Package 9

INSTRUCTION SHEET, DATA SHEET AND RESULTS REPORTING FORM FOR THE STEP 7A AUDIT

This package contains the following forms:

Instruction Sheet for quality audits of output factors of small fields shaped with an MLC;

Data Sheet for quality audits of output factors of small fields shaped with an MLC;

Certificate for the step 7a audit.

[DAN LETTERHEAD]

ADVANCED TECHNOLOGY IN RADIOTHERAPY DOSE DELIVERY QUALIT AUDIT FOR HIGH ENERGY X RAY BEAMS

INSTRUCTION SHEET

STEP 7a: Quality audits of output factors of small fields shaped with an MLC

GENERAL INSTRUCTIONS

1. Calculate the number of monitor units (MU) for 5 field sizes shaped with a multileaf collimator (MLC) to deliver 10 Gy on axis at 10 cm depth, 100 cm SSD in water using your treatment planning system (TPS). These calculations should be repeated for each photon beam energy used for IMRT treatments.
2. Calculate the dose rate (Gy/MU) for each of the five MLC defined field sizes given in Section B below and normalize each value to the 10×10 cm^2 value.
3. Fill in the Data Sheet. An evaluation of the small field dose rate dependence results is only possible if these forms are complete.
4. Return the Data Sheet to the [DAN].

CONFIDENTIALITY

The small field dose rate dependence results of individual radiotherapy centres are kept confidential by the [DAN] staff and will not be disseminated without the written permission of the participating centre. The statistical distribution of the results may be reported anonymously to the relevant authorities or published.

TECHNICAL INSTRUCTION

A. Aim of the small field dose rate dependence audit

The purpose of the small field dose rate dependence audit is to check dosimetric data in the treatment planning system (TPS), as used for patient Intensity Modulated Radiation Therapy (IMRT) treatments, related to a radiotherapy treatment unit equipped with an MLC. The extension of the [DAN] programme to advanced technology (IMRT) treatments using small MLC fields requires the verification of dose rate changes for small MLC defined field sizes. An independent verification of the dose calculated by treatment planning systems is an essential step in the improvement of quality assurance in radiotherapy and therefore an important extension of the [DAN] programme.

The absorbed dose rate to water at 10 cm depth for four MLC defined small fields (6 × 6 cm^2, 4 ×4 cm^2, 3 ×3 cm^2 and 2 ×2 cm^2) normalized to a reference 10 ×10 cm^2 field will be checked using published dose rate dependence values[1].

B. Calculation of monitor units for MLC defined small field sizes

- *Small field size dose rates for **Elekta and Siemens accelerators***: a 30 × 30 × 30 cm^3 water phantom will be created in the TPS. The number of monitor units will be calculated to deliver 10 Gy to a point at a depth of 10 cm on the central axis at 100 cm SSD for each MLC shaped field size set symmetrically about the central axis (10 ×10 cm^2, 6 ×6 cm^2, 4 ×4 cm^2, 3 ×3 cm^2 and 2 ×2 cm^2). These calculations should be repeated for each photon beam energy used for IMRT treatments.
- *Small field size dose rates for **Varian accelerators***: a 30 × 30 × 30 cm^3 water phantom will be created in the TPS. The number of monitor units will be calculated to deliver 10 Gy to a point at a depth of 10 cm on the

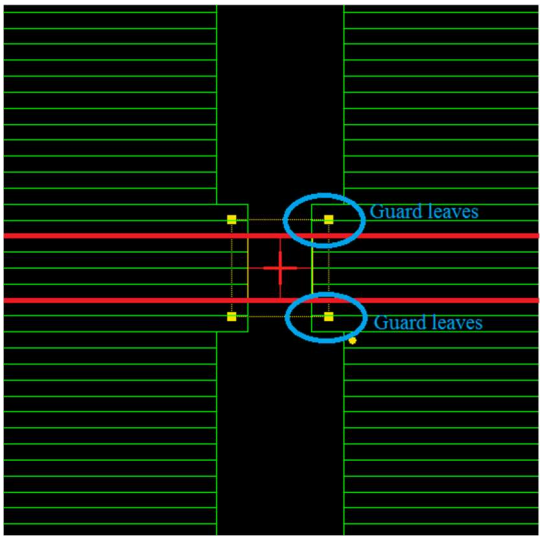

FIG. 1. Field size as defined for Elekta accelerators. For Elekta accelerators equipped with Agility or MLCi2 the fields are defined by the MLC; 1 cm of guard leaves (2 leaf pairs for Agility, 1 leaf pair for MLCi2) are opened on either side to define the in-plane profile by the jaws only.

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[1] FOLLOWILL, D. S., et al., The Radiological Physics Center's standard dataset for small field size output factors, J. Appl. Clin. Med. Phys. **13** (2012) 3962.

Erratum: The Radiological Physics Center's standard dataset for small field size output factors, J. Appl. Clin. Med. Phys. **15** (2014) 356–357.

KERNS, J. R., et al., Technical Report: Reference photon dosimetry data for Varian accelerators based on IROC Houston site visit data, Med. Phys. **43** (2016) 2374.

KERNS, J. R., et al., Reference dosimetry data and modeling challenges for Elekta accelerators based on IROC-Houston site visit data, Med. Phys. **45** (2018) 2337–2344.

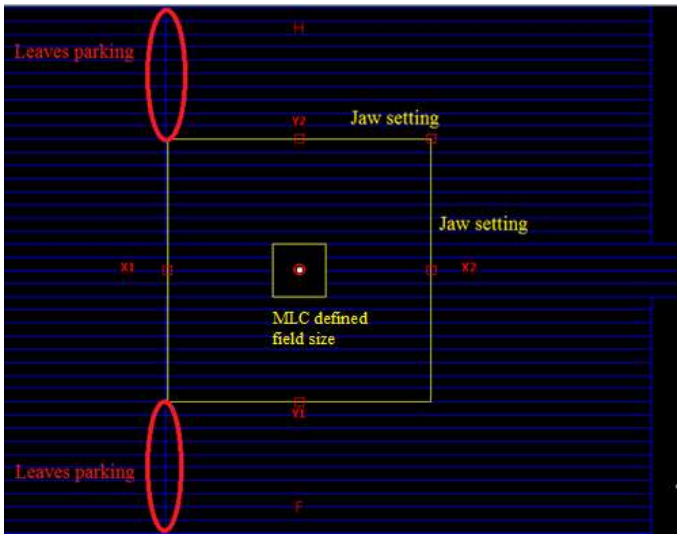

FIG. 2. Field size as defined for Varian accelerators. The secondary jaws define a 10 x 10 cm² field while the MLC defines the segment size.

central axis, at 100 cm SSD for each MLC shaped field size set symmetrically about the central axis (10 × 10 cm², 6 ×6 cm², 4 ×4 cm², 3 ×3 cm² and 2 ×2 cm²) *with the secondary jaws kept at a fixed field size of 10 ×10 cm²*. These calculations should be repeated for each photon beam energy used for IMRT treatments.

- The calculated monitor unit values will be recorded for each photon beam energy modelled in the TPS on the "Quality audits for dose rate dependence of small fields shaped with MLC" datasheet. The participants are also requested to provide a TPS screenshot (print screen) of the beam's eye view for each field size.

TABLE 1. IRRADIATION CONDITIONS TO BE USED. THESE ARE A REFERENCE FIELD AND FOUR DIFFERENT FIELDS WITH SHAPES AND DIMENSIONS DEFINED BY THE MLC.

Field No.	Field size	Field	**Depth in water**	**Irradiation distance**	Delivered dose
1	10 ×10 cm²	Reference field	10 cm	100 cm, SSD	10 Gy
2	6 ×6 cm²	Small square MLC field	10 cm	100 cm, SSD	10 Gy
3	4 ×4 cm²	Small square MLC field	10 cm	100 cm, SSD	10 Gy
4	3 ×3 cm²	Small square MLC field	10 cm	100 cm, SSD	10 Gy
5	2 ×2 cm²	Small square MLC field	10 cm	100 cm, SSD	10 Gy

***NOTE**: For Varian accelerators, the secondary jaws are kept fixed at a 10 ×10 cm² field size for all MLC defined field sizes.*

[DAN LETTERHEAD]

ADVANCED TECHNOLOGY IN RADIOTHERAPY DOSE DELIVERY
QUALITY AUDIT FOR HIGH ENERGY X RAY BEAMS

DATA SHEET

Step 7a: Quality audits for dose rate dependence of small fields shaped with an MLC

It is of a great importance for the TLD evaluation that the information requested below be completed. Please complete Part II, if additional absorbed dose to water determination was made by ionization chamber measurements.

Individuals responsible

Radiation oncologist .....
name *position*

Medical physicist .....
name *position*

Name of institution .....
.....

Address .....
.....

Telephone number .....

Fax number .....:

E-mail .....

Form completed by

Name .....

Position ☐ Medical physicist ☐ Radiation oncologist ☐ Technician
Other: .....

On the day |__|__| |__|__| |__|__|__|__|
day *month* *year*

TLD irradiation performed by

Name .....

Position ☐ Medical physicist ☐ Radiation oncologist ☐ Technician
Other: .....

Previous participation in an external audit or inter-institution comparison for this beam

No ☐
Yes ☐ Date .....

Please also give information on participation in any other audit .....

FOR HOSPITAL STAFF (physicist, oncologist, technician)

A. Specifications of the treatment unit

The treatment unit modelled by the TPS was

.....

model *manufacturer* *serial number* *production year*

installed in the year .....

The manufacturer's stated beam energy is.....MV

The beam is ☐ with ☐ without the flattening filter and is commissioned as ☐ standard ☐ SRS ☐ SRT beam.

The beam quality is characterized by one of the following:

☐ D_{20}/D_{10} = ... (10 cm × 10 cm at SSD = 1 m)

☐ TPR $^{20}/_{10}$ = ... (10 cm × 10 cm at a constant source detector distance of ..... cm)

other ..... conditions: .....

The MLC used is of the type

.....

model *manufacturer* *#leaves* *leaf width at isocentre*

B. Specification of the treatment Planning System (TPS)

Treatment Planning System used is: .....Software version: .....

Dose calculation algorithm used is: ..... (version, if applicable).....

Calculation grid used is: .....

Original TPS commissioning date: ...../...../.....

Original software commissioning date: ...../...../.....

C. Monitor unit (MU) calculations for the MLC defined small field sizes

Field size [cm^2]	MU*	Dose rate Gy/MU	Normalized Dose Rate
10 × 10			1.000
6 × 6			
4 × 4			
3 × 3			
2 × 2			

* The number of monitor units should be calculated to deliver 10 Gy to a point at a depth of 10 cm on the central axis at 100 cm SSD for each MLC shaped field size set symmetrically about the central axis (10 × 10 cm^2, 6 × 6 cm^2, 4 × 4 cm^2, 3 × 3 cm^2 and 2 ×2 cm^2).

Any additional comments:

.....

.....

.....

Please return this datasheet together with TPS screenshot (Print screen) of the beam's eye view for each field.

STEP 7a AUDIT CERTIFICATE

RESTRICTED

[DAN letterhead]

[DAN] TLD POSTAL DOSE QUALITY AUDIT

Institution:	*Institution name*	**TPS calculations done by:**	*Name*
Address:	*Institution address*	**TPS used:**	*TPS Model*
Country:	*Country name*	**Evaluation:**	*yyyy-mm-dd*

STEP 7a: RESULTS OF SMALL BEAM OUTPUT FACTORS FOR HIGH-ENERGY X RAY BEAMS

Radiation unit	**Field size [cm × cm]**	*Beam 1: ... MV*			*Beam 2:... MV*		
		Published* output factor	**Institution output factor**	**Institution OF / Published OF**	**Published* output factor**	**Institution output factor**	**Institution OF / Published OF**
	10 × 10						
	6 × 6						
	4 × 4						
	3 × 3						
	2 × 2						

*Followill et al. (2012) The Radiological Physics Center's standard dataset for small field size output factors. Journal of Applied Clinical Medical Physics 13, pp 282-289.
*Followill et al. (2014) Erratum: "The Radiological Physics Center's standard dataset for small field size output factors." Journal of Applied Clinical Medical Physics 15.

Signature
……...
[TLD Officer] – [DAN]

Date:
yyyy-mm-dd

Signature
…….
Head – [DAN]

IMPORTANT NOTICE: This information is provided only as an independent verification of small beam output against the reference data set. **IT DOES NOT CONSTITUTE A STATEMENT WITH REGARD TO THE QUALITY OF RADIOTHERAPY**