GAFCHROMIC®
User Protocol Guide for IMRT QA

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Analysis Requirements

A minimum of three films are required for a complete IMRT case analysis:

- **Patient film** – This can be for either a single fluence field exposure or the composite exposure.

- **Calibration film(s)** – Proper calibration of the dose distribution is crucial to obtain accurate results. An appropriate calibration consists of:
  - **8 to 12 dose levels, equally spaced.** If you strive for absolute dosimetry, it is necessary to expose calibration films for every QA session.
  - **Two or three** of the calibration points should be above the **maximum dose** of the patient field, with the last point ~20% higher than this value.
  (e.g. Maximum Patient Dose of 200 cGy; Calibration Doses: 30, 60, 90, 120, 150, 180, 210, 240 cGy)

- **Unexposed GAFCHROMIC® EBT2 film** – This film is used as a zero-dose point and for the background correction. It should be from the same lot as the exposed films. It can be re-used for future QA sessions using films from that same lot. This film should be scanned along with the patient and calibration films of each analysis session.

**Calculation Data** - In order to perform an IMRT analysis using a verification software package like FILMQA™, it is necessary to export the calculation file from your treatment planning software. Be sure to export the correct dose plane (i.e. check the planar dose and max dose to be sure they correspond to the film exposure).

**Hardware and Software** - GAFCHROMIC® EBT2 film is best analyzed using FILMQA™ Verification Software and an Epson flat-bed, color scanner (e.g. EPSON® Expression® 10000XL Photo). FILMQA™ is optimized for use with GAFCHROMIC® EBT2. Epson flat-bed, color scanners allow you to use responses in the red and blue color channels to optimize your results. FILMQA™ is the only software package that makes use of these responses to account for both film and scanner artifacts.

**Pre-Analysis Steps**

**Expose the patient film** - This film should be exposed at the isocenter of the treatment field and marked with fiducial points (used to register the image during the analysis). If you do not have a fiducial template, place marks on the axes of the alignment lasers as indicated:

- Tape the film to the solid water phantom (if applicable)
- Mark the fiducial points
- Close the phantom and irradiate according to the plan at the appropriate depth

**Expose the calibration film(s)** - Calibration fields should be exposed separately and on separate pieces of film. If the film is cut for this purpose, be sure to keep track of the orientation with respect to the original sheet of film. It is possible to use a single, un-cut sheet for calibration if the total cumulative dose for each field can be verified using an ion chamber.

- Cut film into 8 to 12 equal pieces
- Put a piece in the phantom, and irradiate to the appropriate dose level in an open field of 10 x 10 cm, or larger
- Remove the film from the phantom, and repeat with another piece of film until you have 8 to 12 pieces with known doses.

**Scan films in the order they were irradiated** - Please see the document “Scanner User’s Protocol for GAFCHROMIC® EBT2”. GAFCHROMIC® dosimetry films do not require a processor. For best results, all of the films should be scanned in the center of the scan bed, and at the same time interval from irradiation.
Scanning Tips

Launch the EPSON® Scan software. Choose the file type as TIFF with Windows byte order, no compression, and no ICC profile embedding. Set the other the settings as shown in the windows to the right and below left. Choose 50 dpi resolution. If you are testing for spatial accuracy in a small region, as in the End-to-End test for CyberKnife®, choose 300 dpi resolution.

Click the “Preview” button to view the film image in the right-hand “Preview” window. Use the cursor to draw the Region-of-Interest (ROI) around your film image, as shown right. Use only the EPSON® Scan software to scan the GAFCHROMIC® EBT2 films with the EPSON® Expression® 10000 XL Photo Scanner.

Place GAFCHROMIC® EBT2 films on the scan bed at the center, and in preferably in landscape orientation (see below right). Be sure to place all subsequent films in the same location.

Place smaller (cut) pieces of film also in the center of the scan bed. If the film was cut into 12 pieces for calibration, scan six pieces at a time in two separate scans (films aligned down on the center of the long axis of the scanbed).

Within an analysis, the size of the ROI chosen (see above right) should be at least as large as the largest film in the analysis. For all subsequent film scans within that analysis, do not change the size or the position of the ROI, or the scan resolution.
QD+ Quick Reference Guide for GAFCHROMIC® Film-based IMRT QA
(Featuring GAFCHROMIC® EBT2 Film and FILMQA Software)

The GAFCHROMIC® QD+ film-based IMRT QA System has been specifically designed and optimized for fast, easy, and sophisticated IMRT plan verification that is less time consuming and easier to use than conventional QA methods. This unique combination of a self-developing dosimetry film with an intuitively-designed verification software package provides medical physicists and dosimetrists with consistent accuracy and performance that are crucial in the fast-paced and economically conscious field of therapeutic radiation therapy.

Analysis Necessities

The three main components of the GAFCHROMIC® QD+ film-based IMRT QA system are as follows:

- **GAFCHROMIC® EBT2 Dosimetry Film** – It is self-developing, energy-independent, and useable in room light. Excellent for external beam therapy QA applications, such as IMRT QA and Physics QA.

- **EPSON® Expression® 10000XL Photo Professional Flat-Bed Color Scanner** - GAFCHROMIC® EBT2 film can be digitized with this scanner for a 48-bit RGB response. (no expensive medical scanner required). The resulting TIFF image can be analyzed in the red or green color channels for dosimetry, and the blue channel for film response uniformity.

- **FILMQA Verification Software** - Optimized for use with GAFCHROMIC® EBT2 film, it automatically extracts the red color channel for the analysis, and performs a background correction for consistently accurate results. The upcoming version is planned to provide even better accuracy by using the blue channel data for even tighter response uniformity.

In order to perform a complete IMRT QA analysis using GAFCHROMIC® EBT2 film with FILMQA, the following items are required: The treatment planning calculation files, an unexposed GAFCHROMIC® EBT2 film, the GAFCHROMIC® EBT2 calibration film(s), and the exposed GAFCHROMIC® EBT2 patient films. It is also necessary to have available the cGy dose values of the calibration film(s), and the number of MUs used to expose the patient films and to calculate the fluence maps. This guide is to walk you briefly through a typical IMRT QA analysis using GAFCHROMIC® EBT2 film and FILMQA verification software. The "Patient QA" window of FILMQA displays the six-step task list to be followed for the analysis. After you complete the steps for each task, you will simply select the next task to continue the analysis.

Analysis Steps

For an IMRT QA analysis, do the following:

1) Import Calculations - Choose the "File Type", locate the directory where the files are stored using the "File Browser", select the calculation files, choose the "Group Name", and select the "Add Dataset(s)" button to add these files to the analysis.

2) Import Films - Choose the directory where you would like your scanned images to be saved, choose the "Group Name", and select the "Scan" button. Scan the films into the analysis using the scanner software. While scanning, be sure to keep the scan area, scan location, scan resolution, and film orientation consistent. If your films are already digitized, locate the directory where your digitized images are stored using the "File Browser", select the files to be imported, and select the "Add Dataset(s)" button to add these files to the analysis.

3) Register - Drag-and-drop a measurement image into the left window. Choose the appropriate fiducial map from the drop-down menu and select the "Detect" button to register all of your films simultaneously. If the fiducial map detection failed, or the films are not marked with fiducial points, select the "Manual Registration" tab and use the tools to manually register the films.

4) Calibrate - Designate the background image. Click on the calibration image, draw ROI's at the center of each of the calibration fields, select the "Add ROI" button, enter the dose value for those areas, and select "OK". Select the "Apply Background Corrections" check-box. In the "Conversion & Sorting" tab, choose the group name and select "Convert Dataset(s)".

5) Evaluate - Drag-and-drop the first calculation and measurement images into the top and bottom windows, respectively. Select the "Normalization" button to normalize the images using the calculated and delivered MU values. If the calculated MU values are the same as the delivered MU values, simply select the "Absolute (cGy/MU)" normalization method, select "Synchronize", and select "OK". If the calculated MU values are not the same as the delivered MU values, input the MU values into the "Monitor Units" fields for both images, select the "Absolute (cGy/MU)" normalization method, select "Synchronize", and select "OK". Use the evaluation tools to evaluate the measurement images versus the calculation images.

6) Reports - Use the "Add to Report" buttons in the "Evaluate" task to add either a current view or a snapshot view page into the report. These reports can be viewed in the "Reports" task, where either the most recently generated report or the report summary page is displayed. Choose the report to be viewed and use the navigation buttons in the top right corner to navigate to the different pages in the report.

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