Automatic analyzation of patient specific QA measurements made with the Octavius 4D verification device

P. Haering , C. Lang, M. Splinter

DKFZ German Cancer Research Center, Heidelberg, Germany

dkfz.
GERMAN
CANCER RESEARCH CENTER
IN THE HELMHOLTZ ASSOCIATION

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Purpose:

Patient specific 3D QA measurements with the PTW Octavius phantom are well accepted [1]. A small drawback of the method is, that only the 3d dose distribution can be evaluated what makes it difficult to understand possible deviations found. We present a tool that compares the measurement file to the DICOM RT plan file and detects deviations automatically.

Material and Methods:

The measurement of the PTW Octavius results in a time sampled structured file, based on the settings given for the system. This file includes the dose matrix together with gantry and time information. The tool presented detects the dose information and puts them together as dose groups by eliminating the beam off times. Calibration and correction factors are also applied. The DICOM RT plan file is searched for MU, MLC, Gantry information which will be sorted to fit the order of the measurement data. Knowing the geometry, RT-plan data are transferred to dose matrixes using a simple scatter model (Gaussian curve based). Measured values are given in the Octavius/array resolution needing an interpolation and correction of partial volume effects, which is also taken care of by a scatter model. The tool now analysis both data sets for dose and position errors which are indicated only if given limitations are exceeded and finally calculates a gamma pass rate per segment/gantry step. 12 patient cases from a Siemens Artiste have been analyzed so far with the IDL (Fig. 2) written tool. Excel sheets then help to understand and display the generated data.
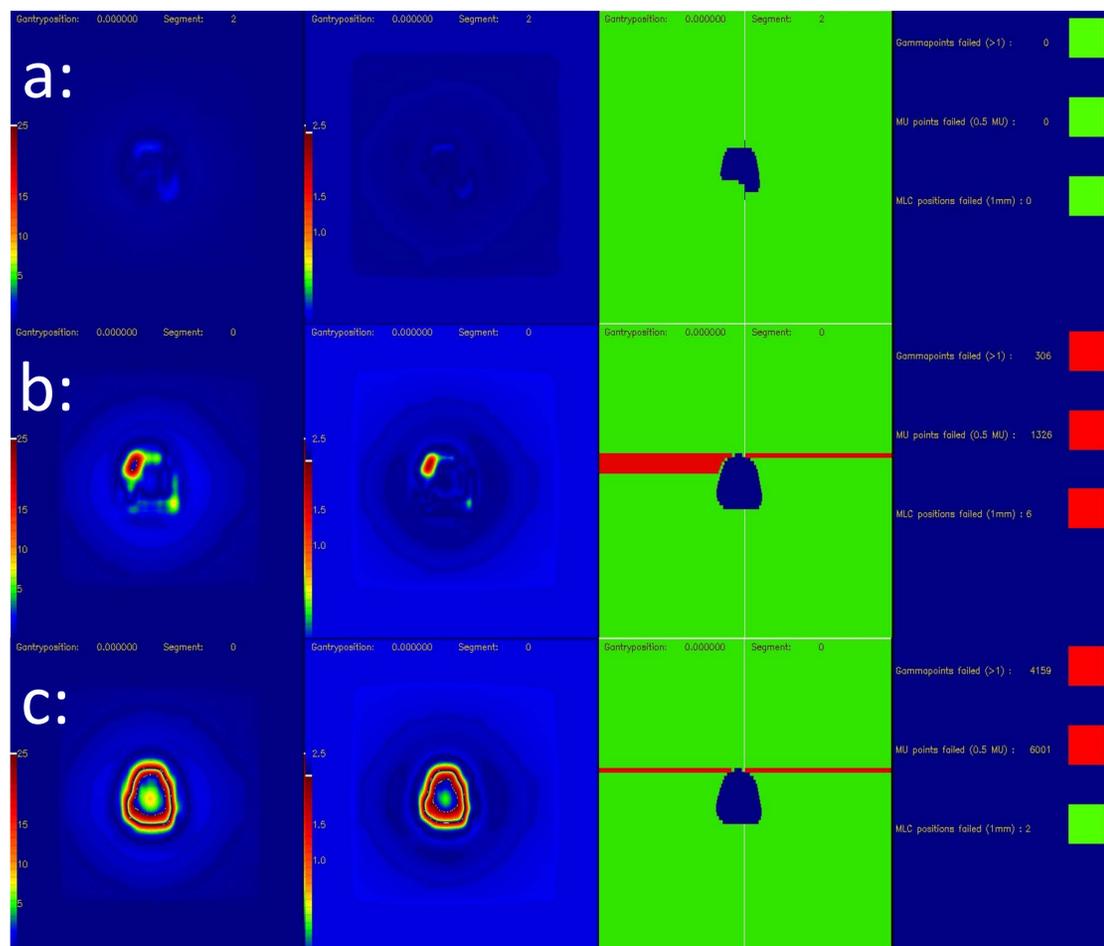

Fig- 1: Results from measurement analysis (Gamma, MU, MLC position). a: perfect segment field. b: segment with some leafs manipulated by 2mm. c: segments with manipulated MU (+ 30%).
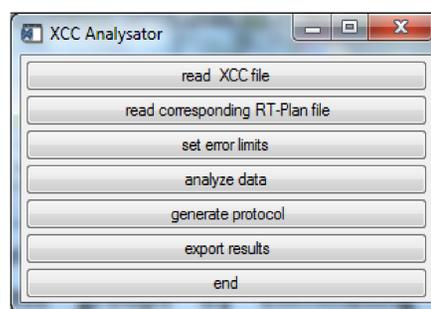

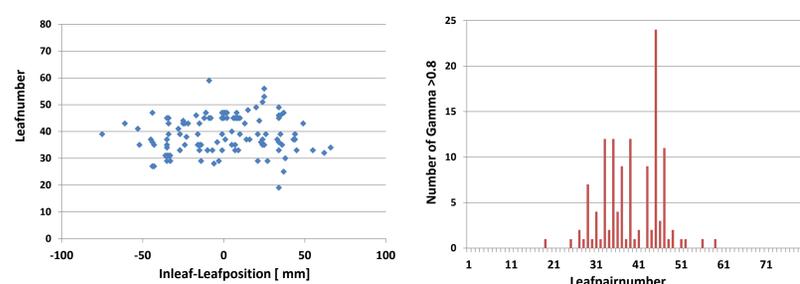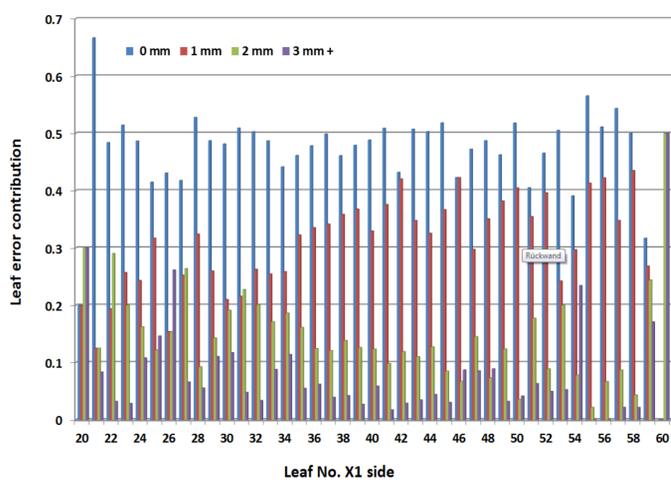Fig- 2: GUI of the IDL Tool.

Fig- 3: Statistical evaluation of results. Left: Positions of Gamma > 0.8 equally distributed. Right: sorted by leaf number.
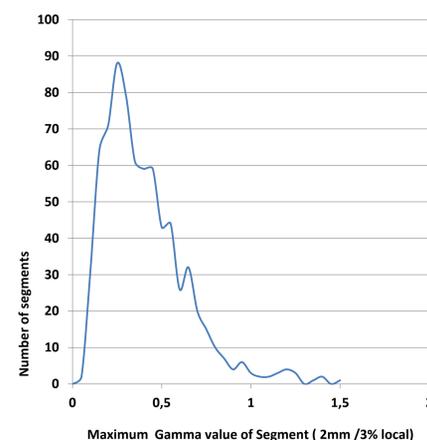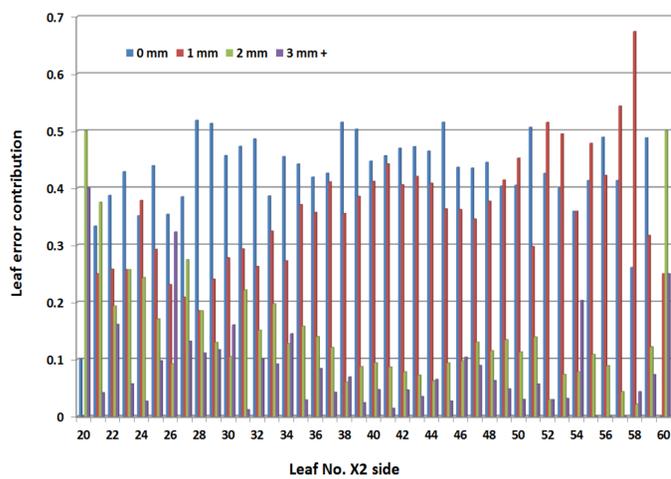

Fig- 4: Histogram of Gamma values.

Fig- 5: Statistical leaf position error frequency for MLC side x1 and x2 sorted by size for 0 ,1, 2, 3mm and larger.

Results:

The additional effort for the analyzation is quite low and just takes a few minutes for copying data and starting the tool. All results can be summarized in a printable report file or Excel sheets. The analyzation of the 12 cases with almost 1000 segmented fields resulted in a mean gamma value 0,549 while only 19 segment fields had a maximum gamma of more than 1, based on a 2mm/3% local criteria (Fig. 4) . Fig 3 (left) shows positions of gamma values >0.8 in the dose distribution [2]. While here results are equally distributed the histogram of leaf pairs indicates that the area of leaf pair 45 has the highest number of >0.8 gamma values of the matrixes (Fig 3, right) . Here it might be worth to look at the leaf calibration even though center leafs are more in use than others. Detected leaf position errors are shown in Fig. 5. Beside that, patient cases did show good results and thereby supported the positive 3d dose results. A manipulated test case (changed leaf positions and MU settings) was easily detected by gamma index, local dose error and leaf positions (Fig. 1).

Conclusion:

The tool breaks up the complex 3D dose verification measurement into an understandable field based approach and automatically checks the dose delivery in a different way. This might have the potential to easier understand why some patient verification measurements might show higher or lower pass rates.

Literature:

[1] Poppe B, Blechschmidt A, Djouguela A, Kollhoff R, Rubach A, Willborn K C, Harder D, (2006) : Two-dimensional ionization chamber arrays for IMRT plan verification. Med Phys 33 1005-1015
[2] Low D A, Dempsey J F, (2003): Evaluation of the gamma dose distribution comparison method. Med Phys 30 2455-2464