Seminar Presentation Summary

Task Group 142 report: Quality assurance of medical accelerators

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1. Paper Information

Klein, Eric E., et al. "Task Group 142 report: Quality assurance of medical accelerators". Medical physics 36.9 (2009): 4197-4212. AAPM 2009.

2. Introduction

This paper is well known in the field of radiation physics, and is always be called 'TG-142'. It defines the tasks which will be performed in daily, monthly and annually quality assurance (QA), the machine-type tolerance for the tasks, and the testing procedure standards.

The task group (TG-142) has two main charges: first to update, as needed, recommendations of Table II of the AAPM TG-40 report on quality assurance and second, to add recommendations for asymmetric jaws, multi-leaf collimation (MLC), and dynamic/virtual wedges.

Years ago, AAPM published TG-40 in 1994, which is a widely used and referenced document for general quality assurance tests for medical linear accelerators. Nowadays, technology develops so fast, several additional task groups had been published before 2009 to update TG-40 (TG-50, TG-58, TG-76, etc.). The aim of TG-142 is to establish a standard QA procedure for all medical accelerators until now and in the future. So that all QA programs should follow TG-142 to implement a trustworthy QA task.

Quality assurance (QA) is all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy the given requirements for quality. As such, QA is wide ranging and covering: procedures, activities, actions, and groups of staff. To be specific, the QA program for radiation oncology should provide measures to achieve the following: 1. Reduction of uncertainties and errors (in dosimetry, treatment planning, equipment performance, treatment delivery, etc.); 2. Reduction of the likelihood of accidents and errors (occurring as well as increase of the probability that they will be recognized and rectified sonner); 3. Full exploitation of improved technology and more complex treatments in modern radiotherapy.

3. TG-142 QA Workflow.

Table I and Table II are two most important tables from TG-142, which defines the QA procedure for daily QA and monthly QA.

Table I. Daily

Procedure	Machine-type tolerance Non-IMRT	IMRT	SRS/SBRT
Dosimetry			
X-ray output constancy (all energies)			
Electron output constancy (weekly, except for machines with unique e-monitoring requiring daily)			
Mechanical			
Laser localization	2 mm	1.5 mm	1 mm
Distance indicator (ODI) @ iso	2 mm	2 mm	2 mm
Collimator size indicator	2 mm	2 mm	1 mm
Safety			
Door interlock (beam off)		Functional	
Door closing safety		Functional	
Audiovisual monitor (s)		Functional	
Stereotactic interlocks (lockout)	NA	NA	Functional
Radiation area monitor (if used)		Functional	
Beam on indicator		Functional	

Table II. Monthly

Procedure	Machine-type tolerance Non-IMRT	IMRT	SRS/SBRT
Dosimetry			
X-ray output constancy			
Electron output constancy		2%	
Backup monitor chamber constancy			
Typical dose rate output constancy	NA	2% (@ IMRT dose rate)	2% (@ stereo dose rate, MU)
Photon beam profile constancy		1%	
Electron beam profile constancy		1%	
Electron beam energy constancy		2%/2 mm	
Mechanical			
Light/radiation field coincidence		2mm or 1% on a side	
Light/radiation field coincidence (asymmetric)		2mm or 1% on a side	
Distance check device for lasers compared with front pointer		1 mm	
Gantry/collimator angle indicators(@		1.0 °	

cardinal angles) (digital only)			
Accessory trays (i.e., port film graticle tray)		2 mm	
Jaw position indicators (symmetric)		2 mm	
Jaw position indicators (asymmetric)		1 mm	
Cross-hair centering (walkout)		1 mm	
Treatment couch position indicators	2 mm/1 °	2 mm/1 °	1 mm/0.5 °
Wedge placement accuracy		2 mm	
Compensator placement accuracy		1 mm	
Latching of wedges, blocking tray		Functional	
Localizing lasers	±2 mm	±1 mm	< ±1 mm
Safety			
Laser guard-interlock test		Functional	
Respiratory gating			
Beam output constancy		2%	
Phase, amplitude beam control		Functional	
In-room respiratory monitoring system		Functional	
Gating interlock		Functional	

To sum up the two tables, the TG-142 QA workflow can be described as following: first, to setup a gold standard for the whole QA process; second, check if all mechanical parts function well; third, QA the optical field to ensure that the geometry function of the machine is in a reasonable range; finally, QA the radiation field. In the last step, we need to do two kinds of QAs: geometric QA, and dosimetric QA. The geometric QA ensures that the radiation shape is exactly what we want, and the dosimetric QA ensures that the dose we project into the patient is within 5% tolerance. The TG-142 workflow is shown in Fig.1.

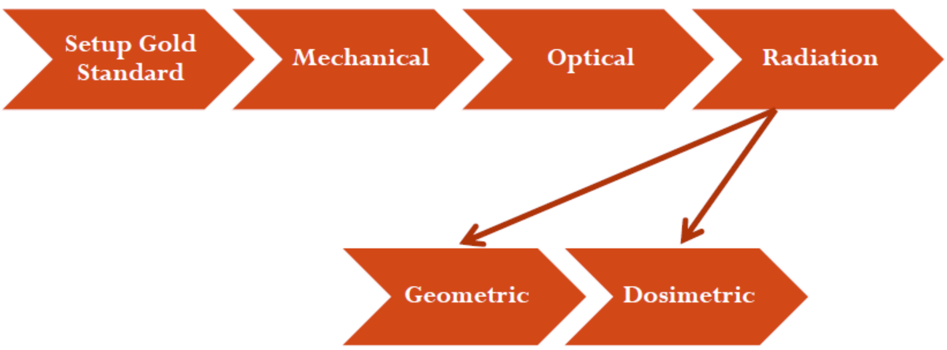

Fig.1. TG-142 QA workflow

4. Raven QA workflow

Following the TG-142 workflow, I redesign the Raven QA workflow as following. The idea of the redesigning is to separate the QA box from the user to reduce the times when the user has to go inside the radiation room. All tasks should be performed on the computer which remotes the QA box.

First of all, as shown in Fig.2 a Winston-Lutz test is performed with a BB machine. The test will find the isocenter of the accelerator, then the QA box will be set to the isocenter. The BB machine is also controlled in the Raven QA software. Now the user is inside the radiation room to setup the mechanism of the QA box.

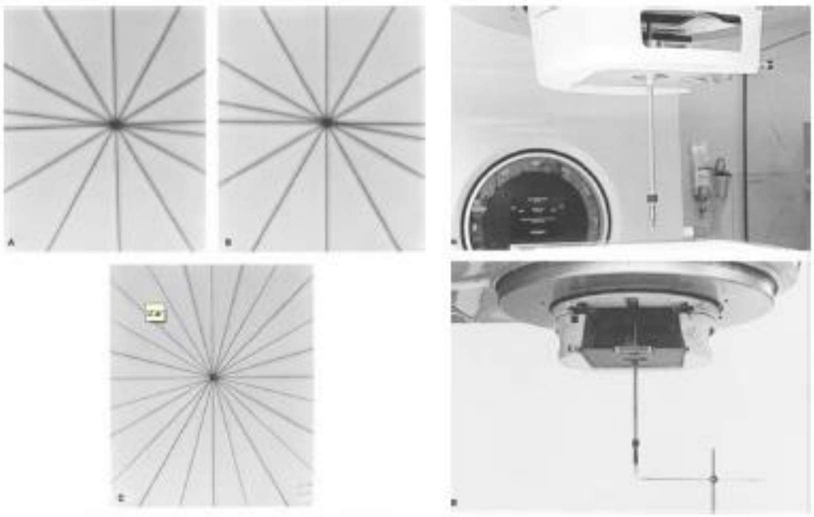

Fig.2. Winston-Lutz test with a BB machine

Then I integrate the mechanical test and the optical test together. As shown in Fig.3, several tests such as collimator rotation test will be performed. The user should go outside the radiation room before the mechanical and optical tests. All tasks can be remote from the laptop.

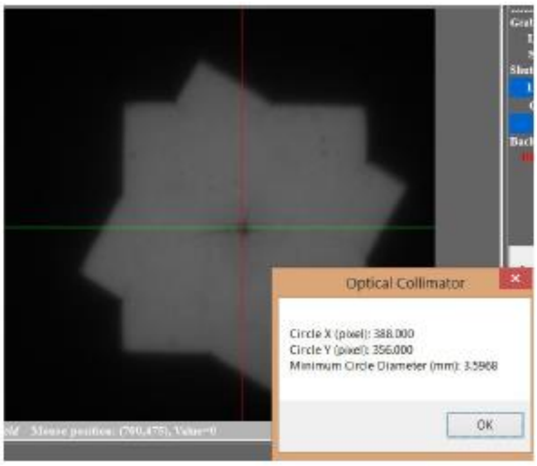

Fig.3. Mechanical/Optical Tests

Finally, the radiation tasks can be implemented. Flatness and symmetry test is performed as the geometric test, and a dose comparison test is performed as the dosimetric test. The user will go inside the radiation room once when doing the dosimetric test to change the solid water on the QA box.

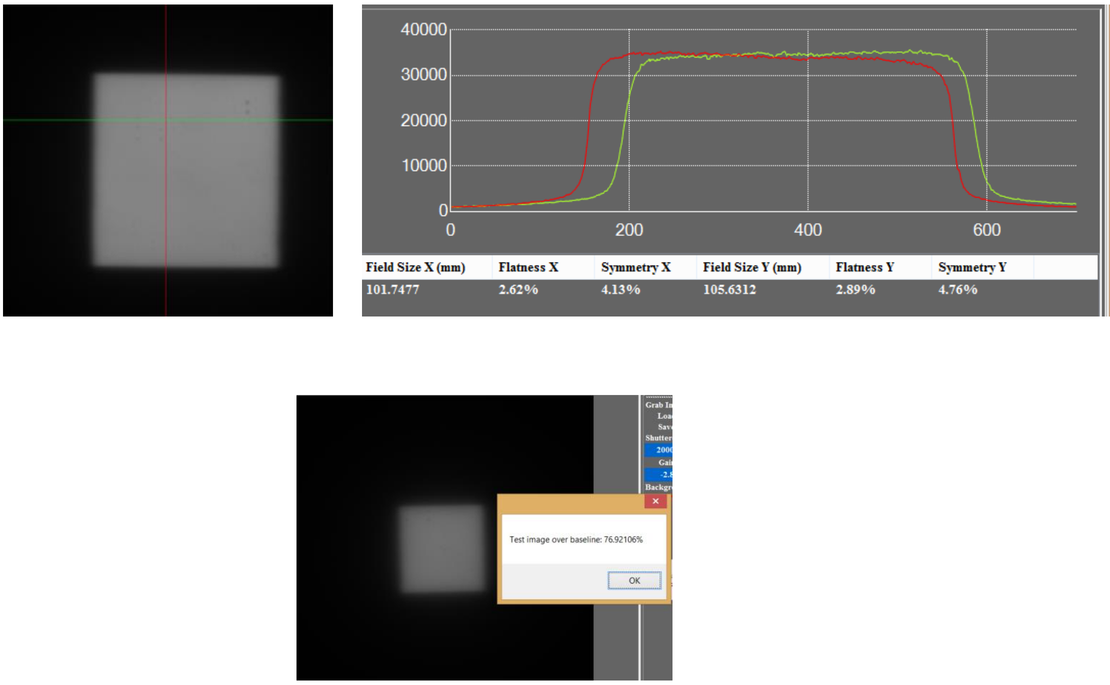

Fig.4. Radiation Tests

Fig.5. shows an overview of Raven QA workflow. The Raven QA workflow covers TG-142 daily, monthly, and part of the annual table. Physicists will go inside the radiation room once only. Mechanical and optical tests can be done within 15 minutes. Radiation tests can be done within one hour. The whole time of the QA will be less than one hour and a half, which is much less than the traditional QA time, which is as long as 8 hours.

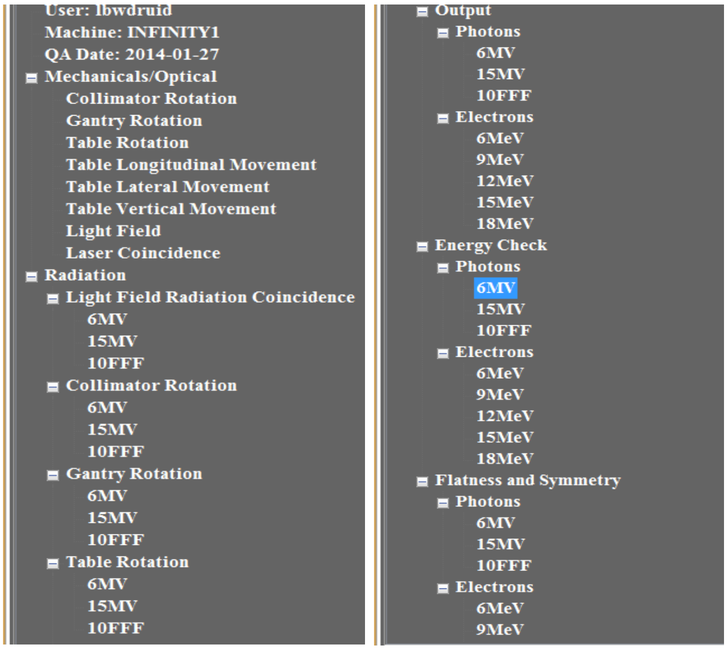

Fig.5. Overview of Raven QA workflow

5. Summary

TG-142 provides a very good work flow for quality assurance tasks for medical accelerators. My project should follow it to redesign the QA procedure to make users feel convenient using Raven QA.

QA team led by the quality management plan supports all QA activities, policies and procedures. The first step is to establish institution-specific baseline and absolute reference values. There is over lap of tests for daily, monthly and annual that can achieve independence with independent measurement devices. During the annual QA, absolute outputs should be calibrated as per TG-51 and all secondary QA dosimeters cross-checked.

My project will work on testing absolute outputs in the future to provide a way to implement annual QA. Also, for geometric QA, my project should be able to perform a geometric check for each gantry angle besides testing the flatness and symmetry for a square.