Dose reconstruction in standard & off-axis situations

In the **standard situation** (OCTAVIUS 4D phantom placed at the LINACs isocenter), the 3D dose distribution is determined as described in our white paper (Allgaier et al., Dose reconstruction in the OCTAVIUS 4D phantom and in the patient without using dose information from the TPS, variables & figures adapted):

1. Convert the PDDs measured in water upon commissioning to PDDs in the OCTAVIUS 4D phantom, using the known relation of the electron densities of water and phantom material
2. At the current gantry angle (time) consider one detector of the detector panel ("current detector")
3. Measure the dose D_q in Gy at this position
4. Construct a ray line through the current detector to the focus of the beam
5. Determine the current field size A from the irradiated detectors
6. Apply corrections for non-central-axis TPRs according to [1] in case of beams with flattening filter, or according to [2] in case of flattening filter free (FFF) beams
7. Inside the phantom, using the PDD appropriate for the current field size, reconstruct dose values D_P in Gy at the distance z_P from the current detector along the ray line according to equation (1)
8. Do this for all detectors of the detector panel
9. Do this for all gantry angles
10. Sort all of the dose values obtained this way into voxels of 2.5 x 2.5 x 2.5 mm³ (can be changed by the user) by linear interpolation
11. For the Detector 729 and the Detector 1500, remove a layer of 3 cm in thickness from the outer shell of the phantom to obtain a dose grid in a cylinder with 26 cm in diameter and 26 cm in length. For the Detector 1000 SRS the reconstructed cylinder is 11 cm in diameter and 11 cm in length.

VeriSoft formalism for standard dose reconstruction in the OCTAVIUS 4D phantom with standard top (diameter: 32 cm) according to Fig. 1:

$$D_P = D_q \cdot \frac{PDD(z_P, A, SSD_{85}, h\nu)}{PDD(z_q, A, SSD_{85}, h\nu)} \qquad (1)$$

In the **off-axis situation** (OCTAVIUS 4D phantom positioned off-axis), the 3D dose distribution is determined as described in the following:

1. Convert the PDDs measured in water upon commissioning to PDDs in the OCTAVIUS 4D phantom, using the known relation of the electron densities of water and phantom material
2. At the current gantry angle (time) consider one detector of the detector panel ("current detector")
3. Measure the dose D_q in Gy at this position
4. Construct a ray line through the current detector to the focus of the beam
5. Determine the current field size A from the irradiated detectors
6. Calculate the current SSD_{new} at the current gantry angle (time)
7. Apply corrections for non-central-axis TPRs according to [1] in case of beams with flattening filter, or according to [2] in case of flattening filter free (FFF) beams
8. Inside the phantom, using the PDD appropriate for the current field size, reconstruct dose values D_P in Gy at the distance z_P from the current detector along the ray line according to equation (2)

taking into account the current SSD_{new} according to [3]. (Comment: We take the influences of the inverse square law into account. Changes in scattering are neglected as recommended.)

9. Do this for all detectors of the detector panel
10. Do this for all gantry angles
11. Sort all of the dose values obtained this way into voxels of 2.5 x 2.5 x 2.5 mm³ (can be changed by the user) by linear interpolation
12. For the Detector 729 and the Detector 1500, remove a layer of 3 cm in thickness from the outer shell of the phantom to obtain a dose grid in a cylinder with 26 cm in diameter and 26 cm in length. For the Detector 1000 SRS the reconstructed cylinder is 11 cm in diameter and 11 cm in length.

VeriSoft formalism for off-axis dose reconstruction in the OCTAVIUS 4D phantom with standard top (diameter: 32 cm) according to Fig. 1:

$$D_P = D_q \cdot \frac{PDD(z_P, A, SSD_{85}, h\nu) \cdot \left(\frac{SSD_{85} + z_p}{SSD_{new} + z_p}\right)^2}{PDD\left(z_q, A, SSD_{85}, h\nu\right) \cdot \left(\frac{SSD_{85} + z_q}{SSD_{new} + z_q}\right)^2} \qquad (2)$$

Generally, for dose reconstruction in the OCTAVIUS 4D phantom with SRS top (diameter: 17 cm) SSD_{95} has to be used instead of SSD_{85} .

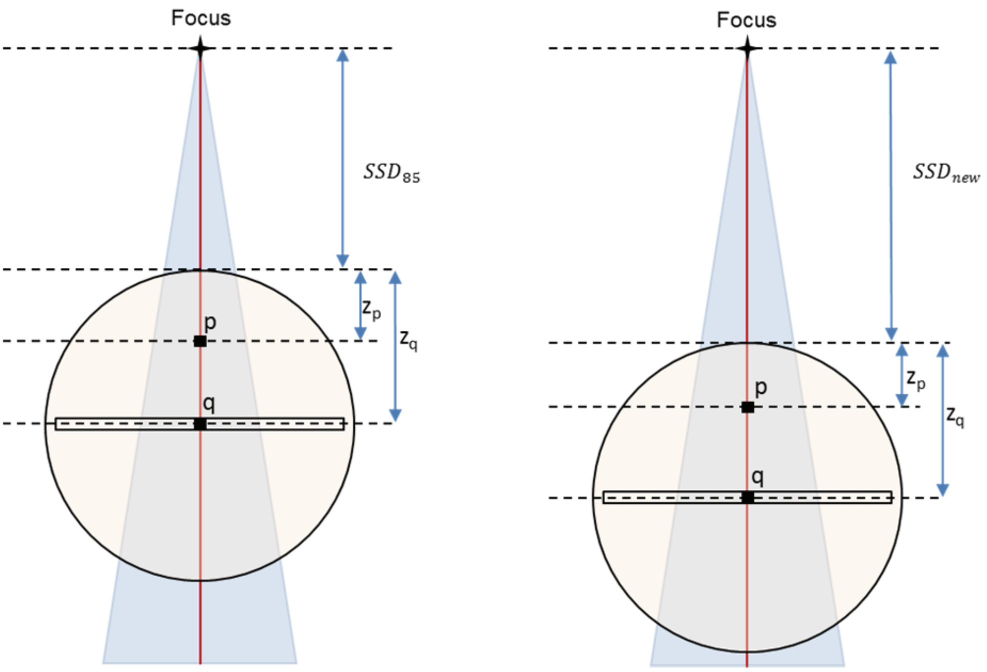

Figure 1: Standard situation with SSD_{85} (left) and off-axis situation with SSD_{new} (right)

[1] R. C. Taylor et al., "A generic off-axis correction for linac photon beam dosimetry", Med. Phys. 25 (5), May 1998, 662 - 667<Literaturliste>
[2] Dietmar Georg and Gabriele Kragl, „Photon beam quality variations of a flattening filter free linear accelerator“, Med. Phys. **37** (1), January 2010, 49 – 53
[3] A Handbook for Teachers and Students, E.B. Podgorsak Technical Editor, International Atomic Energy Agency, Vienna, 2005, STI/PUB/1196, ISBN 92–0–107304–6

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