

Protonen therapie & hersentumoren 7-10-16

Daniëlle Eekers
Radiotherapeut Oncoloog

● *Maastrro clinic*

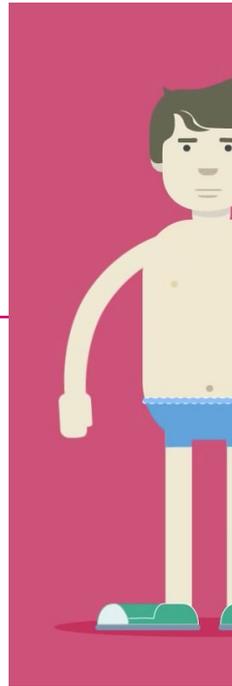


Disclosure belangen spreker

(potentiële) belangenverstrengeling	Geen / Zie hieronder
Voor bijeenkomst mogelijk relevante relaties met bedrijven	Bedrijfsnamen
<ul style="list-style-type: none">• Sponsoring of onderzoeksgeld• Honorarium of andere (financiële) vergoeding• Aandeelhouder• Andere relatie, namelijk ...	<ul style="list-style-type: none">••••

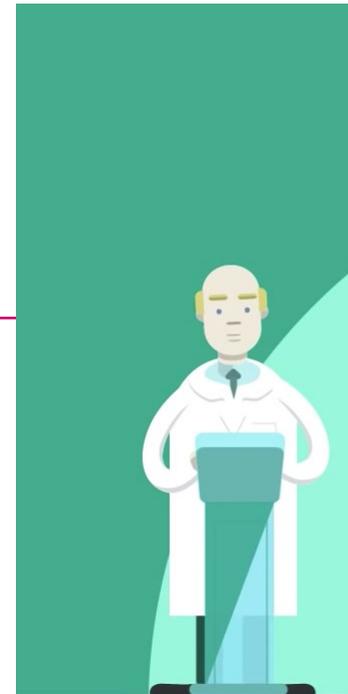
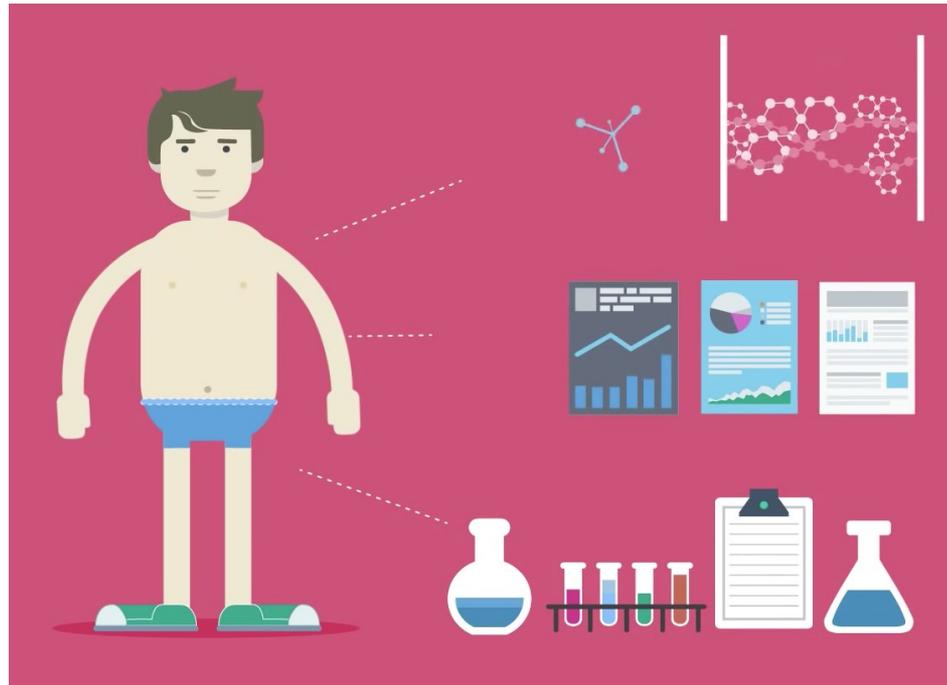
Behandelproces

intake



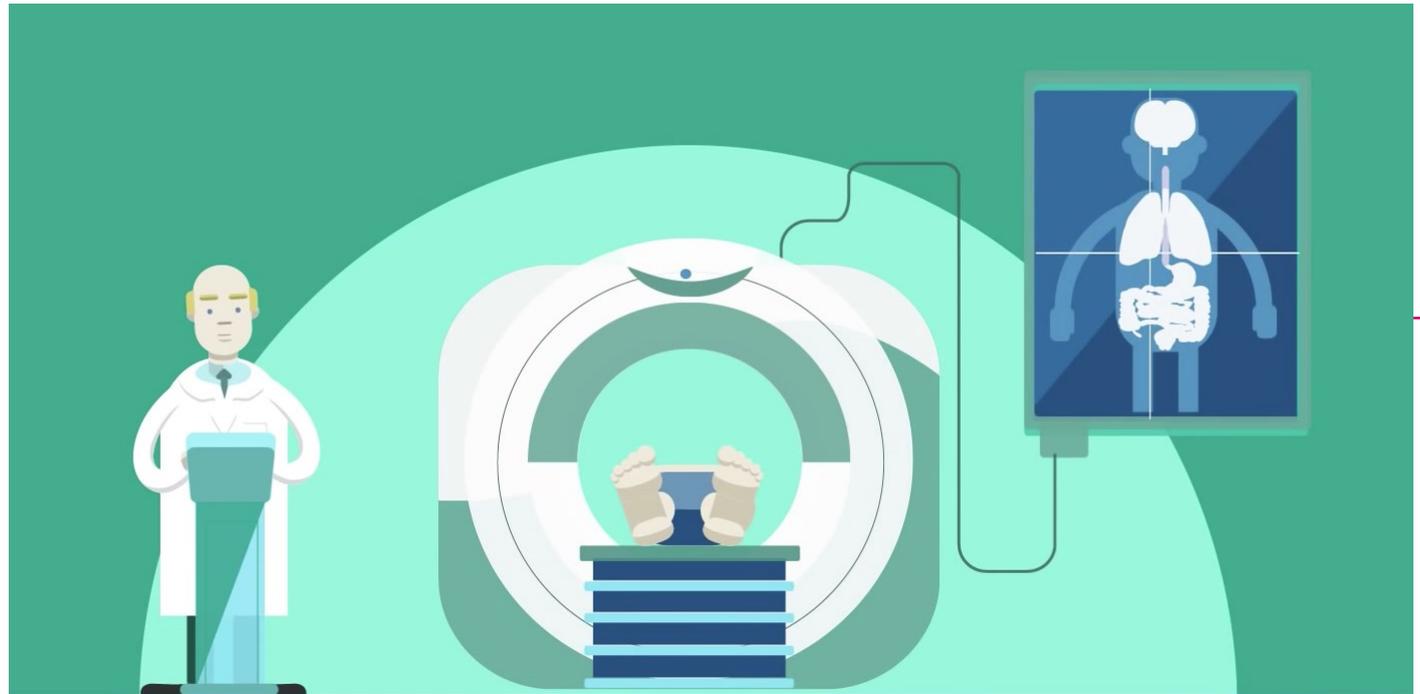
Behandelproces

CT-MRI-
scans



Behandelproces

bestrijdings-
systemen



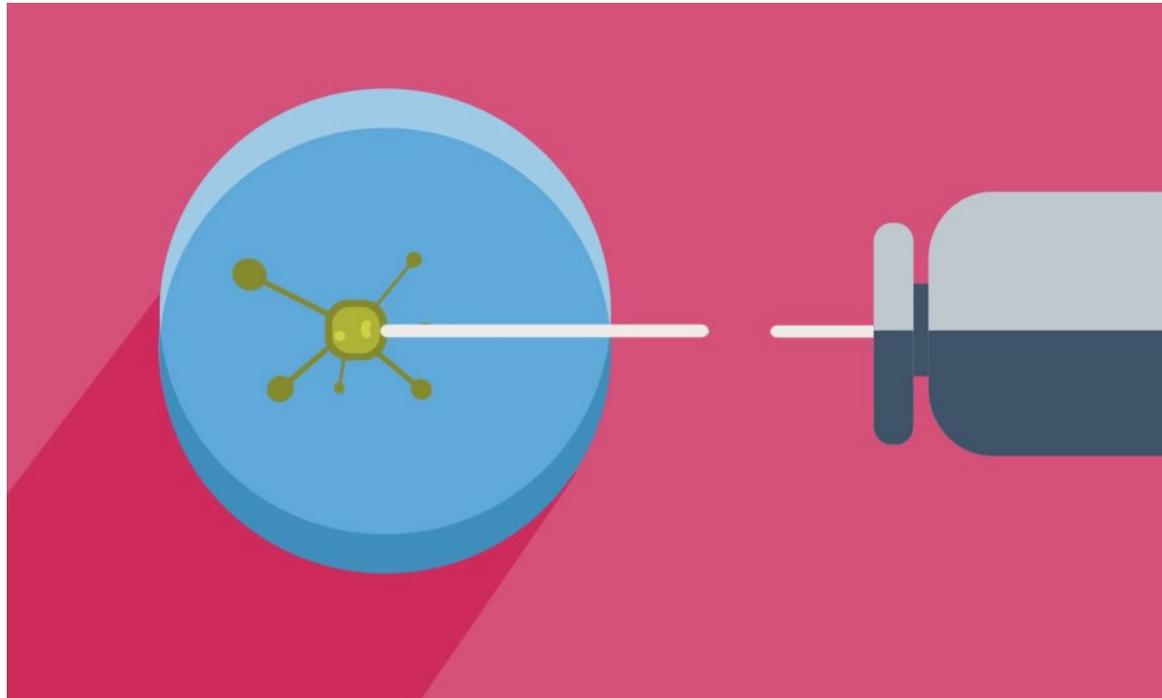
Behandelproces

bestraalings-
plan
systemen



Behandelproces

*Uitwezig
bestraling*



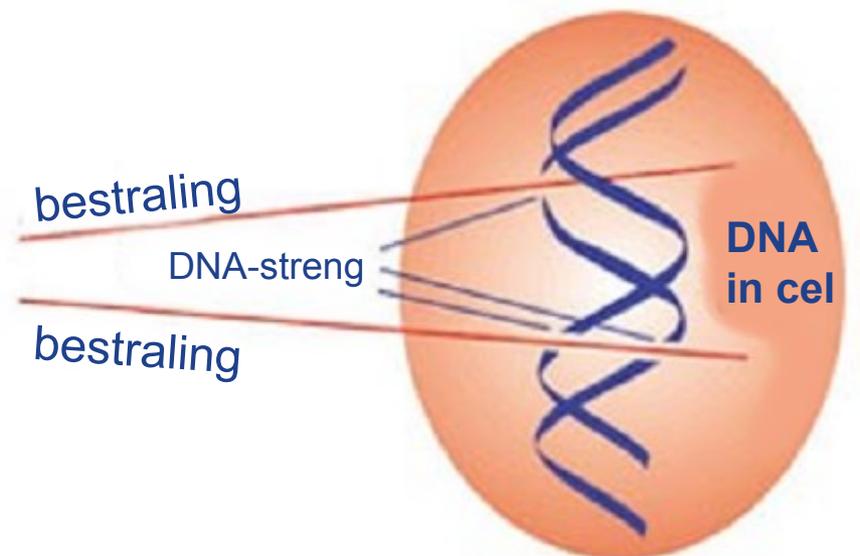
Behandelproces

eindcontrole

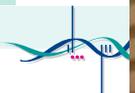
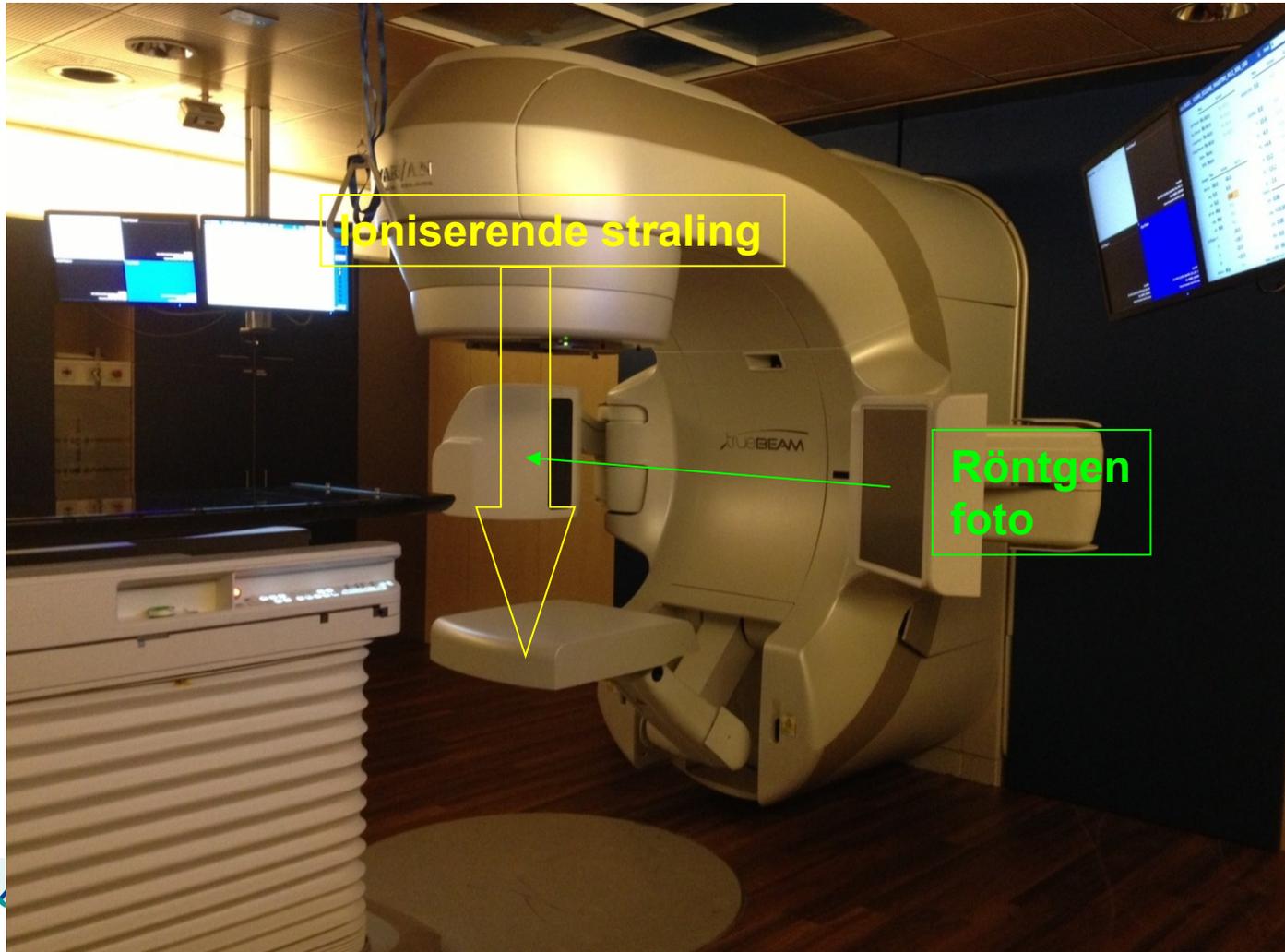


Wat is bestraling?

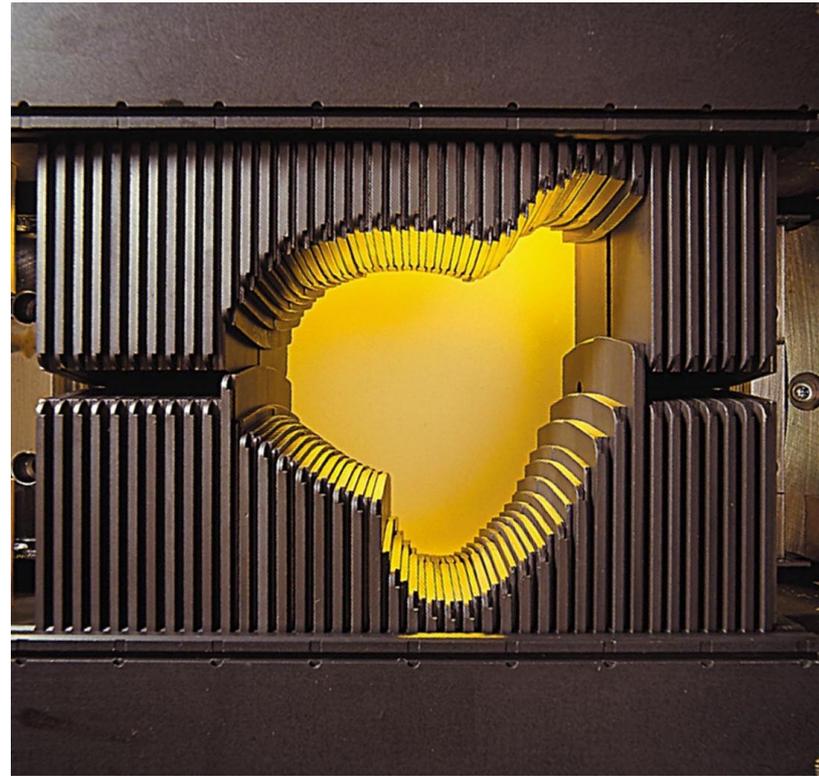
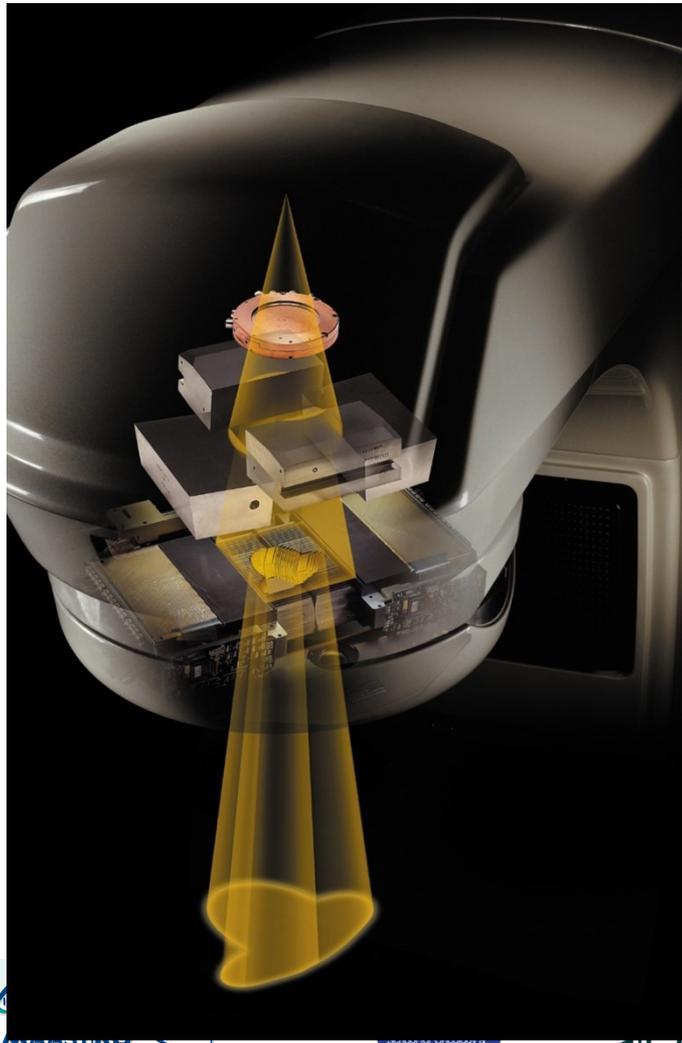
- Lokale behandeling
- Bestraling beschadigt DNA in cel
- Slecht herstel kankercellen



Lineaire versneller



Multi Leaf Collimator (MLC)



Stereotactische bestraling

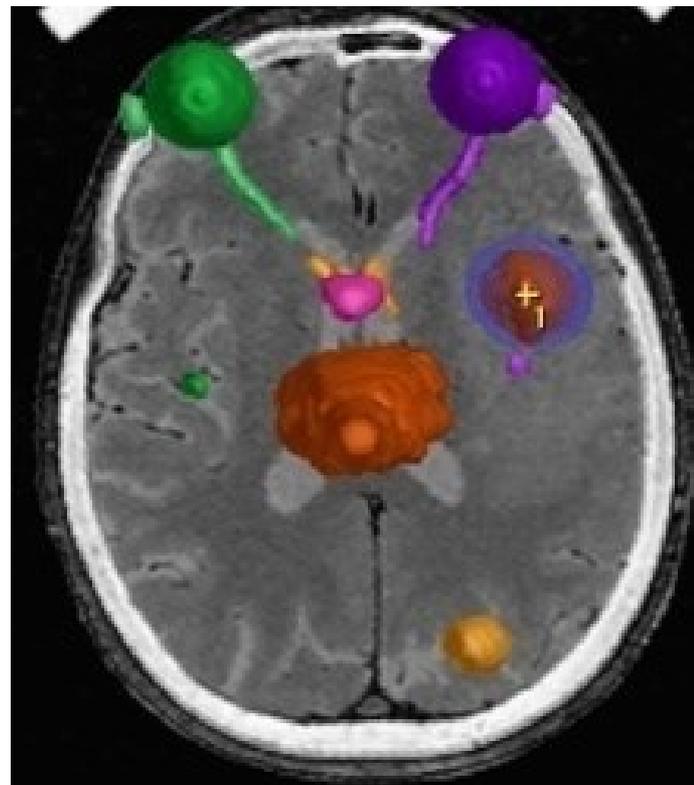
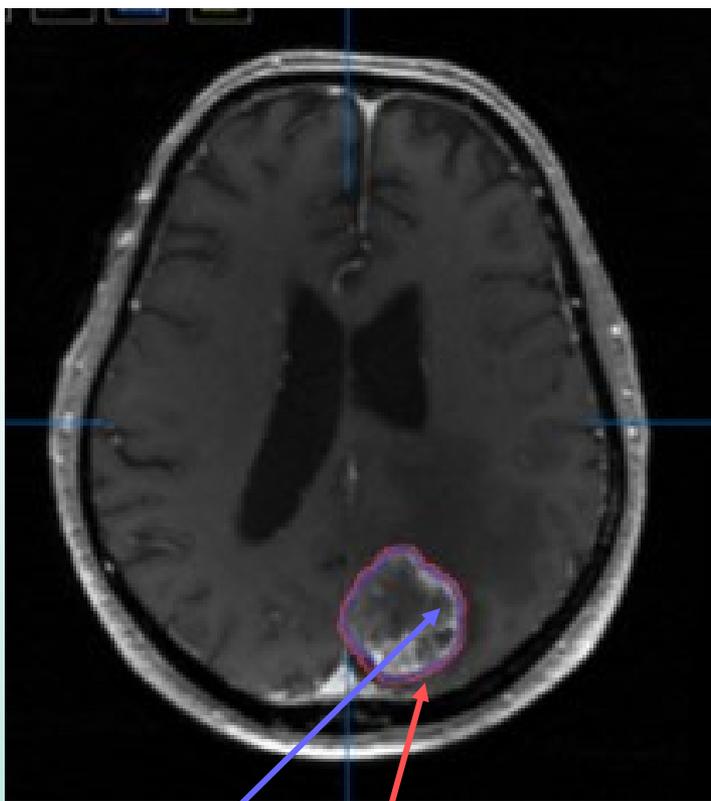
- **Speciale vorm van uitwendige bestraling**
- **Multiële arcs:**
 - Voor kleine tumoren
 - Hoge dosis op tumor
 - Optimaal sparen van gezond weefsel

Hulpmiddelen

- Hulpmiddelen voor fixatie van patiënt in bepaalde houding
- Masker :
 - voor fixatie
 - als ondergrond voor aantekenen

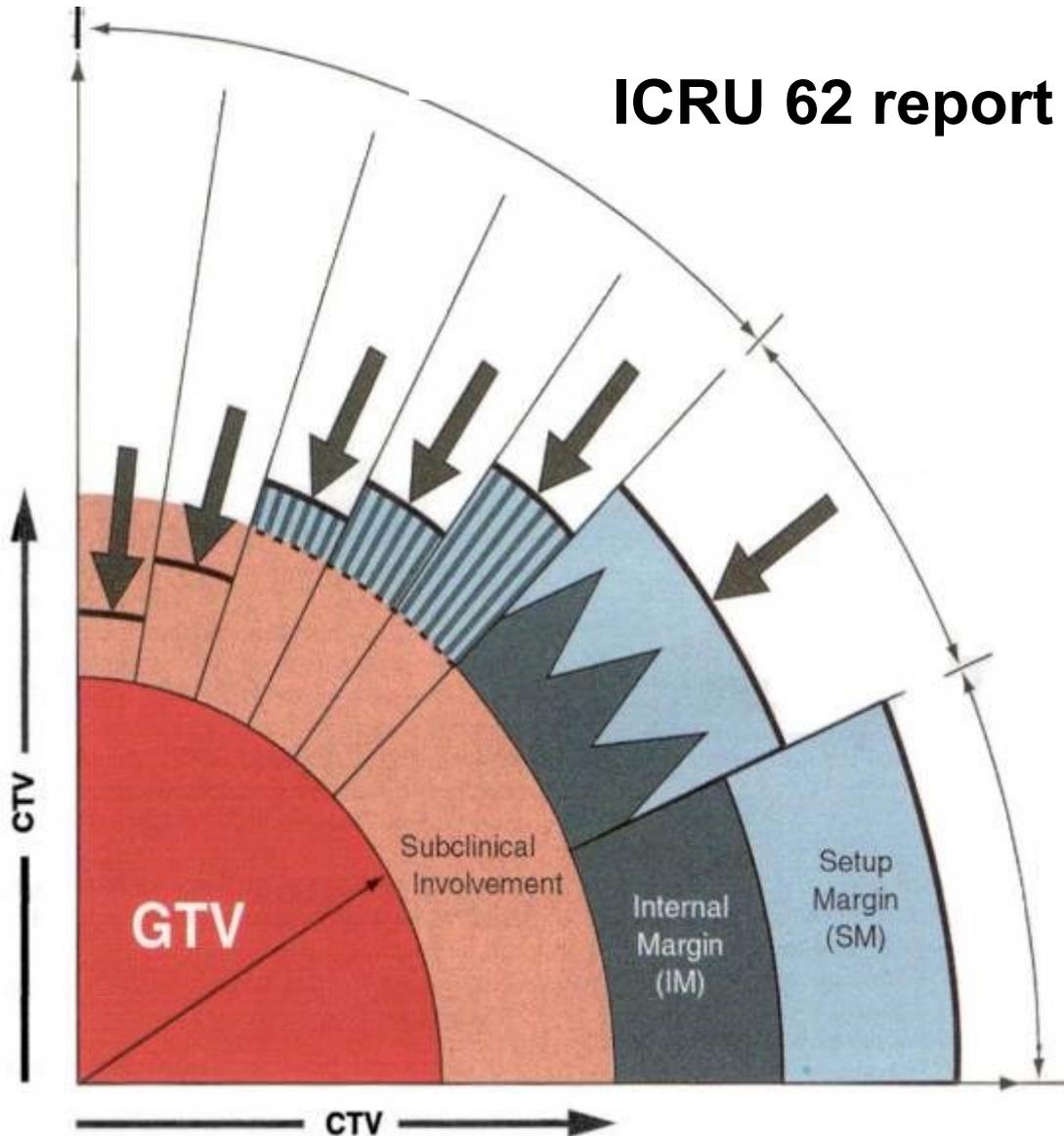


Intekenen



OAR

ICRU 62 report



•GTV = Gross Tumour Volume

= Macroscopische tumor

•CTV = Clinical Target Volume

= Microscopische tumor

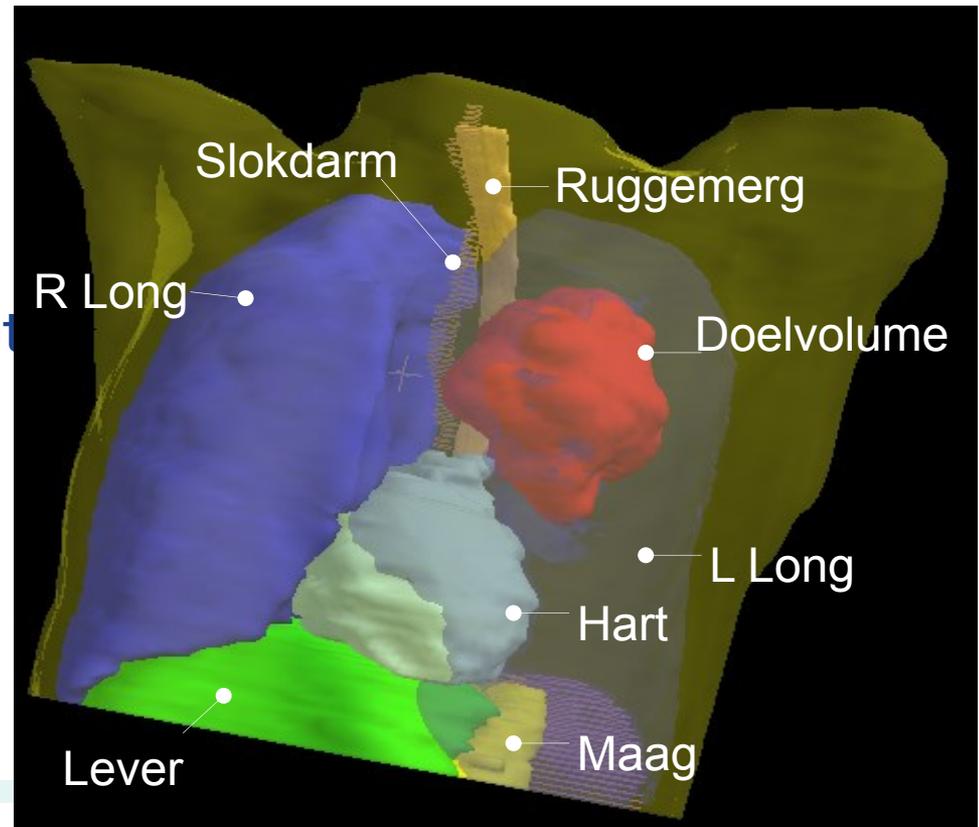
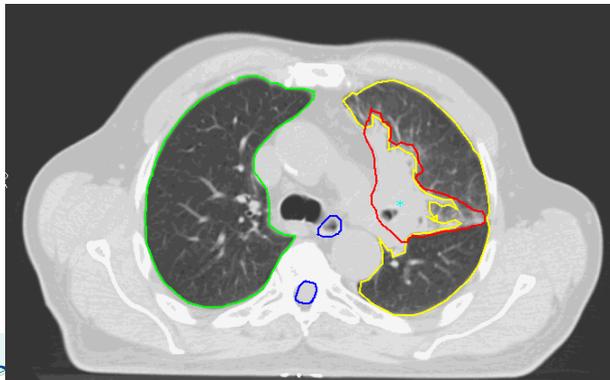
•PTV = Planning Target Volume

= IM + SM

Bestralingsplan

Intekenen tumor en organen

- 3-D aanzicht na aanbrengen inwendige cont

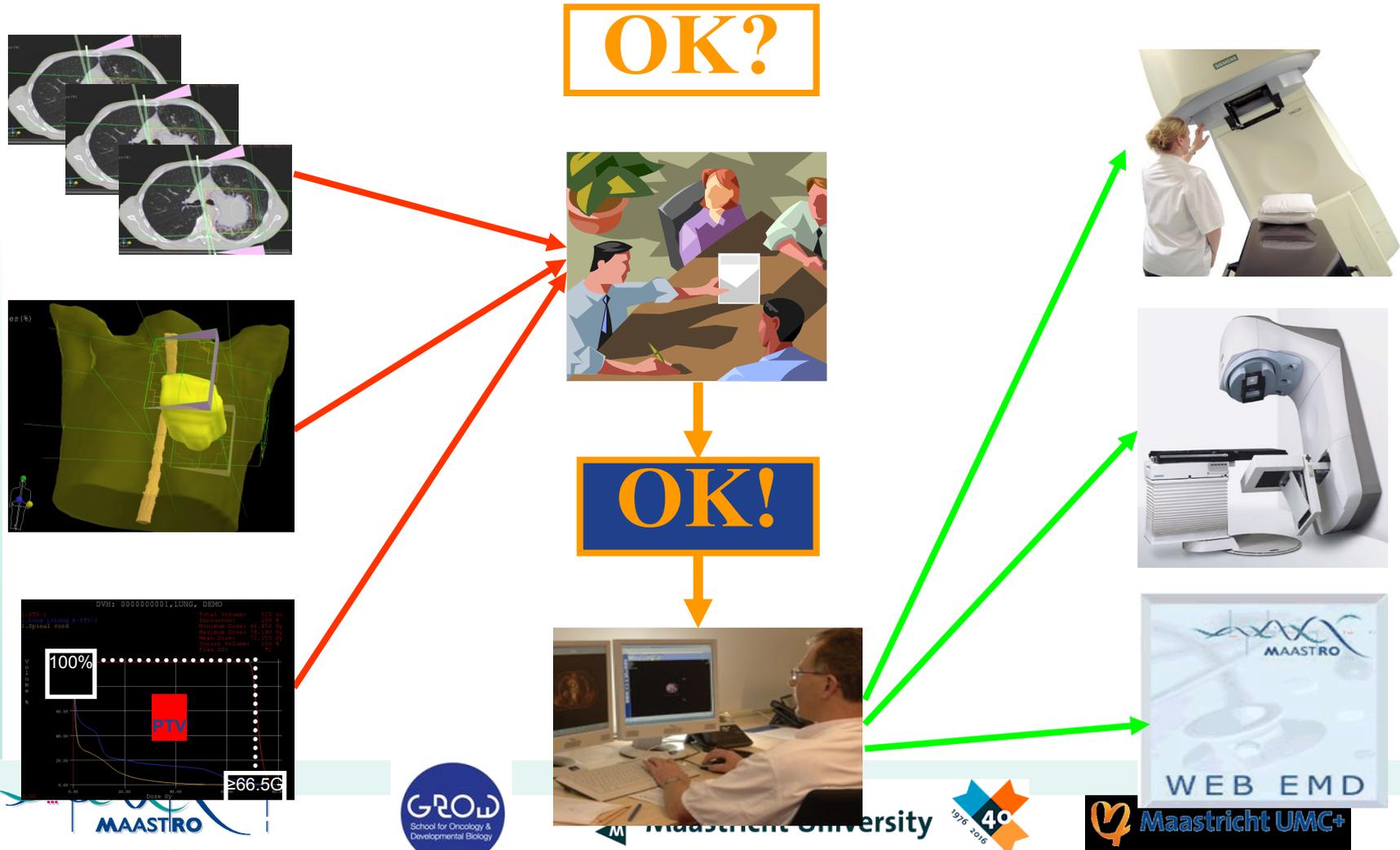


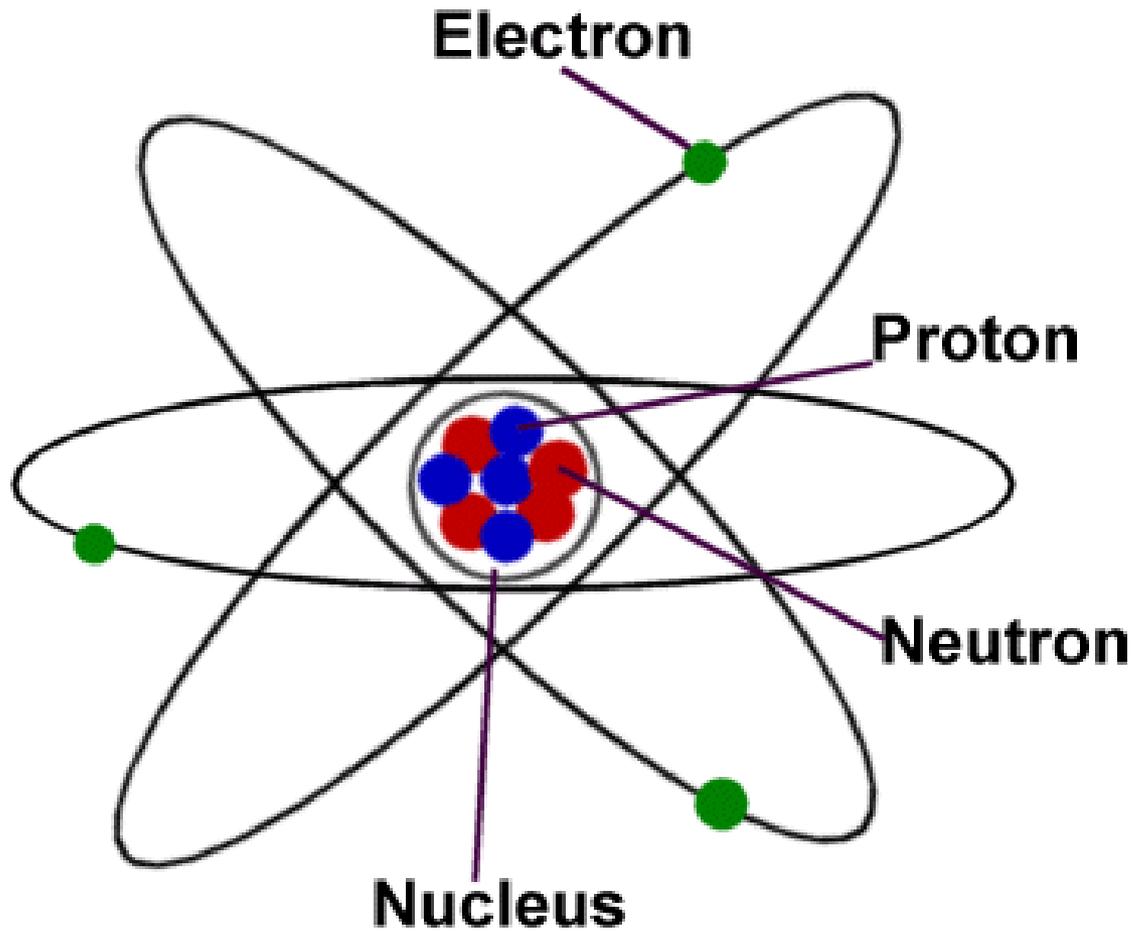
Bestralingsplan

- Bestralingsplan: optimale manier van bestralen berekenen:
 - Hoge dosis op tumor
 - Lage dosis op gezond weefsel
- Maken bestralingsplan: varieert van 1 uur tot hele dag



Bestralingsplan





Proton



"I'm positive!"

Electron



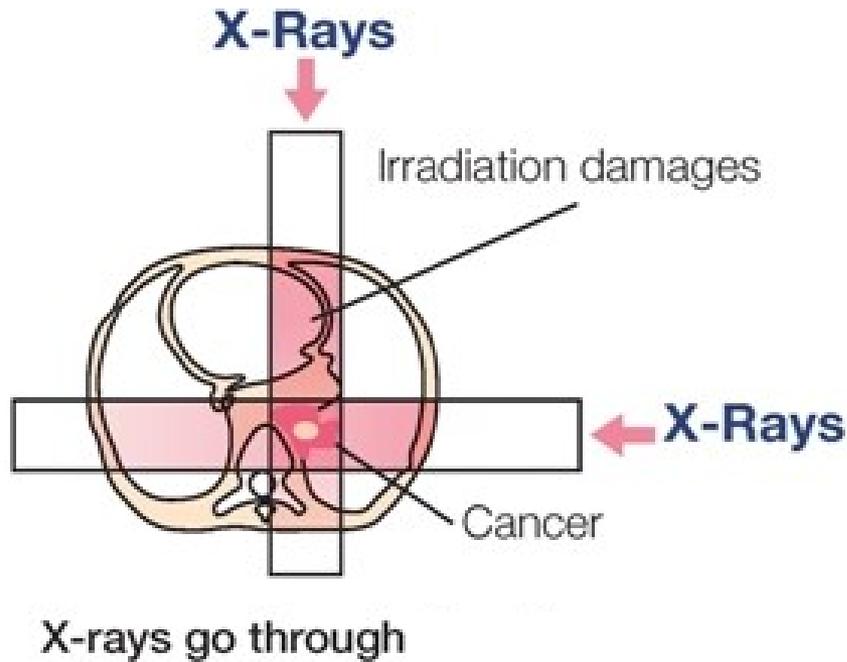
"I'm negative"

Neutron

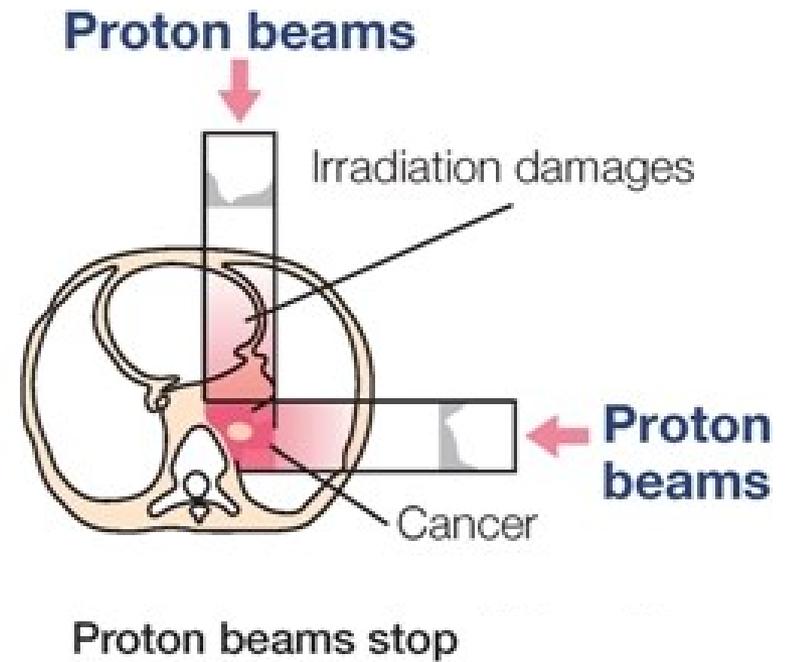


"I don't give a fuck"

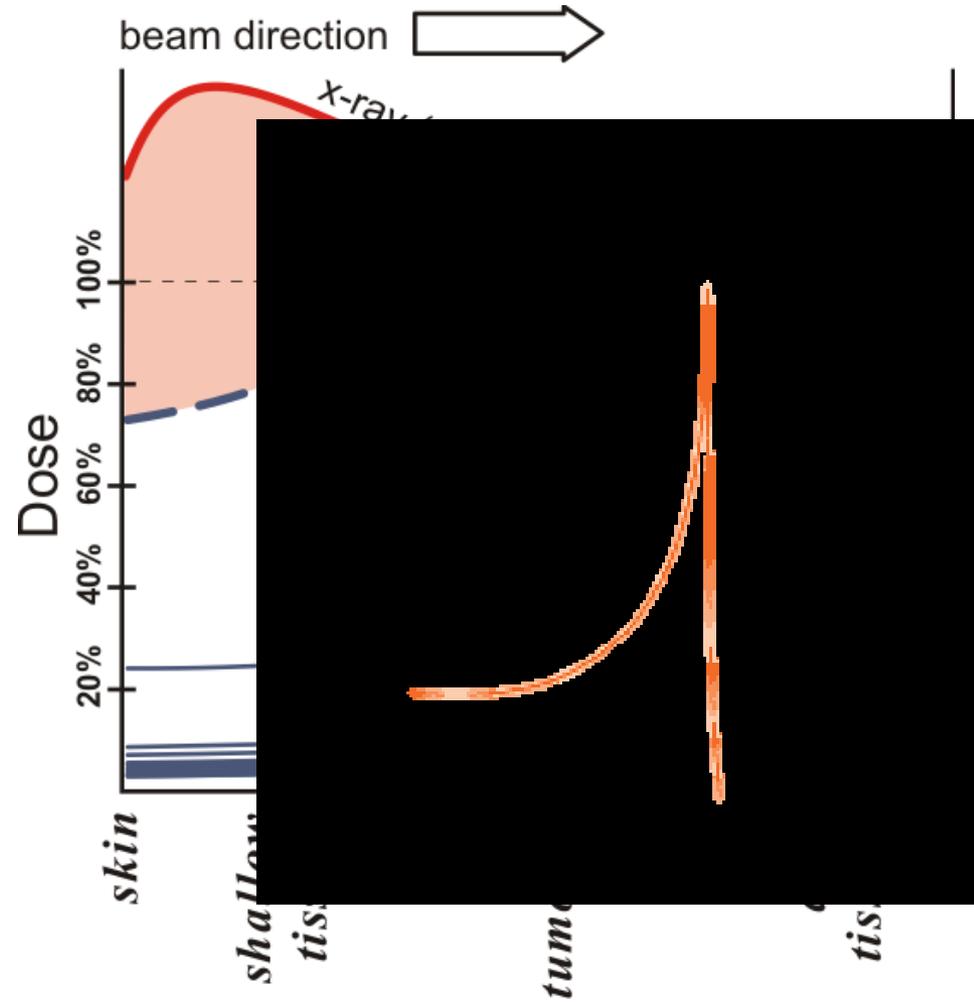
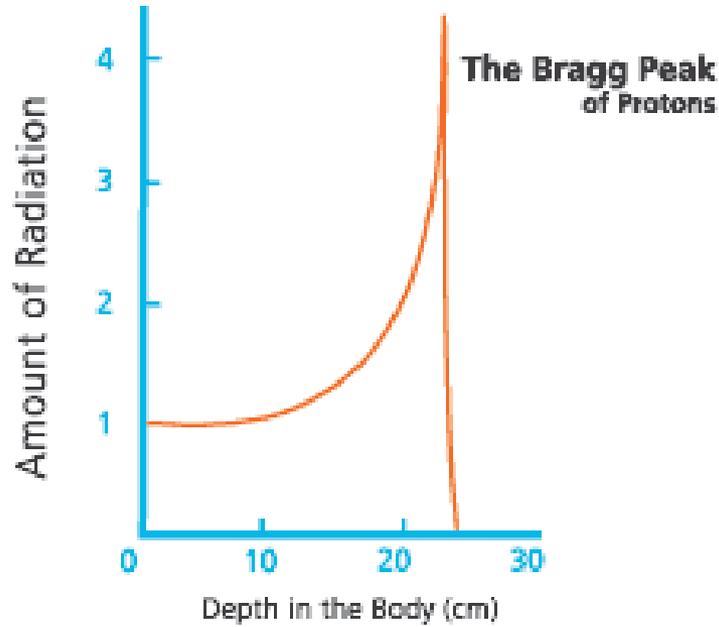
Fotonen



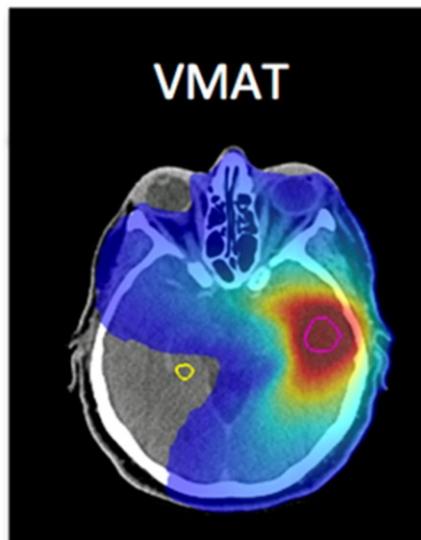
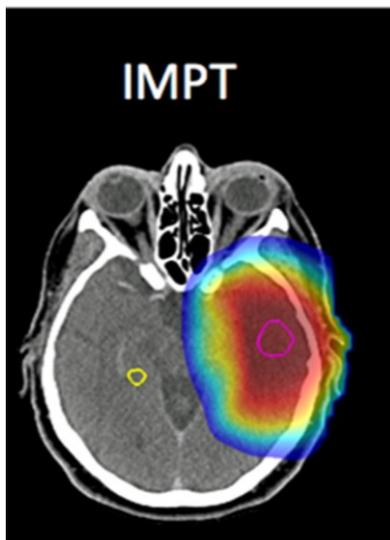
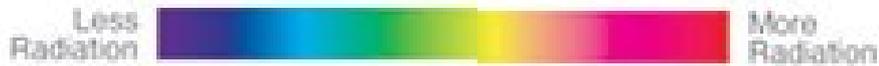
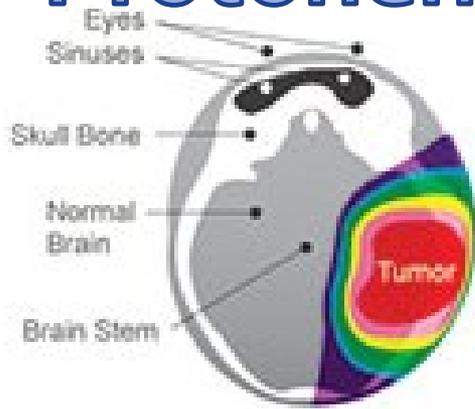
Protonen



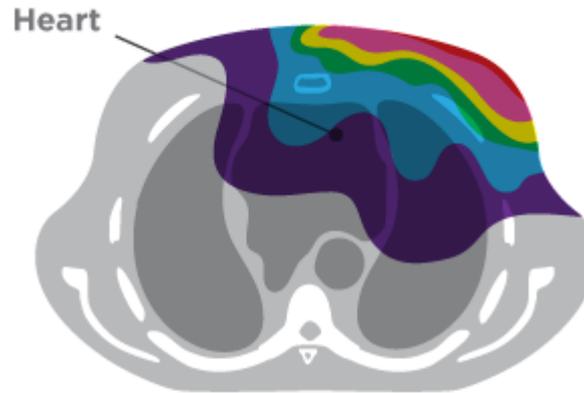
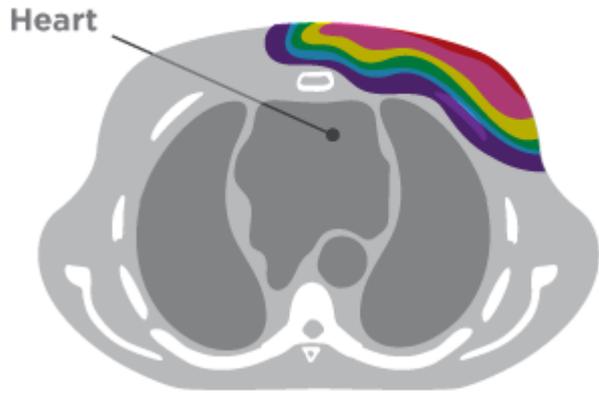
Protonen



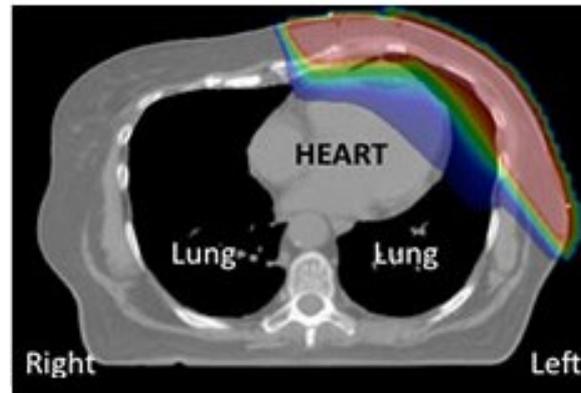
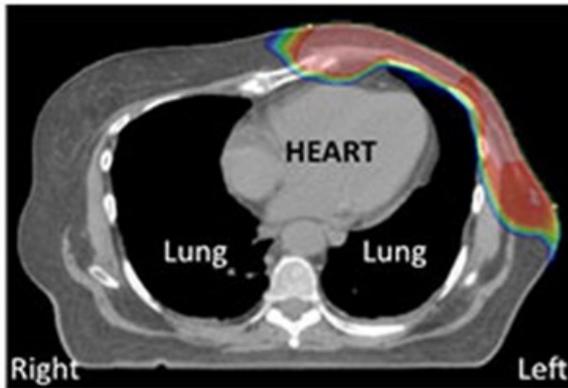
Protonen Fotonen

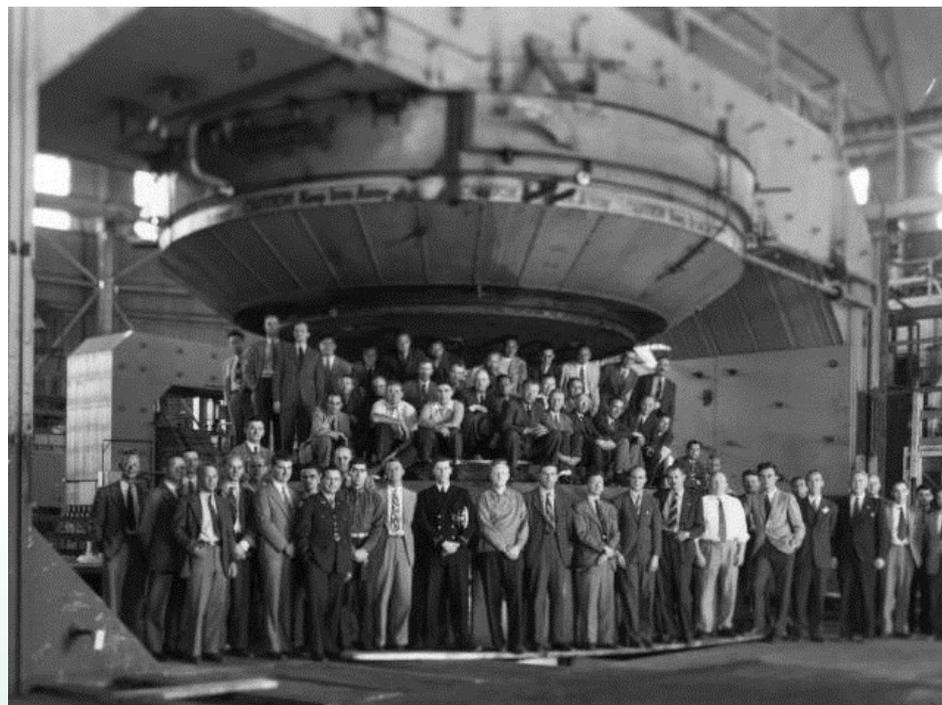


Protonen Fotonen

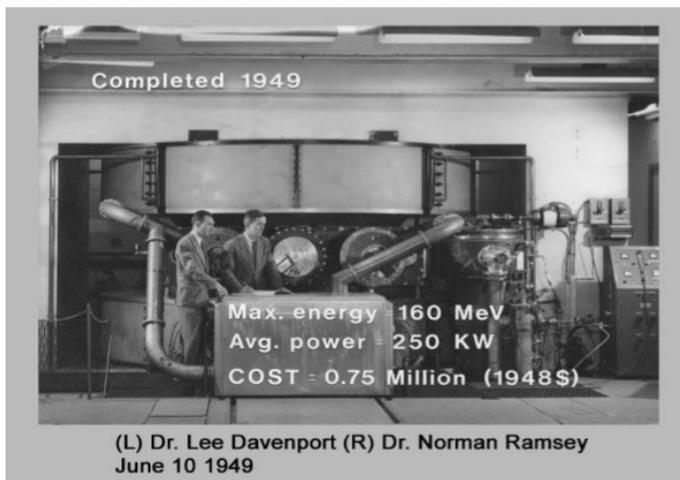


These images show the areas exposed to radiation during treatment.





THE HARVARD SYNCHROCYCLOTRON



1903 Discovery of the Bragg peak

1929	Cyclotron invented by Ernest O. Lawrence as a way to accelerate nuclear particles to very high speeds.
1930s	60-inch cyclotron built at Berkeley Radiation Laboratory with financing from the late William H. Crocker, a University of California regent. Machine is used in creation of seven new elements.
1939	Lawrence wins Nobel Prize in physics for invention of cyclotron.
1946	Lawrence protégée Robert R. Wilson, a professor of physics at Harvard and designer of Harvard's cyclotron, first proposes using protons for the treatment of cancer.
1948	Berkeley Radiation Laboratory conducts extensive studies on protons and confirms predictions made by Wilson.
1954	First patient treated with protons at Berkeley Radiation Laboratory.
1957	Treatment successfully duplicated on patients in Uppsala, Sweden.
1950s	Lawrence offers 60-inch cyclotron to John Jungerman, who would become the founding director of the Crocker Nuclear Laboratory at UC Davis. In collaboration with Oak Ridge National Laboratory and the Naval Research Laboratory in Washington, D.C., the Berkeley machine is modified to a 76-inch cyclotron.
1961	Harvard treats first patient in its cyclotron.

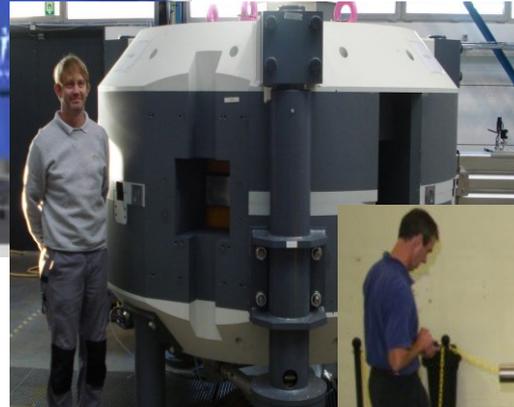
“Miniaturization” of the proton source...



IBA – 220 Ton
Isochronous Cyclotron



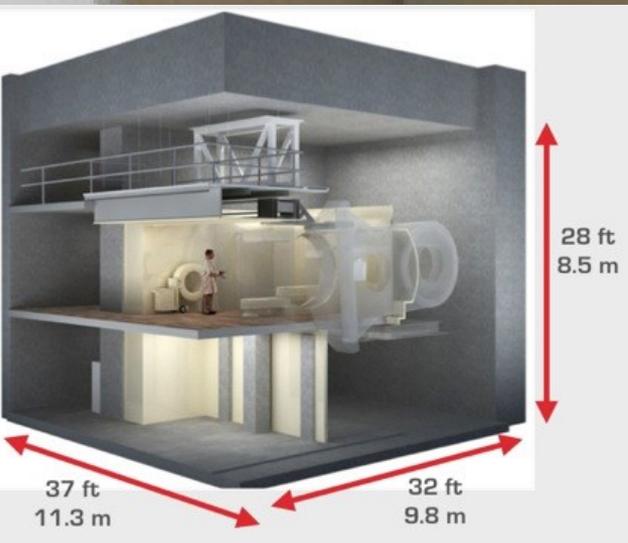
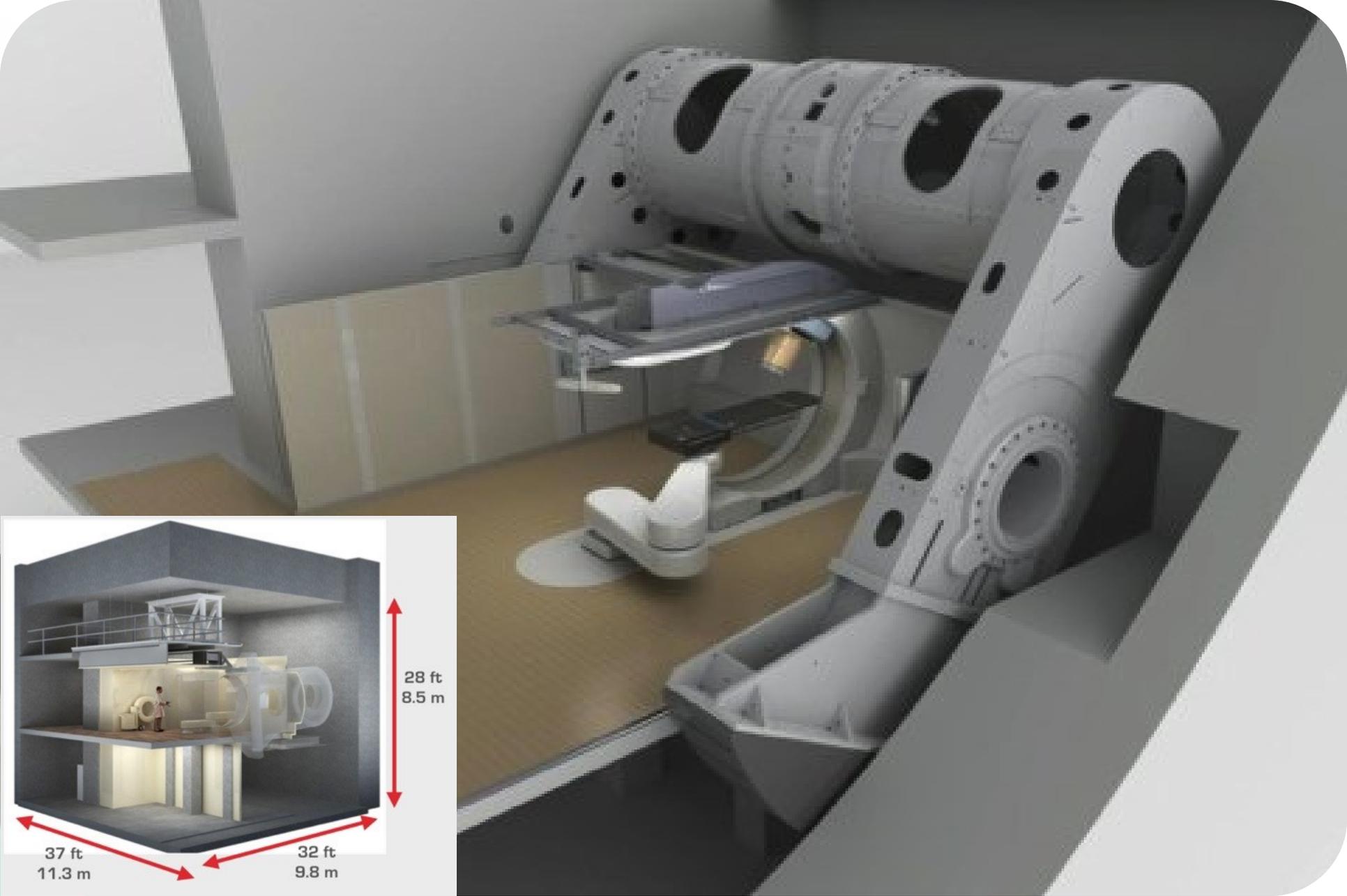
Varian – 90 Ton
Isochronous Cyclotron



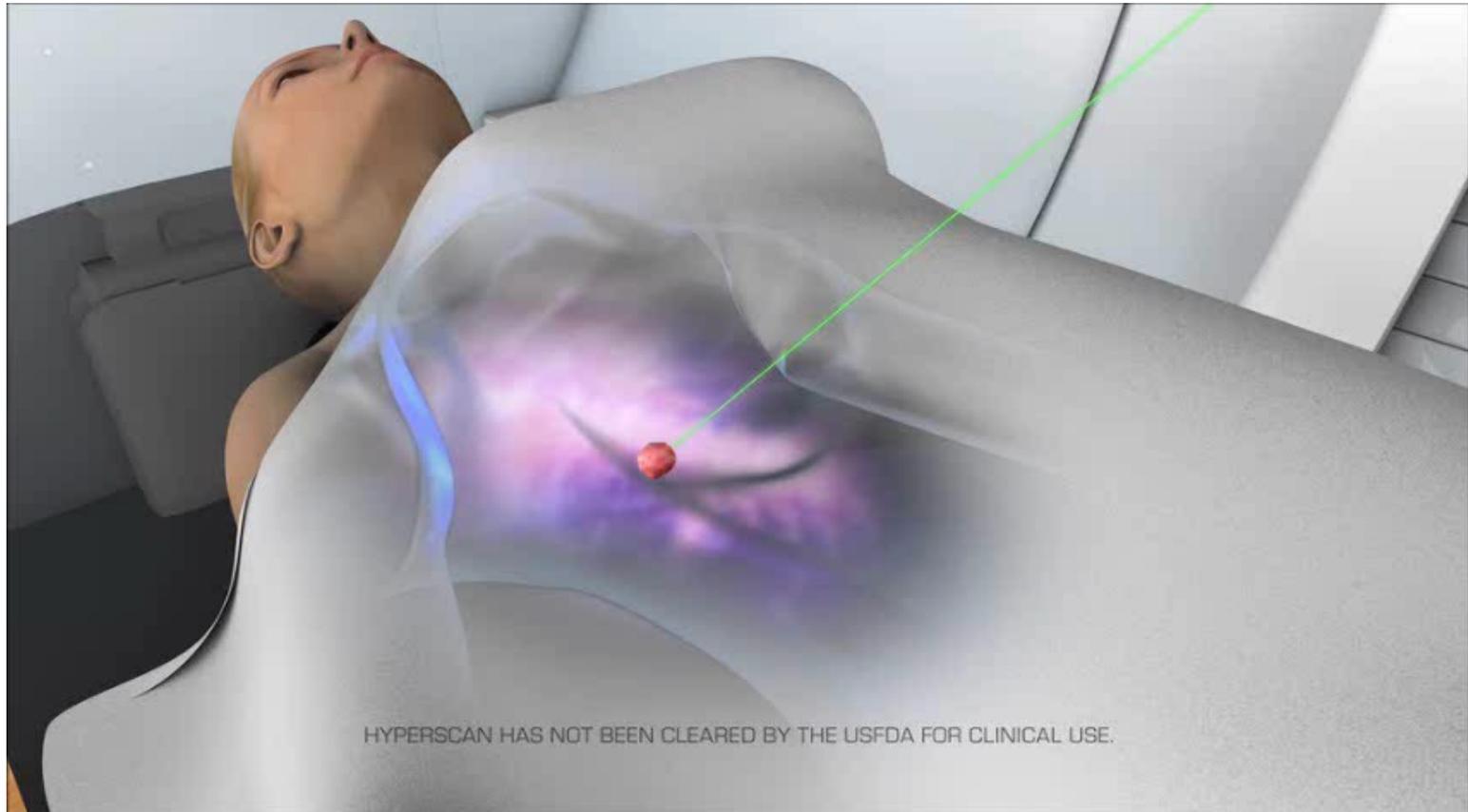
IBA – 50 Ton
Synchrocyclotron



MEVION – 15 Ton
Synchrocyclotron



Robust Intensity Modulated Proton Therapy (IMPT)

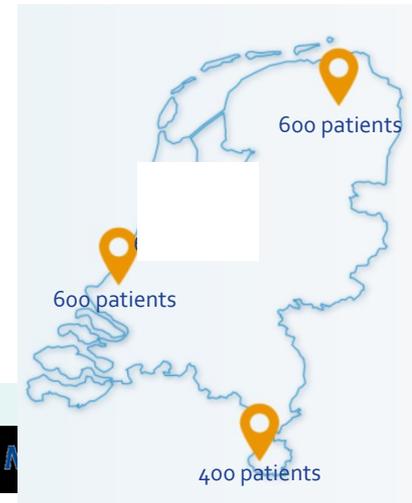


HYPERSCAN HAS NOT BEEN CLEARED BY THE USFDA FOR CLINICAL USE.



Protonen in NL UMC's

- Erasmus MC, LUMC, TUDelft Holland PTC
- UMCG Groningen PTC
- Maastrro, MUMC+ ZON-PTC
- RadboudUMC, samenwerking met ZON-PTC
- UMCU -> ontwikkeling MRI-Linac

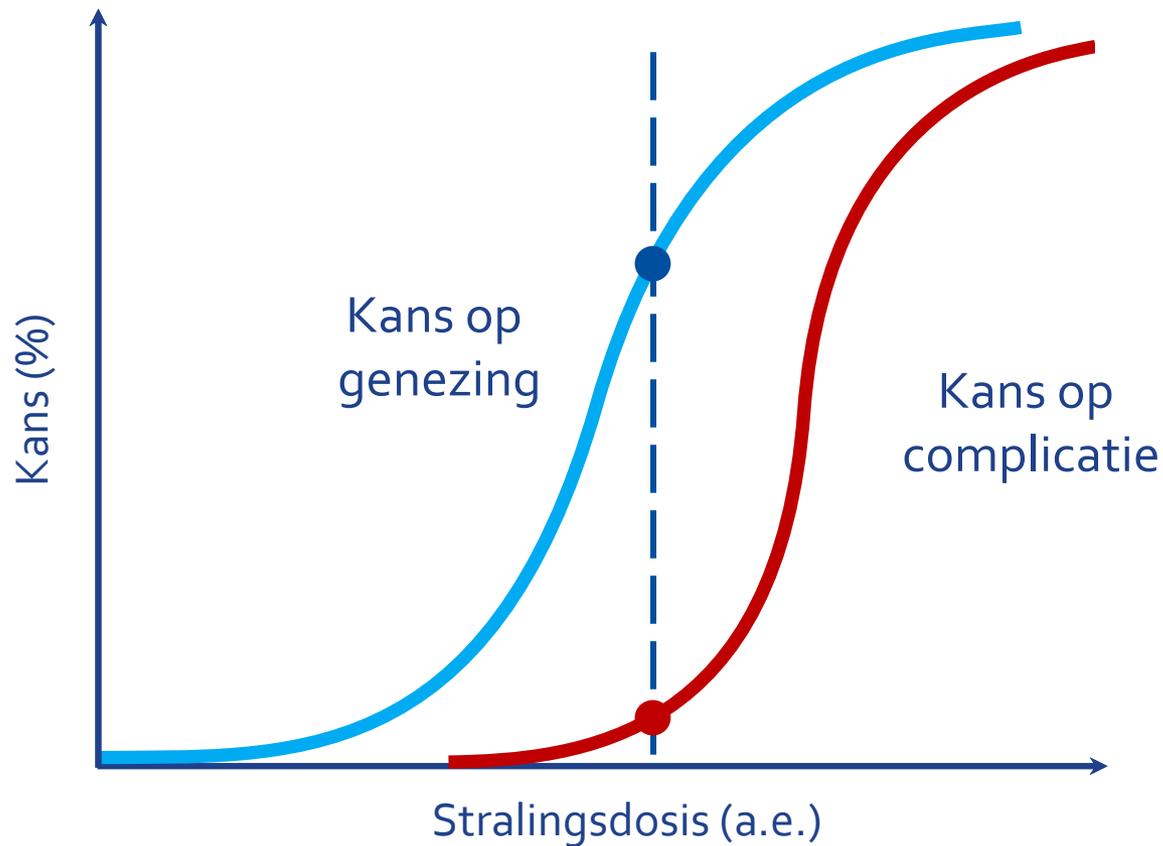


Protonentherapie in NL

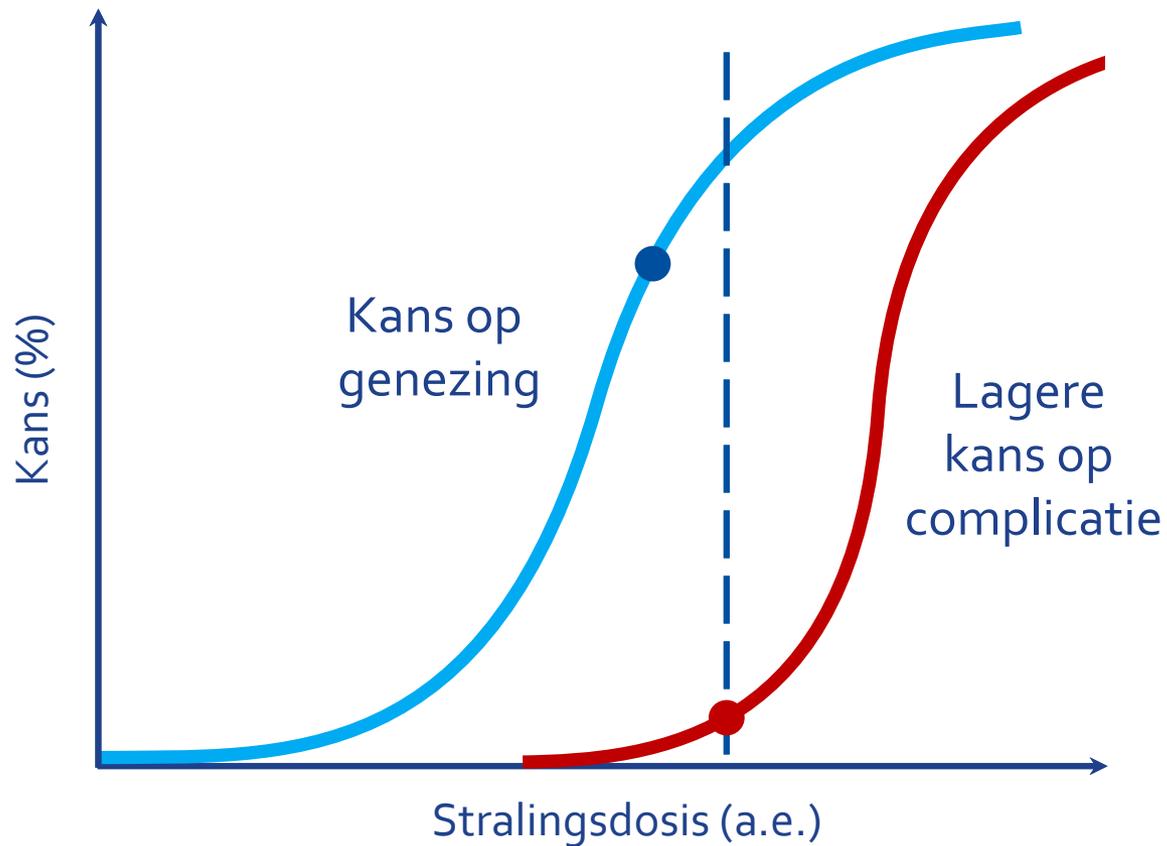
- Standard indicaties
 - Pediatrische tumoren
 - Oogmelanomen
 - Schedelbasistumoren
- Model – based indicaties
 - Hoofd-hals, Long, mamma en prostaat
 - Overige model-based indicaties (vb. herbestraling)

Proton therapy reimbursement decision tree for the Netherlands

Risico's bij behandelen

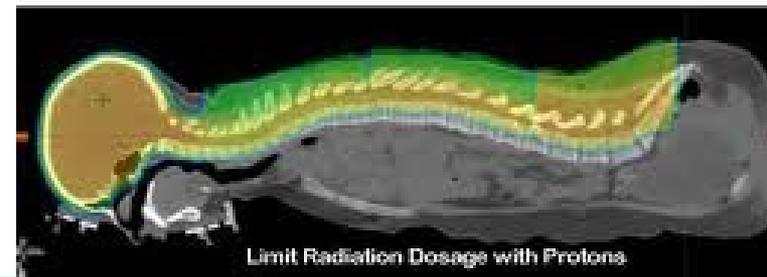
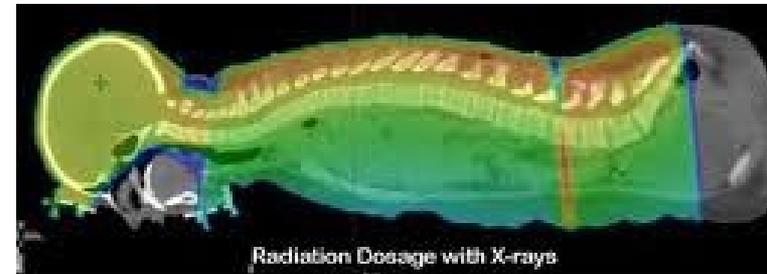
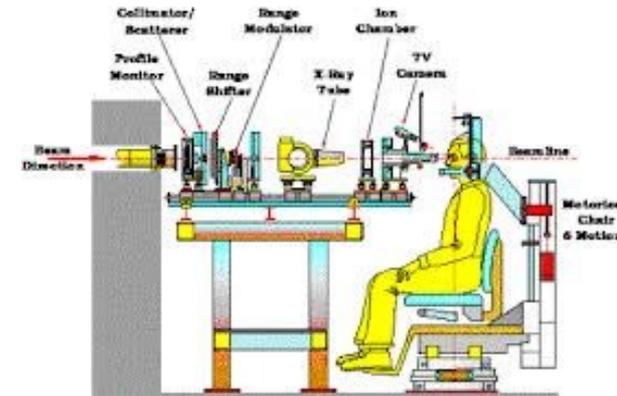


Risico's bij behandelen



Standard indications (250/yr)

- Intra-ocular tumors
- Chordoma / chondrosarcoma
- Pediatric tumors



Pediatric tumors

Mean % Volume of Non-Target Tissue Irradiated With Protons vs IMRT⁵

Pediatric Cancer Type	Non-Target Tissue	DVH Dose Level	Protons	IMRT
Retinoblastoma	Orbital bone	≥ 20 Gy	3%	22%
	IL optic nerve	> 36 Gy	8%	25%
Medulloblastoma	Cochlea	≥ 20 Gy	34%	87%
	Hypothalamus-pituitary	≥ 10 Gy	21%	81%
Pelvic Sarcoma	Ovaries	≥ 2 Gy	0%	100%
	Bowel	≥ 30 Gy	5%	12%
	Vertebrae	≥ 20 Gy	9%	29%

Secondary Malignancies

A Comparison of the Risk of Secondary Malignancies After Treating Medulloblastoma³

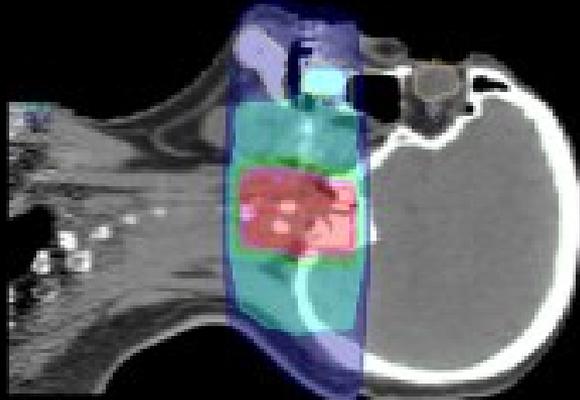
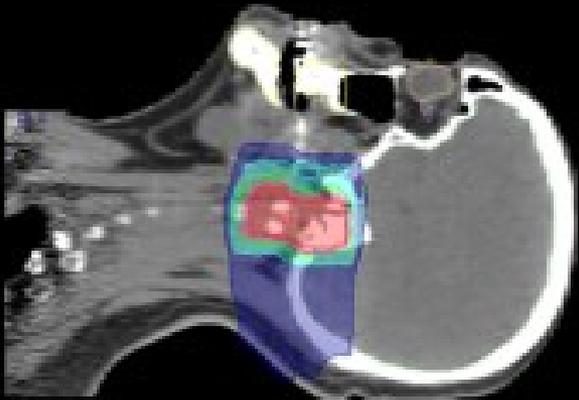
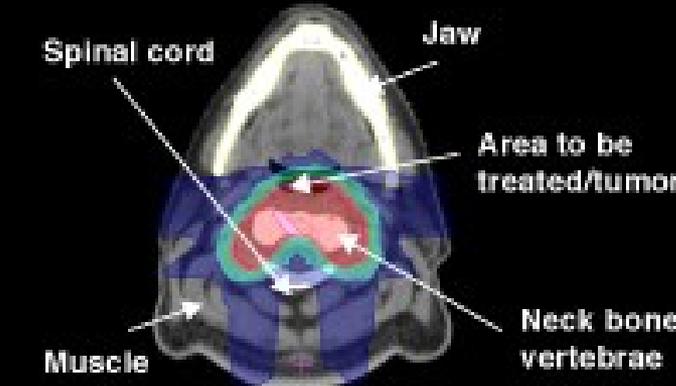
Tumor Site	IMRT X-Rays	Proton Therapy
Stomach and esophagus	11%	0%
Colon	7%	0%
Breast	0%	0%
Lung	7%	1%
Thyroid	6%	0%
Bone and connective tissue	2%	1%
Leukemia	5%	3%
All Secondary Cancers	43%	5%

Lee Int J Radiat Oncol Biol Phys. 2005;63(2)

Base of Skull

Protons

X-ray/IMRT



Chordoma and Chondrosarcoma

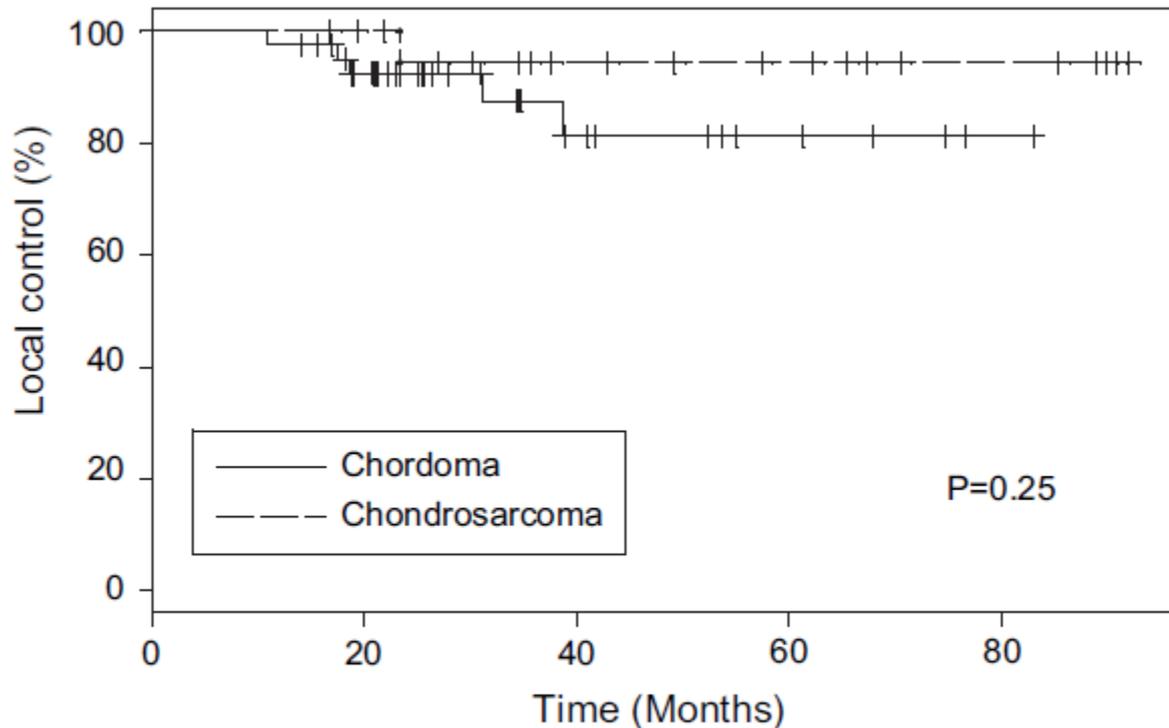


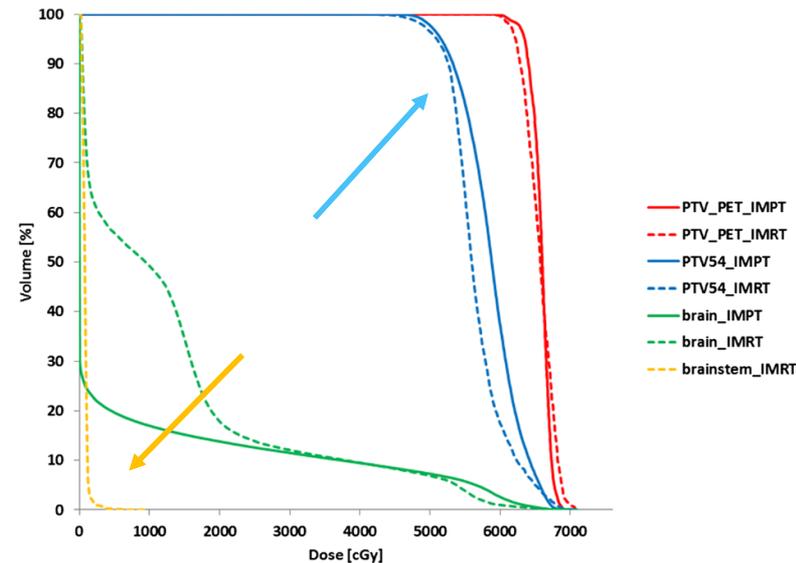
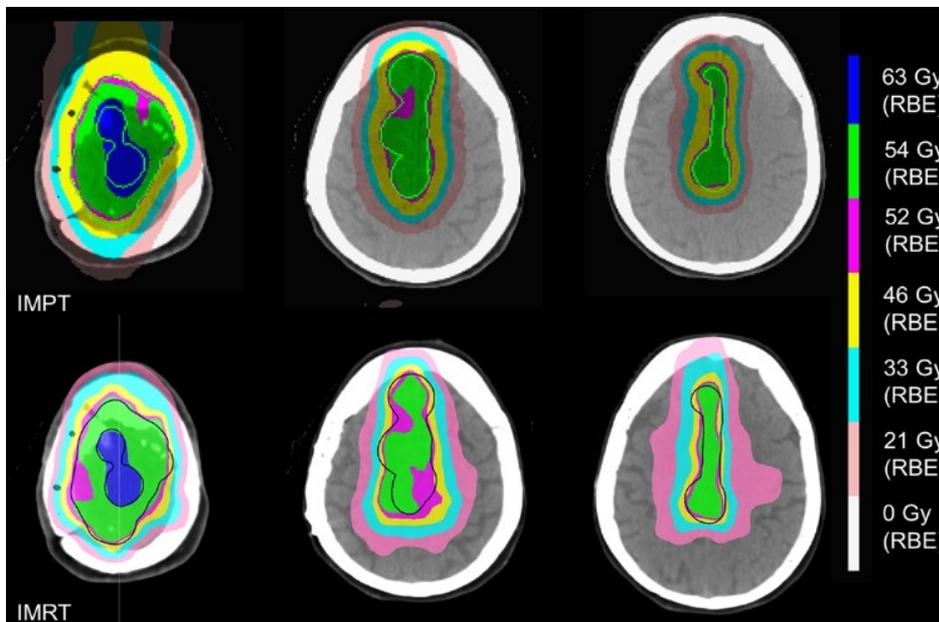
Fig. 2. Local control probability in 64 patients with skull-base chordoma and chondrosarcoma following spot-scanning-based proton radiotherapy.

RESEARCH

Open Access

Dose-painting intensity-modulated proton therapy for intermediate- and high-risk meningioma

Indira Madani^{1,2*}, Antony J Lomax¹, Francesca Albertini¹, Petra Trnková¹ and Damien C Weber^{1,3}

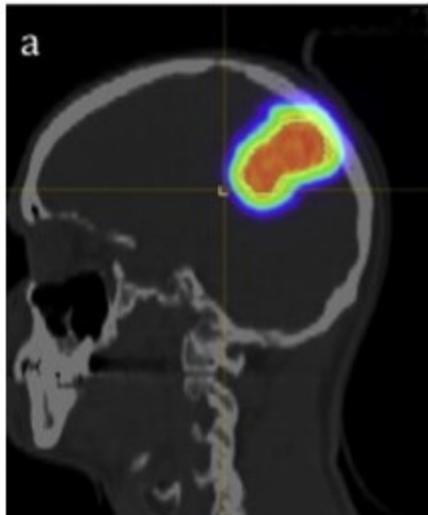


STUDY PROTOCOL

Open Access

Randomized phase II study evaluating a carbon ion boost applied after combined radiochemotherapy with temozolomide versus a proton boost after radiochemotherapy with temozolomide in patients with primary glioblastoma: The CLEOPATRA Trial

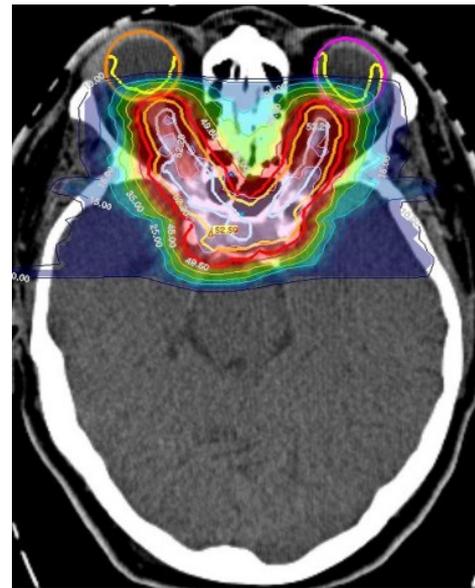
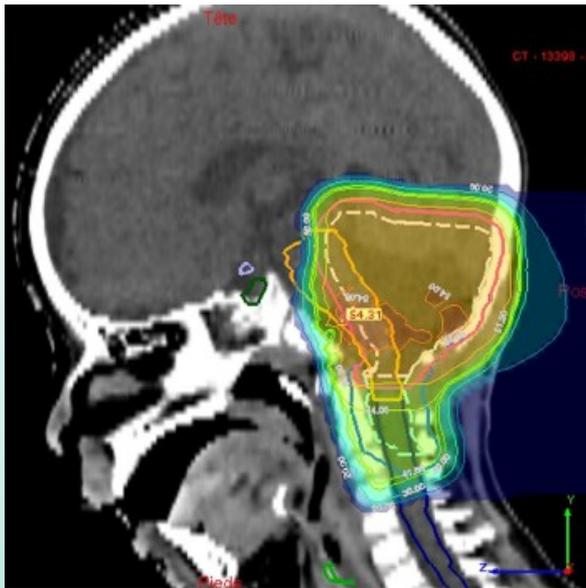
Stephanie E Combs^{1*}, Meinhard Kieser², Stefan Rieken¹, Daniel Habermehl¹, Oliver Jäkel³, Thomas Haberer³, Anna Nikoghosyan¹, Renate Haselmann¹, Andreas Unterberg⁴, Wolfgang Wick⁵, Jürgen Debus¹



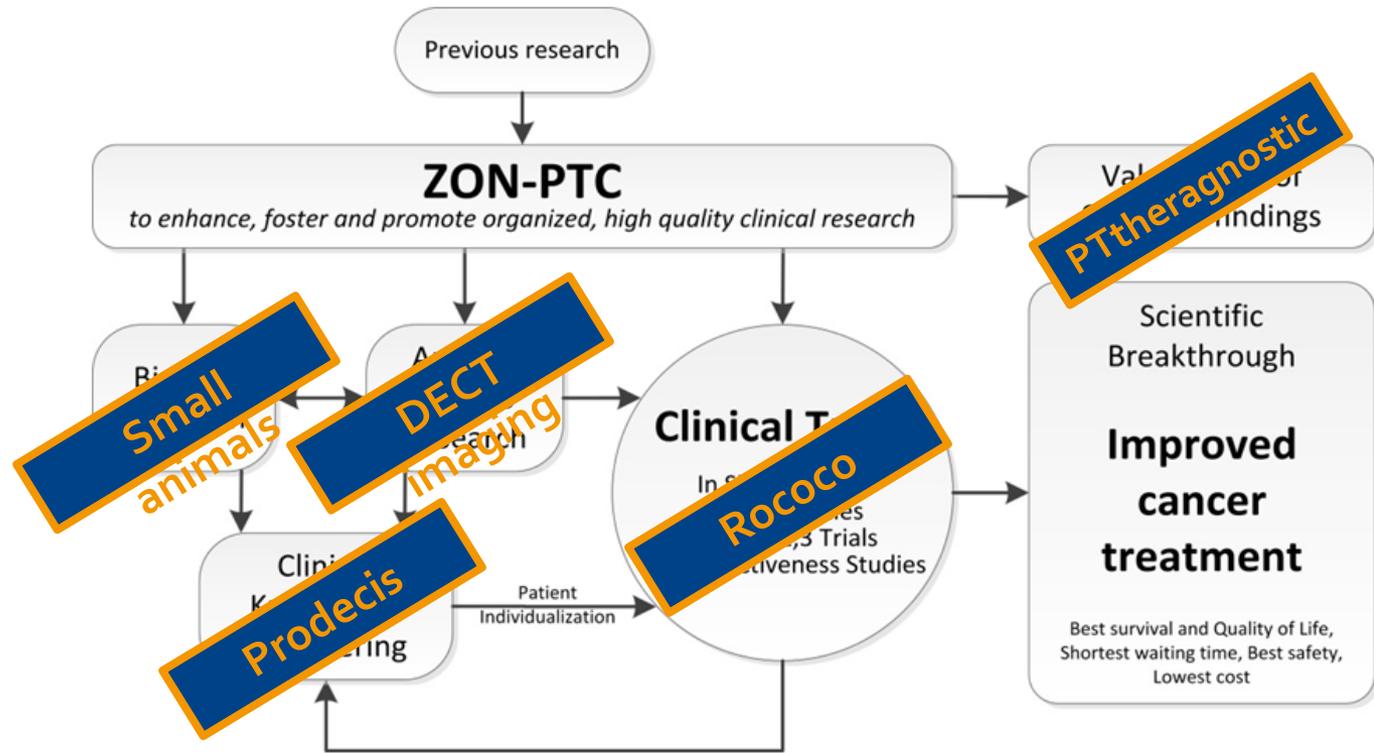
Review article

Paediatric brain tumours: A review of radiotherapy, state of the art and challenges for the future regarding protontherapy and carbontherapy

A. Laprie^{a,b,*,c}, Y. Hu^d, C. Alapetite^e, C. Carrie^{d,f}, J.-L. Habrand^{e,g,h,i,j}, S. Bolle^{e,k}, P.-Y. Bondiau^{l,m}, A. Ducassou^{b,c}, A. Huchetⁿ, A.-I. Bertozzi^{c,o}, Y. Perel^o, É. Moyal^{a,b,c}, J. Balosso^{d,p}, on behalf of the radiotherapy committee of SFCE and France Hadron¹



Research



- 5 PhD students with subject on proton therapy
- 5 professors of Maastricht University working in the field of proton therapy (*Lambin, de Ruyscher, Verhaegen, Dekker, Vooijs*)

Low Grade Glioma

VMAT



TOMO



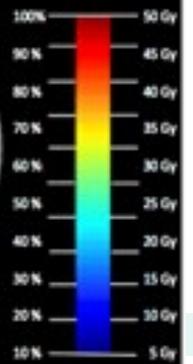
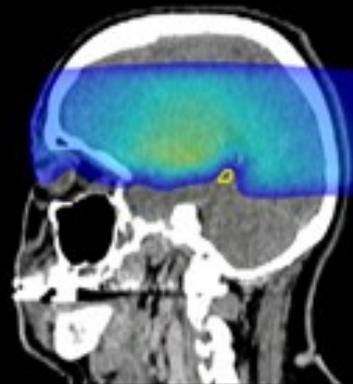
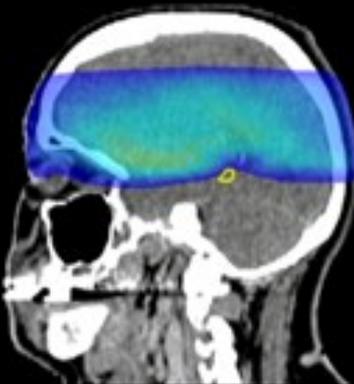
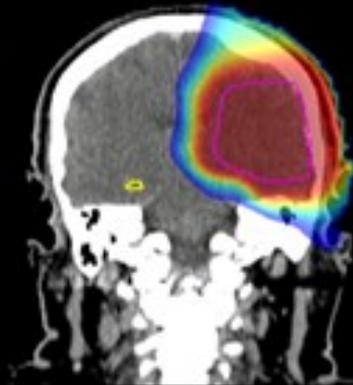
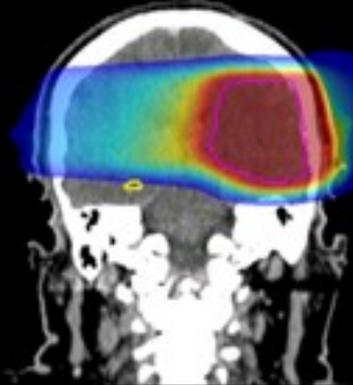
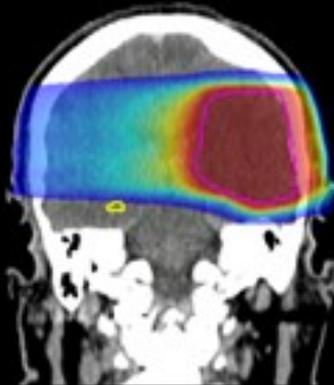
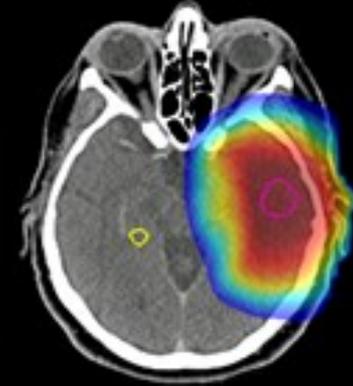
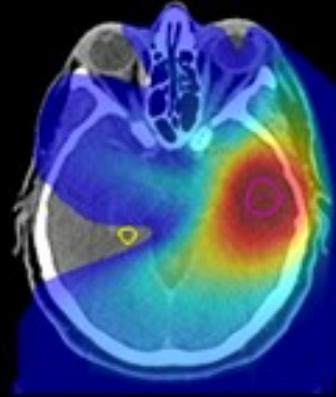
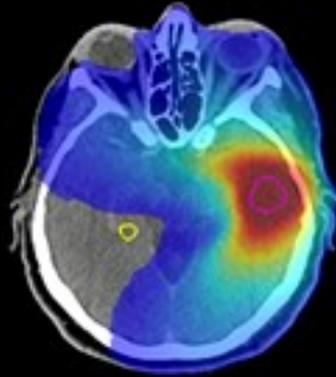
IMPT



VMAT

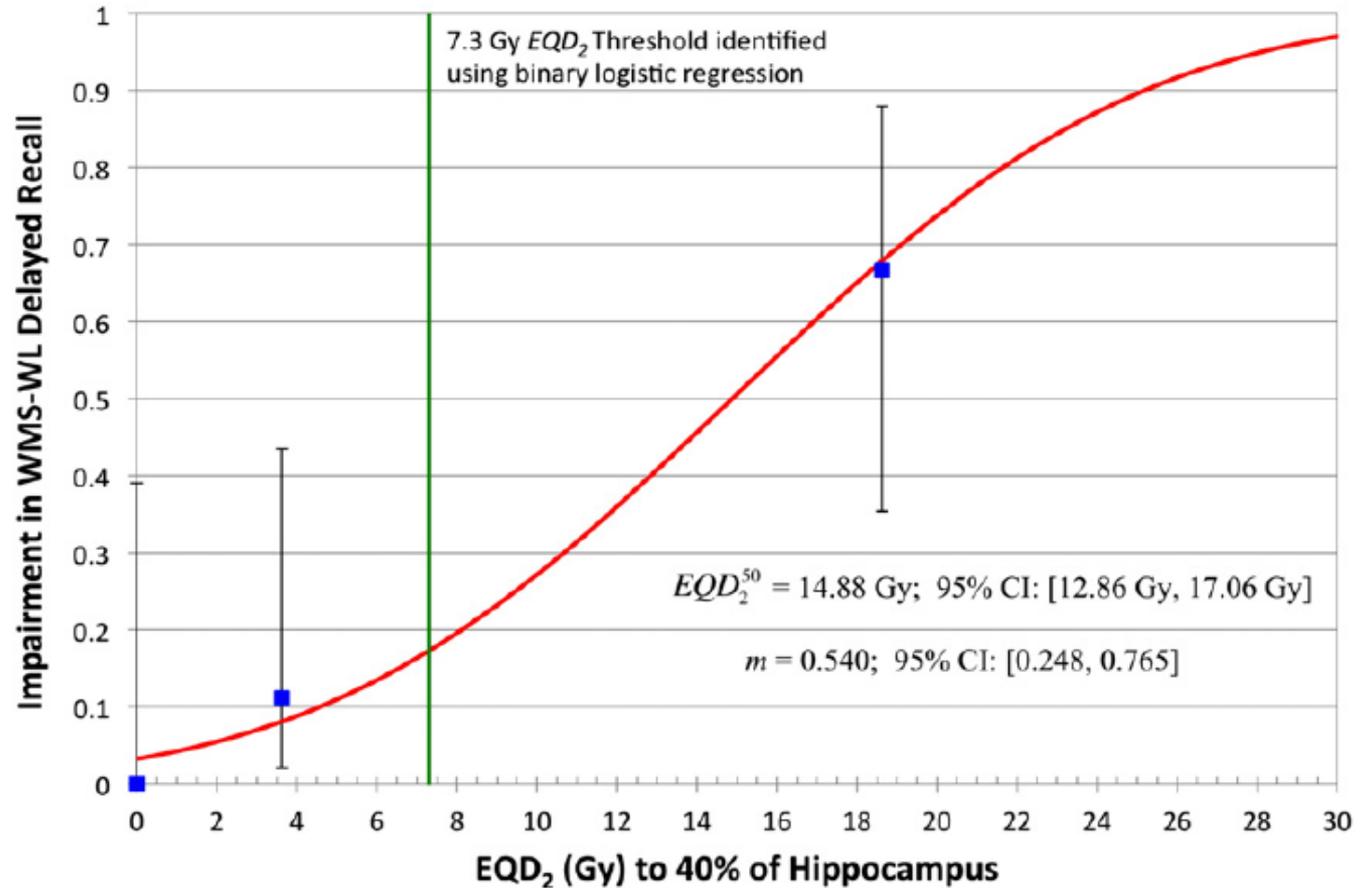
TOMO

IMPT



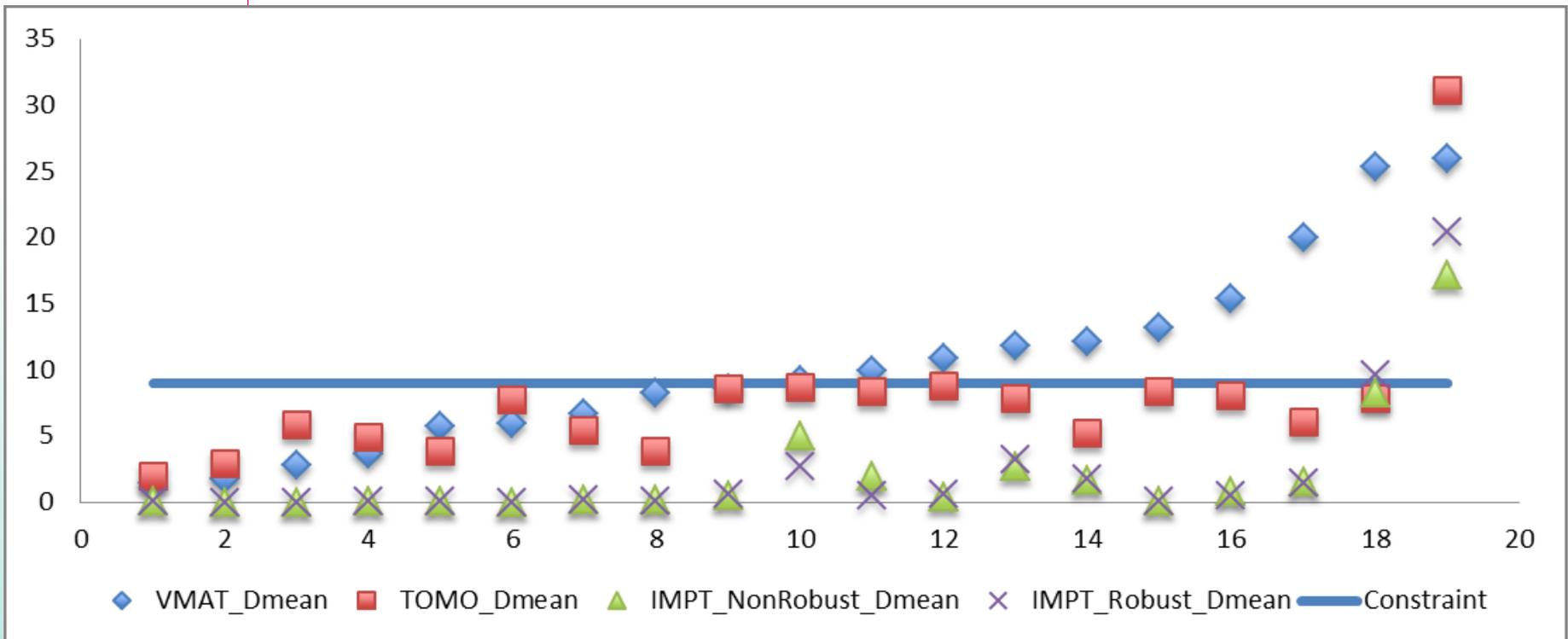
Eekers, 2016

Hippocampus D40%



Hippocampus Dmean

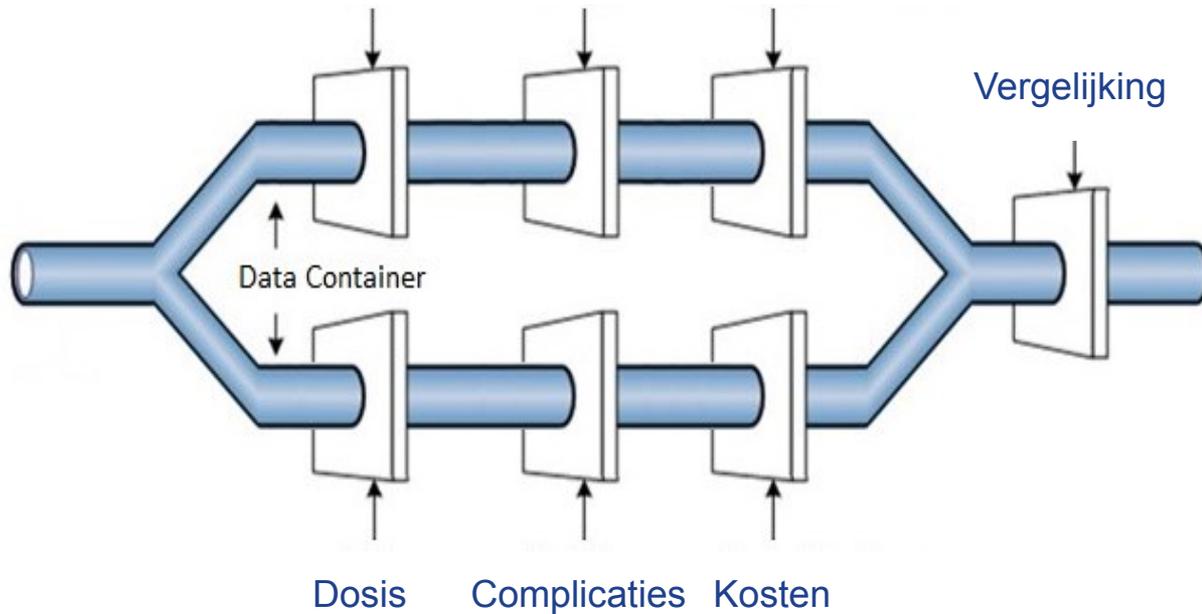
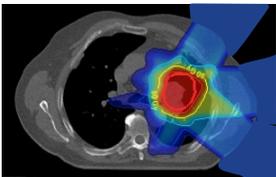
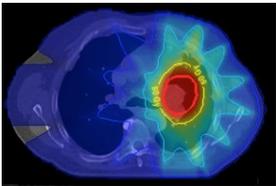
contralateral



Protontherapie keuzehulp

Proton Decision Support (PRODECIS)

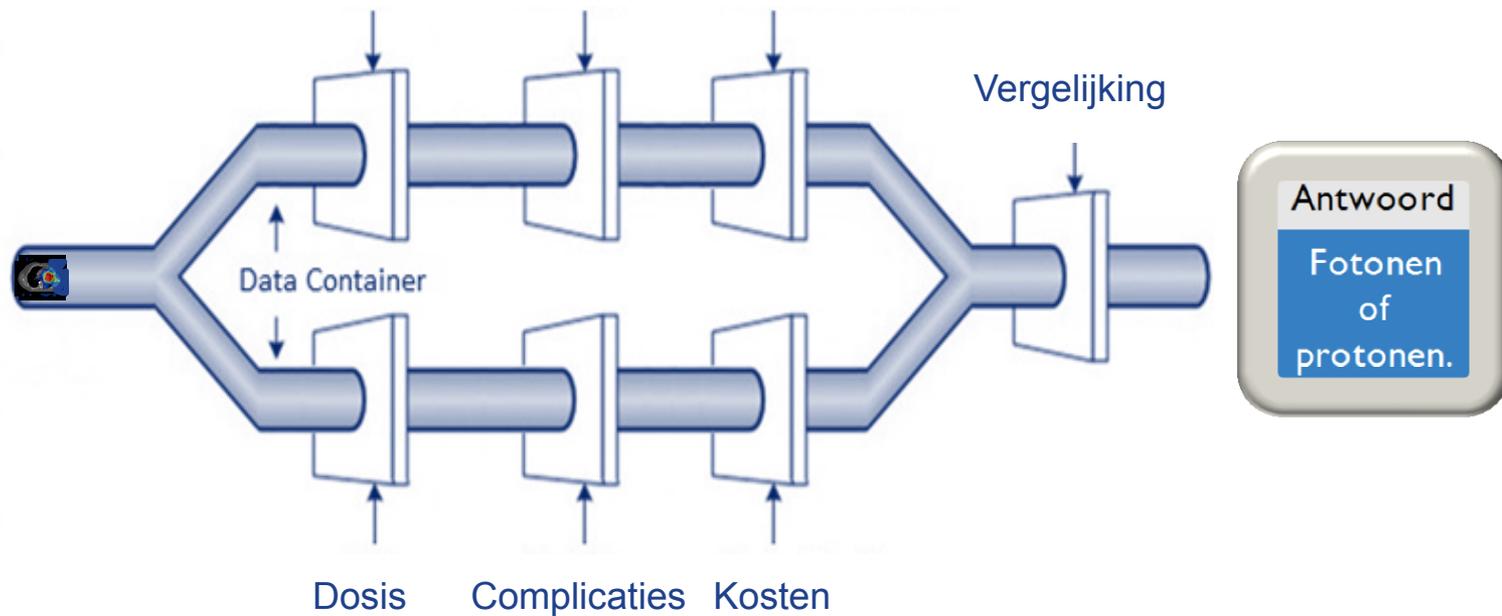
Invoer data



Protontherapie keuzehulp

Proton Decision Support (PRODECIS)

Invoer data





Maastricht University



BraCom



ZON PTC



Ronald McDonald
Huis Maastricht

Maastricht UMC+



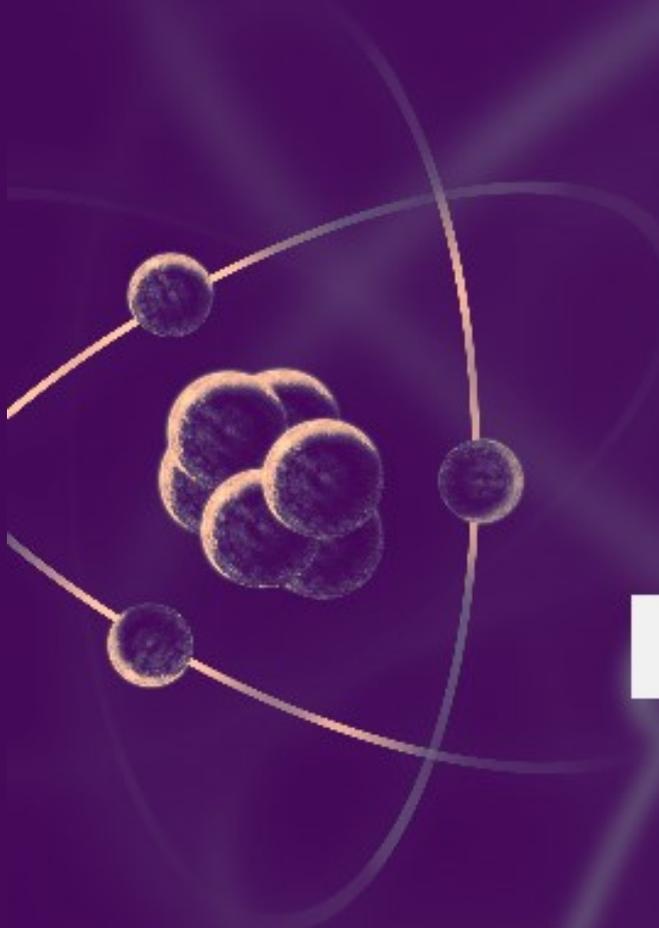
Maastricht University



Maastricht UMC+



Cognitie



**THINK
LIKE
A
PROTON
AND**

STAY POSITIVE.