SGSMP
SSRPM
SSRFM

Schweizerische Gesellschaft für Strahlenbiologie und Medizinische Physik
Société Suisse de Radiobiologie et de Physique Médicale
Società Svizzera di Radiobiologia e di Fisica Medica

Swiss Society for Radiobiology and Medical Physics (SSRMP)
Member of the European Federation of Organisations for Medical Physics (EFOMP) and the International Organization for Medical Physics (IOMP)

Quality control for Intensity-modulated radiation therapy

Recommendations No. 15

ISBN 3 908 125 41 3 **September 2007**

/

Contents

1. Introduction

The objectives of these recommendations are to describe the commissioning and quality assurance (QA) for photon intensity-modulated radiation therapy (IMRT) performed with static (sMLC) or dynamic (dMLC) multileaf collimator (MLC) technique. IMRT performed with compensators or with tomotherapy units are not covered by this document.

The first section describes the minimal requirements for the commissioning, acceptance and quality control of IMRT (chapter 2). The next section deals with the clinical implementation (chapter 3) and chapter 4 with individual patient QA. Finally, chapter 5 presents a summary of the different QA tests that should be performed.

In many cases, the details of the QA tests to be performed, and their respective frequencies and tolerances, will depend upon the department's technical equipment and resources. Consequently, it remains the responsibility of the medical physicists how to apply these recommendations in the clinic.

2. IMRT commissioning, acceptance and quality controls

This section presents different tests that should be performed during commissioning, acceptance and quality control of IMRT treatments.

2.1. Linear accelerator

In most cases, commissioning and acceptance of IMRT software and hardware will follow on from the normal commissioning process of a linear accelerator. We will therefore focus in these recommendations on topics with special importance for IMRT or on issues where stricter quality controls are necessary than in conventional three dimensional conformal radiation therapy (3DCRT). As a vital component of IMRT on LINACs is the MLC, many of these recommendations will focus on this device. Detailed suggestions and hints for their evaluation and control are described in [1], while detailed procedures especially for dMLC are outlined in [2-4].

The foundations of linear accelerator quality assurance for IMRT are the established procedures corresponding to SSRMP recommendations No. 11: "Quality Control of Medical Electron Accelerators" [5]. The additional topics for QA which are necessary for IMRT are described below.

2.1.1. Radiation protection

As IMRT treatments delivered with MLCs generally require 2-4 times higher monitor units (MUs) per delivered dose at the isocenter than conventional treatments [6-8], the room shielding for radiation should* be re-evaluated. This increase in MUs per week by IMRT treatments is usually not critical for primary barriers but it may be of importance for secondary barriers. In addition, the choice of photon energy for IMRT should take into account the increased scatter, leakage dose and neutron production when energies above 10 MV are selected [9-10].

2.1.2. Basic dosimetry

Although the basic dosimetry of the linear accelerator is closely linked to the treatment planning system (TPS), two aspects of this topic are addressed here. For IMRT using the sMLC technique, output factors and profiles of small beams have a larger impact on calculated dose distributions than in 3DCRT. Consequently, the consistency of output factors between measurement and calculation should be checked for fields as small as 1 x 1 cm^2. In addition, the effect of profile measurements on dose calculations is difficult to assess in a quantitative way and this is a particularly critical problem in the penumbra region. For the dMLC approach, the modeling of the single pencil beam scatter kernels in the TPS is an issue [2]. In this case, it is advisable to measure dose profiles with a detector which has a small effective volume [2].

2.1.3. Linear accelerator performance with low MUs

An exact linearity of dose output for low monitor units is an important property of the sMLC-technique, as each IMRT segment is typically delivered with MUs of between 5 to 20.

* In these recommendations, the word "should", or the adjective "recommended", mean that "there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course" [11].

Consequently, the variation of dose/MU should be measured throughout the range of use for IMRT. Similarly, the stability of flatness and symmetry for low MU segments should be checked.

The recommended tolerance is ± 1 % relative to the reference conditions.

This test should be repeated quarterly.

2.1.4. MLC positional accuracy

The positional accuracy of the MLC has a larger impact on delivered dose in IMRT than in conventional 3DCRT, where the MLC defines only the outer border of the beam. An uncertainty of 1-2 mm in leaf location may be clinically inconsequential in 3DCRT, but could have a large impact on the accuracy of IMRT delivery [12]. Thus, the positional accuracy of the MLC should be evaluated over the full range of leaf travel and carriage motion that will be clinically employed.

A simple test for the most important factors mentioned above is the acquisition and analysis of a match line-pattern usually called the "garden fence test". These tests rely on the matching of adjacent strips producing narrow strips (e.g. 5 mm). An obvious advantage of this method is that the delivered and recorded patterns can be inspected visually to detect improper positioning of leaves with a precision of about 0.5 mm. Additionally, the position of the stripes, and consequently that of the leaves, can be simply measured in relation to the marked isocenter with a ruler.

The recommended tolerance is ± 1 mm for each leaf.

This test should be repeated weekly at 0° gantry angle, and the gantry-angle dependence with a period of 3 months.

2.1.5. MLC penumbra

Depending on the design of the MLC, the penumbra can change as a function of both beam energy and the location of the leaf with respect to the central axis. This can be measured using film dosimetry. Such measurements have to be performed for at least two distances from the central axis in order to establish a relation between the nominal locations of the leaf ends and the radiation field edge. The field edge is defined by the 50 % decrement line of the radiation field.

It is recommended to irradiate a set of small strips, each with a width of, for example, 3 cm, delivered on both sides of the central plane covering the full range of travel of leaves and carriages. Profiles through these strips should be measured in the direction of leaf travel using a high-resolution detector.

These measurements should be performed during the commissioning process of IMRT.

2.1.6. Leaf speed

Quality assurance of the leaf speed, i.e., of leaf position vs. time or monitor units, is only strictly necessary if performing IMRT with the dMLC technique. With this technique however, exact control of leaf speed is the main condition determining the accuracy of IMRT delivery, and its measurement is therefore a critically important element of the IMRT QA chain for dMLC delivery. Leaf speed instability may arise from mechanical or steering problems or also due to the calibration technique employed.

A simple test can be performed by an MLC test pattern where the leaf pairs move with constant gap and constant speed during beam on, possibly using different gap width and/or different speeds for different leaf pairs. The delivered dose should be uniform in travelling direction of the leaves, which can be checked with a dosimetric film or a portal imaging device. Furthermore, it should be correct in absolute dosimetry and independent of the gantry angle, which can be checked with measurement in the central axis using a detector whose sensitivity is suitable for the effect to be measured (e.g. an ionising chamber).

Variations in measured dose with this test should not exceed ± 2 %.

This test should be repeated weekly at 0° gantry angle, and the gantry-angle dependence with a period of 3 months.

2.1.7. MLC transmission and TPS model parameters

In contrast to conventional 3D-CRT, during IMRT delivery with MLCs, the treatment area is occluded (shadowed) by the leaves for a large fraction of the delivered MUs. Consequently, most treatment planning systems require a value of the MLC transmission, generally in the form of an average value, which must be measured. For this, it is important that the measurement device, film or chamber, spans a large enough area to adequately sample the radiation due to transmission through the leaves themselves and leakage through the leaf gaps.

For this measurement, it is recommended to position a cylindrical ionisation chamber with its axis perpendicular to the direction of motion of the leaves

This measurement, and also the determination of possible other MLC model parameters for the TPS, should be performed during the commissioning process of IMRT.

2.1.8. MLC control issues

In [1], the authors highlighted a number of control issues regarding MLC devices which should be fully understood, together with their impact on IMRT. Therefore, when considering and implementing IMRT, the medical physicist should consider the following questions:

1. How is the MLC calibrated?

2. How is the MLC leaf position indexed to MU and are fractional MU permitted?

3. How, and to what precision, is the MLC leaf position measured?

4. What tolerance applies to the MLC leaf position and can it be controlled?

5. Which interlocks check that the MLC leaf position is correct?

6. What verification records or logs are created by the control system?

7. How to respond if the QA checks show that the calibration has drifted?

8. How to recover from delivery interruptions?

2.2. Treatment planning system (TPS)

2.2.1. Dosimetric verification of the whole process

The SSRMP recommendations Nr. 7 (or an updated version of it) "Quality control of treatment planning systems for teletherapy" [13] are considered to be the foundations of TPS QA for IMRT. Starting from these recommendations ensures that the dose calculations for the patients are as accurate as possible. The final dose distribution should always be calculated with a state of the art algorithm with heterogeneity corrections, where possible using the best available algorithm provided by the TPS, even if during the optimisation a simplified dose calculation is used. All the results have to be displayed and evaluated under these conditions.

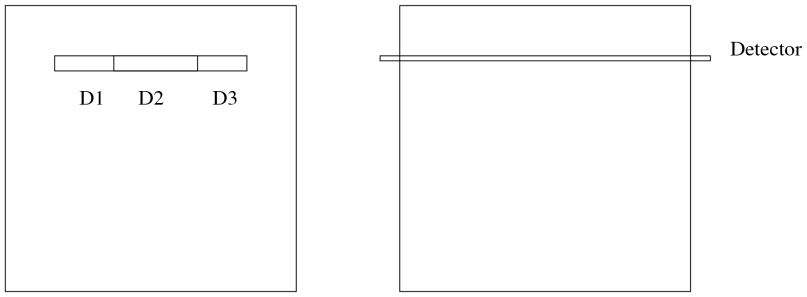
Patient specific QA requires the possibility to apply the IMRT fields to a slab phantom and calculate the dose in that phantom. Depending on local resources and equipment, different QA checks may be performed, and it is the responsibility of the medical physicist to evaluate the needs. In addition, further controls, especially concerning the optimisation algorithm, should be performed. They are described in the following sections. All these tests should be performed yearly or at each TPS upgrade, except for the chair test (see below) which is recommended to be performed on a monthly basis.

2.2.2. Exactness of the optimisation

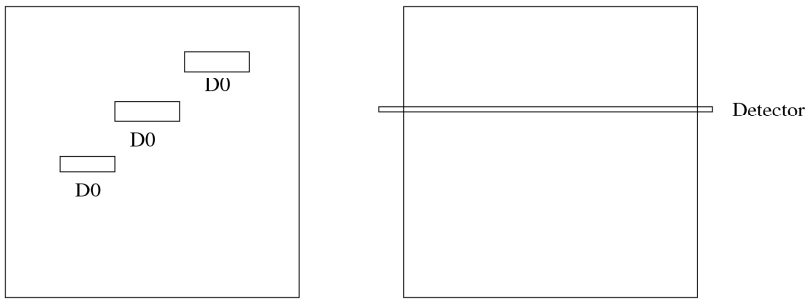
The recommended tests to check the optimisation are similar to the ones described in detail in [2]. For these tests, a simple phantom – for instance a cubic solid water phantom – is recommended. The idea is to verify the basic properties of the optimisation process, i.e., to determine whether it is possible to fulfil the defined constraints with sufficient accuracy. The measurements are meant to verify the effect of the optimization rather than the dose calculation, as the precision of the latter is managed in SSRMP recommendations Nr. 7 [13].

1) Different doses at a given depth.

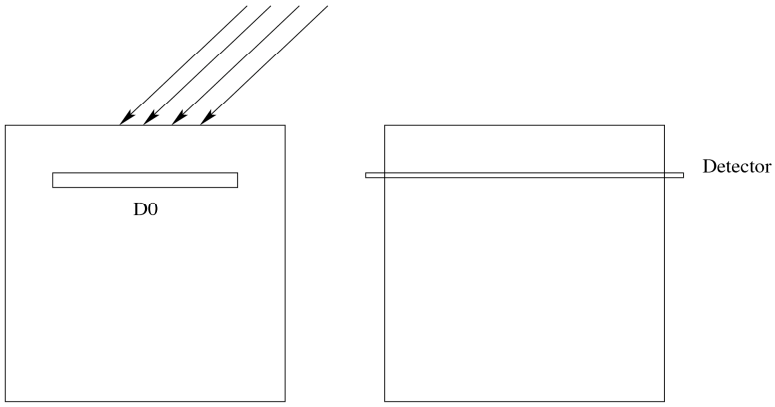
A variety of dose prescriptions (D_1, D_2, D_3 with $D_1=D_3$, $D_2=0$, or $D_1 < D_2 < D_3$) for a set of regions with constant depth should be defined and should be used as input to the optimisation process. A transition zone between the D1, D2, D3 regions – for instance a 5 mm margin inside each region – should be considered. The measured dose corresponding to the application of the results of the optimisation should respect the "prescription" inside these smaller regions.



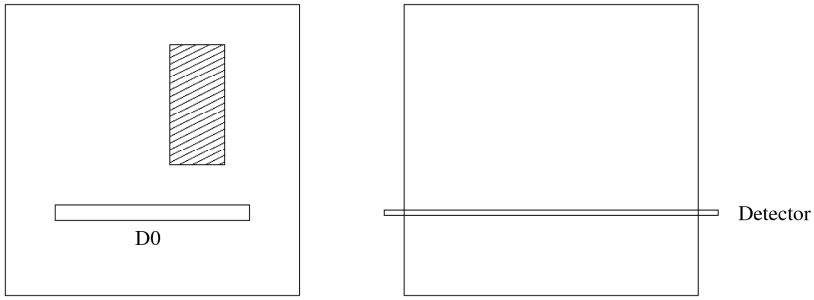
2) Same dose at different depth. A similar test as 1 above, but three regions at different depths but the same dose = D_0.



3) An oblique beam with a single dose prescription at a single depth.

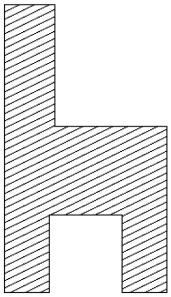


4) Single dose prescription at a single depth with a density heterogeneity partially occluding the incident beam.



5) Test for dMLC dosimetric model parameters.

With the help of suitably designed dMLC test pattern, as for example the chair test [2], the dMLC dosimetric model parameters in the TPS should be measured and compared to the values obtained at commissioning on a monthly basis.



6) Clinical test cases.

Clinical test cases should be performed in order to test the optimisation algorithm in realistic clinical conditions. The selected test cases should cover the same geometry and dose constraints applied to the planning target volume (PTV) and organs at risk (OAR) relationship in order to validate a more clinical situation (heterogeneity, conflicting constraint, etc…). Note: if the patient QA is applied with measurement and not only by calculation from log files this point is less critical. Particular attention should be paid to:

1. The variety of target volume sizes and shapes should encompass the clinical range;

2. The sizes and shapes of OAR, as well as the geometric relationship among them, should be modelled from clinical cases;

3. The placement of targets should be varied to provide verification of the treatment planning and delivery systems throughout the available delivery and planning space;

4. The treatment plan prescriptions used for testing purposes should provide regions of high-dose gradient such that the spatial localisation accuracy can be determined in all three directions.

2.2.3. Optimisation algorithms

The vendor of the TPS has to provide a good description of the optimisation algorithm(s) used. In particular, it should explain if the optimisation problem is convex or not. The user should also evaluate the effect of the input parameters on the optimised dose distribution.

3. Clinical implementation

IMRT can be considered to be an extension of conventional 3DCRT. As such, and as a necessary prerequisite, it requires that all conditions for the application of 3DCRT are fulfilled. In this section, the additional requirements for IMRT are highlighted. The most important points are

1. Equipment requirements
2. Time requirements
3. Staff requirements
4. Treatment planning and treatment delivery
5. Documentation

3.1. Equipment requirements

Obviously, it may be necessary to upgrade existing accelerators to be able to deliver IMRT treatments. Less obviously, it may also be necessary to upgrade the accelerators with an Electronic Portal Imaging Device (EPID) of the latest generation. Similarly, existing record and verify systems and computer networks may need to be upgraded to save and process the large data sets resulting from IMRT (see e.g. [14]). Comprehensive dosimetry equipment, in particular detectors for dose measurements of small fields and in steep dose gradients will be required, as well as phantoms and detector arrays for 2D/3D dose verification and routine quality assurance. Furthermore, given the generally higher conformity of IMRT treatments, additional or improved patient immobilisation devices may be needed. Such additional equipment can often lead to increased storage space for devices and material as well as additional personnel.

3.2. Time requirements

The individual steps required to introduce IMRT into a department (e.g. QA, training etc) can be time consuming depending on the equipment and experience of the people involved. In addition, treatment planning and quality assurance of IMRT treatments are also generally more time consuming compared to conventional 3DCRT. This additional time must be taken into account when planning future resources for the department, and sufficient time should be allowed for the implementation team to perform the necessary tasks safely and reliably.

3.3. Staff requirements

The safe introduction of IMRT into routine clinical practice pre-supposes a treatment team with detailed knowledge and experience of conformal radiotherapy. All members of the team – physicians, medical physicists and technicians – should be trained in the different aspects of IMRT for their field of responsibility. Ongoing education should be encouraged and organised to keep the team up-to-date with new developments and techniques.

Particularly the medical physics team, which has to work on many tasks like commissioning and developing new procedures for machine and patient specific QA, might require increased personnel and/or realistic time scales time for the implementation process and subsequent routine operation.

3.4. Treatment planning and treatment delivery

In general terms, the IMRT treatment process and workflow can be outlined as follows:

1. Immobilisation
2. Image acquisition and registration
3. Volume delineation and dose prescription
4. Treatment planning
5. Individual patient QA
6. Position verification
7. Dose delivery

The steps that differ substantially from 3DCRT are described in more detail in the following paragraphs.

3.4.1. Immobilisation

The precision of an IMRT treatment depends primarily on the precision and reproducibility of the patient setup. Modern immobilisation techniques in combination with state of the art portal imaging and volumetric imaging can reduce the inter- and intra-fraction errors significantly. In order to establish reasonable margins for treatment planning, these errors should be investigated in detail.

3.4.2. Image acquisition and registration

IMRT treatment planning, like that for conventional 3DCRT, is based on three-dimensional CT-datasets. In addition, most planning systems allow the co-registration of other three-dimensional datasets like PET or MRI which are desirable for a more accurate tumour/target and critical structure delineation. During the acquisition of the planning CT, a small slice separation should be considered in order to obtain high quality digitally reconstructed radiographs (DRRs) for virtual simulation and image matching.

3.4.3. Volume delineation and dose prescription

Treatment volumes should be defined on the CT-images according to the latest version of the International Commission on Radiation Units and Measurements (ICRU) report on volume delineation and dose prescription [15, 16]. IMRT may require more target volumes and normal tissues to be delineated than for 3DCRT and additional non-anatomic structures may sometimes be necessary to guide the optimisation algorithm to reduce the doses in regions outside of normal organs at risk. As a consequence, the dose prescription may also be more complicated, since the prescription will not only be defined at the ICRU point, but also for each delineated structure. Some optimization procedures require the indication of a maximum dose and/or dose-volume parameters for the OAR and the surrounding healthy tissue. All such input data used by the optimisation, including dose constraints and boundary conditions, should be logged.

3.4.4. IMRT treatment planning

During treatment planning, there should be an interactive collaboration between physicists, physicians and dosimetrists in order to obtain as good a treatment plan as possible. However, compared to conventional planning, segmentation is an additional task in IMRT planning and the final plan should be checked in order to determine if the segmentation is optimal. For example, in the sMLC approach, it is standard practice to remove small segments before the final dose calculation.

3.5. Documentation

According to Swiss legislation [17], and in addition to standard documentation, a special IMRT documentation procedure has to be established. This may include printouts of various plan parameters, isodose distributions in three orthogonal planes, dose volume histograms, DRRs and/or simulation images for each field and possibly independent MU calculations. Furthermore, the dose constraints should be visible in the prescription sheet and the results of all IMRT quality assurance checks must be recorded.

4. Individual patient QA

In IMRT, patient specific QA is of great importance as the segmentation of an individual treatment field leads to complex patterns of intensity distributions as well as non-trivial MU settings. The whole treatment plan must therefore be checked before being applied to the patient. In addition, patient specific dosimetry should be performed for each individual treatment plan. Such a dosimetric verification involves the measurement of dose distributions in a phantom and the measurement of the absolute dose for a representative point. An independent check calculation of the MU values (determined by the treatment planning system) may replace the absolute dose measurement.

4.1. Measurement of dose distributions in a phantom for individual patient QA

Calculated and measured dose distributions should be checked using a standard verification phantom. The measurements can be made using ionisation chambers, diodes, TLDs, films, or EPIDs. For the comparison of spatial dose distributions, the use of the gamma evaluation method [18] is recommended. There is, however, no consensus on the details of this evaluation method. Usual tolerances are ± 3-5 % in dose and ± 3-4 mm in distance. The percentage of pixels within a suitable region of interest which are out of tolerance should not exceed 5-10 %. If the field-by-field method is used, there is furthermore the problem of normalisation of the field dose. A number of different parameters have been proposed, e.g., mean dose, maximum dose or 95 % of the maximum dose in the field. It is therefore the responsibility of the medical physicists to locally define evaluation parameters and tolerances. Regions of disagreement should be discussed with the responsible clinician to estimate the clinical relevance or the need of replanning.

4.1.1. Verification on a field-by-field basis

For every treatment field of a treatment plan, a verification field should be created by the treatment planning system. For this purpose, the dose distribution is recalculated in a phantom and the field verified by comparing the calculated dose distribution with the corresponding dose measured in that phantom.

4.1.2. Verification of a composite treatment plan

For the entire treatment plan a verification plan should be created by the treatment planning system. The treatment plan, calculated in the patient, should be re-calculated in a phantom and verified by comparing the calculated dose distribution with the corresponding dose measured in the phantom.

4.2. Absolute dose measurement and independent MU checks for IMRT QA

For absolute dose measurements in a phantom, it is recommended to measure the dose in low dose gradient regions in order to prevent errors due to small displacements. An ionisation chamber metrologically traceable should be used for the measurements.

If available, independent MU calculation (e.g. with a second TPS) may replace absolute dose measurement.

5. Summary of the tests to be performed

All actions and tests for quality assurance of IMRT delivery are summarized below.

Ref.	Control	Type of action	Freq.	Tolerance
Linac				
2.1.1.	Radiation protection	Re-evaluate shielding	c	N/A
2.1.2.	Basic dosimetry	Output factors and profiles measurement	c	N/A
2.1.3.	Low MU performance	Dose output and profiles at low MU	q	± 1 %
2.1.4.	MLC leaves position	Test pattern with gantry at 0°	w	± 1 mm
		Test pattern at other gantry angles, alternating	q	± 1 mm
2.1.5.	MLC penumbra	Strip profiles	c	N/A
2.1.6.	MLC leaves speed	Gaps; gantry at 0°	w	± 2 %
		Gaps; other gantry angles, alternating	q	± 2 %
2.1.7.	MLC leakage	Profiles	c	N/A
2.1.8.	MLC control	Documentation	c	N/A
TPS				
2.2.2	Different dose, same depth		a	GI*
	Same dose, different depth		a	GI
	Oblique beam	Same dose at a given depth with an incident oblique beam	a	GI
	Heterogeneity	Same dose at a given depth with an heterogeneity partially in the beam	a	GI
	dMLC dosimetric model parameters	dMLC test pattern (e.g. chair)	m	GI
	Clinical tests	Test various clinical cases	a	GI
2.2.3	Optimisation algorithms	Documentation	c	N/A
4.1	Dose distribution in a phantom	Compare TPS calculation and measurements	Every patient	GI
4.2	Absolute dose measurement or independent MU check	Measurement or dedicated software	Every patient	3 %

* GI: Gamma index.

Abbreviations: c: commissioning; w: weekly; m: monthly; q: quarterly; a: annually.

6. References

[1] Ezzel G. A., Galvin J. M., Low D., Palta J. R., Rosen I., Sharpe M. B., Xia P., Xiao Y., Xing L., Yu C. X., Guidance document on delivery, treatment planning, and clinical implementation of IMRT: Report of the IMRT subcommittee of the AAPM radiation therapy committee, Medical Physics 30 2089-2115 (2003).

[2] Van Esch A., Boschung J., Sorvari P., Tenhunen M., Paiusco M., Iori M., Engström P., Nyström H., Huyskens D., Acceptance tests and quality control (QC) procedures for the clinical implementation of intensity modulated radiotherapy (IMRT) using inverse planning and the sliding window technique: experience from five radiotherapy departments. Radiother. Oncol. 65, 53-70 (2002).

[3] Essers M., de Langen M., Dirkx M. L. P., Heijmen B. J. M., Commissioning of a commercially available system for intensity-modulated radiotherapy dose delivery with dynamic multileaf collimation. Radiother. Oncol. 60, 215-224 (2001).

[4] Venencia C. D., Besa P., Commissioning and quality assurance for intensity-modulated radiotherapy with dynamic multileaf collimator: Experience of the Pontificia Universidad Católica de Chile. J. Appl. Clin. Med. Phys. 5, 37-54 (2004).

[5] SSRMP, Recommendations No. 11: "Quality control of medical electron accelerators", 2003, ISBN 3 908 125 34 0.

[6] Pirzkall A., Carol M., Lohr F., Höss A., Wannenmacher M., Debus J., Comparison of intensity-modulated radiotherapy with conventional conformal radiotherapy for complex-shaped tumors, Int. J. Radiation Oncology Biol. Phys. 48, 1371-1380, 2000.

[7] Klein E., Maserang B., Wood R., Mansur D., Peripheral doses from pediatric IMRT, Med. Phys. 33, 2525-2531, 2006.

[8] Followill D., Geis P., Boyer A., Estimates of whole-body dose equivalent produced by beam intensity modulated conformal therapy, Int. J. Radiation Oncology Biol. Phys., 38, 667-672, 1997.

[9] Schneider U., Lomax A., Pemler P., Besserer J., Ross D., Lombrieser N., Kaser-Hotz B., The impact of IMRT and Proton radiotherapy on secondary cancer incidence, Strahlentherapie und Onkologie 11, 647-652, 2006.

[10] Reft C. S., Runkel-Muller R., Myrianthopoulos L., In vivo and phantom measurements of the secondary photon and neutron doses for prostate patients undergoing 18 MV IMRT, Med. Phys. 33, 3734-3742, 2006.

[11] http://rfc.net/rfc2119.html

[12] LoSasso T., Chui C.-S., Ling C. C., Physical and dosimetric aspects of a multileaf collimation system used in the dynamic mode for implementing intensity modulated radiotherapy, Med. Phys. 25, 1919-1927, 1998.

[13] SSRMP, Recommendations No. 7: "Quality control of treatment planning systems for teletherapy", 1997, ISBN 3-908125-23-5.

[14] SSRMP, Empfehlung Nr. 12: "Radio-Onkologie-Klinik-Informations-Systeme (ROKIS)", 2004, ISBN 3 908 125 35-9; http://www.sgsmp.ch/r12ris-d.pdf

[15] International Commission on Radiation Units and Measurements, “Prescribing, recording, and reporting photon beam therapy” in ICRU report 50, edited by ICRU (Bethesda, 1993).

[16] International Commission on Radiation Units and Measurements, “Prescribing, recording, and reporting photon beam therapy (supplement to ICRU Report 50)” in ICRU Report 62, edited by ICRU (Bethesda, 1999).

[17] Beschleunigerverordnung 5. Abschnitt Art. 16 und Anhang 5.

[18] Low D. A., Hams W. B., Mutic S., Purdy J. A., A technique for the quantitative evaluation of dose distributions, Med. Phys. 25 (5), 656-661, 1998.

7. Members of the working group

Jürgen Besserer	Stadtspital Triemli, Zürich
Luca Cozzi	IOSI, Bellinzona
Giovanna Dipasquale	Hôpitaux Universitaires, Genève
Stephan Klöck	Kantonsspital, Münsterlingen
Guntram Kunz	Unispital, Zürich
Carola Kurth	Kantonsspital, Luzern
Tony Lomax	PSI, Villigen
Peter Manser	Inselspital, Bern
Roman Menz	Unispital, Basel
Raphaël Moeckli (chair)	IRA, Lausanne
Karin Münch-Berndl	Lindenhofspital, Bern
Giorgia Nicolini	IOSI, Bellinzona
Stefano Presilla	Kantonsspital, Luzern
Karl Ludwig Rittmann	Kantonsspital, Chur
Hans Schiefer	Kantonsspital, St. Gallen
Bruno Schnekenburger	Unispital, Basel
Regina Seiler	Luzern
Pierre-Alain Tercier	Hôpital cantonal, Fribourg
Daniel Vetterli	Inselspital, Bern