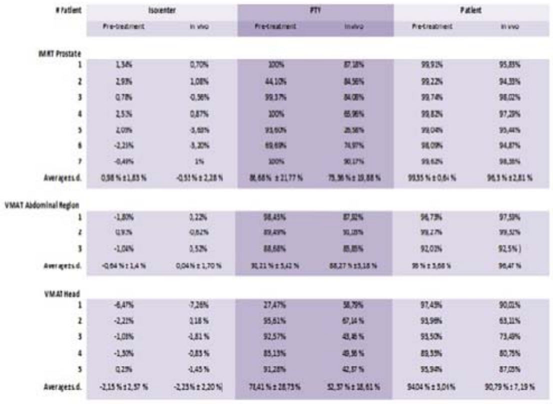

# Patient	Isocenter		PTV		Patient	
	Pre-treatment	In vivo	Pre-treatment	In vivo	Pre-treatment	In vivo
IMRT Prostate						
1	1,34%	0,70%	100%	87,18%	99,91%	95,83%
2	2,93%	1,08%	44,10%	84,56%	99,22%	94,33%
3	0,78%	-0,36%	99,37%	84,08%	99,74%	98,02%
4	2,5%	0,87%	100%	65,96%	99,82%	97,20%
5	2,03%	-3,60%	93,60%	26,56%	99,04%	95,44%
6	-2,21%	-3,20%	69,69%	74,97%	98,09%	94,87%
7	-0,49%	1%	100%	90,17%	99,62%	98,36%
Average±s.d.	0,98 % ±1,83 %	-0,51 % ± 2,28 %	86,68% ± 21,77 %	75,36 % ± 19,88 %	99,35 % ± 0,64 %	96,3 % ±2,81 %
VMAT Abdominal Region						
1	-1,80%	3,22%	98,45%	87,82%	96,73%	97,59%
2	0,93%	-0,62%	89,49%	91,10%	99,27%	99,32%
3	-1,04%	3,52%	88,68%	85,85%	92,03%	92,5%)
Average±s.d.	-0,64 % ± 1,4 %	0,04 % ± 1,70 %	92,21 % ± 5,42 %	88,27 % ±3,18 %	96 % ± 3,68 %	96,47 %
VMAT Head						
1	-6,47%	-7,26%	27,47%	58,79%	97,49%	90,01%
2	-2,21%	3,18 %	95,61%	67,14 %	93,98%	63,11%
3	-1,03%	-1,81 %	92,57%	43,46 %	93,50%	73,49%
4	-1,30%	-0,83 %	85,13%	49,36 %	89,35%	80,75%
5	0,23%	-1,45 %	91,28%	42,57 %	95,94%	87,03%
Average±s.d.	-2,15 % ±2,57 %	-2,23% ± 2,20 %|	78,41 % ± 28,73%	52,37 % ± 18,61 %	94,04 % ± 3,01%	90,79 % ± 7,19 %

Tab.1 Dose difference at isocenter and gamma analysis results related to pre treatment and in vivo measurements are reported for 15 patients

Conclusions: DC is capable of successfully reconstruct the dose distribution in the patient from the EPID measured exit fluences. In our experience, systematic in vivo dosimetry demonstrated to be a valid tool for quality assurance, both in detecting systematic errors and in giving an effective way of estimating the accuracy of treatment delivery.

EP-1413

Dosimetry verification of mixed-energy IMRT plans using Verisoft and Octavius 4D System

A. Walewska[1], M. Gizynska[1]

[1]The Maria Sklodowska-Curie Memorial Cancer Center, Medical Physics, Warsaw, Poland

Purpose/Objective: After introducing IMRT technique, several studies showed that 6MV should be first choice of energy. However, our clinical practice and some research made on prostate cancer plans, shows that mixing energies plans allow to use advantages of higher energy with minimizing negative impact at the same time. Pre-treatment verification of mixed-energy plans seems to be more complicated because splitting these plans to two single energies plans gives two sets of data for separate evaluation with adequate calibration. The purpose of this work was to test quite an easy way of evaluating mixed-energy IMRT pre-treatment verification plans. Octavius 4D system for measurements and Verisoft (PTW) for evaluation were used.

Materials and Methods: For 35 patients, with different cancer location, mixed-energy IMRT (6MV and 15MV) plans have been prepared. RT plans were prepared on Eclipse TPS with sliding window technique. For each plan, three pre-treatment verification plans were: one plan with all beams, and two separate plans for each photon energy beam. Verification plans were evaluated for separate energies at first. Than, after 3D dose calculation, measurements were exported into dicom files. Mixed-energy verification plan was compared with sum of RT dose dicom files for separate energies (summed plan). Each comparison was done with gamma 3D concept for different set of parameters:

a) 3mm 3% of max dose (33max)

b) 3mm 3% of local dose (33local)

Each time dose below 10% of max dose calculated volume was suppressed and increased toleration of 5% dose difference for values below 0.5Gy was used. Weighted average gamma result for separate energies verification plans were calculated, where number of fields with each energy served as weight. Result of gamma 3D evaluation for summed plan and weighted average result were compared. Wilcoxon signed-rank test was used.

Results: In Figure 1 you can see results of gamma evaluation with 33max and 33local criteria for separate energies, summed plans and weighted average for separate energies as well. Wilcoxon signed-rank test confirmed null hyphotesis of no significant differences between gamma results weighted average for single energy plans and summed plans (p-values were: 0.92 for 33max; 0.63 for 33local).

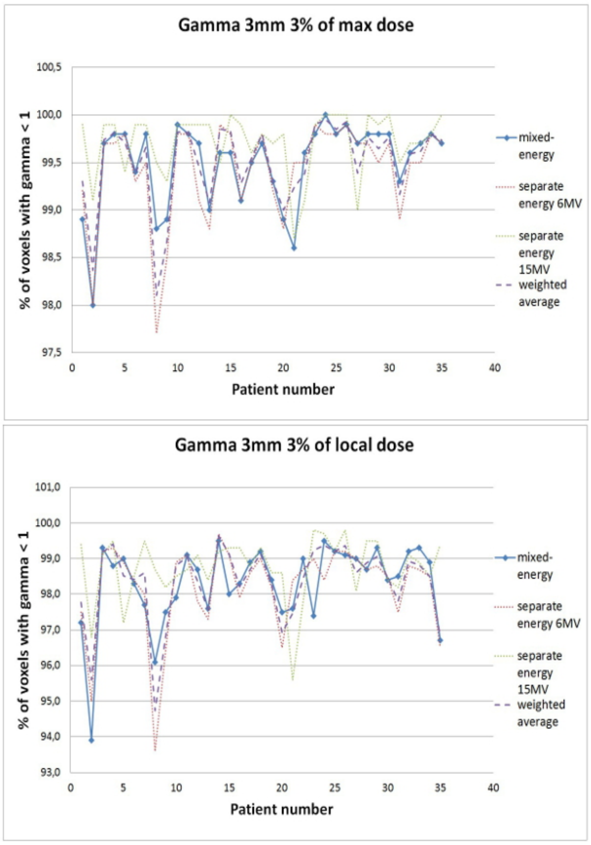

Figure 1. Comparison of results of gamma evaluation with 33max and 33local criteria for separate energies, summed plans and weighted average for separate energies

Conclusions: Proposed by us method of summing up dicom RT dose files for single-energy plans is easy to use and gives one single result of gamma comparison, which is quite easy to interpret. Although there is no significant difference for 33max, 33local we highly recommend to use gamma evaluation for summed plans.

EP-1414

The effect of depth and control point number for MLC transmission and dosimetric leaf gap

E. Kucukmorkoc[1], M. Doyuran[1], M. Caglar[1], N. Kucuk[1], H. Acar[1], A. Altinok[1], H. Caglar[1]

[1]Medipol University, Radiation Oncology, Istanbul, Turkey

Purpose/Objective: MLC transmision (MLCT) and dosimetric leaf gap (DLG) in Treatment Planning System (TPS) are important parameters for dose calculation and they provide accuracy of delivering IMRT plans. MLCT and DLG account the leakage of MLC and the effect of rounded leaf ends, respectively. The aim of this study is to examine control point (CP) and depth dependance for MLCT and DLG.

Materials and Methods: MLCT and DLG parameters were measured with PTW 0.125 cc semi-flex ionization chember in a solid water phantom for Varian Trilogy machine with Millenium MLC. MLCT measurements were obtained 15x15cm^2 field size at different depths (Dmax,5,10 and 15cm) for 6 MV photon beam. To derive the DLG measurement , a series of Sliding Window (SW) fields of 2,4,7,10,15 and 20 mm gap widths were used. These SW fields were prepared with different number of CP (2,3,5,7,9,11,13,16 and 21) and DLG measuremets were performed at same depths and field size. DLG values were calculated for each depth using MLCT parameters which were measured at same depth.

Results: MLCT results according to depths Dmax, 5, 10 and 15 cm were 0.0153, 0.0156, 0.0160 and 0.0168 respectively. Our results showed that MLCT values increase with increasing depth. DLG values change with the CP number of SW fields. As shown in the table, calculated DLG values change with the number of CP. Especially when the number of CP is smaller than 7, DLG values are not stable. They also change with depth and our results are 1.253, 1328, 1.373 and 1.418 at Dmax, 5,10 and 15 cm, respectively.

The relation between # of CP and DLG

# of CP*	DLG* (mm)
2	2.208
3	1.42
5	1.432
7	1.388
9	1.388
11	1.388
13	1.373
16	1.373
21	1.373

CP*: Control point, DLG*: Dosimetric leaf gap

Conclusions: MLCT and DLG are not constant values for MLCs. They have directly related with depth and the number of CP. However many TPS allowed to user to insert only one value for each of them. The possibility of inserting more values for different parameters to TPS could be increase the accuracy level of dose calculation.

EP-1415

Calibration of diodes for in vivo dosimetry in breast treatments delivered using a sliding window IMRT technique

A. Latorre Musoll[1], P. Carrasco[1], N. Jornet[1], A. Ruiz[1], T. Eudaldo[1], M. Ribas[1]

[1]*Hospital de la Santa Creu i Sant Pau, Servei de Radiofísica i Radioprotecció, Barcelona, Spain*

Purpose/Objective: Calibration of diodes for entrance dose *in vivo* dosimetry is a well-established method in conventional radiotherapy. However, the validity of such calibration is not straightforward when using sliding window IMRT techniques. We developed a calibration method of diodes for *in vivo* dosimetry in breast treatments delivered using a sliding window IMRT technique.

Materials and Methods: We used a Clinac 2100C/D equipped with a Millenium 120 MLC (Varian). We calibrated 6-12 MV QED diodes (Sun Nuclear) by placing them on the surface of a Plastic Water phantom (CIRS), and comparing their readings to a traceable ionometric system placed at the depth of dose maximum for 6 MV x-rays (1.5 g/cm^2). Field size was set to 10 cm x 20 cm and SSD to 90 cm. The calibration geometry was set by averaging field size and SSD from 14 randomly-selected IMRT breast plans to minimize the value and uncertainty of field size and distance correction factors (CFs). Field size, distance and beam obliquity CFs were measured in two opposite scenarios: open and MLC-blocked fields. In between these scenarios, we obtained CFs using sliding window slits ranging from 2 to 25 mm to study their behaviour in sliding window IMRT conditions. We studied the influence of intra/interleaf leakage and beam hold-offs for gating techniques on diode readings.

Results: Field size, distance and beam obliquity CFs were smooth functions of (X,Y), SSD and angle for open fields (table), and any interdependence between them was below 0.3%. For MLC-blocked fields, field size and distance CFs required a trilinear interpolation of a 3-dimensional matrix $CF_{MLC}(X,Y,SSD)$ (figures a-c). The obliquity CF was independent.

Variable (range)	Correction factor	
	Open fields	MLC-blocked fields
Field size (4x10 - 16x30 cmxcm)	0.993 – 1.002	0.989 – 1.007 (fixed SSD)*
Distance (80 - 100 cm)	0.991 – 1.010	0.990 – 1.099 (fixed X,Y)*
Angle (0 - 90°)	1.000 – 1.025	0.982 – 1.049

*Due to interdependencies, field size and distance CFs for MLC-blocked fields can only be presented by fixing one variable of the 3-dimensional matrix $CF_{MLC}(X,Y,SSD)$.

CFs for sliding window slits showed a smooth behaviour (as slit aperture increased) between MLC-blocked fields and open fields. Therefore, we defined an effective CF, CF_{eff}, by combining the open and MLC-blocked fields CFs using a weighting factor $0 < \tau < 1$ which accounts for the fractional dose contribution of the MLC transmission:

$$\mathrm{CF_{eff}}(X, Y, \mathrm{SSD}, \mathrm{angle}) = (1-\tau)\mathrm{CF_{open}}(X, Y)\mathrm{CF_{open}}(\mathrm{SSD})\mathrm{CF_{open}}(\mathrm{angle}) + \tau\, \mathrm{CF_{MLC}}(X, Y, \mathrm{SSD})\mathrm{CF_{MLC}}(\mathrm{angle})$$

Beam hold-offs did not affect diode readings. Diode placement with respect to the intra/interleaf assembly is random in nature, and the contribution of MLC transmission to dose is therefore variable. We found that intra/interleaf variations increased up to 55% for MLC-blocked fields as slit aperture decreased (figure d).