Experience Using DosimetryCheck software for IMRT and RapidArc Patient Pre-treatment QA and a New Feature for QA during Treatment.

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Abstract. We have used the DosimetryCheck program with the EPID’s on our Varian 2100EX’s to perform pre-treatment QA on more than 350 patients, between the last quarter of 2006 and the present. The software uses the EPID measured fluences of the treatment fields to reconstruct the dose distribution in the CT planning model of the patient. Since the dose calculation algorithm, is different from that used by our Eclipse planning system, this provides an independent check of planning accuracy as well as treatment delivery. 2D and 3D dose distributions, point doses, Gamma distributions, DVH statistics and MU calculations can be compared. Absolute differences of Reference Point doses between Dosimetry Check and Eclipse average 1.20%, which is similar to the ionization chamber dose differences of 1.29% for the same patient verification plans. Examples of cases for various treatment sites and delivery modes will be presented. A Special Report in Medical Physics Vol. 37 Number 6 Pg. 2638-2644 from Mans et al at The Netherlands Cancer Institute demonstrated the ability of in vivo EPID dosimetry to detect treatment errors, that escaped other QA checks. A new version of DosimetryCheck awaiting FDA approval, is capable of successfully reconstructing the dose distribution in the patient from the EPID measured exit fluences. This can also be applied to CBCT images providing actual patient dose verification for a treatment session. This should be particularly useful for monitoring hypo-fractionated treatment regimens. Examples of this method will also be presented.

1. DosimetryCheck
The DosimetryCheck software [1,2,3,4, 5], was created by Wendel Dean Renner, who also created Render-Plan 3-D, the first 3D radio-therapy planning system to receive FDA510K approval. DosimetryCheck enables one to compare the Dose Distribution created from measured field fluences in the Patient Model exported from the Treatment Planning System, with the Planned Distribution. Interfaces are provided for Varian, Elekta, and Siemens EPID’s, MapCheck diode, and PTW 729 ion chamber arrays as well as Kodak CR, or film. Dicom RT and RTOG protocols are supported for importing patient plan, dose, structure, and CT image files. The default calculation grid is 0.5 cm., but
may be adjusted down to 0.1 cm.. I personally prefer using 0.25 cm. which lengthens calculation time, but matches the default grid of our Eclipse TPS.

Generic deconvolution kernels are available for the various electronic devices, or may be customized from a relatively simple set of measurements. Utilities are provided for importing the treatment machine beam data from the TPS. While the beam parameters are the same as used by the TPS, the calculation algorithm is different. Input of CT# to electron density data is also required.

2. Capabilities
In addition to creating 2D isodose distribution, DVH, Gamma, point dose, and dose profile comparisons, the program offers a variety of 3D dose evaluation tools. The 3D tools are impressive, but are more applicable to specific research projects than to routine QA. There is also a MU Calculation Check Module, which in the case of dual carriage position IMRT fields provides calculations for each position. In our use at NMMC, we use only the point dose comparison at the Plan Reference Point, the 2D isodose distributions in the principal planes, through that point, and the DVH comparison.

3. Example
7 Field IMRT Prostate Case. The First Image shows the DosimetryCheck Display after the patient plan, dose, structures, CT’s and EPID fluence images have been loaded, and the program run to show the comparison Isodoses and point doses.

The DosimetryCheck Isodoses are in Red, and the Eclipse Isodoses are in Blue and show excellent agreement. The Reference Point dose is 7446 cGy. in DC and 7475 cGy. in Eclipse a -0.39% difference. The ion chamber dose in the verification phantom agreed at +0.76% with the Eclipse plan. The second image shows the DVH comparison for various structures. PTV, Penile Bulb, Rectum, Seminal Vesicles, Bladder an Posterior Avoidance. The DC curves are solid, the Eclipse dotted.
4. Exit Dosimetry

A recent Special Report in Medical Physics [4] demonstrated the ability of in vivo EPID dosimetry to detect treatment errors, that escaped other QA checks. A new version of DosimetryCheck awaiting FDA approval, is capable of successfully reconstructing the dose distribution in the patient from the EPID measured exit fluencies[5,6]. The following three images, show the Axial, Coronal, and Sagittal Dose distributions for a Rapid Arc Prostate patient, reconstructed from the exit fluencies during an actual treatment. The DC isodoses and area are in Magenta, the Eclipse isodoses are Green. The isocenter dose is +0.47% greater than planned, exceptionally good agreement for Exit Dosimetry. The calculation Matrix in this and the following Head & Neck case is 0.5Cm.
5. Exit Dosimetry Head&Neck Case
The following three images, show the Axial, Coronal, and Sagittal Dose distributions for a Head & Neck patient, reconstructed from the exit fluencies during an actual treatment, at NMMC. The DC isodoses and area are in Magenta, the Eclipse isodoses are Green. The Reference dose is +1.33% greater than the plan which is good agreement for Exit Dosimetry.
6. Conclusion
In 1992 Andre Dutreix published a paper[7], in which he wrote: “As it is not feasible to eliminate all possible errors in these complex procedures, it is highly recommended to add to the conventional programs of Quality Assurance a verification of the treated volume by portal images combined with in vivo dosimetry for each individual patient, to reach the ultimate goal: the verification of the actually delivered treatment with the prescribed treatment.”

References
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