

WEBINAR of the Federal Commission on Radiation
Protection (KSR) Radiation Protection in Medicine

**Radiation therapy:
Image-guidance and tracking
methods with and without
ionising radiation**

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Ionising radiation in Radiotherapy

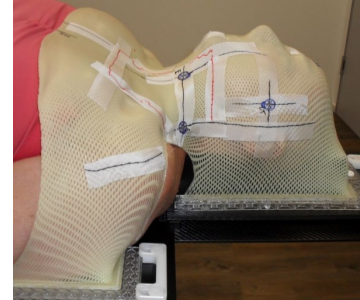
- Planning-Scans (CT, 3D/4D)
- Positioning / Imaging
- Intrafractional Monitoring
- Treatment

Vocabulary

- Image guidance: Support of positioning / isocenter-Setup by images. Higher accuracy leads to smaller margins for positioning uncertainties
- Tracking: (Intrafractional) surveillance of the target
- Gating: Limiting delivery to a “window” of movement, in which the target is allowed to be for treatment

Image-Guidance / Verification of Position

- Paintings/Skinmarkers = External markers. Different correlation to internal target no dose



- MV-Images “in-beam”/”field-control”, single or orthogonal
Dose (2x2 MU: 40-48mGy)

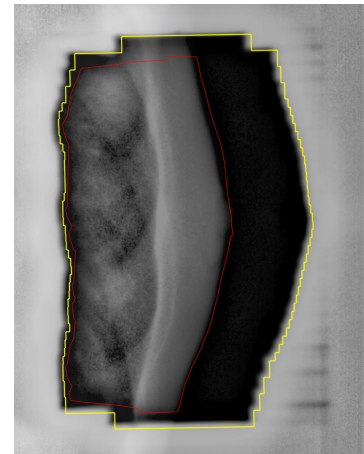
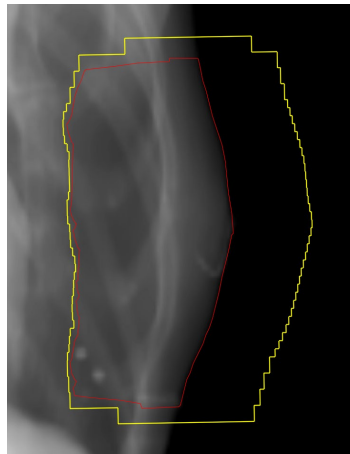
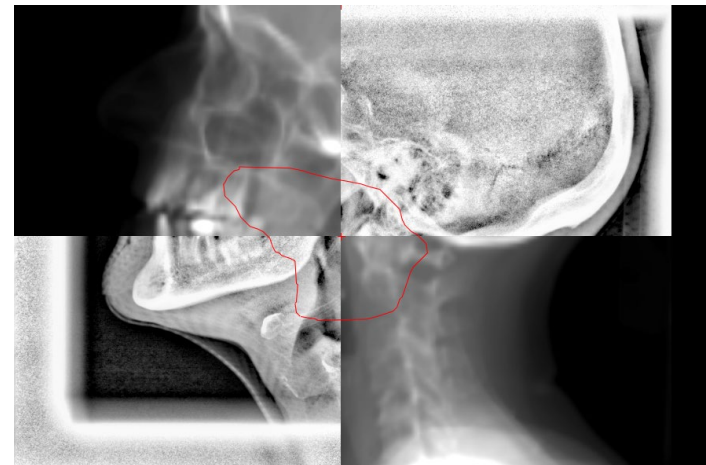
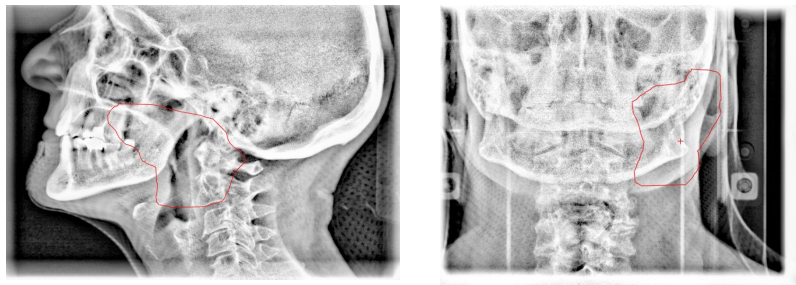


Image-Guidance / Verification of Position

➤ “on-board” kv-images (0°/90°)

90° to Gantry (QA!)

Dose 0.05mGy-0.2mGy



➤ Better imaging quality, lower dose

Image-Guidance / Verification of Position

➤ Goldmarker (kv-dose)



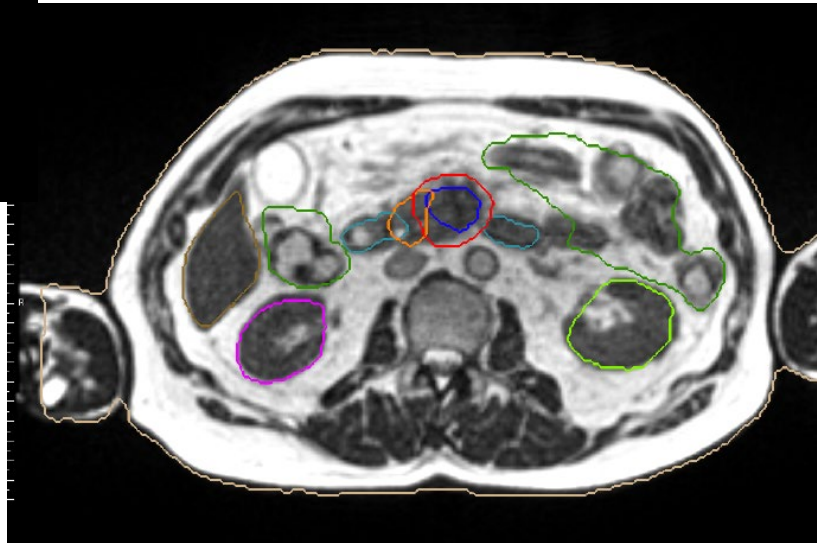
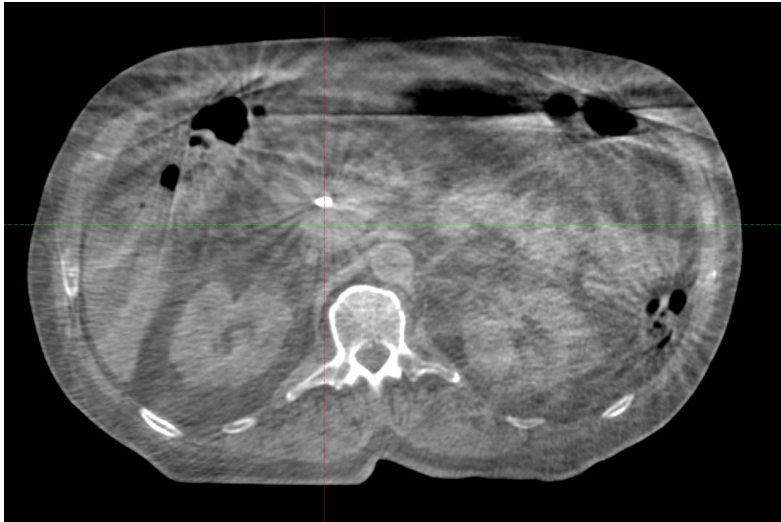
➤ Cone-Beam-CT (kv/MV) Dose 5-36mGy



➤ Reduced setup-error, higher correlation external vs. internal Marker

Image-Guidance / Verification of Position

➤ MRI-Linac-Hybrid



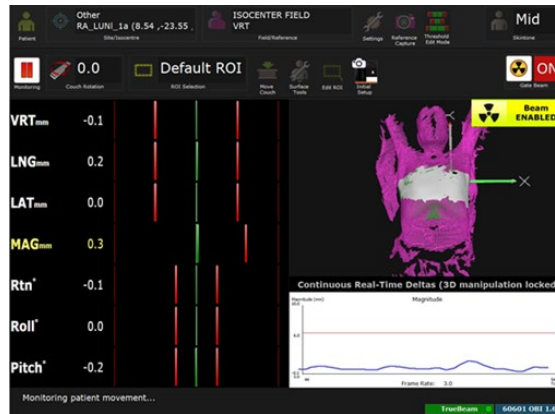
➤ Better tissue contrast, less artefacts, higher anatomical correlation

Tracking / Gating / Monitoring

- Mostly dealing with Motion of Patient and/or target.
- Different Approaches:
 - predict all possible positions
 - (follow target)
 - wait for target in position
 - reduce motion
- Condition: “See” the target, “real-time”, direct Beam-control

Tracking / Gating / Monitoring

- Surface-guided RT: external, real-time, no dose, beam-off when out of tolerance

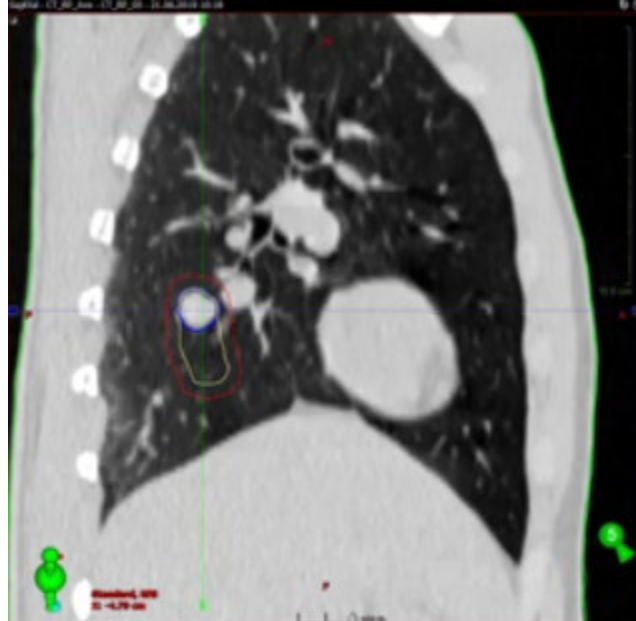


- Gold fiducials: internal (invasive), several kv-images (Beam-off)
- Transponder: internal (invasive), real-time, beam-off, no dose, besides setup-image, Electromagnetic HF-waves

- Different correlation internal/external site-dependant

Tracking/Gating - Motion management (passive)

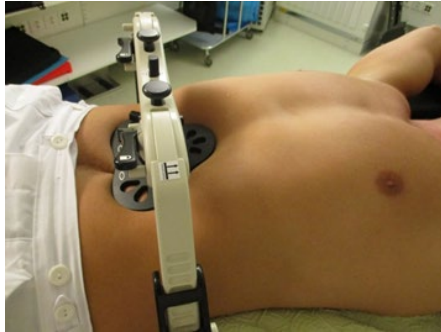
- Prediction of Target (4D/ITV)
(Film)



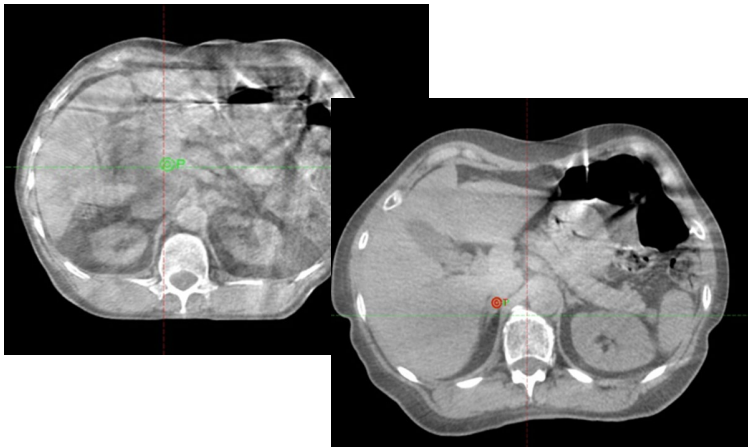
- External infrared-Marker for breathing monitoring: Breathing Gate, CBCT for setup, no dose during delivery

Tracking/Gating - Reduction of Motion

- Vacuum mats, Belly press

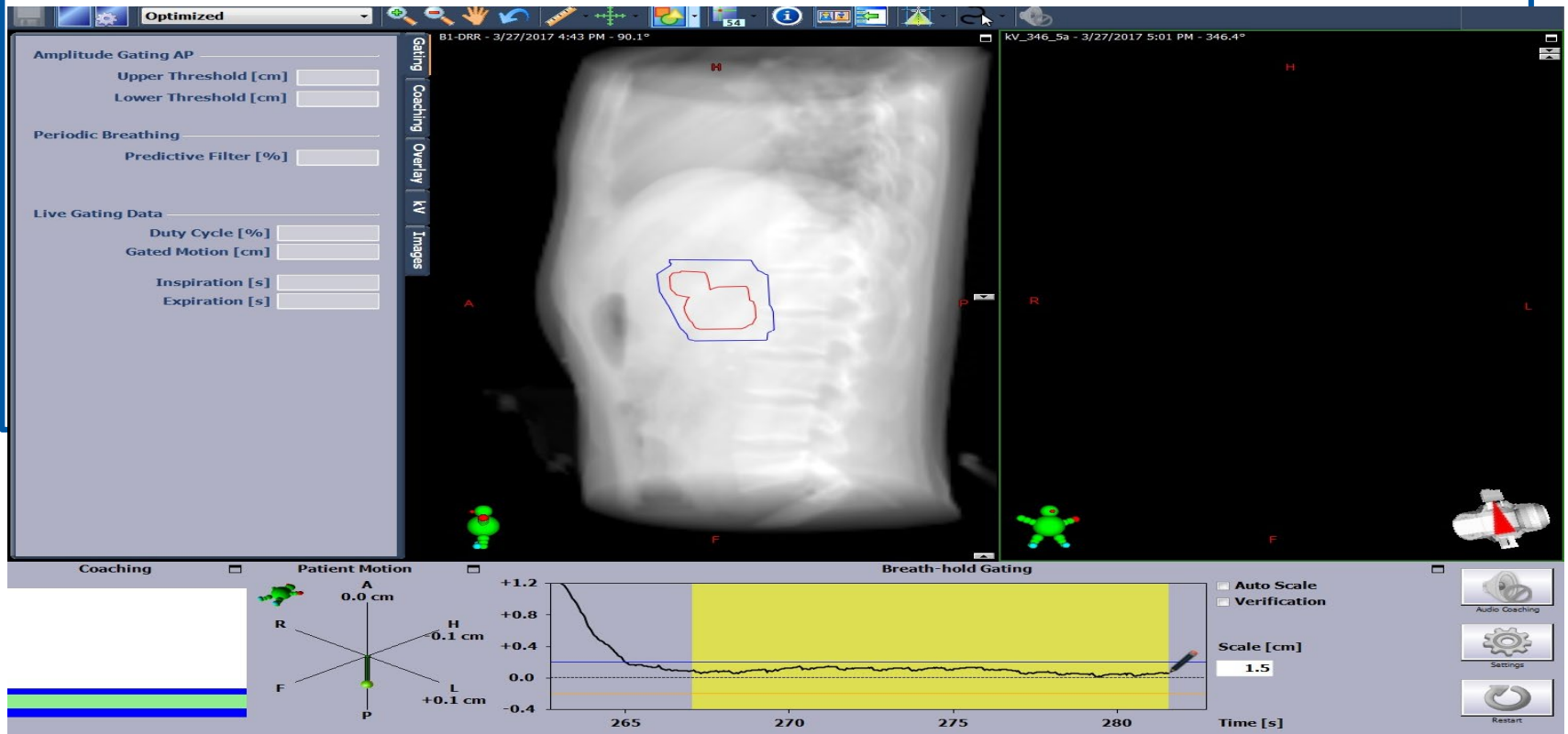


- External (RPM)+ Breath-hold: Lower planning-Dose (4D vs. 3D CT), better image-quality CBCT, reduced treatment Volume, longer table-time



Tracking/Gating - Reduction of Motion

- External (RPM)+ Breath-hold: Lower planning-Dose (4D vs. 3D CT), better image-quality CBCT, reduced treatment Volume, longer table-time



Tracking/Gating - MRI

- MRguided tracking: high image quality, real-time internal surrogate, no dose (Film)



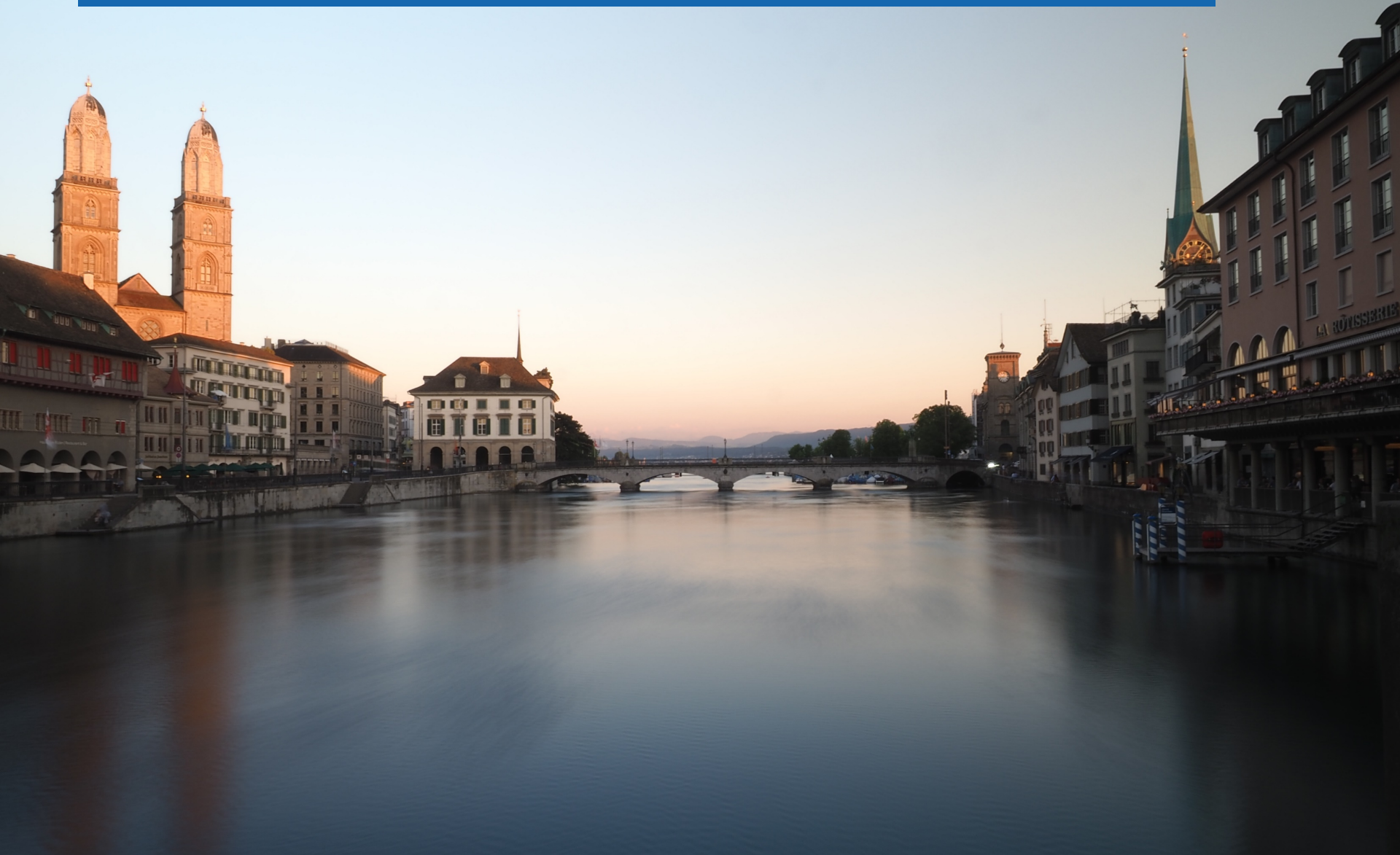
Radiation protection by Imaging?

- Choosing the optimal imaging and tracking method for patient
- Reduction of Dose by
 - Less images (higher positioning accuracy)
 - Non-dose-Methods
 - Dose-methods, leading to smaller Margins due to more reliable targeting and movement-management and tracking (ITV vs. GTV)
 - Non-dose-Methods with movement-management and tracking leading to smaller margins and high precision

Radiation protection by imaging?

- (Daily) dose application by imaging is justifiable, if this leads to relevant smaller volumes treated with a therapeutic dose
- High precision targeting, gating and tracking leads to more hypofractionated regimens (3-10 Fractions)
- Further development and improvement of non-dose-methods to make them better accessible needed

Thank you for your attention



Questions?