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EURADOS

EURADOS Working Group 6: *Computational Dosimetry*

Chair: Rick Tanner, PHE
Secretary: Carmen Villagrasa, IRSN

EURADOS AM2017, KIT, 1 March 2016

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Working Group 6: tasks

Working Group 6 promotes scientific research and development activities in the field of Monte Carlo Modelling for Radiation Dosimetry and Protection. It carries out activities that promote good practice and advance the science in the area of computational dosimetry.

- 6.1: Neutron energy distribution unfolding
- 6.2: Micro and nano dosimetry (WG7)
- 6.3: Individual monitoring (WG10)
- 6.4: In-vivo monitoring (WG7)
- 6.5: Linac modelling
- 6.6: Voxel phantoms
- 6.7: High-energies (WGs 9 & 11)
- 6.8: EANM collaboration (provisional)

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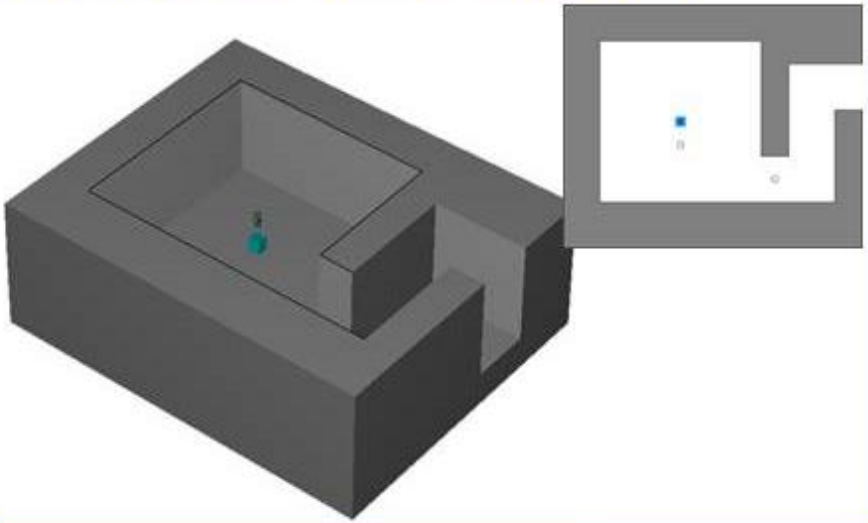
6.1 Neutron spectrum unfolding

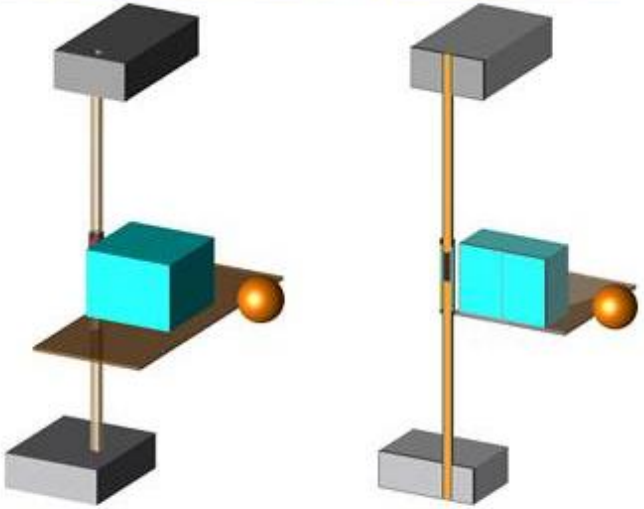
Task Leader J-M Gomez Ros (CIEMAT); Deputy C Domingo (UAB).
Intercomparison on unfolding methods: ideal Bonner sphere set modelled to generate response functions

- Four realistic “workplace” fields – Monte Carlo models
- Intercomparison launched at AM2016
- Distributed via: EURADOS newsletter and website; targetted mailing list; ResearchGate
- Deadline for results: 31 May 2017
- Currently 4 solutions submitted and 7 promised
- Oral presentation on the scenarios at NEUDOS-13
- Analysis by February 2018

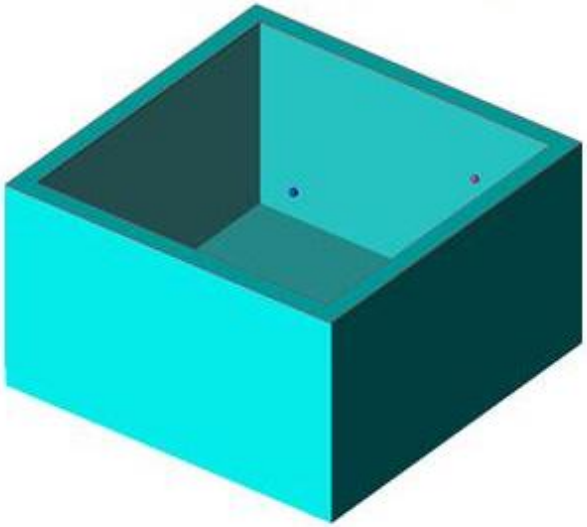
Problem 1: Medical accelerator



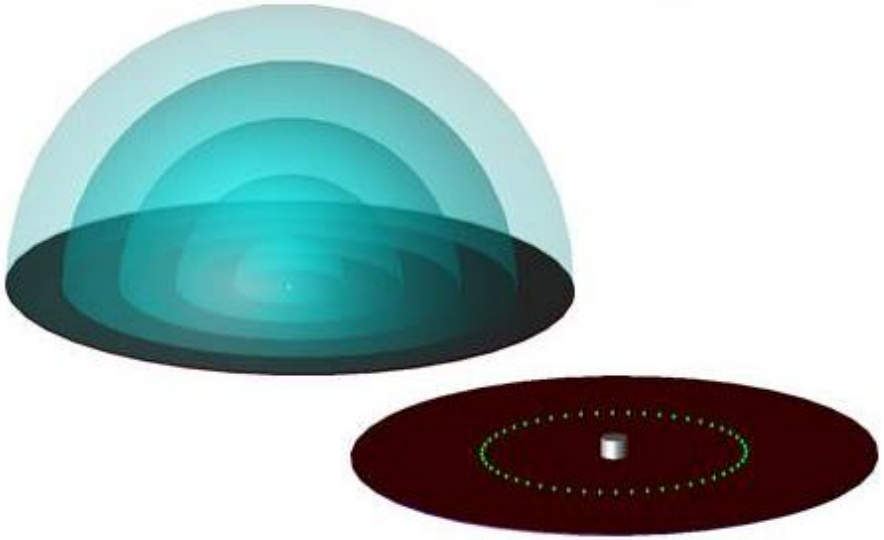
Problem 2: Simulated workplace field



Problem 3: Irradiation room



Problem 4: Skyskhine scenario



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6.2 Micro & nano dosimetry

Task leader Hans Rabus (PTB) seconded for 18 months. Replaced by Carmen Villagrasa (IRSN). Deputy E Gargioni (Hamburg)

- EURADOS exercise on uncertainty assessment in micro- and nanodosimetry using Monte Carlo calculations
- Fundamental issues in track structure simulations
  - Monte Carlo uses classical treatment of quantum objects
- **EURADOS Report on Workshop "Challenges in micro- and nanodosimetry for ion beam cancer therapy" – published as a EURADOS Report**
- Collaboration with WG 7 TG 7 on Monte Carlo modelling of radiation effects of nanoparticles

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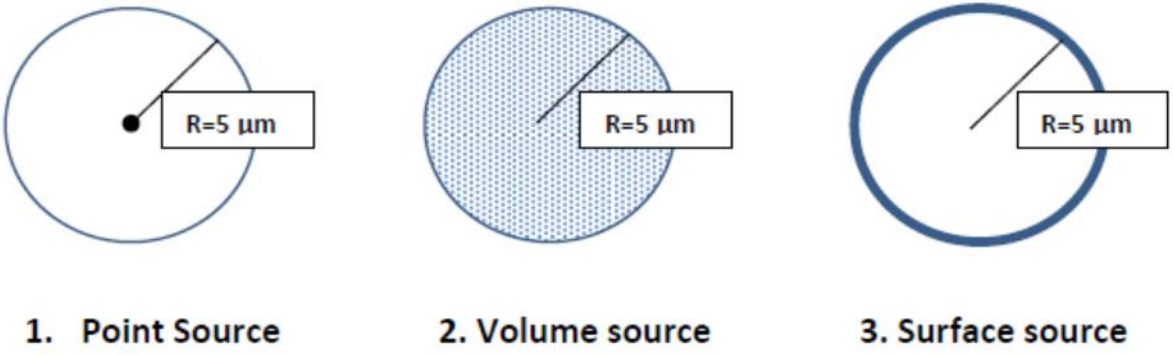
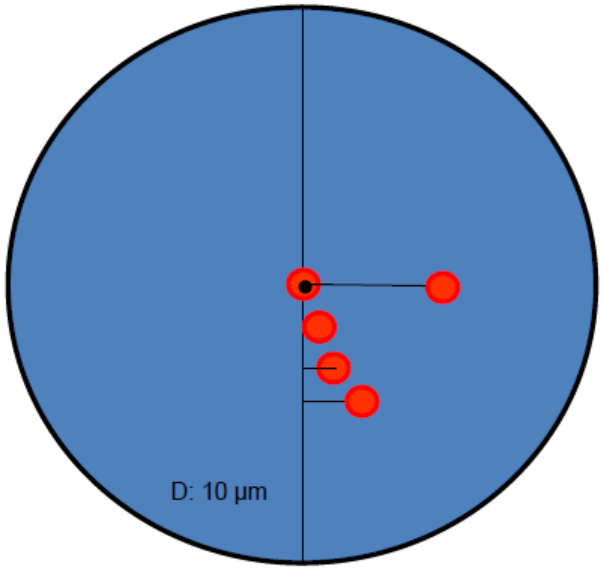
6.2 Micro & nano dosimetry



1. Point Source
2. Volume source
3. Surface source

Radioactive ^{125}I source is placed within a liquid water sphere with 10 µm diameter



^{125}I Source

Target 1 diameter: 3 nm (liquid water)

Target 2 diameter : 8 nm (liquid water)

Distances from the source: 0, 1, 2, 4 and 8 times the target radius

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Microdosimetric Exercise

Microdosimetric calculations:

- Nine participants have sent their results. Currently, only results from four different participants have been compared.
- For three others, data files are missing (sent plots) and still some more information is needed from the other two
- New participants are still welcome.
  - Geant4-DNA 10.02 Opt0 - E_{cut} =7.4eV
  - Geant4-DNA 10.02 Opt2 - E_{cut} 7.4 eV
  - Geant4-DNA 10.02 Opt7 - E_{cut} 10 eV
  - PENELOPE – E_{cut} = 50 eV
  - MNCP6.1 – E_{cut} 20 eV, 14 eV and 6 eV
  - FLUKA – E_{cut} = 1 keV
  - NASIC – E_{cut} =7.4 eV

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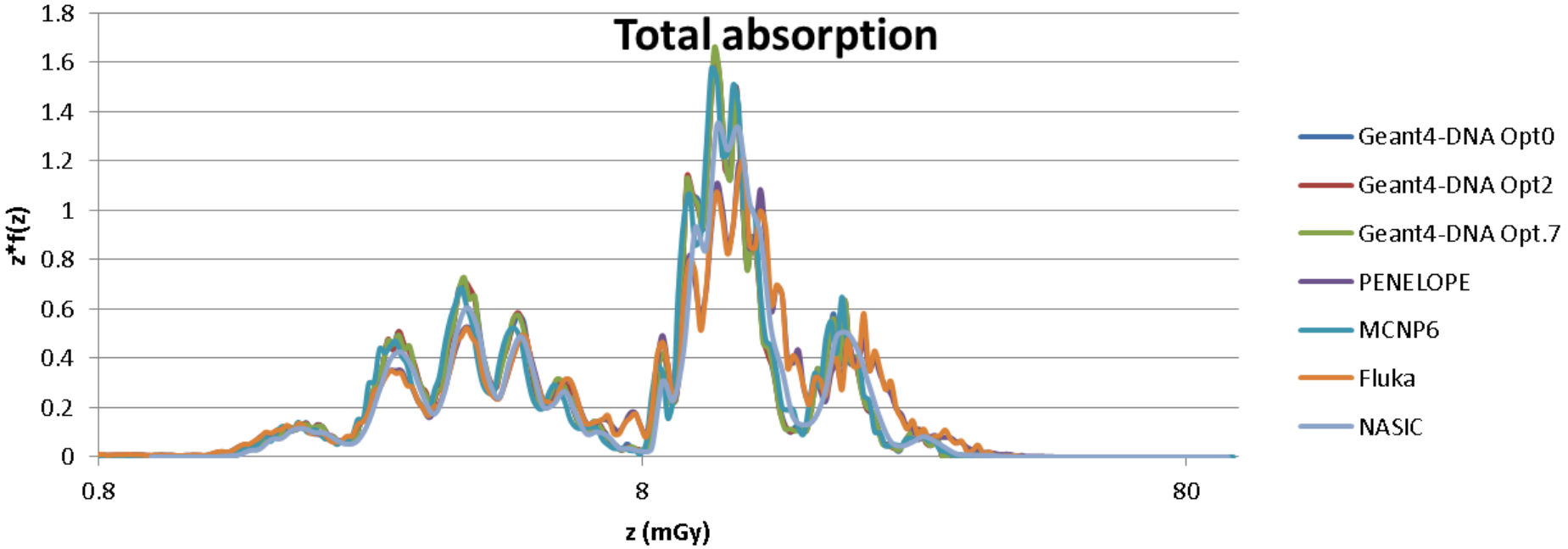
Microdosimetric Exercise



Z mean (mGy)-
Total Absorption

Geant4-DNA Opt0	Geant4-DNA Opt2	Geant4-DNA Opt7	PENELOPE	MCNP6	FLUKA	NASIC
9,3	9,3	9,3	10,42	9,7	10,46	9,36

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6.3 Individual Monitoring

Task Leaders: Wilson (AWE)? and Struelens (SCK)

- Training school: *Monte Carlo for External Dosimetry: pitfalls and best practice*
  - Programme under revision to account for ICRU and eye lens changes
- Criticality dosimetry – Monte Carlo modelling and unfolding
- Skin dosimetry – development of microscopic model to better simulate tissue reactions in skin
- Modelling in collaboration with WG 10, Retrospective Dosimetry:
  - Best quantity for protection against tissue reactions (paper in press)

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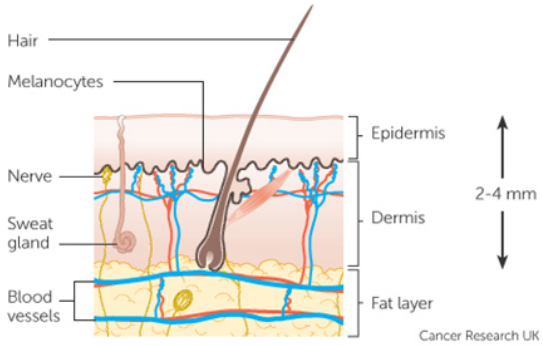
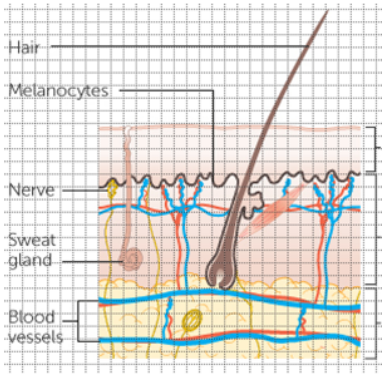
6.3 Realistic skin model

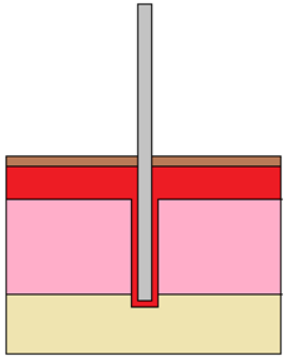
How best to develop a skin model for use in radiation protection?

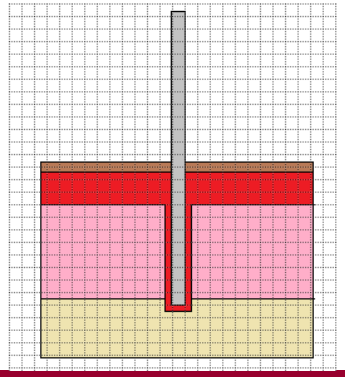
Realistic model?
Voxelized?





Stylized model?
Voxelized?





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6.4 In vivo monitoring

- Task Leader: Vrba (CTU)
- Collaboration with Working Group 7, Internal Dosimetry
- Work programme on hold whilst CAThyMARA project in progress
- Hope to produce a EURADOS report summarizing the intercomparison exercises performed with WG7
- Will review the work programme at Autumn WG6 meeting:
  - Possible development of a reference skull phantom/model

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6.5 Linac modelling

- Task leaders: Caccia (ISS) & Blideanu (CEA)
- Paper on the intercomparison of linac modelling submitted to Physics in Medicine and Biology
  - Some negative comments received from the editors – seeking to address and submit again
- Possible preparation as a EURADOS report
- Use results as input to develop a training module

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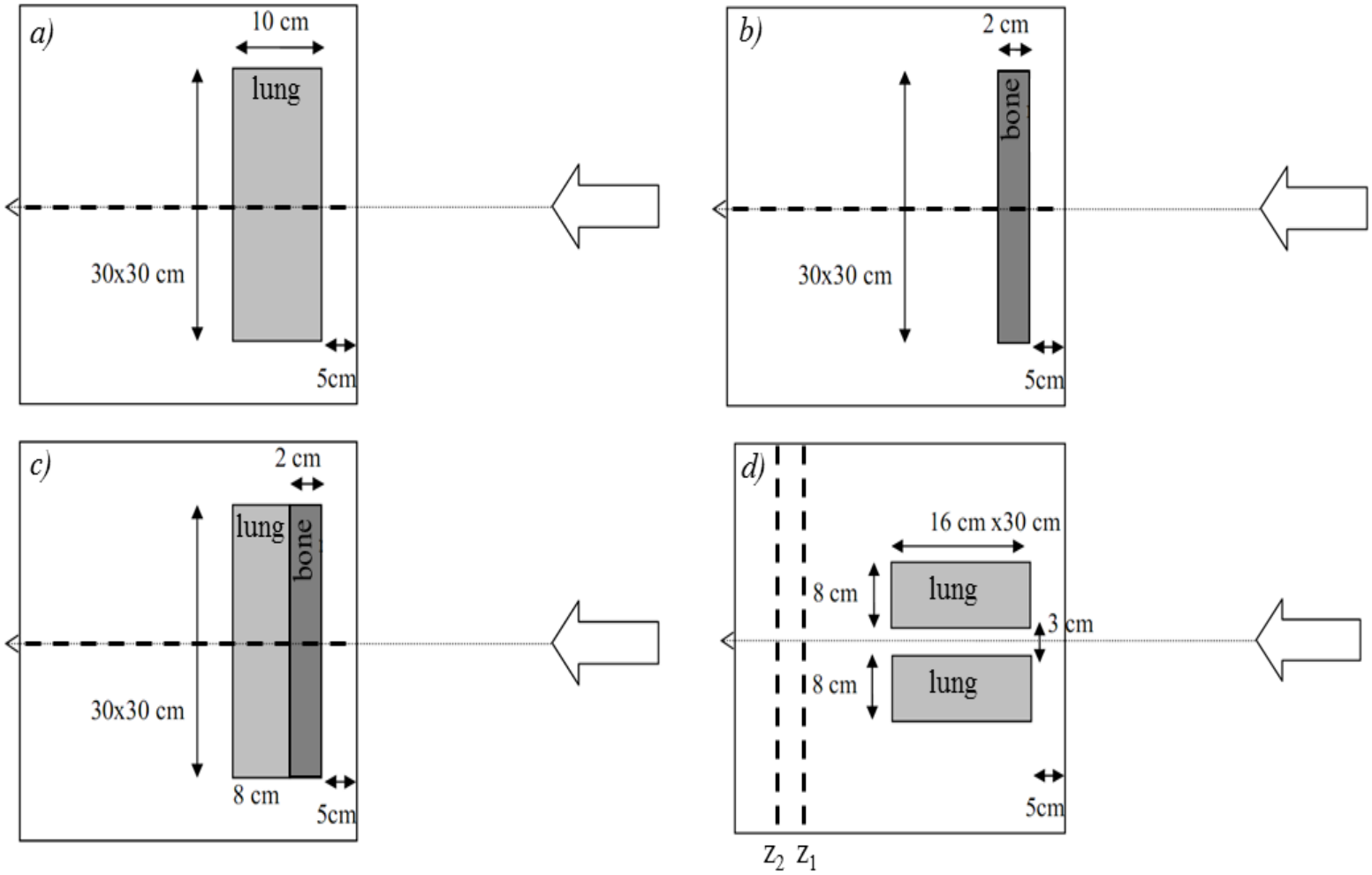
6.5 Linac modelling



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6.5 Linac modelling

EURADOS intercomparison exercise on Monte Carlo modelling of a medical linear accelerator

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[6] Université Abdelmalek Essaadi, faculté des Sciences, Tétouan, Morocco
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6.6 Voxel Phantom Development

- Task Leader M. Zankl (Helmholtz); Deputy C. Huet (IRSN)
- Two schools on voxel phantoms run: at IRSN and HGMU
    - Hold a further school, possibly in 2017 or 2018
- Test of the IMPLEMENTATION of ICRP reference phantoms
    - Use non-ICRP 116 geometries: test whether users have
        - Correctly set up the phantom from raw data
        - Know how to implement it in a Monte Carlo code
        - Know how to calculate effective dose, SAF …
        - External and internal problems, medical imaging
        - Environmental/emergency

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6.6 Voxel Phantom Intercomparison

- Final scenarios not fully decided:
  - Point source
  - Exposure in a cloud
  - Ground contamination
  - X-ray exam
  - Internal source
- Need to get two people to generate reference solution
- Distribution: by May 2017
- Participants' solutions: to be collected by end of 2017

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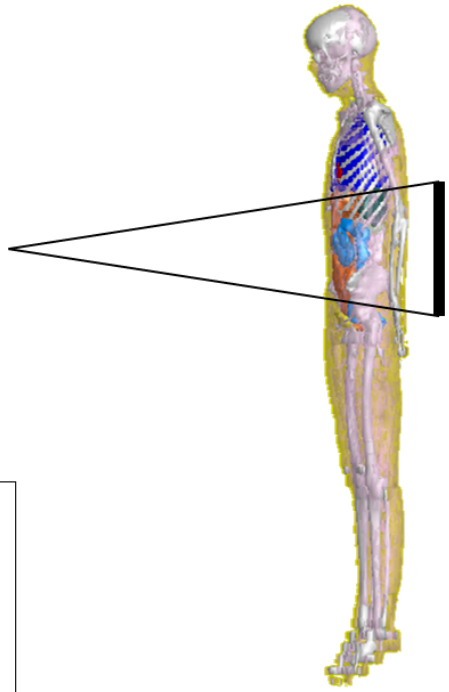
6.6 Voxel Phantom Intercomparison

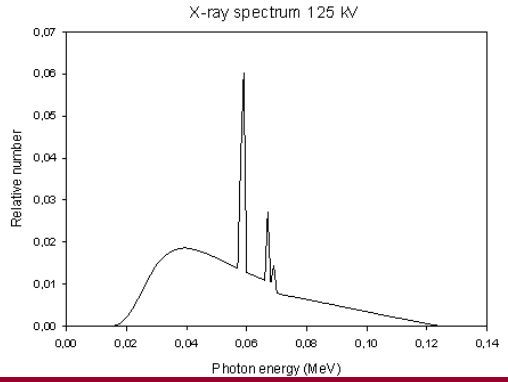
Typical X-ray examinations (1)

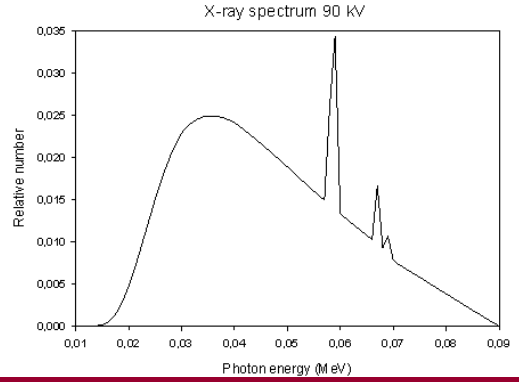
Chest p.a., abdomen a.p.: male/female

Specification:

- X-ray spectrum (numerical values of photon energies and their probabilities)
- Direction of beam incidence (a.p./p.a.)
- Source co-ordinates – in terms of
  - Relation to landmarks in the body
  - Focus-to-skin distance
- Focus-image receptor distance
- Field size (rectangular) at image receptor







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6.7 High energies

- Task Leader S. Rollet (AIT); Deputy S. Agosteo (POLIMI)
- Planned benchmarking with WG9 and WG11:
  - Meeting this morning
  - Chaired by Vladimir Mares (WG11)
  - 23 participants
  - Lively discussion
  - Already reported by WG11 (Jean-Francois Bottolier-Depois)

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Work Plan 2017-18

- Plenary Meeting at AM2017, KIT, February – 50+ people registered
- Plenary meeting at RPW2017, Paris, October (10-15 people?)
- Micro/nano Dosimetry intercomparison – analysis likely to be complete by AM2018
- Neutron spectrum unfolding intercomparison – analysis likely to be complete by AM2018
- Work plan for benchmarking for high energies with WG9 & WG11 – need dedicated meeting to better define
- Develop intercomparison on the implementation of the ICRP reference phantoms – expect to launch this year
- PMB paper - publish: *Intercomparison exercise of Monte Carlo codes for the modelling of a medical linac*