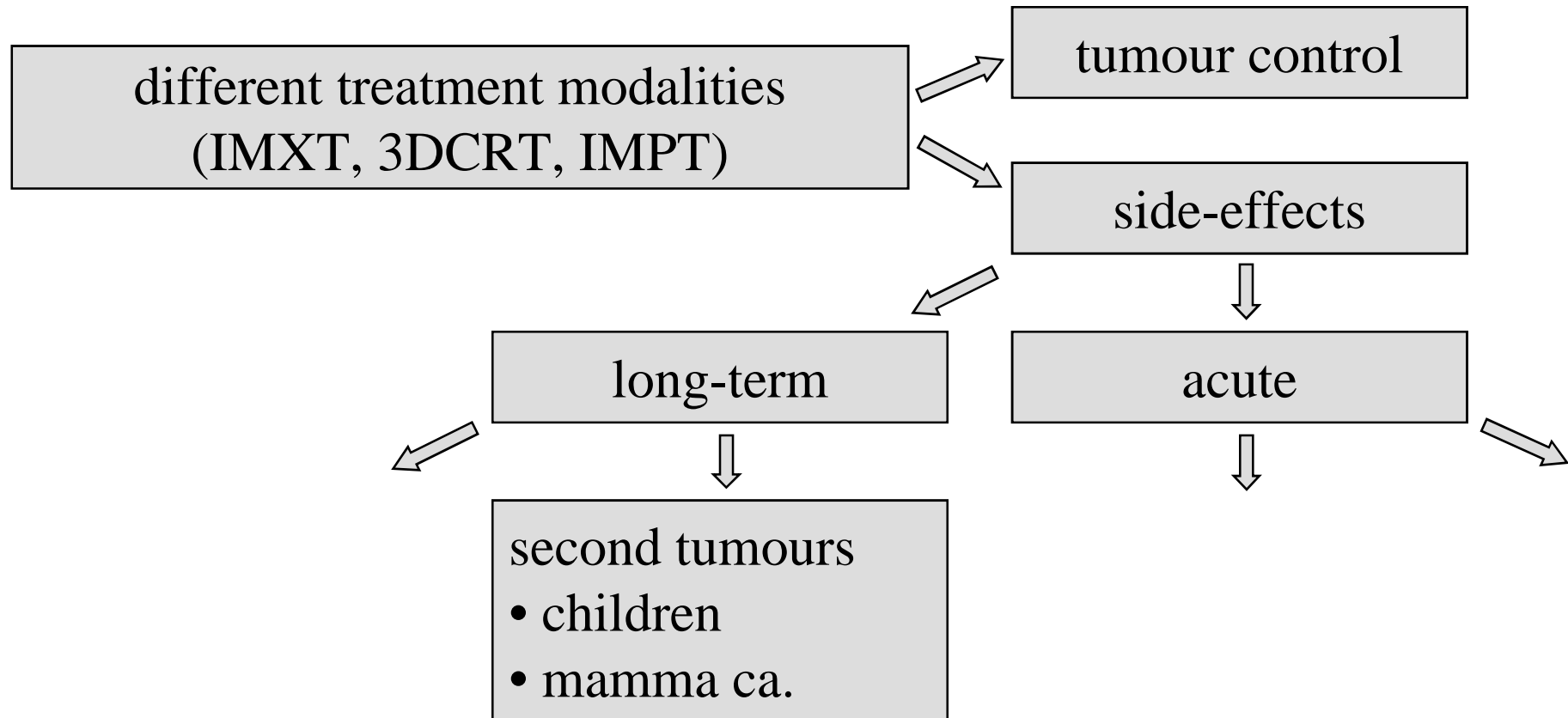


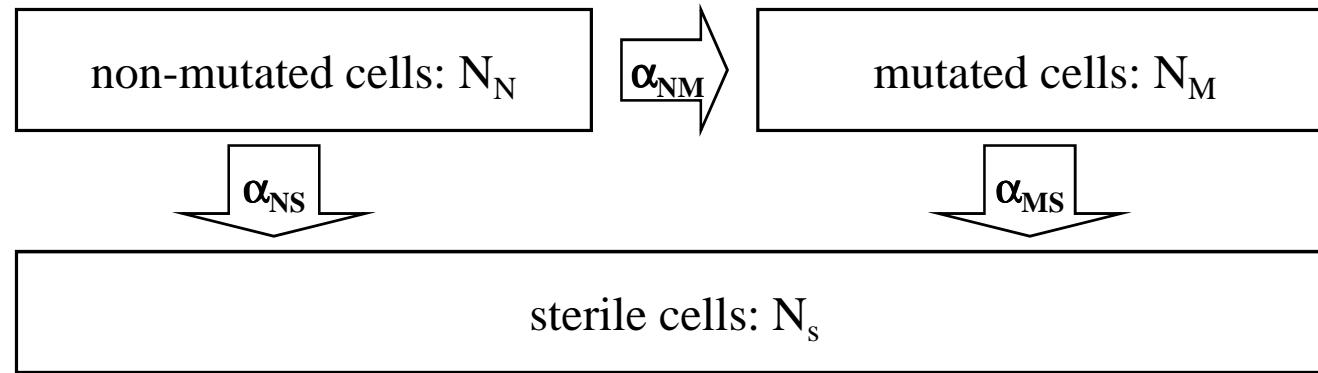
Estimating Second Cancer Incidence after Radiation Therapy

ESTRO – 9th Oct, 2006

Asja Pfaffenberger, Uwe Schneider, Björn Poppe, Uwe Oelfke



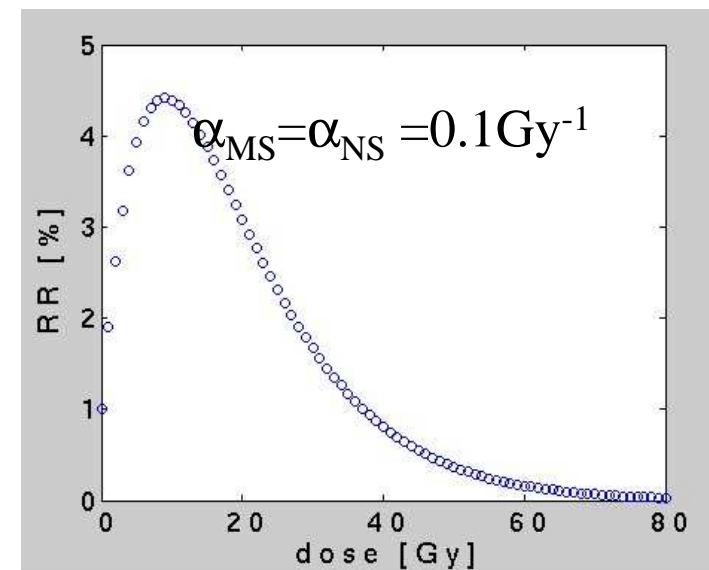
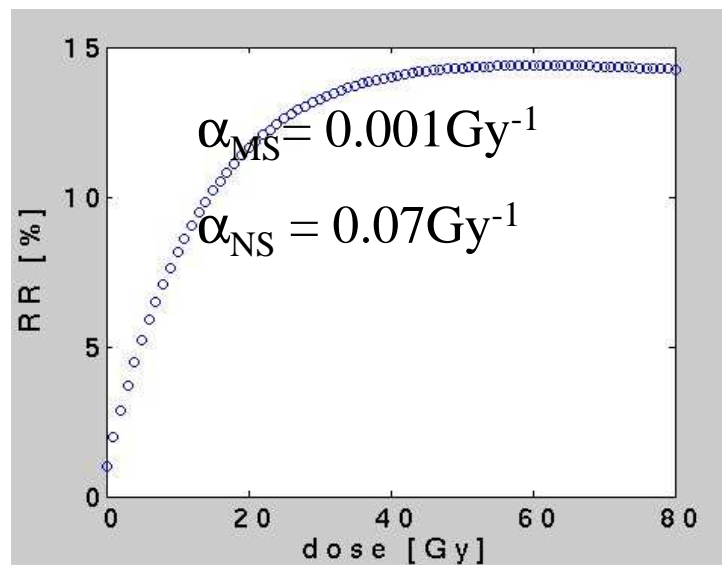
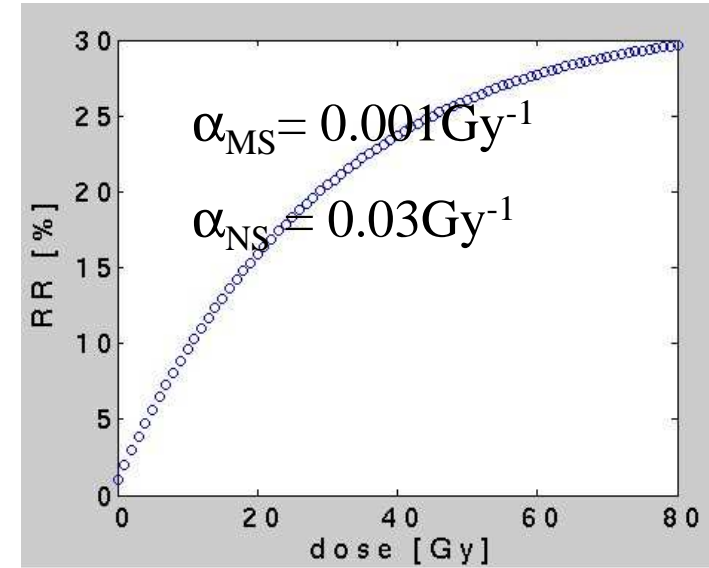
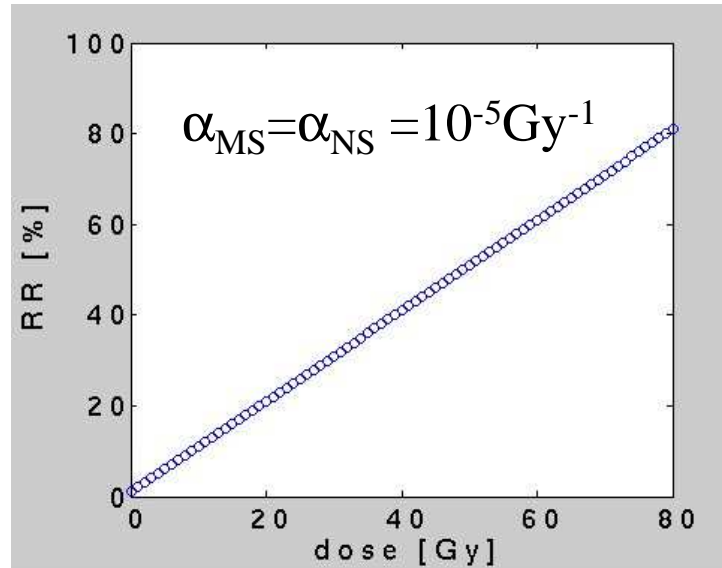
- “*IMRT may **double** the incidence of solid cancers in long-term survivors*” (E.J.Hall 2006)



$$AR(D) = \gamma N_M(D)$$

$$ERR(D) = \frac{AR(D) - AR(0)}{AR(0)} = RR(D) - 1$$

Variation of parameters



Dose response of radiation-induced solid tumours

- Life-span study A-bomb survivors
 - *linear* < 5 Gy
- Several studies in lower dose area
- Cancer incidence after RT
 - Gilbert et al. ***Lung Cancer after Treatment for Hodgkin's Disease [...]*** Radiat Res 2003; 159: 161–173.
 - van Leeuwen et al. ***[...] Breast Cancer Following Hodgkin's Disease.*** J Natl Cancer Inst 2003; 95(13): 971-80.
 - *Increase of risk with dose*

Aim

- Determination of the influence of the dose-response curve on
 - Organ risk estimation
 - Total risk estimation

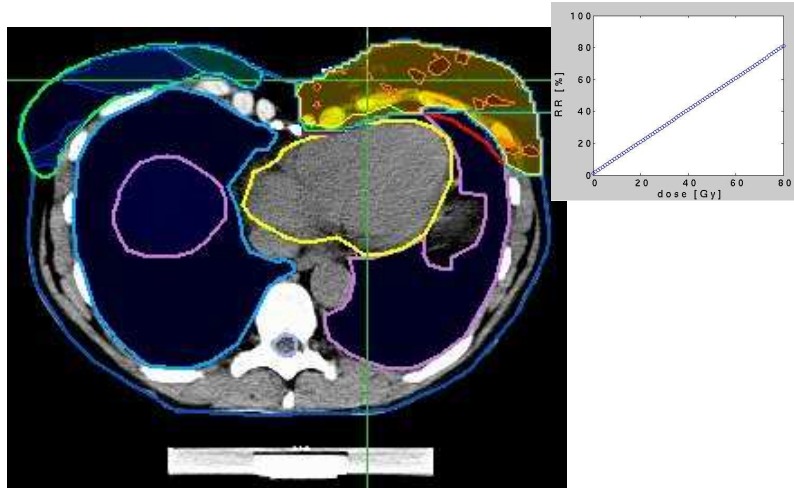
Assumptions

- Organ risks at lower doses proportional to findings of LSS
- Dose-response curve for all organs of same shape

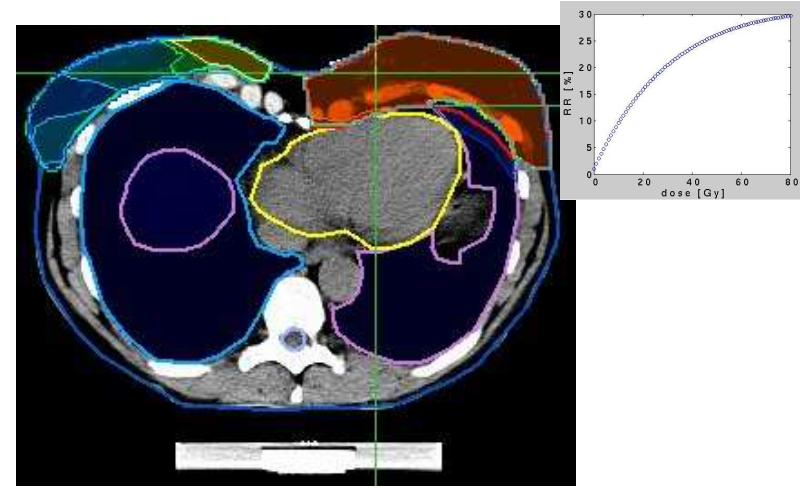
Method

- Voxel-wise risk calculation
- Visualisation and quantification

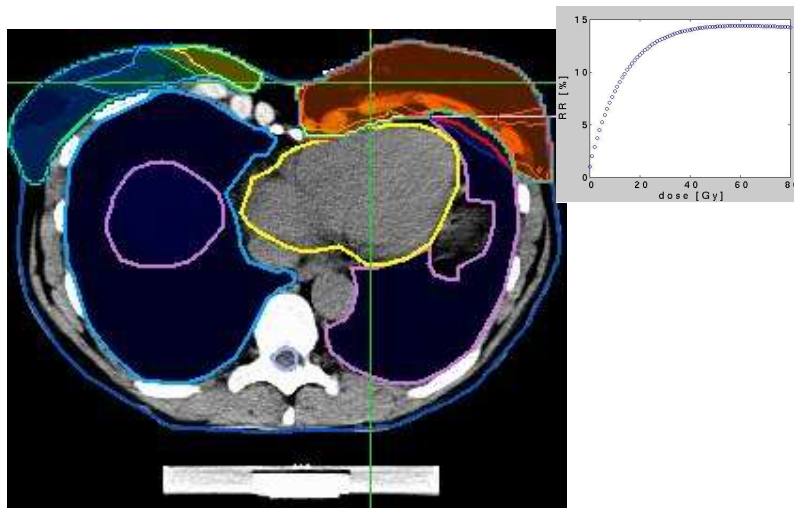
Comparison of risks



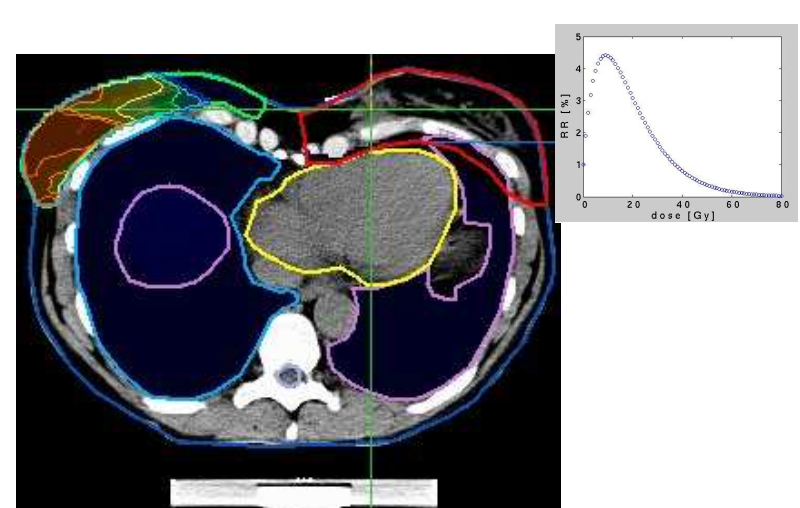
linear: $AR_{ges} = 403/10^4PY$



increase: $AR_{ges} = 192/10^4PY$



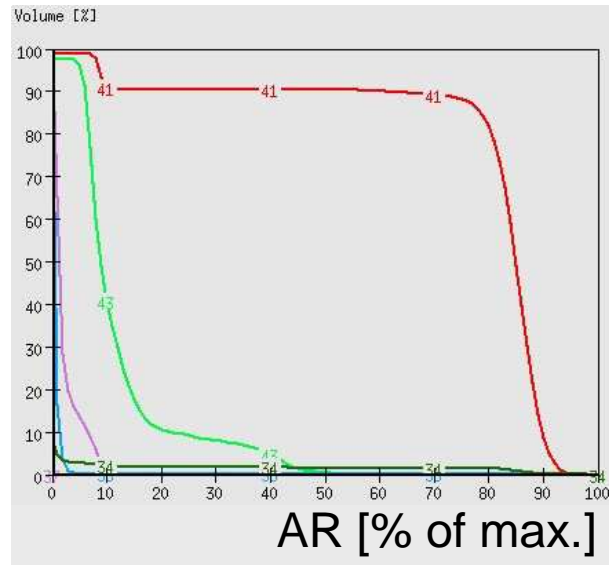
plateau: $AR_{ges} = 150/10^4PY$



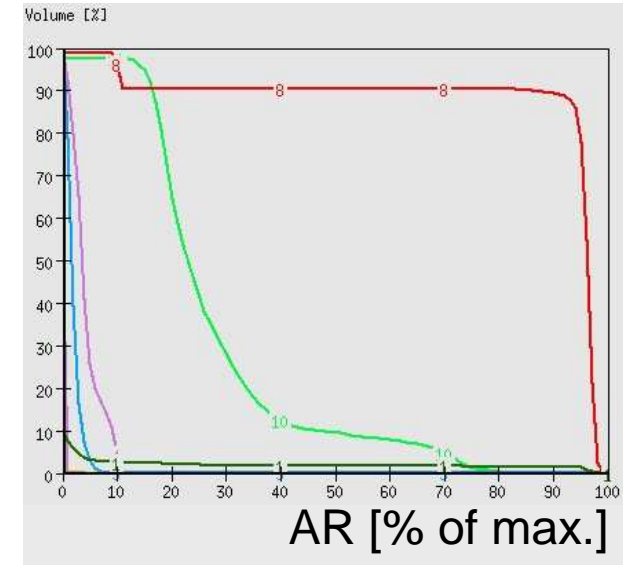
“optimal” dose: $AR_{ges} = 12/10^4PY$

Comparison of risks

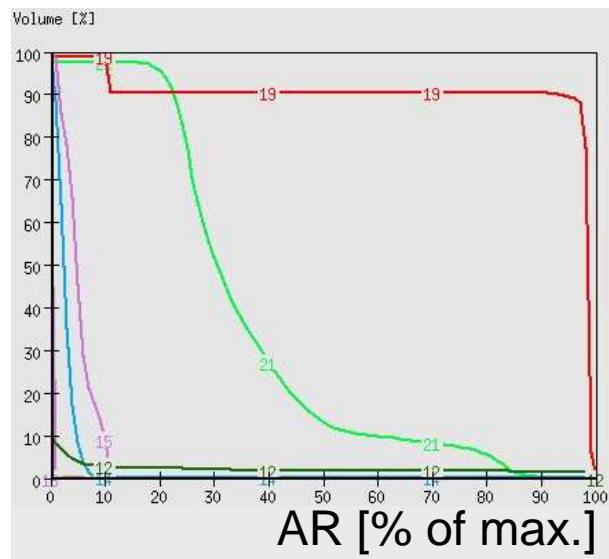
linear:



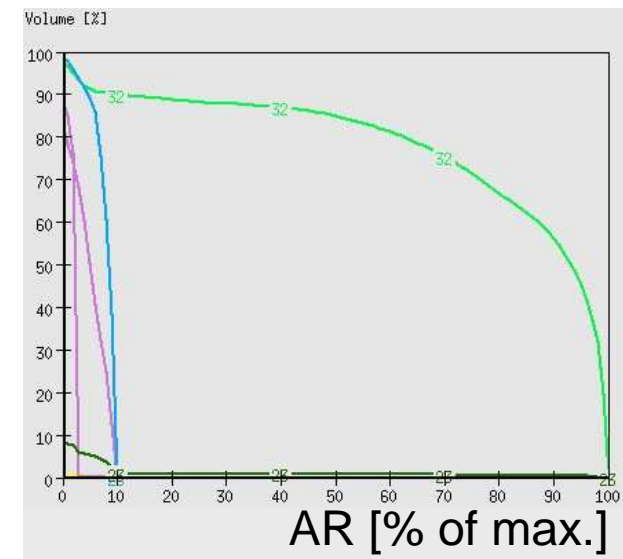
increase:



plateau:



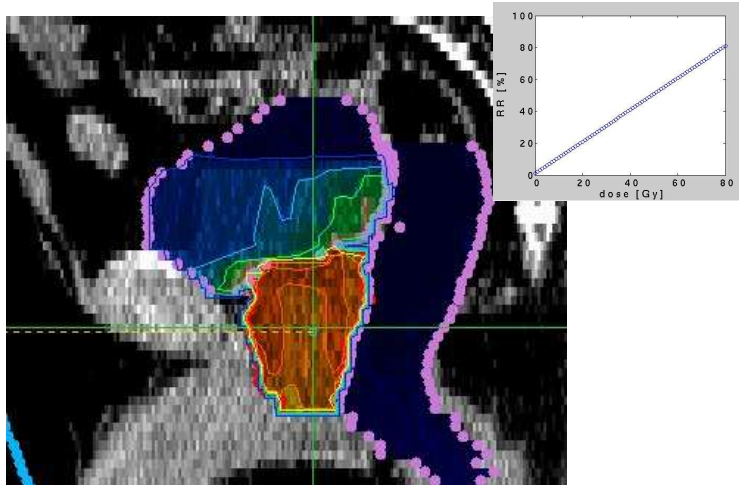
“optimal”
dose:



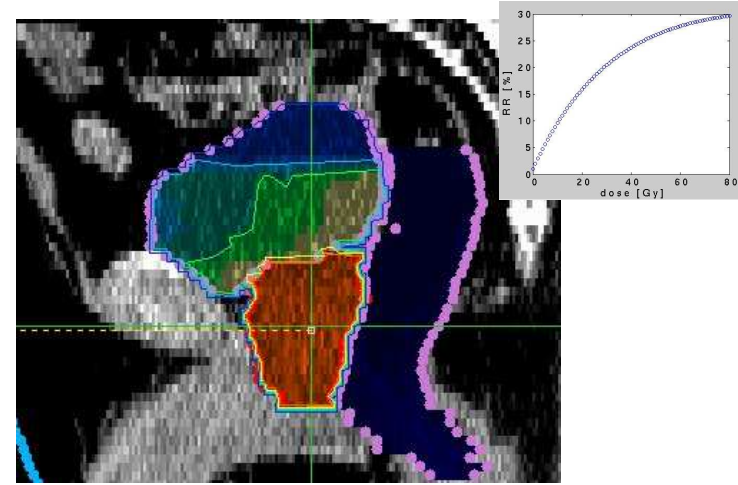
- Model proposes an explanation for difference in dose-responses discussed
 - *high radio-resistance of mutated cells → plateau/increase*
 - *comparable radio-resistance around 0.1Gy^{-1} → decline after maximum*
- The choice of dose response can strongly affect the expected second cancer incidence
- Analysis tool for treatment planning
 - *visualisation / quantification of risks*
 - *comparison of risk of late-effects implied by different treatment modalities / plans*

Thank you
for your attention

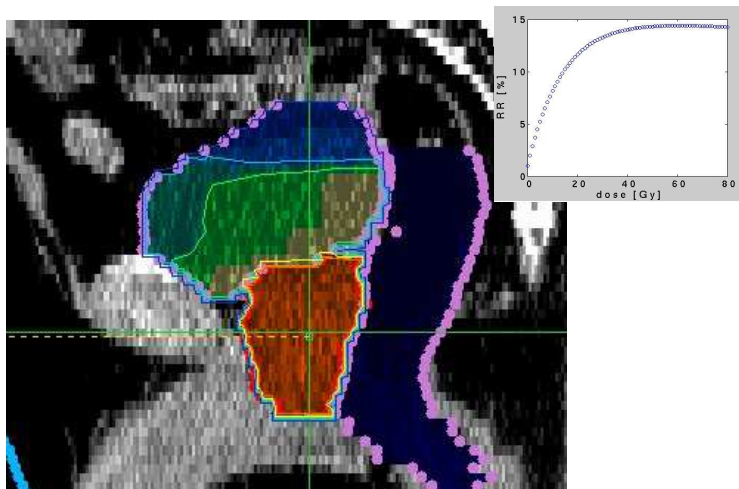
Comparison of risks



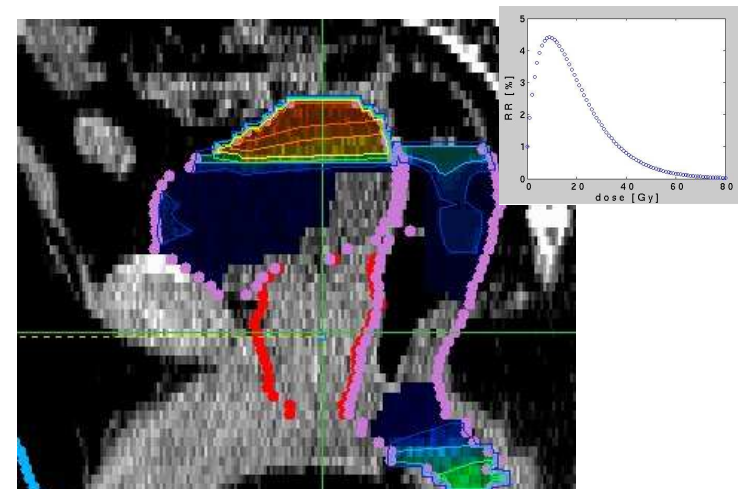
linear: $AR_{ges} = 292/10^4PY$



increase: $AR_{ges} = 126/10^4PY$



plateau: $AR_{ges} = 98/10^4PY$



“optimal” dose: $AR_{ges} = 2.6/10^4PY$