Increased leukemias near nuclear power stations

Dr Ian Fairlie
Consultant on Radiation in the Environment
London
United Kingdom

Childhood leukemias near nuclear facilities

- in 1980s and 1990s, large increases found near Windscale, Dounreay, Burghfield
- NRPB said - not due to radiation as doses were 300 x too low
- debate fizzled out: few had the expertise to challenge NRPB/COMARE
- Major legal case Reay v BNFL lost

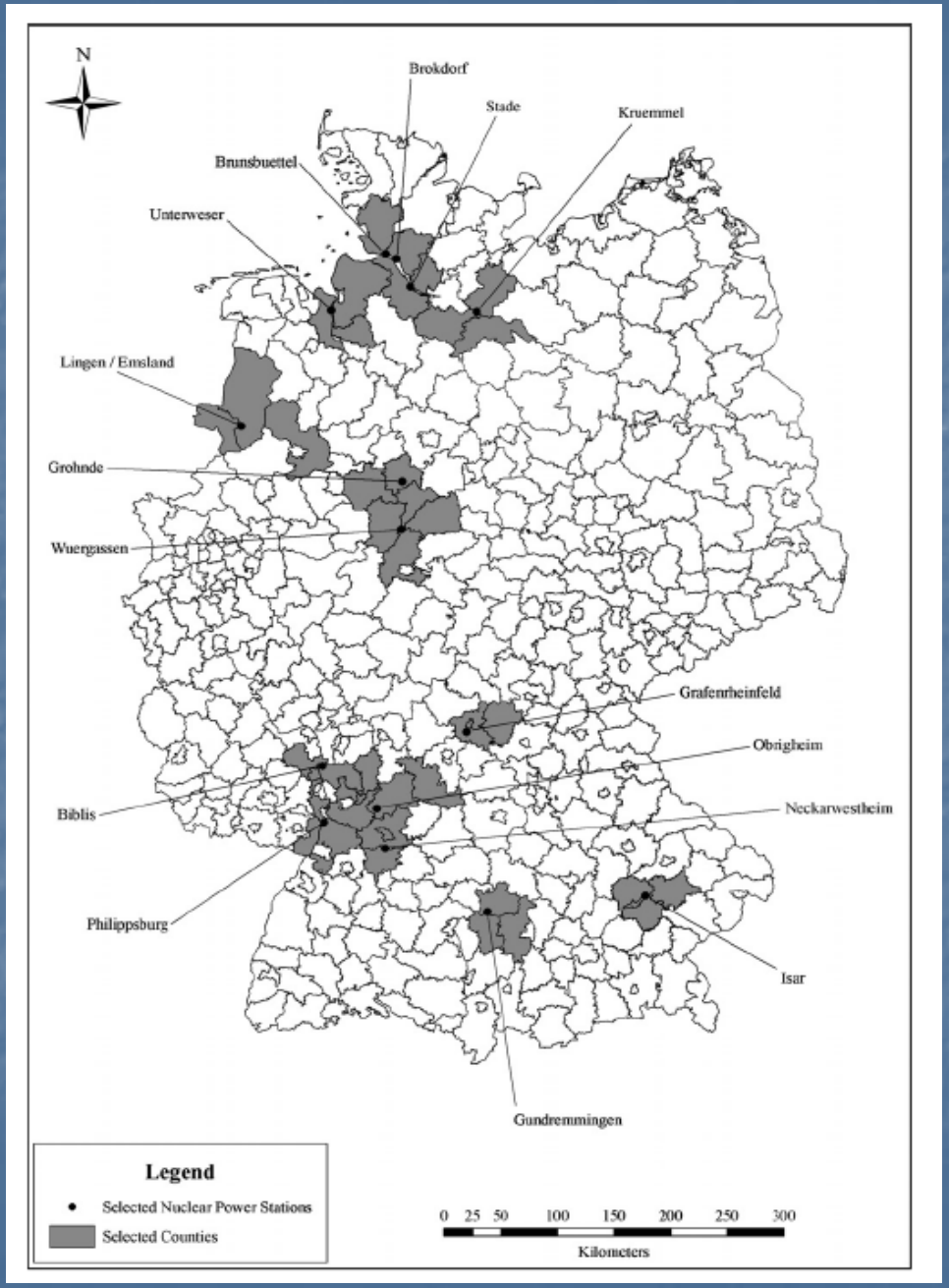
Recent KiKK study in Germany has reignited the debate

- ongoing debate in Germany

- almost unknown here

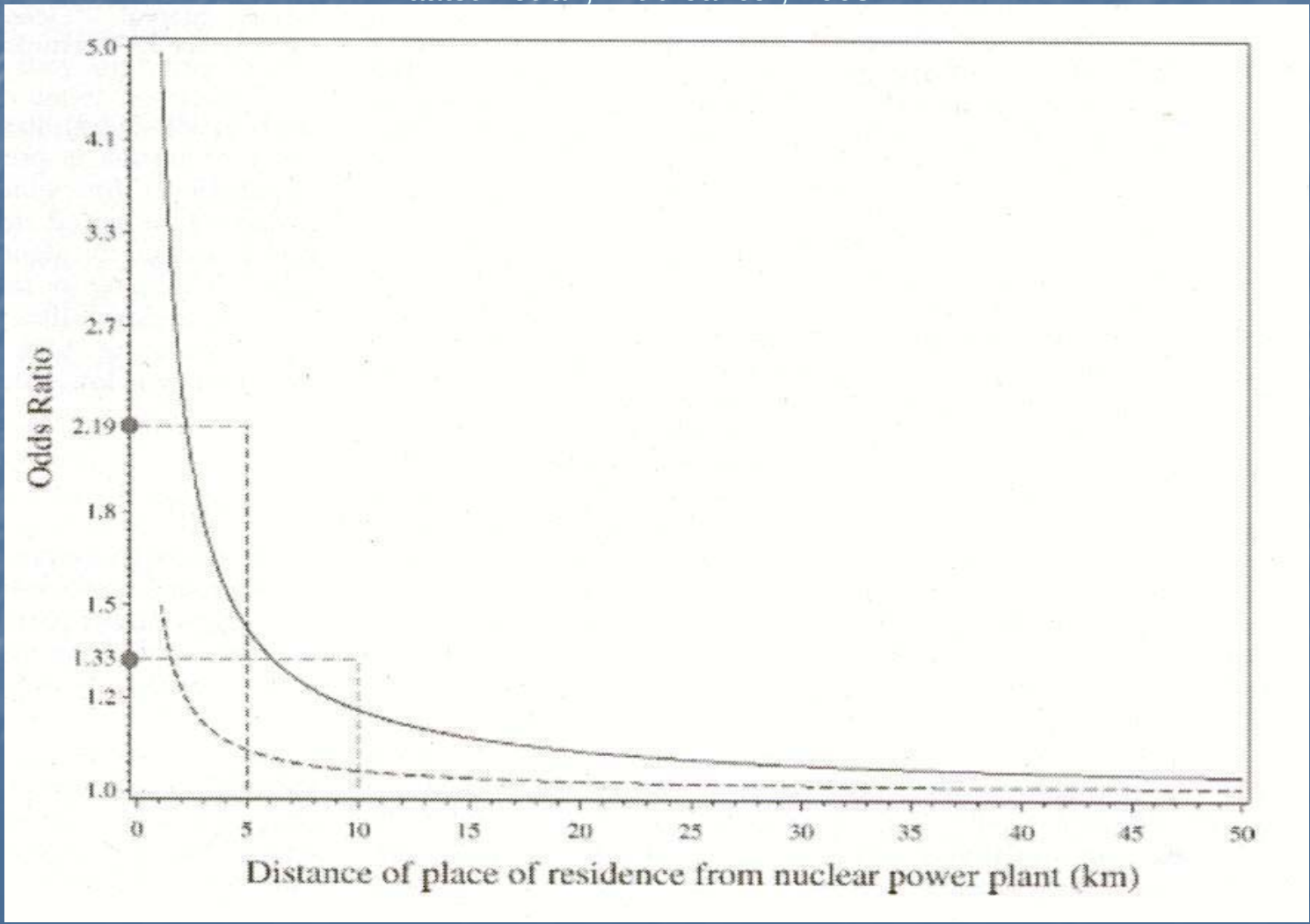
German KiKK Study

- increased cancer incidences near all (16) German nuclear reactors
- commissioned by German Government
- 2.2 x increase in child leukemias
- 1.6 x increase in embryonic tumours
- strongly linked to living near reactors
- accepted by German Government


N
Brokdorf
Stade
Kruemmel
Brunsbuettel
Unterweser
Lingen / Emsland
Grohnde
Wuergassen
Grafenrheinfeld
Obrigheim
Neckarwestheim
Biblis
Philippsburg
Isar
Gundremmingen
Legend
Selected Nuclear Power Stations
Selected Counties
0 25 50 100 150 200 250 300
Kilometers

the closer to reactor – the greater the child leukemia risk

Kaatsch et al., Int J Cancer, 2008



As a result of KiKK Report

- No new NPPs proposed in Germany
- Instead RWE and E.ON are proposing to build them in UK

KiKK: Possible Causes

- coincidence X
- population-mixing (ie a virus) X
- chemicals X
- radiation ?

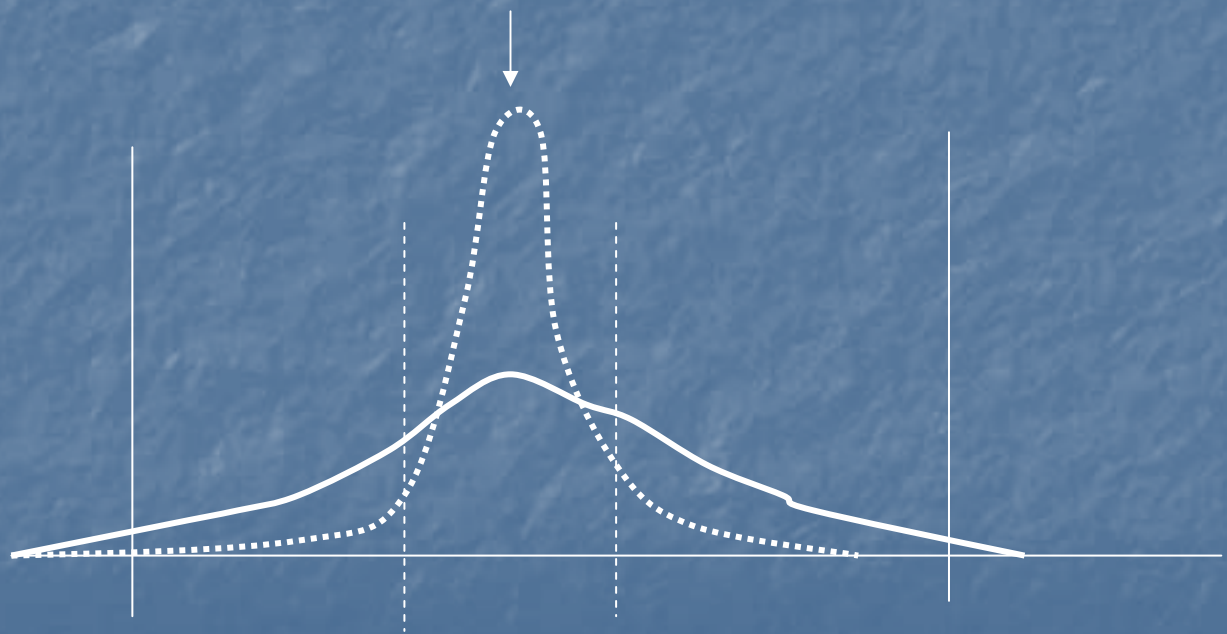
  but KiKK study *said* estimated radiation doses/risks were too low

Large uncertainties in estimated doses/risks near reactors

- Environmental models (behaviour of nuclides in environment)
- Biokinetic models (uptake and retention of nuclides in humans)
- Dosimetric models (convert Bq to mGy: mSv)
- Weighting factors (tissue W_T and radiation W_R)
- *in utero* exposures?

ie OFFICIAL DOSES/RISKS HAVE MANY UNCERTAINTIES (CERRIE Report www.cerrie.org)

Uncertainty Distributions in Dose Estimates



Uncertainties in Dose Coefficients

Goossens LHJ, Harper FT, Harrison JD, Hora SC, Kraan BCP, Cooke RM (1998) Probabilistic Accident Consequence Uncertainty Analysis: Uncertainty Assessment for Internal Dosimetry: Main Report. Prepared for U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, USA. And for Commission of the European Communities, DG XII and XI, B-I049 Brussels Belgium. NUREG/CR-6571 EUR 16773.

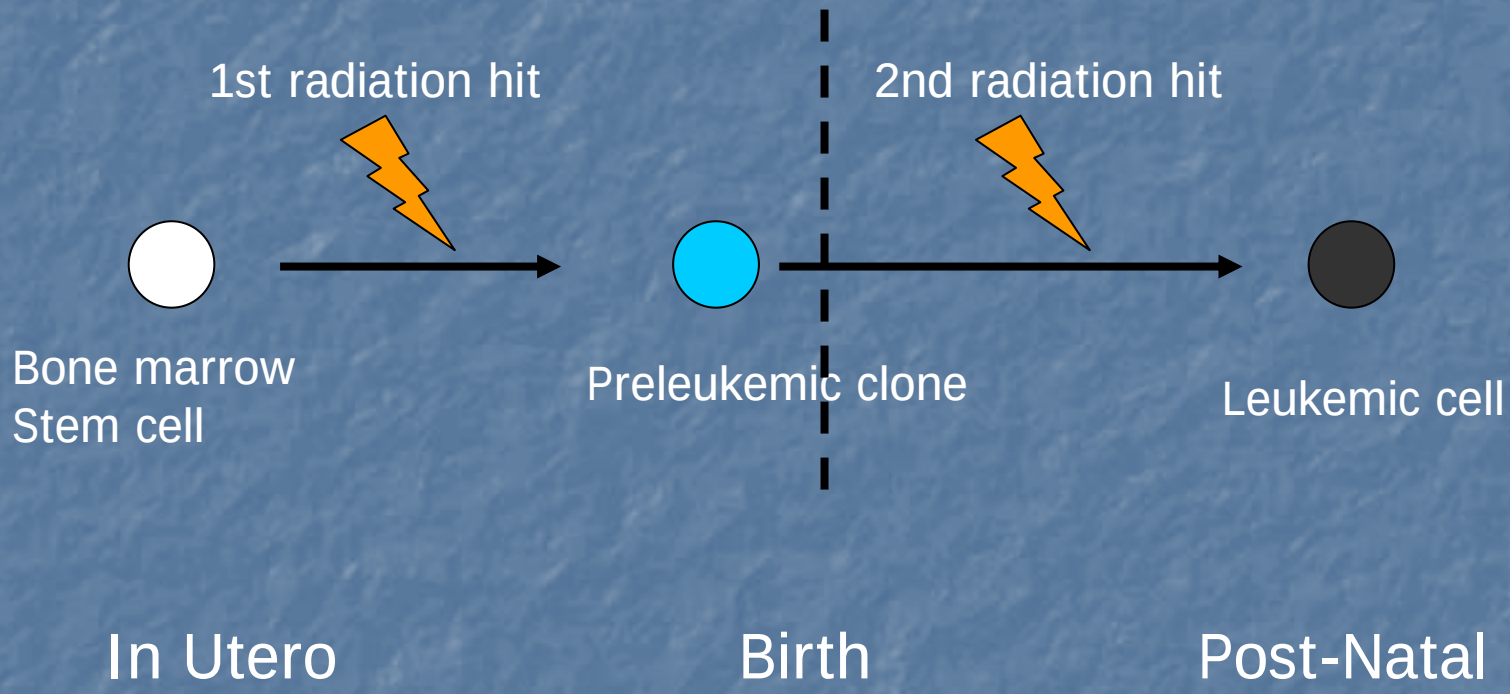
Nuclide	**Intake**	**Organ**	**U Range = (ratio of $95^{th}/5^{th}$ percentiles)**
Cs-137	ingestion	red bone marrow	4
I-131	inhalation	thyroid	9
Sr-90	ingestion	red bone marrow	240
Pu-239	ingestion	red bone marrow	1,300
Sr-90	inhalation	lungs	5,300
Ce-144	inhalation	red bone marrow	8,500
Pu-239	ingestion	bone surface	20,000

Possible biological mechanism to explain KiKK findings

- spikes in reactor releases
- high concentrations in embryos/fetuses
- babies born pre-leukemic, 1-2 years later develop full leukemia
- + babies born with embryonic tumours

Leukemogenesis in Children

(after Roessig)



4 Stages

1st Stage – Emissions from NPPs

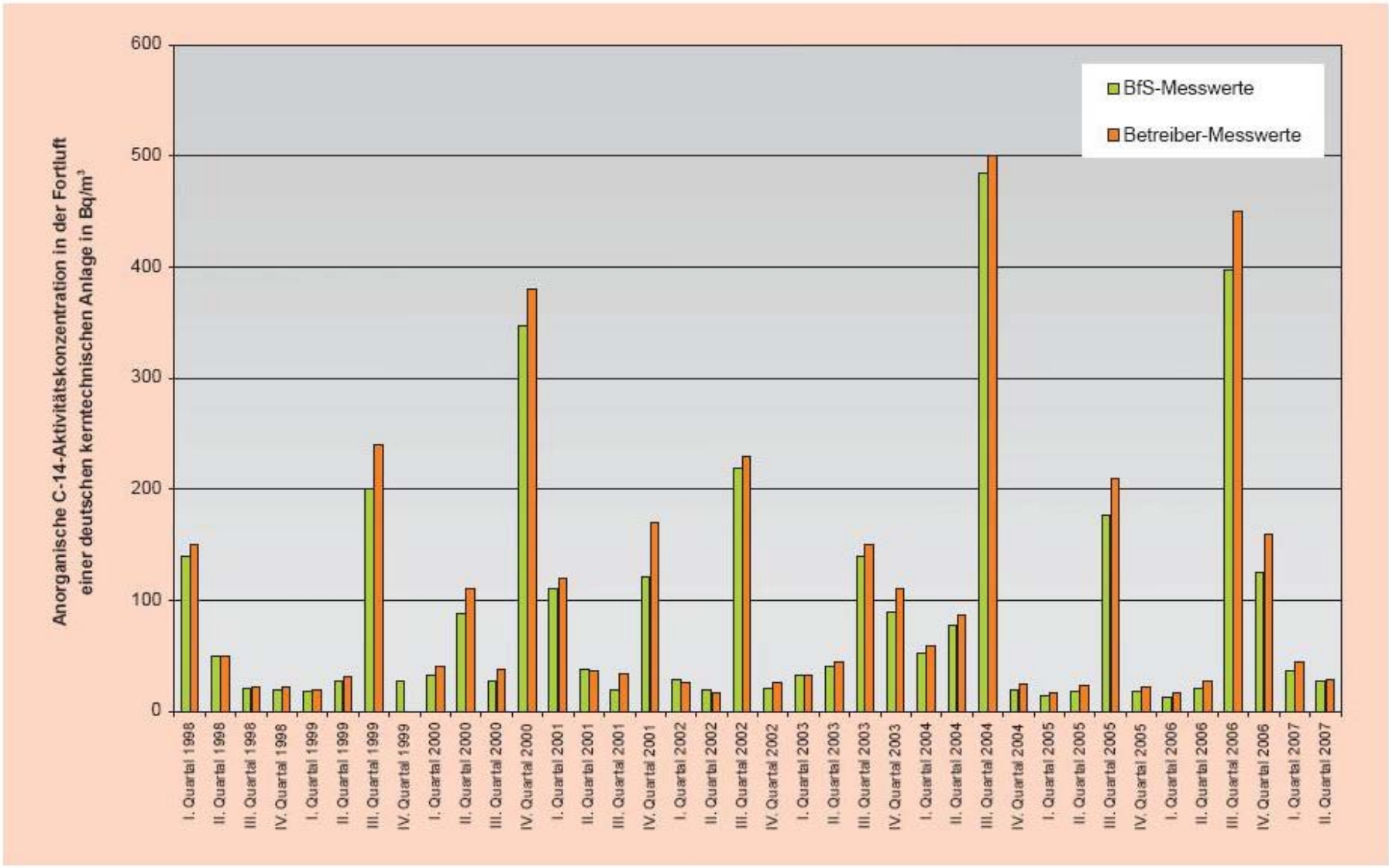
2nd Stage – Environmental transport

3rd Stage – Human doses

4th Stage – Resulting cancer risks

1st Stage – Environmental Emissions

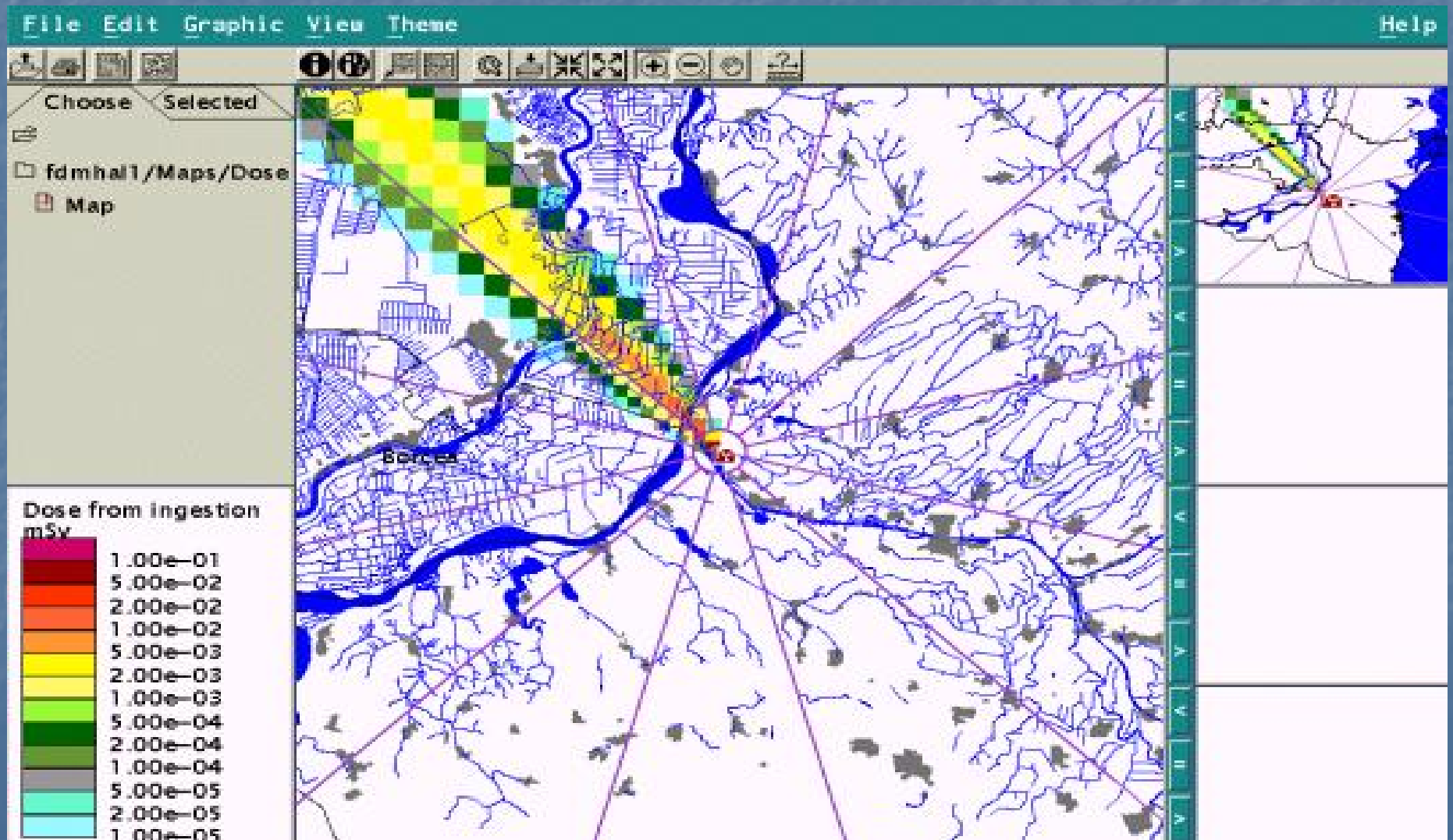
- when reactors opened –a pulse of radioactive gases
- raised concentrations in biota downwind



Vergleich der vom Betreiber und dem BfS ermittelten Kohlenstoff-14-Aktivitätskonzentrationen in der Fortluft am Beispiel eines süddeutschen Druckwasserreaktors (KKW Neckarwestheim 2)

Tritium doses from ingestion (EU RODOS Model) in mSv

8th Meeting of the IAEA (EMRAS) Tritium & C-14 Working Group
May 30 - June 1, 2007 - Bucharest, Romania (http://www.nipne.ro/emras/)



Estimated tritium levels in cow's milk (EU RODOS Model) OBT Bq/kg

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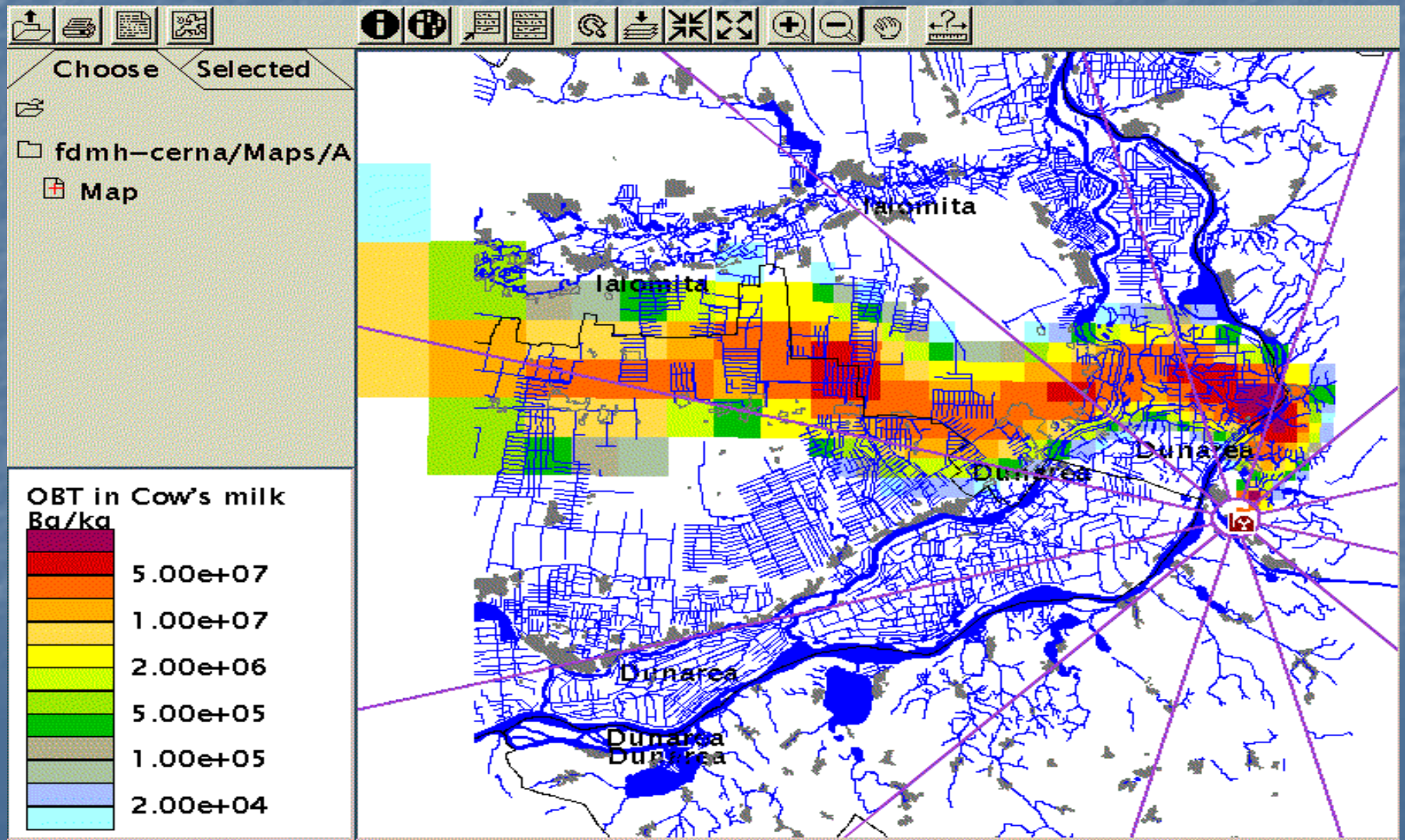
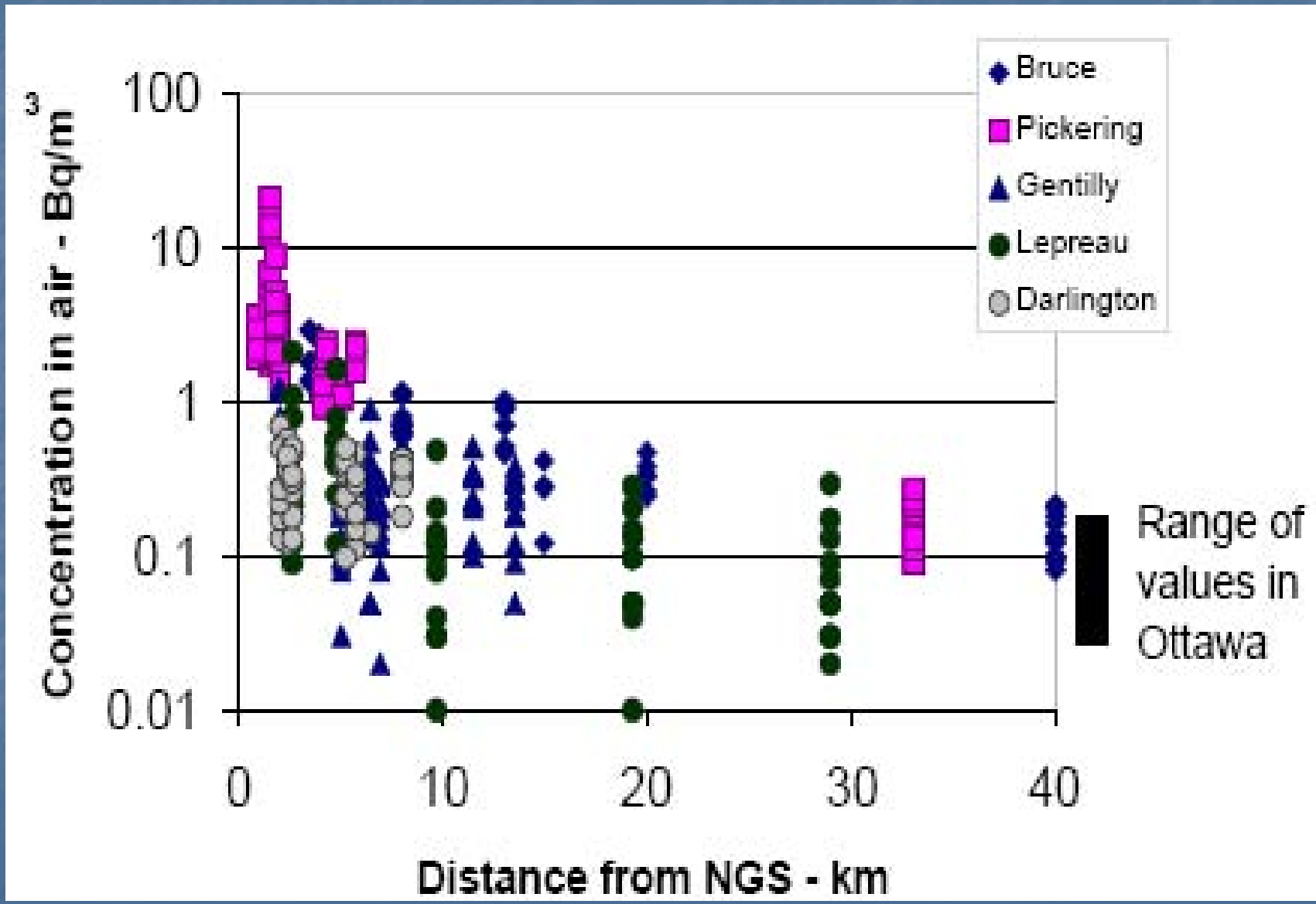
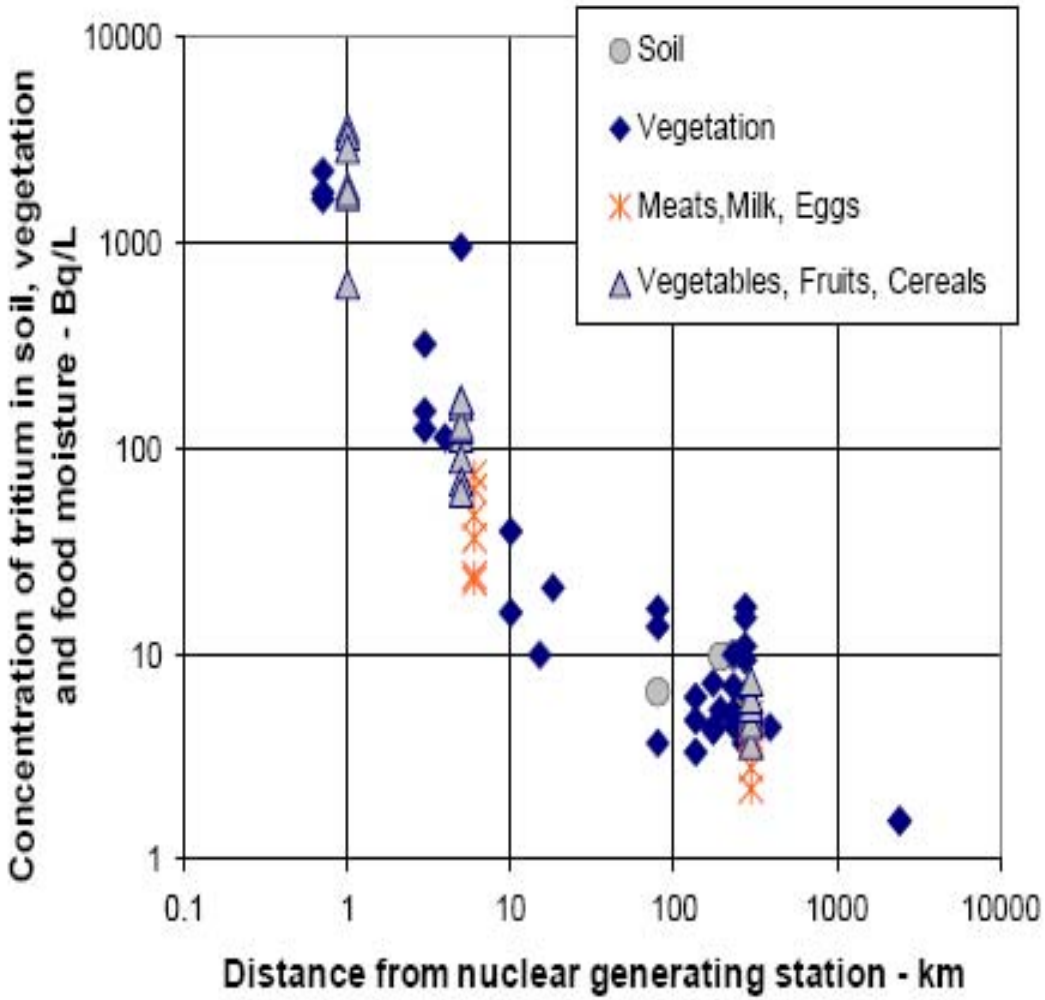


Tritium in air



Tritium in Food Moisture



2nd Stage – into Humans

1. breathing
2. skin absorption
3. eating contaminated food
4. drinking contaminated water
5. is incorporated in embryos /fetuses (including bone marrows)

Tritium absorbed by adults near Canadian nuclear station

Source	Bq/year
Water in food	850,000
Air Inhalation	84,000
Water in drinks	55,000
Skin absorption	33,000
OBT in food	~53,000
TOTAL	**~1,000,000 Bq/year**

3rd Stage –Doses?

- Data from Oxford Study on Childhood Cancer (by Alice Stewart) suggests fetal doses at KiKK were ~ a few mGy
- suggests most child leukemias due to background radiation?

4th Stage – Cancer Risks?

Official (ICRP) risks are to the whole body, to a general population, averaged over all ages

- Irrelevant for embryos/fetuses
- Irrelevant for bone marrow

Official adult leukemia risks are ~100 times too low for infants, based on OSCC data

"We conclude that there is strong evidence that low dose irradiation of the fetus *in utero*, particularly in the last trimester, causes an increased risk of cancer in childhood."

Doll R and Wakeford R (1997) Risk of childhood cancer from fetal irradiation. Br J Radiol; 70: 130-9

Increased child leukemias near UK nuclear power stations?

- yes, Gov't study found a 23% increase
- but study said data not statistically significant, therefore "no suggestion" of cancer
- bad science - low statistical significance should not be interpreted as measuring the probability of effect
- should be guided by the larger German KiKK study (data were statistically significant)

Main Radioactive Releases to air from UK Nuclear Facilities

- noble gases (mainly Kr-85)
- tritium (as water vapour)
- carbon-14
- iodine-129

Which Nuclides are Hazardous?

(after Gerald Kirchner)

Tritium = √ Carbon-14 = √

1. large releases √ √
2. rapid transport and cycling in biosphere √√
3. high solubility √
4. many environmental pathways to humans √√
5. rapid molecular exchange (ie v fast intakes) √
6. high uptake to blood after intake √
7. organic binding ie long residence in humans √√
8. long radiological half-life √√
9. global distribution √√

Precautionary Principle

- if good evidence of toxic effects, - then take precautionary steps
- uncertainty (eg re mechanisms) should not be used as excuse for inaction

Recommendations

1. Use the Precautionary Principle
2. Further studies (EU wide)
3. Advise local people of KiKK study
4. Rethink plans to build new reactors

Thanks to

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