

QA BEAMCHECKER PLUS FOR THE DAILY QUALITY ASSURANCE OF A CYBERKNIFE

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PURPOSE:

Described is the utilization of the QA BeamChecker Plus (BC+, Standard Imaging Inc., Middleton, WI), for the efficient and consistent test of the CyberKnife's (CK) output constancy.

METHODS:

To use the BC+ with the CK, a water-equivalent extension is attached to the BC+. This contains four fiducial markers on the same coronal plane; appearing with acceptable separation on the CK's stereoscopic imagers. The user first attaches the CK extension to the BC+ and CT scan the phantom in a technique consistent with the density table setup in the treatment planning system. Following export of the imaging study and import into the MultiPlan TPS, five targets are contoured in the coronal plane (center, superior, left, inferior, and right), each representing the central and peripheral-most plane-parallel ionization detectors of the BC+ unit. During planning, single-path isocentric targets are placed on each of the five detectors. For each of the targets, 500 MU are delivered. Baselines are acquired and automatically corrected for temperature and pressure.

RESULTS:

Testing uncertainty in repeat measurements, ten measurements were performed immediately after setting baselines. Average output was +0.25% with an SD of 0.11%. On the same day as baseline acquisition, ten acquisitions were delivered with a change in the position of the BC+ system. This required the treatment localization system to recalculate translation and rotation as well as the positional adjustment of the treatment nodes of the accelerator. By performing this study on the same day as the baseline acquisition, output variation is suppressed. The average output was +0.30% high with an SD of 0.13%. In a three-week study, average output was +0.23% with an SD of 0.12%.

CONCLUSION:

When used in conjunction with the CK-specific extension, the QA BeamChecker Plus provides the user with an efficient and consistent means for the daily verification of beam output.

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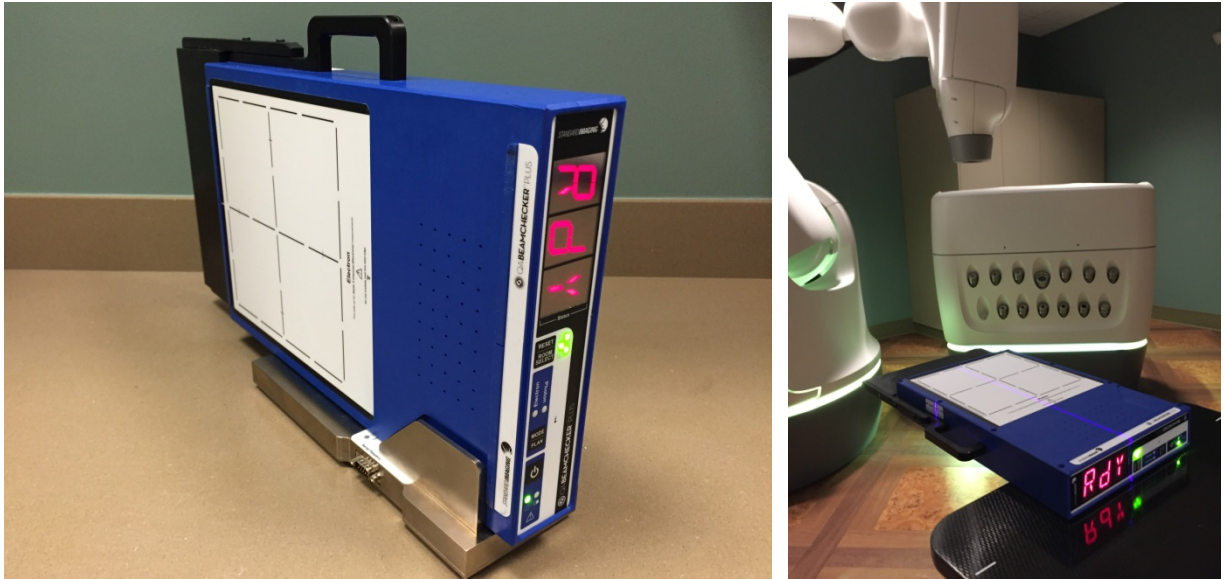


Figure 1. *Left.* The modified QA BeamChecker Plus resting in its cradle. When placed in the cradle, the battery on the BC+ charges and the user is able to download recent measured data and upload these data to the database. *Right.* The modified QA BeamChecker Plus in the proper imaging/treatment position. The BC+ is rough-aligned to the center of the fiducial markers of the phantom extension.

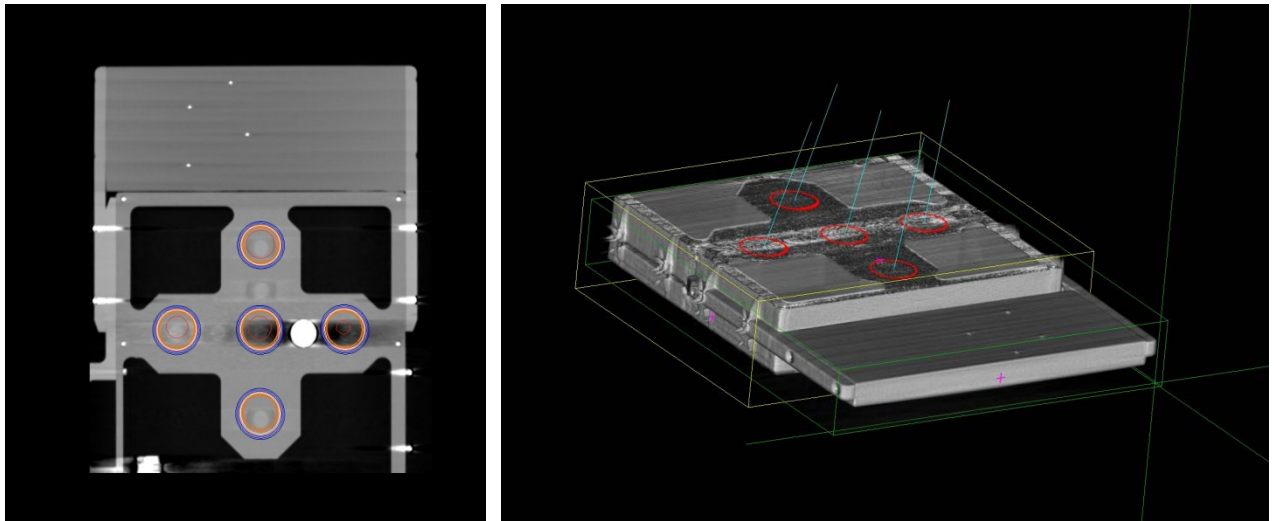


Figure 2. *Left.* The coronal slice 1cm anterior of the detector plane with isodose curves shown (representing arbitrary units). During irradiation of the BC+, the CyberKnife system aligns the phantom so that the imaging center is approximately located at the centroid of the four fiducial markers. *Right.* Phantom surface rendering of the modified BeamChecker Plus (with several mm-thick slices removed from the top surface in order to demonstrate targeting). The blue rays which terminate centrally inside the detector volume (delineated in red) are beams. The four fiducial markers are also visible.

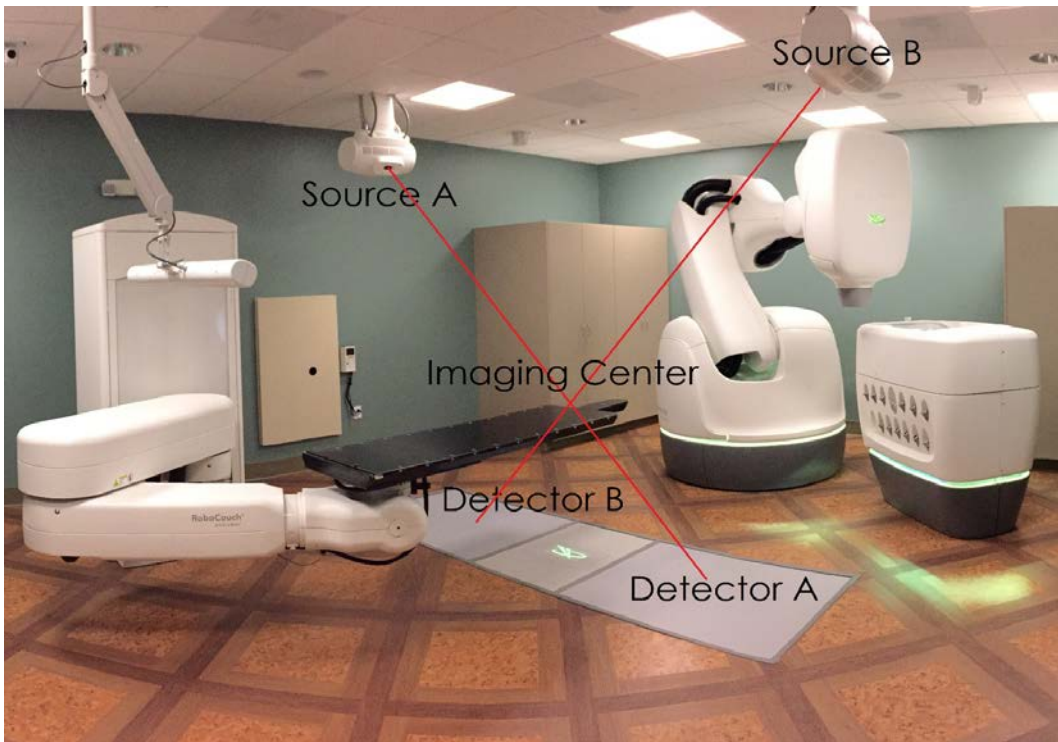


Figure 3. The Accuray CyberKnife M6 FIM System used in the current study. This image demonstrates the location of the x-ray sources, x-ray detectors, and the system's imaging center.

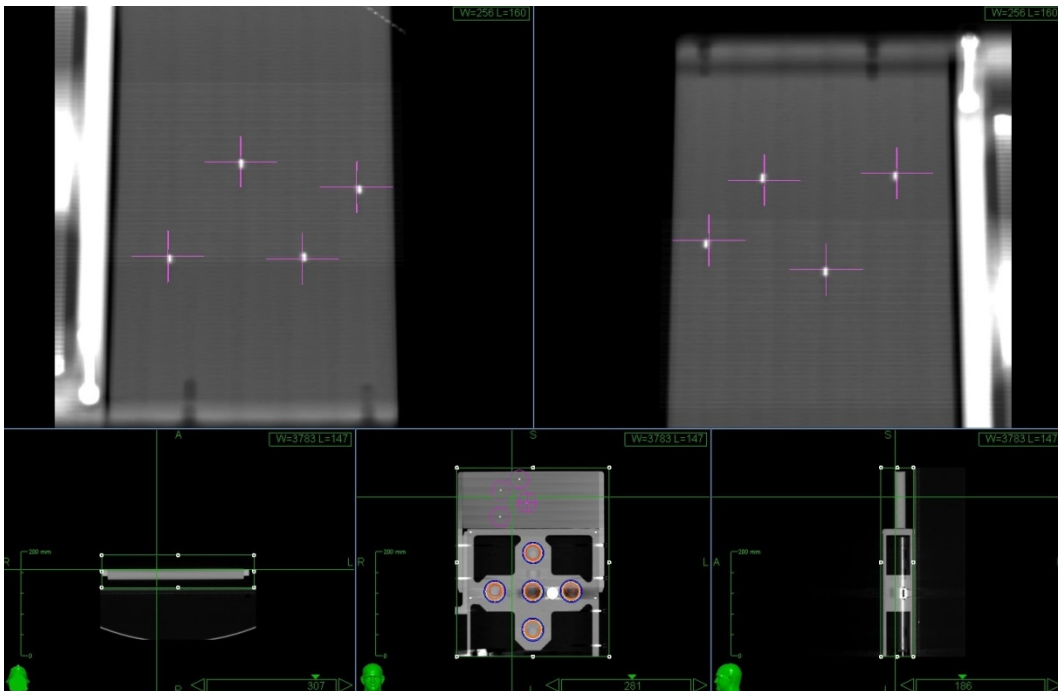


Figure 4. The top two sub-images show CT-generated digitally-reconstructed radiographs (DRRs) which are representative of the images acquired from the CyberKnife system's stereoscopic imaging system and used in phantom/patient alignment.