User Guide for Varian Medical Systems BrachyVision^{TM} Algorithm Testing

Contents

I Introduction

The American Association of Physicists in Medicine (AAPM) Task Group 186 report[1] provides general guidance for early adopters of model-based dose calculation algorithms (MBDCAs) for brachytherapy (BT) treatment planning. The report's aim is to facilitate uniformity of clinical practice. Among its recommendations is a two-level approach to commissioning MBDCAs embedded in BT treatment planning systems (TPSs) insofar as specific tasks relating to the dose calculation algorithm are concerned. In commissioning level 1, the clinical physicist should assess agreement of MBDCA TPS-derived absolute dose or dose rate with the dose or dose rate obtained in the TPS using AAPM-recommended consensus TG-43 dosimetry parameters for a given BT source model. In commissioning level 2, the physicist should compare 3D dose distributions calculated with the MBDCA-based TPS for specific virtual phantoms mimicking clinical scenarios against benchmark dose distributions derived independently from the same phantom geometries.

The AAPM Working Group on Dose Calculation Algorithms in Brachytherapy (WG-DCAB)[2] was created to facilitate implementation of the recommendations for MBDCA commissioning made in the TG-186 report. One of its charges is to develop a small number of prototypical virtual phantoms and corresponding benchmark dose distributions for use in level 1 and 2 commissioning of high dose rate (HDR) Ir-192 BT sources. These sources can be dealt with collectively by virtue of their similar photon emission properties, and therefore the WG-DCAB has designed a generic HDR Ir-192 virtual source for the express purpose of MBDCA commissioning[3]. At the present time, the generic Ir-192 source model has been implemented by two MBDCA-based TPS vendors and hence is available to test the commissioning process described in the TG-186 report. Four treatment plans using virtual phantom geometries, designated Test Cases 1 - 4, have also been created by the WG for commissioning purposes and are described below.

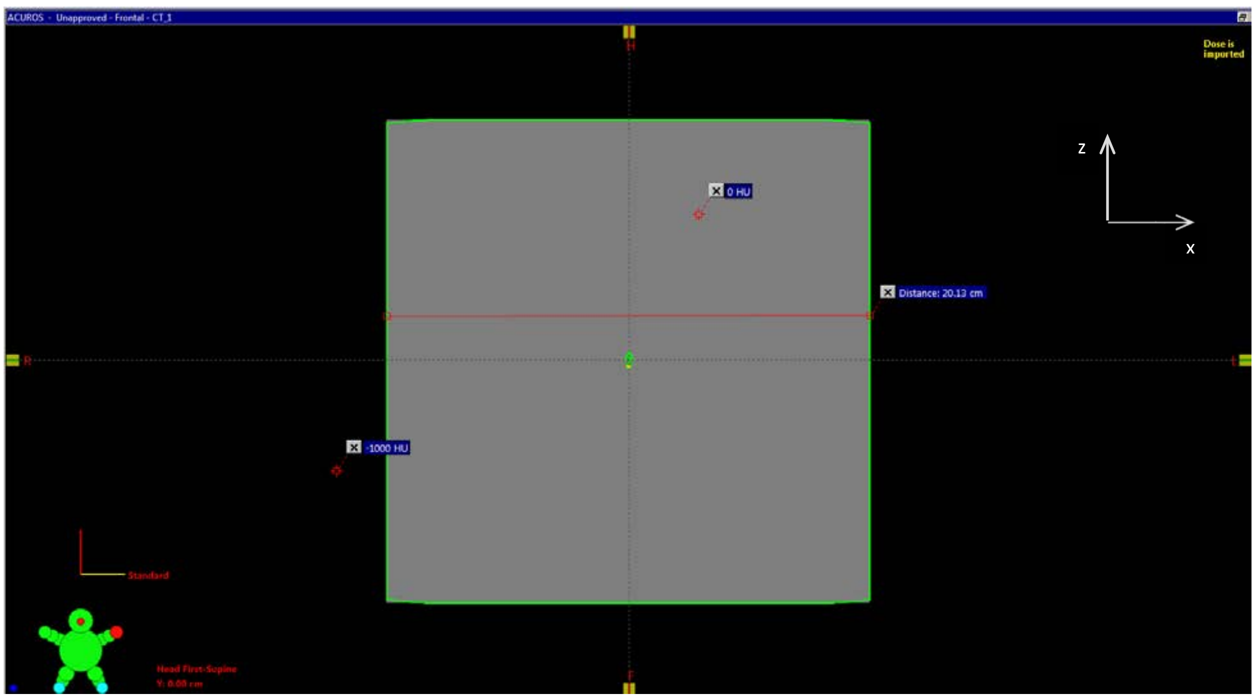
Test cases 1 - 4, which have been prepared by the WG-DCAB, are based on a voxelized computational model of a homogeneous water cube (20.1 cm side) set inside either a water or an air cube (51.1 cm side), represented as a CT DICOM image series. Both cubes have a common center located at $(x, y, z) = (0, 0, 0)$ cm and their sides are parallel. The dimensions, in-plane resolution, and number of images were chosen so that 511×511×511 cubic voxels $(1\ \text{mm})^3$ fill the space. The patient coordinate system origin, as defined in the Image Position Patient (0020, 0032) and Image Orientation Patient (0020, 0037) DICOM tags, coincides with the cube centers which facilitates calculations and precludes comparison bias, i.e., the center voxel indices are (255, 255, 255) with the ordering [0:510]. An odd number of voxels was chosen so that the center of a voxel coincides with the geometrical center of the phantom. The four test cases are summarized in Table 1.

The following descriptions might slightly deviate for different versions of BrachyVision™.

Table 1: Test case geometries for Acuros BV algorithm testing

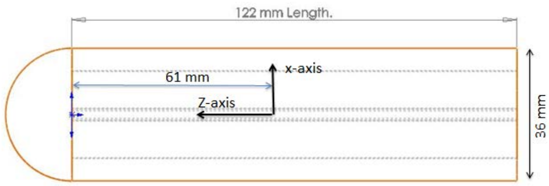
Test Case	Inner cube material ‘Cube’	Outer cube material ‘BgBOX’	Ir-192 source center location	Ir-192 source orientation	Applicator
1 – Patient ID WGMBDCA_1_IIA	H_2O	H_2O	(0, 0, 0) cm	+z	none
2 – Patient ID WGMBDCA_2_IIB	H_2O	air	(0, 0, 0) cm	+z	none
3 – Patient ID WGMBDCA_3_IIC	H_2O	air	(7, 0, 0) cm	+z	none
4 – Patient ID WGMBDCA_1_III	H_2O	air	(0, 0 ,0) cm	+z	Generic WG Applicator

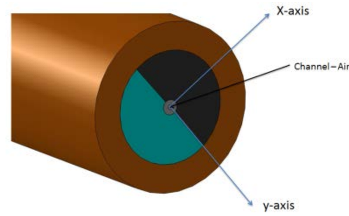
The geometry for Test Case 2 is depicted in the figure below as an example.



The geometry for Test Case 2 consists of a generic Ir-192 source located at coordinates (7, 0, 0) cm within a $(20.1\ cm)^3$ water-filled cube (‘Cube’, gray) embedded in a $(50.1\ cm)^3$ air-filled box (‘BgBOX’, black).

The applicator in Test case 4, is also a generic, virtual shielded cylinder prepared by the WG-DCAB for the purpose of MBDCA commissioning. Its basic features are illustrated in the following figure.





(a) (b)

PMMA shielded applicator (a) Dimensions and the origin of coordinates. (b) The black portion is a tungsten shield and the blue portion represents air.

Varian Medical Systems (Palo Alto, CA) has implemented the WG-DCAB Ir-192 source and applicator in v.15 of their BrachyVision™ planning system which incorporates the Acuros®BV algorithm which is denoted as Acuros BV in this document. Acuros BV is a grid-based Boltzmann transport equation solver developed by Transpire Inc. (Gig Harbor, WA) and optimized for use as a licensable module of BrachyVision versions 8.9 and higher, as well as external beam radiation therapy (Acuros XB in Eclipse). Information on the implementation of the Acuros BV algorithm for brachytherapy can be found in the reference guide available from the vendor.[4] Dosimetric benchmarking studies are also available in the literature.[5–9] The present guide has been prepared for experienced BrachyVision users participating in testing the TG-186 commissioning process for the Acuros BV algorithm and the WG-DCAB HDR Ir-192 virtual source.

In overview, the testing process involves downloading a Test Case treatment plan and an associated reference dose distribution and importing them into BrachyVision (Sec. II), locally calculating a dose distribution using Acuros BV (Sec. III), comparing the locally calculated and reference dose distributions (Sec. IV), and finally reporting the results of the dose comparison (Sec. V). As a "sanity check", a second reference dose distribution generated by the WG-DCAB using the Acuros BV algorithm has been made available in the Test Case repository. Comparison of this latter reference dose distribution with the locally calculated one should not any yield dose differences.

II Test Case Import

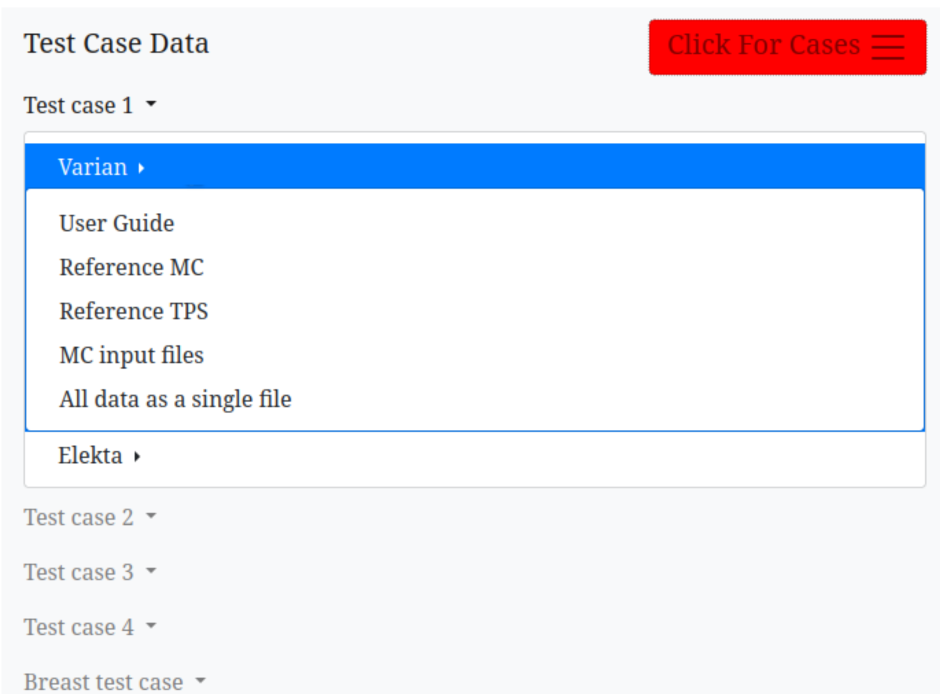
A. Accessing the Test Case Repository

Data for test cases 1 - 4 are web-accessible at https://doi.org/10.52519/00005 .

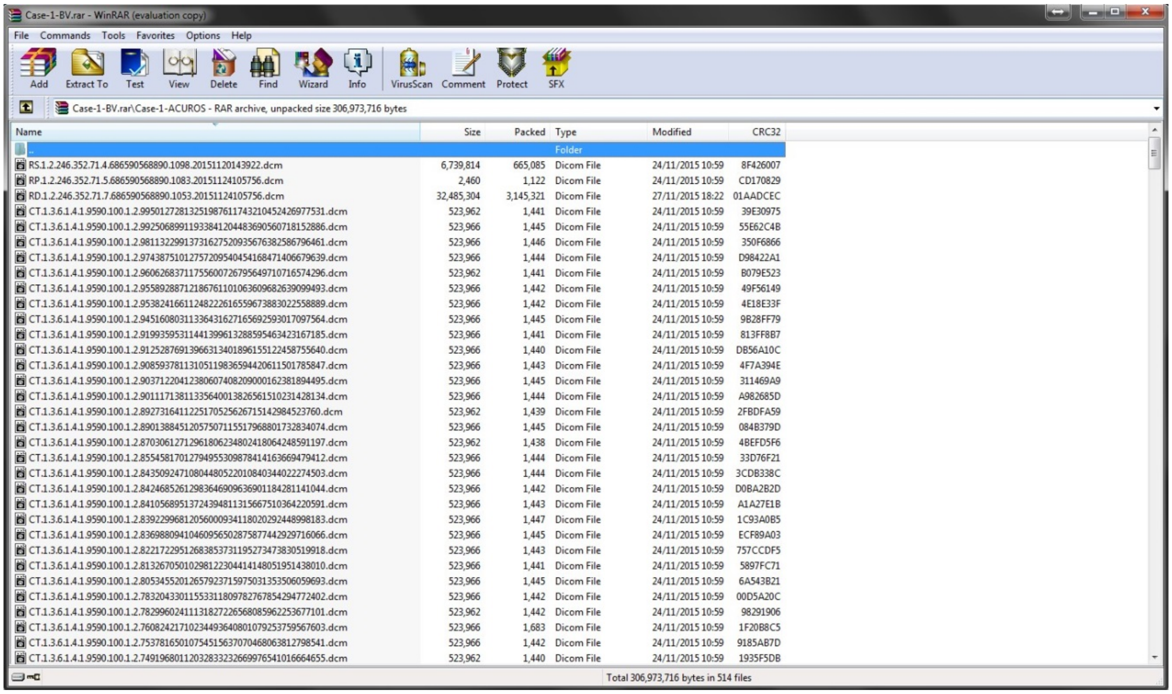
The main page contains links to Reference Data generated using the Monte Carlo code MCNP6, and to TPS-specific data for Elekta and Varian users for each Test Case under the tab “Click for Cases”.

B. Downloading a Test Case

Select a test case by navigating to the Case of interest. This will open a download dialogue box. Save the associated .zip file to the BrachyVision workstation.



Each test case .zip file contains 517 DICOM files including 511 virtual CT slices of a test phantom, a 3D reference radiotherapy dose (RD) matrix calculated using MCNP6 Monte Carlo simulation, a radiotherapy plan (RP), and a radiotherapy structure set (RS).



Extract all files from the test case .zip folder to a local folder on the BrachyVision workstation.

The contents of the zip folder will produce the following directory structure:

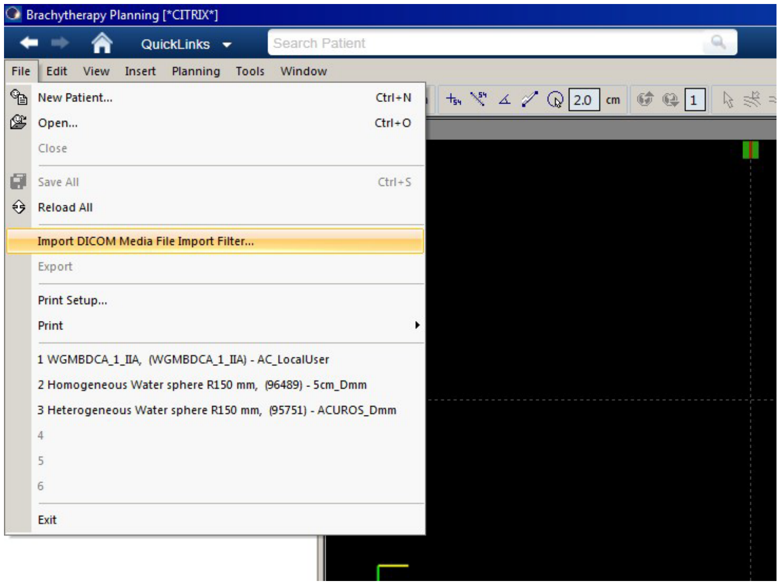
\Case-1-ACUROS (Contains the CT data, Structure Sets, Acuros BV plan and (pre-calculated) Acuros BV dose grid)

\ Case-1-MCNP6 (Contains the CT data, Structure Sets, MCNP6 plan and MCNP6 dose grid used as the primary reference)

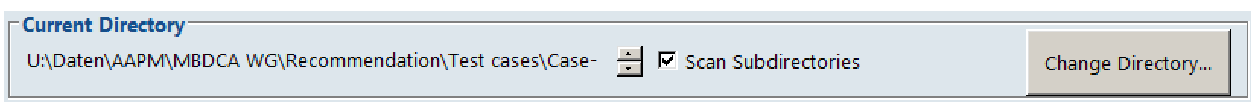
C. Importing a Test Case into BrachyVision

Note: The following steps use Test Case 1 to illustrate the case import process. The same import process is used for all test cases.

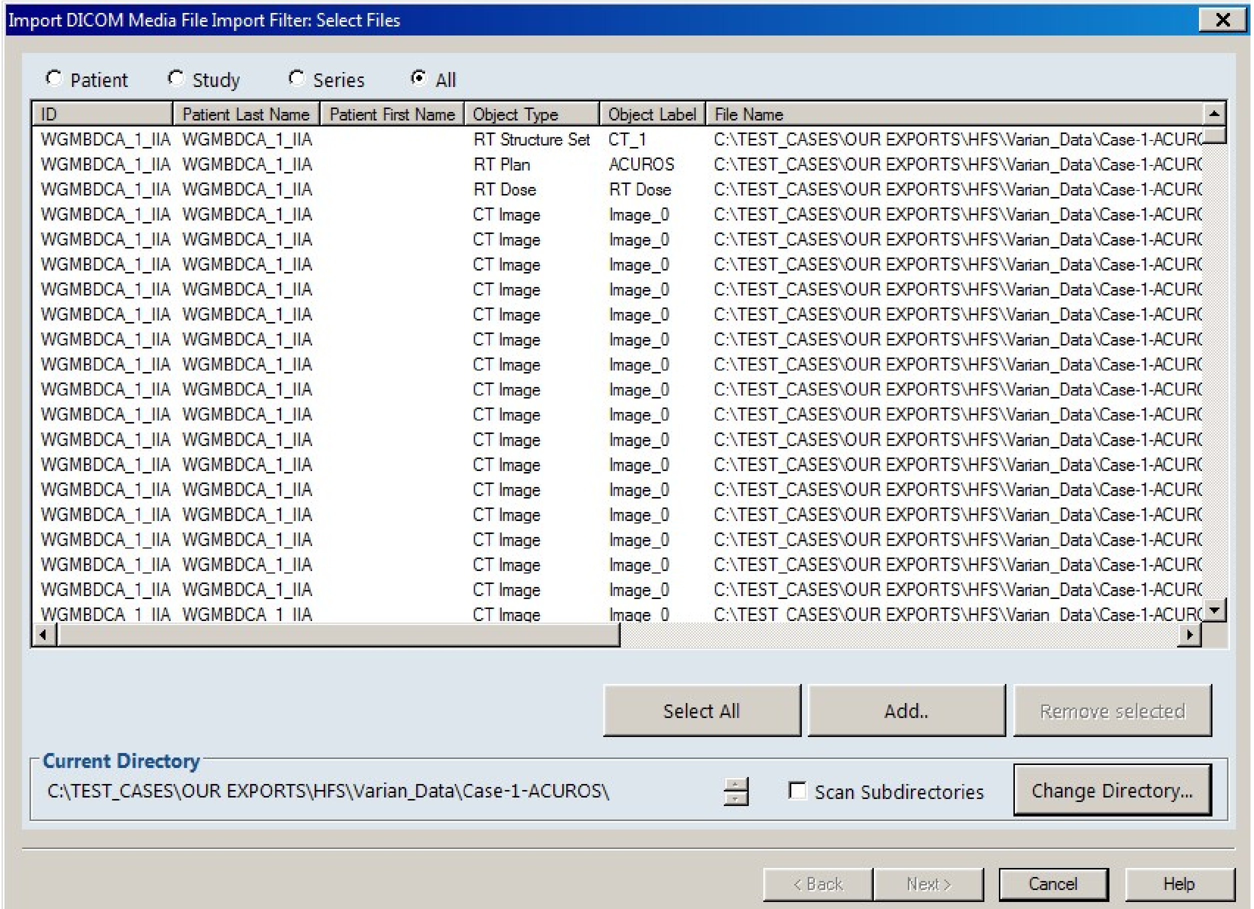
- In BrachyVision click'File → Import DICOM Media File Import Filter…'.



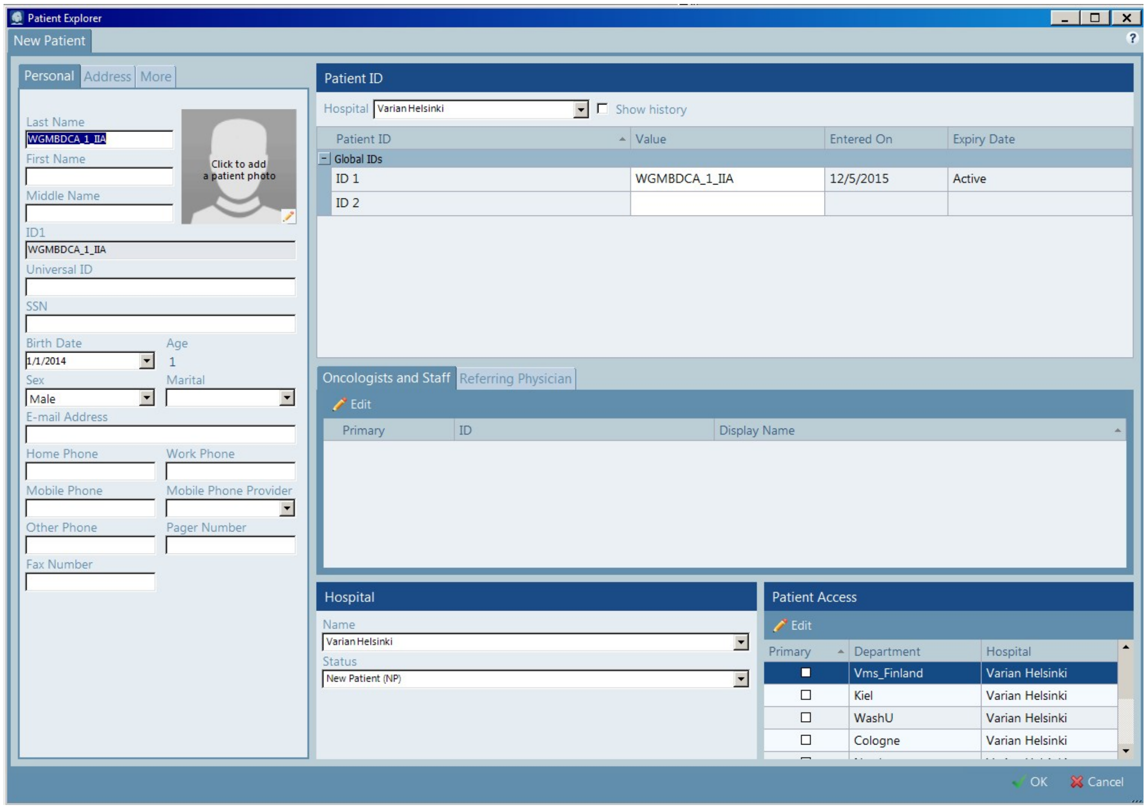
- The import of the test case will occur in two steps, firstly importing the pre-calculated Acuros BV plan & dose and then importing the reference MCNP6 plan & dose.
- Click the [Change Directory...] button and browse to the folder containing the unzipped test case, '…\Case-1-ACUROS\'. Enter the folder and click [Open]. Be sure to have the 'Scan Subdirectoires' checkbox activated.



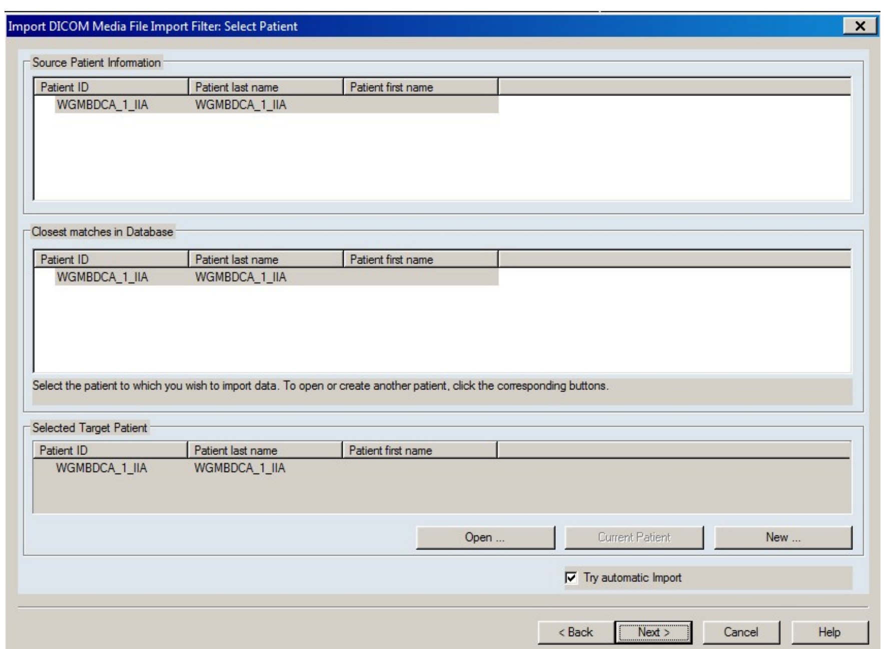
- The system will display a list of CT Image data, RT Plan, RT Structure Set, and RT Dose.



- Click the Select All button and the Next > button gets activated. Click the 'Next>' button and the system will read and validate the data ready for import.
- Then the 'Log Details' window appears with a message: "DVH import is not supported - histogram(s) will be skipped". Click Yes to continue.
- When the import window appears, select the New ... button. The Patient Information will automatically populate the fields (as shown below).

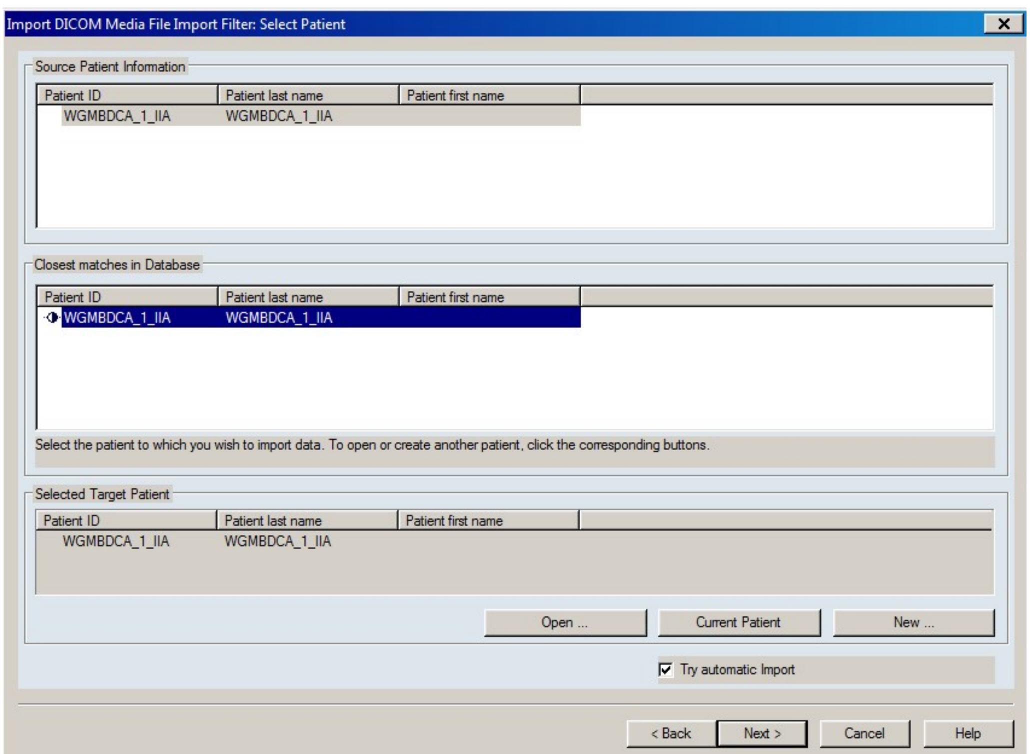


- Click the  button to create the new patient.
- The import window appears again with the WGMBDCA_1_II patient created.



- Click  to import the new patient data.
- The imported plan opens when the import is complete.

- Click 'File → Import DICOM Media File Import Filter…' again and select the folder containing the unzipped test case with the MCNP6 data files, '…\Case-1-MCNP6\'. Enter the folder and click Open.
- The system will display again a list of CT Image data, RT Plan, RT Structure Set, and RT Dose.
- Click the Select All button and the Next > button gets activated. Click the 'Next>' button and the system will read and validate the data ready for import.
- The same 'Log Details' window appears with the message: "DVH import is not supported - histogram(s) will be skipped". Click Yes to continue.
- The system will attempt to match the patient details with an existing patient already in the BrachyVision database. Check the correct patient has been identified, in this case ID='WGMBDCA_ 1_IIA'.
- *If the system has not identified the correct patient, click the* Open ... *button and then the* Search *button to browse the database for the correct patient. Click* OK *to return to the 'Import DICOM Media File Import Filter: Select Patient' window.*
- Click the Next > button to start the import of the MCNP6 data.

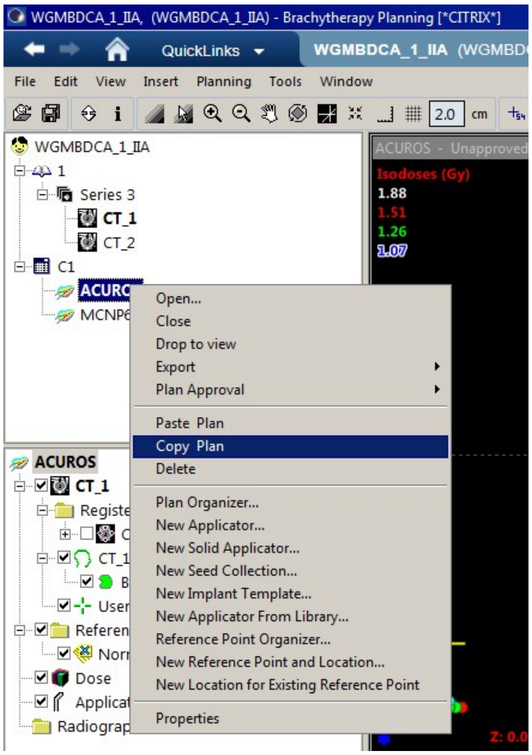


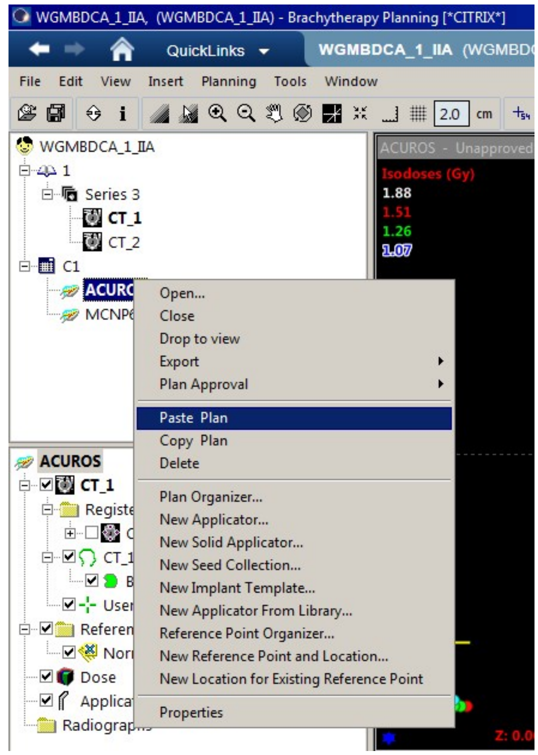
- The plan opens when the import is complete with the two datasets loaded.

The data for Test Case 1 have been imported.

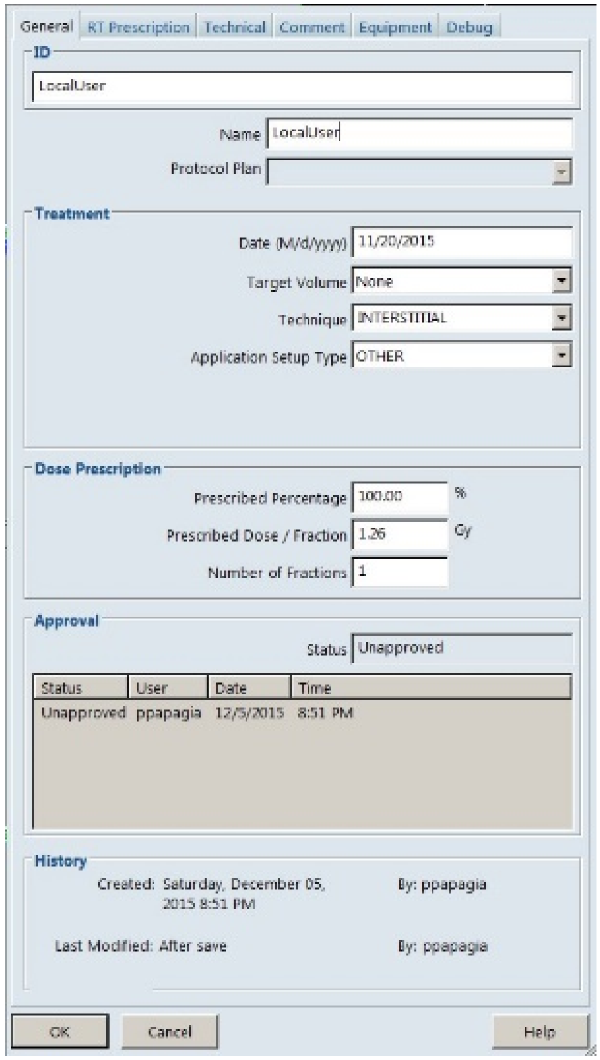
A local working copy of the Acuros BV plan will now be created for the local user to calculate dose which will be then used for comparison with the reference MCNP6 dose.

- Select the 'ACUROS' plan, right-click on it and select the 'Copy Plan' option.
- Select the 'ACUROS' plan, right-click on it and select the 'Paste Plan' option.





- The 'Plan Properties' window opens.
- Enter 'LocalUser' in the ID field, 'LocalUser' in the Name field and Click OK.

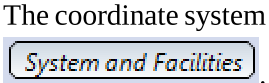


The import process and local plan creation is complete.

Test Case 2, 3 and 4 can be imported into the BrachyVision system by following the same procedure above.

D. BrachyVision coordinates

BrachyVision supports standard, IEC-61217 and user-defined coordinate systems as illustrated below. This user-guide adopted the standard coordinate system. Therefore, systems using the IEC-61217 coordinate system will display swapped Y and Z axes with inverted Z axis, in relation to the standard coordinate system, as illustrated along this user-guide. **Note the user should not change the configuration of BrachyVision, but be aware of the adopted coordinate system.**

The coordinate system can be checked in Aria/BrachyVision in Administration -> RT Administartion. Press 

. In the system Properties the current Planning Coordinate System is shown.


Planning Coordinate System
Coordinate System
Patient support coordinate system: Standard
Patient support coordinate system: IEC 61217
Patient support coordinate system: User-defined
Patient coordinate system: DICOM
Help
Select the way coordinates are displayed in Treatment Planning applications. In the patient-based system axes are defined by the patient DICOM orientation.
Z
X
Y

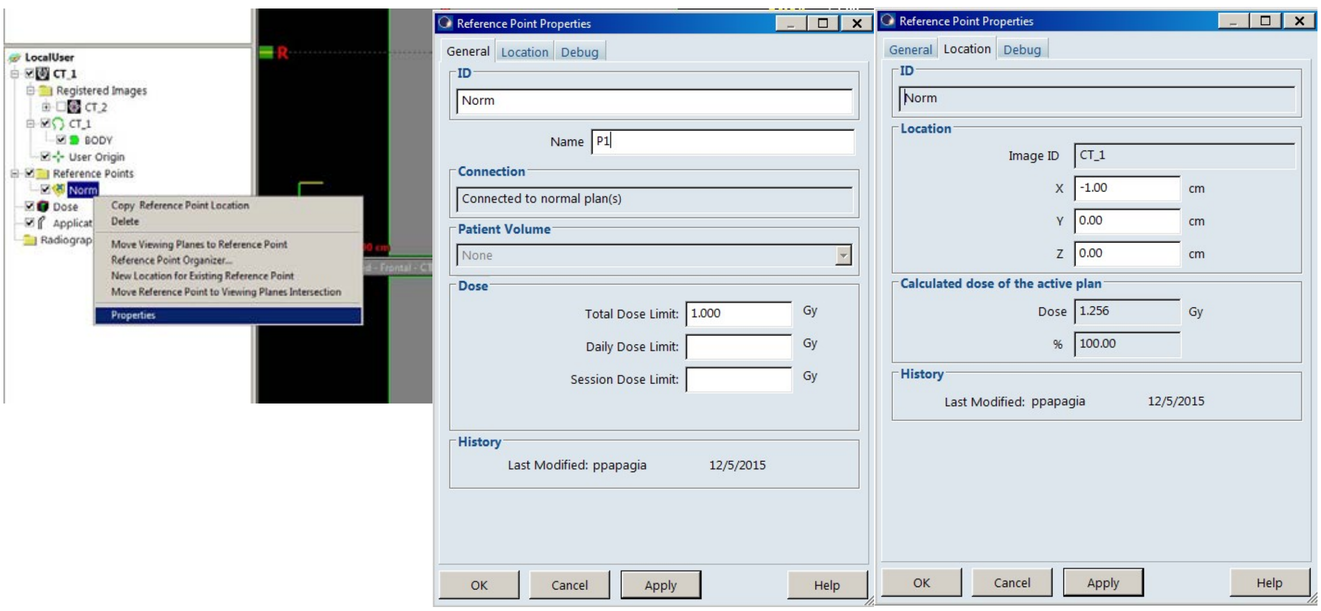

Planning Coordinate System
Coordinate System
Patient support coordinate system: Standard
Patient support coordinate system: IEC 61217
Patient support coordinate system: User-defined
Patient coordinate system: DICOM
Help
Select the way coordinates are displayed in Treatment Planning applications. In the patient-based system axes are defined by the patient DICOM orientation.
Z
Y
X

III Dose Calculation

TEST CASES 1-3

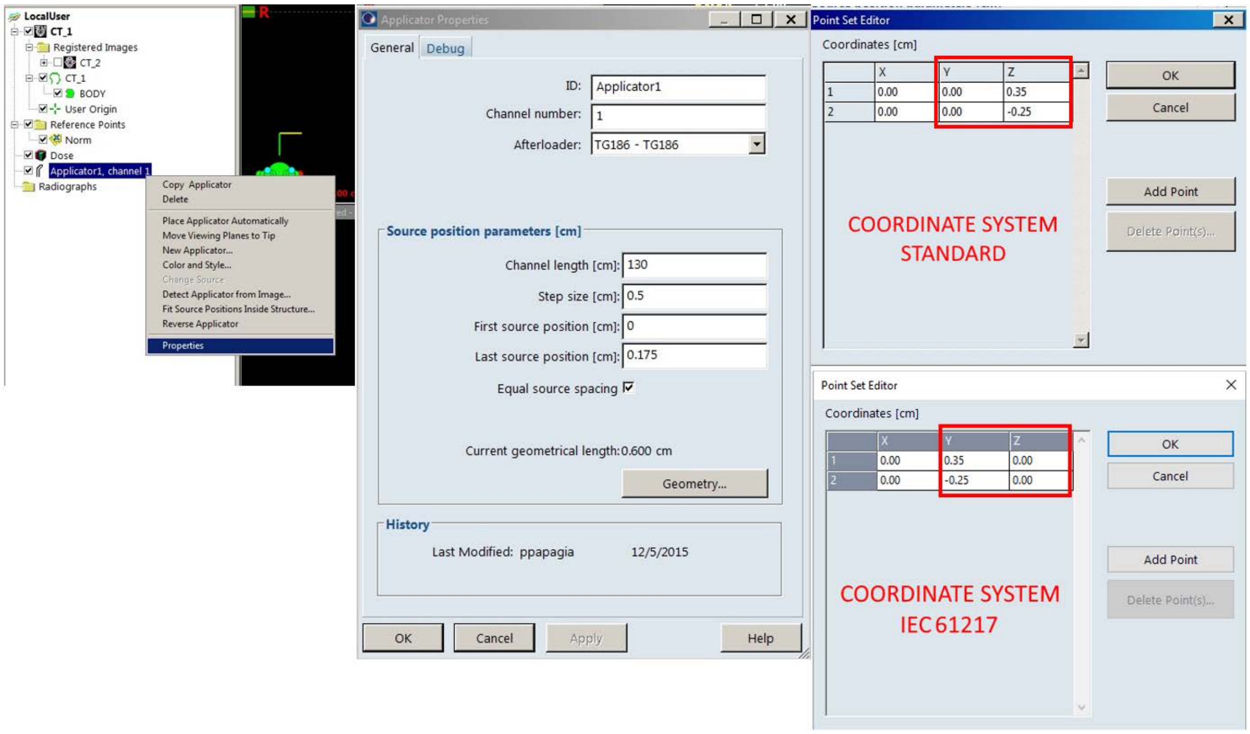
A. Confirming the Plan Properties

- Select the ‘LocalUser’ plan, right-click on it and select ‘Drop to view’.
- Select the ‘Norm’ Reference Point, right-click on it and select ‘Properties’. Confirm the Reference Point ‘P1’ is at the “prescription” point (-1 cm, 0 cm, 0 cm) with a prescription of 1 Gy.
-

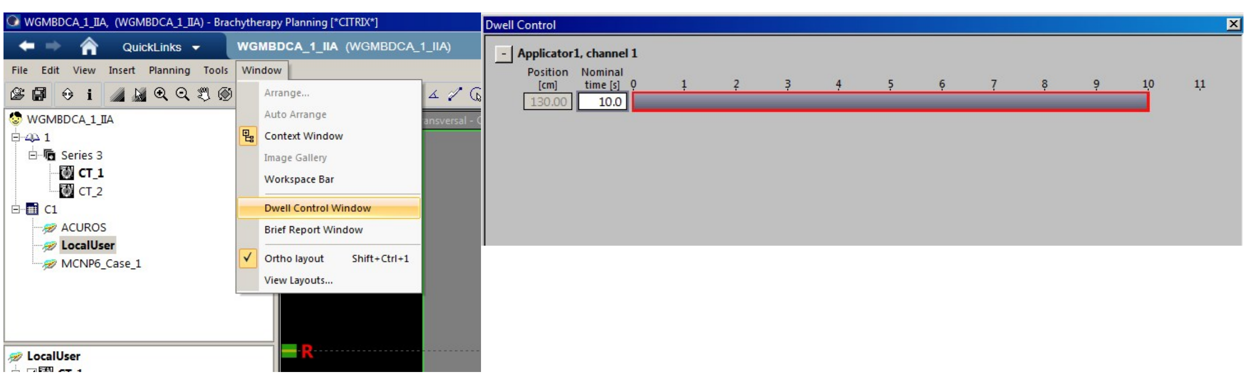


- Select the ‘Applicator1, channel 1’, right-click on it and select ‘Properties’. Confirm all applicator properties as shown below. Click the 

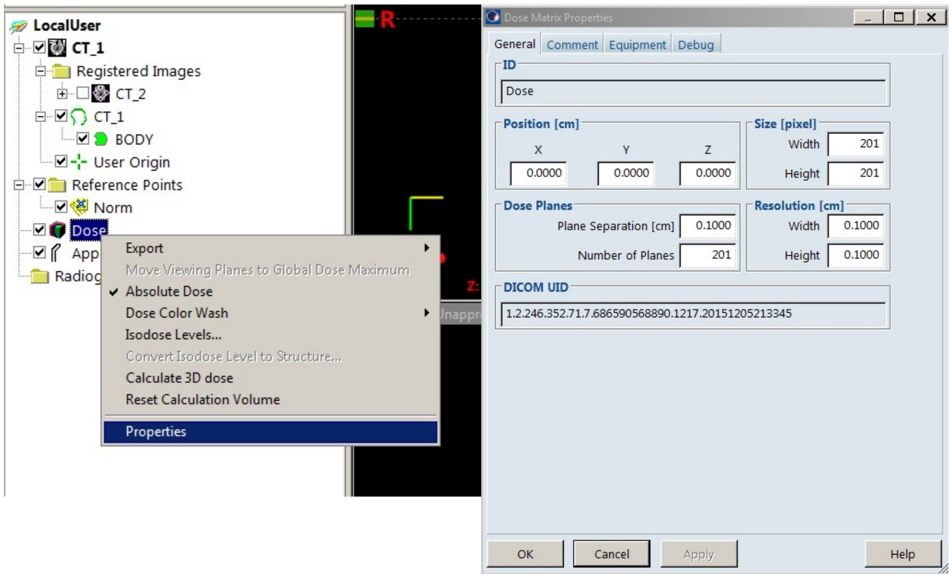
button and confirm the applicator points (as shown below in the ‘Point Set Editor’ window) so that the applicator tip points towards the positive z-axis (standard coordinate system) or y-axis (IEC-61217).



- Click OK to close all windows. A message appears saying 'A change has occurred that invalidates the previous dose calculation. Real time dose is calculated according to TG-43 formalism'. Click OK.
- Click the 'Window → Dwell Control Window' and confirm the active source dwell position is at the centre of the cube (130cm) and the dwell nominal time is 10sec.



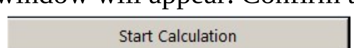
- Select the 'Dose', right-click on it and select 'Properties'. Confirm the 'Dose Matrix Properties' as shown below. Click OK.



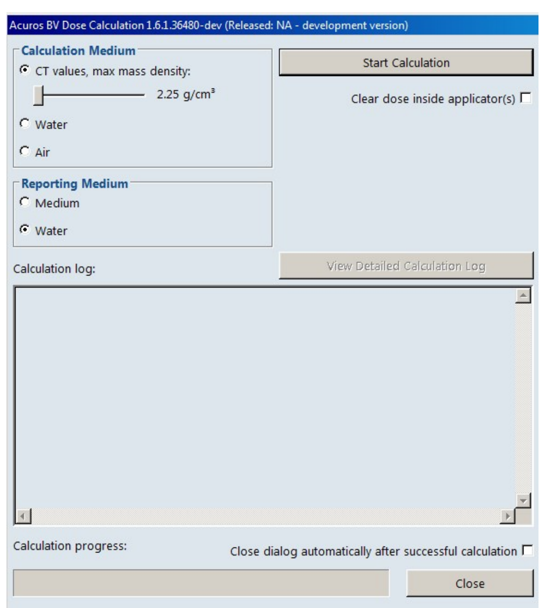
B. Performing the Acuros BV Dose Calculation

The loaded 'ACUROS LocalUser' plan will have dose defined already as this is a copy from the downloaded data set but now is calculated according to TG-43 formalism *(This dose will be overwritten by the local Acuros BV calculation).*

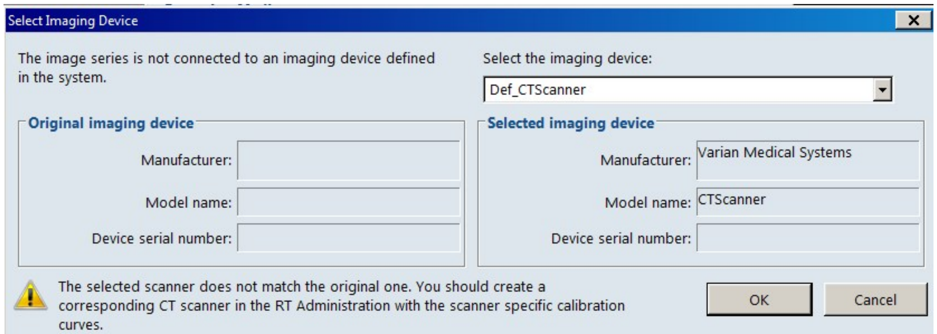
The end user will now perform a local model based dose calculation using the geometry defined by the selected case, overwriting any previous dose contained in the 'ACUROS LocalUser' plan.

- To perform an Acuros BV dose calculation, click the  button.
- The Acuros BV dose calculation window will appear. Confirm that for the calculation medium the 'CT values' are used and click 

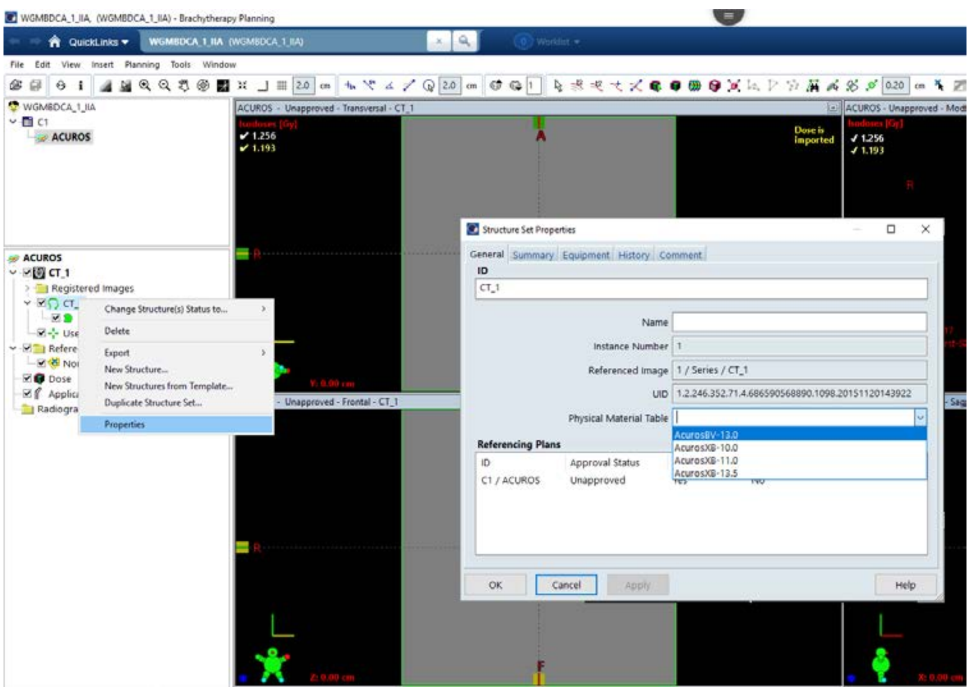
button to begin the Acuros BV calculation.



- The 'Select Imaging Device' window appears. Click OK. The calculation starts.



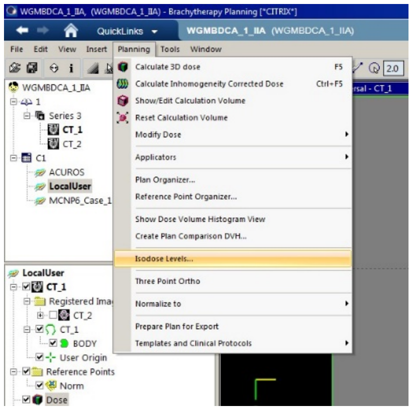
- If error message appears "Physical material table has not been assigned", right-click on the structure set, select proprieties and select a physics material table.

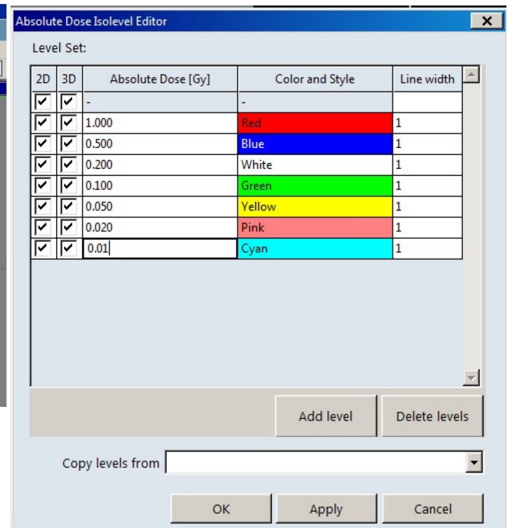


- When the calculation is completed, a warning message appears. Click OK.

Close the window. The display will be updated with isodoses for the Acuros BV calculation. The display will also specify the calculation algorithm 'Transport in medium. Dose to water'. **Transport in medium Dose to water**

- Click 'Planning → Isodose Levels' to change the isodose line values and properly see the dose distribution. Click OK. Dose values exist inside the dose matrix defined. Click the  button to see the dose matrix.





Save the plan by clicking File → Save All.

The test case is ready for comparison as defined in section IV, Dose Distribution Comparison.

Dose calculation in Test Cases 2 and 3 can be performed in the BrachyVision system by following the same procedure above. Note the different source center location in test case 3 (refer to Table 1).

TEST CASE 4

Test Case 4 is different regarding the process that should be followed to perform the Acuros BV dose calculation due to the presence of the solid Generic WG Applicator. Note that in BrachyVision versions prior v15 the virtual WG-MCAB applicator is not included in the TPS and this test case cannot be applied.

To install the TG-186 applicator manually for these cases proceed as follows:

- Download the file *TG186-01.acrpx* from the IROC data base (here) or, alternatively, these files are housed in the following location on the client BrachyVision system (16.0 may be different depending on the version):
    - C:\Program Files (x86)\Varian\RTM\16.0\Brachytherapy\acurosbrachy\data\parts\tg186
- In the Acuros BV system go to C:\Program Files (x86)\Varian, search for *.acrpx files
- Right click on a GM########-##.acrpx file and select Open file location
- Some example paths are:
    - C:\Program Files (x86)\Varian\RTM\15.0\brachytherapy\acurosbrachydata\parts
    - C:\Program Files (x86)\Varian\vision\13.6\Bin64\acurosbrachy\data\parts
    - C:\Program Files (x86)\Varian\RTM\16.0\Brachytherapy\acurosbrachy\data\parts
- Copy the TG-186 applicator file to this location

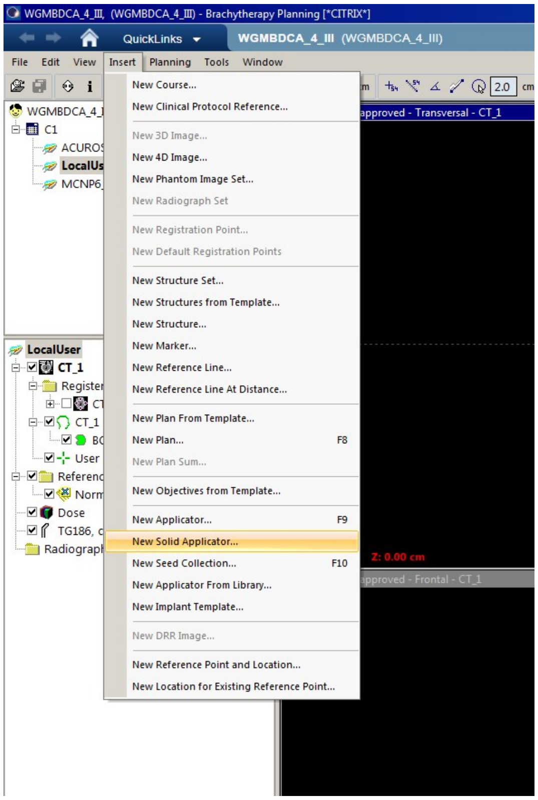
The file location might differ for various Acuros BV versions. When using Acuros BV with Citrix it might be necessary to copy the file at different Citrix servers.

For further instructions, please contact the Varian support.

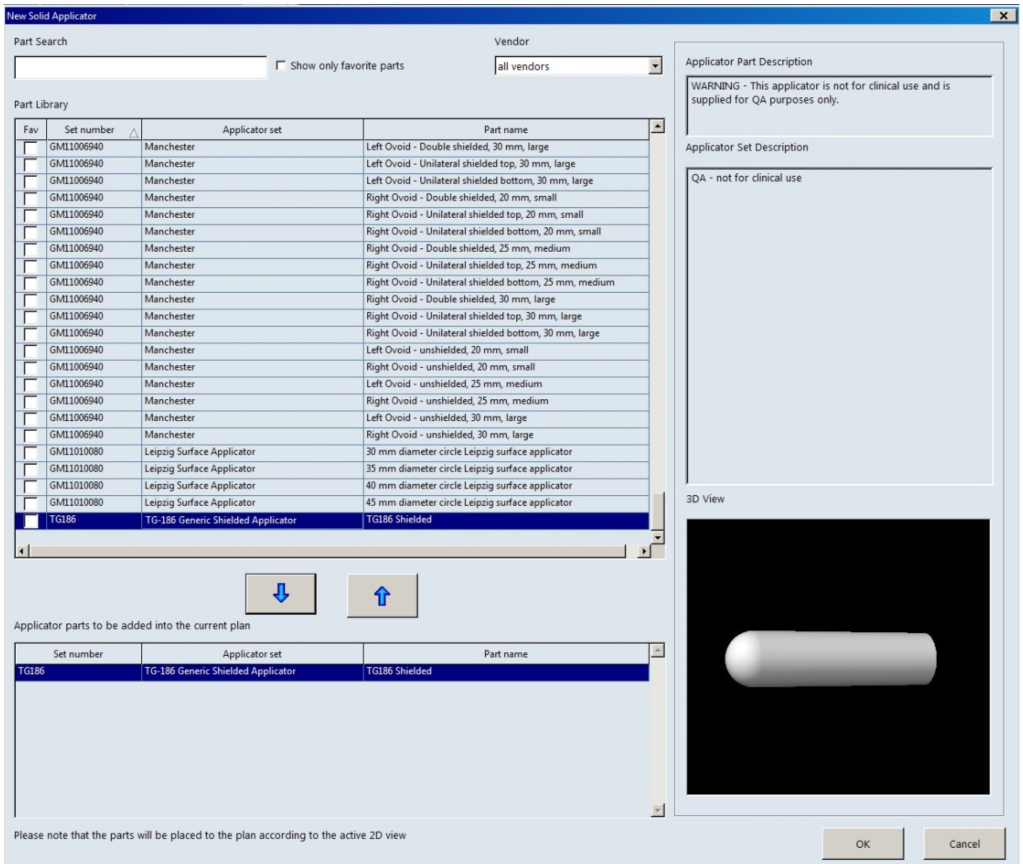
A. Inserting the Generic WG Applicator

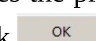
When the import process and local plan creation is complete, the user can observe that the applicator channel containing the TG186 source is loaded but not the actual applicator probe. So before proceeding to the Acuros BV dose calculation, the Generic WG applicator has to be inserted.

- Select the 'LocalUser' plan, right-click on it and select 'Drop to view'.
- Select the 'LocalUser – Transversal (axial)' CT plane to activate it.
- With the 'LocalUser – Transversal (axial)' CT plane activated, click the 'Insert' tab and select the 'Insert New Solid Applicator…' option.

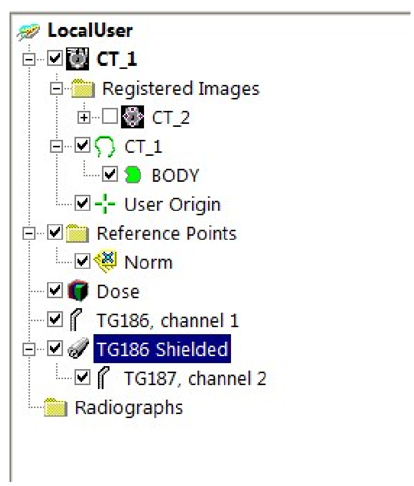


- The Solid Applicator library opens, select the 'TG-186 Generic Shielded Applicator', and add it to the plan by pressing the arrow pointing down and clicking .

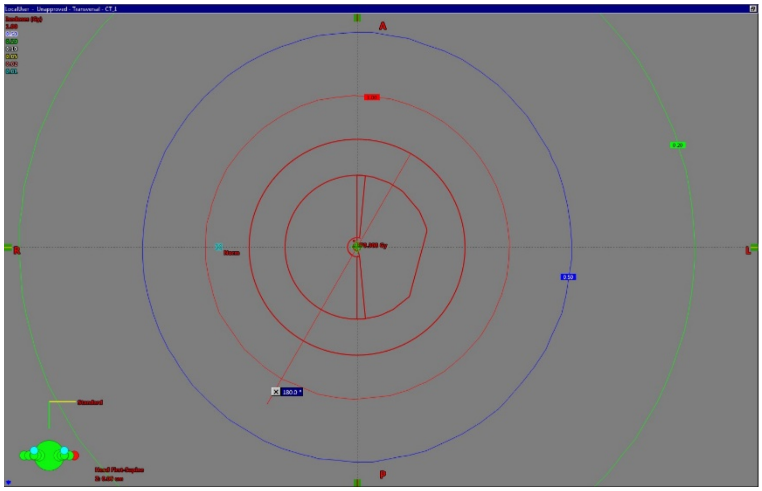


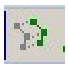
- A message appears informing you that 'A change has occurred that invalidates the previous dose calculation. Real time dose is calculated according to TG-43 formalism'. Click 

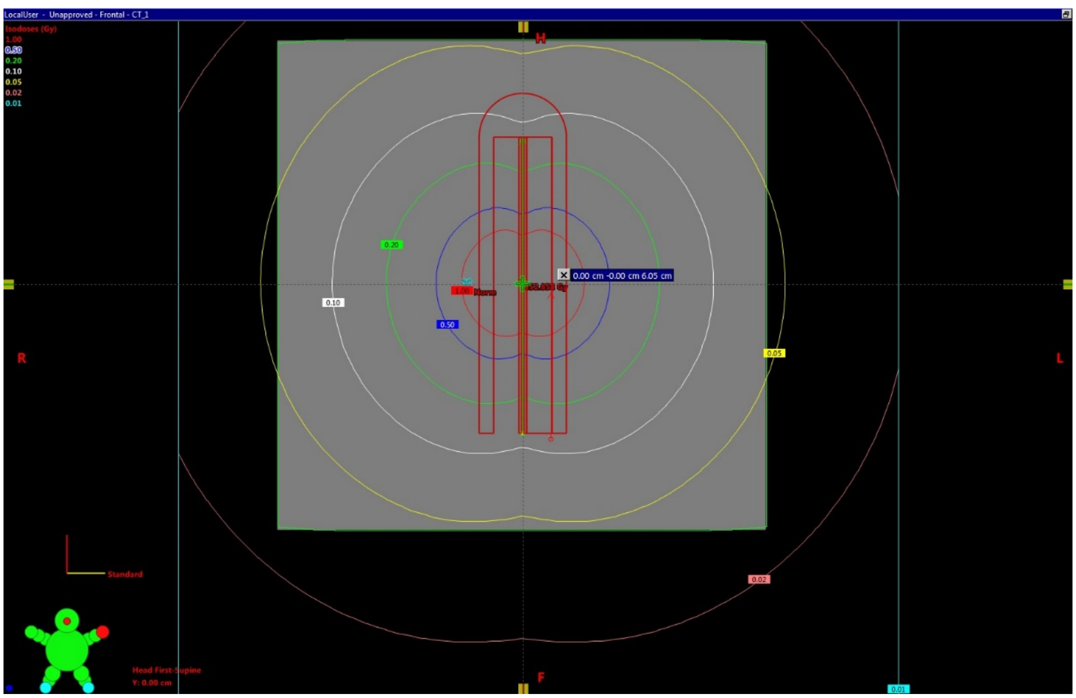
.
- The WG Applicator is loaded with its central axis on the z-axis (standard coordinate system) or y-axis (IEC-61217), the first available dwell position at the origin and the shielded part on the negative x-axis. Hence the applicator has to be rotated 180º (the shielding should be placed on the positive x-axis) and moved by 6.05 cm towards the positive z-axis (standard coordinate system) or y-axis (IEC-61217) so that the center of the active source dwell position of the plan moves at the origin.



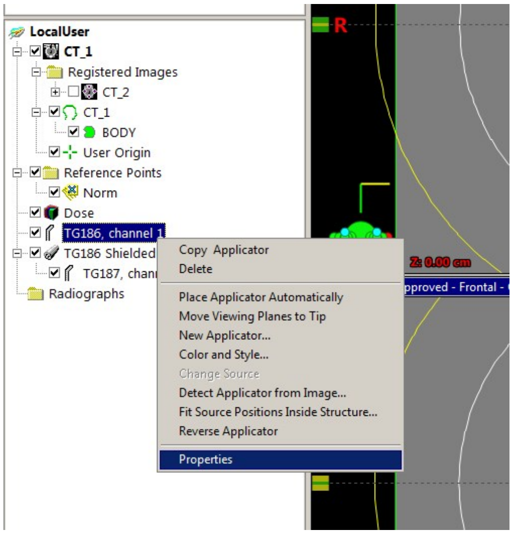
- Maximize the 'LocalUser – Transversal (axial)' CT plane.
- Select the 'TG186 Shielded' applicator to have a better view of the part you have to rotate.
- Click the  button. Place the mouse on the applicator and rotate it by 180º.



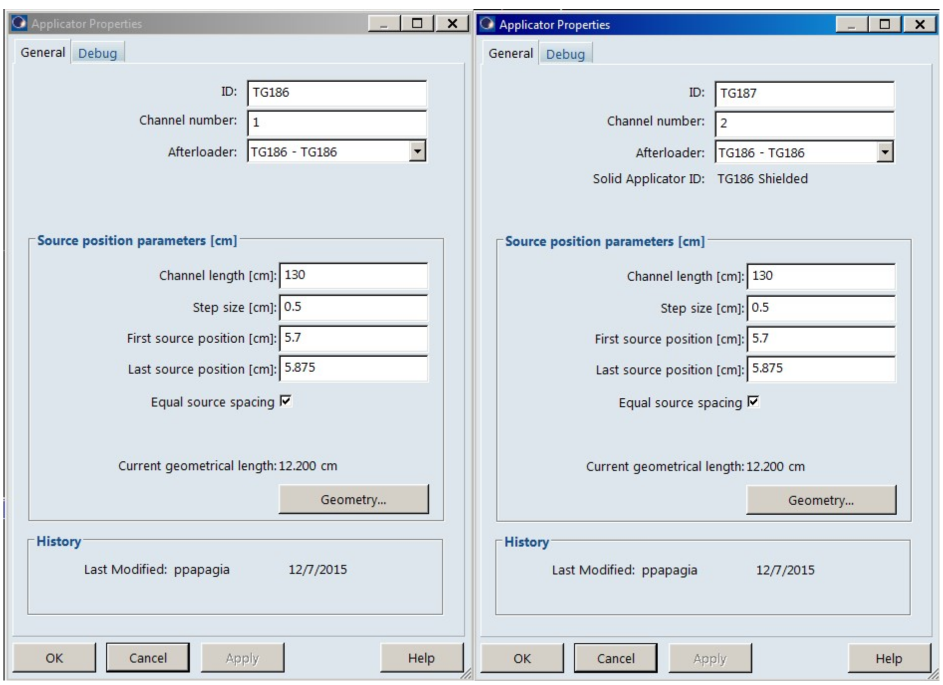
- Return to the main view. Maximize the ‘LocalUser – Frontal (coronal)’ CT plane.
- Click the  button to move the applicator 6.05 cm towards the positive z-axis (standard coordinate system) or y-axis (IEC-61217). The center of the probe should be at the origin.



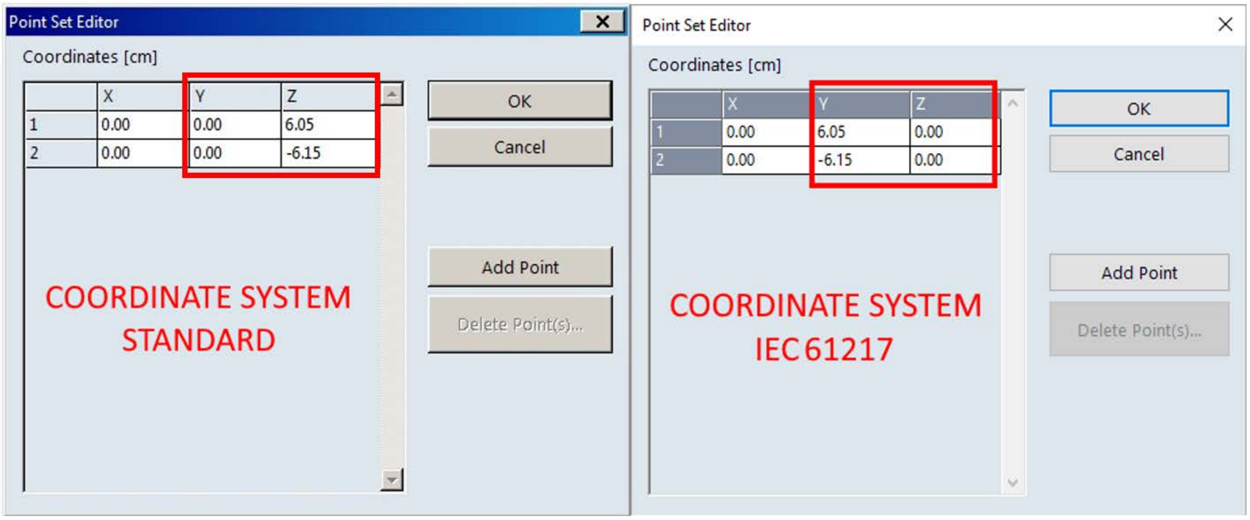
- Return to the main view.
- Select the ‘TG186, channel 1’, right-click on it and select ‘Properties’.



- The ‘Applicator Properties’ window opens. Copy all the source position parameters to the ‘Applicator Properties’ of the ‘TG187, channel 2’ by selecting it from the list on the left. Note that when you switch between the applicator channels from the list on the left, the properties window also switches between the two obviating the need to close and re-open the properties window.

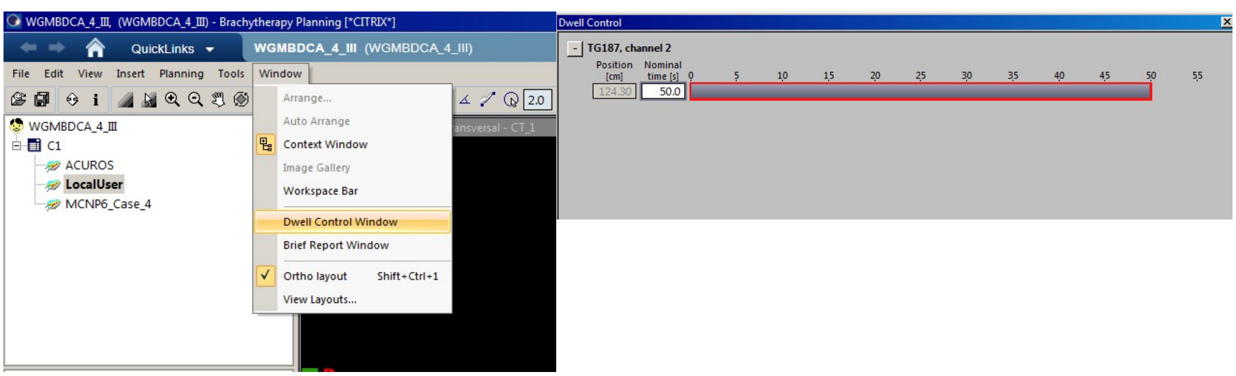


- Click the Geometry... button and confirm that both applicators have the same points (as shown below in the ‘Point Set Editor’ window).



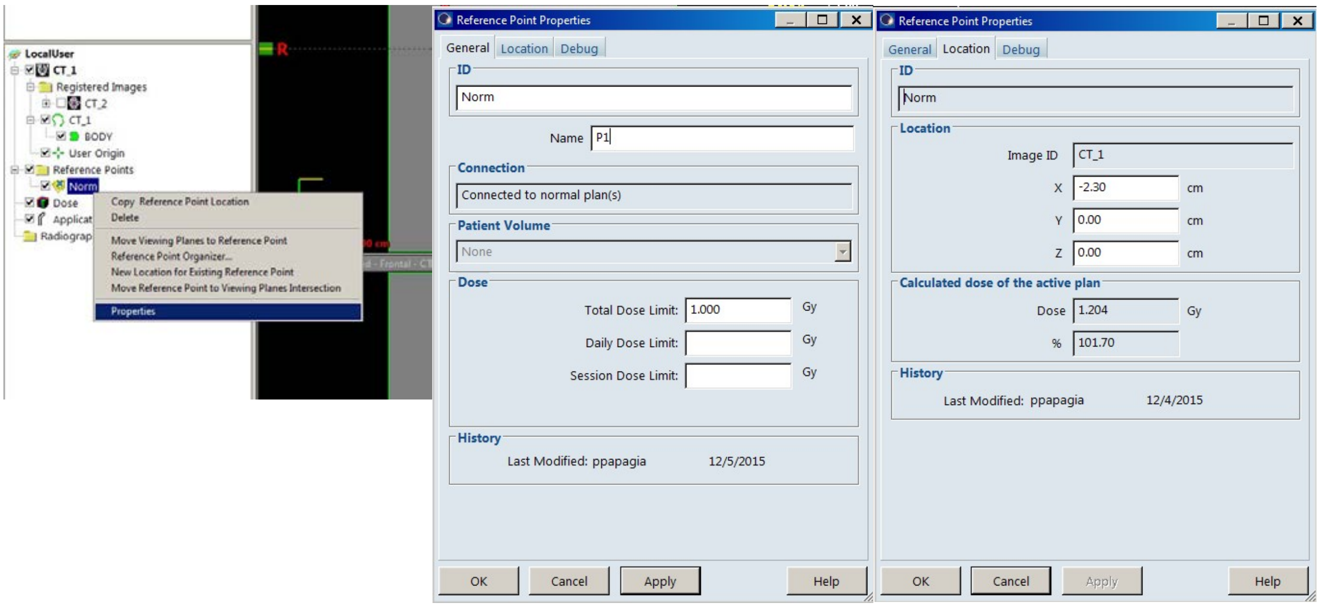
In case the coordinates shown in your system do not match the values shown above, please repeat the procedure for correctly placing the applicator.

- Close all the above mentioned windows and return to the main view. Select the 'TG186, channel 1', right-click on it and select 'Delete'.
- Click the 'Window → Dwell Control Window' and confirm the active source dwell position is at the centre of the cube (124.30cm) and enter a dwell time $t' = (Sk_{nominal}/Sk_{current}) * 50$ sec. $Sk_{nominal} = 40700\, cGy * cm^2/h$. If the nominal source strength is used for planning, this correction is not necessary.

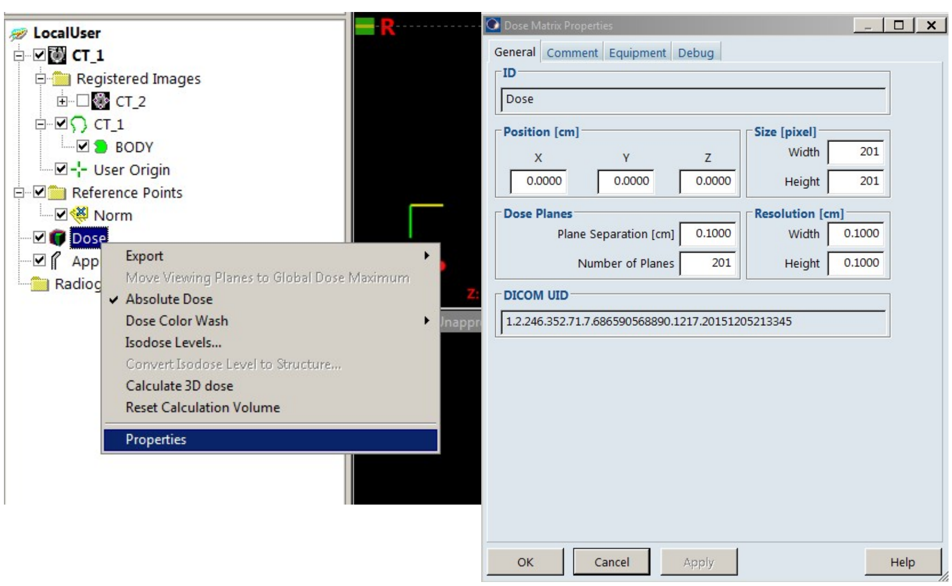


B. Confirming the Plan Properties

- Select the 'Norm' Reference Point, right-click on it and select 'Properties'. Confirm the Reference Point 'P1' is at (-2.3 cm, 0 cm, 0 cm) with a prescription of 1 Gy.



- Select the 'Dose', right-click on it and select 'Properties'. Confirm the 'Dose Matrix Properties' as shown below. Click OK.



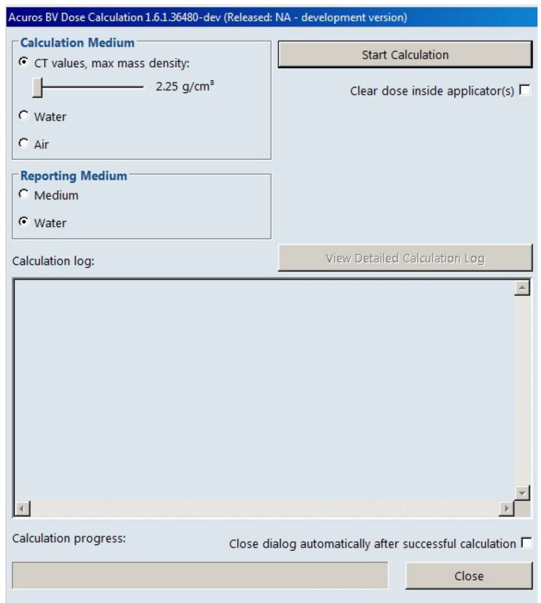
C. Performing the Acuros BV Dose Calculation

The loaded 'ACUROS LocalUser' plan will have dose defined already as this is a copy from the downloaded data set but now it is calculated according to TG-43 formalism *(This dose will be overwritten by the local Acuros BV calculation).*

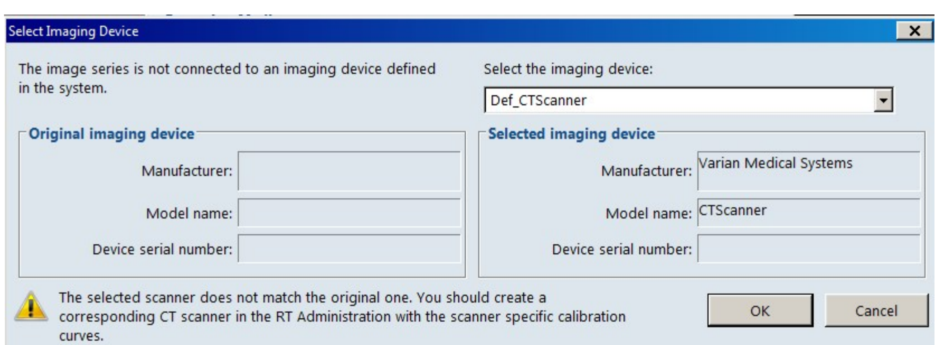
The end user will now perform a local model based dose calculation using the geometry defined by the selected case, overwriting any previous dose contained in the 'ACUROS LocalUser' plan.

To perform an Acuros BV dose calculation, click the  button.

The Acuros BV dose calculation window will appear. Confirm that for the calculation medium the 'CT values' are used and click Start Calculation button to begin the Acuros BV calculation.

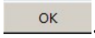


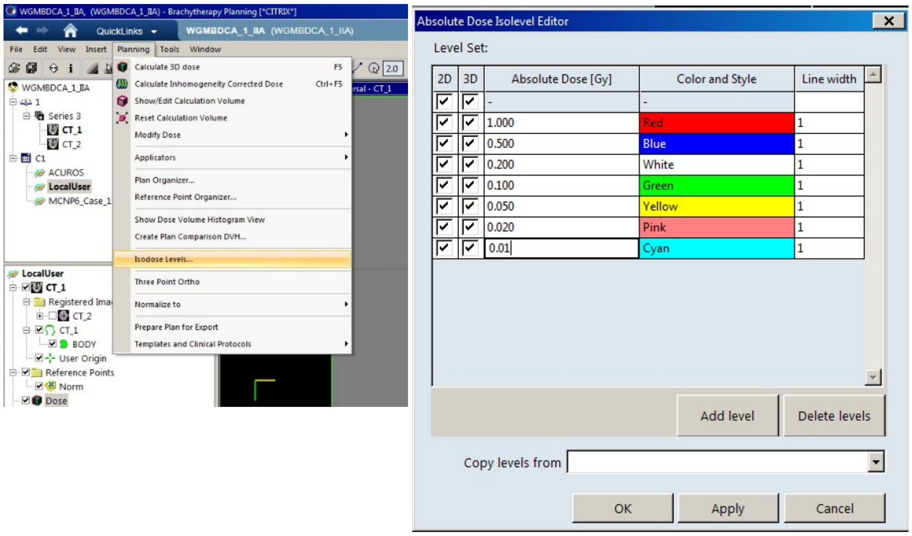
- The 'Select Imaging Device' window appears. Click OK. The calculation starts.



- When the calculation is completed, a warnings message appears. Click OK.

Close the window. The display will be updated with isodoses for the Acuros BV calculation. The display will also specify the calculation algorithm 'Transport in medium. Dose to water'. 

- Click 'Planning → Isodose Levels' to change the isodose line values and properly see the dose distribution. Click . Dose values exist inside the dose matrix defined. Click the  button to see the dose matrix.



Save the plan by clicking File → Save All.

The test case is ready for comparison as defined in section IV Dose Distribution Comparison.

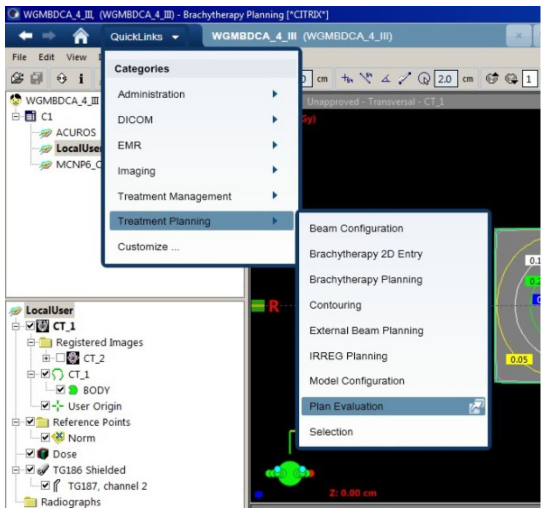
- Open the MCNP6_Case_4 and apply the same isodoses level settings.

IV Dose Distribution Comparison

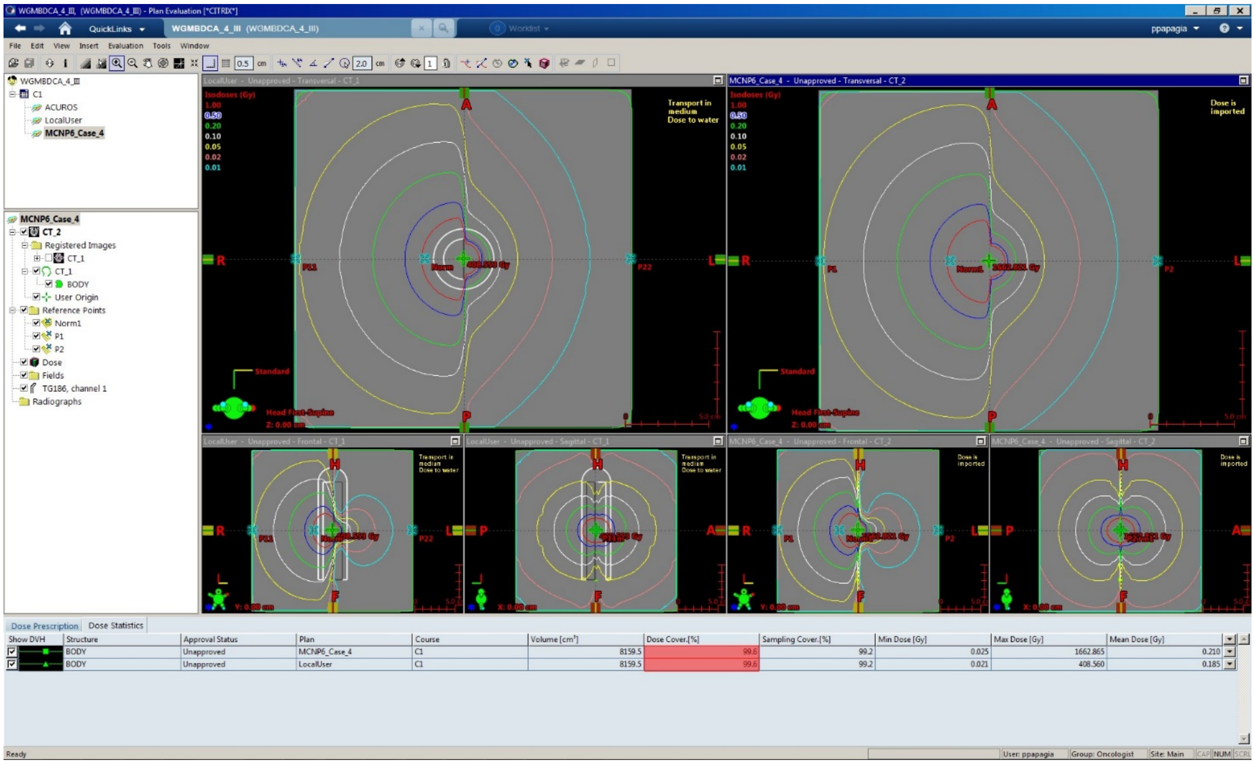
Dose comparisons should be performed for all 4 test cases. In this section only Test Case 4 is explained in detail. The Test Cases 1, 2, and 3 should be analyzed accordingly.

A. Comparison Process Overview

- In BrachyVision open the Plan Evaluation Link.



- Select the 'LocalUser' plan, right-click on it and select 'Drop to view → Left'.
- Select the 'MCNP6_Case_4' plan, right-click on it and select 'Drop to view → Right'.



The comparison of 3D dose distributions is typically done at specified points, in selected planes (dose maps), or for defined volumes within the distributions. Commonly used comparative metrics include dose differences, dose ratios, and the gamma index. The comparison tools available within the BrachyVision treatment planning system are limited to those based on dose differences; correspondingly, the detailed dose comparison and reporting guidance provided below is limited to dose differences.

To augment the OCB dose comparison tools, end-users are encouraged to also make use of appropriate and available third party software, and to report their experiences using it. In this regard, public-domain software such as BrachyGuide v2[10] (available at: http://www.rdl.gr/downloads) or SlicerRT[11] (available at: http://slicerrt.github.io/) may be of interest.

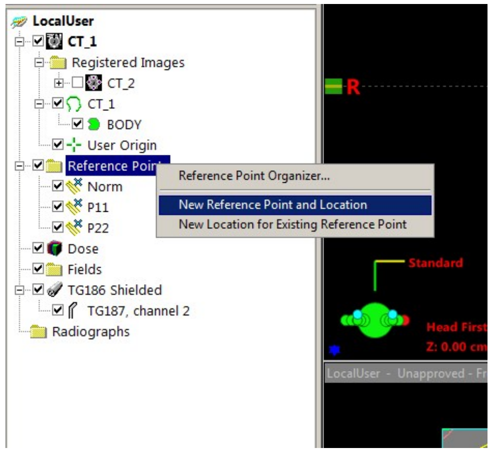
B. Doses at Specified Points

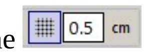
Reference doses at 12 different positions are provided in Appendix A.

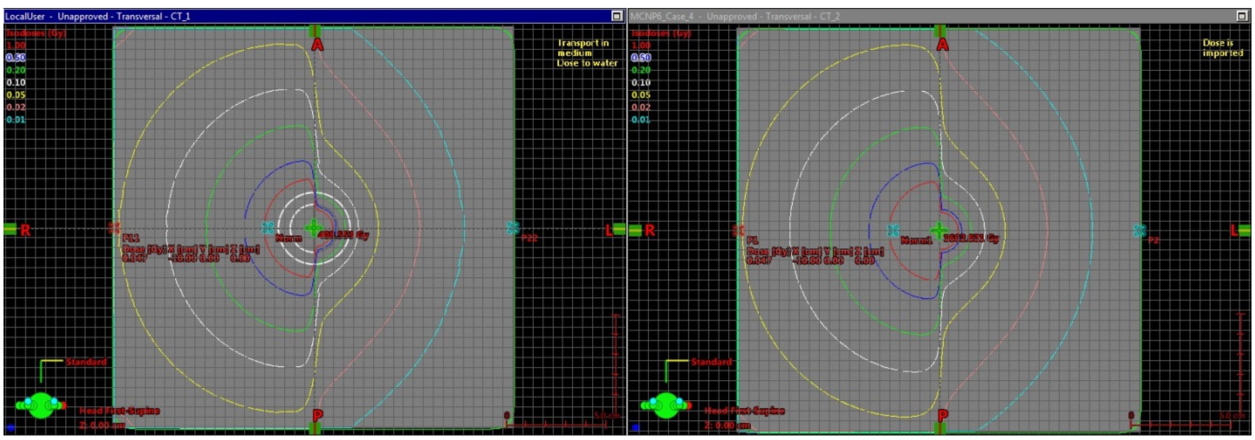
To perform a dose point check in the BrachyVision:

- Click the 'Point Dose'  button and place the mouse at the point of interest. Repeat the same procedure in both plans and check the dose value.

- Alternatively, create ‘New Reference Points’ in both plans at the same location and by selecting each point from the list on the left, review the calculated dose.



- Create a display grid using the grid definition tool in the toolbar. Click the  button to facilitate the whole process.



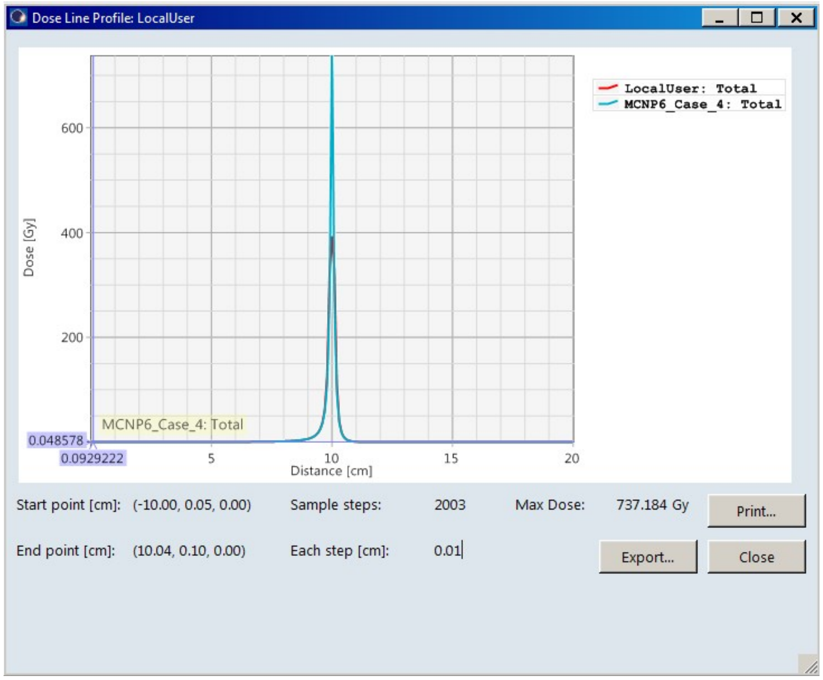
- Using ‘Link View Geometries’  can help in correlating the positions of the point doses.

C. 2D Dose Maps and 1D Dose Profiles

To set up a side-by-side display of a locally calculated and a reference dose distribution:

- Choose or define an appropriate set of isolines for dose display by selecting ‘Planning → Isodose Levels’ from the main menu.
- Click in the upper left panel of the display grid the  buttons, and zoom/pan the image to show an area of dosimetric interest.

- Click the  button to create a dose profile for that area of the image. Use the cross-hair enabled to navigate through the Distance-Dose values of each plan.

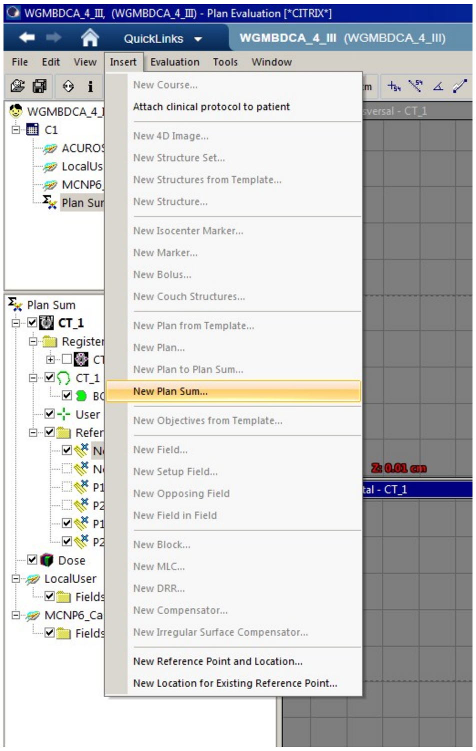


- Without closing the 'Dose Line Profiler' window, scroll through the slices to visually compare 2D doses and 1D dose profiles throughout the phantom.
- For the source centered geometry (Test Cases 1, 2 and 4), dose maps and "horizontal" dose profiles through the center of the source could be generated and recorded using screen capture software in planes x = 0 cm, y = 0 cm, and z = 0 cm. For the source displaced geometry (Test Case 3), dose maps and "horizontal" dose profiles through the center of the source could be created and recorded in planes x = 7 cm, y = 0 cm, and z = 0 cm.

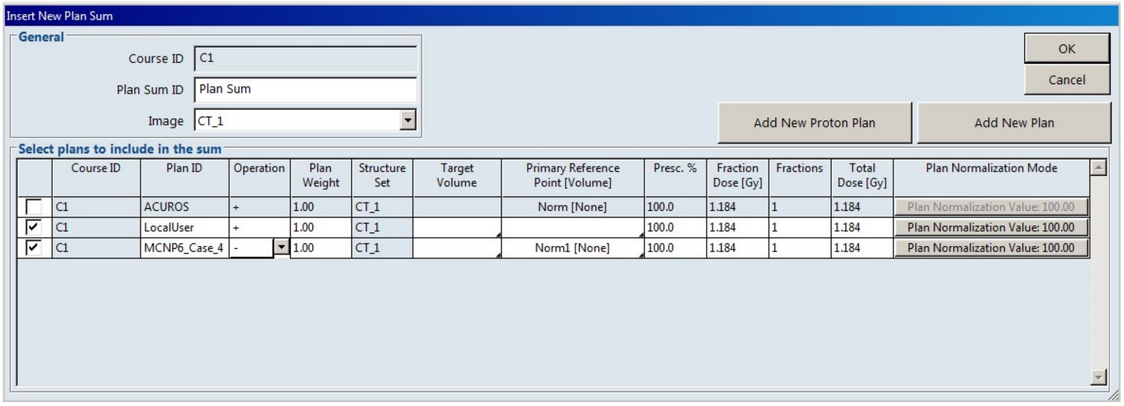
D. 2D Dose Map Differences

To display differences between a locally calculated and a reference dose distribution:

- Click the 'Insert' tab and select 'New Plan Sum'.

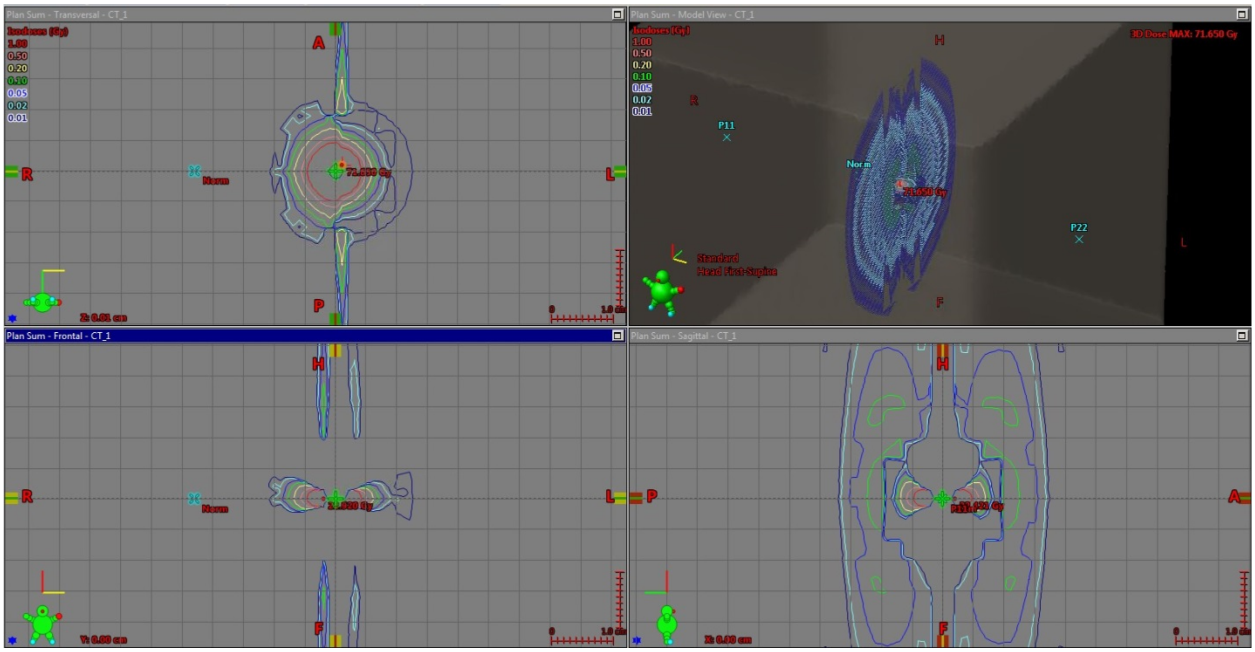


- Tick both plans of interest for comparison by checking the box for each plan (‘LocalUser’ and ‘MCNP6_Case_4’). Set the ‘Operation’ for the reference plan (MCNP6_Case_4’) to ‘–‘; this yields the difference in the locally calculated dose distribution relative to the reference distribution. Click Ok.



- Choose or define an appropriate set of isolines for dose display by selecting ‘Planning → Isodose Levels’ from the main menu.

- Choose from the 'Window' tab the desired views. Click 'Window → Orthogonal Views and BEV'.



- Scroll through the slices to inspect 2D dose differences throughout the phantom.
- For the source centered geometry (Test Cases 1, 2 and 4), dose difference maps through the center of the source could be generated and recorded using screen capture software on planes *x* = 0 cm, *y* = 0 cm, and *z* = 0 cm. For the source displaced geometry (Test Case 3), dose difference maps through the center of the source could be created and recorded on planes *x* = 7 cm, *y* = 0 cm, and *z* = 0 cm.

V Test Case Recording

Reporting on test case dose calculations is intended to provide: (1) end-user generated dosimetric data for inter-comparison purposes; and (2) feedback on the test case calculation process itself. Both types of information are valuable for refining the detailed testing procedures introduced in this Guide.

Dosimetric data to be reported for each test case should include:

- Doses at selected points, in spreadsheet form (.xls, .xlsx)
- Dose maps and "horizontal" dose profiles in the planes indicated in Sec. IV.C, in screen capture form (.jpg, .tiff, .png)
- Dose difference maps in the planes indicated in Sec. IV.D, in screen capture form (.jpg, .tiff, .png)
- Any other dose data highlighting an issue that the end-user believes requires attention, in spreadsheet or screen capture form, along with a concise description of the issue

Written feedback on the calculation process itself should include:

- A description of any issues encountered with test case import, set up, dose calculation, dose display, etc.
- A description of any difficulties encountered in following this User Guide
- Suggestions for improving the calculation process and the User Guide.

Feedback can be sent directly to the WG-DCAB; contact information is available at the URL in Ref. 2.

VI Creating a generic HDR Ir-192 virtual WG-DCAB source model in the TPS

Depending on BrachyVision TPS version (v. 13 or higher) a source model for the generic WG source might have to be created before proceeding with test case import and dose calculations. Users should follow the BrachyVision reference guide instructions. In short, users can create a new radioactive source model with the ID "TG-186" in RT Administration. It is imperative that the above mentioned ID is used as it is used to link the source to the correct source model in the Acuros BV dose calculation algorithm. Since the source model is non-clinical, the status of the source model must be kept as "Commissioning" to ensure that it is not used in treatments. Users can then create a new brachytherapy treatment unit and add the new radioactive source model to the created treatment unit as "nominal" source with 40.700 cGycm^2/h.

VII References

1 L. Beaulieu *et al.*, "Report of the Task Group 186 on model-based dose calculation methods in brachytherapy beyond the TG-43 formalism: current status and recommendations for clinical implementation.," Med. Phys. **39**(10), 6208–36 (2012).

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3 F. Ballester *et al.*, "A generic high-dose rate 192Ir brachytherapy source for evaluation of model-based dose calculations beyond the TG-43 formalism," Med. Phys. **42**(6), 3048–3062 (2015).

4 *BrachyVision-Acuros algorithm reference guide (P/N B5202151R01A). Palo Alto, CA: Varian Medical Systems Inc.; 2009.* (n.d.).

5 K. Zourari *et al.*, "Dosimetric accuracy of a deterministic radiation transport based [sup 192]Ir brachytherapy treatment planning system. Part I: Single sources and bounded homogeneous geometries," Med. Phys. **37**(2), 649 (2010).

6 L. Petrokokkinos *et al.*, "Dosimetric accuracy of a deterministic radiation transport based [sup 192]Ir brachytherapy treatment planning system. Part II: Monte Carlo and experimental verification of a multiple source dwell position plan employing a shielded applicator," Med. Phys. **38**(4), 1981 (2011).

7 K. Zourari *et al.*, "Dosimetric accuracy of a deterministic radiation transport based (192)Ir brachytherapy treatment planning system. Part III. Comparison to Monte Carlo simulation in voxelized anatomical computational models.," Med. Phys. **40**(1), 011712 (2013).

8 J.K. Mikell and F. Mourtada, "Dosimetric impact of an [sup 192]Ir brachytherapy source cable length modeled using a grid-based Boltzmann transport equation solver," Med. Phys. **37**(9), 4733 (2010).

9 P. Papagiannis, E. Pantelis, and P. Karaiskos, "Current state of the art brachytherapy treatment planning dosimetry algorithms.," Br. J. Radiol. **87**(1041), 20140163 (2014).

10 E. Pantelis, V. Peppa, V. Lahanas, E. Pappas, and P. Papagiannis, "BrachyGuide: A brachytherapy-dedicated DICOM RT viewer and interface to Monte Carlo simulation software," J. Appl. Clin. Med. Phys. **16**(1), 208–218 (2015).

11 C. Pinter, A. Lasso, A. Wang, D. Jaffray, and G. Fichtinger, "SlicerRT: radiation therapy research toolkit for 3D Slicer.," Med. Phys. **39**(10), 6332–8 (2012).

This sections includes the dose for 12 reference points (see section IV.B) obtained with Acuros BV version 15.6. Note that users might oberserve small variations due to the software and/or placement of the applicator (test case 4).

Table A1. Test case 1 - Dose (cGy) at 12 reference points.

Coordinate System IEC 61217			Acuros BV Dose (cGy)
X [mm]	Y [mm]	Z [mm]	Version 15.6
-10.0	0.0	0.0	125.6
10.0	0.0	0.0	125.6
0.0	-10.0	0.0	78.4
0.0	10.0	0.0	84.7
0.0	0.0	-10.0	125.6
0.0	0.0	10.0	125.6
-50.0	0.0	0.0	5.1
50.0	0.0	0.0	5.1
0.0	-50.0	0.0	3.5
0.0	50.0	0.0	3.6
0.0	0.0	-50.0	5.1
0.0	0.0	50.0	5.1

Table A2. Test case 1 - Dose (cGy) at 12 reference points.

Coordinate System Standard			Acuros BV Dose (cGy)
X [mm]	Y [mm]	Z [mm]	Version 15.6
-10.0	0.0	0.0	125.6
10.0	0.0	0.0	125.6
0.0	-10.0	0.0	125.6
0.0	10.0	0.0	125.6
0.0	0.0	-10.0	78.4
0.0	0.0	10.0	84.7
-50.0	0.0	0.0	5.1
50.0	0.0	0.0	5.1
0.0	-50.0	0.0	5.1
0.0	50.0	0.0	5.1
0.0	0.0	-50.0	3.5
0.0	0.0	50.0	3.6

Table A3. Test case 2 - Dose (cGy) at 12 reference points.

Coordinate System IEC 61217			Acuros BV Dose (cGy)
X [mm]	Y [mm]	Z [mm]	Version 15.6
-10.0	0.0	0.0	125.6
10.0	0.0	0.0	125.6
0.0	-10.0	0.0	78.4
0.0	10.0	0.0	84.7
0.0	0.0	-10.0	125.6
0.0	0.0	10.0	125.6
-50.0	0.0	0.0	5.1
50.0	0.0	0.0	5.1
0.0	-50.0	0.0	3.5
0.0	50.0	0.0	3.5
0.0	0.0	-50.0	5.1
0.0	0.0	50.0	5.1

Table A4. Test case 2 - Dose (cGy) at 12 reference points.

Coordinate System Standard			Acuros BV Dose (cGy)
X [mm]	Y [mm]	Z [mm]	Version 15.6
-10.0	0.0	0.0	125.6
10.0	0.0	0.0	125.6
0.0	-10.0	0.0	125.6
0.0	10.0	0.0	125.6
0.0	0.0	-10.0	78.4
0.0	0.0	10.0	84.7
-50.0	0.0	0.0	5.1
50.0	0.0	0.0	5.1
0.0	-50.0	0.0	5.1
0.0	50.0	0.0	5.1
0.0	0.0	-50.0	3.5
0.0	0.0	50.0	3.5

Table A5. Test case 3 - Dose (cGy) at 12 reference points.

Coordinate System	Acuros BV

IEC 61217			Dose (cGy)
X [mm]	Y [mm]	Z [mm]	Version 15.6
60.0	0.0	0.0	125.6
80.0	0.0	0.0	125.3
70.0	-10.0	0.0	77.5
70.0	10.0	0.0	83.8
70.0	0.0	-10.0	125.1
70.0	0.0	10.0	125.1
20.0	0.0	0.0	5.0
100.0	0.0	0.0	13.4
70.0	-50.0	0.0	3.2
70.0	50.0	0.0	3.3
70.0	0.0	-50.0	4.8
70.0	0.0	50.0	4.8

Table A6. Test case 3 - Dose (cGy) at 12 reference points. Coordinates are specified in the Standard coordinate system.

Coordinate System Standard			Acuros BV Dose (cGy)
X [mm]	Y [mm]	Z [mm]	Version 15.6
60.0	0.0	0.0	125.6
80.0	0.0	0.0	125.3
70.0	-10.0	0.0	125.1
70.0	10.0	0.0	125.1
70.0	0.0	-10.0	77.5
70.0	0.0	10.0	83.8
20.0	0.0	0.0	5.0
100.0	0.0	0.0	13.4
70.0	-50.0	0.0	4.8
70.0	50.0	0.0	4.8
70.0	0.0	-50.0	3.2
70.0	0.0	50.0	3.3

Table A7. Test case 4 - Dose (cGy) at 12 reference points.

Coordinate System IEC 61217	Acuros BV Dose (cGy)

X [mm]	Y [mm]	Z [mm]	Version 15.6
-10.0	0.0	0.0	622.8
10.0	0.0	0.0	74.1
0.0	-10.0	0.0	351.6
0.0	10.0	0.0	376.2
0.0	0.0	-10.0	315.1
0.0	0.0	10.0	314.8
-50.0	0.0	0.0	23.7
50.0	0.0	0.0	2.2
0.0	-50.0	0.0	4.4
0.0	50.0	0.0	4.8
0.0	0.0	-50.0	11.3
0.0	0.0	50.0	11.3

Table A8. Test case 4 - Dose (cGy) at 12 reference points.

Coordinate System Standard			Acuros BV Dose (cGy)
X [mm]	Y [mm]	Z [mm]	Version 15.6
-10.0	0.0	0.0	622.8
10.0	0.0	0.0	74.1
0.0	-10.0	0.0	314.8
0.0	10.0	0.0	315.1
0.0	0.0	-10.0	351.6
0.0	0.0	10.0	376.2
-50.0	0.0	0.0	23.7
50.0	0.0	0.0	2.2
0.0	-50.0	0.0	11.3
0.0	50.0	0.0	11.3
0.0	0.0	-50.0	4.4
0.0	0.0	50.0	4.8