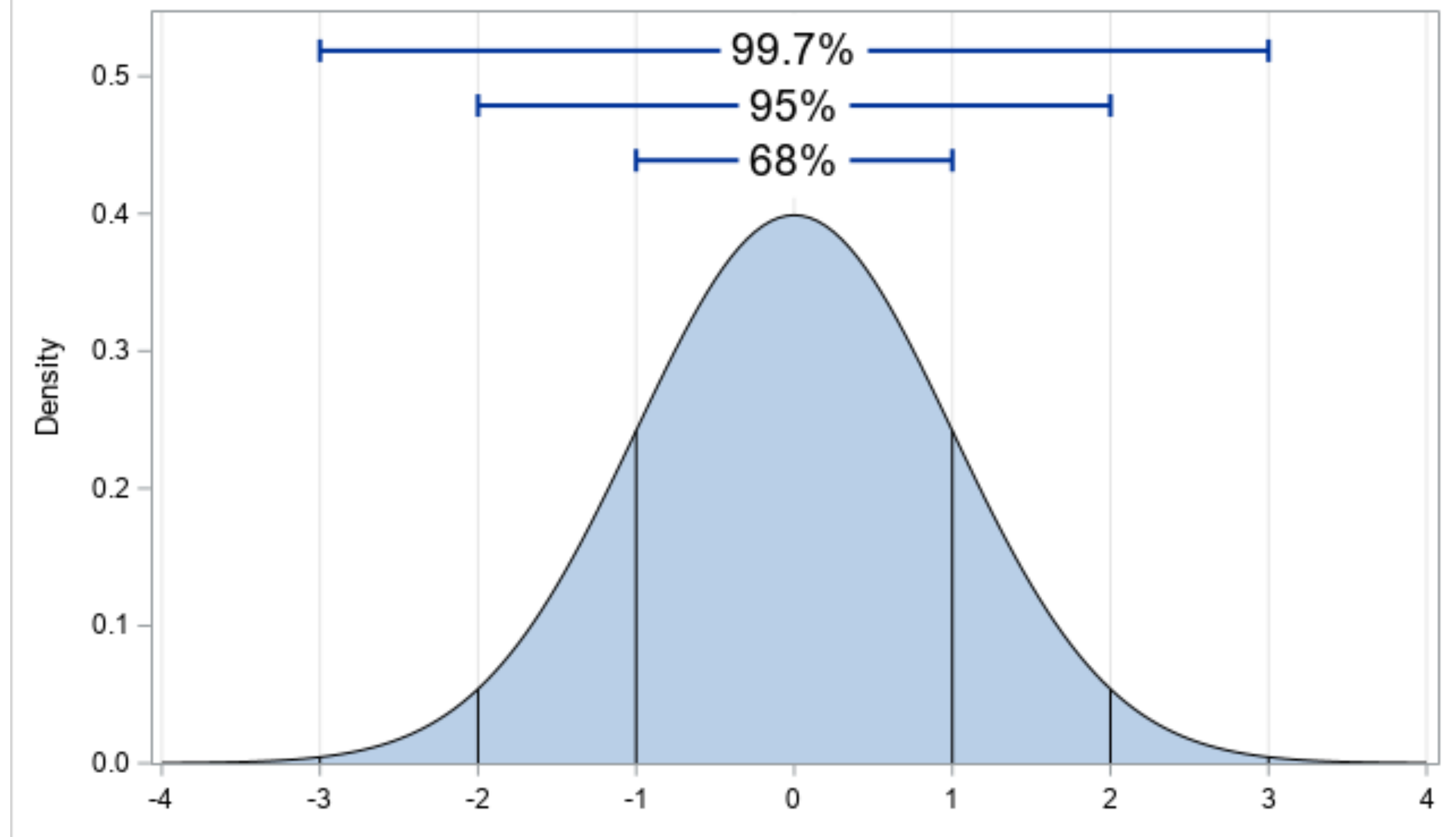
p-value = 0.05 is the probability such an extreme result would be observed under the null hypothesis.

Toss a coin 100 times. Repeat.

100 tosses - 1,000 repetitions



The 68-95-99.7 Rule for the Normal Distribution



JELLY BEANS
CAUSE ACNE!

SCIENTISTS!
INVESTIGATE!

BUT WE'RE
PLAYING
MINECRAFT!
... FINE.



WE FOUND NO
LINK BETWEEN
JELLY BEANS AND
ACNE ($P > 0.05$).



THAT SETTLES THAT.

I HEAR IT'S ONLY
A CERTAIN COLOR
THAT CAUSES IT.

SCIENTISTS!

BUT
MINECRAFT!



WE FOUND NO
LINK BETWEEN
PURPLE JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
BROWN JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
PINK JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
BLUE JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
TEAL JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
SALMON JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
RED JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
TURQUOISE JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
MAGENTA JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
YELLOW JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
GREY JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
TAN JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
CYAN JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND A
LINK BETWEEN
GREEN JELLY
BEANS AND ACNE
($P < 0.05$).



WE FOUND NO
LINK BETWEEN
MAUVE JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
BEIGE JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
LILAC JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
BLACK JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
PEACH JELLY
BEANS AND ACNE
($P > 0.05$).



WE FOUND NO
LINK BETWEEN
ORANGE JELLY
BEANS AND ACNE
($P > 0.05$).



== NEWS ==

GREEN JELLY BEANS LINKED TO ACNE!

95% CONFIDENCE

.....

ONLY 5% CHANCE OF COINCIDENCE!

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SCIENTISTS...
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== NEWS ==

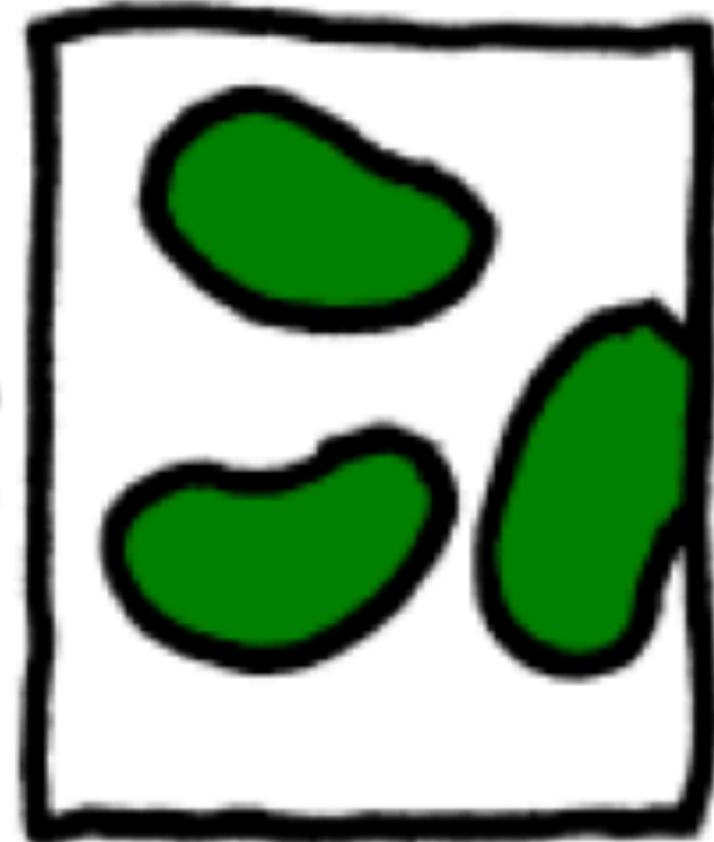
GREEN JELLY BEANS LINKED TO ACNE!

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SCIENTISTS...  
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Dose of sanity and science:

**Radiation and Health,
Thormod Henriksen**

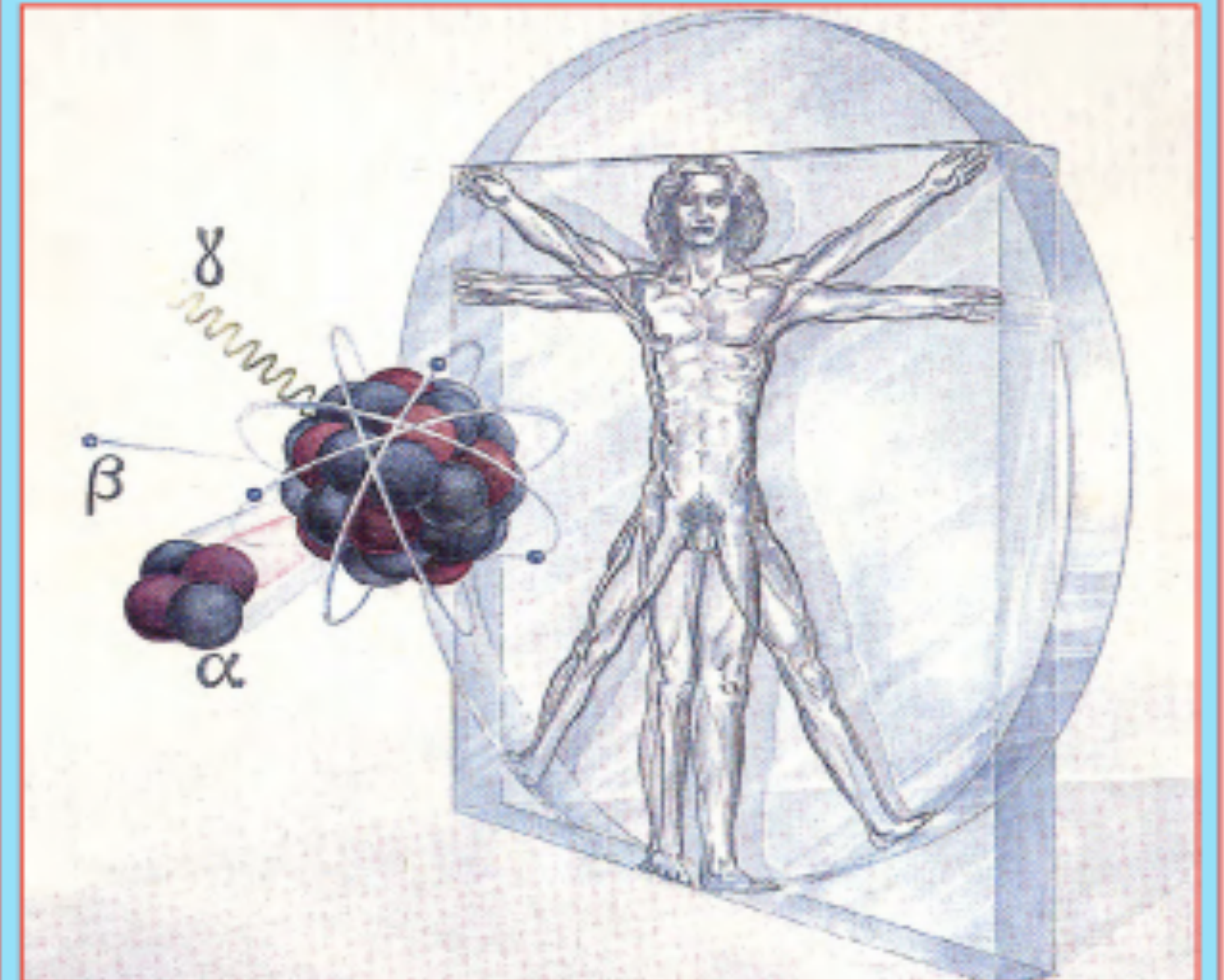
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With his OK, I published paperback
version on Amazon at cost.

[https://www.amazon.com/dp/
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Radiation and Health

by
Thormod Henriksen
and
Biophysics group at UiO



American Nuclear Society

reprinted two dozen scientific studies showing low level radiation is benign.

Free to download at:

https://www.ans.org/file/1336/special_session-low_level_radiation-fukushima-v1.4.pdf

https://www.ans.org/file/1336/special_session-low_level_radiation-fukushima-v1.4.pdf

**President's Special Session:
Low-Level Radiation & Its
Implications for
Fukushima Recovery**

2012 ANS Annual Meeting

"Nuclear Science and Technology: Managing the Global Impact of Economic and Natural Events"

Hyatt Regency Chicago
Chicago, IL
June 25, 2012

Ed Calabrese uncovers LNT's scientific fraud.

22 episodes, 12 hours

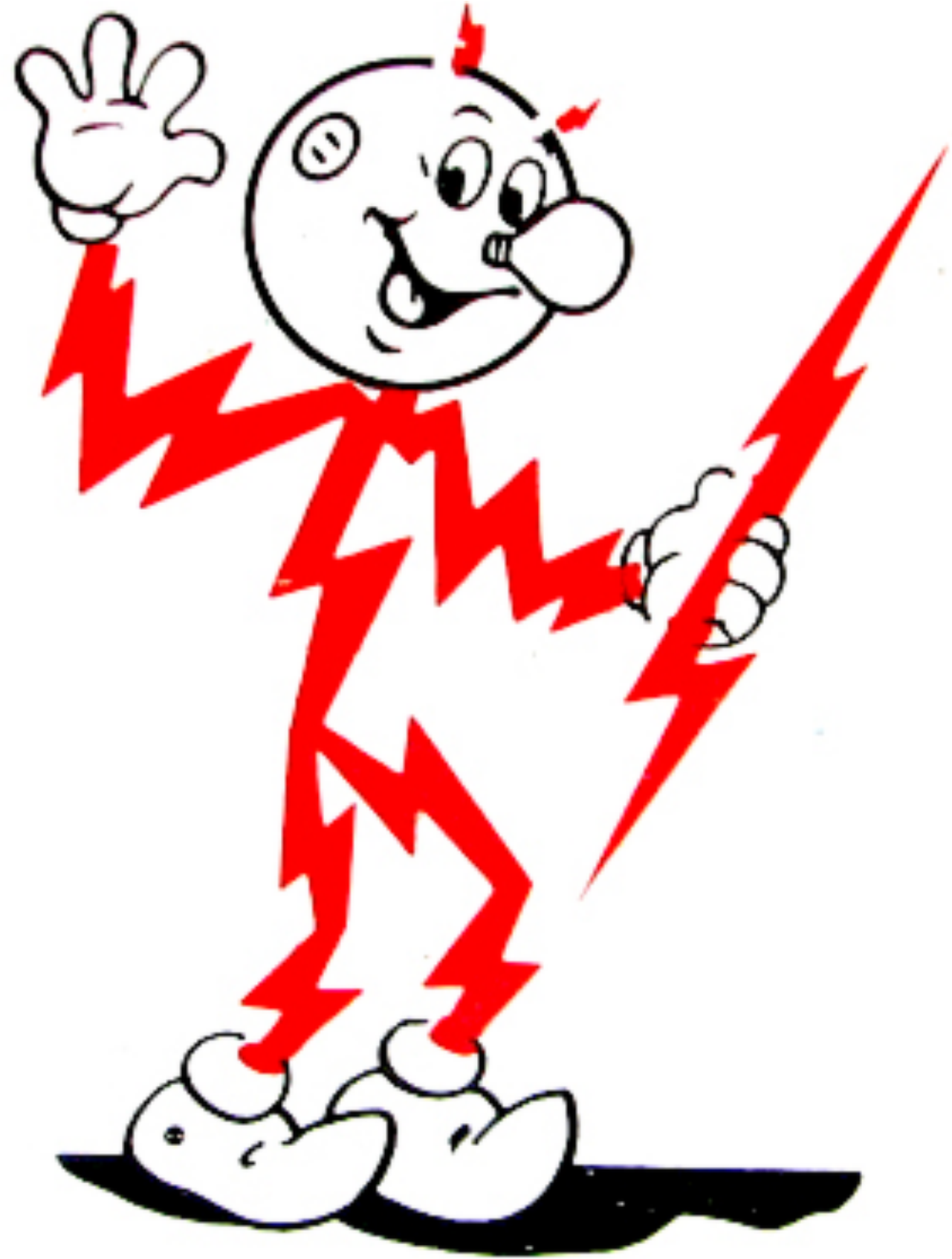
The Historical Foundations
of the Linear No-Threshold
Dose Response Model for
Cancer Risk Assessment

Episode 2:
LNT Beginnings:
Extrapolation from $\sim 100,000,000$ x Background?

A wide-angle photograph of a coastal city. In the foreground, the ocean waves gently wash onto a sandy beach. The middle ground is filled with a dense line of multi-story apartment buildings and hotels. The sky is a vibrant blue, dotted with soft, white clouds. The overall scene is bright and clear, suggesting a sunny day.

No More Radiophobia!

8 Radiophobia



Fission is in Fashion

Fear sells

Fission power safest

Metabolism

DNA, cellular repair

Evidence ignored by authorities

Deadly evacuations unnecessary

Radiophobia policy, NRC, EPA

Educational video, book

Confounders, controls, p-hunting