Multimodal Imaging for Radiotherapy and its Benefit.

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Myths and facts in Oncology: the challenge of local therapies

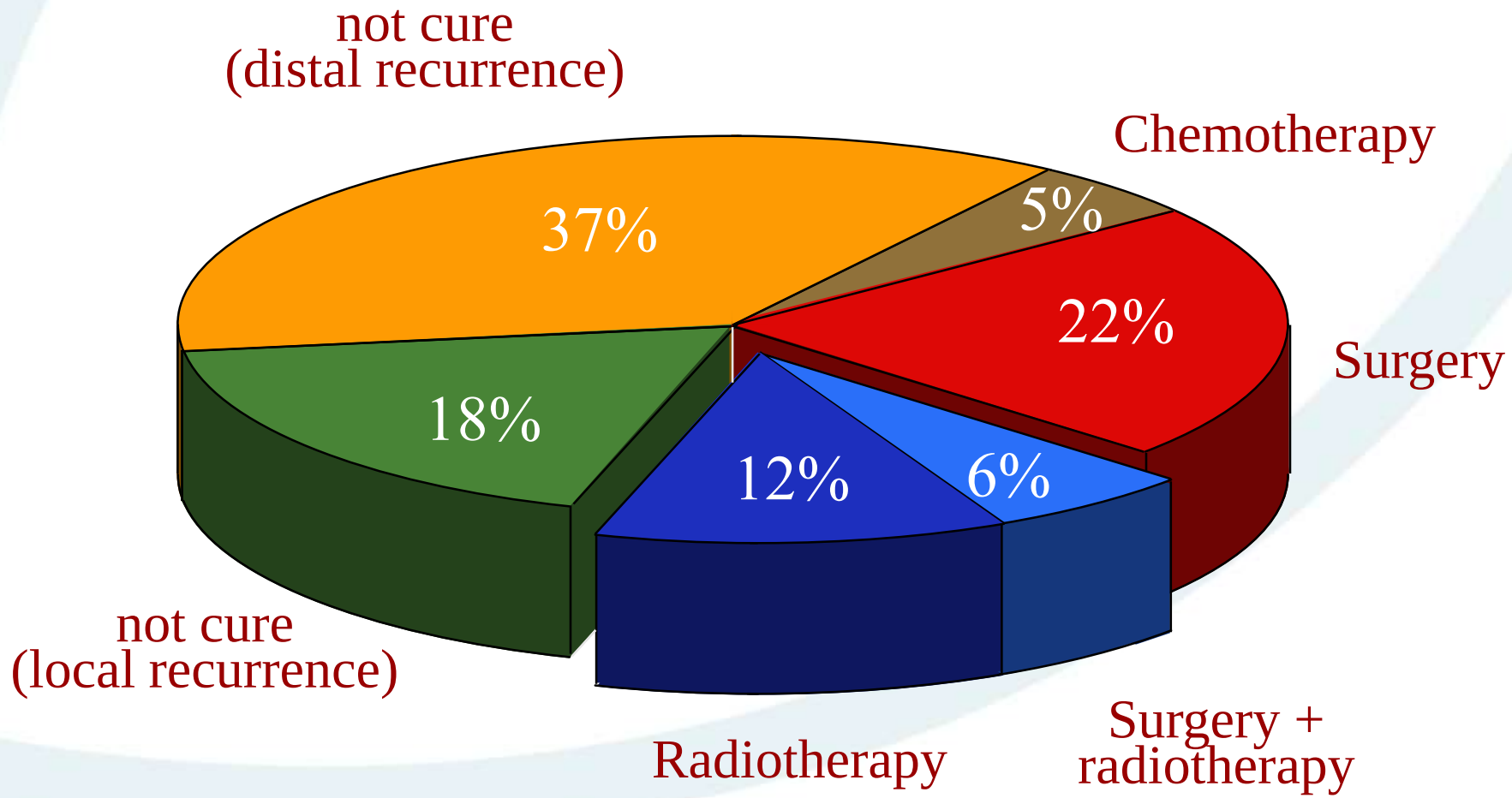
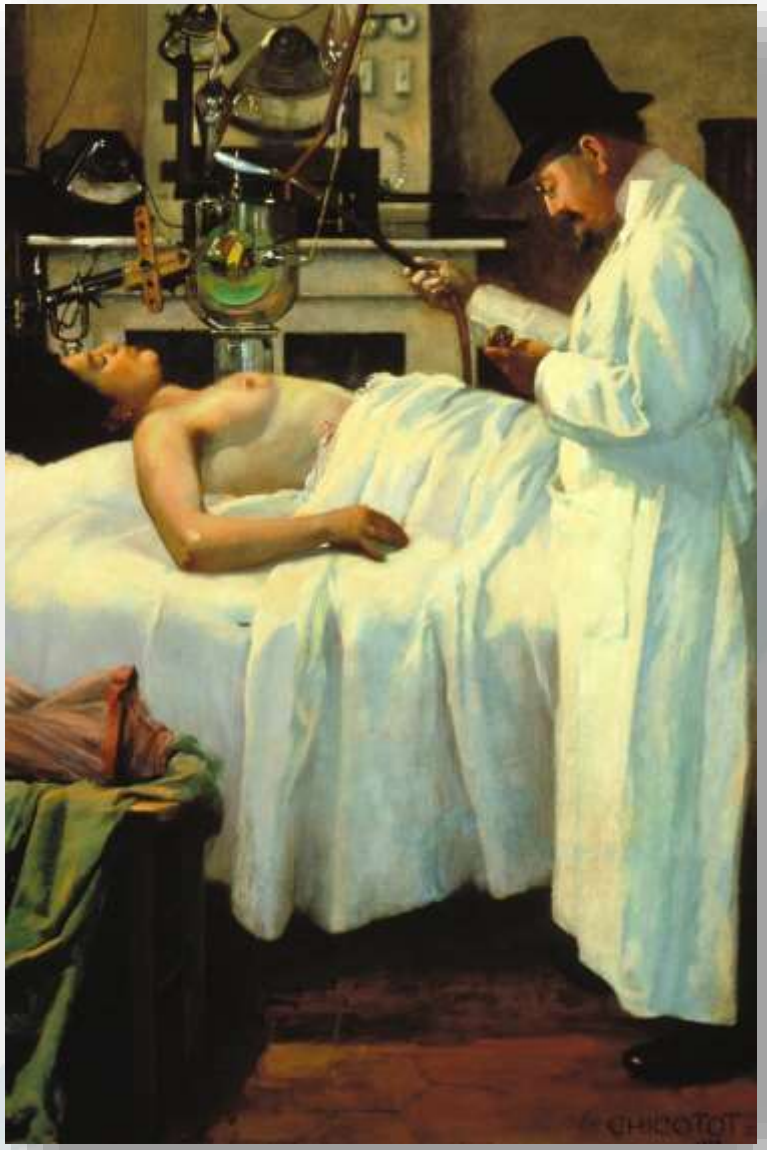


Table of Content

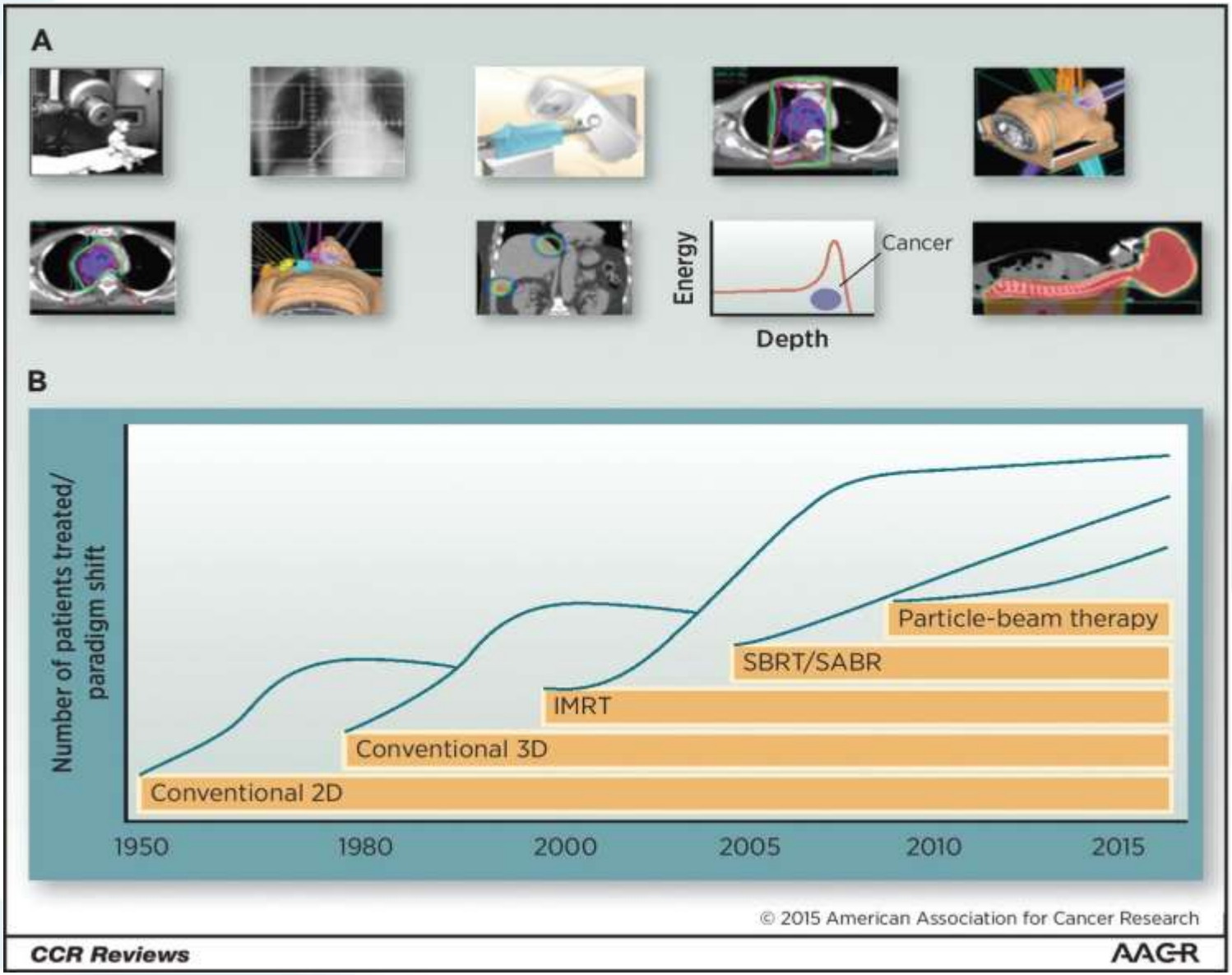
- Set the scene
- Multimodality imaging
- Future prospects

From X-rays …

Discovered in 1895 and immediately used for the treatment of cancer…
Why so quickly?
Surgery was the only option but it was not armless…



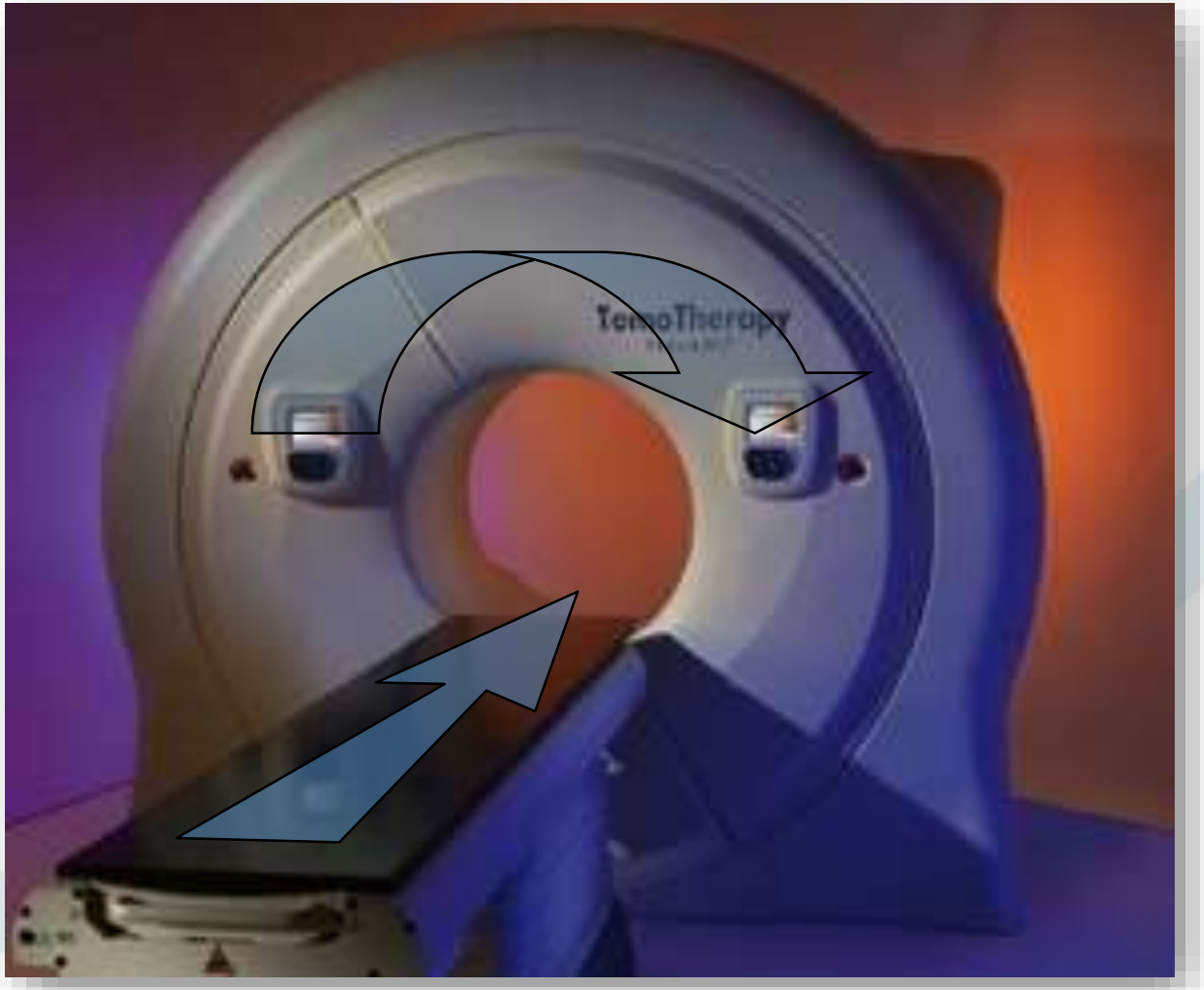
Evolution of Radiation Delivery



ICRP, Oct. 2017

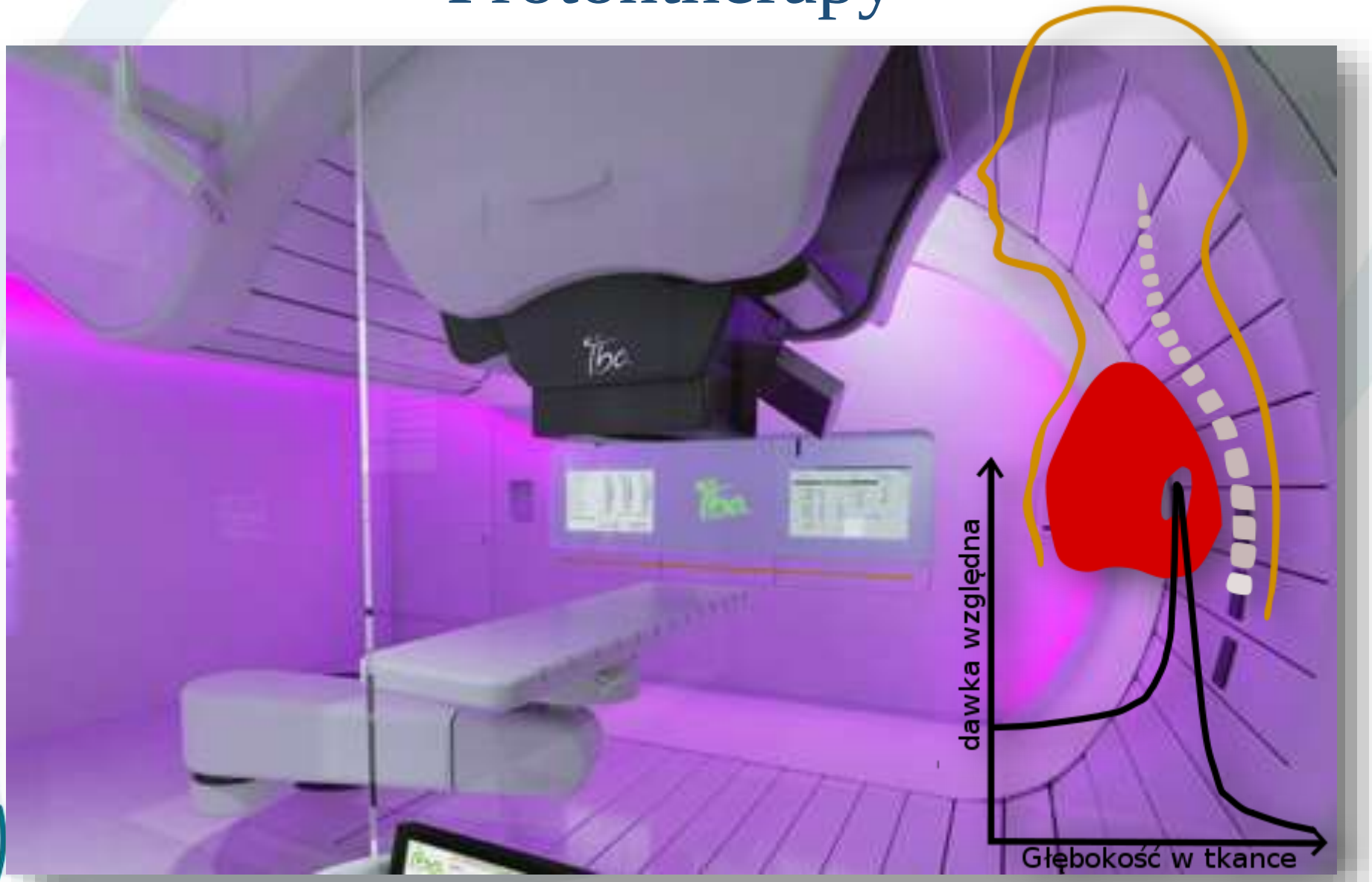
Q-T Le, CCR, 2015

Arc therapy: the linac is constantly rotating while the coach is moving

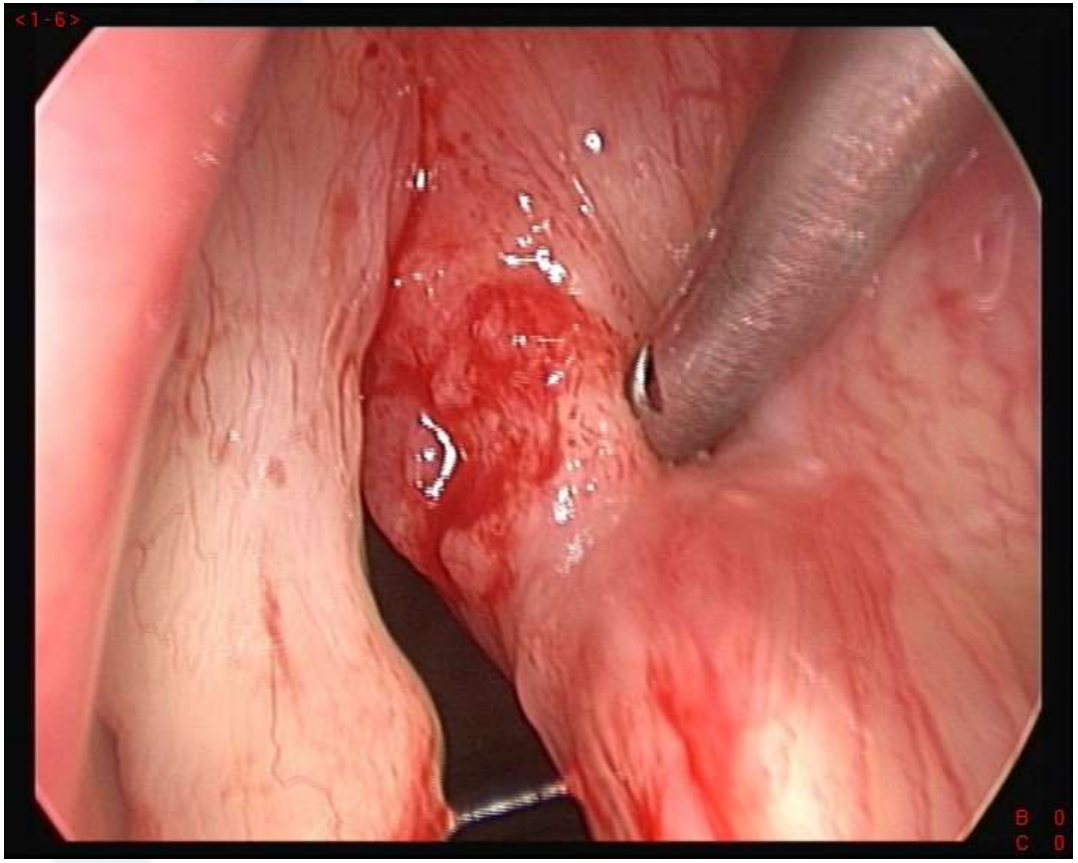


Protontherapy

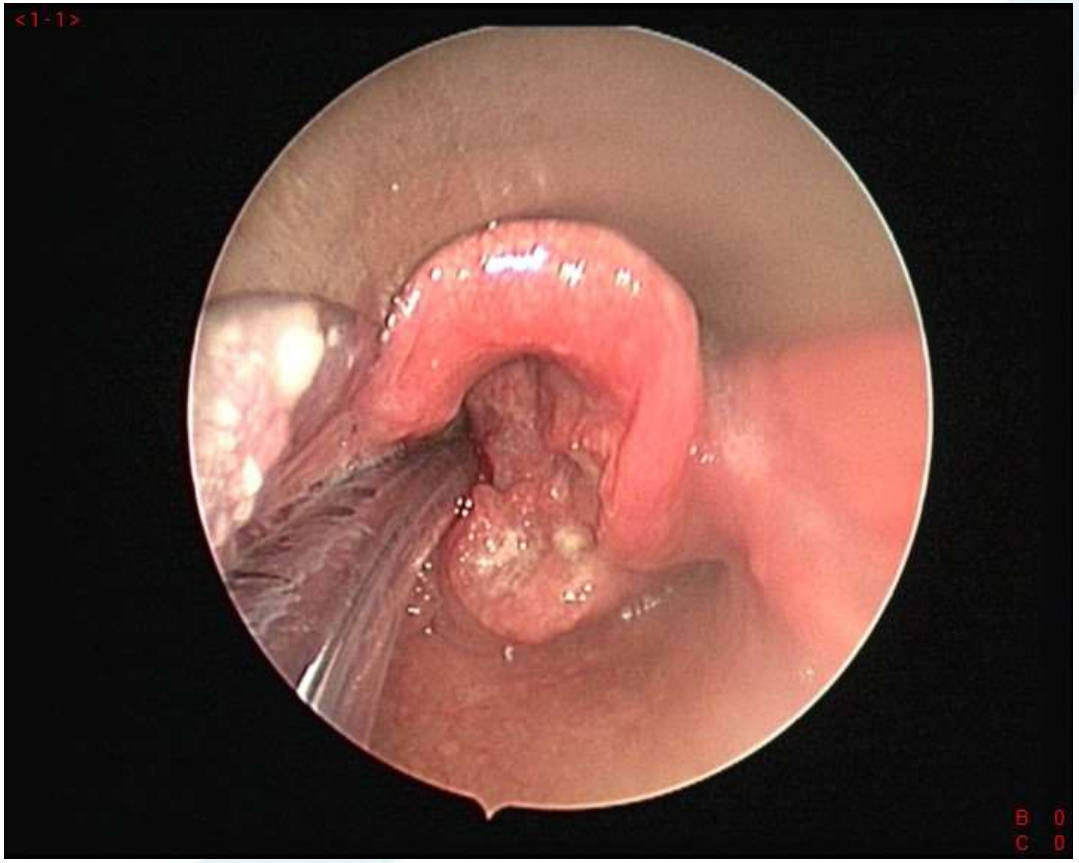
Protontherapy



Target volume: clinical examination

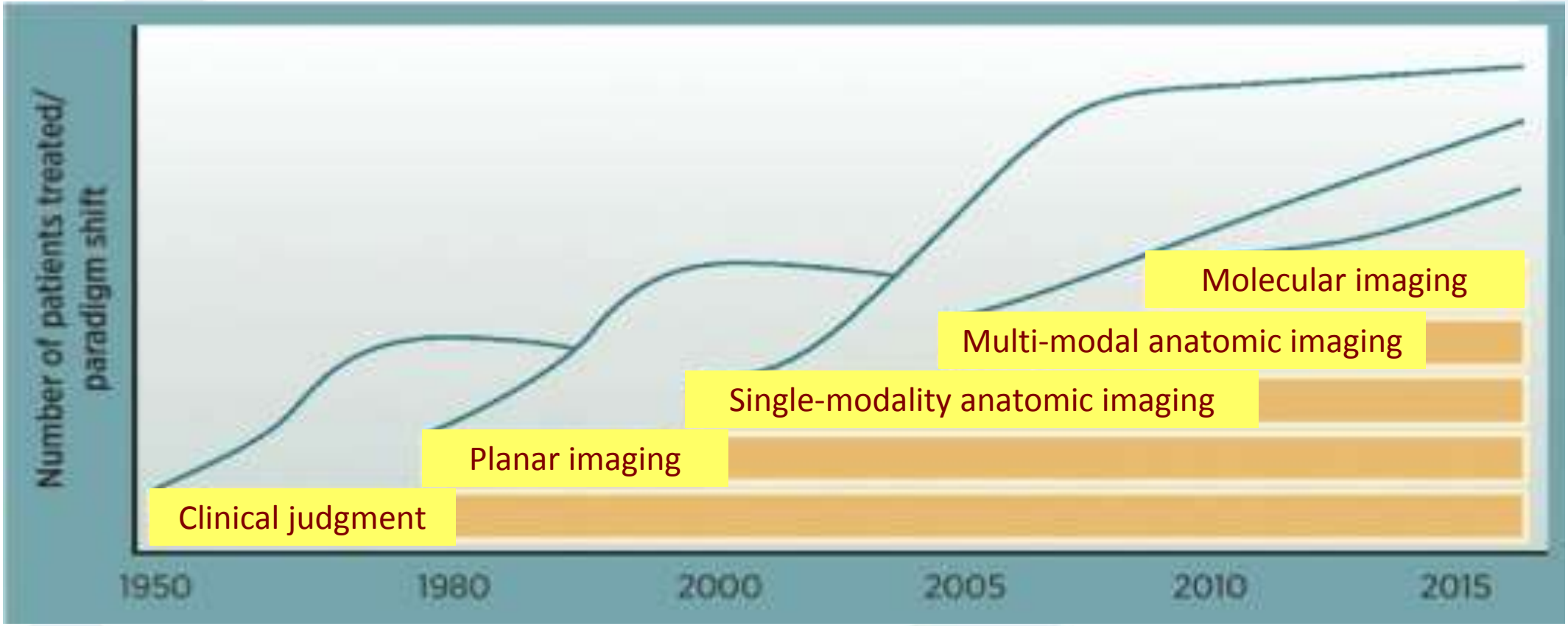


T1a glottic larynx

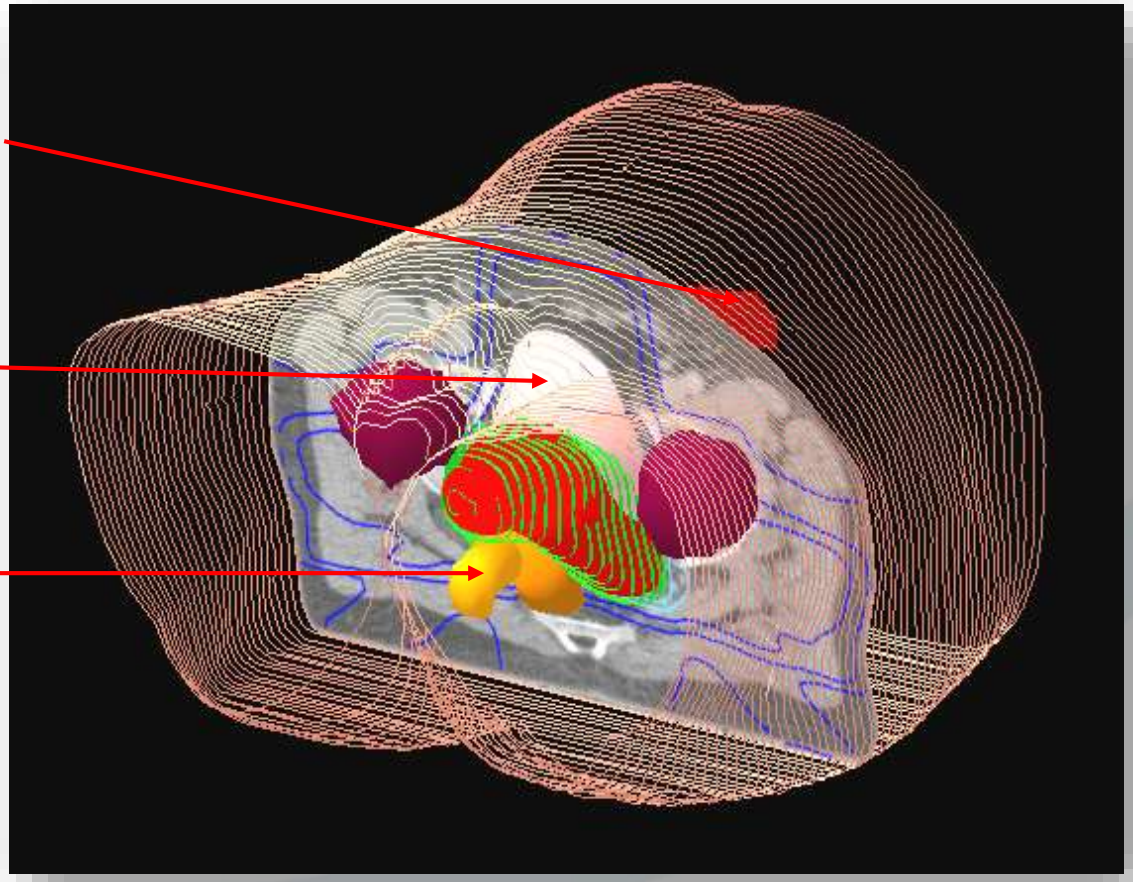


T3 supra-glottic larynx

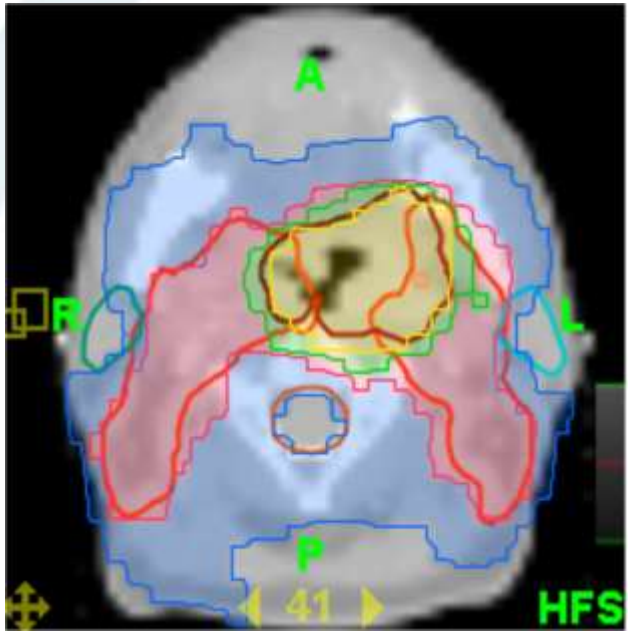
Evolution of Target Volume/normal anatomy definition

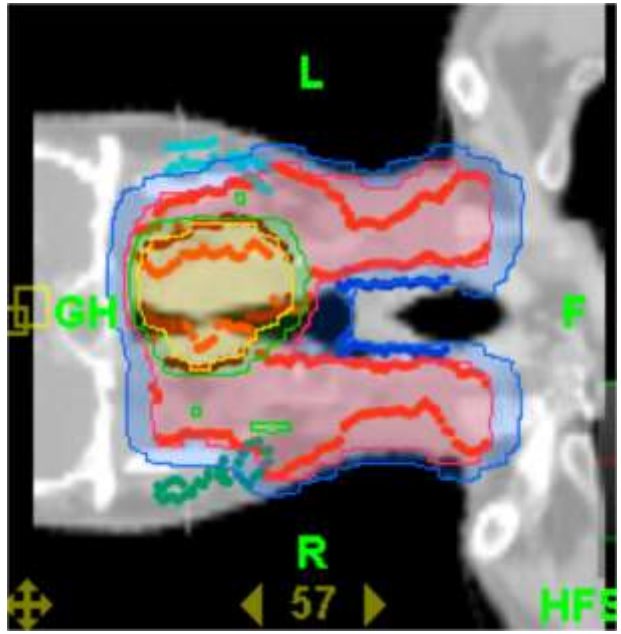


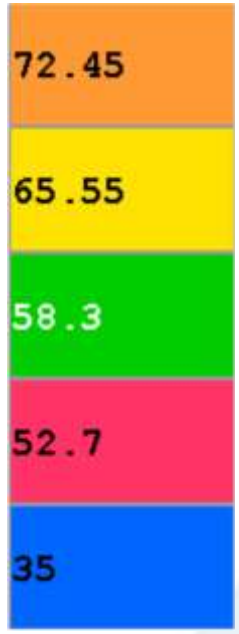
3D- Reconstruction

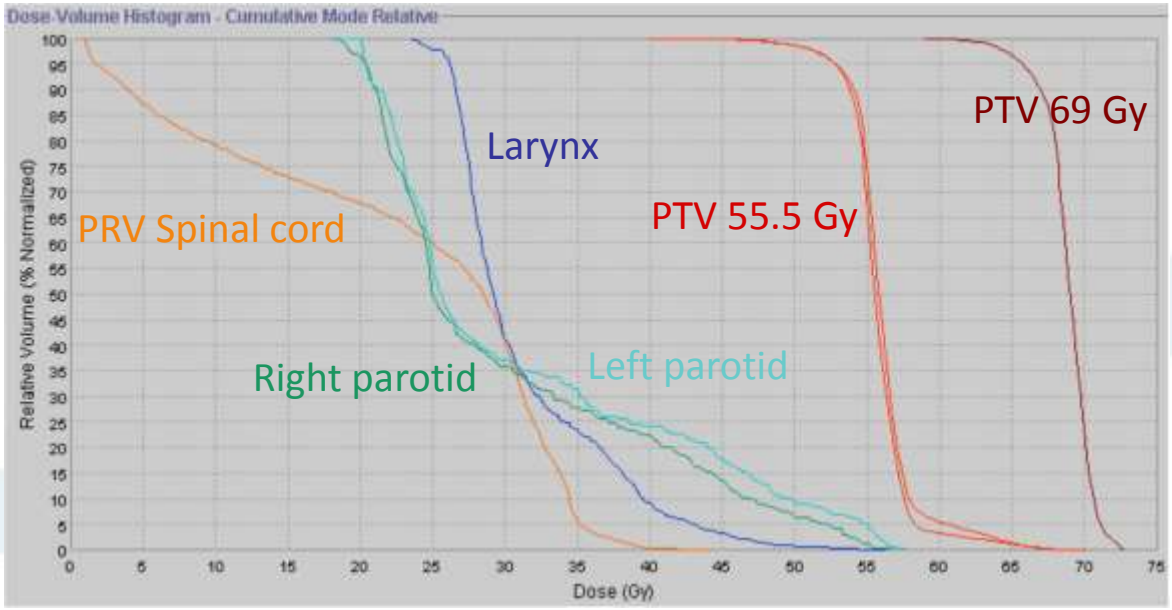


IMRT for Head and Neck Tumors









Oropharyngeal SCC

T2-N0-M0

SIB-IMRT: 30x2.3 Gy

30x1.85 Gy

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Target volumes in Radiation Oncology: ICRU 50, 62 and 83:

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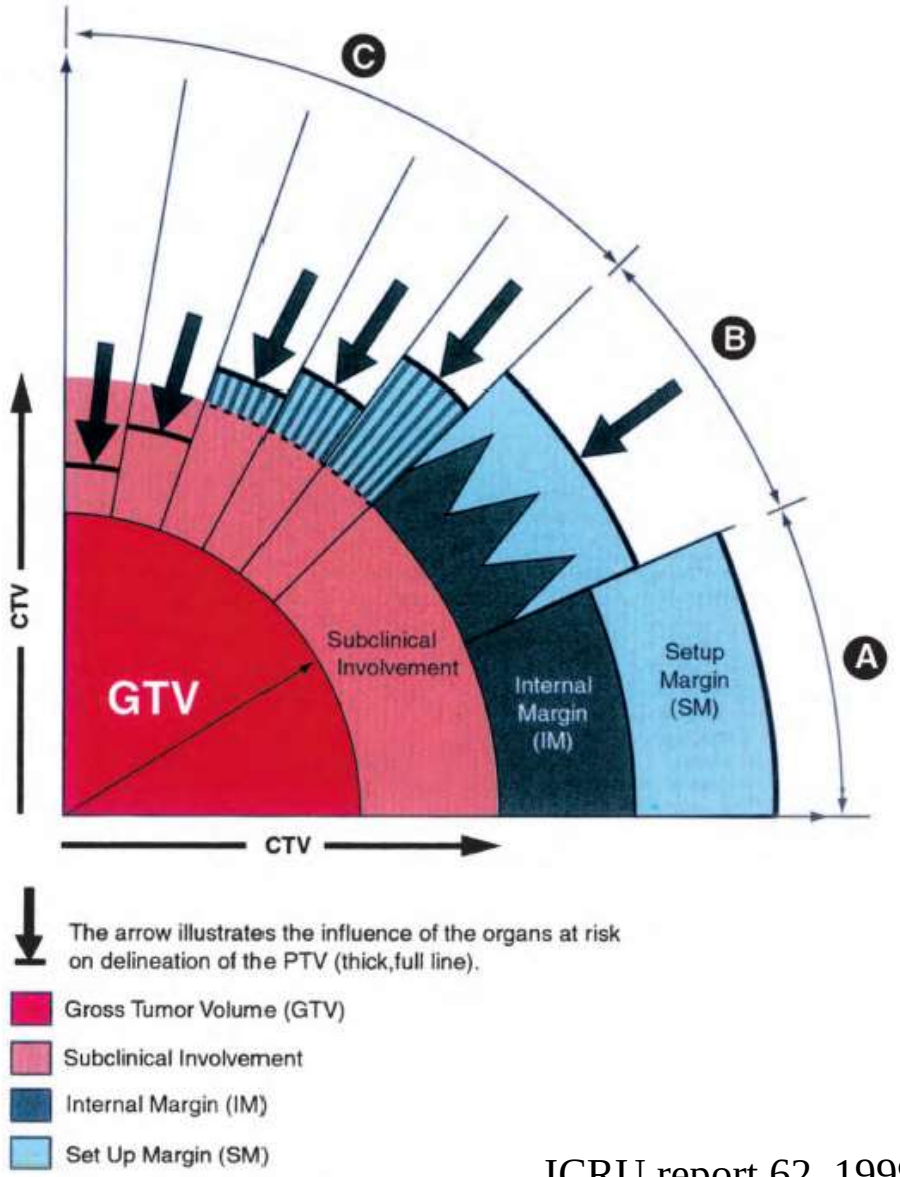
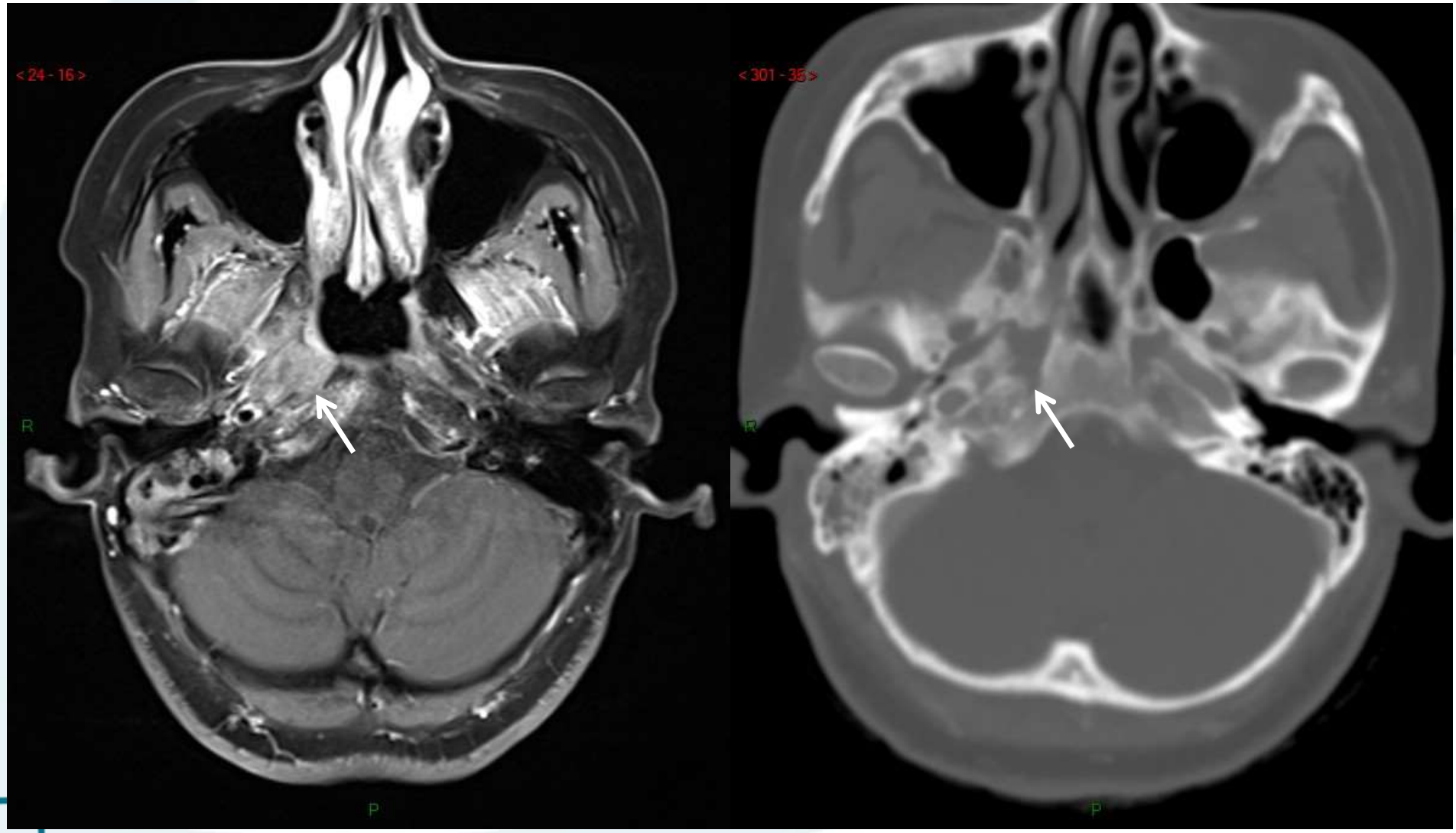
- Internal Target Volume: ITV
- Planning Target Volume: PTV
- Organ at Risk: OAR
- Planning Organ at Risk Volume: PRV



ICRU report 62, 1999

Multimodality imaging for target visualisation

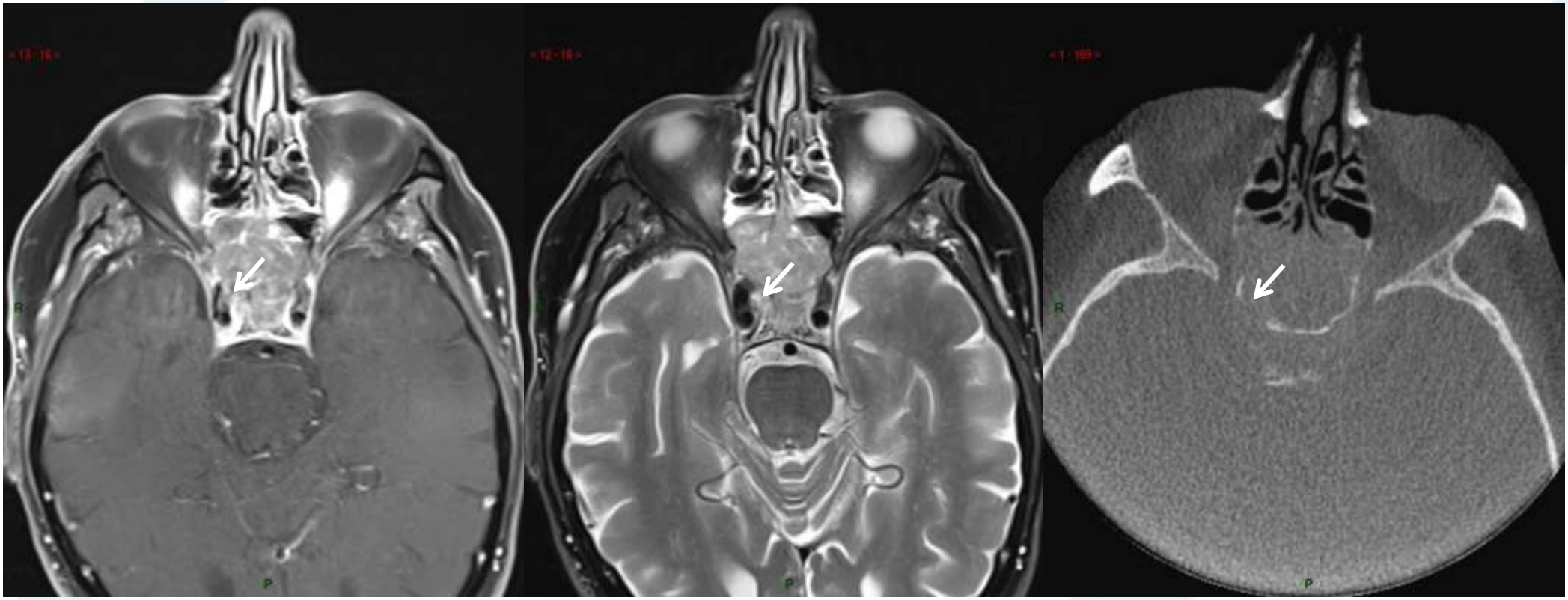


Gadolinium-enhanced T1 FatSat

Contrast-enhanced CT (bone window)

Courtesy of Th. Duprez

Multimodality imaging for target visualisation



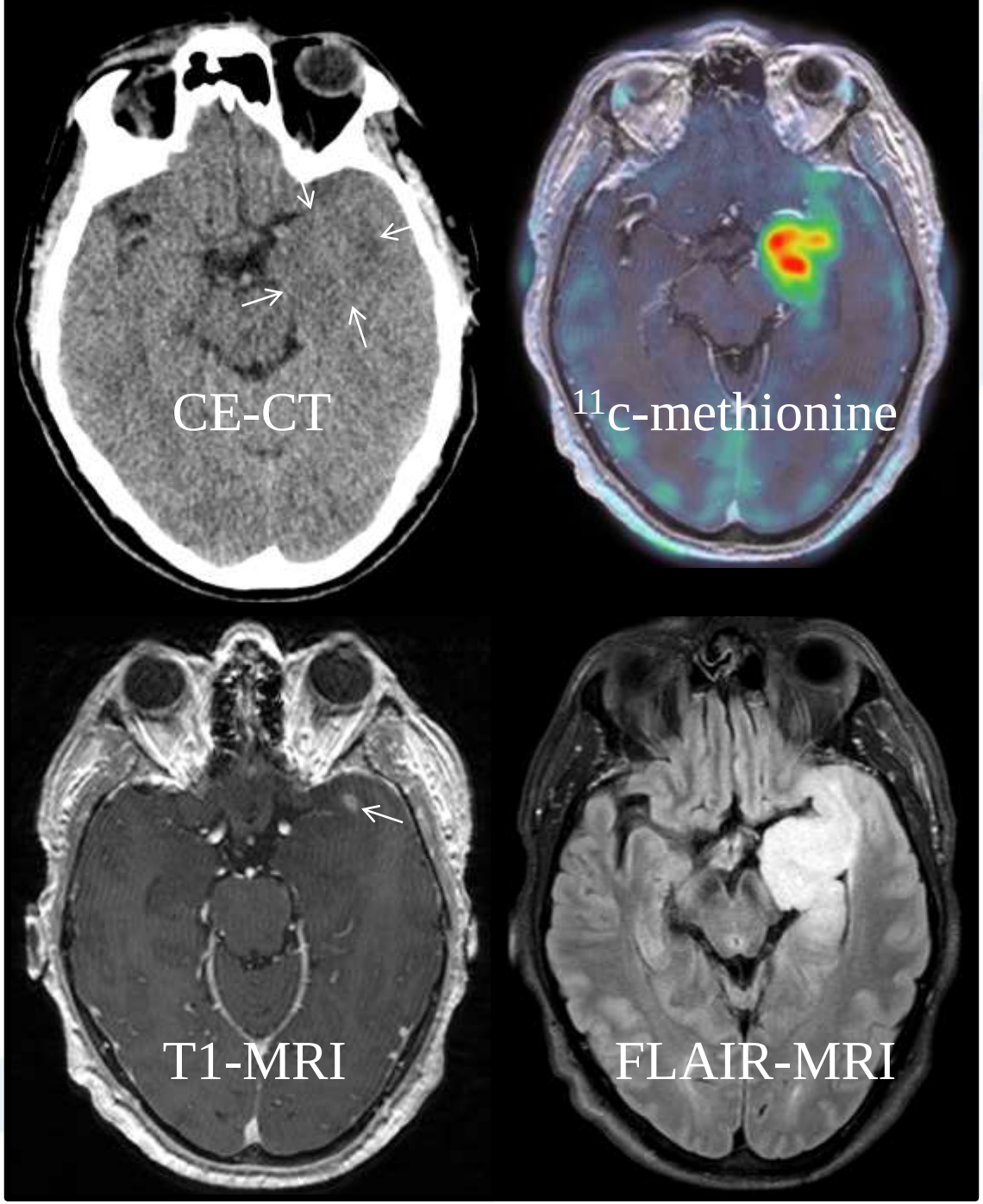
CE T1-W (fat Saturated)

T1-W (fat Saturated)

ConeBeam CT scanner

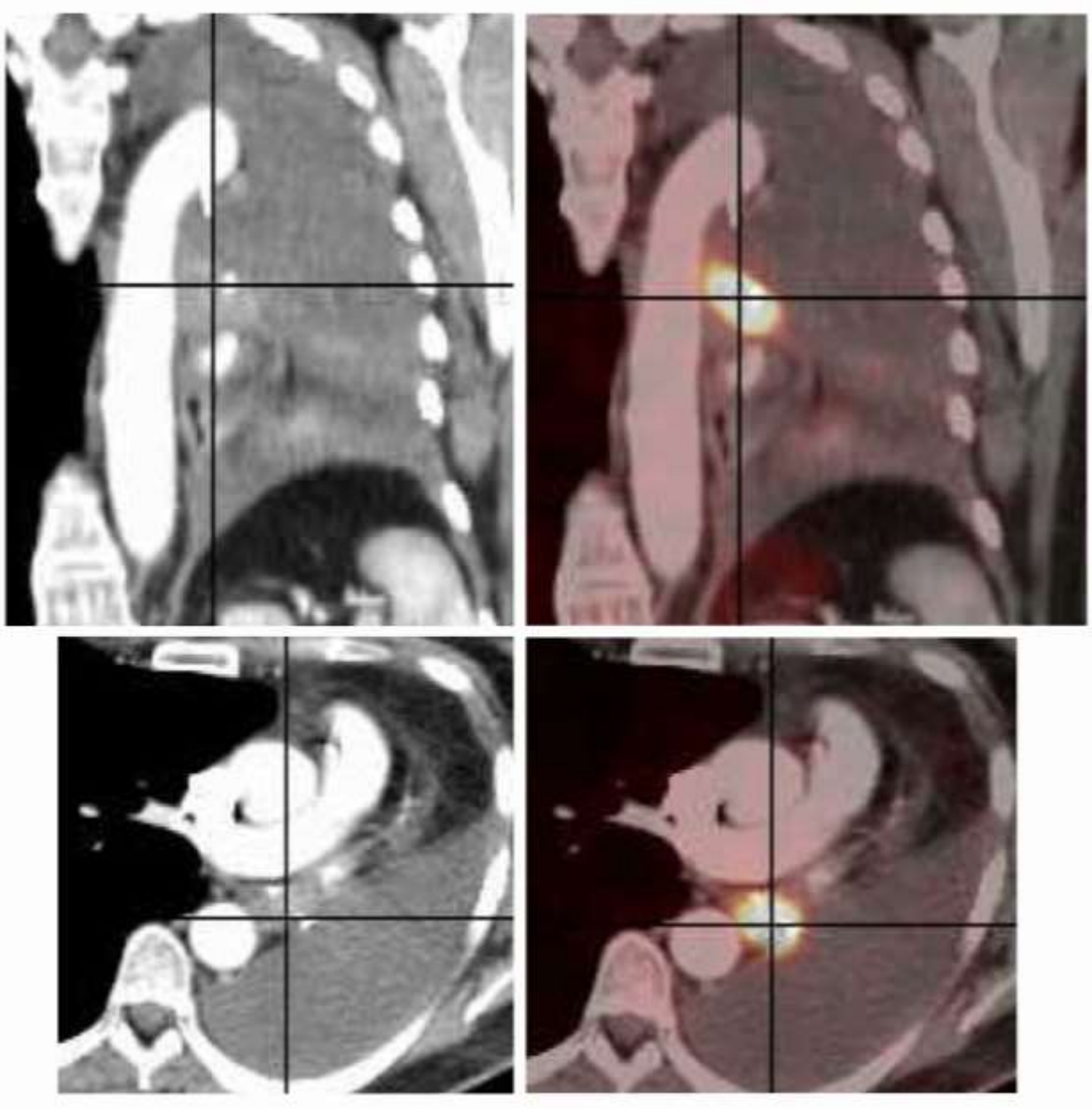
Courtesy of Th. Duprez

Multimodality imaging for target visualisation



Courtesy of L. Renard

Multimodality imaging for target visualisation



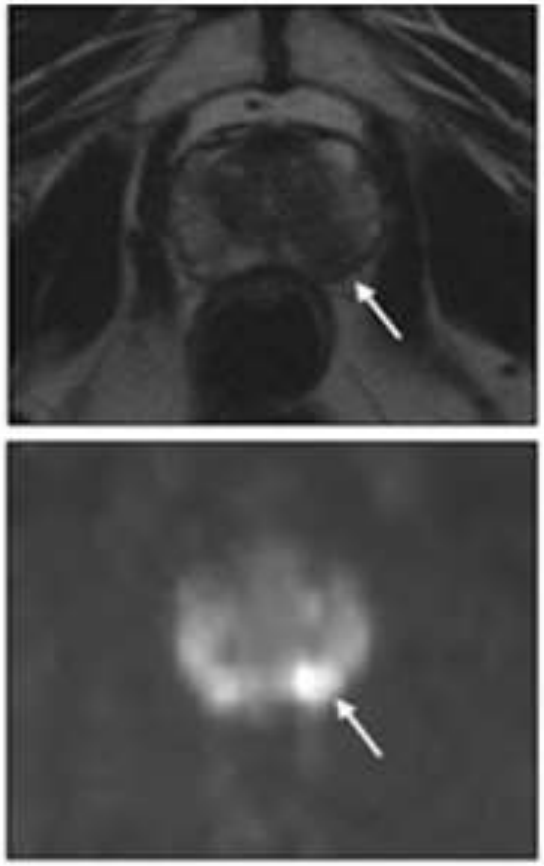
Courtesy of X. Geets

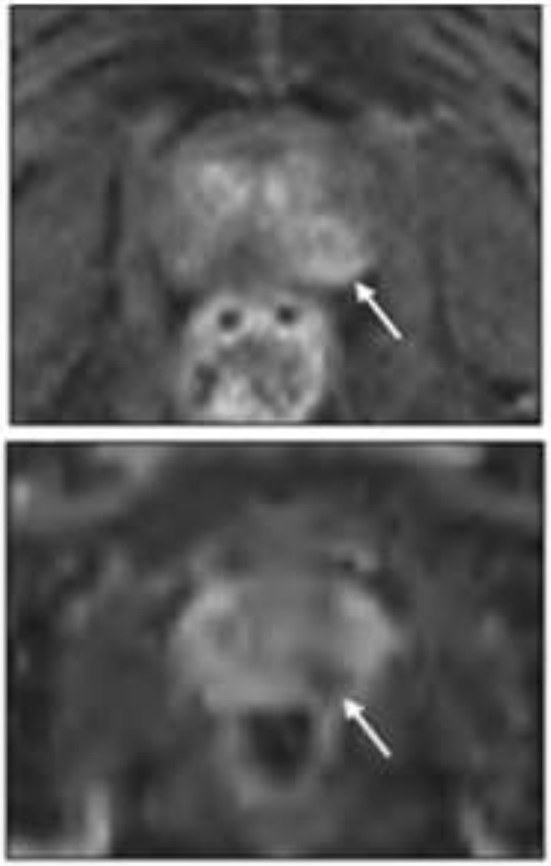
Multimodality imaging for target visualisation

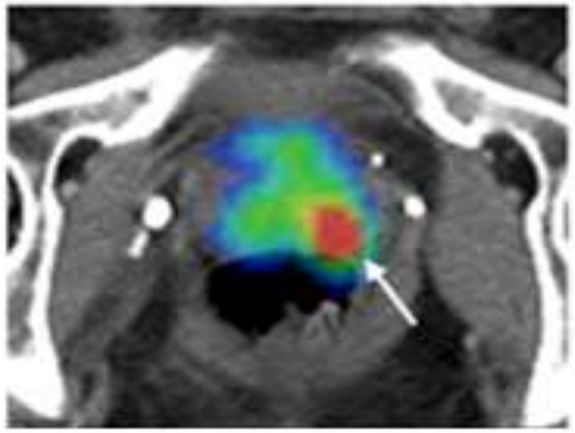
T2w MRI

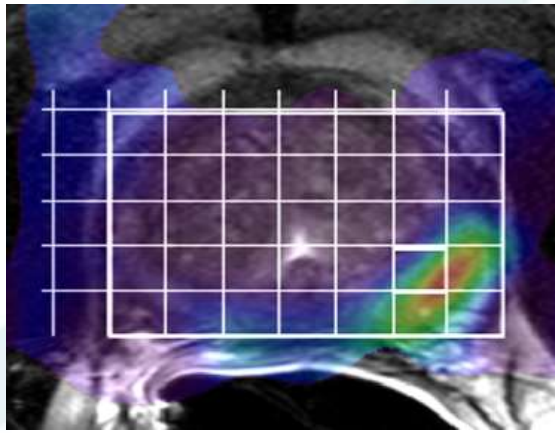
DCE MRI

^{11}C-Choline PET-CT









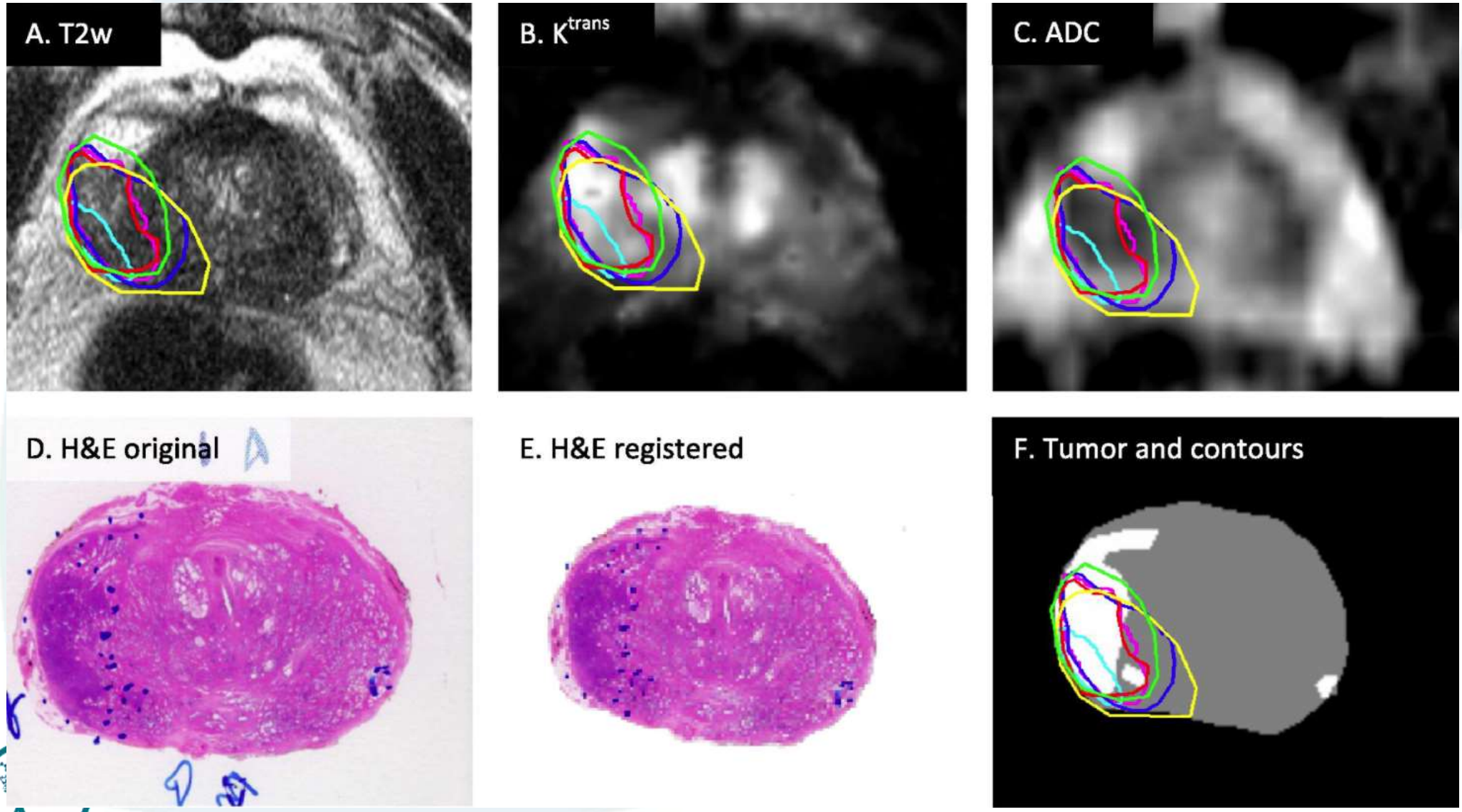
DW MRI: b1000

DW MRI: ADC map

MRS

Courtesy of K. Haustermans

Multimodality imaging for target visualisation

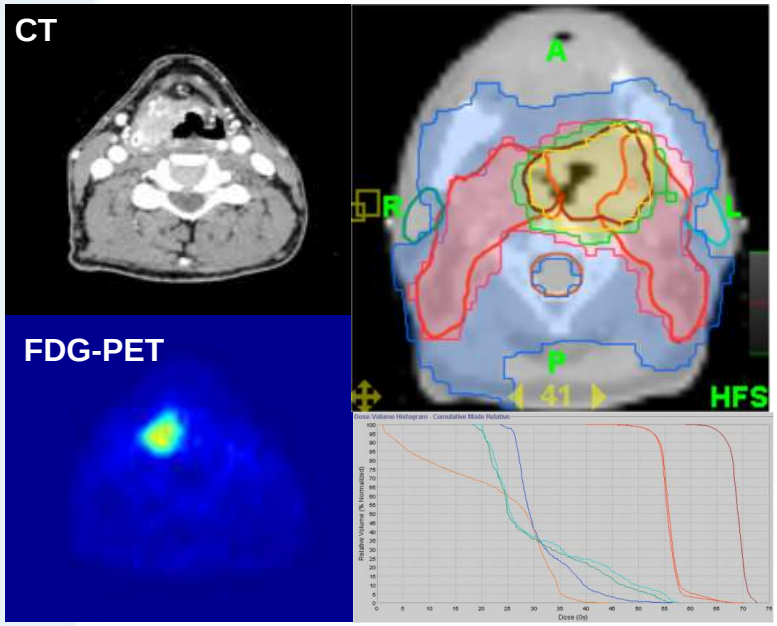


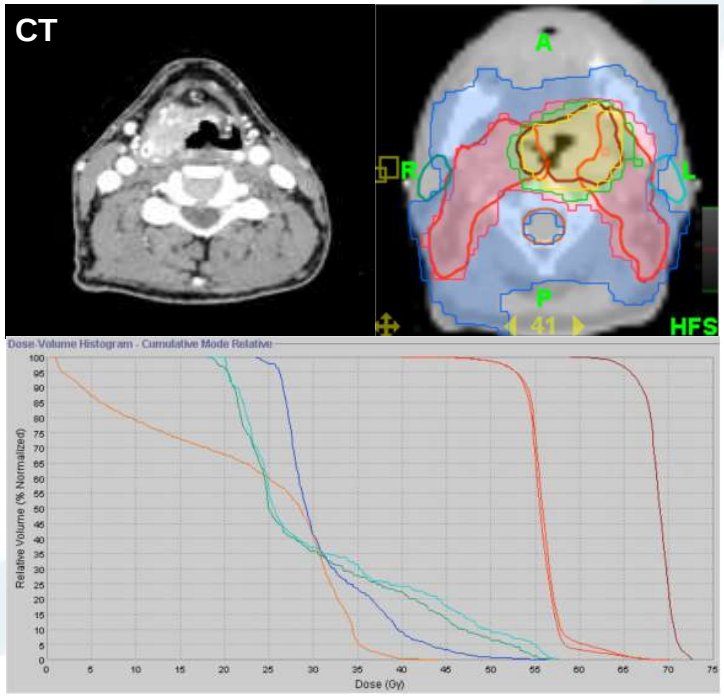
Courtesy of K. Haustermans

FDG-PET based target volume delineation

R/ PET-based IMRT treatment

CT-based IMRT planning



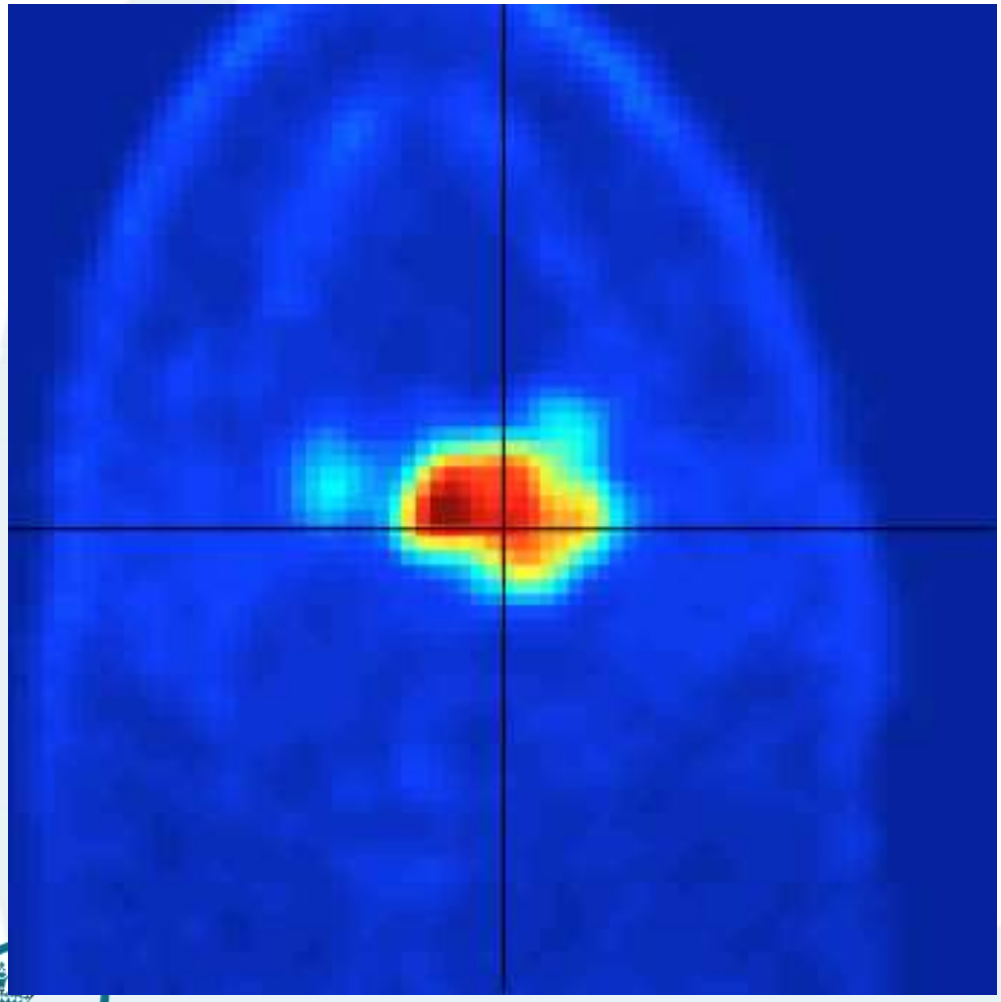


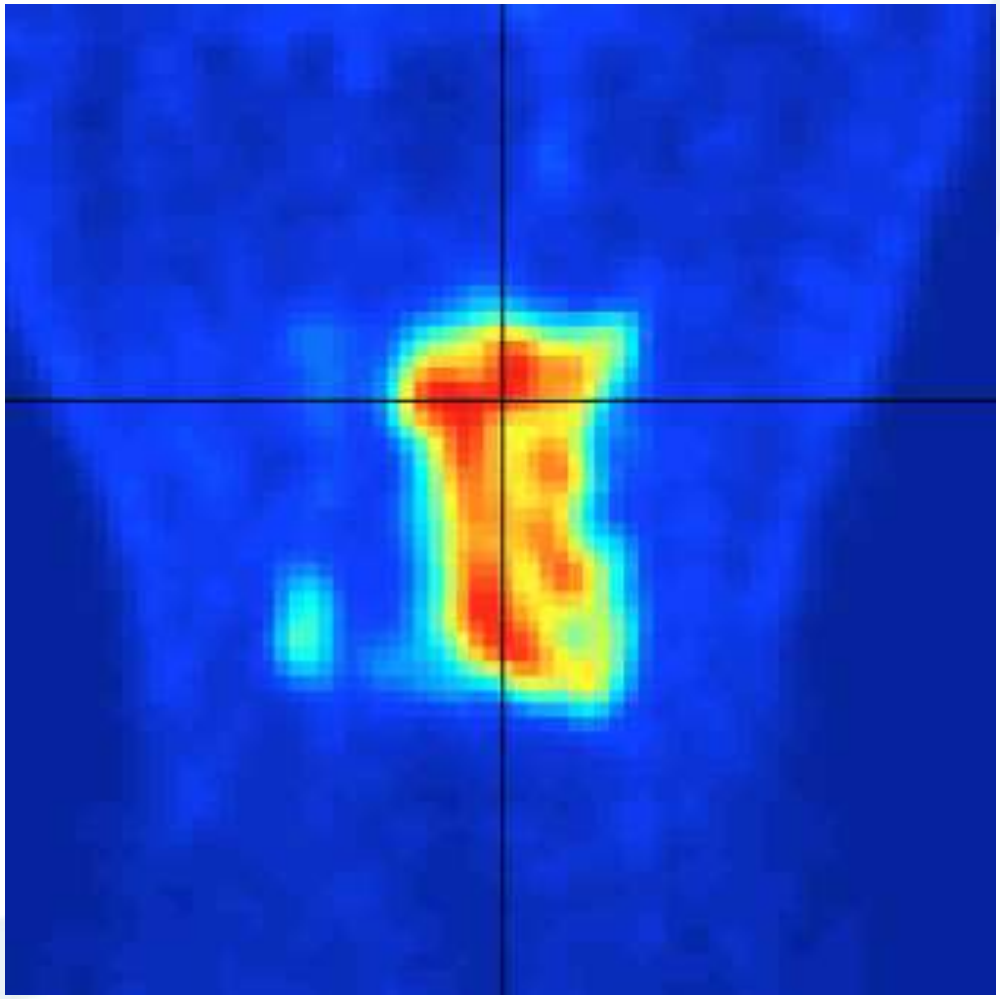
No difference in target volume conformity: p = ns

Leclerc & Grégoire, R&O, 2015

Imaging the target: intra-tumour heterogeneity

SCC oropharynx: T4b-N0-M0 – FDG-PET-CT





S. Differding, RO, 2017

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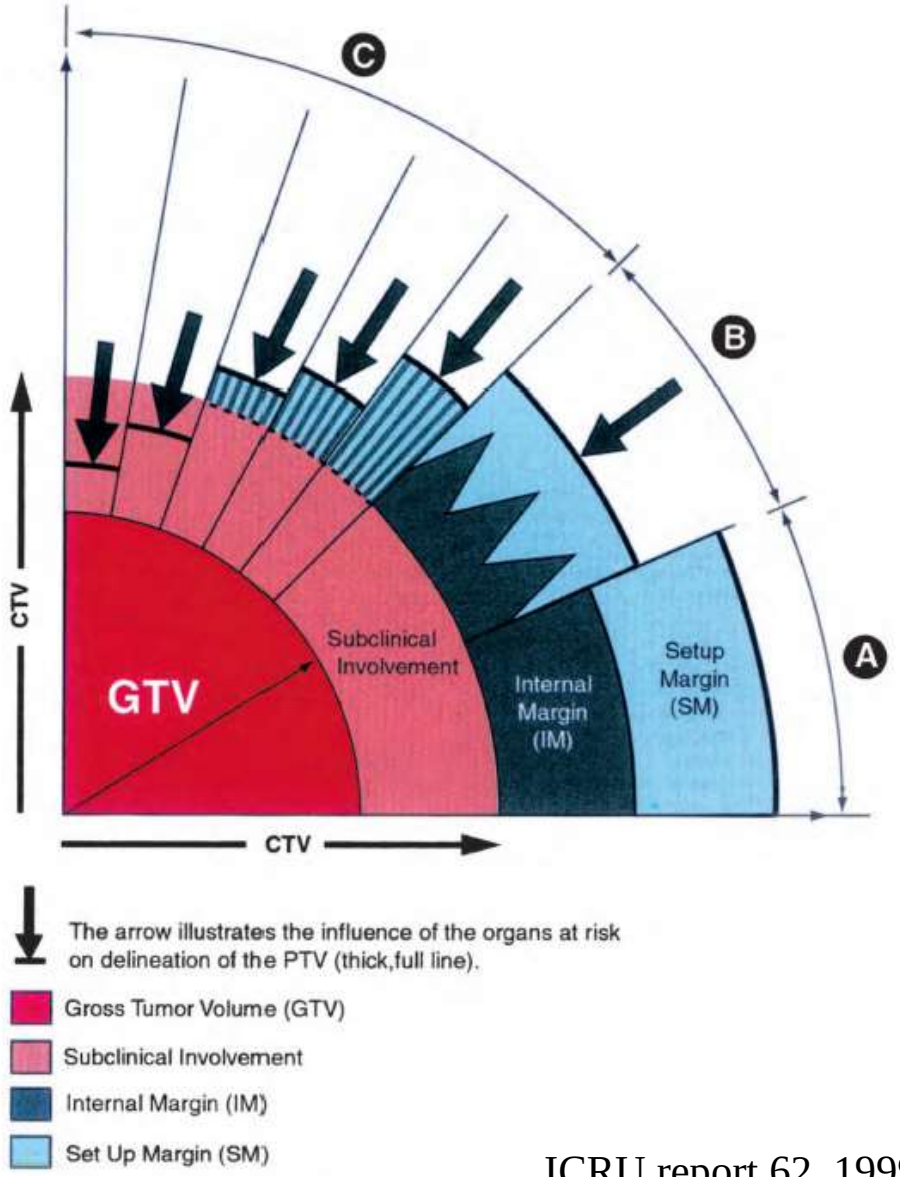


ICRU report 62, 1999

From primary tumor GTV to CTV

Geometrical margins

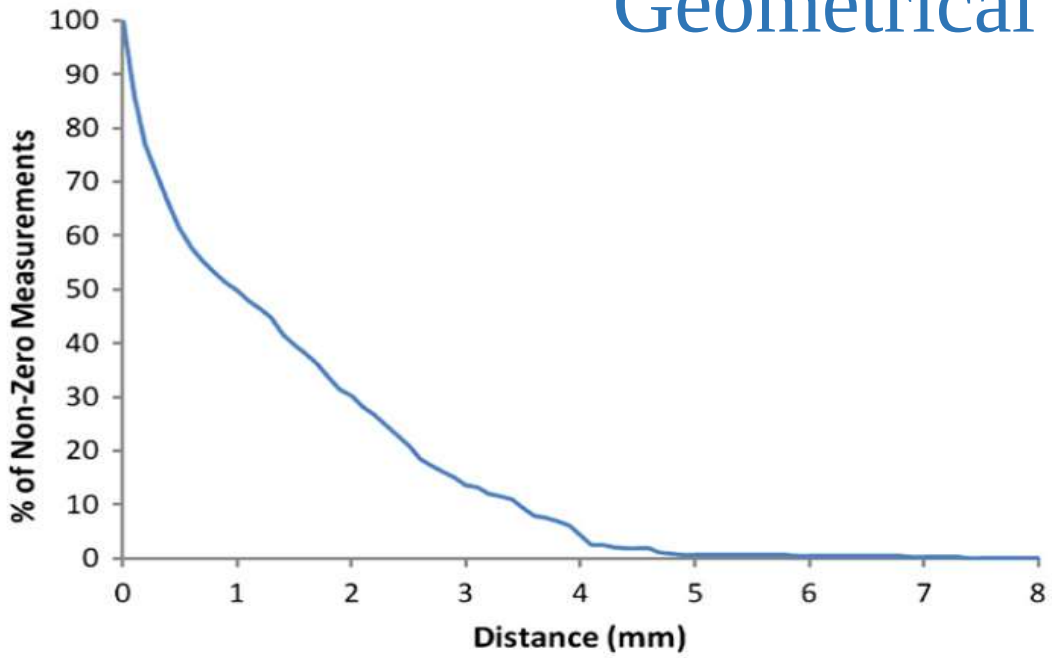


Fig. 8. Graph showing the percentage of nonzero measurements against distance from the gross tumor volume.

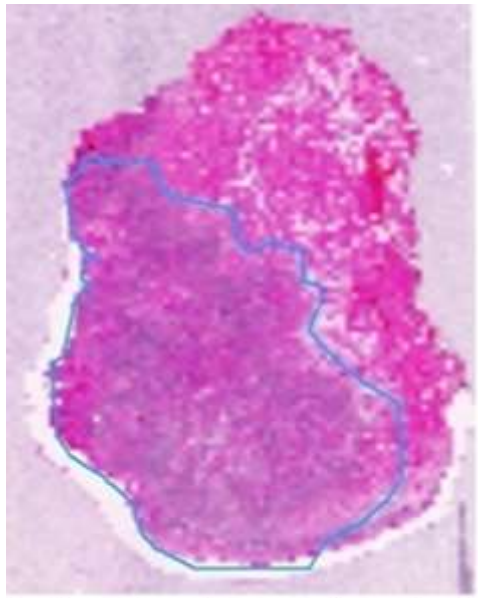
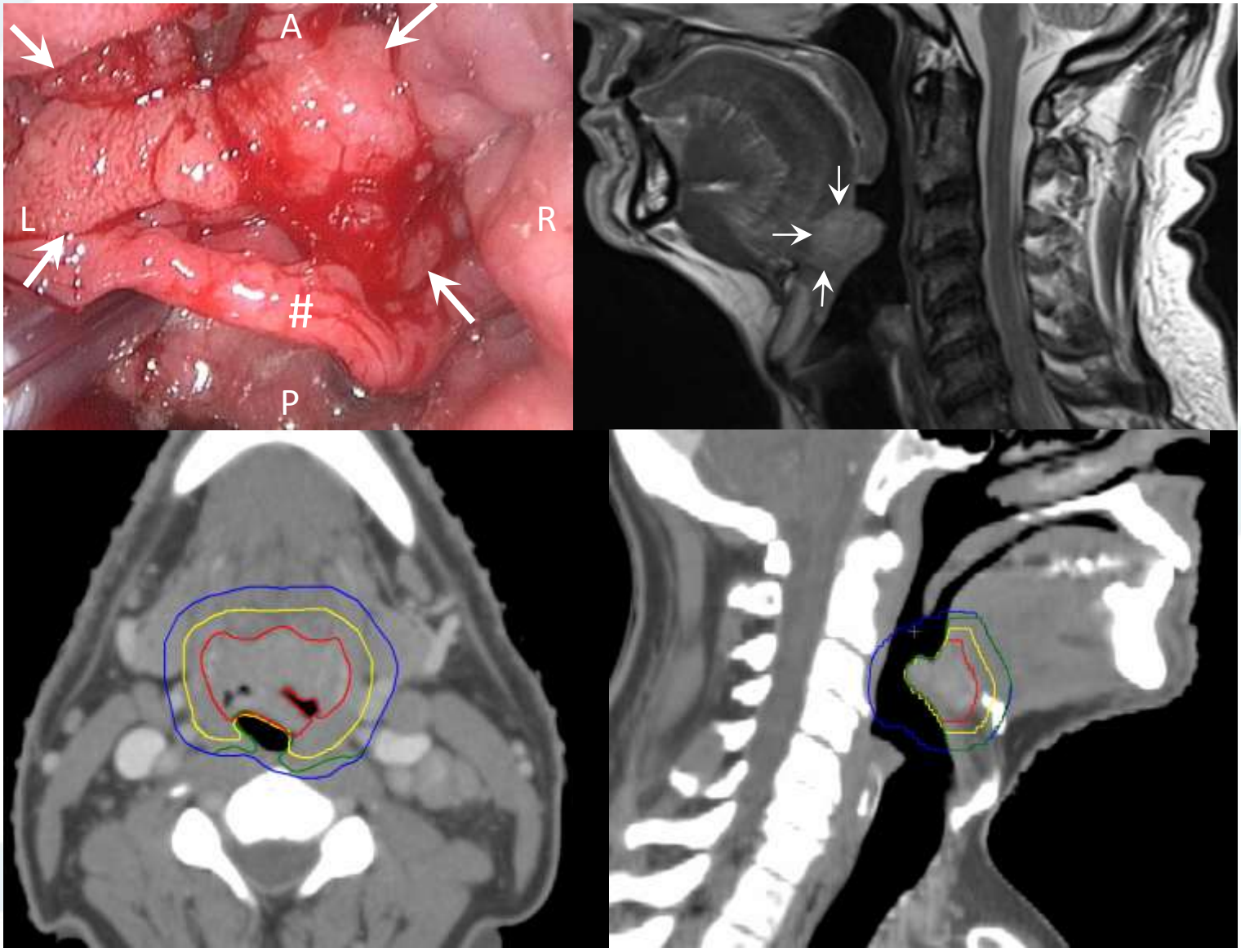


Fig. 4. Image at ×4 magnification and naked eye resolution with gross tumor volume contoured in blue.

Of 88 slides from 10 patients with oral cancers, 44 (50%) had signs of microscopic extension. The maximum distance from the border was 7.8 mm. Ninety-nine percent of all MD was within 4.75 mm and 95% was within 3.95 mm of the GTV.

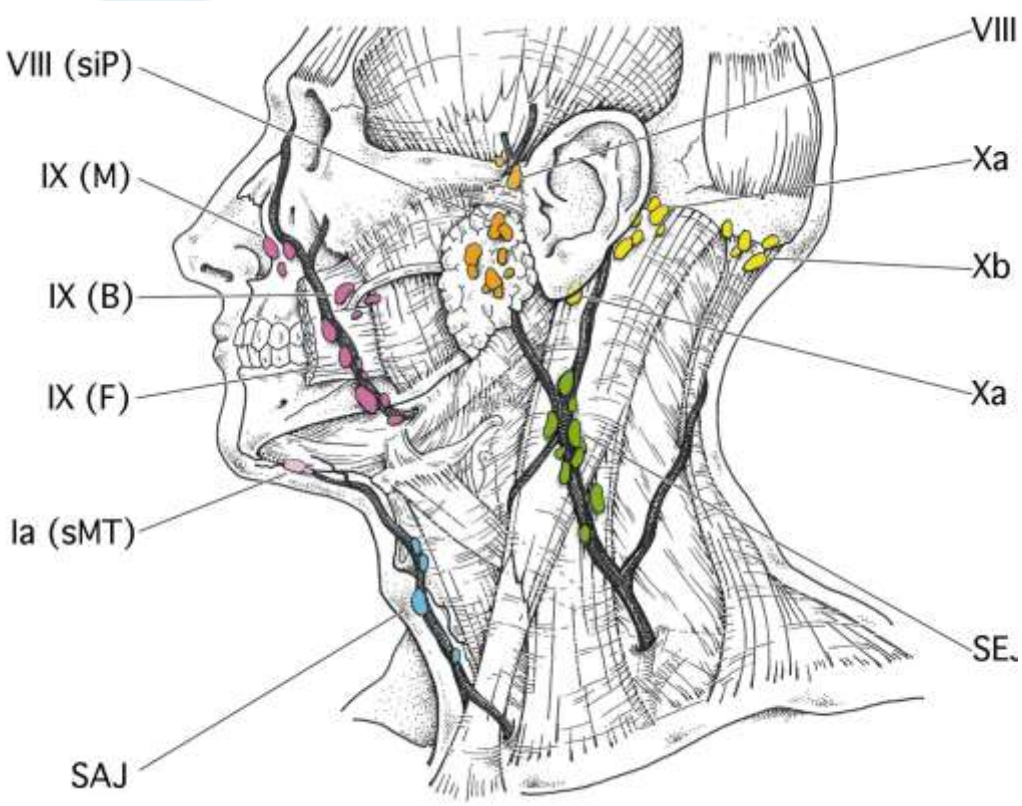
Campbell et al. IJROBP, 2012

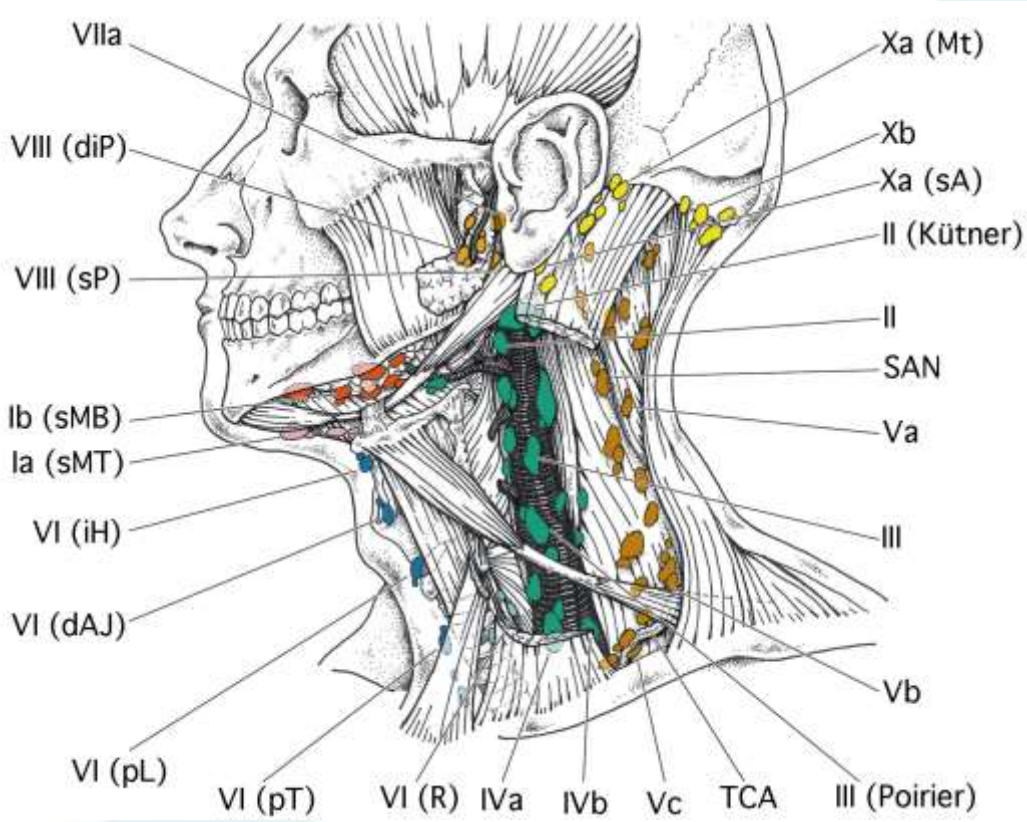
From macroscopic (GTV_P) to microscopic (CTV_P) target volumes



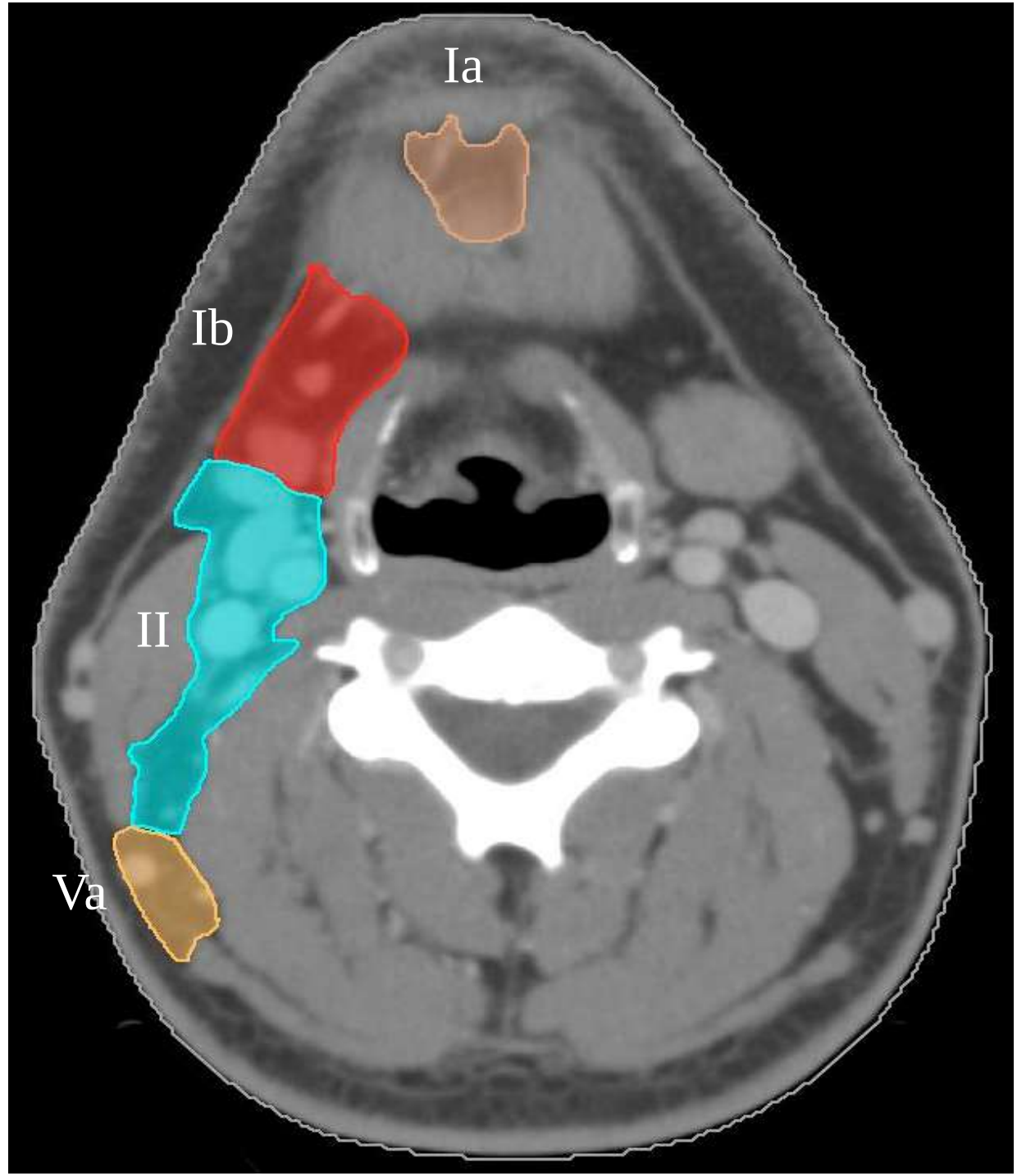
Grégoire, 2017

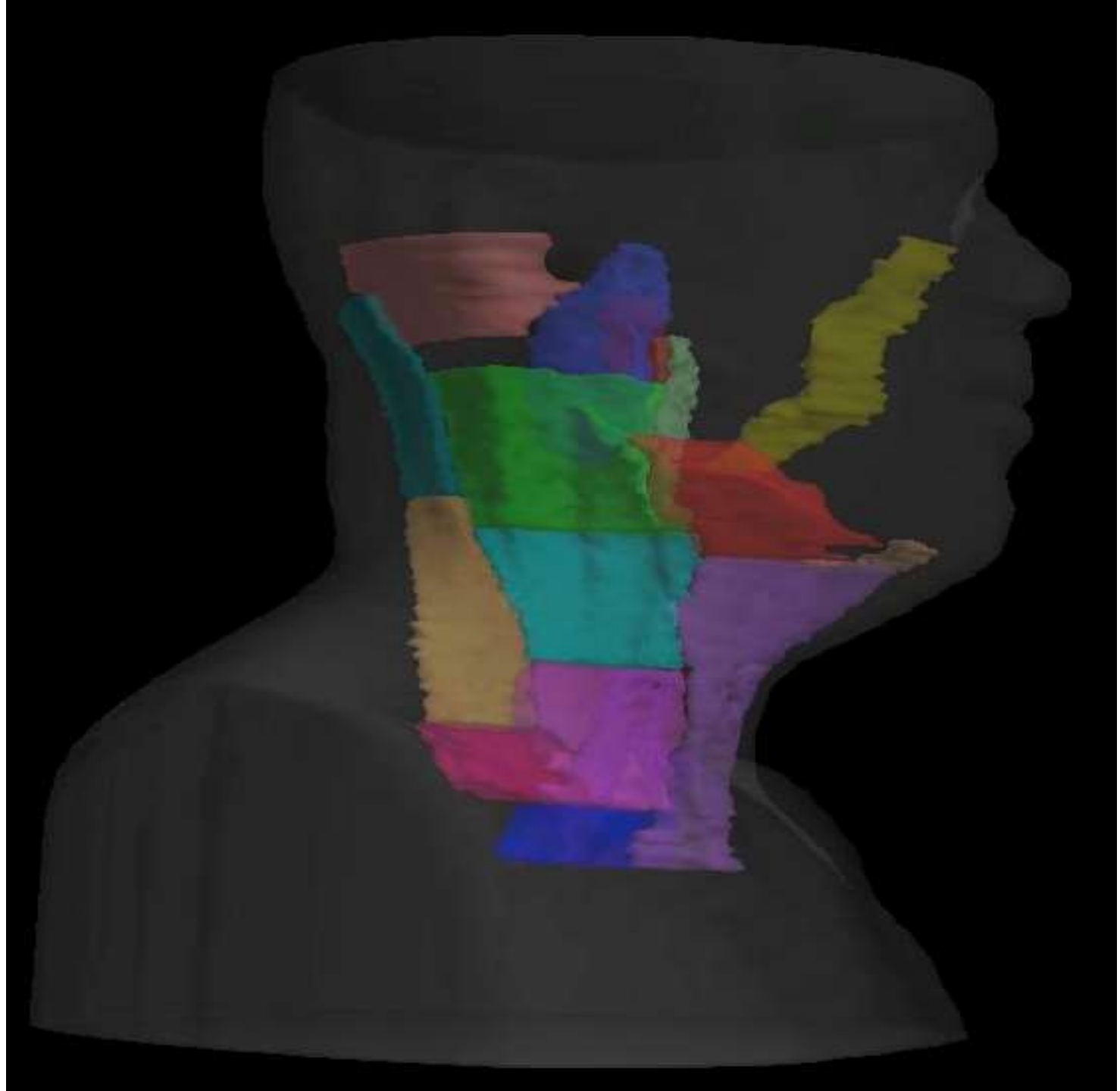
CT-based delineation of lymph node levels in the neck (revised version 2013)





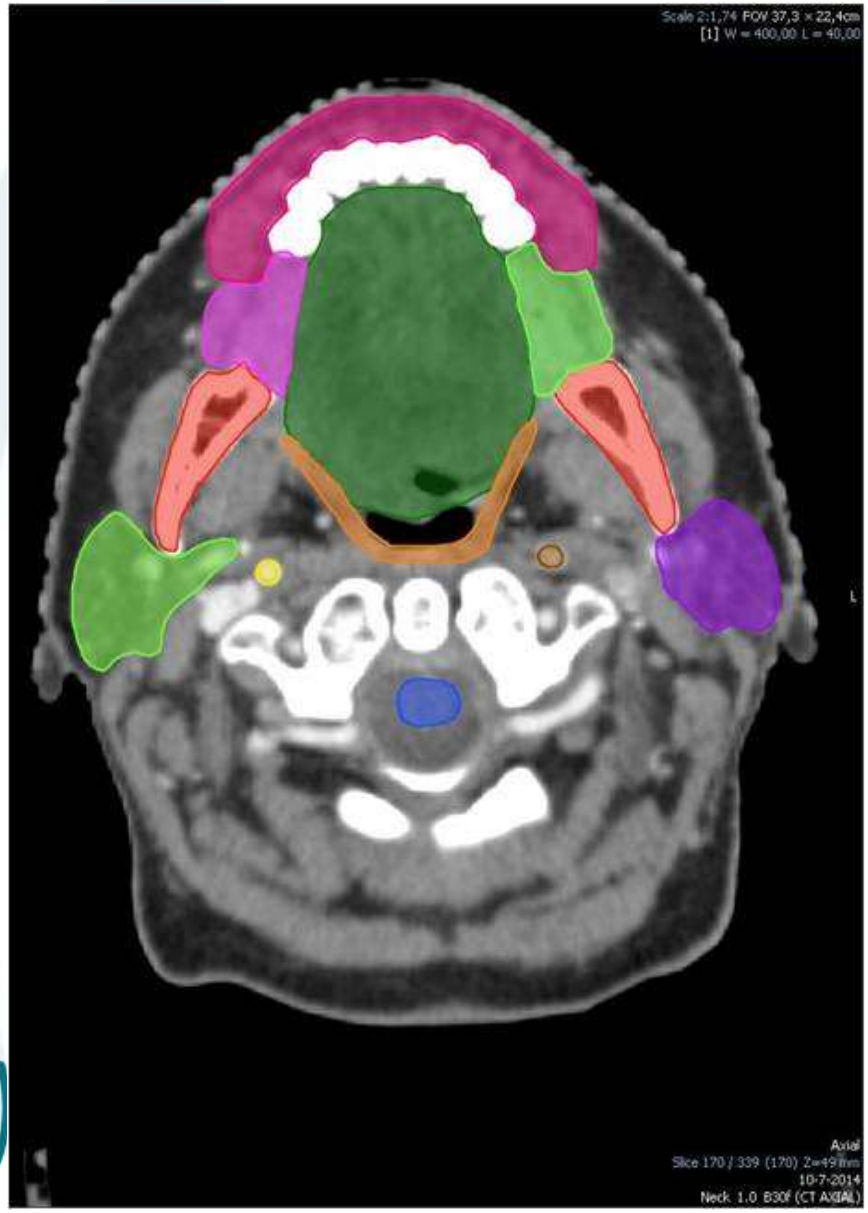
Gregoire et al., 2013

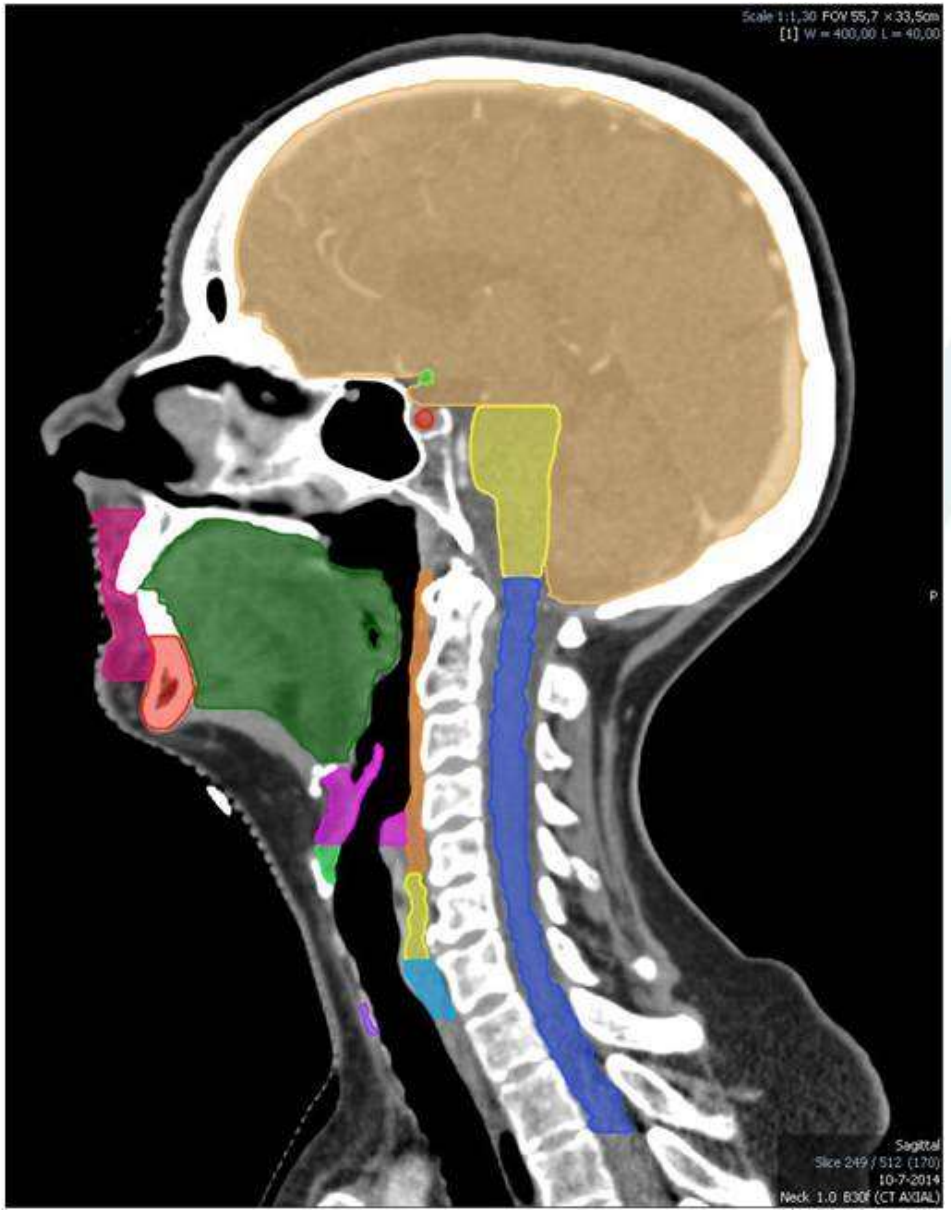

Ia
Ib
II
Va



Grégoire, 2014

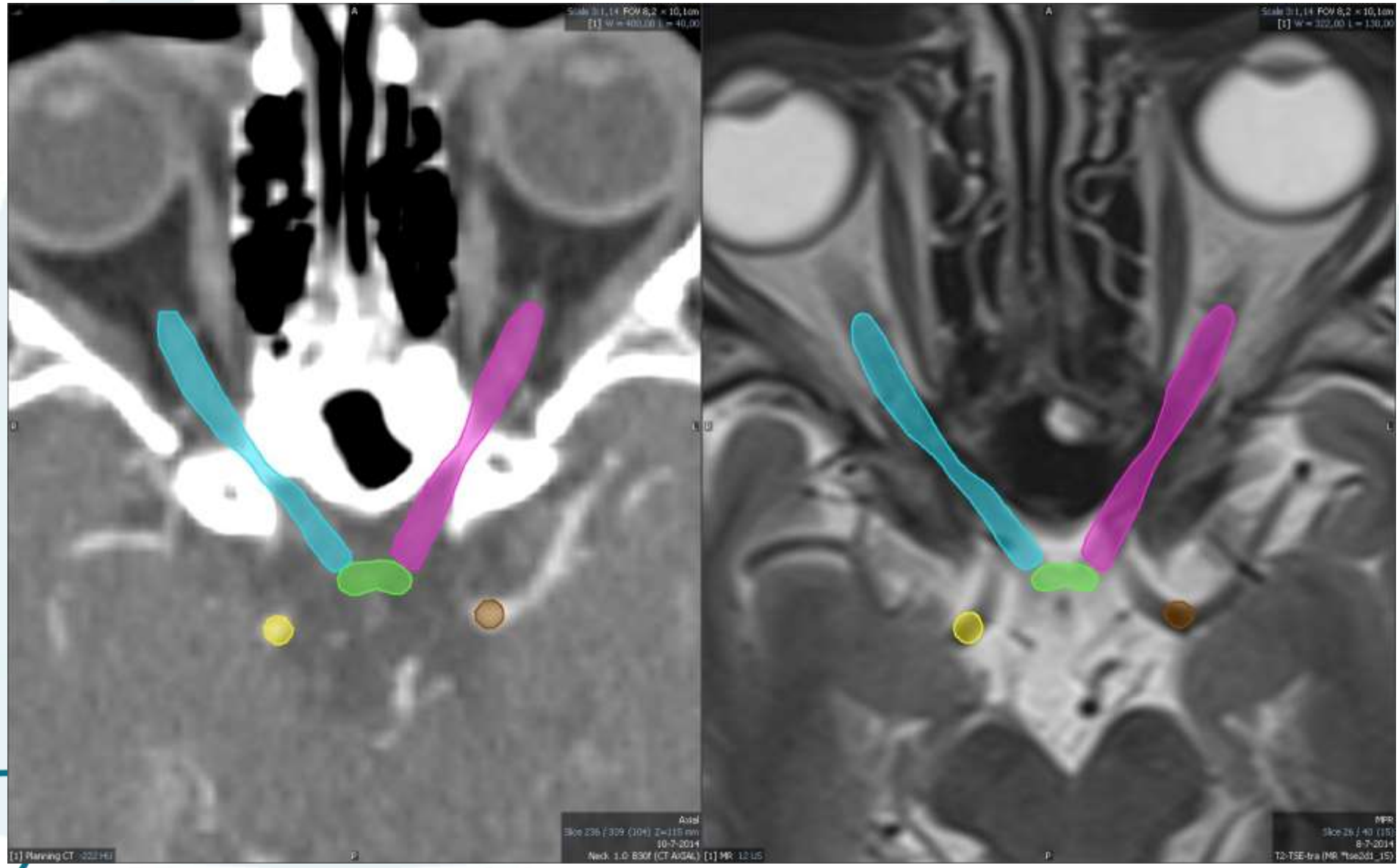
Imaging the Organ at Risk





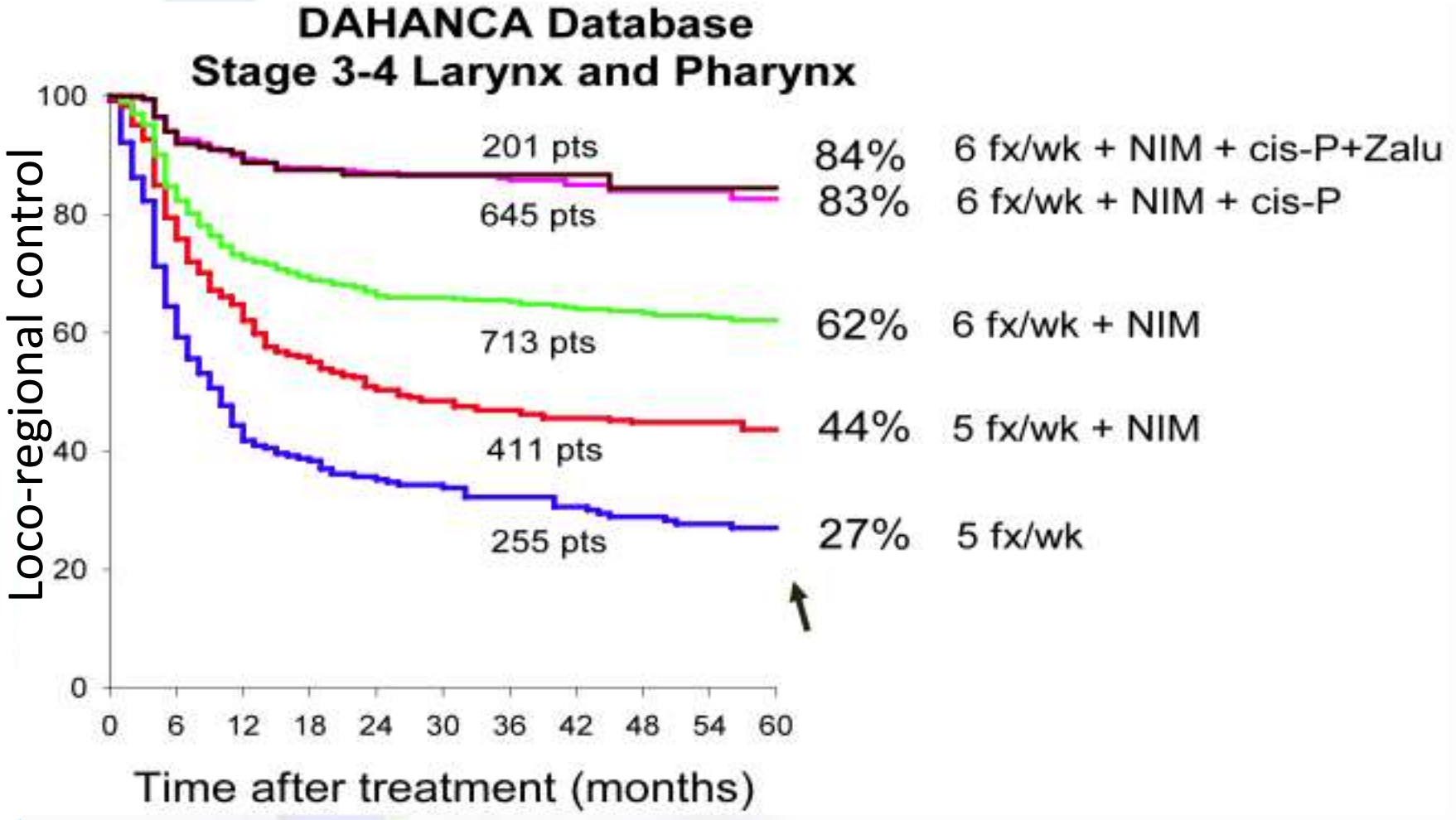
Brouwer et al., 2015

Multimodality imaging for Organ at Risk visualisation



Brouwer et al., 2015

Thirty years of progresses: the Danish example



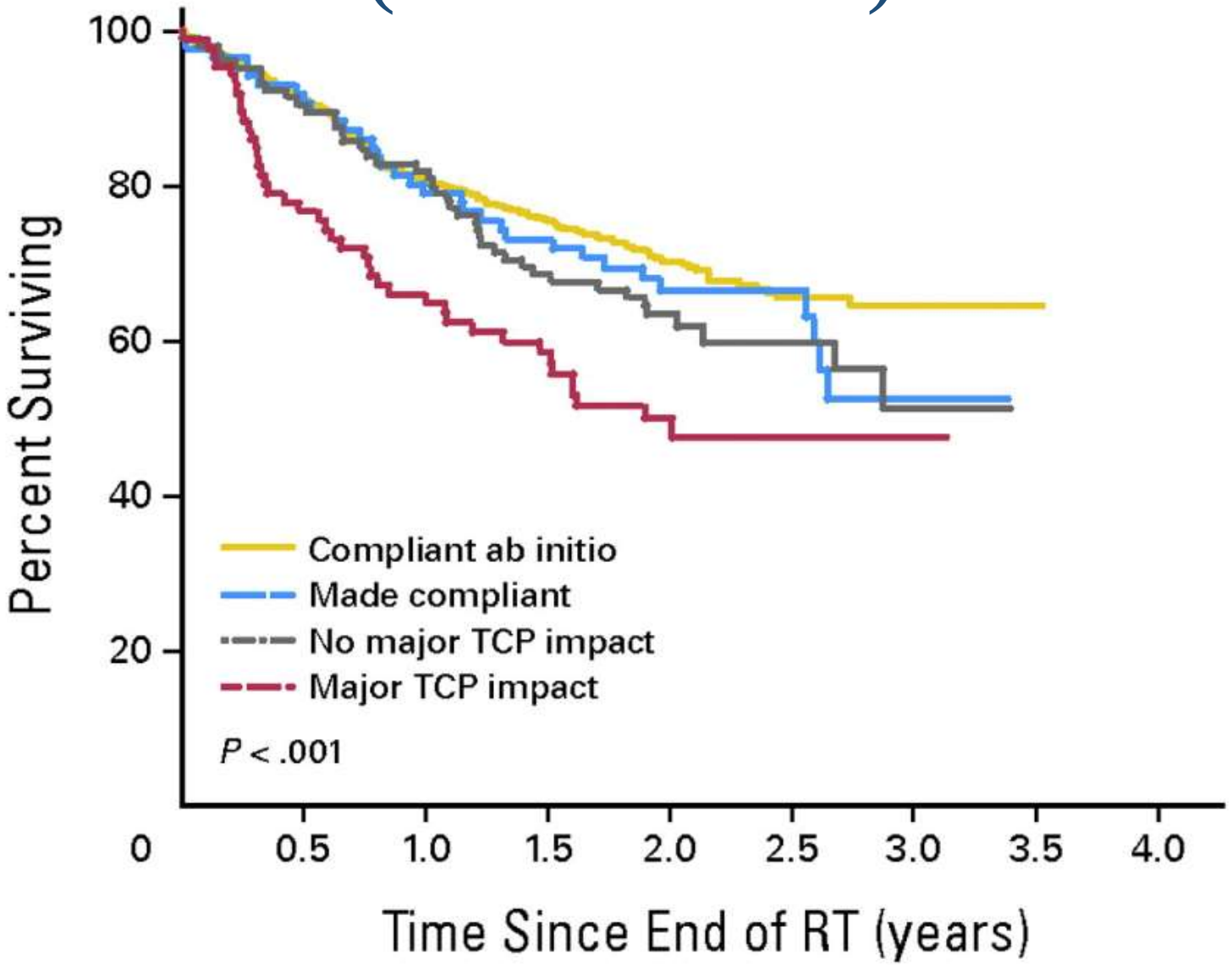
IMRT 2013

2D 1985

DAHANCA.dk

Courtesy of Overgaard 2015

Clinical Impact of Radiotherapy Compliance (TROG 02.02)



Peters et al, JCO 2010

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- Set the scene
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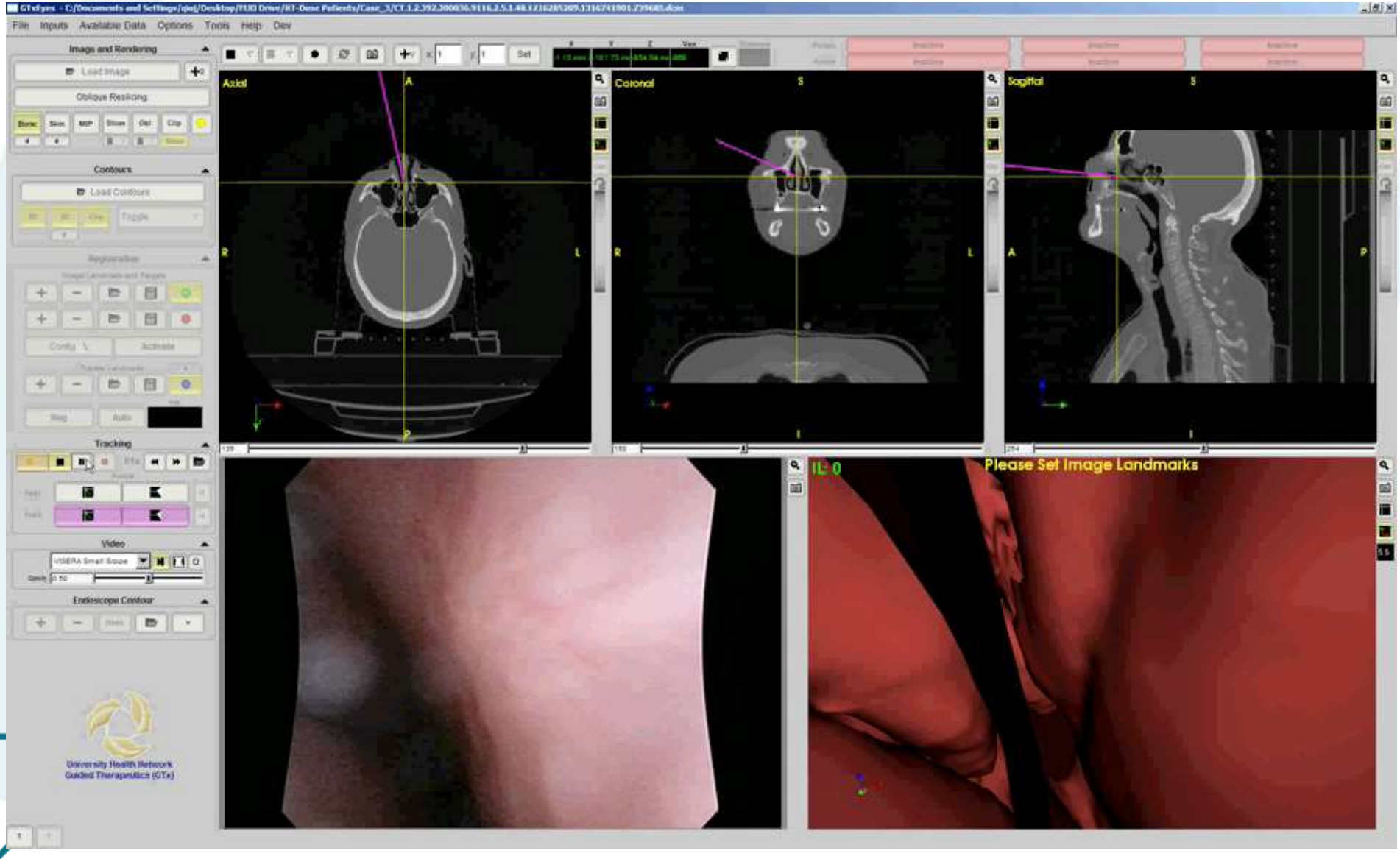
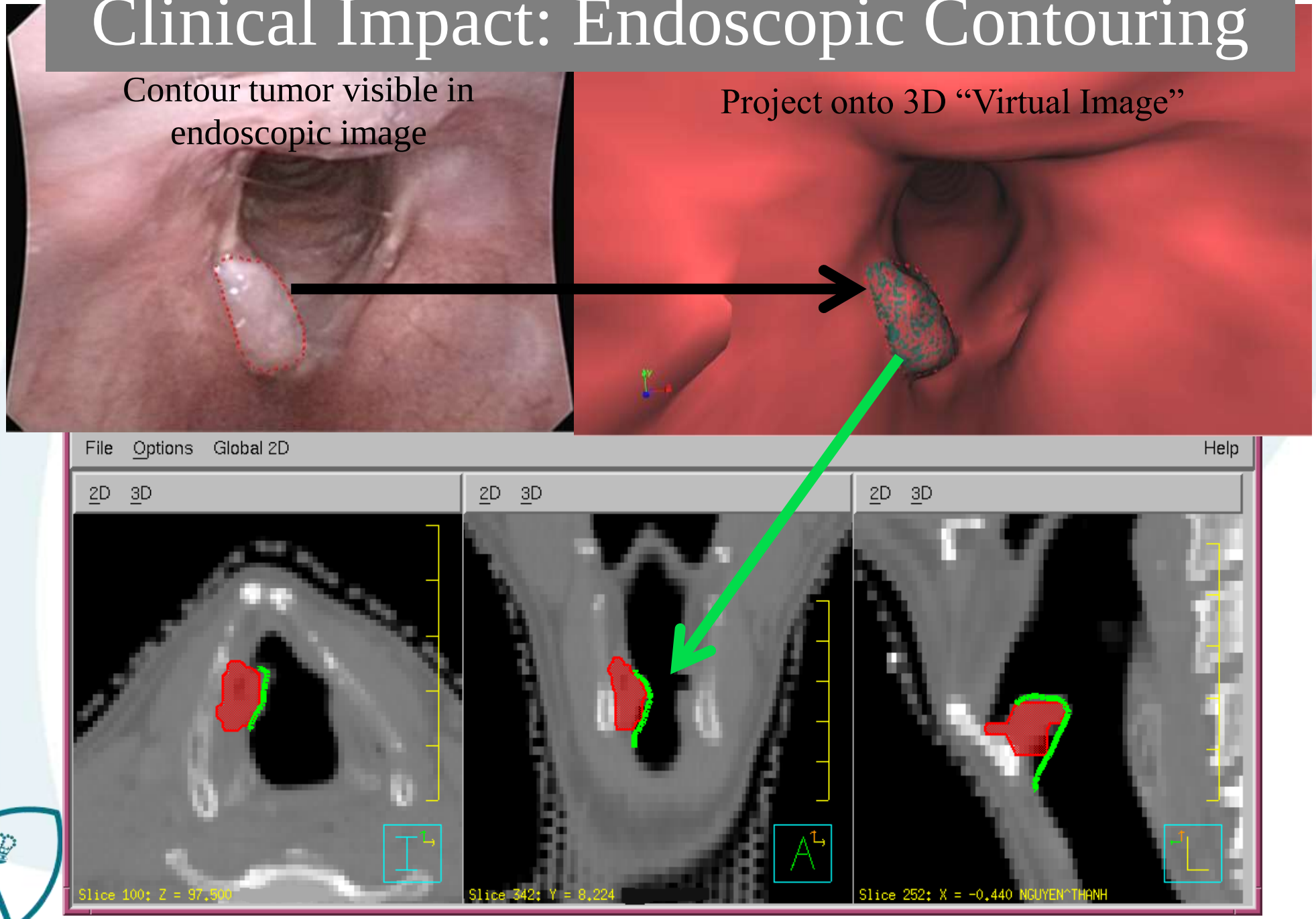
And in the “foreseeable” future… Augmented reality?



Weersink et al Med. Phys 38 6458, 2011

Weersink, US Patent: 9,138,597

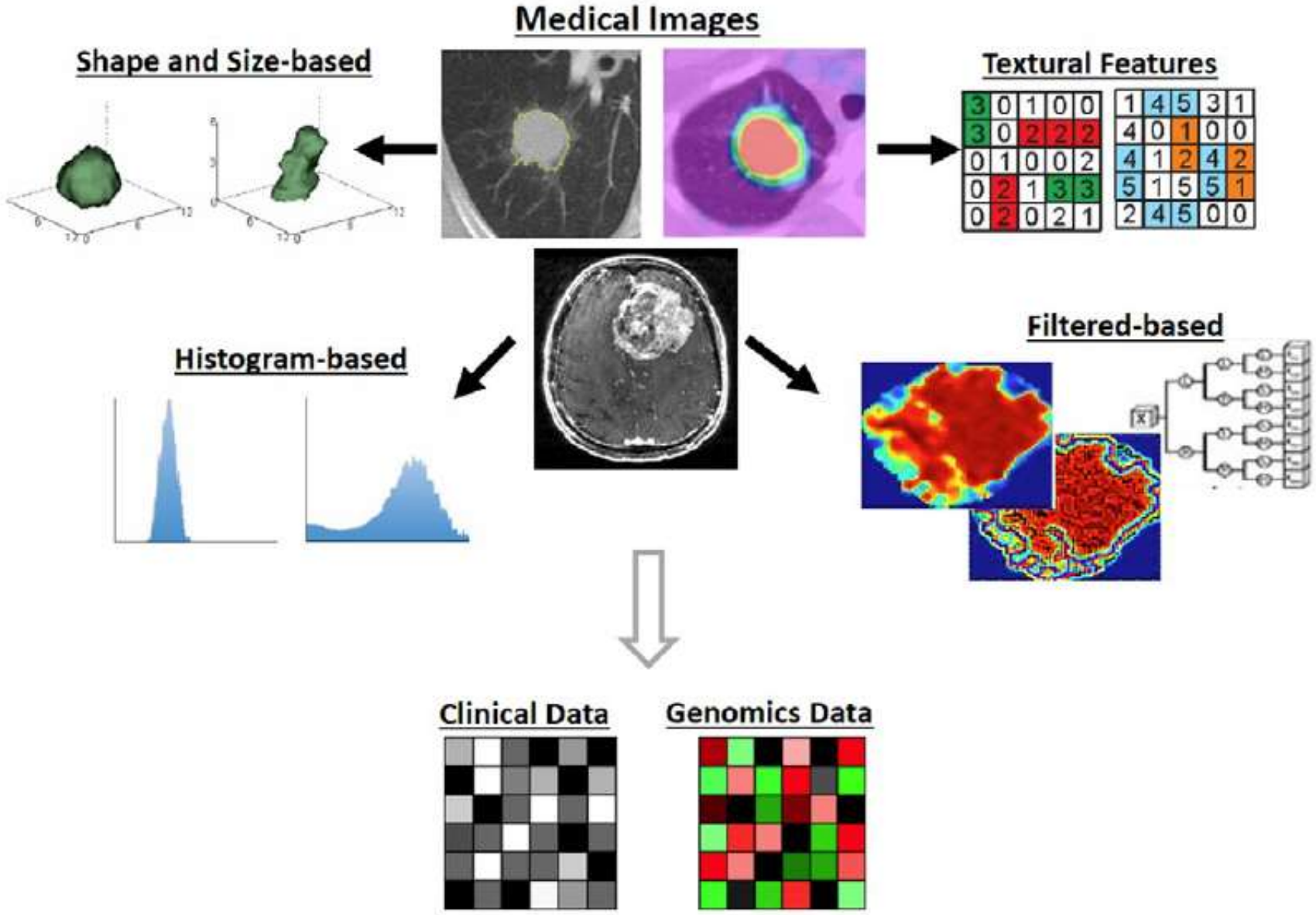
Clinical Impact: Endoscopic Contouring



Weersink et al Med. Phys 38 6458, 2011

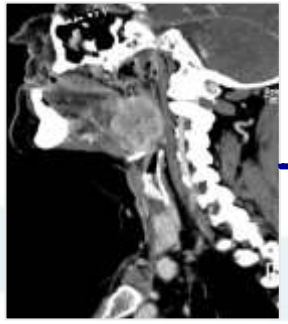
Weersink, US Patent: 9,138,597

Radiomics for treatment individualization



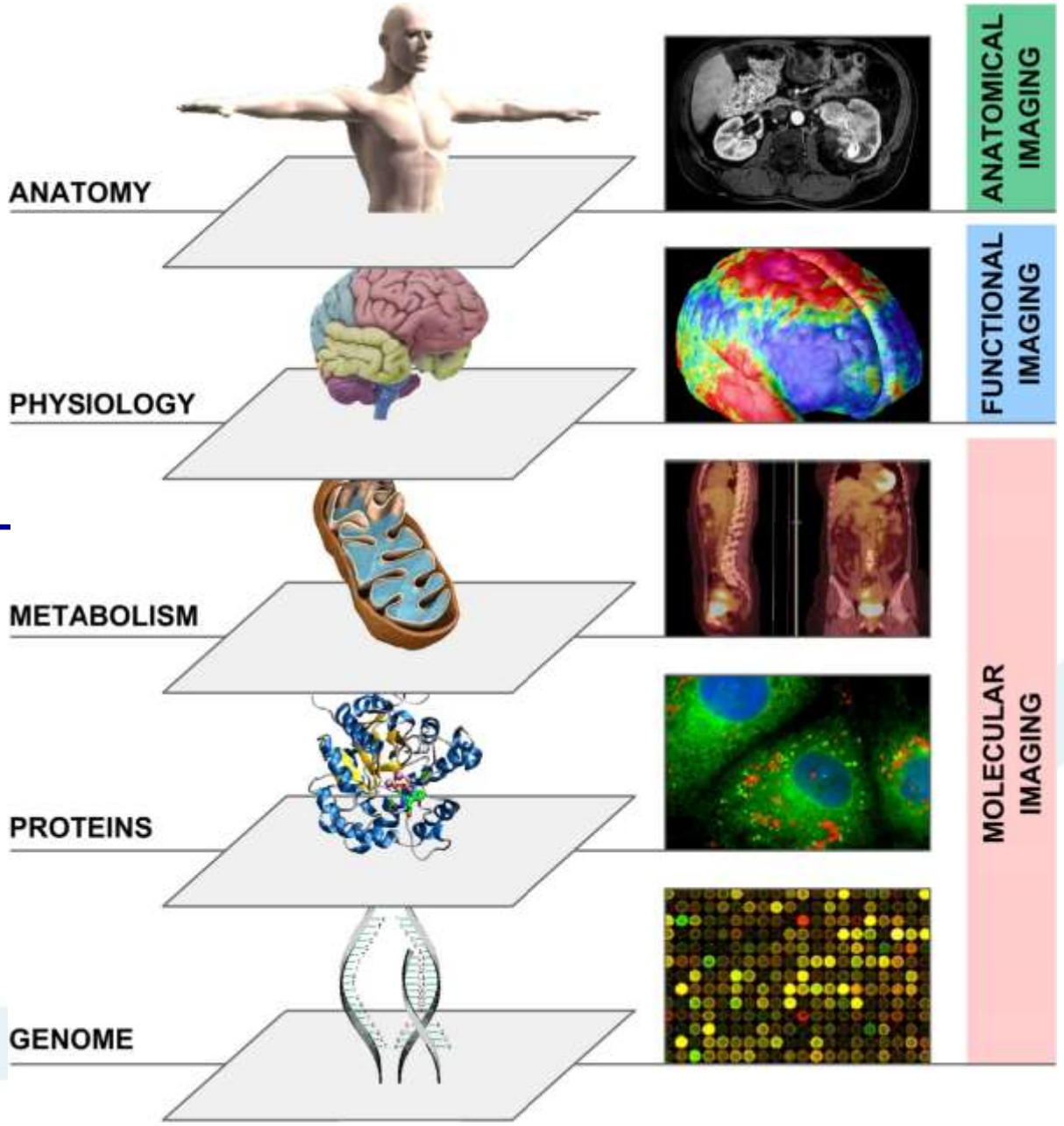
Yip, PMB, 2016

From care to the “average” …



Multidisciplinary
Tumor board

… to personalized care



"Here's my sequence..."

One patient …

One disease …

One treatment …

Nature, 2000