Epiqa: EPID Dosimetry for Pre-treatment and *in vivo* Consistency QA

Epiqa software in the IBA Dosimetry portfolio
Epiqa is a pre-treatment Patient/Plan Specific QA (PSQA) software based on Electronic Portal Imaging Device (EPID) data and was recently added to the IBA Dosimetry portfolio for the European market.

Modern EPIDs are amorphous-silicon detectors available on all commercial linear accelerators. Their integrated images can be used for dosimetric verification in PSQA. Epiqa converts EPID images into absorbed dose in water at the depth of dmax, at the isocentre, comparing the resulting map with the corresponding dose map calculated in the treatment planning system (TPS). Primarily, Epiqa performs TPS vs. EPID comparison for pre-treatment QA. The EPID vs. EPID module instead compares EPID doses from different sessions, enabling an in-vivo constant QA process.

A clinical example
A prostate cancer patient was treated post-prostatectomy on a Varian Halcyon® unit with 50 Gy in 25 fractions, followed by a 20 Gy boost to the tumour bed. Halcyon® is an O-ring linac equipped with an in-beam EPID opposite the 6 MV FFF source.

A three-arc VMAT plan was prepared and delivered with kV-CBCT image guidance (Varian HyperSight). The pre-treatment PSQA based on EPID and Epiqa software resulted in a gamma agreement index (GAI, defined as the percentage of the points passing the gamma criteria, here set to 3%/2mm, no low dose cutoff) in the field bounding box of 99.70%, 99.99%, and 99.99% for the three arcs, respectively. The same figures in the CIAO (Completely Irradiated Area Outline, i.e. the field area including the irradiated area of all the control points) were 99.48%, 99.98%, and 99.98% (Figure 2).

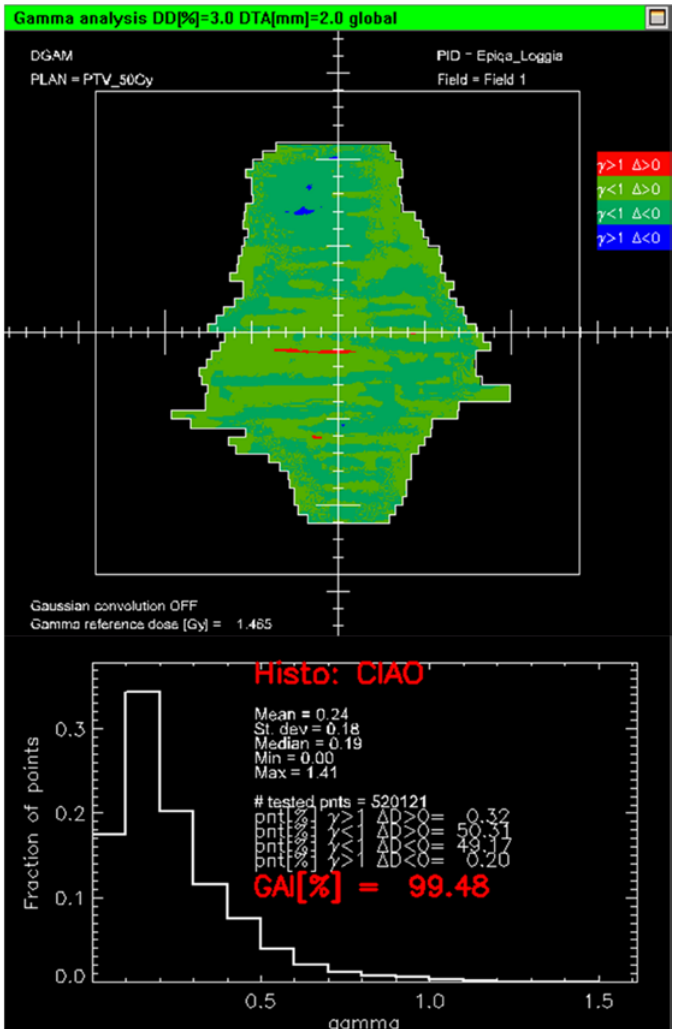


Figure 1. Epiqa pre-treatment PSQA of arc 1. Gamma criteria 3%/2mm, no cutoff, analysis inside CIAO.

An EPID image per arc was acquired at every fraction. The "EPID vs. EPID" *in-vivo* constancy analysis used the first fraction as reference, with fixed gamma criteria (3%/2 mm, no cutoff, inside CIAO) consistent with pre-treatment QA. Figure 3 shows the comparison between session 10 and session 1 for arc 1. The gamma analysis across all sessions and fields (Figure 4) yielded mean ± SD GAI values of 98.5 ± 2.1%, 97.8 ± 2.2%, and 98.5 ± 1.7% for the three arcs, respectively.

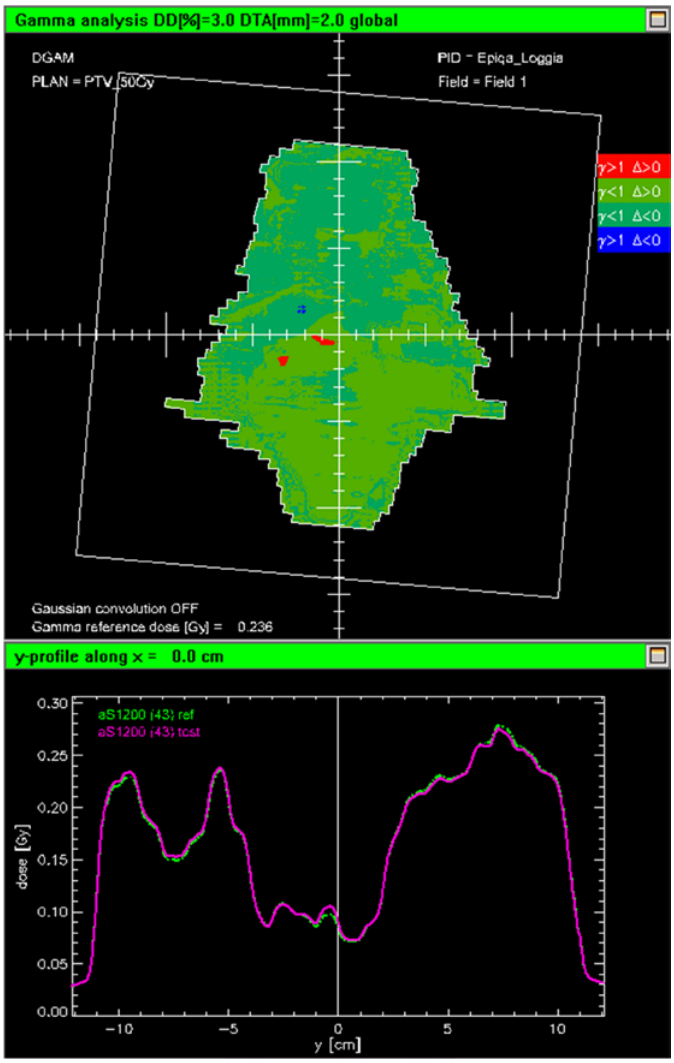


Figure 2. Epiqa in-vivo constancy analysis of arc 1, session 10. On left: test session 25. On right: reference session 1.

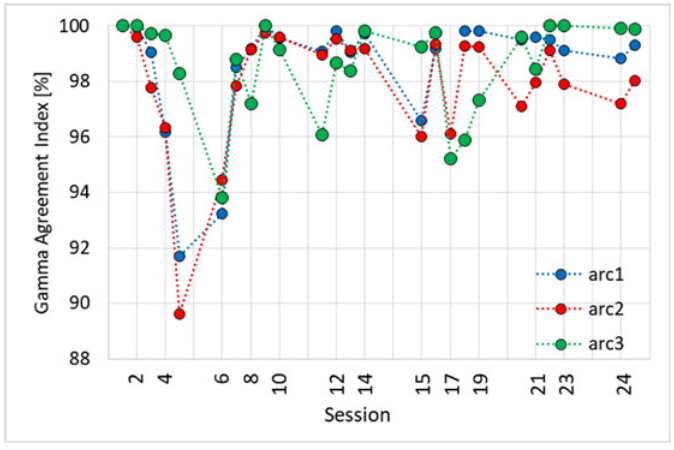


Figure 3. Gamma agreement index (criteria 3%/2mm, inside CIAO) from the analysis between the first and the subsequent sessions for the 3 arcs.

The fifth and sixth sessions presented a GAI sensibly lower than the other sessions relative to the first fraction. The CBCT of fraction 6 showed indeed an important air pocket in the bowels. The delivered dose was estimated for that session by calculating the plan on the CBCT. The 3D gamma agreement between the first and the fifth calculated sessions (3%/2mm, 10% cutoff) was 94.3%, lower than the average over the whole treatment of 96.3±1.1 %. Figure 5 shows the calculation on the session 6 CBCT (where the air pocket is visible), and the 3D gamma between the two calculations. Figure 6 shows the gamma evaluation and the percentage dose difference from Epiqa for the 3 arcs of the same session 6. The CBCT and the calculations confirmed the decreased gamma obtained by Epiqa *in-vivo* constancy analysis.

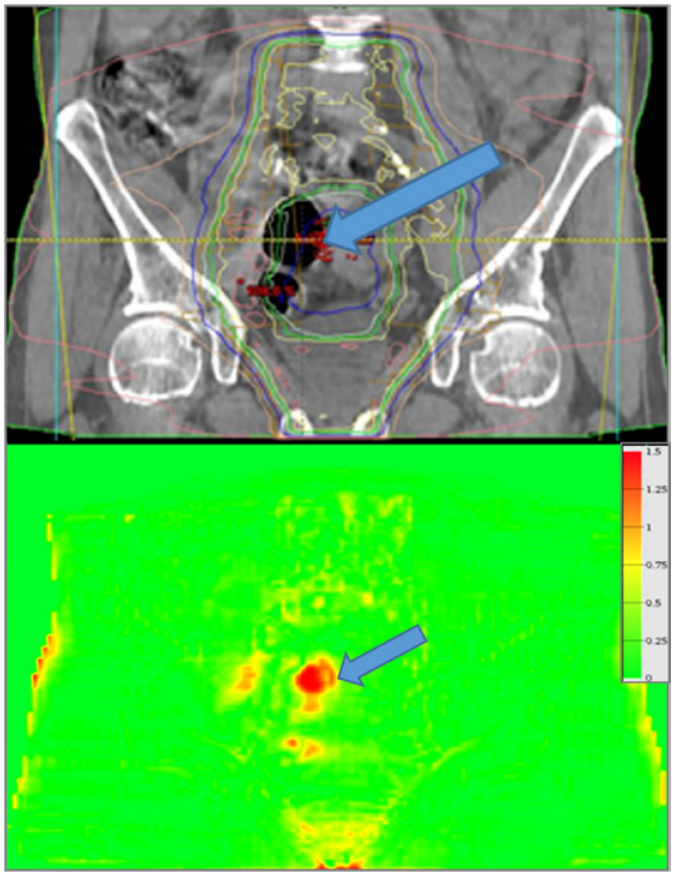


Figure 4. On top: the CBCT of session 6 with the recalculated daily dose distribution. On bottom: 3D gamma evaluation on the coronal view through the isocentre. Arrows highlight the correspondence of gamma fails, and gas pockets in the abdomen.

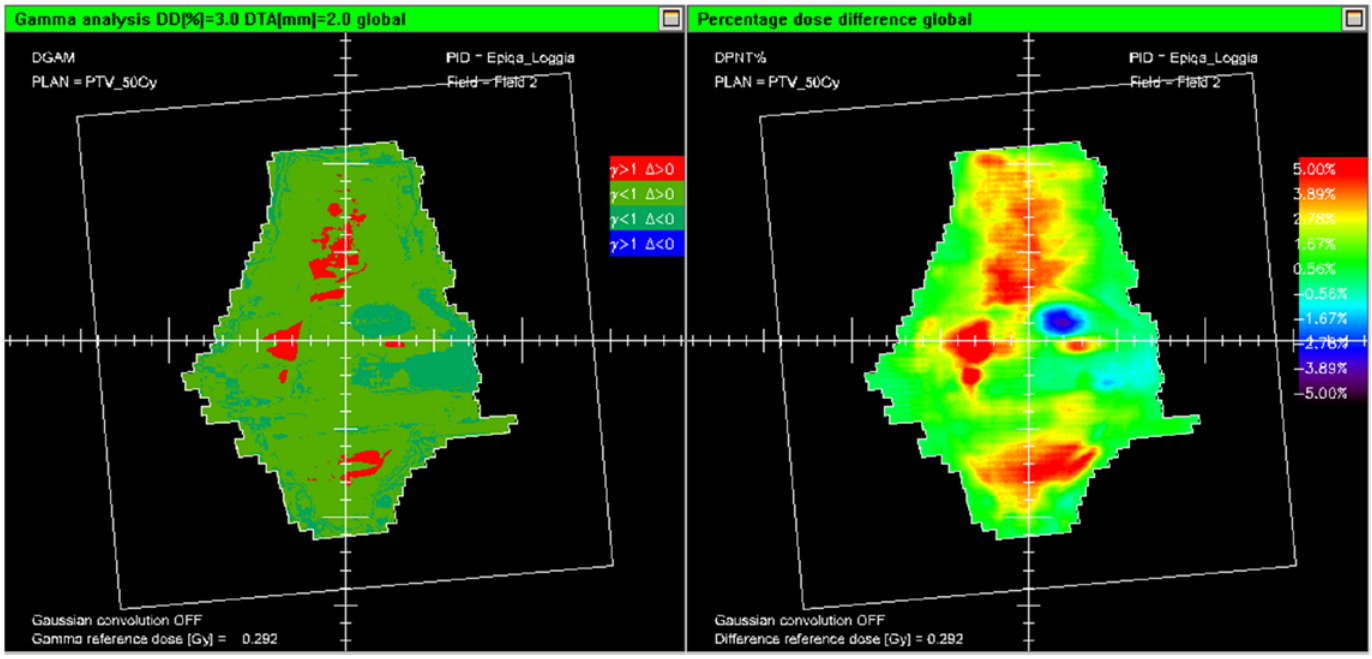


Figure 5. On the left: Epiqa gamma evaluation of session 6 for one arc. On the right: Epiqa percentage dose difference of the same (color range -5%, +5%)

Conclusion

Epiqa proved to be a promising tool for *in-vivo* constancy during patient treatment. It could enable detection of anatomical artifacts even when gamma values remain within tolerance, supporting more detailed, site-specific QA analyses. This could lead to more detailed studies, site by site, of the quality of the treatments. The choice of the best gamma criteria for *in-vivo* constancy should be analysed. The use of *in-vivo* constancy is of particular interest on the Halcyon® unit, where the EPID images are automatically acquired at each treated field, allowing a straightforward quality assurance of the whole patient treatment.

Authors in next page ▸



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Antonella Fogliata is a medical physicist with about 35 years of experience in radiotherapy, having spent most of her career at Bellinzona Hospital in Switzerland. In the past decade, she has collaborated closely with Humanitas Hospital in Italy. She is active in photon dosimetry, treatment planning for intensity modulation optimization and calculation algorithms, and clinical and R&D implementation technologies. She has also lectured extensively on radiotherapy and dosimetry courses.