

Medicinsk fysik i kræftbehandling

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Kræft – i tal

34.000 danskere

over 60 år

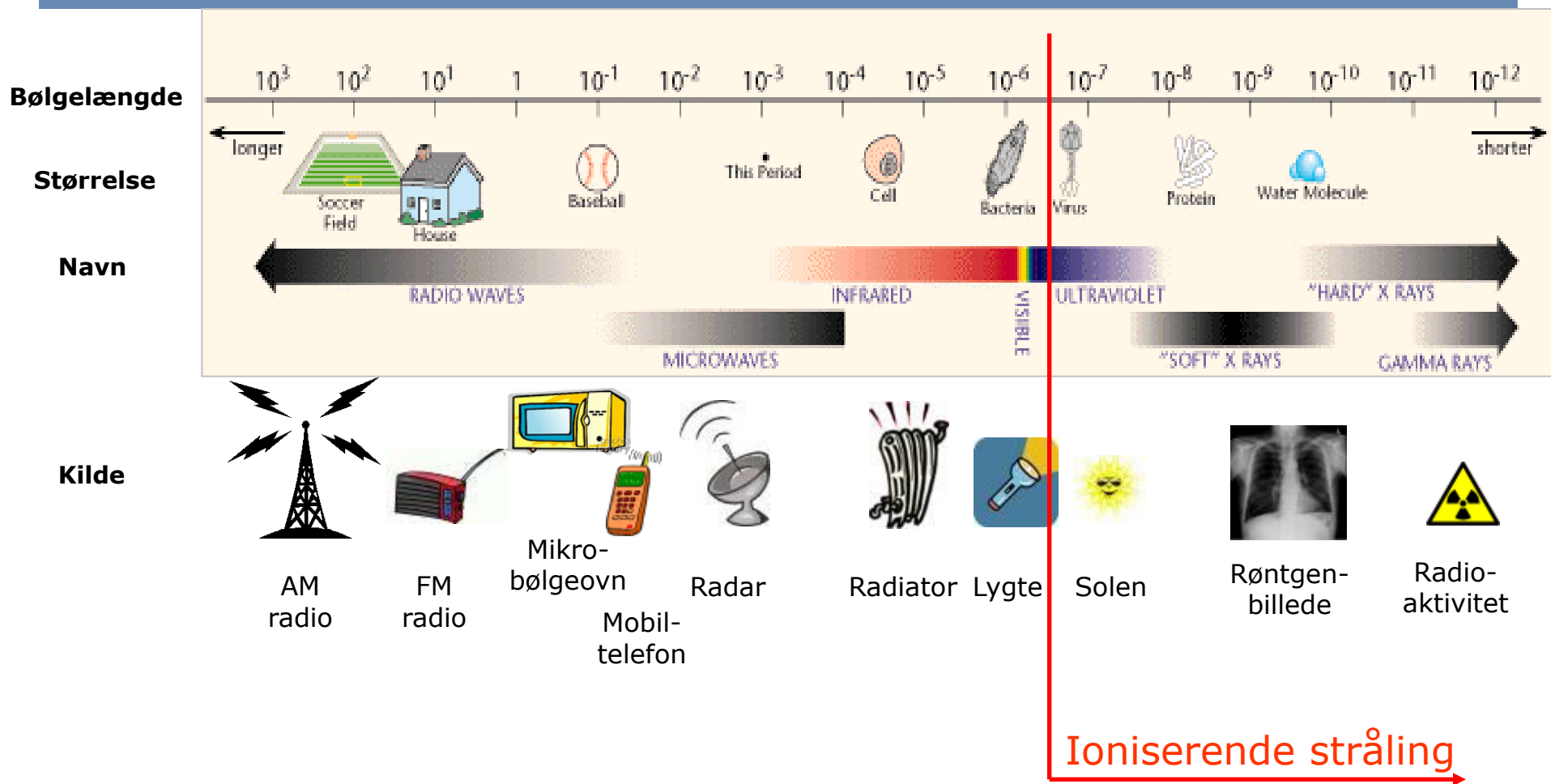
$\frac{1}{3}$



$\frac{1}{2}$



Elektromagnetisk stråling



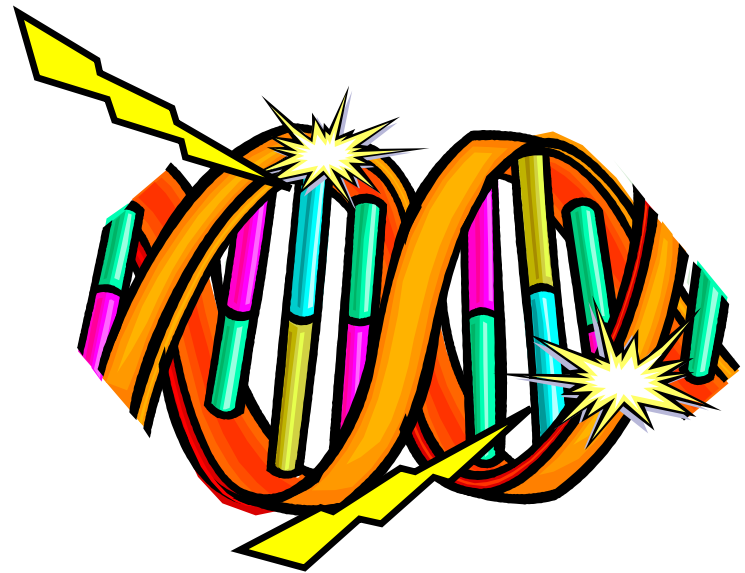
Strålebiologi

Stråling forårsager skade på DNA

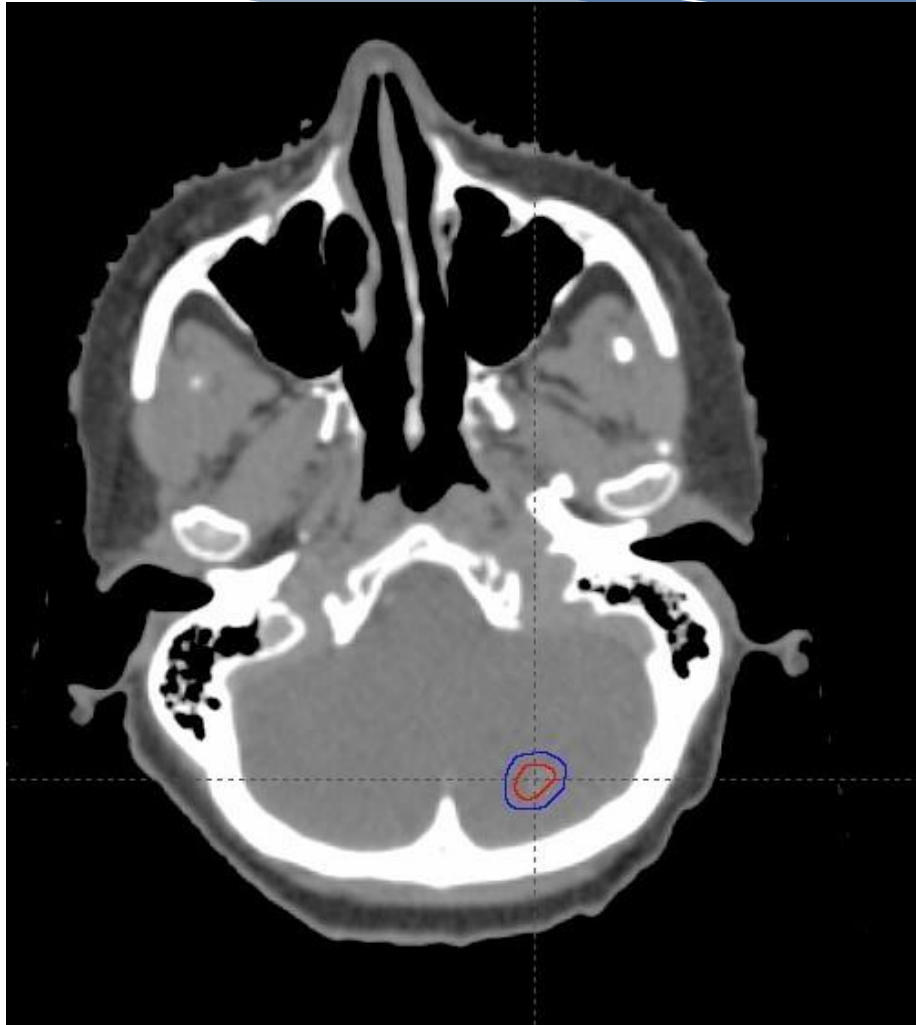
Skader både tumor og raske celler
(...bivirkninger!)

Forskellig strålefølsomhed

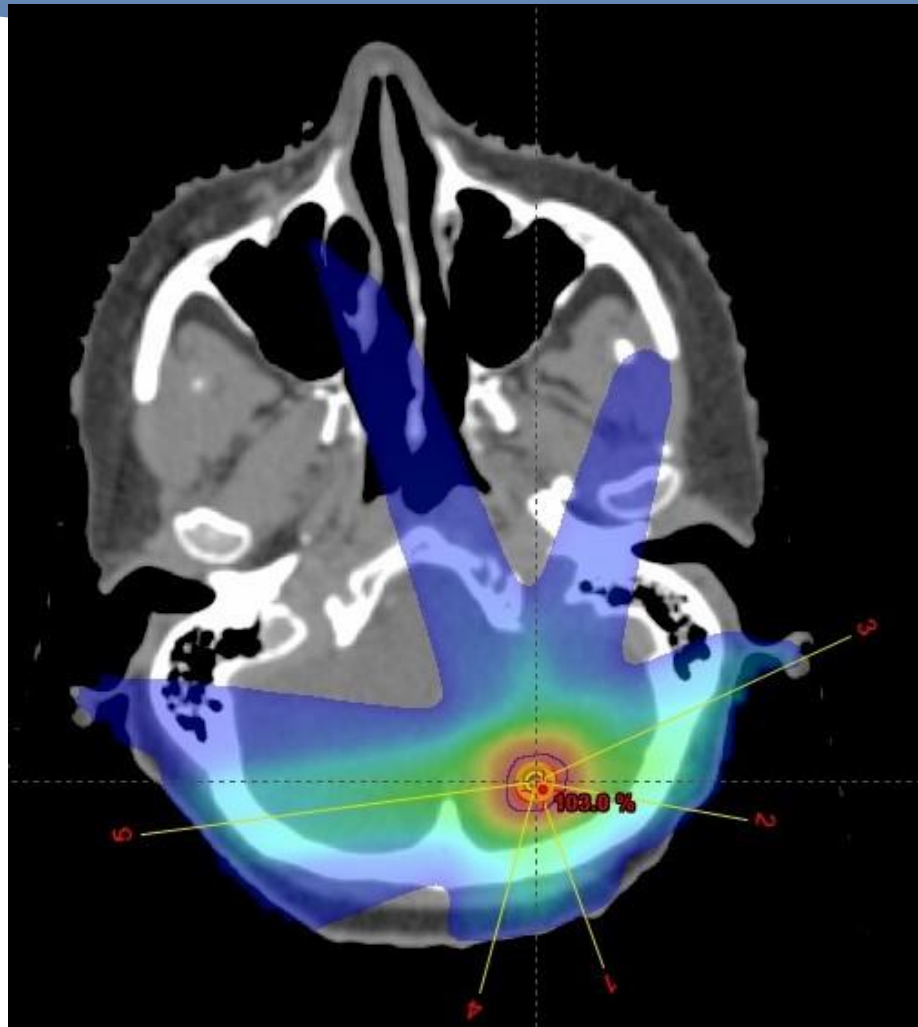
Behandling fraktioneres:
Rask væv reparerer bedre



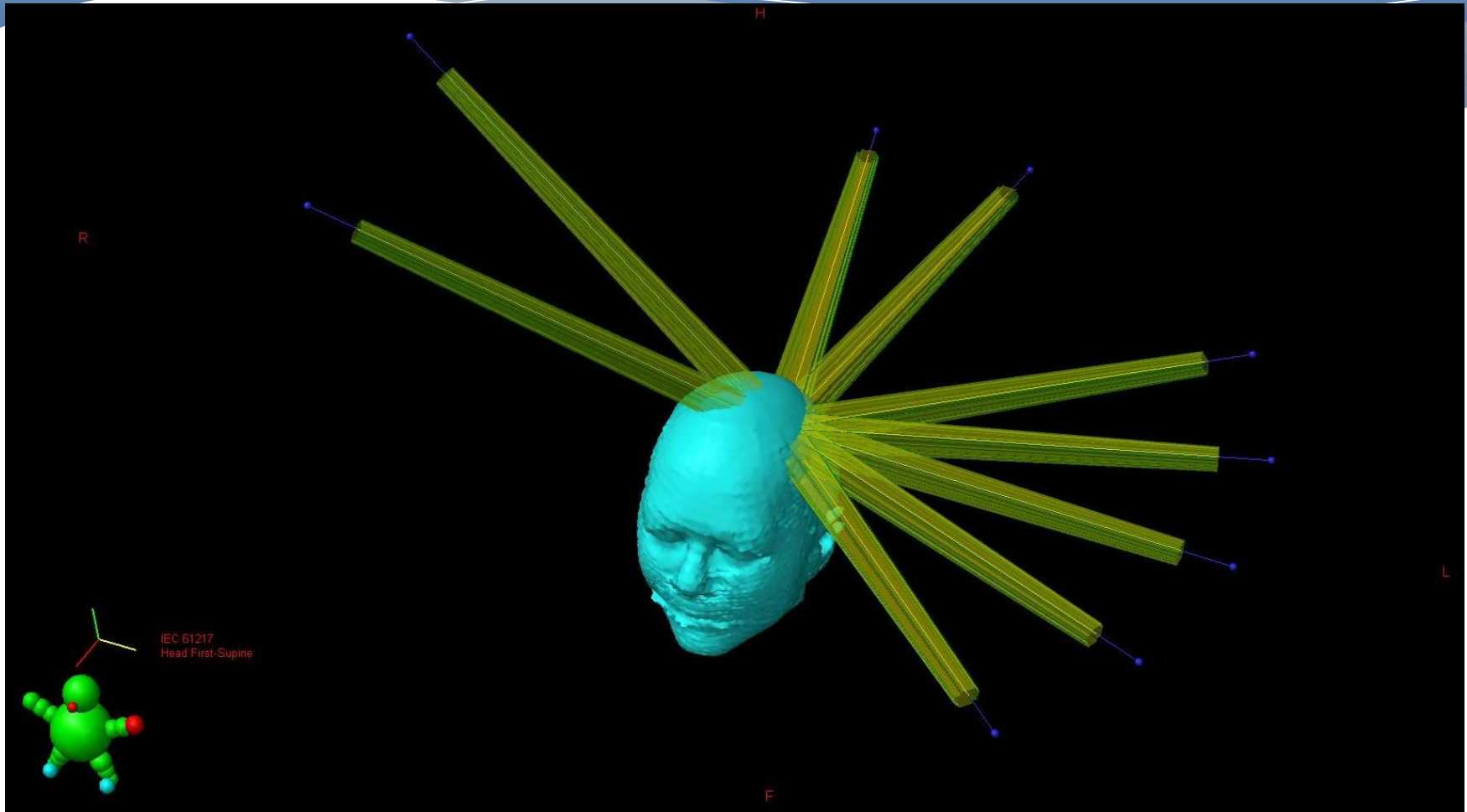
Indtegning af tumor og normal væv



Dosisplanlægning



Feltretninger



Lejring af patienten til behandling

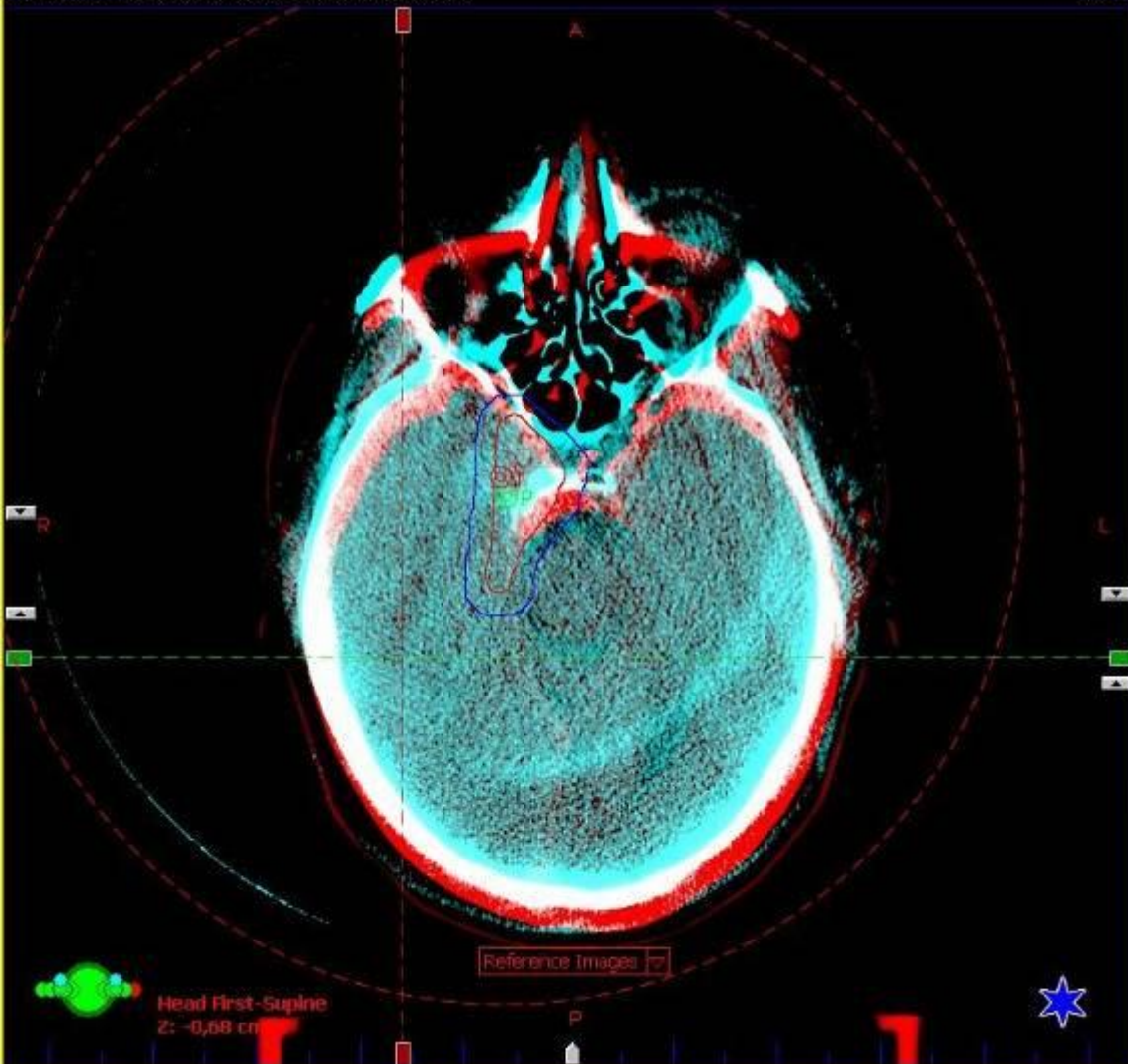


Optagelse af skanning på lejet

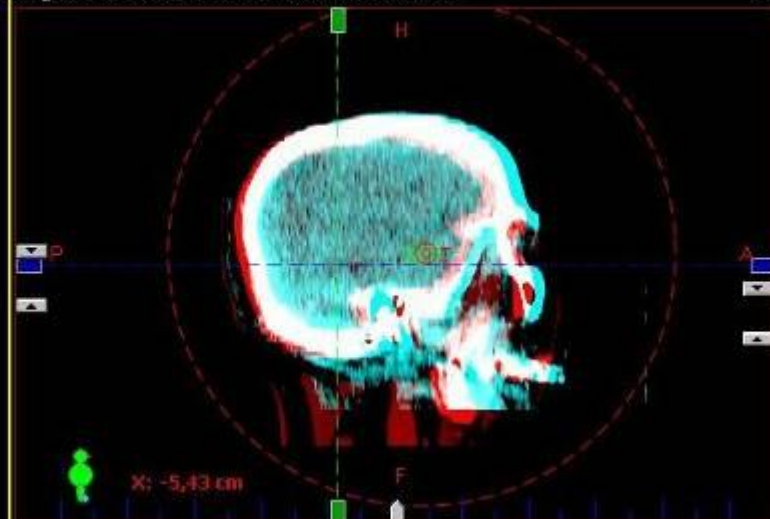


Match med planlægnings skanning

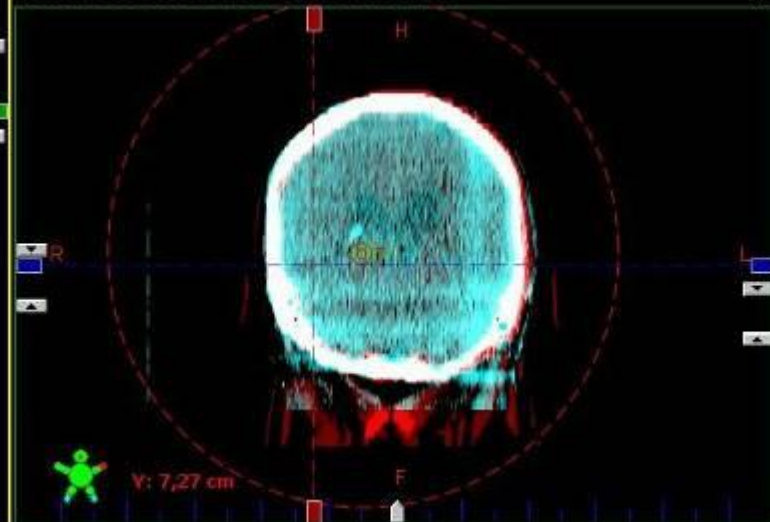
Transversal - CT070910 - CBCT - 04-10-2010 09:58



Sagittal - CT070910 - CBCT - 04-10-2010 09:58

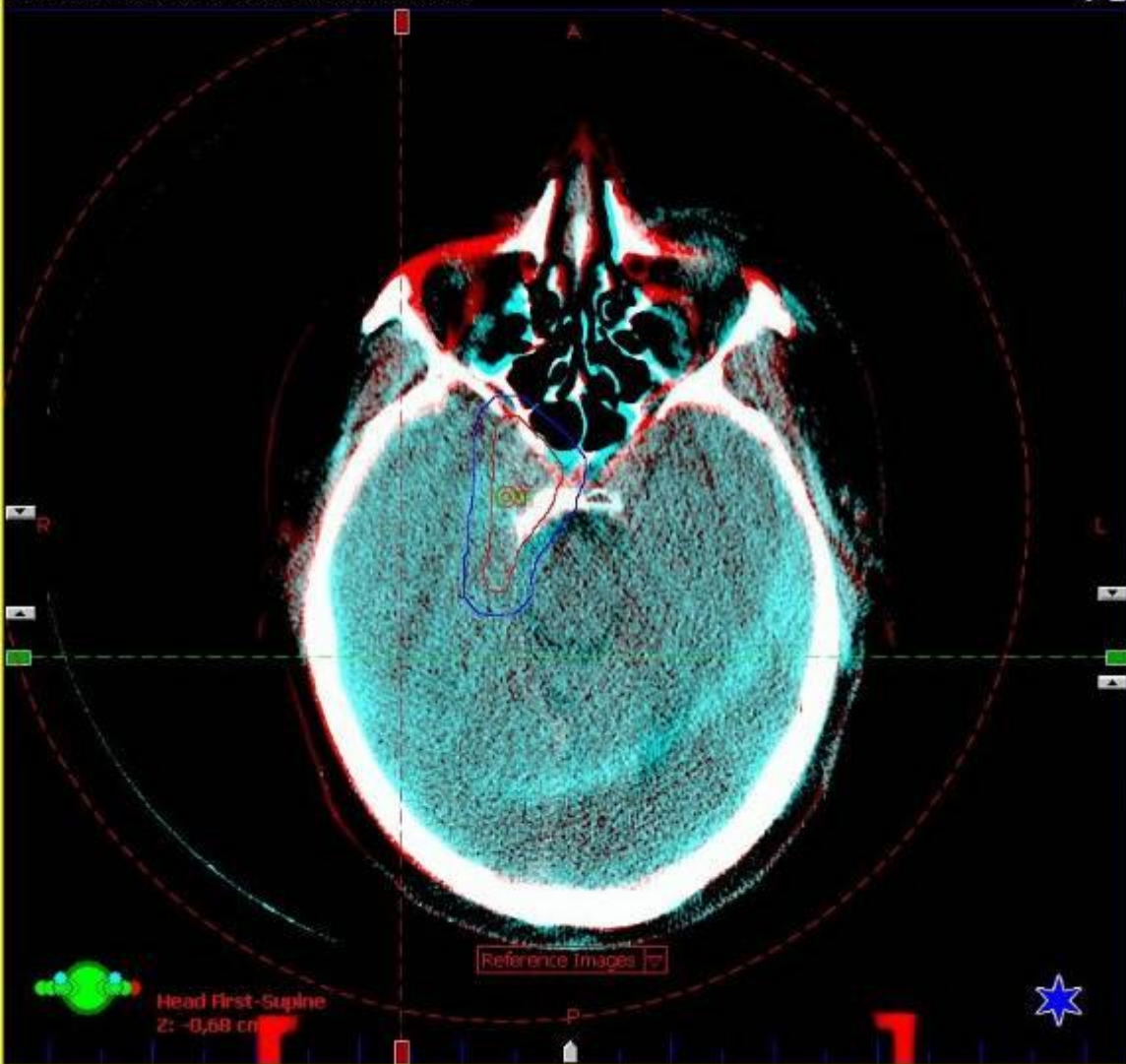


Frontal - CT070910 - CBCT - 04-10-2010 09:58

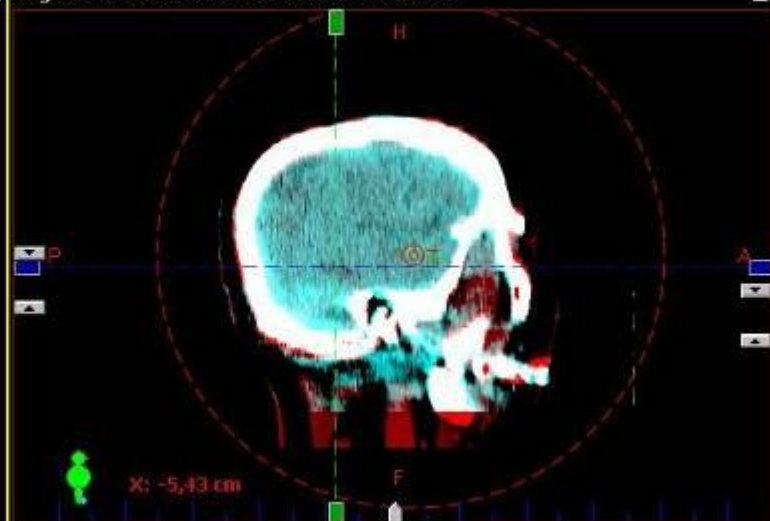


Efter match af skanningerne

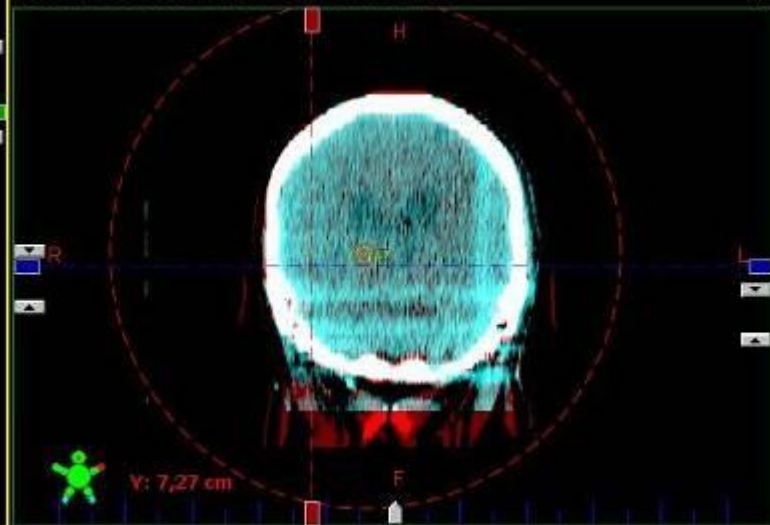
Transversal - CT070910 - CBCT - 04-10-2010 09:58



Sagittal - CT070910 - CBCT - 04-10-2010 09:58



Frontal - CT070910 - CBCT - 04-10-2010 09:58



Billedvejledt og tilpasset strålebehandling

- I 2005 fik vi de to første accelerators med billedvejledning
- 2006 IMRT og IGRT for *hoved halskræft*
- 2009 CT-baseret IGRT for en stor gruppe patienter
- Ændringer i patientens anatomi blev registreret
- Forskningsprojekter blev udviklet
- 2012 Dagligt tilpasset strålebehandling af blærekræft
- 2013 Dagligt match på lunge tumor blev indført
- 2016 Daglig monitorering af bevægelse for livmoderhalskræftpatienter

Billedvejledt strålebehandling

Transversal - CT_1 - CBCT 11-09-2008 22:32:05 - <?>

Sagittal - CT_1 - CBCT 11-09-2008 22:32:05 - <?>

3D / 3D Match

Auto Matching

Start Close

Reset

Status

Match Finished

Parameter Set

Head 3D

Settings ...

Axes

Lat Rot

Lng Roll

Vrt Pitch

Intensity Range

Structure VOI

Couch Position (IEC1217 Scale, All units in cm and degrees) and Shift

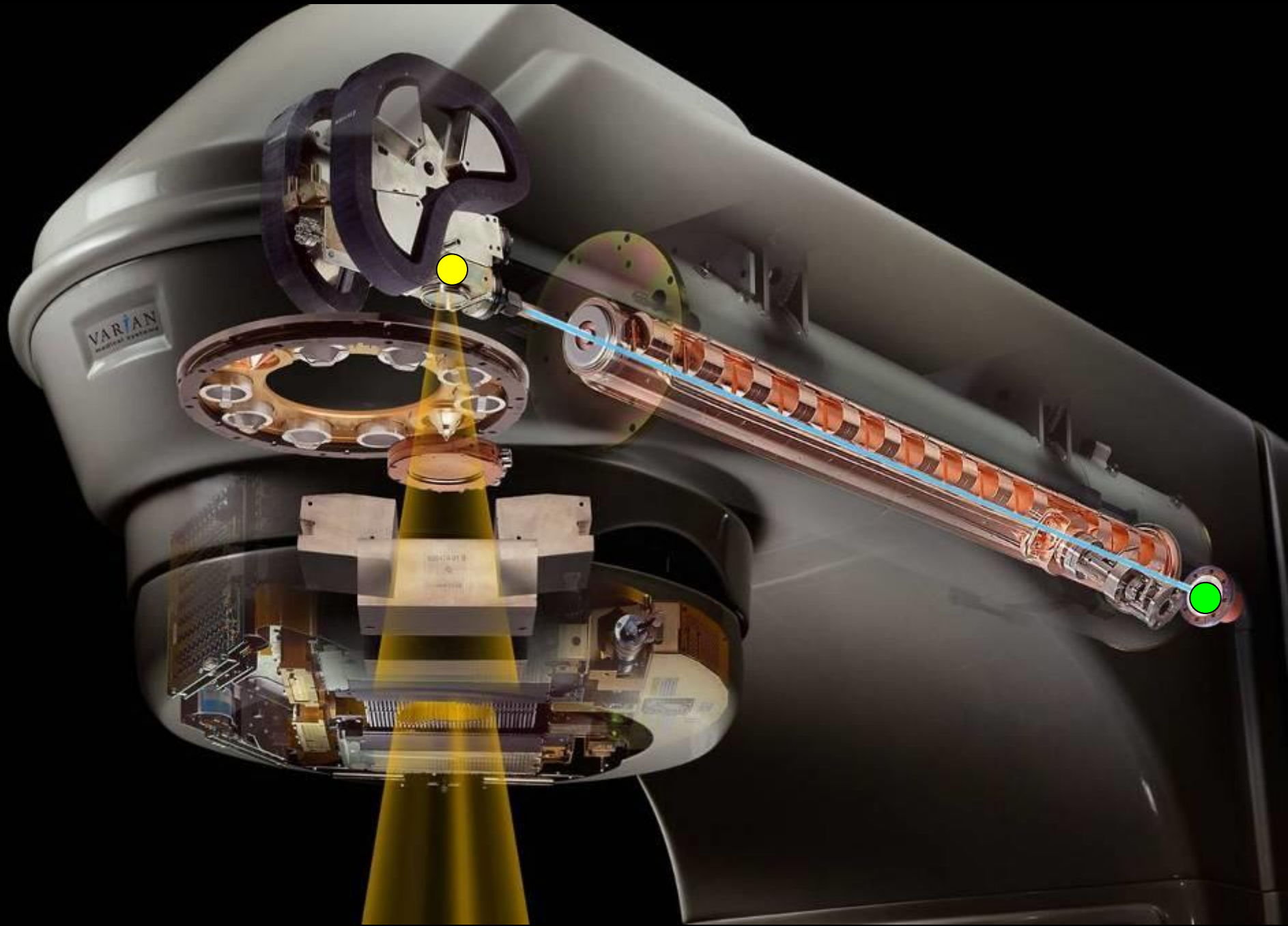
Raw Shift Values				Machine Values			
	SHIFT		SHIFT	TARGET	ACTUAL	SHIFT	
Couch Lat	0,2	Couch Pitch	0,0	Couch Lat	+0,8	+0,7	0,2 <input checked="" type="checkbox"/> Include
Couch Lng	0,0	Couch Roll	0,0	Couch Lng	119,0	119,0	0,0 <input checked="" type="checkbox"/> Include
Couch Vrt	0,4	Couch Rtn	0,0	Couch Vrt	-17,0	-17,4	0,4 <input checked="" type="checkbox"/> Include
		Couch Proj Rtn	0,0	Couch Rtn	0,0	0,0	0,0 <input checked="" type="checkbox"/> Include

Reset Shift

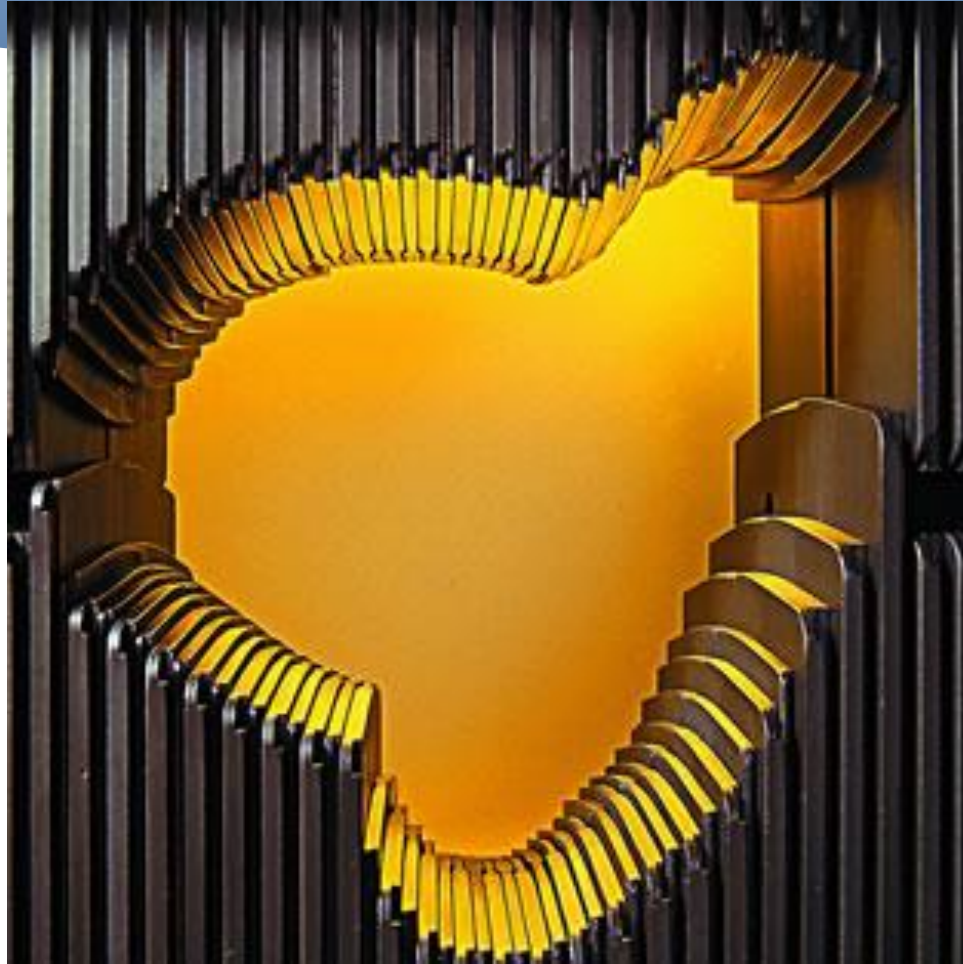
Save Match

Apply Shift

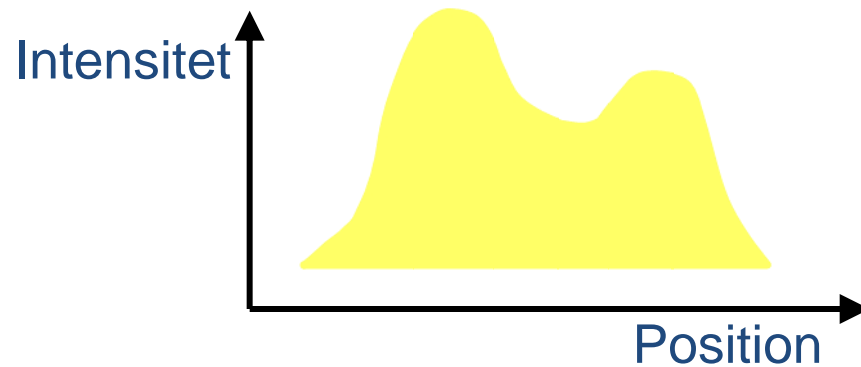
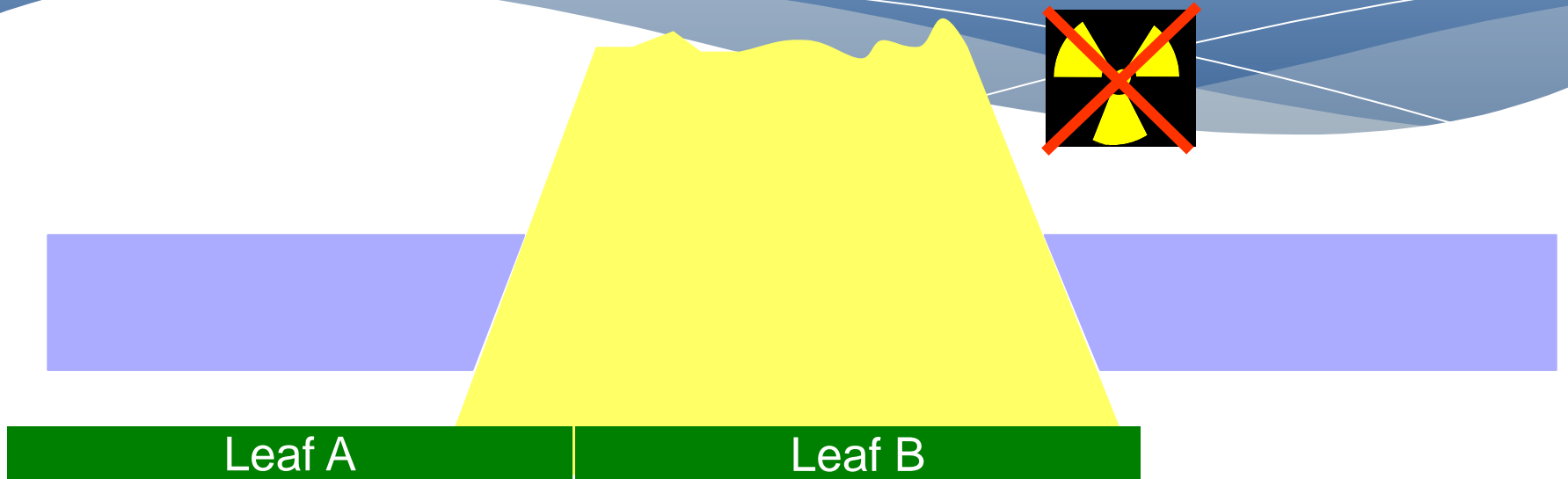
Ulrik V. Elstrøm



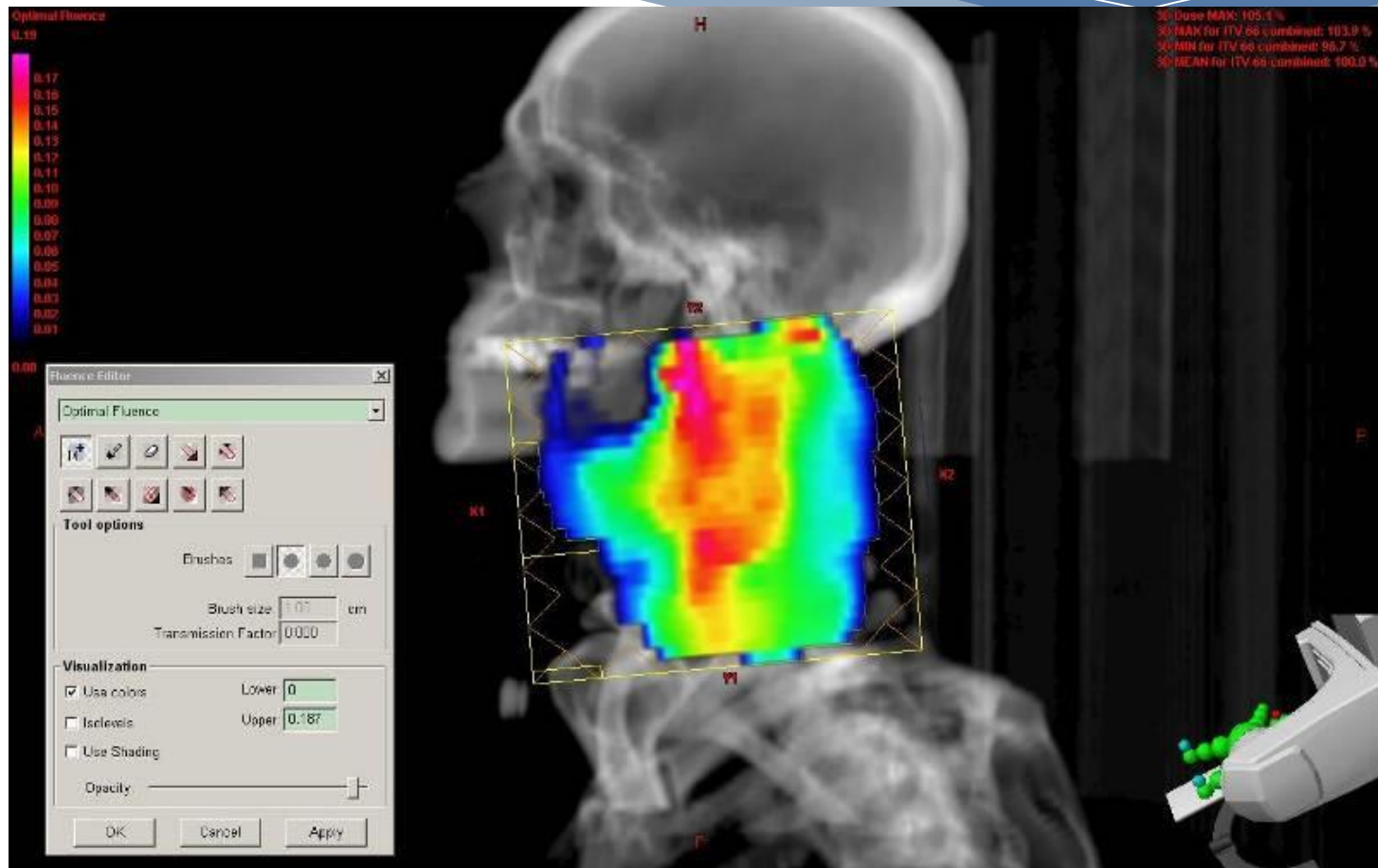
Multi Leaf Collimator (MLC)



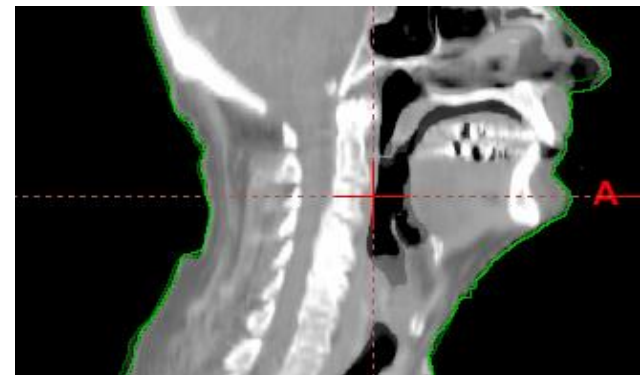
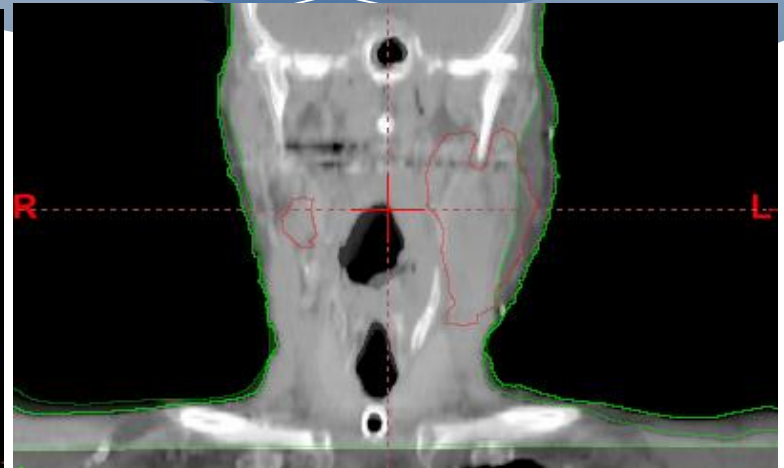
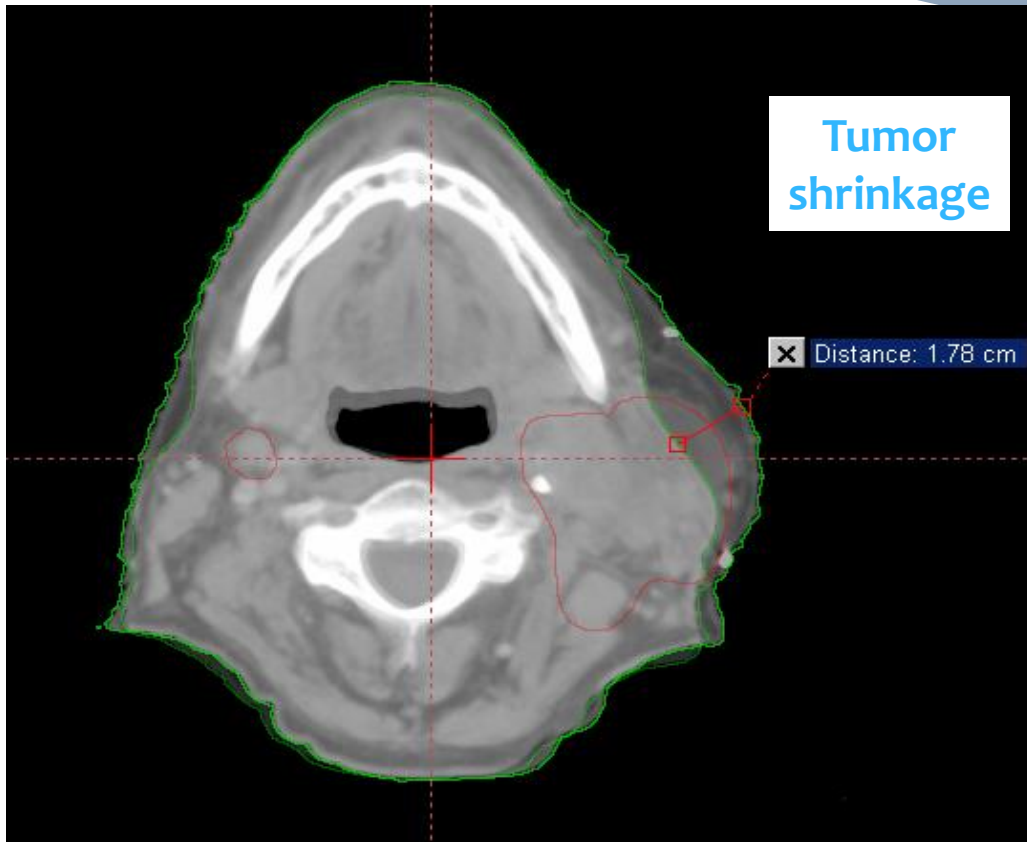
Intensitets-moduleret RT (IMRT)



Intensitetsvariation over et felt

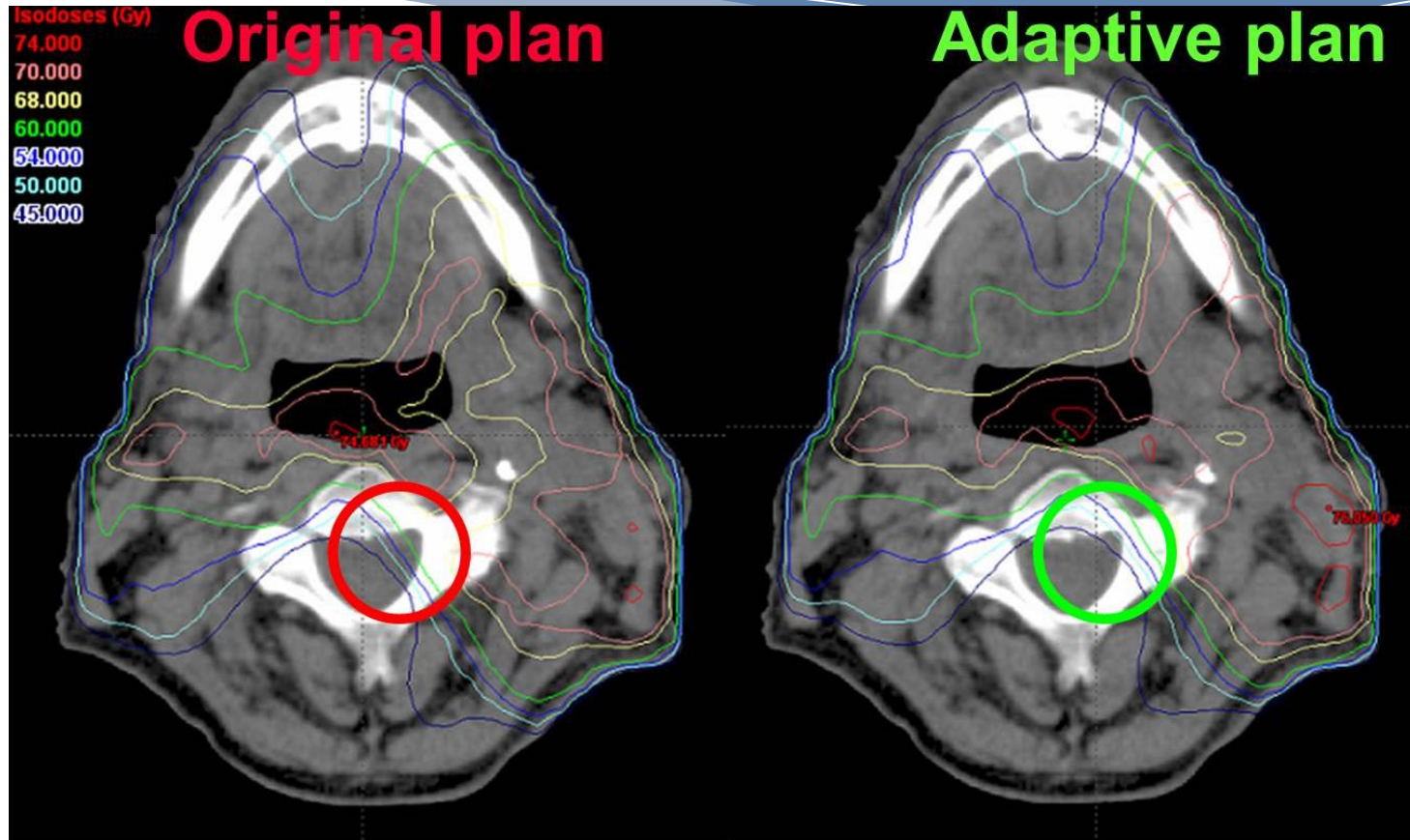


Anatomisk ændring ved Hoved- hals kræft



Ulrik V. Elstrøm

Patient med Hoved-hals kræft



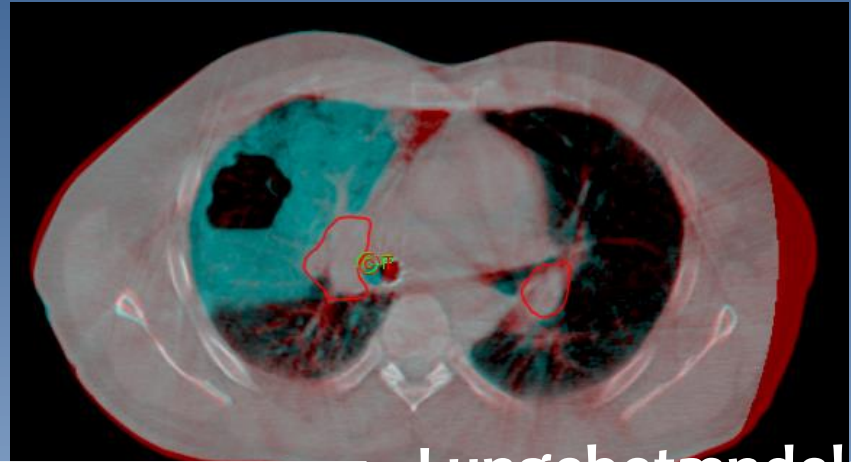
Ulrik V. Elstrøm

Adapteret behandling af lunge cancer

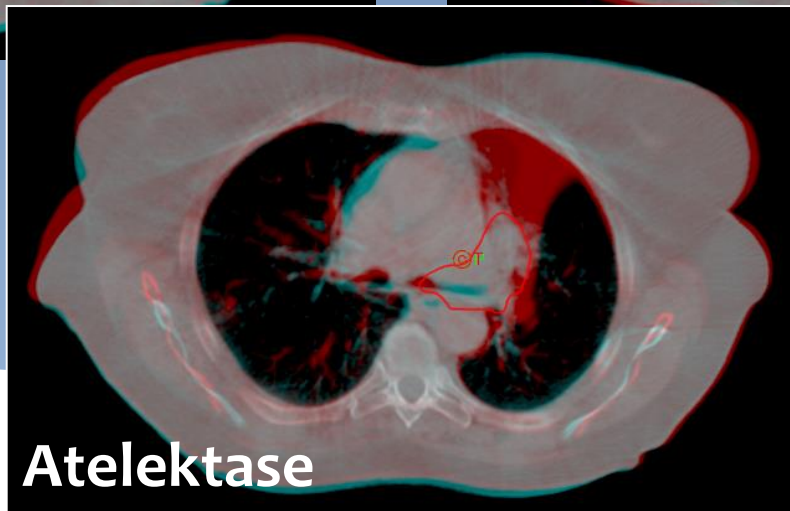
Red=CT Blue=CBCT



Væske i lungen



Lungebetændelse



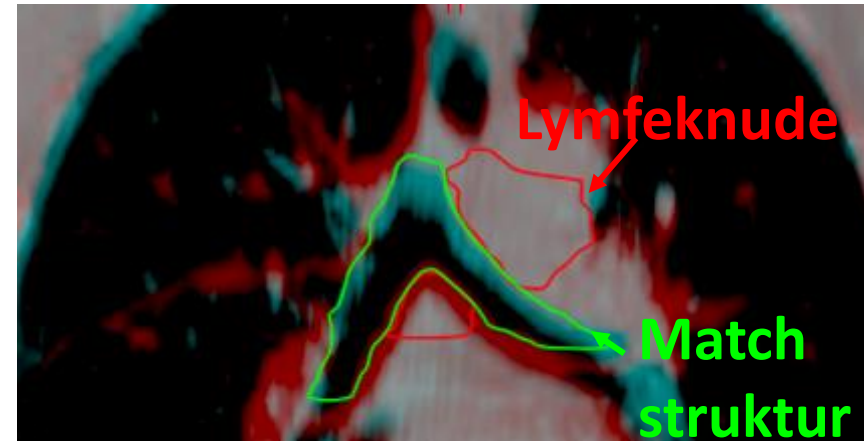
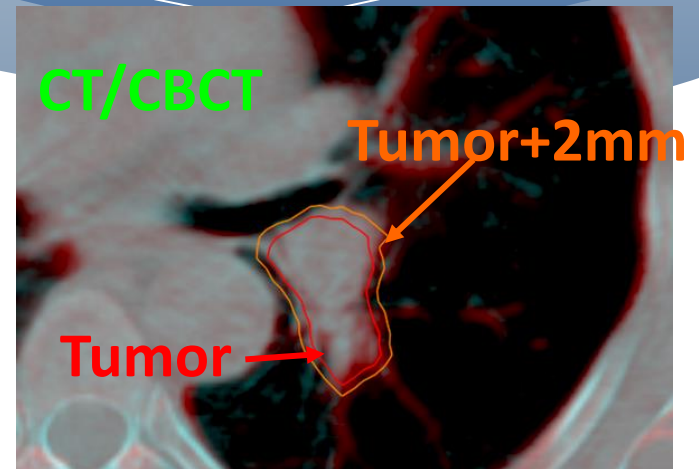
Atelektase

Match på tumor

Lunge cancer

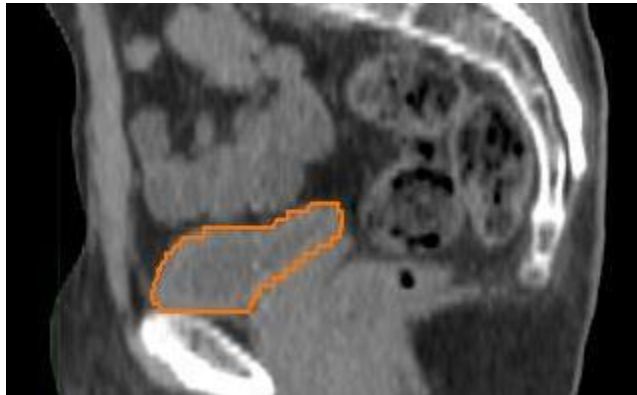
Match på tumor

- * Check om tumor er indenfor 2 mm
- * Check om Match N **passer indenfor 5mm** Behandling afgives
 - 5 to 10 noter
 - over 10 mm stop

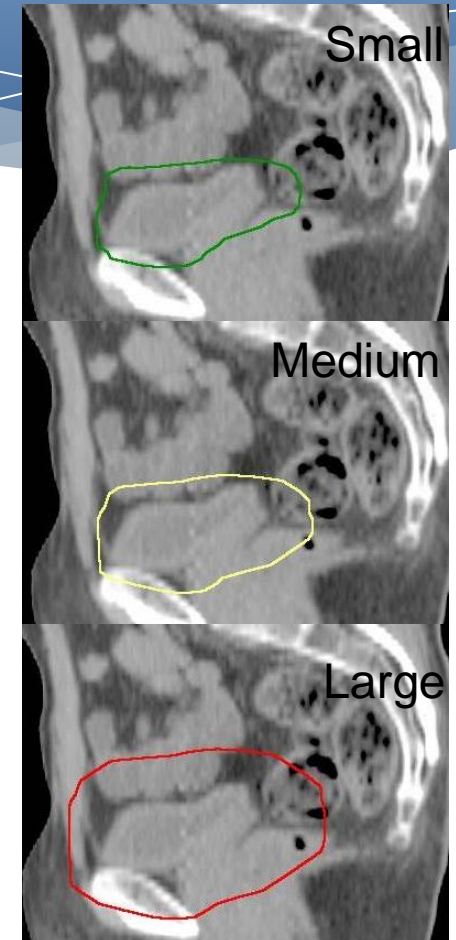
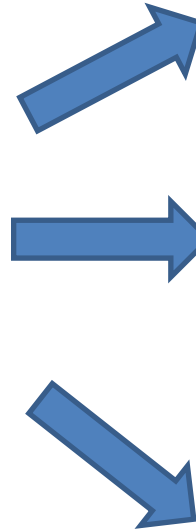


Plan Selektion til blærekræft

Planlægnings CT



Bibliotek af planer



Wright et al. Phys Med Biol 2009

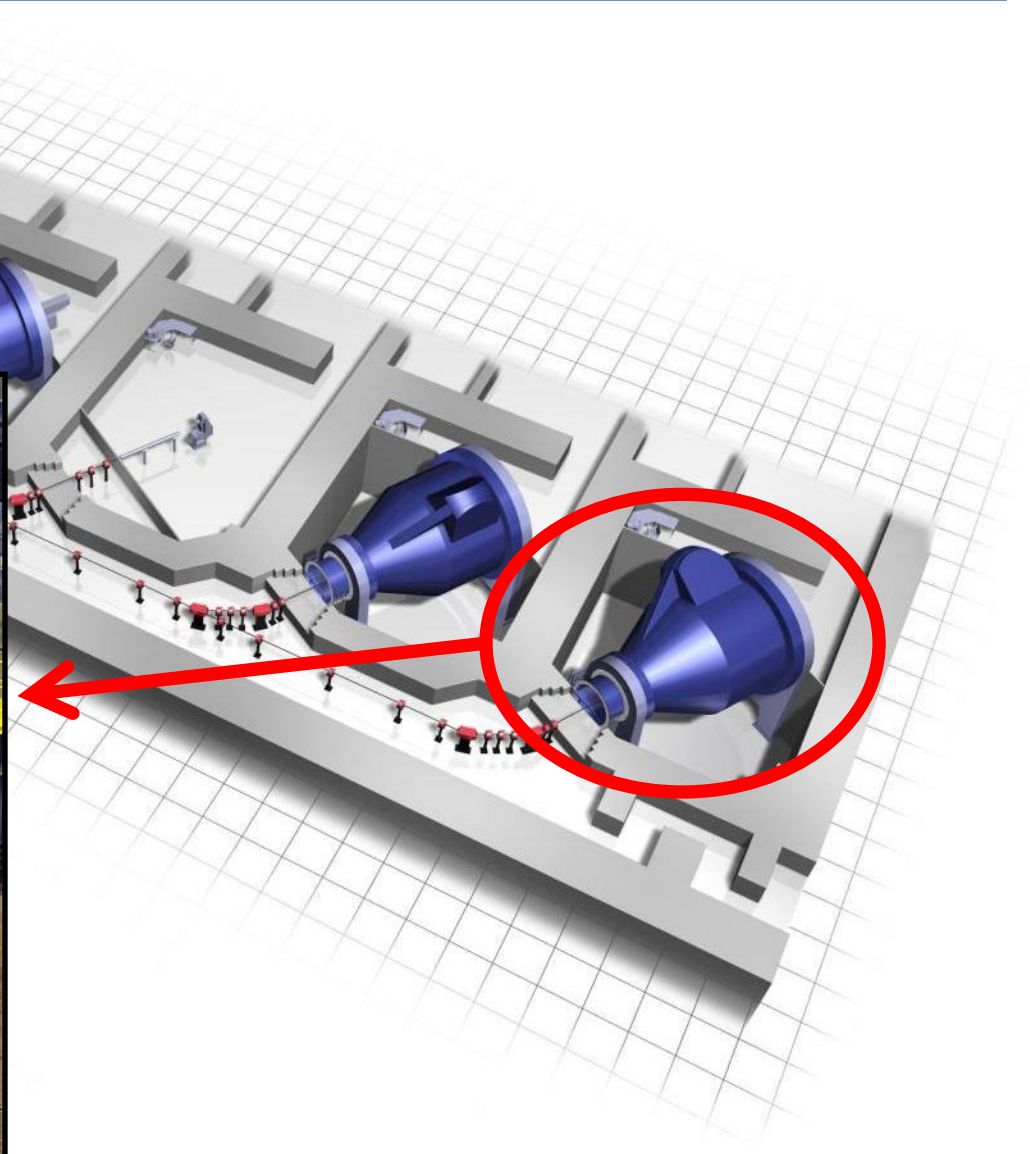
Ved behandling vælges den plan der netop dækker dagens blære





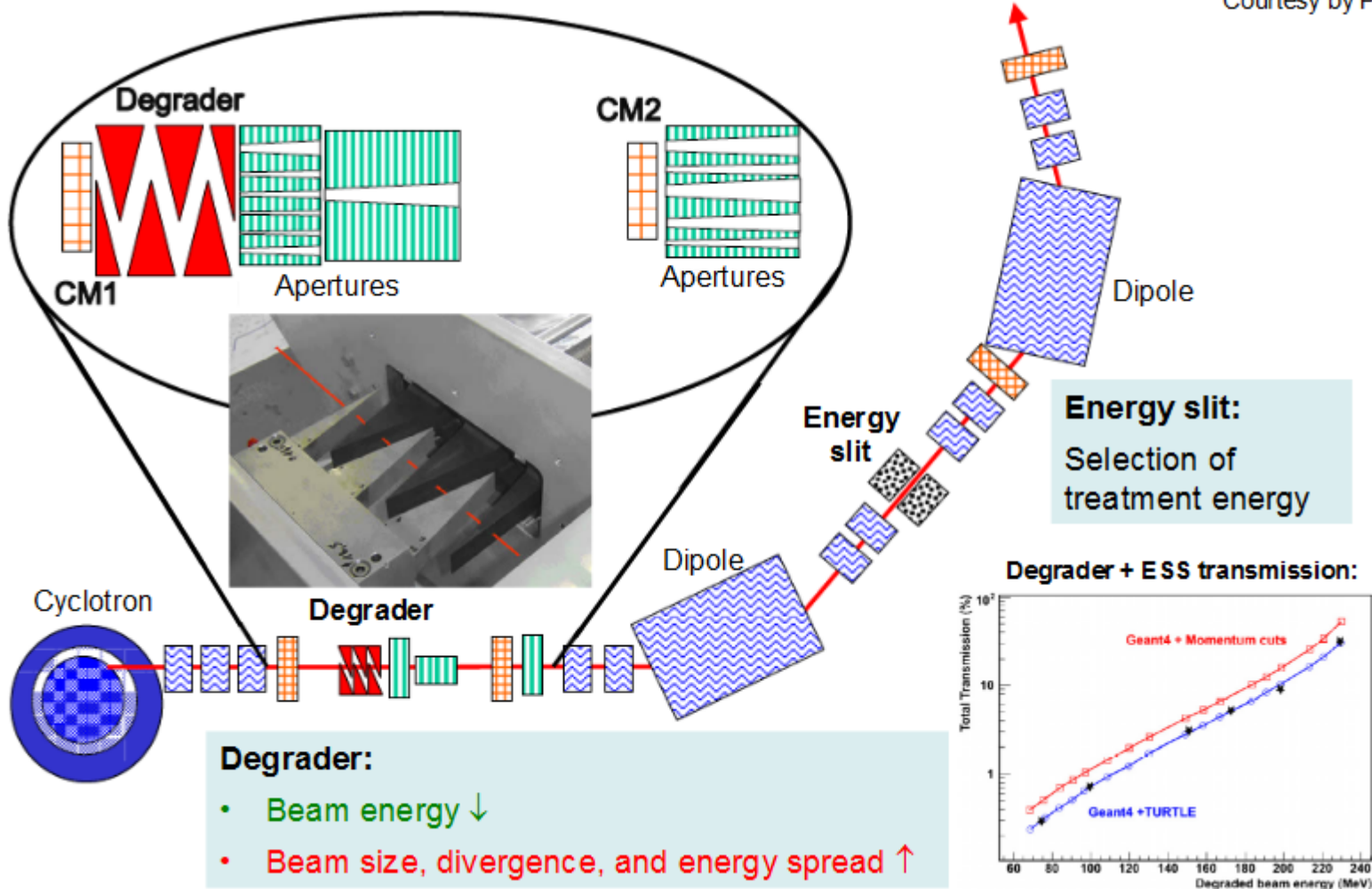


Bygning med cyklotron 4 gantry-rum og en horisontal beam line

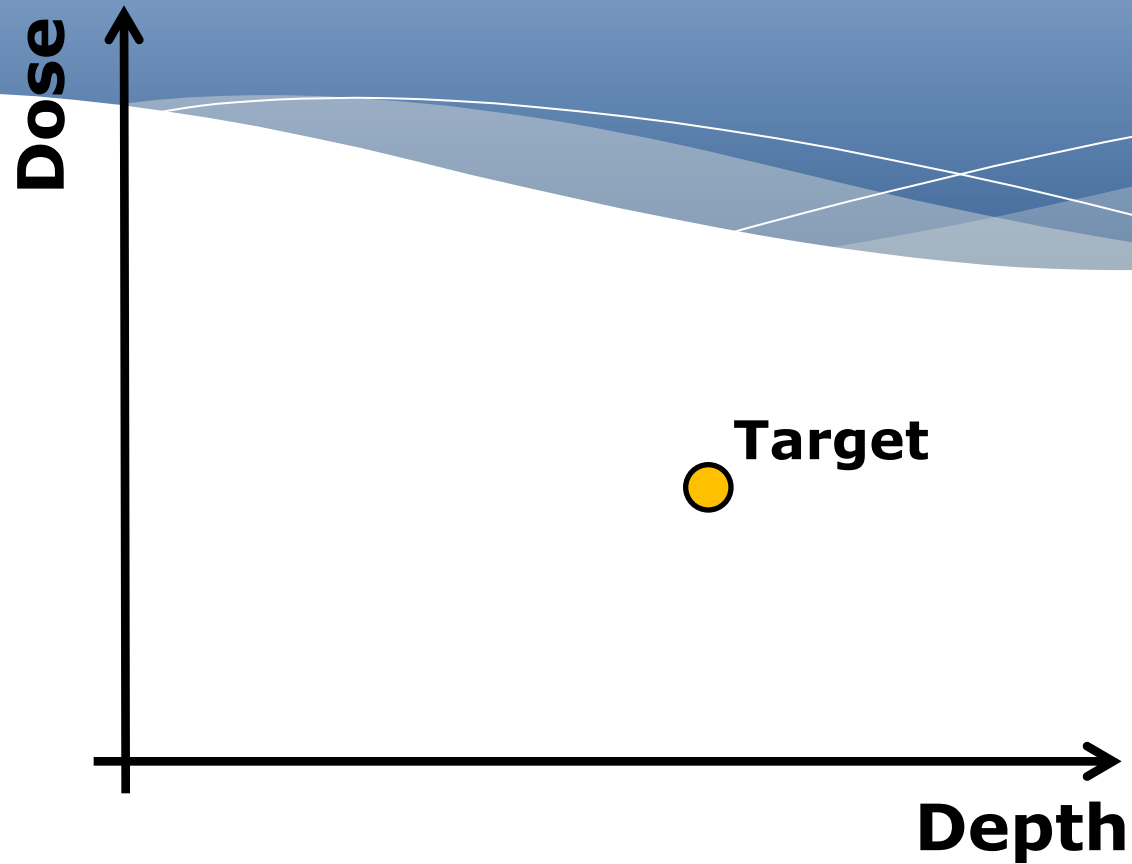


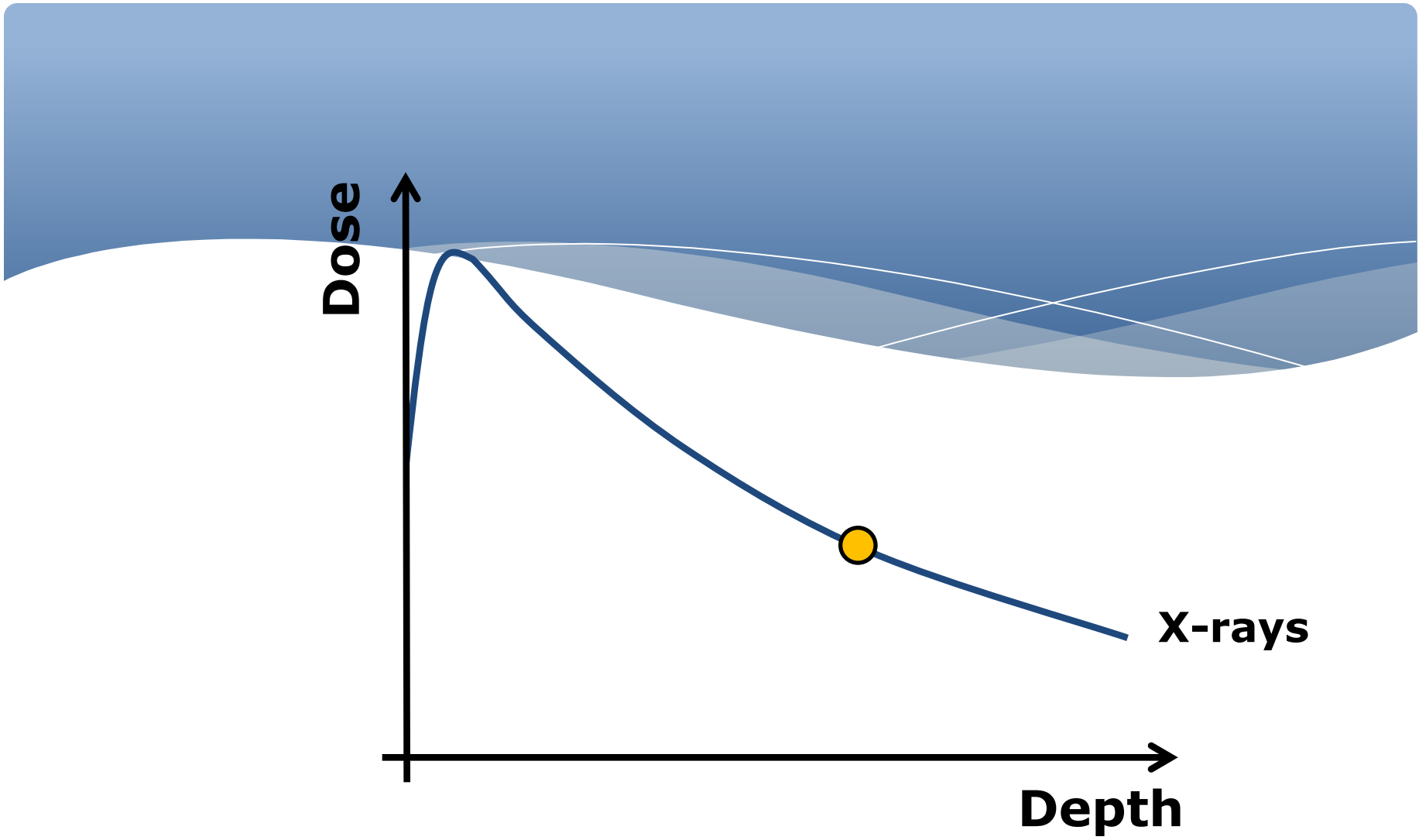
Cyklotron: Energi selektion

Courtesy by PSI



Forskellen på protoner og fotoner



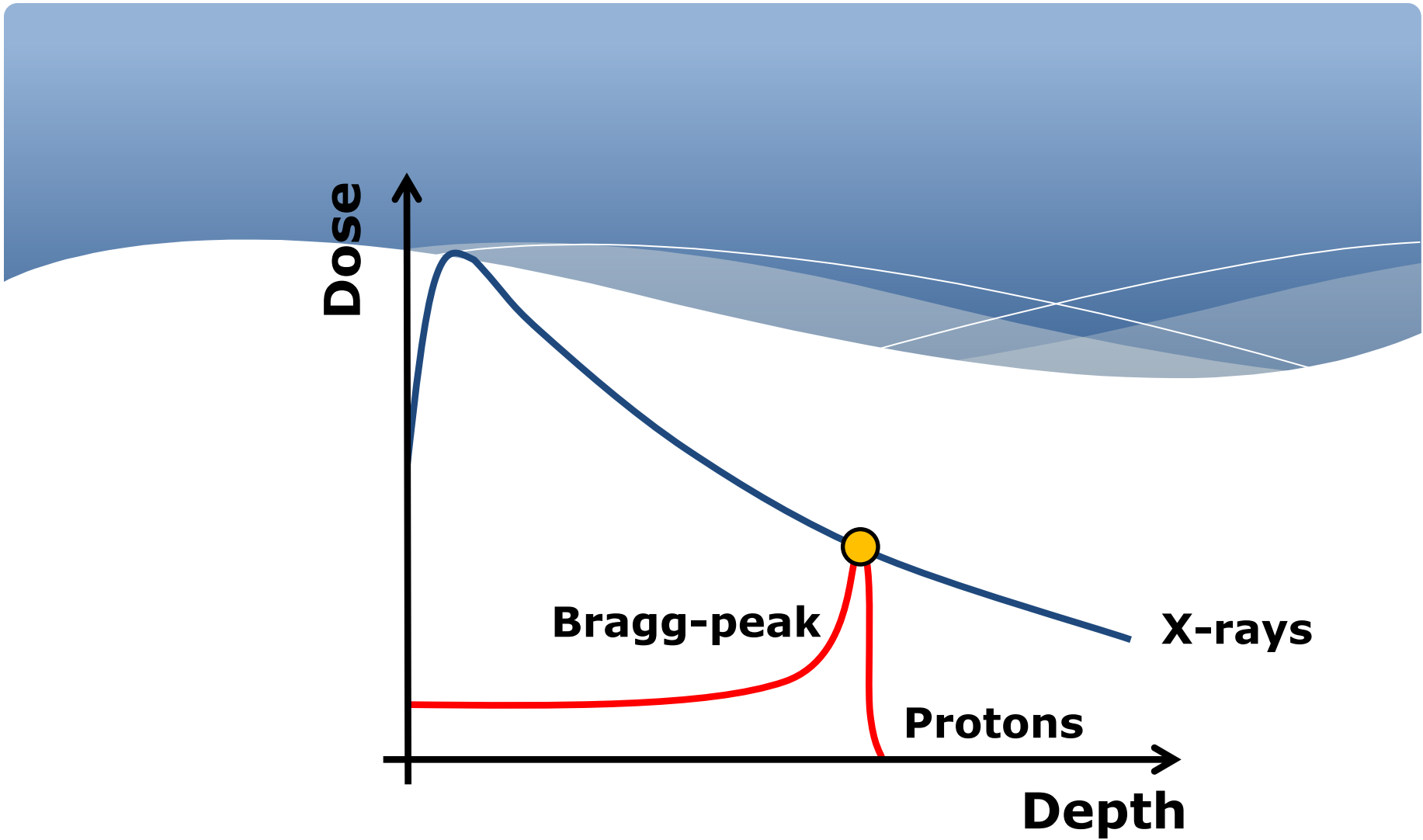


Dose

Depth

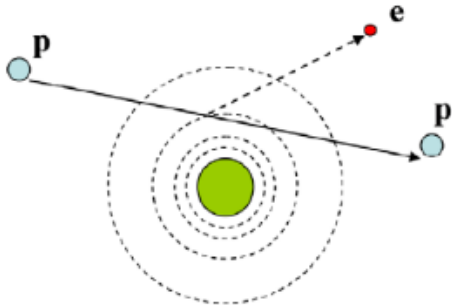
X-rays





Protoners vekselvirkning med væv

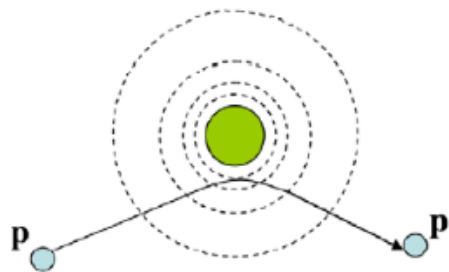
1. Inelastic Coulomb interaction with atomic electrons



Dominating interaction:

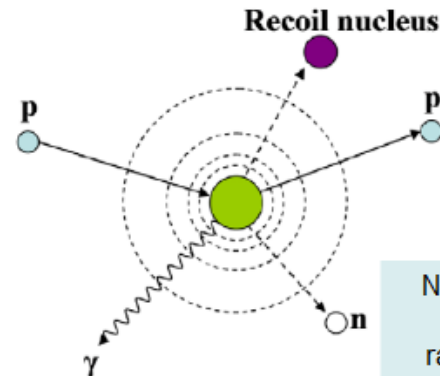
- Ionization (=dose)
- Small energy loss per interaction \Rightarrow **Continuous slowing down of proton** \Rightarrow **Well-defined range**
- Range secondary electrons $< 1\text{mm}$ \Rightarrow **Dose is absorbed locally**
- **No significant deflection** of protons ($m_p = 1832 \cdot m_e$)

2. Elastic coulomb scattering with nucleus



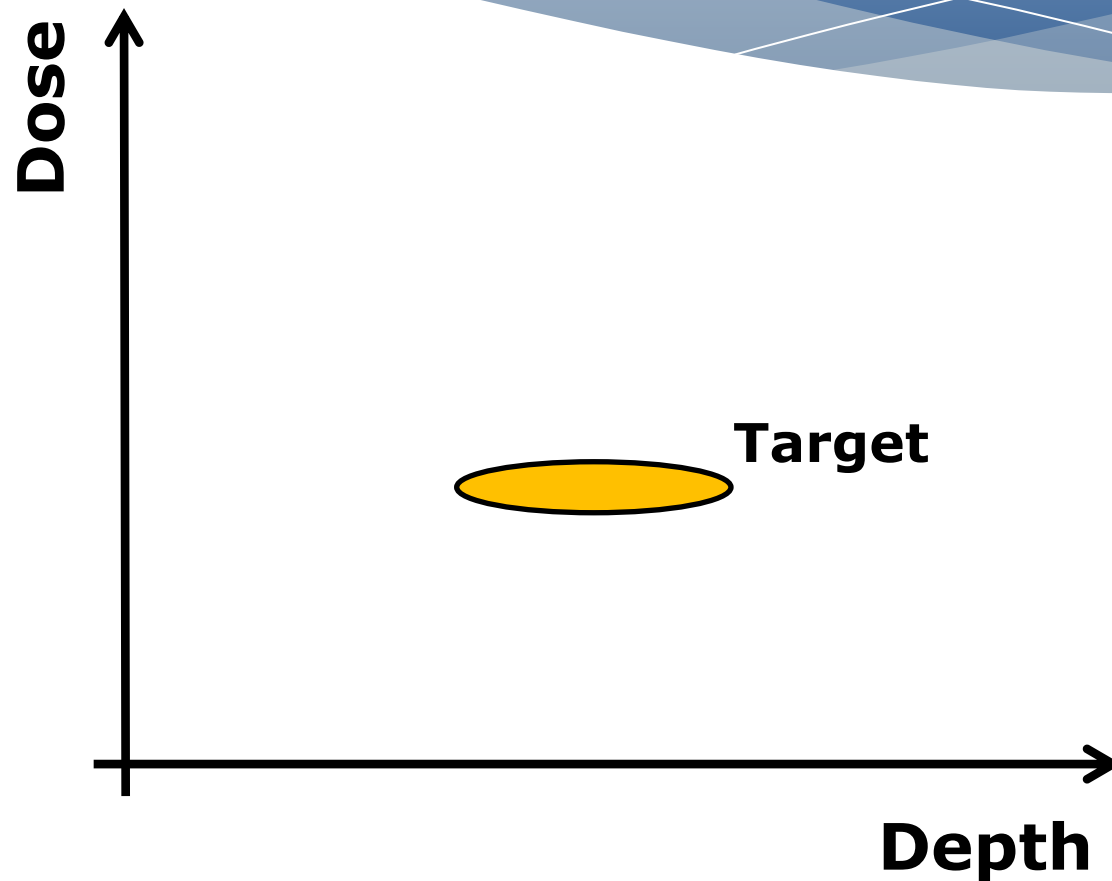
Lateral scattering of treatment field versus depth

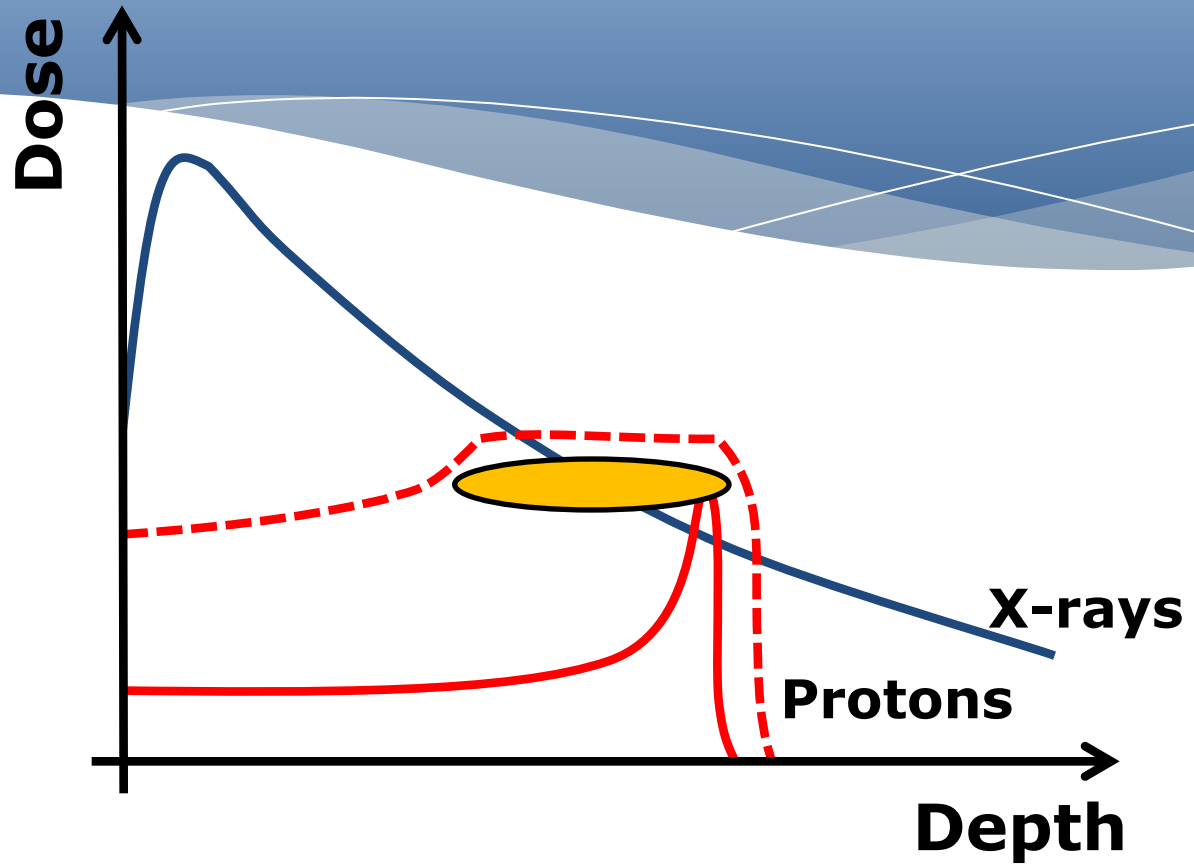
3. Non-elastic nuclear interaction

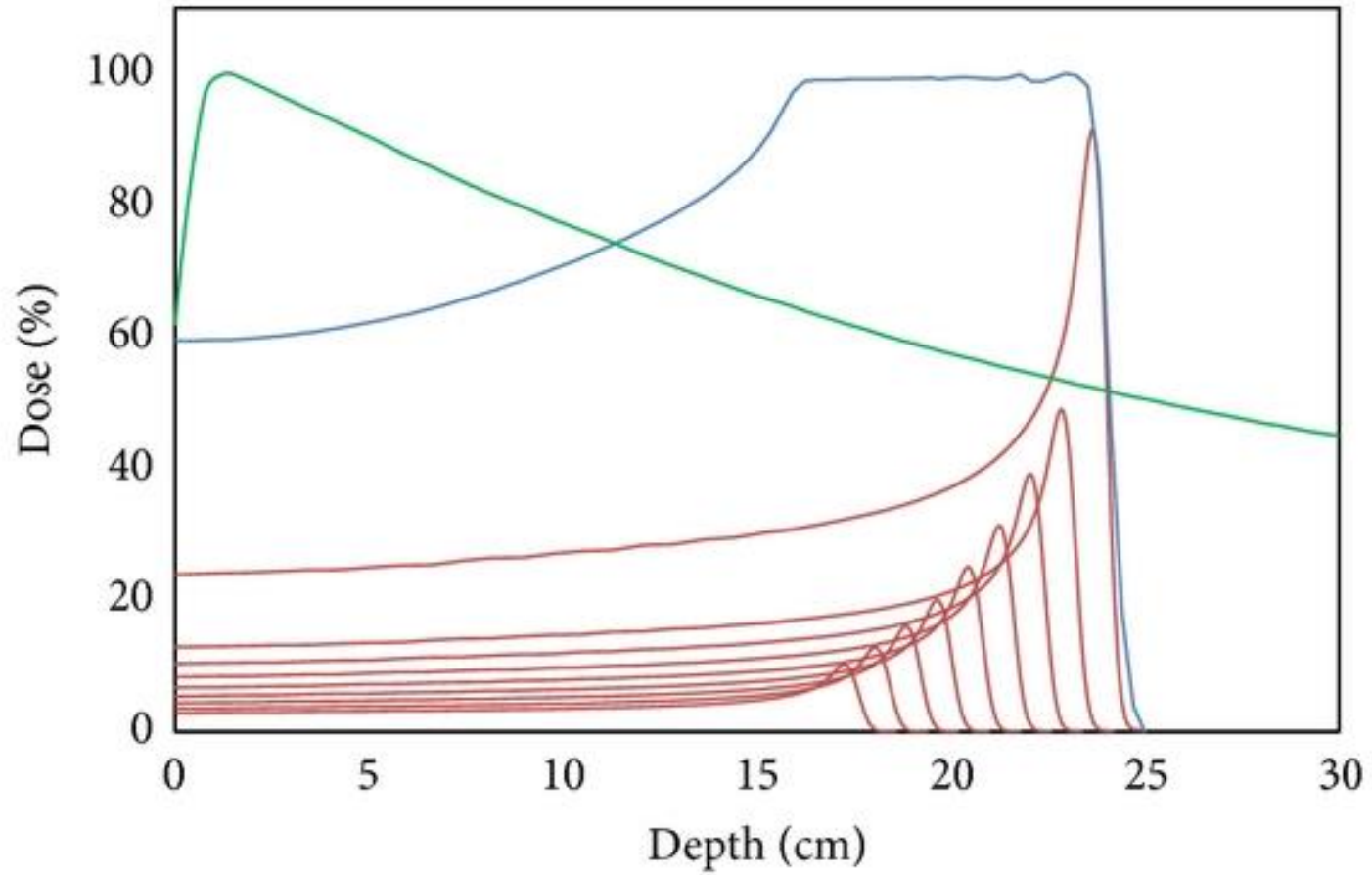


Neutrons are the main external radiation hazard

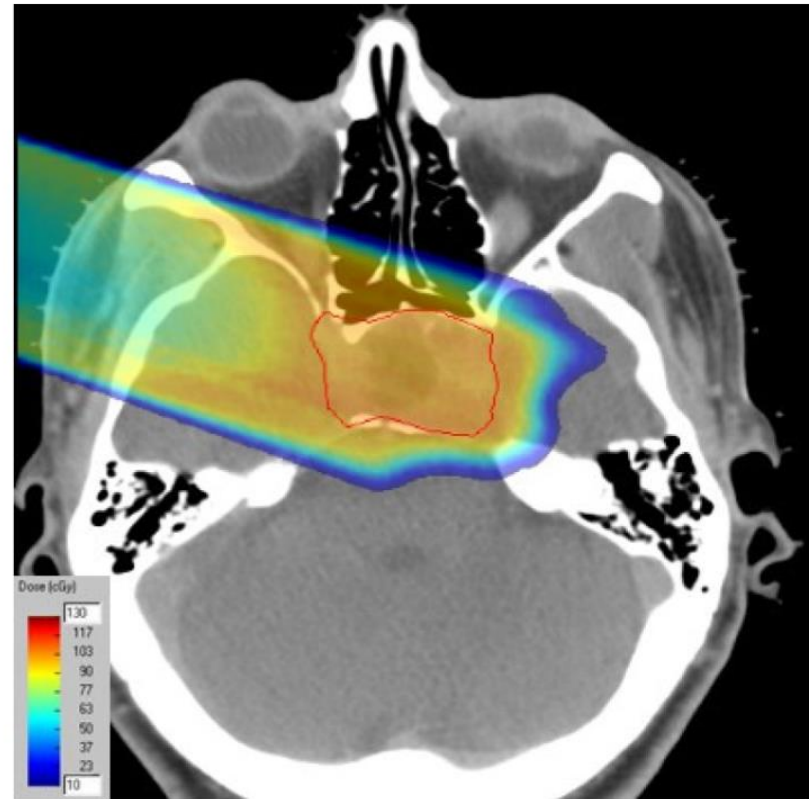
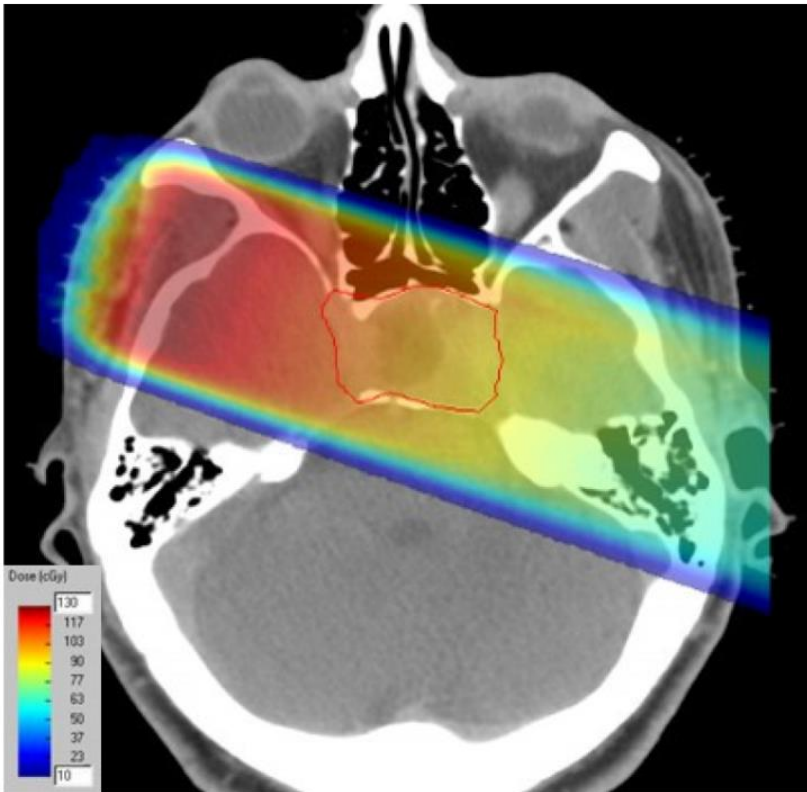
Protonterapi er en mere skånsom behandling







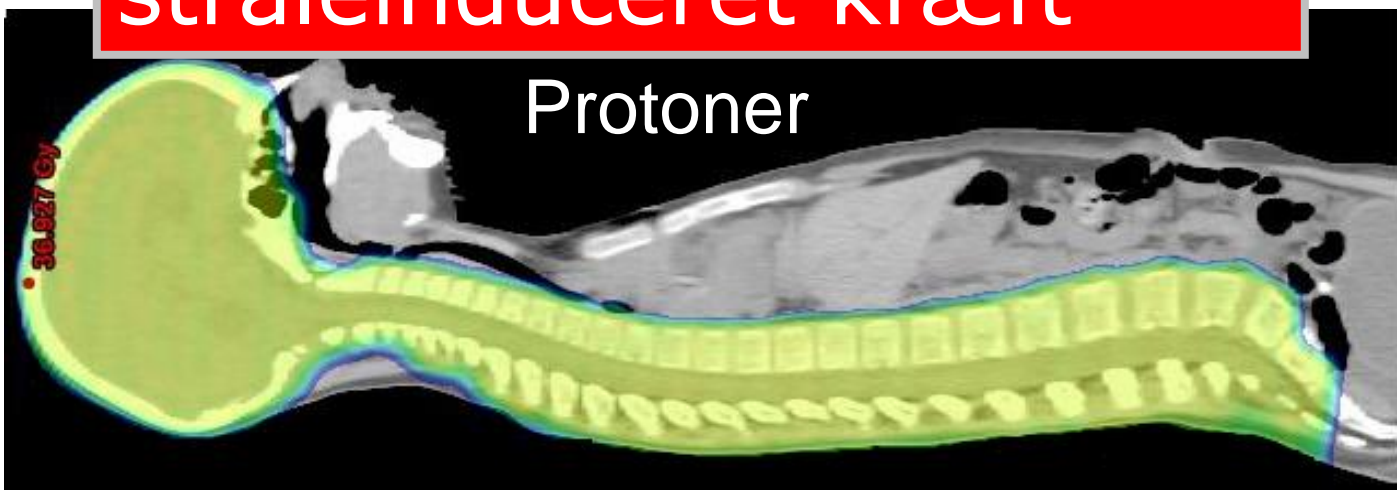
Fotoner vs. protoner



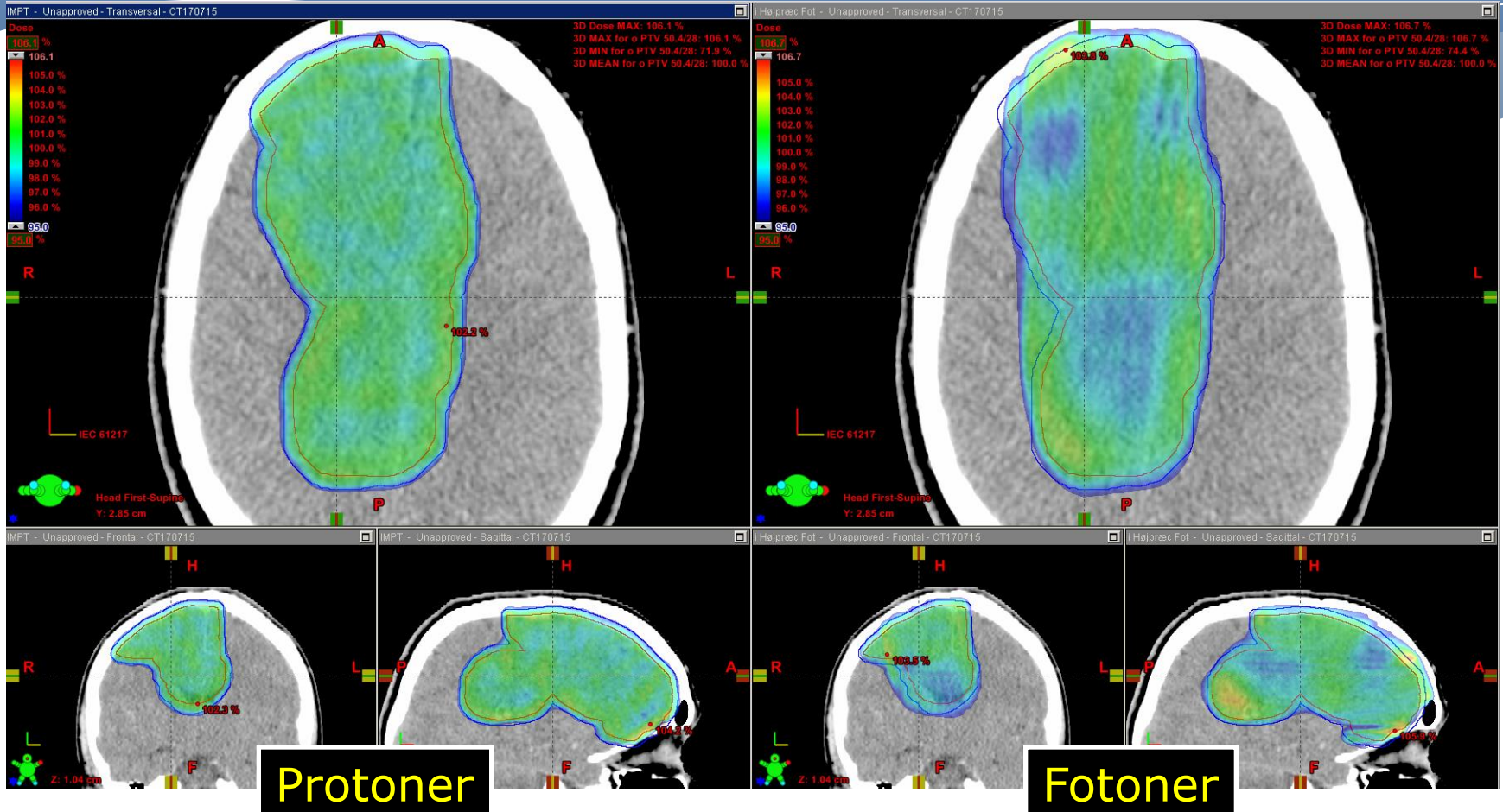
Bestrålning af hele centralnervesystemet



Nedsætter risiko for
stråleinduceret kræft



Protoner vs fotoner



Dansk Center for Partikelterapi

