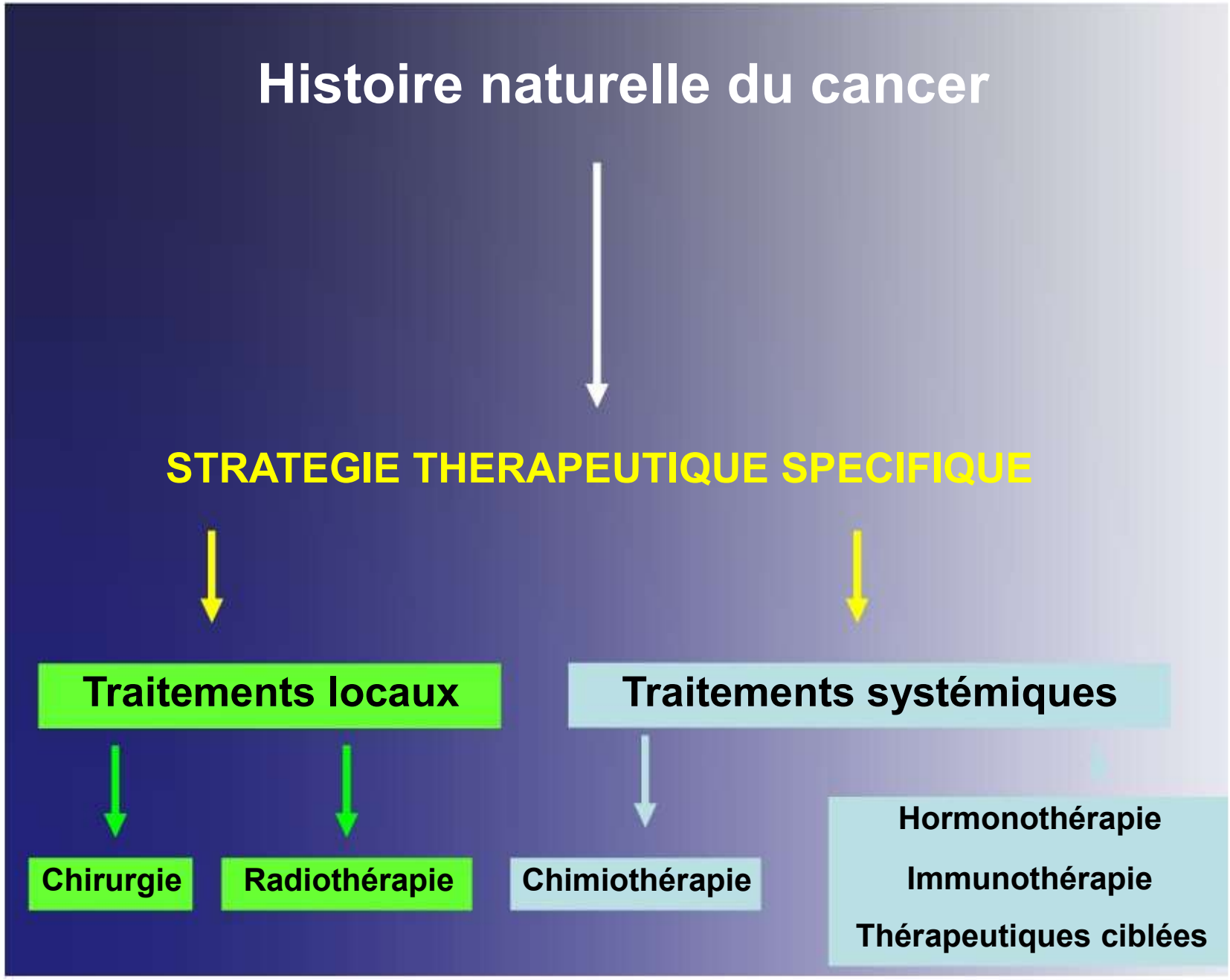
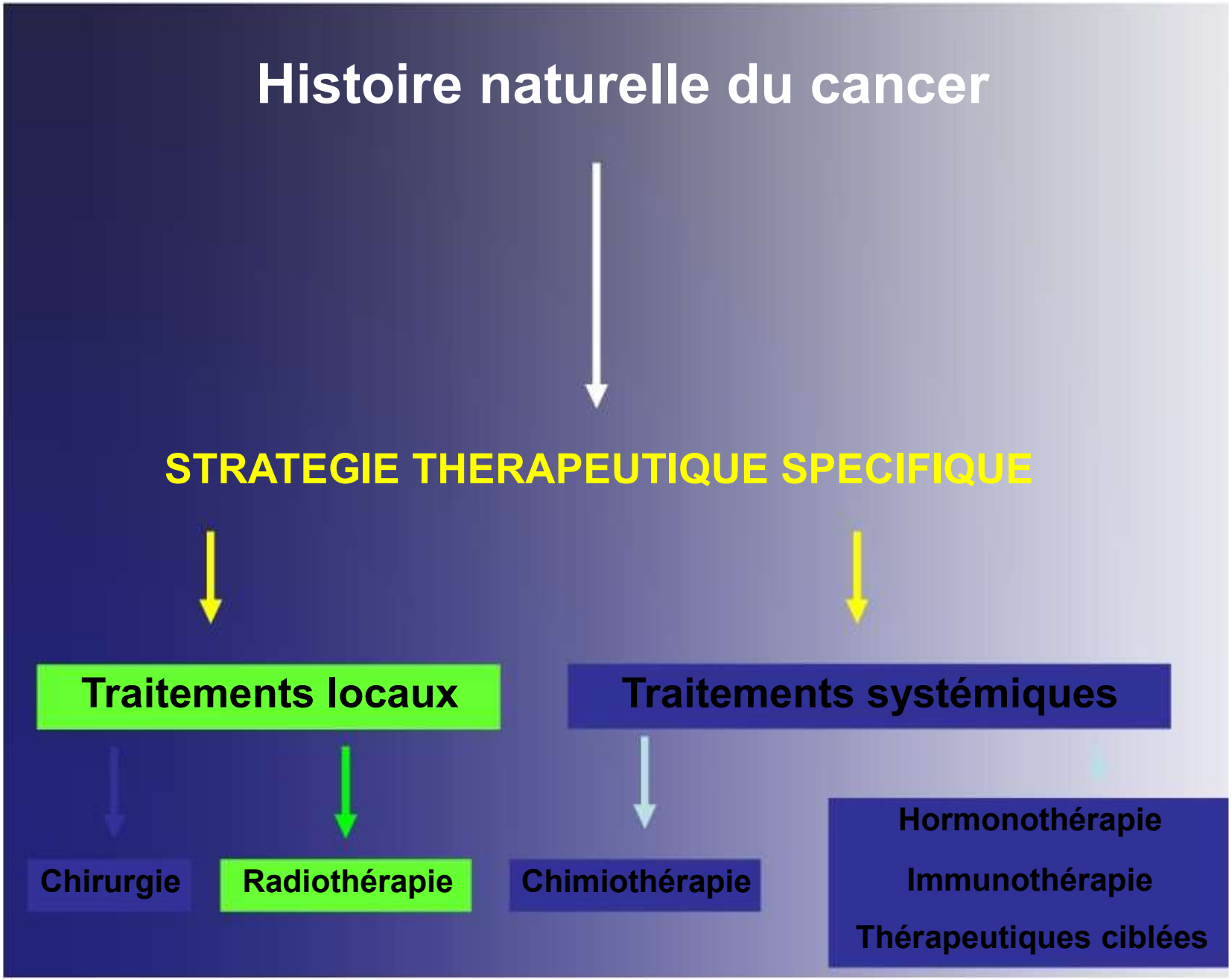
Dr. Luis Schiappacasse
Service de radio-oncologie
Centre hospitalier universitaire vaudois
Faculté de biologie et médecine
Université de Lausanne

Pediatric Radiotherapy


Histoire naturelle du cancer
STRATEGIE THERAPEUTIQUE SPECIFIQUE
Traitements locaux
Traitements systémiques
Chirurgie
Radiothérapie
Chimiothérapie
Hormonothérapie
Immunothérapie
Thérapeutiques ciblées


Histoire naturelle du cancer
STRATEGIE THERAPEUTIQUE SPECIFIQUE
Traitements locaux
Traitements systémiques
Chirurgie
Radiothérapie
Chimiothérapie
Hormonothérapie
Immunothérapie
Thérapeutiques ciblées

HISTORIQUE de la radiothérapie (1)

1896 : premiers traitements des tumeurs

1896 : découverte des propriétés radioactives de l'uranium (Becquerel)

1898 : découverte du radium (P. & M. Curie)

1901 : premières applications de radium à l'hôpital Saint Louis

curiethérapie

HISTORIQUE (2)

1950 : télécobalt-thérapie

197

19

19

Innovations techniques majeures :
- Meilleur ciblage de la dose :
- Amélioration du contrôle local
- Diminution de la toxicité

2000 : modulation d'intensité, suivi de cible (IGRT) et contrôle/suivi respiratoire

Innovations techniques majeures: meilleur ciblage de la dose

Unités en Radiothérapie

L'unité de dose en radiothérapie est le **Gray**

Le **Gray (Gy)** est l'unité qui définit la dose absorbée par l'eau ou un tissu

Il correspond à une absorption d'énergie de 1 Joule/kg

1 Gray = 1 J / kg

Objectif de la radiothérapie

Dose minimale dans les organes à risque de toxicité

Dose maximale dans la tumeur

Toxicité minimale

Contrôle local maximal

Distribution de dose: Photons
courbes de rendement en profondeur

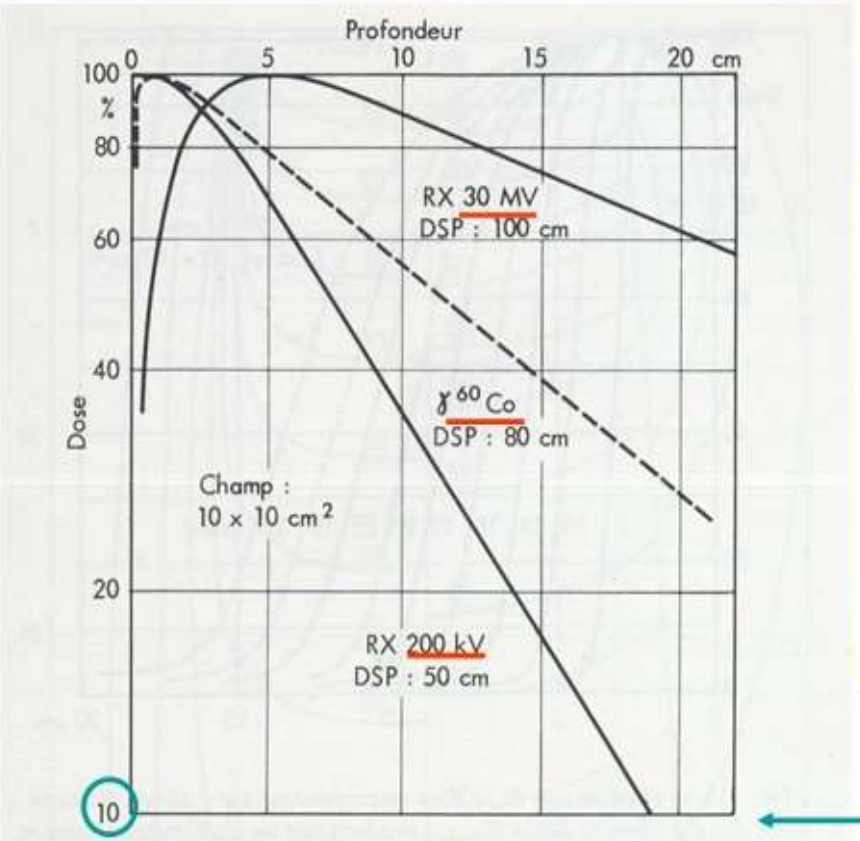


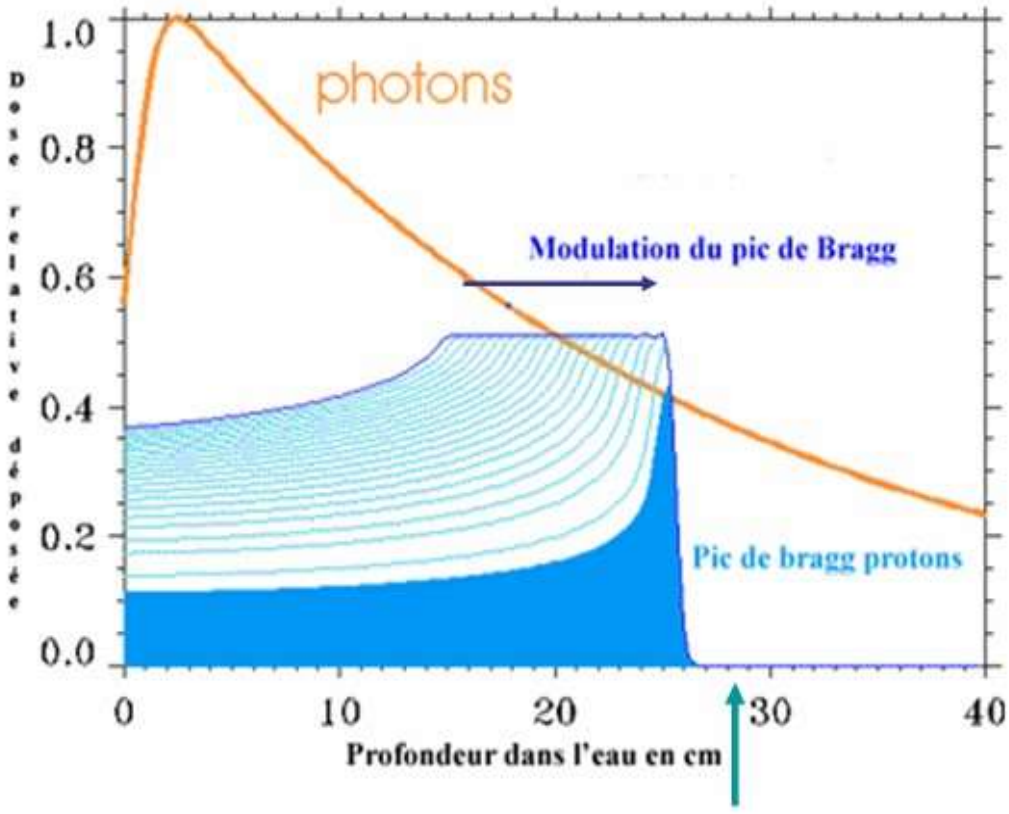
FIG. 114. — *Distribution de la dose en profondeur sur l'axe du faisceau pour des rayonnements X et γ de diverses énergies.*
(DSP = distance source-peau)

La profondeur du maximum de dose augmente avec l'énergie du rayonnement

La dose diminue avec la profondeur de pénétration du faisceau

Les photons ont un parcours infini

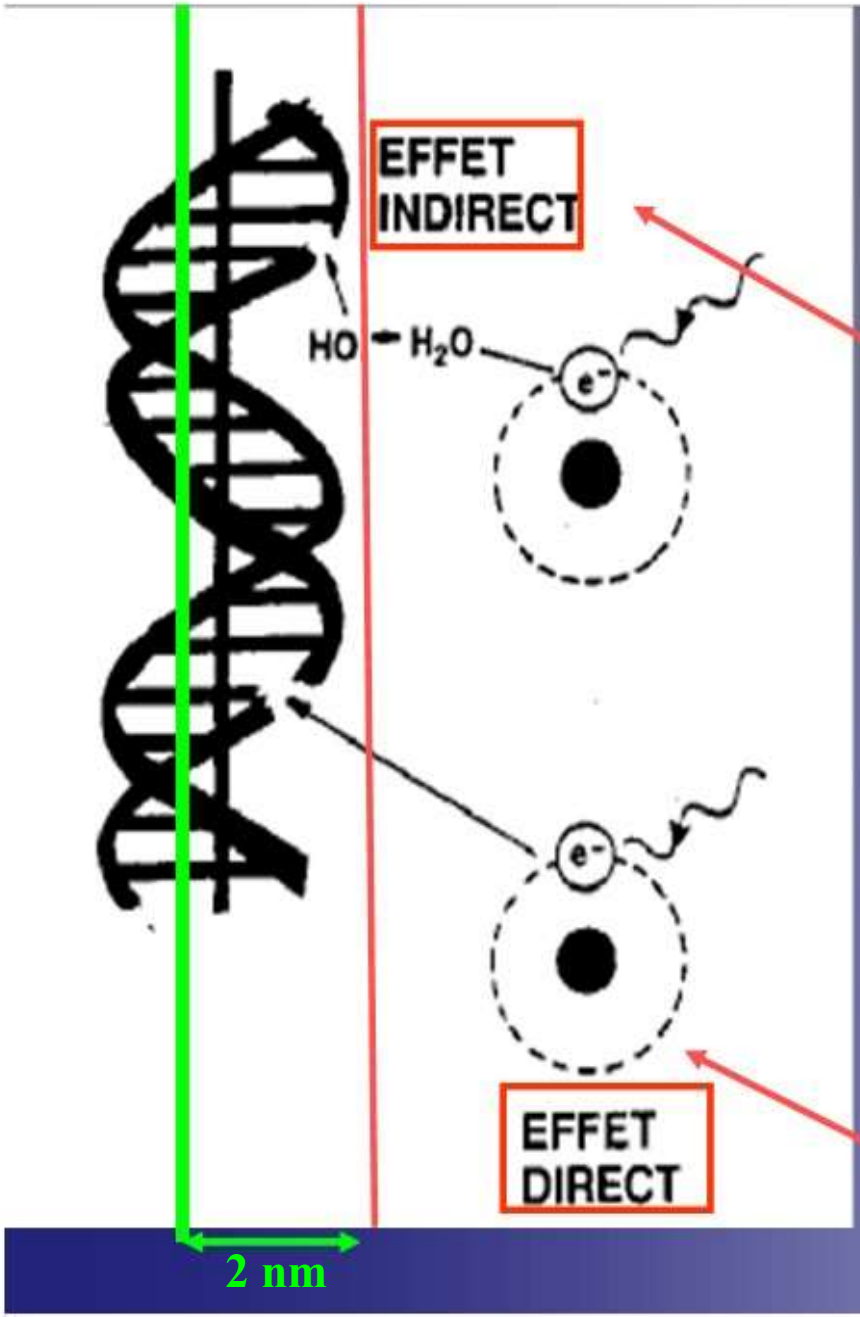
Distribution de dose: Protons
courbes de rendement en profondeur



La dose est délivrée sous forme d'un pic (avant et après le pic peu et pas de dose)

Les protons ont un parcours fini

EFFET des RAYONNEMENTS IONISANTS



RADIOLYSE DE L'EAU (70-80%)

Les radicaux libres produits dans un cylindre de 2 nm peuvent atteindre l'ADN

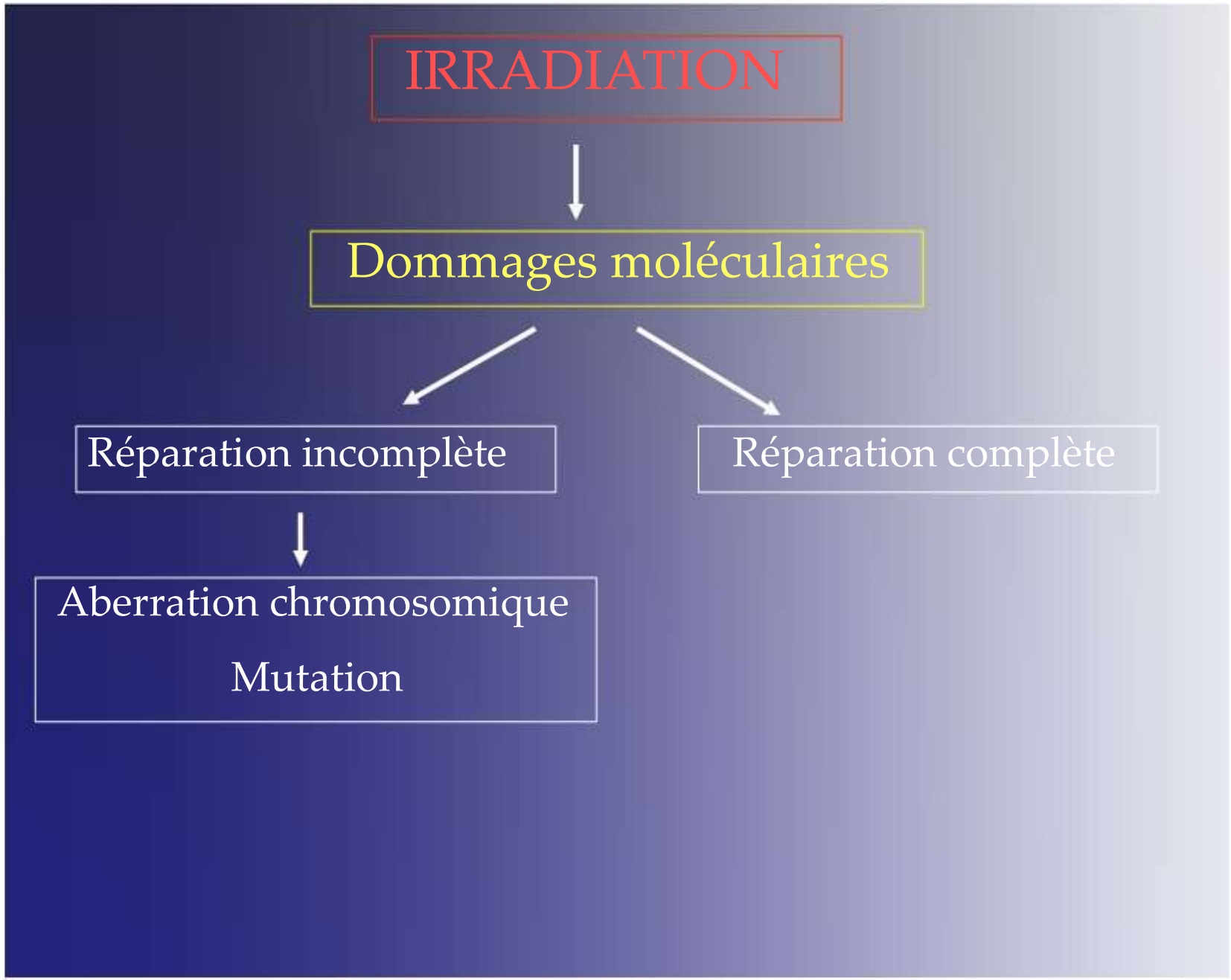
IONISATION DIRECTE DES ATOMES DE L'ADN (20-30%)

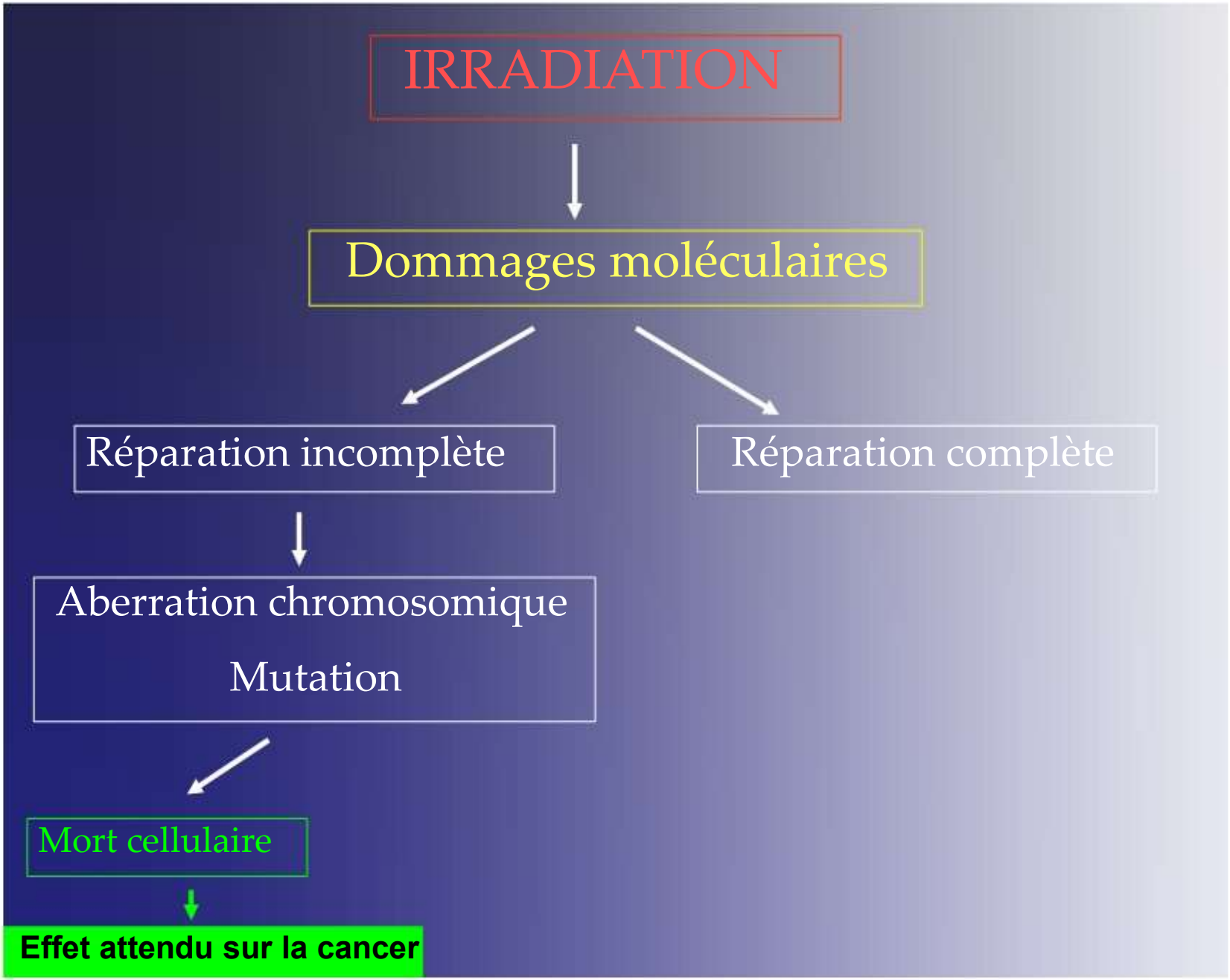
Conséquences de l'Irradiation sur l'ADN :

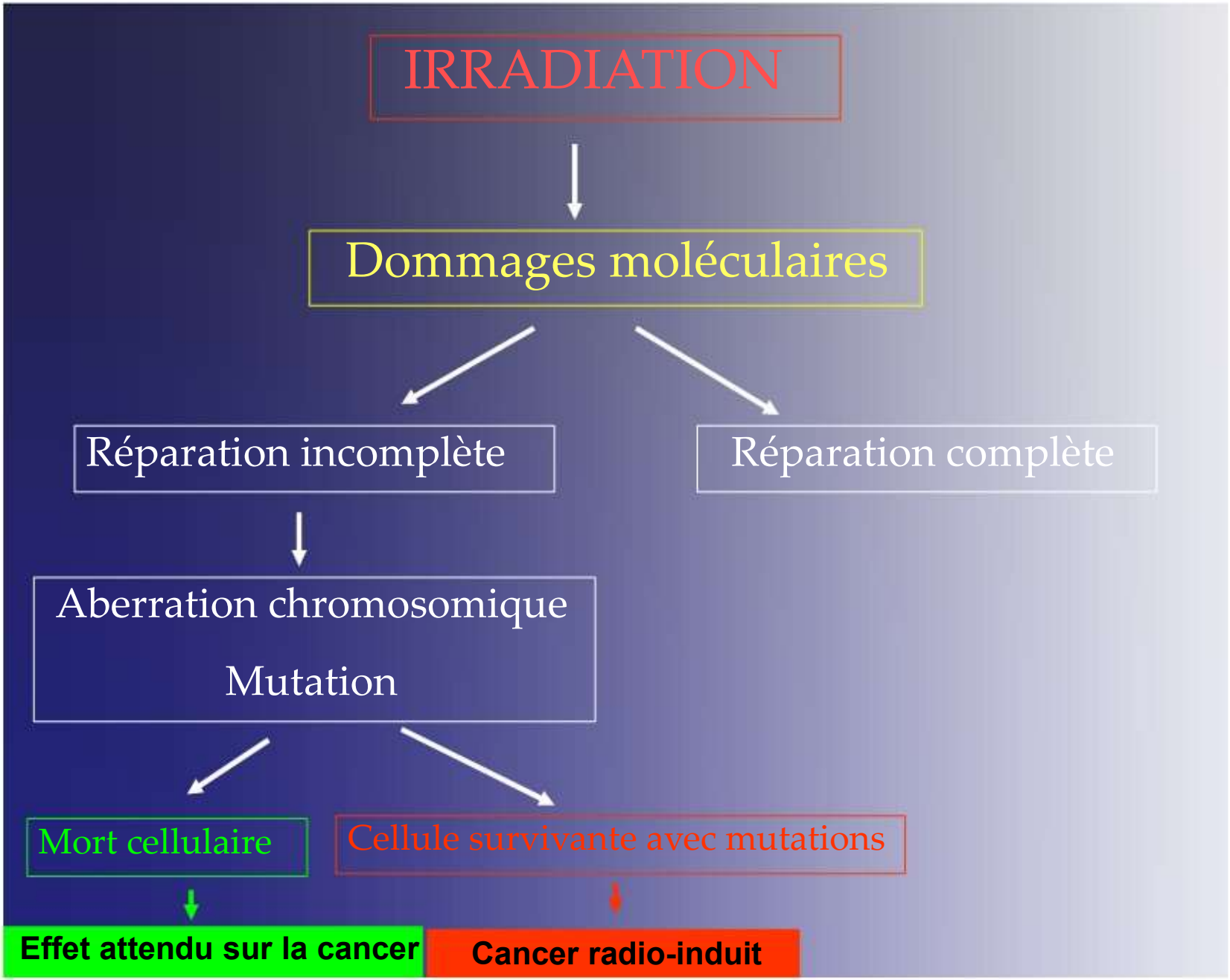
- CASSURES DOUBLE BRIN

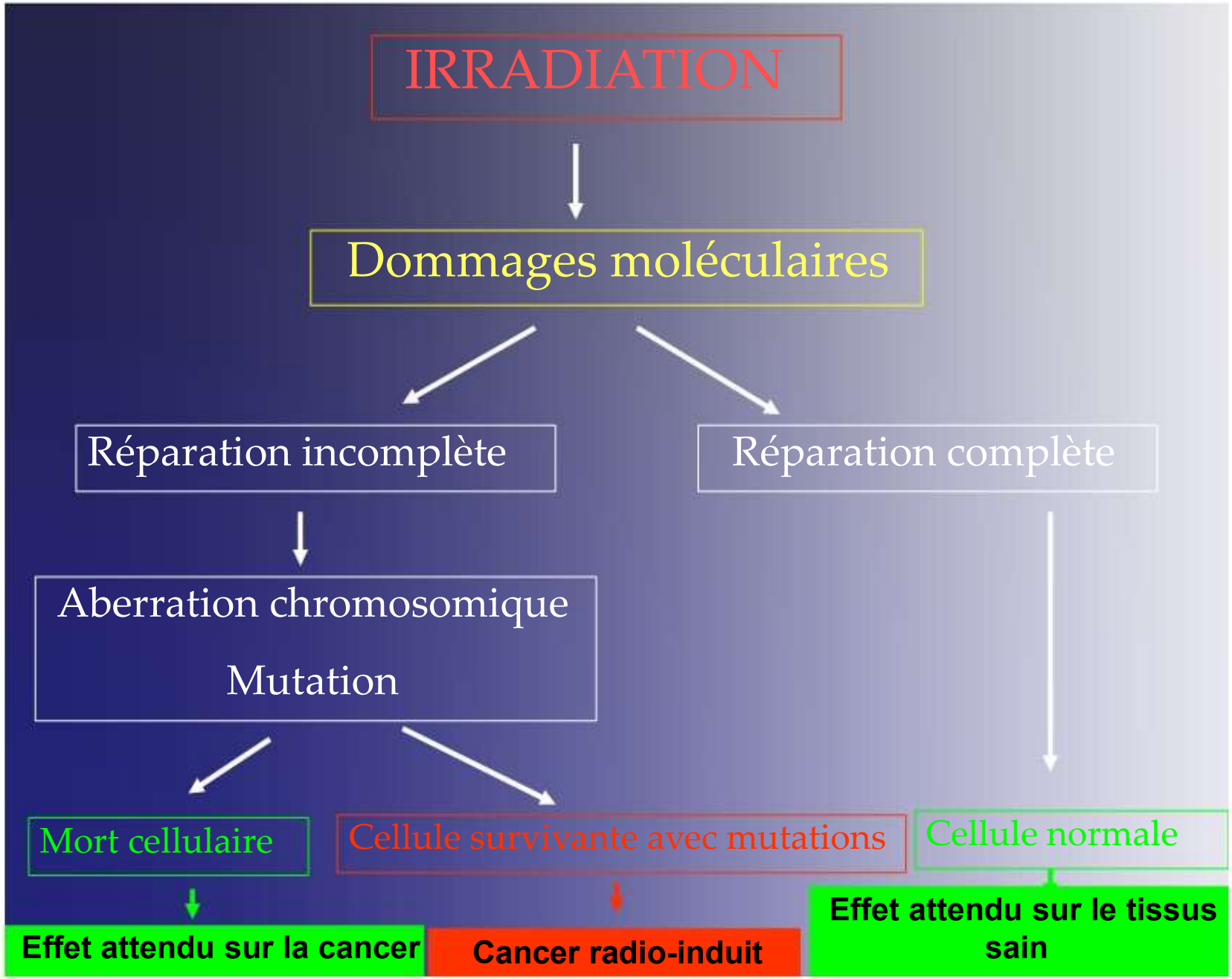
  = principales responsables de la létalité

- CASSURES SIMPLE BRIN
- Altération des bases
- Destruction des sucres
- Formation de pontages (inter-brins, intra-brins ou ADN-protéines…)


IRRADIATION
Dommages moléculaires
Réparation incomplète
Réparation complète
Aberration chromosomique
Mutation


IRRADIATION
Dommages moléculaires
Réparation incomplète
Réparation complète
Aberration chromosomique
Mutation
Mort cellulaire
Effet attendu sur la cancer


IRRADIATION
Dommages moléculaires
Réparation incomplète
Réparation complète
Aberration chromosomique
Mutation
Mort cellulaire
Cellule survivante avec mutations
Effet attendu sur la cancer
Cancer radio-induit


IRRADIATION
Dommages moléculaires
Réparation incomplète
Réparation complète
Aberration chromosomique
Mutation
Mort cellulaire
Cellule survivante avec mutations
Cellule normale
Effet attendu sur la cancer
Cancer radio-induit
Effet attendu sur le tissus sain

Utilisation de drogues en radiothérapie

Drogues radio-protectrices

Dose minimale dans les organes à risque de toxicité

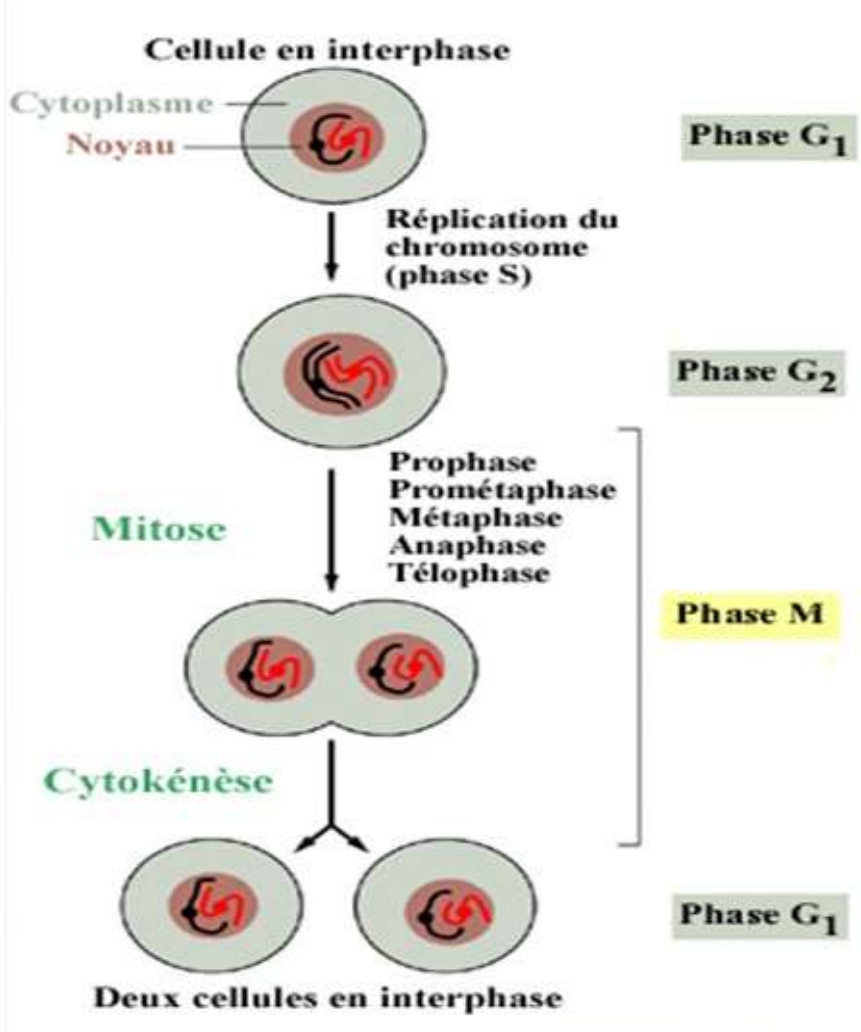
Dose maximale dans la tumeur

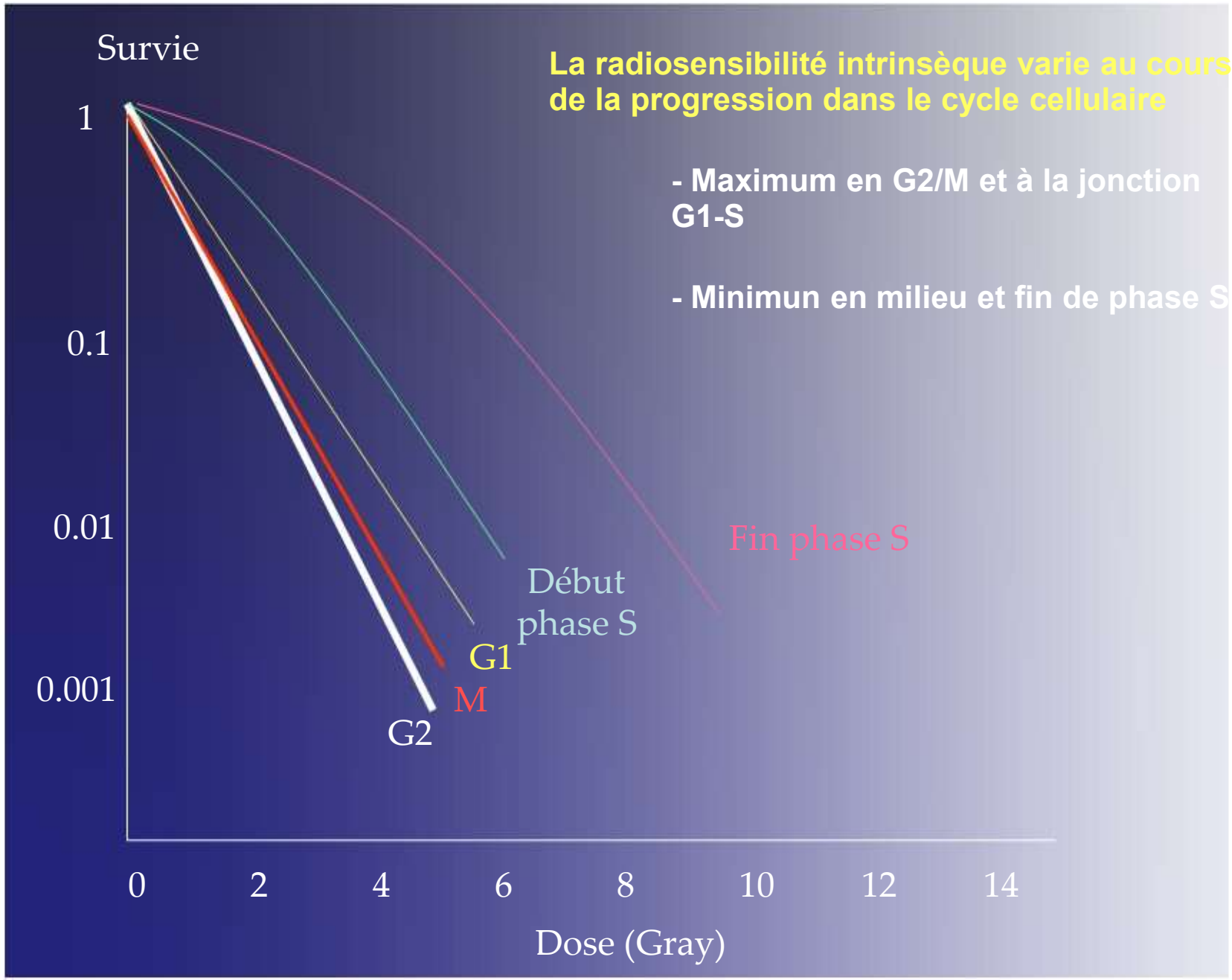
Chimiothérapie

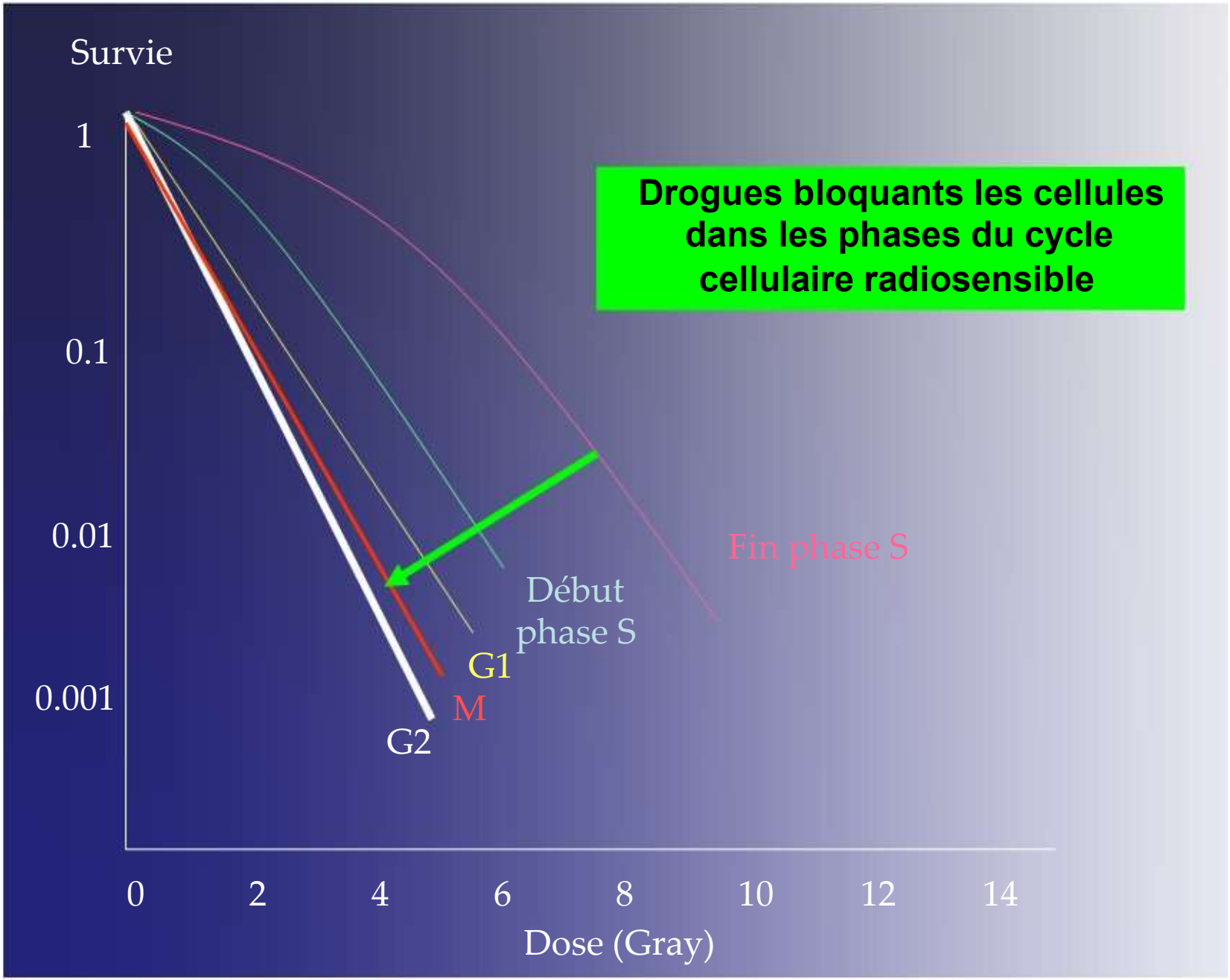
Toxicité minimale

Contrôle local maximal

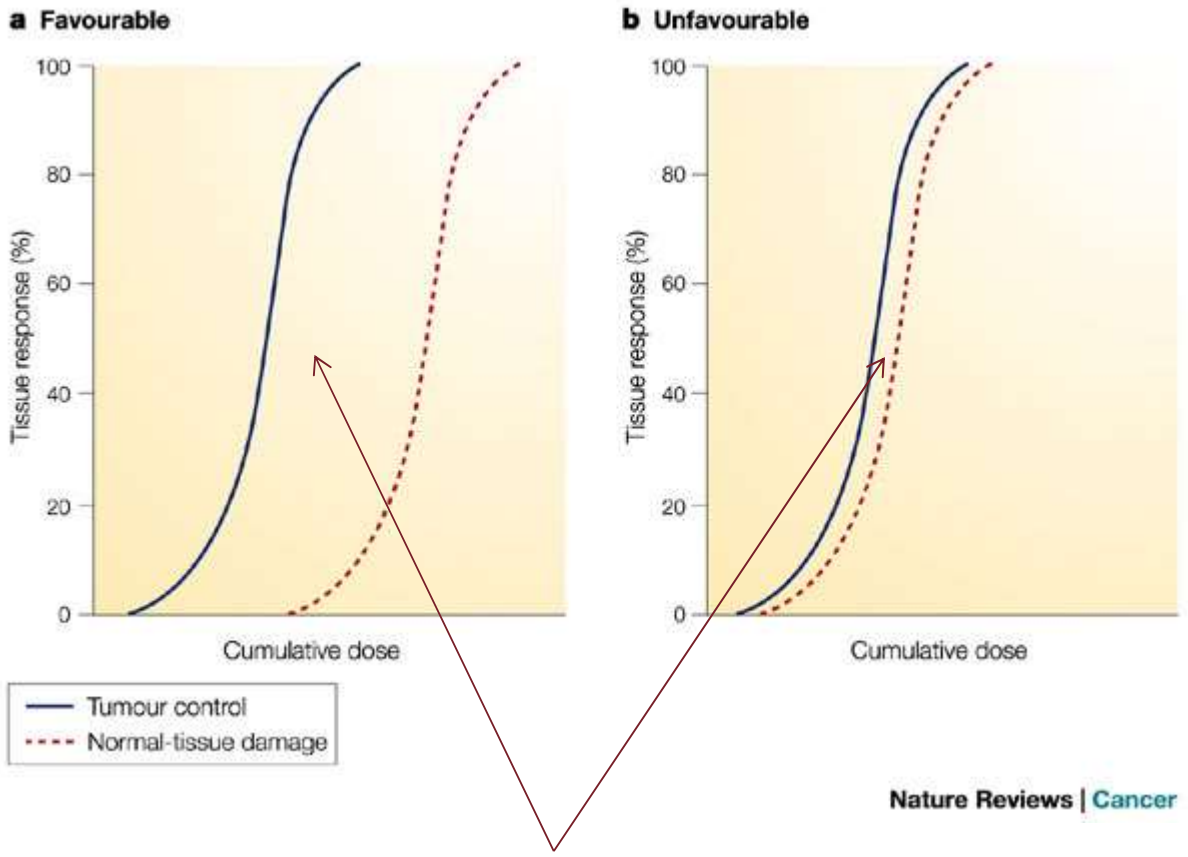
2. Redistribution dans le cycle cellulaire :




Survie
1
0.1
0.01
0.001
La radiosensibilité intrinsèque varie au cours de la progression dans le cycle cellulaire
- Maximum en G2/M et à la jonction G1-S
- Minimun en milieu et fin de phase S
Fin phase S
Début phase S
G1
M
G2
0
2
4
6
8
10
12
14
Dose (Gray)


Survie
1
0.1
0.01
0.001
Drogues bloquants les cellules dans les phases du cycle cellulaire radiosensible
Fin phase S
Début phase S
G1
M
G2
0
2
4
6
8
10
12
14
Dose (Gray)

Dose response curves



Therapeutic window:
Maximum probability of "Complication Free" Tumour Control

Unique Aspects of Pediatric Oncology

- Overall Prognosis is Good - 65%
- Usually otherwise healthy patients
- May have specific sensitivity to treatment
  - CNS sensitivity
  - Growth issues

Unique Aspects of Pediatric Oncology

- Long Term Survivors
  - Second Malignancies
    - Chemotherapy and radiation therapy
    - Development and CNS function
    - Cardiac, Renal, and Pulmonary Toxicity
    - Reproductive Function

Cancer survivors

MENU TIME

CANCER

Childhood Cancer Survivors Have Significant Chronic Disease

By Alexandra Sifferlin @acsifferlin | June 12, 2013 | 21 Comments

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A study of over 1,700 childhood cancer survivors found that 98% of the participants had at least one chronic disease such as new cancers, heart disease or abnormal lung function.

Jessica Key / Getty Images

The research, published in the *Journal of the American Medical Association*, presents a dismal picture of life after cancer. Conducted by St. Jude Children's Research Hospital, it provides a glimpse into St. Jude's LIFE program, a two- to three-day initiative that brings long-term childhood cancer survivors back to the hospital for regular check-ups throughout their adult lives. The goal is to monitor adult survivors to better understand the mechanisms that promote survival. The former patients undergo various checks and screenings including basic health exams, blood tests and X-rays.

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+ Share Comment

Key areas in discussing late effects

- Effects on sexual and reproductive function
  - Ways to mitigate these
- Neuro-cognitive deficits
- Hormonal deficiencies and the need for hormone replacement therapy
- Effects on bone and soft tissue growth
- Effects on vision and hearing
- Risk of second malignancies

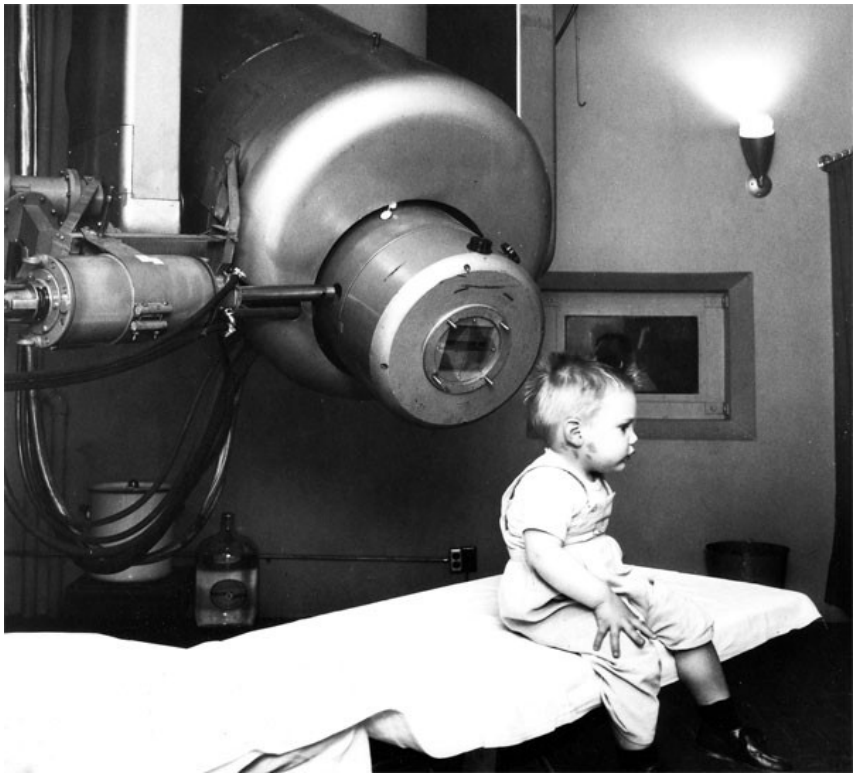
Incidence of second sarcomas: a cancer registry-based study (1976 - 2010)

- 107,238 first cancers/885,000 inhabitants: 126 second sarcomas
- Hodgkin lymphoma (C81)
  - First primaries: 735
  - Second sarcomas: 3 (0.53 expected)
- Standardized incidence ratio (SIR) all sites
    - < 5 years [58(O)/36.0(E)]: 1.61
    - > 5 years [68(O)/32.2(E)]: 2.11

Levi F et al, Cancer Causes Control (2014)

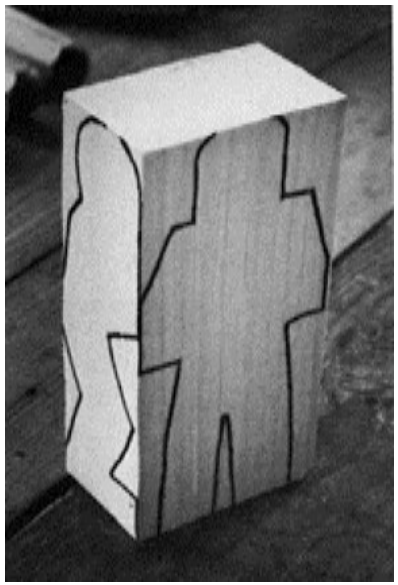
1952: First linear accelerator (Henry S. Kaplan in Stanford - California)

Henry Kaplan, left, and head of radiologic physics Mitchell Weissbluth, the first physicist

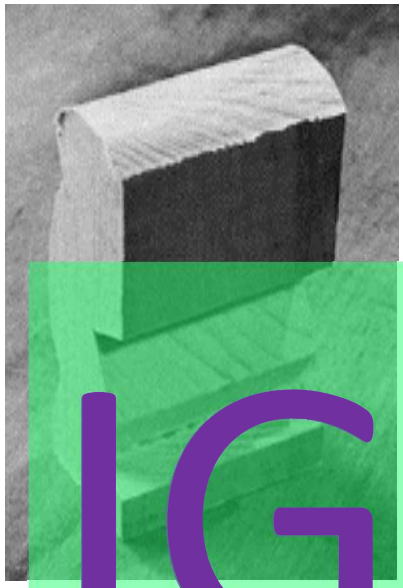


The first patient to receive radiation therapy from the medical linear accelerator at Stanford was a 2-year-old boy

Evolution of Radiotherapy after 2000: *Improving conformality, precision,* ***dose sculpting***



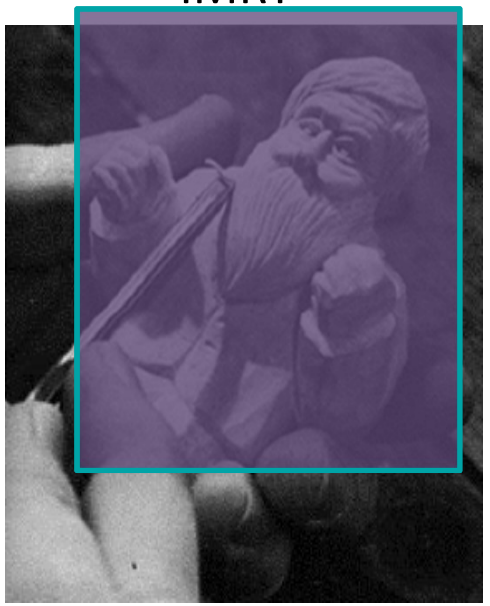
2D Planification



3D Conformal

IGRT

IMRT

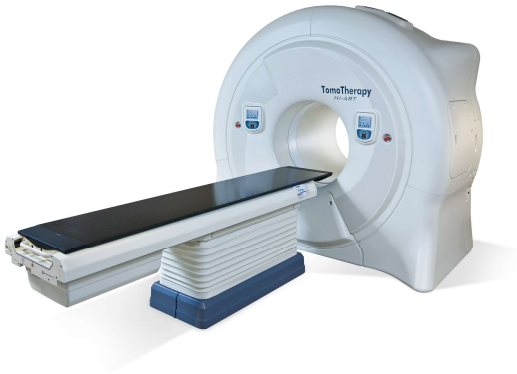


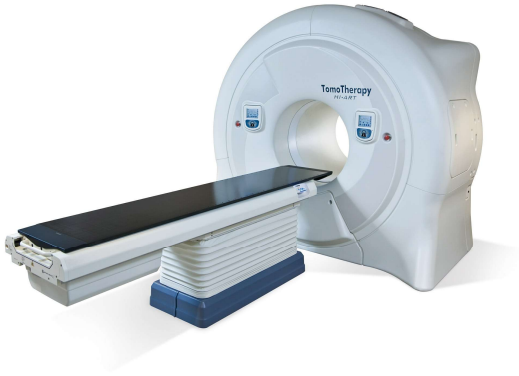
J. Schreiner Kingston Regional Cancer Centre, Ontario

Good practice in paediatric radiotherapy: ten key themes

Technical platform University of Lausanne Hospitals (CHUV)

Tomotherapy (2)





GammaKnife (1)

CyberKnife (1)

Elekta Synergy (1)

Toshiba Aquilion

Protontherapy

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Mevion Medical Systems to Install a Proton Therapy System in Switzerland

Public-private partnership between Innovative Care and Centre Hospitalier Universitaire Vaudois (CHUV) will place a MEVION S250 at the CHUV

LITTLETON, MASS., October 8, 2015 – Mevion Medical System's industry-leading cancer fighting technology is coming to the prestigious Centre Hospitalier Universitaire Vaudois (CHUV) in Lausanne, Switzerland. A MEVION S250 proton therapy system is being purchased by Swiss-based Innovative Care SA (IC) and will be installed at the CHUV through a public-private partnership. It is the first announced sale of a MEVION S250 in Europe.

"Innovative Care SA is proud to partner with the CHUV to bring advanced proton therapy to Switzerland," said Michel Racheter, CEO of Innovative Care SA. "Since 2009, we undertook a rigorous yearly international search for the best proton therapy partner and determined the quality and value of the Mevion system is unique. Mevion's low capital, operating and energy costs, combined with its repeatedly proven fast ramp-up and high throughput, make the MEVION S250 the ideal system to complement the CHUV's state-of-the-art medical and technical platform."

"This strategic public-private partnership for several decades with IC gives our patients access to Mevion's proton therapy and highly contributes to the development of the CHUV as a major cancer center in Europe," said Philipp Müller, chief financial officer at the CHUV. The MEVION S250 at the CHUV will be based in the French-speaking region of Switzerland providing convenient access to this leading-edge treatment for patients in Switzerland and beyond. Construction will begin the first quarter of 2016 and the first patient will be treated in 2017.

A MEVION S250, like this one at Robert Wood Johnson University Hospital in New Brunswick, N.J., U.S.A, will be installed at the CHUV in Lausanne, Switzerland.

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CHUV

Indications for proton beam therapy (England)

Box 18. Paediatric indications for referral abroad for proton beam therapy[33]

Base of skull & spinal chordoma
Base of skull chondrosarcoma
Spinal and paraspinal 'adult type' bone and soft tissue sarcomas
Rhabdomyosarcoma

- Orbit
- Parameningeal & head & neck
- Pelvis

Ependymoma
Ewing's sarcoma
Retinoblastoma
Pelvic sarcoma
Optic pathway and other selected low grade glioma
Craniopharyngioma
Pineal parenchymal tumours (not pineoblastoma)
Esthesioneuroblastoma

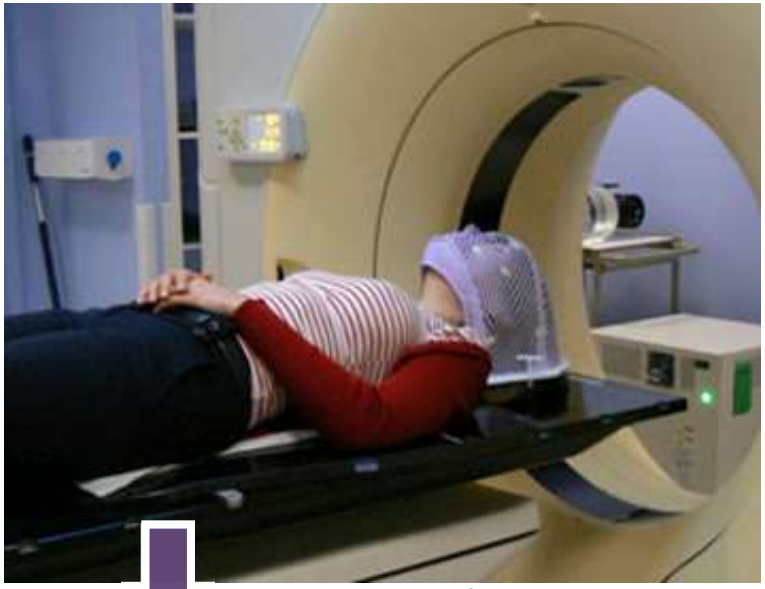
Tomotherapy

Immobilisation devices

Thermoplastic masks

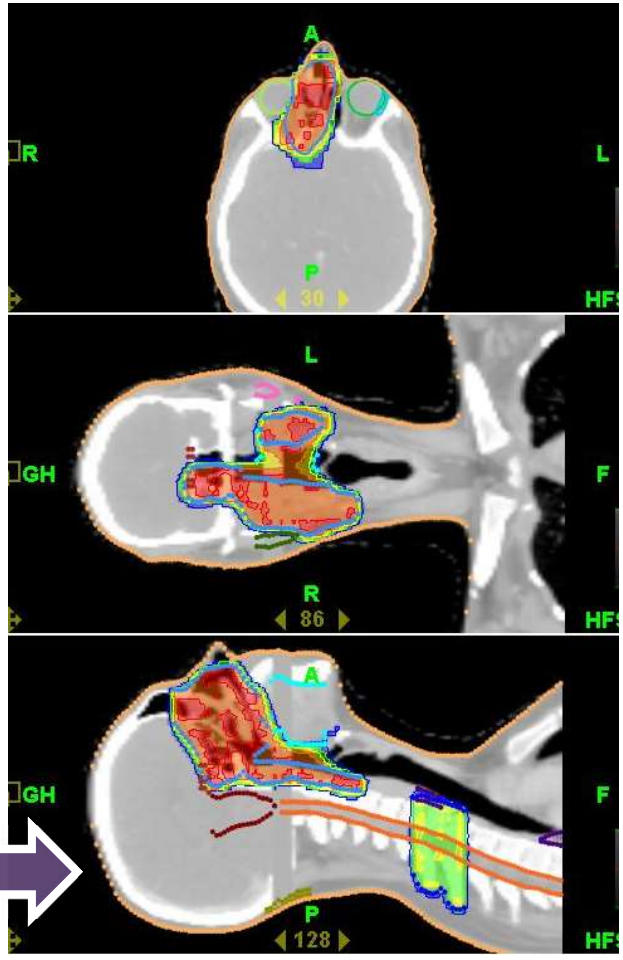
Vacuum cushions

Radiotherapy workflow



Simulation CT scan

Tumor and OAR definition



Dosimetry

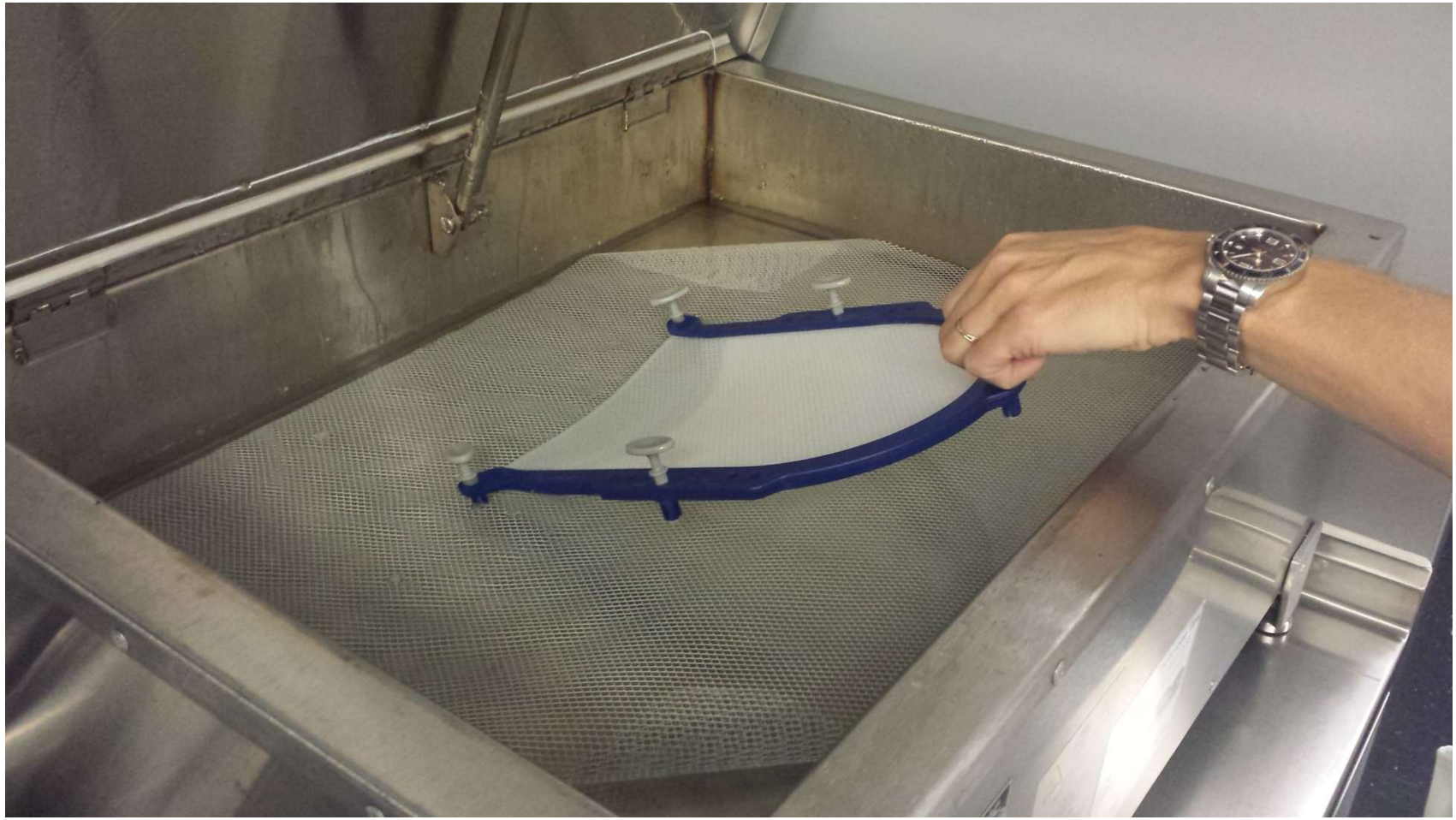
Mould room: craniospinal radiotherapy

BodyFIX

BodyFIX: body immobilisation

Thermoplastic mask

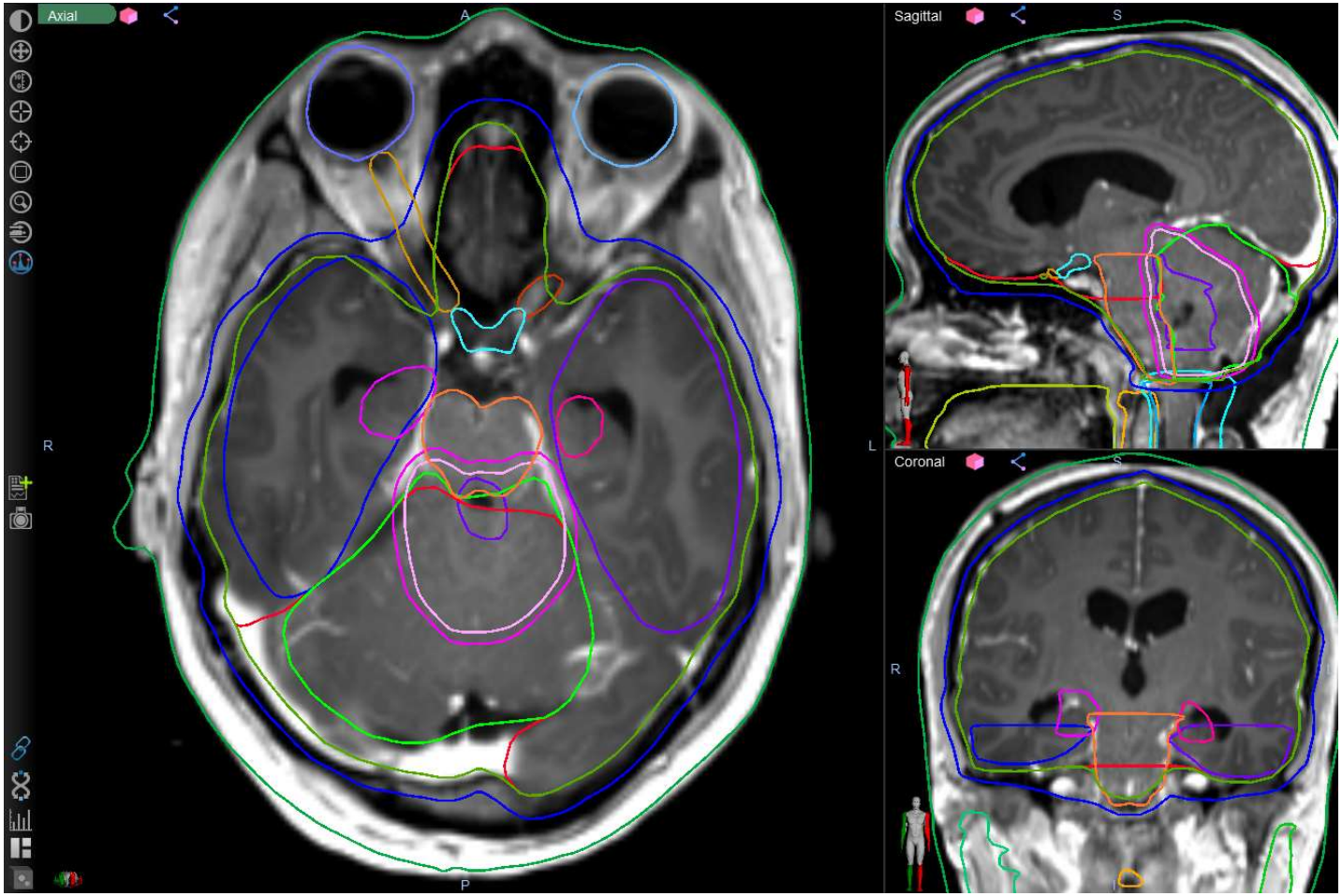
Thermoplastic mask



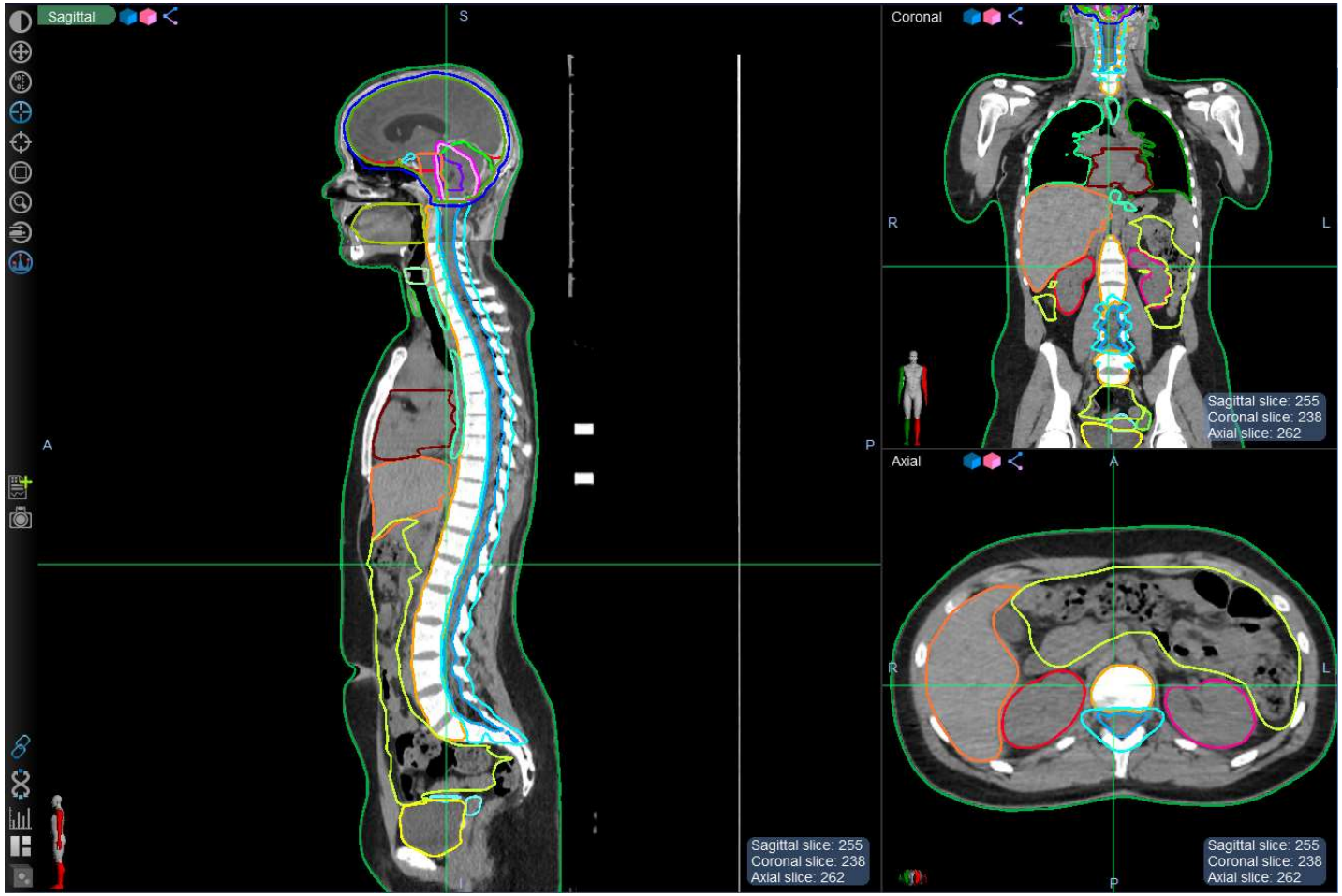
Laser alignment/references

CT-scan

Target volumes and OARs contouring



Target volumes and OARs contouring



Dosimetry

Radiotherapy *(Tomotherapy)* process

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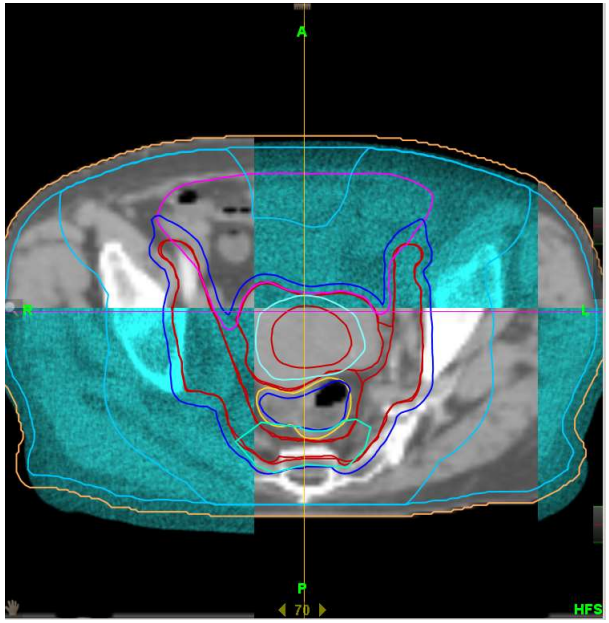
CHUV

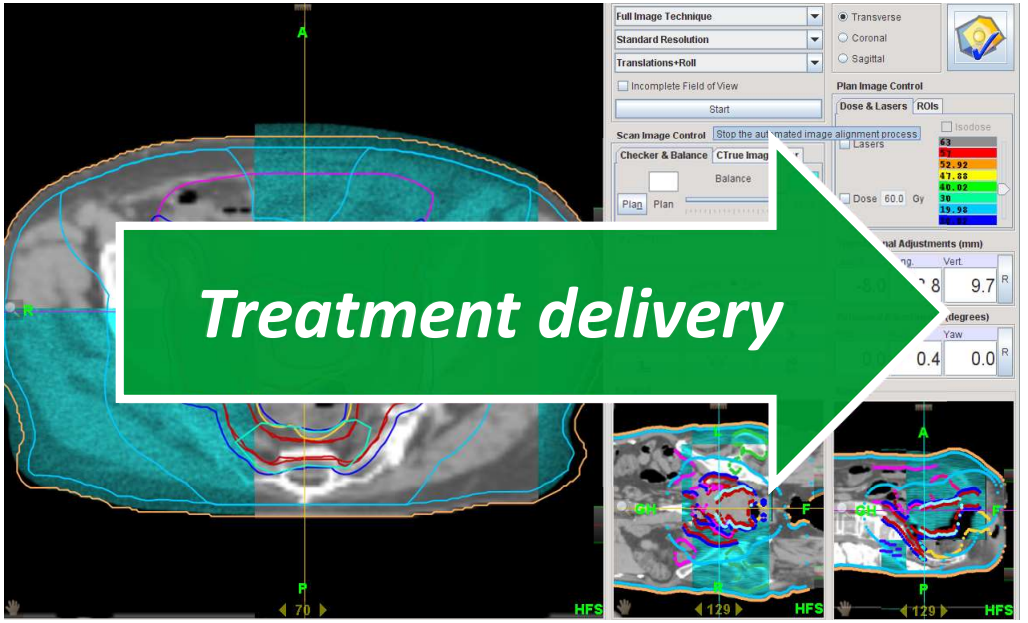
Radiotherapy *(Tomotherapy)* process

MVCT scan adquisition

Rigid fusion after scan



Positionning automatic/manual corrections

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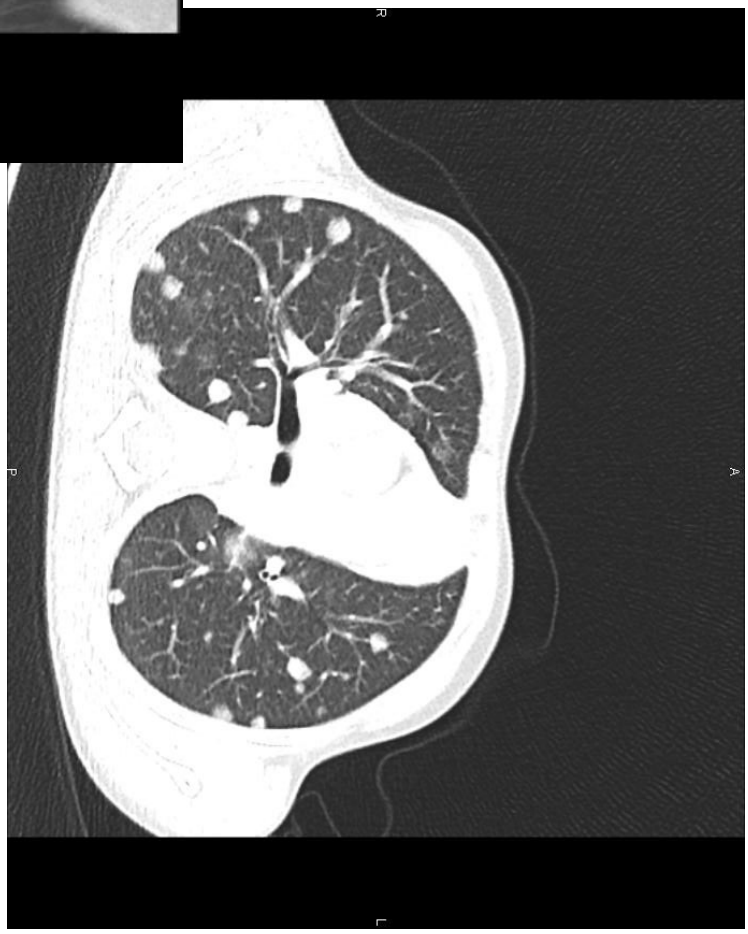
Abdominal/pelvic tumours
CHUV

Clinical case

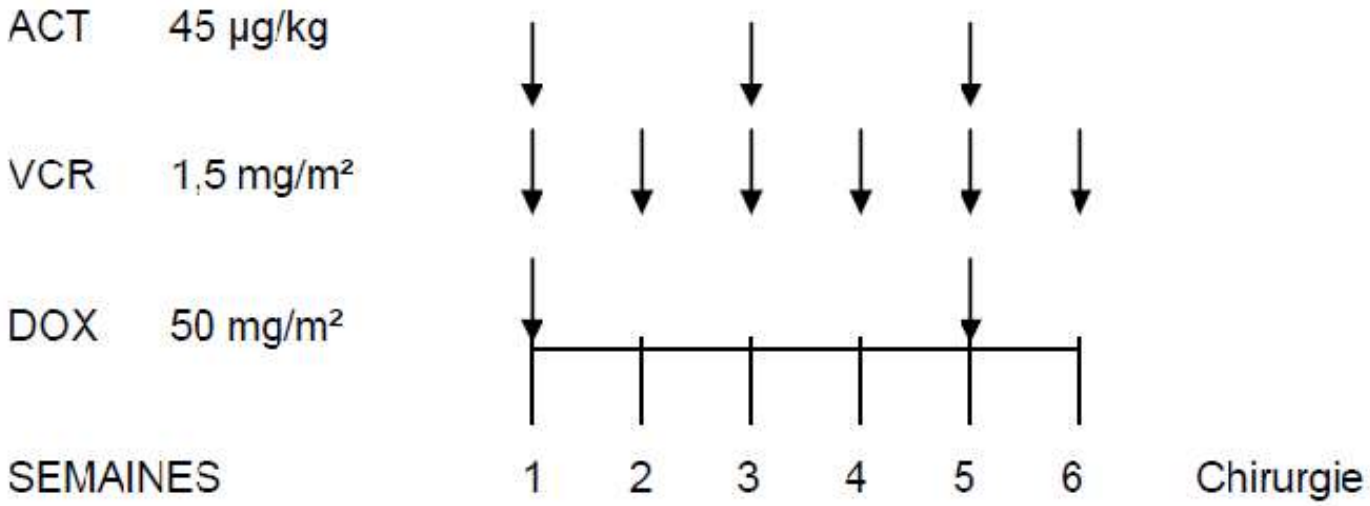
- Female, 8 years old
- *Stage IV nephroblastoma* with major loco-regional extension
  - Lung metastases
- Neo-adjuvant chemotherapy: Nephro SIOP 2001
- Surgery (nephrectomy + cavectomy): R2 (right hepatic venae), *stage III locally*, tumoral thrombus of the cave venae


A
R
L
P



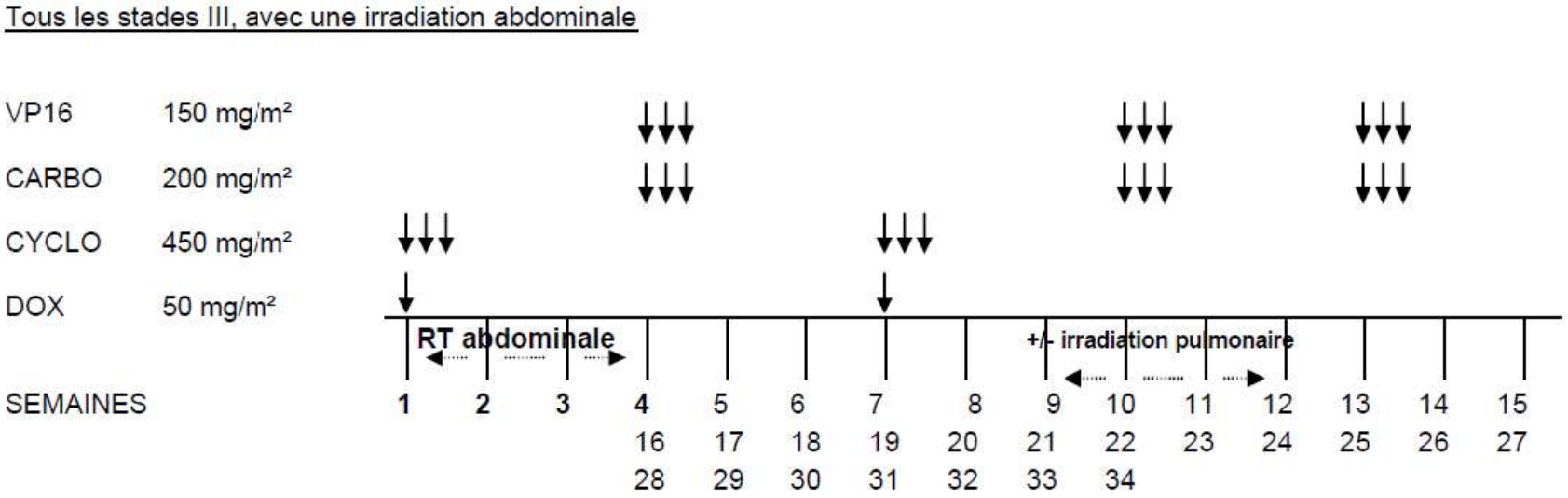
Nephro SIOP 2001

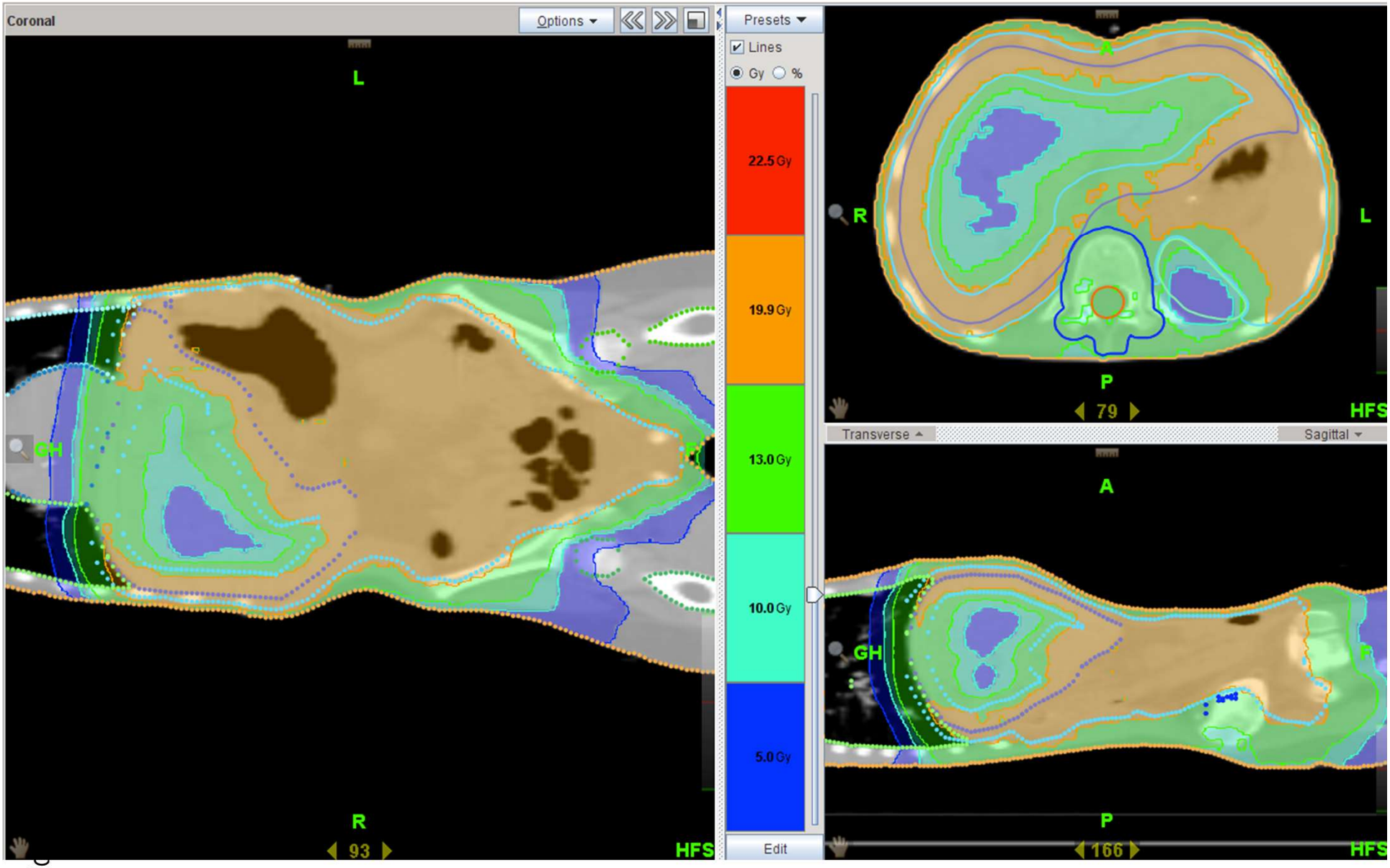
- Neo-adjuvant chemotherapy associating vincristin, actinomycin and doxorubicin over 6 weeks

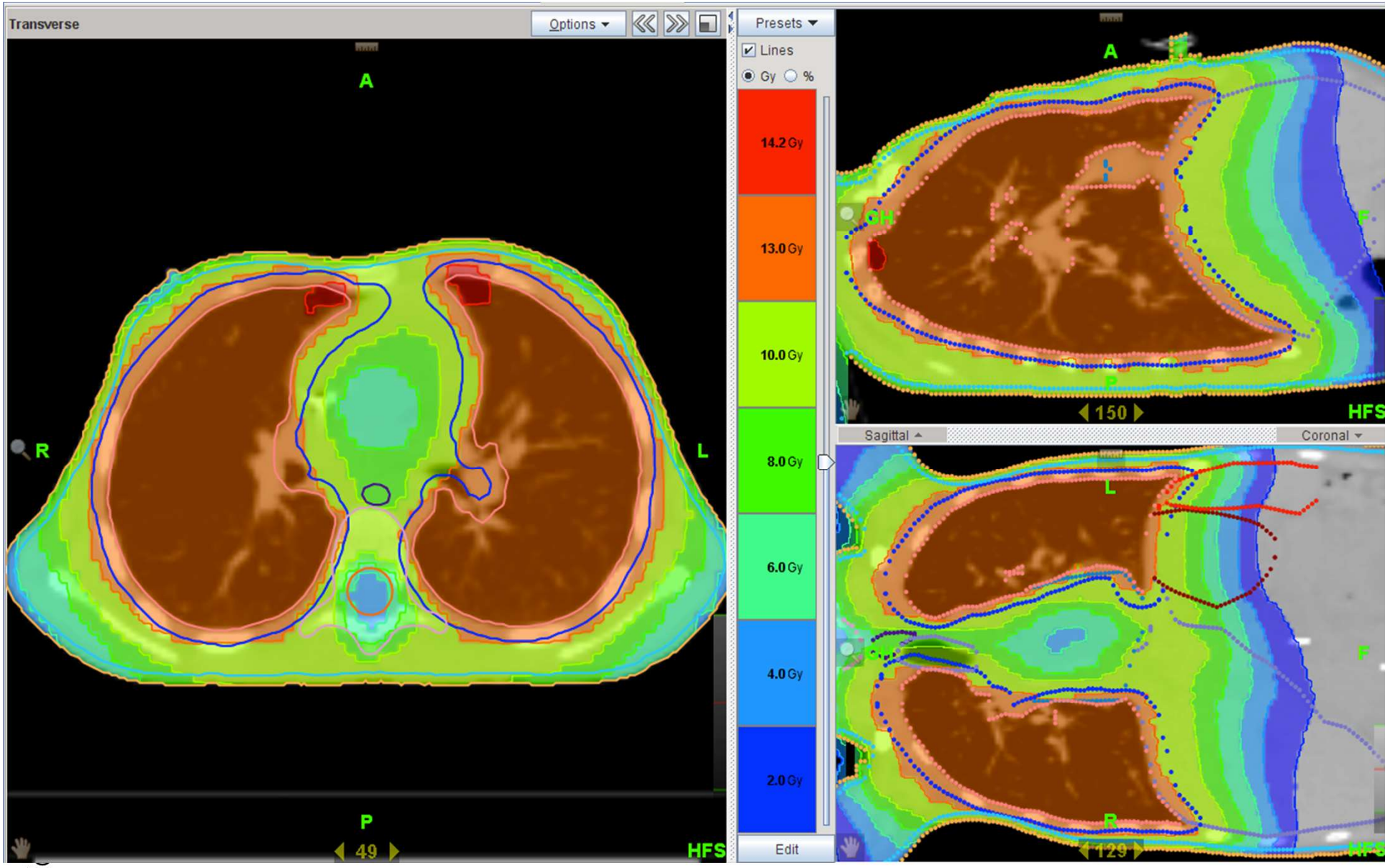


Adjuvant chemotherapy

- Adjuvant chemotherapy for stage IV
- Stage III locally with lung metastases in partial response (strategy B)




Coronal
Options
L
GH
R
93
HFS
Presets
Lines
Gy
%
22.5 Gy
19.9 Gy
13.0 Gy
10.0 Gy
5.0 Gy
Edit
A
R
L
P
79
HFS
Transverse
Sagittal
A
GH
P
166
HFS


Transverse
Options
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HFS
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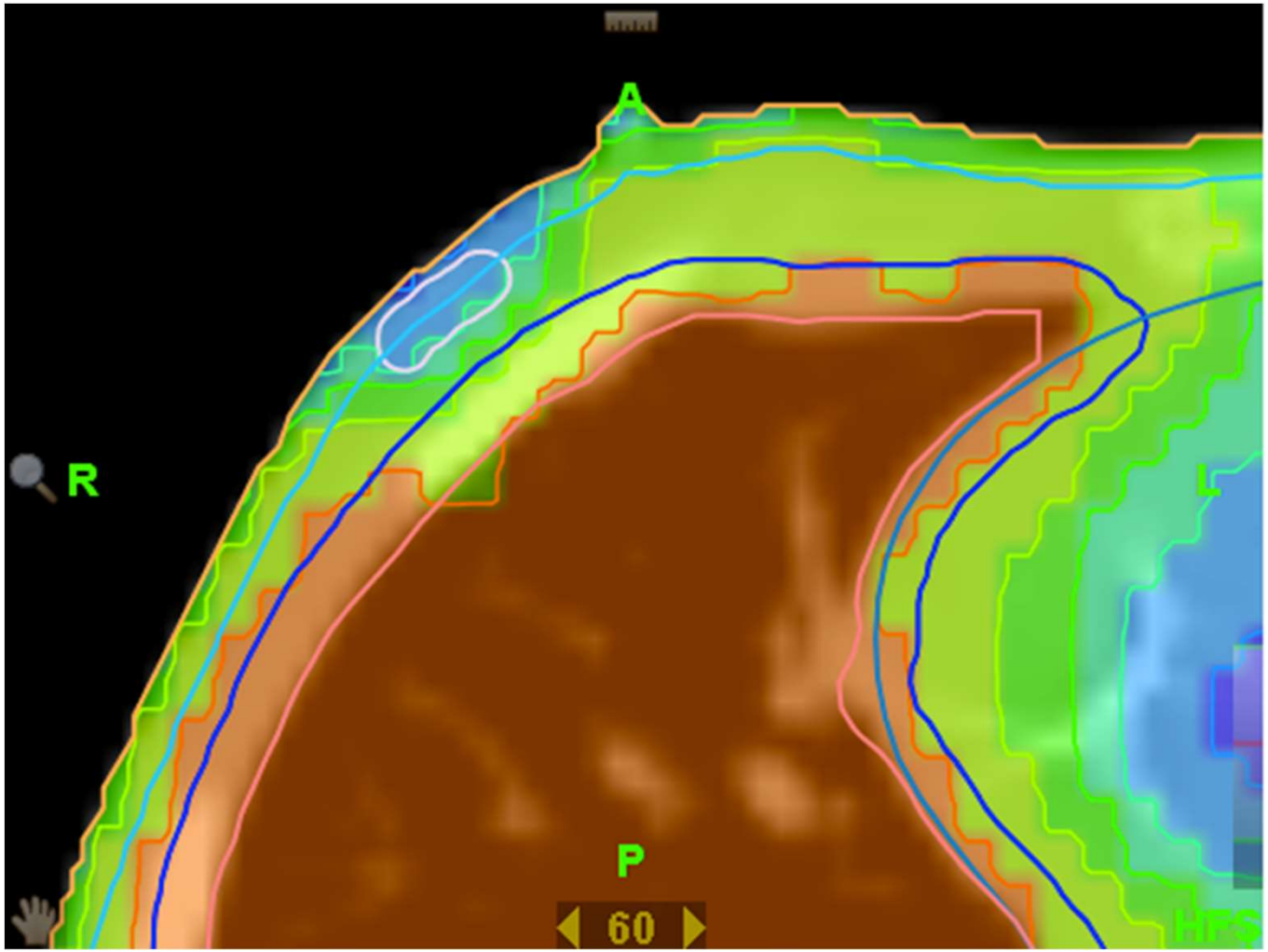
Gy
%
14.2 Gy
13.0 Gy
10.0 Gy
8.0 Gy
6.0 Gy
4.0 Gy
2.0 Gy
Edit
A
OH
F
P
150
HFS
Sagittal
Coronal
L
F
R
129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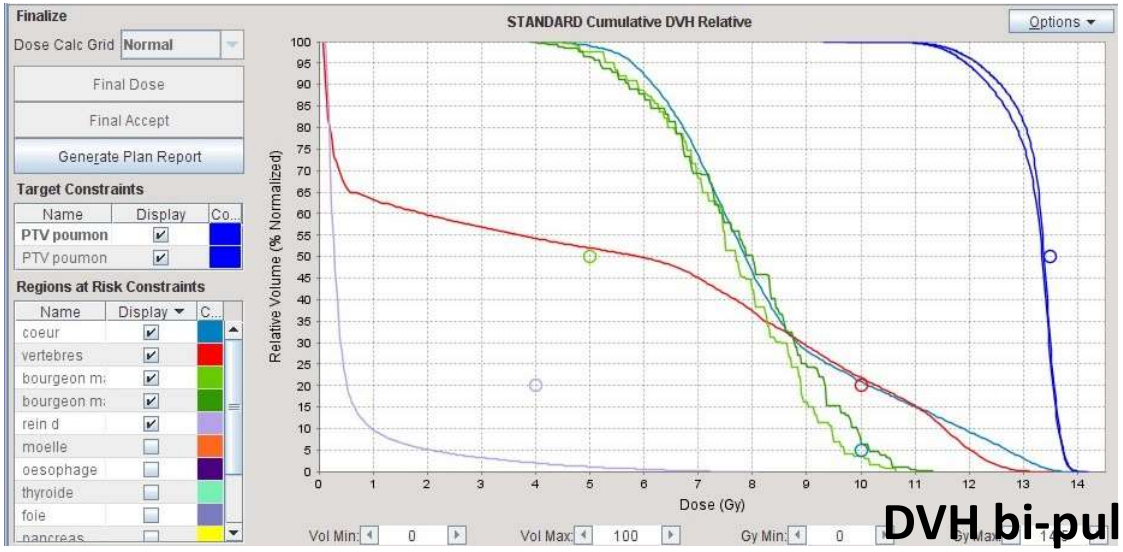
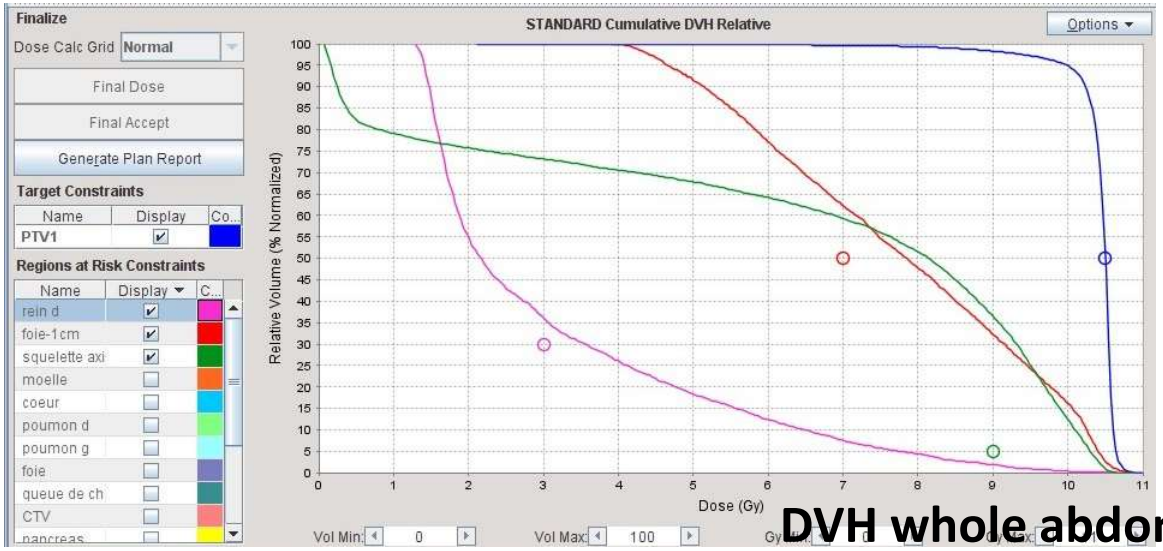
60

Nephroblastoma

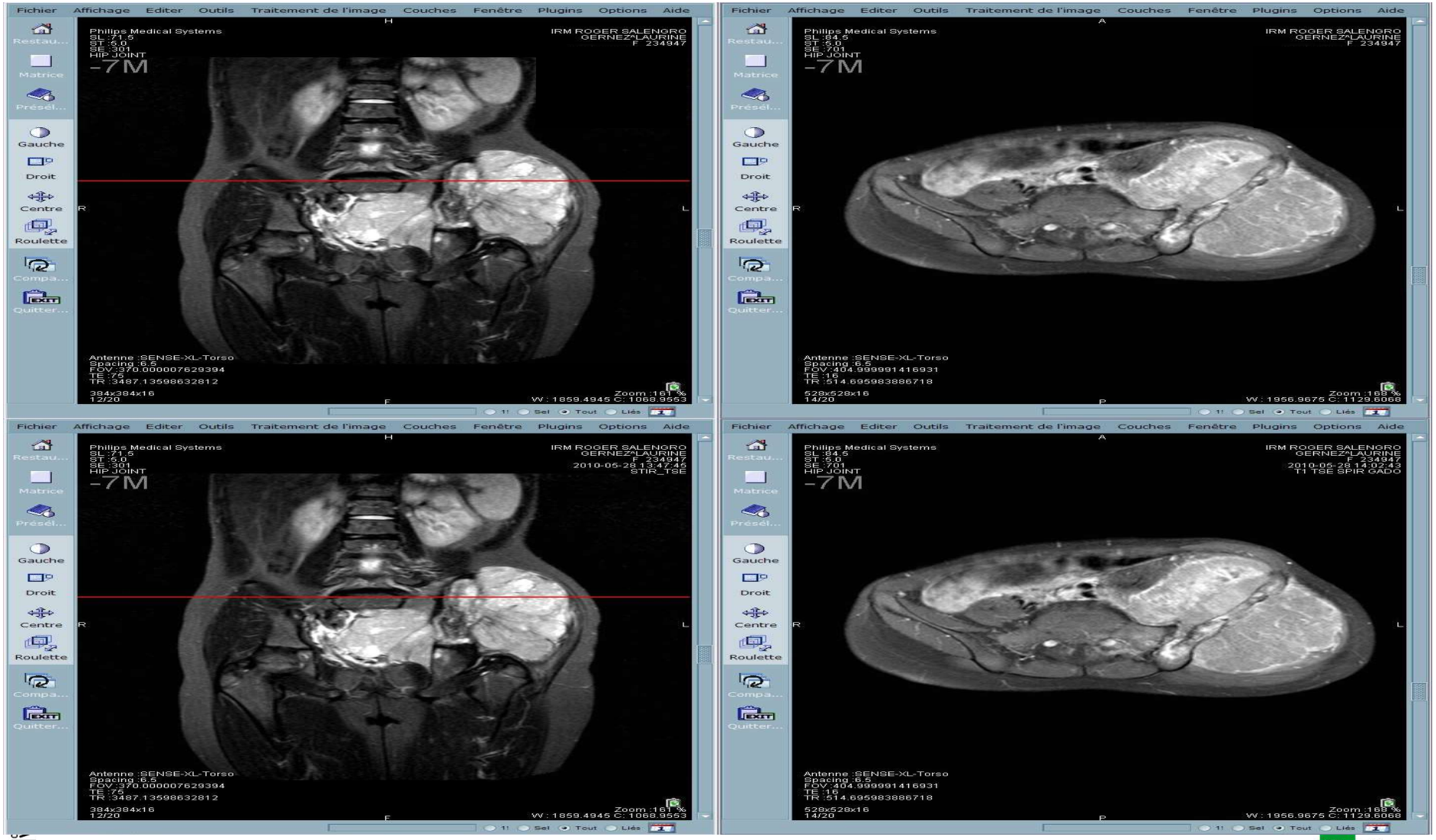


DVH bi-pulmonary Tomotherapy

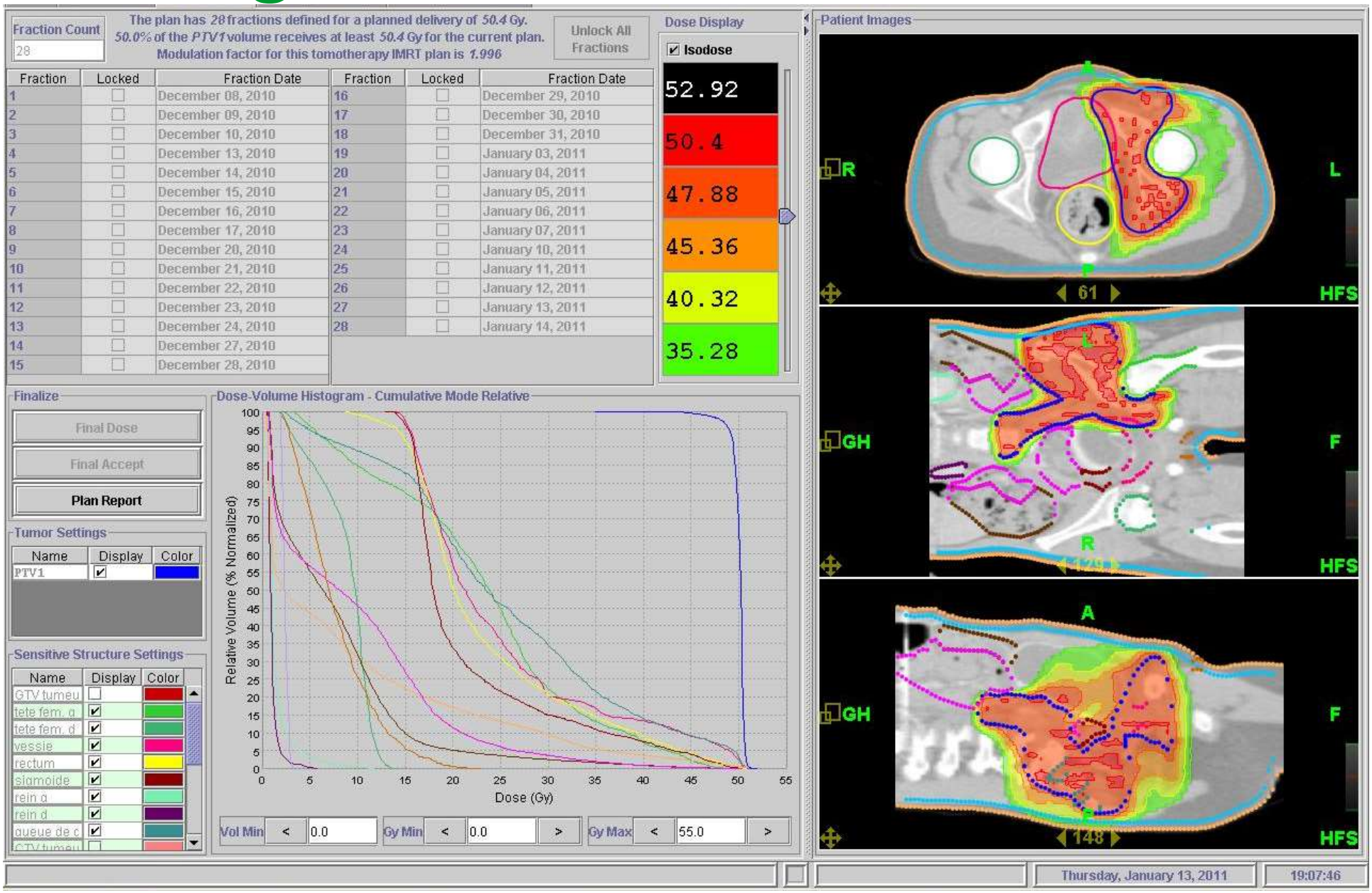


DVH whole abdominal Tomotherapy

Ewing sarcoma

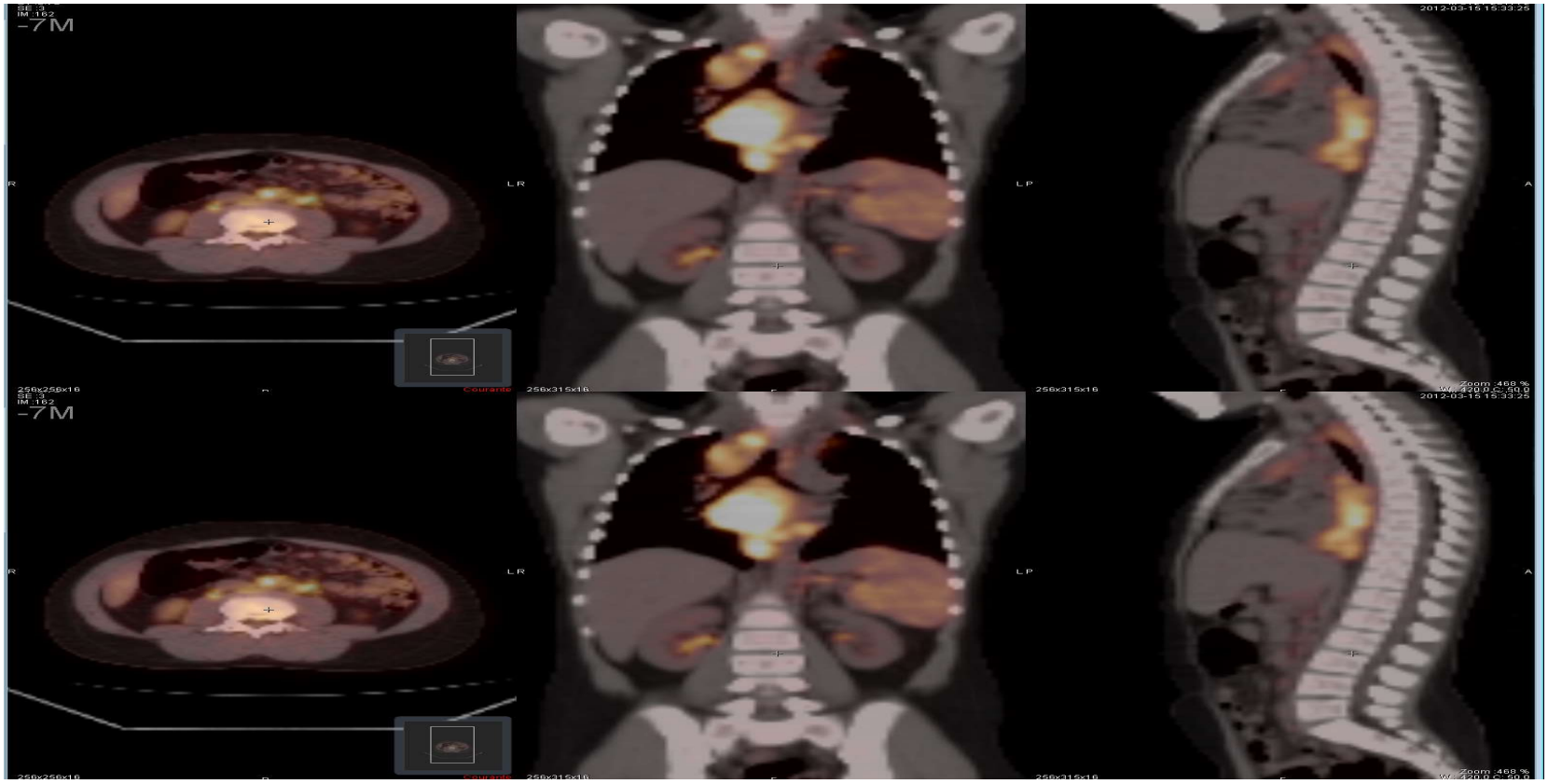


Ewing sarcoma

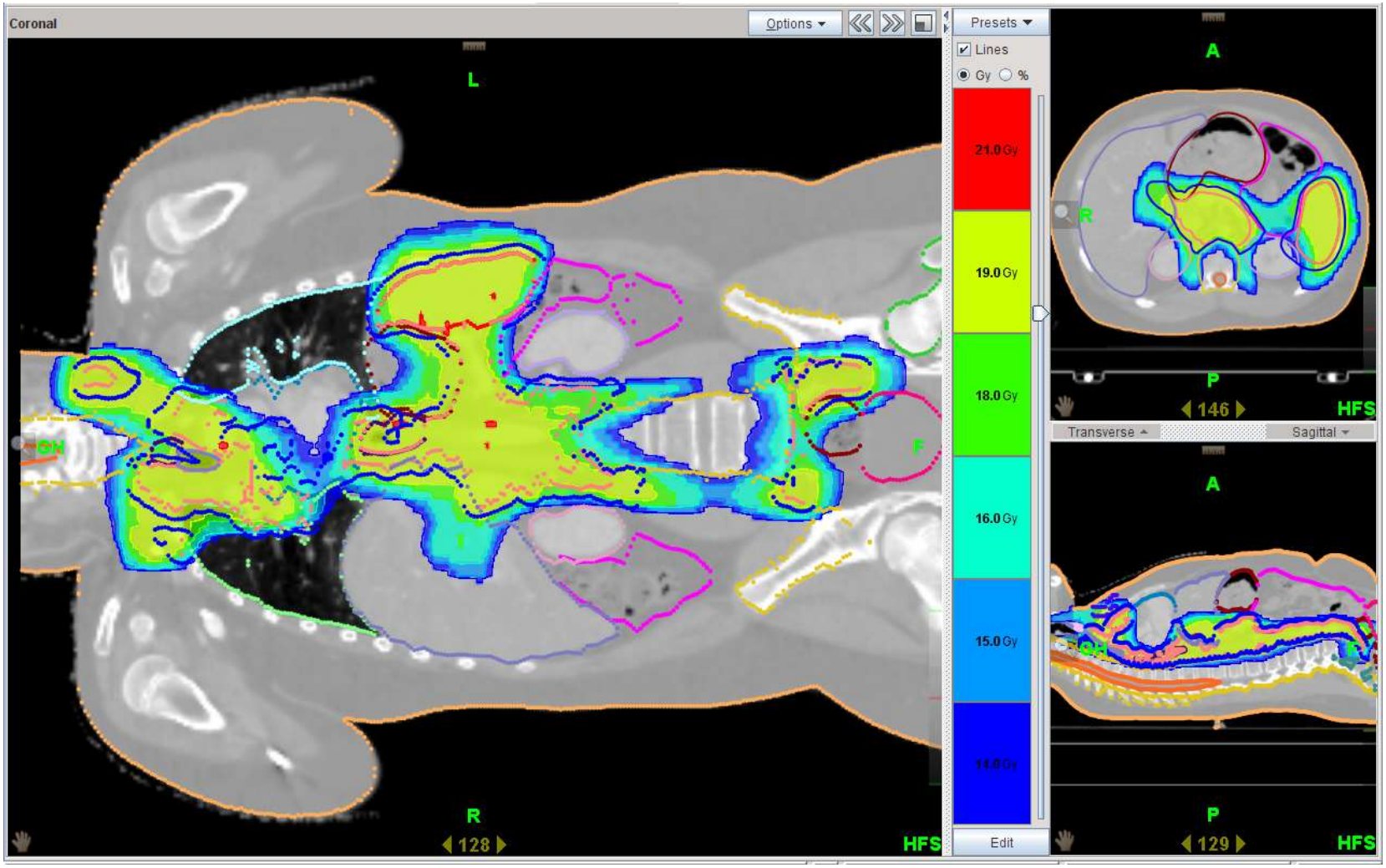



canton de vaud
Hodgkin disease
CHUV

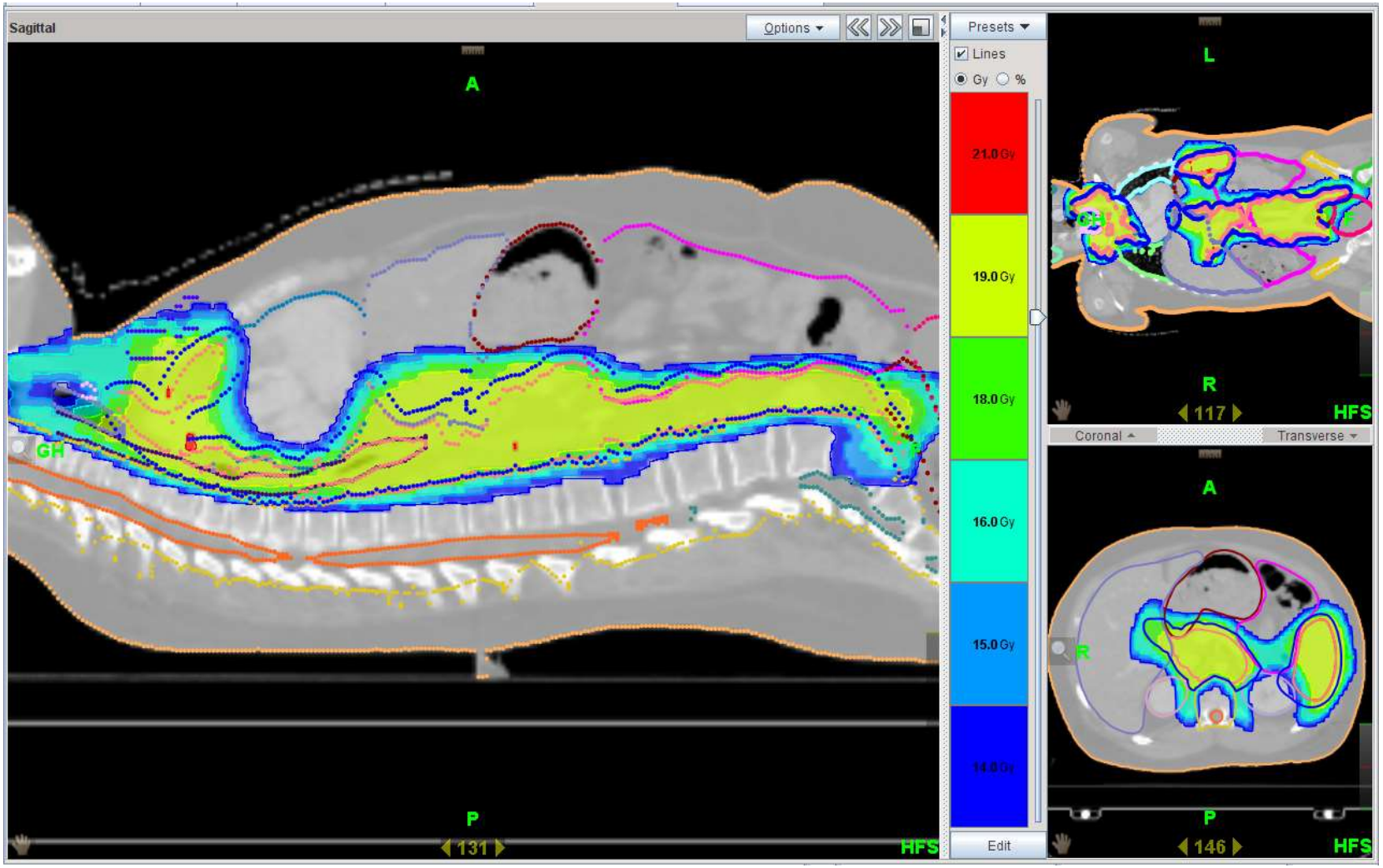
Hodgkin disease, sclero-nodular type , stage IIIB (EURONET PHL C1 group TG3)



Hodgkin disease, sclero-nodular type , stage IIIB (EURONET PHL C1 group TG3)



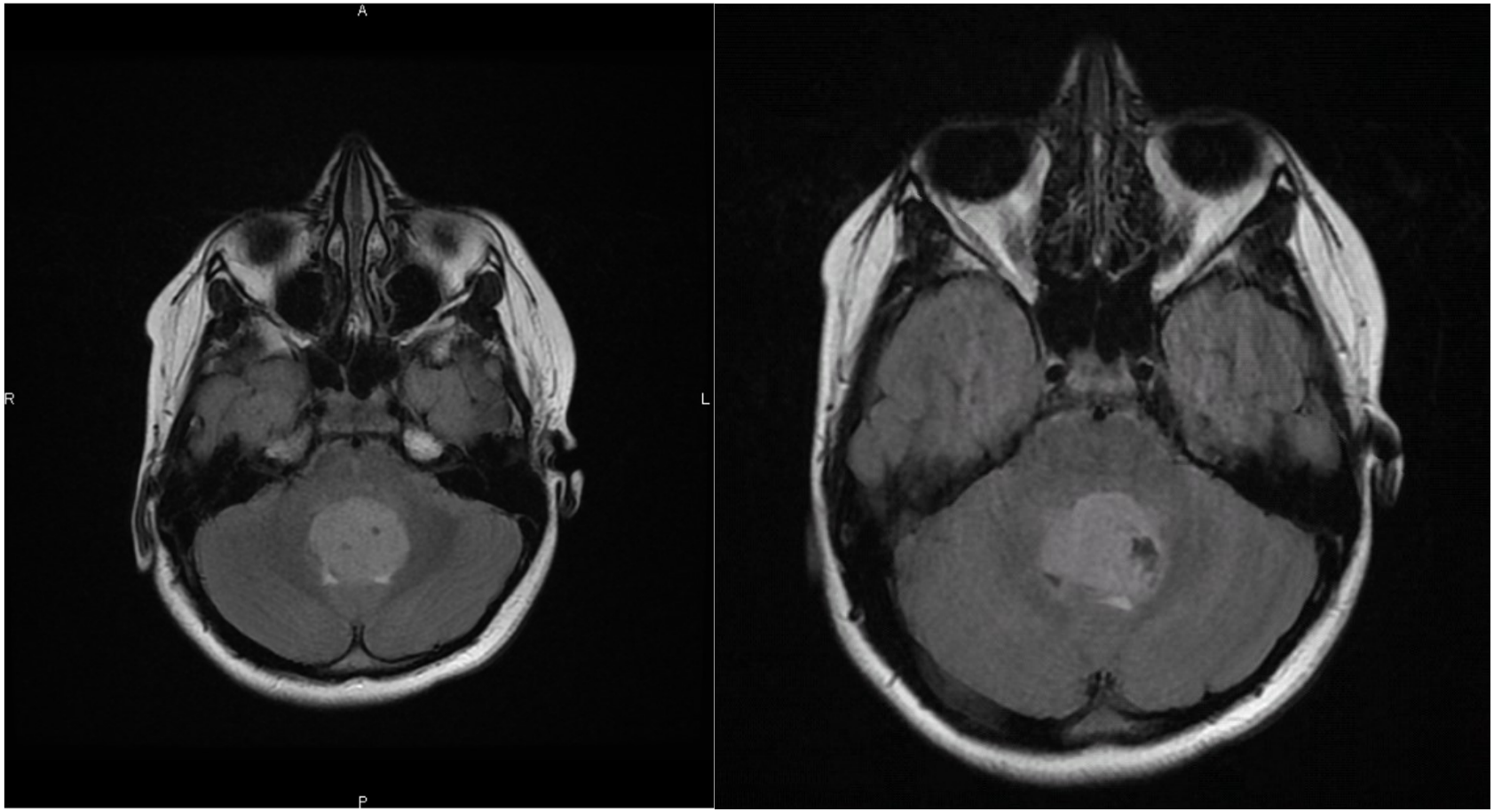
Hodgkin disease, sclero-nodular type , stage IIIB (EURONET PHL C1 group TG3)

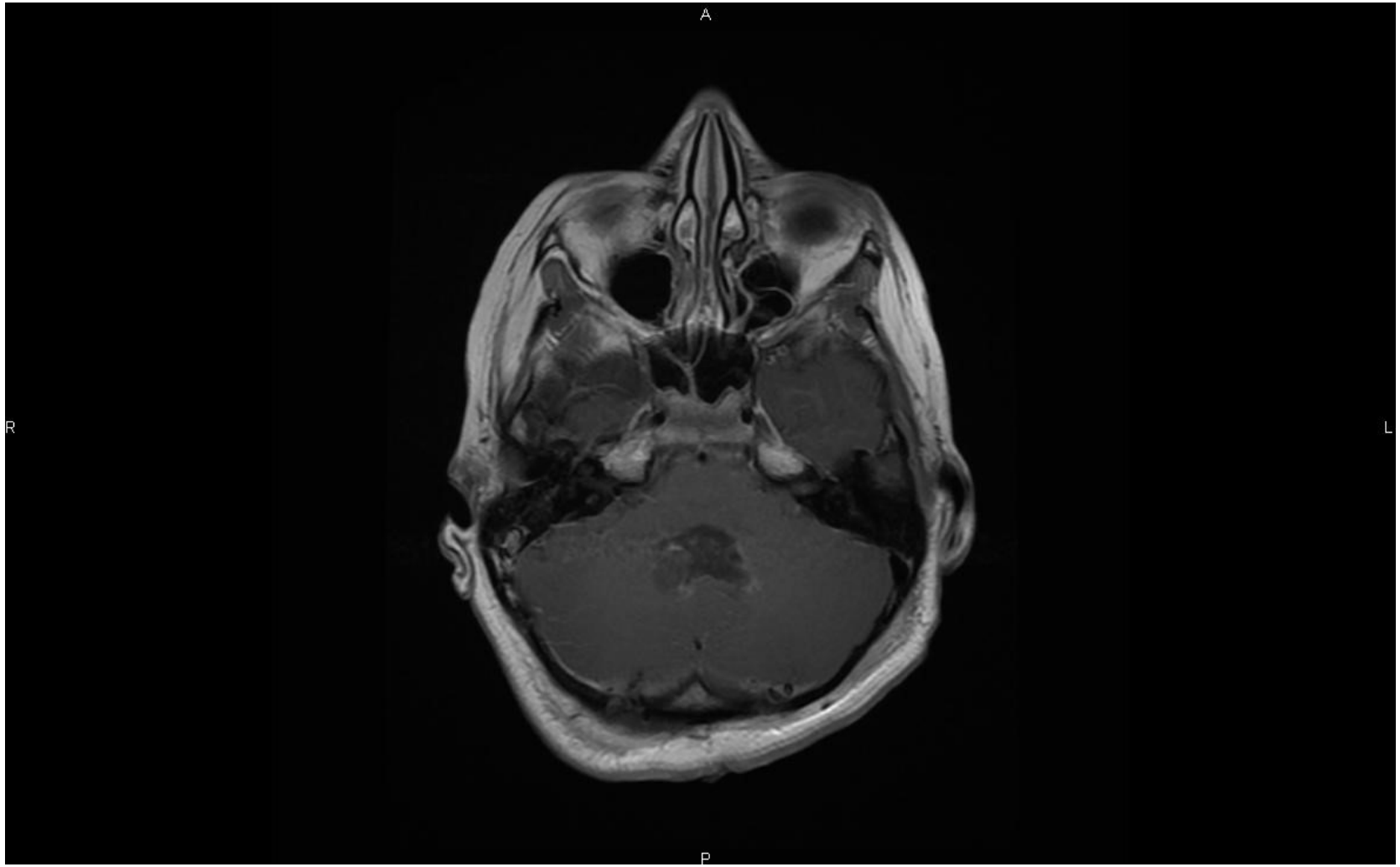


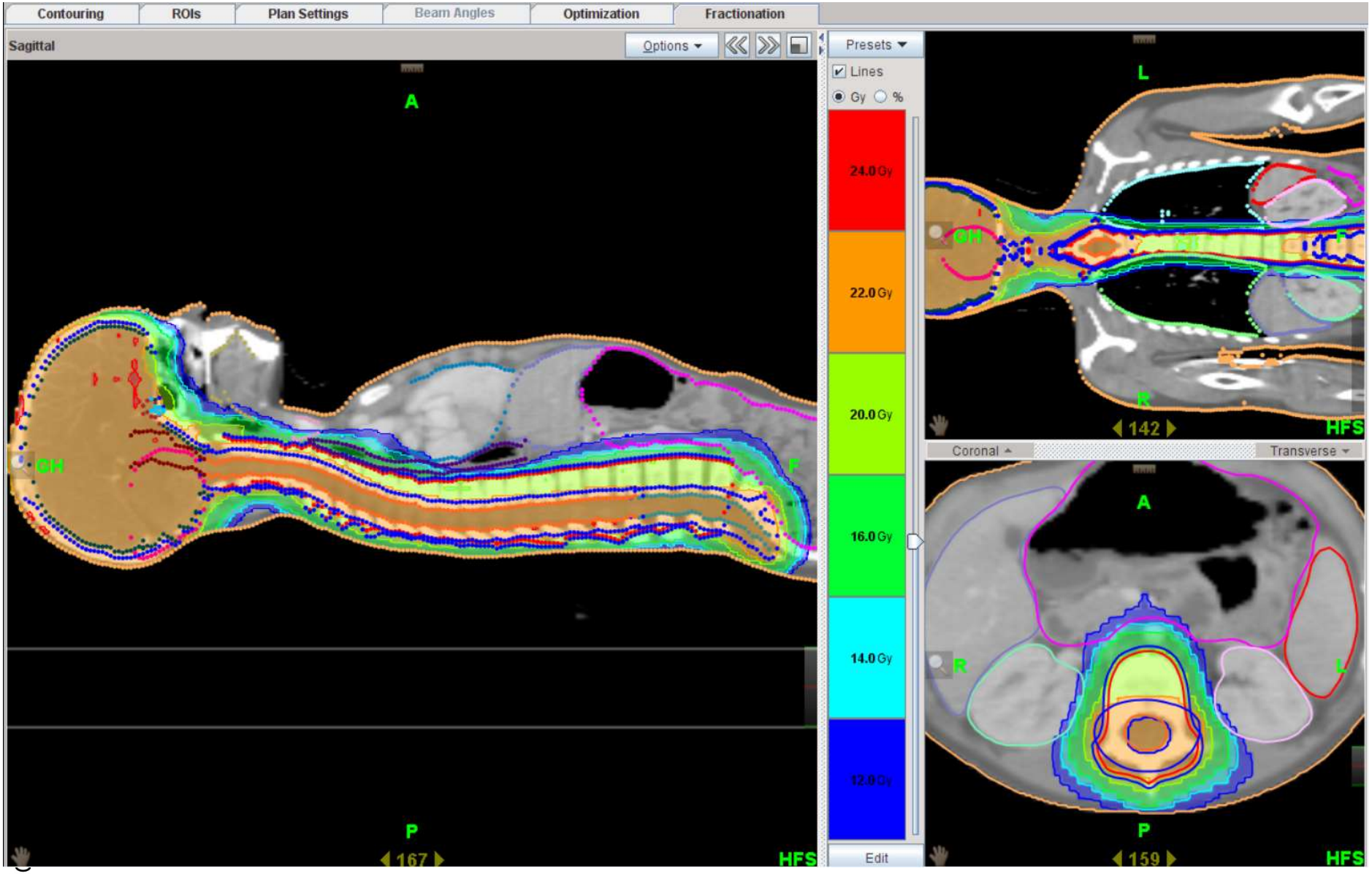

canton de vaud
Central nervous system (CNS)
CHUV

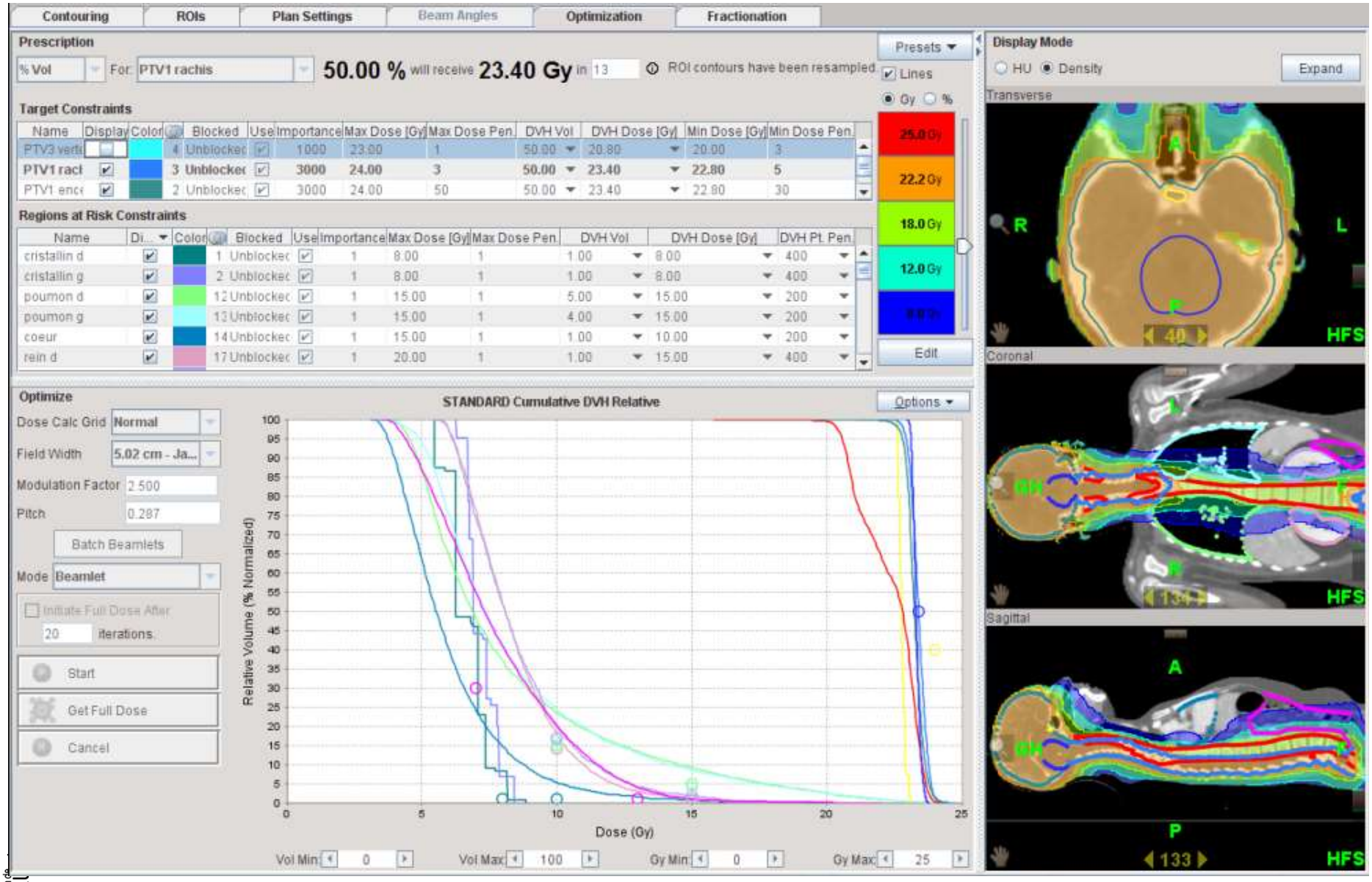
Clinical case

- Male, 12ans
- Posterior fossa tumour, 40 x 27 x 36 mm
- Complete macroscopic resection (R0)
  - Postoperative MRI without residue
  - Normal spinal MRI, normal LP
- Grade IV medulloblastoma (OMS)
  - No NMYC/CMYC amplification, loss of 17p and gain of 17q
- Average risk medulloblastoma

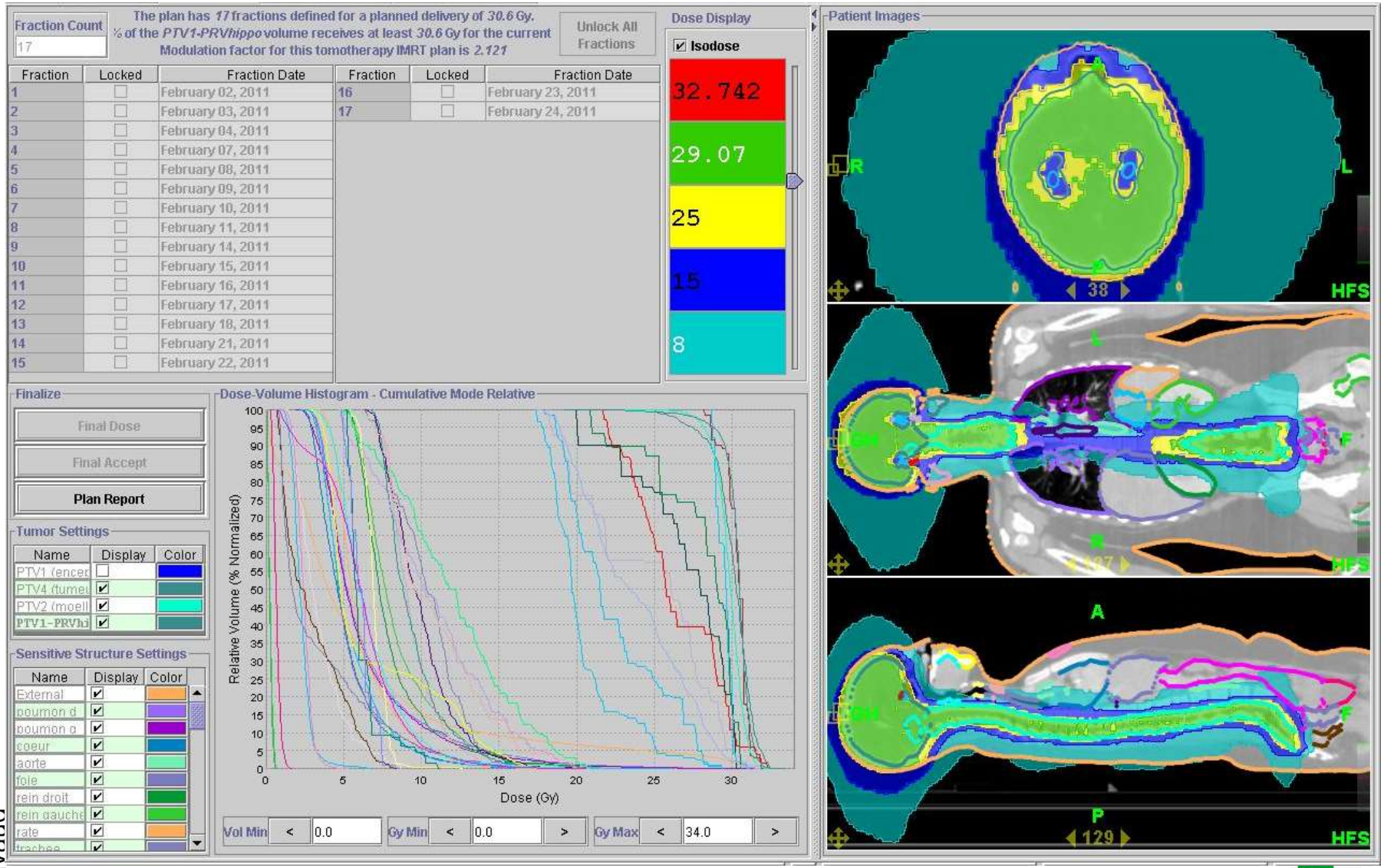

A
R
L
P


A
R
L
P


Contouring
ROIs
Plan Settings
Beam Angles
Optimization
Fractionation
Sagittal
Options
A
GH
F
P
167
HFS
Presets
Lines
Gy
%
24.0 Gy
22.0 Gy
20.0 Gy
16.0 Gy
14.0 Gy
12.0 Gy
Edit
L
GH
R
142
HFS
Coronal
Transverse
A
R
L
P
159
HFS


Contouring
ROIs
Plan Settings
Beam Angles
Optimization
Fractionation
Prescription
% Vol
For: PTV1 rachis
50.00 % will receive 23.40 Gy in 13
ROI contours have been resampled
Presets
Lines
Gy
%
Target Constraints
Name Display Color Blocked Use Importance Max Dose [Gy] Max Dose Pen. DVH Vol DVH Dose [Gy] Min Dose [Gy] Min Dose Pen.
PTV3 verte 4 Unblocker 1000 23.00 1 50.00 20.80 20.00 3
PTV1 racl 3 Unblocker 3000 24.00 3 50.00 23.40 22.80 5
PTV1 encl 2 Unblocker 3000 24.00 50 50.00 23.40 22.80 30
Regions at Risk Constraints
Name Di... Color Blocked Use Importance Max Dose [Gy] Max Dose Pen. DVH Vol DVH Dose [Gy] DVH Pt. Pen.
cristallin d 1 Unblocker 1 8.00 1 1.00 8.00 400
cristallin g 2 Unblocker 1 8.00 1 1.00 8.00 400
poumon d 12 Unblocker 1 15.00 1 5.00 15.00 200
poumon g 13 Unblocker 1 15.00 1 4.00 15.00 200
coeur 14 Unblocker 1 15.00 1 1.00 10.00 200
rein d 17 Unblocker 1 20.00 1 1.00 15.00 400
25.0 Gy
22.2 Gy
18.0 Gy
12.0 Gy
Edit
Optimize
Dose Calc Grid Normal
Field Width 5.02 cm - Ja...
Modulation Factor 2.500
Pitch 0.287
Batch Beamlets
Mode Beamlet
Initiate Full Dose After
20 iterations
Start
Get Full Dose
Cancel
STANDARD Cumulative DVH Relative
Options
Relative Volume (% Normalized)
Dose (Gy)
Vol Min 0
Vol Max 100
Gy Min 0
Gy Max 25
Display Mode
HU
Density
Expand
Transverse
Coronal
Sagittal
R
L
A
P
HFS
40
133

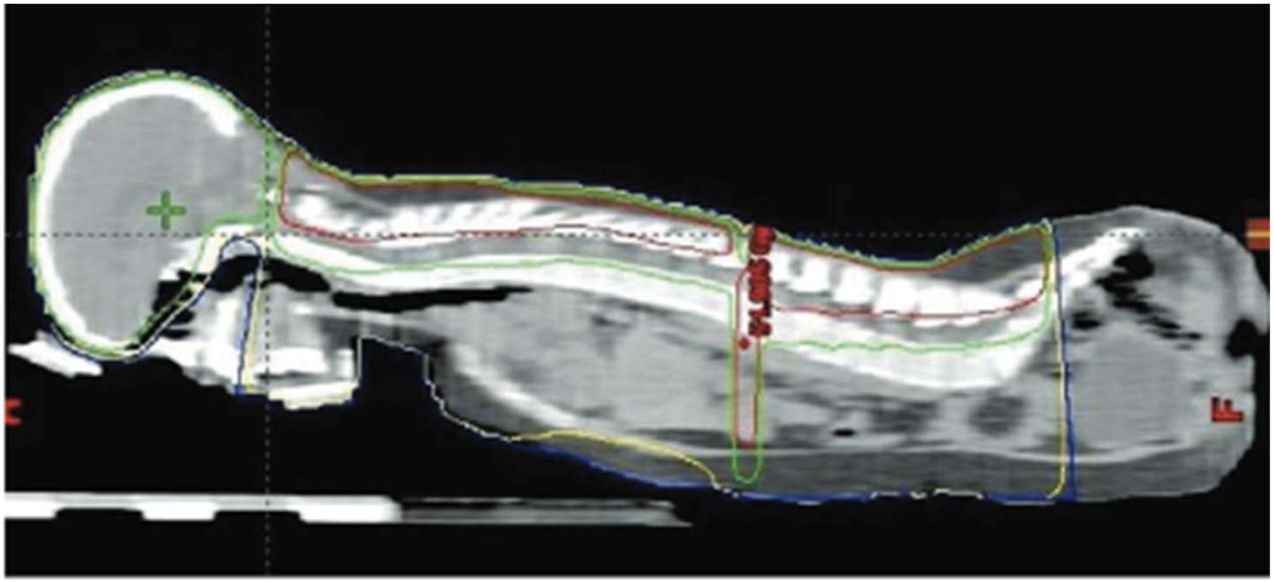
Hippocampal-Sparing Whole-Brain Radiotherapy




canton de vaud
Craniospinal irradiation in TomoTherapy: Assessment of the feasibility and tolerance in 68 patients
CHUV

Craniospinal irradiation: standard technique

- Doses:
  - 23.4 to 36 Gy to the brain and spinal axis
  - 54 Gy to the posterior fossa (fractions of 1.8 Gy) or tumoral bed (SIOP)
- Problem with overlaps: *hot spots next to the larynx and spinal cord*



French experience: Lille and Nantes

- Retrospective study
- August 2007 to June 2013
- 68 patients
- Centre Oscar Lambret (Lille) and Centre René Gauducheau (Nantes)
- Craniospinal irradiation indication:
  - Medulloblastoma
  - PNET
  - Metastatic ependymomas

Toxicity

- **Acute toxicity (< 90 days)**
  - 55 patients (81%) at least one grade 2 toxicity
  - 29 patients (43%) at least one grade 3 toxicity
  - 3 patients (4%) haematological grade 4 toxicity
  - Non-significant correlation with previous treatment or concomitant chemotherapy

Types of acute toxicity	Total	Grade 1	Grade 2	Grade 3	Grade 4
Haematological	45 (66,2%)	7	12	23	3
Digestive	36 (52,9%)	14	17	5	0
Neurologic	13 (19,1%)	7	3	3	0
Mucosal-cutaneous	24 (35,3%)	6	15	3	0
Asthenia	15 (22,1%)	11	4	0	0

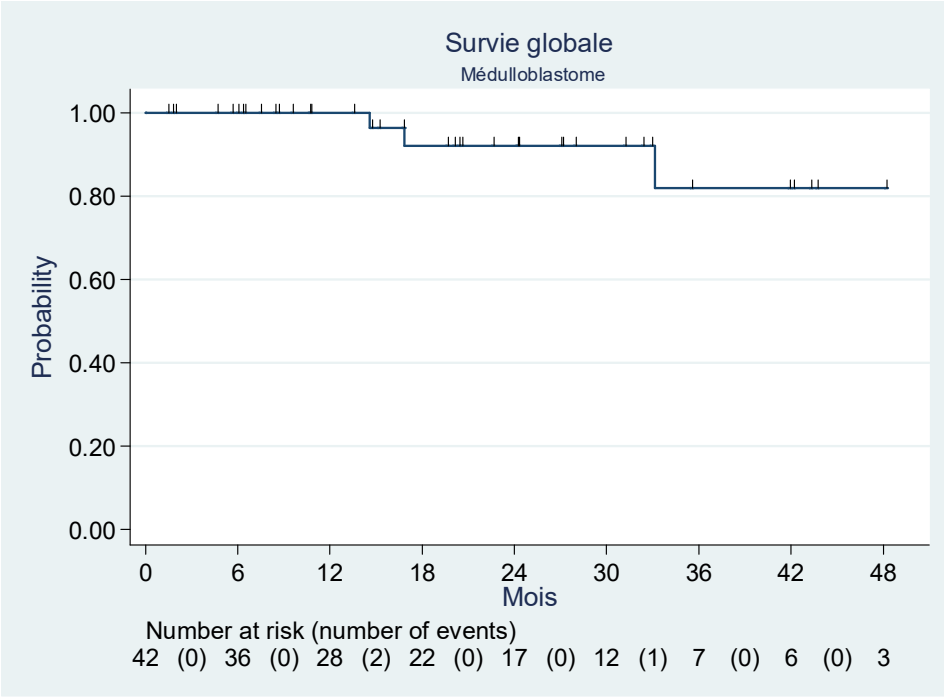
Toxicity

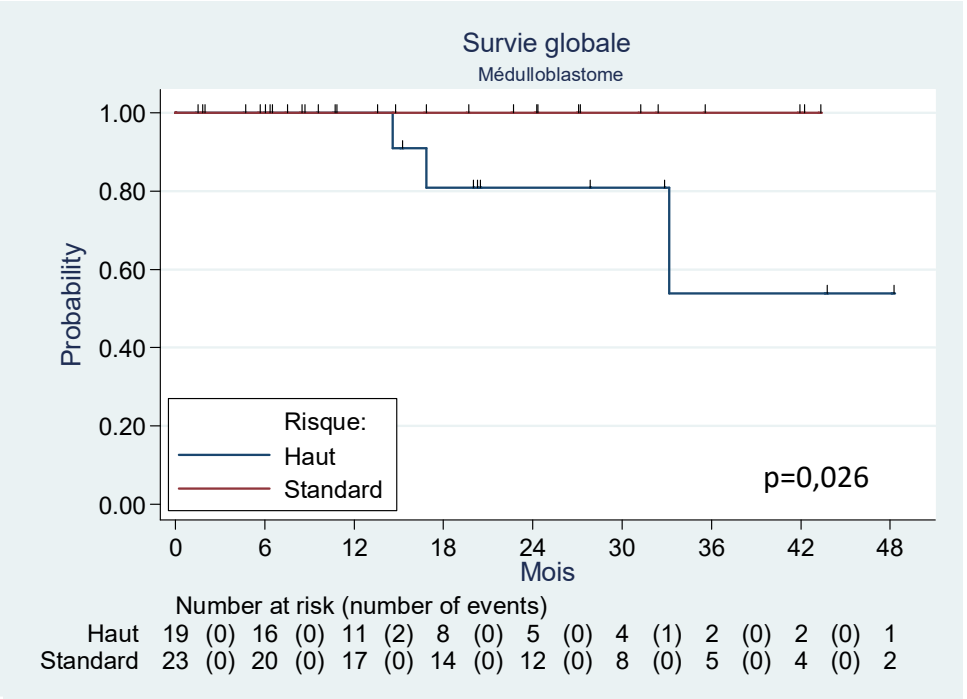
- **Late toxicity (> 90 days)**
  - 28 patients (41%)
  - 4 patients (6%) grade 3 toxicity
  - No grade 4 toxicity
  - Non-significant correlation avec cochlear, pituitary and thyroid doses

Types of late toxicity	Total	Grade 1	Grade 2	Grade 3	Grade 4
Neurologic	15 (22,1%)	4	11	0	0
Hormonal	10 (14,7%)	2	7	1	0
Hearing	7 (10,3%)	1	4	2	0
Haematological	3 (4,4%)	2	0	1	0

Overall survival

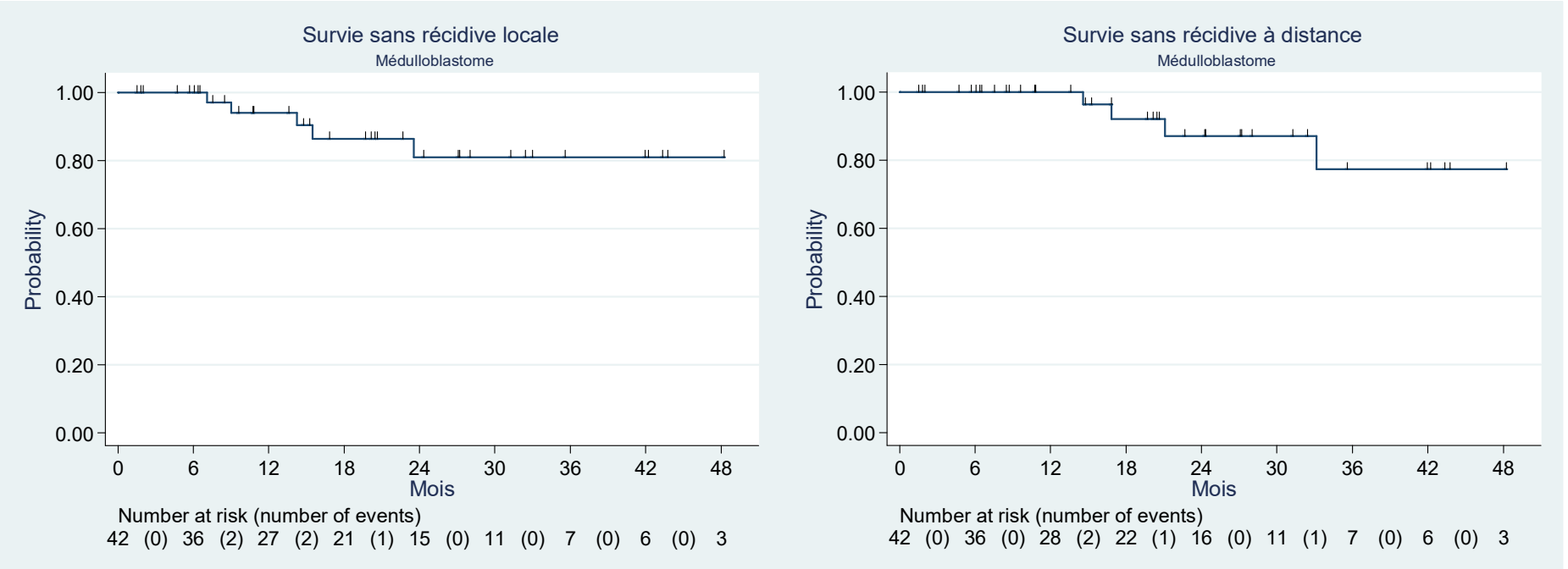
- **Medulloblastoma**
  - 12, 24 and 36 months OS: 100%, 92% and 82%





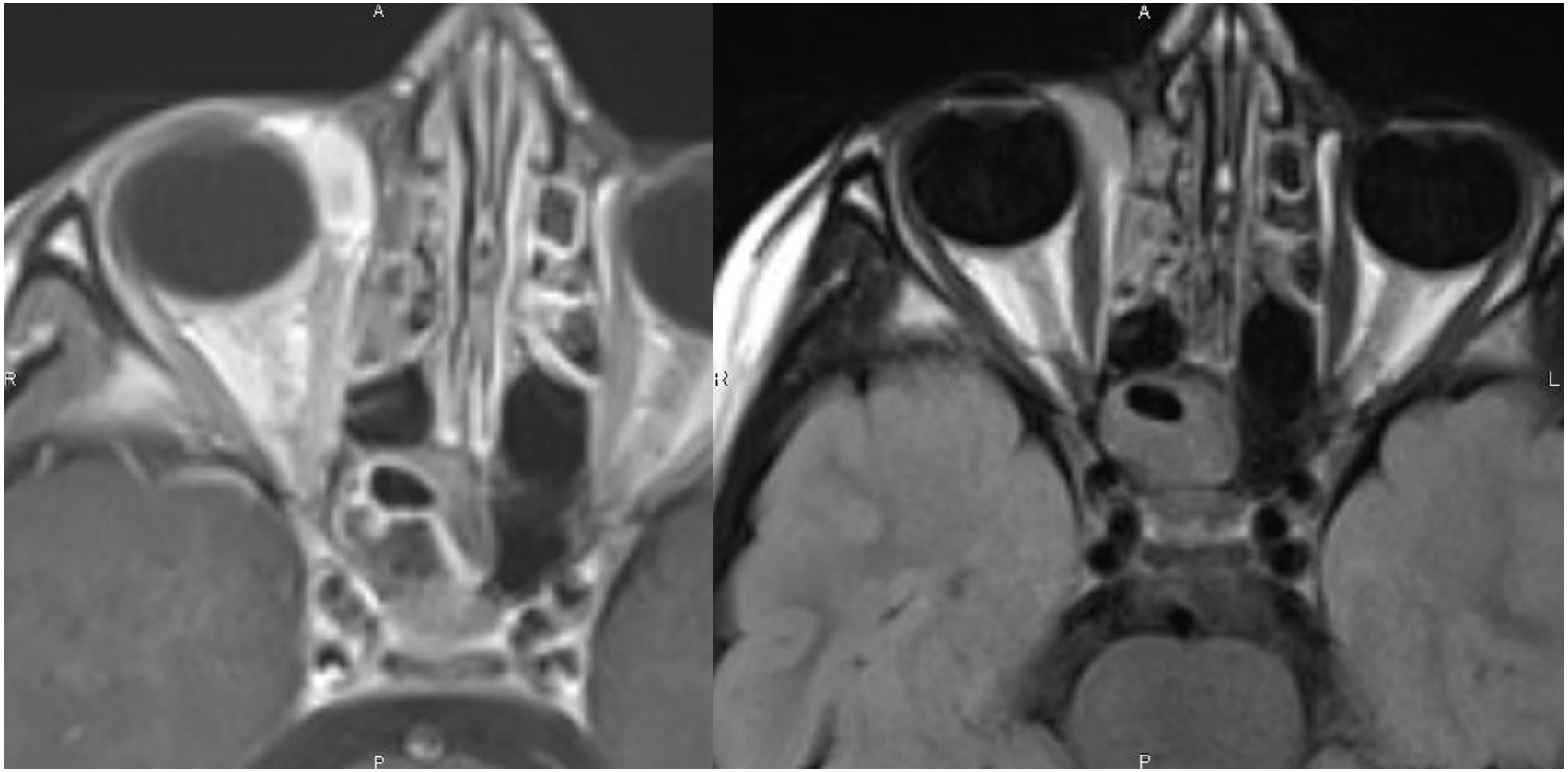
Progression free survival (local/distant)

- **Medulloblastoma**
  - 5 local recurrences, 1 distant recurrence
  - 12, 24 and 36 months *local* PFS: 94%, 81% and 81%
  - Distant PFS: 100%, 87% and 77%




canton de vaud
Head & neck
CHUV

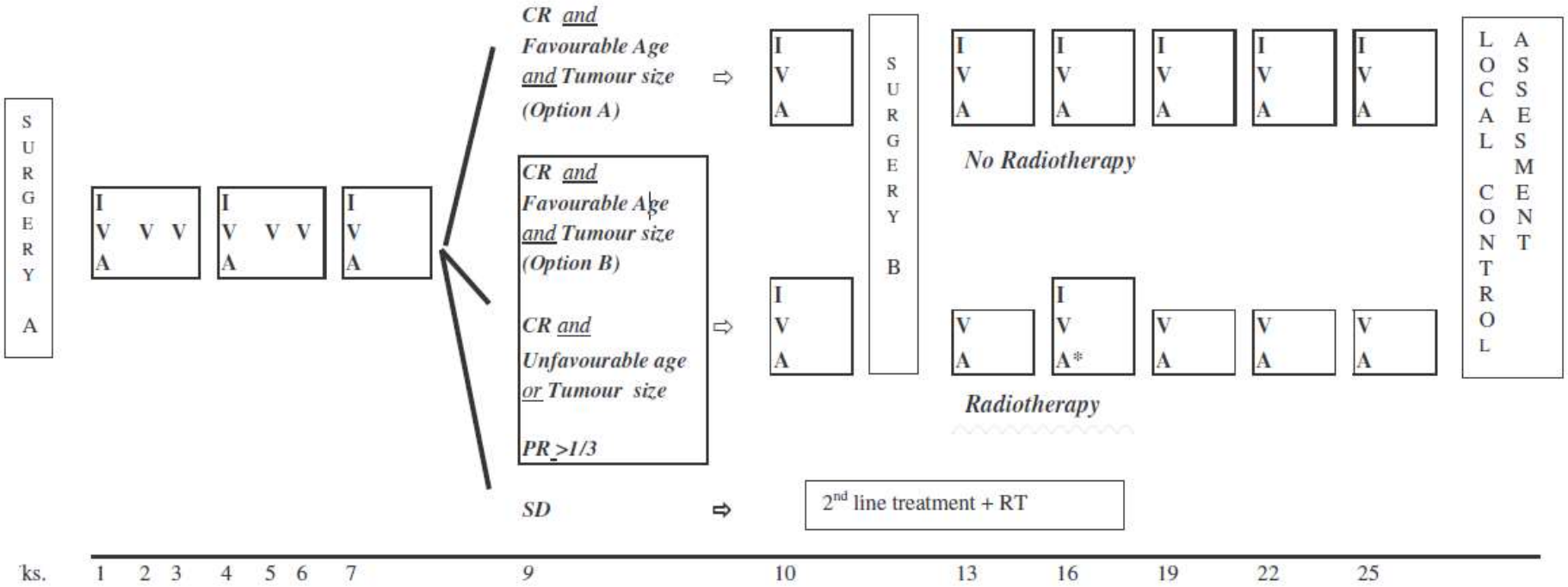
Orbital embryonary rhabdomyosarcoma



RMS 2005 protocole (groupe C)

6.4 TREATMENT SUMMARY: STANDARD RISK GROUP – SUBGROUP C

SUBGROUP C	**non alveolar RMS, IRS Group II or III, localised in orbit, head and neck non PM or GU non bladder-prostate,** *and* **nodes negative** *and* **any size** *or* **age**

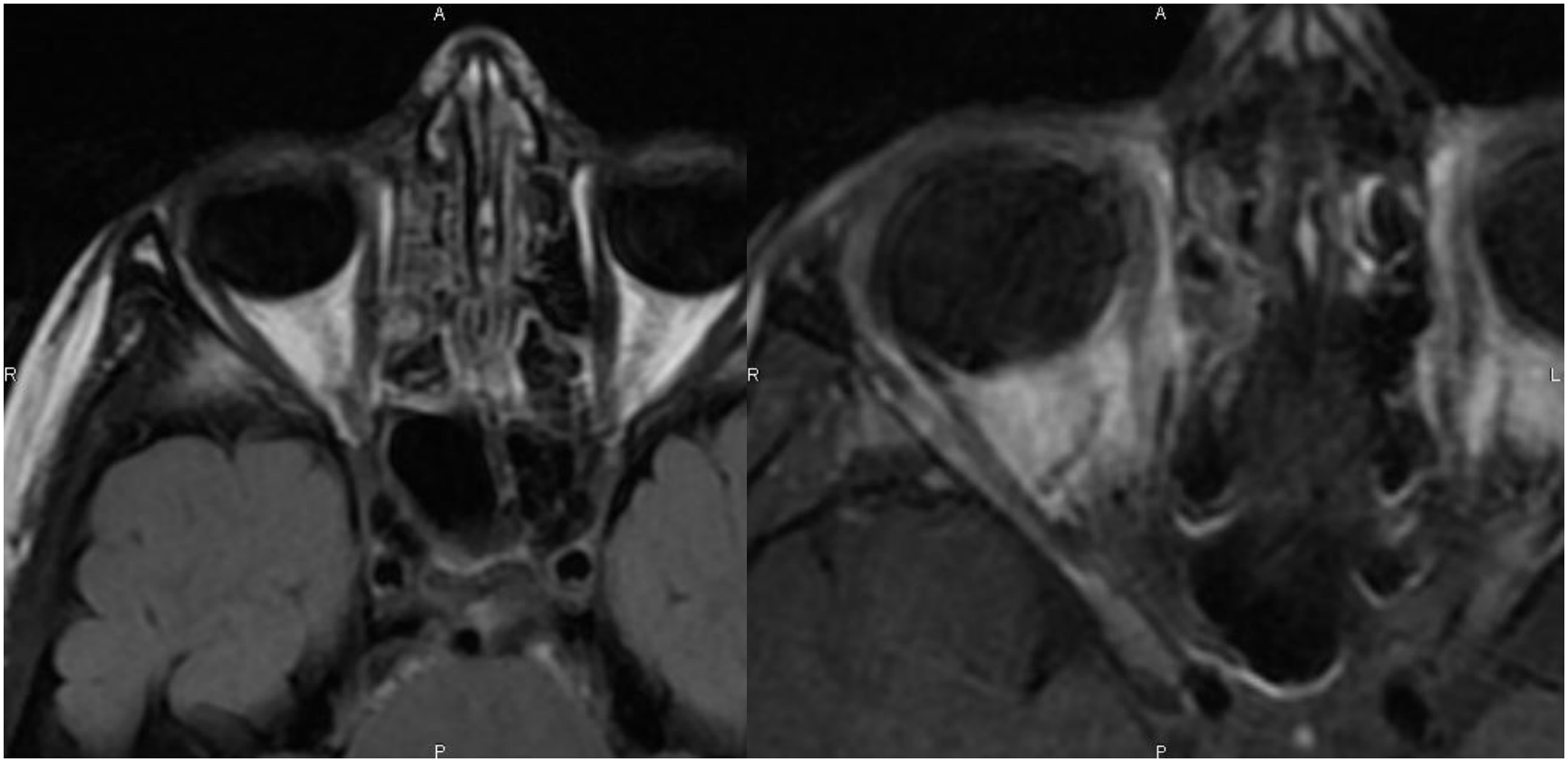


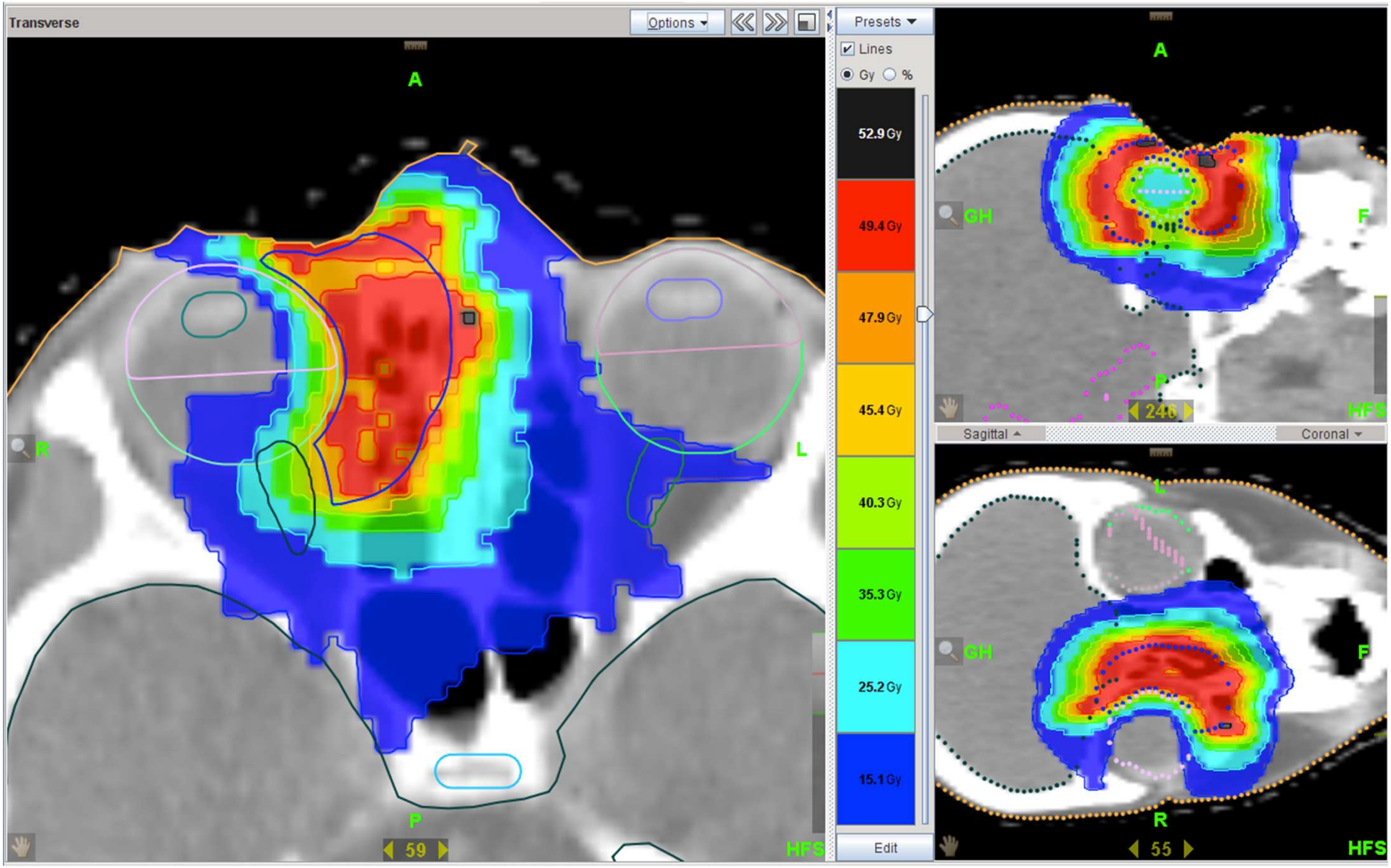
I Ifosfamide 3 g/m^2 is given as a 3 hour i.v. infusion daily, with Mesna (3 g/m^2) and hydration, on days 1 & 2 for each course of treatment. (Total IFO/course = 6 g/m^2).
V Vincristine 1.5 mg/m^2 (max. single dose 2 mg) is given as a single i.v. injection on day 1 of each course and weekly, for a total of 7 consecutive doses, from week 1 to 7.
A Actinomycin D 1.5 mg/ m^2 (maximum single dose 2 mg) as a single i.v. injection on day 1 of each course.
** Actinomycin may be given at the very beginning of RT (week 13) but is omitted during RT (week 16), see chapter23.11.*

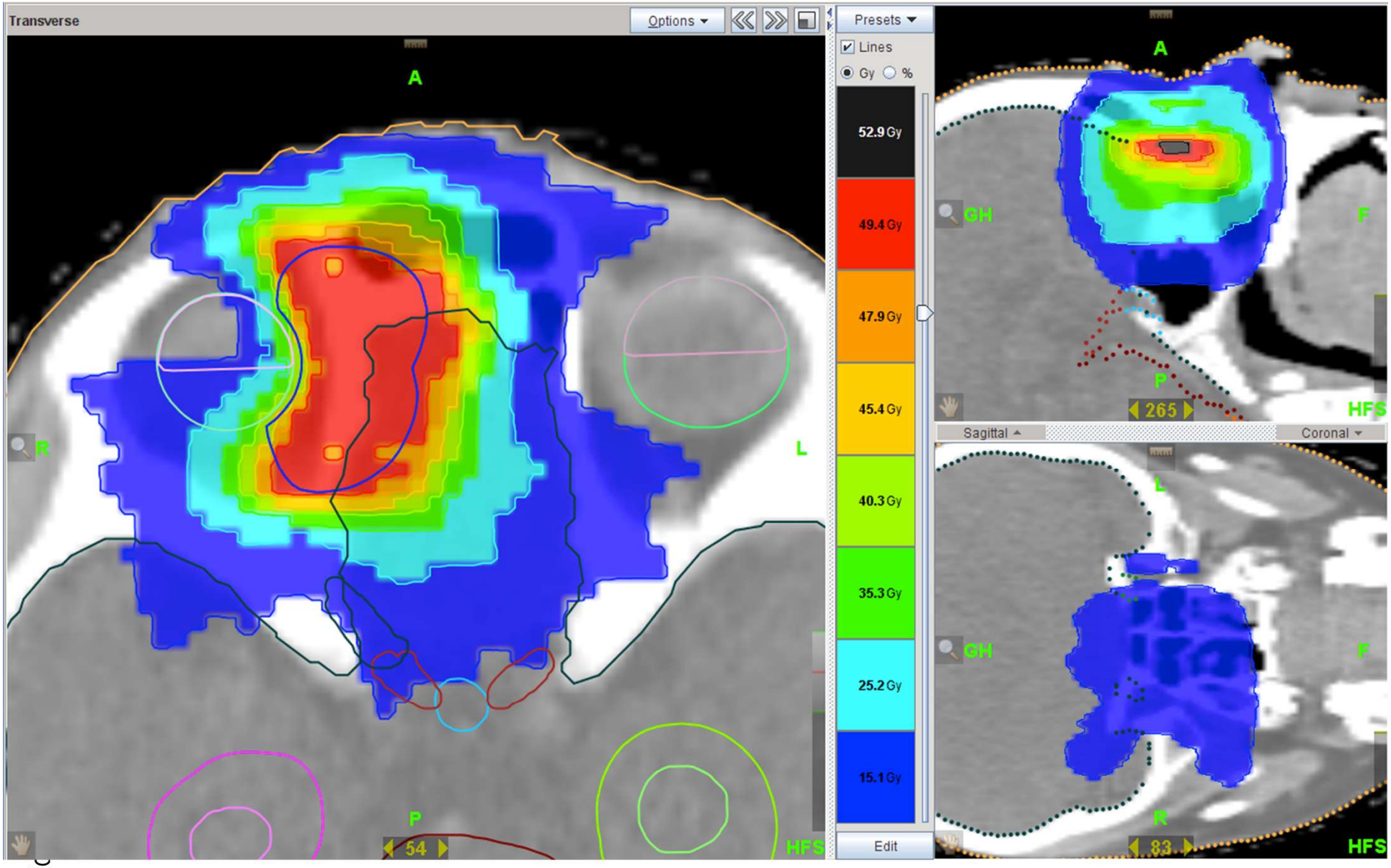
Note: Patients with favourable age (< 10 years) and tumour ≤ 5 cm at diagnosis, who achieve the complete remission after the initial treatment (3 courses of IVA + surgery) have two options:

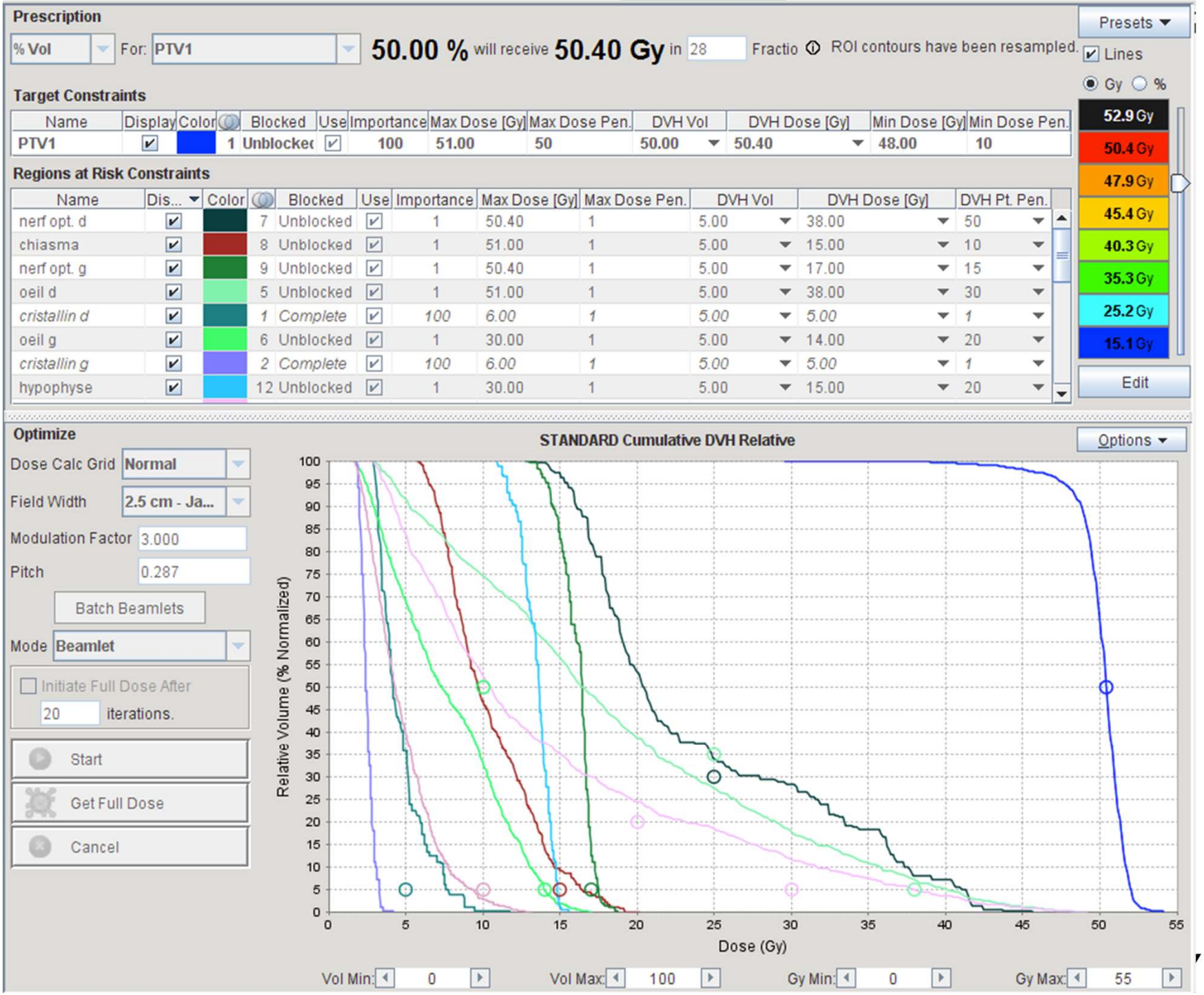
- **Option A:** patients will receive 6 courses of IVA without radiotherapy.
- **Option B:** patients will receive 6 courses of IVA without radiotherapy only if the CR has been obtained through a secondary operation (histologically CR). Otherwise they will be treated as patients in CR with unfavourable features. *NOTE: The German (CWS), the Italian (STSC) and the Spanish Group do recommend option B.*

Partial response after 3 cycles of chemotherapy

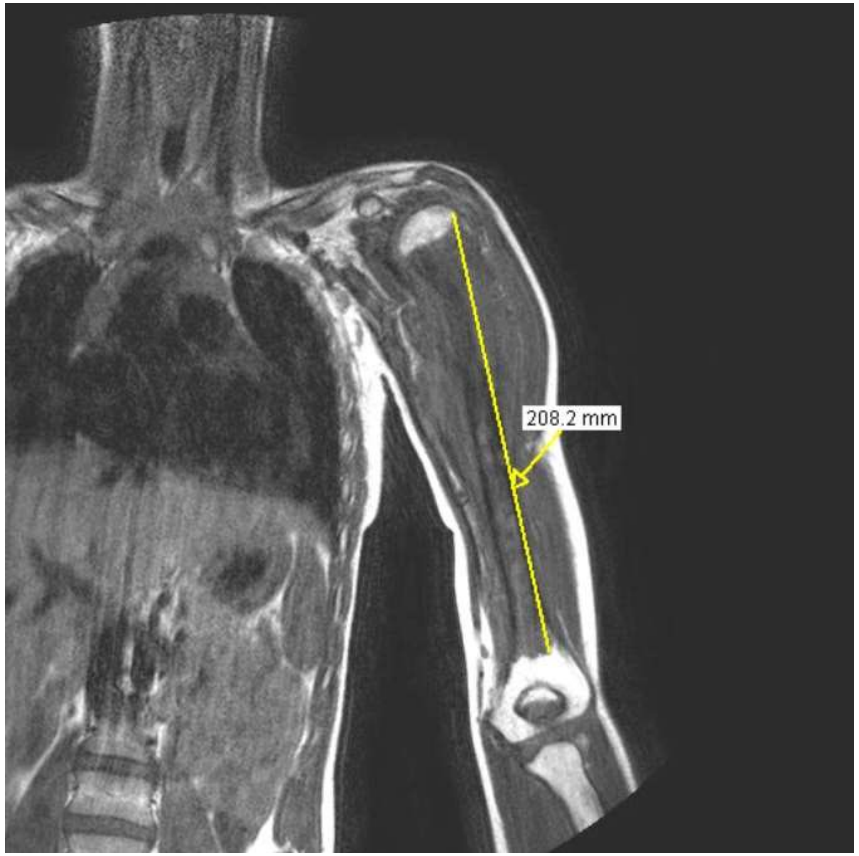



Transverse
Options
A
R
L
P
59
HFS
Presets
Lines
Gy
%
52.9 Gy
49.4 Gy
47.9 Gy
45.4 Gy
40.3 Gy
35.3 Gy
25.2 Gy
15.1 Gy
Edit
A
GH
F
P
246
HFS
Sagittal
Coronal
L
GH
F
R
55
HFS

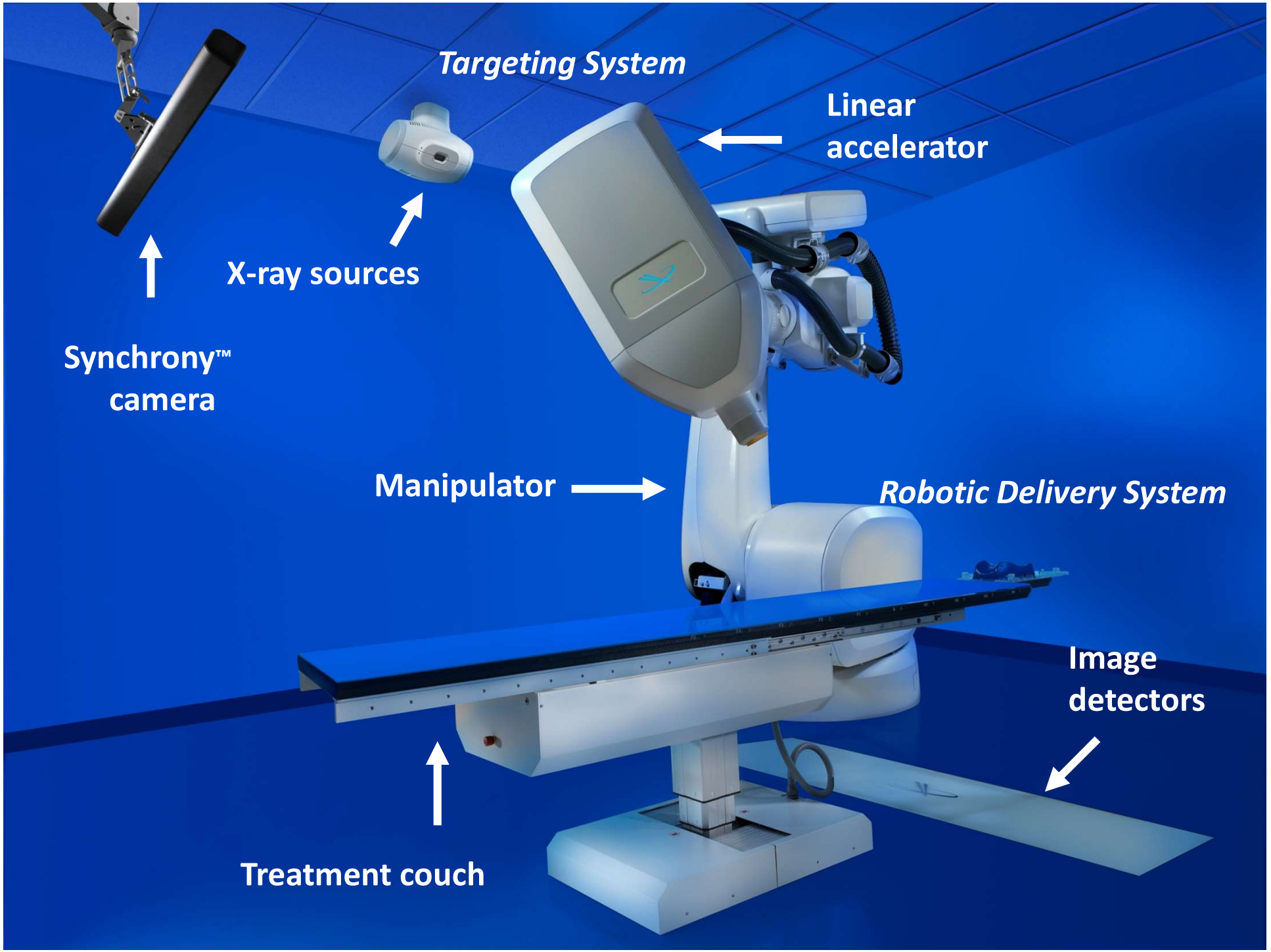

Transverse
Options
A
R
L
P
54
HFS
Presets
Lines
Gy
%
52.9 Gy
49.4 Gy
47.9 Gy
45.4 Gy
40.3 Gy
35.3 Gy
25.2 Gy
15.1 Gy
Edit
A
GH
F
P
265
HFS
Sagittal
Coronal
L
GH
F
R
83
HFS


Prescription
% Vol
For: PTV1
50.00 % will receive 50.40 Gy in 28 Fractio
ROI contours have been resampled.
Presets
Lines
Gy %
Target Constraints
Name Display Color Blocked Use Importance Max Dose [Gy] Max Dose Pen. DVH Vol DVH Dose [Gy] Min Dose [Gy] Min Dose Pen.
PTV1 1 Unblocke 100 51.00 50 50.00 50.40 48.00 10
Regions at Risk Constraints
Name Dis... Color Blocked Use Importance Max Dose [Gy] Max Dose Pen. DVH Vol DVH Dose [Gy] DVH Pt. Pen.
nerf opt. d 7 Unblocked 1 50.40 1 5.00 38.00 50
chiasma 8 Unblocked 1 51.00 1 5.00 15.00 10
nerf opt. g 9 Unblocked 1 50.40 1 5.00 17.00 15
oeil d 5 Unblocked 1 51.00 1 5.00 38.00 30
cristallin d 1 Complete 100 6.00 1 5.00 5.00 1
oeil g 6 Unblocked 1 30.00 1 5.00 14.00 20
cristallin g 2 Complete 100 6.00 1 5.00 5.00 1
hypophyse 12 Unblocked 1 30.00 1 5.00 15.00 20
52.9 Gy
50.4 Gy
47.9 Gy
45.4 Gy
40.3 Gy
35.3 Gy
25.2 Gy
15.1 Gy
Edit
Optimize
Dose Calc Grid Normal
Field Width 2.5 cm - Ja...
Modulation Factor 3.000
Pitch 0.287
Batch Beamlets
Mode Beamlet
Initiate Full Dose After
20 iterations.
Start
Get Full Dose
Cancel
STANDARD Cumulative DVH Relative
Options
Relative Volume (% Normalized)
Dose (Gy)
Vol Min: 0
Vol Max: 100
Gy Min: 0
Gy Max: 55

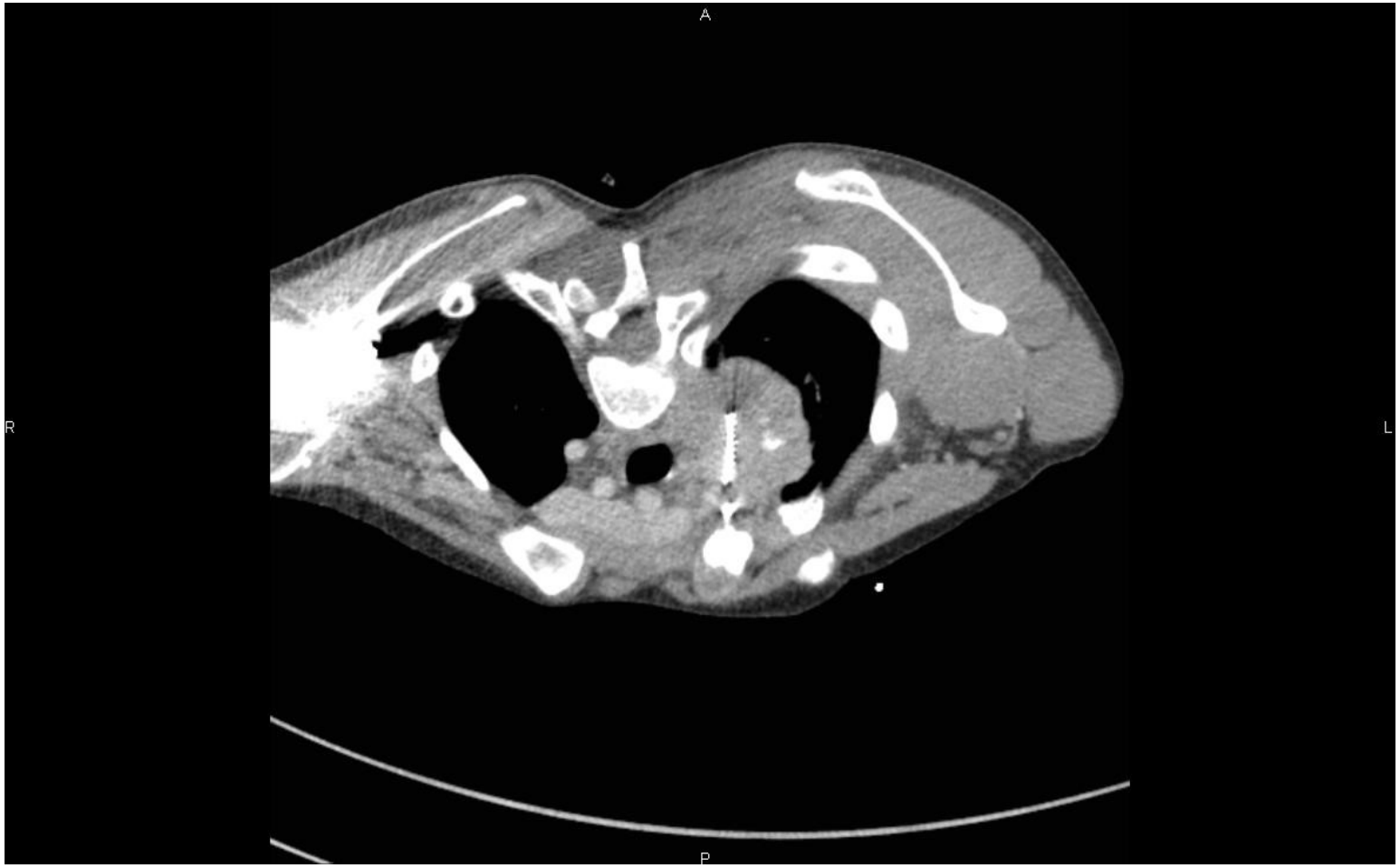
Humeral osteosarcoma

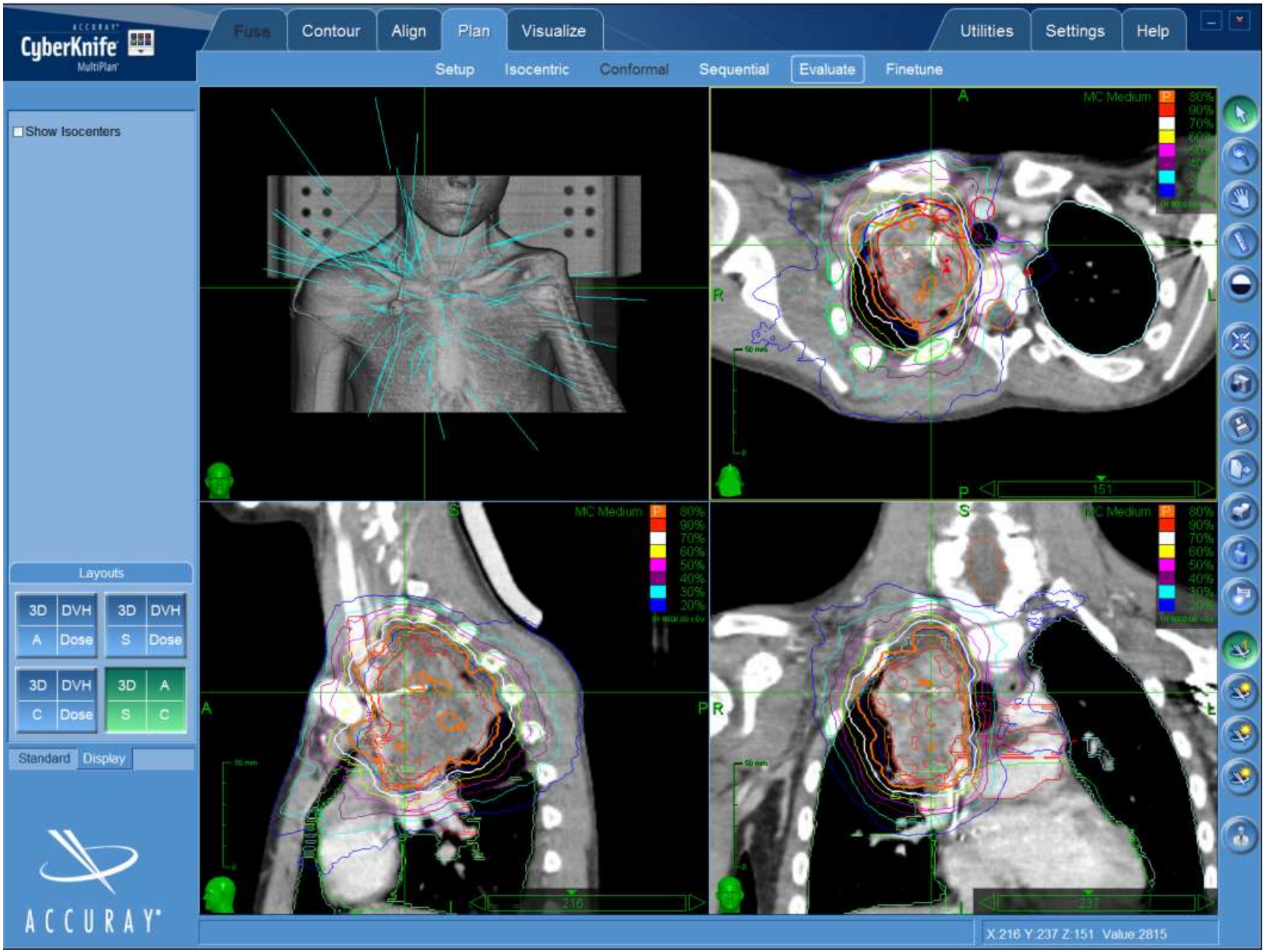


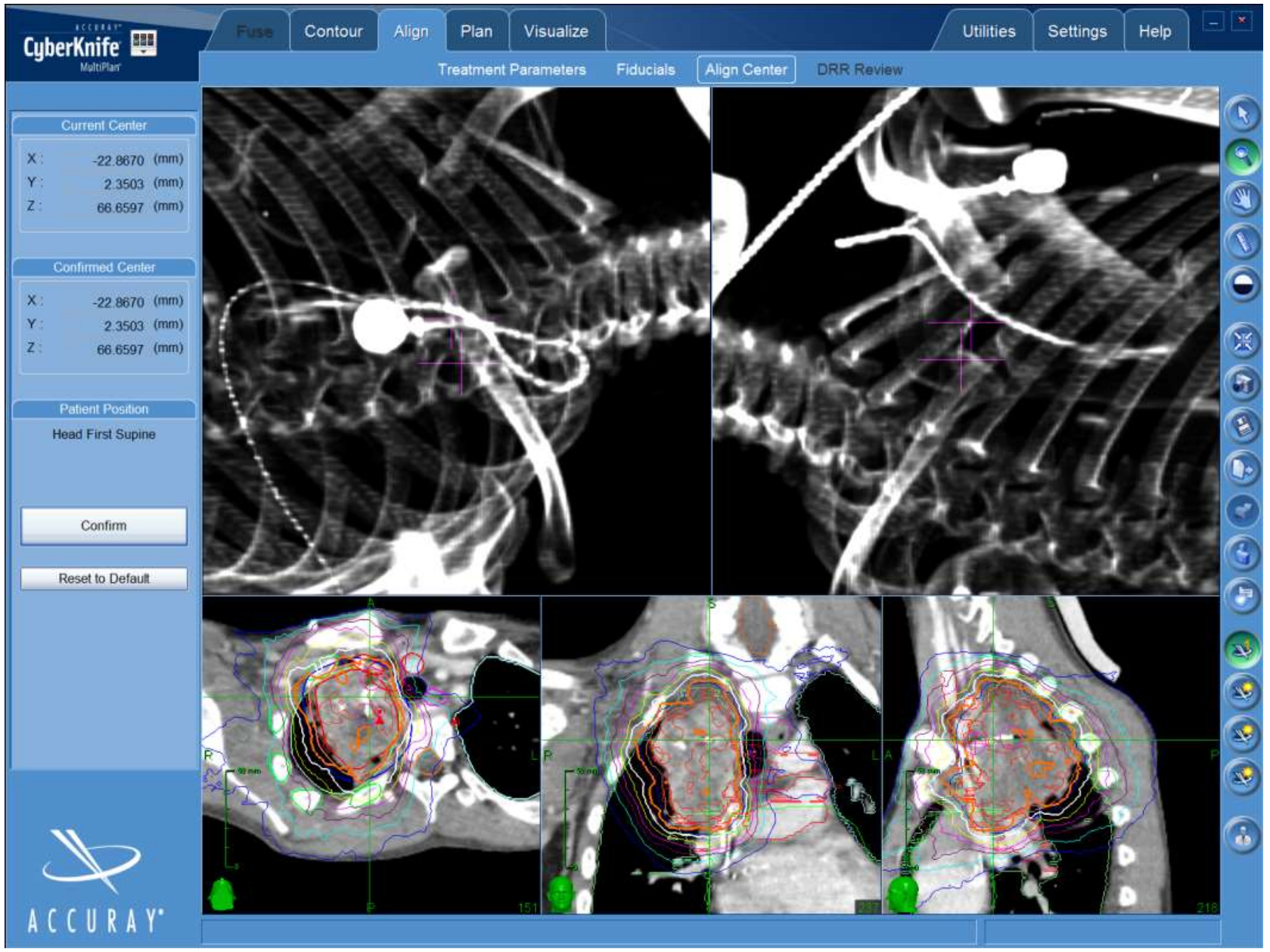
Lung metastases


Targeting System
Linear accelerator
X-ray sources
Synchrony™ camera
Manipulator
Robotic Delivery System
Image detectors
Treatment couch

CT-guided fiducial implant




CyberKnife
MultiPlan
Fuse
Contour
Align
Plan
Visualize
Utilities
Settings
Help
Setup
Isocentric
Conformal
Sequential
Evaluate
Finetune
Show Isocenters
Layouts
3D DVH A Dose
3D DVH S Dose
3D DVH C Dose
3D A S C
Standard
Display
ACCURAY
MC Medium
80%
90%
70%
60%
50%
40%
30%
20%
151
216
237
X:216 Y:237 Z:151 Value:2815


CyberKnife
MultiPlan
Fuse
Contour
Align
Plan
Visualize
Utilities
Settings
Help
Treatment Parameters
Fiducials
Align Center
DRR Review
Current Center
X : -22.8670 (mm)
Y : 2.3503 (mm)
Z : 66.6597 (mm)
Confirmed Center
X : -22.8670 (mm)
Y : 2.3503 (mm)
Z : 66.6597 (mm)
Patient Position
Head First Supine
Confirm
Reset to Default
ACCURAY

Conclusions: “Children-driven radiotherapy”

- Top quality clinical outcomes
- Excellent patient safety
- Good patient experience
- Information and communication with families
- Communication and multi-professional relationships
- Child, teenager and family-friendly environment
- Radiotherapy equipment and techniques
- Human and financial resources
- Education and training
- Research and development