Conclusion: A radiation QA probe EDINA for small field dosimetry using new fabrication technology of silicon diodes and packaging has been developed. The EDINA has isotropic response, and well matching to EBT output field factor response making it suitable for small field dosimetry and quality assurance for SRS.

EP-1491
Energy response of radiophotoluminescent glass dosimeter for non-reference condition
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Purpose or Objective: When an absorbed dose to water is determined using radiophotoluminescent glass dosimeter (RGD), it is necessary to convert the radiophotoluminescent quantity into a water absorbed dose with calibration factor. Generally, dose calibration is performed at reference condition (on the central axis at a depth of 10 cm for a 10 cm×10 cm field). However, patient specific dose measurement is performed at non-reference condition, RGD response may be changed because RGD has energy dependence. In this study, we evaluated the variation of RGD response for non-reference condition measurement using Monte Carlo (MC) simulation.

Material and Methods: To analyze the energy response of RGD for non-reference condition beam, absorbed dose ratio of water to RGD and mass energy absorption coefficient of water to RGD ((μen/ρ)w,(RGD)) was simulated using EGSnrc code. The irradiation conditions for the MC simulations were set to 5 cm×5 cm, 10 cm×10 cm and 20 cm×20 cm field for 10 MV photon beam. RGD was set to the central axis at 10 cm depth in water phantom. For 20 cm×20 cm field, 20 cm off axis position were calculated, respectively. The photon beams source for the MC simulation, radiation transport in the accelerator was modeled using the BEAMnrc Monte Carlo code. The accelerator geometry and materials were obtained from the manufacturer’s data for the Clinac21EX.

Results: The dose ratio was from 1.168 to 1.149 for 5 cm×5 cm to 20 cm×20 cm, respectively. (μen/ρ)w RGD was 1.079 and 1.075 for field sizes of 5 cm×5 cm and 20 cm×20 cm, respectively. When the field size became large, scattered low energy photon increase. Mass energy absorbed coefficient of RGD is very high for low energy photon. Therefore, the RGD response became increase with increase field size. In the 20 cm off axis position for 20 cm×20 cm field, energy response showed more variation. The dose ratio and (μen/ρ)w RGD was 0.962 and 0.937, respectively. In out of field locations, the spectra contained more low-energy photons.

Conclusion: In this study, we evaluate the variation of RGD response for non-reference condition measurement. As a results, RGD response was affected by the low energy photon. This response change should be considered when the non-reference condition measurement is performed using RGD.

EP-1492
Basic investigation on performance of low-density polymer gel dosimeter
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Purpose or Objective: In this study a series of basic dosimetric properties of a low density (LD) gel dosimeter are studied. The dose response is investigated regarding to temporal stability, detectable dose range, sensitivity, dose-rate and energy dependence as well as lung tissue equivalence.

Material and Methods: The LD gel is made by mixing the polymer gel with expanded poly styrene spheres. Methacrylic acid is used as a monomer and tetrakis-hydroxy-methyl-phosphonium chloride (THPC) as an oxygen scavenger (MAGAT polymer gel dosimeter). The temporal stability of LD gel is monitored for a period of a month. Energy dependence is studied at two energies; 1.25 MeV and 6 MV photon beam which are produced by 60Co and Linac machines. Investigation of dose rate dependence is performed in the low, medium, and high absorbed region. Also reproducibility of dose response is studied in three sets of LD gel with identical preparation, irradiation and imaging procedure in three different days. Moreover the linearity and sensitivity is investigated up to dose of 20 Gy.

Results: The response of the gel indicates, the dose response curve attained stability during the measured time. The results also show that the dose response is reproducible. The gel response is found linear over the measured dose with r²=0.981 and sensitivity of 0.814 S-1Gy-1. In the measured range, the dose response of the NIPAM gel is independent of beam energy within less than ±0.02 and the dose rate had no effect on the gel response. LD gel is nearly lung tissue equivalent with average mass density of 0.35 to 0.43 g/cm3 and average relative electron density of 0.41.

Conclusion: MAGAT LD gel dosimeter appears to be a promising dosimeter in all aspects of dosimetric properties evaluated in this study. In addition, its high linearity together with no dose rate dependence in different level of dose make it a suitable dosimeter to measure 3D-dose distributions inside a non-homogeneous media such as lung tissue.

EP-1493
Modelling the energy dependence of Cherenkov light correction in plastic scintillation detectors
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Purpose or Objective: Plastic scintillation detectors (PSD) are highly valuable for a variety of dosimetry applications, since their atomic composition and volume size produce small perturbation effects. A commercial PSD provided by Standard Imaging Inc (Exradin W1) is available and its Cherenkov light correction is based on the method proposed by Guillot et al. However, recent studies showed that the Cherenkov light ratio (CLR) is energy dependent, which could compromise its performance in clinical photon beams. The goal of this work is to investigate a theoretical model to characterize the
Energy dependence of the CLR and evaluate its effect on photon beam measurements.

Material and Methods: The electron energy cut-off at which Cherenkov light is produced varies with the wavelength-dependent refractive index. Based on this rationale, the theoretical CLR describing the relative amount of blue to green light, is formalised analytically using the Cherenkov emission distribution and the detection efficiency functions of the blue and green channels. As the analytic expression depends on the electron spectrum, Monte Carlo simulations of several photon beam qualities are performed to evaluate the spectrum. This allows predicting the theoretical CLR as a function of the TPR2010 quality index (QI), which includes cobalt-60 and megavoltage (MV) beams. Experiments are performed to evaluate CLR over a wide range of QI in cobalt-60 and clinical MV beams.

Results: Comparison between experiments and theory show that the model reproduces the behaviour of the CLR energy dependence. However, the model under predicts the magnitude of the effect. For clinical MV beams, the variation of the theoretical CLR is about 0.5% while it is found to be about 1.8% with experiments. For cobalt-60 beam, the theoretical CLR is found to be about 1.005 of the value at the reference QI while the experiment reports a value of 1.017. Discrepancies between experiments suggest that other effects play a role in the energy dependence. More specifically, the model implicitly assumes isotropic Cherenkov emission, while the angular distribution of the light varies with the electron kinetic energy and the optical fibre only guides light emitted at a specific angular range. Further improvements modelling Cherenkov light transport explicitly should confirm these hypotheses.

Conclusion: The theoretical model proposed in this work is promising to evaluate the energy dependence of the Cherenkov correction in commercial PSD. Potential applications of this work could allow determining the energy dependence of PSD measurements using the CLR technique in small photon fields.

EP-1494 Absolute dosimetry with EBT3 Gafchromic films in a pulsed electron beam at high dose-rate

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Purpose or Objective: Animal studies have shown that irradiation by a pulsed electron beam with high dose-rate allows for tumour control while sparing normal tissues. Dosimetry of clinical high dose-rate pulsed beam is challenging because of dose-rate dependence and saturation effects. The aim of this study was to assess the suitability of Gafchromic EBT3 films for performing absolute dose measurements in the electron beam of a prototype linac capable of mean dose-rate (DM) ranging from 0.07 to 1000 Gy/s, dose-rate in pulse (Dp) up to 106 Gy/s, and energy between 4 and 6 MeV. To this purpose, we evaluated the overall uncertainties of film dosimetry as well as the energy and dose-rate dependence of their response.

Material and Methods: Our dosimetry system is composed of EBT3 Gafchromic films (Ashland Inc., Wayne, NJ, USA) in combination with a flatbed scanner. All sources of uncertainties in film dosimetry (dispersion of pixel values, film inhomogeneity, reproducibility, scanner variability) were carefully evaluated using a conventional clinical linac. Energy dependence was also investigated by acquiring and comparing calibration curves at three different energies (4, 8 and 12 MeV), for doses between 25 cGy and 30 Gy. Dose-rate dependence was studied with the prototype linac for DM ranging from 0.07 Gy/s to 1000 Gy/s and Dp between 103 and 106 Gy/s. The determination of dose-rate dependence was performed by comparing doses from the films to three independently calibrated dosimeters, namely thermoluminescent dosimeters (TLD), alanine dosimeters and a chemiluminescent dosimeter based on methyl viologen (MV). Furthermore, we studied the correlation between the dose measured by the films and the total charge of electrons measured at the exit of the machine.

Results: We showed that, sticking to a fixed protocol of film processing, a total uncertainty below 4% (k=2) can be obtained in the dose range between 3.5 and 16 Gy. Results also demonstrated that EBT3 films did not display any significant energy dependence for electron energies between 4 and 12 MeV and doses between 25 cGy and 30 Gy since differences between calibration curves were all within uncertainties. In addition, we obtained excellent consistency between films, TLD, alanine and MV over the entire dose-rate range showing the absence of dose-rate dependency. This aspect was further corroborated by the fact that the dose per pulse as measured by films was proportional to the electron charge contained in the pulse.

Conclusion: Our study shows that the use of EBT3 Gafchromic films can be extended to absolute dosimetry in pulsed electron beams with very high dose-rate (Dm up to 1000 Gy/s and Dp up to 106 Gy/s) and energies between 4 and 12 MeV. The measurements results are associated with an overall uncertainty below 4% and are dose-rate and energy independent.

EP-1495 Evaluation of measurement dose uncertainty of Gafchromic EBT3 because of local inhomogeneity

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Purpose or Objective: Operation of any dosimeter assumes knowledge of the expected uncertainty that could be caused by different factors. The possible sources of uncertainty for Gafchromic EBT3 film were investigated (Phys. Med. v. 29(6), (2013) p. 599) where it was shown that the error amounted 0.55% neglecting local inhomogeneity of the film. The homogeneity of Gafchromic EBT2 film was investigated (Med. Phys. v. 37(4), (2010) p. 1753) and it was shown that inhomogeneity of absorbed dose amounted 6%. The purpose of current work is to calibrate Gafchromic EBT3 films using 10 MV photon beam, 6 MeV and 10 MeV electron beam and to estimate value of the measured absorbed dose uncertainty caused by the local inhomogeneity of the film.

Material and Methods: The calibration of Gafchromic EBT3 film was carried out using 10 MV photon beam and 10 MeV electron beam of Elekta Axesse linac, and also at 6 MeV electron beam using compact betatron for intraoperative therapy. In the case of Elekta Axesse the Farmer FC65-P cylindrical chamber and DOSE-1 electrometer were used. In the case of betatron we used the plane-parallel chamber PTW 23342 (Markus) and Unidose-E electrometer. The pieces of Gafchromic EBT3 film were irradiated by different doses.