# EURADOS Working Group 9
# Radiation Dosimetry in Radiotherapy

## Motivation

The motivation of this Working Group is to assess and develop existing and potential dosemeters and dosimetric techniques in radiotherapy and, in particular, to assess non-target patient doses and the related risks of secondary malignancy, with the emphasis on a thorough evaluation of dosimetry methods for the measurement of doses remote from the target volume in phantom experiments.

This work lays the foundations for the determination of the complete dose specification for patients undergoing radiotherapy, i.e the total dose to all organs from all sources of radiation, including the imaging procedures necessary for planning and treatment verification. This latter stage is a collaboration with WG12 (Dosimetry in Medical Imaging). The total dose to all critical organs is required for input into epidemiological studies as well as providing robust dosimetric data for the long term studies of radiation effects.

Because of improved treatment techniques, it is recognized that survival rates in radiotherapy are increasing, but secondary cancers (and other long term conditions) might also increase in the future. These occurrences are amplified by the early detection of disease in younger patients. Many of these patients are cured of the primary disease and have long life-expectancies, which increase their chances of developing secondary malignancies. The topic is central to EURADOS activities since our organization has access to experts and developers of the required physical dosimetry techniques and risk prediction models. Whilst common and developing dosimetric techniques are easily identified (eg, ion chambers, TLDs, OSL, RPL, bubble detectors) traceability and consistency need to be established through intercomparison exercises between laboratories and appropriate reference facilities. An ongoing objective of WG9 is to identify new and emerging dosimetric techniques and materials and assess their potential use in radiotherapy dosimetry (e.g. optical fibre and gel dosemeters).

The increasing diversity of radiotherapy treatments following the introduction of techniques such as intensity-modulated, image guided and image adaptive radiotherapy (IMRT, IGRT, IART) means that radiotherapy clinics will need to simulate their treatments in order to estimate and minimize doses to healthy tissues and organs. This is likely to be accomplished by a combination of calculation (via treatment planning algorithms, Monte Carlo simulations and analytical out-of-field models) and measurement in anthropomorphic phantoms. The work of this Group is designed to generate robust datasets of out of-field dose measurements which can be used for the development, validation and application of dose algorithms and analytical models.

A major future activity of the Group is to contribute to the recent rapid development of proton radiotherapy facilities by studying, developing and harmonising dosimetric techniques for proton and neutron dosimetry in such facilities, including experimental and computational studies of phantom and ambient mixed radiation fields. The Group also promotes the development of dosimetric techniques for mailed dosimetry audits of proton therapy beams. A Sub-Group (SG9.2)

on Hadron Radiotherapy Dosimetry has been formed to address this field. An additional Sub-Group (SG9.1) on Computational Methods in Medical Physics provides complementary Monte Carlo studies in support of the experimental programmes.

## Aims

The specific aims are:

**Scientific Aims**

- To select and review dosemeters suitable for radiotherapy photon, proton and neutron dosimetry.
- To evaluate the characteristics of dosemeters for out-of-field measurements and in-vivo dosimetry.
- To perform experimental work jointly with clinical partners at selected hospitals. The determination of out-of-field doses in paediatric radiotherapy treatments, using various photon and proton radiotherapy techniques, is a major clinical focus of the Group.
- To develop appropriate phantoms for out-of-field dosimetry.
- To simulate aspects of the experimental campaigns using Monte Carlo techniques, in order to assess and further analyze the experimental results.
- To investigate and develop combined techniques for out-of-field dosimetry (e.g. combinations of measured and calculated doses, using experimental data to test and verify analytical dose models).
- To develop and harmonise dosimetry techniques for all aspects of proton and light ion therapy by experiment and mathematical simulation.

**Organisational Aims**

- To seek funding opportunities
- To increase visibility and disseminate results at international conferences and in peer reviewed journals

## Actions

**Completed**

- Selection of clinical cases for study
- Establishment of protocols for measurement
- Measurement protocol campaigns
- Calibration of dosemeters & measurement of out-of-field data
- Measurements of out-of-field scatter and leakage
- Simulated clinical dosimetry measurements using a BOMAB phantom
- Workshop “Dosimetry for second cancer risk estimation in radiotherapy” at AM2012, Vienna
- Published Proceedings from AM2012 Workshop: Radiat. Meas. Vol. 57, 2013.
- Dissemination of completed work at international conferences and in peer reviewed journals
- EURADOS Report on dosimetry for second cancer risk estimation (EURADOS Report 2017-01. ISSN 2226-8057; ISBN 978-3-943701-14-2)
- Some clinical simulations using paediatric anthropomorphic phantoms

**In Progress**

- Proton radiotherapy – measurements using water tank and anthropomorphic phantoms
- Paediatric radiotherapy dose and risk estimates
- Clinical simulation of brachytherapy using anthropomorphic phantom
- Joint WG9 / 12 action on experimental determination of complete dose specifications in radiotherapy
- System for mailed dosimetry audits of proton therapy radiotherapy beams
- Compilation of current risk models for use with measured organ dose data

**Planned / discussed**

- Development of Monte Carlo simulations of radiation fields in the vicinity of treatment machines
- Analysis of potential for dose/risk reduction
- In-vivo dosimetry (patient & remote measurements, simulations)
- Small field dosimetry
- Collaboration with TP system manufacturers
- Dosimetry studies of 3-D printed compensators in proton beam scanning
- Dosimetry studies of proton grid therapy

## Members

**Chairperson**


- Liliana Stolarczyk Danish Centre for Particle Therapy at the Aarhus University Hospital

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**Full members**

- Working Group 9 has currently 13full members from 10 countries.

**Corresponding members**

- Working Group 9 has currently 45 corresponding members from 17 countries.

**Associated contributors**

- Working Group 9 has currently 3 associate contributors from 3 countries

## Additional information

See EURADOS web site (www.euroados.org).