Radiation protection: from knowledge to action

HIGHLIGHTS AND CONCLUSIONS

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A FEW NUMBERS

- Total number of participants: 672
- Number of countries represented: 50
  - N° of European countries: 26
  - Top 7 (above 20) : France (214) , UK (48) , Germany (43), Italy (42), Spain (39), Austria (26), Belgium (24)
- N° of abstract received: 560
  - 472 Posters
  - 84 Oral presentations
- 9 Refresher course
- 4 Panel sessions
- 2 Poster sessions

CONTENTS

- Radiation biology and effects
- Dosimetry and instrumentation
- Occupational radiation protection
- Radiation protection in medicine
- RP of the public and the environment
- Waste management and decommissioning
- Incidents and accidents
- Non ionizing radiations
- Radiation protection systems and regulation
- Radiation protection : policy and society

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- Radiation protection : policy and society

Radiation biology and effects (1)

- Keynote lecture *(Streffer)*
- Panel session 1 - The scientific bases of radiation protection : 4 presentations
- TA1 - Radiation effects : 8 presentations
- Posters : 52 on radiation effects

Radiation biology and effects (2)

- **Spontaneous lesions in DNA *(Cadet)***
  - DNA spontaneous lesions are not as frequent as initially thought in human cells : background level of oxidized guanines (8-oxoguanines) of up to 20 000 per 10^6 guanine bases (Beckman and Ames 1999), down to a maximum of 5 per 10^6 guanine bases (ESCODD 2002, European Standards Committee on oxidative DNA damage)

  - DNA spontaneous lesions are more frequent than that induced by a dose of 1Gy and are quite often of the same type

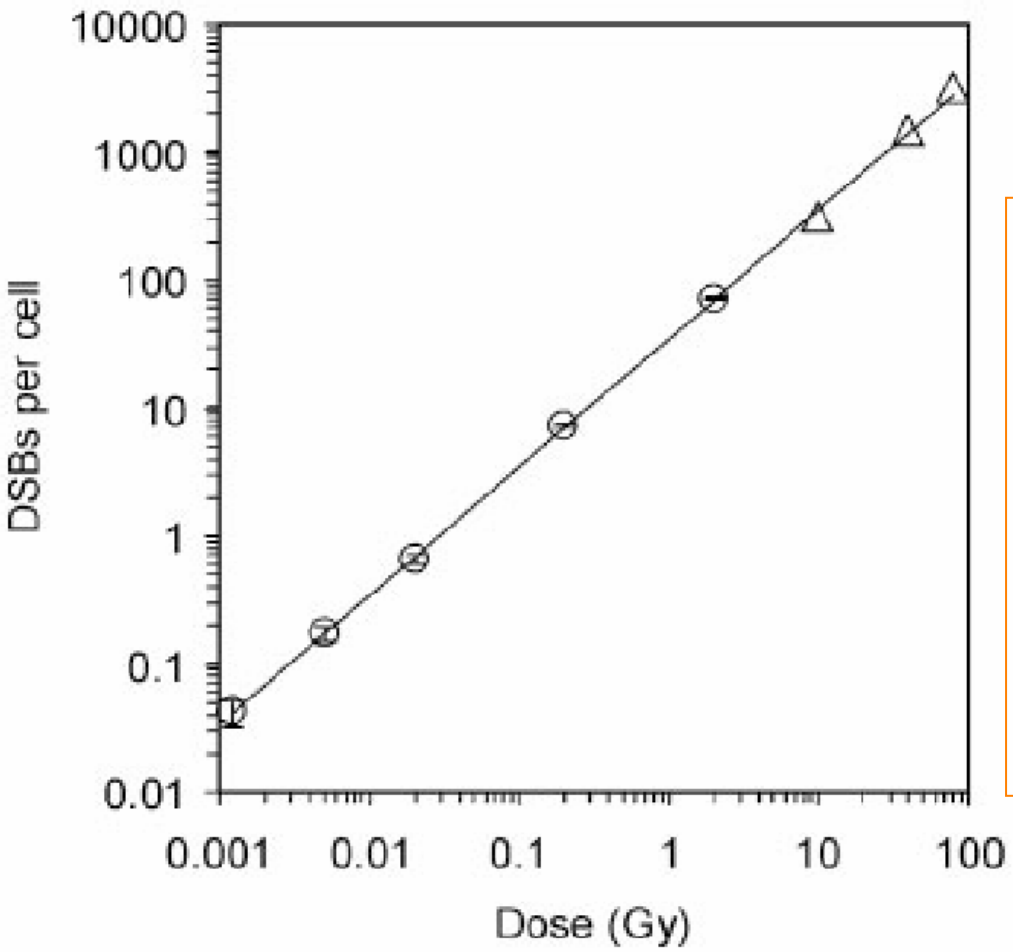
Radiation biology and effects (3)

- **Radiation-induced lesions *(Cadet, Averbeck*)**
  - Some DNA radio-induced lesions appear to be rather specific to ionizing radiations : clustered lesions or locally multiply damaged sites (LMDS) (tandem type lesions, clusters of SSB-DSB-oxidative lesions) but not as frequent as initially thought after high and low LET-radiation (technique of limitation of artefactual oxidation of DNA during analysis)
  - Clustered lesions or LMDS *(Cadet*)
    - Give rise to cell killing and lethal effects
    - May have some mutagenic potential in conjunction with other lesions

Radiation biology and effects (4)

- **The reaction of living cells to IR is different at low doses/rates and high doses/rates *(Rothkamm*)**
  - At very low dose (1 mGy), cells are going to die because no DNA signaling and no initiation of DNA repair of DSBs with oxidized endings
  - At slightly higher doses (5-20 mGy), DNA repair is initiated
  - At medium doses (200 mGy) DNA repair starts to be counteracted by apoptosis.
  - <u>Extrapolations from high dose effects to low dose effects do not respond to the actual reaction of living cells to IR</u>

Radiation biology and effects (5)



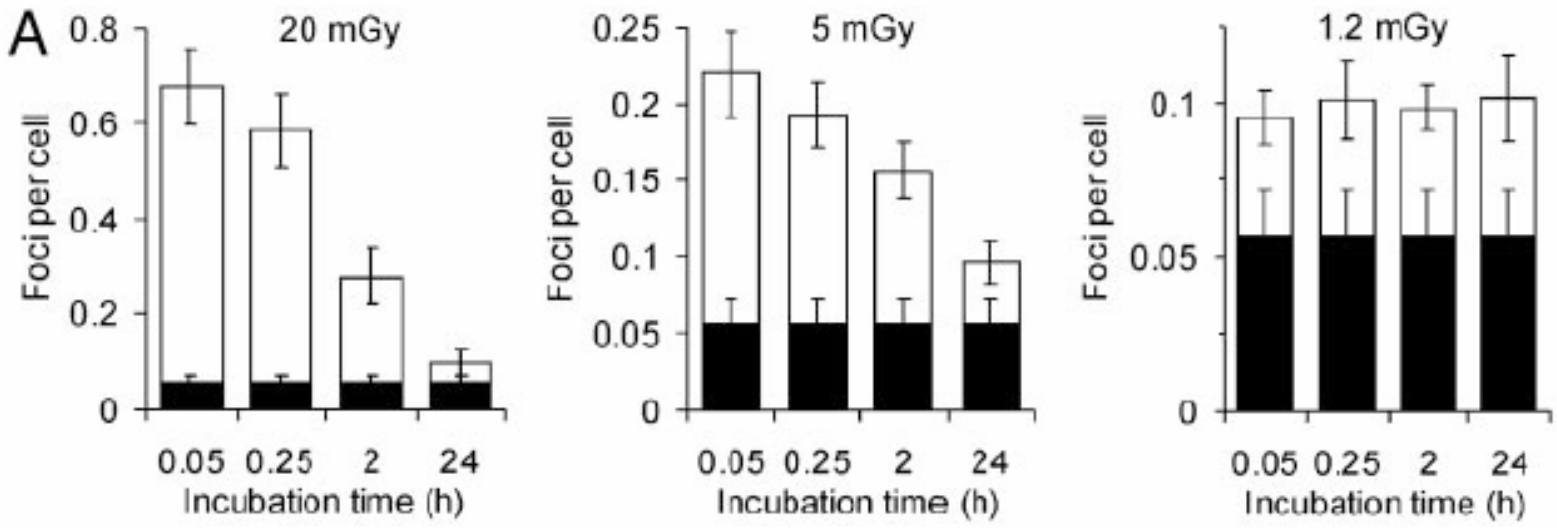
Double strand breaks DSBs

Linear induction of DSBs (phosphorylation of histone γH2AX) as a function of radiation dose in human fibroblasts :
DSBs appear at 1 mGy,
idem in vivo and in vitro,
half time repair 30 minutes

Rothkamm et Löbrich,
PNAS 2003;100:5057-5062

Radiation biology and effects (6)

Repair of radiation-induced DSBs in human fibroblasts at low doses



absence of repair at a very low dose

Rothkamm and Löbrich 2003 Proc. Natl. Acad. Sci. USA 100(9):5057-5062

Radiation biology and effects (7)

- **Dose-effect relationships in radiation biology are affected by non targeted and delayed effects (*Salomaa, Belyakov*)**
  - Adaptive responses (Rigaud and Moustacchi 1996)
  - Bystander effects (Mothersill and Seumour 2004)
  - Genomic instability (Murnane and Sabatier 2004)
  - Low dose hypersensitivity (Chalmers et al. 2004, Marples et al. 2004) and hyperfast early cell responses (Fernet et al. 2000, Ponnette et al. 2000)

  ⇒ Microdosimetric calculations based on target size of single cells do not correspond to the reality of radiation-induced effects
  - Revision of the estimation of cancer risk ?
  - Applicability of LNT model in the low dose region ?
  - Mechanistic explanations for the development of non-cancer disease ?

Radiation Biology and effects (8)

- **Non-targeted effects of ionising radiation may have positive consequences *(Belyakov)***
  - Non-targeted effects of ionising radiation might be interrelated and possibly have a protective role under *in vivo* conditions.
  - These effects might relate to adaptive response because of increased non-targeted differentiation in irradiated samples.
  - Based on these experimental data the authors proposed a theory that the main function of the non-targeted effects is to decrease the risk of carcinogenesis in a multicellular organism exposed to oxidative damage (including radiation induced)

Radiation biology and effects (9)

- **Different gene families are induced at different dose and dose rate levels (*Lebeau, Chevillard*)**

  Bishay et al. 2001, Carcinogenesis ; Amundson et al. 2003 Mol. Cancer Res.

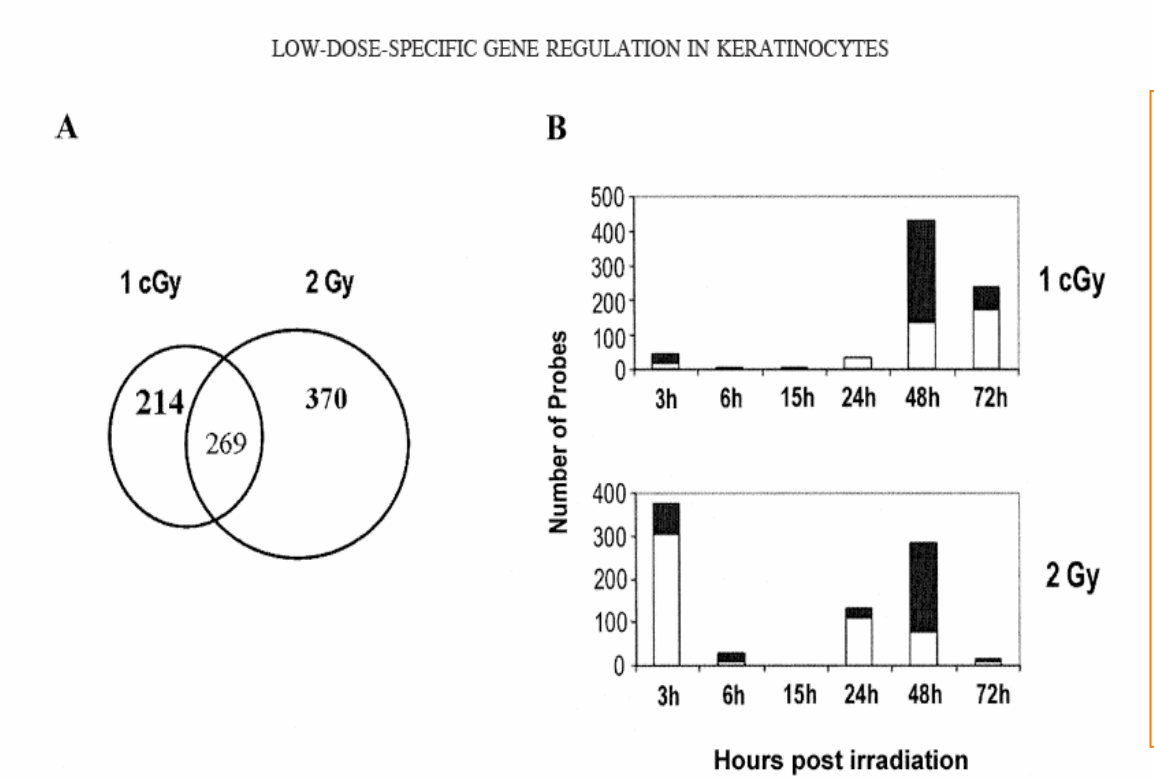
  - Use of microarray technologies to measure radiation induced modifications of the transcriptome
  - Specific genes are induced at low dose

    Franco N et al. Radiat. Res. 163, 2005
  - Specific genes are induced in thyroid cancers after Tchernobyl

→ Direct extrapolations from high to low dose radiation effects for radiation protection effects do not correspond to the actual radiobiological responses

Radiation biology and effects (10)

- **Specific genes are induced at low dose**
  Franco N et al. Radiat. Res. 163, 2005



1- Genes induced at 1 cGy include genes involved in homeostasis, stress, cellular signaling, cytoskeleton, RNA synthesis, membrane function and transport

2- Low dose-responsive genes include rarely DNA repair genes

Radiation biology and effects (11)

- **Individual radiation sensitivity: implications in medical practice (*Gisone*†, *Dubner*)**
  - Review of all possible mechanisms involved in genetic and epigenetic susceptibility of cells to radiations, including DNA repair machinery and cell signalling pathways
  - Implication of non targeted effects *(Salomaa)*
  - Detection of hypersensitivity by γH2AX spots *(Rothkamm)*
  - Radiation therapy : hypersensitivity to IR in about 5% of patients, hyposensitivity ?
  - Genetic testing / discrimination ?
    - Global international consensus on a principle of non-genetic discrimination
    - At work, medical investigations should be restricted only to the health status of the worker, and genetic testing can be used only to detect abnormalities due to the exposure to genotoxic agents
    - Genetic testing is permitted only for medical purpose or medical research.

Radiation biology and effects (12)

- **Alteration of the immune system in Mayak veterans *(Krillova)***
- **Mechanisms of alterations of the immune system by ionising radiations (*Bourguignon*)**
  - Immunosuppression / immunopromotion of cancer
  - Literature review of all possible mechanisms
    - Apoptosis
    - TCR mutations
    - Modification of Th1-Th2 balance
    - Bystander and genetic instability
    - Shift toward an inflammatory profile
    - Acceleration of immunological aging
    - Modification of antigen presentation
    - Autoimmune reactions
    - Perturbation of immunological homeostasis

Radiation Biology and effects (13)

- **Risk of a Second Malignant Neoplasm (SMN) in children treated with radiotherapy *(Rubino)***
  - Cohort of 4,401 children, 3-year survivors of all types of childhood cancer, treated between 1947 and 1986, in eight treatment centres in France and Great Britain
  - 124 SMNs : cumulative incidence of 5% at 25 years
  - Evaluation of the estimated relative risk (RR) as the ratio between the risk of developing a cancer at a given site that received a given dose and the risk of developing a cancer at the same site in the absence of this dose of radiation
  - RR increases significantly as the integral dose (dose absorbed by the whole body) increases : the risk of a SMN for patients in the highest dose category, which represents 20% of the irradiated population, was 5.45 (95%CI: 2.91-10.20; p=0.001) compared to that of unirradiated patients
  - Are these children hypersensitive ?

Radiation Biology and effects (14)

- **Incidence and mortality by cancer among French nuclear workers of contracting compagnies *(Guerin)***
  - 13,000 French nuclear industry workers of 10 contracting companies and subsidiary companies
  - 280 deaths, 36% of them from cancer
  - Healthy worker effect +++

Radiation Biology and effects (15)

- **Thyroid cancer risk in ukrainian and belarussian areas affected by the Chernobyl accident *(Jacob)***
  - Analysis of thyroid cancer incidence risk in 1034 settlements .
    - Measurements of ^{131}I content in human thyroids in May/June 1986.
    - EAR is higher for females than for males by a factor of 1.4. It decreases with age at exposure and increases with age attained.
    - ERR is smaller for females than for males by a factor of 3.8 and decreases strongly with age at exposure.
    - Effects more important in Belarus than in Ukraine
  - At the end of the observation period, excess risk estimates were found to be close to those observed in a major pooled analysis of seven studies of childhood thyroid cancer after external exposures.

Radiation Biology and effects (16)

- **Evaluation of risk of circulatory diseases in the German uranium miners cohort study *(Kreuzer)***
  - 1,801,630 person-years under observation with a mean duration of follow-up of 30 years
  - No increase in risk of heart diseases, circulatory diseases and stroke with increasing cumulative exposure to radon, to external gamma radiation and to long-lived radionuclides
  - Target organs dosimetry is unknown
  - Doses are probably too low to induce pathologies

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Dosimetry and instrumentation (1)

- TA3a - Dosimetry and instrumentation :
  6 presentations

- TA3b - Dosimetry and instrumentation :
  6 presentations

- Posters : 70

Dosimetry and instrumentation (2)

- **Exact determination of doses : the key for RP**
  - Continuous challenge for optimisation of occupational dose measurements : more calculation and modelling than new instrumentation
    - Monte Carlo *(Telles, Brettner-Messler, Pinheiro, Ramos Pascual)*
    - Voxel phantom *(Furstoss, Maia)*
  - Routine evaluation of internal dosimetry to determine risk *(Roberts)*
  - National programs of quality assurance and quality control :
    - TLD data base in Portugal *(Alves)*
    - Dose calibrators quality controls in Switzerland *(Bochud)*
    - National external dosimetry program in Malaysia *(Noriah)*
    - CERN external dosimetry data base *(Carbonez)*

Dosimetry and instrumentation (3)

- **Focus on special dosimetric issues:**
  - Development of space and aircraft dosimetry requires 3D recording : combined TLD and CR-39 Plastic Nuclear Track Detectors *(Benton),* track-etch detectors *(Jardnickova),* TEPC *(Beck),* 3D silicon detector *(Pazmandi)*
  - Development of radiotherapy bremsstrahlung beam dosimetry with track-etch detectors *(Jardnickova)*
  - Photon and neutron doses of the personnel using moisture and density measurement devices in construction companies *(Carinou)*

Dosimetry and instrumentation (4)

- **Focus on special dosimetric issues :**
  - Use of X-ray screening system for passenger and cargo controls. Issues : justification (terrorism, contrabandism), $H_p(10)$ and H*(10) dosimetry, privacy *(Hupe, Ankerhold)*
  - Dosimetry of hadrons, leptons, photons at high energy accelerators and reactors *(Ginjaume, Gregory, Devita, Ranogajec-Komor)*
  - New possibilities: application of CVD technique in the fabrication of ionisation chamber and TLD for radiotherapy *(Descamps)*
  - Skin dose after external contamination *(Le Coulteulx)*

Dosimetry and instrumentation (5)

- **Biological dosimetry : new applications**
  - Cytogenetic techniques to evaluate dose in interventional radiology workers *(Montoro)*
  - EPR dosimetry to evaluate radiation background in the Urals region: comparison of Mayak workers (> 50mGy) with Techa rivers side residents *(Shishkina)*, beta dosimetry in teeth for ^{90}Sr exposed subjects *(Fattibene)*
  - mFISH and mBAND techniques for biological dosimetry of Mayak workers *(Azizova)*, mFISH and FISH 3 painting to evaluate translocations in radiotherapy patients *(Pouzoulet)*
  - Diagnosis of acute radiation disease by enzyme immune assay *(Popov)*
  - Requirements for biological dosimetry accreditation process *(Voison)*

Dosimetry and instrumentation (6)

- **<u>Calibration remains critical in dosimetry</u> *(Boziari, Klamert)* as well as the evaluation of uncertainties *(Potiens)***

- **<u>Intercomparisons</u> are needed *(Itié)***
  - to reach international standards,
  - to ensure international traceability
  - to improve measurement uncertainties

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Occupational radiation protection (1)

- Plenary Panel 3 - Occupational radiation protection : 4 presentations
- TA4 - Radiation protection at workplaces : 8 presentations
- Posters : 42

Occupational radiation protection (2)

- **Large variety of topics**
  - Management & safety culture (mainly nuclear): 4
  - NPP/Fuel Cycle/Fusion: 7
  - NORM & Cosmic & Space: 18
  - Non Nuclear Industry (incl. mining): 5
  - Research/Teaching/Accelerators: 8
  - Waste & decommissioning: 2
  - Other (incl. transport & medical): 4

Occupational radiation protection (3)

- **International occupational radiation protection programs of IAEA *(Mhrabit)* and ILO *(Niu)***
  - New IAEA safety series on NORMs in preparation
  - IAEA assistance to countries
  - Complete IAEA training package for trainers
  - IAEA/ILO action plan on occupational radiation protection (14 topics)

Occupational radiation protection (4)

- **Evaluation of worker exposures to natural radiations *(van der Steen)***
  - Radon exposure from Th & U progeny in IPEN nuclear facility in Brasil *(Caccuri)*
  - Exposure to Th & U radionuclides in zirconium manufactures *(Ballesteros, Righi)*
  - NORM in building materials *(Dupuis, Kant)*
  - Radon exposures in mushroom tunnels in Italy *(Fontana)*, in tourist caves in Spain *(Sainz)*, in Austrian spas *(Ringer)*
  - Dose measurements of aircrew members *(Beck, Kojo, Spurney, Stegemann)* and of space stations members *(Deme)*

Occupational radiation protection (5)

- **New large equipements : optimisation of RP at the design stage**
  - ITER Nuclear Fusion Facility *(Sandri) :* Rigorous treatment of sources and exposure scenarios : outcome seems favorable compared to fission facility
  - CERN - CNGS and LHC *(Brugger) :* close collaboration between RP and maintenance groups for ALARA design and preventive intervention planning
  - EPR *(Terry)* : European pressurized reactor designed for optimized radiation protection
  - 3rd generation synchrotrons – DIAMOND, SOLEIL and SSRF *(Asano)* : shielding design
  - High intensity lasers – LUCI, VULCAN, CLRC RAL *(Borne)* : Monte Carlo simulations of exposures

Occupational radiation protection (6)

- **Responsibility of operators to develop RP *(Lacoste)***
  - Strengthening of EDF's action on RP culture *(Garcier)*
  - Harwell Solid Waste Plant : solid waste plan *(Gallacher)*
  - Cogema uranium mill at McClean Lake:
    ALARA action plans in practice *(Pollock)*
  - Actions in industrial radiography in France *(Abela)* and development of a good practice guide *(Paul, Coletti)*
  - UK-Russian cooperative action on solving nuclear legacy problems at Andreeva Bay *(Hammon)*
- **The Global Information Network on Occupational Exposure (ISOE):** a useful tool for dose comparison and optimisation, exchange and analysis of data *(Gagnon)*

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Radiation Protection in medicine (1)

- Panel 2 - Radiation Protection in Medicine : 4 presentations
- TA5 a - Radiation Protection in Medicine – Patients : 6 presentations
- TA5 b - Radiation Protection in Medicine – Workers : 6 presentations
- Posters : 73

Radiation Protection in medicine (2)

- **Radiation Protection in interventional radiology *(Cousins)***
  - Interventional radiology is a growing field :
    - number and complexity of procedures are increasing
    - new procedures in other organs
    - new procedures in younger patients
  - Non radiologists perform interventional procedures often with little or no training in RP
  - Equipement should be appropriate for the procedure
  - High individual doses for patients and staff *(Vicedo)*
  - Urgent need for dedicated training

Radiation Protection in medicine (3)

- **Radiation Protection in digital radiology *(Faulkner, Bahreyni Toosi)***
  - Impressive technological change in imaging : new radiation protection issues
  - A real possibility to decrease patient dose but a real risk to increase patient doses without benefit for the patients (images are always good, easiness in the use of the technique)
  - High individual doses for staff can be high
  - Urgent need for dedicated training
  - European DIMOND III and SENTINEL projects for image quality and dose management in digital radiology
  - Call to industry to offer better information on patient doses for optimisation, and to standardize patient dose information in the DICOM header

Radiation Protection in medicine (4)

- **Radiation Protection in CT and PET/CT *(Geleijins)***
  - New CT applications : virtual endoscopy, angiography...
  - Self prescription increases, e.g., in cardiology
  - A real increase of patient doses, mostly unknown by prescribers and practitioners
  - Justification criteria to be reinforced
  - Some high individual doses for staff in some interventional CT techniques
  - Urgent need for dedicated training

Radiation Protection in medicine (5)

- **Radiation Protection in radiation therapy *(Cosset)***
  - Treatment of 50 % of all cancers
  - New radiation therapy techniques :
    - To increase the dose to the tumor while preserving surrounding tissues
    - Multiplication of incidence and possible significant increases of volume of healthy tissues receiving doses of 3 to 4 Gy
  - Second cancer risk (children) ?
  - Individual sensitivity to be taken into account
  - Objective evaluations to be made : real medical benefit (± recognized for some of the new techniques) to put in balance with some drawbacks (high financial cost, manpower cost)

Radiation Protection in medicine (6)

- **Evaluation of patient doses in radiology**
  - Patient dose evaluation programs *(El Messaoudi, Mozziconacci,)*
  - Dose evaluation in mammography *(Denozière, Ferrer, Kalatahi, Novak)*
  - Dose evaluation in interventional radiology *(Pellet)*
  - Quality assurance in interventional radiology *(Nikodemova),* in mammography *(Mayo),*
  - Evaluation of radiation exposures from medical practices in France *(Scanff)*

Radiation Protection in medicine (7)

- **Effect of the European directive on medical exposures on patient doses *(Wade)***
  - Positive effect on identifying wrong referrals and optimising the doses patients receive
  - It is questionable that the Total Collective Dose for Medical Exposures will be reduced because of the increasing use of CT and PET where individual doses are much larger.
  - The current vogue for CT being used in private practice for cancer and heart disease screening is likely to undo any dose benefits gained from the directive

Radiation Protection in medicine (8)

- **Diagnostic reference levels in France *(Talbot)***
  - In nuclear medicine, for bone and thyroid scans, a large number of departments do not follow manufacturer's prescribing information.

Examination	Number of departments	Recommended activity (DRL) (MBq)	Mean (range) injected activity (MBq)
^{99m}Tc - bone	67	300-700	706 (475-932)
^{99m}Tc -thyroid	16	20-80	165 (81-281)

  - In radiology significant effort must be made to train professionals and to incite them to send data to IRSN

Radiation Protection in medicine (9)

- **Activation products in medical linear accelerators *(Tabot)***
  - To determine the radiation burden to the staff due to induced activity, measurements were performed immediately after treatment and 48 hours later at four different brands of treatment machines under the same experimental conditions.
  - The measured dose rates ranged:
    - between 1.4 and 2.7 µSv/h 2 mins after beam-off
    - between 0.5 and 1.57 µSv/h 10 mins after beam-off.
    - between 0.11 and 0.28 µSv/h, 48 hours after beam off
  - Annual dosimetry of staff between 1 and 2.5 mSv

Radiation Protection in medicine (10)

- **Protection of workers in nuclear medicine**
  - Evaluation of doses *(Barth,Olszewski)*
  - Characterization and improvements of syringe shields in nuclear medicine for ^{90}Y and ^{18}F *(CHEA)*
    - For ^{90}Y, a device made of an inner layer of 3.5 mm lucite, followed by 5 mm tungsten would reduce the dose equivalent rate by a factor 2.5 with respect to 5 mm tungsten
    - For ^{18}F, a new design reduces the dose rate by a factor of 2 with respect to its equivalent in terms of total thickness of 7 mm tungsten.
  - Design of automated injection system *(Balduyck)*
  - During radionuclide therapy *(Rezio, Orlic)*

Radiation Protection in medicine (11)

- **Protection of workers**
  - During prostate brachytherapy implants *(Piracco, Mannino)*
  - Radiology staffs *(Popescu, Oh, Towson)*

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RP of the public and the environment (1)

- TA6 a - Radon : 6 presentations
- TA6 b - Public and environment :
  8 presentations
- Posters : 99

RP of the public and the environment (2)

- **Radon : the largest component of natural exposure**
  - Epidemiology has shown the responsibility of radon in lung cancer *(Catelinois, Leuraud)*
  - Chronic exposure at low dose rate : mainly in “terra incognita” regarding dose effect relationship
  - Internal contamination including non gamma emitter : knowledge of microrepartition is essential
  - Importance of pathways, transfers and real (bio)availability
  - Radon could be responsible of degenerative diseases (Multiple sclerosis, Alzheimer, Parkinson…): accumulation of ^{210}Po & ^{210}Pb in the brain (10 times normal value) *(C. Groves-Kirby)*

➡ Need for more experimental work

RP of the public and the environment (3)

- **Radon**
  - Measurement and theoretical study of radon and aerosol distribution in house : an obvious key for successful mitigation *(Ameon* (Radon2 software), *Rahman, Strand, Jiranek, Gooding* (UK program), *Arvela* (Finnish program)*)*
  - Necessity to find a good equilibrium between mitigation costs and saved exposures *(Strand)*
  - Evaluation of retrospective radon exposure: a requirement for establishing health consequences of radon exposure by epidemiological methods
    Retrospective estimation of past exposures by using long lived progeny ^{210}Po may be improved *(Kelleher)*

RP of the public and the environment (4)

- **Other contaminants : the issues**
  - The impact through environment and impact to environment
  - Measurements and monitoring of contaminants : link between monitoring and models, and link between models and experiments
  - Measurements of very low levels of contaminants. Question of uncertainties to be seriously adressed *(Mercat-Rommens)*
  - Choice of what is measured on the pathway to man and other living matter. Bioavailable contaminants are much more important than contaminants that have reached a dead end in pathways (deep soil, sedimentation zones…)
  - Need for experimental studies of the effects of contaminants on living organisms (IRSN, ENVIRHOM program), but large uncertainties about effects

RP of the public and the environment (5)

- **Other contaminants**
  - Development and optimisation of techniques :
    - Excretion rates of Th and daughters *(Schaeffer)*
    - Solubility in corporal fluids of U and Th *(Frelon)*
    - Biomolecular techniques to determine the expression of genes encoding stress markers at the cell level *(Farcy)*
    - ICPMS to improve the measurement of ^{99}Tc *(Kasprzak)* or U *(Giovanetti)*
    - Real time monitoring of ^{3}H in air *(Bidica)*
    - EPR on teeth for retrospective dosimetry *(Fattibene)*
    - Use of a reference organism (earthworm) to investigate the bioaccumulation and biological effects after soil contamination by uranium *(Giovanetti)*

RP of the public and the environment (6)

- **Other contaminants**
  - Follow-up of specific contaminations :
    - Belgian phosphate industry *(Vanmarcke)*
    - ^{239}Pu in Mayak workers *(Azizova)*
    - ^{137}Cs in potatoes in Croatia *(Franic)*
    - NORM in oil industry *(Heaton)*
    - NORM in coal, fly ash and cement in India *(Kant)*
    - NORM in water in Romania *(Botezatu)*, in Austria *(Gruber)*, in Iran *(Botireyni Toosi)*
    - Large monitoring programme at Sellafield *(Parker)*

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Waste management and decommissioning (1)

- TA7 – Waste management and decommissioning : 8 presentations
- Posters : 12

Waste management and decommissioning (2)

- **Decommissioning**
  - Decommissioning is *a* growing activity in the nuclear field
    - there should be a growing interest related to the RP issues
    - It is somewhat surprising that a rather limited number of papers were presented on decommissioning
  - Decommissioning projects allow efficient preparatory work, as characteristics of the installations are fixed and there is no external "pressure" from production constraints
    - possibilities for optimisation (ALARA)
    - development of new methodologies for radiation cartographies *(Toubon):* CARTOGRAM and CZT detector coupled with MERCURAD modeling
    - specific procedures developed for the decommissioning of the pulse column laboratory at Dounreay *(White)*

Waste management and decommissioning (3)

- **Waste management**
  - Waste management and disposal technology : to deal with wastes of various origins, also from non-nuclear installations
    - Need for expansion of the interim storage facility of STUK to handle non-nuclear radwaste and obsolete sources, before transfer to the national waste repository of Olkiluoto *(Rahola)*
    - Limited disposal routes for NORM waste from North sea platform decommissioning *(Wade)*
  - More attention should go to the transfer to future generation(s) of a safe patrimony *(Schneider)*
    - Need to combine the technical and societal aspects for a long term governance
    - Dialogue with stakeholders to favour a sustainable management (e.g. COWAM)

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Incidents and accidents (1)

- TA8 - Incidents and accidents : 4 presentations
- Posters : 32

Incidents and accidents (2)

- **Management of nuclear accidents**
  - Evaluation of national exercises in the Netherlands *(De Hoog van Beynen)*
  - Reference scenarios for the Swiss emergency planning *(Navert)*
  - Towards an international consensus on public information practices with the successful development of INES scale in RP (sources, transport, and medicine in the future) *(Jouve)* and development of a common and unambiguous language of communication on radiation risks *(Tschurlovits)*
  - The Tchernobyl accident and its environmental and societal consequences provide fruitful lessons to improve radiation emergency preparedness *(Konstantinov)*

Incidents and accidents (3)

- **Management of post-accidental phase**
  - Lessons from INEX 3 exercise with a focus on response planning and rehabilitation *(Molhoeck, NEA)*
  - Implementation of an inclusive radiation monitoring system in the Bragin district in Belarus as a result of European program ETHOS and CORE : evaluation of whole body contamination of children and of the contamination of foodstuffs, with the involvement of the public authorities, local professionals and population and the French NGO ACRO *(Crouail)*
  - Successful application of the FARMING initiative in Belgium : engagement of stakeholders in the event of radiaoctive contamination of the foodchain, and identification of issues (political, legal, operational, societal, ethical, economical) *(Hardeman)*

Incidents and accidents (4)

- **New therapeutic strategies**
  - Cytokines to treat the hematopoietic syndrome *(Bertho)*
  - TIARA (Treatment initiatives after radiological accidents): European network for identifying effective medical treatment in case of malevolent dispersion of radionuclides *(Ménétrier)*
  - Use of stems cells to treat skin necrosis (Percy Hospital, IRSN)

Incidents and accidents (5)

- **Prevention of accidents**
  - Strengthening in Slovenia of a program of control of orphan sources which are not so easy to detect and could be possibly used for malevolent acts *(Janzekovic)*

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Non ionizing radiation (1)

- TA10 - Non ionizing radiation : 4 presentations
- Posters : 29

Non ionizing radiation (2)

- **Radiofrequency fields**
  - **Mobile phones**
    - Measurement of transient modifications of functional brain activity and behavior of rats after prolonged acute exposure to 900MHz GSM ? No indication of neurotoxicity *(Brillaud)*
    - MONIT : network of autonomous remote probing stations and electromagnaetic sounding program developped in Portugal in public areas to meet public concern about mobile telephones. Results, all below safety levels, available on website *(Oliveira)*

Non ionizing radiation (3)

- **Radiofrequency fields**
  - Electrical power lines
    - Typologies and ELF measurement procedures *(Benes)*
    - Modelisation of magnetic induction field *(Comelli)*
  - MRI : analysis of safety and protection related to 4T field for human research *(Russo)*

Non ionizing radiation (4)

- **UV & Lasers**
  - How to provide adequate safety exposure to UV radiations and particularly for the hands at work ?

    In the choice of disposable gloves, the material is more important than the thickness or the colour, som gloves not providing adequate protection against UV *(Khazova)*

  - Do not count on the blink reflex as a protection from laser radiation (class II LED Radiation) because it works in only 16.7 % of the population *(Reidenbach)*

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Radiation protection systems and regulation (1)

- TA 2 – Radiation protection systems and regulation : 8 presentations

- Posters : 38

Radiation protection systems and regulation (2)

- **To regulate or not to regulate *(Mason, Lacoste)***
  - When is it necessary to apply regulation to the control of exposure to ionizing radiation and when is regulatory control not warranted ?
    - Exemption of practices and sources
    - Exclusion of exposures
    - Clearance of materials
  - <u>The operator is first responsible for radiation protection</u>
  - The success of the regulation depends on the quality of the <u>dialogue between authorities and the operating management of operators</u>

Radiation protection systems and regulation (3)

- **The representative individual *(Till, ICRP)***
  - The issue is the evaluation of the doses to the public which cannot be measured directly
  - The "representative individual" is proposed to replace the "critical group" concept
  - Goal is to characterize an individual, either hypothetical or specific, whose dose can be used for determining compliance with the relevant dose constraints
  - Requirements. The dose assessment
    - must account for all relevant pathways of exposure
    - must consider spatial distribution of radionuclides to be sure that the person receiving the highest dose is included
    - habit data must be reasonable, sustainable and homogenous
    - dose coefficients have to be applied according to specific age categories

Radiation protection systems and regulation (4)

- **The optimisation principle : constrained optimisation *(Weiss)***
  - ICRP proposal to optimise the level of protection achieved below source related dose constraints whatever the new classification of exposure situation : normal, emergency and existing
- **The problem of the outdoor workers *(Janssens)***
  - Review of the EC Directive 90/641/Euratom necessary because EC Directive 96/29/Euratom has changed the definition of the natural or legal person responsible for controlled areas
  - European survey:
    - 100.000 workers concerned
    - need for a uniform layout and content of the radiation passports and an European Dose Recording System
    - need for training and education in RP

Radiation protection systems and regulation (5)

- **Radiation protection of the environment (ICRP)**
  - The conceptual approaches for environmental protection are laid down: the protection of non-human species against ionising radiation is conceptionally similar to environmental protection against hazardous chemicals
  - But it suffers from many gaps in scientific knowledge, including :
    - dosimetry of bioata (models for fauna and flora)
    - impact of ionising radiation on living organism
    - the fate of many radionuclides in the environment

Radiation protection systems and regulation (6)

- **Training and education *(Coeck)***
  - The "European Network for Education and Training in Radiological Protection" (ENETRAP)
  - Project to establish a sustainable education and training infrastructure for radiation protection as an essential component to combat the decline in expertise and to ensure the continuation of the high level of radiation protection knowledge
  - Need for harmonized training programmes combining :
    - theoretical knowledge
    - and the ability to practice radiation protection

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Radiation protection : policy and society (1)

- Panel 4 – Radiation protection and society : 4 presentations
- TA 9 - Radiation policy and society

  8 presentations
- Posters : 5

Radiation protection : policy and society (2)

- **The Italian debate on nuclear energy during the immediate post-Chernobyl period *(Cantone)***
  - Difficult communication : distrust in the real capability of experts (not prepared) and institutions to manage the emergency, enhanced by the lack of information, high uncertainties, contradicting information, ideological positioning of the experts, wide conflict of values and conceptions, role of the mass media...
  - The debate polarized around two opposing positions, limiting the confrontation to a “yes/no” choice
  - It anticipated crucial risk governance issues that characterize today relationship between science and society

Radiation protection : policy and society (3)

- **Post-Chernobyl rehabilitation process in the territories *(Lochard, Lazo)***
  - Active engagement of experts with the affected population
  - Active involvement of the population instead of being passive
  - Focus on actions yielding tangible results has given rise to sustainable, quality-of-life improvements
  - Closer and more productive relationships of experts and population with professionals and authorities
  - The authorities begin to rebuild confidence and trust with the stakeholders

Radiation protection : policy and society (4)

- **Stakeholder engagement**
  - Networking is an efficient way of favouring stakeholder commitment in radiation protection *(Lefaure, Rick Jones)*
    - Networks clearly favour a bottom-up approach that complements already existing decision systems
    - Keywords of successful networks: personal links and communication - enthusiasm - flexibility - collective efficiency
    - International networks (ISOE, ALARA…) are very successful
  - Communication on risks *(Tschurlovits, Salomon)*
    - An area of conflict between radiological, sociological and perceptional issues. The different contributing parties should adjust their way of thinking and their language to the requirements of the others, and use a precise language
    - Same difficulties regarding stakeholder involvement in non ionizing radiations and electromagnetic fields issues

Radiation protection : policy and society (5)

- **Stakeholder Engagement**
  - The Salamanca workshop defined the processes and tools for stakeholder engagement *(Gallego).* But new workshops are needed to launch future actions, especially at IRPA level, and to disseminate “stakeholder engagement culture” within RP professionals
  - The UK experience has shown a general loss of trust in politicians and Government . Attempts made to engage the public seriously have not been very successful. Need for a change of culture *(Bandle)*
  - The Montbéliard Radiation Protection Pilot Project *(Klein)*
    - a global approach of RP addressing occupational, public and patient exposures at the level of a large urban community
    - Important actions on RP education at the university and public levels

Radiation protection : policy and society (6)

- **Stakeholder Engagement : a synthesis*(Lochard, Gallego, Bandle, Klein, Salomon)***
  - Decisions are taken by responsible organisations and authorities
  - Societal demand of participative democracy
  - In order to reach sustainable solutions, which enhance public trust and security, complex radiation protection issues require:
    - the intervention of multiple social agents (stakeholders)
    - the dialogue between scientists, experts and the general public
    - the transparency of the decision making process
  - Thus, need for appropriate mechanisms and tools for listening to and balancing off the different opinions and a shift in attitudes and behaviours aimed at greater transparency and openness to wider stakeholder views and experience.

Conclusions

- Radiation protection has made great progress and new insights are in view

- Radiation protection is challenged in all fields which have been reviewed and highlighted. European radiation protection societies can meet the challenges : long life to IRPA !

We cannot predict the future of radiation protection, but IRPA can invent it !

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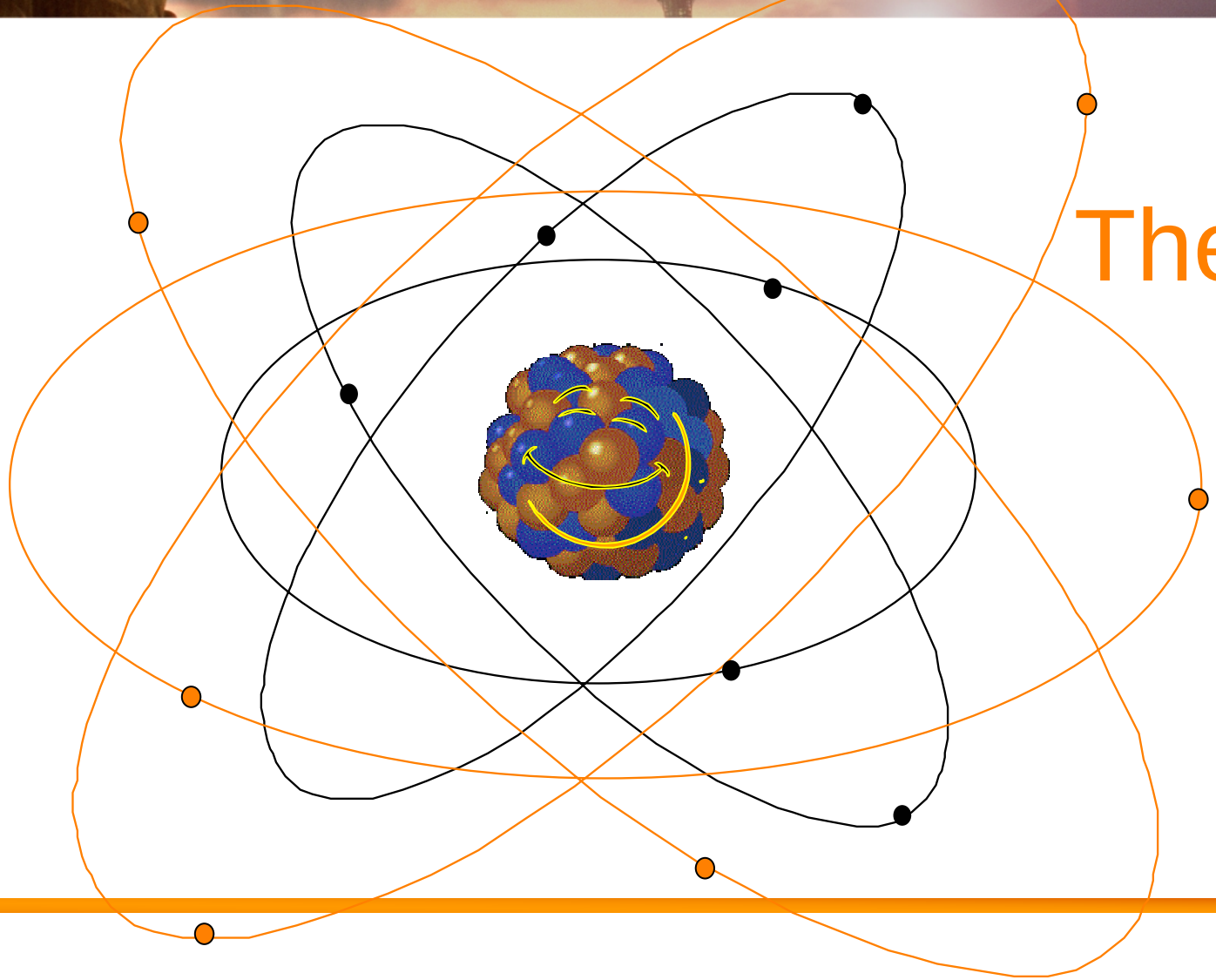
- New proceedings CD-ROM to be sent to all participants by post within one month

- Proceedings on web sites including abstracts, full papers, no ppt :
  - *http://www.irpa2006europe.com*
  - *http://www.sfrp.asso.fr*



The end