POSTAL TLD DOSIMETRY AUDITS IN RADIOTHERAPY IN POLAND – RESULTS OF 2017 YEAR

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Introduction

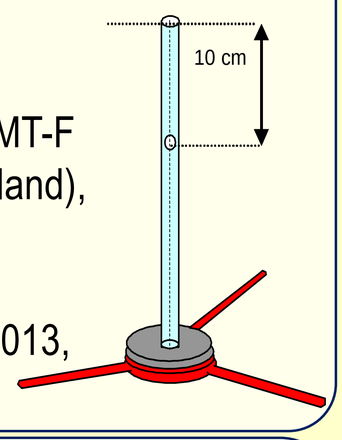
The regulation of the Ministry of Health on safe use of ionizing radiation for medical exposures (18.02.2011) makes it obligatory for all radiotherapy centers in Poland to participate in external dosimetric audits. The first external dosimetric audit in Poland was organized by the Secondary Standard Dosimetric Laboratory (SSDL) of the Institute of Oncology in Warsaw in 1991. The aim of the TLD audits in radiotherapy centers is to assure proper calibration of radiotherapy beams to avoid mistreatment of cancer patients and prevent radiation accidents. The Polish SSDL offers dose measurement in water, for which measurement it is accredited by the Polish Centre for Accreditation (accreditation No AB 1499). The SSDL in Warsaw is the only laboratory in Poland performing postal TLD dosimetry audit.

Material

In 2017, 37 radiotherapy centers participated in the audit: 143 radiation beams were audited, including 131 photon beams and 12 electron beams.

The TLD system consist of:

- a Fimel PCL 3 TLD automatic reader,
- Thermoluminescent dosimeters (TLD) of Li-F MT-F type (Institute of Nuclear Physics, Cracow, Poland),
- IAEA holders and waterproof capsules,
- a Water phantom MT-150T (Med-Tec),
- a Unidos E, ionisation chamber, type PTW 30013,
- a Co-60 unit Theratron 780E.



Methods

Before the TLD powder is used it is annealed at 400°C for 1 hour and at 100°C for 3 hours. Approximately 155 mg of the powder is put into polyethylene capsules (20 mm inner length, 3 mm inner diameter and 1 mm wall thickness). The participants are instructed to irradiate three TL detectors for each beam, with a dose of 2 Gy in reference conditions (field 10 cm x 10 cm). After irradiation, the detectors are sent back to the SSDL. At the same time, a set of reference detectors was irradiated with known doses at the SSDL. For the reading, the powder from each capsule is divided into 4 portions, thus 4 independent reeadings are obtained from each capsule. The absorbed dose to water derived from irradiated TLD detectors is determined as:

$$D_{\mathrm{SSDL}} = \mathrm{M}\cdot\mathrm{N}\cdot f_{\mathrm{lin}} \cdot f_{\mathrm{en}} \cdot f_{\mathrm{fad}} \cdot f_{\mathrm{hol}}$$

where: M - the TLD response, N - the calibration coefficient of the TLD system,
f_{lin} - the non-linearity dose response correction factor, f_{en} - the energy correction factor,
f_{fad} - the fading correction factor, f_{hol} - the standard holder correction factor.

The deviation of the dose reported by the participant and the dose measured by the SSDL, were calculated as follows:

$$\mathrm{delta} = 100 \cdot \frac{D_{\mathrm{P}} - D_{\mathrm{SSDL}}}{D_{\mathrm{SSDL}}} \ [\%]$$

where: D_{P} - the dose reported by the participant;
D_{SSDL} - the dose determined by the SSDL.
The results were classified in three categories:
$\mathrm{delta} \leq \pm 3.5\%$ - correct result;
$3.5\% < |\mathrm{delta}| \leq 5\%$ - the reason for the deviation has to be explained;
$\mathrm{delta} > \pm 5\%$ - the reason of deviation has to be explained, and then the external audit should be repeated.
Such levels are adopted by the IAEA only in the case of Secondary Standard Dosimetry Laboratories (SSDL).


Fimel PCL 3

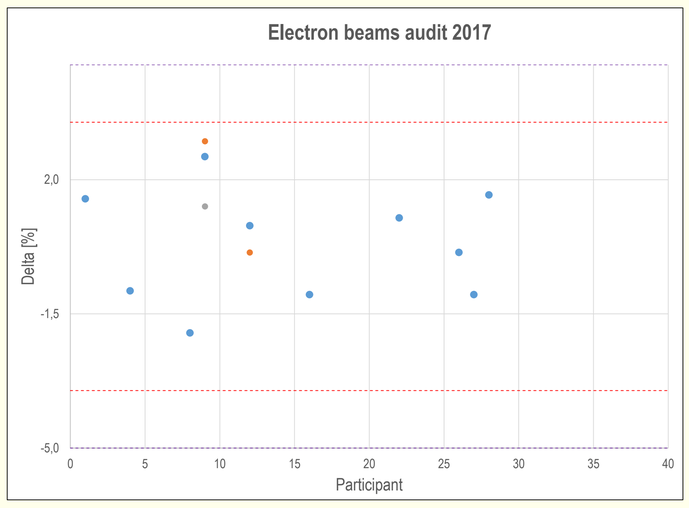
The SSDL maintains strict internal quality control of the TLD system. The system calibration is verified every year by the IAEA. These verifications are followed by internal verifcation of the reproducibility in dose determination with the TLDs, which is performed through a `blind check' TLD irradiation. The irradiation of the TLDs, for deriving the energy response when using high energy photon and electron beams, is carried out by one of the reference radiotherapy centres for every batch of powder.

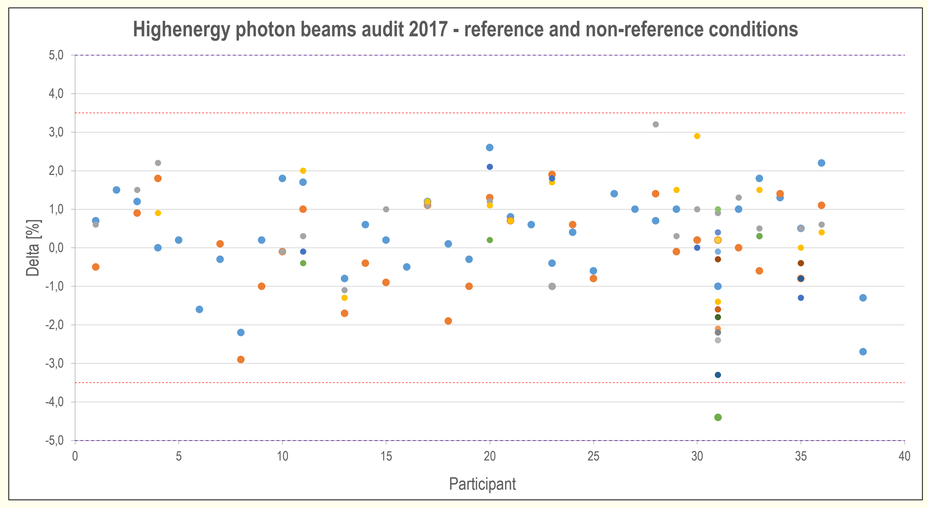
Results

In 2017, there were 147 accelerators installed in Poland, which produced 331 photon beams and 621 electron beams. In the table, the results of the ‘blind check’ in the years 2009-2017 are presented.

The results were correct for a vast majority of cases. Deviations larger than 3.5% were observed for five beams in five radiotherapy centers. For one photon beam the deviations were between 3.5% and 5%, while for four photon beams, they were larger than 5% (from 5.3% to 30.1%). In all the radiotherapy centers, we put forth explanations for the negative results obtained. A repeated audit gave correct results. The graphs below show the correct results for electron beams and for reference and non-reference photon beams. The total expanded uncertainty of the method is 3.5%.

Year	Dose: D [Gy]		$D_{\mathrm{SSDL}} / D_{\mathrm{IAEA}}$
	D_{SSDL}	D_{IAEA}	
2009	2,060	2,058	**1,001**
2010	1,976	1,959	**1,008**
2011	2,037	2,029	**1,004**
2012	1,995	1,999	**0,998**
2013	2,036	2,029	**1,003**
2014	1,964	1,960	**1,002**
2015	2,084	2,079	**1,002**
2016	1,905	1,919	**0,993**
2017	2,031	2,039	**0,996**





Conclusions

Over the last 20, years the postal TLD audits have fulfilled their role, and remain the main and well established dosimetric audit method.
Postal TLD dosimetric audits are an important tool for the assurance of safe and effective radiotherapy in Poland.