Special applications with OCTAVIUS 4D

1 Off-axis measurements

In a few treatment scenarios the isocenter is positioned far away from the PTV. With an isocentric setup of OCTAVIUS 4D (phantom midpoint matched with the isocenter) it could happen that the high dose region would not be covered completely/ at all from the field of view of the OCTAVIUS detector. In these cases the verification measurement could be performed with the rotation unit positioned in the region of the PTV (off-axis position). This feature requires VeriSoft 7.1 or higher.

1.1 Treatment planning

- Import one of the artificial CT datasets of OCTAVIUS provided by PTW into your TPS (https://www.ptwdosimetry.com/en/octavius-4d-ct-scans/).
  Names:
  OCTAVIUS_4D_CT_structure_sets_RU_Standard
  OCTAVIUS_4D_CT_structure_sets_RU_SRS
  OCTAVIUS_4D_CT_structure_sets_RU_SRS_plus
- After CT import the center of the phantom is identical to the isocenter of the linac.
- Define a new isocenter position (X-,Y- & Z coordinates) in the phantom's DICOM matrix in order to ensure the phantom covers the dose distribution completely after recalculation.
  Note: The definition of a new isocenter position in the TPS corresponds to a phantom shift in reality.

  Note: The phantom shifts are limited depending on OCTAVIUS accessory and array type:
  Accessory Rotation Unit with all OCTAVIUS detectors:
  All directions: (0 … ± 250) mm

  Accessory Rotation Unit SRS or SRS plus with OCTAVIUS detector 729 or 1500:
  TG direction: (0 … ± 120) mm
  LR and BT direction: (0 … ± 250) mm

  Accessory Rotation Unit SRS or SRS plus with OCTAVIUS Detector 1000^{SRS} or 1600^{SRS}:
  All directions: (0 … ± 250) mm

- Export the RT Dose and the RT Plan file (treatment plan includes the total dose)

1.2 Phantom setup and measurement workflow

- Setup the rotation unit on the treatment table and align it at the isocenter using the laser system.
- Shift the phantom with the patient couch in X-,Y- & Z- direction according to the shift applied during treatment planning
  Note: Check with the gantry if there are any clearance problems in LR or BT direction. If there are some clearance issues in LR direction reposition the phantom on the couch so that the couch is still in the zero position while the phantom is at the off-axis position.

- Open the "Measurement" window in VeriSoft.
- Start the measurement and deliver the plan.
- Stop and save the measurement (format .xcc). Extend the file name with energy and shift information.

1.3 Dose reconstruction in Verisoft

- Select *Tools* → *Options…* → *4D Dosimetry* and activate *Off-axis 4D dosimetry* as non-standard 4D dosimetry.
- Select *File* → *Data Set A/B* → *Open…* and load the measurement file of the off-axis measurement.
- The dialogue *Set an angle range for dataset A/B* appears. Perform the dose reconstruction as desired and define the phantom shift in category *Off-axis 4D dosimetry* as it had been applied in treatment planning/during the measurement (see. Fig. 1).
  Note: Usually, in treatment planning systems coordinates are defined according to IEC standard. When entering these values, refer to the definition of the coordinate system in the standard IEC 61217 and Fig. 2 (see below).
- After dose reconstruction continue with the comparison analysis as known.

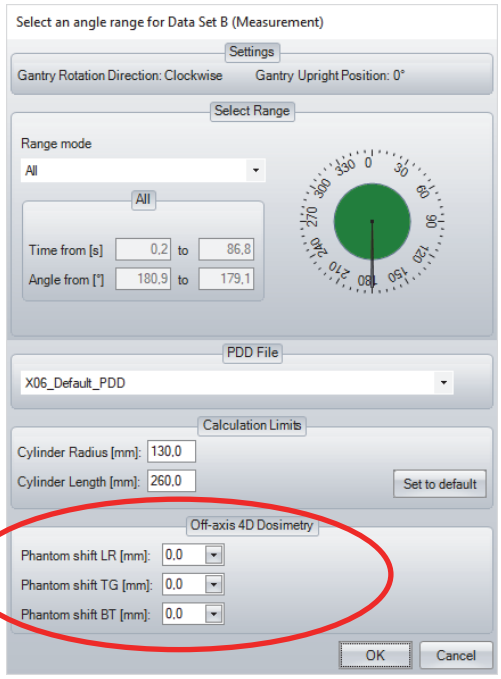

Figure 1: Definition of the phantom shift in the dialogue *Set an angle range for dataset A/B.*

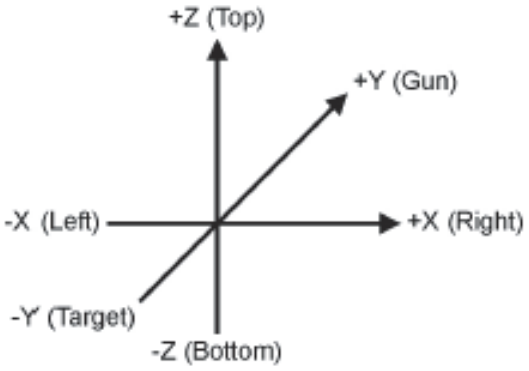

Figure 2: Correspondence between IEC coordinates and PTW coordinates

Detailed information about the dose reconstruction of off-axis measurements can be found in PTW document D655.200.08/00

2 Non-coplanar measurements

Mostly, treatment plans contain only coplanar fields. In special situations non-coplanar fields are applied to increase the conformity of the treatment plan (=> more dose to PTV & less dose to OARs). The verification of non-coplanar beams with OCTAVIUS 4D is supported in VeriSoft 7.1 or higher.

2.1 Treatment planning

- Import one of the artificial CT datasets of OCTAVIUS provided by PTW into your TPS (https://www.ptwdosimetry.com/en/octavius-4d-ct-scans/).
  Names:
  OCTAVIUS_4D_CT_structure_sets_RU_Standard
  OCTAVIUS_4D_CT_structure_sets_RU_SRS
  OCTAVIUS_4D_CT_structure_sets_RU_SRS_plus
- Recalculate the patient's treatment plan on the artificial CT. The treatment plan includes coplanar and/or non-coplanar fields.
- Export the RT Dose and the RT Plan file (treatment plan includes the total dose)

2.2 Phantom setup and measurement workflow

- Setup the rotation unit on the treatment table and align it at the isocenter using the laser system.
- Open the "Measurement" window in VeriSoft
- Deliver and measure the plan stepwise:
  - Deliver all fields that belong to a certain couch angle
  - Always collapse the couch angle to 0° at non-coplanar fields (=> Phantom mustn't be deflected during the measurement!)
  - Start, stop and save each measurement (format .xcc). Extend the file name(s) with energy and couch angle information

Figure 3 presents the measurement workflow for an exemplary 6-Field prostate IMRT.

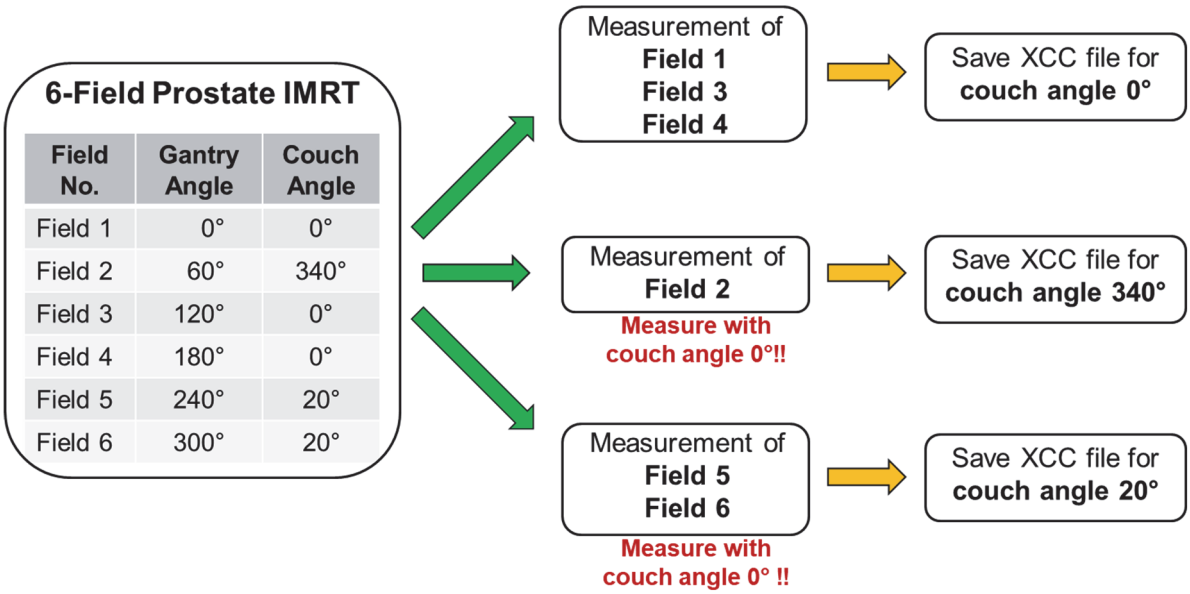

Figure 3: Exemplary presentation of the measurement workflow for a 6-Field Prostate IMRT plan consisting of both coplanar and non-coplanar fields

2.3 Dose reconstruction in Verisoft

- Select *Tools → Options… → 4D Dosimetry* and activate *Non-coplanar 4D dosimetry* as Non-Standard 4D dosimetry.

  Note: Make sure the phantom length used in treatment planning corresponds exactly to the phantom length used in VeriSoft for dose calculation. This is in particular important for beams penetrating the phantom's head. The phantom length used in VeriSoft can be adjusted in Tools → Options… → 4D Dosimetry (see Fig. 4).

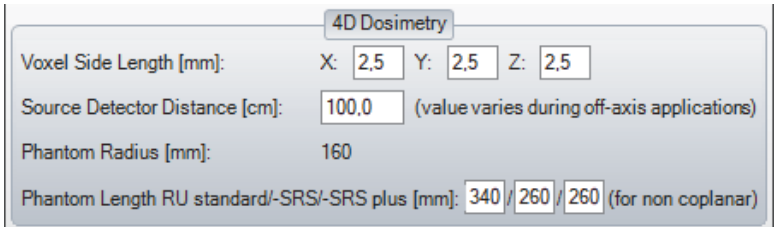

Figure 4: Definition of the phantom length used in VeriSoft for dose reconstruction for either the rotation unit standard, the rotation unit SRS or the rotation unit SRS plus (Default Rotation Unit: 340 mm, Rotation Unit SRS/SRS plus: 260 mm)

- Select *File → Data Set A/B → Open…* and load the measurement file(s) of the off-axis measurement.
- The dialogue *Set an angle range for dataset A/B* appears. Perform the dose reconstruction as desired and define the couch angle that should be taken into account during dose reconstruction (See Fig. 5).
- After dose reconstruction continue with the comparison analysis as known.

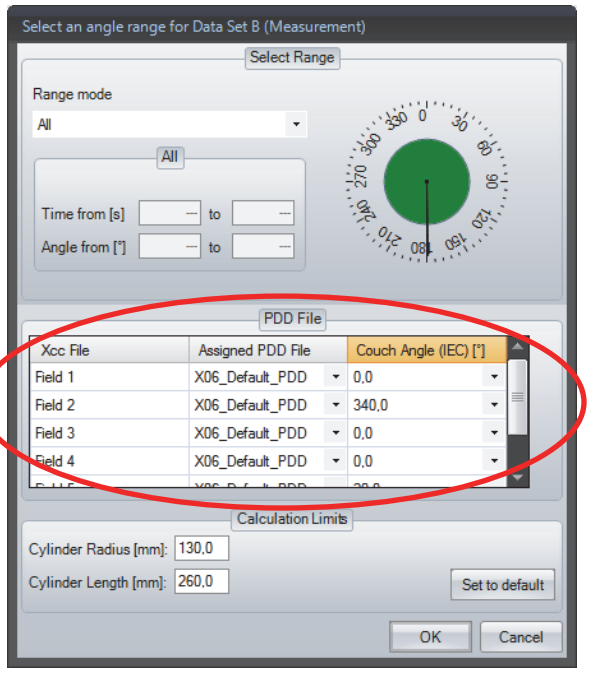

Figure 5: Definition of the couch angle in the dialogue *Set an angle range for dataset A/B.*

3 Compose measurements

VeriSoft allows to compose two measurements aiming to increase the length of the field of view of OCTAVIUS detector arrays from 26 cm to 48 cm (in case of OCTAVIUS® Detector 729 and 1500), from 11 cm to 20 cm (in case of OCTAVIUS® 1000^{SRS}) and from 15 cm to 18 cm (in case of OCTAVIUS® 1600^{SRS}). Compose measurements require VeriSoft 7.1 or higher as well as a OCTAVIUS Control Unit with serial number SN > 800.

3.1 Treatment planning

- For OCTAVIUS Detector 729 and 1500: recalculate the patient's treatment plan on the extended artificial CT dataset of OCTAVIUS (length 50 cm) provided by PTW (https://www.ptwdosimetry.com/en/octavius-4d-ct-scans/).
  Name: OCTAVIUS_4D_CT_structure_sets_RU_Standard_increased_length
  For OCTAVIUS Detector 100^{SRS} or 1600^{SRS} use the provided CTs:
  OCTAVIUS_4D_CT_structure_sets_RU_Standard
  OCTAVIUS_4D_CT_structure_sets_RU_SRS
  OCTAVIUS_4D_CT_structure_sets_RU_SRS_plus
- Export the RT Dose and the RT Plan file (treatment plan includes the total dose)

3.2 Phantom setup and measurement workflow

Step 1: Phantom setup for TARGET measurement

- Setup the rotation unit on the treatment table and align it at the isocenter using the laser system.
- Shift the rotation unit in TARGET direction using the treatment couch. This setup ensures that only the gearbox of the rotation unit will be irradiated (gearbox facing in GUN direction), but not the electrometers of the detector.

  Note: As the shift of the detector array must ensure that the detectors of both TARGET and GUN measurement are superimposed in the overlapping area the phantom shift is depending on the array type. Furthermore the maximum shifts are limited:

  Maximum shift:
  OCTAVIUS Detector 729 / 1500: 110 mm
  OCTAVIUS Detector 1000^{SRS}: 45 mm
  OCTAVIUS Detector 1600^{SRS}: 65 mm

  The shift must be a multiple of the following values:
  OCTAVIUS Detector 729: 10 mm
  OCTAVIUS Detector 1500: 5 mm
  OCTAVIUS Detector 1000^{SRS}: 2.5 mm
  OCTAVIUS Detector 1600^{SRS}: 2.5 mm

Step 2: TARGET measurement

- Open the "Measurement" window in VeriSoft.
- The "Measurement" window displays "Face Out" orientation (), which is the normal orientation of the Rotation Unit (gearbox facing in GUN direction).
- Start the measurement and deliver plan.
- Save the measurement (format .xcc). Extend the file name with energy, shift direction and shift value information.

Step 3: Phantom setup change for GUN measurement

- Set gantry to 0°.
- Rotate the rotation unit by 180° and align it at the isocenter again (gearbox now facing in TARGET direction).
- Shift the rotation unit in GUN direction using the same shift value as applied in step 1.

Step 4: GUN measurement

- In the “Measurement” window, select *Face In* orientation ( ). This inverts the rotation direction of the rotation unit in order to ensure a synchronous rotation with the gantry.
  Note: The rotation direction can only be switched when the rotation unit/gantry is at 0°.
- Start measurement and deliver plan.
- Save the measurement (format .xcc). Extend the file name with energy, shift direction and shift value information.

3.3 Dose reconstruction in Verisoft

- Select *File → Data Set A/B → Compose.* The *Open Data to Compose dialog* will appear (see Fig. 6)
- Click the “Open #1” button to load “Face Out“ measurement.
- Click the “Open #2” button to load “Face In” measurement.
- In the „TG Offset” input box, enter the shift value in [mm].
- By clicking *OK,* the “Face Out” and “Face In” measurements will be automatically composed.
- The dialogue *Set an angle range for dataset A/B* appears. Perform the dose reconstruction as desired.
- After dose reconstruction continue with the comparison analysis as known.

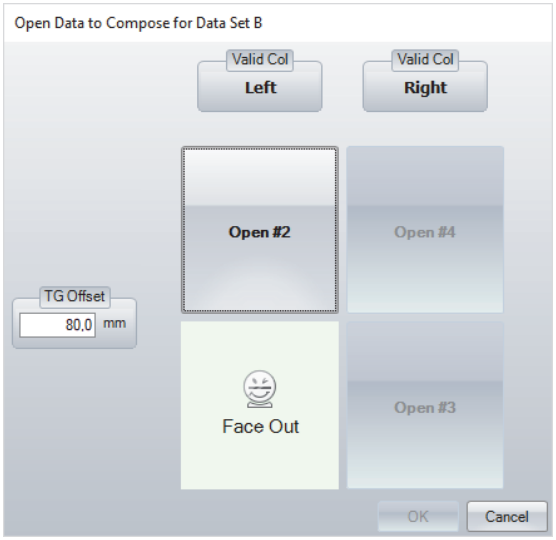

Figure 6: ***Loading of “Face Out/ Face In” measurements in VeriSoft***

4 Measurements with multiple energies

Treatment plans can contain mixed photon energies (i.e. boosts with a different photon energy). VeriSoft 7.1 or higher allows the dose reconstruction of added measurements with different energies.

4.1 Treatment planning

- Import one of the artificial CT datasets of OCTAVIUS provided by PTW into your TPS (https://www.ptwdosimetry.com/en/octavius-4d-ct-scans/).
  Names:
  OCTAVIUS_4D_CT_structure_sets_RU_Standard
  OCTAVIUS_4D_CT_structure_sets_RU_SRS
  OCTAVIUS_4D_CT_structure_sets_RU_SRS_plus
- Recalculate the patient’s treatment plan on the artificial CT. The treatment plan includes all beams with all energies.
- Export the RT Dose and the RT Plan file (treatment plan includes the total dose).

4.2 Phantom setup and measurement workflow

- Setup the rotation unit on the treatment table and align it at the isocenter using the laser system.
- Open the “Measurement” window in VeriSoft.
- Start the measurement and deliver all beams that belong to a certain energy.
- Stop and save the measurement (format .xcc). Extend the file name with energy information.
- Repeat these steps for each energy.

4.3 Dose reconstruction in Verisoft

- Select *Tools* → *Options…* → *4D Dosimetry* and activate *4D dosimetry for multiple energies* as non-standard 4D dosimetry.
- Select *File* → *Data Set A/B* → *Open…* and load all the measurement files acquired before.
- The dialogue *Set an angle range for dataset A/B* appears. Perform the dose reconstruction as desired and define the energy (PDD file) for each of the loaded measurement files (see Fig. 7).
- After dose reconstruction continue with the comparison analysis as known.

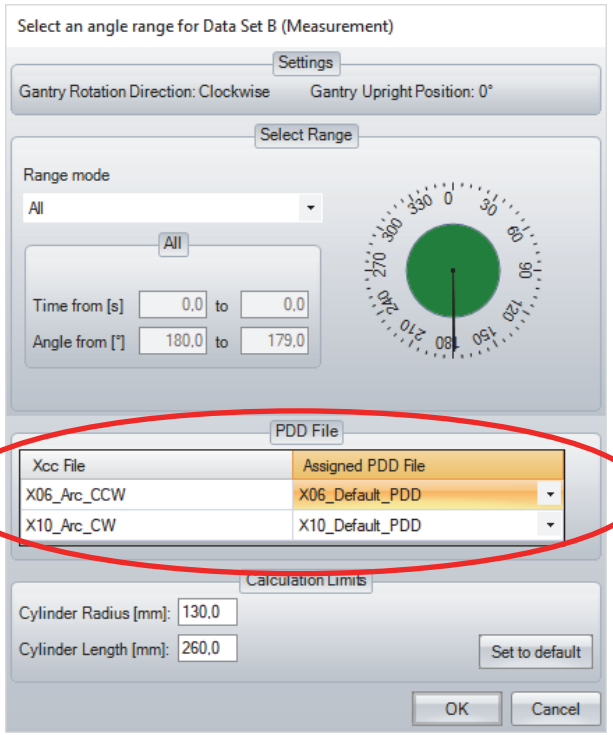

Figure 7: Definition of different PDD files for added measurements with multiple energies.

Disclaimer

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