Conclusions: TG119 structures and plans were found to be easily adaptable to Delta4 phantom CT enabling a rigorous evaluation procedure for IMRT plans verification. Preliminary results on VMAT plans showed that TG119 could be a practical commissioning procedure for modulated arc therapy too. Delta4 allows a fast on-line 3D dose distributions analysis substituting more traditional dosimeters suggested in TG119, but this solution is more expensive than the one proposed inside this report and it is not available in every department for intercomparison purposes.

PO-0773
Use of portal imaging for quality control of VMAT delivery
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Purpose/Objective: Quality control (QC) of volumetric modulated arc therapy (VMAT) delivery represents a significant additional workload during monthly accelerator checks. This study therefore aims to implement VMAT QC in as few arcs as possible using portal imaging. Synchronisation between gantry position, multileaf collimator (MLC) leaves and dose rate is the focus of the study, since this is the aspect which is covered least by already-implemented tests of intensity modulated radiation therapy (IMRT) delivery.
Materials and Methods: An Agility accelerator with iViewGT portal imager (Elekta AB, Stockholm, Sweden) was used for this study. A steel bar of diameter 12 mm was accurately positioned in the G-T direction, 80 mm laterally from the isocentre (Figure 1a). An arc prescription was designed which irradiated the bar with a 16 mm x 220 mm field during a complete 360° arc, so as to cast a shadow of the bar onto the portal imager. This resulted in a sinusoidal sweep of the field and shadow across the portal imager and back. The prescribed monitor units (MU) were chosen so as to give a uniform intensity during this sweep. A total of 640 MU were delivered with control point spacing 10°. The method was tested by simulating an MLC leaf position error of 2 mm at one control point, a gantry position error of 9° at one control point, and a dose error of 20 MU (3% of overall dose) at one control point. The portal images were viewed as integrated images. Coefficient of variation of mid-leaf profiles was used to evaluate the magnitude of features appearing in the portal images due to simulated errors.
Results: The test requires a counter-clockwise arc and a clockwise arc to fully evaluate the VMAT performance of all MLC leaves. In the absence of simulated errors, the integrated images show uniformity. With simulated delivery errors, irregular patterns appear in the integrated portal images (Figures 1b - 1d). The increase in coefficient of variation relative to no delivery error is 42% due to a 2 mm MLC leaf position error at one control point, 108% due to a 9° gantry position error at one control point and 239% due to a 20 MU dose error at one control point. The method is more sensitive to errors at gantry angle 90°/270° than at 0°/180° due to the geometry of the test.
Conclusions: This method provides fast and effective VMAT QC suitable for inclusion in a monthly accelerator QC programme. The test is able to detect errors in the delivery of individual control points, with the possibility of using movie images to further investigate suspicious image features. We are grateful for engineering assistance and to Elekta AB for their collaboration on VMAT and Agility.
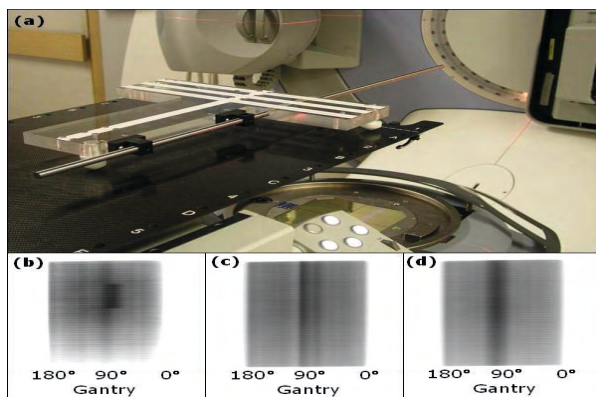

Figure 1. (a) Test geometry, (b) result of 2-mm position error in 10 MLC leaves at one control point, (c) result of 9° gantry position error at one control point, (d) result of 20 MU dose error at one control point.

PO-0774
PET-guided simultaneous integrated boost of lung tumors: Alanine/EPR dosimetry in an anthropomorphic phantom
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Purpose/Objective: The predictive role of FDG-PET in identifying lung cancer patients at risk of relapse has opened for PET-guided simultaneous integrated boost (SIB), where the PET-active tumor region may be dose escalated [1]. Such treatment involves intensity modulated radiotherapy (IMRT), with a high degree of beam modulation, of a target positioned in the lungs. Dose calculation algorithms may show deficiencies under such conditions, and it is thus pivotal to verify whether the planned dose is correctly delivered.
Materials and Methods: An anthropomorphic thorax phantom made of polystyrene (ρ=1.06,soft tissue surrogate) and polyurethane (ρ=0.25,lung tissue surrogate) was constructed in-house based on CT images of a lung cancer patient. One-hundred and one cylindrical cavities for alanine/EPRdosimeters (height 2.5 mm, diameter 5 mm) were made throughout the phantom. A SIB based on PET/CT images of the given patient was planned for a Varian Trilogy linear accelerator equipped with a 120 leaf Millennium multileaf collimator (Varian Medical Systems) using 6 MV photons. The IMRT boost plan objectives comprised, among others, a boost dose of 3.8 Gy/fraction to the FDG-avid region including margins (biological planning volume; BTV) with 3.1 Gy/fraction to the planning target volume (PTV, excluding the BTV). The IMRT plan was transferred to the anthropomorphic phantom where the dose distribution was calculated using the AAA algorithm in the Eclipse treatment planning system. Irradiation of the phantom, including 101 alanine/EPR dosimeters, was carried out at the linear accelerator in question. Phantom setup was verified with the accompanying OBI cone beam CT system, and portal dosimetry was performed for beam verification. A dosimeter calibration series with 15 dosimeters was irradiated at the same accelerator. Readout of the alanine/EPR dosimeters were performed at an EleXsyS 560 Super X EPR spectrometer.
Results: The phantom dose points were separated into four region categories; BTV, PTV (excluding BTV),lung tissue and nonspecific soft tissue. The mean measured versus calculated point doses within these regions were 3.83 vs3.84 Gy, 3.30 vs 3.29 Gy, 1.68 vs 1.63 Gy and 0.36 vs 0.33 Gy, respectively. The mean relative difference in point doses ($\pm$ 1 S.D.) between measurement and plan were (-0.5±1.8) %, (0.4±2.9) %,(5±13) % and (14±36) %, respectively. A high linear correlation between measured and planned doses (range 0.71-0.99) was seen in all regions.
Conclusions: The PET-guided SIB can be delivered to patients with high dosimetric accuracy with the given planning and delivery system. Although some discrepancies are observed between measurements and calculations, these are mostly seen in non-specific soft tissue receiving very low doses and are most likely not clinically relevant.
[1] van Elmpt, W., De Ruysscher, D., van der Salma,A., et al. The PET-boost randomised phase II dose-escalation trial in non-small cell lung cancer. Radiother Oncol 2012; 104: 67-71.

PO-0775
EPID-based transit in-vivo dosimetry for step-and-shoot IMRT
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Purpose/Objective: The aim of this work was to extend an EPID-based in-vivo dosimetry (IVD) method, developed in the last years by the authors for conformal radiotherapy, to step-and-shoot IMRT treatments of pelvic tumours. The algorithm was developed for Elekta linacs equipped with IviewGT EPIDs, with the aim to simplify the commissioning procedures and supply IVD tests in quasi-real time.
Materials and Methods: The algorithm is based on correlation functions to convert EPID transit signals into in-vivo dose values, Diso, at the isocenter point. The EPID images were obtained by the so-called 'IMRT Dosimetric Weighting' mode as a superposition of many segment fields. Each integral dosimetric image could be acquired in about 10 s after the end of beam delivery and could be processed while delivering the successive IMRT beams. A specific algorithm for