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Purpose: IMRT QA using phantom measurements requires registration of a phantom CT scan with the original treatment plan, registration of measured dose planes to extracted plan data, and quantitative comparisons. To facilitate this, we have developed a new open-source film QA tool, the IMRT Quality Assurance Software tool (IQAS, pronounced, I-case).

Method: IQAS was built in MATLAB with the addition of 2D and 3D gamma calculations which were written in C++ and integrated with MATLAB.

Results: To perform QA, the phantom film is scanned into a Flexible Image Transport System (FITS) file format. That file is read into the film QA tool and displayed using image information stored in the file header. The film is registered to the known pin prick coordinates. The coordinates are stored in a phantom profile file and the registration is done by manually selecting points on the film. Users can select between custom optical-density-to-dose conversion profiles to compute dose in the film plane. Additional tools provide options to generate plots for dose, changing the color map, or export the film to a DICOM dose file. The integration of film with the 3D treatment plan is done via CERR (Computation Environment for Radiotherapy Research) which is open-source MATLAB based software. The user registers the 3D dose to coordinates by selecting fiducial points on the CT scan of phantom within CERR. A rigid transformation, which is purely translations and/or rotations, is applied to the 3D data. Once 3D data is transformed, tools available for evaluation include distance-to-agreement, and 2D gamma and 3D gamma functions based on new mesh algorithms for adequate speed. The results can be stored in CERR and can later be retrieved.

Conclusions: IQAS is a flexible open-source tool which provides broad functionality supporting 3D dose comparisons for film QA.

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Figure 1. Figure 1. Workflow of the IMRT QA process which this tool is designed to support.

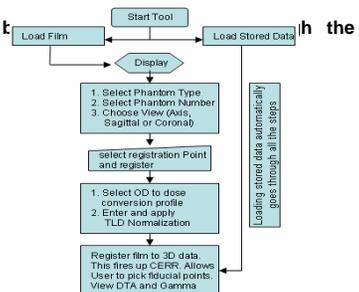


Fig 2. A FITS film is loaded. Fiducial Points are marked for rigid registration. Zoomed view can be seen 'on the fly' in the lower right view port to assist with point selection

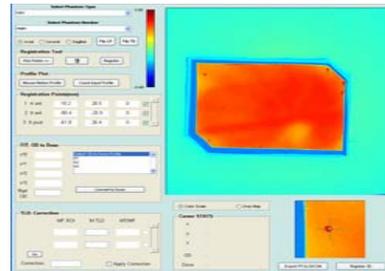


Fig 3. The RMS error after registration is reported.



Fig 4. Dose is calculated based on optical density-to-dose calibration curves. Multiple OD-to-dose curves can be stored and easily accessed. The range of doses is shown on the color bar

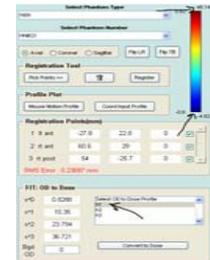


Fig 5. Mean ROI and TLD dose is calculated and displayed for the TLD locations, as well as the ratio of MTLT (mean TLD reading) and MROI (mean film reading in local areas around TLD positions). This can then be applied as a correction to the film, to bring it into agreement with the TLD readings.

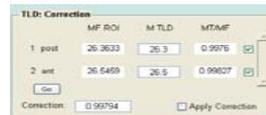


Fig 6. A left-mouse click can be used to retrieve the statistics of dose, OD and X,Y,Z coordinates of the registered film at that point.



Fig 7. Profile plots can be created interactively to analyze dose distributions. The profiles can be exported to excel.

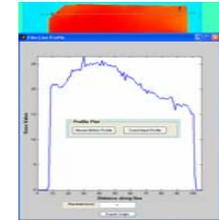


Fig 8. Pre-stored plot profiles can be generated. The underlying data-base can be updated with the new profiles. Profiles can be exported as well.

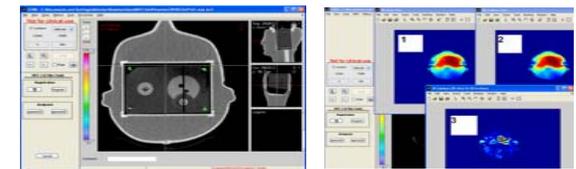
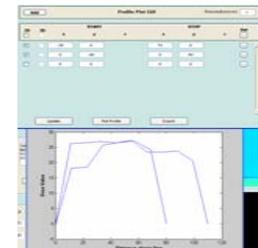


Fig 9. CERR is used to do 3D registration to the imported and registered treatment plan (Left). The film results can then be compared to treatment plan results. Fast 3-D gamma dose comparisons are available (< 1 minute) (Right).

Conclusions

- A software film QA tool has been developed to the beta stage. The tool facilitates film-based QA, as well as integration of TLD measurements, and comparisons with treatment planning system results.
- The tool is continuously under development and is currently being tested at the RPC.

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