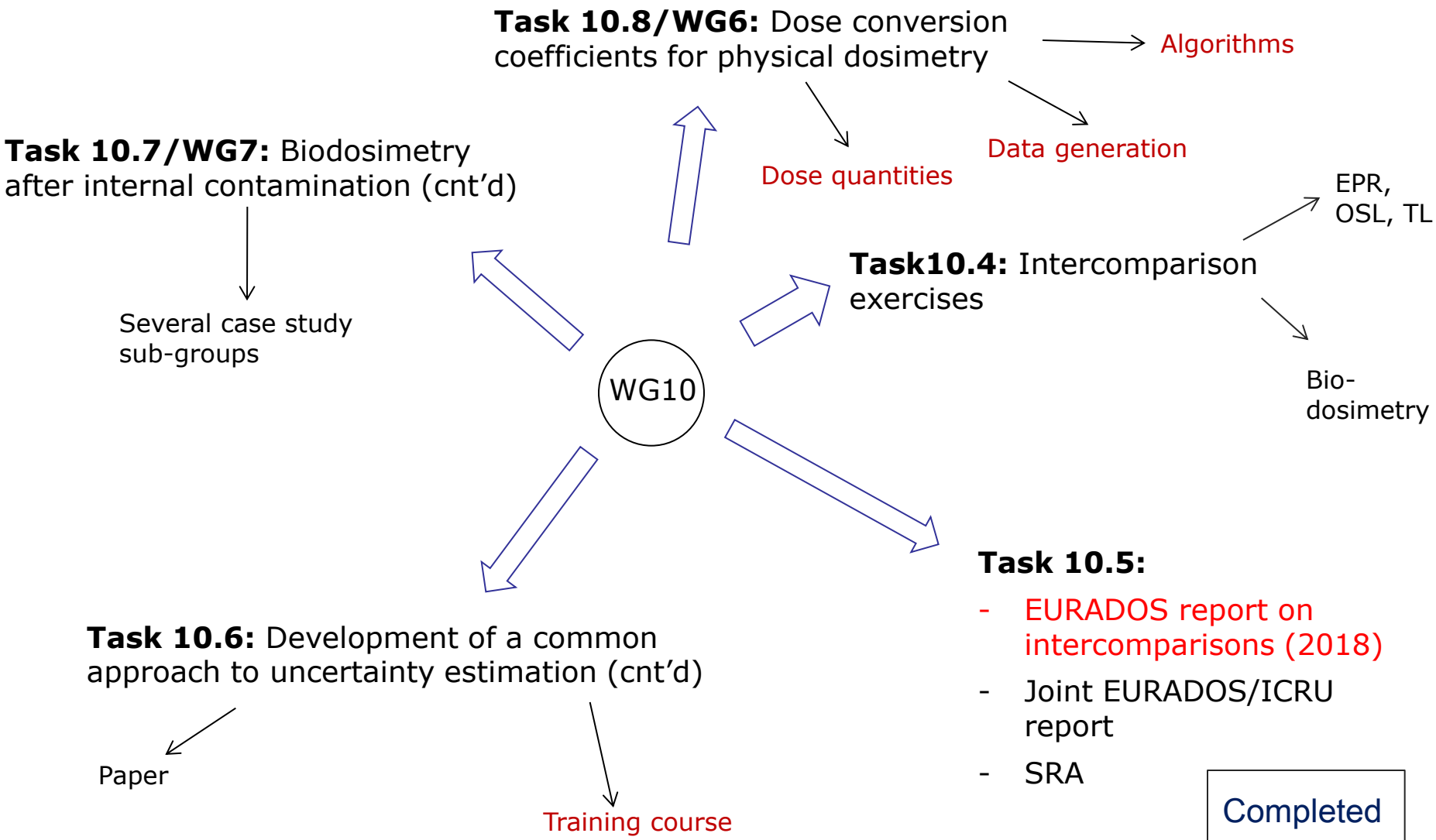
WG10- Retrospective dosimetry

Progress Report

EURADOS General Assembly
Karlsruhe, Germany
March 1st, 2017

C. Woda

WG10 Tasks



Completed
In progress
Future

Tasks in progress

TG10.4 Intercomparison exercises

Task chairs: L. Ainsbury, C. Woda

Joint EURADOS/RENEB ILC in 2017 :

- All biological assays, TL/OSL on phones, EPR separate ILC
- different irradiation setup but same doses for biological and physical retrospective dosimetry, all irradiations done at IRSN (for biodosimetry carried out in January 2017)
- Use ISO norm for statistical analysis of all assays

Design of the ILC for TL/OSL:

- Three phones (high dose, low dose, sham irradiation). Labs provide own samples for sham and high dose, same model (bought) will be used for low dose.

10.4 Inter-laboratory comparison

Aims of the ILC for TL/OSL:

- Assessment and reduction of uncertainty for OSL method on resistors
- Validation of the TL protocol on resistors
- Validation of the TL method on display glass for arbitrary phone samples.

Timeline:

- April/May 2017: Irradiation & shipment of samples
- Discussion of results at fall meeting of WG

TG 10.5 – Joint ICRU/EURADOS report

Commission Sponsors:

- Søren Bentzen
- Elena Fantuzzi

Members:

- Stephen McKeever, Co-Chairman
- Clemens Woda, Co-Chairman (WG10)

- Paola Fattibene (WG 10)
- Alexander Romanyukha
- Horst Romm (WG 10), until Sept. 2016
- Antonella Testa (WG10), since Sept. 2016
- Steven Simon
- François Trompier (WG 10)
- Ruth Wilkins

- 1st Meeting: 27-29 January 2016 (Bethesda)
- 2nd Meeting: 26-28 September 2016 (Rome)

TG 10.5 – Joint ICRU/EURADOS report

- Title was modified following input from RC28:

"Methods for Initial-Phase Assessment of Individual Doses following Acute Exposure to ionizing Radiation"

- Words "Emergency Decision Making" were removed from previous title
- "Initial phase" -> hours to weeks after the exposure (i.e. early-to-intermediate, but not years, which is the focus of ICRU 68).
- Only „dose" will used in the title, as EPR and biodosimetry will be affected by both, external and internal sources.
- Focus of report on initial phase after incident with acute exposures, internal component is likely to be small
- Short section on bioassays will be included and on area dose mapping
- Main emphasis: biodosimetry, EPR, TL/OSL, experiences from accidents
- A first draft of approximately 1/2 of the report has been written

TG10.6
Development of common approach to uncertainty estimation

(TG chairs: F. Trompier; E. Ainsbury)

Aims:

To survey, compare and assess techniques of uncertainty analysis for physical and biological retrospective dosimetry

Deliverables:

- A paper surveying and comparing uncertainty evaluation methods used within WG10 members
- Organize a training school in uncertainty estimation (2017)

To date:

- Paper finalized. Sent for comments to WG members, will be submitted April 2017
- Successful application to CONCERT 2nd E&T Call for training school
- First version of software for uncertainty analysis (M. Marrale)

- General description of retrospective dosimetry
- General methodology
- Introduction to GUM, Monte Carlo and Bayesian statistics
  - Methodology (including use of software)
  - Strengths, weaknesses, main pitfalls
  - Examples from participants and exercises
- Emphasis on practical sessions

Organizers: S. Ancelet (IRSN), F. Trompier (IRSN), L. Ainsbury (PHE)

TG 10.7
Biodosimetry in internal exposure scenarios

TG chair: H. Romm (until Sept. 2016). A. Testa

Aims

To establish the usefulness and limitations of cytogenetic dosimetry in cases of internal and mixed internal/external exposures

Deliverable:

Paper to a peer reviewed journal

To date:

- Joint meetings with WG 7 (2013-2017, 2 x per year).
- Agreement on organizing the work in case studies, agreement on the structure of the review
- Nomination of contact persons for each scenario /and each WG

Actual status and next steps

(1) Main focus on scenarios involving incorporation of single radionuclide (much easier to describe and to find correlation between biodosimetry and internal contamination data)

(2) and some case studies of complex scenarios involving more radionuclides.

(3) During this meeting … decisions on:

- which scenarios are consistent
- how to make the presentation of data more homogeneous
- collecting input from WG7 and WG10 colleagues

(4) Major part of the paper written (30+ pages)

(5) Foreseen submission end of 2017

TG10.8
Dose conversion coefficients for physical dosimetry

(TG chairs: J. Eakins; M. Discher)

- Cross-cutting activity with WG6

Aims:

To develop the means for relating the dose measured by a retrospective dosemeter to the detriment to the individual

Definition of three subtasks:

- Development of conversion algorithms for use in emergency / retrospective scenarios (webtool hosted at IRSN)
- Generation / harmonization of conversion data, plus associated limitations / uncertainties
- Exposition into the correct dose quantity for use in emergency scenarios

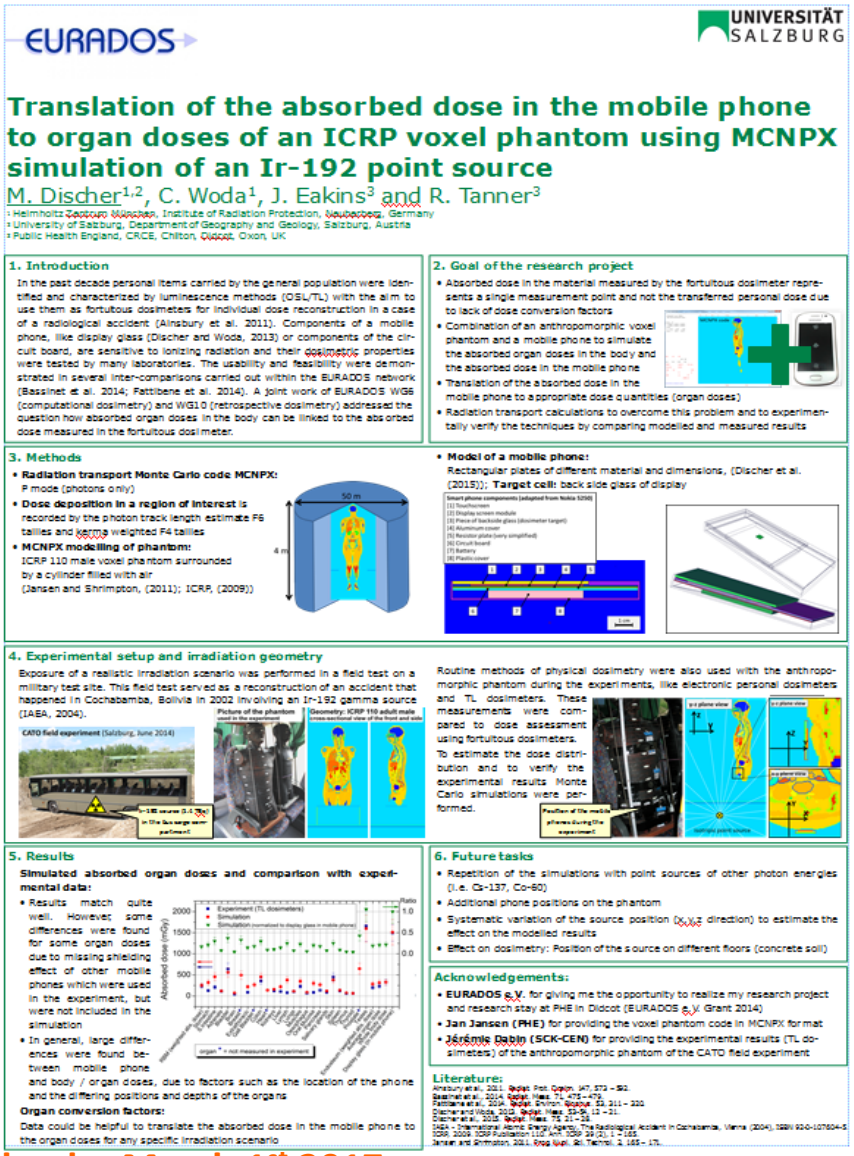
TG10.8
Dose conversion coefficients for physical dosimetry

Presentation of conversion data generated for real emergency scenario ('Cochabamba incident') at SSD18, Munich, Germany (July 2016), Michael Discher, EURADOS

Travel grant

- Organ dose coefficients from Ir-192 point source
- Compares / validates method with measured results
- Investigates some parameters of CATO experiment (e.g. effects of limbs)

Conversion factors agreed well with measured results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Translation of the absorbed dose in the mobile phone to organ doses of an ICRP voxel phantom using MCNPX simulation of an Ir-192 point source

M. Discher[1,2], C. Woda[1], J. Eakins[3] and R. Tanner[3]

[1] Helmholtz Zentrum München, Institute of Radiation Protection, Neuherberg, Germany
[2] University of Salzburg, Department of Geography and Geology, Salzburg, Austria
[3] Public Health England, CRCE, Chilton, Didcot, Oxon, UK

1. Introduction

In the past decade personal items carried by the general population were identified and characterized by luminescence methods (OSL/TL) with the aim to use them as fortuitous dosimeters for individual dose reconstruction in a case of a radiological accident (Ainsbury et al. 2011). Components of a mobile phone, like display glass (Discher and Woda, 2013) or components of the circuit board, are sensitive to ionizing radiation and their dosimetric properties were tested by many laboratories. The usability and feasibility were demonstrated in several inter-comparisons carried out within the EURADOS network (Bassinet et al. 2014; Fattibene et al. 2014). A joint work of EURADOS WG6 (computational dosimetry) and WG10 (retrospective dosimetry) addressed the question how absorbed organ doses in the body can be linked to the absorbed dose measured in the fortuitous dosimeter.

2. Goal of the research project

- Absorbed dose in the material measured by the fortuitous dosimeter represents a single measurement point and not the transferred personal dose due to lack of dose conversion factors
- Combination of an anthropomorphic voxel phantom and a mobile phone to simulate the absorbed organ doses in the body and the absorbed dose in the mobile phone
- Translation of the absorbed dose in the mobile phone to appropriate dose quantities (organ doses)
- Radiation transport calculations to overcome this problem and to experimentally verify the techniques by comparing modelled and measured results

3. Methods

- **Radiation transport Monte Carlo code MCNPX:** P mode (photons only)
- **Dose deposition in a region of interest is** recorded by the photon track length estimate F6 tallies and kerma weighted F4 tallies
- **MCNPX modelling of phantom:** ICRP 110 male voxel phantom surrounded by a cylinder filled with air (Jansen and Shrimpton, (2011); ICRP, (2009))

50 m
4 m

- **Model of a mobile phone:** Rectangular plates of different material and dimensions, (Discher et al. (2015)); **Target cell:** back side glass of display

4. Experimental setup and irradiation geometry

Exposure of a realistic irradiation scenario was performed in a field test on a military test site. This field test served as a reconstruction of an accident that happened in Cochabamba, Bolivia in 2002 involving an Ir-192 gamma source (IAEA, 2004).

CATO field experiment (Salzburg, June 2014)
Picture of the phantom used in the experiment
Geometry: ICRP 110 adult male

Routine methods of physical dosimetry were also used with the anthropomorphic phantom during the experiments, like electronic personal dosimeters and TL dosimeters. These measurements were compared to dose assessment using fortuitous dosimeters.
To estimate the dose distribution and to verify the experimental results Monte Carlo simulations were performed.

5. Results

Simulated absorbed organ doses and comparison with experimental data:

- Results match quite well. However some differences were found for some organ doses due to missing shielding effect of other mobile phones which were used in the experiment, but were not included in the simulation
- In general, large differences were found between mobile phone and body / organ doses, due to factors such as the location of the phone and the differing positions and depths of the organs

Absorbed dose (mGy)
Experiment (TL dosimeters)
Simulation
Simulation normalized to display glass in mobile phone
Ratio
organ "-" not measured in experiment

Organ conversion factors:

Data could be helpful to translate the absorbed dose in the mobile phone to the organ doses for any specific irradiation scenario

6. Future tasks

- Repetition of the simulations with point sources of other photon energies (i.e. Cs-137, Co-60)
- Additional phone positions on the phantom
- Systematic variation of the source position (x,y,z direction) to estimate the effect on the modelled results
- Effect on dosimetry: Position of the source on different floors (concrete soil)

Acknowledgements:

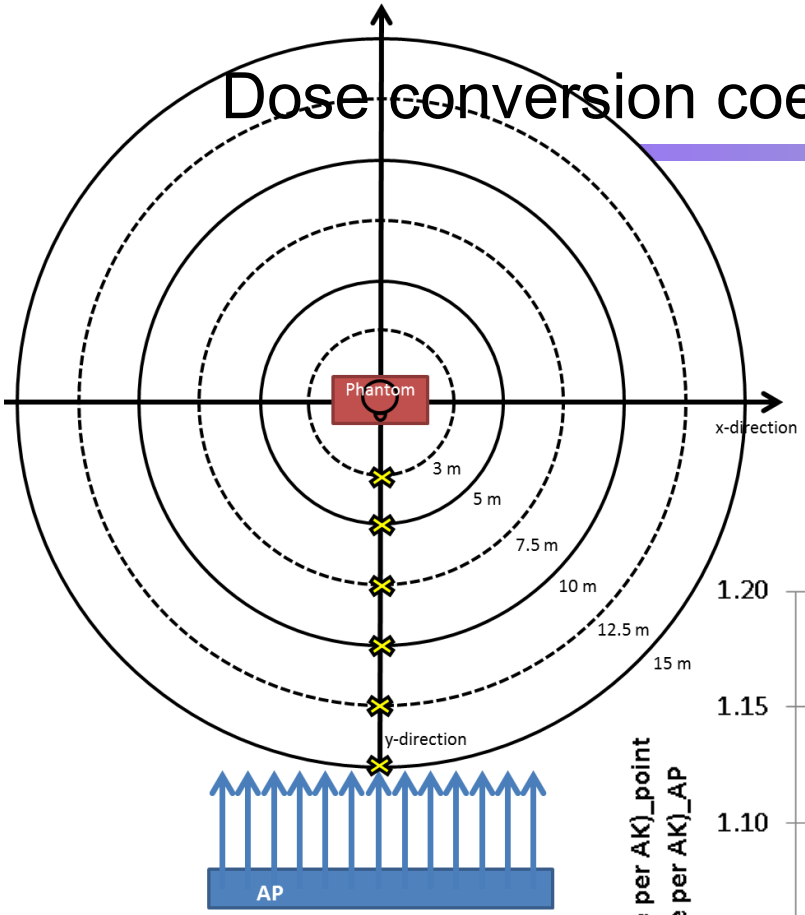
- **EURADOS e.V.** for giving me the opportunity to realize my research project and research stay at PHE in Didcot (EURADOS e.V. Grant 2014)
- **Jan Jansen (PHE)** for providing the voxel phantom code in MCNPX format
- **Jérémie Dabin (SCK-CEN)** for providing the experimental results (TL dosimeters) of the anthropomorphic phantom of the CATO field experiment

Literature:

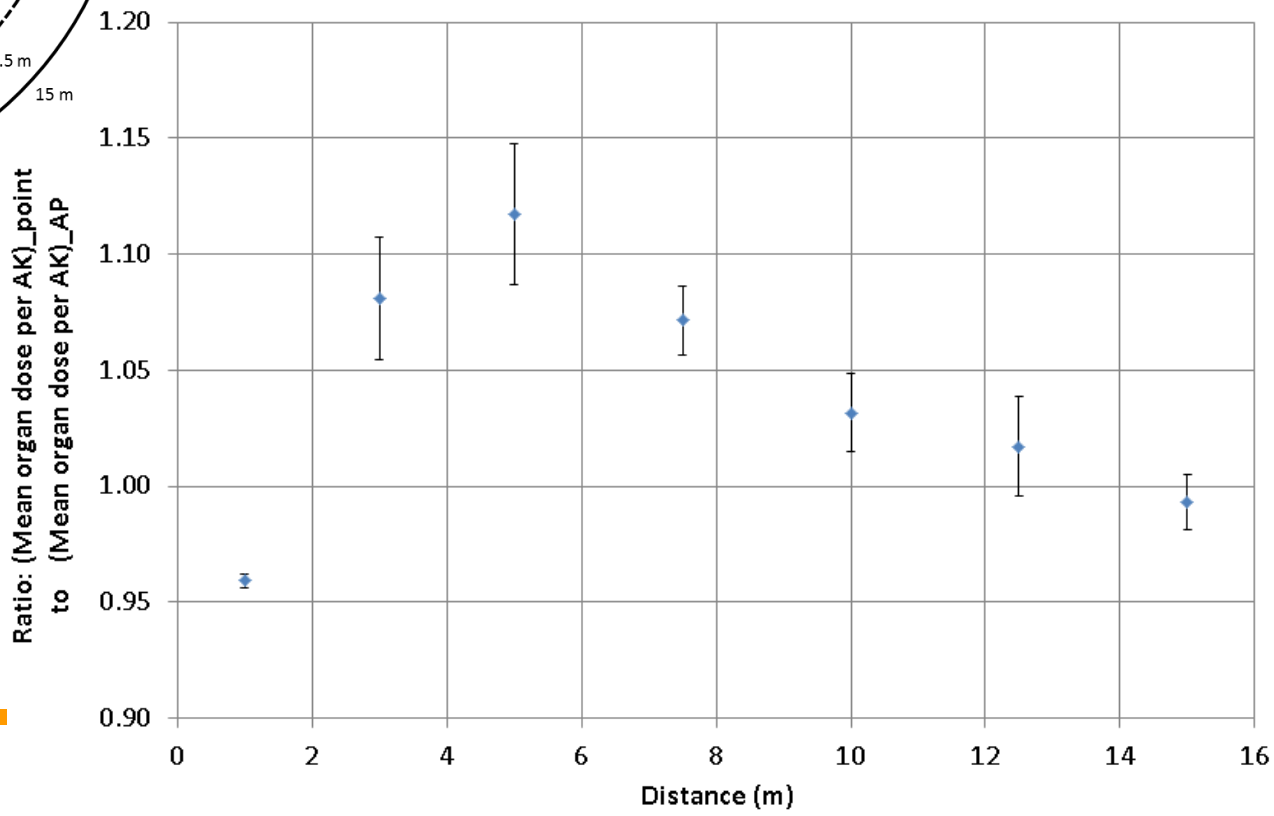
Ainsbury et al., 2011. Radiat. Prot. Dosim. 147, 573 – 592.
Bassinet et al., 2014. Radiat. Meas. 71, 473 – 479.
Fattibene et al., 2014. Radiat. Environ. Biophys. 53, 211 – 220.
Discher and Woda, 2013. Radiat. Meas. 53-54, 12 – 21.
Discher et al., 2015. Radiat. Meas. 74, 51 – 58.
IAEA – International Atomic Energy Agency: The Radiological Accident in Cochabamba, Vienna (2004), ISBN 92-0-107604-5
ICRP, 2008. ICRP Publication 110. Ann. ICRP 39 (2), 1 – 165.
Jansen and Shrimpton, 2011. Prog. Nucl. Sci. Technol. 2, 165 – 171.

TG10.8

Dose conversion coefficients for physical dosimetry



10 - 15 m the “magical” distance:
(i.e. roughly equivalent to a plane-parallel exposure)



- Cs-like source initially
- To be extended to Ir-192, Cs-137, Co-60 (+others?) effects of ground scatter (concrete?, soil?)

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Dissemination

- SSD 18, 18th International Solid State Dosimetry Conference (Munich, July 2016)
  - Presentation of WG10/TG4 TL results (Michael Discher)
  - Presentation of EURADOS Grant results (Michael Discher)
- Publication forecast 2016/2017:
  - 2 MS on the intercomparison results 2015 and 2016 (10.4)
  - MS on the uncertainty assessment in retrospective dosimetry (10.6)
  - MS on biodosimetry after internal contamination (10.7)
  - Results of EURADOS Grant research (Voxel phantom calculations for emergency dosimetry, 10.8)