

# Radiation and Reason

Why radiation at modest dose rates is quite harmless and  
current radiation safety regulations are flawed

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**CERN Colloquium**  
Geneva, 3 October 2013

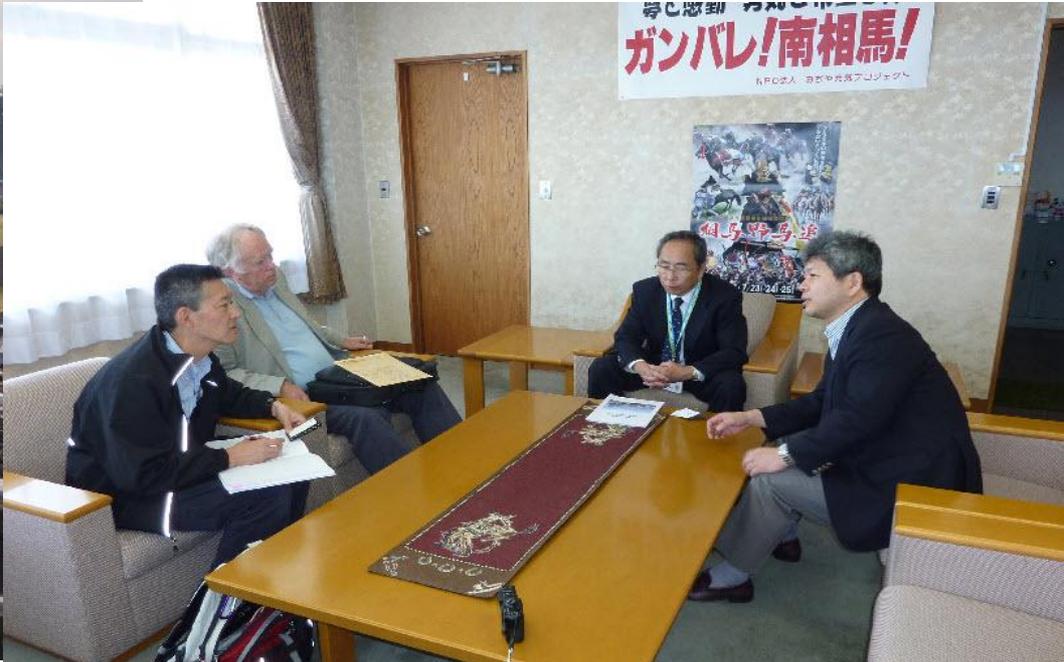


**The final demonstration by the Anti Fire Party, 25,000 BC**

# Radiation and Reason

1. What happened at Fukushima?
2. More evidence of significance
3. Is the current radiation safety regime actually safe?
4. Why is nuclear so safe in spite of its high energy?
5. Why is there so little public confidence?
6. How can we build confidence and trust in science and society?
7. How high might reasonable safety regulations be set?
8. Conclusions. Attitudes, waste, costs and public policy

## 2. What happened at Fukushima?



Oct 2011. Fukushima1 from 3 kms. Talks with doctors, teachers and community leaders (Minamisoma and Iitate)



## At Fukushima three things happened

First: Major earthquake and tsunami driven by (natural) radioactivity heating the Earth.

**Result: physical destruction & 18,800 deaths. Natural disaster**

Second: Three destroyed nuclear reactors with a release of (artificial) radioactivity.

**Result: no casualties, none expected in future. No disaster**

Third: Local and worldwide panic driven by excessively cautious radiation regulation, lack of education.

**Result: displaced people (>1000 deaths), condemned food, power stations turned off, imported fossil fuel, severe economic damage, reduced trust in society, science and medicine**

**A disaster, self inflicted, not due to radiation**

11 March 2011 The accident

26 March 2011 Allison BBC Article

*We should stop running away from radiation*

*“More than 10,000 people have died in the Japanese tsunami and the survivors are cold and hungry but the media concentrate on the radiation from which no one has died – and is unlikely to.”*

*“Unfortunately, public authorities react by providing over-cautious guidance - and this simply escalates public concern.”*

31 May 2013 UNSCEAR

*No rise in cancer rates after Fukushima – UN*

*“It is this upheaval to people's lives that has brought real health effects, and these will need "special attention" in coming years,”*  
*said Carl-Magnus Larsson, chair of UNSCEAR.*

*"Families are suffering and people have been uprooted and are concerned about their livelihoods and futures, the health of their children... it is these issues that will be the long-lasting fallout of the accident."*

# Food Regulation at Fukushima

July 2011. Less than 500 Bq/kg = 0.008 mSv per kg.

Then one CT scan (8 mSv) equivalent to eating  
 $8/0.008 = 1000 \text{ kg} = 1 \text{ tonne}$  in 3 months.

But in April 2012 regulation tightened to 100 Bq/kg.

Then one CT scan equivalent to 5 tonnes in 3 months.

## Water released

April 2011. 11,500 tonnes release into sea, intentionally.

Stated to be a) 100 times regulation limit. b) “Quite safe”.

Both statements true!!

Inept regulation created a guaranteed massive loss of confidence.

(2 CT scan equivalent to drinking a litre a day for 3 months)

Then reduced credibility when smaller leaks of higher concentration reported

# The public see fear dressed up as fact



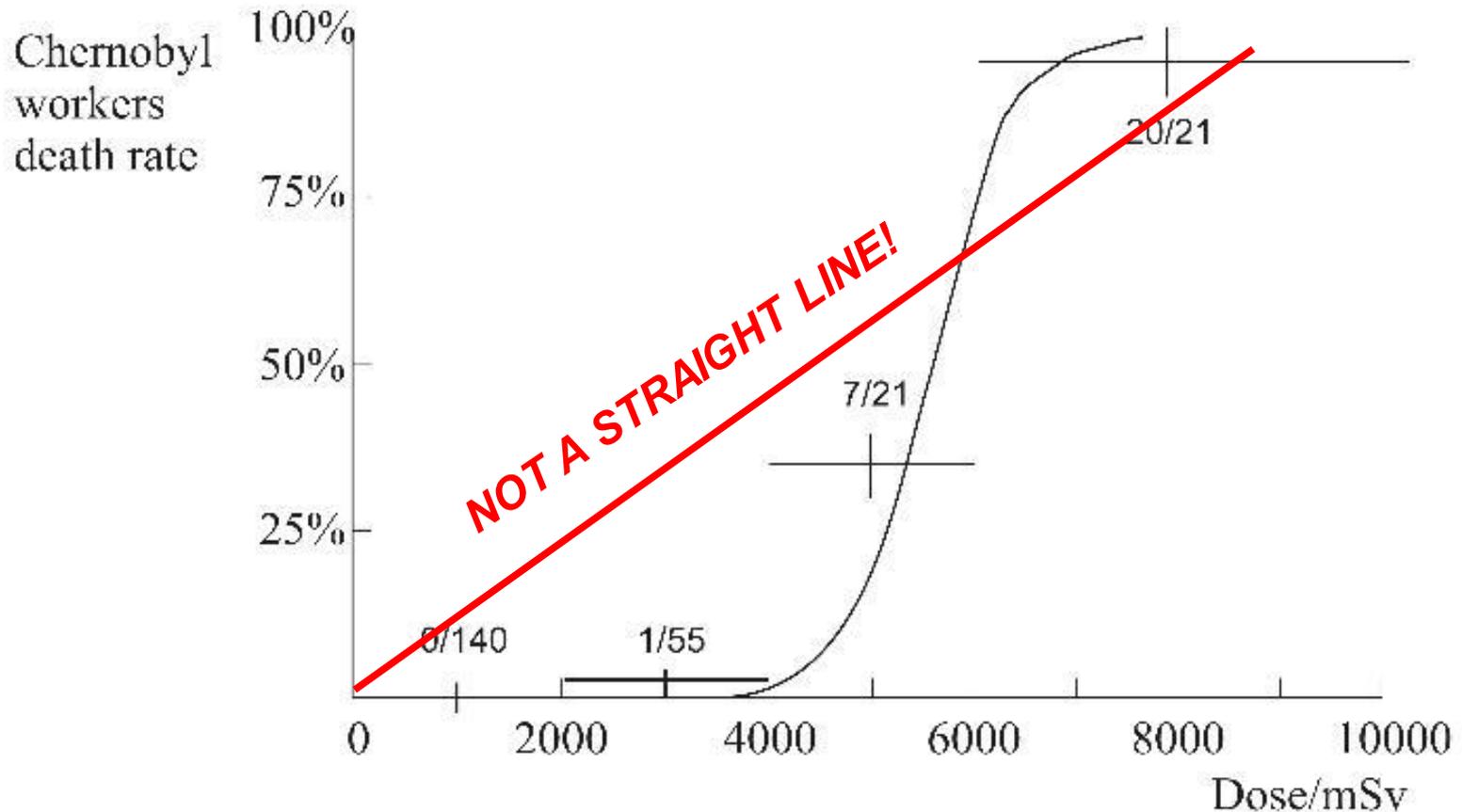
## 2. More evidence of significance

# Chernobyl early firefighters

**Not LNT**

Crosses show the mortality (curve is for rats).

The numbers show the number who died/total in each dose range.



Above 4,000 mSv 27/42 died from ARS in 2/3 weeks.

Below 2,000 mSv zero out of 195 died.

**Acute threshold above 2000 mSv (ARS, not cancer)**

# Medical scans CT, PET, SPECT

## PET/CT がんどック

### PET/CT検査とは、

「がん細胞が正常な細胞に比べて多くのブドウ糖を取り込む」という性質に着目した検査です。

この検査では、一度の撮影でほぼ全身をみることができ、PET単独検査に比べて診断精度が格段に向上した「がん画像診断法」です。



### 料 金

94,500円

※出雲市では、2万円を補助する制度があります。  
対 象 者：40歳以上の出雲市民  
実施期間：平成23年4月1日～24年3月31日  
詳細は健康増進課までお問い合わせください。

### 実施日

毎週月曜日～金曜日

(但し祝日・年末年始は除く)

### 申込 方法

事前に電話で予約が必要です

### 申込 先

出雲市立総合医療センター 健康管理センター  
TEL 0853-63-5119 (直通)  
FAX 0853-63-5118

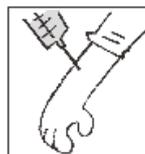
### 診療の流れ

#### 絶 食



検査の6時間以上前から絶食にしてください。ただし、糖分を含まない飲み物（お茶、お水）は飲んでかまいません。

#### F D G の注射



F D G を注射します。

#### 安 静



薬剤が全身にいきわたるまで、約1時間安静にします。

#### 撮 影



排尿後、PET/CTカメラの下で約30分安静にし、撮影します。

#### 診 断



専門の医師がPET/CT画像を読影し、総合的に診断します。

### PET/CT検査に関するQ & A

**Q** 糖尿病でも、検査を受けられますか？

**A** 糖尿病など血糖値が高い方の場合、FDGが筋肉や脂肪へ集積しやすい傾向にあるため、がんへのFDGの集積が低下します。そのため診断精度が下がる場合があります。PET/CT検査が実施できるかどうかについては、かかりつけの医師にご相談ください。

**Q** 妊娠中や妊娠の可能性のある場合は検査を受けられないのですか？

**A** FDGは、微量の放射性物質を含んでいますので、妊娠中や、妊娠の可能性のある方は必ずかかりつけの医師にご相談ください。

**Q** PET/CT検査なら、どんな種類のがんも見つけられるのでしょうか？

**A** 臓器や部位によっては、発見しにくいがんがあることもご了承ください。FDGは尿中へ排泄されるため、腎臓や膀胱などのがんも発見しにくい場合があります。

#### 発見しにくいがん

膀胱・尿管の癌  
腎臓癌  
肝細胞癌  
胃癌  
前立腺癌  
(すべての臓器の) 微小ながんなど

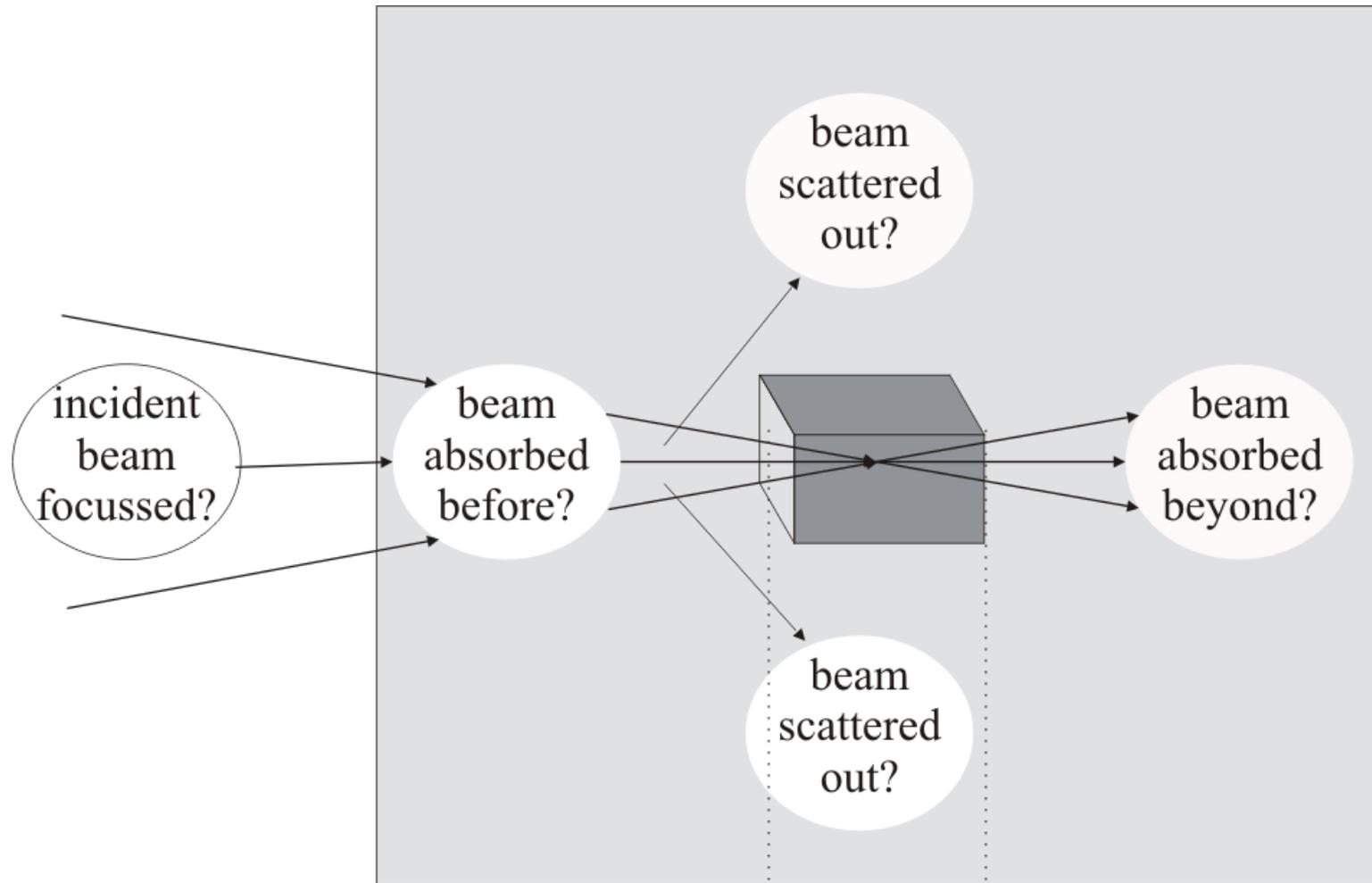
**Q** PET/CT検査は入院が必要なのでしょうか？

**A** FDGを注射してから撮影終了まで、5時間程度ですので、入院の必要はありません。

Poster advertising the availability and benefit of scans using internal PET and external radiation CT. The dose (10 mSv) of a single scan exceeds dose from eating 5 tonnes of "contaminated" food (100 Bq/kg caesium-137) [Regs of April 2012]

# Radiotherapy

Getting the radiation through the body into the tumour (schematic)  
Tissue outside tumour gets 50% dose to tumour!

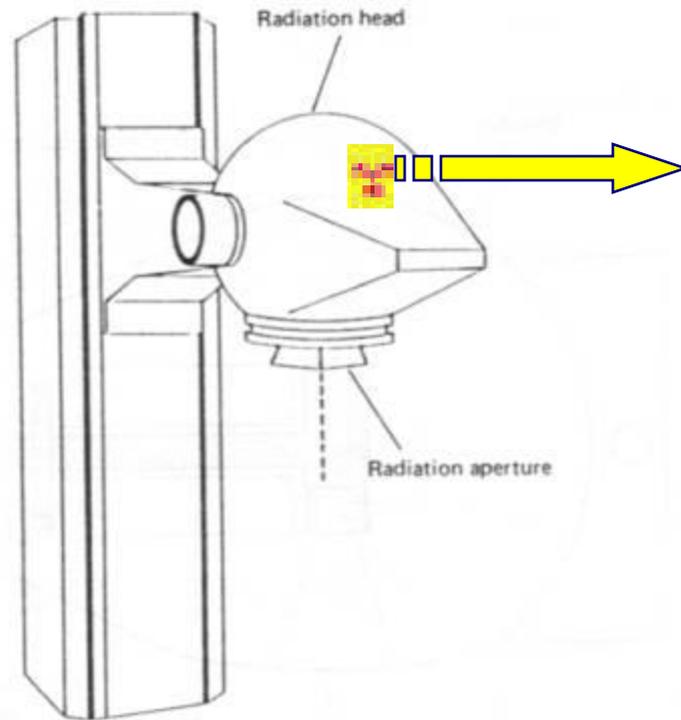


# Radiotherapy doses (to tumour) recommended by Royal College of Radiologists

[Doses actually quoted in gray where 1 sievert = 1 gray, for gammas.]

tumour	fractions	total dose	
bladder	30 x 2000 mSv	60000 mSv	5 times a week
breast	16 x 2750 mSv	44000 mSv	5 times a week
arm pit	15 x 2700 mSv	40500 mSv	5 times a week
glioma	30 x 2000 mSv	60000 mSv	5 times a week
cervical	30 x 1500 mSv	45000 mSv	5 times a week
lung	36 x 1800 mSv	54000 mSv	over 12 days
prostate	39 x 2000 mSv	78000 mSv	5 times a week

**Would be fatal to peripheral tissue (50%)  
without fractionation or with linear response (LNT)**



**$^{137}\text{CsCl}$**   
**(caesium chloride)**  
**50.9 TBq (1375 Ci)**  
**main gamma: 0.66 MeV**  
**main beta: 1.17 MeV**  
 **$T_{1/2}=30$  years**

FIG. 4. Schematic view of a teletherapy machine similar to the one from which the source assembly was removed in Goiânia. The radiation head is adjustable vertically and can be rotated about two horizontal axes.

# IAEA Goiania

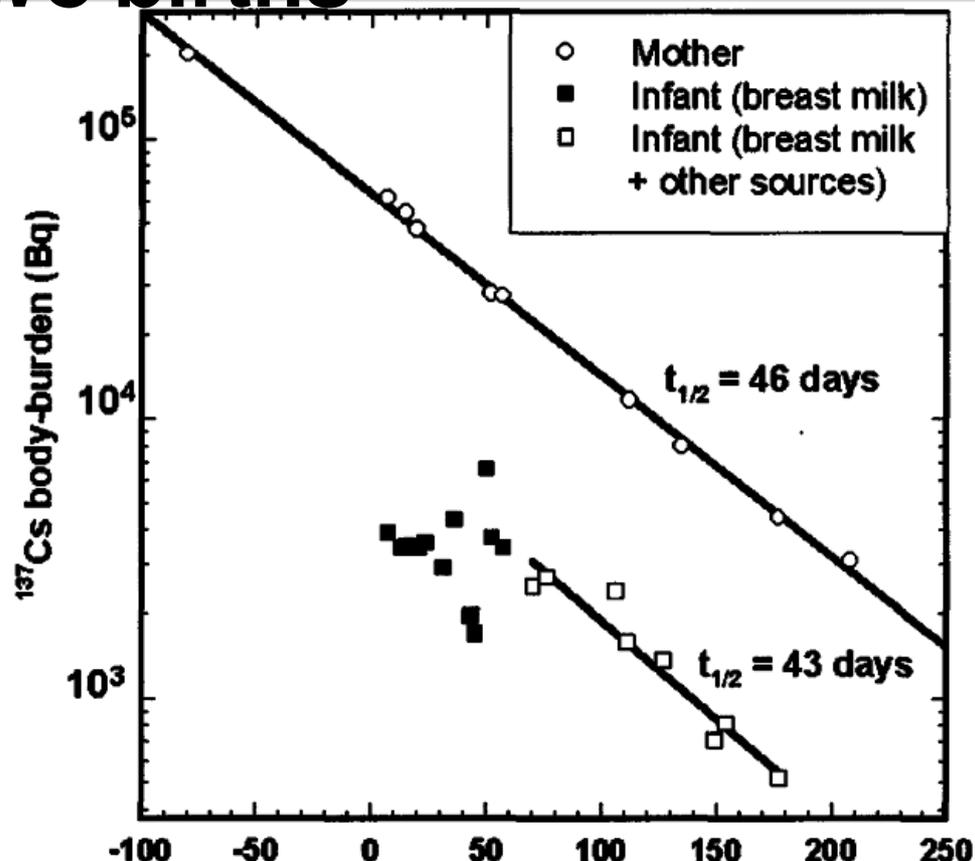
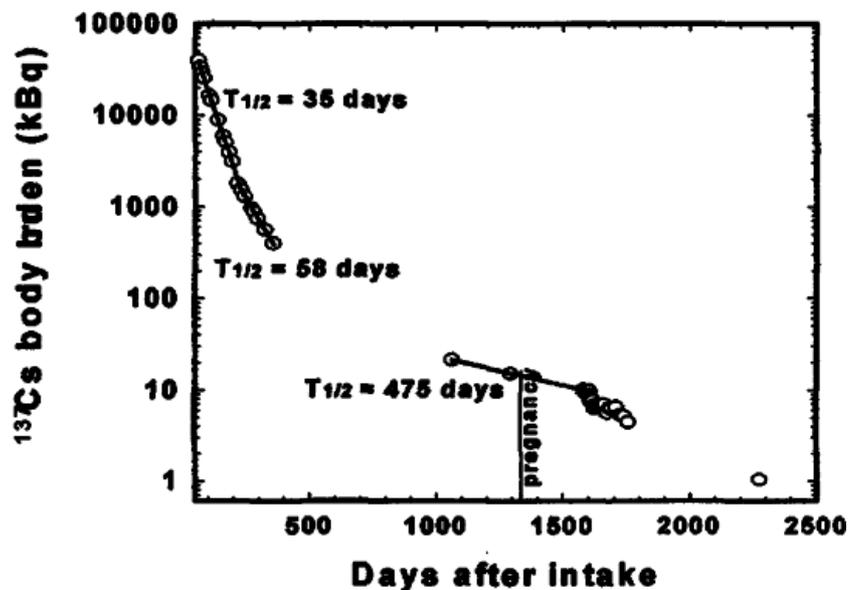


4. *The physicist W.F. monitoring for contamination at the Olympic stadium.*

**112 000 persons monitored**  
**249 identified contaminated**  
**120 only clothing and shoe contamination**  
**129 internal contamination**  
**50 subjected to direct medical surveillance**

# IAEA Goiania Two births

Decline of Cs radioactivity for a mother and child irradiated 4 months before birth All OK



...and a mother who had an activity of **300 million Bq** who became pregnant 3y 8 m later. No problems.

FIG. 6.2. <sup>137</sup>Cs retention curve of woman that became pregnant three years and eight months after intake.

# Internal Caesium-137, Accident in Goiania

Source 1988 IAEA publication 815

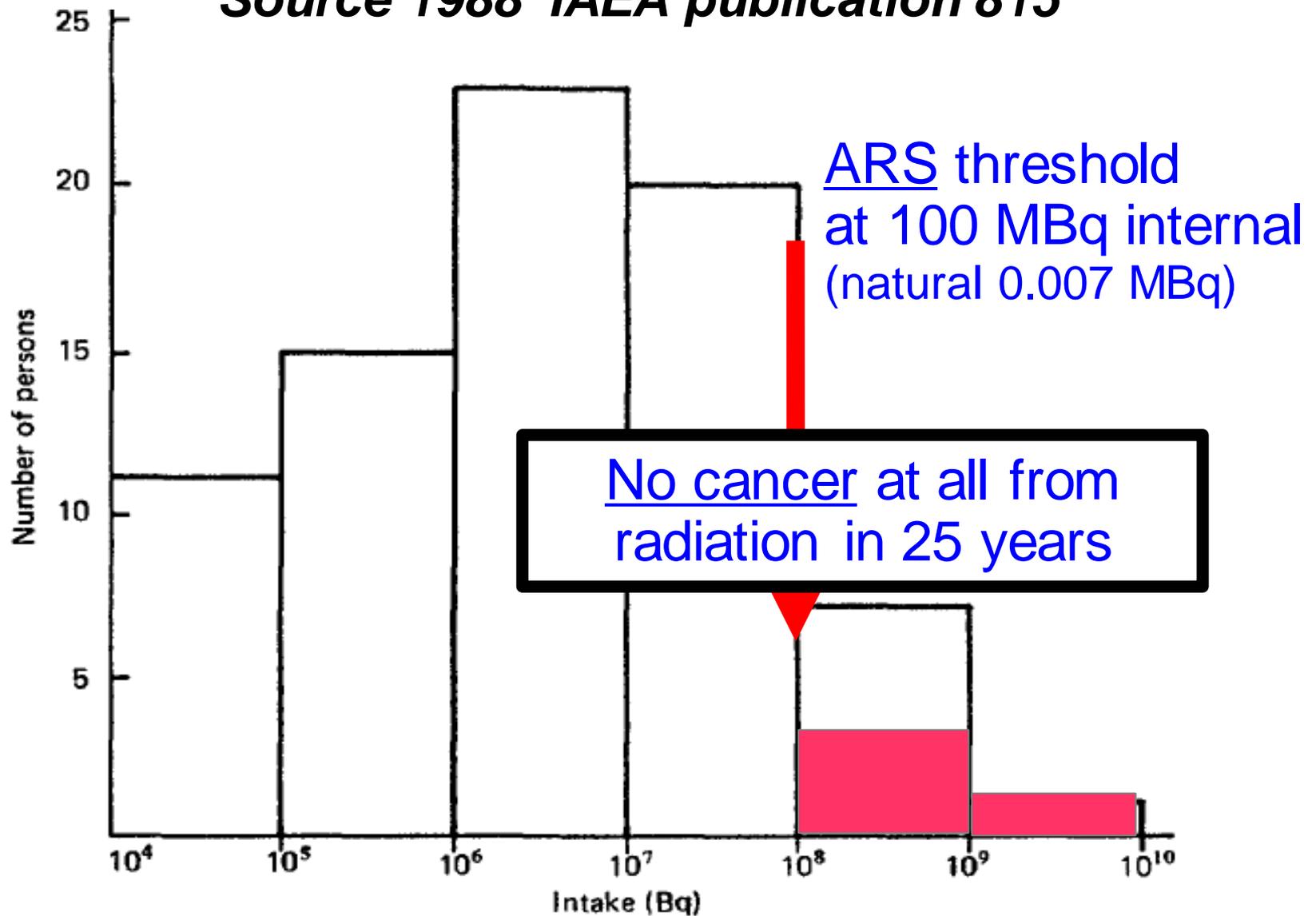


FIG 13. Histogram of the frequency distribution of estimated radioactivity of intakes of persons contaminated. number of individuals versus radioactivity in becquerels

3. Is the current radiation safety regime actually safe?

## ► *Radiological Safety trumps Industrial Safety (1)*

### **Whistle blowing statement by Ken Chaplin, senior inspector**

*“...working in a relatively high temperature environment in lead jackets and plastic lined suits. The radiological hazards ... insignificant,... we almost passed out from the heat in a very difficult to access location.*

*... ladders, with very little space to get their feet on rungs... required to wear steel toed shoes, inside rubber 'one size fits all' boots, inside paper booties.... in the name of contamination control; however, I am far more concerned about people falling 8 metres onto piping.*

*Staff are increasingly worried ... lower productivity ... higher stress levels ... entire organization pursuing ALARA, without ... health benefits.*

*I am watching as radiological protection dogma, ALARA, stops the nuclear industry dead in its tracks. It is hard to prevent this, but I am trying.”*

**[My comment: ALARA radiation safety, intended to allay fears, achieves the opposite. Such regulation and worker stress drive up costs, bring no benefit and are economically damaging.]**

▶ *ALARA trumps Industrial Safety (2)*

**Whistle blowing statement by  
Howard Iskayn, design engineer**

*“ a real hazard of death by the escape of hot gas.  
Regulator stated that ... not concerned with death by anything  
other than nuclear exposure....  
'death by hot gas was satisfactory so long as the body could  
be buried without radiation restrictions' ”*

▶ *ALARA conflicts with academic and clinical biology*

**Pollycove and Feinendegen, 2008, radiobiologists**

*“Current knowledge of radiobiology is incompatible with world  
radiation safety based on ALARA and linearity (LNT)”*

**Académie des Sciences & Académie Nationale de Médecine,  
Aurengo et al (2005)**

*Dose-effect relationships and estimation of the carcinogenic  
effects of low doses of ionizing radiation*

## 4. Why is nuclear so safe in spite of its large energy?

# A billion years of evolution to stabilise life

- For protection against threats that do not change
- For all cellular life incl. plants/animals without brain
- For all DNA damage, radiation and chemical oxidation
- By static design  
many individuals, many cells each with complete DNA copy, double stranded DNA, steady cell renewal by cycle, steady individual renewal by birth-sex-death cycle
- By dynamic reaction  
by antioxidants, by inter-cellular signalling, by apoptosis, by DNA repairs, by cell cycle suspension, by immune reaction
- By progressive stimulated change  
extra antioxidants, added repair enzymes, adaptive immune system

# Response vs dose. Typical stabilisation as in engineering or electronics **never LINEAR**

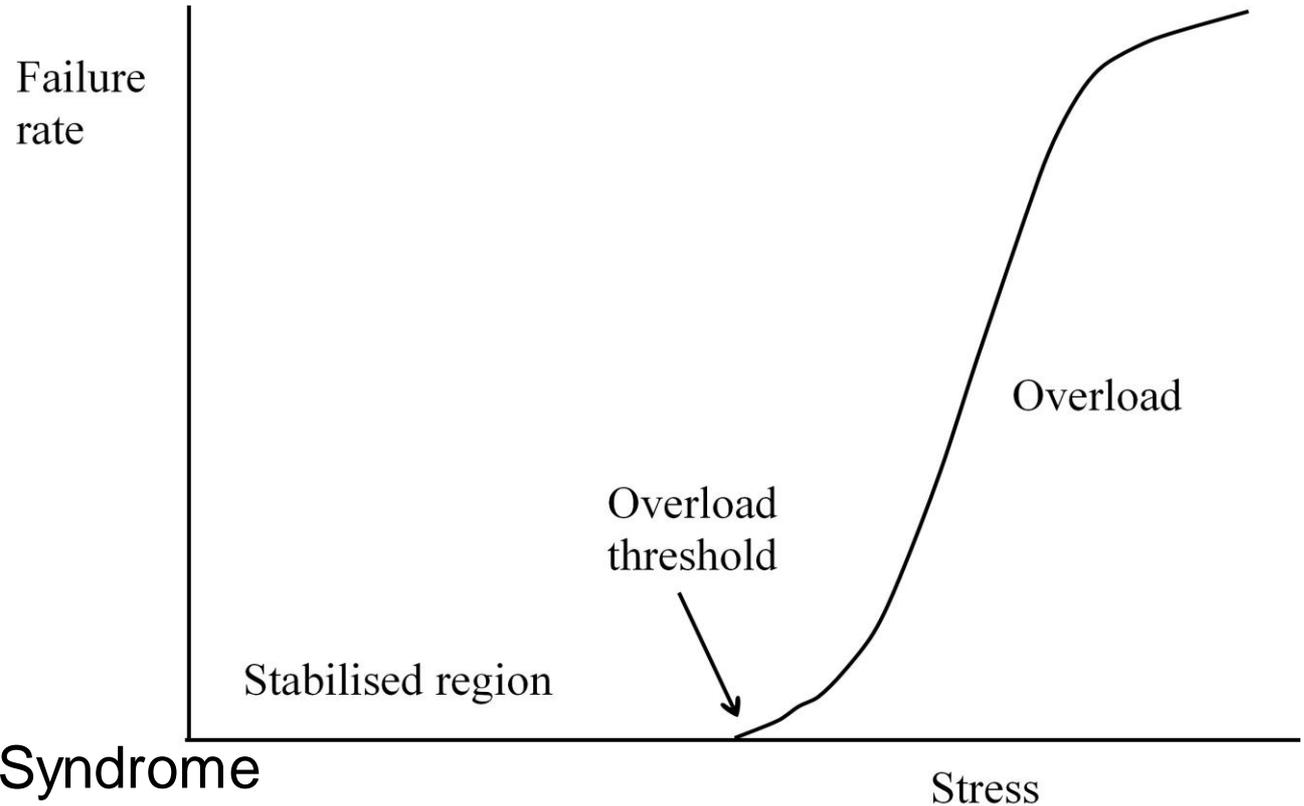
Stabilisation **time**  
hours to weeks

Stress:  
**Chronic**/protracted  
(mGy per month)

OR  
**Acute** (mGy)

Failure **threshold**:  
**Early**, Acute Radiation Syndrome  
OR  
**Late**, immune failure and cancer

With **adaption**, threshold can increase,  
through the stimulation of extra resources.



## 5. Why is there so little public confidence?

# Reasons to fear radiation

1. Aftermath of a holocaust.  
Effective Cold War message that frightened everybody.
2. Failed appeasement of public opinion  
Recommended international regs (ICRP)  
to keep radiation close to background, eg 1 mSv per year.  
As Low As Reasonably Achievable (ALARA)
3. Cannot feel nuclear radiation.
  - get a detector, a smoke detector
  - trust your body to sense and repair
4. An icon for fear --  
control by authority, not education



Adam Smith (18<sup>th</sup> Century economist and philosopher)

*“Science is the great antidote to the poison of enthusiasm and superstition”*

**Increased fear,  
increased regulations to reassure (fail),  
increased costs and prices,  
economic damage,  
more fear, and round again .....  
STOP!**

6. How can we build confidence and trust in science and society?

# Pillars of public confidence – scientists!

## Marie Sklodowska-Curie

Physicist, chemist, radiologist

*“Nothing in life is to be feared. It is to be understood.”*

## Charles Darwin

student of divinity, naturalist, biologist, geologist

## Florence Nightingale

Nurse and pioneering statistician

*“How very little can be done under the spirit of fear”*

## Adam Smith

*.... as before*

3 October 2013

CERN Colloquium, Wade Allison



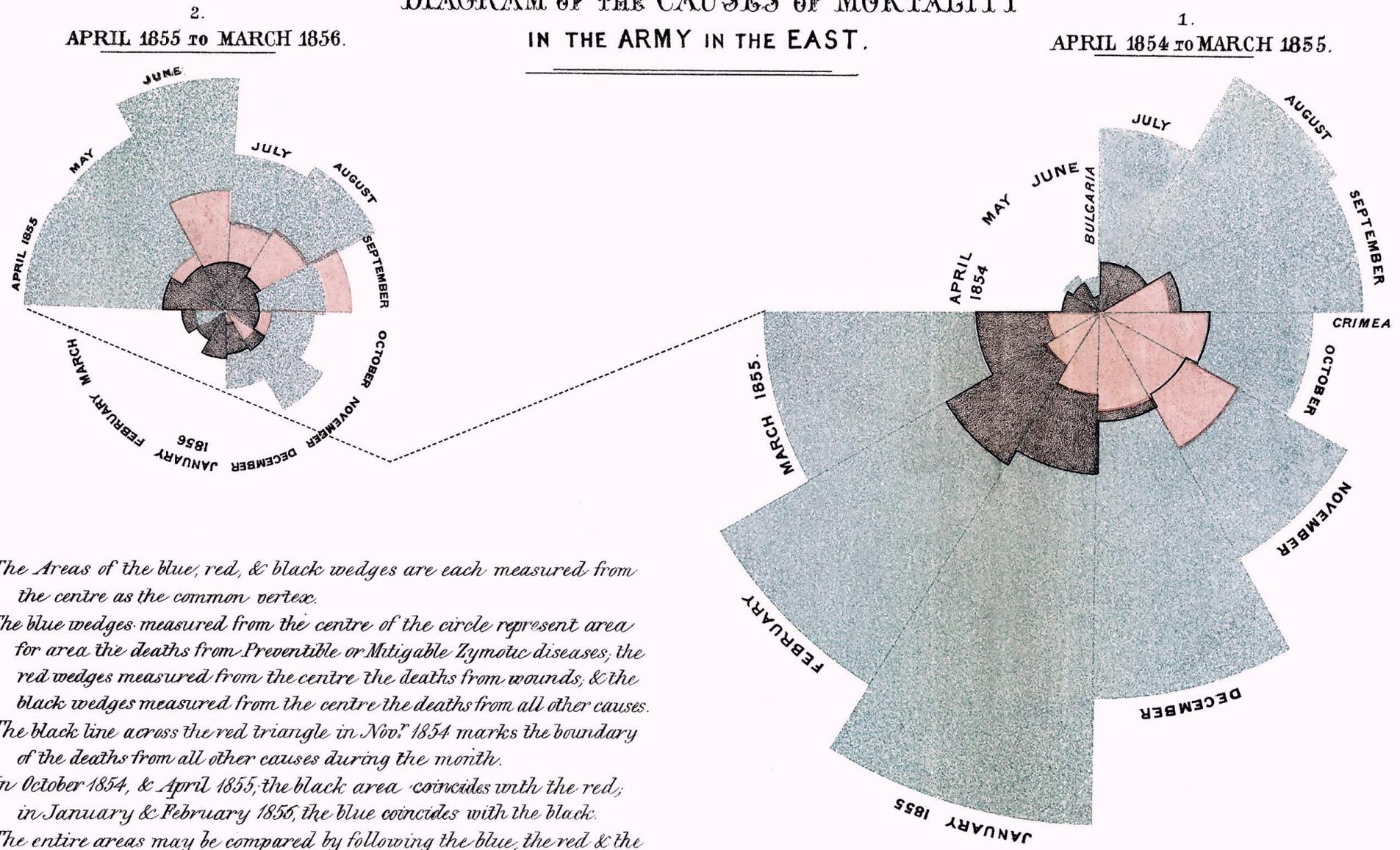
7. How high might reasonable safety regulations be set?

# Statistics, graphics and public persuasion

## Florence Nightingale

### DIAGRAM OF THE CAUSES OF MORTALITY

#### IN THE ARMY IN THE EAST.



*The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex.*

*The blue wedges measured from the centre of the circle represent area for area the deaths from Preventible or Mitigable Zymotic diseases; the red wedges measured from the centre the deaths from wounds; & the black wedges measured from the centre the deaths from all other causes.*

*The black line across the red triangle in Nov. 1854 marks the boundary of the deaths from all other causes during the month.*

*In October 1854, & April 1855, the black area coincides with the red; in January & February 1856, the blue coincides with the black.*

*The entire areas may be compared by following the blue, the red & the black lines enclosing them.*

# Action plan, Nightingale style

## 1. Evidence. Measure thresholds

Get factors of 10 right, ignore factors of 2, ignore small samples or tiny doses

<u>Chernobyl Fire Fighters</u>	<u>Acute</u>	<u>ARS</u>
<u>Goiania</u>	<u>incl internal</u>	<u>ARS and cancer</u>
<u>Hiroshima &amp; Nagasaki</u>	<u>Acute</u>	<u>Cancer</u>
<u>Radium Dial Painters</u>	<u>Chronic</u>	<u>Cancer</u>
<u>Radiotherapy fractionation</u>	<u>Protracted</u>	<u>Secondary cancer</u>
<u>Animal experiments</u>	<u>Chronic</u>	<u>Cancer</u>

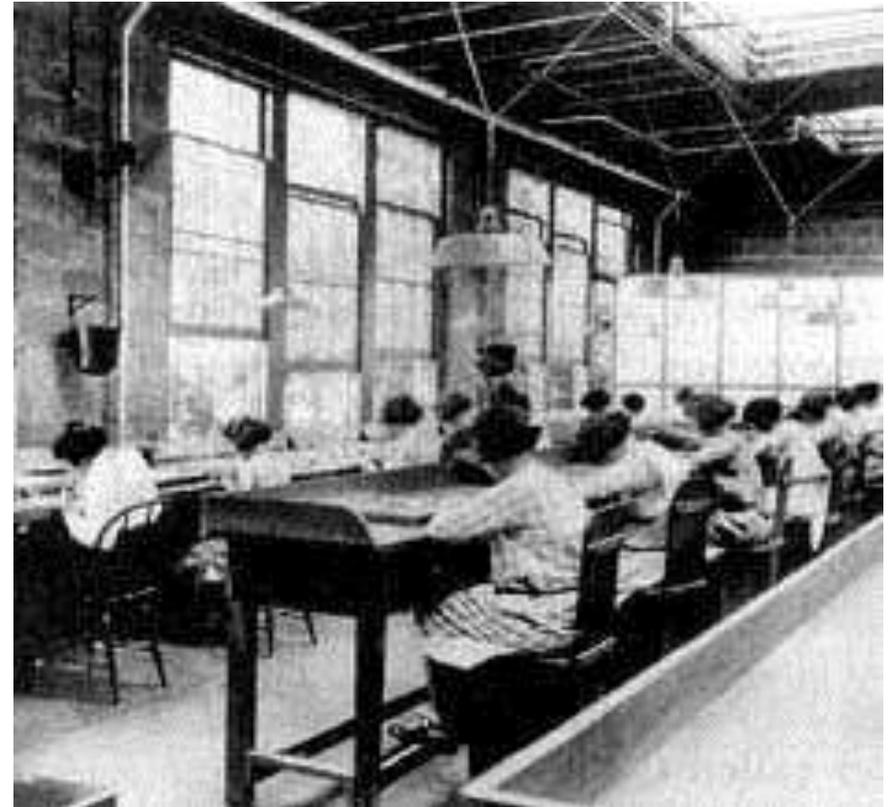
2. Draw pictures of statistical data for authorities

3. Connect with public. Contrast familiar beneficial high clinical doses and tiny Fukushima doses

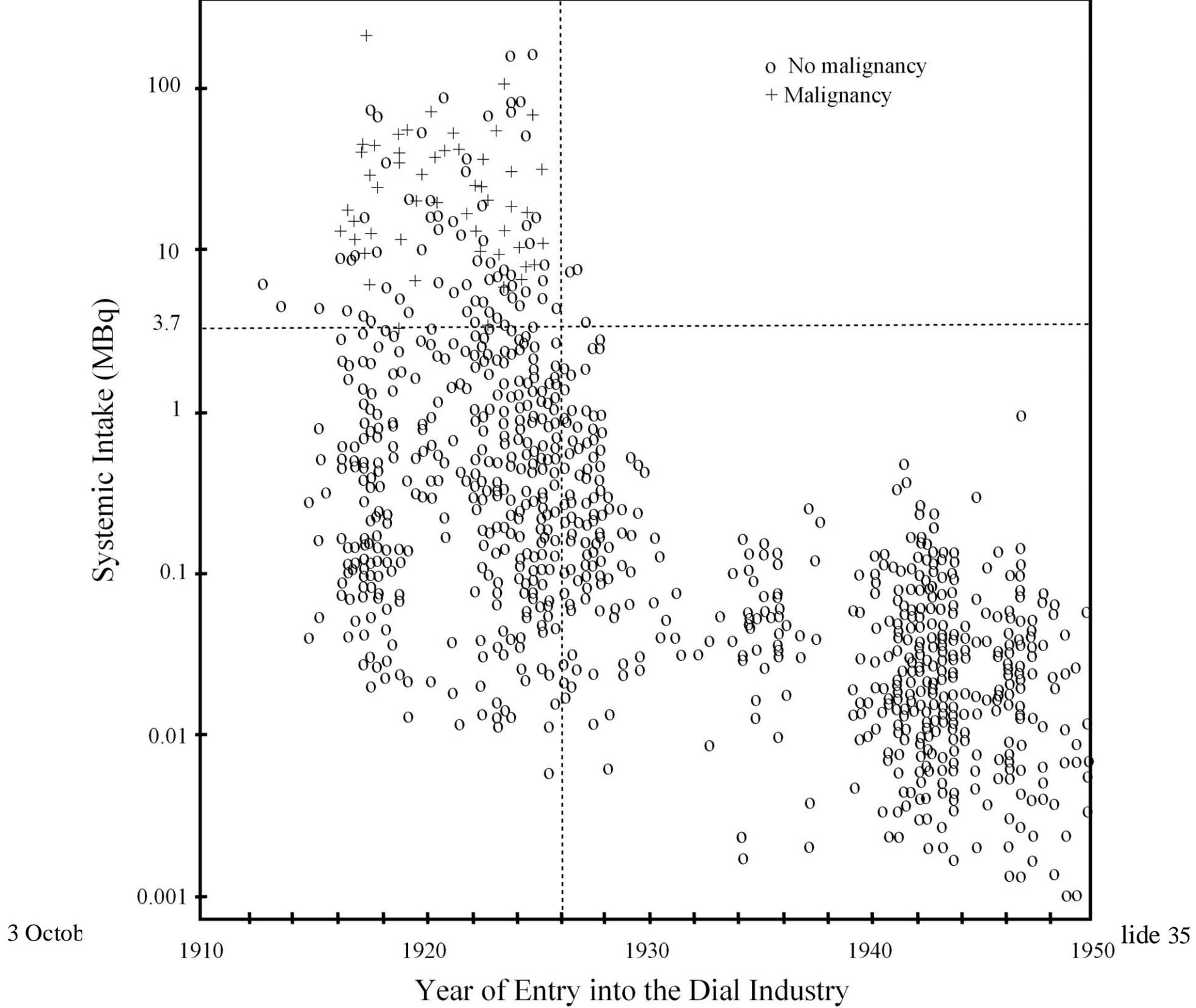
4. International lobby to end ALARA/LNT safety levels  
damage to social health, the world economy,  
the environment, industrial safety

# Cancer and lifelong chronic radiation

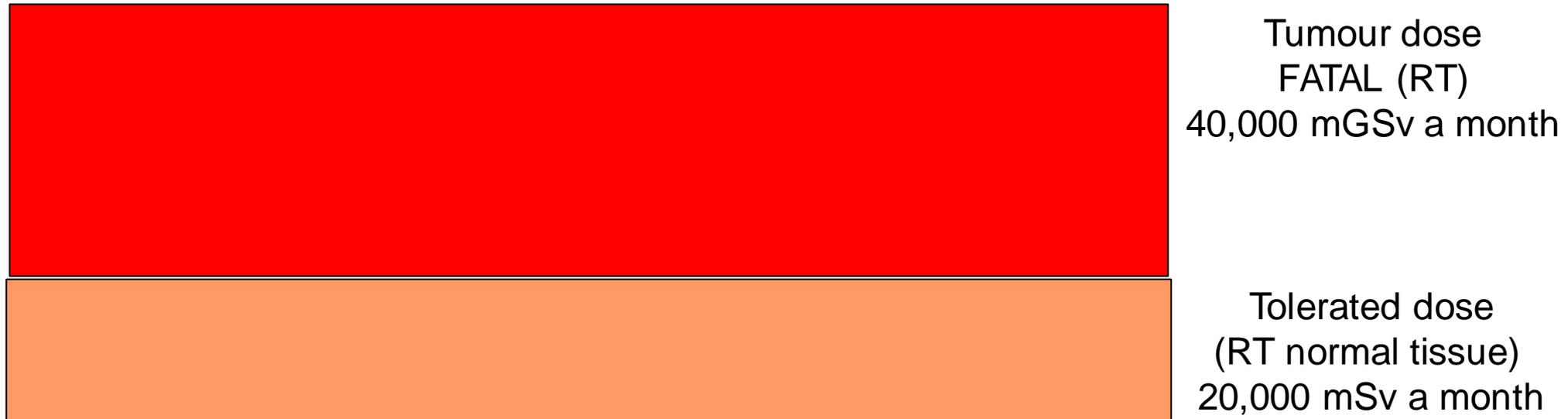
luminous watches and dials painted with radium paint



Bone cancer usually 1/400. Evidence for threshold: (Rowland 1997)  
1339 painters with less than 10,000mGy, 0 cases [3 expected]  
191 painters with more than 10,000mGy, 46 cases. [ $<1$  expected]



# Monthly doses depicted as areas



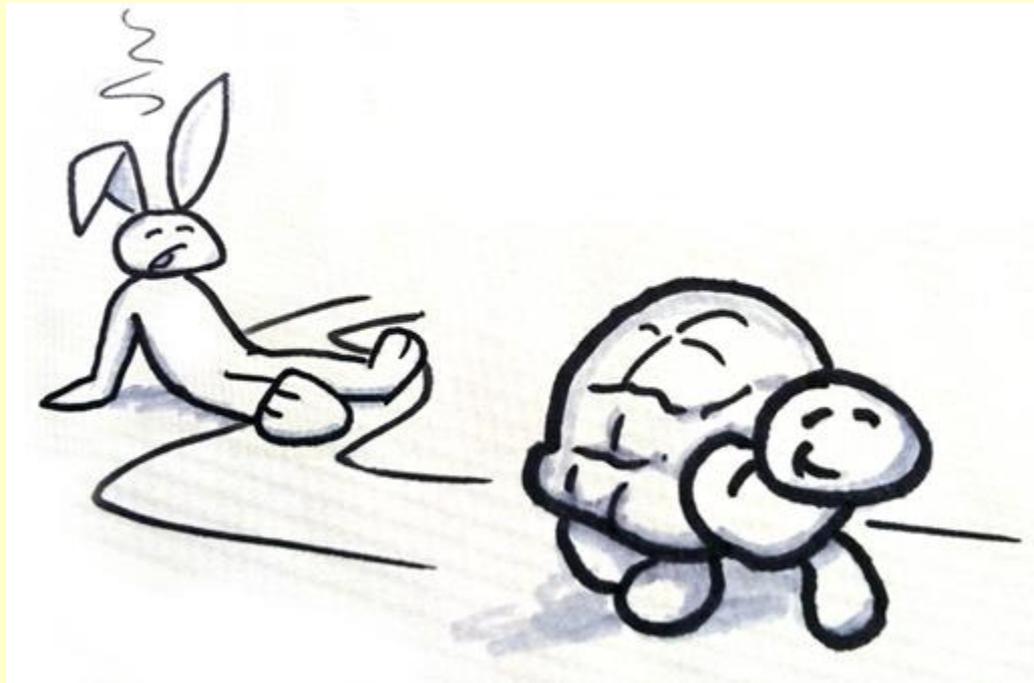
■ A **conservative safe dose** (AHARS). Less than Dial Painter threshold.  
**100 mSv per month**. [Also max **5000 mSv per lifetime**, for the present]

→ Current public “safe” dose (ALARA). Small addition to natural Background  
0.1 mSv per month, [or 1 mSv per yr]

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As High As Relatively Safe (AHARS)  
would be a relaxation by **about 1000 times** over  
As Low As Reasonably Achievable (ALARA) .

# Radiation Protection: the Tortoise and the Hare

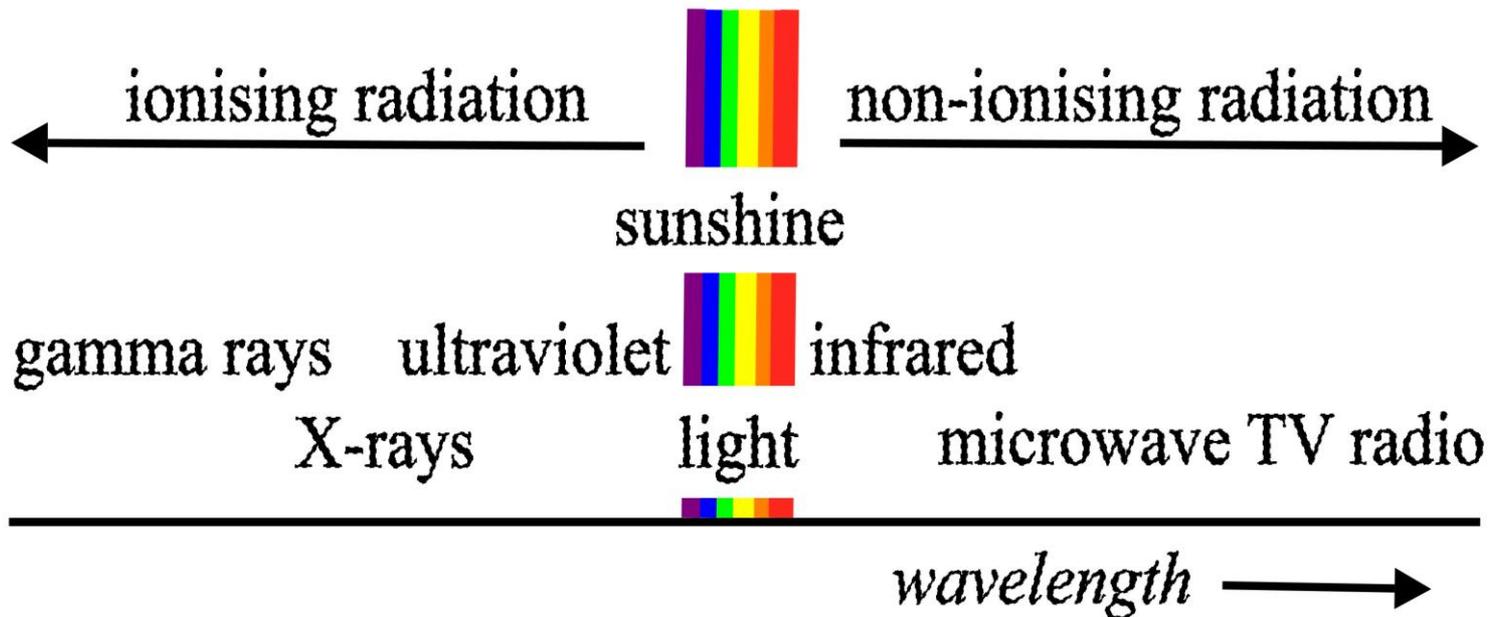


Hare: Protection by regulation based on 60 years of expert discussion with United Nations agreement

Tortoise: Protection by daily/monthly repair/adaption based on 1000 million years of *in situ* biological cellular evolution

## 8. Conclusions Attitudes, waste, costs and public policy

# The radiation spectrum

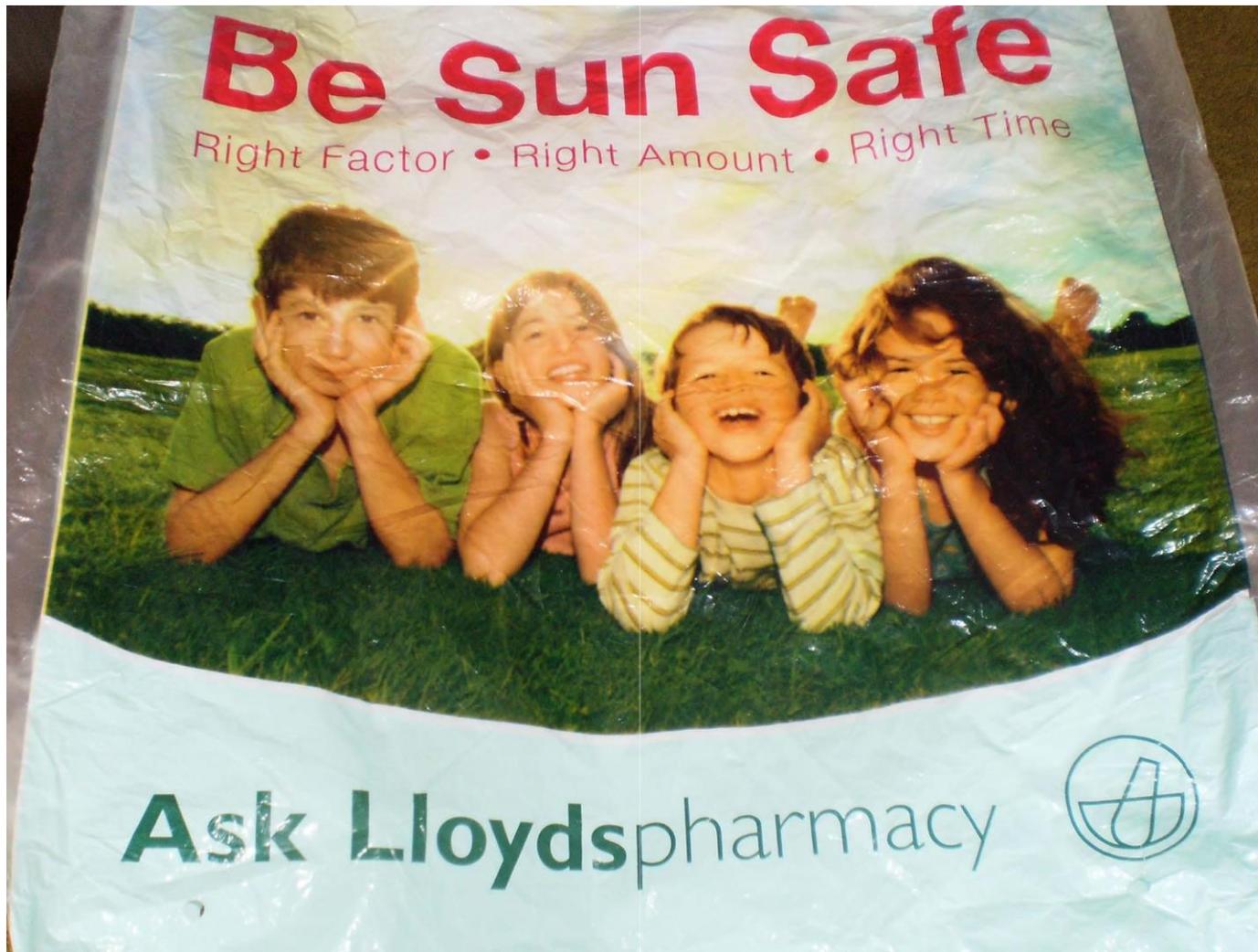


## Effects

Ionising radiation (incl UV)	Cell death DNA damage	Acute Radiation Syndrome Cancer
Non-ionising radiation	Can heat	Otherwise harmless

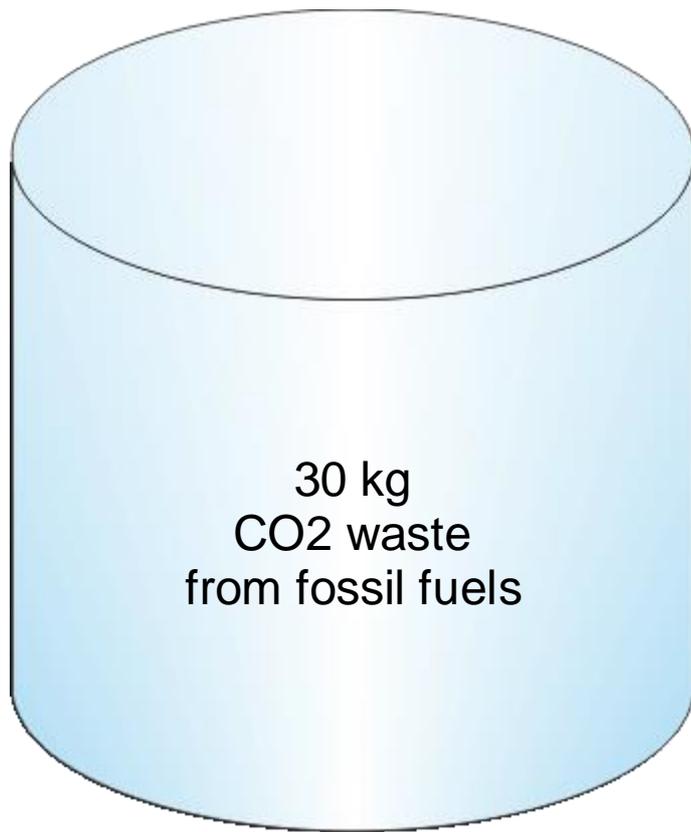
*A plastic carrier bag giving simple accessible advice about personal responsibility for safety from ionising radiation (ultraviolet in sunshine).*

*This advice engages with the enjoyment of life and common sense, not imposed safety regulations emanating from an international committee. Just the local pharmacy telling Mum and Dad -- what a breath of fresh air!*



# Waste per person per day fossil/biological/nuclear

Canister volumes show weight (UK figures)



CO2 and burning:  
Waste directly into air driving climate change.  
Fire (thermal chain reaction)  
causing 000s deaths a year



Faeces and disease:  
Waste directly into environment driving disease.  
Disease (biological chain reaction)  
causing 000,000s deaths a year

1/4000 kg   
high level nuclear waste

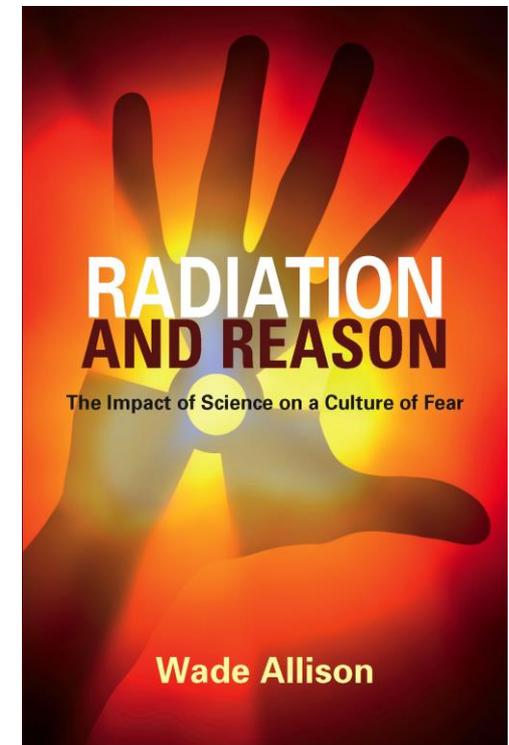
Nuclear waste: Contained and suitable for safe burial.  
No increase outside a working nuclear reactor.  
In 50 years about 50 deaths (Chernobyl).

# Conclusions

1. Radiation is **not global danger** like:  
climate change,  
political & economic instability,  
population, water and food
2. Major **cost reduction**, no extra risk, no ALARA/LNT  
New **safety thresholds**, AHARS As High As Relatively Safe  
*example* 100mSv single acute dose,  
100mSv per **month** chronic/protracted dose rate,  
5000mSv whole-of-life (for now)
3. **Education** to remove stigma of nuclear,  
build trust in science and society  
by explanation in simple terms
4. **Nuclear technology** for individual health,  
power, fresh water, food preservation,  
health of the planet.

Books and articles/lecture/interviews (free download)

[www.radiationandreason.com](http://www.radiationandreason.com)



# END

# SARI

## Scientists for Accurate Radiation Information

To help prevent unnecessary radiation-phobia-related deaths, morbidity and injuries associated with nuclear/radiological emergencies through countering phobia-promoting misinformation spread by alarmist via the news and other media including journal publications.

*Letter sent to the Gen. Sec. of UNSCEAR*

*Letter to be sent to Shinzo Abe, Japanese PM*

## Is local dose or wholebody dose the important measure?

1. The initial energy loss is local (LET)
2. The early cell damage is local except for some spread by ROS migration/ the Bystander Effect
3. It is granted that the **same** local dose when applied over a larger volume should have an incidence of disease proportional to that volume.
4. In Radiotherapy it is the local radiation dose that kills the cells, not the wholebody dose, otherwise directing the dose would be pointless
5. Secondary cancers occur in the irradiated region.
6. Sites of initial carcinogenesis are relatively local to the causative radiation site: eg skin cancers are on the exposed skin, smoking gives mainly lung cancer, excess drinking gives mainly liver cancer not lung or skin cancers, etc Most precisely, radio-iodine is trapped by the thyroid and causes thyroid cancer, not another cancer.)
7. Only when the cancer metastasises does it migrate elsewhere
8. The idea that wholebody dose is the appropriate measure comes from the LNTH which would validate dose averaging, as it would for a whole population (as in use of man-sievert).

26 March 2011 Last updated at 12:50

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## Viewpoint: We should stop running away from radiation

By Wade Allison  
University of Oxford

More than 10,000 people have died in the Japanese tsunami and the survivors are cold and hungry. But the media concentrate on nuclear radiation from which no-one has died - and is unlikely to.

Nuclear radiation at very high levels is dangerous, but the scale of concern that it evokes is misplaced. Nuclear technology cures countless [cancer patients](#) every day - and a radiation dose given for radiotherapy in hospital is no different in principle to a similar dose received in the environment.

What of Three Mile Island? There were no known deaths there.

And Chernobyl? [The latest UN report](#) published on 28 February confirms the known death toll - 28 fatalities among emergency workers, plus 15 fatal cases of child thyroid cancer - which would have been avoided if iodine [tablets](#) had been taken (as they have now in Japan). And in each case the numbers are minute compared with the 3,800 at Bhopal in 1984, who died as a result of a leak of chemicals from the Union Carbide pesticide plant.

So what of the radioactivity released at Fukushima? How does it compare with that at Chernobyl? Let's look at the measured count rates. The [highest rate reported, at 1900 on 22 March, for any Japanese prefecture](#) was 12 kBq per sq m (for the radioactive isotope of caesium, caesium-137).

A [map](#) of Chernobyl in the UN report shows regions shaded according to rate, up to 3,700 kBq per sq m - areas with less than 37 kBq per sq m are not shaded at all. In round terms, this suggests that the radioactive fallout at Fukushima is less than 1% of that at Chernobyl.



Modern reactors are better designed than those at Fukushima - tomorrow's may be better still

### Becquerels and Sieverts

- A becquerel (Bq), named after French physicist Henri Becquerel, is a measure of radioactivity
- A quantity of radioactive material has an activity of 1Bq if one nucleus decays per second - and 1kBq if 1,000 nuclei decay per second
- A sievert (Sv) is a measure of radiation absorbed by a person, named after Swedish [medical](#) physicist Rolf Sievert
- A milli-sievert (mSv) is a 1,000th of a Sievert

[Q&A: Health effects of radiation](#)

Allison  
26 Mar 2011  
15 days

And later in the article I wrote

*Unfortunately, public authorities react by providing over-cautious guidance - and this simply escalates public concern."*

## No rise in cancer rates after Fukushima disaster - UN

Cancer rates are not expected to rise as a result of the Fukushima nuclear disaster in Japan, UN scientists say.

The evacuation of thousands of people shortly after the [accident](#) in 2011 sharply lowered their exposure to radiation, a draft report concluded.

The World Health Organisation has said local residents have a slightly higher risk of developing certain cancers.

Reactors at the Fukushima nuclear plant were crippled by an earthquake and tsunami that killed some 19,000 people.

It was the world's worst nuclear incident since Chernobyl in 1986.

### 'No radiation-related deaths'

The findings of the [draft](#) report were presented by the UN Scientific Committee on the Effects of Atomic Radiation (Unsear) in the Austrian capital, Vienna.

Committee member Wolfgang Weiss said the decision by the Japanese authorities to evacuate large numbers of people had proved to be the right one.

"If that had not been the case, we might have seen the cancer rates rising and other health problems emerging over the next several decades," he added.

Unsear's report also stated that "no radiation-related deaths have been observed among nearly 25,000 workers involved at the accident site".

Studies after Chernobyl linked cases of thyroid cancer to radioactive iodine that contaminated milk. But Mr Weiss said that had not been the case in Japan.

The report was prepared by 80 scientists from 18 countries and will be published in full later this year.

The findings contradicted a report published by the WHO in February, which said the risk of cancer for those living near the nuclear plant had risen.



The Fukushima nuclear plant was crippled by the deadly earthquake and tsunami on 11 March 2011

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"It is this upheaval to people's lives that has brought real health effects, and these will need "special attention" in coming years," said Carl-Magnus Larsson, chair of UNSCEAR.

**"Families are suffering and people have been uprooted and are concerned about their livelihoods and futures, the health of their children... it is these issues that will be the long-lasting fallout of the accident."**