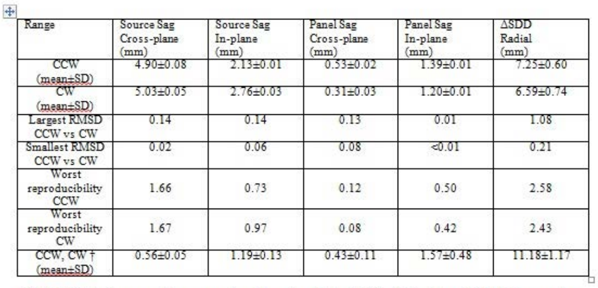
imager separately. To access these information, we applied a method previously used for QA of Elekta linac gantry heads and portal-imaging systems.

Material and Methods: The sag pattern of the CBCT unit of an Elekta linac was investigated using five tungsten-carbide ball-bearings of diameter 4.8 mm. One ball-bearing was attached to the treatment couch top and four were attached to the kV source. Image acquisition was carried out for small-field of view with an average of 343 planar images in each gantry rotation. An in-house software coded in MATLAB was used to extract the ball-bearing positions in the images and to calculate the sag patterns of the CBCT unit.

Results: The results of six gantry rotations are listed in Table 1. The cross-plane sag of the kV source was found to be approximately 10 times larger than the sag of the gantry head, while the in-plane sag was almost two times larger. The cross-plane source sag corresponds to a gantry angle displacement of up to 0.3 degrees . The kV panel sag was comparable to the sag of the MV panel. The kV source-to-panel distance variation was almost half the amount for the MV system. The algorithm also allows for extraction of the skewness and panel-tilt data, but they are not presented in the Table. The kV system was found to have high reproducibility.



Range	Source Sag Cross-plane (mm)	Source Sag In-plane (mm)	Panel Sag Cross-plane (mm)	Panel Sag In-plane (mm)	ΔSDD Radial (mm)
CCW (mean±SD)	4.90±0.08	2.13±0.01	0.53±0.02	1.39±0.01	7.25±0.60
CW (mean±SD)	5.03±0.05	2.76±0.03	0.31±0.03	1.20±0.01	6.59±0.74
Largest RMSD CCW vs CW	0.14	0.14	0.13	0.01	1.08
Smallest RMSD CCW vs CW	0.02	0.06	0.08	<0.01	0.21
Worst reproducibility CCW	1.66	0.73	0.12	0.50	2.58
Worst reproducibility CW	1.67	0.97	0.08	0.42	2.43
CCW, CW † (mean±SD)	0.56±0.05	1.19±0.13	0.43±0.11	1.57±0.48	11.18±1.17

Table 1. Data for the range of the source and panel sag of one Elekta CBCT unit. The data are divided into cross-plane, in-plane and radial (ΔSDD) directions. Mean, standard deviation (SD), root-mean-square deviation (RMSD), and reproducibility in terms of standard deviation are displayed. For comparison, the data of the average values of the gantry arm and the EPID panel (from [1]) are listed in the row marked with †.

Conclusion: The measurements and analysis in this study quantify the sag pattern of the CBCT unit components. The Elekta kV flexmap do not compensate for all sag contributions such as panel rotation and tilt, source sag, and radial source-panel distance variations. A new kV flexmap is suggested for compensation of some additional flex contributions with the exception of panel rotation which cannot be measured in our setup or separated from skewness. The new kV flexmap could improve the reconstructed volumetric cone-beam CT image quality.

EP-1803

An immobilization device-based procedure to predict couch coordinates and set-up tolerance levels

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Purpose or Objective: We propose and evaluate a simple method to predict absolute couch coordinates (ACC) based on different landmarks identified on two immobilization devices. We analyze the inter-observer variability of the method and establish set-up tolerance levels.

Material and Methods: Two immobilization devices were evaluated in this study: the Portrait Head and Neck Device by Qfix and the PosiRest-2 by Civco, used in HN and thorax/breast positioning respectively. Each device was indexed on the treatment table (Varian Exact Couch) and one plastic screw was matched to the room lasers were the ACC were read. The isocenter ACC were obtained by taking simple distance measurements on the CTfrom isocenter to the screw. We studied the inter-observer variability by having 5 different observers repeating all measurements. A total of 46 patients were analyzed: 22 breasts, 12 lungs and 12 HNs. All patients were set-up according to a NAL-3 protocol. A total of 1020 treatment sessions were recorded. We compared predicted couch positions to treatment couch positions acquired after the systematic error correction (4th day). We established device and location specific tolerance levels to accommodate 95% of all sessions. We finally studied if there was any correlation relating these differences and patient random set-up error.

Results: The average of the standard deviations of predicted positions among the 5 observers was <2 mm for all coordinates (vert, lat, long) and devices. There was strong correlation between almost all predicted positions and the systematic error corrected positions (r>0.9) but for the lateral coordinate prediction on the HN device (cause by having small values (<7 mm)). No correlation was found between predicted vs. corrected deviations positions and random error. Thus, this difference cannot be used to predict difficult to set-up patients. In order to accommodate 95% of all treatment sessions couch positions the following tolerances (2σ) were obtained (in mm) for (vert, lat, long): breast (12, 23, 30); lung (12, 20, 22); hn (7, 7, 7).

Conclusion: Our designed procedure based on immobilization device landmarks offers a simple and reproducible method to correctly predict absolute isocenter coordinates. Difficult to set-up patients (large random error) cannot be isolated from the differences between predicted and treated positions on a specific day. However, the procedure allows obtaining tight set-up tolerance levels to prevent gross set-up errors.

EP-1804

A comparative analyse of prostate positioning guided by transperineal 3D ultrasound and cone beam CT

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Purpose or Objective: The accuracy of the Elekta ClarityTM transperineal three-dimensional ultrasound system (3DUS) was assessed for prostate positioning and compared to seed- and bone-based positioning in kilovoltage cone beam computed tomography (CBCT) during a definitive radiotherapy.

Material and Methods: The prostate positioning of 7 patients, with fiducial markers implanted into the prostate, was controlled by 3DUS and CBCT. In total, 177 transperineal ultrasound scans were performed and compared to bone-matches and seed-matches in CBCT scans. Setup errors detected by the different modalities were compared. Using seed-match as reference, systematic and random errors were analysed, and optimal setup margins were calculated for 3DUS.

Results: The discrepancy between 3DUS and seed-match in CBCT was 0 ± 1.7 mm laterally, 0.2 ± 2.0 mm longitudinally and 0.3 ± 1.7 mm vertically and significant only in vertical direction. Using seed-match as reference, systematic errors of 3DUS were 1.2 mm laterally, 1.1 mm longitudinally and 0.9 mm vertically, and random errors were 1.4 mm laterally, 1.8 mm longitudinally, and 1.6 mm vertically. Using the optimal margin recipe by van Herk, the optimal setup margins for 3DUS were 3.9 mm, 4.0 mm and 3.3 mm in lateral, longitudinal and vertical directions respectively.

Conclusion: Transperineal 3DUS is feasible for image guidance for patients with prostate cancer and seems comparable to fiducial based guidance in CBCT in the retrospective study. While 3DUS offers some distinct advantages such as no need of invasive fiducial implantation and avoidance of extra radiation, its disadvantages include the operator dependence of the technique. Further study of transperineal 3DUS for image guidance in a large patient cohort is warranted.