Results: The fluorescence response increased linearly with the absorbed dose from 0 to 200 Gy. The absorbance also increased linearly, indicating that the fluorescent dye is the only chemical in the material with a significant absorption in the relevant wavelength range. The dye absorbs from 500 nm to 575 nm and the fluorescence response is in the range from 565 nm to 650 nm.

Conclusion: We have established that the material exhibits a linear relationship between fluorescence response and radiation dose. The fluorescence response is strong enough to be used at low doses. Measurements on individual samples are highly reproducible, but the variance between different samples is still too high to be used at clinically relevant doses. We expect that this variance can be reduced through improvements to the sample preparation. The fluorescence response of the radiochromic dye is highly dependent on the composition of the polymer matrix, since a different study[3] using the same dye observed a decrease in fluorescence with increasing dose. The factors affecting the fluorescence of the dye and hence its dosimetric properties are still being investigated, but in this work we have shown that dosimetry measurements are possible with this novel material. With improvements this could become a precise quantitative 3D dosimeter that is inexpensive, quick, and easy to use.

[3] A.A.Abdel-Fattah, W.B.Beshir, El-Sayed A.Hegazy, H.Ezz El-Din. Photo-luminescence of Risø B3 and PVB films for application in radiation dosimetry. Radiat. Phys. Chem. 62 (2001) 423-428.

EP-1502

Effects on dosimetric measurements due to difference in calibration and dosimetry protocols followed

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Purpose or Objective: Radiation dosimetry plays a vital role in external beam radiotherapy. For precise and accurate dose delivery, the dosimetry system should be calibrated properly, following the recommendations of standard dosimetry protocols e.g. TG-51 or TRS-398. Nonetheless, the dosimetry protocol followed by calibration laboratory is often different from the protocols in practice at various clinics. The study is designed to investigate the effects added in dosimetry measurements due to such situations.

Material and Methods: In this study, the dosimetry were performed for a Co-60 teletherapy unit and a high-energy Varian linear accelerator (CLINAC) with 6 and 15 MV-photon and 6, 9, 12 and 15 MeV-electron beams, following the recommendations and reference conditions of AAPM TG- 51 and IAEA TRS-398 dosimetry protocols. A PTW water phantom (T41014) with a cylindrical chamber (PTW-30001) connected to an electrometer (PTW UNIDOS E) was used for the absolute dosimetry of Co-60 unit. Similarly, dosimetry systems consisting of a farmer type ionization chamber (IBA-FC65-G) and a plane-parallel chamber (IBA PPC-05), connected to an electrometer (PTW UNIDOS E) in a Wellhofer water phantom was used for absolute dosimetry of two photon beams and four electron beams dosimetry respectively. Each chamber type combined with PTW UNIDOS E was calibrated in a Co-60 radiation beam at Secondary Standard Dosimetry Laboratory (SSDL) PINSTECH, Pakistan, following the IAEA TRS-398 protocol.

Results: The measured ratios of absorbed doses to water Dw (TG-51/TRS-398) were 0.999 and 0.997 for 6 and 15 MV photon beam respectively whereas the ratios were 1.013, 1.009, 1.003 and 1.000 for 6, 9, 12 and 15 MeV electron beams, respectively as shown in Figure 1 (a & b). The difference arises between the two protocols mainly due to beam quality (KQ) and ion recombination correction factor (Table 1).

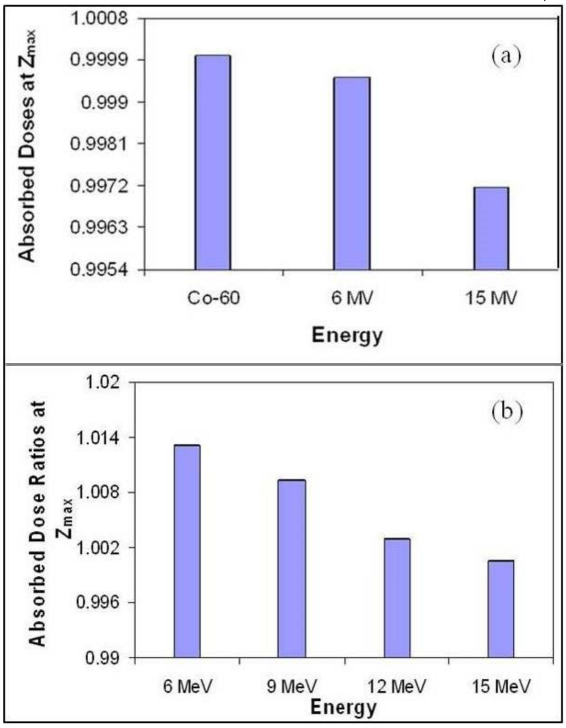

Figure 1: (a) Ratio of the absorbed doses at Zmax of Co-60, 6 MV and 15 MV photons by using two protocols (TG-51 / TRS-398). **(b)** Ratio of the absorbed doses at Zmax of 6, 9, 12, 15 MeV Electron beam by using two Protocols (TG-51 / TRS-398).

Table 1: Comparison of the Absorbed Doses at Z_{max}, bean quality factor (K_q) and ion recombination correction factor, (P_{ion}) values of AAPM TG-51 and IAEA TRS-398 Protocols.

Type of Beam	Energy	AAPM TG-51					IAEA TRS-398				
		%dd(10)$_x$		P_{ion}	K_q	$D_w(Z_{max})$	$TPR_{20,10}$		P_{ion}	K_q	$D_w(Z_{max})$
Photon	6 MV	66.7		1.00734	0.991	0.9970	0.668		1.00714	0.992	0.99748
	15 MV	77.63		1.01135	0.970	0.9967142	0.762		1.01109	0.973	0.999535
	Co-60	NA		1.0	1.0	1.6489	NA		1.0	1.0	1.6489
Electron		R_{50} (cm)	Z_{ref} (cm)				Z_{max} (cm)	$R_{50,ion}$ (cm)			
	6 MeV	2.15	1.19	1.023	0.937	1.026418	1.08	2.15	1.023	0.923	1.013106
	9 MeV	3.459	1.975	1.00503	0.921	1.0056445	1.99	3.42	1.00455	0.913	0.99643
	12 MeV	4.910	2.846	1.013377	0.908	1.005852	2.44	4.83	1.013099	0.905	1.002825
	15 MeV	6.237	3.642	1.013551	0.8983	0.998504	2.8	6.12	1.013277	0.898	0.997916

Conclusion: In conclusion TRS-398 gives relatively high doses than TG-51 and the percentage difference increases as the energy increases for photon beams. While in case of electron beams TG-51 calculates relatively high doses than TRS-398 and percentage difference decreases as the energy increases. Since the chambers are calibrated according to the recommendations of IAEA TRS-398 Dosimetry protocol, all the medical centres are requested to follow the IAEA TRS-398 Dosimetry protocols.

EP-1503

Small field output correction factors for 6-X and 6-X FFF beams: GAMOS Monte-Carlo study

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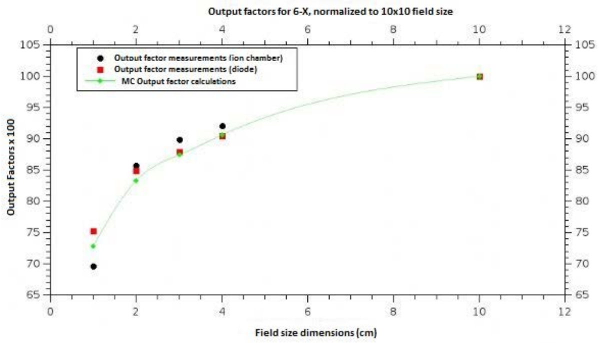
Purpose or Objective: Our purpose was to calculate detector specific small field output correction factors with GAMOS Monte Carlo (MC) for 6-X and 6-X flattening filter free (FFF). In this study MC simulations and water phantom measurements were used to obtain correction factors.

Material and Methods: A formalism of Alfonso et al for correction of output factor measurements was used in the current study. Absorbed dose to water was calculated with MC using 2x2x2 mm^2 voxel at 5 cm depth of water phantom. "Range cut" and "Kill particles at BIG X/Y" options were used to optimize simulation in GAMOS MC. Results were obtained below 2% statistical noise. Fields sizes varied from 4x4 to 1x1 cm^2. Also water phantom measurements were taken at same field sizes at source phantom distance 95 cm with diode(photon) and PinPoint ion chamber to use in formalism. Varian TrueBeam STx LINAC was used for the purpose.

Results: For diode detector, correction factors were 0.993 and 1.000 for 3x3, 4x4 cm2 at 6-X respectively and correction factors of 0.999 and 1.000 were found for 6-X FFF. For smaller field sizes, obtianed correction factors were below 0.98 for both energies. For ion chamber at the smallest field size, the respective correction factors were 1.046 and 1.079 for 6-X and 6-X FFF. At 2x2 cm2 , it was 0.971 and 0.967 for 6-X and 6-X FFF respectively. However, with increase of field size, the value of correction factors for ion chamber became close to 1.0.



Output Correction Factors for diode and ion chamber at 6-X energy

Dedector Model	1x1	2x2	3x3	4x4	10x10
TM60016 – Diode(photon)	0.968	0.980	0.993	1.000	1.000
TM31014 - PinPoint Ion Chamber	1.046	0.971	0.972	0.983	1.000

Conclusion: For ion chamber, at 1x1 and 2x2 field sizes, correction factors were up to 3% more or less than of optimum value of 1.0. Our MC calculations showed that Pinpoint detector required output correction factor for field sizes below 3x3 cm2. For diode detector this requirement was for field sizes below 2x2 cm^2.

EP-1504

Evaluation of transmission detector model using Monte Carlo simulation of VMAT delivery

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Purpose or Objective: The Device for Advanced Verification of IMRT Deliveries (DAVID) is a novel, transparent transmission detector. It is designed for in-vivo verification by measuring the radiation fluence from the linac head during treatment. In order to investigate its properties and sensitivity to standard errors it was desirable to build an accurate Monte Carlo model of the device. In this study a working Monte-Carlo model of the detector was built and verified by comparing simulation and measured signals from simple square fields as well as complex IMRT and VMAT fields.

Material and Methods: All results were collected on an Synergy linear accelerator (Elekta AB, Stockholm, Sweden) equipped with an MLCi2 collimator. All treatment plans have been delivered as clinical treatments in the department and were generated by the Monaco 3.3 TPS (Elekta AB, Stockholm, Sweden). The Monte Carlo simulation of the linac and DAVID used BEAMnrc and DOSXYZnrc.
The DAVID is a transmission style detector, specific to the linac (MLC) model. As the MLCi2 collimator has an 80 leaf (40 leaf pairs) MLC; the DAVID used in this work had 40 wires. These collection wires are held in a 2mm thick vented air gap that is encased by two polymethyl methacrylate (PMMA) plates, each 4mm thick. On the inside of the PMMA a thin layer of aluminium is been evaporated on to the inner surfaces; this layer is thin enough so that the device remains optically transparent, but thick enough to maintain a potential of 400V between the plates and the collection wires. Ionisation charge in the air gap, as a consequence of primary and scattered radiation, migrates towards the collection wires under the influence of the potential, each wire having a collection area of 0.03 cm3 per centimeter of length.
It was shown that the collection wires had a negligible effect on the dose deposited in the collection volume allowing the DAVID to be modeled as two 4mm slabs of Perspex separated by a 2mm air gap.

Results: The DAVID signal measured on the linac was shown to be repeatable and stable. All simulated results were shown to agree with measured results to within 3% of the maximum signal
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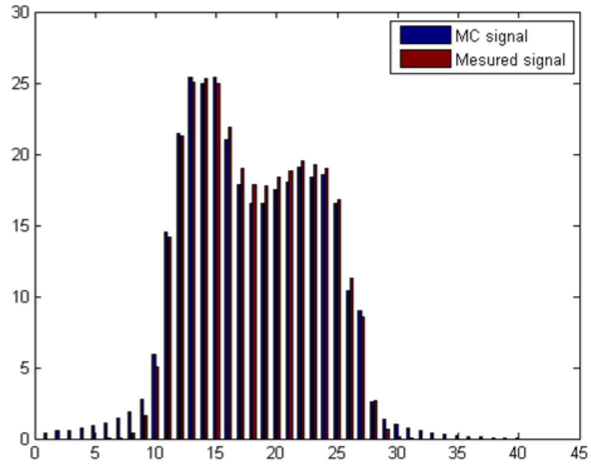

Conclusion: The Monte Carlo model of the DAVID works well for both simple and complex deliveries. The model will provide a useful tool for investigating the sensitivity of the DAVID to linac faults. These can easily be simulated for a variety of cases in the Monte Carlo model.

EP-1505

Comparison of two unshielded diodes for commissioning of Cyberknife

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Purpose or Objective: The aim of this study was to evaluate the suitability of two recently launched unshielded diodes for commissioning of CyberKnife (Accuray Inc., Sunnyvale, CA) system.

Material and Methods: IBA Razor (IBA dosimetry GmbH, Schwarzenbruck) and PTW SRS 60018 (PTW Freiburg, Freiburg) diodes were used to commission CyberKnife M6 unit. TPR/PDD, OCR and output factors for 12 stereotactic cones (range 5-60mm) were measured with both detectors using PTW MP3-M water tank. The measurement results were compared between each other and with the composite data from the manufacturer.

Results: Output factors measured with both diodes agreed within 1% to the manufacturer supplied uncorrected data for all cones except 5 mm. For 5 mm cone differences of up to 2.3% were observed. Output factors for 5 mm cone were also compared with published Monte Carlo data and correction factors for PTW SRS 60018 and IBA Razor diodes are 0.95 and 0.94, respectively were noted. The difference is being larger for IBA Razor diode. For all other cones the correction for IBA