3D treatment planning: tricks and tips

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Aims of interstitial implants

- good dose coverage of the target volume
- uniform dose distribution inside the target volume
- steep dose fall-off outside the target volume

Both the dose **homogeneity** and **conformality** can be manipulated by using individual source dwell times in the different dwell positions.
DNR as a function of prescription isodose

Catheter separation: 15 mm
DNR in the function of reference isodose at different number of catheters

No optimization
Catheter separation: 15 mm
Source step size: 5 mm
DNR in the function of reference isodose at different active lengths

No optimization
Catheter separation: 15 mm
Source step size: 5 mm
$DNR_{\text{min}}$ as a function of ratio of step size and catheter separation
COIN in the function of active length
(single-plane implant, $L_{PTV}=5$ cm, $d=1$ cm, GOS, CI=0.95)
Optimal active lengths ($L_a$) for the dosimetry systems

<table>
<thead>
<tr>
<th>System</th>
<th>$L_a$</th>
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<tbody>
<tr>
<td>Paris Dosimetry System</td>
<td>$L_a = 1.3 \text{–} 1.6 \times L_{PTV}$</td>
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<tr>
<td>Geometrically Optimized System</td>
<td>$L_a = L_{PTV}$</td>
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<tr>
<td>Conformal Dosimetry System</td>
<td>$L_a = L_{PTV} - (0.5 \text{–} 1.0) \text{ cm}$</td>
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<tr>
<td>Stepping Source Dosimetry System</td>
<td>$L_a = L_{PTV} - (0.5 \text{–} 1.0) \text{ cm}$</td>
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Effect of dose prescription on target coverage and dose homogeneity in interstitial brachytherapy
Dose prescription in the Paris dosimetry system

Reference isodose = 85% of BD

Basal dose points with dose of $BD_x$

$$BD = \frac{BD_1 + BD_2 + ... + BD_5}{5}$$
CI = 0.94
DNR = 0.33
CI = 0.90
DNR = 0.26
CI = 0.84
DNR = 0.22
CI = 0.77
DNR = 0.19
CI = 0.68
DNR = 0.18
CI = 0.57
DNR = 0.19
CI = 0.45
DNR = 0.20
Effect of dose optimization on target coverage, dose homogeneity and conformality in interstitial brachytherapy
CI = 0.68
DNR = 0.18
Graphical optimization in one plane

CI = 0.75
DNR = 0.19
Graphical optimization in multiple planes

CI = 0.90
DNR = 0.29
Graphical optimization in multiple planes

CI = 0.90
DNR = 0.29
COIN = 0.75
Dose point optimization on points on target

CI = 0.92
DNR = 0.39
COIN = 0.83
Dose point optimization on points on target

CI = 0.92
DNR = 0.39
COIN = 0.83
Highly conformal, but inhomogeneous dose distribution
1. The uniformity of dose distribution in interstitial implants can be improved by
   - increasing the active lengths in the catheters
   - using more catheters/needles
   - applying optimal ratio of step size/catheter separation (0.75)
   - selecting appropriate isodose for prescription

2. The active lengths in the catheters have to be adapted to the type of
   optimization. Keep the dwell positions inside the PTV when dose point
   optimization is used.

3. The conformal dosimetry system can provide highly conformal dose
   distributions but the dose homogeneity may deteriorate.

4. In image-based brachytherapy use DVH-based dose prescription and apply
   volumetric parameters for plan evaluation.
Our current planning protocol

1. Keeping active source positions inside the PTV

2. **Geometrical optimization followed by graphical optimization**

3. Definition of basal plane and basal dose points

4. Normalization (100 %) on mean central dose (MCD)

5. Dose prescription on individual isodose line to get CI ≥ 0.9 and DNR ≤ 0.35

6. Keeping the maximal skin dose below 70 % of prescribed dose