

Introduction to occupational exposure trends and problems to be solved

EUROPEAN STUDIES OF OCCUPATIONAL RADIATION EXPOSURE - E S O R E X

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Content

Optimisation by ICRP

How to evaluate optimisation?

European trends in occupational exposure

Questions, difficulties and problems



Optimisation by ICRP

- *below the appropriate dose constraints*
- ***As Low As Reasonably Achievable***
- *economic and social factors taken into account*



Finding dose constraints

§210 and 211 from the new proposal of ICRP:

- *Appropriate dose constraint by*
 - ... *generic optimization*
 - ... *national or regional attributes and preferences*
 - ... *international guidance and good practice*
- *For planned situations: “level of individual doses ... in well-managed operations”*



Optimisation by ICRP

Targets of optimisation

- *individual doses*
- *likelihood of exposure*
- *number of people exposed*



Measuring optimization focussing the individuum

Target parameters

- *individual doses* → H_i
- *likelihood of exposure* → $P_i(H>0) \sim N_{\text{exposed}} / N_{\text{monitored}}$
- *number of people exposed* → $N(H>0)$

not sufficient to evaluate optimisation measures



Statistical parameters

- *measures of location and dispersion appropriate to the question*

*mean, mode, median, collective dose,
range, percentiles,
n of exposed, n of exceeded dose limits,*

- *combined change analysis*

*shift or change of dose distributions
analysis of gradients (e.g. $\Delta CD / \Delta t$ vs. $\Delta N(H>0) / \Delta t$)*



Statistical evidence of optimisation

Criteria on national and international level:

- *lower average dose*
- *less collective dose*
- *less cases with high exposures*
- *change of dose distribution*
- ...

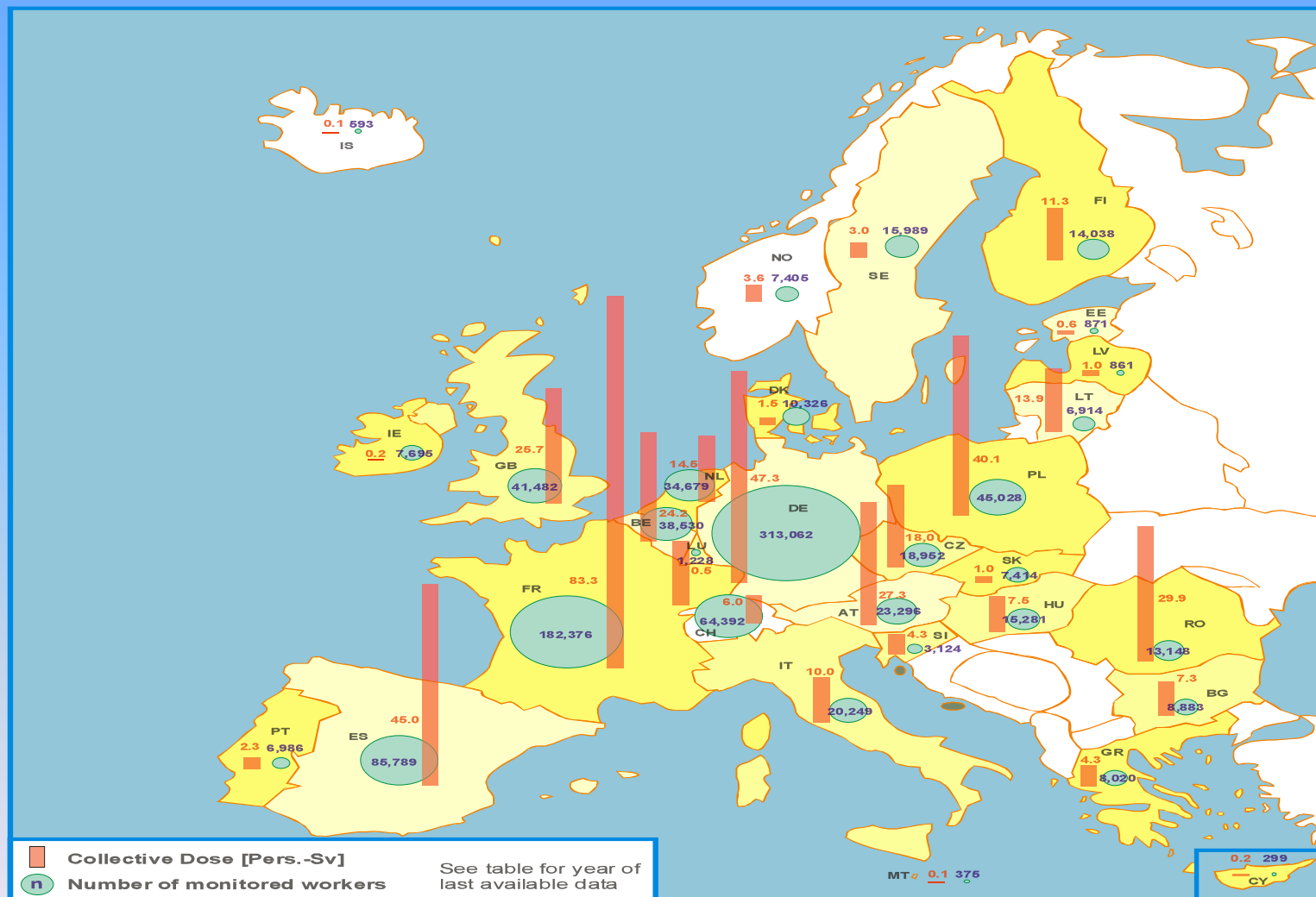


ESOREX

- *European Studies on Occupational Radiation Exposure*
- *by order of the European Commission*
- *executed by German BfS in co-operation with Czech SUJB and vice versa*
- *30 European countries involved*
- *Part I – country reports*
- *Part II – dose distribution data*
- www.esorex.cz

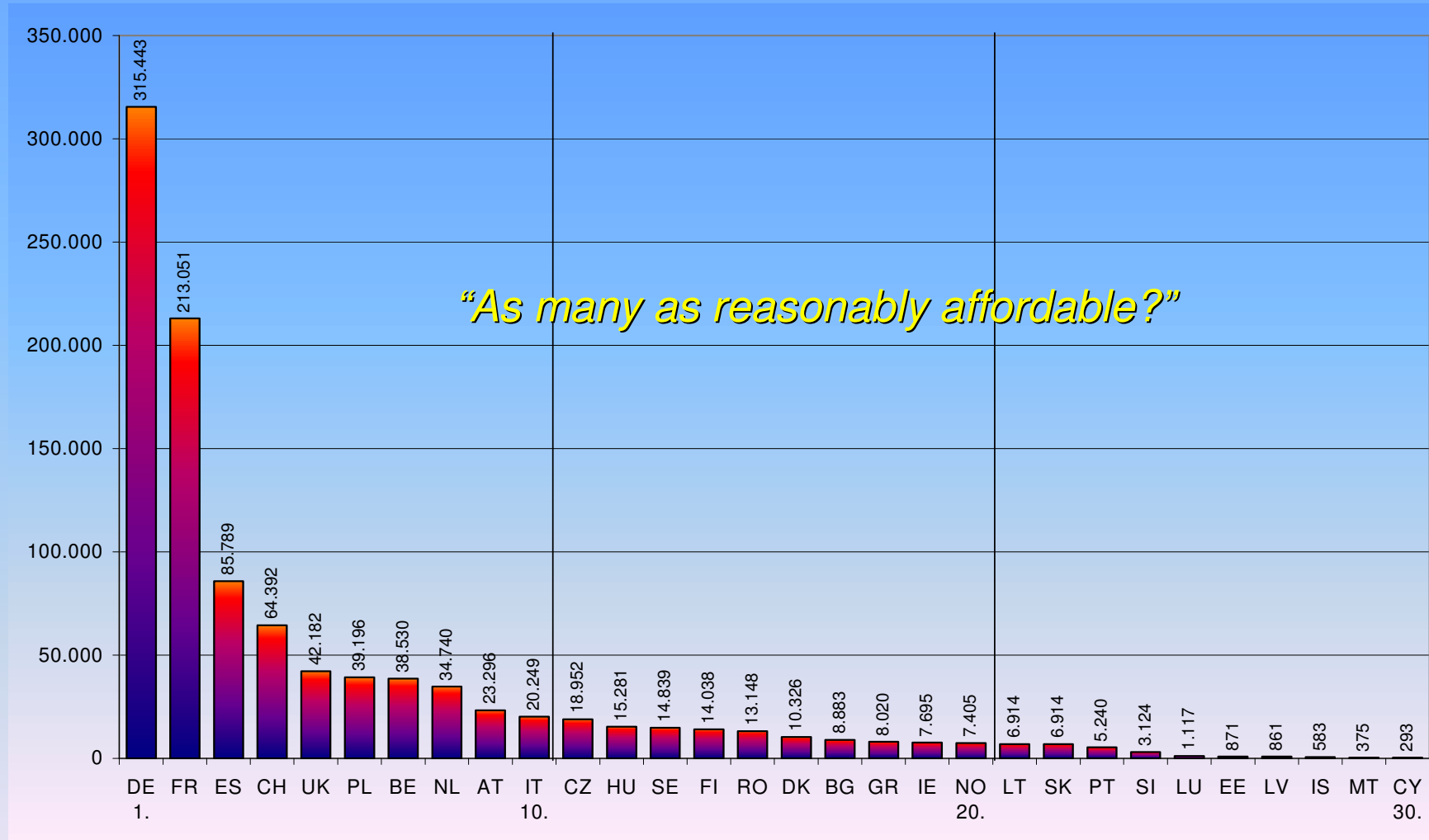


Countries participating in ESOREX

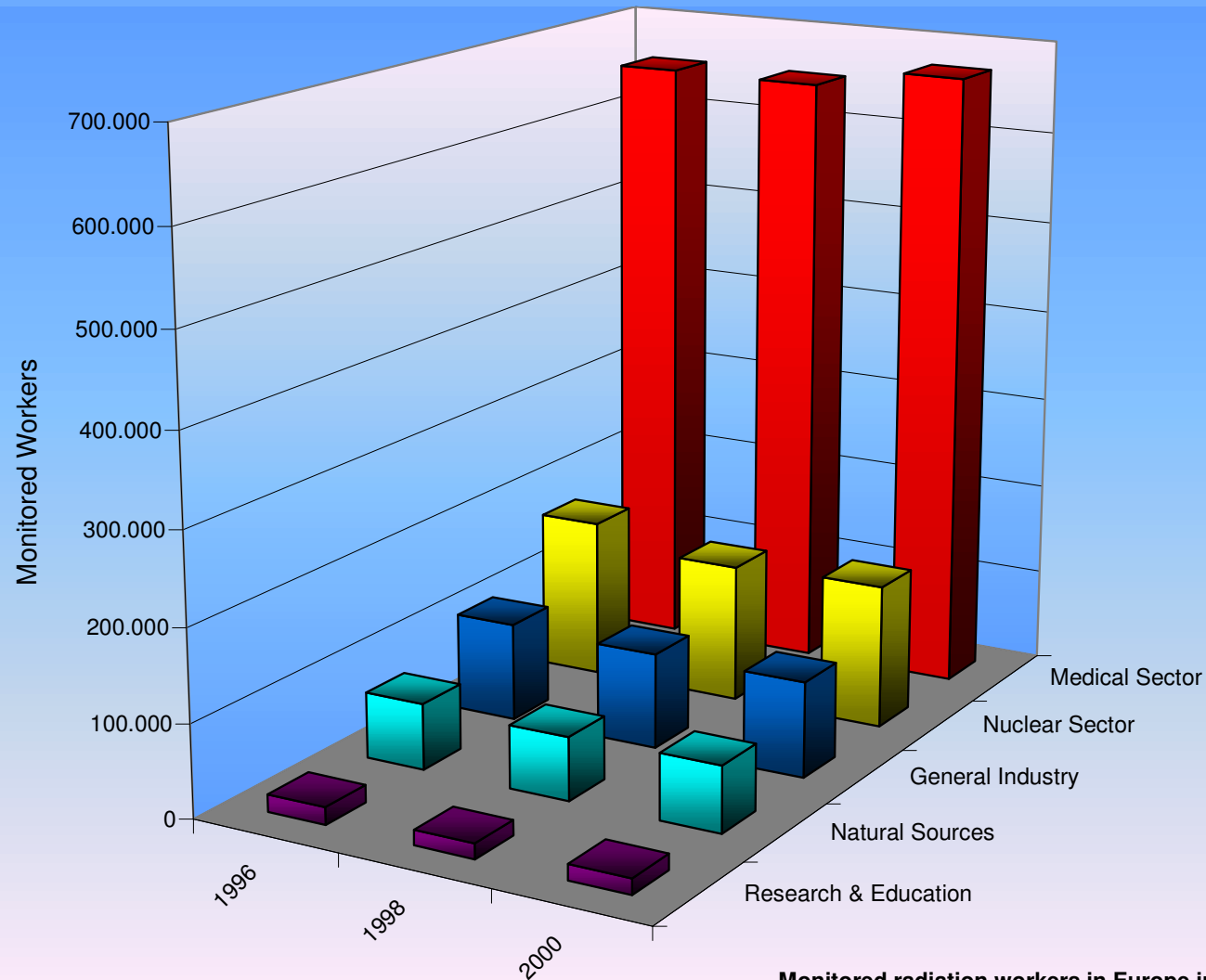


Radiation workers in Europe

Workforce officially monitored for radiation exposure in 2000



Radiation workers by work sectors in Europe



Monitored radiation workers in Europe in 2000: ca. 1 Mio.



Analysed work sectors

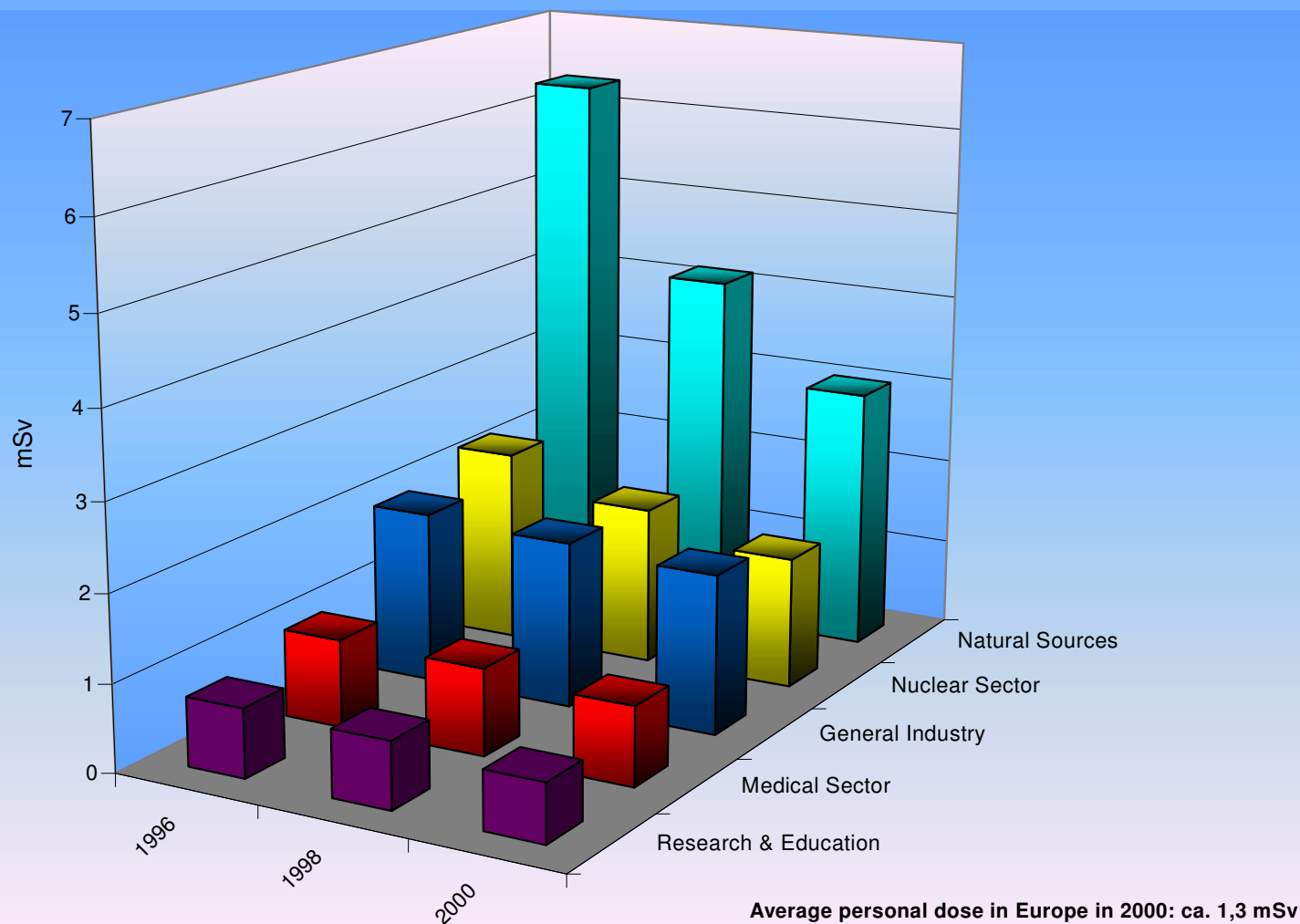
(included: countries with sufficiently detailed dose distributions for 1996, 1998, 2000)

Nuclear sector	Medical sector	General industry	Research and education	Natural sources
Bulgaria Switzerland, Czech Republic Germany Spain Finland Greece Hungary Latvia Netherlands Norway Romania Sweden Slovenia United Kingdom	Austria Bulgaria Switzerland Czech Republic Germany Denmark Spain Finland Greece Hungary Ireland Iceland Lithuania Latvia Malta Netherlands Norway Sweden Slovenia United Kingdom	Austria Bulgaria Switzerland Czech Republic Germany Denmark Spain Finland Greece Hungary Ireland Iceland Lithuania Latvia Malta Netherlands Norway Romania Sweden Slovenia United Kingdom	Austria Bulgaria Switzerland Czech Republic Germany Denmark Spain Finland Greece Hungary Ireland Latvia Malta Netherlands Norway Romania United Kingdom	Austria Czech Republic Germany Netherlands Norway Romania Sweden Slovenia United Kingdom

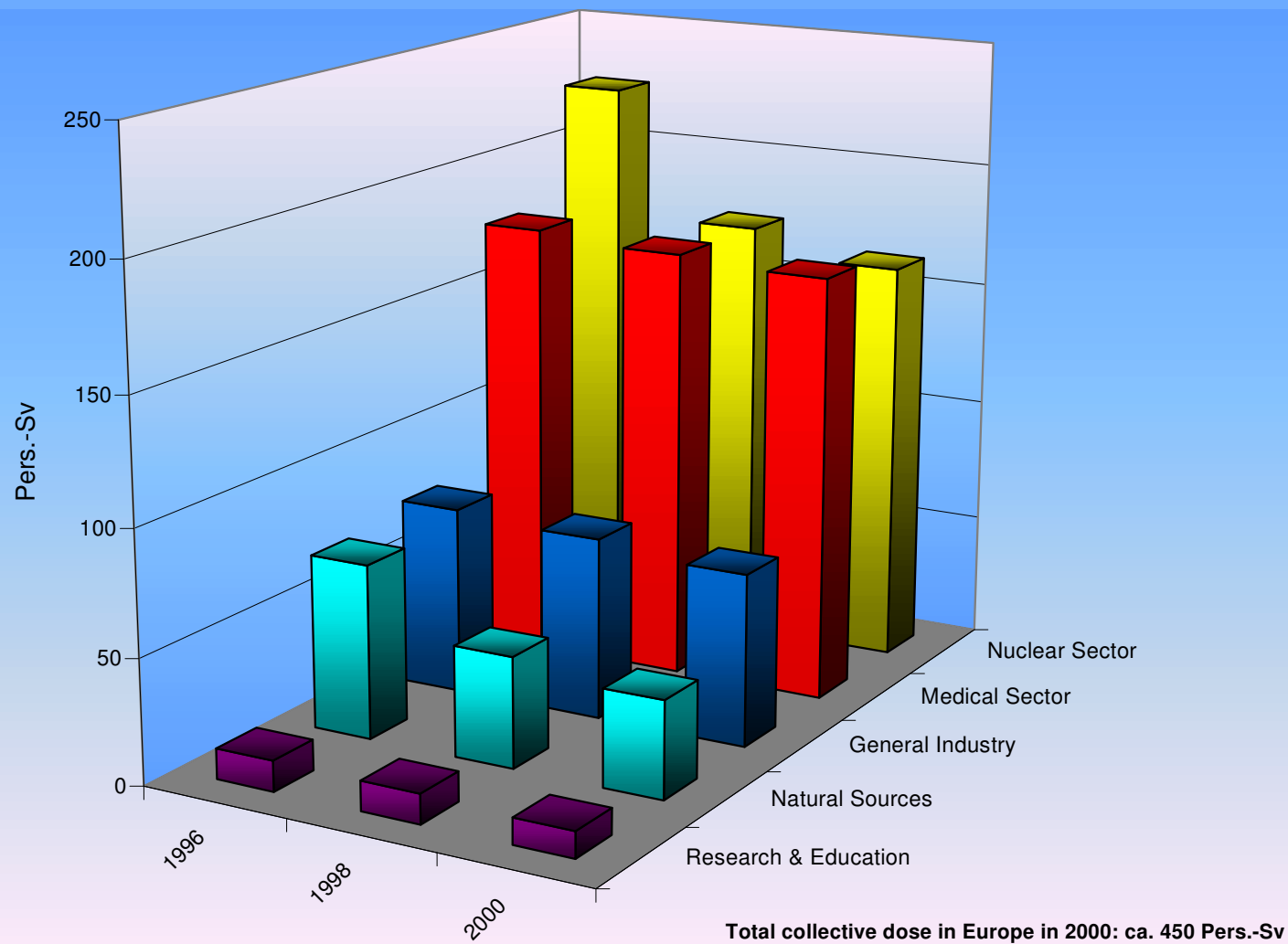


Average doses in Europe

(individual doses of measurably exposed workers)

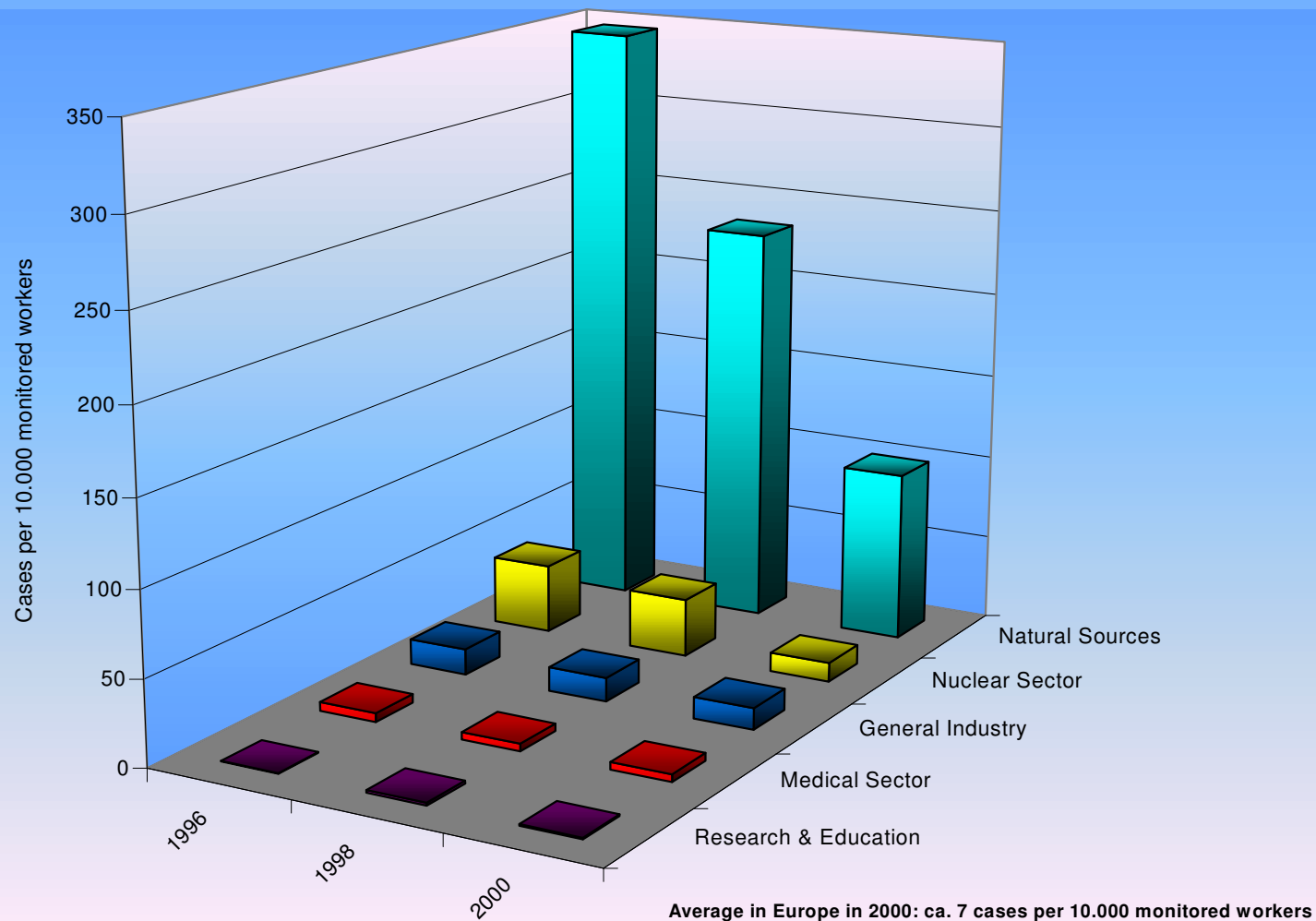


Collective doses in Europe

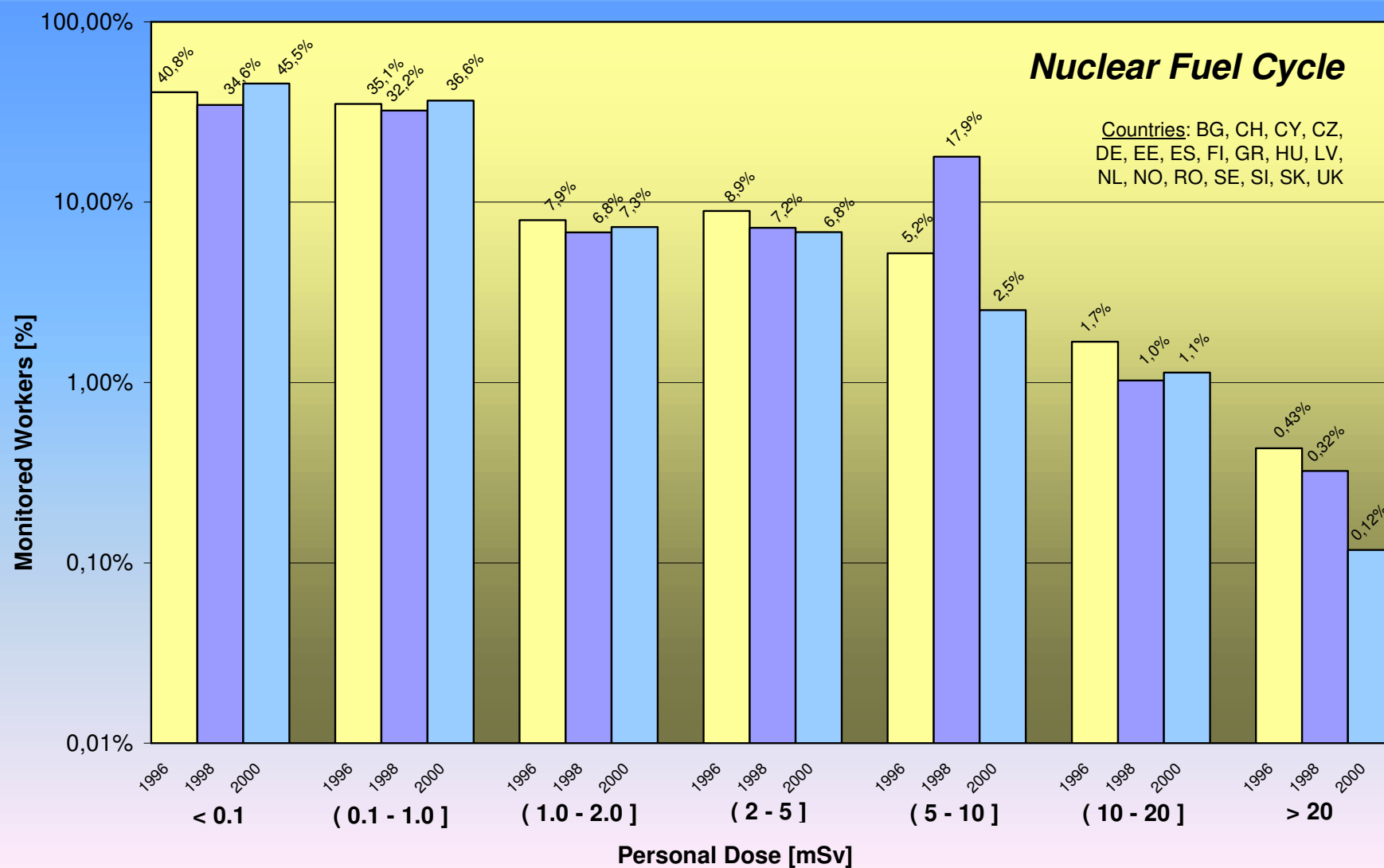


Exposures above 20 mSv/a in Europe

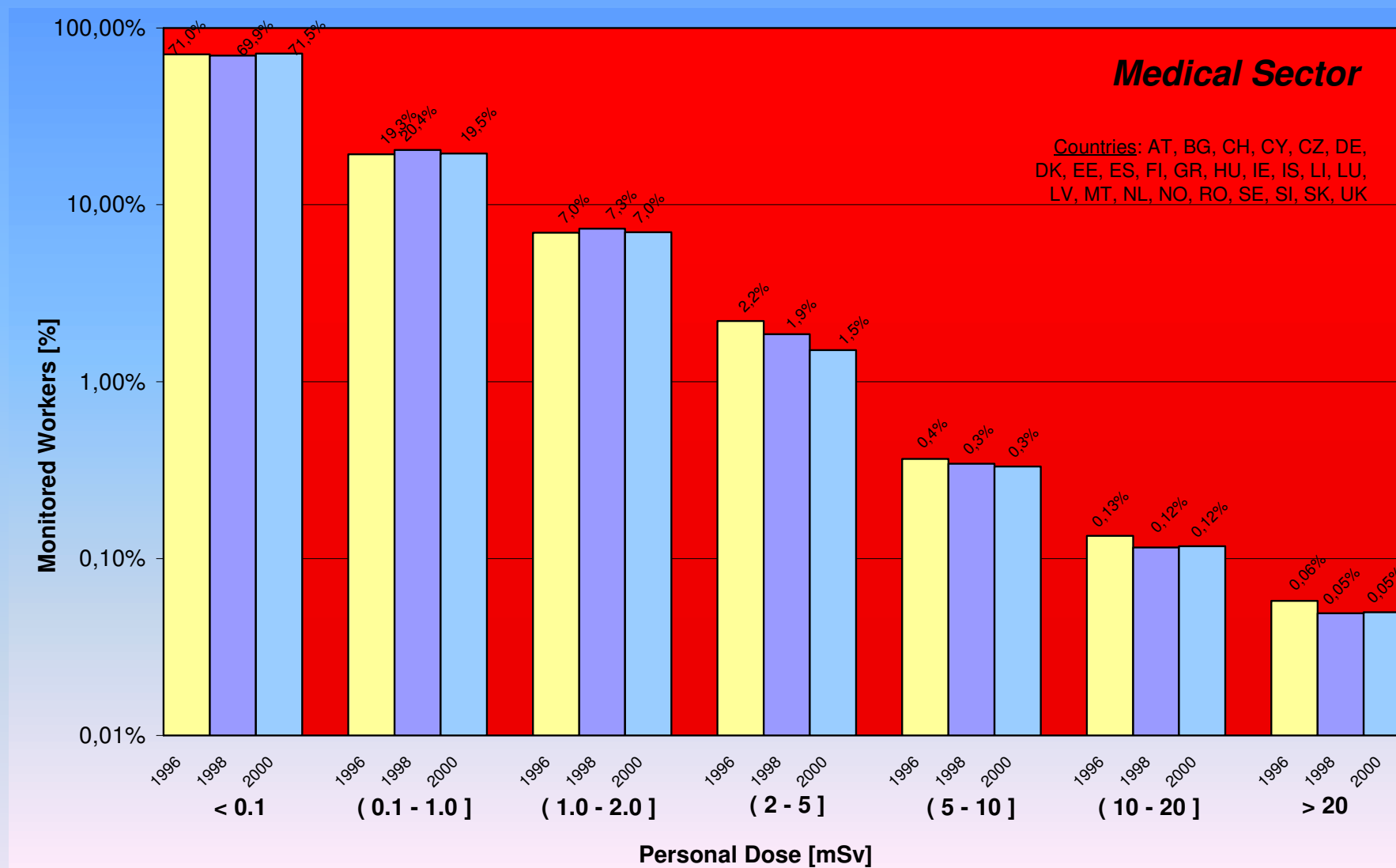
N of cases per 10.000 monitored radiation workers



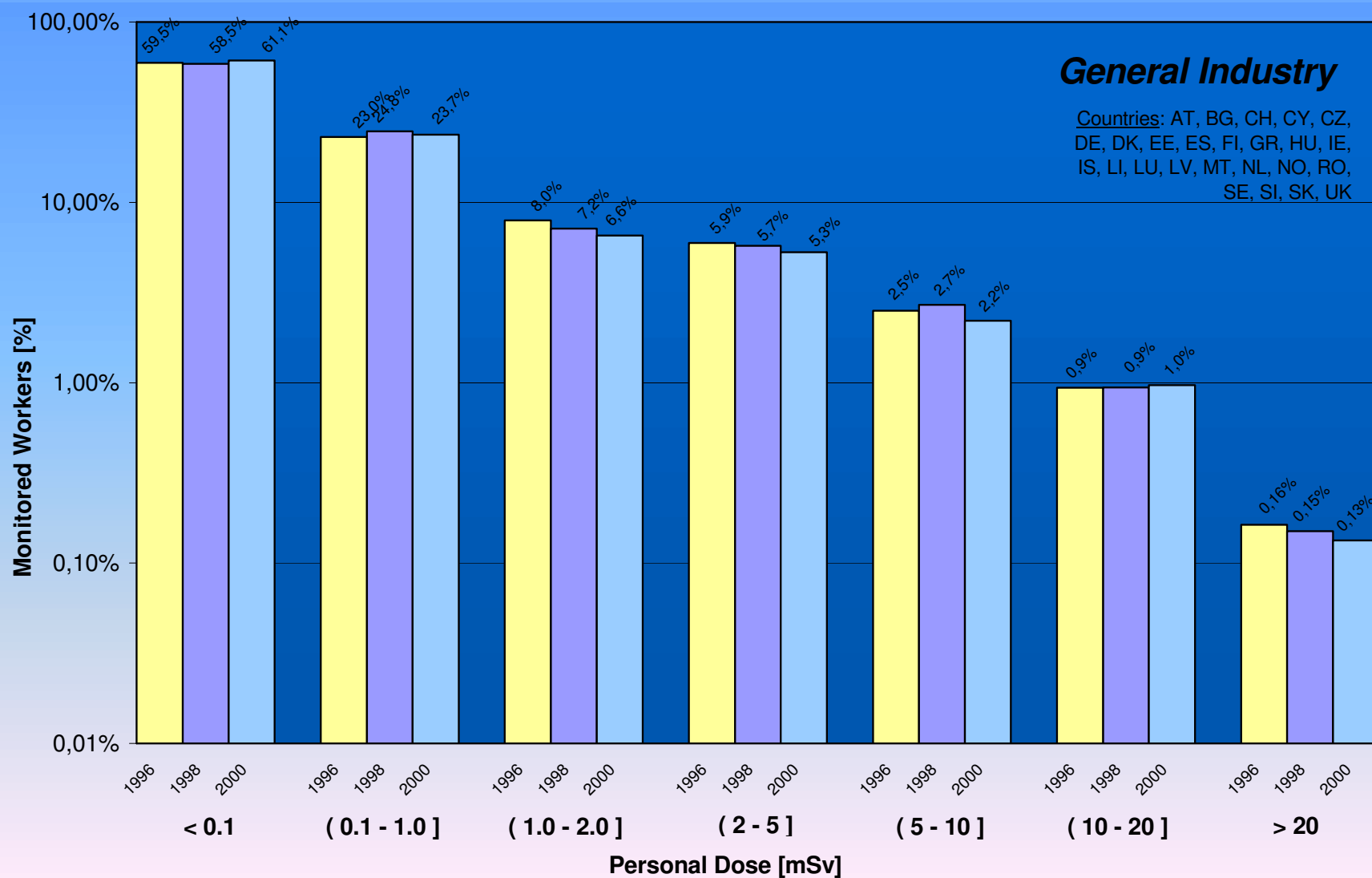
Dose distributions in nuclear sector 1996 - 2000



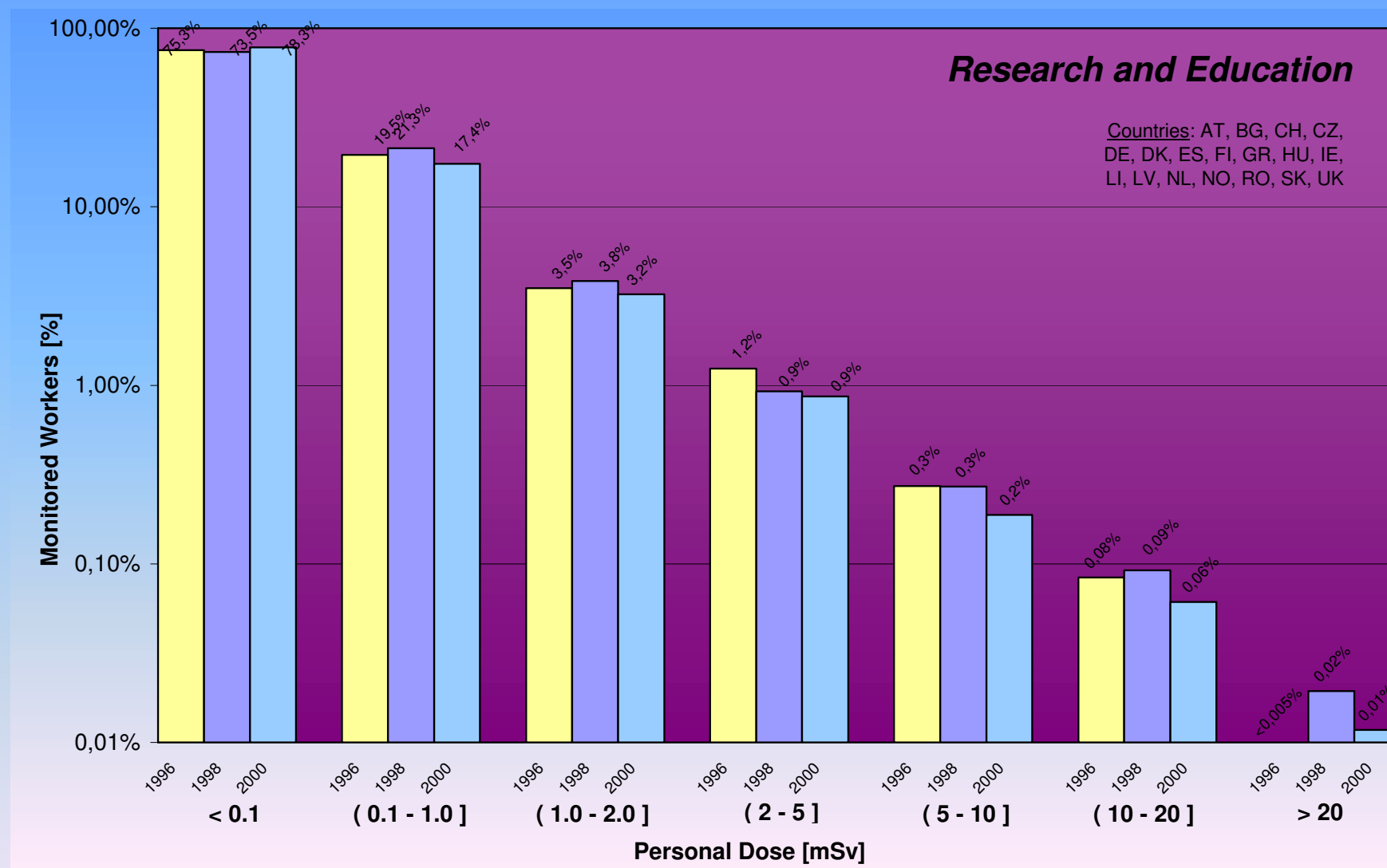
Dose distributions in medical sector 1996 - 2000



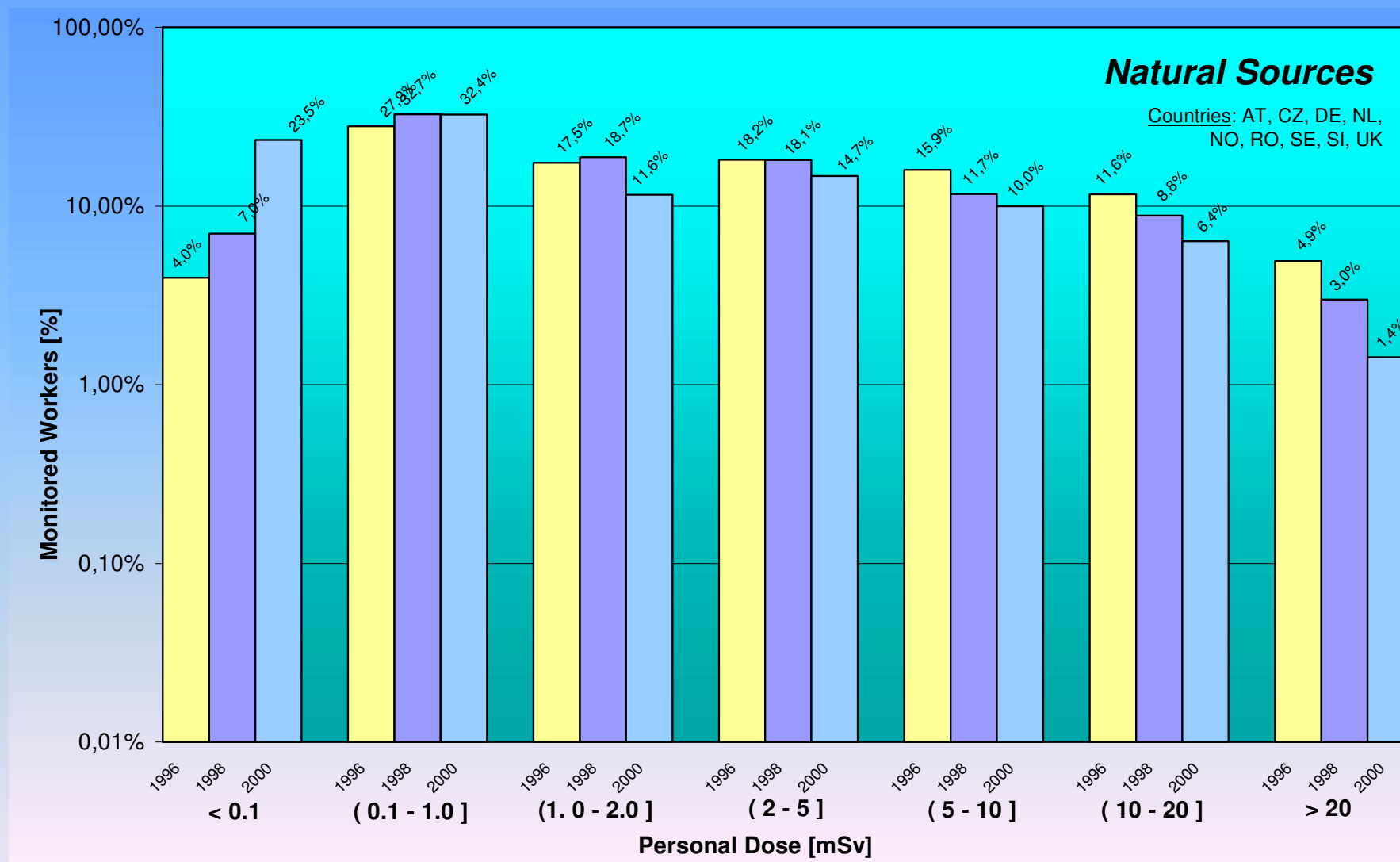
Dose distributions in general industry 1996 - 2000



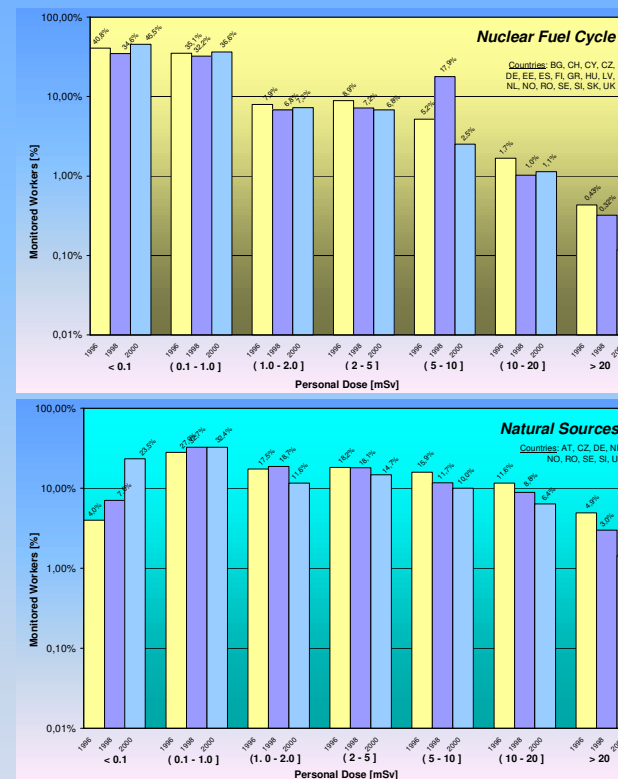
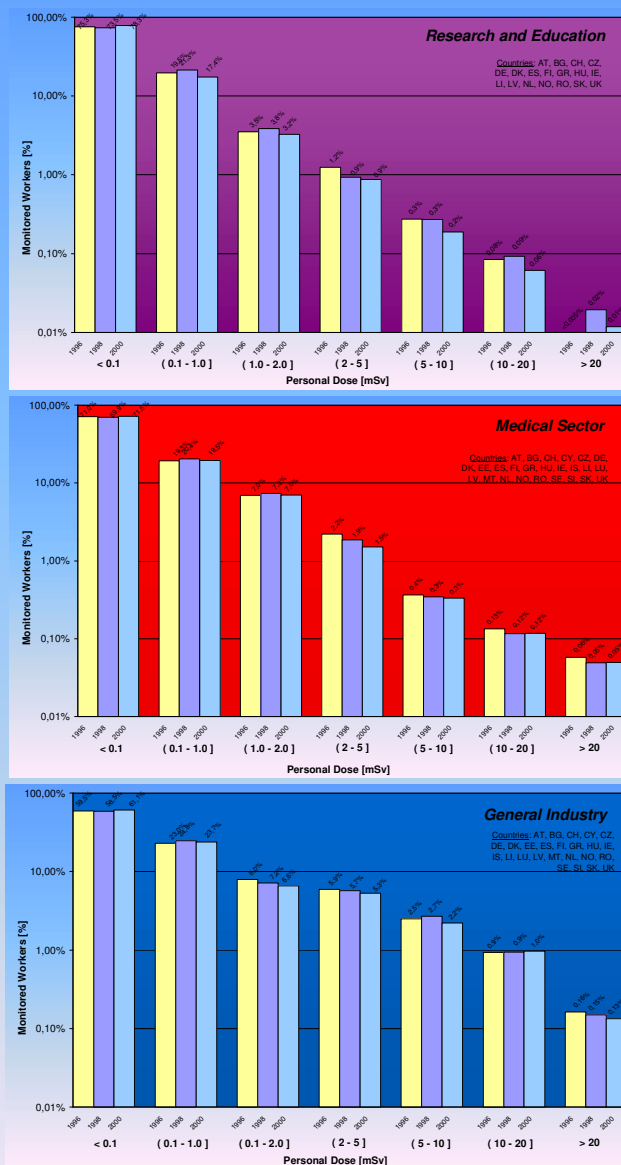
Dose distributions in research & education 1996 - 2000



Dose distributions in sector natural sources 1996 - 2000



Shape of dose distributions in work sectors



Trends and changes 1996 - 2000

↔ no ↘ little ↙ moderate ↘ strong	Nuclear sector	Medical sector	General industry	Research education	Natural sources
Countries	16	20	21	17	8
Mean dose	↘	↔	↘	↔	↘
Collective dose	↘	↘	↘	↘	↘
Cases with high doses	↘	↔	↘	↔	↘
Dose distribution shift	←	←	←	←	←



When to optimize?

- *What is „Good practice“ or „State of the art“?*
- *What level is „normal“?*
- *What level have „the others“?*
- *What level have we now and what before (e. g. 10 years ago)?*

Level:

any appropriate statistic parameter (e.g. man-Sv per reactor unit and year)



What is difficult to judge

- Has the “*reasonably achievable*” level been reached?
- Have “*economical and social factors*” been taken into account?

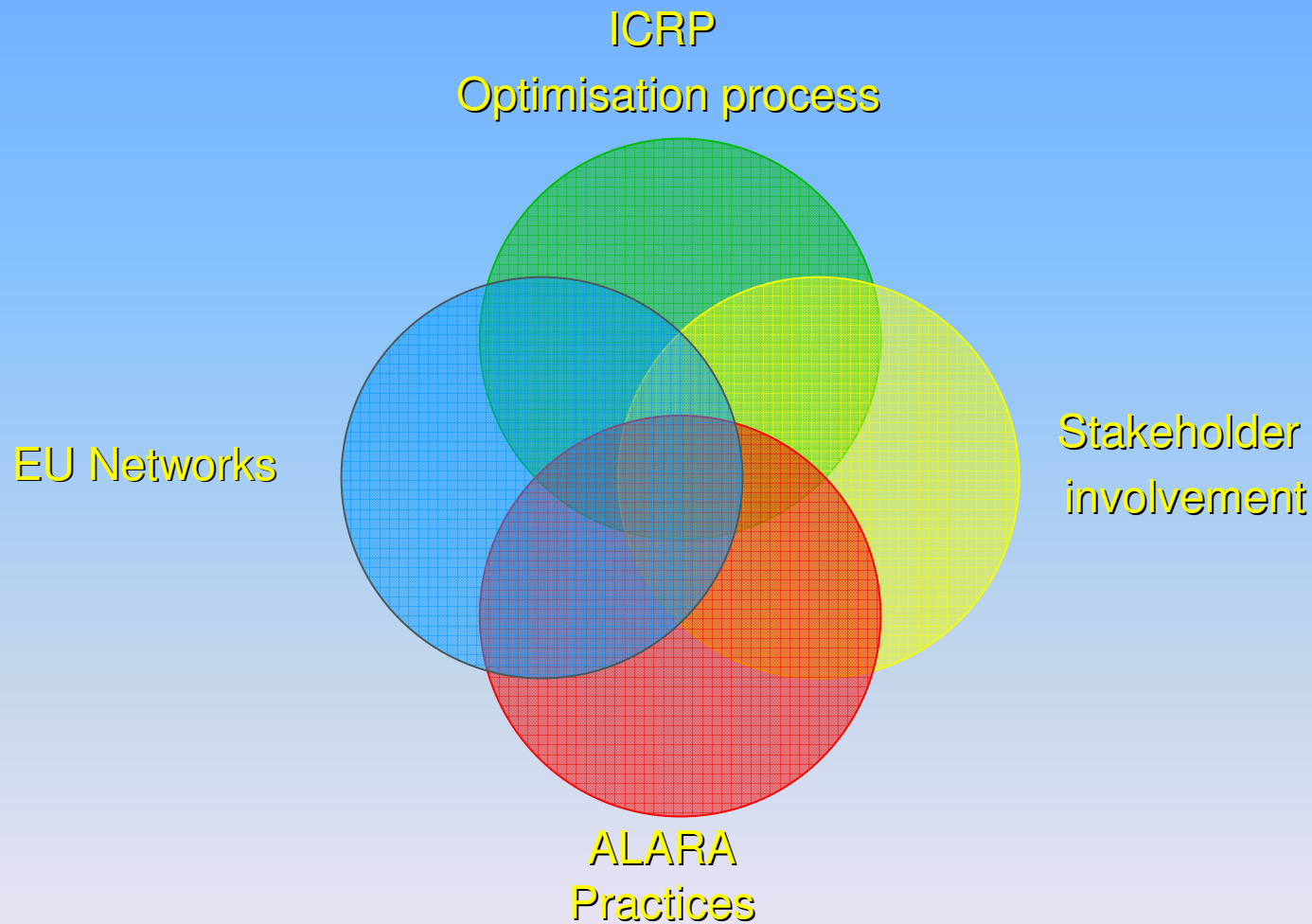


Decision-aiding techniques

- *Linear optimisation*
- *Cost-benefit analysis*
- *Monetary value of the man-Sievert*
- *Cost-effectiveness analysis*
- *Multi-attribute utility analysis*



Cultural climate of comparison and competition



Areas of „suboptimal” solutions

A view from the European perspective:

- *dose limit exceedings of transnationally active outside-workers (multiple radiation passbooks)*
- *inhomogeneous characterization of workers*
- *dosemeter evaluation: with/without background subtraction*
- *dosemeter position: above / below the lead apron*



<http://www.esorex.cz>

