achieve 0.5% uncertainty in relative measurements are determined based on uncertainty analysis including data covariance. Systematic errors are compared to the statistical behaviour of pixel dose.

Results: Comparing single and multichannel methods demonstrate significant reduction of systematic errors (Figure 1). Uncertainties in determining output factors with the proposed procedure are 1.2% for single measurements and 0.4% for measurements repeated ten times. Consistency in determining dose distributions of known beams show systematic errors up to 10% with single channel analysis, while they are on average diminished by a factor up to three with the new multichannel method, leaving these errors well below statistical uncertainties.

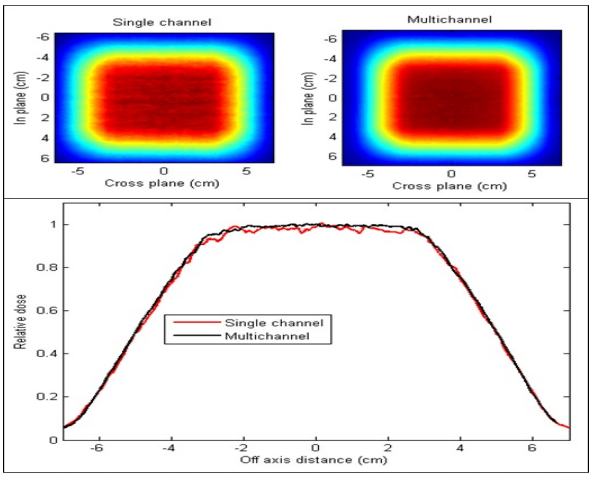

Figure 1. Comparison of the methods in measuring a 10 x 10 cm² cobalt-60 beam profile: a dose map (up) and a beam profile (down).

Conclusions: Results suggest that once a controlled experimental procedure and proper analysis are combined, radiochromic film has great potential for small photon field dosimetry. The proposed method allows uncertainties in quality correction factors comparable to previous film models. Future comparison between experiments and Monte Carlo simulations should validate the theoretical predictions reported herein by evaluating the energy dependence of the film response.

OC-0152

Are correction factors needed for microDiamond detectors in small fields?

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Purpose/Objective: The PTW microDiamond detector has been characterized by several groups who have reached differing conclusions about the need for correction factors for relative output measurements in small fields. Some groups reported significant over-response (Lechner 2013, Azangwe 2014), whereas others (Chalkley 2014, Das 2014, Morales 2014, Kee 2014, Papaconstadopoulos 2014) have concluded that correction factors are not required. The aim of this study was to measure the correction factors for microDiamond detectors in small fields and to shed light on the possible causes for the conflicting conclusions.

Materials and Methods: The relative readings of five microDiamond detectors were measured for Varian, Elekta and Siemens 6 MV fields with cone collimation down to 4 mm and MLC collimation down to 5 mm, normalised at 30 mm. They were compared to those of a fibre optic dosimeter (FOD) with a 1 mm plastic scintillator previously shown to be nearly radiologically water equivalent in these fields (Ralston 2012). The FOD readings were corrected for volume averaging. Field size correction factors were estimated for the microDiamond detector for its readings both corrected and uncorrected for volume averaging.

Results: In our study the microDiamond detectors over-responded by up to 9.3% for a 4 mm cone collimated field and up to 6.5% for a 5 mm MLC collimated field compared to the FOD. The microDiamond detector has a very thin (1 μm) active volume. If this was surrounded by radiologically water equivalent material then the detector response should be similar to that of a water equivalent detector. However this thin active volume is sandwiched between an aluminum electrode and a 400 μm thick diamond substrate. Many of the electrons traversing the active volume are therefore generated in high density materials and the detector should over-respond in small radiation beams (<30 mm) relative to a water equivalent detector (Scott 2012).

Possible reasons for the conflicting opinions in the literature include differences in measurement method, lack of correction for volume averaging, and reference dosimeters which are not radiologically water equivalent, used either directly or as the basis of Monte Carlo models. Variation between individual microDiamond detectors is unlikely to be a significant factor because the readings from all five detectors used in our study agreed within 1.0% and 0.5% of the average readings for cone and MLC collimated fields respectively.

Conclusions: Our study has shown that microDiamond detectors significantly over-respond in small 6 MV fields and that correction factors are required. Given the lack of consensus in the literature we recommend that users of these detectors employ independent methods to verify the correction factors they apply to their readings. Failure to correct detector readings appropriately could result in the planning system data being in error, leading to potentially severe clinical consequences.

OC-0153

Output factors for small radiosurgical Linac beams using a new microDiamond detector: evaluation over 30 centers

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Purpose/Objective: The need for an accurate modeling and dosimetry of small radiation fields is mandatory for novel radiotherapy techniques. The standardization of the small field dosimetry is fundamental to ensure that different institutions deliver comparable and consistent radiation doses to their patients. In 2012 a project dedicated to stereotactic body radiotherapy (SBRT) dosimetric aspects has started in the framework of the Italian Association of Medical Physics (AIFM) SBRT working group. The current study presents measured MLC-defined small field output factors (OF) for the three major linear accelerator manufacturers and for different X-ray energies.

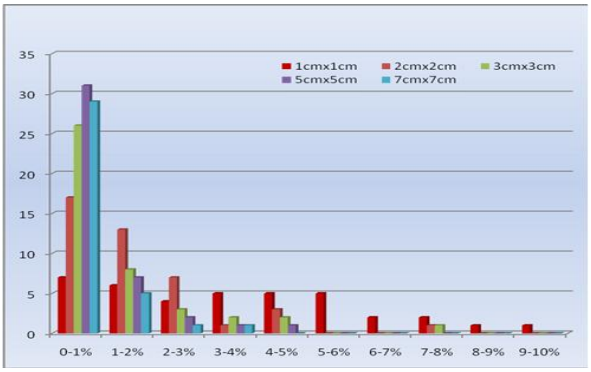
Materials and Methods: A pre-questionnaire was sent to each center in order to evaluate specific differences in terms of the used methodology and detectors. Each center performed OF measurements by routine used detectors for field sizes ranging from 10×10 cm^2 to 0.5×0.5 cm^2, defined by both secondary jaws and MLC. Two set-up conditions were indicated: 10 cm depth in water phantom at SSD 90cm and SSD 100cm. The same measurements were repeated using the new PTW 60019 microDiamond detector. For fasting the measurements, two identical diamond were adopted. National Institute of Ionizing Radiation Metrology ENEA-INMRI carried out a complete characterization of the response of the two diamond dosimeters to ensure the equivalence of the detectors.

Results: The project enrolled 30 Italian centers; micro-ion chambers were used for OF measurements in mostly of the centers (80%); in the remaining cases diode was used. For very small fields (≤ 1x1 cm^2) OF have been measured with Gafchromic films in 10% of the cases and in one center with TLD detectors.

In table are reported OF average values and standard deviations for 6 MV major linear accelerator manufacturers measured for each filed size by user detectors and microDiamond. The values in square brackets and parentheses beneath each field size value are average absolute percent differences between detectors results and the number of centers, respectively.

Field Size (cm× cm)	Varian 6 MV		Elekta 6 MV		Field Size (cm× cm)	Elekta 6 MV Beam Modulator	
	User detector	PTW60019	User detector	PTW60019		User detector	PTW60019
10x10	1.000	1.000	1.000	1.000	10.4 x 10.4	1.000	1.000
7x7	0.941 (0.006) [0.2%] (n=15)	0.943 (0.004)	0.951 (0.004) [0.1%] (n=6)	0.954 (0.010	4.8 x 4.8	0.893 (0.005) [0.1%] (n=6)	0.894 (0.003)
5x5	0.889 (0.010) [0.6%] (n=15)	0.893 (0.006)	0.908 (0.007) [0.2%] (n=6)	0.910 (0.011)	3.6 x 3.6	0.844 (0.006) [0.7%] (n=6)	0.850 (0.005)
3x3	0.825 (0.012) [1.0%] (n=15)	0.832 (0.007)	0.851 (0.010) [0.3%] (n=6)	0.852 (0.009)	2.4 x 2.4	0.811 (0.008) [0.8%] (n=6)	0.817 (0.004)
2x2	0.778 (0.017) [1.9%] (n=15)	0.794 (0.007)	0.801 (0.014) [0.8%] (n=6)	0.811 (0.009)	1.6 x 1.6	0.759 (0.011) [1.4%] (n=6)	0.770 (0.006)
1x1	0.673 (0.028) [3.9%] (n=15)	0.692 (0.011)	0.682 (0.027) [1.5%] (n=6)	0.693 (0.012)	0.8 x 0.8	0.583 (0.071) [6.0%] (n=6)	0.620 (0.015)

Percentual differences between OF measured by user routine detector and microDiamond are showed in figure; results are less than 1% in most cases, even if for the field 1 cm x 1 cm differences reach significant values.



Comparison between the two microDiamond detectors showed the equivalence of the devices with results fully agreeing with the technical specifications of the company.

Conclusions: Results show that there is a relatively high degree of consistency regarding OF for Linac with the same model of the head. Differences between centers decrease with PTW-60019, in particular for very small fields. The agreement between microDiamond and user detector measurements confirms PTW-60019 detector as a candidate for small field clinical radiation dosimetry in advanced radiation therapy techniques.

OC-0154

UK SABR Consortium Lung Dosimetry Audit; relative dosimetry results

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Purpose/Objective: The UK SABR Consortium QA group conducted a postal dosimetry audit of SABR lung plans at 21 UK centres. The purpose of this was to verify the accuracy of calculated dose distributions, improve confidence of centres in the early stages of implementing lung SABR and to establish a benchmark QA method. Here the results of the GafChromic film relative dosimetry arm of the audit are given.

Materials and Methods: Individual centres were asked to plan a treatment to a pre-defined PTV in the CIRS Thorax