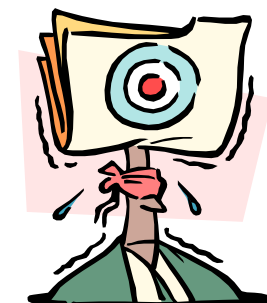
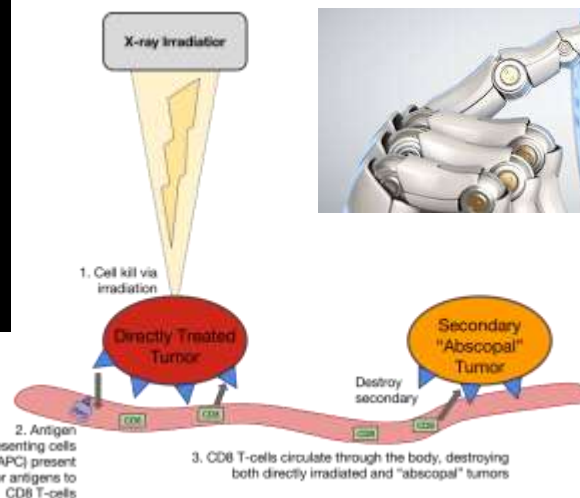
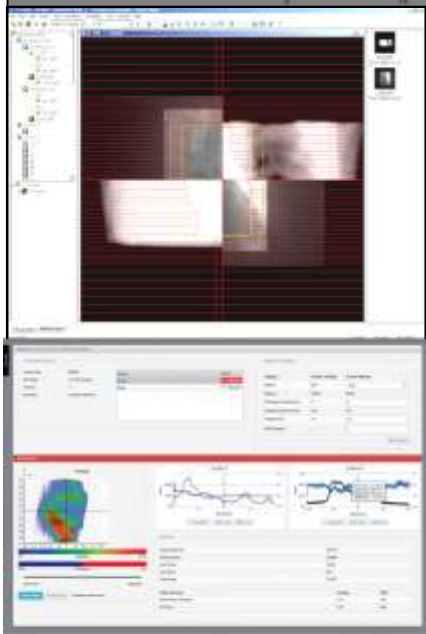
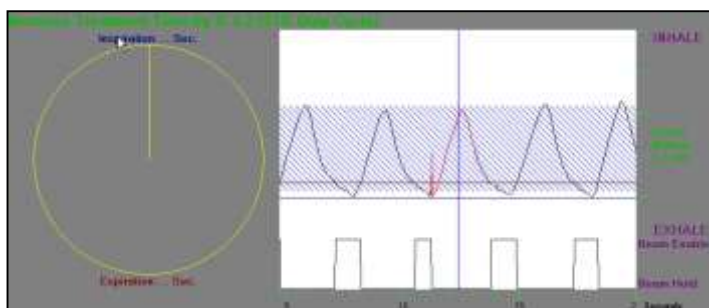


Radiotherapie

Nieuwe benaderingen – Actuele uitdagingen



Christel De Pooter
KARVA 16/11/2019

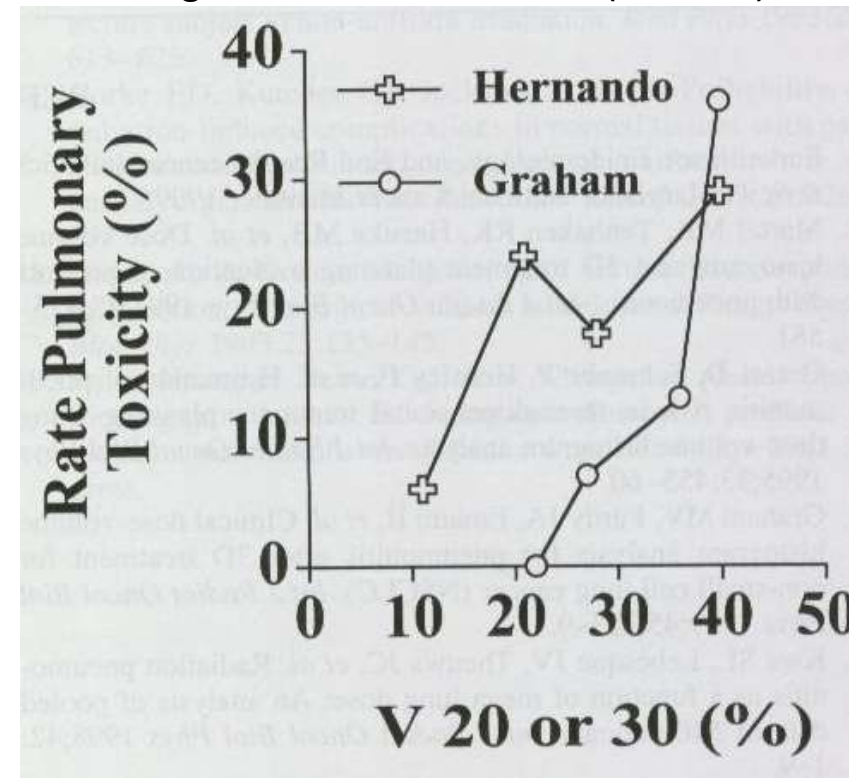
Radiotherapie bij : Primaire tumoren / Recidief / Herbestraling / M+ / Oligometastatische ziekte

Radiotherapie alleen of in combinatie met een andere therapie

- Radiotherapie stond vroeger in een slecht daglicht omdat men niet alleen de tumor bestraalde, maar ook veel gezond weefsel rondom.
- De dosis waarmee men bestraalde was klein.
- De rol van radiotherapie in enkel de palliatie zoals vb. bij klachten van hemoptoe, pijn, ea. was gekend.

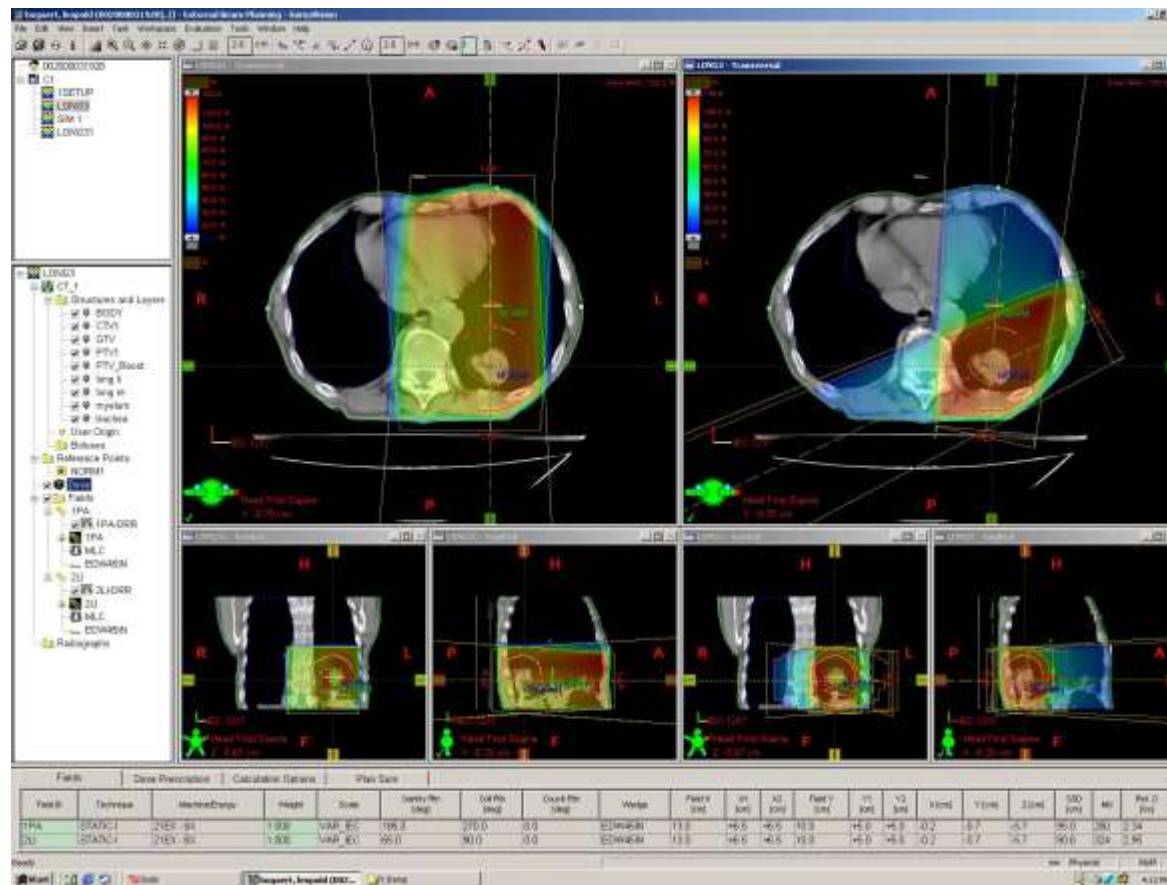
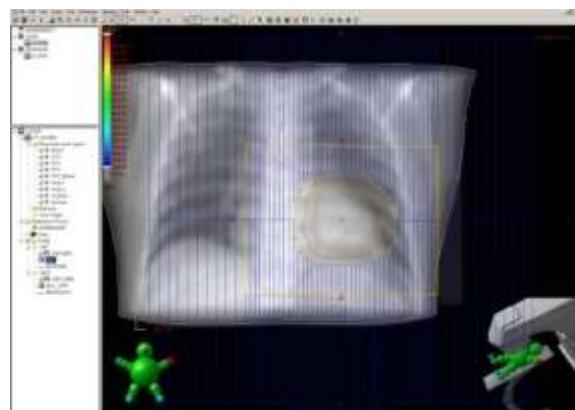
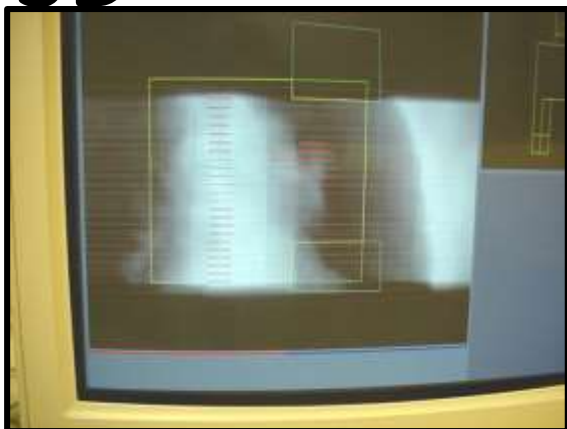
Toxiciteit :

V20 long –MLD: correlatie Gr>2 (Graham)



- Radiotherapie wordt meer en meer gebruikt in curatieve setting.
- Door een vooruitgang in medische beeldvorming (Ct-MRI-PETCT), computertechnieken (oa AI met machine learning), en in radiotherapietechnieken zoals IMRT/RA, IGRT en de 4dimensionele radiotherapie waarbij rekening wordt gehouden met de ademhaling van de patiënt en factoren, kan de bestraling meer doelgericht toegediend worden, en het omgevend gezonde weefsel meer gespaard worden.
- Door vb. rekening te houden met de ademhaling op zich, kunnen we $\frac{1}{4}$ meer gezond longweefsel sparen tov met de vroegere 3D radiotherapie.
- Hierdoor kan een hogere dosis - 66/70Gy - gegeven worden thv het doelvolumen.
- Hoe hoger de dosis, hoe meer tumorcellen we doden, en hoe meer kans op curatie

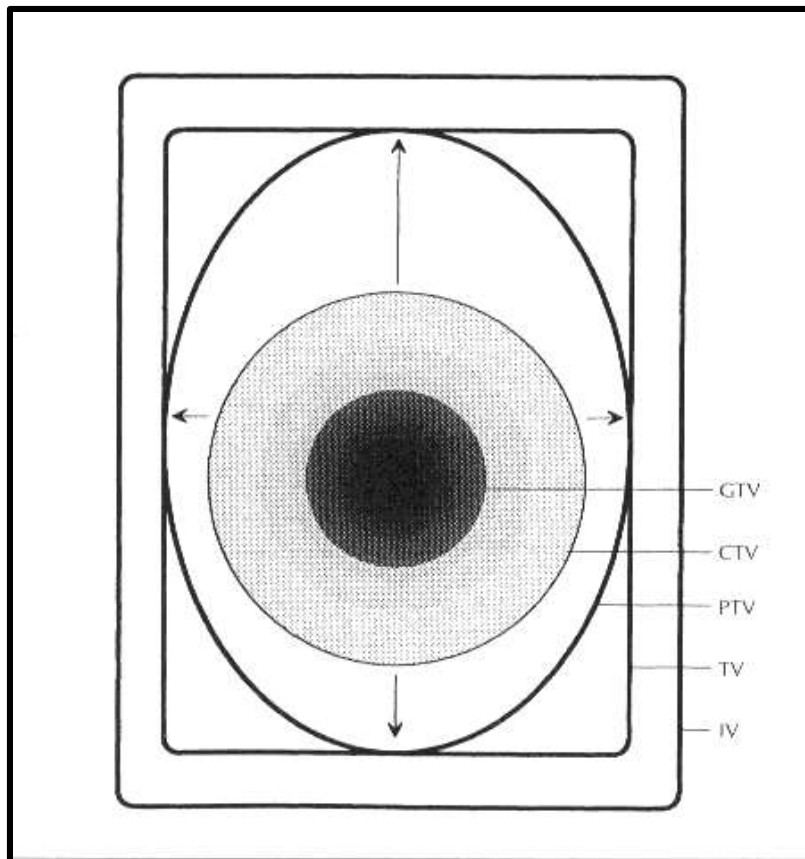
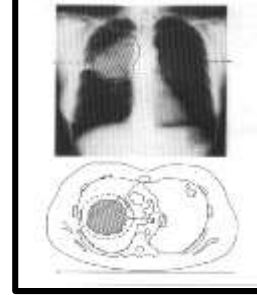
Evolutie in de Radiotherapie : 2D - 3D



Het doel van ‘nieuwe bestralingstechnieken’

- **Om de marge rondom de tumor zoveel mogelijk te verminderen**
- **Om een hogere bestralingsdosis in het ‘doelvolumen’ toe te dienen**
- **Om toxiciteit te reduceren.**

Definitie van het Doelvolumen



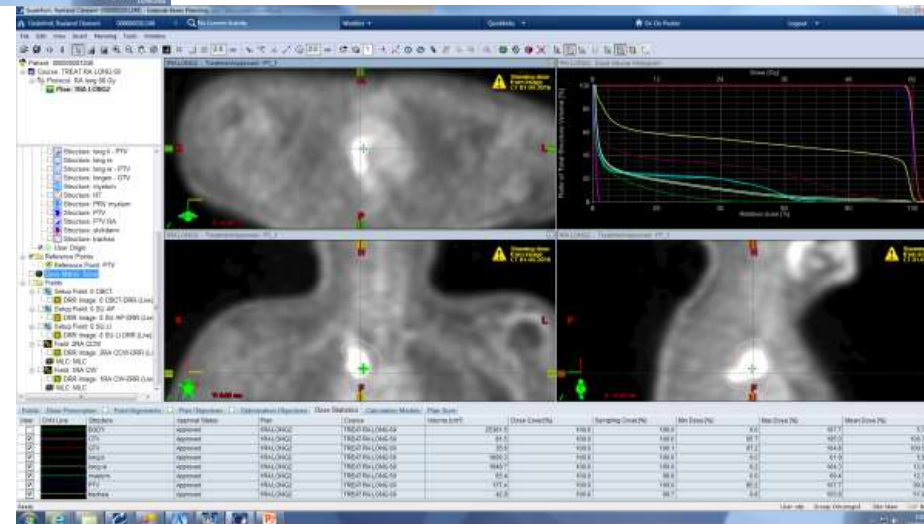
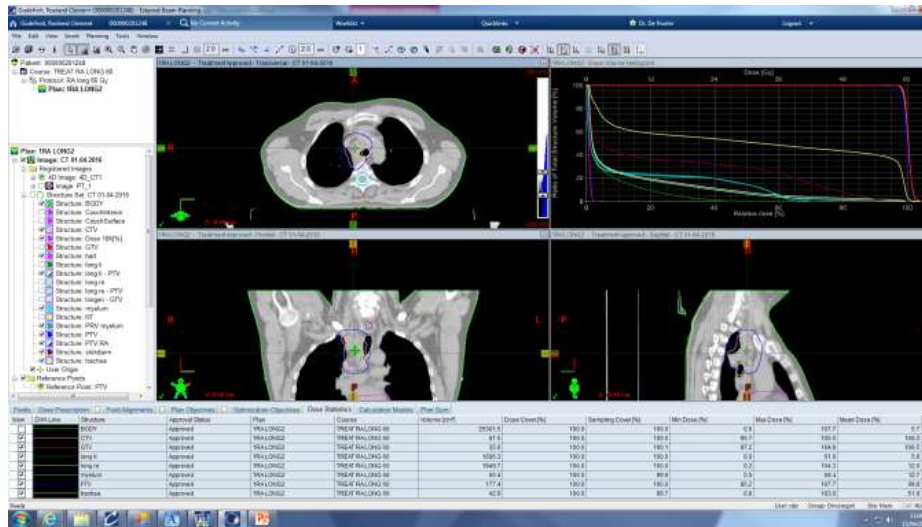
- **GTV : Gross Tumour Volume**
- **CTV : Clinical Target Volume**
- **PTV : Planning target Volume**
 - **Dagelijkse variabiliteit**
 - **Beweging van de patient**
 - **Beweging van de organen**
- **TV : Treated Volume**
- **IV : Irradiated Volume**

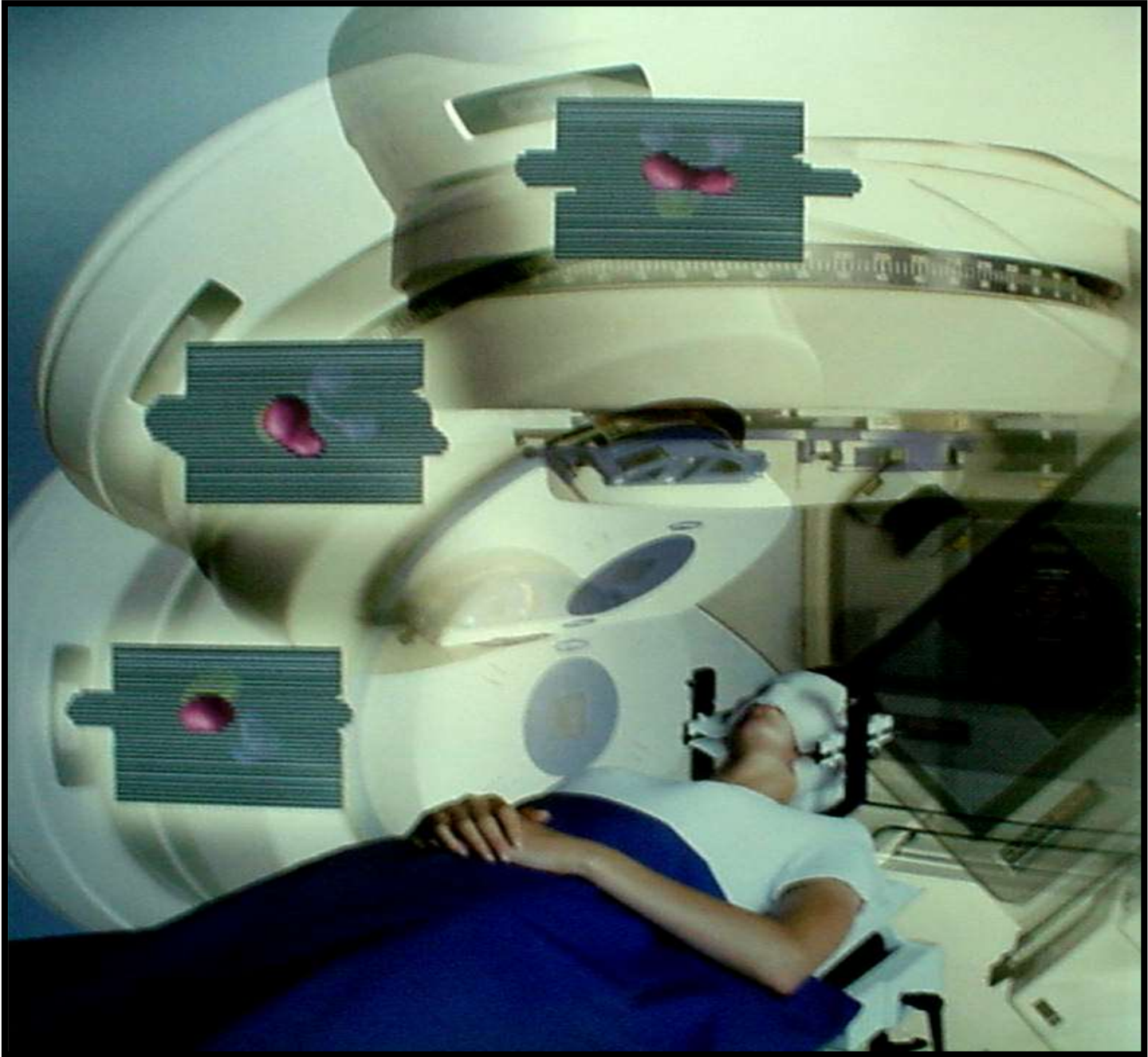
• ICRU 55

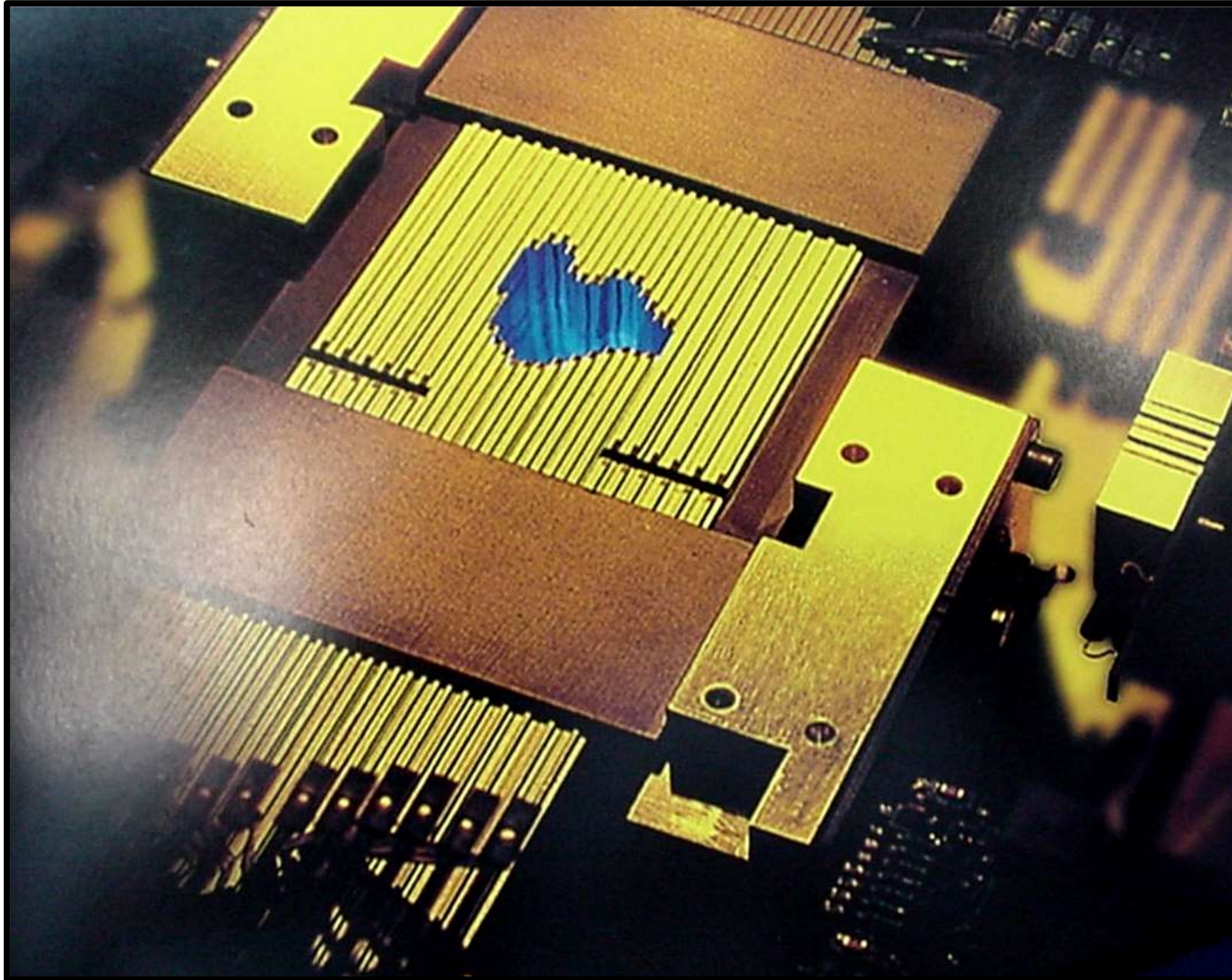
The incorporation of multimodality imaging

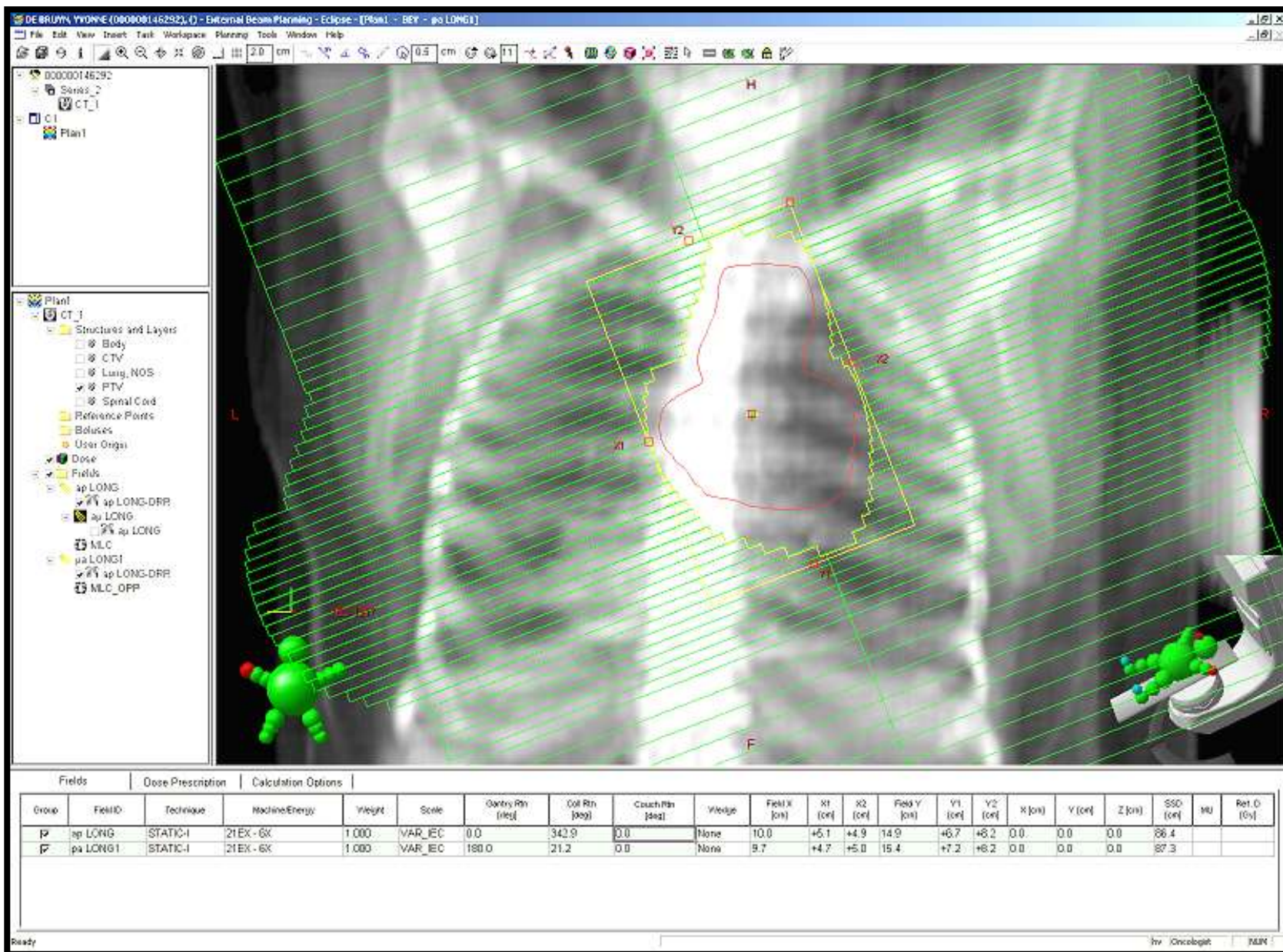
- **Localisation of the target volume for external beam irradiation:**
- **The incorporation of multimodality imaging -**
 - **Ct - MRI**
 - **Ct - PET**
 - **CtSPECT**

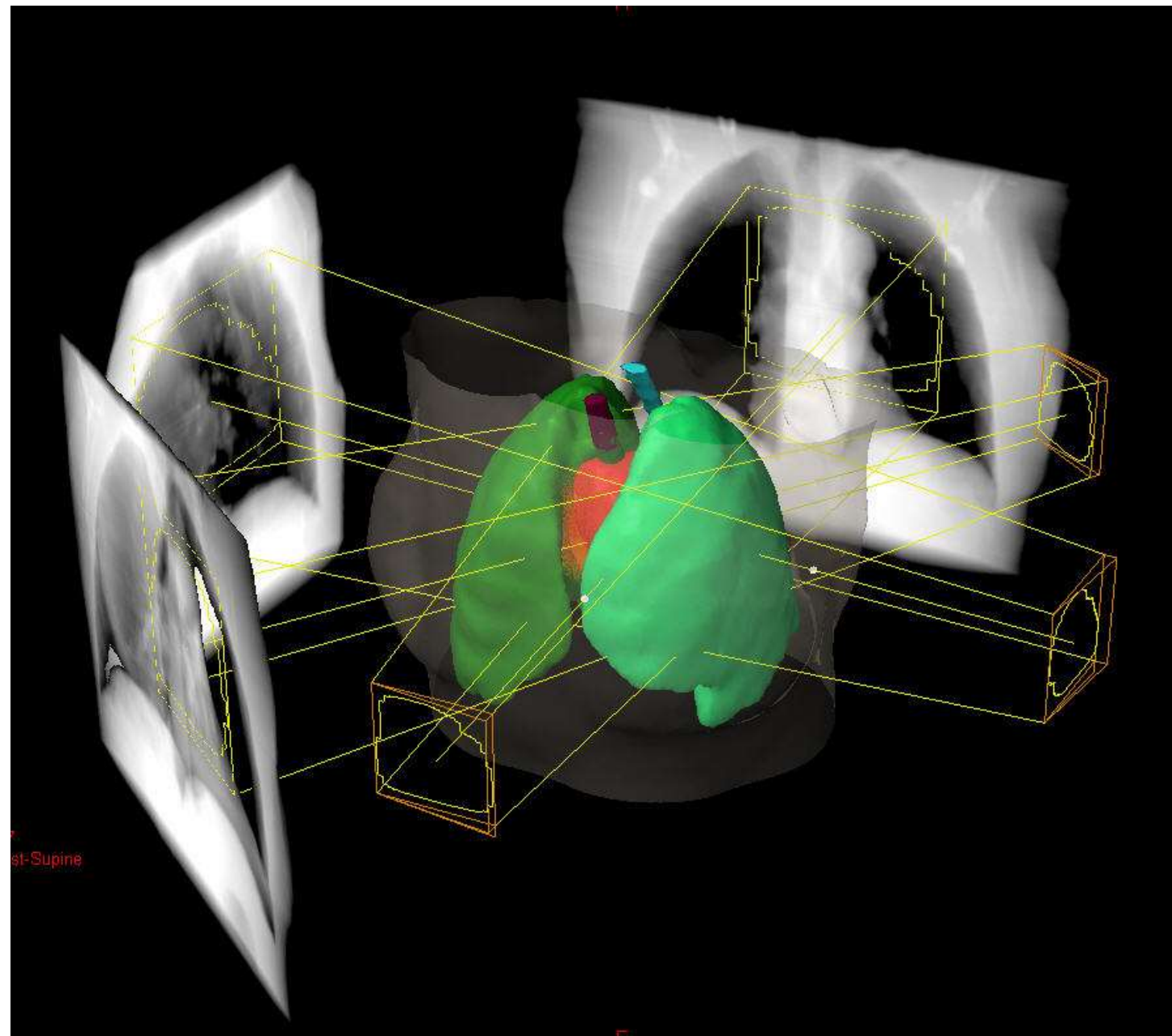
Medische Beeldvorming – Ct/ PETCt

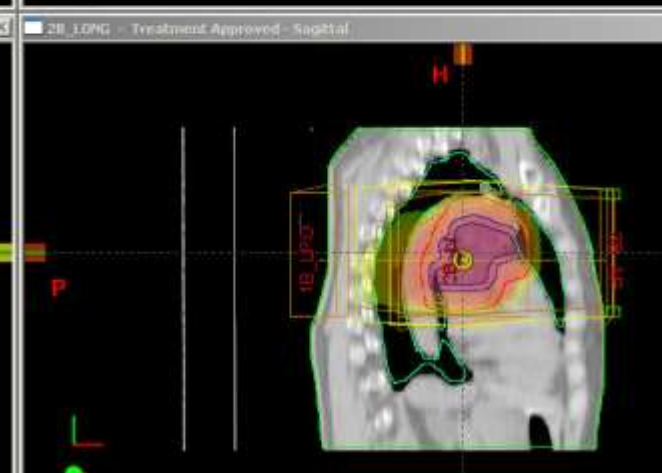
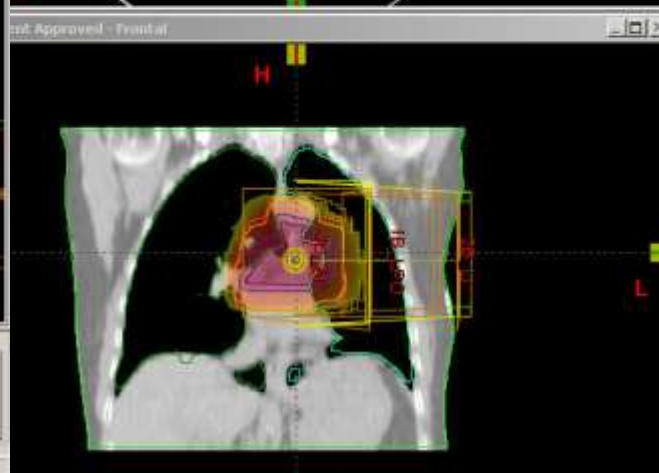
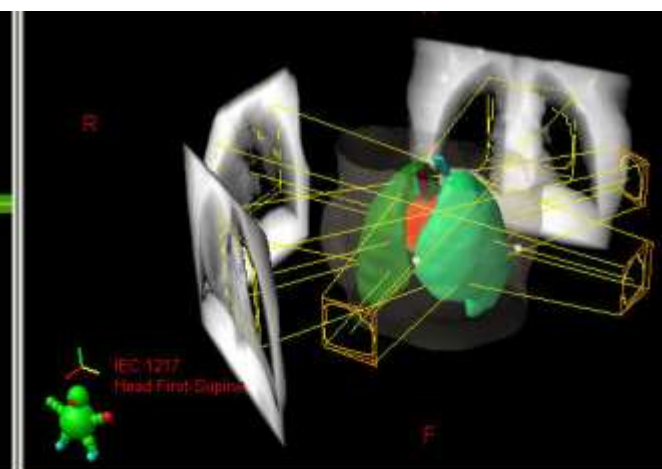
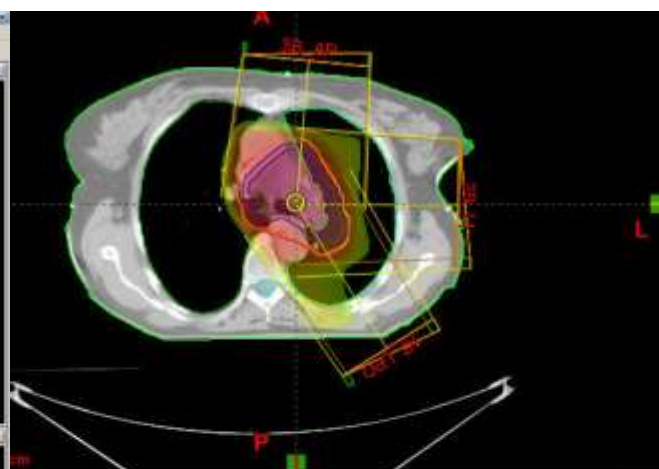
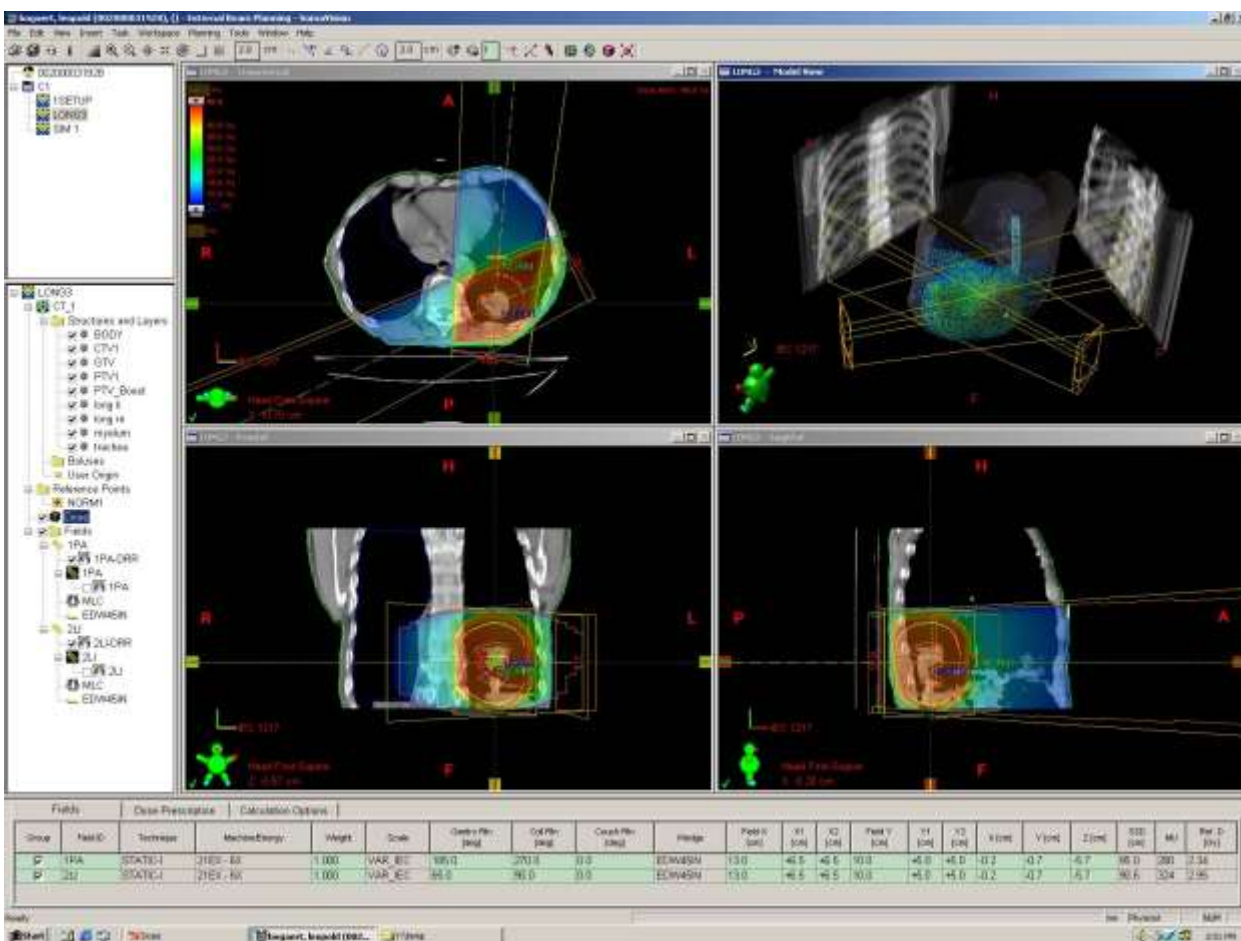








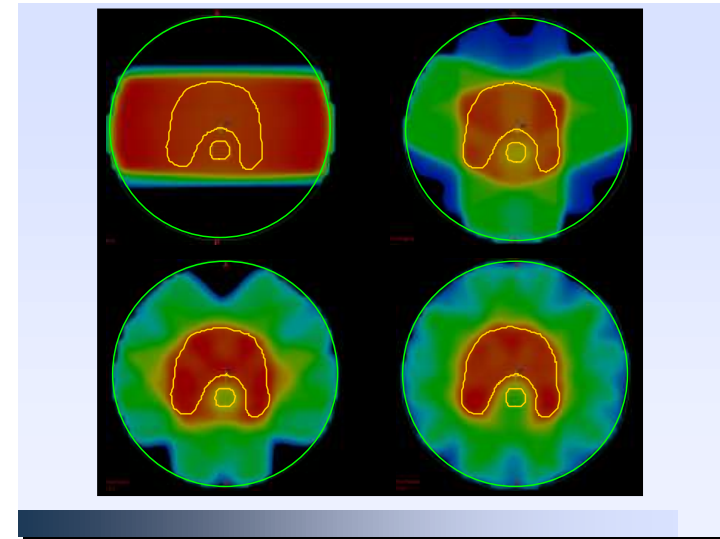
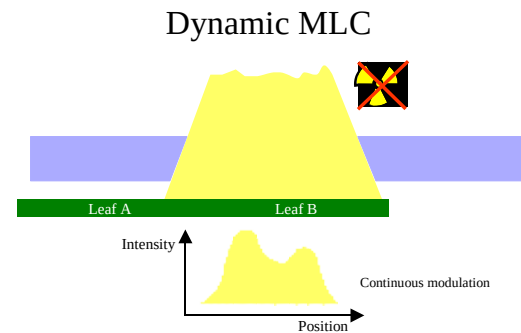
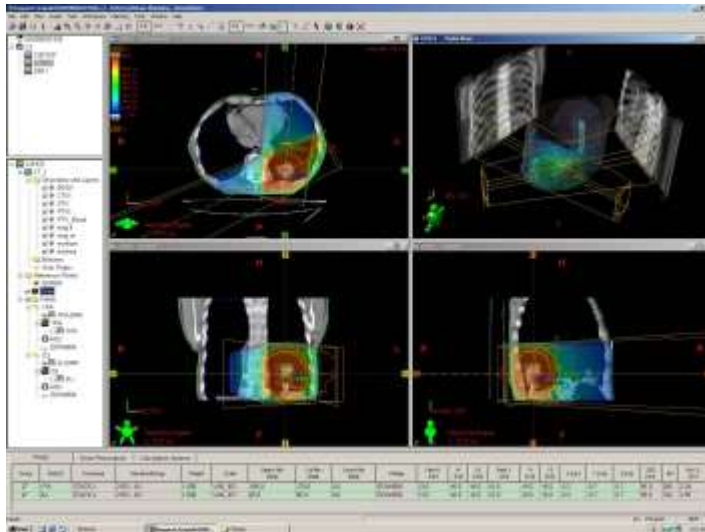




High dose involved radiotherapy

3D conformal radiotherapy

IMRT



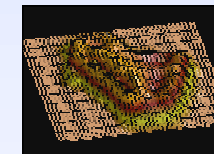
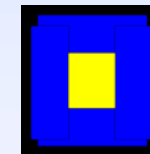
Introduction

IMRT = Intensity Modulated RadioTherapy

Restriction: IMRT with photon beams

IMRT: Highly conformal technique

Lateral fluence modulation: More degrees of freedom



RapidArc™ IMRT

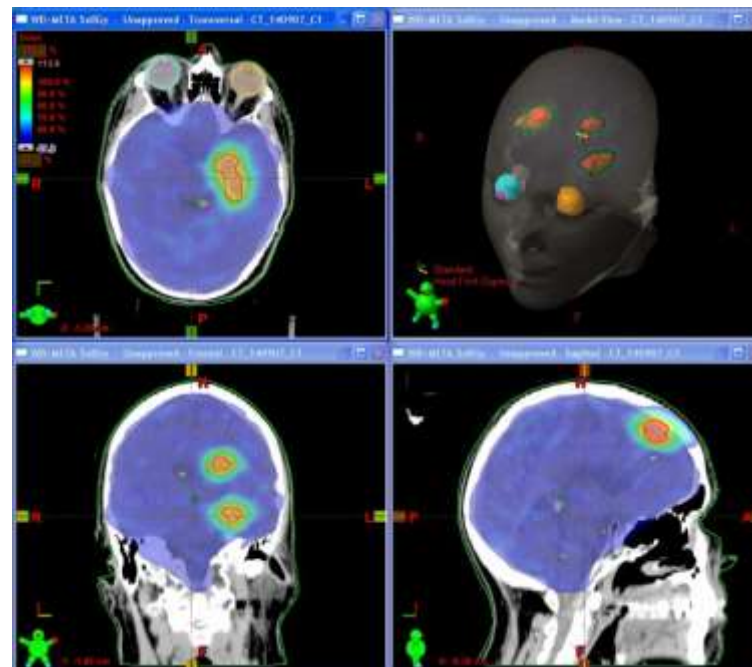
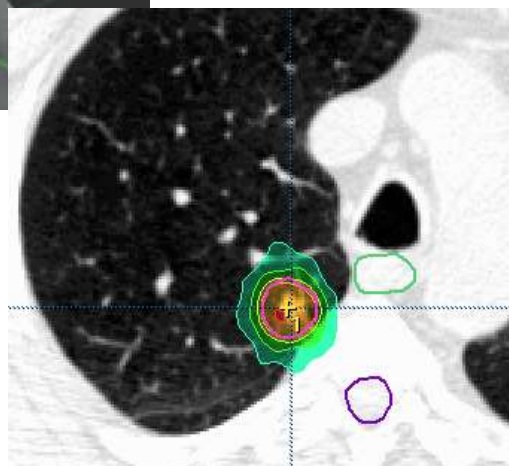
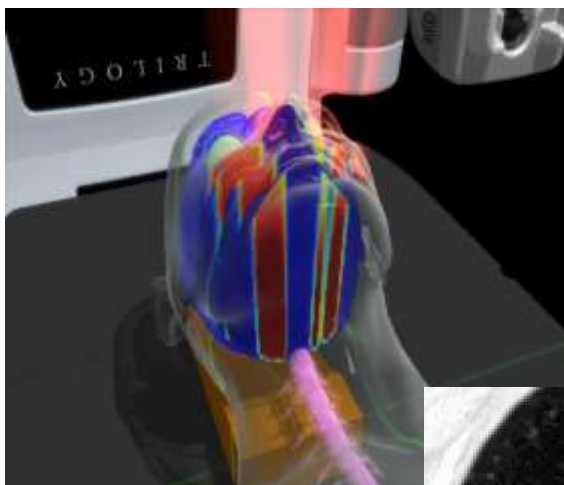
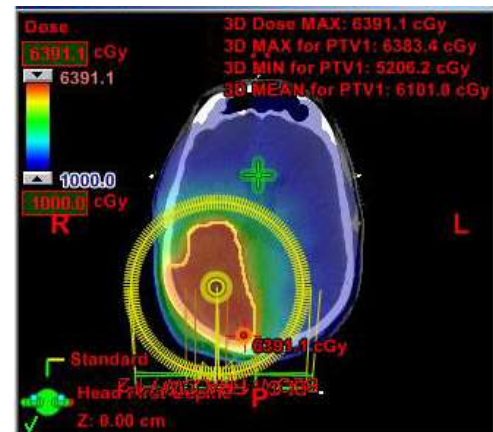
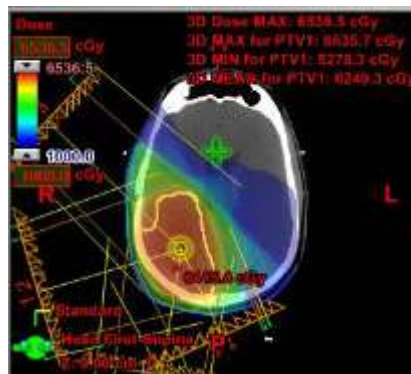
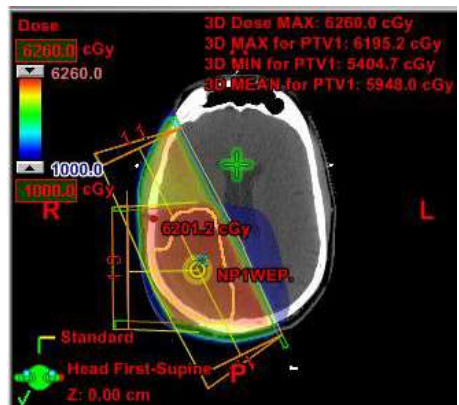


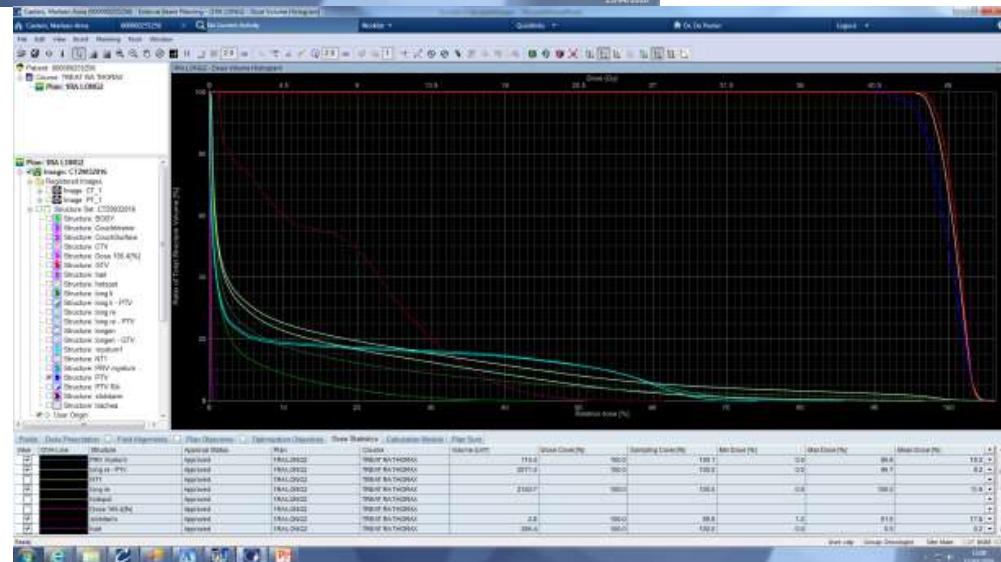
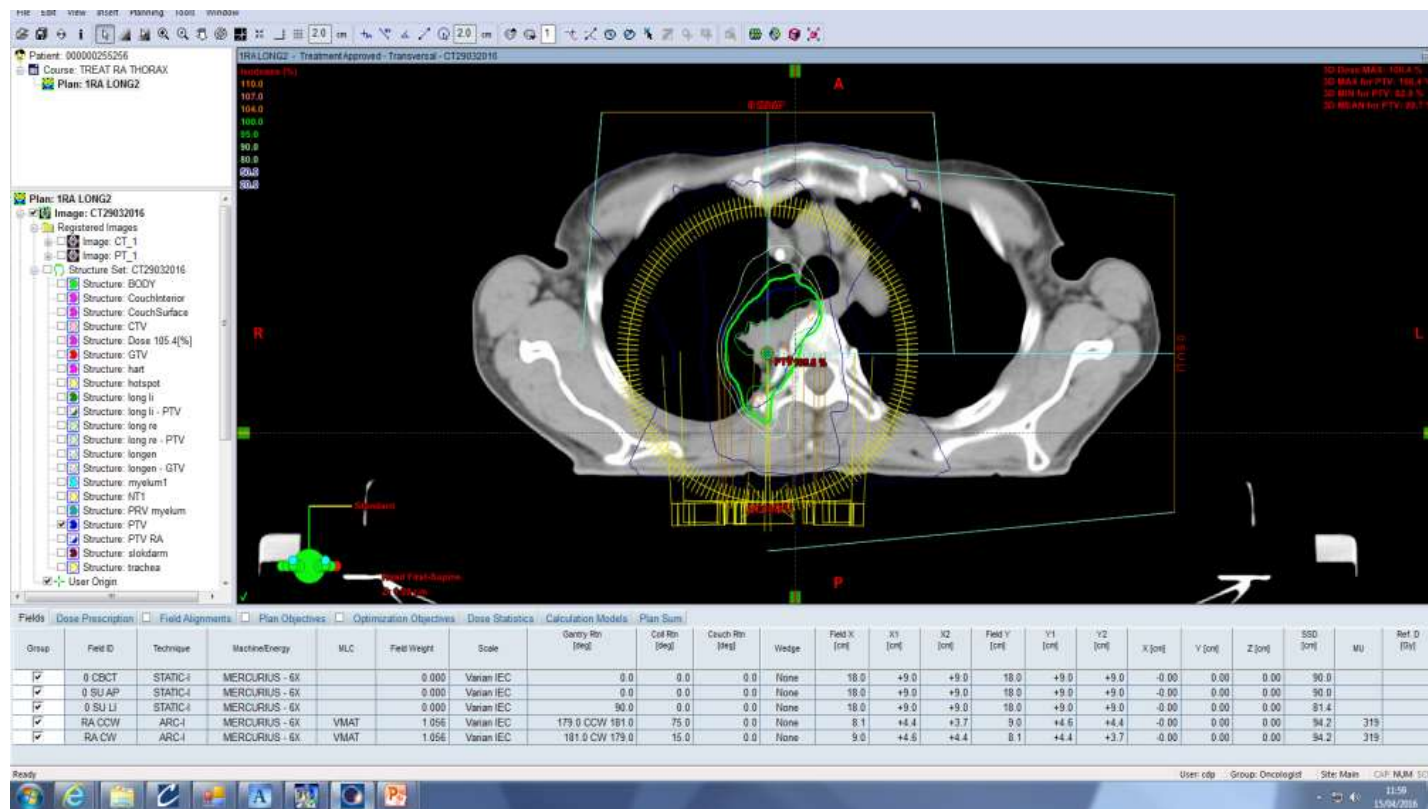
Zeer gelocaliseerde en gespecifieerde snellere
behandeling.

= image-guided, intensity-modulated radiation
therapy (IGRT/IMRT)

Een behandeling van vroeger 15-30 min wordt
voltooid in 2 min door een eenvoudige rotatie
van het toestel rond de patient

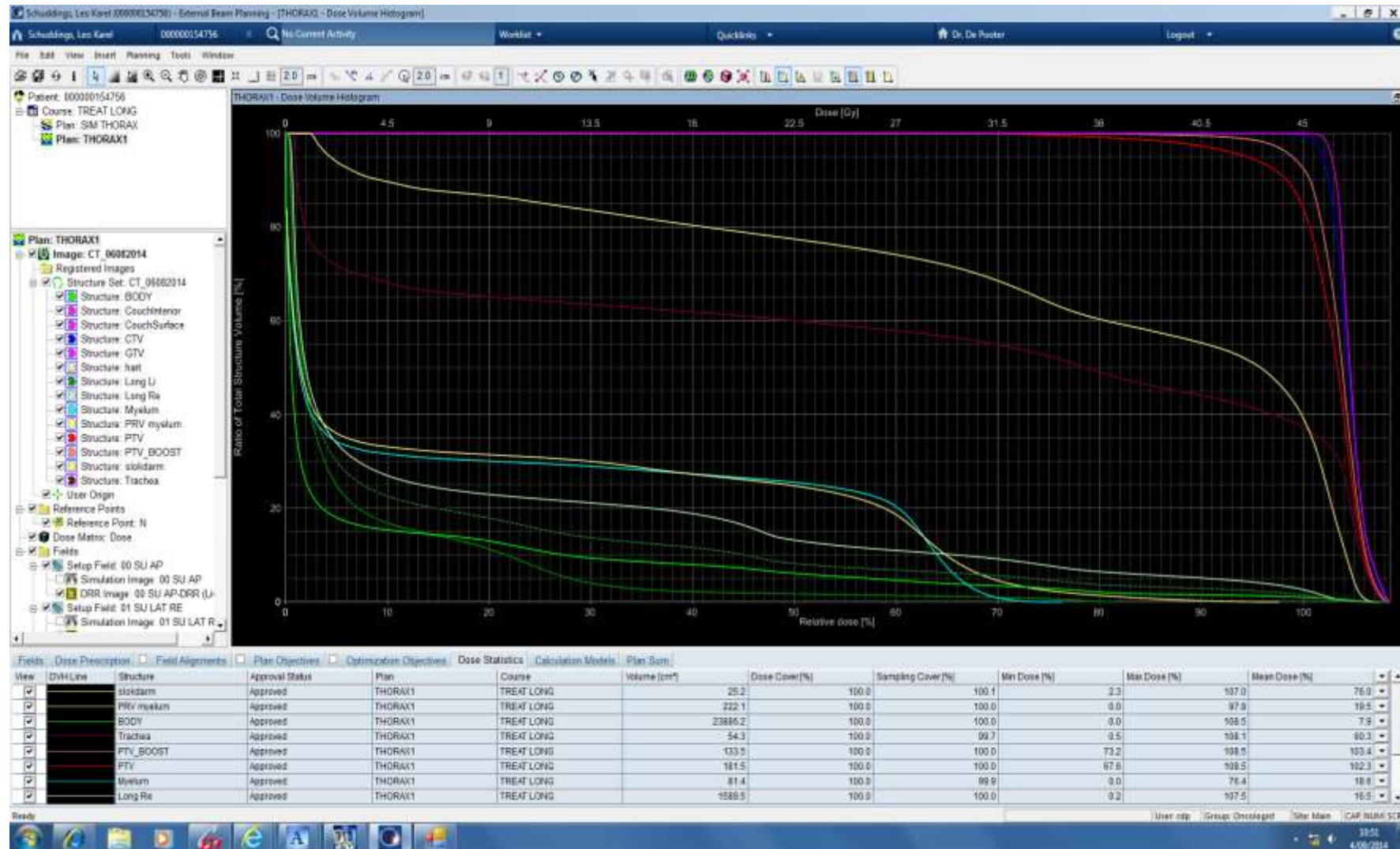
Positief voor de patient is een kortere
behandelingstijd en minder scattering van de
bestraling buiten de tumor in het omgevende
normale weefsel.







DOSISOPTIMALISATIE : DVH's

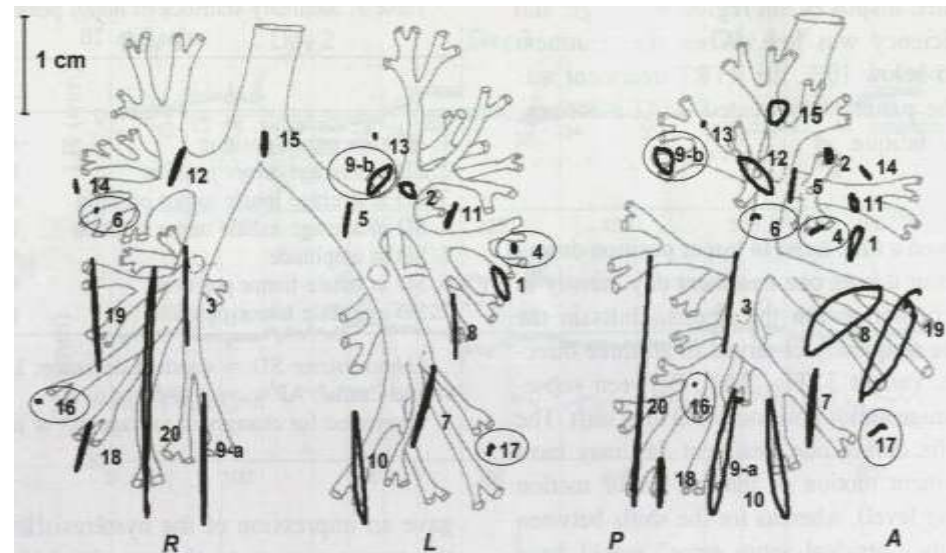




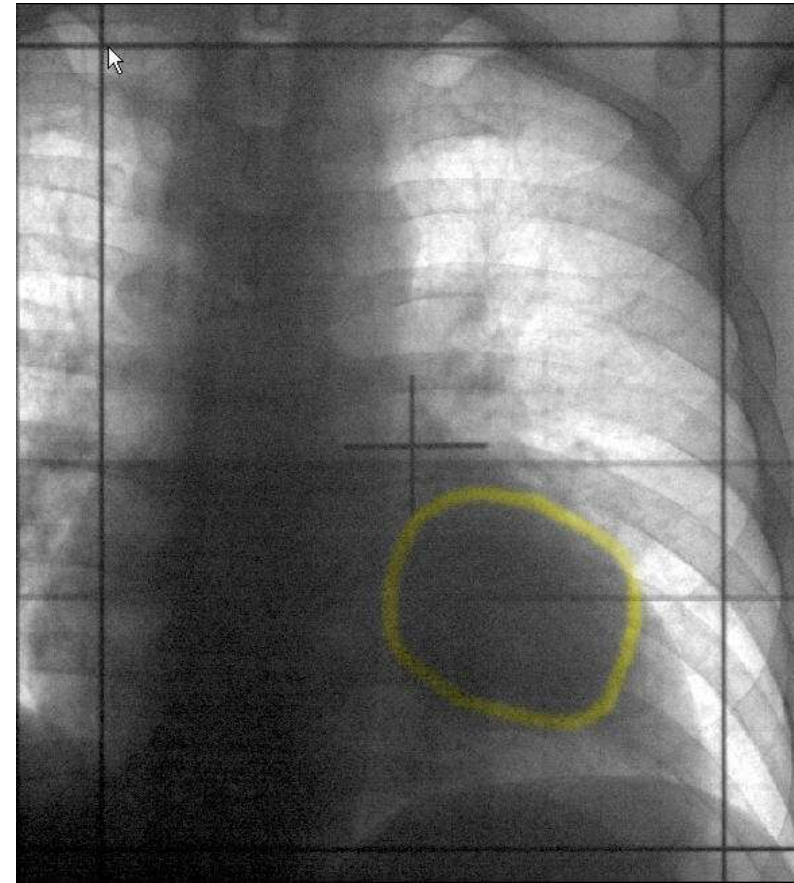
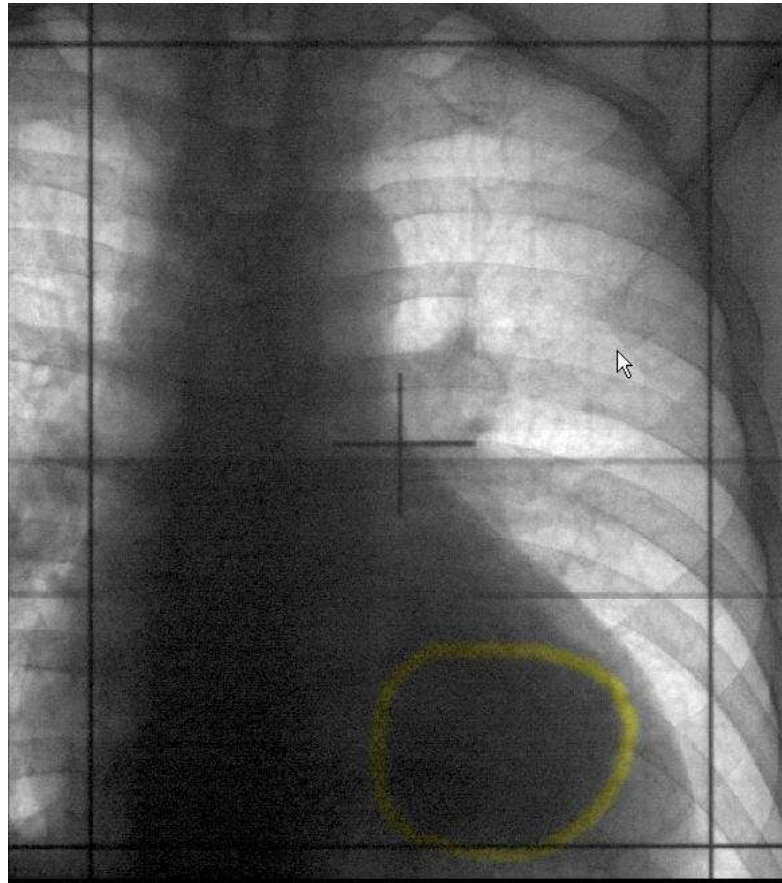


Definitie van het Doelvolum

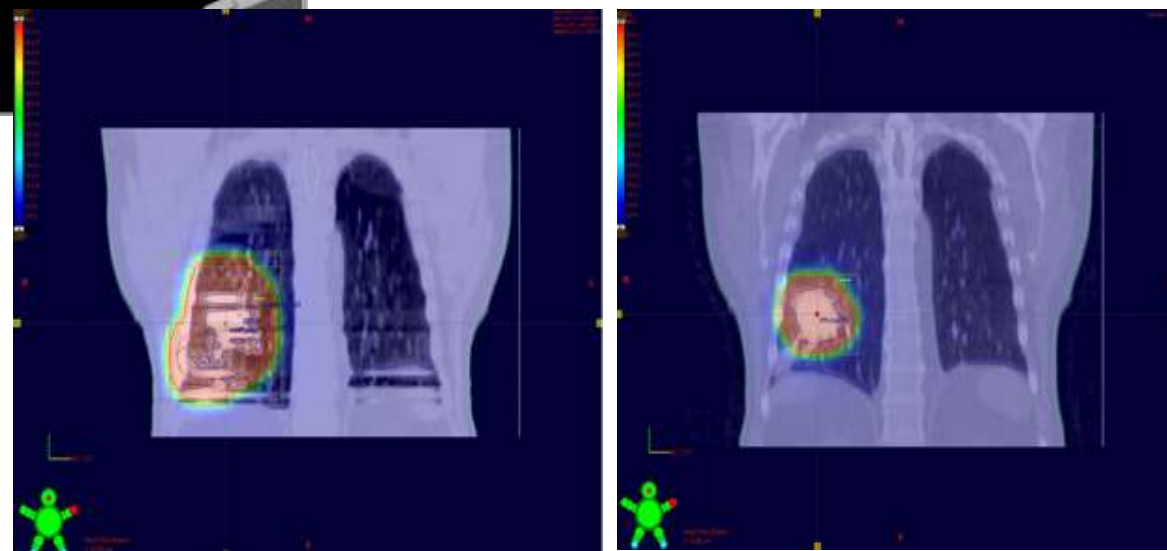
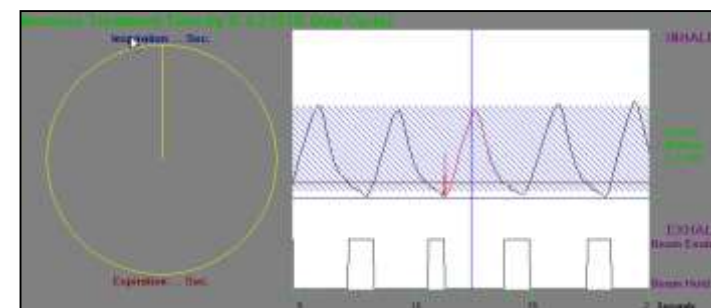
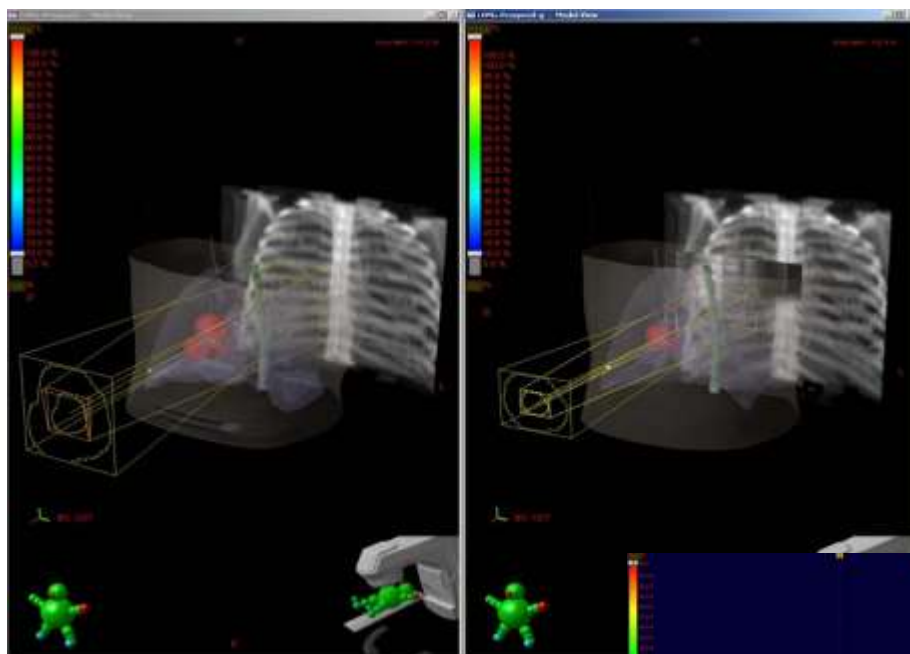
- **Beweeglijkheid van de tumor**
- Uitgesproken beweeglijkheid van long tumoren gedurende een normale ademhalingscyclus: onnodig groot PTV
- Curran et al.
 - Tumor beweging: 3 – 5 cm
 - 30% onderdossage
 - Ct evaluatie : tumor niet zichtbaar in 20%



Beweeglijkheid van de tumor

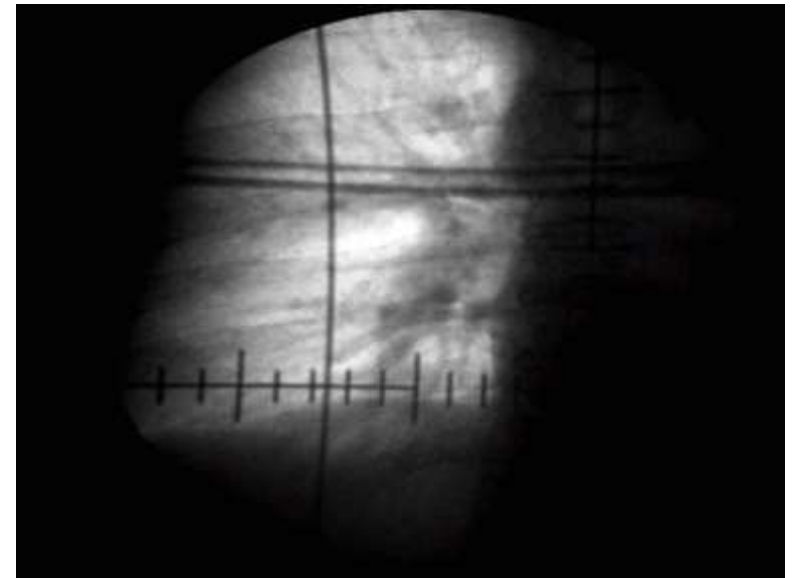
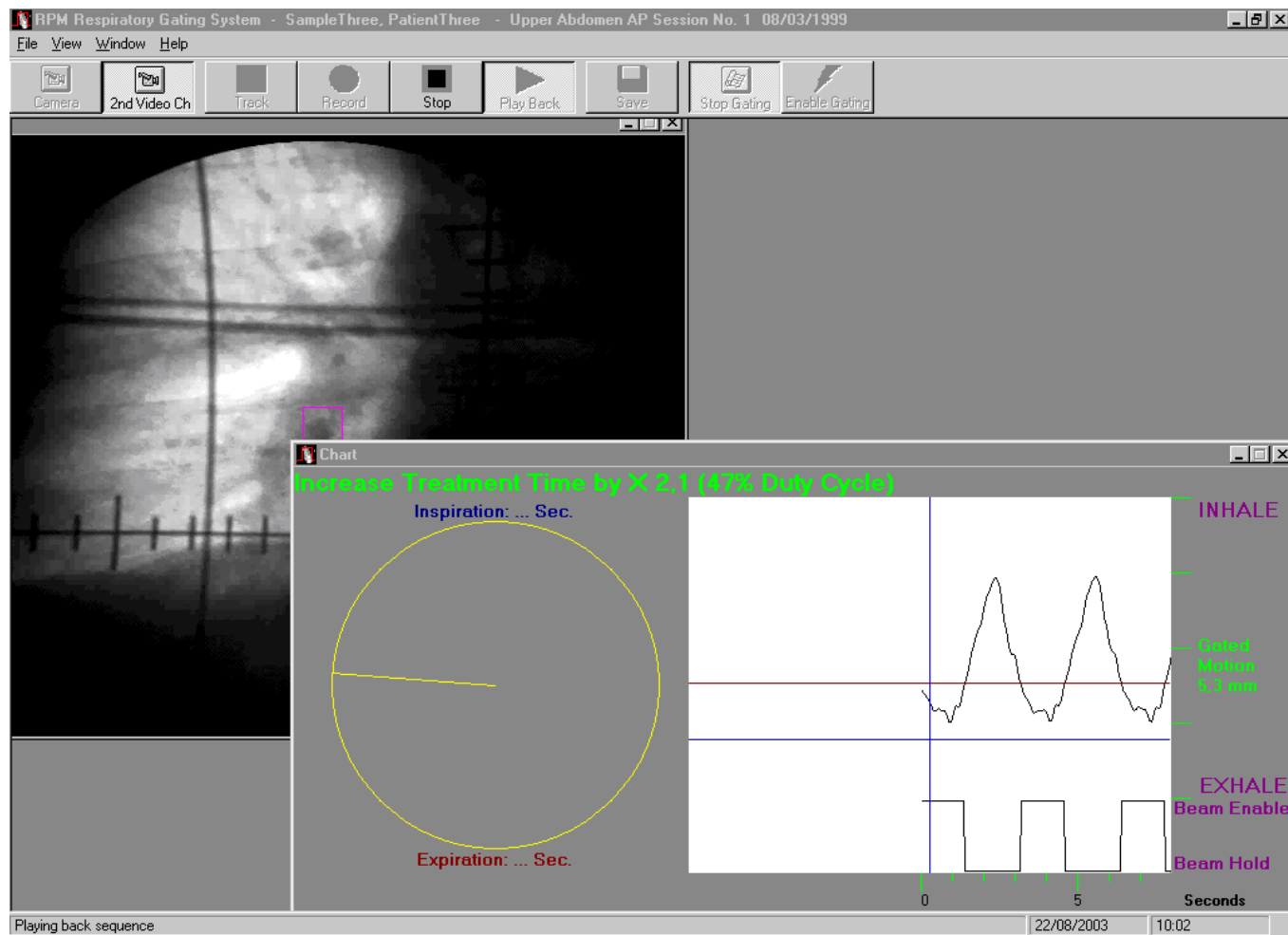


4-dimensionele radiotherapie



Radiotherapie –Behandelung “Motion control”

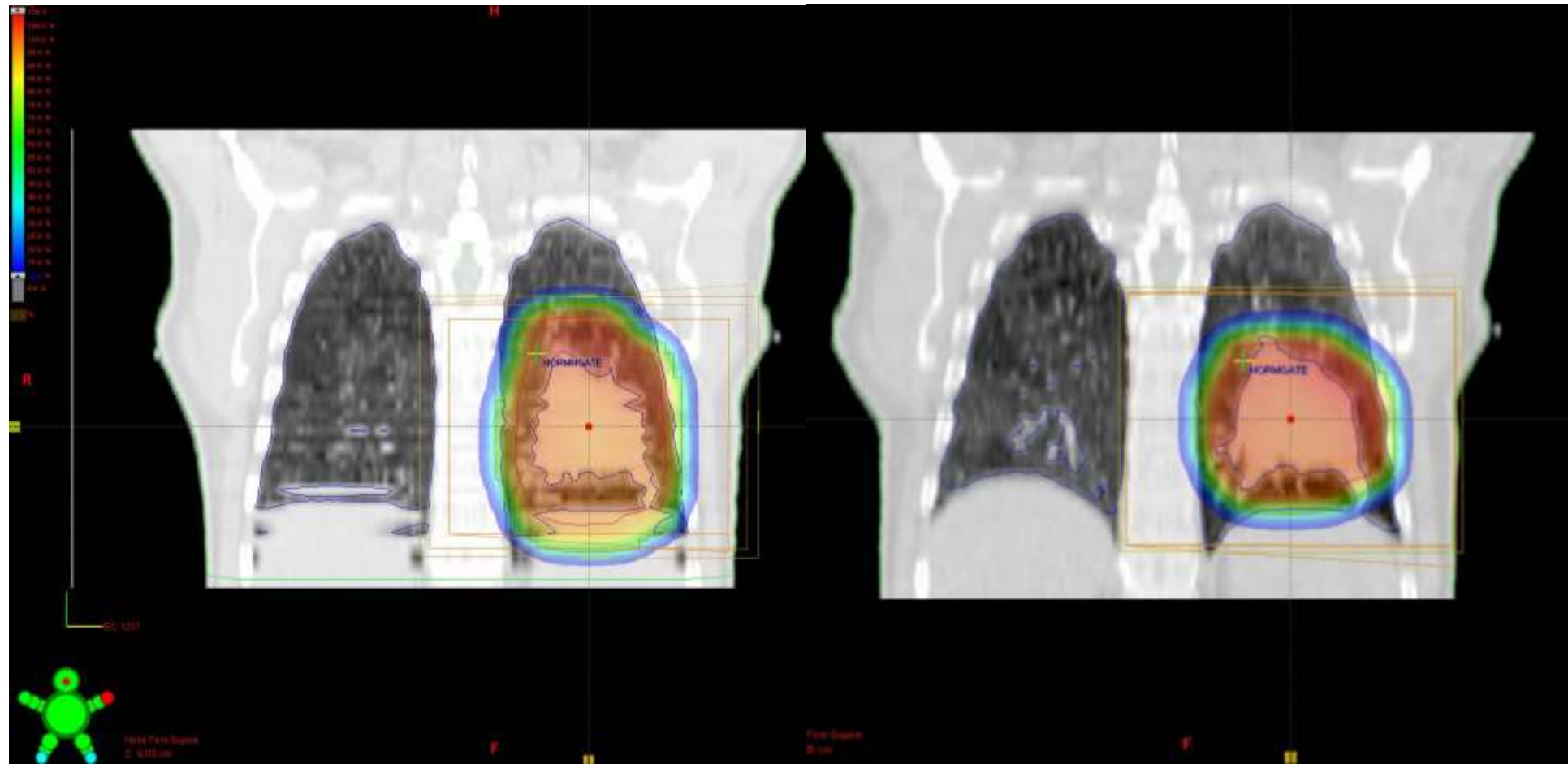
- “Respiratory Gating”



Isodose distributie

non-gated

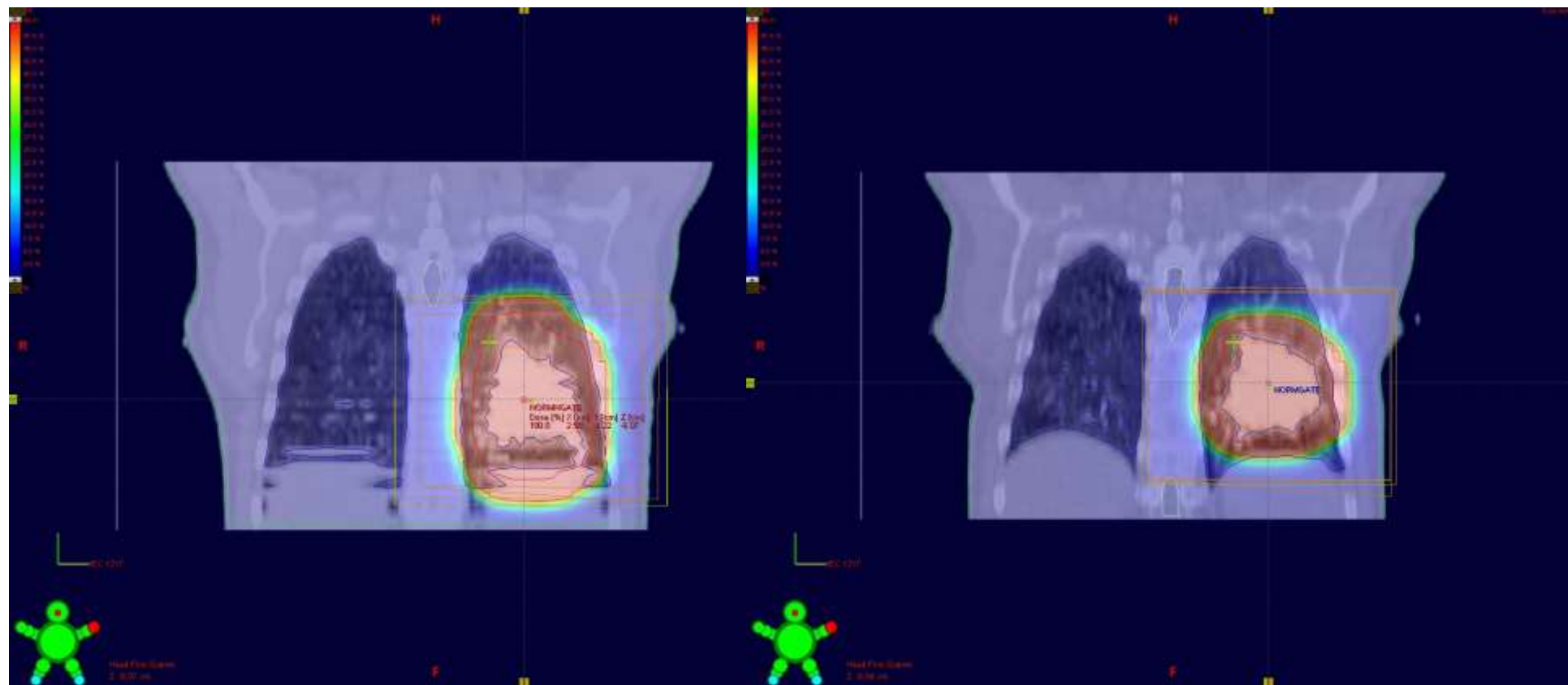
gated



V20 longtoxiciteit

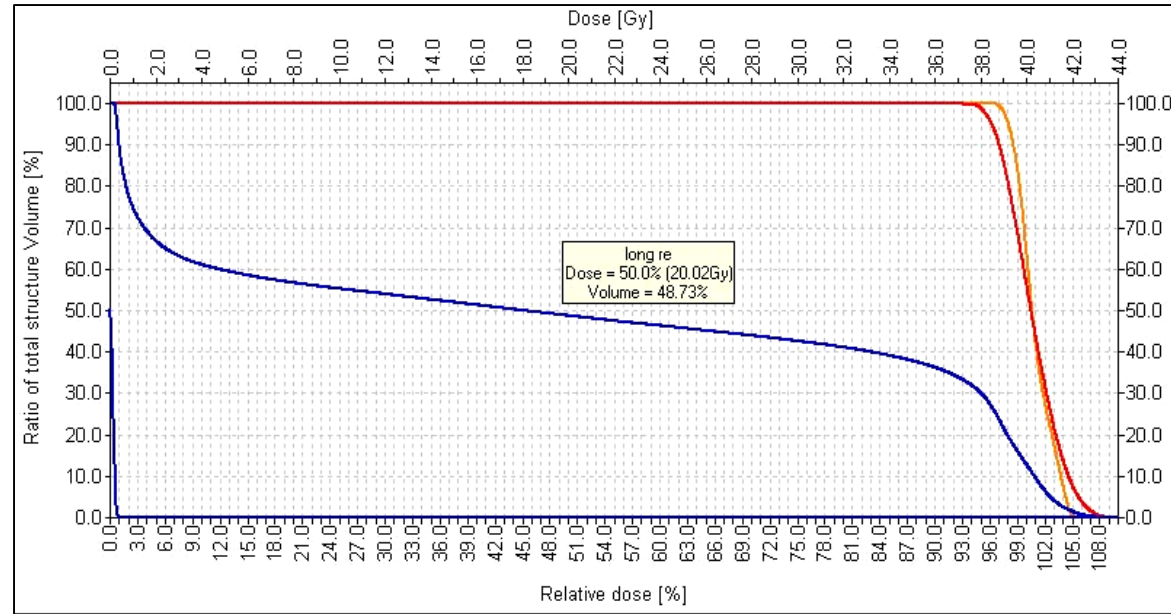
non-gated

gated

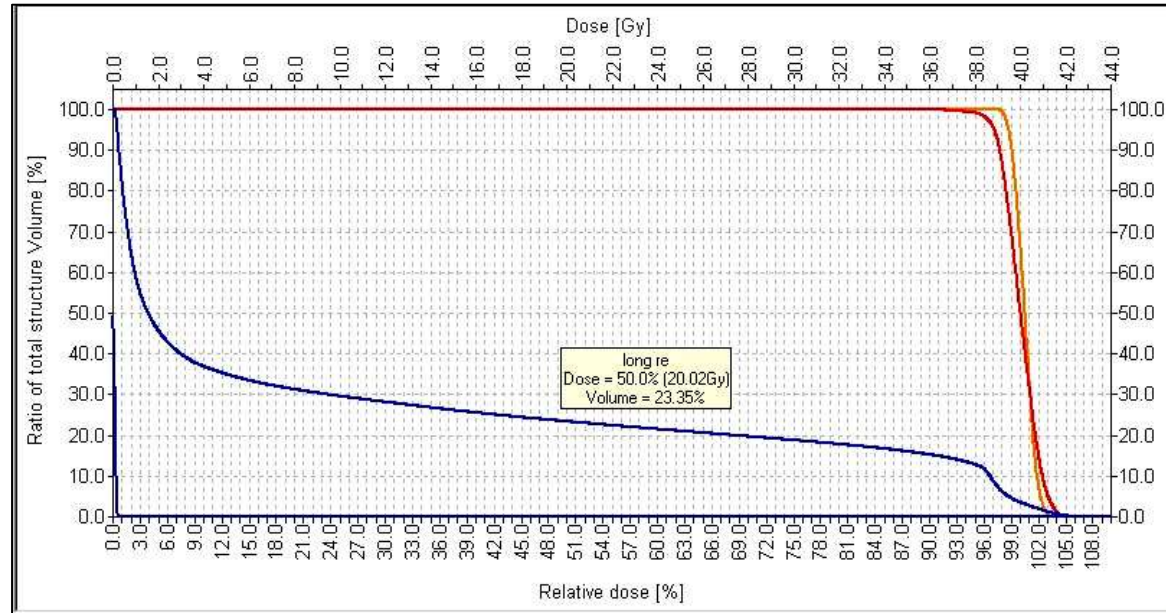


Dose Volume Histograms

- non-gated

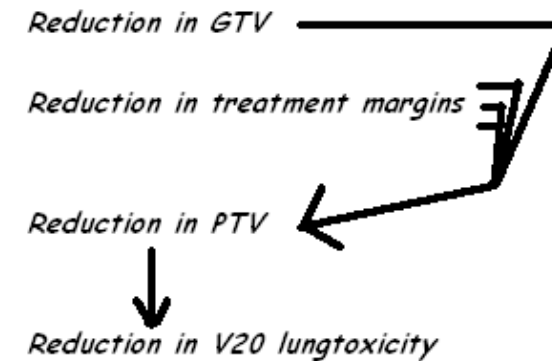
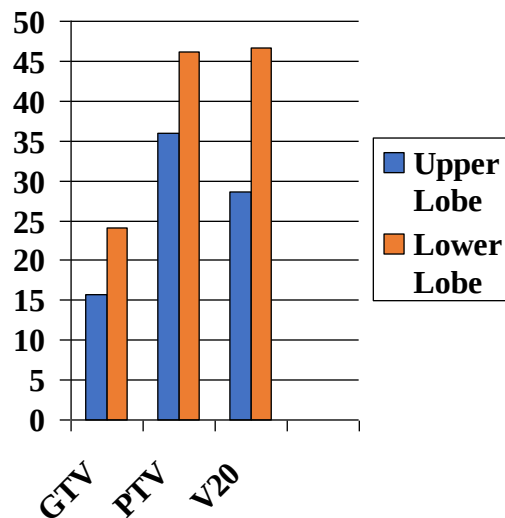


- gated



% Reductie in volume van GTV, PTV en V20 longtoxiciteit door RPM gating.

	GTV	PTV	V20
Upper Lobe	15.7 %	36.0 %	28.5 %
Lower Lobe	24.1%	46.2 %	46.7%



Kontrole van de Bestraling :

EPID : Portal imaging

CBCT: Cone Beam Ct

IGRT : On Bord Imaging

- **EPID/CBCT/IGRT is considered to be necessary in order to justify field localizations and to avoid a geographical miss. (Senan)**

EPID

File Edit View Insert Measure Matching Review Tools Help

Blended: 1PA-DRR - 1PA-4_1_1 - 03/04/2008 09:35

S1 - 1PA - 1PA-DRR - 27/03/2008 13:04 - 180 deg

S1 - 1PA - 1PA-4_1_1 - 03/04/2008 09:35 - 180 deg

H L R F

H L R F (ast 03/04/2008 11:31) ✓

Summary: Images (2 App) / Couch Corrections (VAR_IEC scale)

	1PA-4_1_1	2AP-3_1_2
Status	✓	✓
Lat [cm]	-0,2	0,2
Lng [cm]	0,0	0,0
Vrt [cm]	0,0	0,0
Rtn [deg]	0,0	0,0

1LONG

Patient alert from ast, display date 21/04/2008

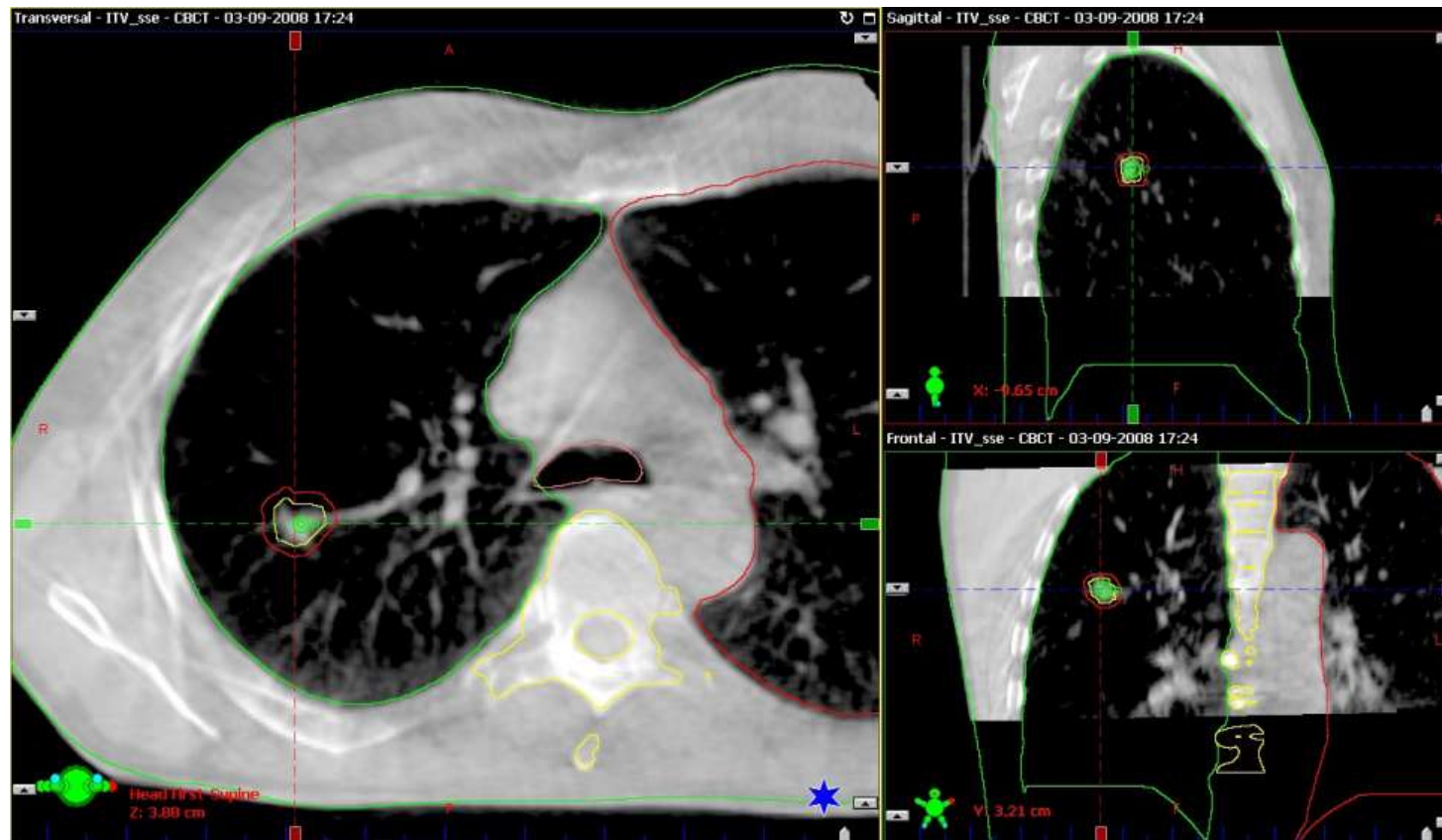
Status: Read Signed off date: 22/04/2008 13:25 Signed off by: ero

Created 21/04/2008 20:39, based on session 21/04/2008:
okas

Alert 1 of 2 New Alert...

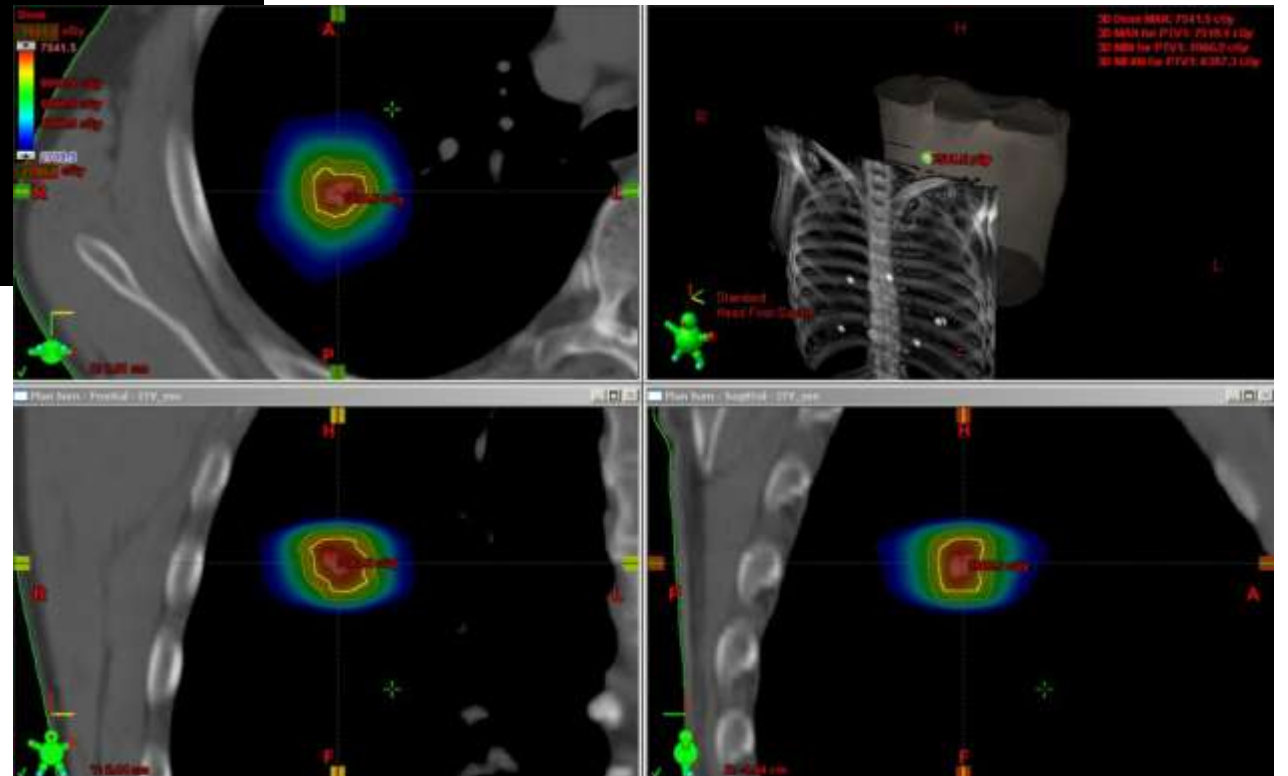
Session 1, do 03/04/2008, Image 1 of 2

Patient-setup using cone beam CT : CBCT





Radiochirurgie



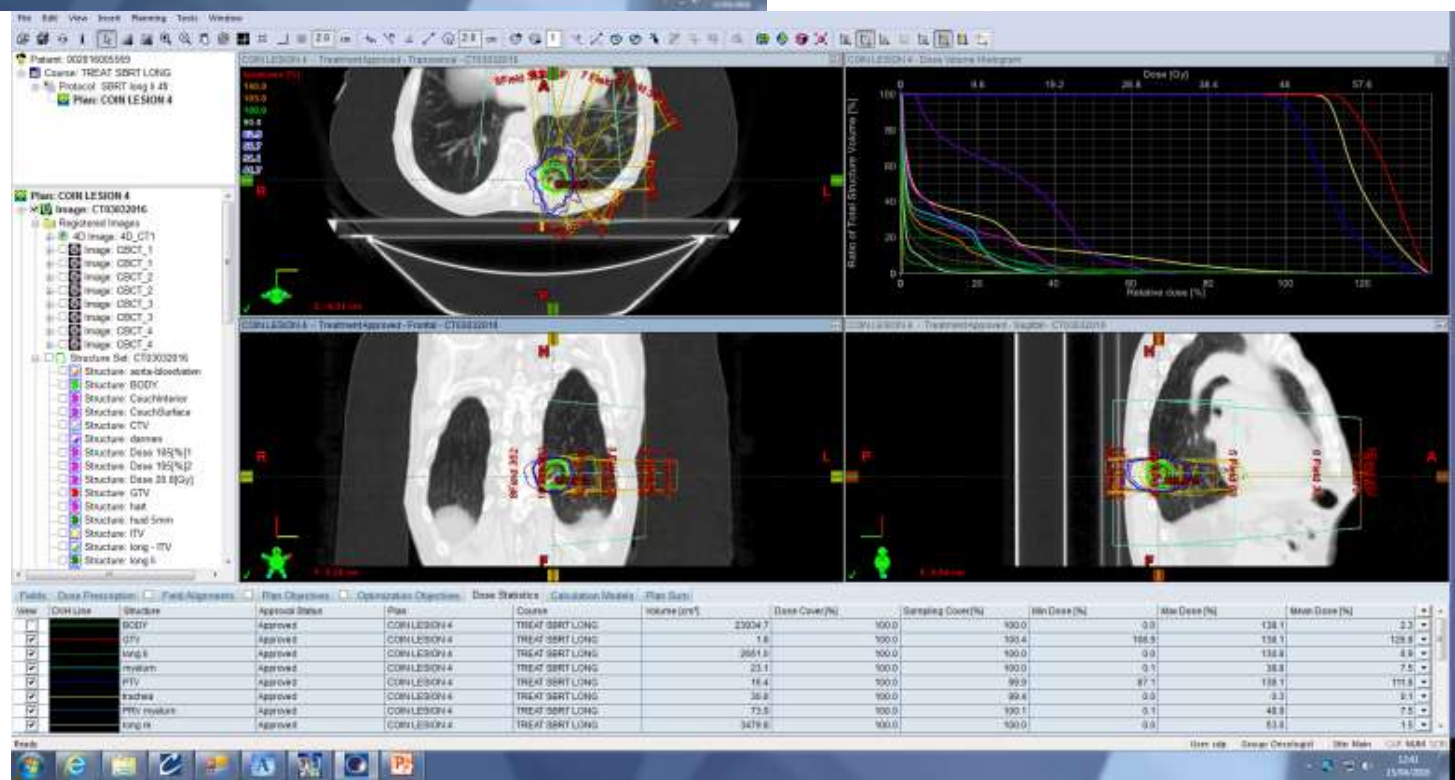
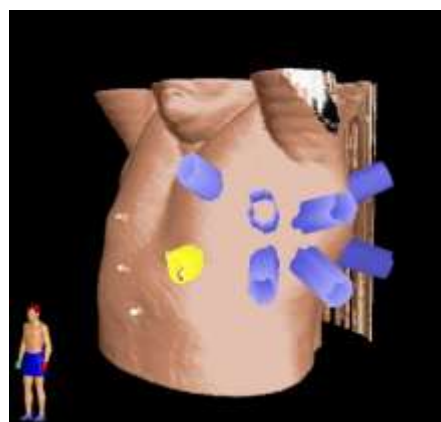
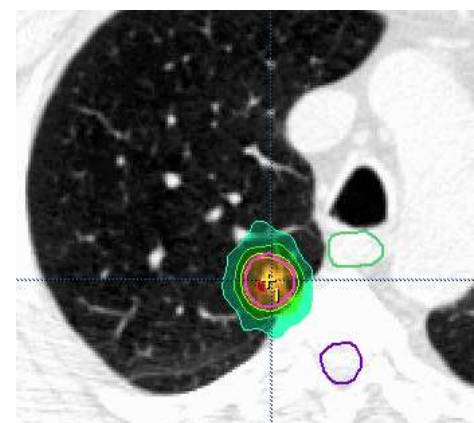
Stereotactische radiochirurgie

- Stereotactische radiochirurgie is een nog meer doorgedreven precisieradiotherapie
- In een beperkt aantal bestralingsfracties wordt een heel hoge dosis op een beperkt volume met krappe marges toegedoend.
- Voor Longtumoren :

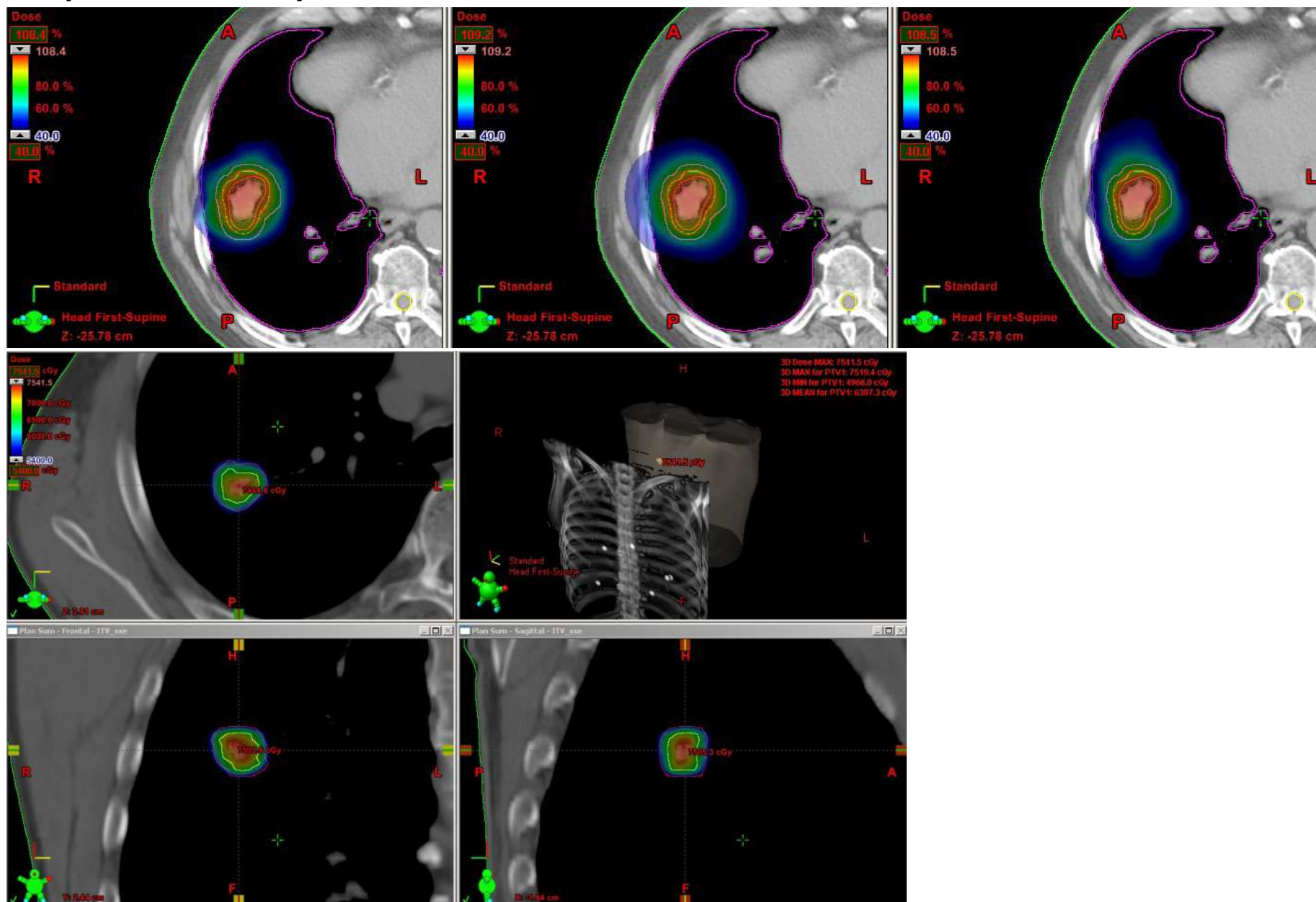
Studies tonen aan dat voor kleine longtumoren (Stage IA-B NSCLC) de lokale controle en overleving vergelijkbaar zijn met deze van een heekundige ingreep (Senan).

De resultaten zijn vooral van belang voor de groep van patiënten van 75 jaar of ouder. Slechts een op de drie van hen kan immers geopereerd worden, en traditionele bestraling is voor de niet-operabele groep meestal te belastend.

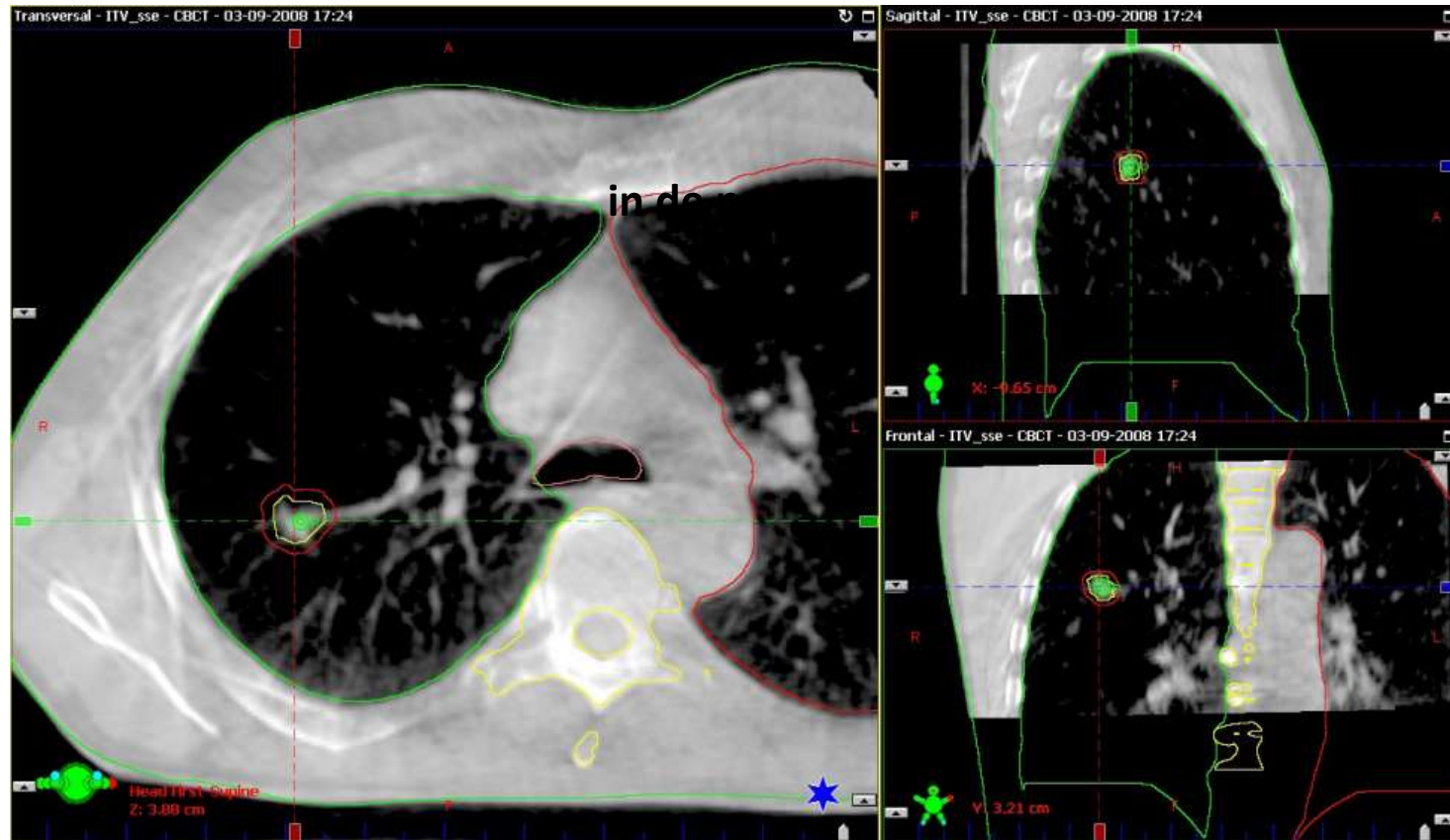
In de praktijk werd vroeger daardoor 40 procent van deze patiënten direct opgegeven.



Rapid Arc - Dynamic conformal arc



Patient-setup using cone beam CTVU



Local, regional & distant failure

Actuarial local failure:

- @1 year: 3%
- @2 year: 8%
- @3 year: 11%
- Crude LF 3% (N=11)
- Med. time to LF 12 mos

Actuarial regional failure:

- @1 year: 6%
- @2 year: 16%
- @3 year: 16%
- Crude RF 8% (N=26)
- Med. time to RF 8 mos

Actuarial distant failure:

- @1 year: 12%
- @2 year: 25%
- @3 year: 34%
- Crude DF 14% (N=48)
- Med. time to DF 8 mos



Toxicity

• Acute:

- No toxicity 51%
- Fatigue 31%
- Chest pain 12%
- Nausea 9%
- Dyspnea 6%
- Cough 6%
- Erythema 2%
- Hemoptysis 1%
- Palpitations 1%

Chronic:

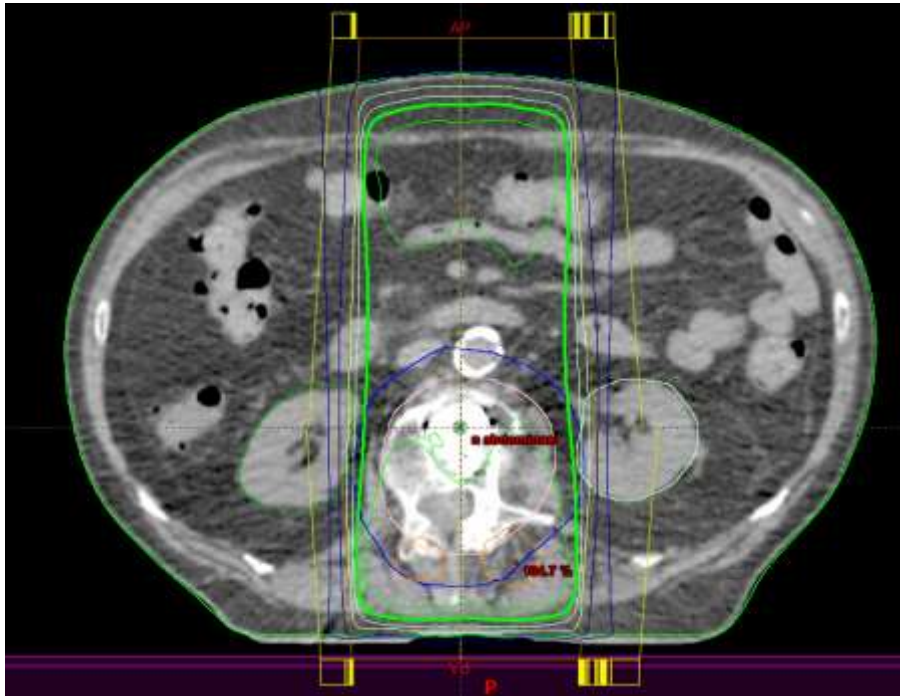
- Radiation pneumonitis 9(3%)
- Thoracic wall pain 6 (2%)
- Rib fracture 4 (1%)
- Pleural effusion 4 (1%)
- Atelectasis1 (1%)

Toepassing

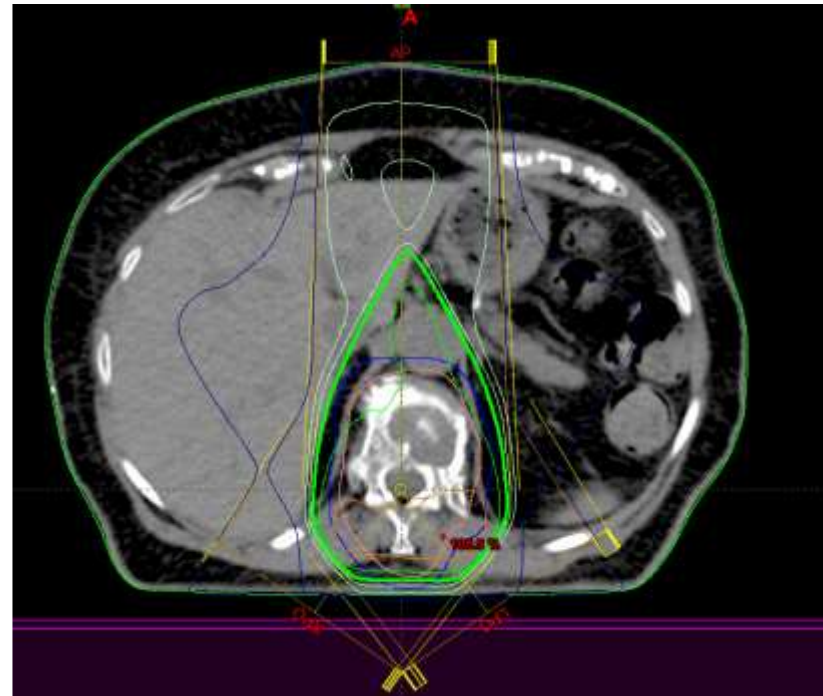
- in de gemetastaseerde setting

- Kanker is meer een chronische ziekte geworden
- Nieuw behandelingsconcept van oligometastatische ziekte

Conventional RT: 1x 8.0 Gy, 5x 4.0 Gy, 13x 3.0 Gy,...

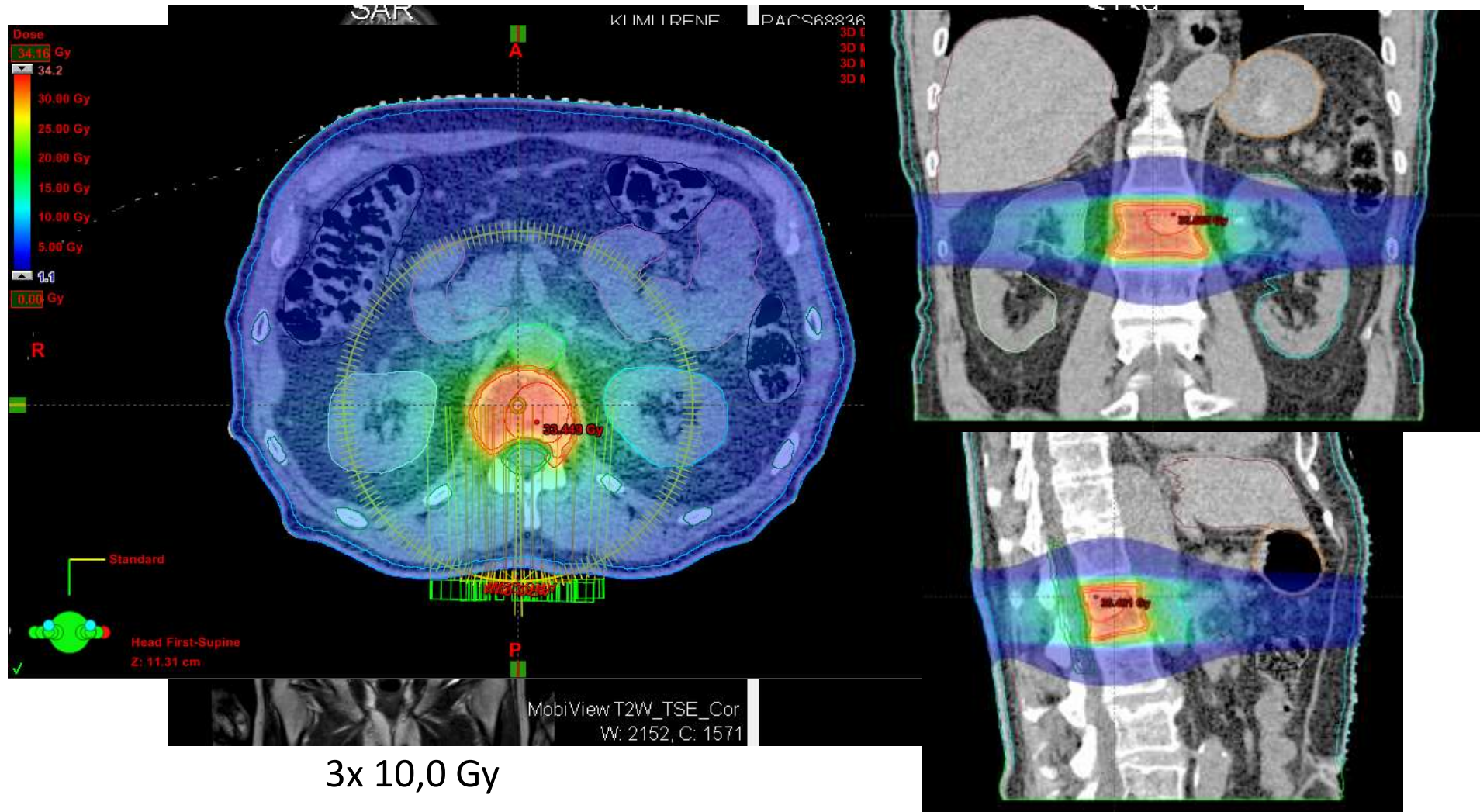


Two fields: AP-PA.



Three fields: inverted Y.

Stereotactic ablative radiotherapy (SABR).



“Uranus”

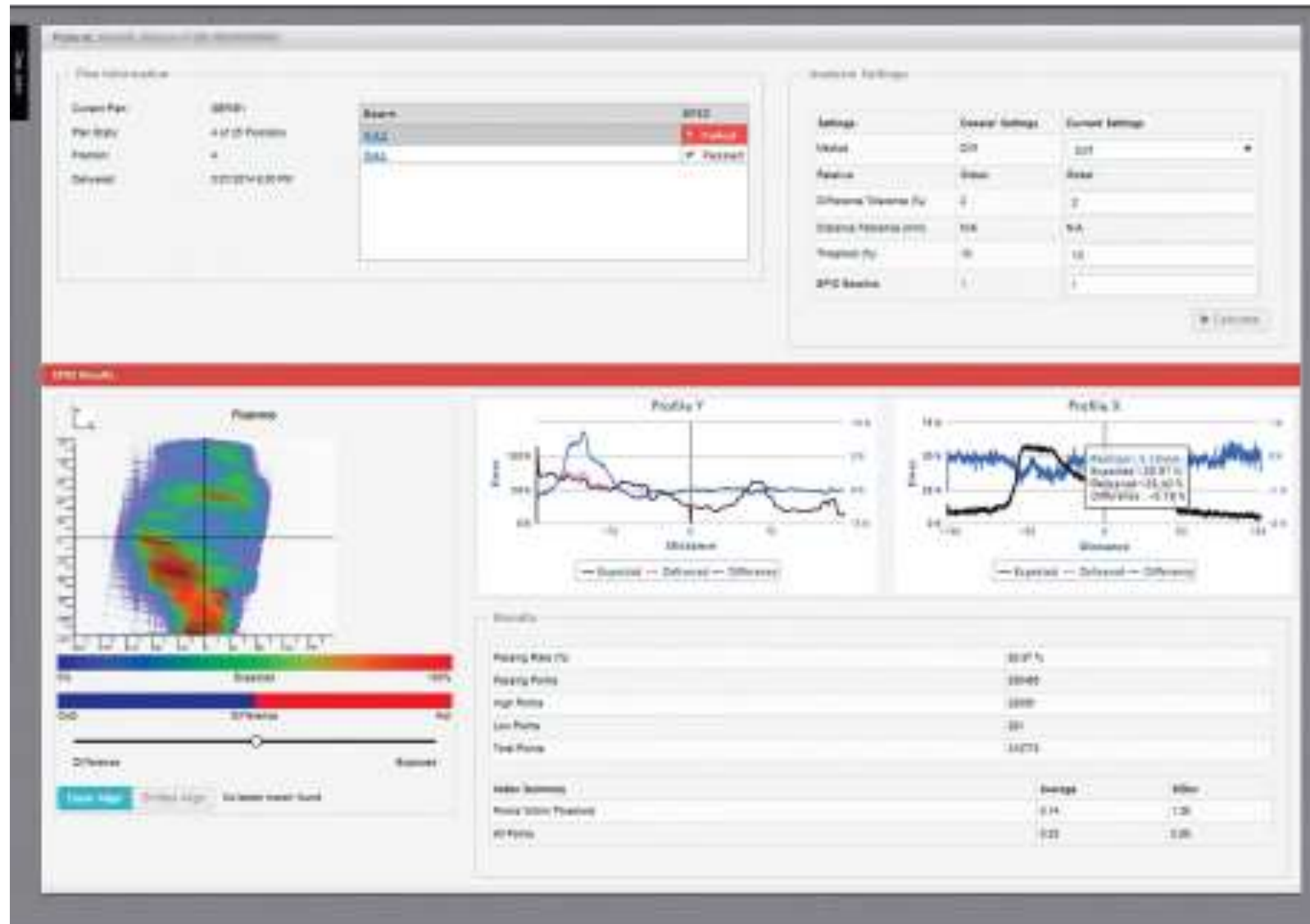


Optical Surface Monitoring System : OSMS





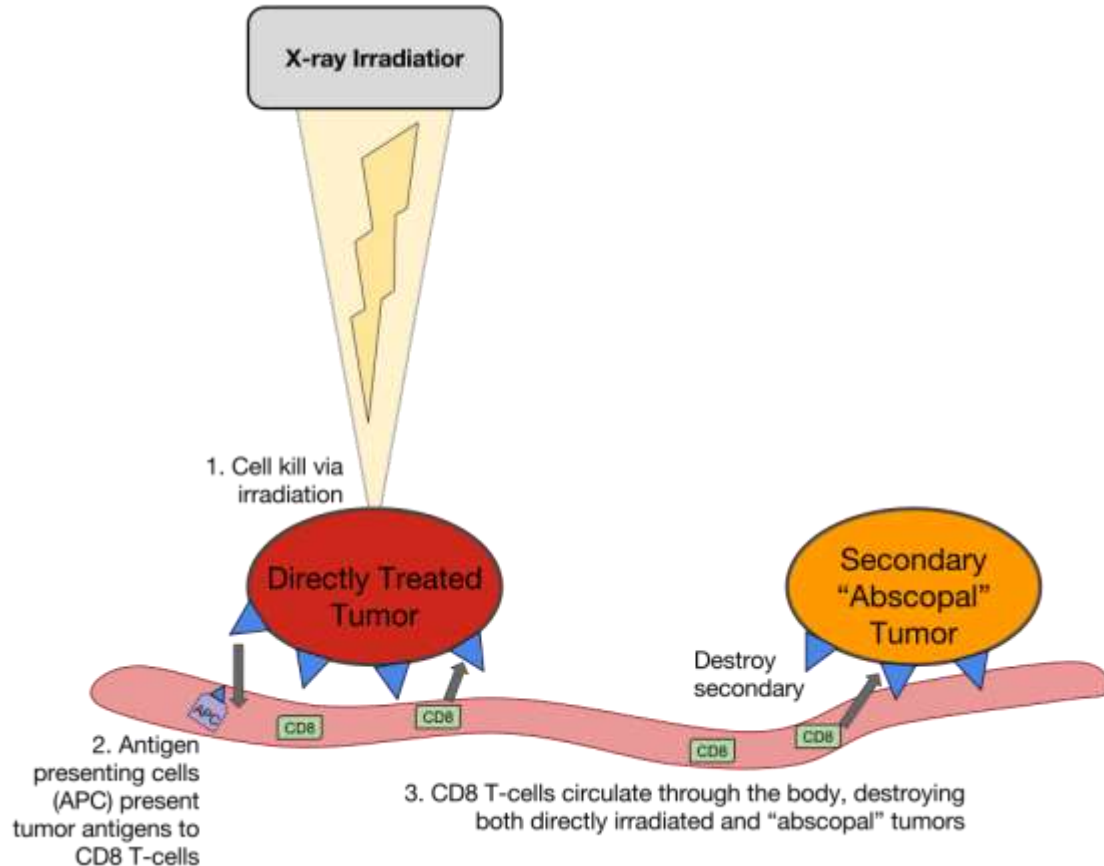
DoseCHECK & PerFRACTION



“Combined modality approaches”

- **Nieuwe radiotherapie technieken**
- **Combinatie met heelkunde : pre- en postoperatieve setting**
- **Combinatie met chemotherapie, targeted therapie, immunotherapie : sekventiëel , concomitant**
- **“Response adapted therapy”**
- **“Tailor multimodality treatment”**
- **Supportive care**

Abscopal effect of Radiotherapy

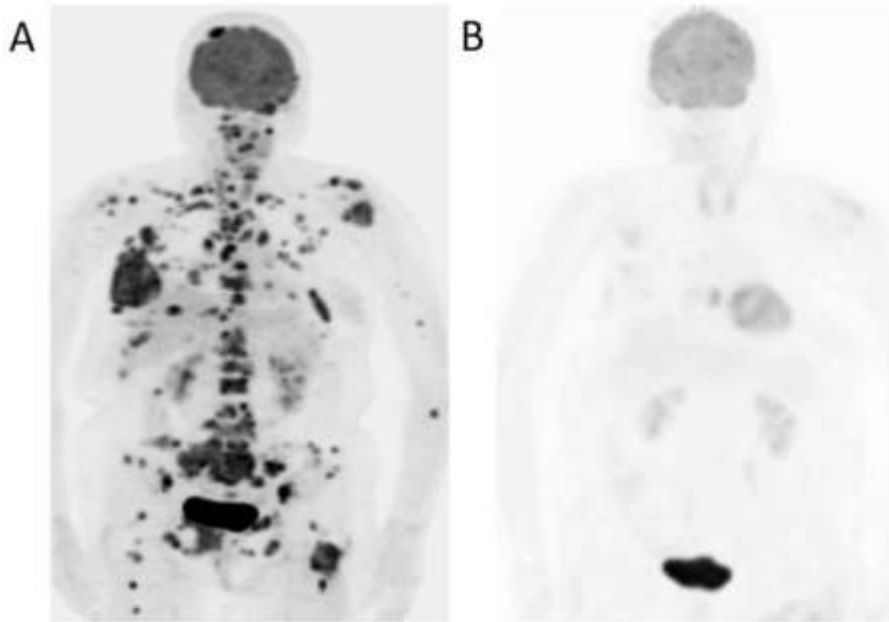
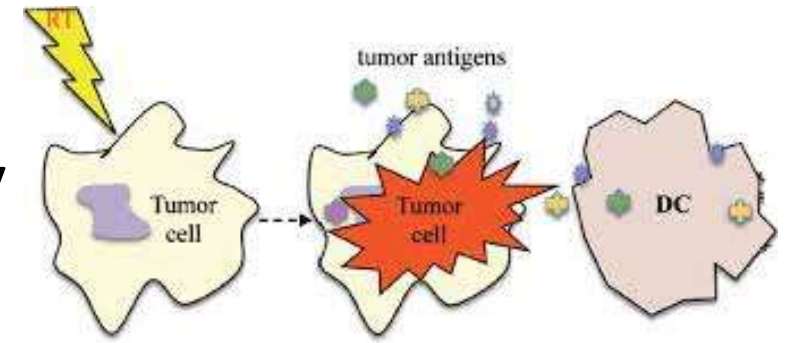


Shrinkage of untreated tumors occurs concurrently with shrinkage of tumors within the scope of the localized treatment.

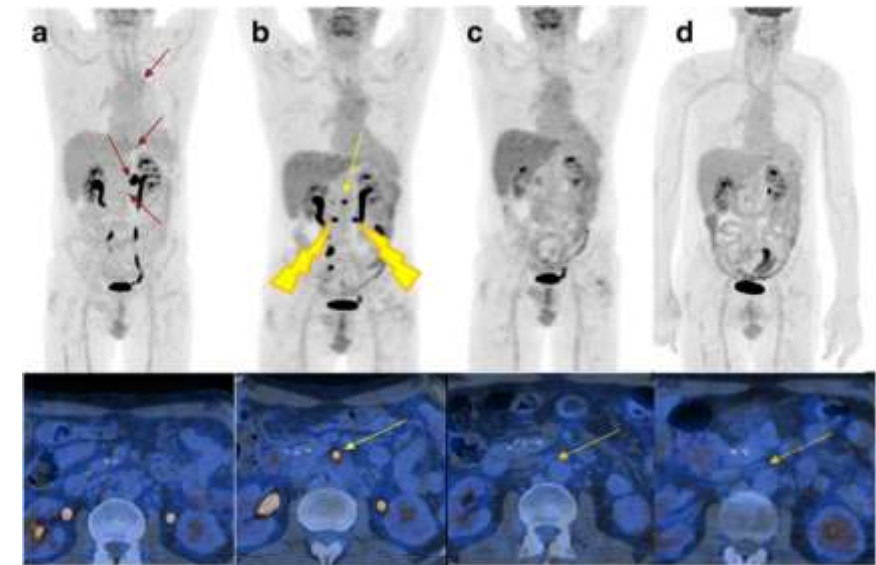
Proposed mechanism of the abscopal effect, mediated by the immune system. Here, local radiation causes tumor cell death, which is followed by adaptive immune system recognition, not unlike a vaccine.

The clinical use of immune checkpoint blocking antibodies such as [ipilimumab](#) or [pembrolizumab](#) has greatly increased the number of abscopally responding patients in selected groups of patients such as those with metastatic melanoma

Abscopal Effect of Radiotherapy



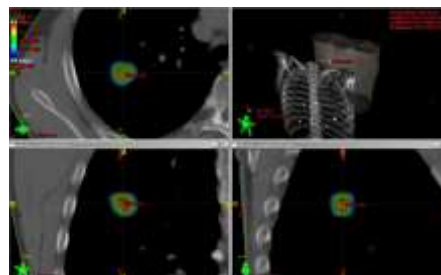
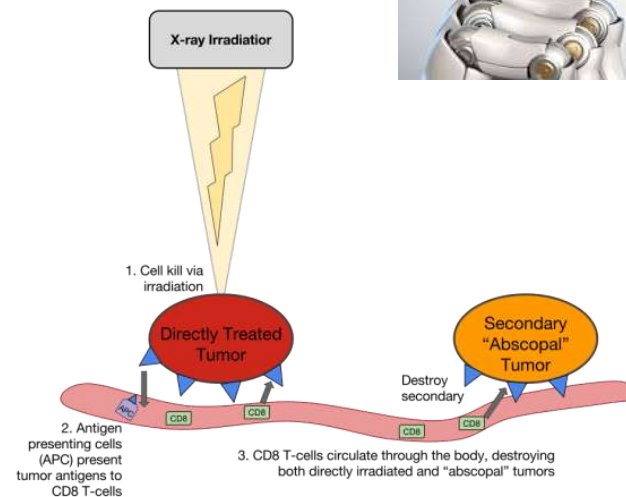
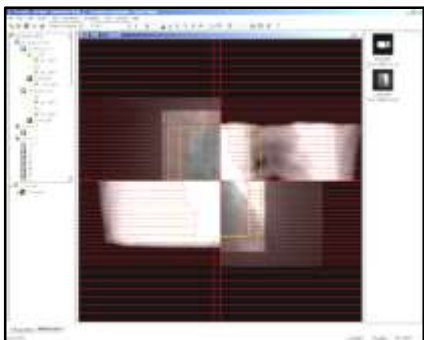
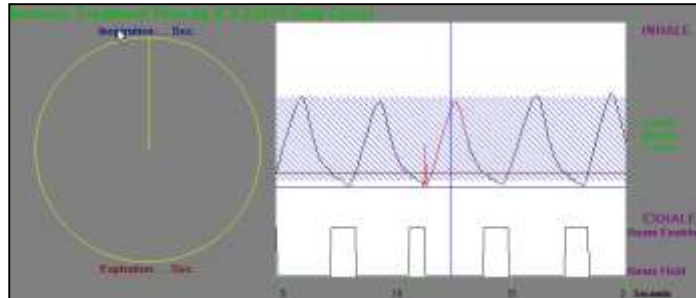
- Abscopal effect following radiation monotherapy in breast cancer: A case report
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- Report of an abscopal effect induced by stereotactic body radiotherapy and nivolumab in a patient with metastatic non-small cell lung cancer
- Christian Britschgi et al,
- Radiation Oncology 2018

Radiotherapie

Nieuwe benaderingen – Actuele uitdagingen





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