Implications for radiation protection regulations

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Possible fields with implications for radiation protection regulations

- Dependence of radiosensitivity on
  - age
  - gender
  - the individual in general
- The cataract issue
- The cardiovascular issue
- The radon issue
- The low dose problem

Dependence of radiosensitivity on age

Examples where specific age groups show a higher radiosensitivity compared to middle-aged adults

- Leukaemia (fetus)
- Thyroid carcinoma (young children)
- Basal cell carcinoma (children and teens)
- Breast cancer (girls during puberty)
- Breast cancer (women under 30 years)
- Lung cancer (individuals older than 50)

The major radiation problem during pregnancy:

Leukaemia risk!

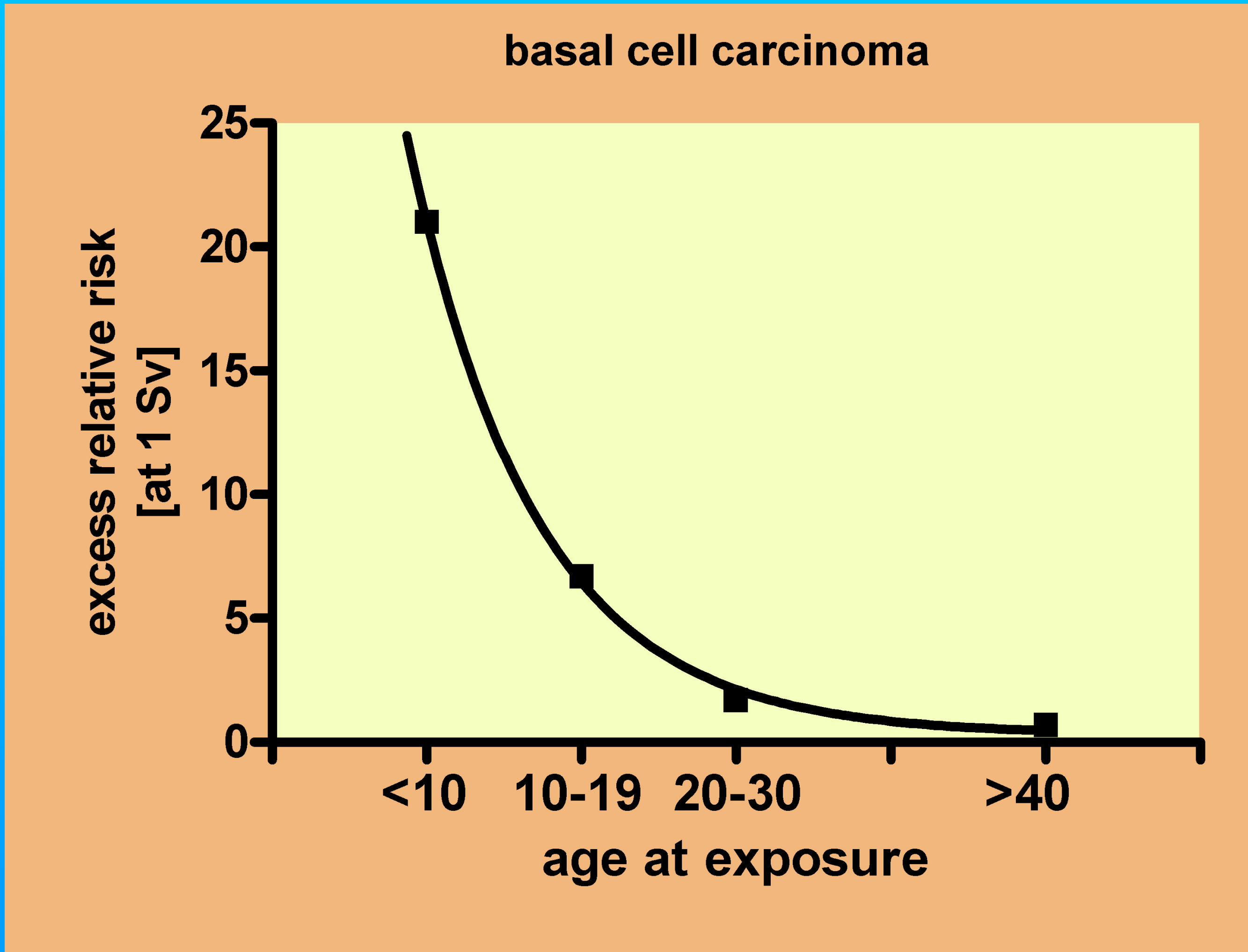
Statistically significant effect at: 10 mSv!

Doubling dose: about 30 mSv!

But:

Doubling the risk means
10 cases per 100.000 children per year
instead of 5 cases.

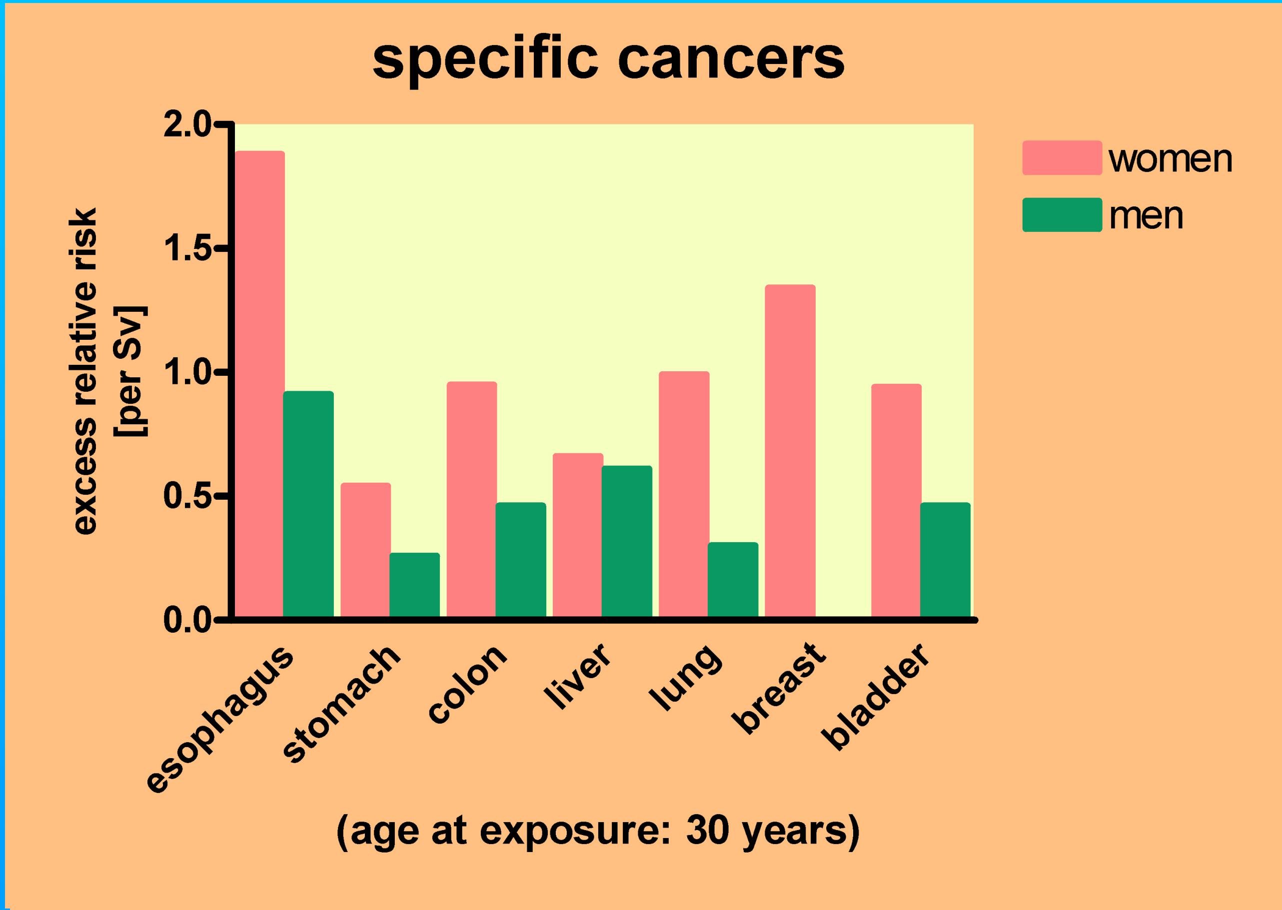
Specific example of age dependence: basal cell carcinoma



Source: UNSCEAR 2000, Annex I, p. 422

Dependence of radiosensitivity on gender

Examples where higher radiation risks have been shown for women compared to men



Source: UNSCEAR 2000, Annex I, p. 425

Individual radiosensitivity in general

Pronounced side effects during radiation therapy

Esophagus carcinoma; reaction after 10 fractions of 2 Gy each; skin dose about 10 Gy

Some known biological factors that determine radiosensitivity

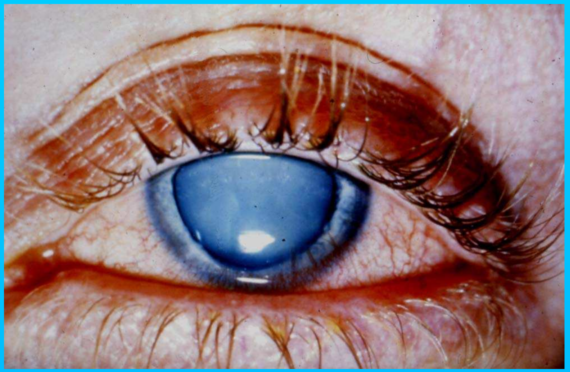
(in alphabetical order)

- Adaptive response
- Apoptosis
- Bystander effect
- Cell-cycle checkpoints
- Cell proliferation
- Cell migration
- Cell differentiation
- Enzyme status
- Genetic predisposition
- Genomic instability
- Hormone status
- Immune competence
- Oxygen supply
- Repair characteristics

Right now, this list is more or less a reminder of what to take into consideration, when it comes to the question of how to assess radiosensitivity.

The cataract issue

Problem:



- **Until recently, it was thought that radiation-induced cataracts emerge only after exceeding a threshold dose of about 1 to 2 Gy (acute exposure) and about 5 to 6 Gy (chronic exposure).**
- **It was overlooked that latency period increases with decreasing dose.**
- **Analyses show now that, if there is a threshold dose at all, then it will be, at least, tenfold lower than previously thought.**

The cardiovascular issue

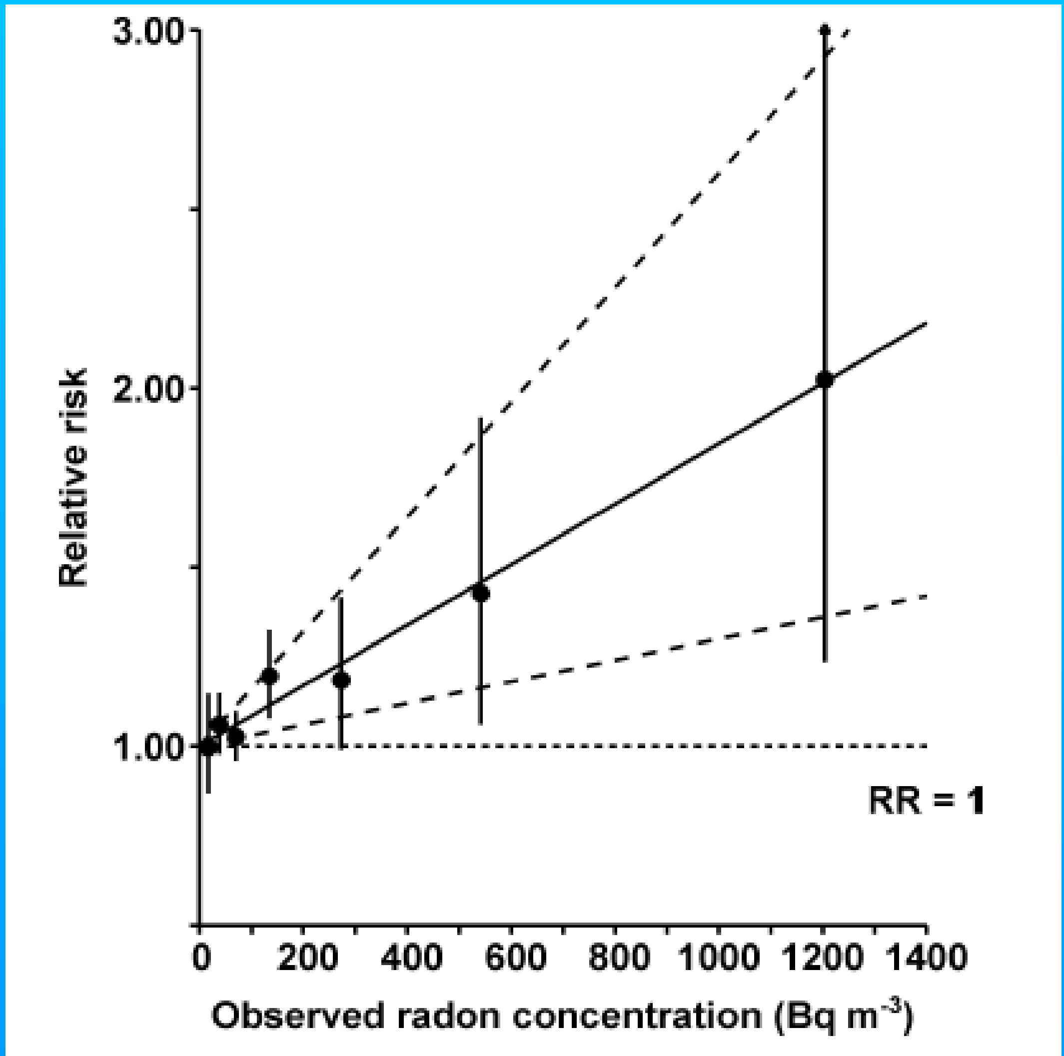
Comparison of CVD findings from various studies of external exposure

Cohort	Mean cumulative dose (Gy)	Mortality or *morbidity*?	No. of deaths or cases	ERR/Gy
Japanese A-bomb survivors:				
LSS	0.20	Mortality	3,954	0.12 (90% CI 0.02, 0.22)
Adult Health Study	0.57	*Morbidity*	729	0.07 (95% CI -0.08, 0.24)
Mayak workers	0.84	Mortality	753	-0.02 (95% CI -0.12, 0.07)
Mayak workers	0.84	*Morbidity*	4,418	0.46 (95% CI 0.36, 0.57)
Nuclear workers (international)	0.018	Mortality	1,224	0.88 (95% CI -0.67, 3.16)
BNFL workers (UK)	0.053	Mortality	1,018	0.43 (90% CI -0.10, 1.12)
Chernobyl recovery operations workers (Russia)	0.109	*Morbidity*	12,832	0.45 (95% CI 0.11, 0.80)

Source: Azizova, Muirhead; Article 31 seminar 2008

The radon issue

Indoor radon risk



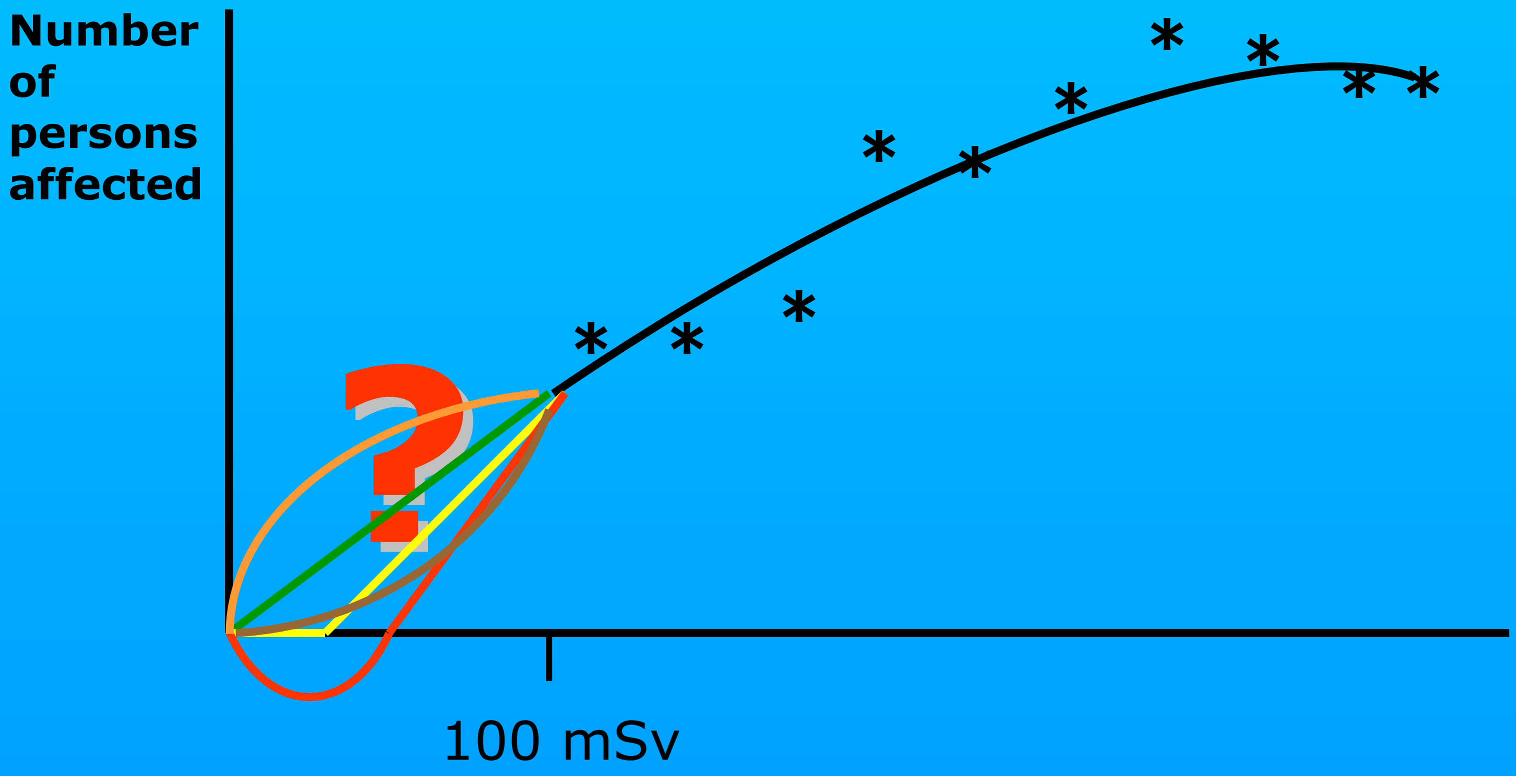
„Darby-Study"; statistically significant increase in lung tumor risk in the range of:

100-199 Bq m^{-3}

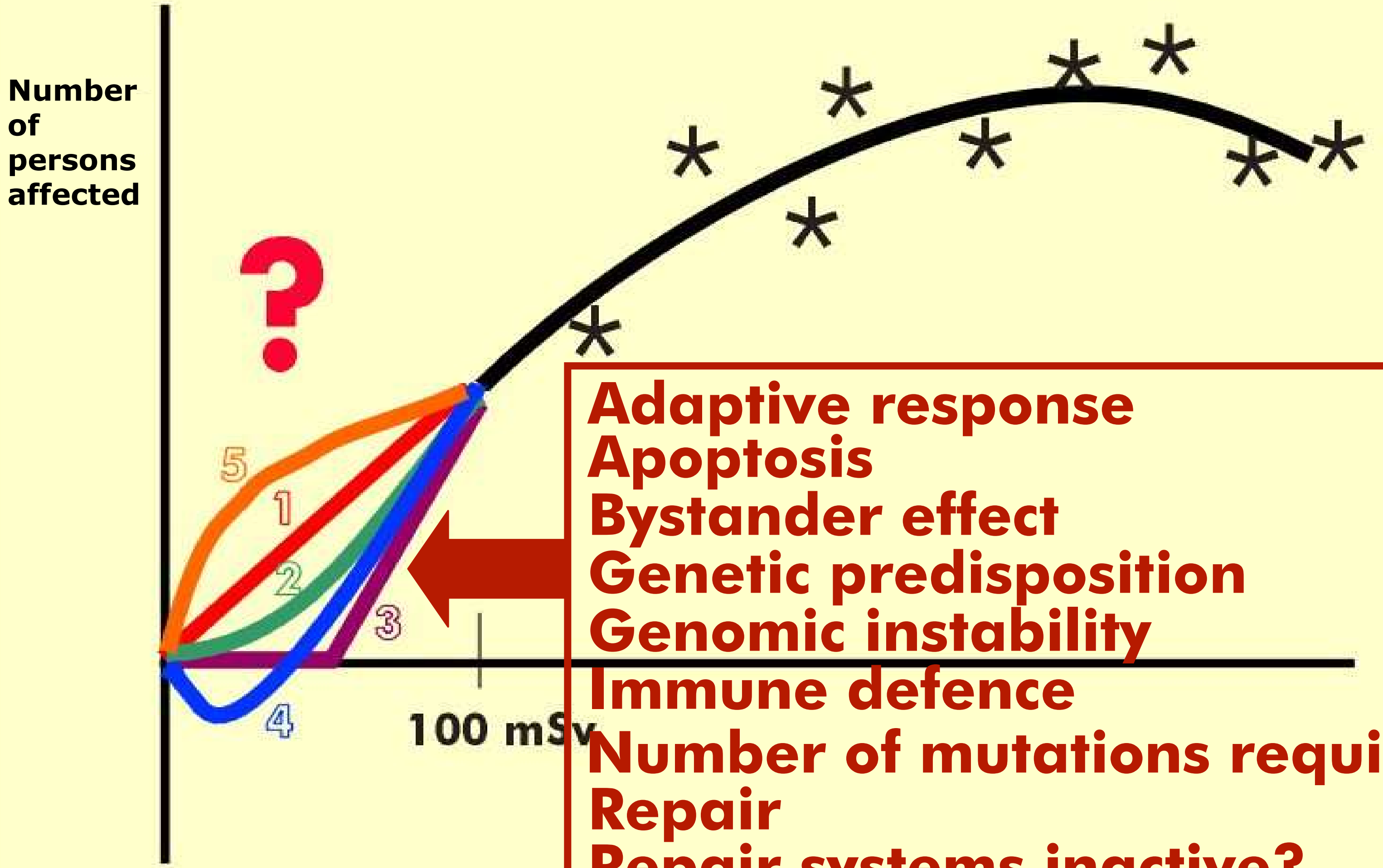
The low dose problem and its possible solution:

Identification of the underlying biological mechanisms

The well-known problem



Biological mechanisms relevant in the low dose range



Adaptive response
Apoptosis
Bystander effect
Genetic predisposition
Genomic instability
Immune defence
Number of mutations required
Repair
Repair systems inactive?

What might be done in the context of radiation protection regulations? (1)

- *Dependence of radiosensitivity on*
  - *age*

    There are already regulations (protection of the fetus by the monthly uterus dose limit, protection of people below the age of 18). But the 100 mSv per year limit for the planning of permanent relocation suggested by ICRP seems to be too high.
  - *gender*

    There will be a lot of discussion necessary; one possibility: Calculating doses for women and men separately; this will lead to the effect that under identical exposure conditions women will reach the dose limits earlier than men.

What might be done in the context of radiation protection regulations? (2)

- *Dependence of radiosensitivity on*
  - *the individual in general*

    Right now, we do not have the techniques to determine individual radiosensitivity precisely; this might change in the future and discussions should prepare for that situation.
- *The cataract issue*

  The 150 mSv per year as dose limit for the lense of the eye seems to be too high. The not easily to be answered question, however, is: which value should be chosen instead?

What might be done in the context of radiation protection regulations? (3)

- *The cardiovascular issue*

  We need more data, before decisions can be made; but discussions are necessary already now to be prepared.

- *The radon issue*

  Again, something should be done, the problem is: how should the exact values look like?

- *The low dose problem*

  The necessity to do extensive research in this field has been recognized by several funding organizations (e.g. EPA, the EU); but it will take time and a lot of brainstorming before solutions that have implications on radiation protection will be obtained.