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Calibration of your Accelerator

You have to review how you calibrate your accelerator as to whether it is 100 cm to the chamber or to the water surface, for your definition of where is 1.0 cGy/mu (or any number that defines your monitor unit at some specified SSD and depth).

Generic beam data is provided and should be sufficient since field flatness is something that comes with the measured fields. Accelerators are in the directory bd.d with one directory entry per machine (start at c:\mathresoluitons Windows or /home/dc on unix). Navigate to a particular energy subfolder and review the file Calibration06 (06 here for energy 6 MV). An example file is shown below:

```
/* file type: 4 = calibration */ 4
/* file format version: */ 1
/* machine directory name */ Varian
/* energy */ 6
/* date of calibration: */ <* 22 April 2005*>
/* calibration Source Surface Distance cm: */   98.4
/* calibration field size cm: */    10.00
/* calibration depth cm: */     1.60
/* calibration dose rate (cG/mu) : */ 1.000
```

Note that the above file specifies an SAD calibration. For an SSD definition the 98.4 entry would be replaced by 100.0.

Either change the file as described below, or run program DefineMonitorUnit to accomplish the same operation.

If you need to change the file do so. On a Windows machine use something like WordPad to edit a text file. After changing this file you must run program tools.dir\ComputeCalConstant.exe. The directory tools.dir is in directory c:\mathresolutions or /home/dc where you loaded Dosimetry Check. ComputeCalConstant.exe is an ASCII program which you must run in a command prompt window.

In Windows after changing directory to mathresolutions (cd c:\mathresolutions) just type the command:
tools.dir\ComputeCalConstant.exe

In Linux and Unix it is:
tools.dir/ComputeCalConstant

You must repeat this procedure for each energy you are going to use.

Wedges

The energy response of the EPID's does not give a correct wedge factor for a physical wedge, but will give the correct slope.   As a work around, a different deconvolution kernal would have to be used for each physical wedge, with those physical wedged fields processed separately.

Integrate Each Treatment Field

Put your EPID into integration mode and save each beam integration to a separate file using a file name that you can associate with each beam in the plan. Varis/Aria will put the beam name from the plan into the file name if you select the suffix Field ID/Beam Name in the export wizard. Dosimetry Check can find the files automatically for a beam if the beam name is in the file name (after conversion below).

On the Elekta system, you must select the mode to write segment out as a separate file during integration. Then run program IviewToDicom to read in and assemble the segments for each beam into one Dicom file. Then run program ConvertEPIDImages.

For a Siemens machine, run ConvertSiemensImages (which uses the same interface described below).

In Air OCR

For Varian we are assuming that the off-axis ratio is being multiplied in by the EPID software since the flood view removes that. If not, you should measure the in air off axis ratio and store it in the proper format in the beam data directory. You will have to use a different kernel file than that specified below as the choice of whether or not to multiply in the in air OCR is made in the kernel file.

Calibration Field

Shoot an extra 10x10 cm field for known monitor units. If you don't have the exact arm Varian EPID, you will need a separate 10x10 field at each gantry angle since the EPID can shift some as the gantry rotates. The 10x10 is used both for defining the central ray and for calibation to monitor units. If you shoot all your beams at 0 gantry angle or have the exact arm, you need only one 10x10 cm field for calibration and centering. Use the letters "cal" within the beam name for calibration files so the letters "cal" appear in the integration file name. ConvertEPIDImages will then be able to automatically recognize a calibration file from one to be converted.

For IMAT, there is presently no correction for movement of the EPID during gantry rotation unless you can generate a 10x10 at each gantry angle that is integrated.

Download the Treatment Plan

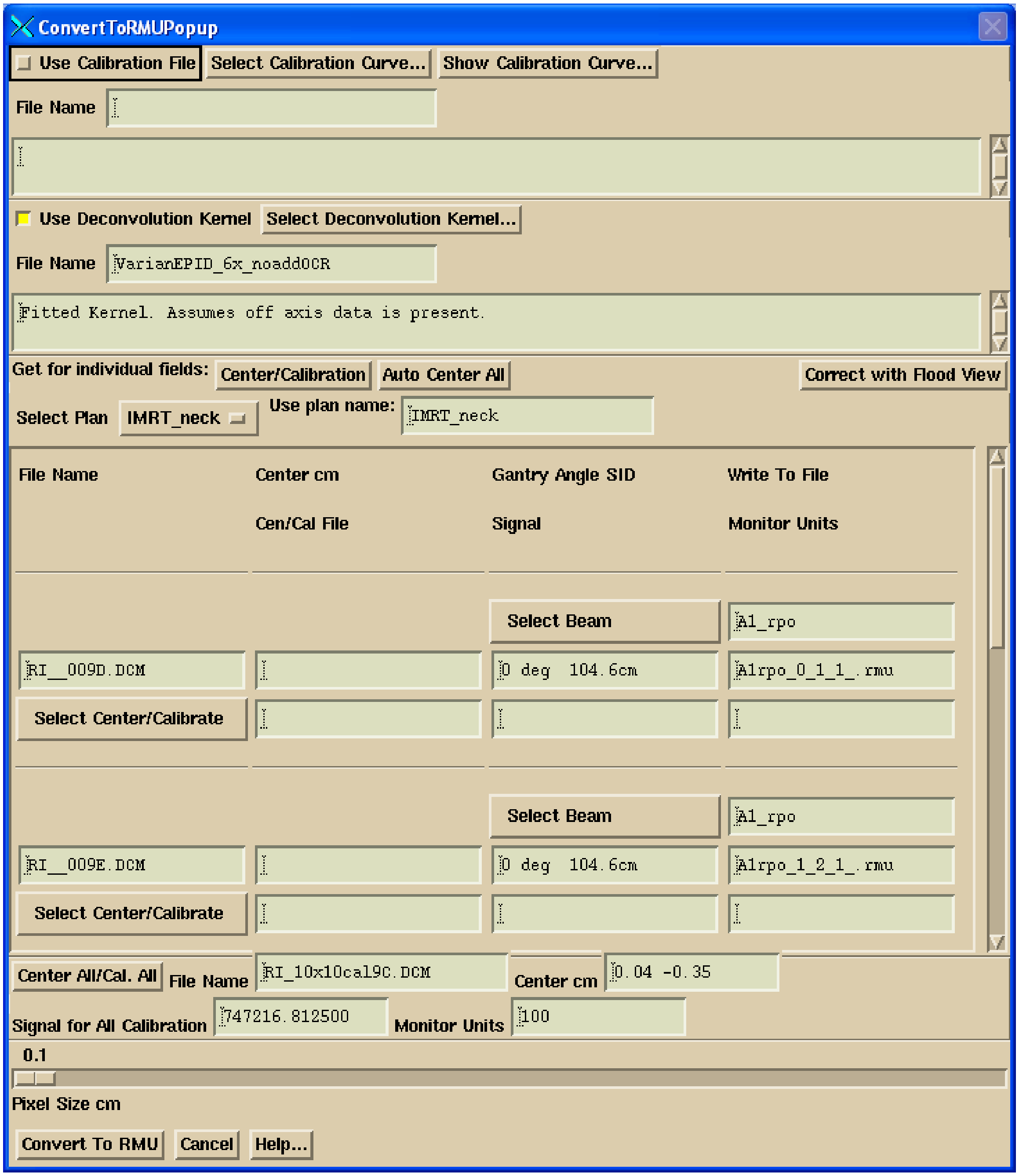
Next run program ReadDicomCheck or ReadRtogCheck to download the plan in DicomRT or RTOG format. Refer to the sections in the Dosimetry Check manual for instructions on how to use those two utilities. The Dicom RT protocol can specify which ROI is the external body skin contour. The RTOG protocol has no such method. Neither specifies CT number to density conversion. ReadDicomCheck will read its starting location for selecting files from NewDicomRTDirectory.loc file in the program resources directory.

Convert Integrated Field Files

The integrated files must be normalized to monitor units and deconvolved for the effect of the EPID. A 10x10 is used for normalization, and a kernel file is used for the deconvolution process. The kernel file VarianStd_6x_noCor is provided for converting images that have the off axis ratio already restored which will generally be the case for Varian. The options in a kernel file are to pass the off-axis-data through, to multiply in the in air off-axis-ratio data, or to first divide out the in water dmax curve before deconvolution and multiply in the in air off axis ratio data afterwards. The easiest thing to do is provide the off axis data as Varian request it but you should use in air data, not in water data, and use the kernel example here that passes it all through. However, there is little difference between in water data at dmax and in air data.

ConvertEPIDImages

Run program ConvertEPIDImages. A separate manual exist for this program on our website. Select the accelerator and energy, and then select or make a new patient entry. Hit the Convert Images button on the Read EPID Toolbar. You will get a file selection box. Select the image files you want to convert. You will then get a popup as appears below:



Calibration

The three methods of calibration are:

1. To enter a calibration curve.
2. To enter a single10x10 to calibrate and center all fields.
3. To enter a separate10x10 to calibrate and center each field.

If method 3 is not present for a beam, then method 2 is used. If method 2 is not present, then 1 is used if selected, otherwise you get an error message that the program can't convert the files. Be careful not to use an old calibration curve. Delete an old curve (in data.d\CalDCur.d) or delete the file that stores the name of the last file used (in data.d\accelerator name\Xenergy.d\EPIDcalFile) if need be.

When you select a 10x10 calibration field file, it will be displayed and a method provided to locate the central ray of the field. Use the name "cal"for your 10x10 calibration files and ConvertEPIDImages will automatically assign those files as calibration files and sort them by gantry angle.

Plan and Beam Names

You should download the plan first for the list of plans available to the patient to be listed here. Select the Plan. Then for each file to be converted, select the beam that the file is for. You can alternately type in these names.
Note the file names on the right that the converted files are written to. You can change the file names if there is some reason to do so. The files will be written to the directory under the patient's directory ->
FluenceFiles.d -> plan_name -> beam_name -> IMRT

[or -> IMAT for arc beams when running program ConvertIMATImages. In that case, you only convert the files for one beam (arc) at a time.]

If the Dicom RT label contains the beam name from the plan, this program will try to sort the files to the proper beam for you, but you must check this for each fluence file. For the Dicom export (Varian) wizard, select Field ID/Beam Name as a suffix.

In Dosimetry Check you will have the option to manually select the fluence files that belong to a beam. Just select the beam to edit from the Plan toolbar and look at the Options pull down menu on the Beam toolbar.

Adding Fluence Files

If you had to use a carriage shift with your Varian MLC, then you can add the separate integrated files in Dosimetry Check by simply selecting more than one file for a beam. Dosimetry Check will add all files found in the IMRT folder above.

Files in the IMAT folder are NOT added together. Rather each is applied at the gantry angle the image was integrated at.

Restrict Area of Fluence File to Use

Next you may want to select the Restrict Area function to reduce the EPID area from 40x30 cm to the size of the radiation field plus a very generous margin to save computation time later. You can do this in Dosimetry Check where you will have the option of applying the restriction on one beam fluence map to all of them.

Run Dosimetry Check

You have done the work. The rest is easy. Run Dosimetry Check. Select the patient and then the stacked image set. Under the Stacked Image Set pull down select Options and check if the proper external ROI is selected for the skin contour. Under Density you must select a CT number to density conversion file. Select the Marconi curve, but you should eventually make your own. However, dose is not sensitive to this conversion.

Under Applications select Dosimetry Check. Select the Plan. Because this system is multi-plan, you have to specify where the plan is to be displayed. On the Display pull down you can select a default screen for a transverse, coronal, and sagittal image through isocenter or the center of an ROI. You can always go under the Display pulldown on the Plan toolbar to select to display in the current frame or screen. You can make reformatted images on the main tool bar under the Stacked Image Set pull down. Or you may use any of the images displayed for the stacked image set.

Assoicate Beams with the Integrated Beam Files

The program will attempt to find the files for the beams by looking in the path:

patient_name -> FluenceFiles.d -> plan_name -> beam_name -> IMRT

If more than one file is found for a beam (in IMRT), the fields are added. You should review the images of the beam files that are displayed for correctness. The files used are part of the labeling on the images that are displayed. Rather, the label assigned above is the file name by default. You can change the label in the popup shown above. Each beam will make a copy of the integrated image dose file. Further changes in the directory where the integrated fields were deposited will have no effect. Upon retrieval of a plan, the program will detect if you have put new files into the FluenceFiles.d path and give you the opportunity to incorporate the newer fluence files.

For IMAT, the fields are not added, rather each is applied at the gantry angle measured.

Manually select fluence files

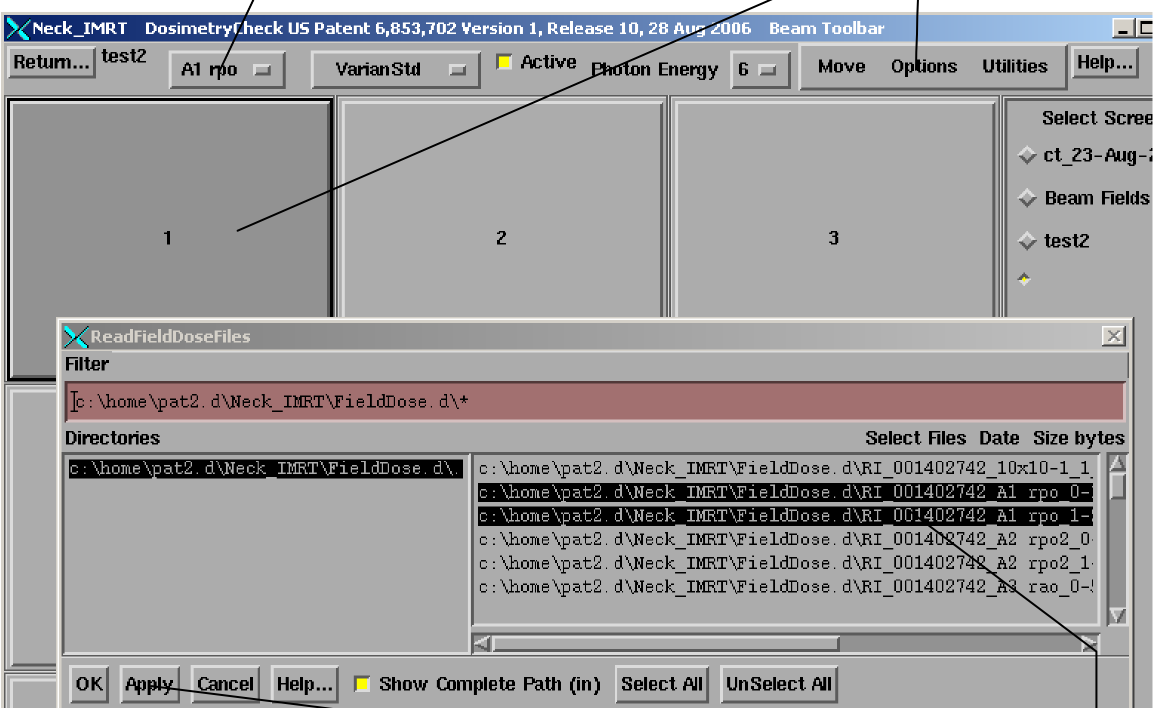
You can also manually select the fluence files for a beam and will have to do so if it was necessary to redo the integration files for some reason. Under the Plans toolbar retrieve the plan (thereafter select this plan to edit). On the Plan toolbar select the first beam to edit. Under Options on the beam toolbar, select “Read Fluence rmu files” if you want the files added together. For IMAT select instead “Read IMAT rmu files”. A screen will be created to hold the images of the beam files or you can create a screen. Select the file where you stored the converted field image above and hit the Apply button. You can select more than one file if they need to be added together (Read Fluence) or for IMAT the files that will simulate the arc. The program will display the image, then increment the beam tool bar to the next beam. [Note you can also go directly to any beam's toolbar using the option menu at the left on the current beam toolbar.] Continue to hit the Apply button being careful to select the beam file for the current beam shown on the beam toolbar. On the last beam just hit the OK button. See below for a picture of the user interface involved.

Reading Fluence Files into the Beams Manually (not IMAT)

1 Select the first beam to be edited from the plan toolbar. The other beams can be selected from the option menu here which shows the current beam selected.

2 The program will put the fluence image in a screen and frame created for this purpose.

3 Read Fluence images is selected right here under the Options pull down. They are the files stored in the path staring at FluenceFiles.d in the patient’s directory.



4 Select the field or fields that belong to the beam shown on the option menu on the beam tool bar (step 1 above). When you hit Apply or Done in step 5, a COPY is made and stored elsewhere under the beam’s directory.

5 Then hit the apply button. 3 things will happen (1) the fields are read and added. (2) the option menu will advance to the next beam (see step 1) and (3) the image will be displayed. Just repeat steps 4 and 5. Last time hit the OK button, or if you forget, hit the Cancel button when done.

Create Beams Manually

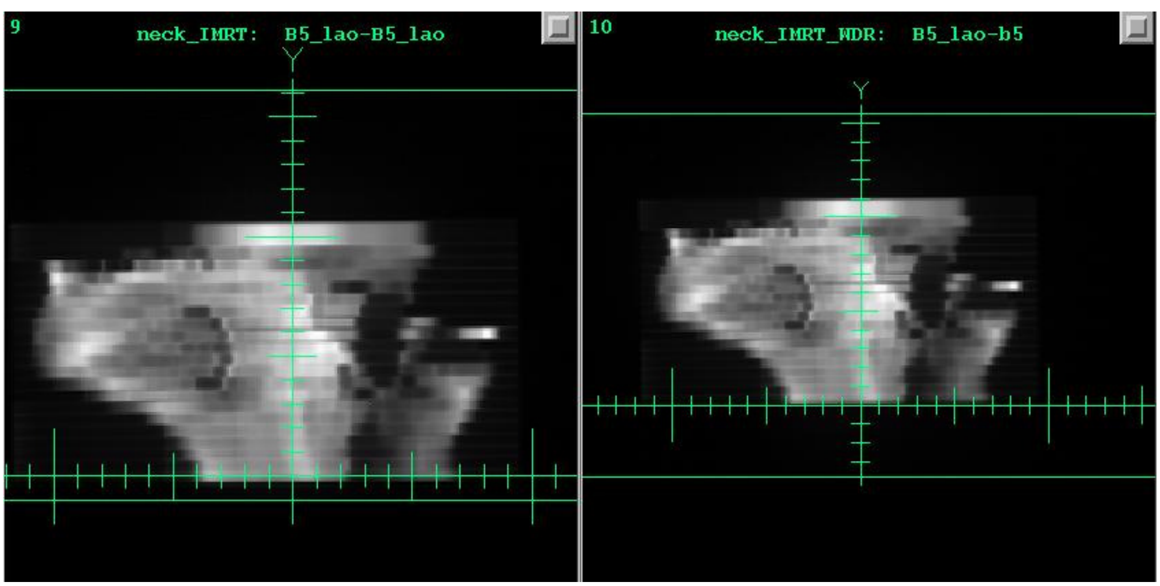
If you did not get the beam positions with the RTOG or Dicom RT files, you will have to create each beam. The successive beams will start with the isocenter of the prior beam. You will have to type in the gantry, collimator, and couch angle under the Move pulldown on the beam toolbar. However, because the EPID does not rotate with the collimator, upon selection of a beam file, the collimator angle will be set to zero.

Be sure the right energy is selected for each beam. That should come up correctly with RTOG and Dicom RT.

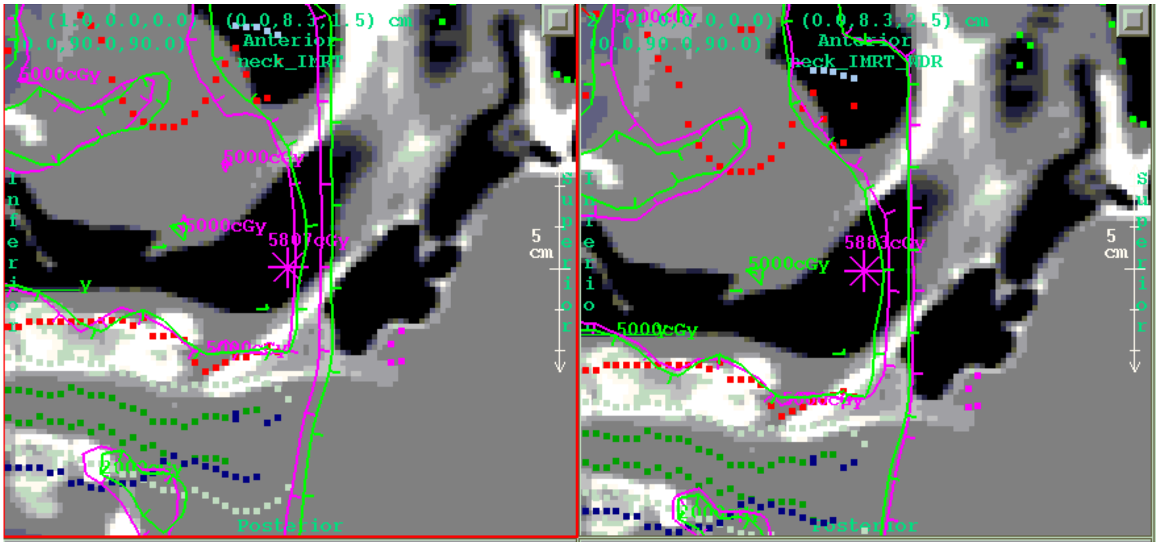
Pit Falls to Watch For

Leave enough margin around the fields.

You need to leave a generous margin around the fields. The margin is needed to model the penumbra since the penumbra intensity comes from the measured field, not a model. Also, the tail does produce dose within the field as the below images demonstrate. On the left is a beam (one of seven) with less margin left then that on the right.



Below on the left is part of the dose distribution using the beam on the left (one of seven, all with less margin). On the right is the plan with more margin. The hot spot dose went from 5807 cGy on the left to 5883 cGy on the right (for 28 fractions), a 1.3% difference. Notice the 2000 cGy line on the right (magenta) agrees better with the planning system isodose line of 2000 cGy (green) .



Associate the correct measured beam fluence file with the correct beam.

If you associate the wrong file with a beam, you obviously won't get the right dose. In the above images of two integrated beams, the label shows the plan name, followed by the beam name, followed by the label names assigned for each image used. These images are displayed as you do the association for you to check. All images are shown in beam's eye view system, x axis to your right, y up. The beam's eye view system rotates with the collimator. But the collimator angle will be reset to zero because the EPID does not rotate with the collimator.

Compare Isodoses

Return to the plan toolbar from the beam toolbar. Under Evaluate select Compare 2D Dose if you got a 3D dose matrix from the planning system. Make a frame current where the plan is being displayed on a 2d image. On the top of the compare tool select what you want to see among dose from Dosimetry Check, foreign dose (from the planning system), and dose difference. Note only one thing can be tinted however. Type in a dose value and hit the enter key. Hit the Display in Current Frame button at the bottom of the popup.

If you did not get a 3D dose matrix, then under Evalute select Display Dose in Current Frame and then select 2D Isodose Lines. In this case use the same image planes used with the plan and reproduce the same isodose levels for comparison of hard copy.

Specific Points

To calculate the dose to specific points, return to the main toolbar, go under the Stacked Image Set pulldown to Options, and then select Points. Locate the points with the mouse on images of the stacked images set. Return to Evaluate under the plan toolbar and select

Point Doses. On the point dose toolbar, select display, print, or file points. Compare the dose to the point for what the planning system computed. Note here you can also locate an isocenter point by specifying the coordinates in beam's eye view, which would be at (0,0,0).

Gamma Analysis

Notice the gamma method under the Evalute pull down. It operates similar to the Compare 2D doses tool. There is a gamma volume histogram available also. You have to specify the dose that the percent is of.

Dose Volume Histograms

Return to the Plans Toolbar (one above the Plan Toolbar) and select dose volume histogram. Select the plan and ROI's that you want a dose volume histrogram for. The dose volume histogram computed from the treatment planning system's dose matrix will be shown as a dotted line. The program generates points a random and computes and displays the curve periodically. Either hit the stop button when the curves settle down or the program will eventually stop on its own.

Multiple Fractions

If you downloaded the dose for multiple fractions, type in the number of fractions in the text field provided on the Plan Toolbar.

Hard Copy

To get a hard copy of any image displayed by the program on the main window or any popup, click the mouse on the image and then hit the Print Screen button or the P key on your key board. Hit the S key to capture the entire application window.

EPID Deconvolution Kernel

To test if you need to fit a deconvolution kernel, look at the dose at dmax for a small and a large field, such as 5x5 cm and 20x20 cm field size. The EPID point spread kernel determines the field size response of the EPID. If the present kernel does not match your EPID, you must fit one. See the manual for instructions.

Percent Depth Dose

The pencil beam dose kernel is derived from measured data. If the depth dose does not agree with your machine, you will have to use your own measured data. See the manual section on beam data.