quantify the registration error based on the delimitation of the spheres on the CT and PET. Our study compared the results for two different types of software.

Materials and Methods: A Siemens Biograph64 mCT was used to acquire CT and PET images of the IEC Body Phantom. Following EANM guidelines for tumour PET imaging, we filled 6 spheres (of diameters from 1.0 to 3.7 cm) with ^{18}F concentration of approximately 20 kBq/ml and the body compartment with a concentration ten times lower. A whole body protocol was applied with matrix size of 512x512 (CT) and 200x200 (PET), leading to a pixel size of 1.52 mm (CT) and 4.07 mm (PET). Plane spacing was set to 1 mm.

After the acquisition, PET/CT images were exported to the software MultiModality WorkStation VE52A (MMWS, Siemens) and, independently, to the treatment planning system Eclipse v11 (Varian).

The spheres in the CT image were manually contoured in Eclipse. For PET images, the delimitation of the spheres was performed -in both MMWS and Eclipse- with an automatic tool, creating a volume containing pixels with standardized uptake value (SUV) higher than a threshold of 20% SUVmax.

The centre of the spheres was determined by creating a treatment plan in Eclipse for each sphere. The isocentre is automatically placed in the centre of mass of the sphere.

To calculate the registration error, the differences of Cartesian coordinates between the centre of mass of the CT-spheres and the corresponding PET-spheres were measured for both PET images contouring systems.

Results: Mean (range) registration errors for all the spheres are summarized in the following table:

	LEFT(+) & RIGHT(-)	ANTERIOR(-) & POSTERIOR(+)	CRANIO(+) & CAUDAL(-)
CT- Eclipse (mm)	0,55 (0.20 – 0.90)	0,47 (-0.30 – 0.90)	0,72 (0.30 – 1.20)
CT- MMWS (mm)	-0,08 (-0.50 – 0.20)	-0,03 (-0.40 – 0.30)	0,85 (0.40 – 1.20)

Conclusions: As it is shown in the previous table, results were below 1 mm in all directions. The main difference was obtained in cranio-caudal direction for both PET images contouring systems.

MMWS showed a better agreement between CT and PET images than Eclipse, for left-right and antero-posterior direction. Although both kind of software are suitable for contouring, results suggest that MMWS could be a better tool for contouring in PET.

EP-1535

Planning quality Variations : for IMRT lung cancer based on treatment plan database

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Purpose/Objective: There have been consistent studies on QA with development of RT technique, but there is a weakness of current QA that there are always some possibilities of accident if human-induced factors were not controlled. And among human factors, planning error is critical to patients. So we focused on plan quality as a main treatment quality determination factor and analyzed 45 lung cancer IMRT plans to verify fluctuation of plan quality as a preliminary study of developing planning QA algorithm.

Materials and Methods: In purpose of verifying plan quality deviations, we collected 45 solitary lung cancer IMRT plans. Volume, length and width were considered to compare cancer sizes of solitary cancers. Cancer position determining factors were vertical distance from lung apex and median line. Organs in or near thoracic cavity, lung, heart, liver, esophagus, cord, and bronchus, were selected as OARs. PTV-OAR surface to surface vertical distance was measured to analyze correlation of distance and irradiation. CVI,HI,EUD,V10,V20,$D_{min,}D_{max}$were used to compare and RT plans. Average normalization point was 94.5%.

Results: Among total 45 cases, esophagus, cord, heart, bronchus, and liver were separated from PTV in 24, 43, 21, 13, 40 plans and respectively. EUD showed a slightly downward tendency as CI decrease and distance increase in most OARs. But heart had a singular value and liver showed a lightly growing tendency when distance from PTV was above 15cm. In PTV-OAR overlapped cases, Bronchus and heart EUD had a growing tendency as an increase in overlapped volume. But it was hard to find a general tendency in PTV-overlapped cord and liver cases because overlapped cases were not enough. Esophagus also barely showed tendency. HI value was 0.19±0.12 and CVI ranged from 0.8 to 1, mostly between 0.9 and 1(0.92±0.04).

	V10	V20	EUD
Lung (PTV)	29.7 ± 20.1	15.0 ± 16.1	8.4 ± 5.4
Lung	6.1 ± 8.6	1.2 ± 2.4	2.5 ± 2.0
Esophagus	25.0 ± 20.4	12.2 ± 16.5	6.7 ± 5.4
Cord	14.5 ± 18.1	5.4 ± 10.2	3.6 ± 3.3
Liver	2.0 ± 6.1	0.8 ± 2.8	0.8 ± 1.7
Heart	20.7 ± 25.8	9.9 ± 16.0	5.3 ± 5.5
Bronchus	36.3 ± 33.8	23.0 ± 32.2	10.8 ± 12.1

Conclusions: In absence of standard quality assurance system for planning, substantial discrepancy of plan quality for similar cases is inevitable. By establishing quantitative references for treatment planning, such as algorithms, deviations of treatment quality from planner to planner could be reduced considerably. Considering that specimens of this study were from one department, which means not many people were involved in making decision, imbalance of treatment result for same patient would be much more severe if many departments were involved. For these reasons, research on planning QA is needed and planning QA may result in upward leveling of radiation treatment.

EP-1536

X-ray pulse time matters in CBCT imaging

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Purpose/Objective: The Elekta XVI CBCT system provides a range of different combinations of x-ray pulse current (mA) and time (ms) when acquiring a CBCT scan. For a range of nominal scan doses (mAs), there is more than one combination of x-ray pulse current and time which provides the same imaging dose to the patient. The objective of the present study was to investigate the effect of using different pulse current and time combinations for CBCT acquisition, and provide local guidelines on how to choose the x-ray current/time.

Materials and Methods: All CBCT scans were acquired on Elekta Synergy or Versa HD accelerators equipped with the XVI 4.5 CBCT system. Three series of 200 projection images were acquired without a phantom on the treatment couch, using different combinations of pulse current and time to provide an x-ray intensity of 0.4 mAs per projection image. All three series were acquired at 120 kVp with the S20 F0 filter combination. The pulse current/time combinations were 10mA/40ms, 20mA/20ms and 40mA/10ms. To further investigate the potential effect on the reconstructed image quality, two CBCT scans of a cylindrical water phantom (20 cm diameter, 48 cm length) were acquired at 120kVp using the S20 F0 filter combination. 200 frames were acquired over an arc of 200 degrees, and projection images were exposed to 10mA/40ms in the first scan and 40mA/10ms in the second scan.

Results: Plotting the mean signal in each projection image of the open scans as a function of projection image number revealed that the shorter pulse times had larger signal variation between the projection images. On top of this, a series of sudden spikes was observed for the 10ms pulse time, and these were completely removed when using the 40ms pulse times. The latter, more consistent x-ray output from the generator will in theory provide a less noisy CBCT reconstruction. Reconstructions of the two scans of the water cylinder are shown in the figure below. It is evident that homogeneity and image noise is reduced when using the long pulse time compared to the short pulse time. These effects are most substantial towards the outer edges of the reconstructed volume, where the undersampling of the data required for reconstruction becomes more severe.

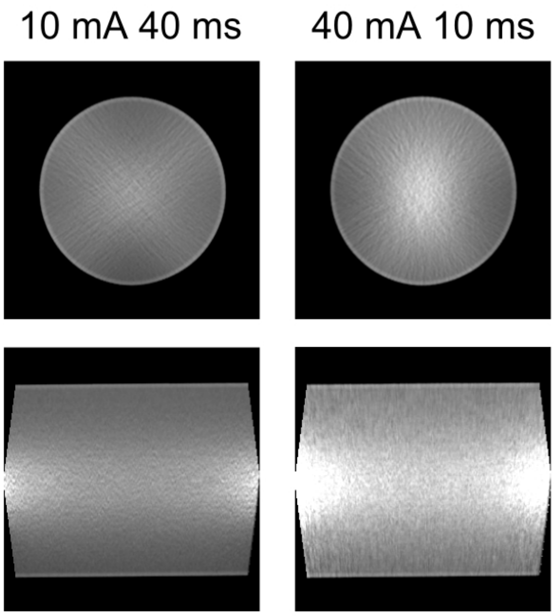

Figure: Axial and coronal view of a homogeneous water cylinder. All images are displayed with the same window/level settings.

Conclusions: The use of longer pulse times and lower pulse currents when acquiring CBCT projection images was found to improve image quality in the reconstructed CBCT volume. Based on this finding, our clinical CBCT acquisition protocols were changed to use the longest possible x-ray pulse times while keeping the imaging dose the same as before this study. We have not observed a significant improvement in image quality of patient CBCTs, possibly because there are other more severe sources of image noise in the system. The change to longer pulse times is however a quick fix in changing the acquisition protocols once, and does not increase the CBCT scan time as the x-ray pulse time remains much shorter than the frame time of the XVI system.

EP-1537

A study of accuracy evaluation of dose distribution calculation based on the cone-beam CT

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Purpose/Objective: The target of this study is to evaluate the accuracy of the dose distribution calculation based on the CBCT by converting the pixel values using a histogram of pixel values of the simulation CT and CBCT.

Materials and Methods: The simulation CT images and the CBCT images just before treatment of 10 prostate cancer patients have been acquired. It is not sufficient to calculate the dose distribution directly using the pixel values of the CBCT, because of insufficient calibration of the pixel values in the CBCT. The pixel values in the CBCT images were converted using an in-house program. Original treatment plans consisting of seven fields were created on the simulation CT images. These plans were applied to the CBCT images and the dose distributions were re-calculated with same monitor units (MUs). These dose distributions were compared with original dose distributions.

Results: The results of the pixel value conversion were as follows. The mean differences of pixel values for the prostate, subcutaneous adipose, muscle and right-femur were -10.78±34.60, 11.78±41.06, 29.49±36.99 and 0.14±31.15, respectively. In the results of the re-calculated dose distributions, the mean differences of prescription doses for seven fields were 4.13±0.95%, 0.34±0.86%, -0.05±0.55%, 1.35±0.98%, 1.77±0.56%, 0.89±0.69% and 1.69±0.71% respectively. As a whole, the difference of prescription dose was 1.54±0.4%.

Conclusions: The dose distribution re-calculation on the CBCT images achieves an accuracy of <2% by using an in-house program to convert pixel values. This method may be able to efficiently allow the implementation of adaptive radiation therapy.

EP-1538

Organ and effective dose from kV stereoscopic imaging as part of image-guided radiotherapy: a Monte Carlo study

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Purpose/Objective: This study aims to quantify the organ and effective doses from BrainLab ExacTrac x-ray exposures