Implementation of Patient Specific QA in CyberKnife using Mapcheck

Anand Prabhu, Bhavin Patadiya, Daljit Saini, Mark Rose*, Sanjeev Saini*

Cancer Care Centers of Brevard, 1430 S.Pine St., Melbourne Florida -32901
* Sun Nuclear Corporation, 425-A Pineda Court, Melbourne, Florida

Introduction

The Cyberknife robotic radiosurgery system is capable of delivering treatment anywhere in the body with sub millimeter accuracy. Such accuracy requires strict Quality Assurance of every component of radiosurgery process. At Present CyberKnife focuses on machine specific QA. End to End tests on phantoms are performed using methods somewhat similar to Wendel-Lutz alignment methods frequently. Presently there are no specific methods available for patient specific QA. In this study we present an easy, convenient and reproducible method for performing patient specific QA using Sun Nuclear Corporation's MapCHECK Software for FILM analysis.

Method

Various Phantoms were evaluated for this study. These phantoms included the Accuray End to end Phantoms such as the Skull Phantom, the Lung Phantom and Standard Imaging's baby Blue Phantom. It was decided that the baby blue phantom provides the most ease of use to develop a generic method for developing the Patient specific QA.

The baby Blue Phantom
The Stereotactic Dose Verification Phantom or the Baby Blue Phantom is a Phantom which has thin slices of solid water ranging from 2mm to 4 cm thick slabs. The two 4.0 cm slabs are imbedded with gold markers which are used for tracking in CyberKnife QA plans. Five 0.2 cm slabs are provided with a centered pocket for one precut film. The planar size of each slab is 20 x 20 cm.
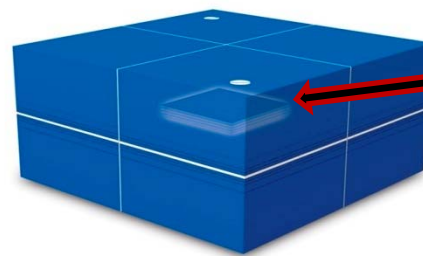
Film Pocket on thin 0.2 cm slab. The Film is kept at a distance of 5 cm from the top and bottom.
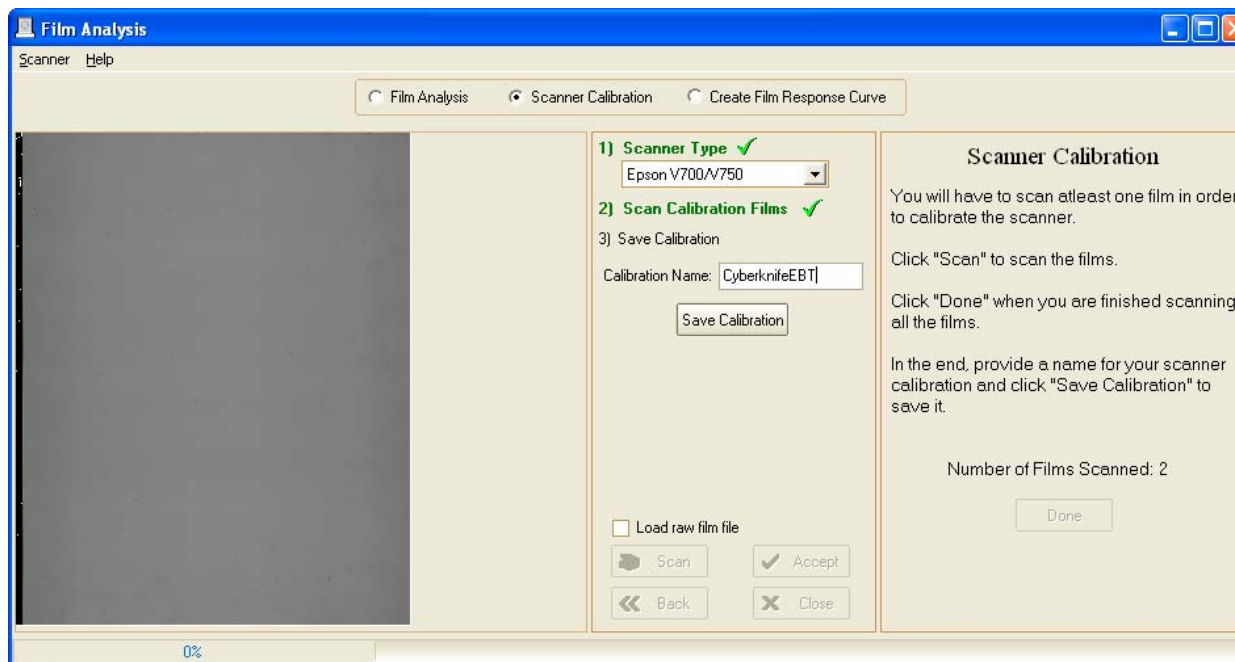
Steps

The QA is done in following steps
- Making a calibration Curve for Film
- Scanning the Baby Blue Phantom
- Scaling down the dose in Multiplan
- Overlaying the Plan on the Baby Blue Phantom
- Treating the Plan on the Baby Blue phantom
- Analyzing the film using MapCHECK Software
- Comparing it with the DICOM plan dose file.

Step 1: Making a calibration curve for the Film

Scanner Calibration: Scanner calibration is done to the scanner to remove any non-uniformity across the scanner bed. It is only done once. It requires at least one film (8x10 for V700/V750 and 14x17 form 10000XL scanner). The film should be fully irradiated. Then it is scanned using the Mapcheck film analysis software. Once the film is scanned the software will save the scanner calibration. This calibration should be selected every time when creating a film response curve (Calibration curve) or scanning the patient film.

Step 1: Making a calibration curve for the Film

Film Response Curve: The film calibration response curve can be made with the following steps
•Cut the EBT film in small 5x5 pieces or use precut films and expose each film with different doses. The EBT film can be exposed to a dose range of about 600 cGy
•The curve can have 20 maximum points so expose 20 different films with different doses. In this study we have exposed 15 films ranging from 50 cgy to 650 cgy
•The user can then scan these pieces one by one or put them together if they fit on the scanner bed. After scanning the film, the user will enter the dose delivered to the film in the software and then select the film corresponding to that dose. Once all the films are scanned, save the curve.

Cancer Care Centers of Brevard 2009
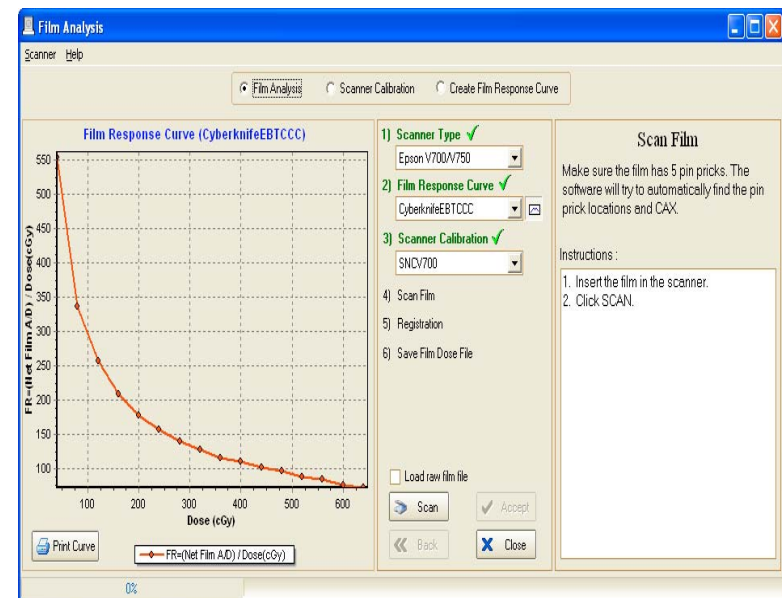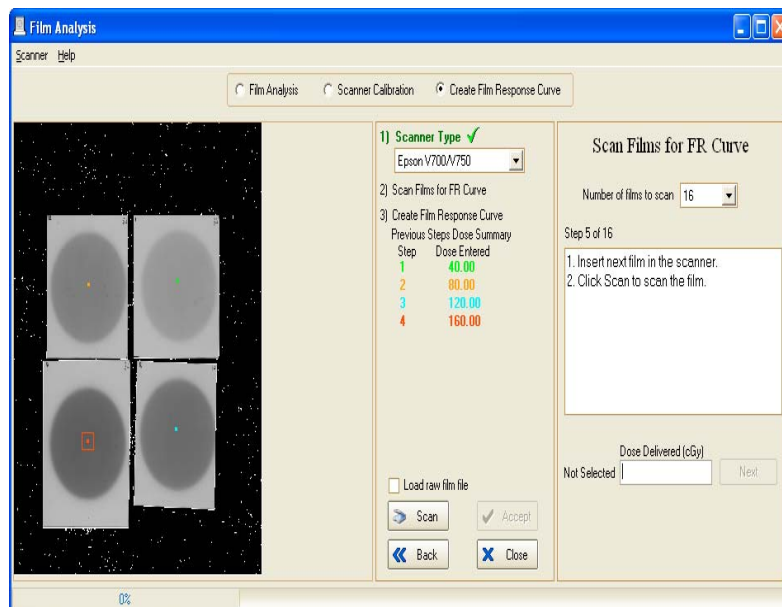
2. Scanning the Baby Blue Phantom
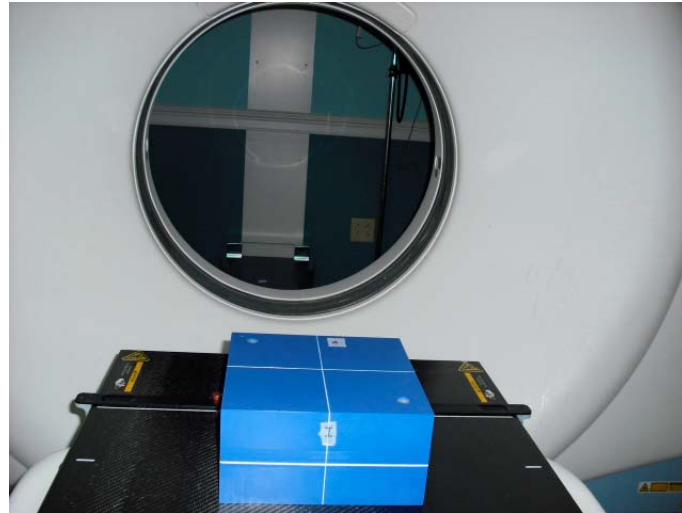
- A blank film should be inserted in the Phantom to get reproducible setup.
- All the directions on the Phantom should be properly labeled
- The scan slice thickness is 0.625 mm which is the minimum available on our scanner.
- The CT Scan should be performed with Maximum Possible MAS and KVP to get a good resolution. This also is in accordance with the scan specifications used for End to End Tests by Accuray

Cancer Care Centers of Brevard 2009

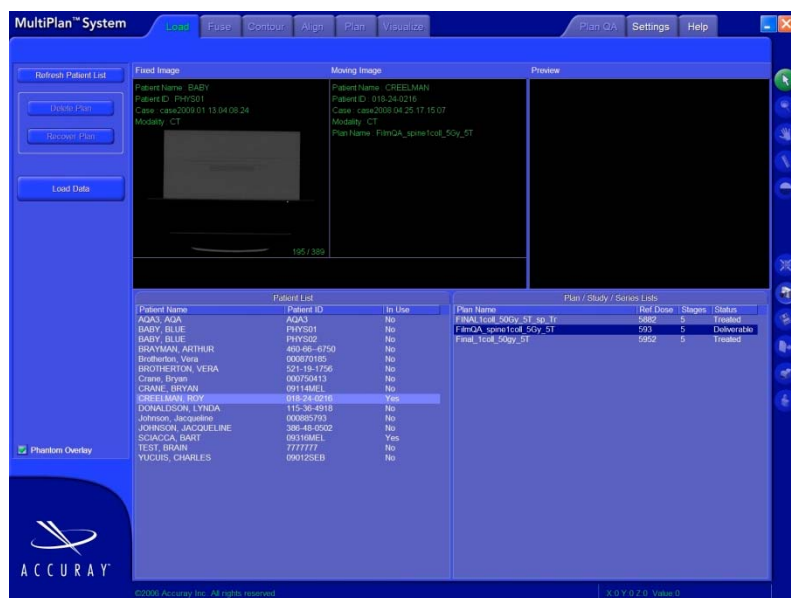# 3. Preparing a QA plan on Multiplan

- Create a copy of the plan of which QA has to be performed
- Scale down the dose. For example in this case the dose was scaled down from 5000 CGy to 500 Cgy
- Calculate it in High Resolution and save it as a deliverable Plan. Make sure you name it as QA plan to differentiate it from the actual Plan
- Make sure to note down the x,y,z coordinates of the center of the tumor to be later used in MapCHECK software
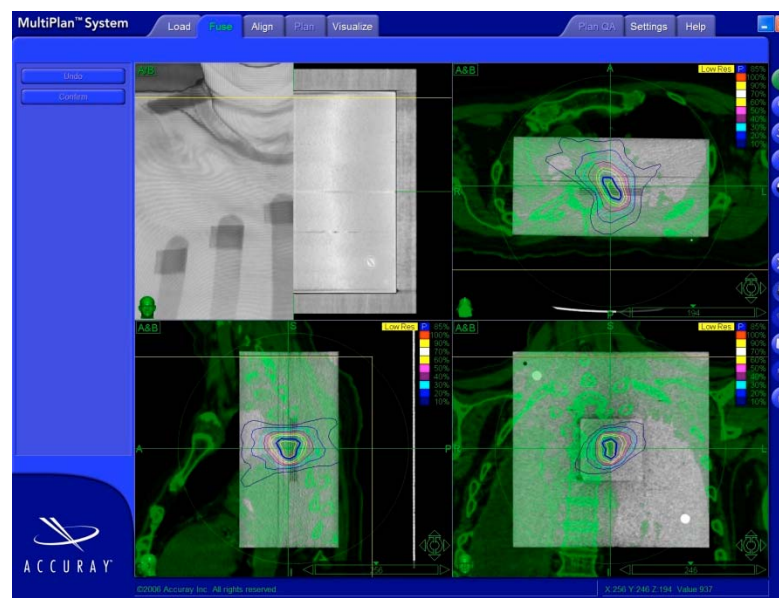
- In Load Plan screen click on Phantom Overlay.
- Select the Phantom, in this case the Baby Blue Phantom.

Cancer Care Centers of Brevard 2009
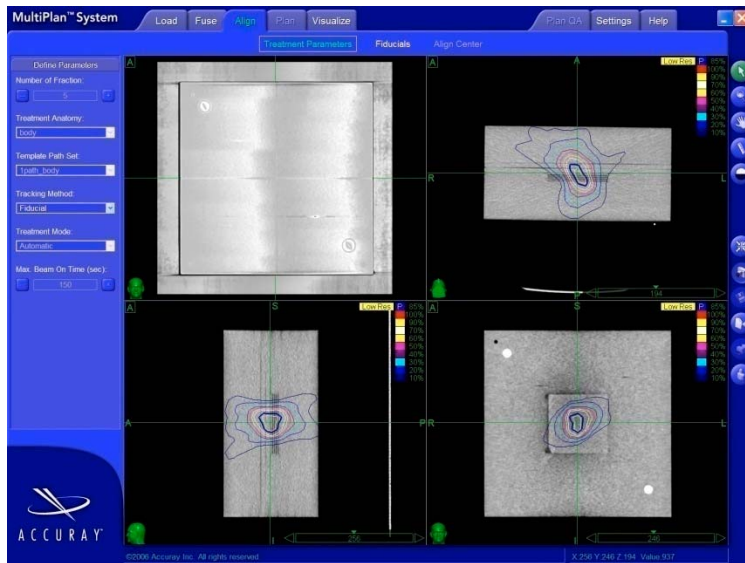
3. Preparing a QA plan on Multiplan

- Now in the Load screen select the Patient plan which we have saved earlier .

- In Fusion screen, Overlay the Plan on the center of the Phantom (center of the Film). This task is done by moving the dose plan multiple times in all views and clicking on confirm tab.

Cancer Care Centers of Brevard 2009
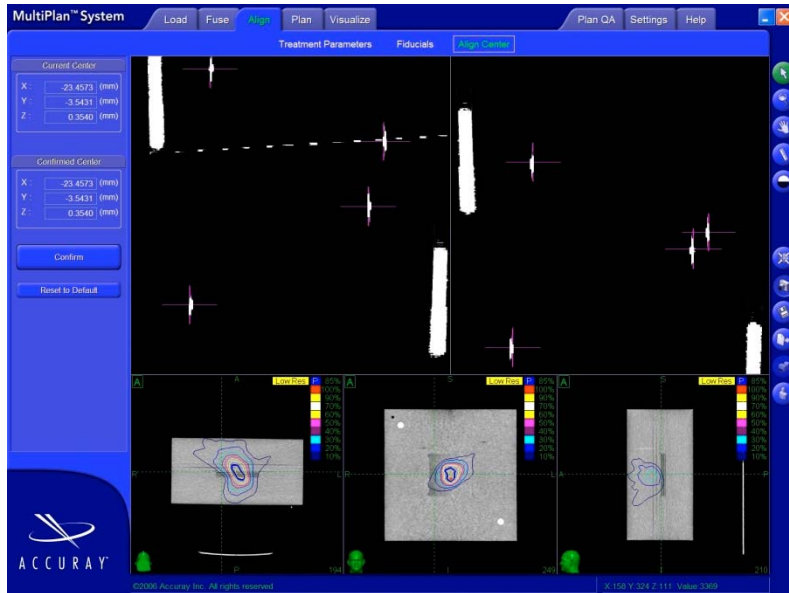
3. Preparing a QA plan on Multiplan

- In Align Tab, under treatment parameters verify that all the parameters are correct as per the plan.
- **Make sure** you select the tracking method as Fiducials.

- In Fiducial Screen identify all the four fiducials on the baby blue Phantom

3. Preparing a QA plan on Multiplan

- In Align Center screen confirm the imaging center.
- Note in this screen that the Patient CT center should be close to the Imaging center so that all the fiducials are tracked during treatment. If they are far apart the QA plan will not be successful.

- In Plan Tab calculate the plan in High resolution.
- Save the plan as deliverable. The deliverable plan will have a **phm** prefix before it to separate it from the actual treatment plan.

**Cancer Care Centers of Brevard 2009**

- Make sure that you label the right directions on the Baby Blue Phantom as well as the film.
- The EBT film is kept at a distance of 5 cm in the center of the phantom in the film pocket provided on the slab.

Cancer Care Centers of Brevard 2009

4. Scanning the film using the Mapcheck software

Scanning Patient Film: After exposing the film to patient plan on the Phantom, the film is scanned and converted to dose. In the MapCHECK Film software a manual registration is performed to identify the crosshairs. After the registration is done the Film Dose file is then saved to be further compared with the Planned dose file using MapCHECK Software.
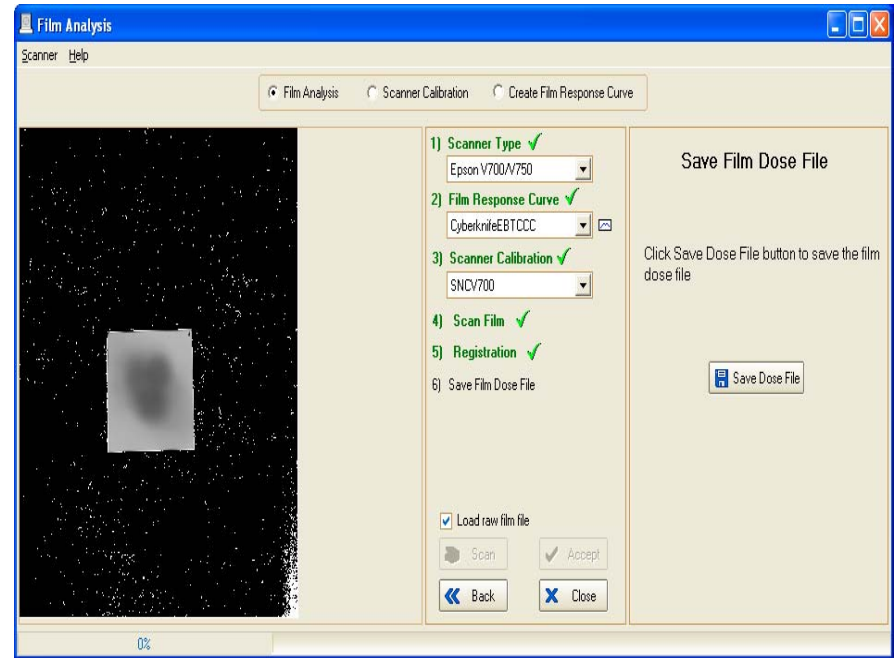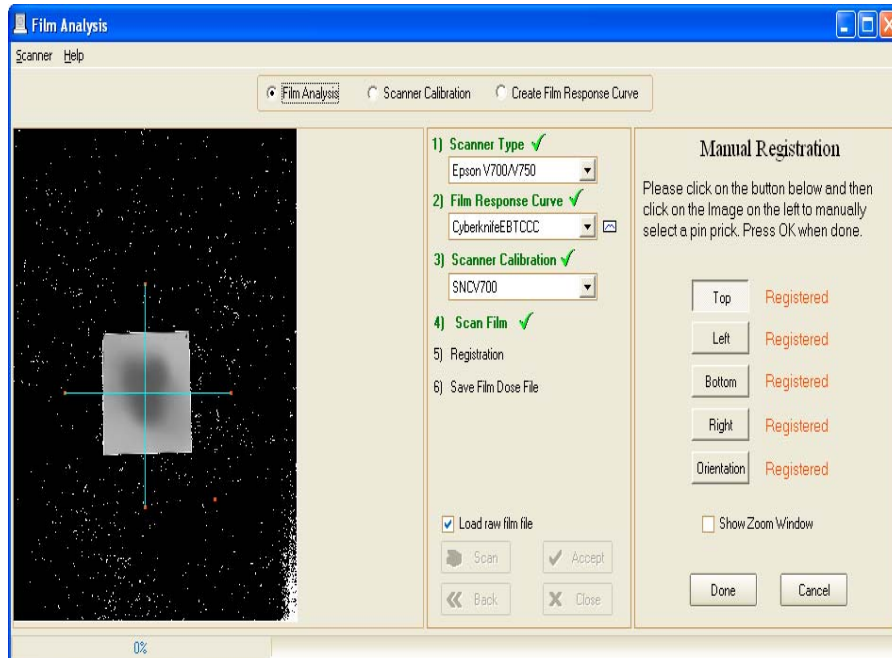

• Make Sure that the right Film response curve and scanner calibration file is chosen

5. Comparison of the film plan with the Multiplan dose file using the MapCHECK software

Film dose file comparison with Treatment Planning dose file: The screen shots in figures below show the comparison of the exposed film in the coronal Plane and the DICOM dose file from Multiplan. The mapCHECK software directly extracts central coronal plane. One has to provide the coordinates X,Y,Z of the central plane which can easily be obtained from the evaluate screen in Multiplan.

Cancer Care Centers of Brevard 2009
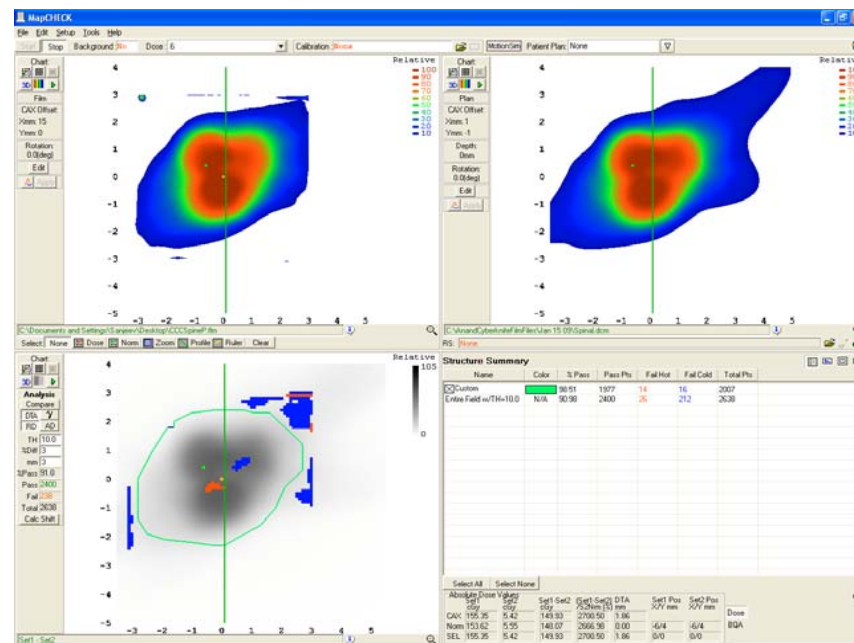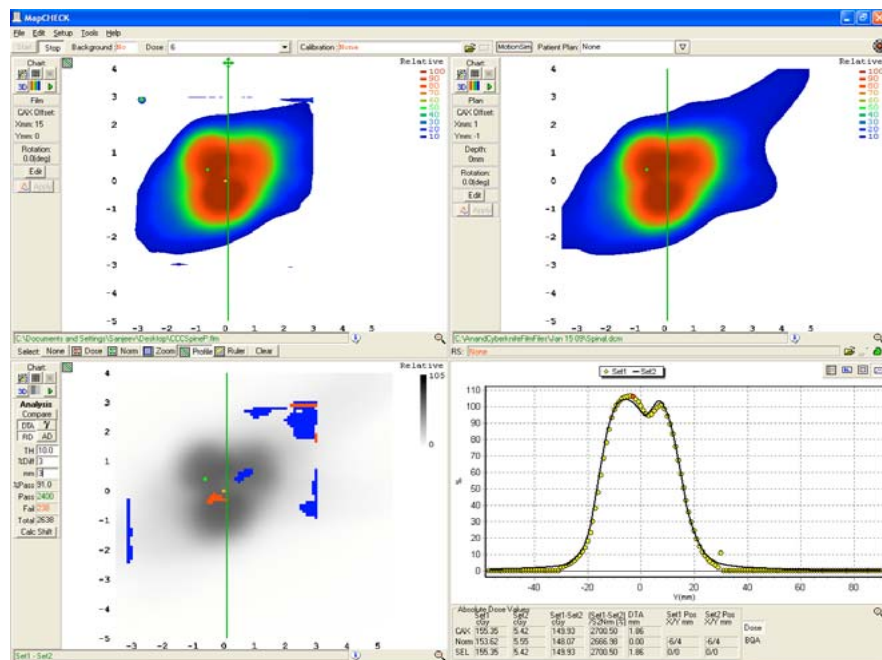
Results

1. The study provides an easy and general Method that can be used for Patient specific QA in CyberKnife.
2. The use of the Baby Blue Phantom makes the overlay of Treatment Plans accurate as compared to overlays on other phantoms.
3. The MapCHECK software allows for a very simple method for evaluating and comparing measured dose on Film to calculated dose on Multiplan.
4. Scaling down the dose makes QA fast, though it adds an additional uncertainty to the process.
5. The Measured Film dose and the Planned dose shows excellent agreement above 90% for a DTA of 3% and 3mm.

Suggestions

- The EBT film provides a convenient way for performing patient specific QA. But a diode array measurement system can make an exciting alternative to film measuring techniques.
- Also the additional uncertainty of scaling down the dose should be prevented by using a wide range of doses on different Gafchromic films or a diode array system rather than confining to smaller doses.
- At the moment since the minimum scan thickness used in planning is 0.625 mm, a minimum of 0.625 resolution is sufficient . The MapCHECK software presently can handle 1mm resolution. It is our judgment that a resolution lesser than the scan thickness may not improve accuracy