

60 Monate Tomo-Therapie am Universitätsklinikum Jena

Tomo-Therapie in der Strahlentherapie



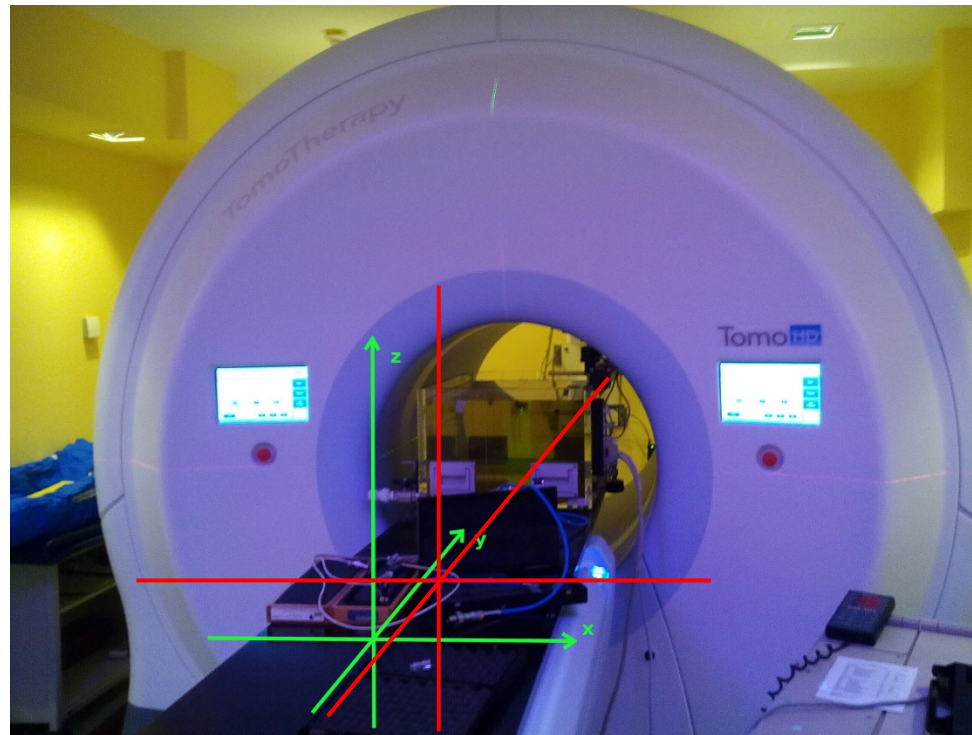
Helikale Tomo-Therapie: Isozentrum

Virtuelles Isozentrum

70 cm außerhalb der Gantry

Patientenreferenz

Patienten-individueller Referenzpunkt
max. ± 20 cm zu virtuellem Isozentrum



Helikale Tomo-Therapie: Au

Linearbeschleuniger

nom. Energie: 6 MV

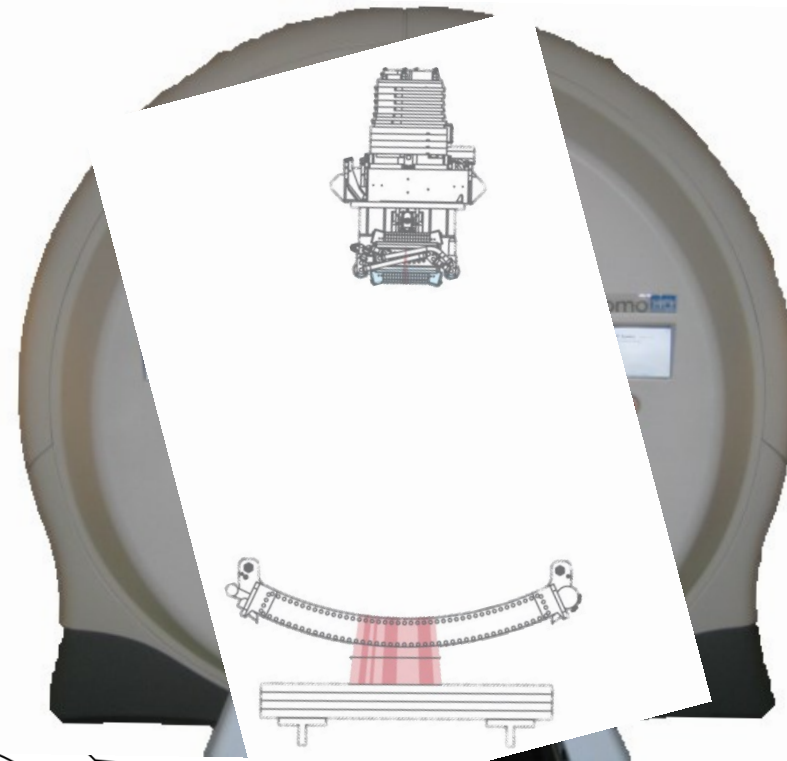
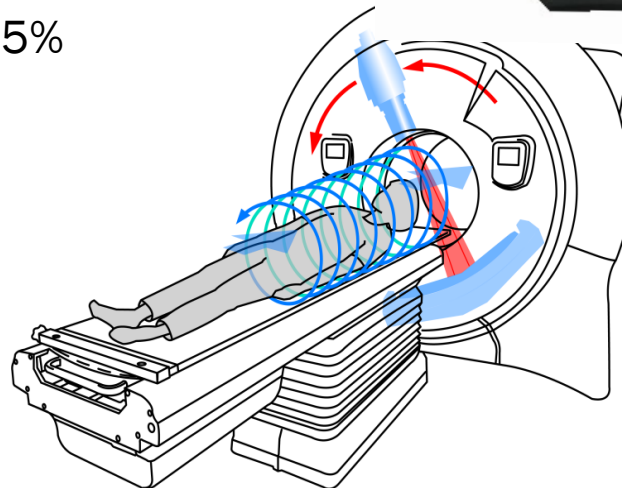
Jaw

Feldgröße in Long-Richtung: 1, 2.5, 5 cm

binärer MLC

64 Leaves - max. Feldbreite: 40 cm

Fahrzeit 20ms, Leakage: 0.25%



Helikale Tomo-Therapie Aufbau

Linearbeschleuniger

nom. Energie: 6 MV

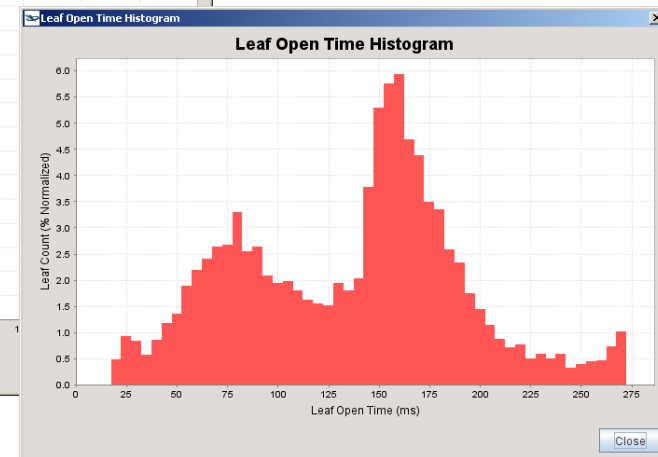
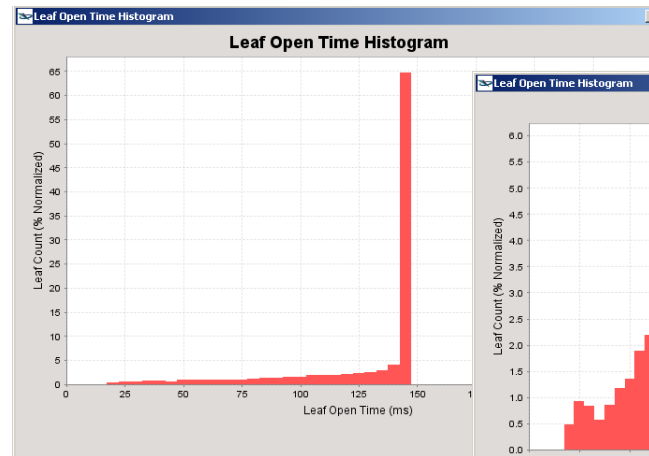
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MV-CT Detektor

Xenon gefüllte Detektoren

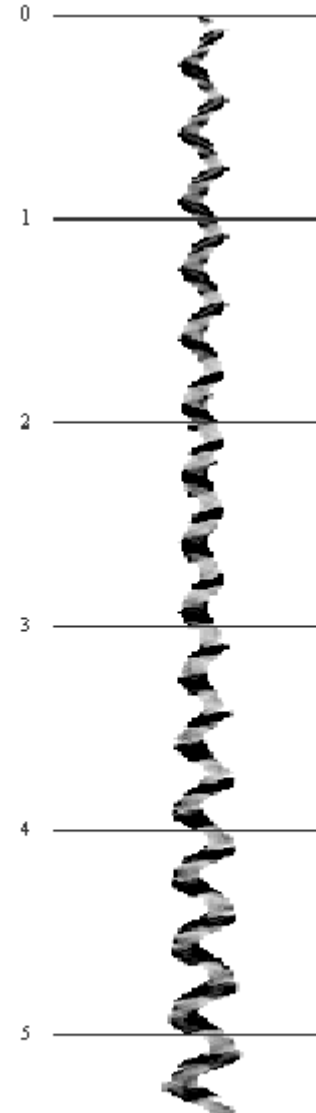
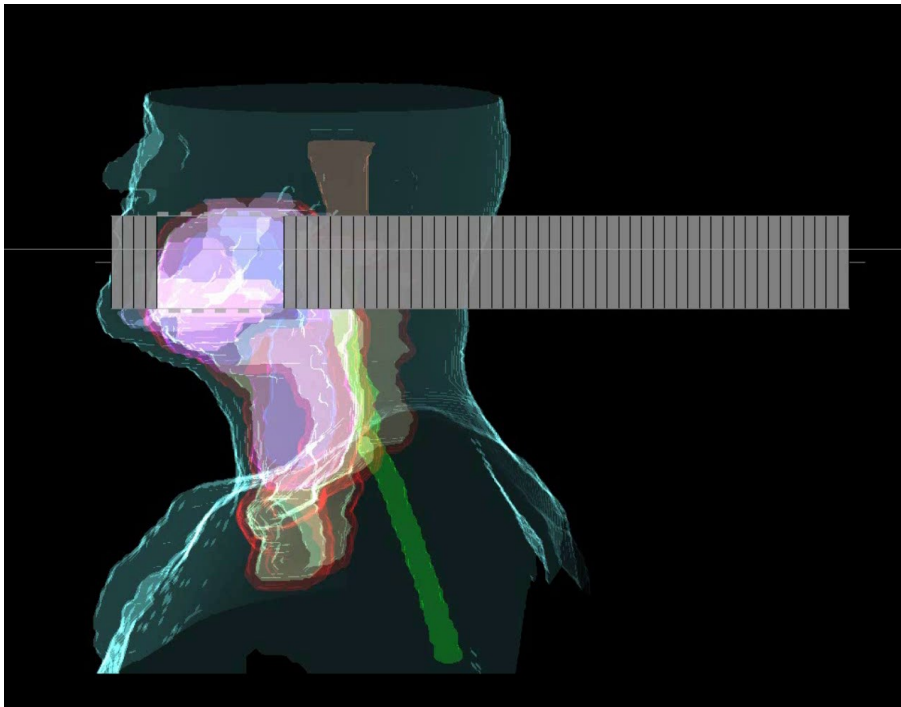
Field of View: 40cm

Beamstopper



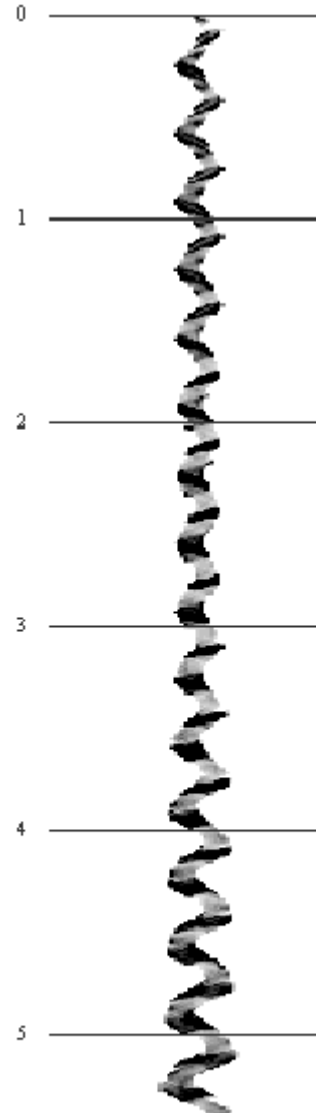
Helikale Tomo-Therapie: Vorteile Fluenzmodulation

- + Helikal: Vorschub pro Gantryrotation klein gegenüber der Jaw-Öffnung
- + fluenzmodulierte Projektionen



Helikale Tomo-Therapie: Vorteile Fluenzmodulation

- + Helikal: Vorschub pro Gantryrotation klein gegenüber der Jaw-Öffnung
- + fluenzmodulierte Projektionen
- + Bestrahlungslänge bis zu 160 cm



Helikale Tomo-Therapie: spezifische Parameter

Jaw - Öffnung

Sterzing et al - 2010 Int. J. Radiation Oncology Biol. Phys.

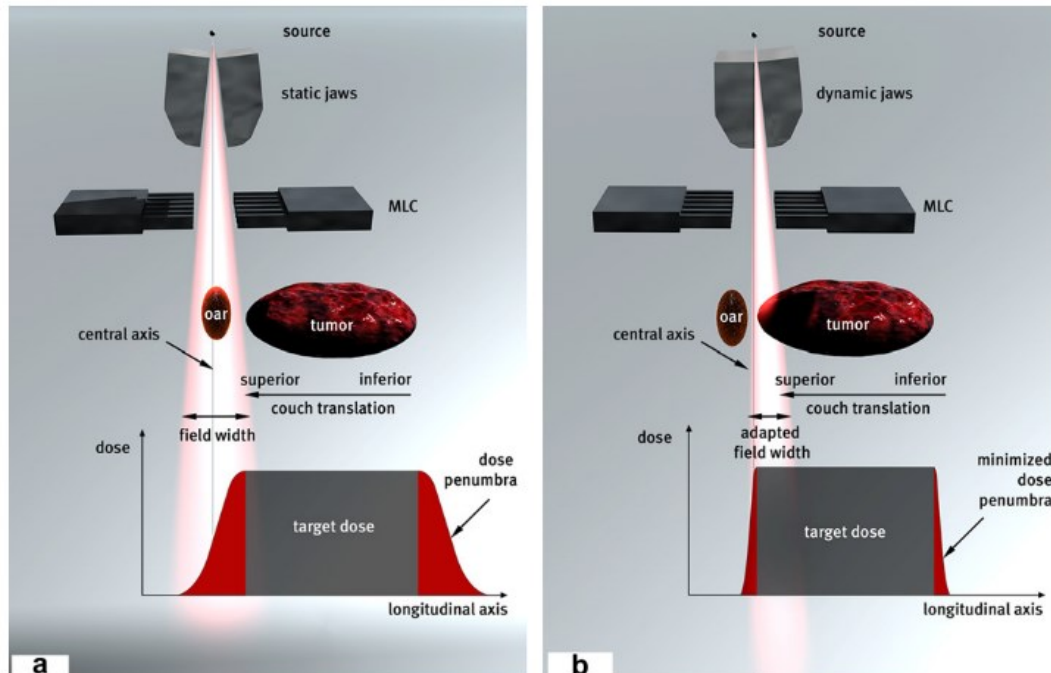


Fig. 1. Outline of jaw and fan beam characteristics of different delivery modes: (a) regular tomotherapy delivery causes a considerable dose penumbra above and below the target, whereas (b) RSS delivery with dynamic jaws reduces this dose exposure to healthy tissue. oar = organ at risk.

Helikale Tomo-Therapie: spezifische Parameter

Pitch

■ Def.:
$$\frac{\text{Tischvorschub [cm]}}{\text{Gantryrotation Feldöffnung [cm]}}$$

- optimaler Pitch = 0.86/n
Thread - Effect: *Kissick et al - 2005 Medical Physics*

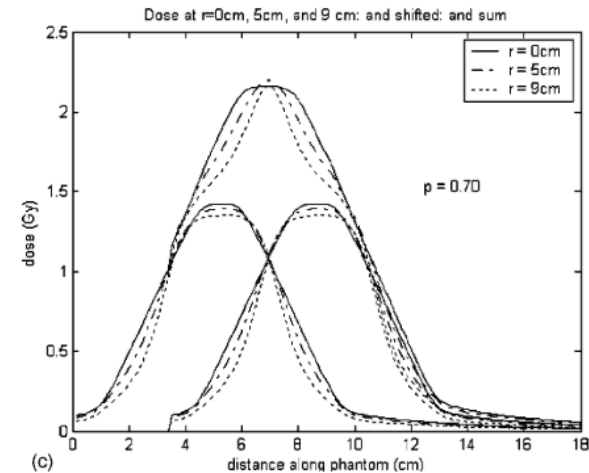
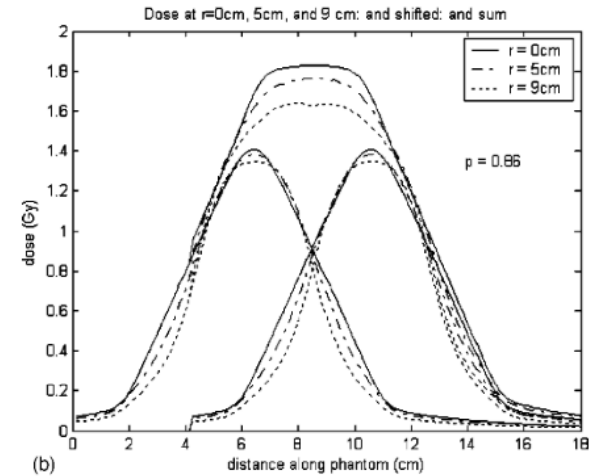
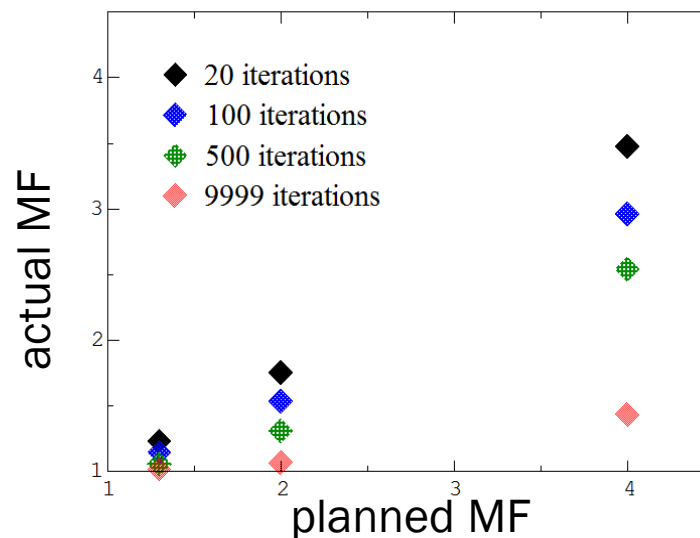
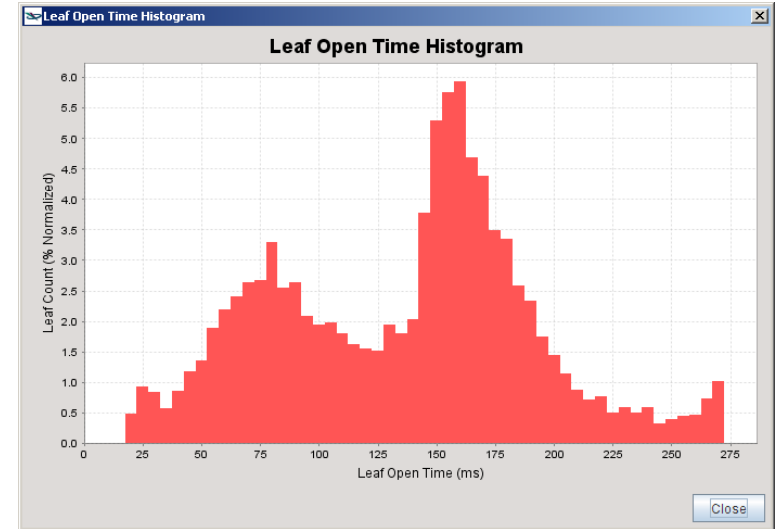


FIG. 6. Single rotation dose profile at radii=0, 5, 9 cm out from the iso-center, then shifted by width*pitch and added to the unshifted profiles. The shift and add is done with the full three-dimension dose profile. Notice the consequence of the non-triangular off-axis dose profiles shape and long axial dose profiles tails in creating the best junctioning at pitch of 0.86 (b) rather than at the expected pitch of 1.0 (a) or at pitch of 0.70 (c).

Helikale Tomo-Therapie: spezifische Parameter

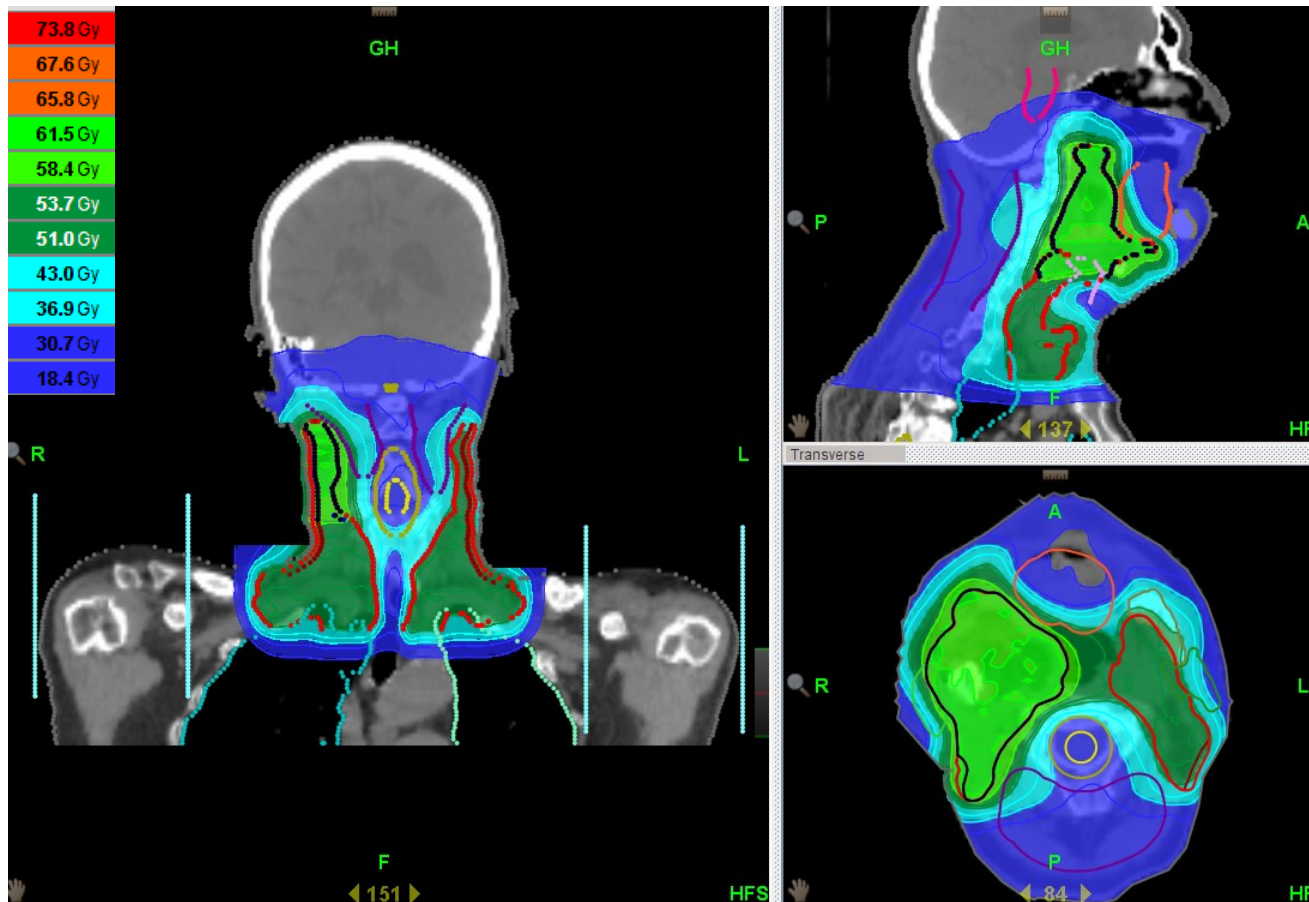
Modulationsfaktor

- Def.:
$$\frac{\text{maximale Leaföffnungszeit}}{\text{mittlere Leaföffnungszeit}}$$



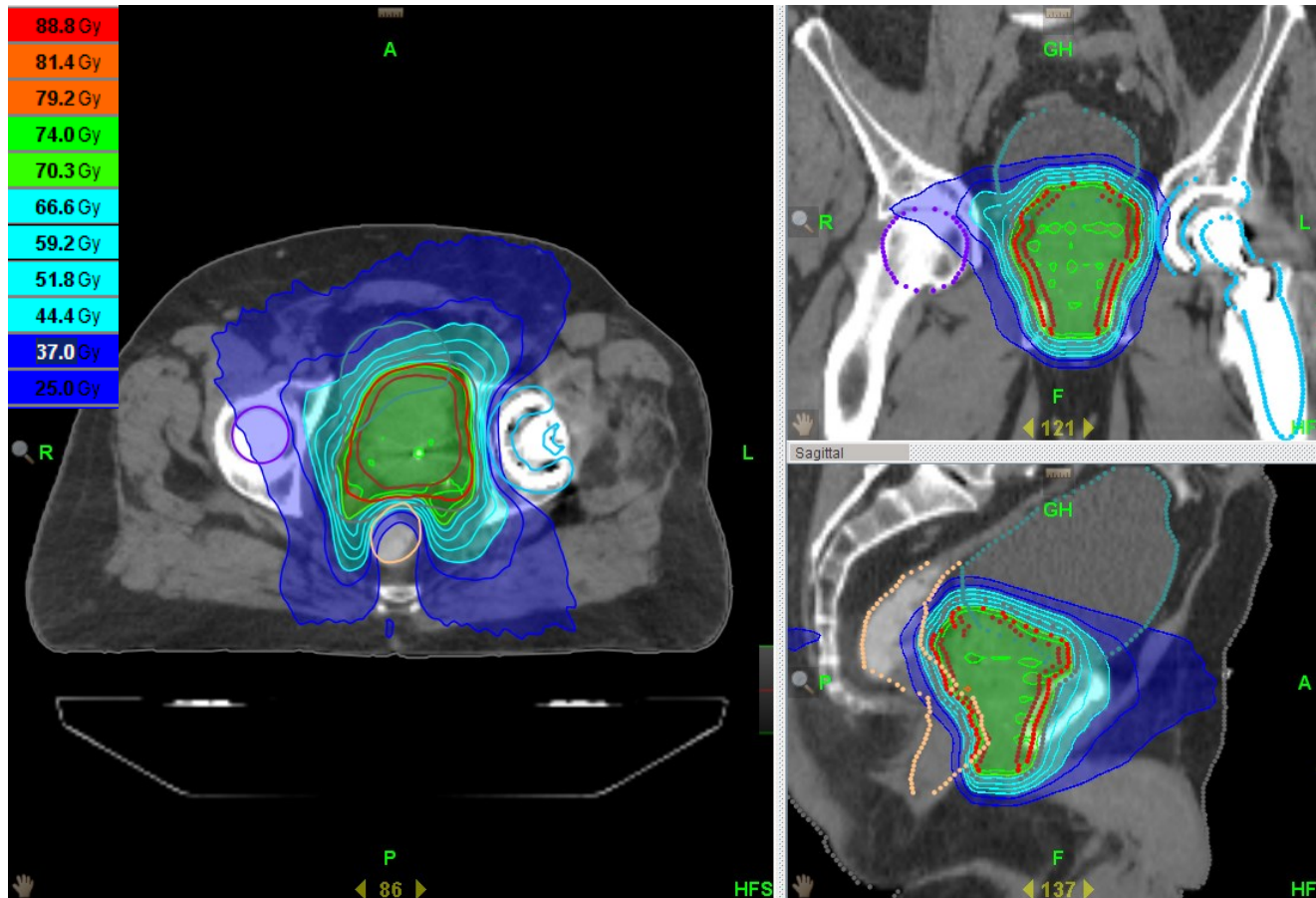
Helikale Tomo-Therapie: spezifische Parameter

Directional Block



Helikale Tomo-Therapie: spezifische Parameter

Directional Block



Planoptimierung in „Planning-Station“

Contouring ROIs Plan Settings Beam Angles Optimization Fractionation

Prescription
 Median For: PTV will receive **70.00 Gy** in 35 Fractions ROI contours have been resampled.

Target Constraints

Name	Display	Color	Blocked	Use	Importance	Max Dose [Gy]	Max Dose Pen.	DVH Vol	DVH Dose [Gy]	Min Dose [Gy]	Min Dose Pen.
CTV1 Prostatabett	<input checked="" type="checkbox"/>	2	Unblocked	<input type="checkbox"/>							
PTV	<input checked="" type="checkbox"/>	1	Unblocked	<input checked="" type="checkbox"/>	20	70.00	50	Median	70.00	70.00	50

Regions at Risk Constraints

Name	Display	Color	Blocked	Use	Importance	Max Dose [Gy]	Max Dose Pen.	DVH Vol	DVH Dose [Gy]	DVH Pt. Pen.
Harnblase	<input checked="" type="checkbox"/>	3	Unblocked	<input checked="" type="checkbox"/>	3	70.00	3	20.00	60.00	3
PTV+8mm	<input checked="" type="checkbox"/>	2	Unblocked	<input checked="" type="checkbox"/>	3	70.00	3	50.00	55.00	3
External	<input checked="" type="checkbox"/>	6	Unblocked	<input checked="" type="checkbox"/>	1	55.00	1	10.00	10.00	5
Hueftkopf links	<input checked="" type="checkbox"/>	4	Unblocked	<input type="checkbox"/>						
Hueftkopf rechts	<input checked="" type="checkbox"/>	5	Unblocked	<input type="checkbox"/>						
Rektum	<input checked="" type="checkbox"/>	1	Unblocked	<input checked="" type="checkbox"/>	5	70.00	5	15.00	65.00	5

Presets
 Lines
 Gy %

84.0 Gy
 77.0 Gy
 74.9 Gy
 70.0 Gy
 66.5 Gy
 63.0 Gy
 56.0 Gy
 49.0 Gy
 42.0 Gy
 35.0 Gy
 21.0 Gy
 7.0 Gy

Edit

Optimize

Dose Calc Grid: Normal
 Field Width: 2.5 cm - Jaws...
 Modulation Factor: 2.000
 Pitch: 0.300
 Batch Beamlets
 Mode: Beamlet
 Initiate Full Dose After 20 iterations.
 Start
 Get Full Dose
 Cancel

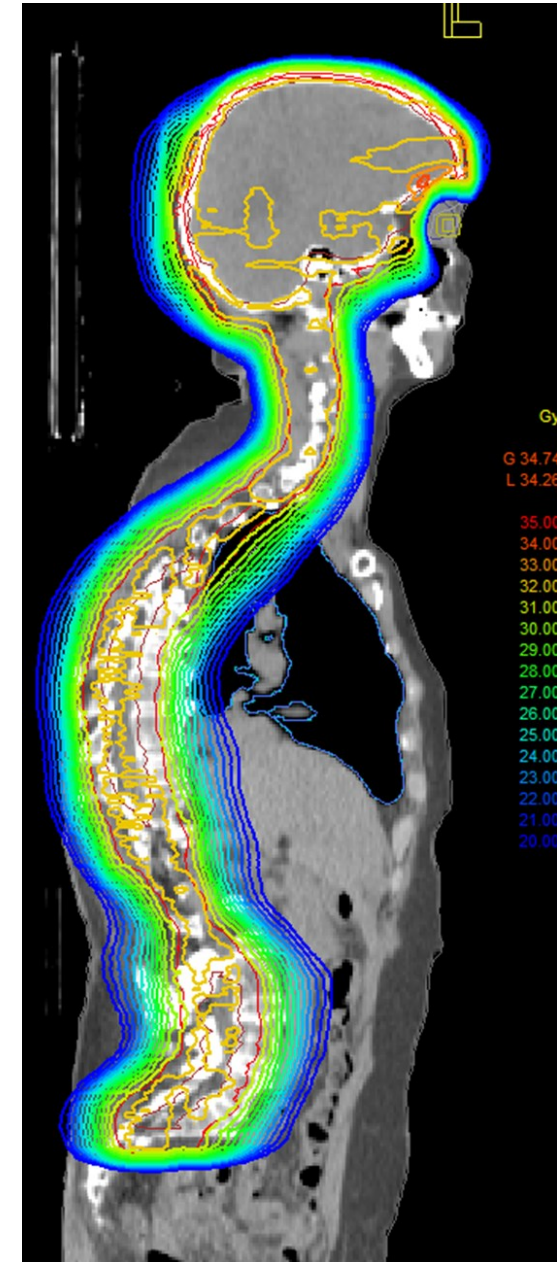
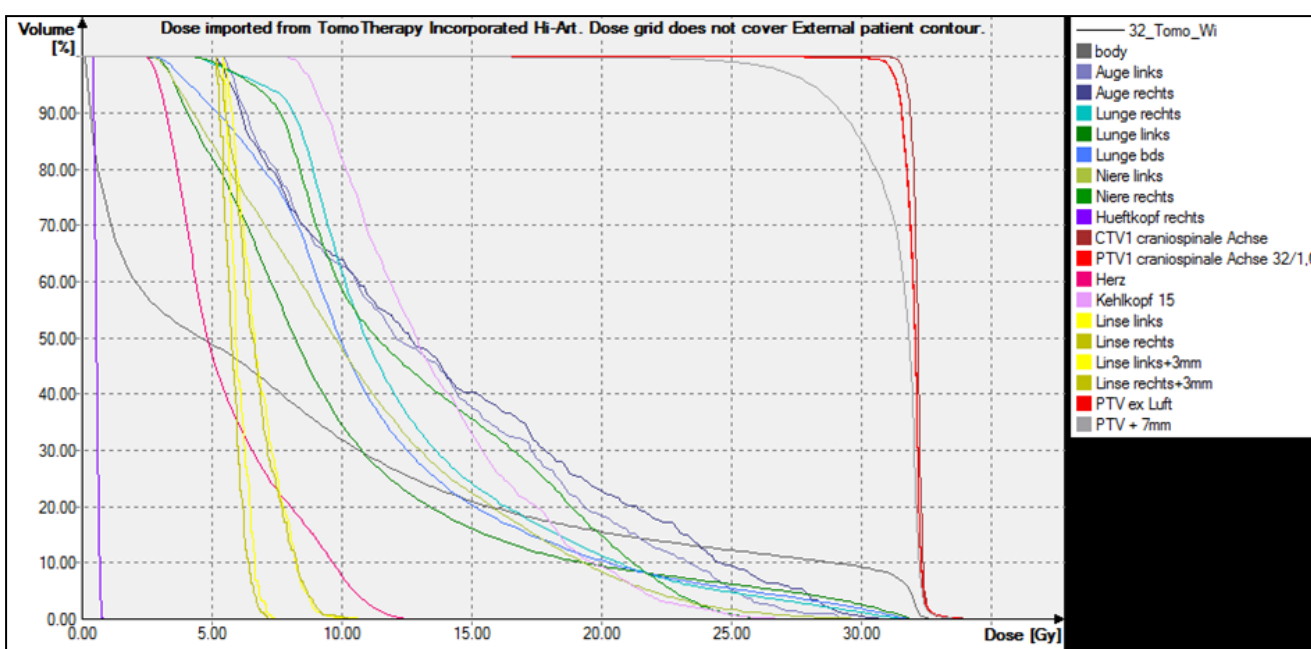
STANDARD Cumulative DVH Relative

Relative Volume (% Normalized)

Dose (Gy)

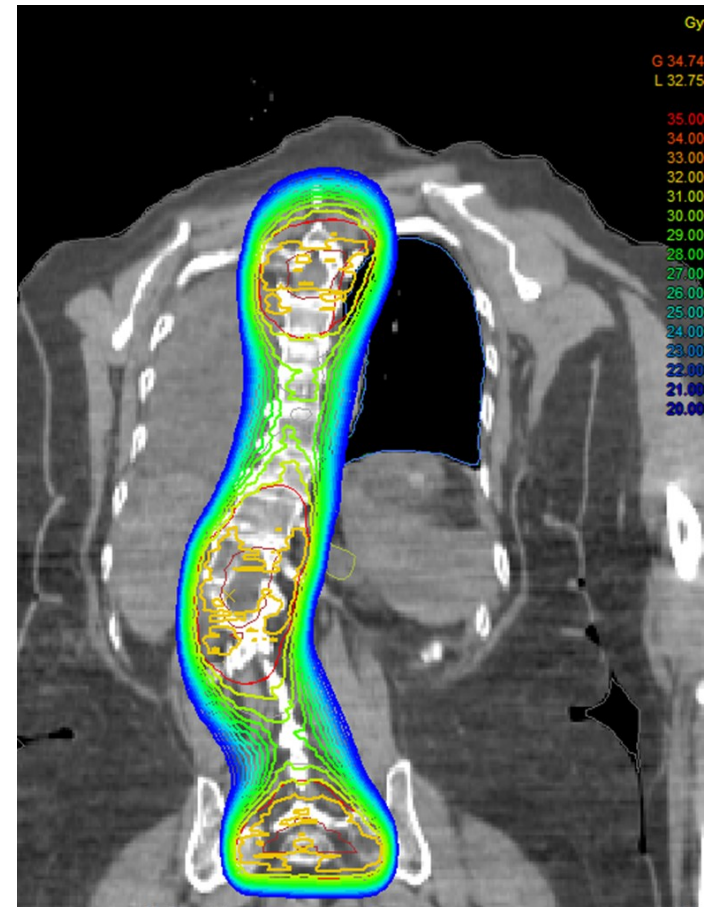
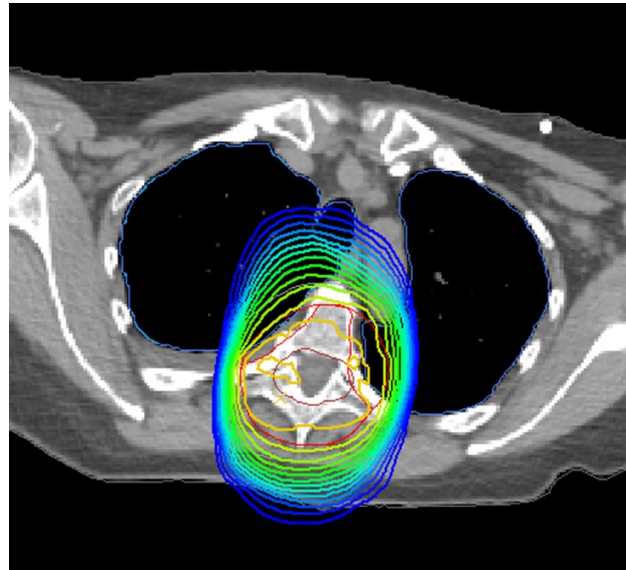
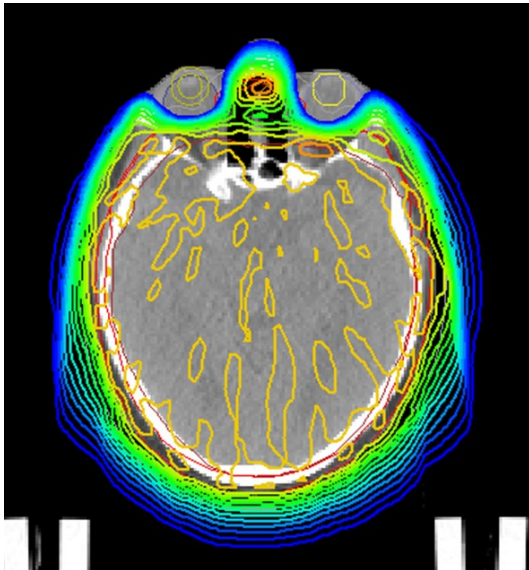
Ergebnisse Bestrahlungsplanung

Große Bestrahlungsregionen Neuro-Achse



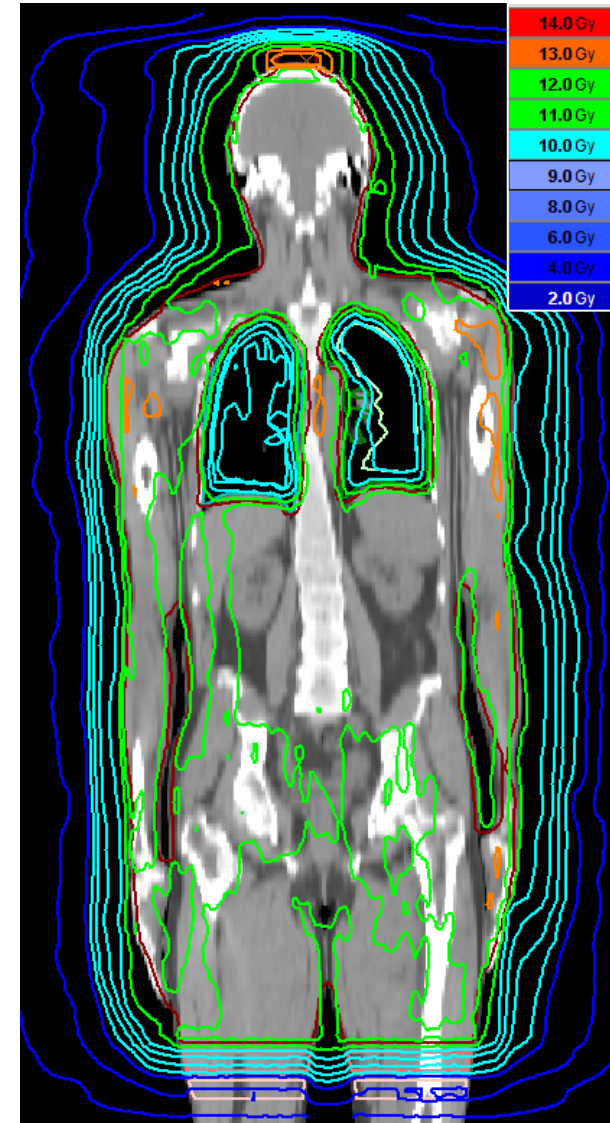
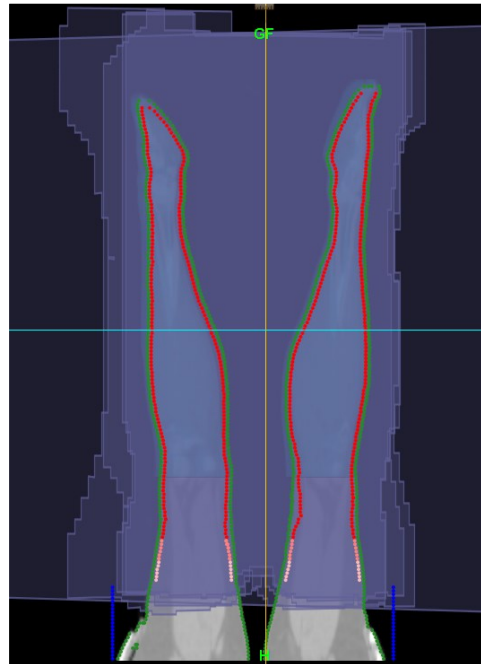
Ergebnisse Bestrahlungsplanung

Große Bestrahlungsregionen Neuro-Achse



Ergebnisse Bestrahlungsplanung

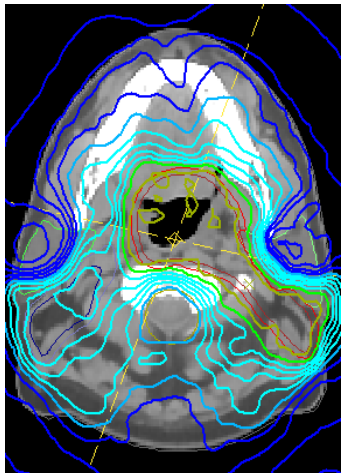
Große Bestrahlungsregionen Ganzkörper



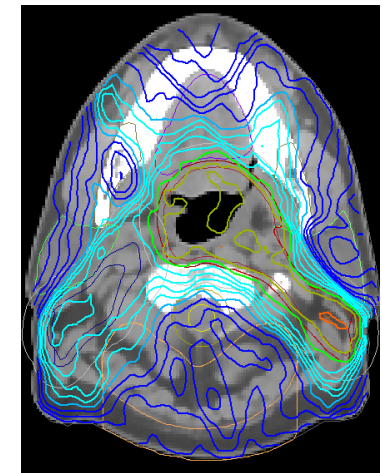
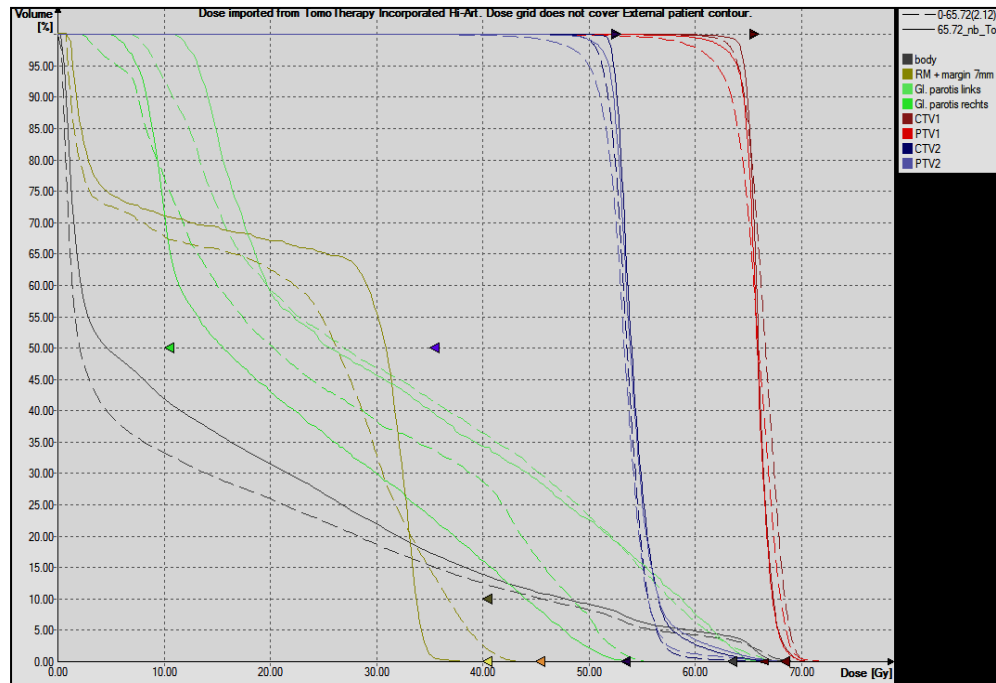
Ergebnisse Bestrahlungsplanung

Komplexe Zielgebiete

- Vergleich HNO m. simultan integr. Boost
- 65.72 Gy (2.12 Gy täglich) und 52.7 Gy (1.7Gy täglich)
- Tomo: steilere PTV-DVHs, Parotisschonung ipsilat. gleich, kontralat. besser



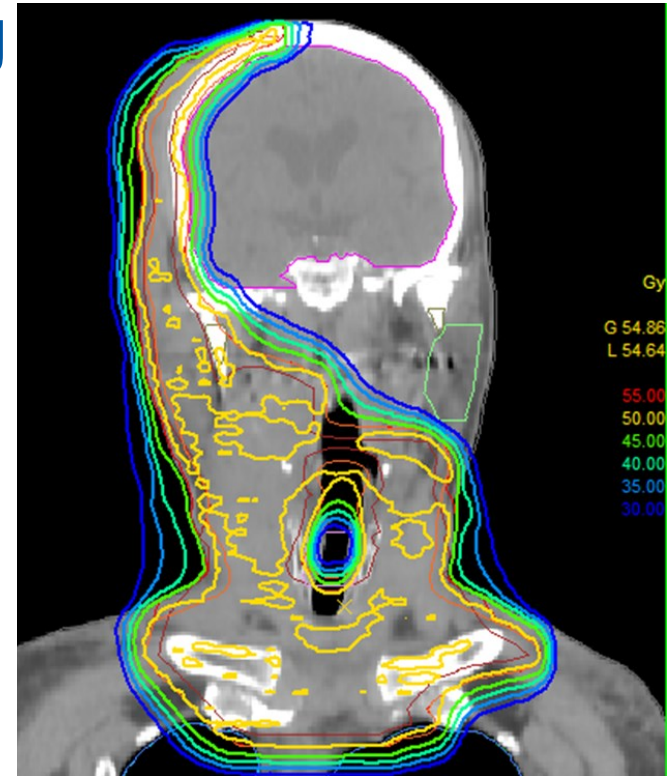
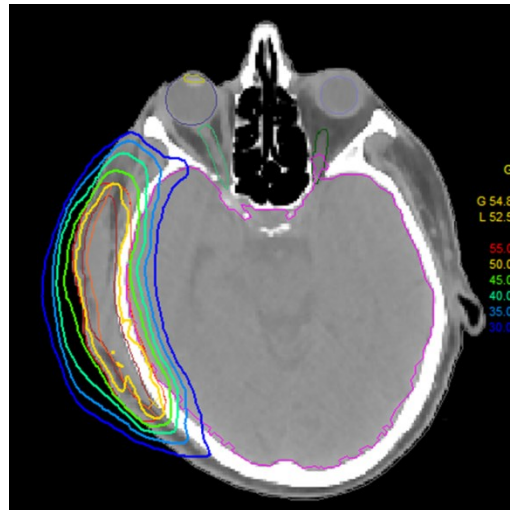
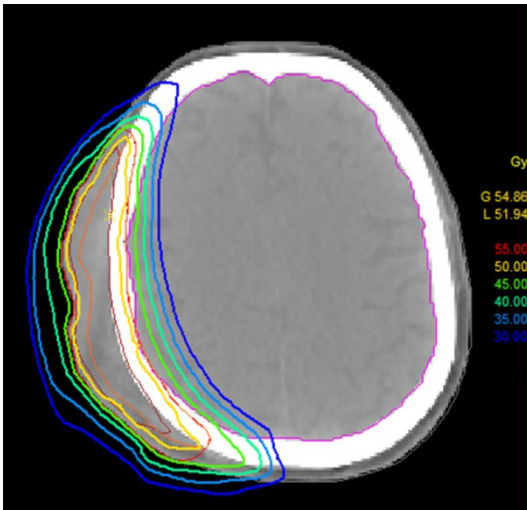
Tomo



11-Felder-IMRT

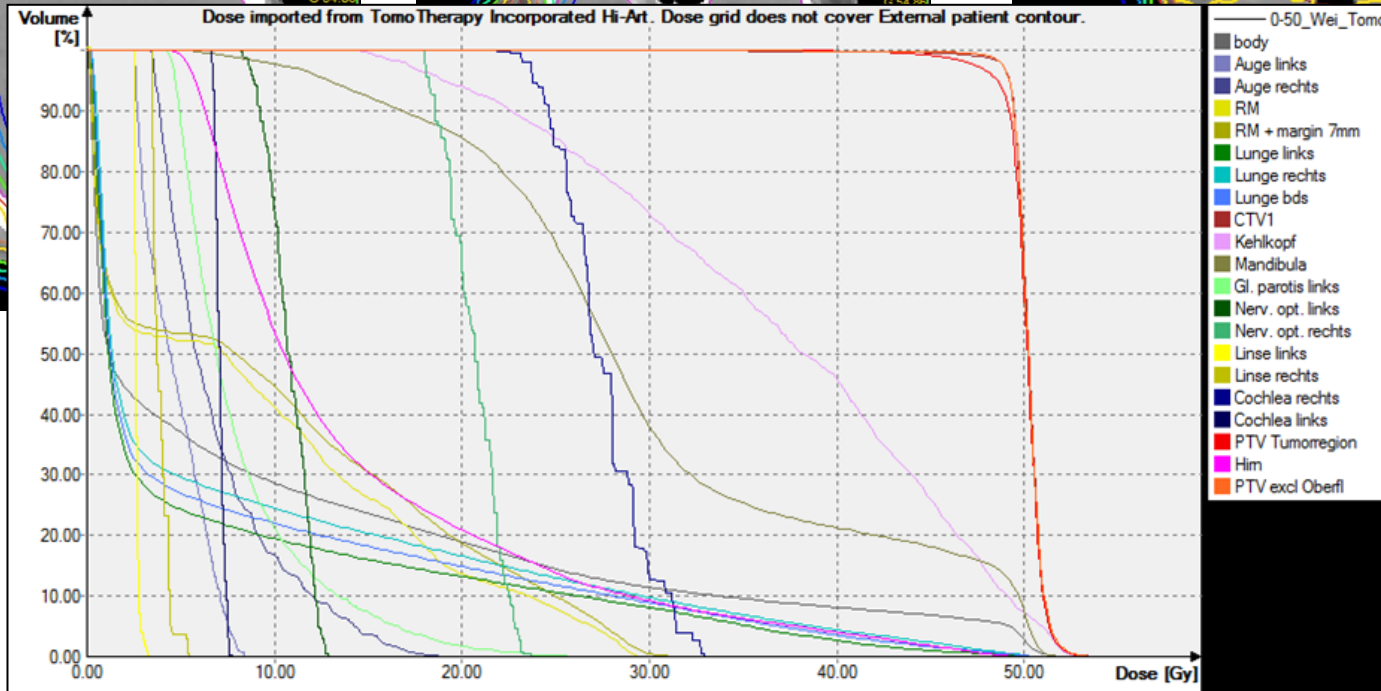
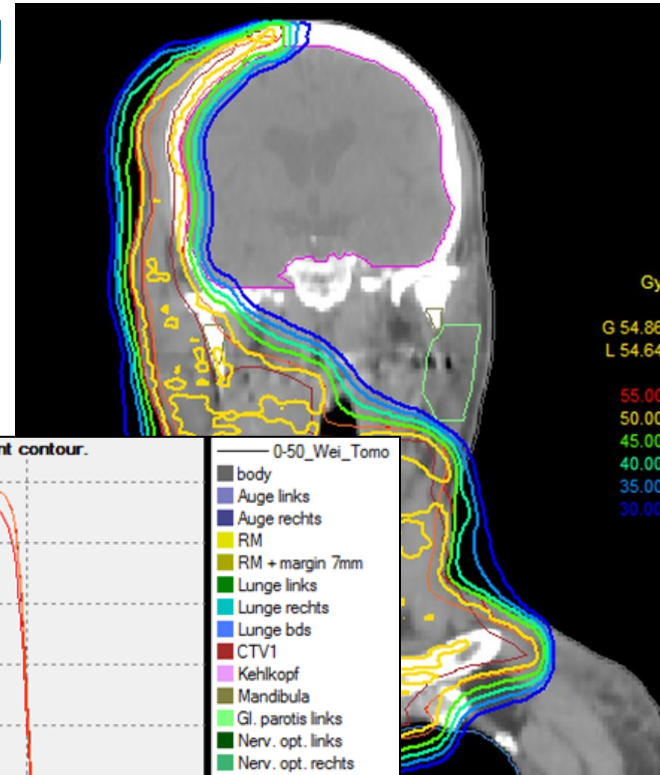
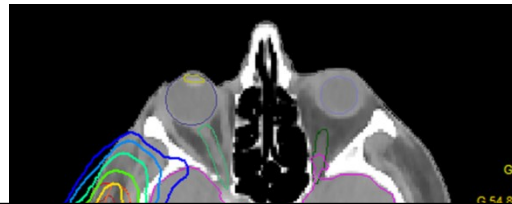
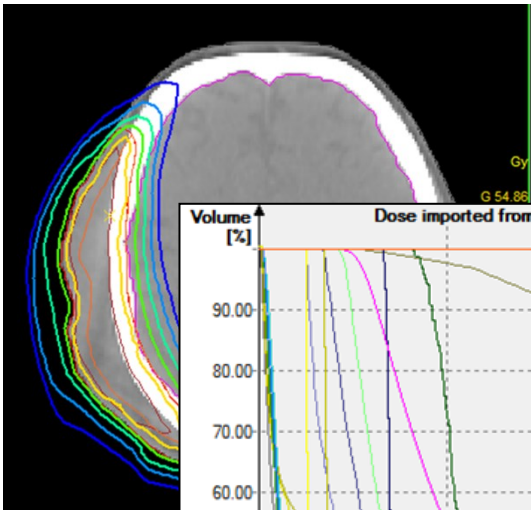
Ergebnisse Bestrahlungsplanung

Komplexe Zielgebiete



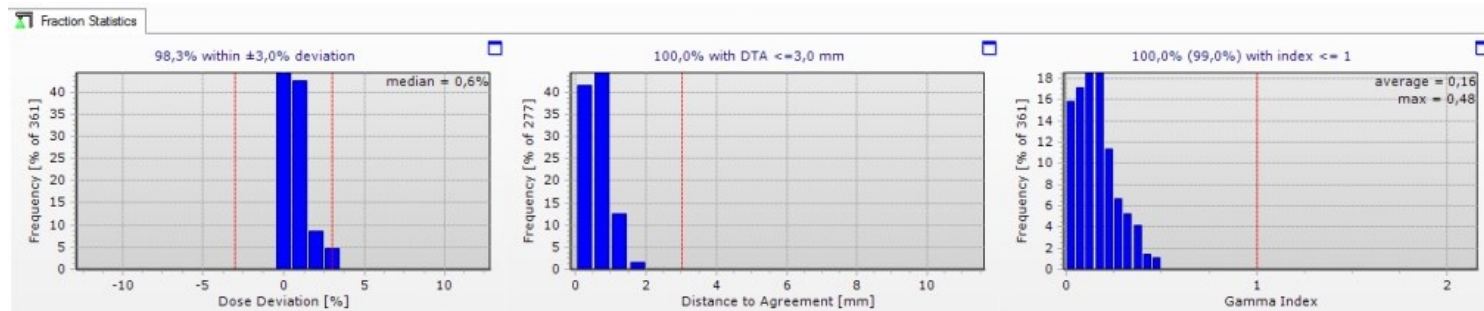
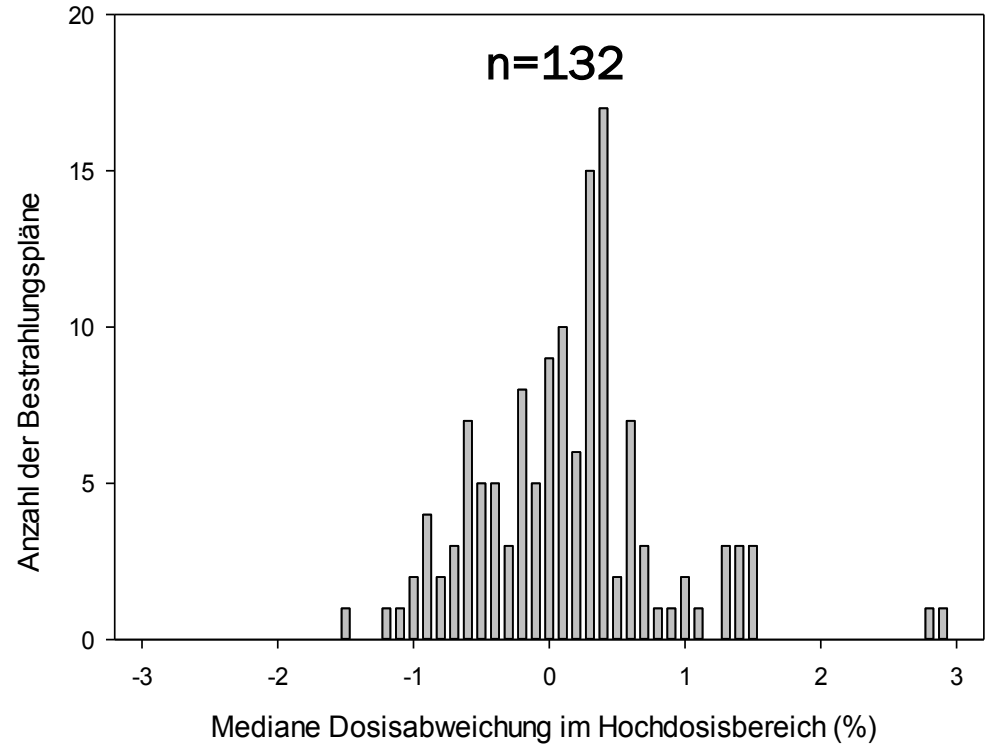
Ergebnisse Bestrahlungsplanung

Komplexe Zielgebiete



Dosimetrische Planverifikation

Delta4+, Scandidos



Behandlung nach MVCT Bildgebung

The screenshot displays the Accuray treatment planning software interface. The main window shows a head CT scan with various contours overlaid in different colors (red, blue, green, yellow, pink). The interface is divided into several control panels:

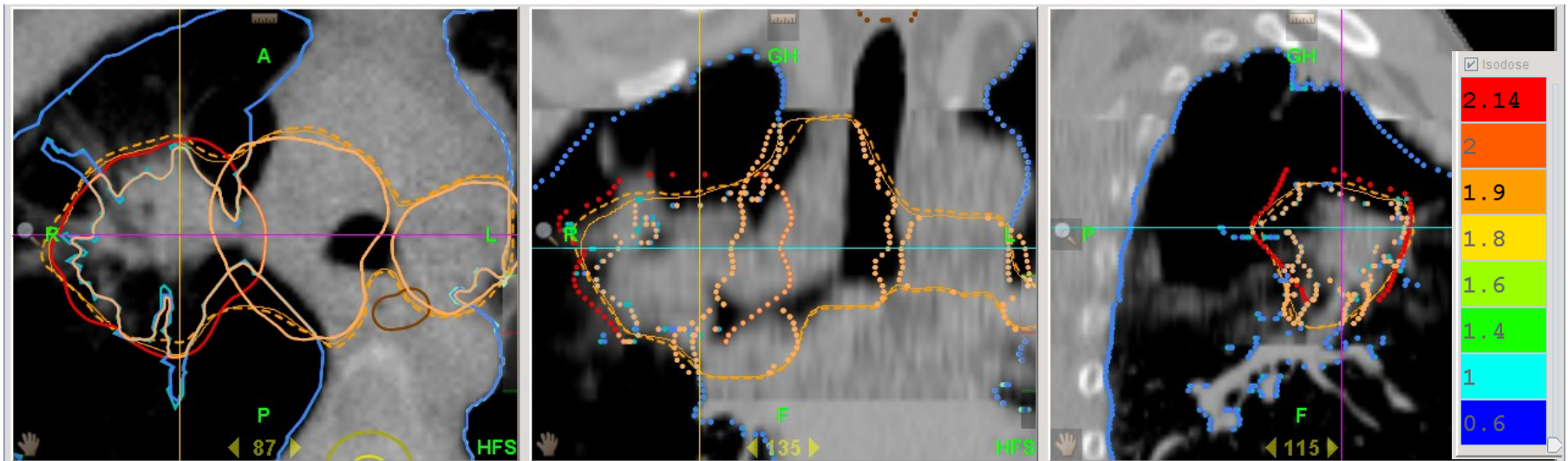
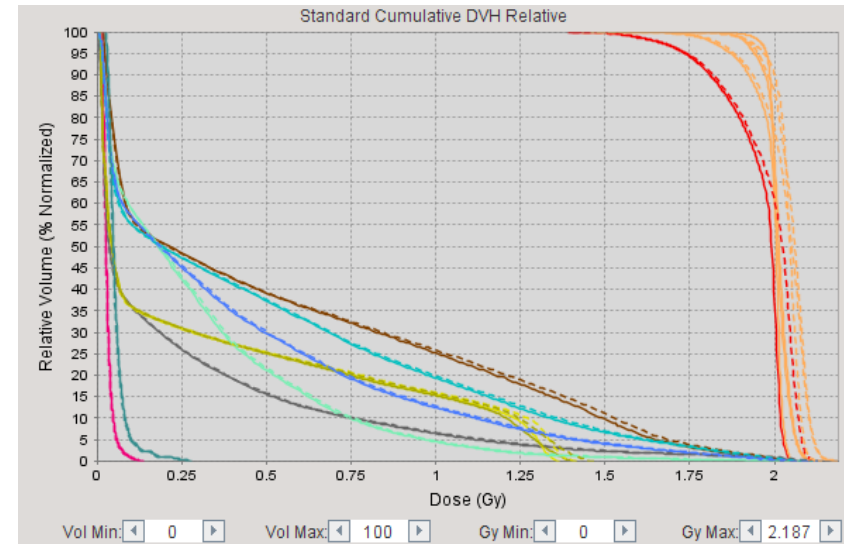
- Automatic Registration Control:** Includes dropdowns for 'Bone Technique', 'Standard Resolution', and 'Translations only'. A checkbox for 'Incomplete Field of View' is checked. A 'Start' button is present.
- Scan Image Control:** Features a 'Checker & Balance' section with a 'Balance' slider and a 'Checker' checkbox. A 'CTrue Image Filter' section is also visible.
- Orientation:** Radio buttons for 'Transverse', 'Coronal', and 'Sagittal' are shown. 'Transverse' is selected.
- Plan Image Control:** Includes a 'Dose & Lasers' section with a color-coded legend for dose levels (e.g., 84.957, 76.956, 72.957, 69.966, 66.967, 62.964, 61.005, 56.988, 50.027, 48.988, 46.986) and a 'Dose' field set to 9.96 Gy.
- Translational Adjustments (mm):** A table showing adjustments in millimeters:

Lateral	Long.	Vert.
-1.2	-3.1	4.0
- Rotational Adjustments (degrees):** A table showing adjustments in degrees:

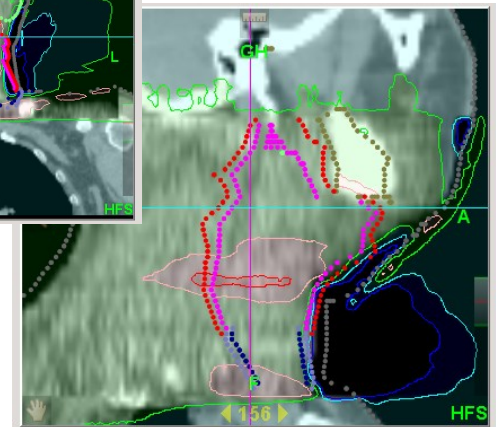
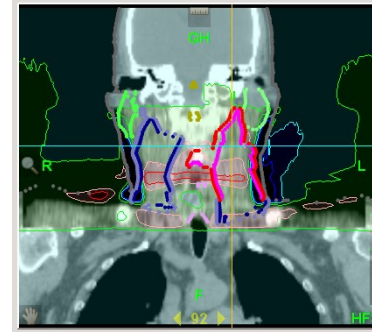
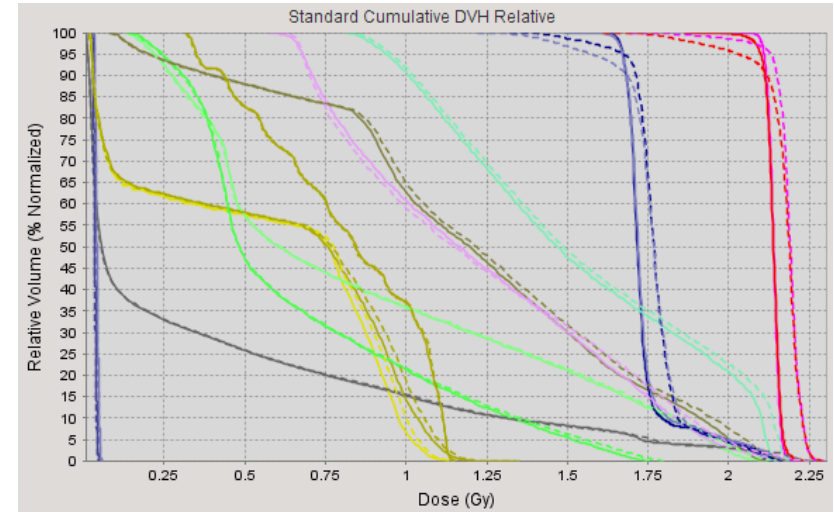
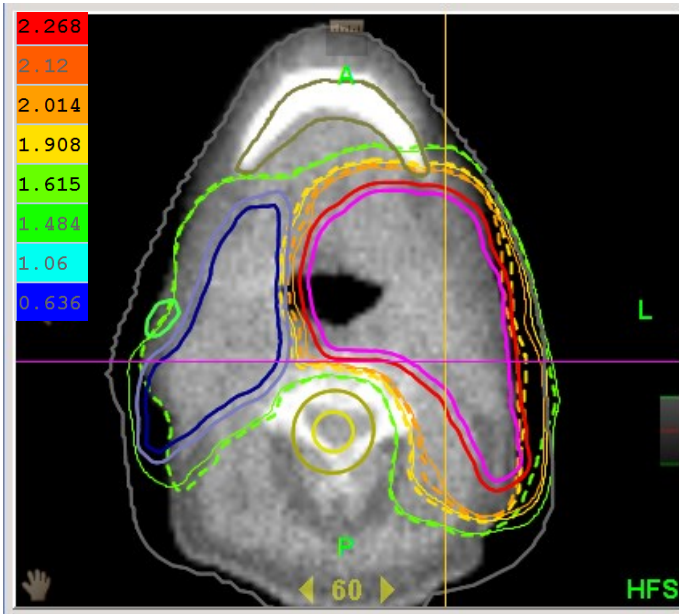
Pitch	Roll	Yaw
0.0	0.0	0.0
- Coronal and Sagittal Views:** Two smaller windows at the bottom show the patient's anatomy in coronal and sagittal planes, with 'GH' labels indicating the target area.

MVCT Planverifikation

- med. Dosiserhöhung kleiner 1 %
- 95% Isodose umschließt Randbereiche des CTV
- $D_{max} < 107\%$ im PTV,
- transformiertes PTV unwesentlichen Einfluss auf Lungen-DVH

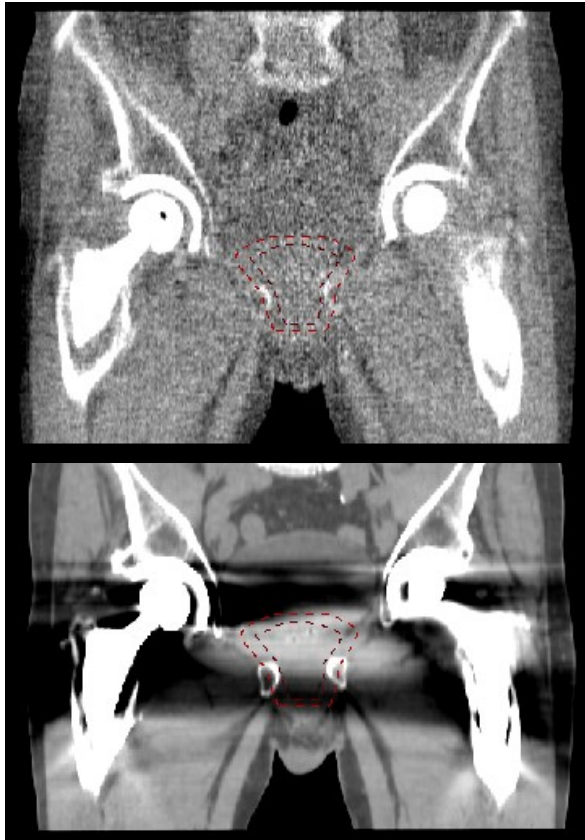


MVCT Planverifikation



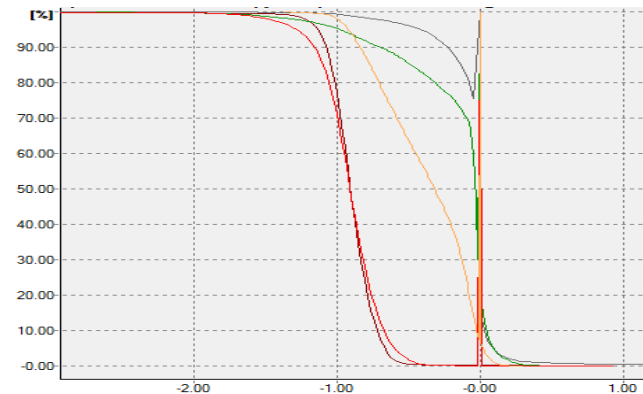
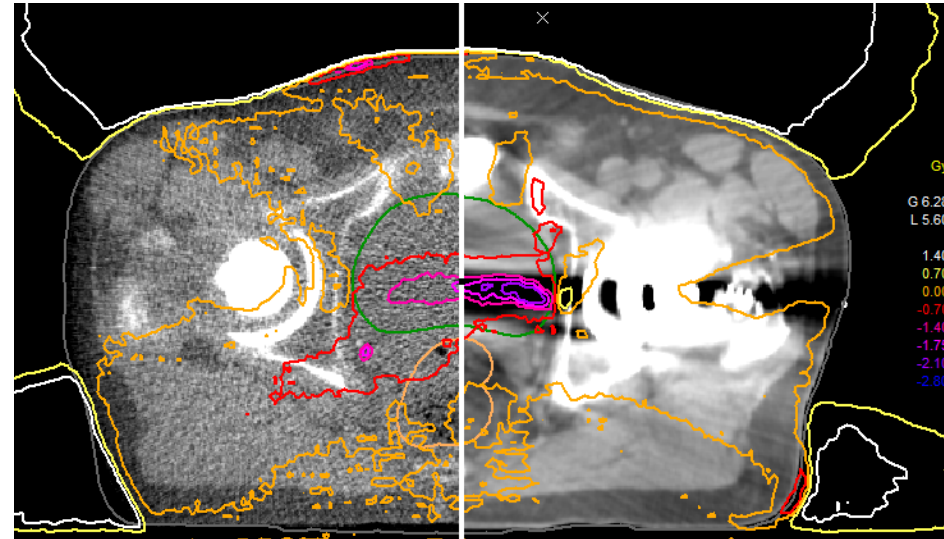
- Voraussetzung: Patient NICHT zu viel Spiel!
- Unsere Erfahrung:
 - homogene Überdosierung in PTV-Region
 - kaum Dosisabweichung an Risikostrukturen
 → Neuplanung sind die Ausnahme - Umständlichkeit Replanning

MVCT Planverifikation



- Anatomischer Mehrgewinn?

[kV CT] – [MV CT]



- Medianer Dosisfehler durch Auslöschung im CT kleiner 1,5% im PTV!

Helikale Tomo-Therapie - IMRT 2.0

- hohe Modulation durch: Helikale Applikation & binäre MLC
- individuelle Parameter: Modulationsfaktor, Pitch, Leaföffnungszeiten, Jaw Öffnung, Directional Block...
- *stabiles System: Dosisverifikation*
- vielseitige Möglichkeiten der MVCT-Dosisberechnung

Vielen Dank für Ihre Aufmerksamkeit