Centre Antoine-Lacassagne
Centre Régional de Lutte contre le Cancer

Centre Antoine Lacassagne

Enjeux et Perspectives de la Radiothérapie

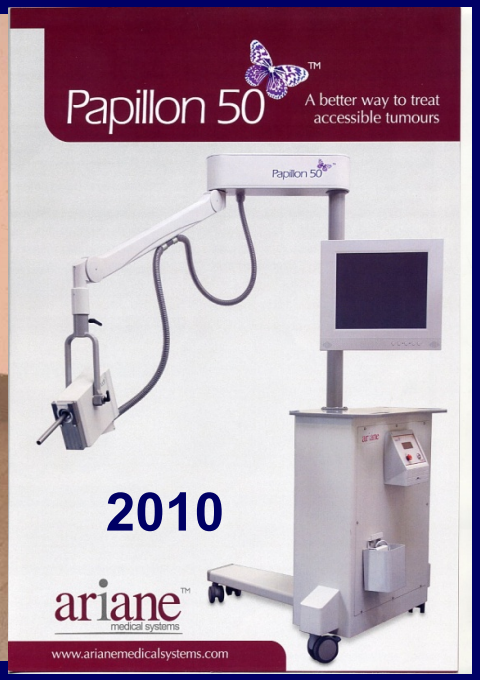
Jean Pierre GERARD
CAL - NICE - France

CNRS/IN2P3 - Guadeloupe
7 décembre 2010

DISCLOSURE

Ariane Medical Systems™ (UK)

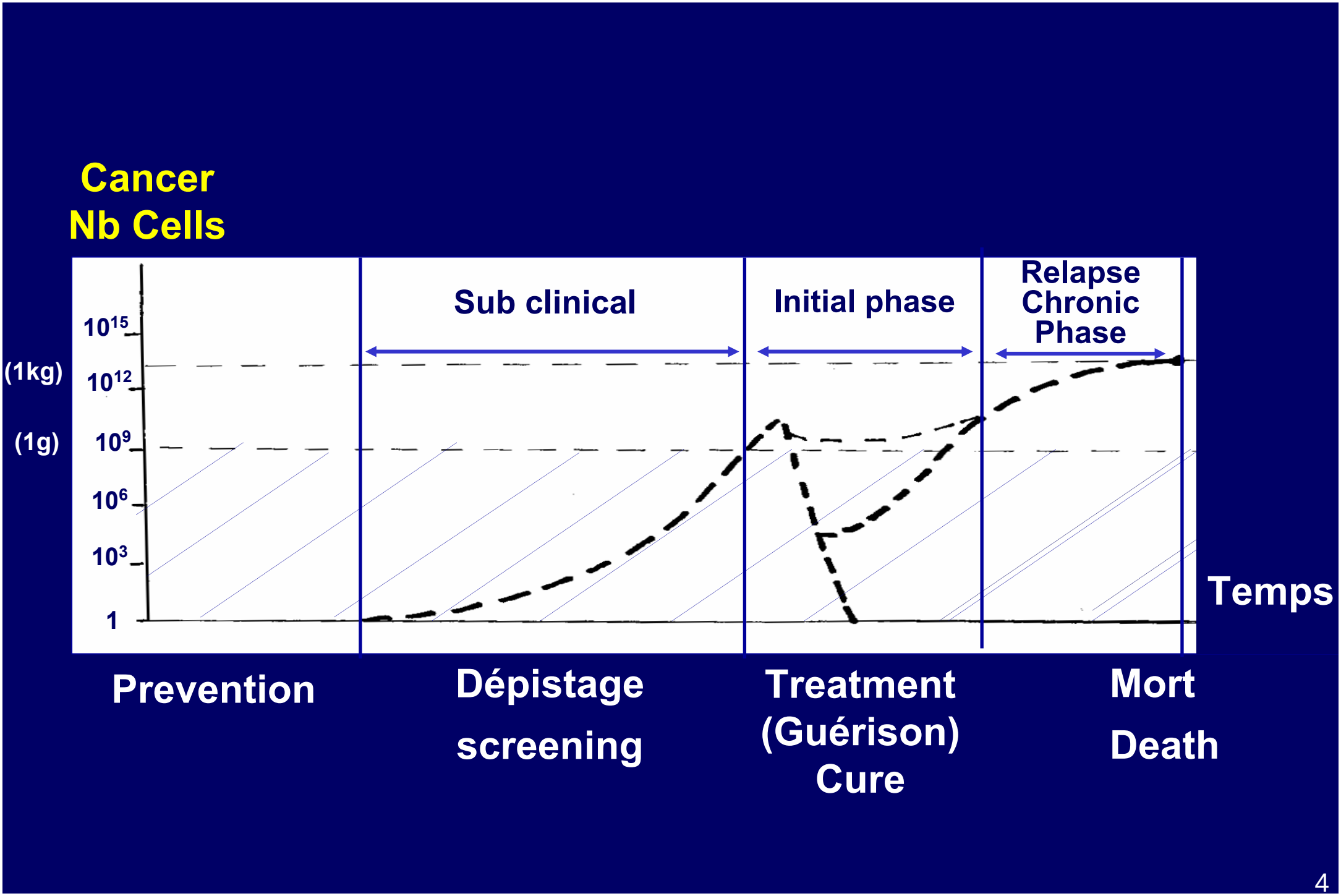
"Papillon 50"



J.P. GERARD

Medical Advisor

- **Enjeux : le cancer**
- **La radiothérapie : une place essentielle en cancérologie “3C”**
- **Historique : développement récent**
- **Perspectives : La Précision – La Dose “Cible – Target”**


Cancer
Nb Cells
(1kg)
(1g)
10^{15}
10^{12}
10^{9}
10^{6}
10^{3}
1
Sub clinical
Initial phase
Relapse
Chronic
Phase
Temps
Prevention
Dépistage
screening
Treatment
(Guérison)
Cure
Mort
Death

Espérance de vie – Life expectancy

- France = 81 ans Japon = 82

  USA = 78 Sierra Leone = 41 (F =1789)

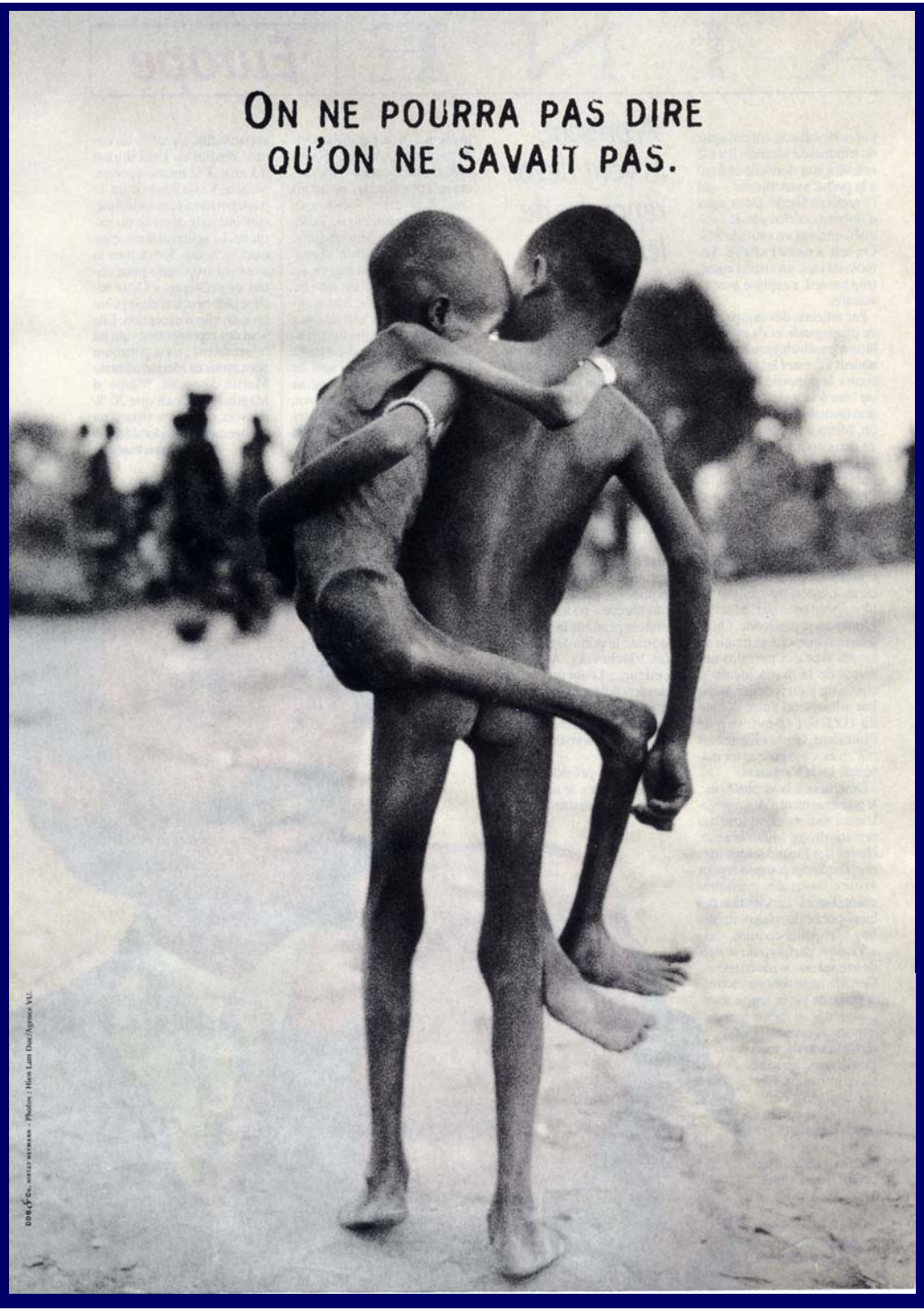
  France Sud = 82 France Nord = 80

- France 1940 = 59 ans (+22)

= Espérance de vie sans handicap (x 2)

= mort évitable < 75 ans France = 1er

J de Kervasdoué. Les prêcheurs de l'Apocalypse - Plon 2007

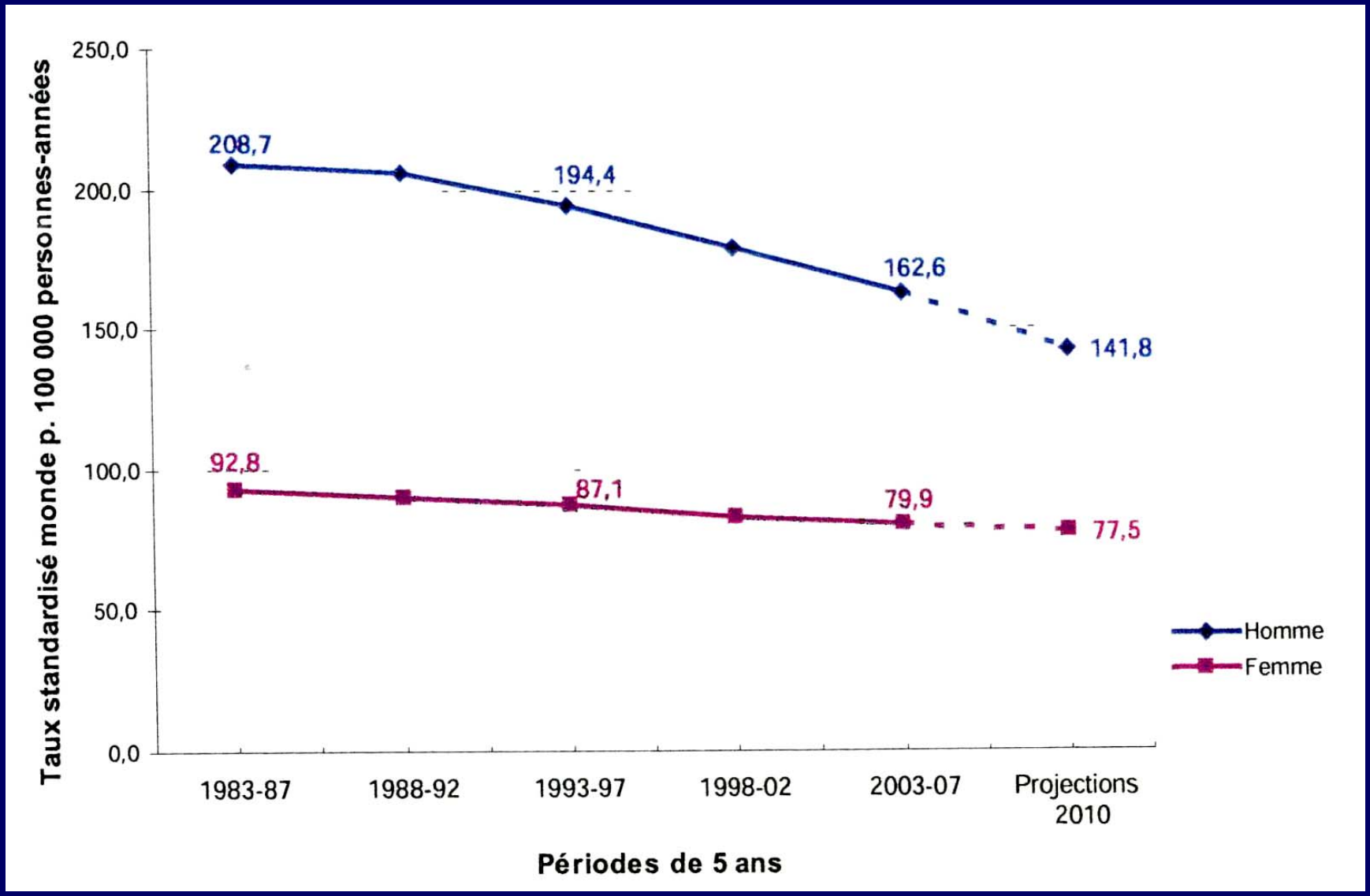

ON NE POURRA PAS DIRE
QU'ON NE SAVAIT PAS.

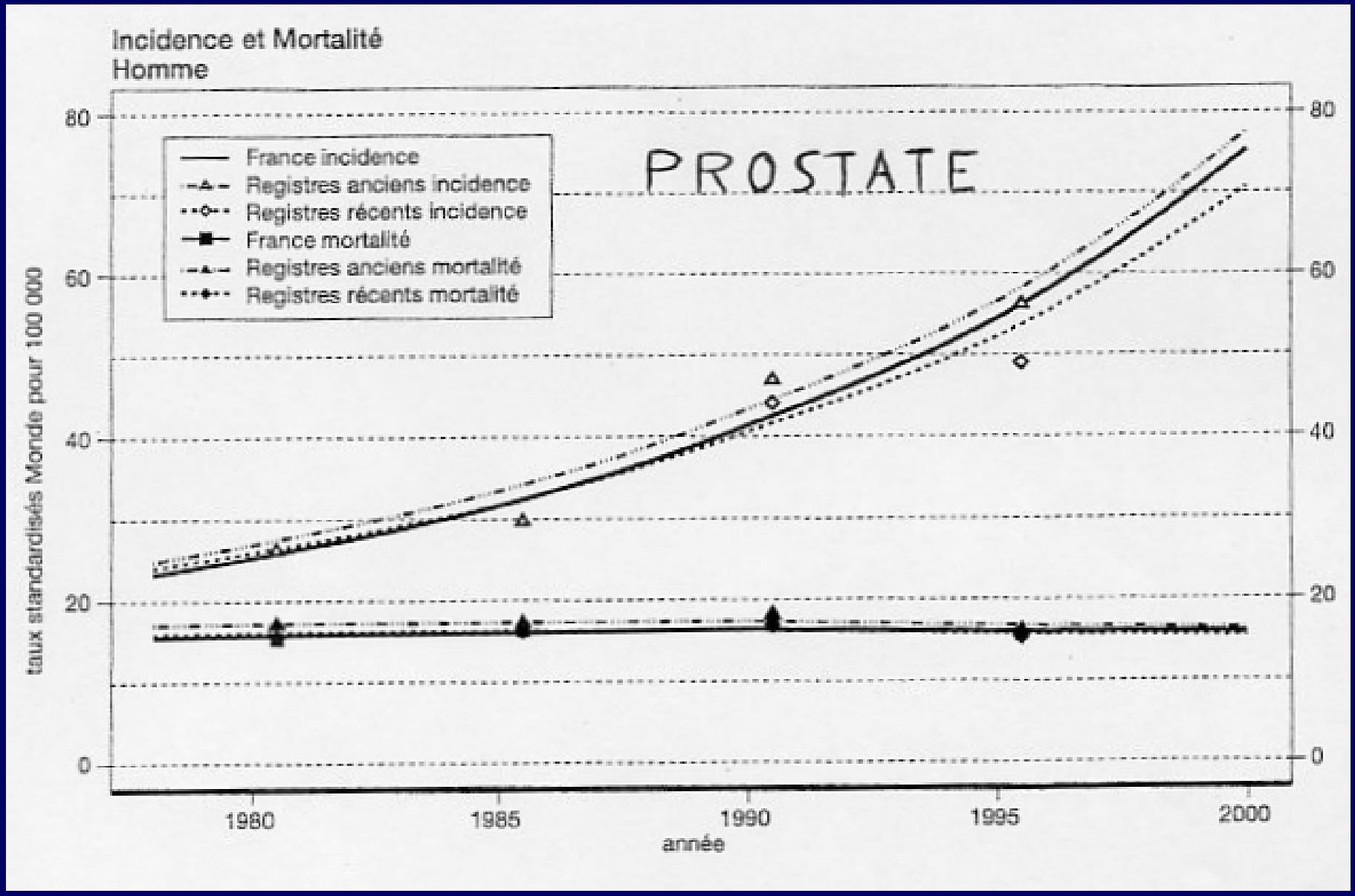
INCIDENCE - MORTALITE (France)

	1980	2010	
Incidence	170 000	320 000	
Mortalité	125 000	146 000	(150/2003)

Augmentation
- population = 25%
- vieillissement = 20%
- "risque" Kc = 55%

Francim 500/100 000


Taux standardisé monde p. 100 000 personnes-années
250,0
200,0
150,0
100,0
50,0
0,0
208,7
194,4
162,6
141,8
92,8
87,1
79,9
77,5
1983-87
1988-92
1993-97
1998-02
2003-07
Projections 2010
Périodes de 5 ans
Homme
Femme


Incidence et Mortalité
Homme
PROSTATE
France incidence
Registres anciens incidence
Registres récents incidence
France mortalité
Registres anciens mortalité
Registres récents mortalité
taux standardisés Monde pour 100 000
0
20
40
60
80
1980
1985
1990
1995
2000
année

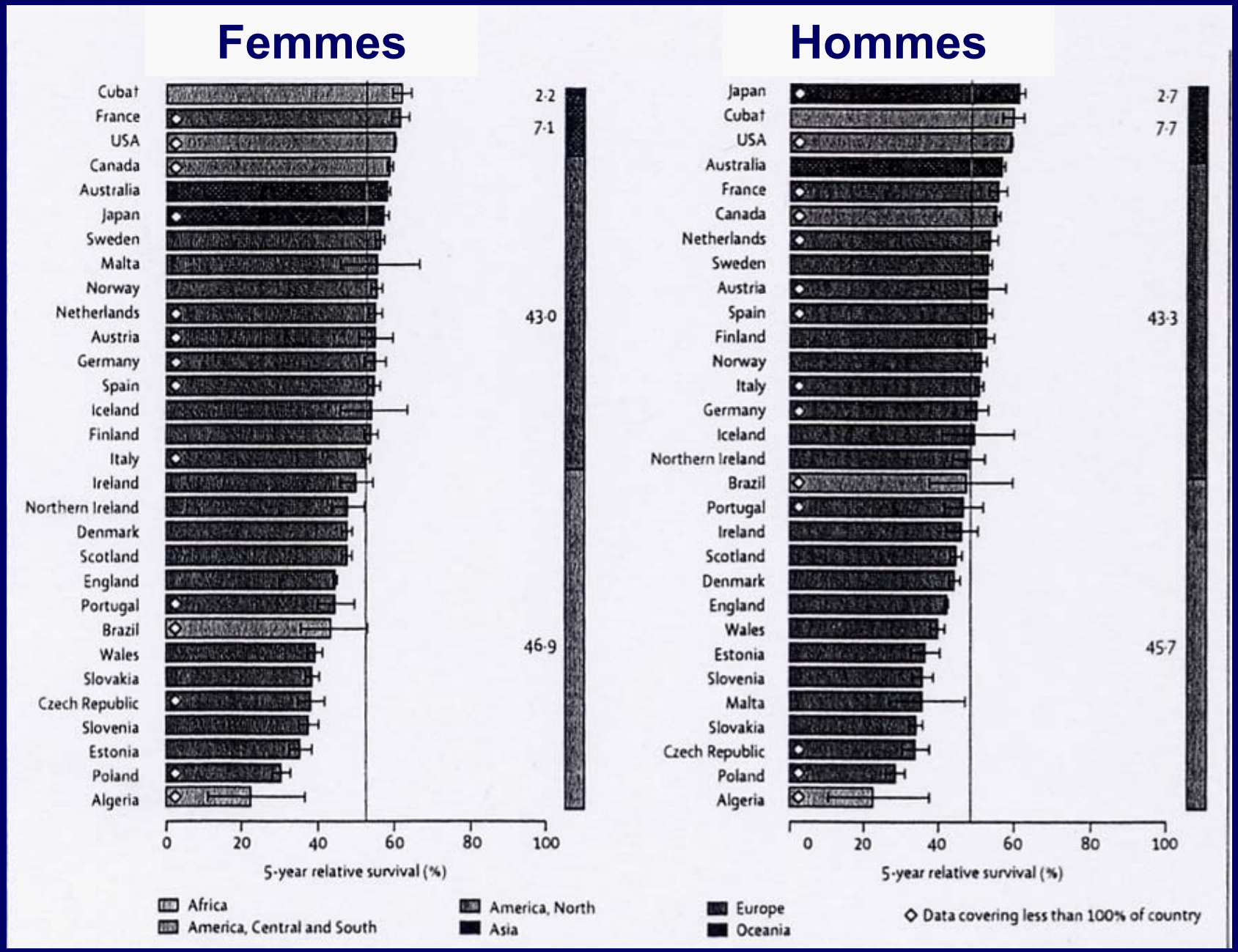
GUERISON : "Survival (relative) 5 ans"

	Hommes				Femmes			
	F	UK	I	EU	F	UK	I	EU
Colon R	56	45	51	48	61	47	53	51
Poumon	13	8	10	10	16	8	11	10
ORL	27	40	32	31	44	49	48	48
Prostate	72	52	59	62				
Leucémie	48	36	32	37	58	38	31	38
Sein					80	72	79	75

Eurocare - 1990 - 94

Guérison = CURE : 40%

EJC 2009;45:1067 Francisi



Cancer colorectal – survie relative 5 ans

Pourquoi je fais tel traitement ?

- Tradition – autorité – **EBM**

"Standard" - RCP

Phase III changement des pratiques

Standard – 10 - 40 % !

200 kv – Cobalt – chirurgie TME

Comment progresser ?

The New York Times

Study Supports Limited Surgery for Breast Cancer

By JANE E. BRODY

Surgery that spares most of the breast can be as effective as radical mastectomy in treating women with early breast cancer, according to a major study done in Italy and published yesterday in The New England Journal of Medicine.

The study, considered the best to date examining two such procedures, has thus far shown no difference in cancer recurrence or survival between women who had a partial mastectomy followed by radiation therapy and women who underwent the older, more disfiguring operation.

Although previous studies suggested this, the new study is the only large-scale, well-controlled study to show it. The researchers concluded that "radical mastectomy appears to involve unnecessary mutilation" in patients with early breast cancer.

The findings, which support the growing trend toward more conservative surgery for breast cancer, apply only to women whose cancers are very small at the time of diagnosis. Such women, though now seen more frequently than in the past as a result of educating patients, self-examination and the use of mammography, still represent only about 14 percent of breast cancer patients.

In another study in the same issue of the Journal, American researchers reported the first clear-cut evidence that older breast cancer patients whose disease has spread beyond the breast can benefit greatly from postoperative chemotherapy. Previous studies had shown such benefits primarily in patients under the age of 50.

Together, the two studies present further evidence that survival of breast cancer patients depends less on the local therapy chosen than on additional treatments given patients with more advanced disease. They also demonstrate that there is no one treatment for breast cancer; rather, therapy must be tailored to the individual, depending on the type of breast cancer, its size, extent and location, as well as the patient's physical and mental condition.

According to Dr. Bernard Fisher, a breast cancer specialist at the University of Pittsburgh and director of several major American studies on treating the disease, the Italian study "is very important."

"It's one of a series of studies which indicate the reasonableness of doing conservative surgery," he said, "and it points out the need for further large-scale trials" to evaluate more fully the various treatment approaches for different patients.

For nearly a century, nearly all breast cancer patients, regardless of how early they were diagnosed, were treated by removal of the entire breast, the chest-wall muscles beneath the breast and the lymph nodes under the arm — the so-called Halsted radical mastectomy. This disfiguring operation sometimes resulted in lasting difficulties in movement, limited choices of clothing and problems with breast reconstruction.

In recent years, however, scattered preliminary studies have suggested that less extensive surgery might be as effective as the radical operation for localized treatment of breast cancer, particularly when the tumor is small. The widely publicized findings prompted many women to request modified surgery and forced breast cancer surgeons to reconsider old dogma.

Today, in the United States, the Halsted radical has given way to a modified operation that spares the major chest muscle but still removes the entire breast and the lymph nodes. A minority of patients have just the lump removed, and usually have weeks of radiation treatments afterward.

In the Italian study, begun in 1973 by Dr. Umberto Veronesi at the National Cancer Institute in Milan, 701 women whose cancers were smaller than two centimeters, or about three-fourths of an inch, in diameter and whose lymph nodes appeared to be free of cancer were randomly assigned to undergo either radical mastectomy or simply removal of the quarter of the breast that harbored the tumor, plus the lymph nodes in the armpit.

Those in the partial mastectomy group underwent up to six weeks of radiation treatments after surgery. All women in both groups treated since 1979 and found to have cancer spread to the nodes also received postoperative chemotherapy for one year.

Dr. Veronesi and his co-workers reported no difference between the groups in the percentage of patients who survived free of cancer recurrence for up to seven and a half years after treatment.

"It appears unlikely that a longer follow-up time will introduce further changes," they said, although some surgeons believe a 10-year period is needed to determine the relative effectiveness of breast cancer treatments.

INSIDE

News Summary and Index, Page B2

U.VERONESI N. Engl J. Med 1981 July 2, 305:6-11

Radiothérapie - 2010 - "3C"

Curatif — 320.000 nouveaux cancers

45% guérison (140.000) RXT = 40%

Conservateur — oeil – larynx – sein – vessie

anorectum – membre

Coût – Efficience — ONDAM : 160 M^{d} Euros

cancer : 16 M^{d} E – **RXT : 1.2 M^{d} E**

ROENTGEN

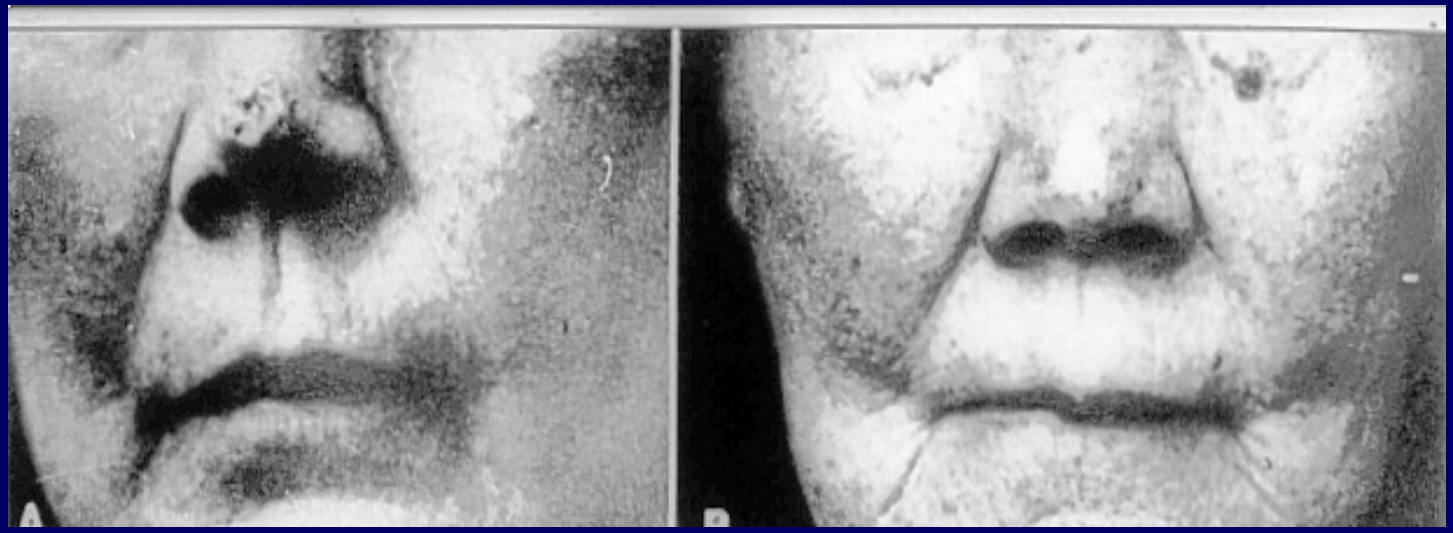
26 décembre 1895

VICTOR DESPEIGNES 1896

Observation concernant un cas de cancer de l'estomac traité par les rayons Rontgen

par le Docteur Victor Despeignes, ancien chef de travaux à la Faculté de Médecine de Lyon.

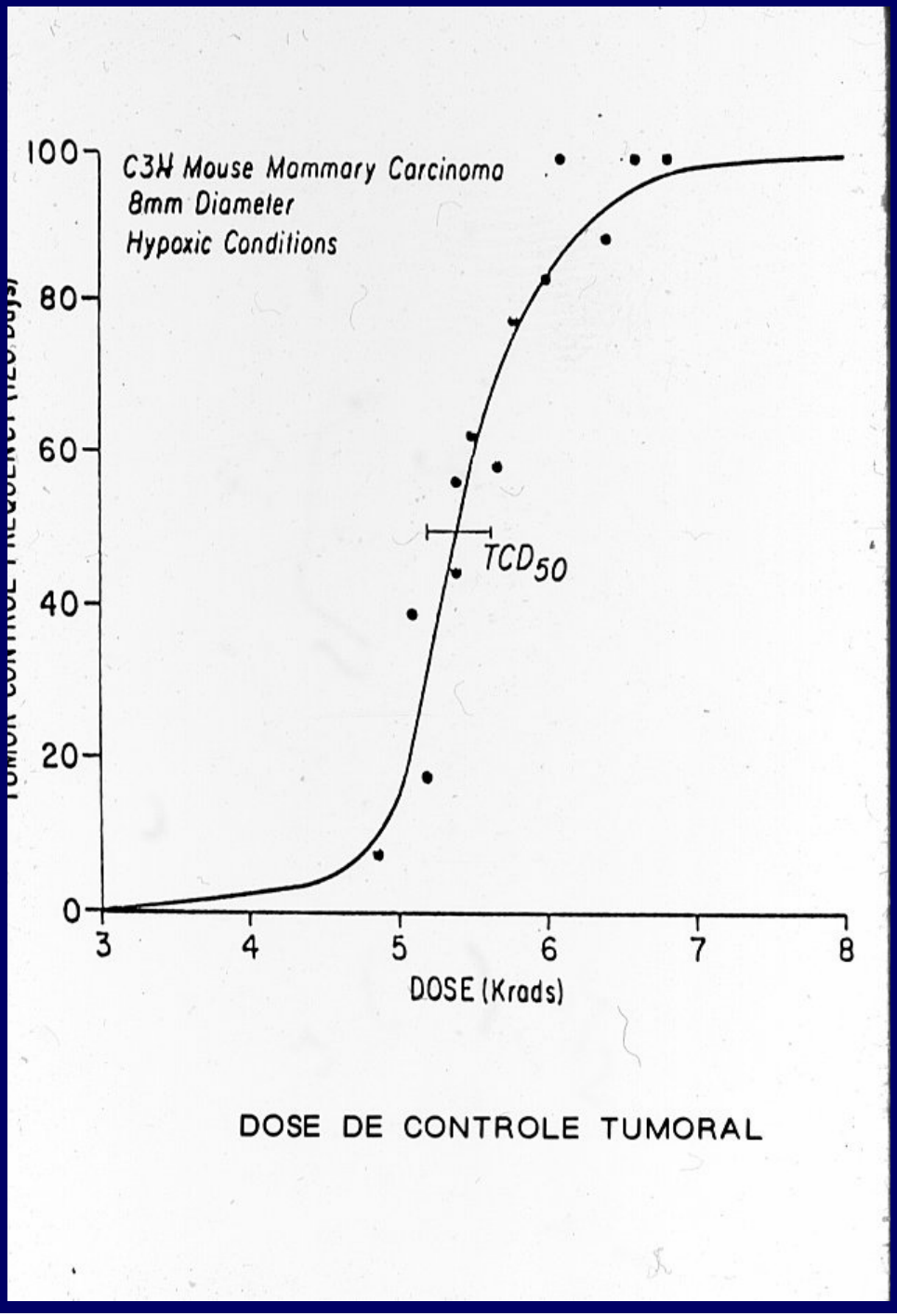
Lyon Médical 26 Juillet 1896:428-506



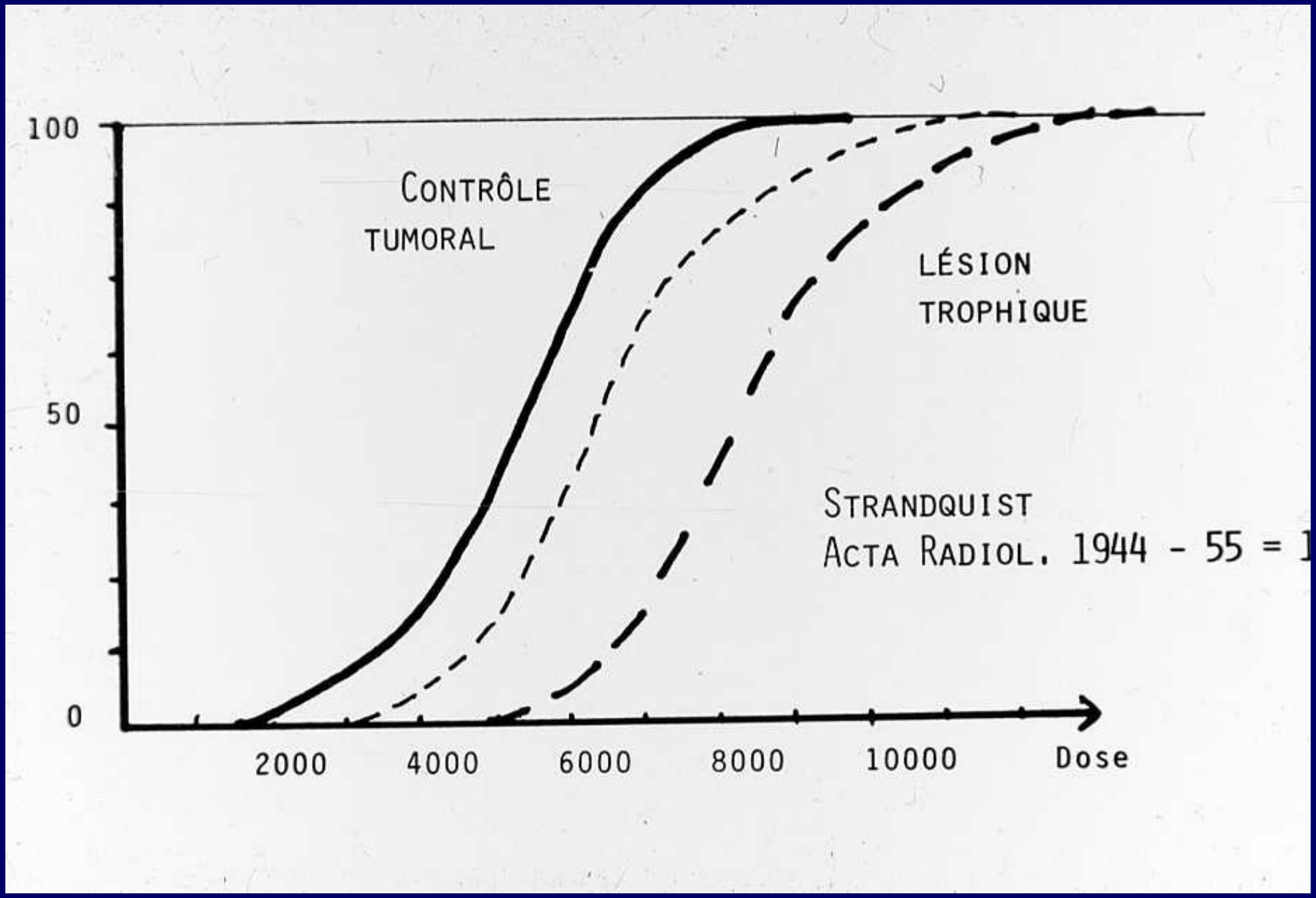
1902

1912

STOCKHOLM



DOSE DE CONTROLE TUMORAL


100
50
0
CONTRÔLE
TUMORAL
LÉSION
TROPHIQUE
STRANDQUIST
ACTA RADIOL. 1944 - 55 = 1
2000
4000
6000
8000
10000
Dose

The ultimate goal of physic

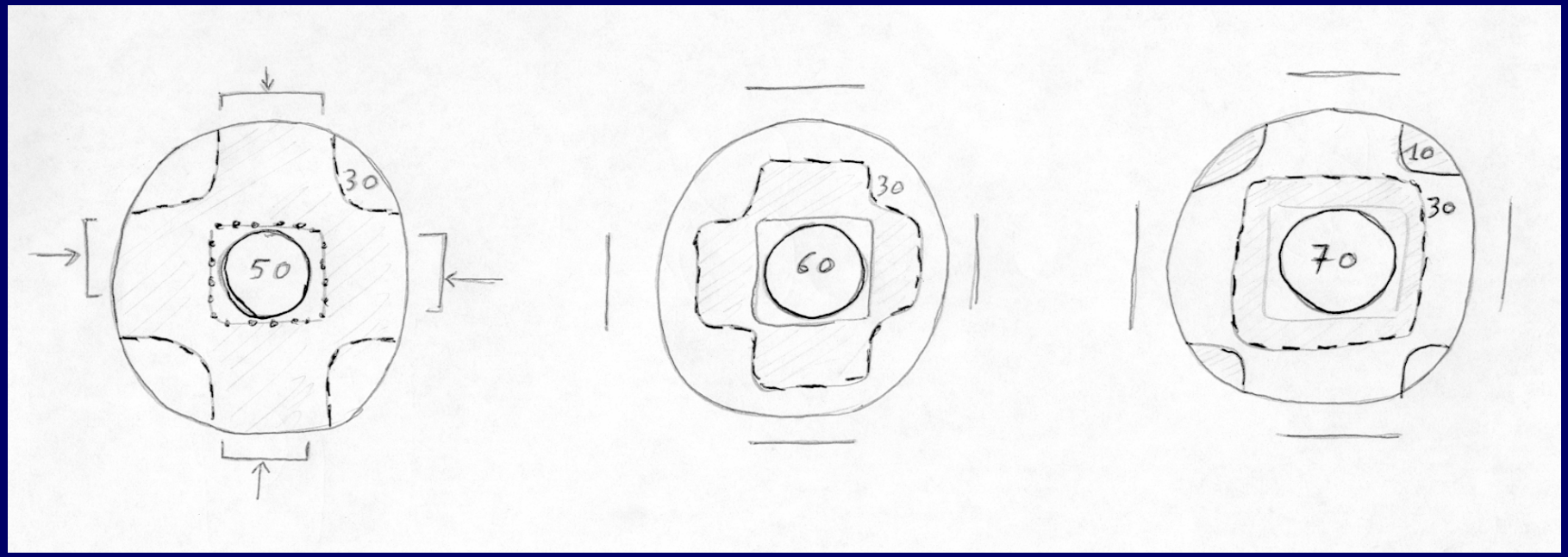
in radiotherapy

- 100% dose in GTV (CTV) (homogeneous ?)

0% " in organ at risk (OAR)

OAR : limiting factor

High **accuracy** (and precision)



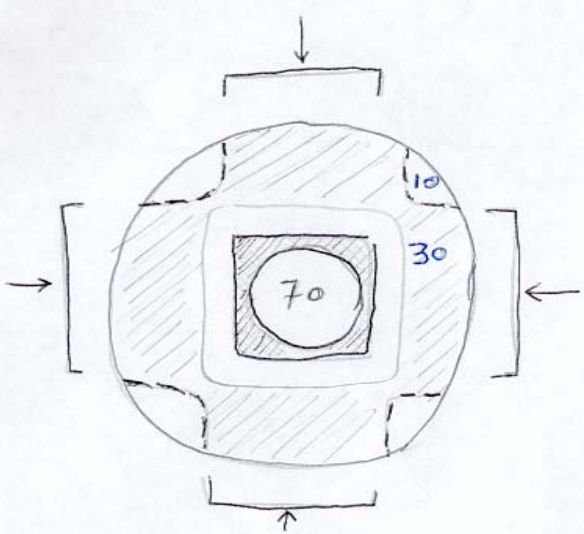
200 kV
1930
"peau - brûlure"

Cobalt
1950
"abdomen"

Linac
1980

FACTEUR LIMITANT : <u>TOLERANCE TISSUS SAINS</u>

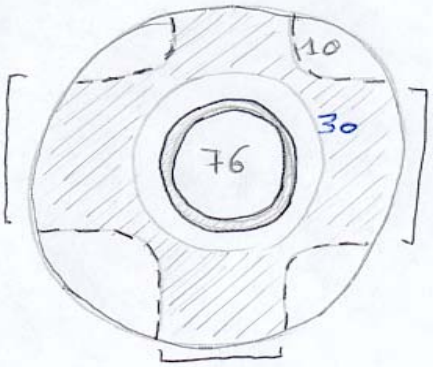
OAR Tolerance ⟶ T Dose Escalation



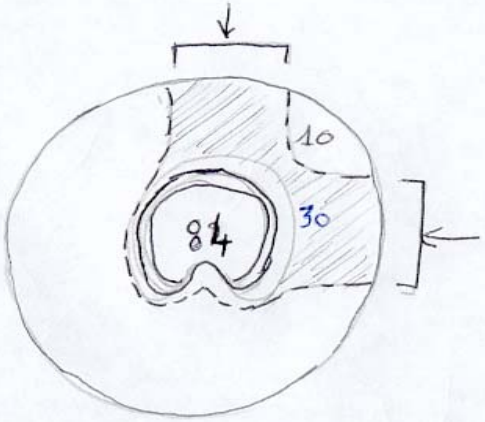
LINAC

1980

1995



RC3D (CML)

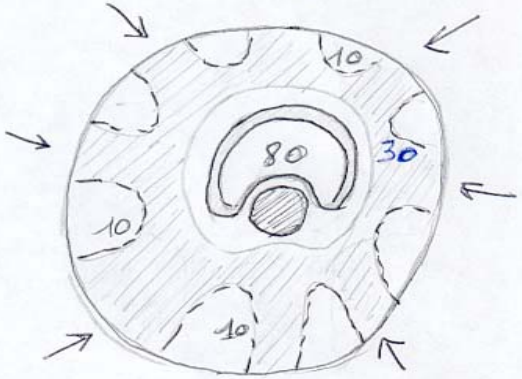


PROTON

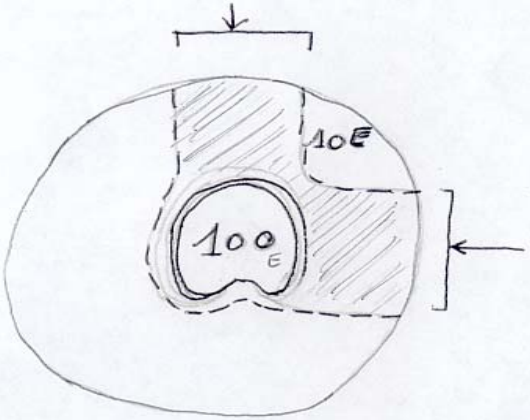
1990

RADIOBIOLOGIE

2000



RCMI concave



CARBONE - Neutron

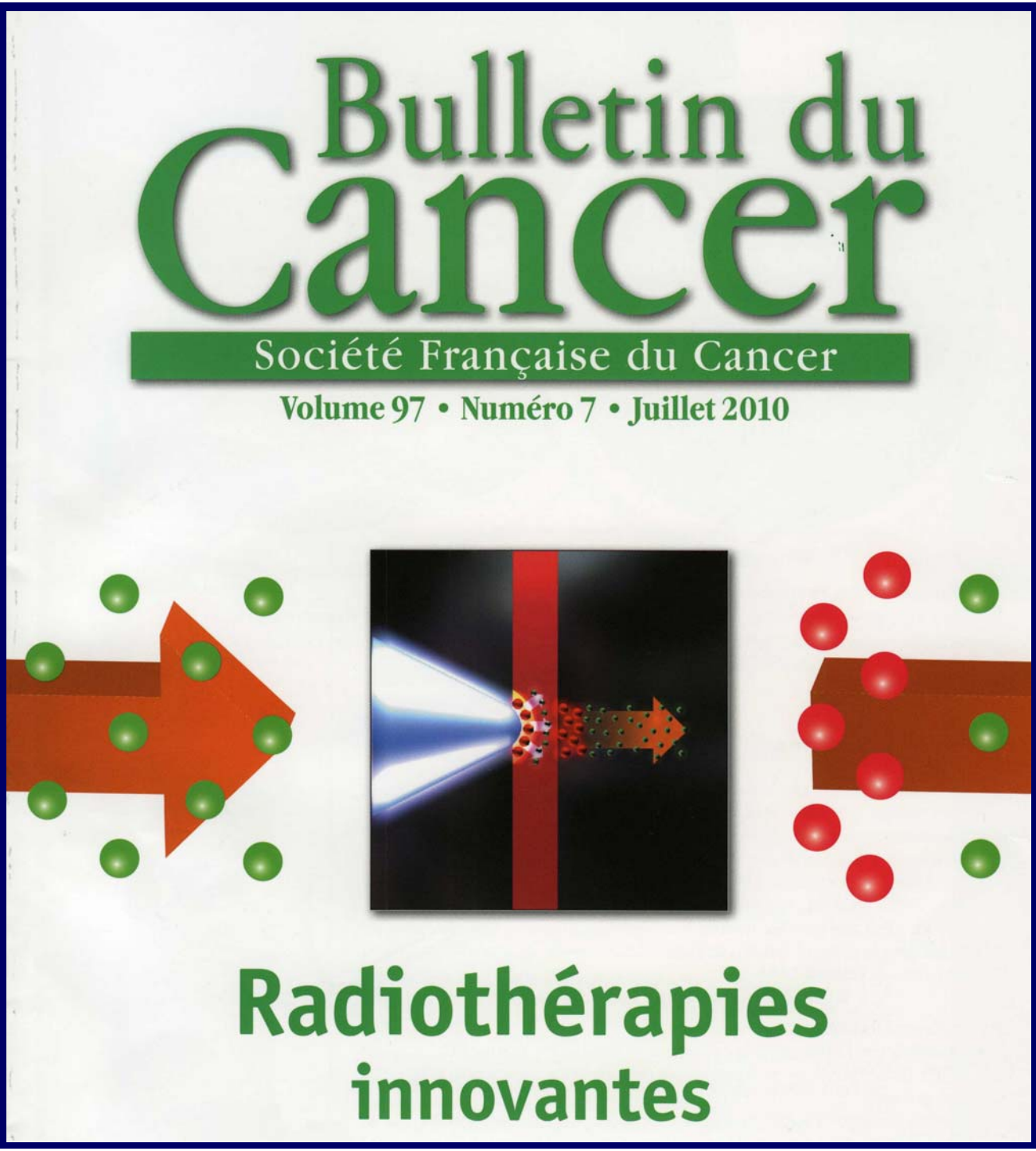
2000

Radiotherapy - History

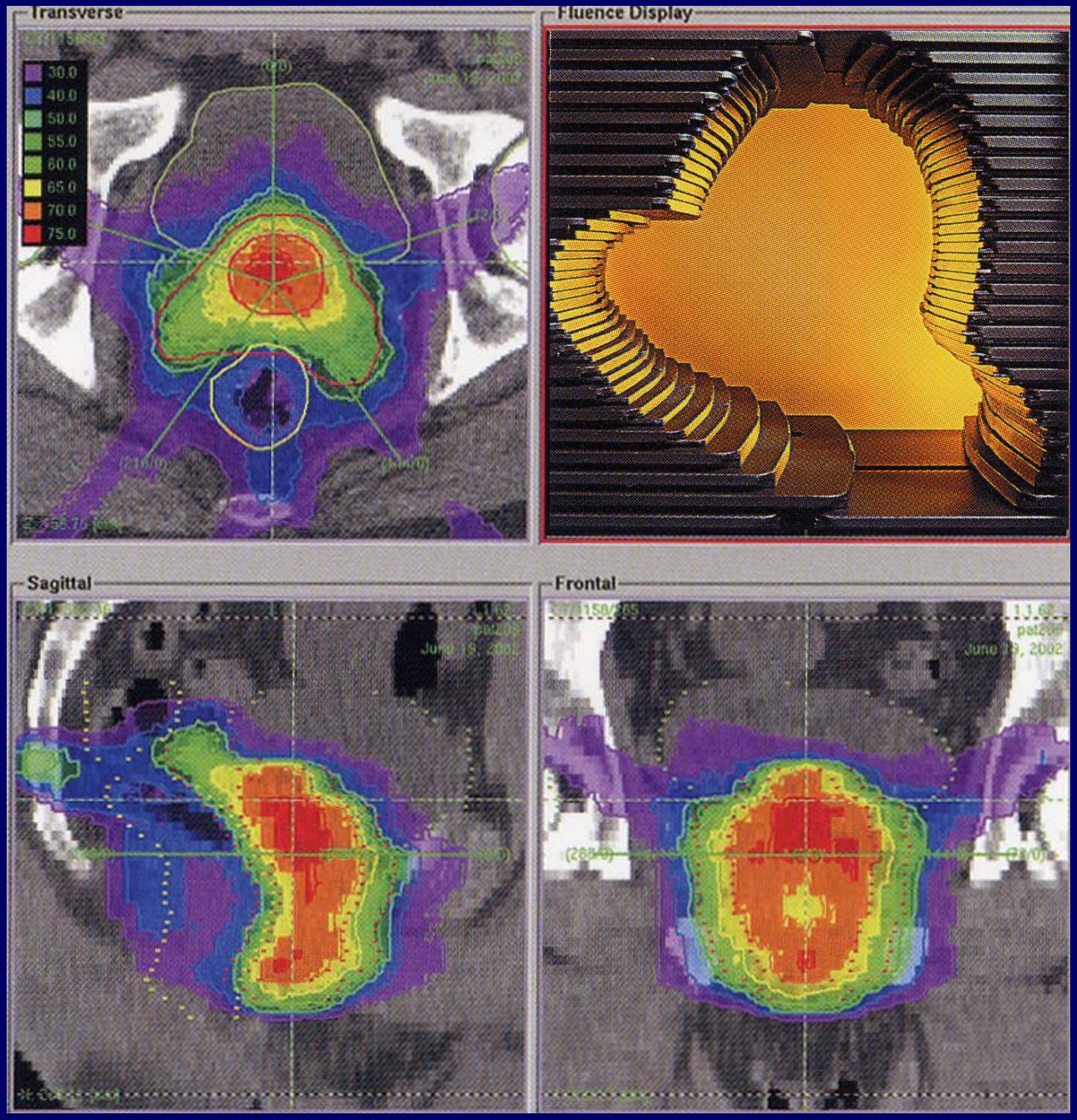
- 1896-1950 : Kilovoltage
- 1950-1995 : Megavoltage
- 1995-2010 : Computer Assisted RXT

  Standard linac - dedicated linac

  . Particles - Hadrontherapy


Bulletin du
Cancer
Société Française du Cancer
Volume 97 • Numéro 7 • Juillet 2010
Radiothérapies
innovantes


SIEMENS
PRIMUS
SIEMENS
10.12.2001



. **Collimateur multilames**

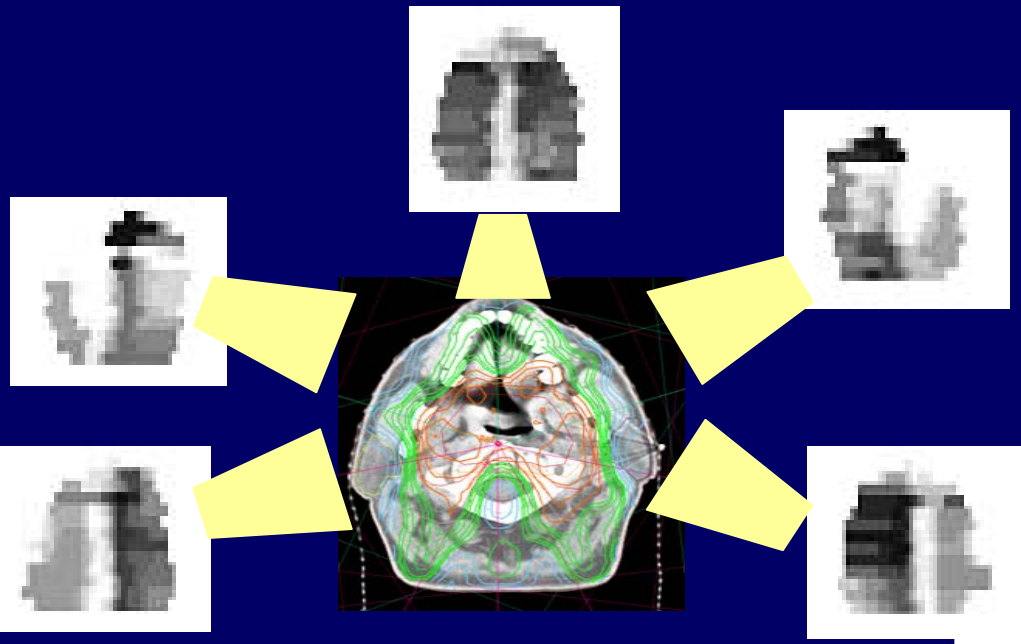
. **Logiciel de planimétrie**

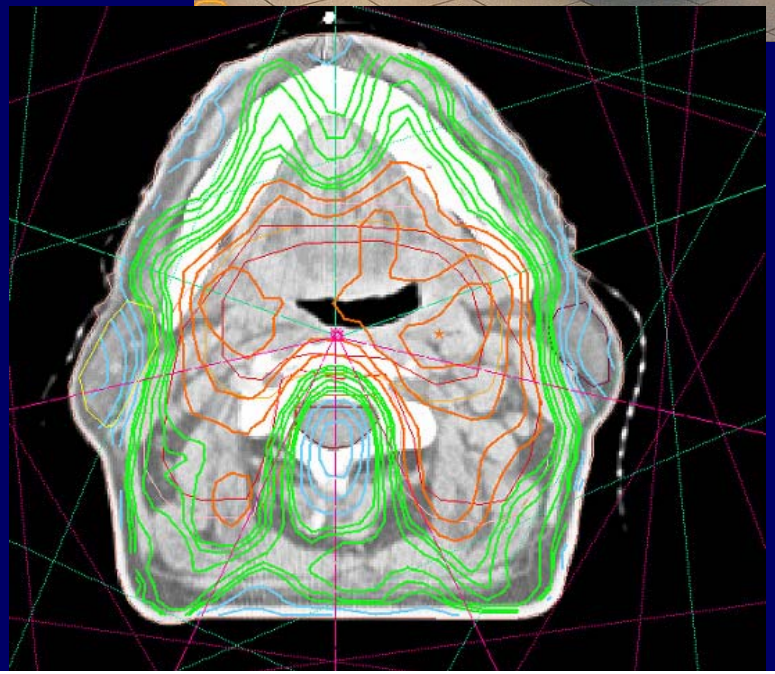
(beam eye view)

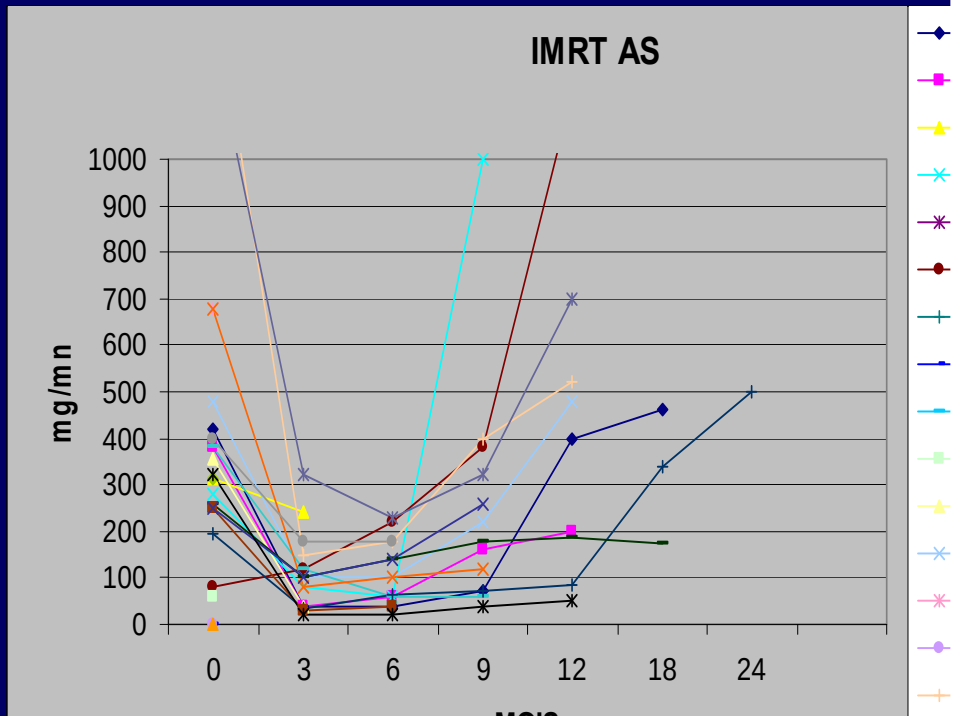
Conformal 3D Radiotherapy

IMRT Intensity Modulation

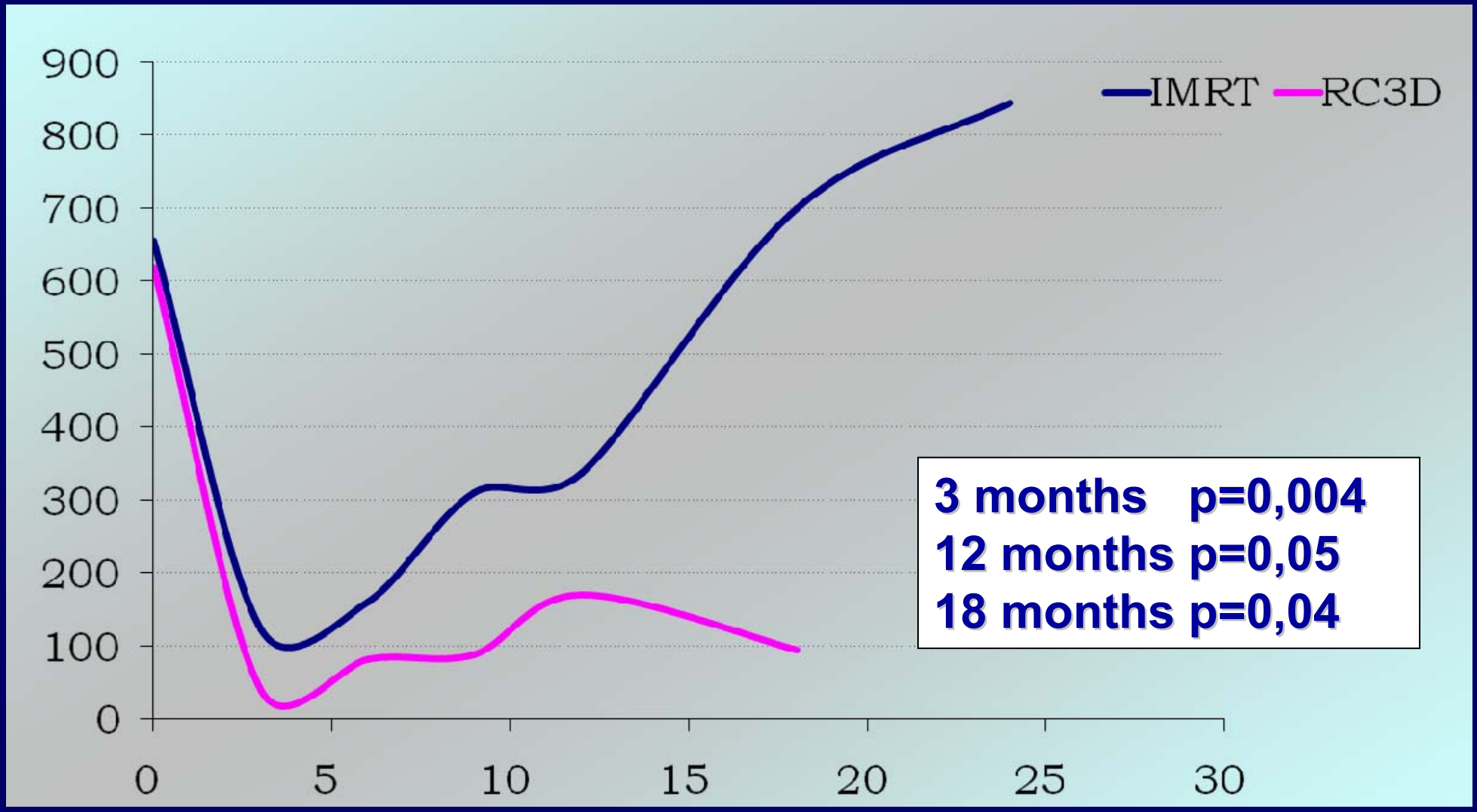
TPS



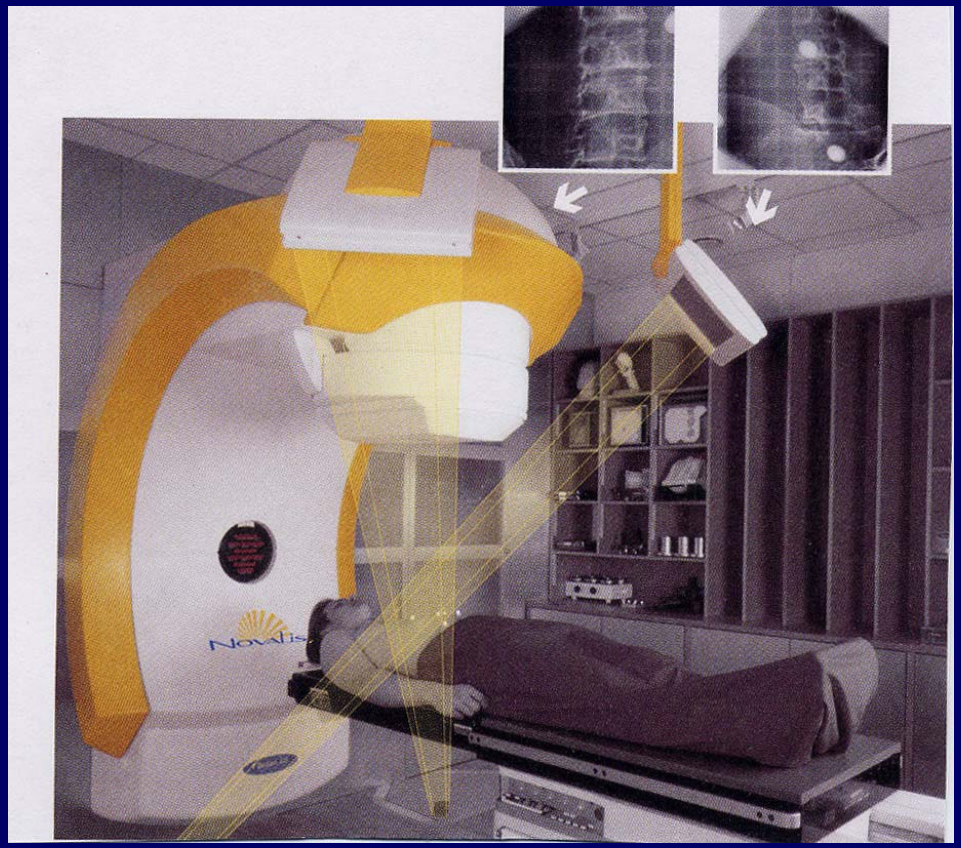


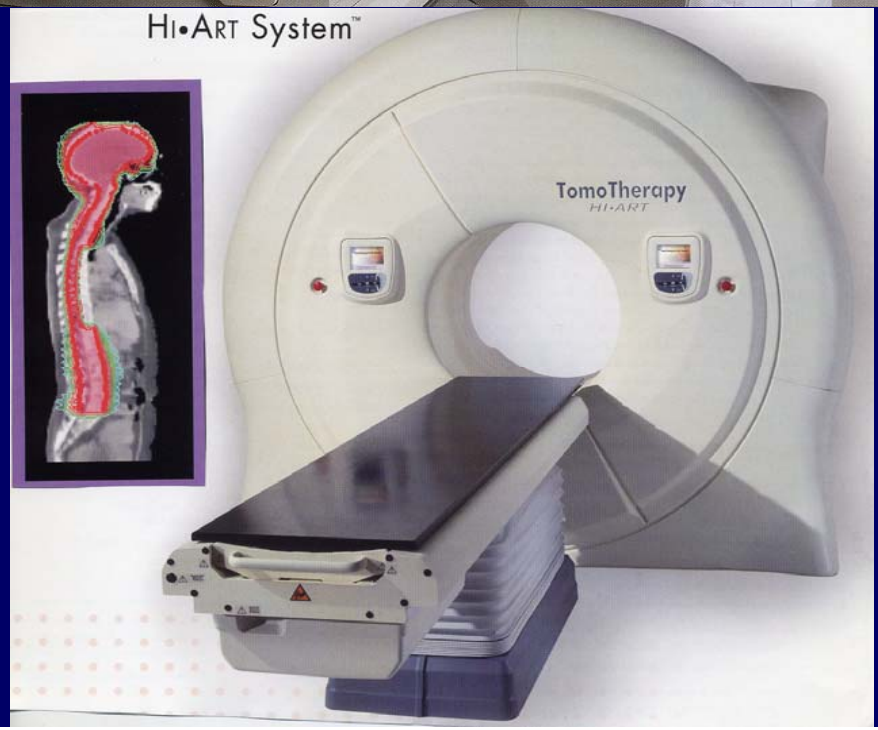


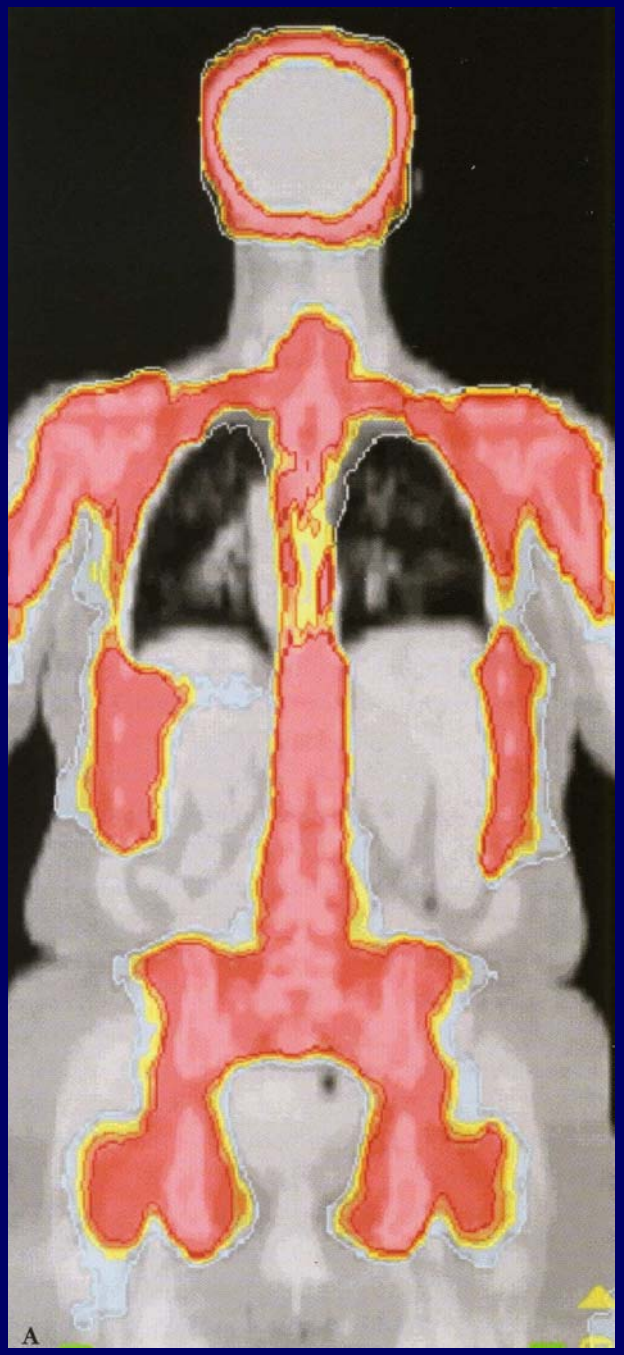
IMRT for parotid sparing and preservation of salivary flow w/ IMRT versus 3D RT

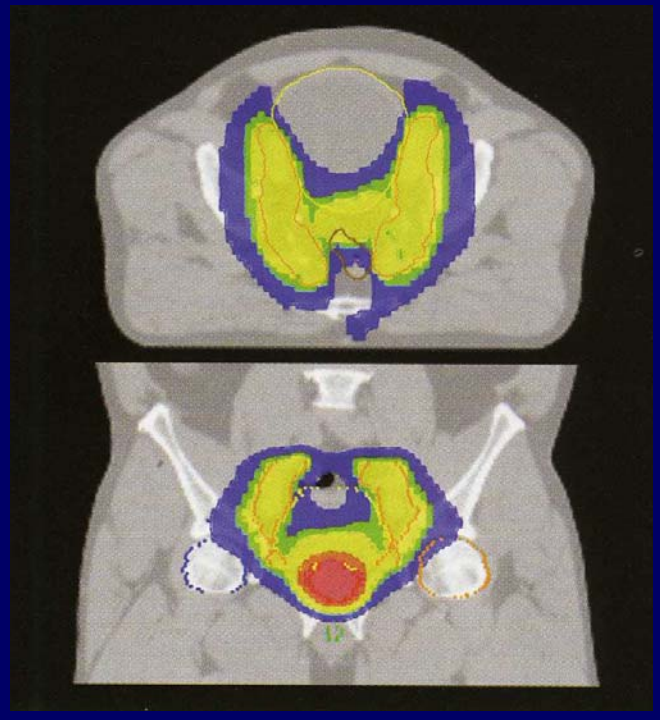


IGRT : Image guided






A



Radiothérapie stéréotaxique (ASN)

- Techniques … évolution … précision millimétrique …
  appareils (équipements) dédiés … multiples faisceaux …
  (glt) non coplanaire … hyprofractionnement
  radiochirurgie : crane – invasif – 1 séance

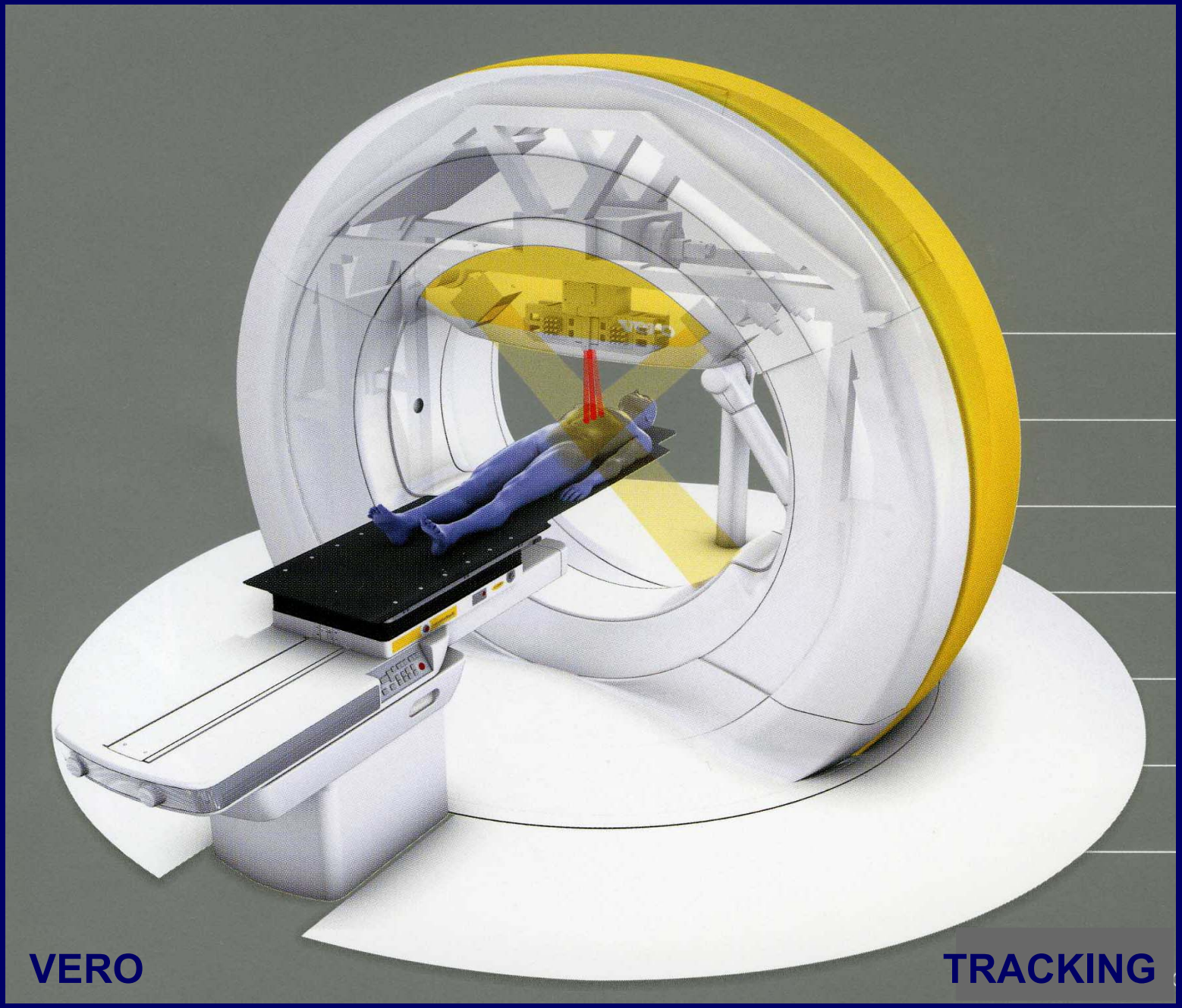
- CCAM – tarif – 10 séances
  CK – Novalis – Vero – Truebeam – Linac dédié … ?

- Petit volume(précis) – forte dose : **hypofractionnement**


VARIAN

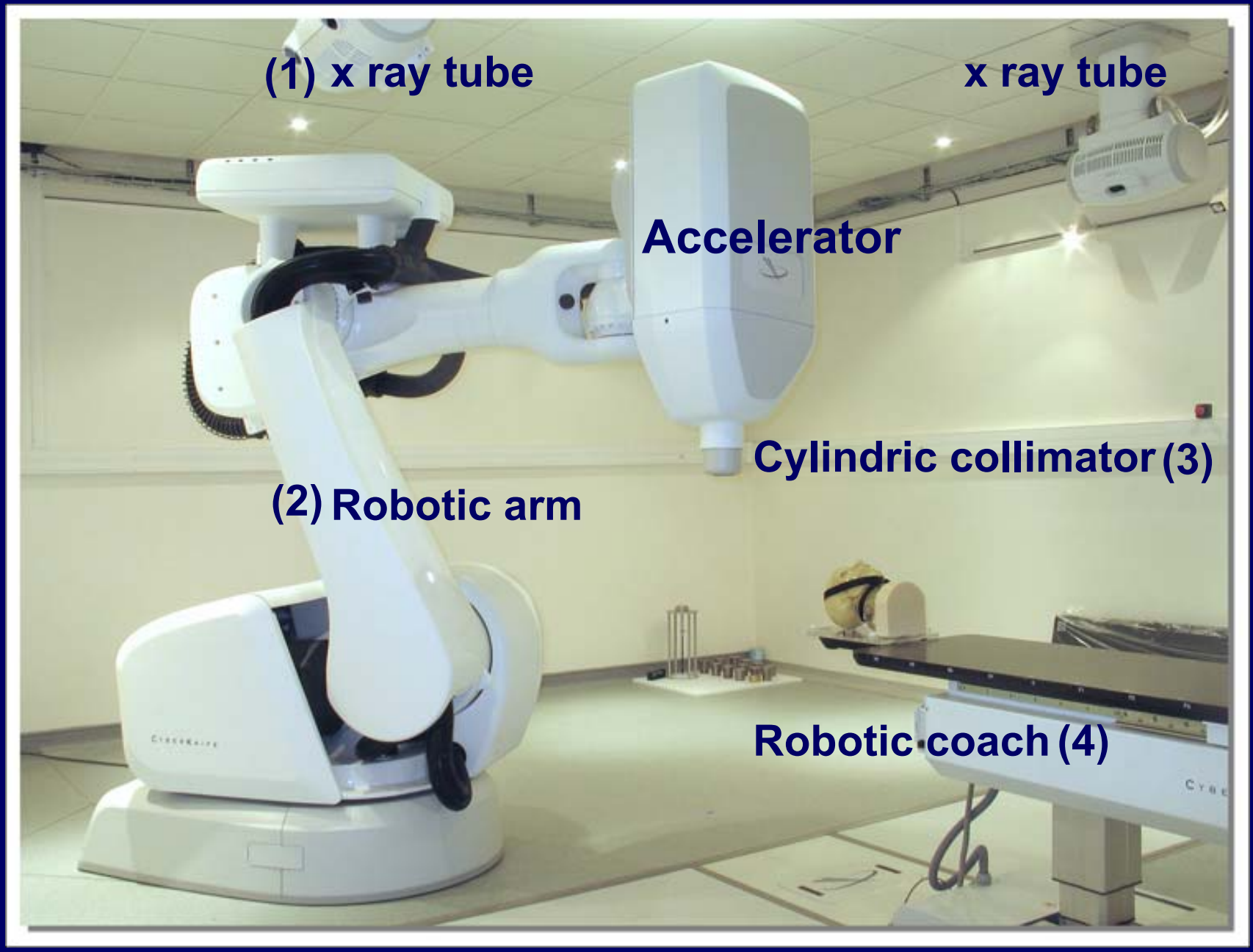
VERO


VERO


VERO
TRACKING

Robotic Stereotactic Radiotherapy (Cyberknife™)

G4

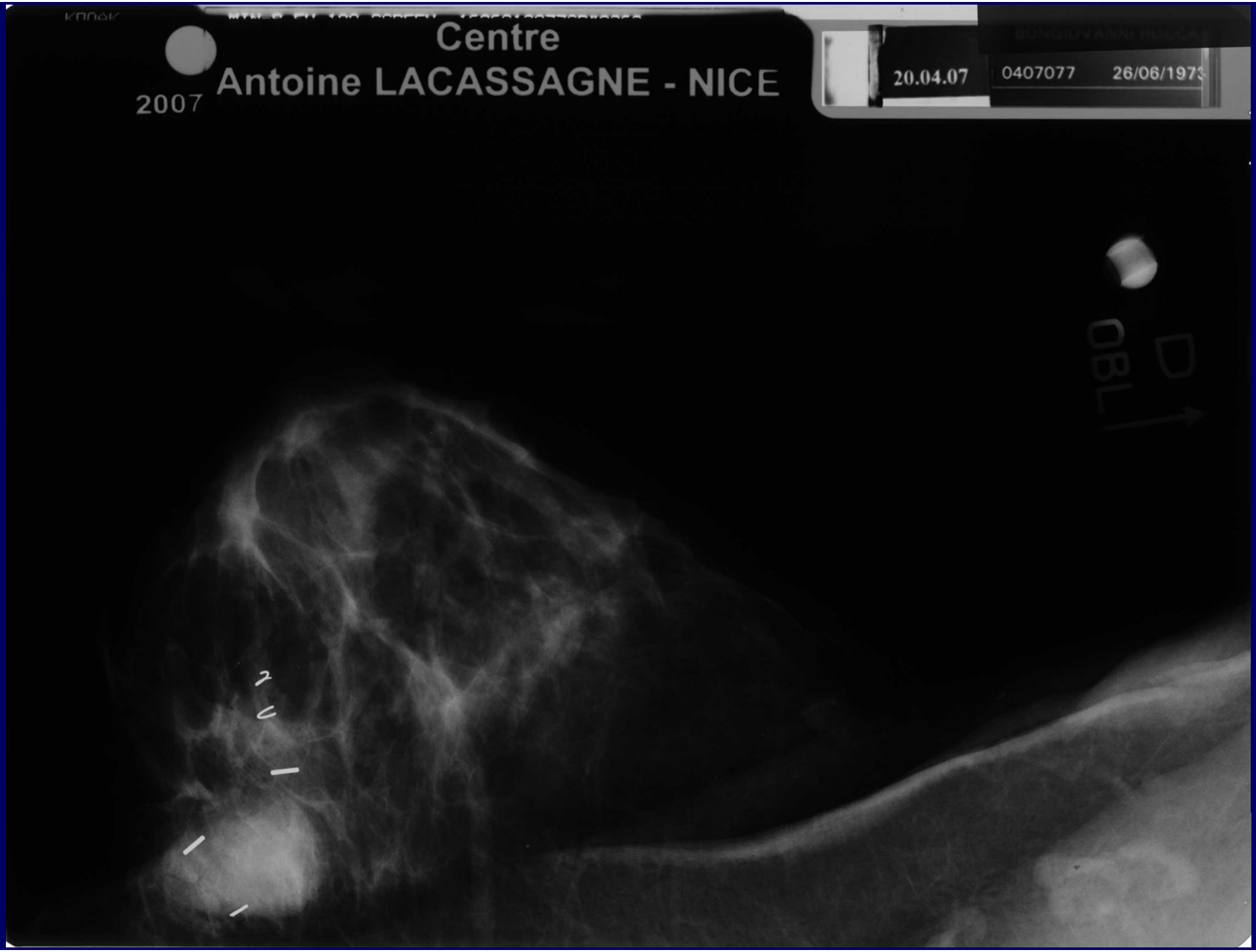


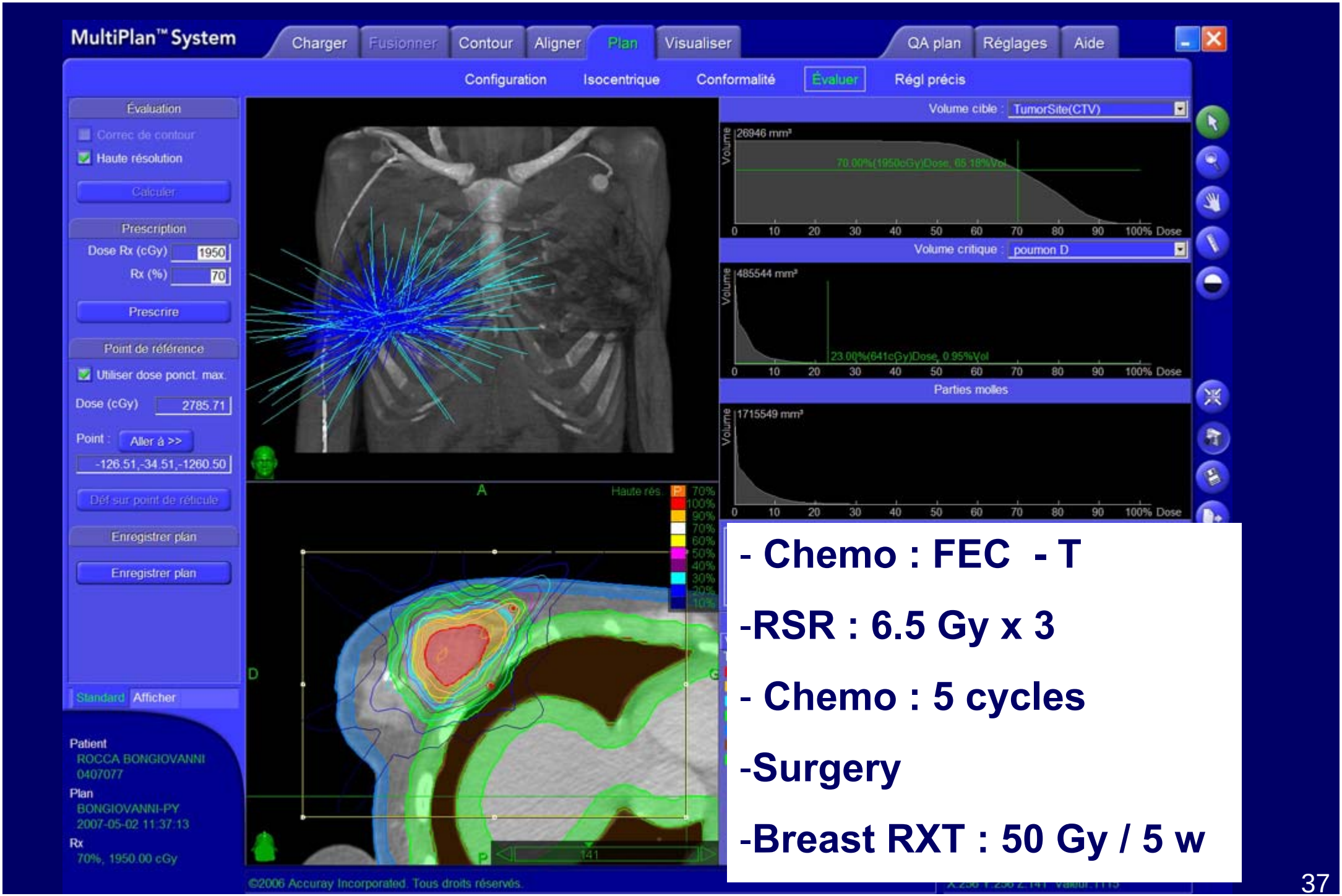
Realtime

tracking

"synchrony“

Vero - TrueBeam


Centre
Antoine LACASSAGNE - NICE
2007
20.04.07
0407077
26/06/1973
D
OBL



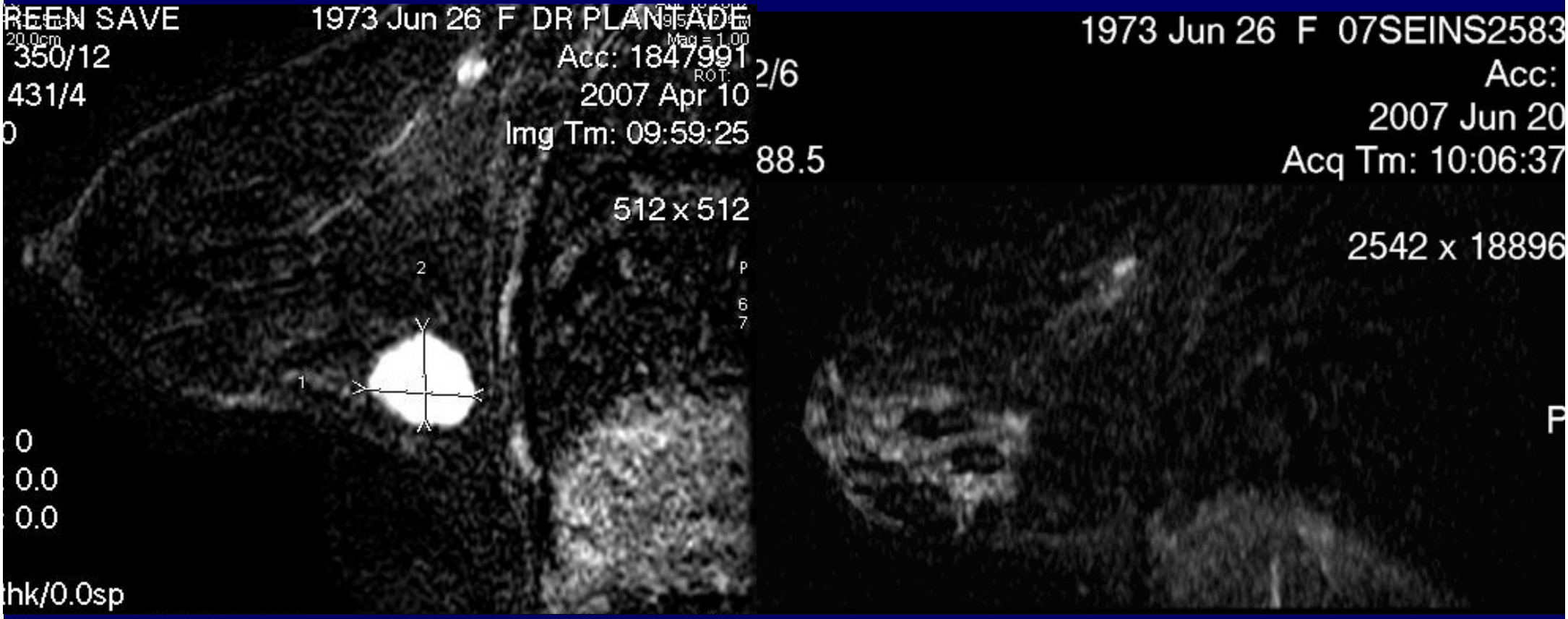
- Chemo : FEC - T

-RSR : 6.5 Gy x 3

- Chemo : 5 cycles

-Surgery

-Breast RXT : 50 Gy / 5 w


REEN SAVE
1973 Jun 26 F DR PLANTADE
350/12
431/4
Acc: 1847991
2007 Apr 10
Img Tm: 09:59:25
512 x 512
1973 Jun 26 F 07SEINS2583
Acc:
2007 Jun 20
Acq Tm: 10:06:37
2542 x 18896

Dose escalation – Phase III

- **Prostate**

  Polak : 70 - 78 Gy : 59% 78% (8y)

- **Breast**

  EORTC : 50 - 65 Gy : 10% 6% (10y)

  Lyon : 50 - 60 Gy : 5% 3% (5y)

- **Brain metastatis**

  RTOG : 15 - 24 Gy : 5 7 months

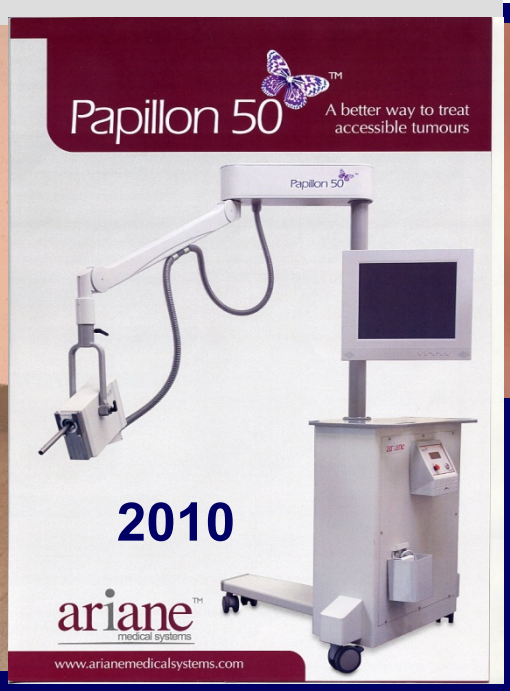
- **Rectum**

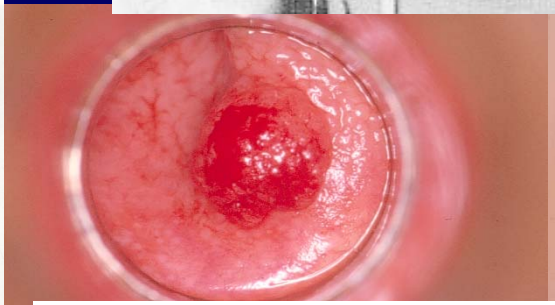
  CXRT : 2% vs 30% pCR (ACCORD 12)

Contact x-ray 50 KV : Alone in T1 N0

J. PAPILLON Lyon 1975

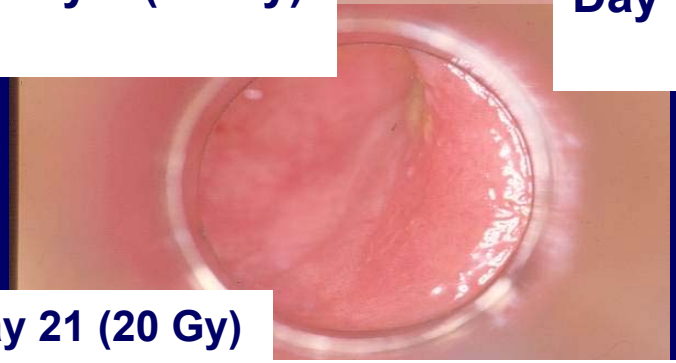
Philips
RT 50





uT1N0 : Day 1 (35 Gy)

Day 7 (30 Gy)



Day 21 (20 Gy)

Radiation Dose escalation : Lyon R96-02

- T2-3 < 1/2 circumf ≤ 6 cm Anal Verge

R → RXT (39 Gy/4w)

" (") + contact x ray (90 Gy/3)

- End Point : sphincter preservation : 40% ⟶ 70 %
- 1996 – 2001 : 88 pts randomized

Gérard : J Clin Oncol 2004; 22 : 2404

LYON R 96 -02 J Clin Oncol 2004 ; 22 : 2404

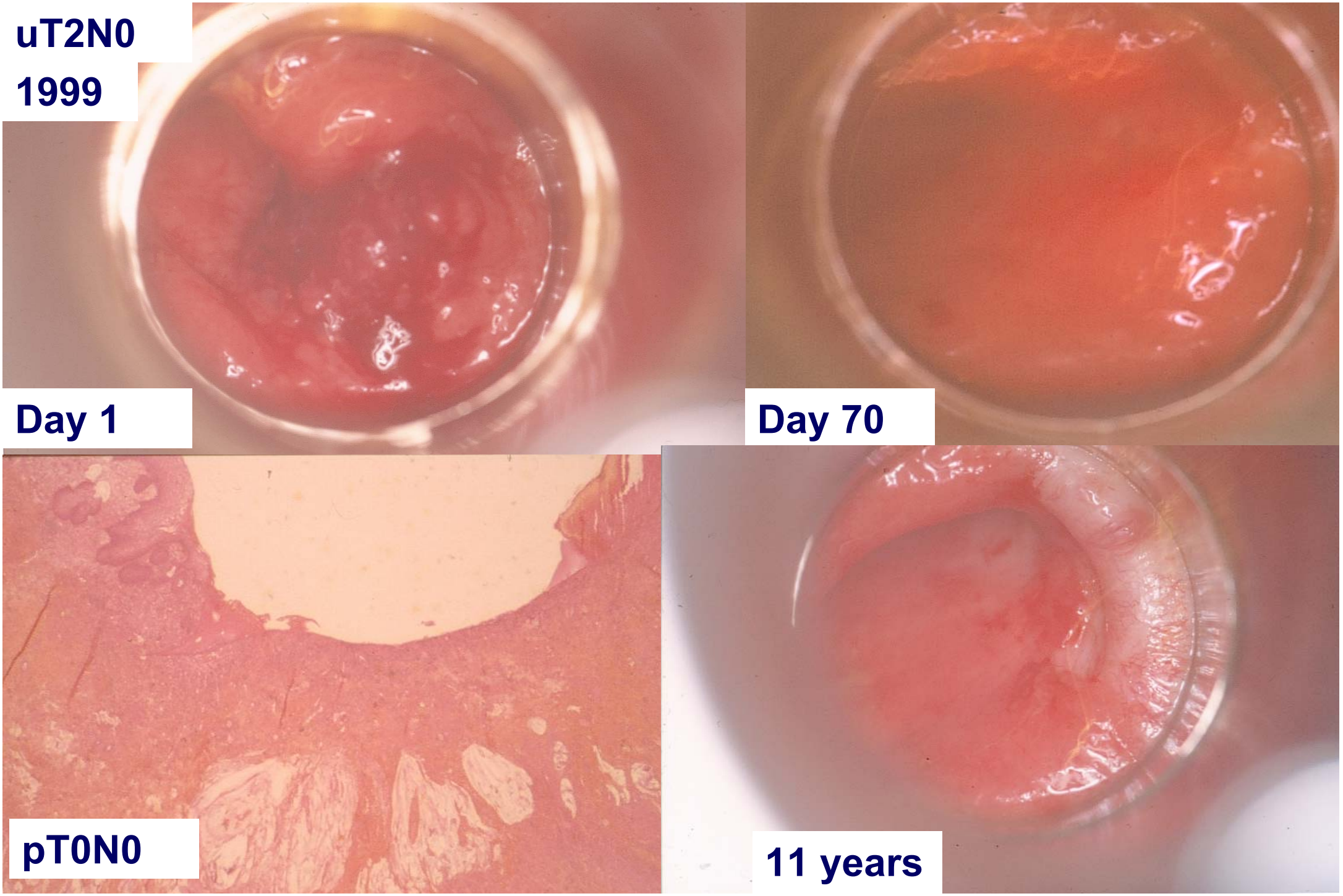
	RXT (43)	RXT + contact (45)	
age (y)	67	68	
distance (cm)	4	4	
T3	29 (70%)	33 (77%)	
clin. complete resp.	2%	29%	< 0.05
yp T0N0	4 (10%)	16 (35%)	< 0.05
Sph. preserv.	44%	76%	< 0.05

* Transanal Local Excis.= 3 RX alone = 7 : Rectal preserv: 10

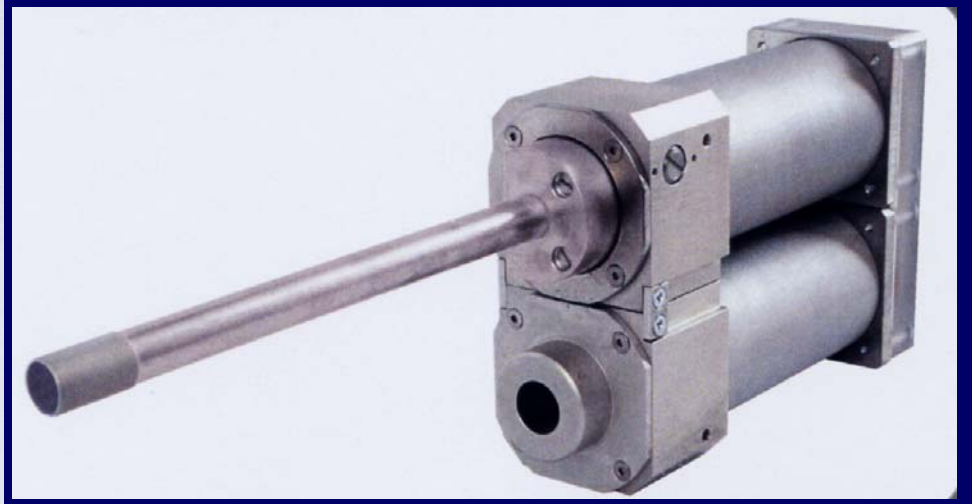
Lyon R96.02 – RXT dose escalation: 10 years

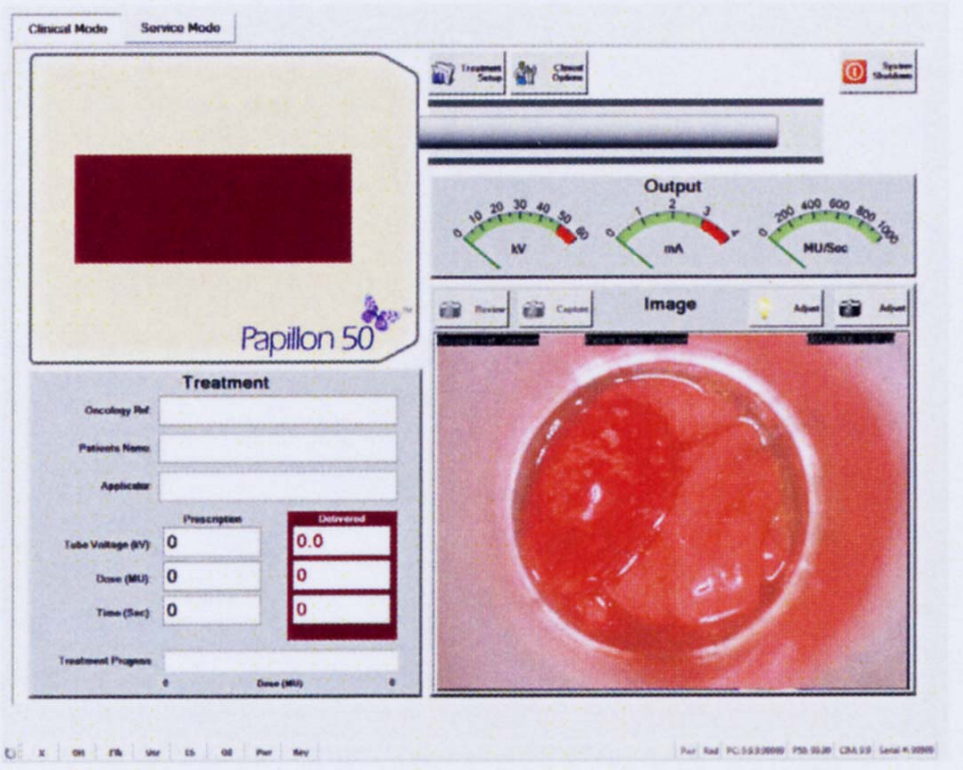
Low rectum	EBRT (43)	EBRT + contact (45)	
T3 (<50%)	29	33	
Clinical CR	2% (1)	29% (13)	.001
10y colst. free	29%	61%	.001
Rectal preserv.	0	9	.006
10y Loc. Rec.	16% (5)	11% (4)	
10y ov. surv.	55%	55%	

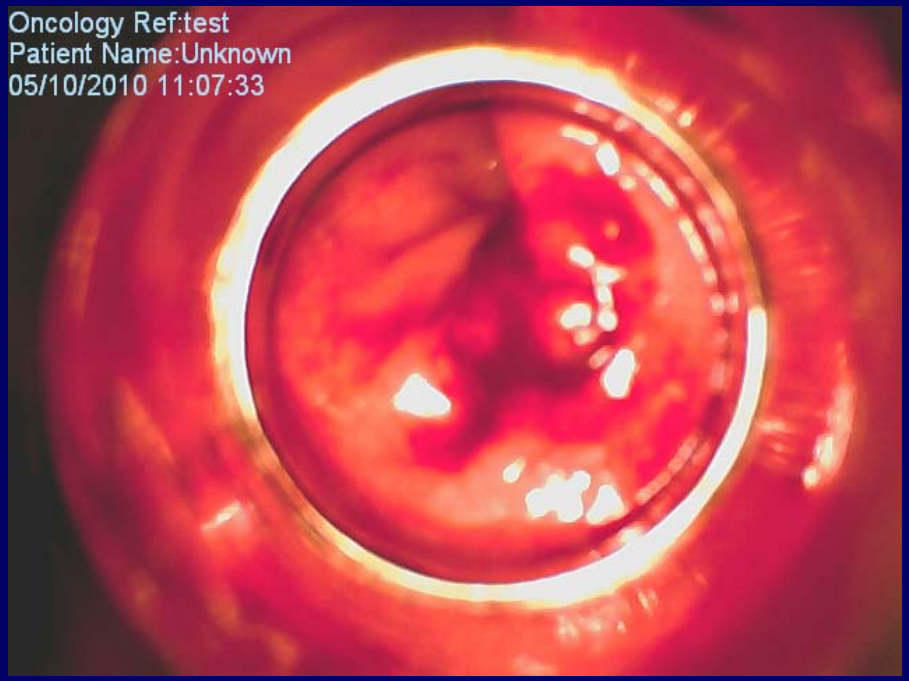
Ortholan-Gérard – ESTRO – Barcelone 2010

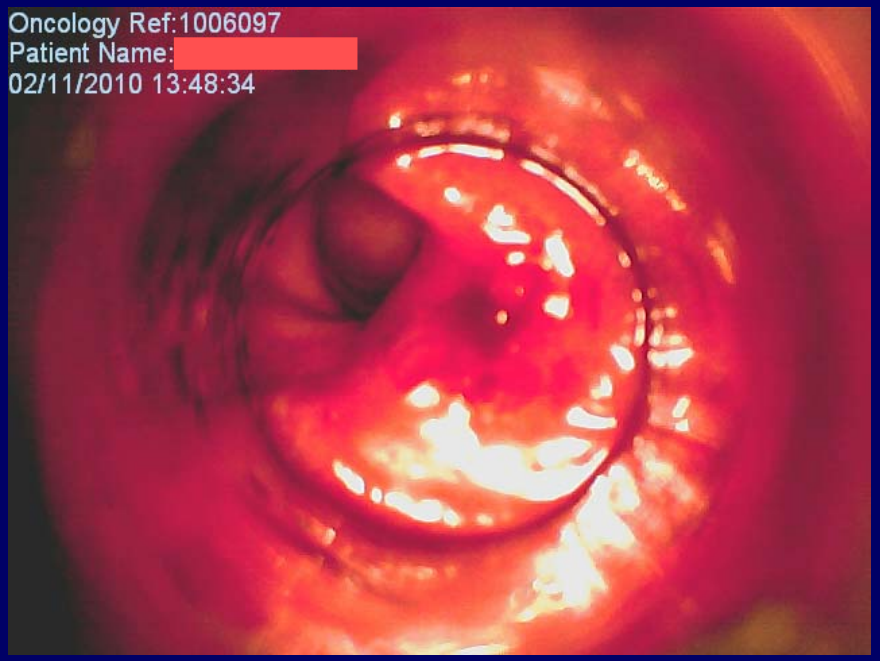

uT2N0
1999
Day 1
Day 70
pT0N0
11 years


Papillon 50
ariane




Clinical Mode
Service Mode
Output
kV
mA
MU/Sec
Image
Papillon 50
Treatment
Oncology Ref
Patients Name
Applicator
Prescription
Delivered
Tube Voltage (kV)
Dose (MU)
Time (Sec)
Treatment Progress
0.0





Mr W. 74 y
Oct. 2010
T2N0
CXRT 110 Gy
CAP 50

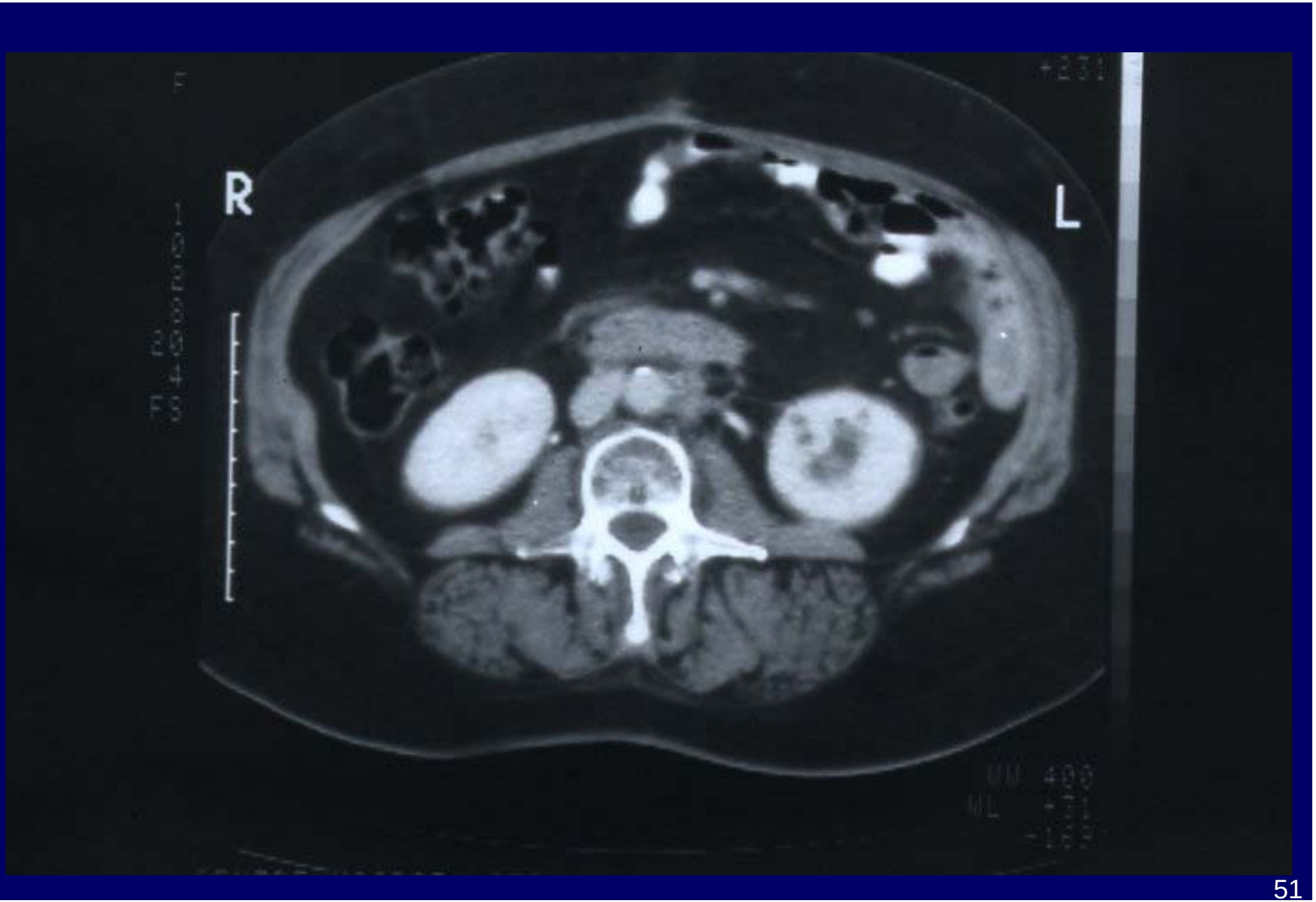
Radiothérapie per opératoire

IOERT

(Electrons)

12 - 20 Gy/1 F

40 Gy/4 w + 18 Gy IORT


R
L

Brachytherapy

Radioactive source – “Radium society”- X Ray

1- endoluminal : (endocavitary – plésio)

uterovaginal – oesophagus – bronchus - rectum

2- interstitial : (“implant” – endo)

tongue – breast – anal canal

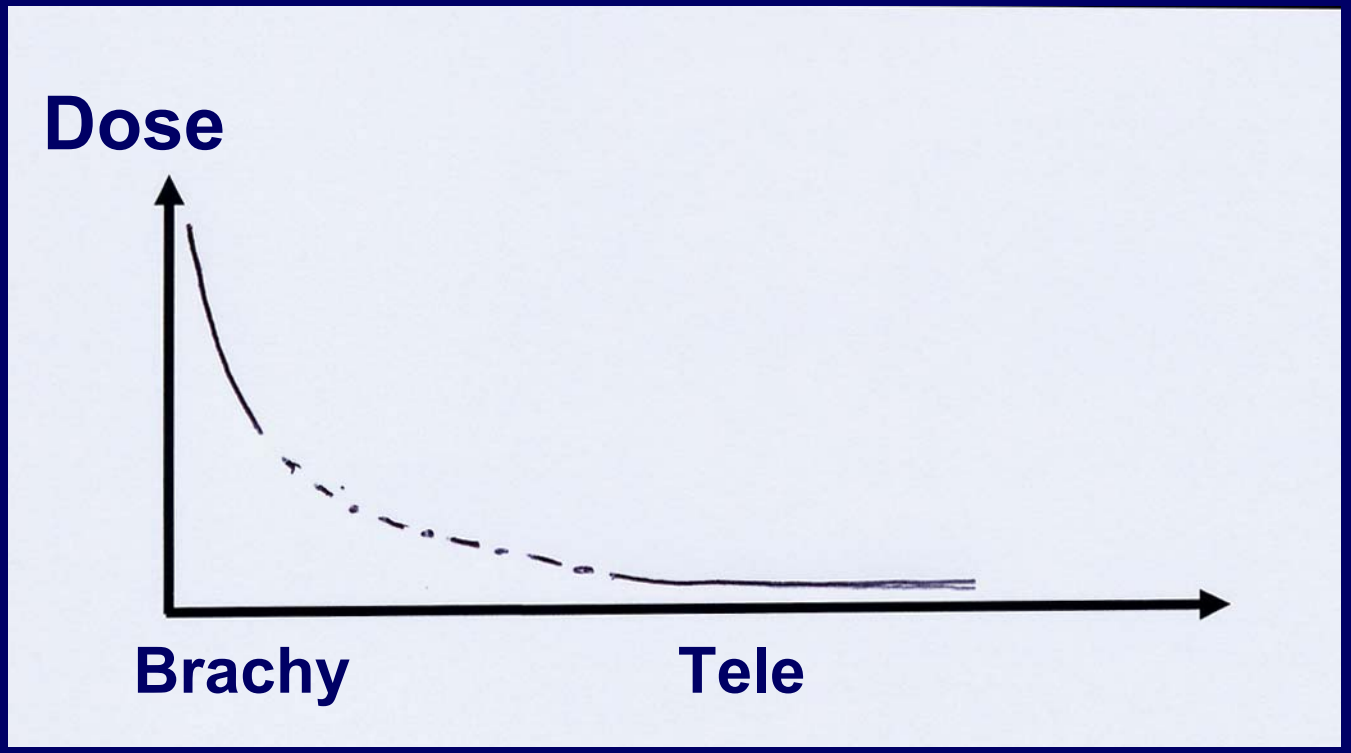
3- “contact” – mould (plesio)

skin eye (ruthenium disk)

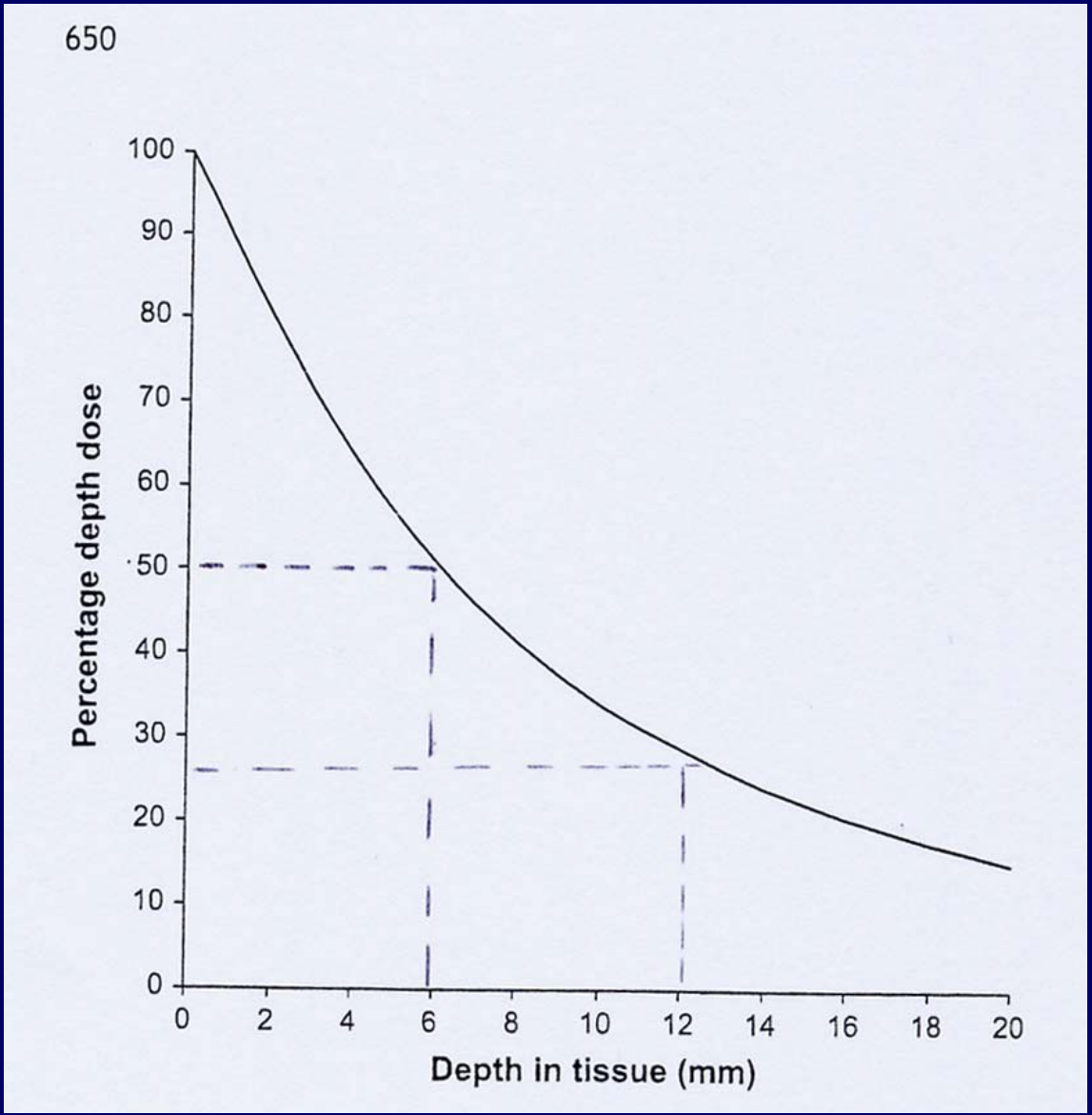
La loi de l'inverse du carré

Isotropisme - sphère

Surface sphère = $4\pi R^2$

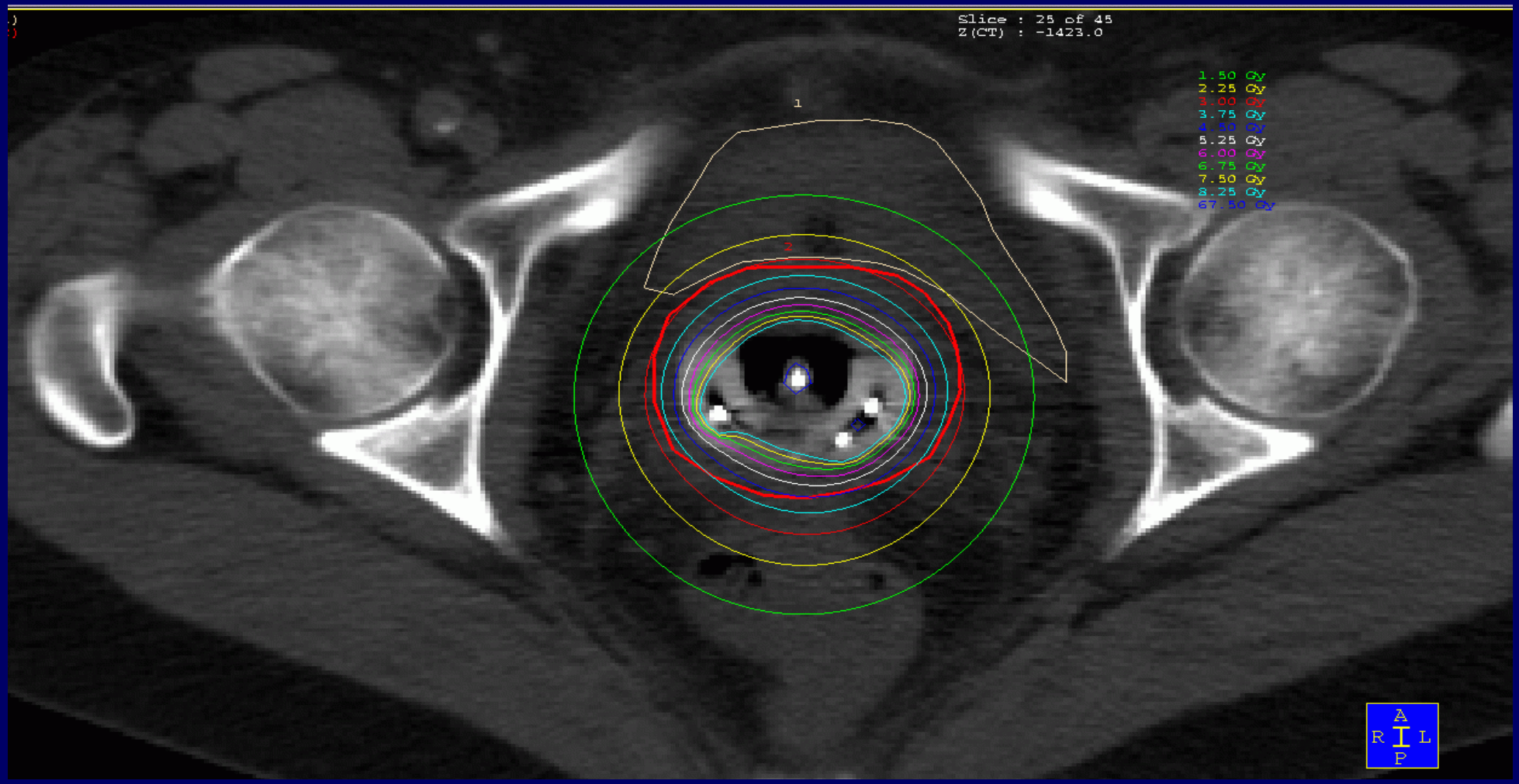


Electrons $1/R^2$ = Ru106 Sr90

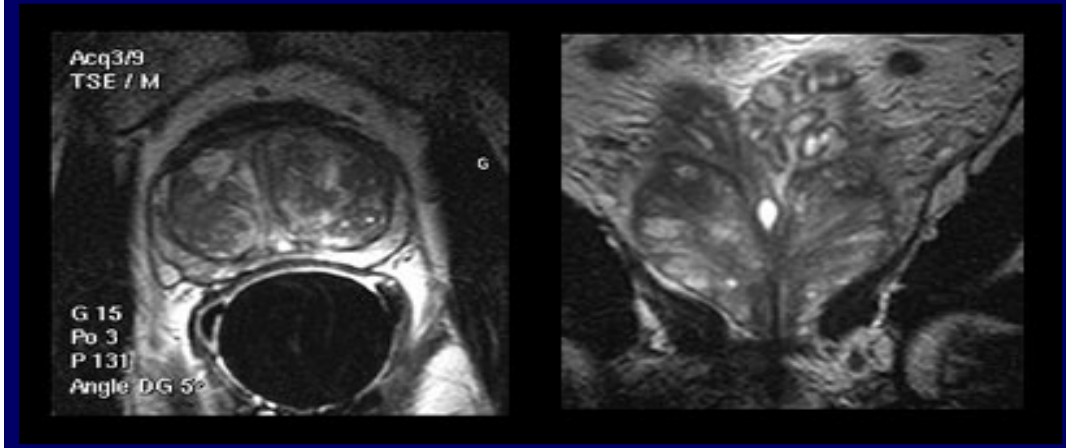


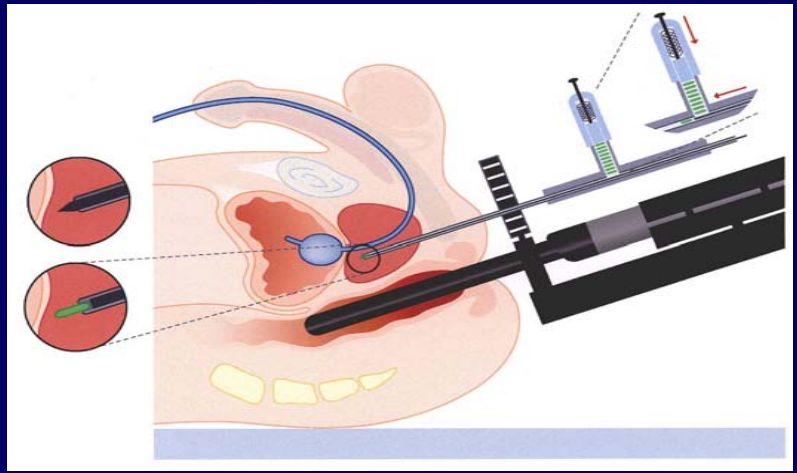
Dale Clin Oncol 2007;19:649

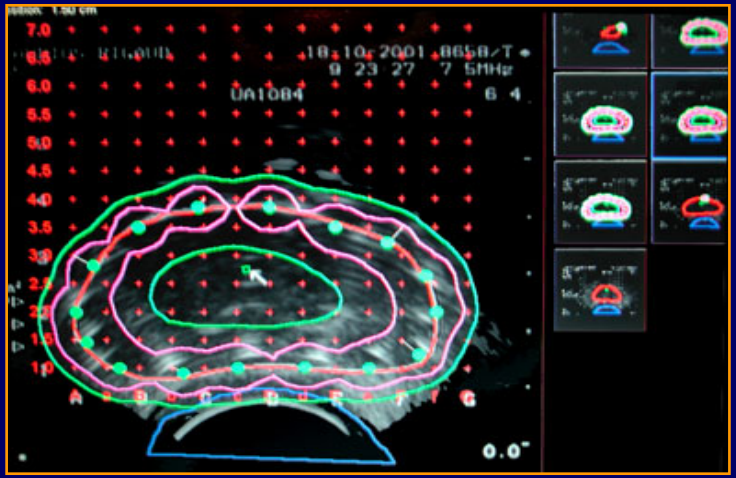

Curie du col uterin HDD

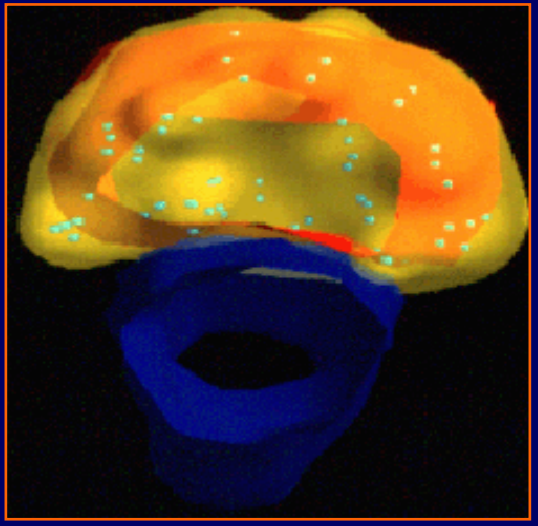

Slice : 25 of 45
Z(CT) : -1423.0
1.50 Gy
2.25 Gy
3.00 Gy
3.75 Gy
4.50 Gy
5.25 Gy
6.00 Gy
6.75 Gy
7.50 Gy
8.25 Gy
67.50 Gy
1
2
A
R
L
P

Curie de prostate à l'Iode 125

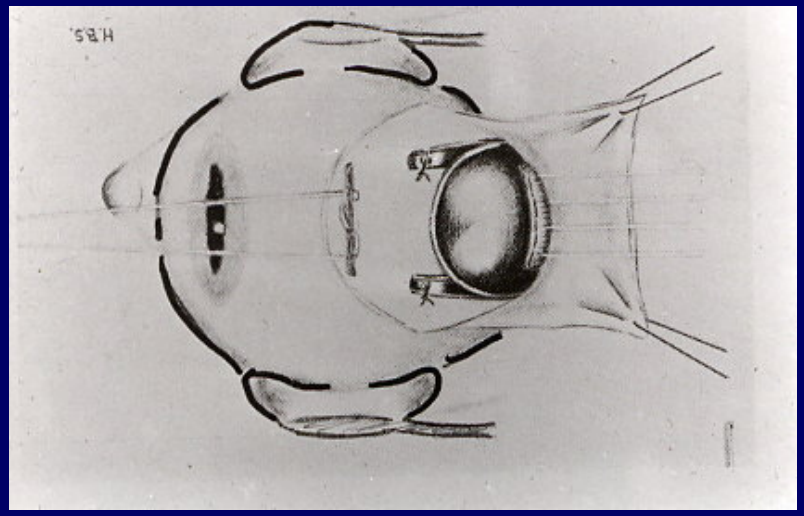


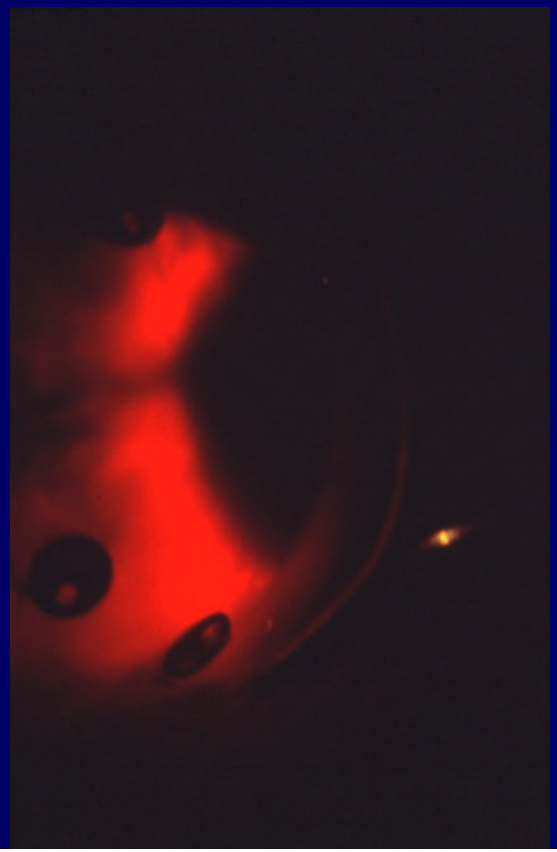


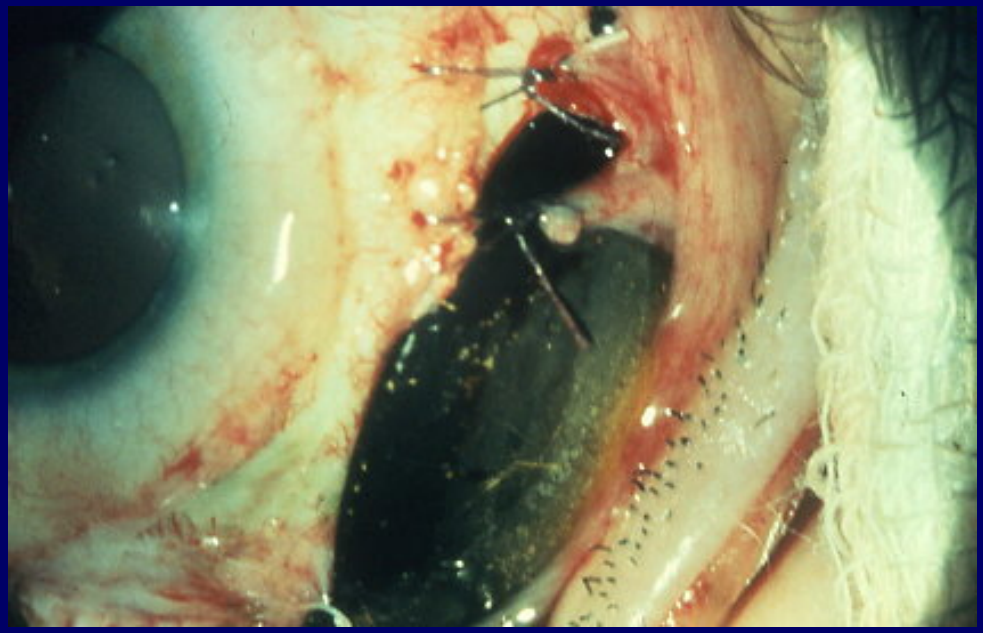





[H]
14/05/2009
Series: 1 Img: 1
100
[R]
[L]
mm
14/05/2009
09:22:38
SP: SN200.0mm
ST: 400.0mm
W: 500 C: 50
LightSpeed RT16
[F]
Centre Antoine Lacassagne /scan







HADRONTHERAPIE

- "Particules Lourdes“

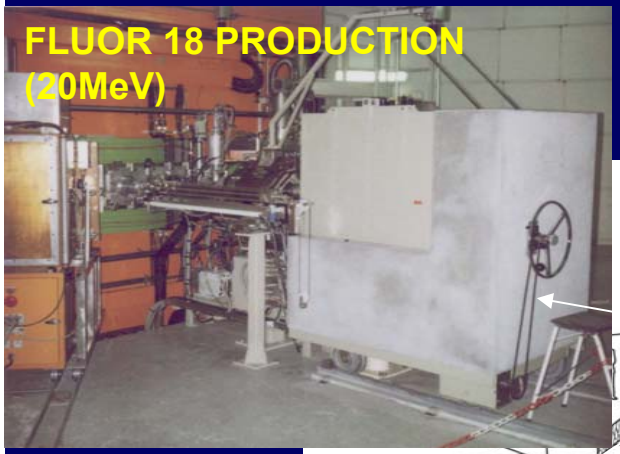
  Proton – (neutrons) – alpha (Hélium) – C12

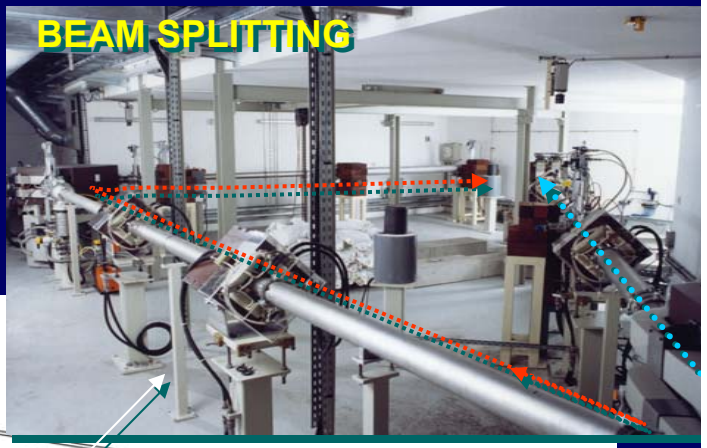
- Propriétés

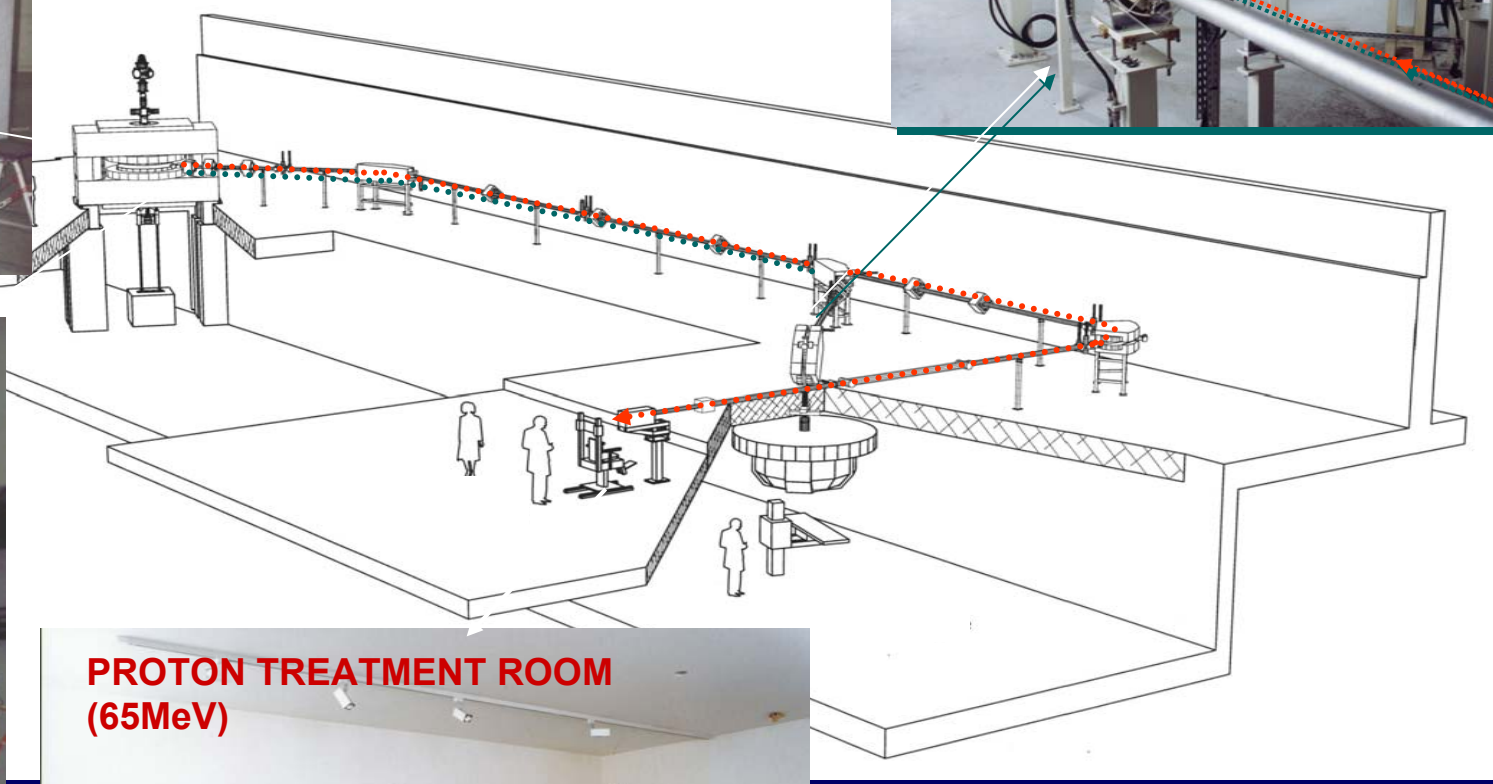
  - Balistique : pic de Bragg – lateral scatter

  - Biologique : EBR - oxygène

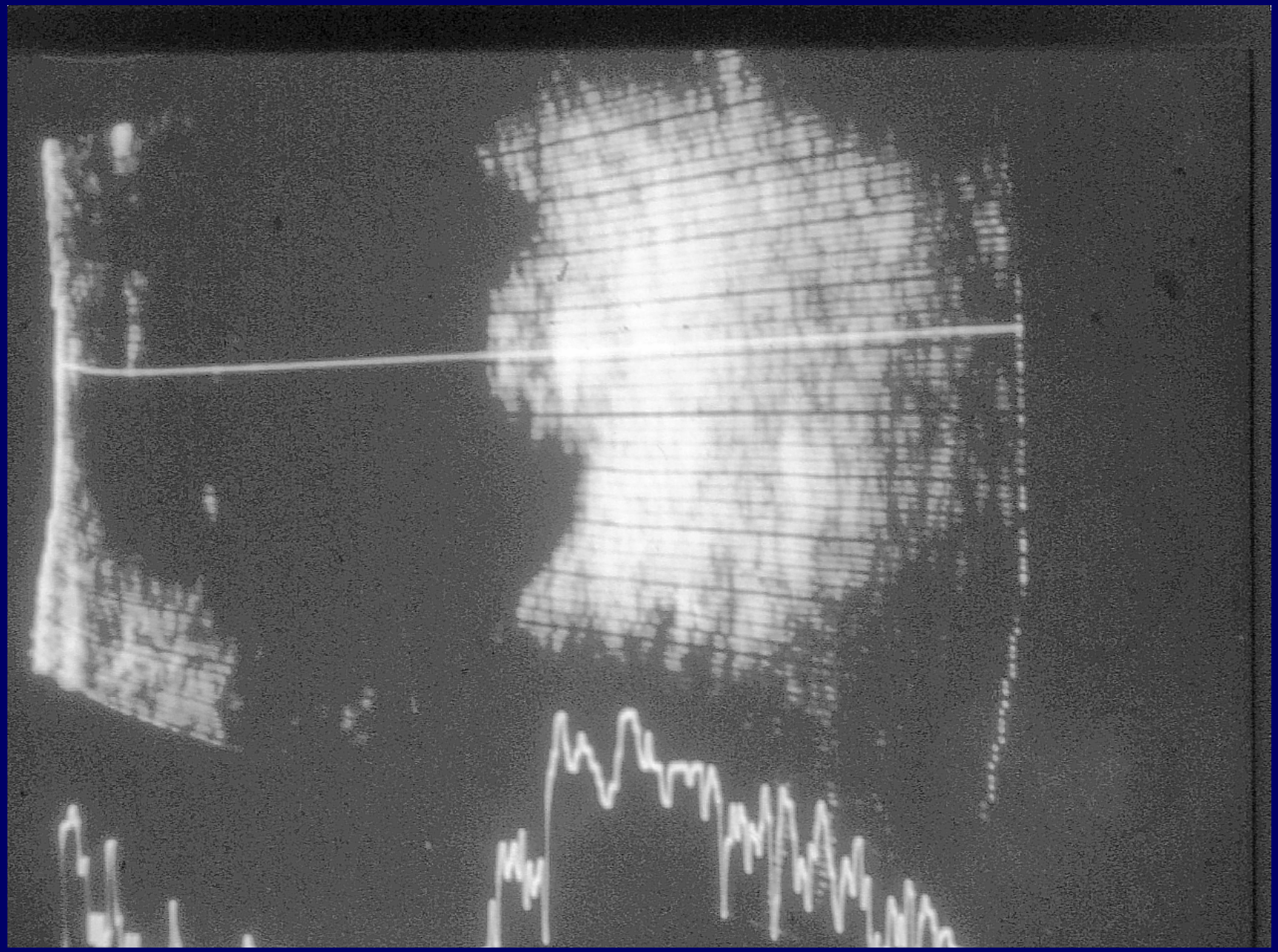
THE HADRON FACILITY in NICE

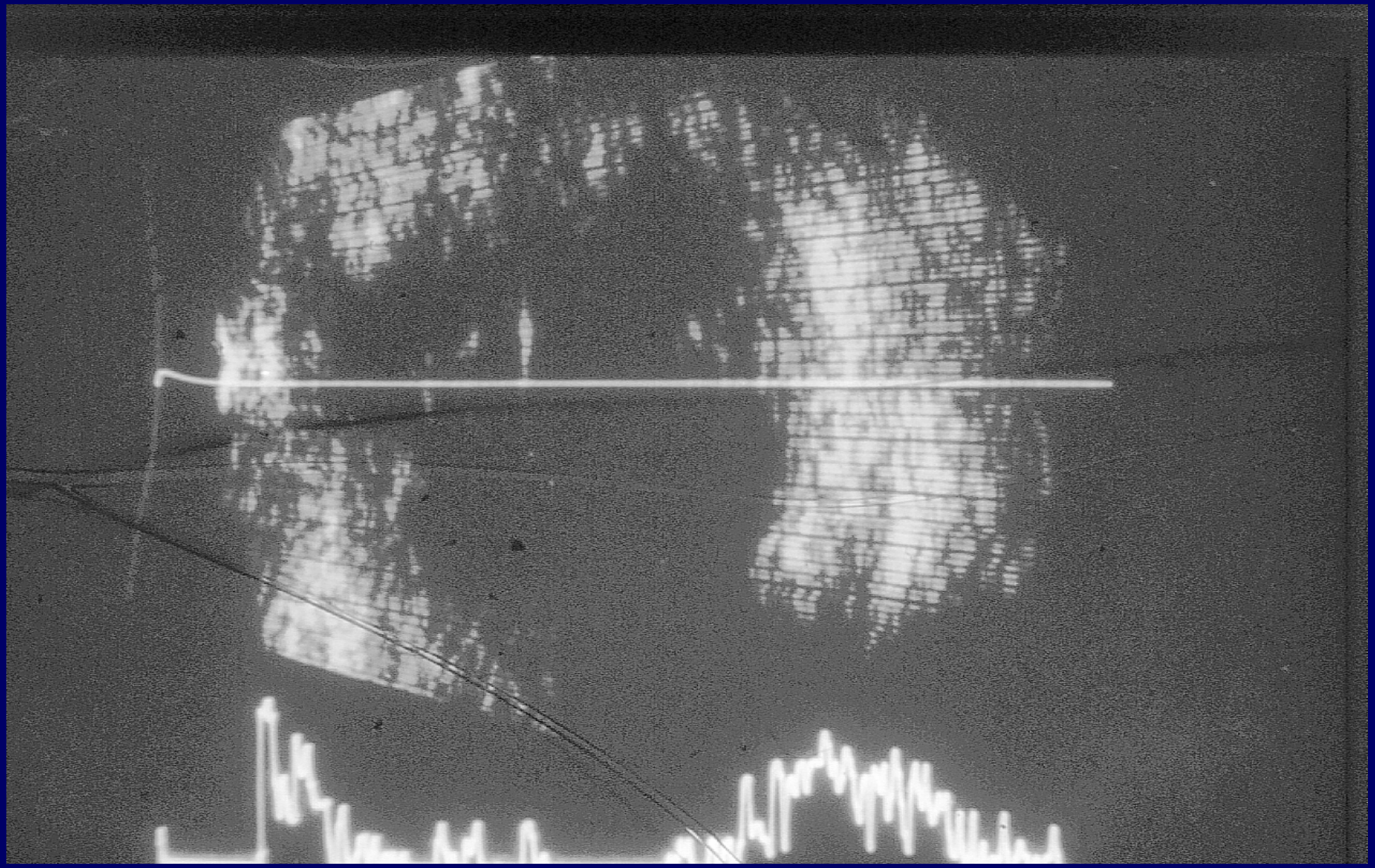




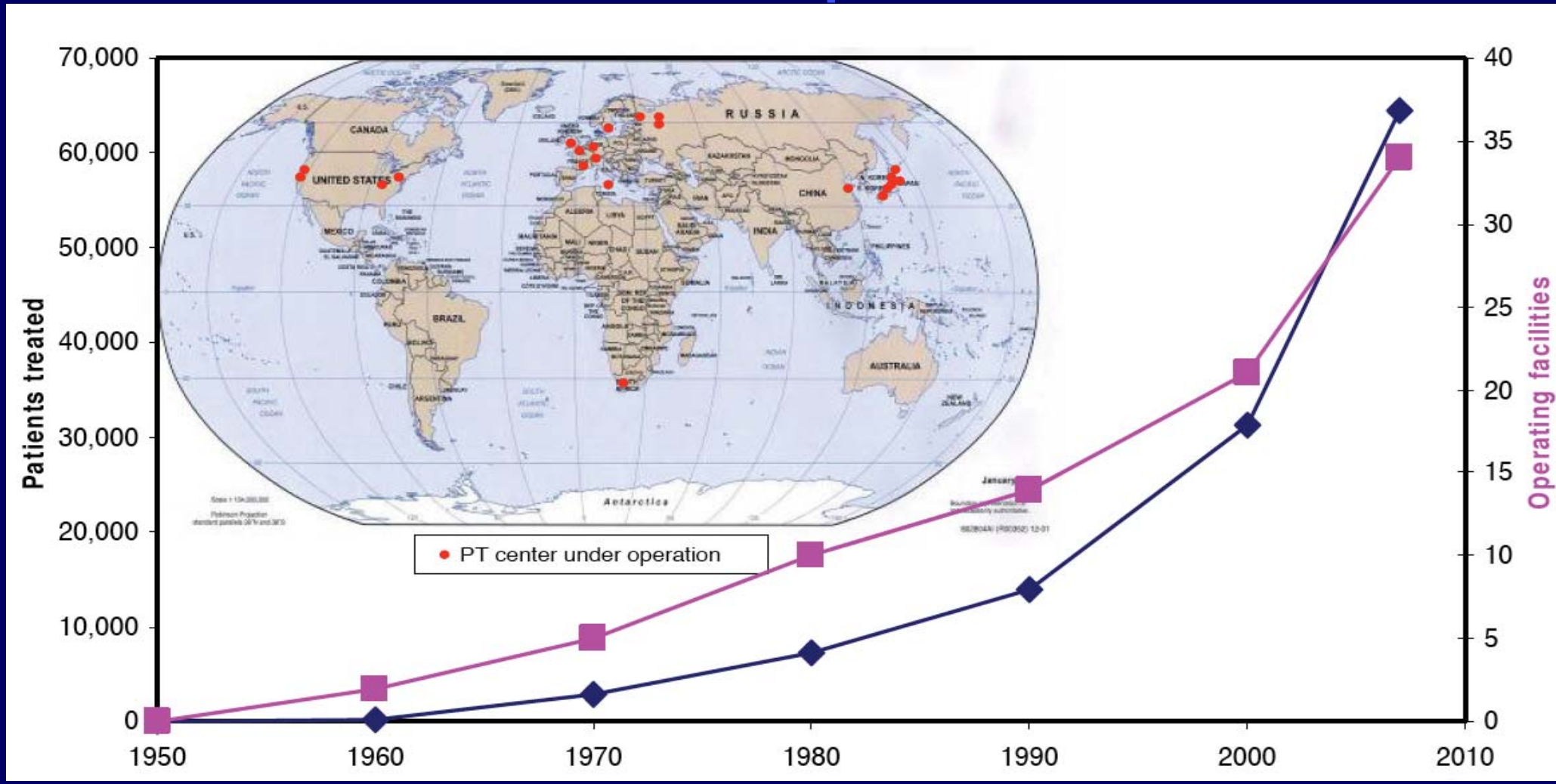


A. Courdi, P. Chauvel : IJROBP 1999 ; 45-5 J Herault,JP Caujolle H Mammar





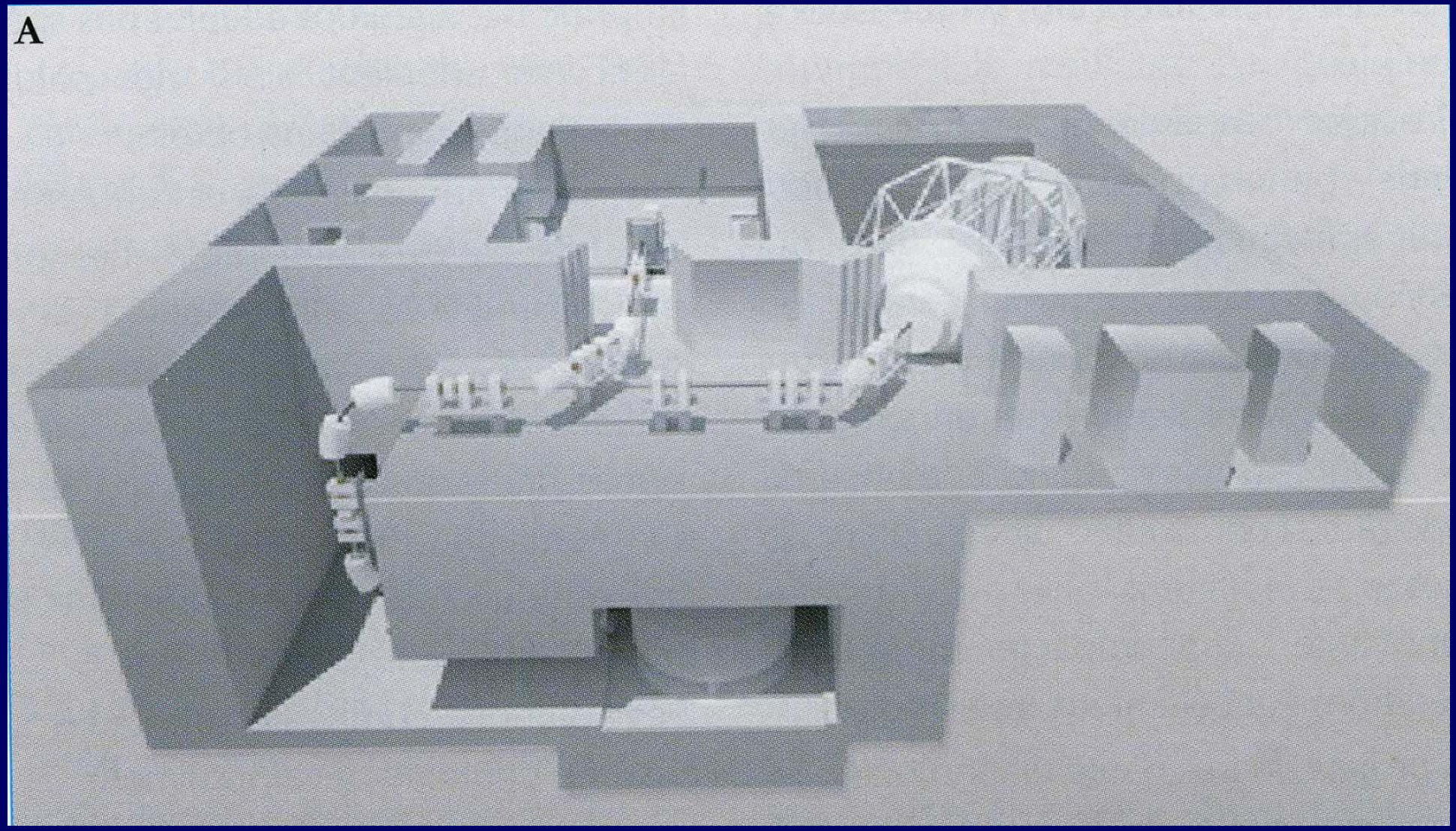
La Protonthérapie fin 2009



La protonthérapie aux USA à la fin Octobre 2010

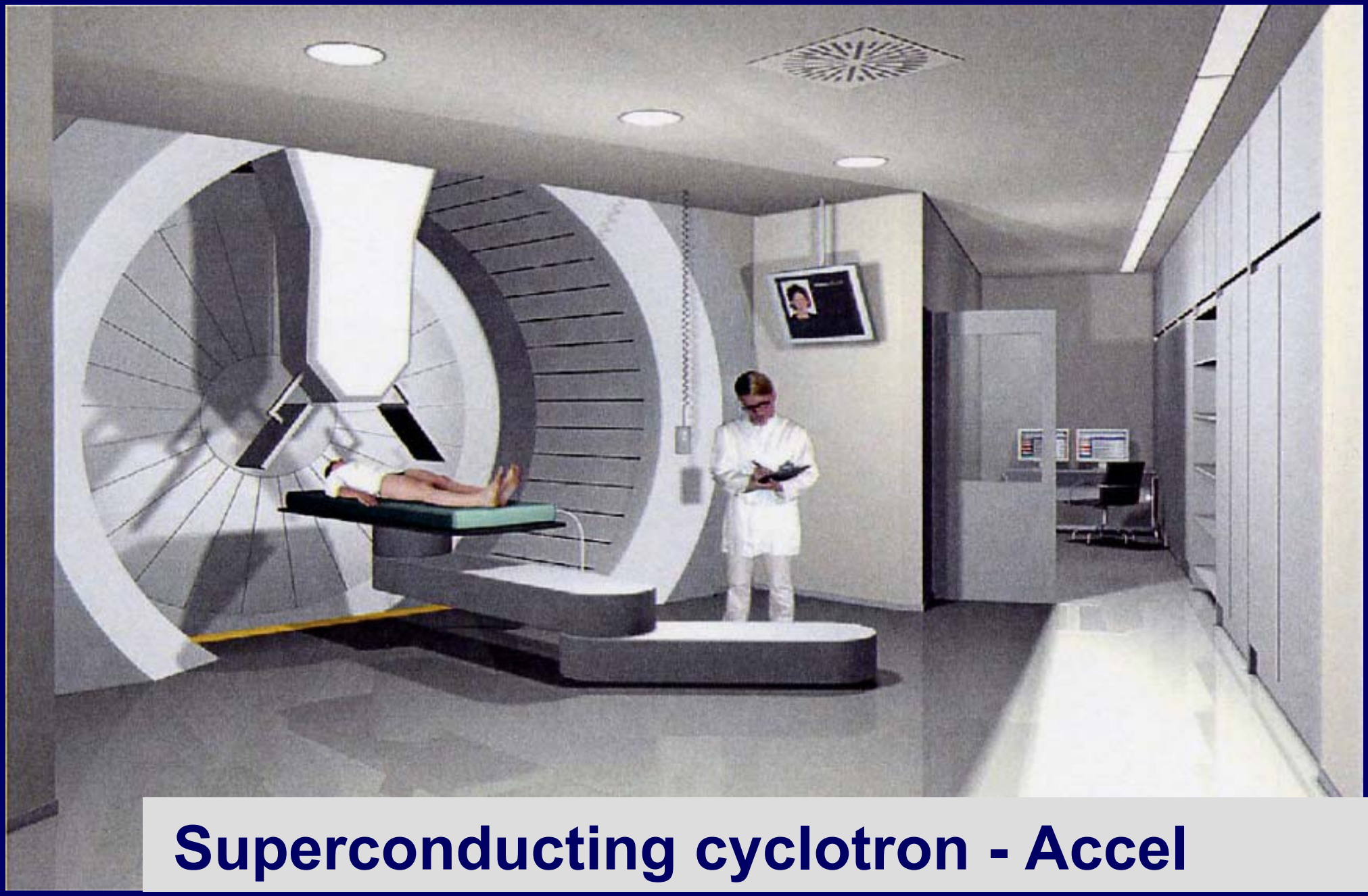
9 Centres en opération:
Loma-Linda
MGH(Boston)
Davis (San Francisco),
Jaksonville
Houston
Chicago
Oklahoma
Bloomington
Philadelphia

3 en construction:
Northern Illinois Univ.
New Jersey
Knoxville

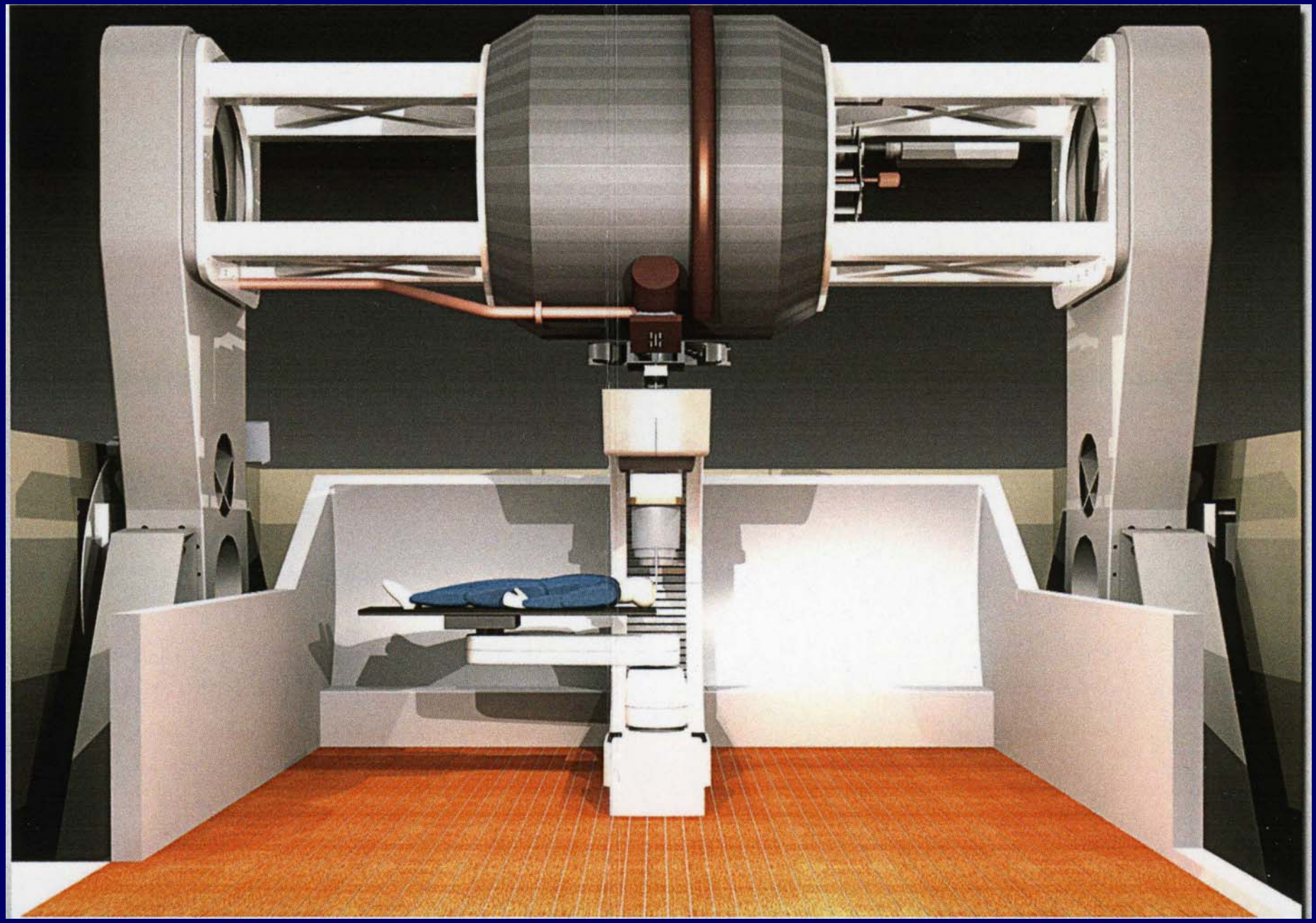

A

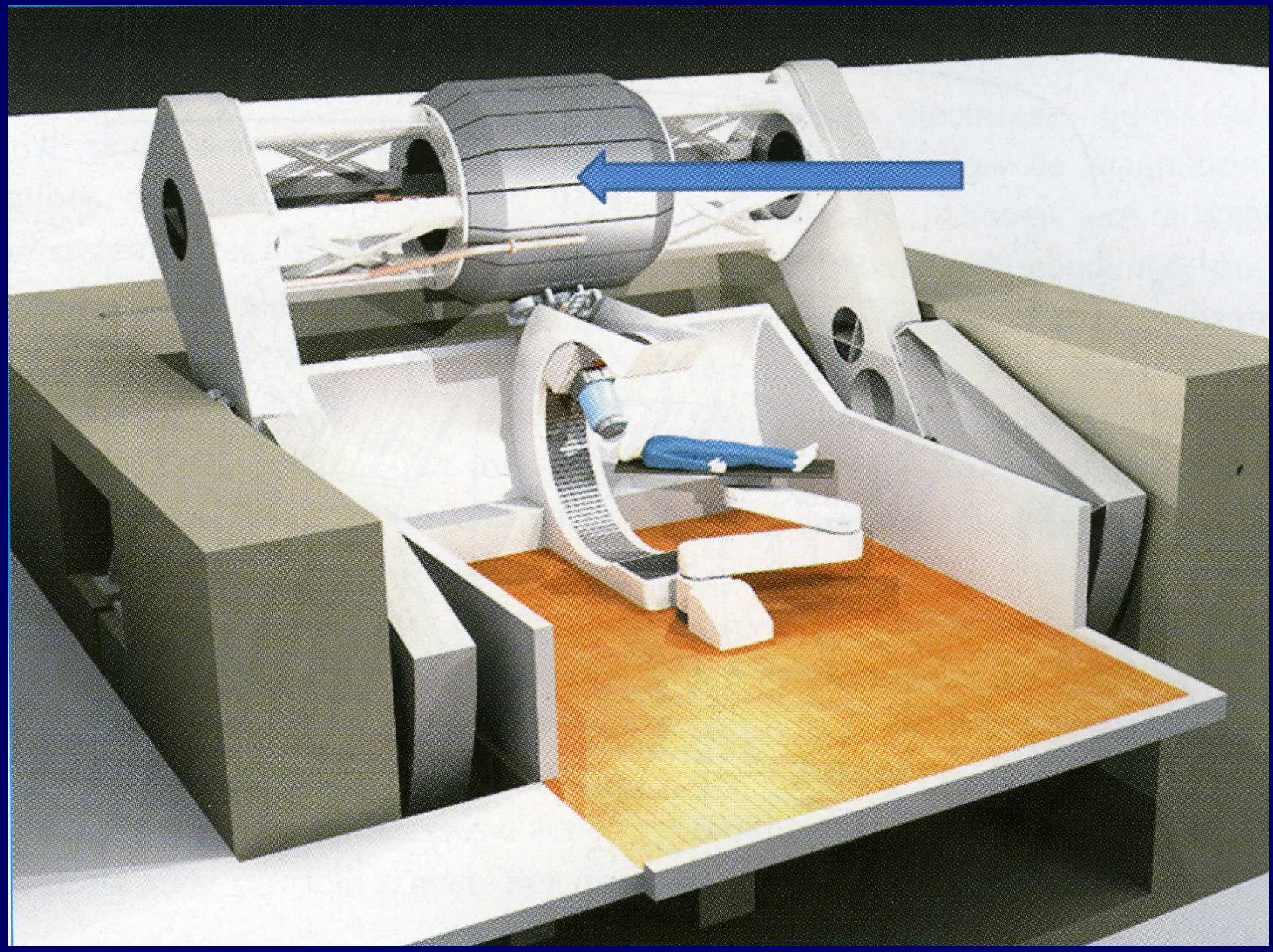
La plupart des centres de ProtonThérapie utilisent aujourd'hui des cyclotrons, ce n'etait pas le cas en 1991 avec le 1er accélérateur dédié (synchrotron de Loma-Linda)

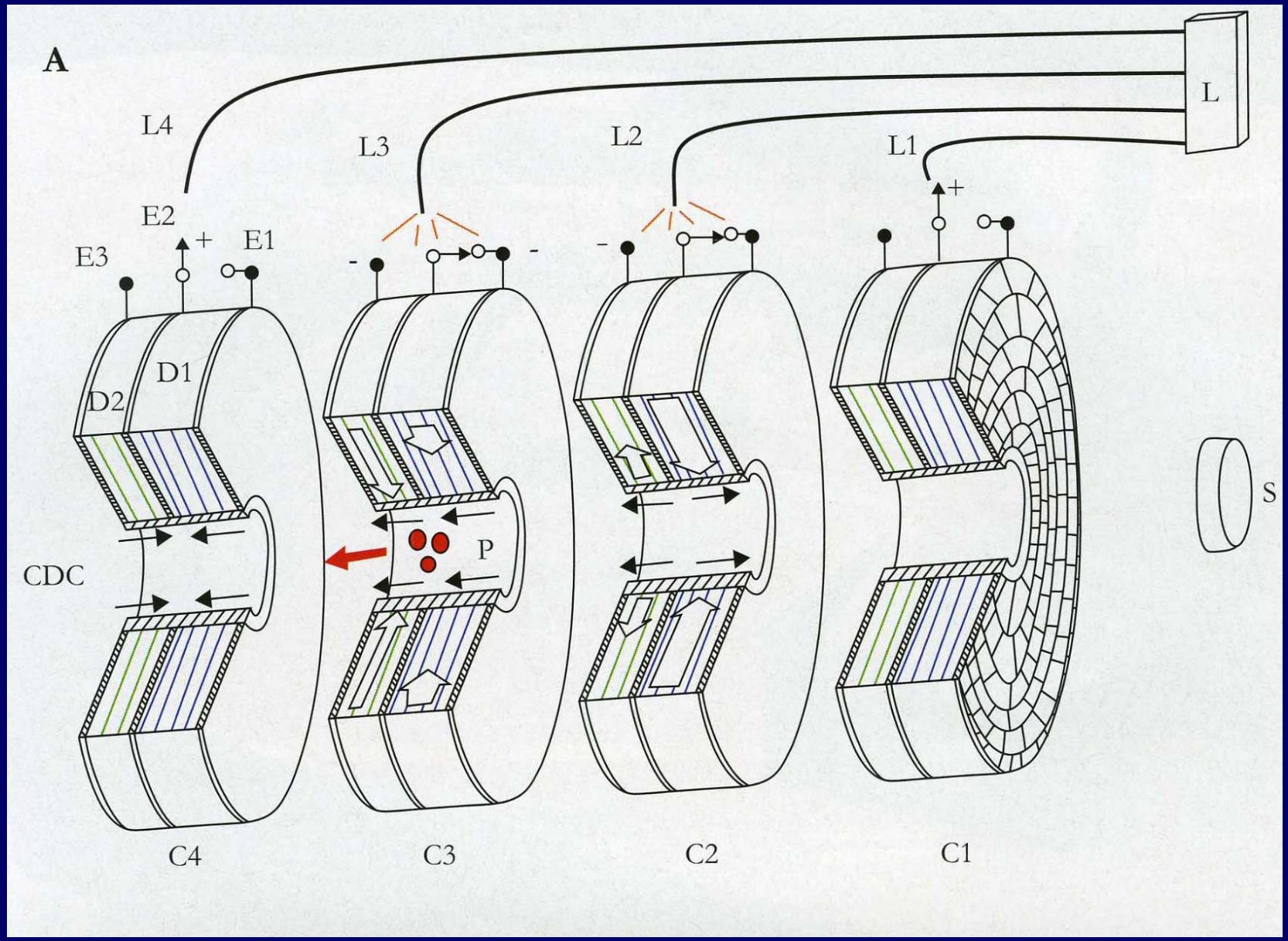
IBA
Varian (ex Accel)
Still River
D'autres bientot!

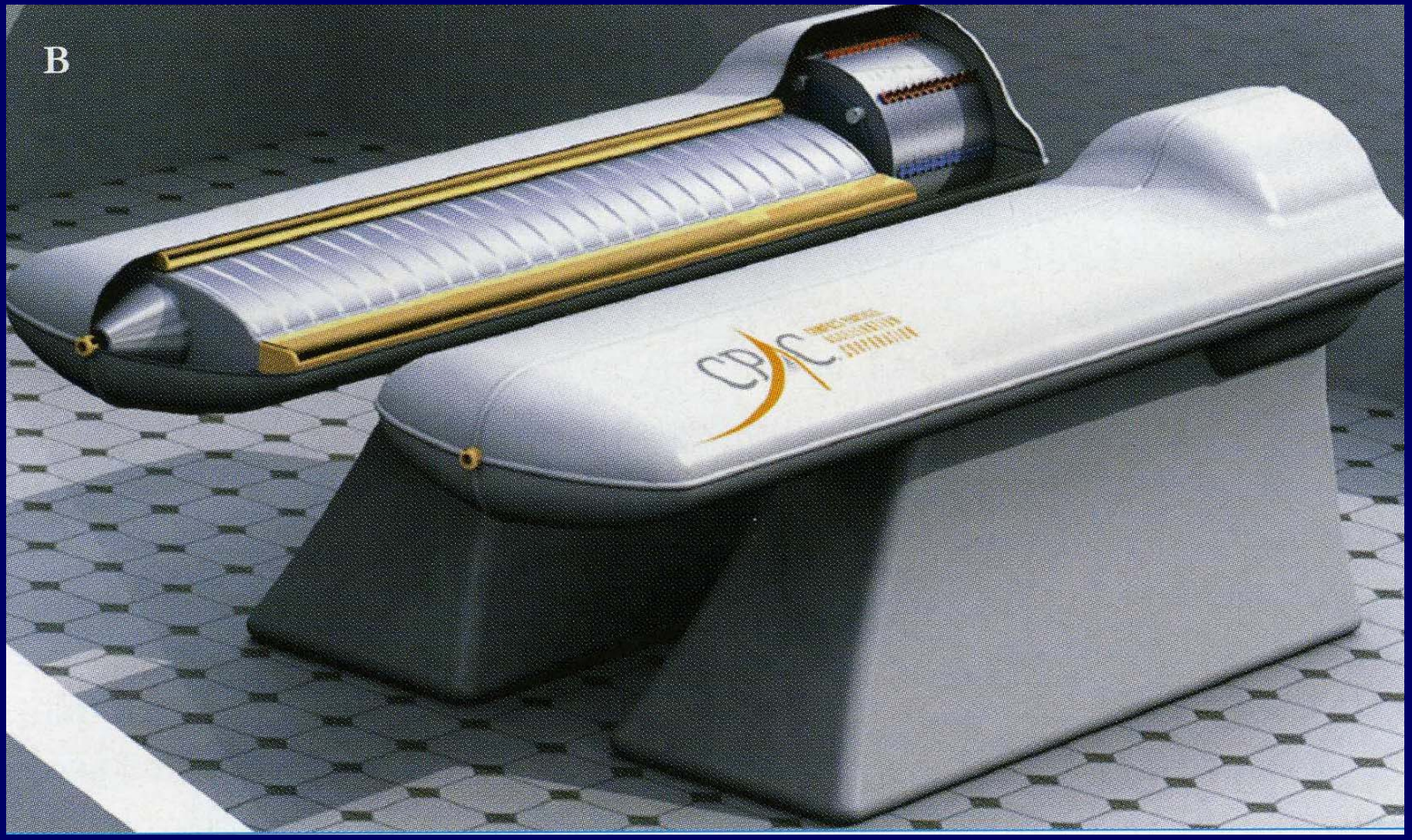


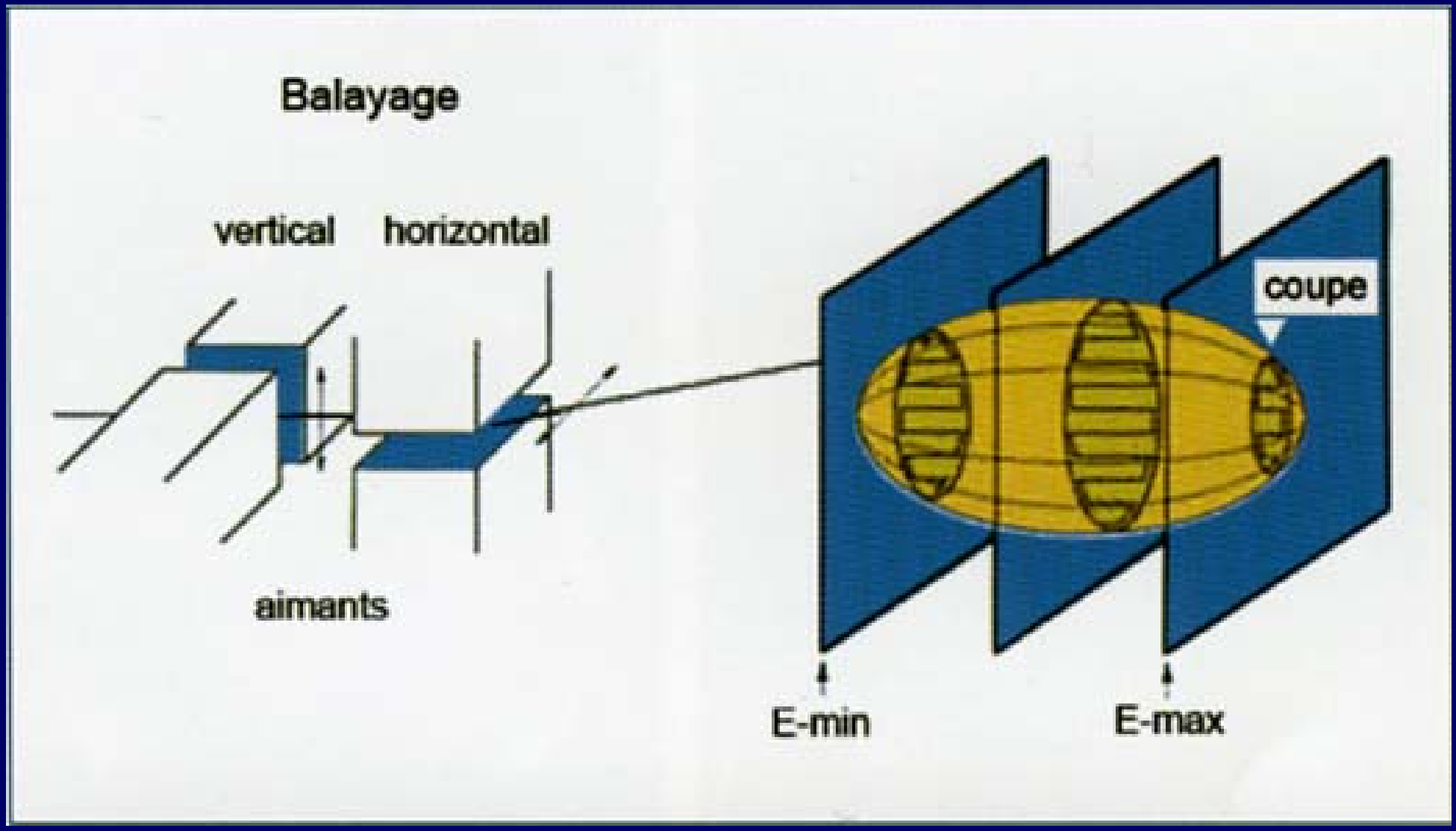
Superconducting cyclotron - Accel

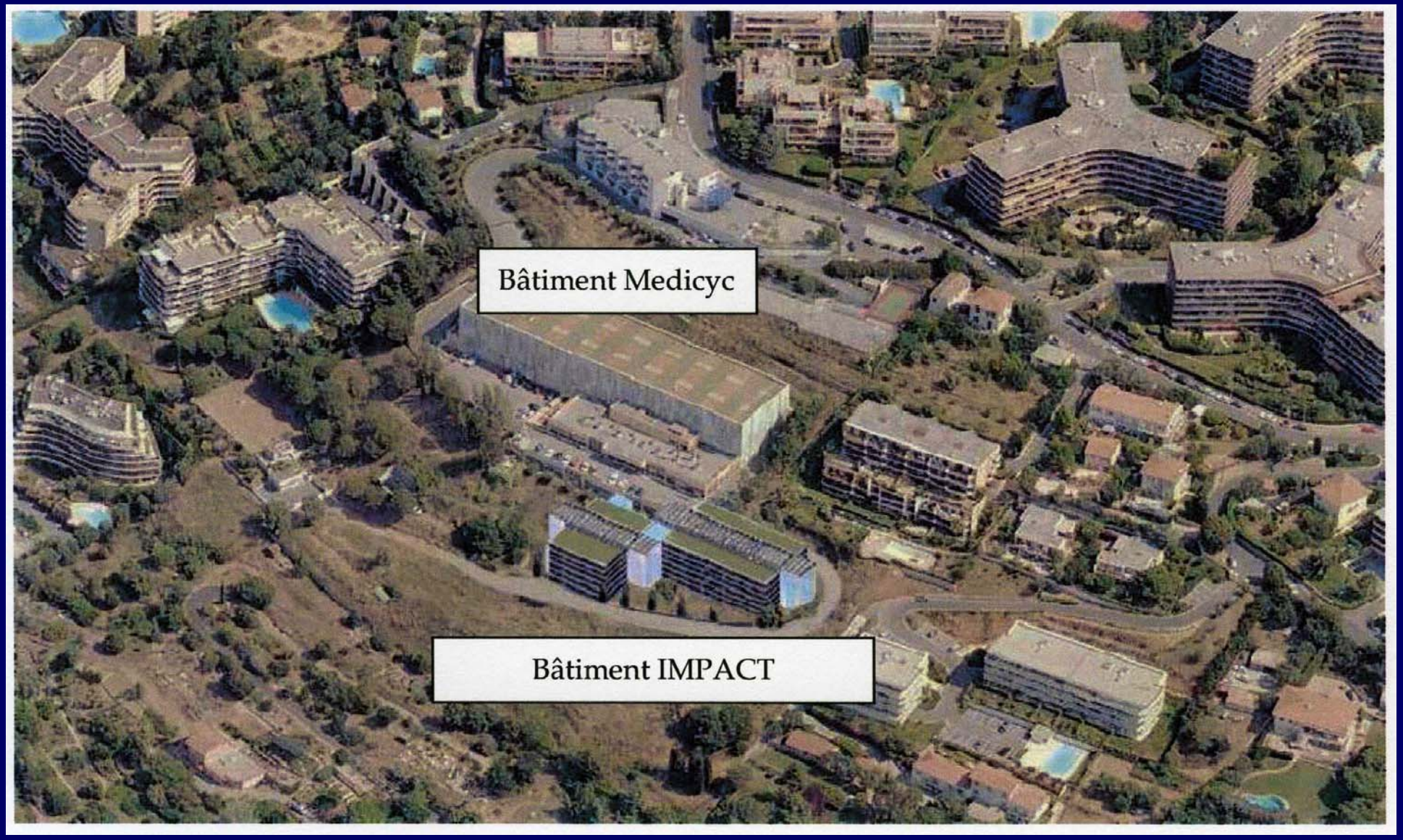


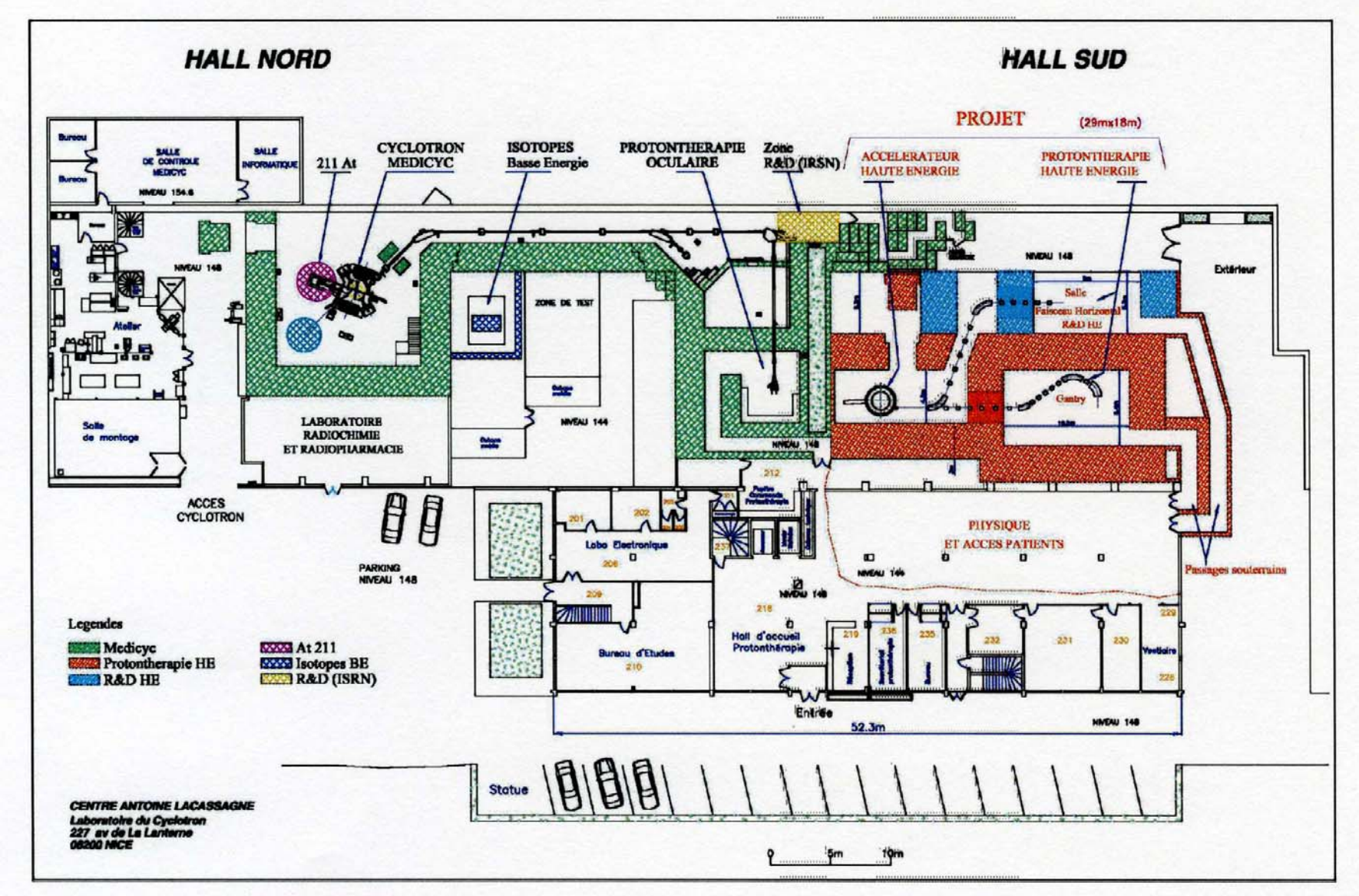


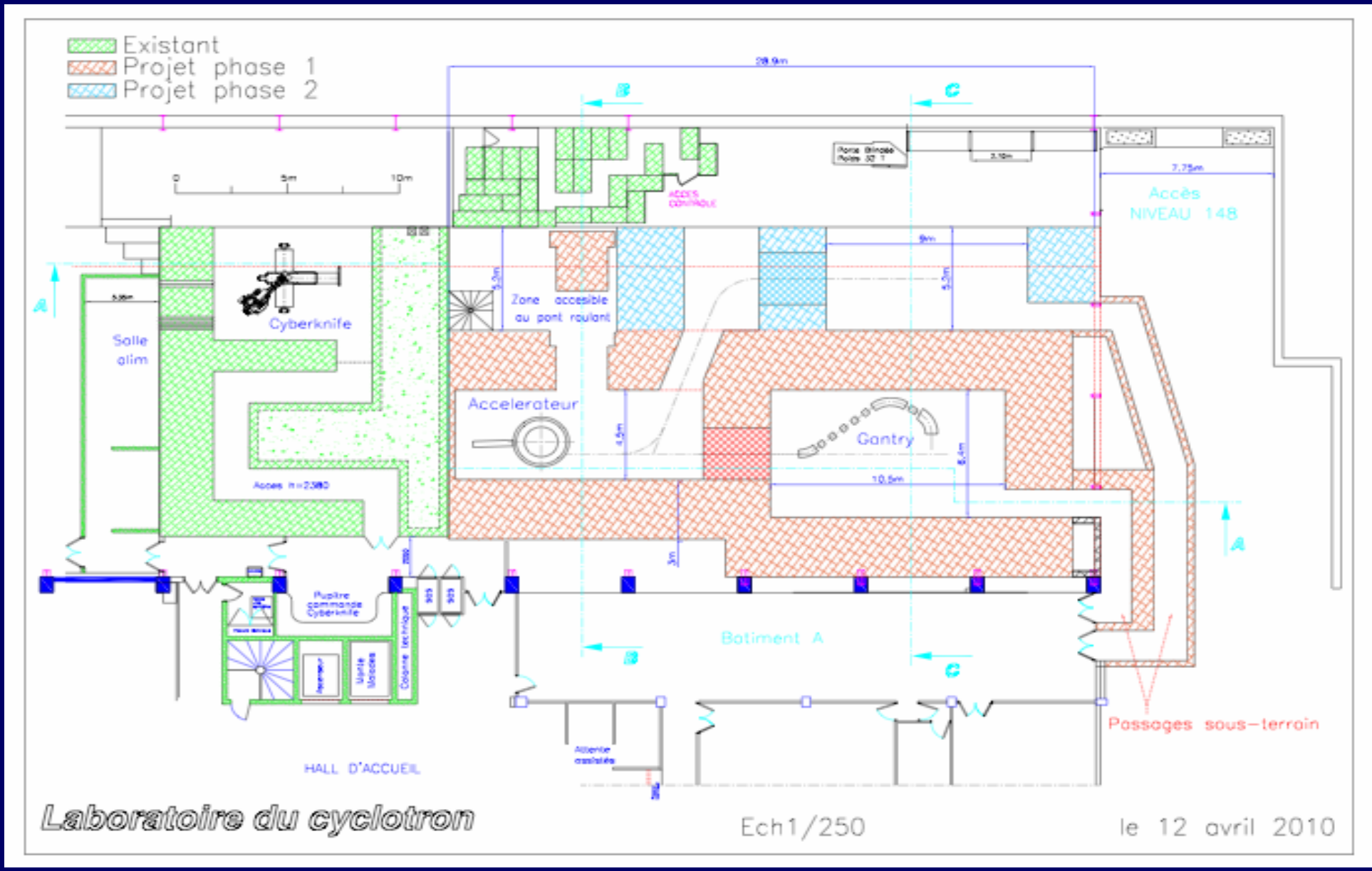

A
L4
L3
L2
L1
L
E2
E3
E1
+
-
-
-
+
D2
D1
CDC
P
S
C4
C3
C2
C1


B

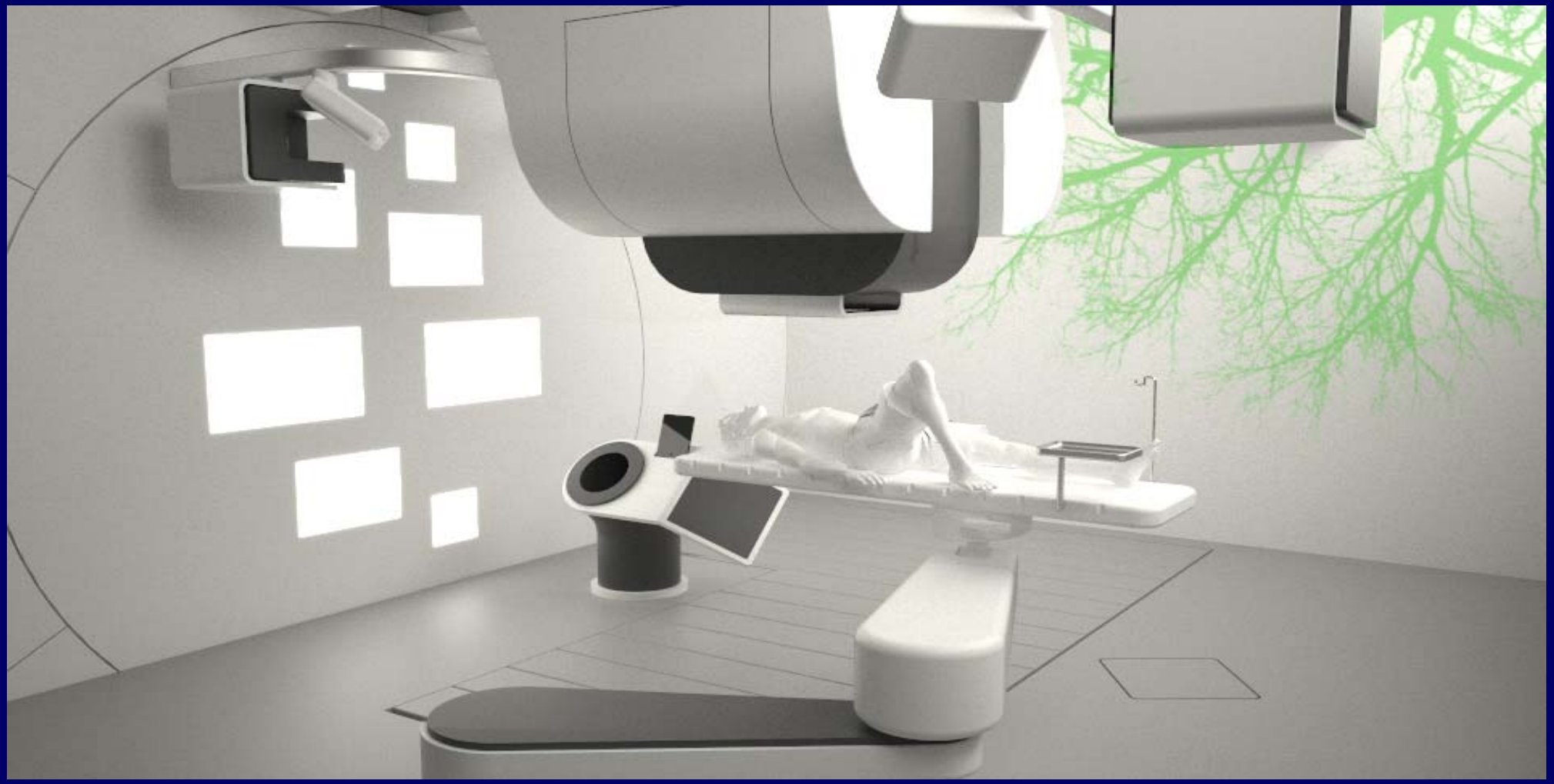

Balayage
vertical
horizontal
aimants
coupe
E-min
E-max


Bâtiment Medicyc
Bâtiment IMPACT


HALL NORD
HALL SUD
PROJET
(29mx18m)
211 At
CYCLOTRON MEDICYC
ISOTOPES Basse Energie
PROTONTHERAPIE OCULAIRE
Zone R&D (IRSN)
ACCELERATEUR HAUTE ENERGIE
PROTONTHERAPIE HAUTE ENERGIE
Bureau
Bureau
SALLE DE CONTROLE MEDICYC
NIVEAU 154.6
SALLE INFORMATIQUE
NIVEAU 148
Atelier
Salle de montage
LABORATOIRE RADIOCHIMIE ET RADIOPHARMACIE
ZONE DE TEST
NIVEAU 144
NIVEAU 148
Salle Faisceau Horizontal R&D HE
Gantry
Extérieur
ACCES CYCLOTRON
PARKING NIVEAU 148
Labo Electronique
PHYSIQUE ET ACCES PATIENTS
NIVEAU 144
Passages souterrains
Bureau d'Etudes
Hall d'accueil Protontherapie
Entrée
52.3m
NIVEAU 148
Statue
Legendes
Medicyc
Protontherapie HE
R&D HE
At 211
Isotopes BE
R&D (ISRN)
CENTRE ANTOINE LACASSAGNE
Laboratoire du Cyclotron
227 av de La Lanterne
06200 NICE
5m
10m


Existant
Projet phase 1
Projet phase 2
Accès
NIVEAU 148
Salle
alim
Cyberknife
Zone accessible
au pont roulant
Accelerateur
Gantry
Batiment A
Passages sous-terrain
HALL D'ACCUEIL
Laboratoire du cyclotron
Ech1/250
le 12 avril 2010

Future salle isocentrique IBA PROTEUS-1 à Nice
Premier traitement en 2013



Trois Accélérateurs

- **MEDICYC**
  - **Protonthérapie ophtalmique**
  - **Accélération des alphas pour production At211**
  - **Production isotopes (p,xn) à haute energie.**
  - **Spectrométrie neutrons pour IRSN.**
- **S2C2-230 MeV**
  - **Protonthérapie de Haute Energie voie isocentrique**
  - **Voie Horiz fixe: R&D imagerie proton**
- **Cyclotron 17/20 MeV**

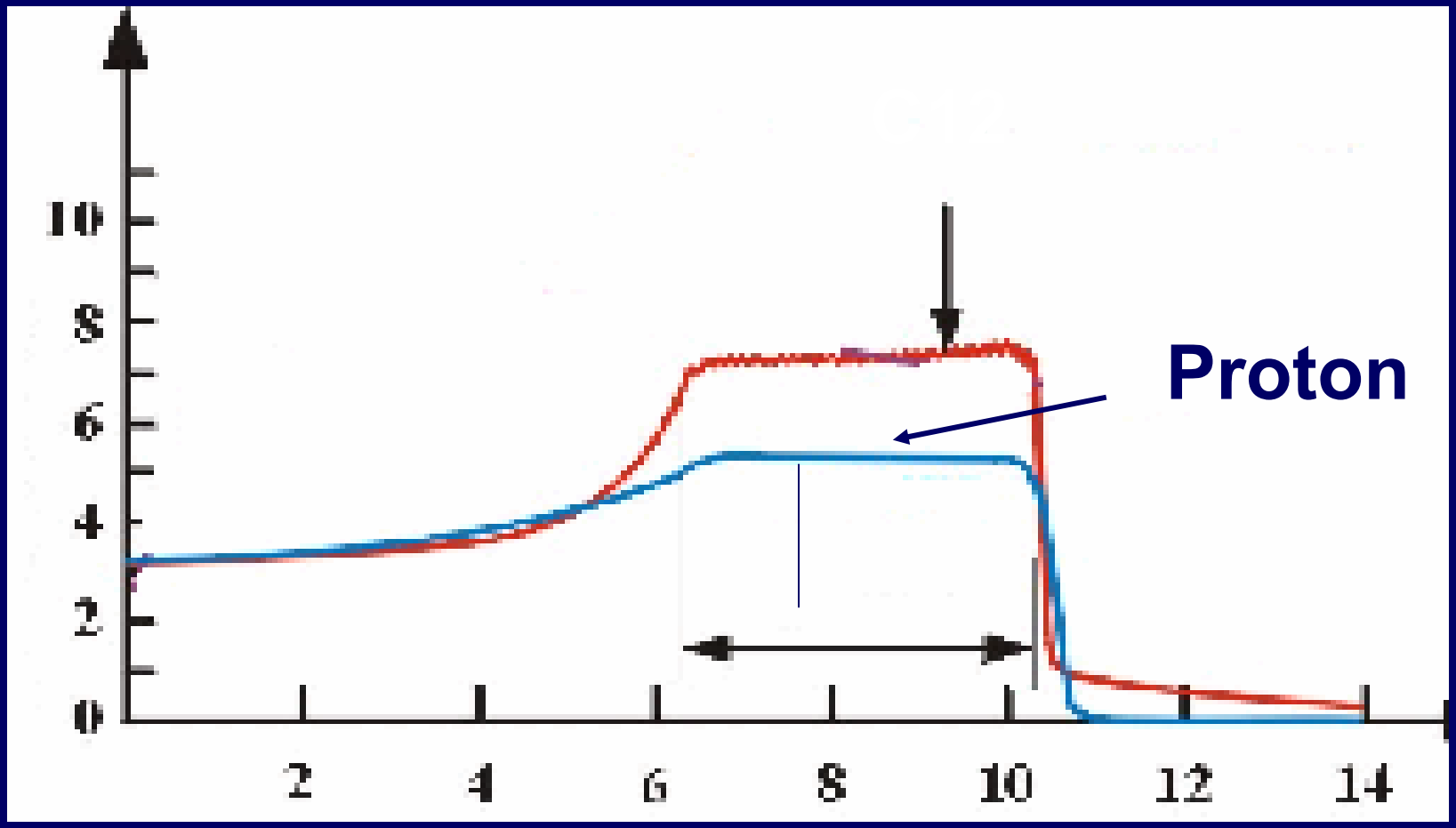
S2C2 proton / hélion-thérapie

Particles	Range (cm)	Max Energy (MeV/q.c.)	Injection Radius @ 20 kV/q.c. (cm)	Extraction Radius (cm)	Field @ Max Energy (Tesla)	Weight (Tonnes)	Classical Cyclotron Weight ratio
H^+	33	230	0.4	42.2	5.4	38	1/5
α	33	230	0.5	60.1	7.7	64.5	1/3

26.5 Tonnes en plus … mais:

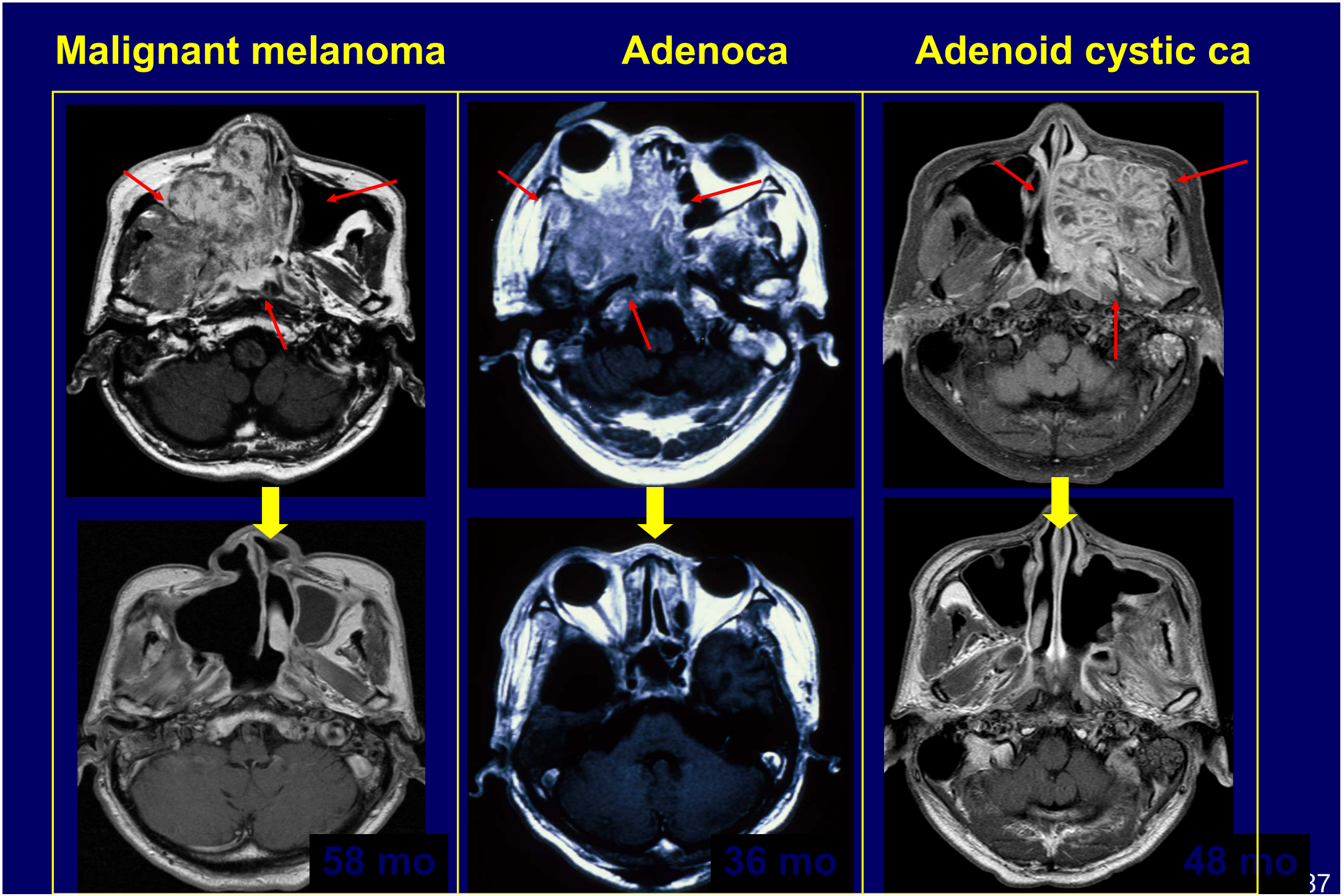
- **gain d'efficacité biologique** (EBR) important (**+50 % sur le TEL /r au proton**)
- **gain sur la précision balistique** (**+100%** xscattering & straggling)
- **Beaucoup moins cher que les ions Carbone (facteur 10 sur la masse du cyclotron!)**
- **Pas de fragmentation derrière le pic de Bragg: avantage important /r au Carbone**

Effet biologique des ions carbone

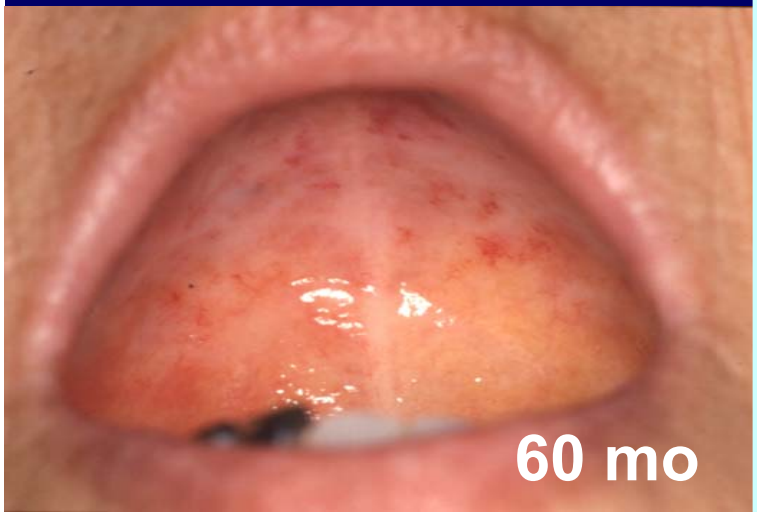


Profondeur dans l'eau (cm)

Effet biologique, pic de Bragg étalé, modulation d'intensité

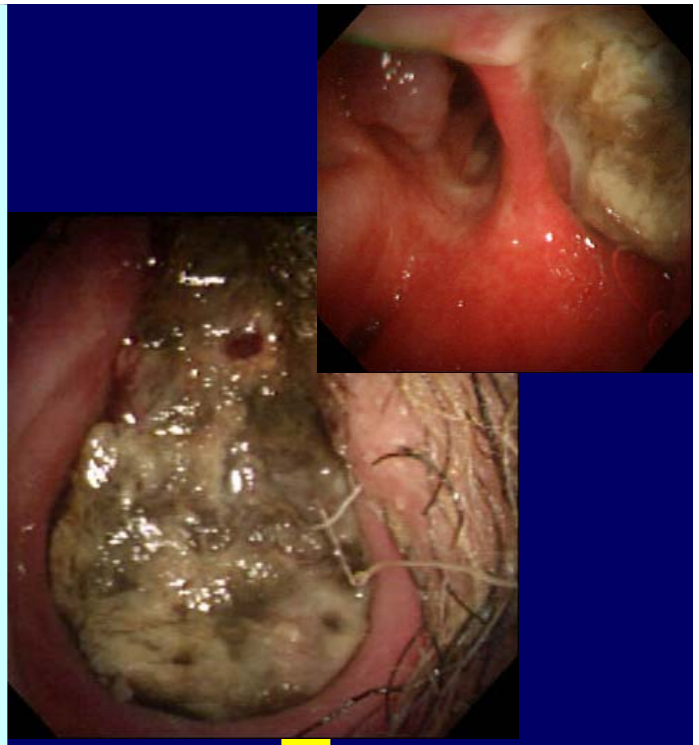

Malignant melanoma
Adenoca
Adenoid cystic ca
58 mo
36 mo
48 mo

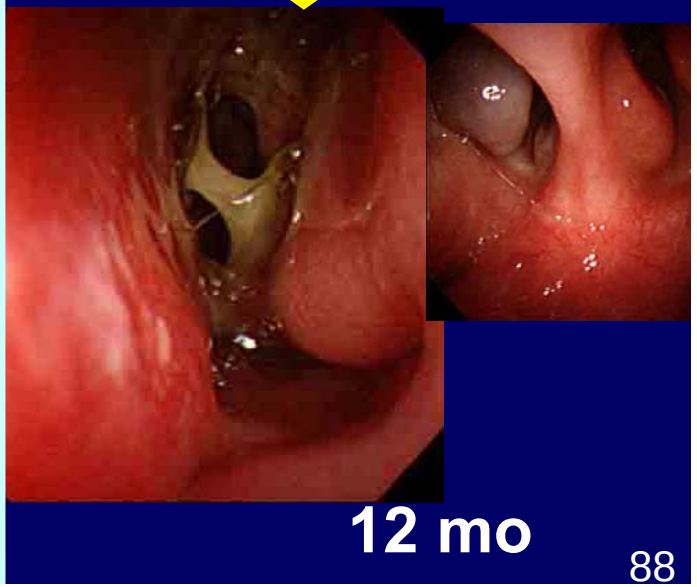
Malignant melanoma



60 mo

36 mo





12 mo

Résultats NIRS - CHIBA

Loc	Lieu	N°	Contrôle	Tox ≥ 3
Sarcome	NIRS	224	85/95%	< 5%
Chordome (base crâne)	GSI	96	70%	4%
Poumon	NIRS	50 (+)	85-91% (dose +)	< 5%
ORL (CAK)	GSI	29	77%	
Foie (CHC)	NIRS	47 (+)	95%	< 5%
Prostate	NIRS	415	86-98%	
Gliome 3-4	NIRS	48	Dose (+)	

Hyogo – Carbon 12

Ion beam facility

Large medical device

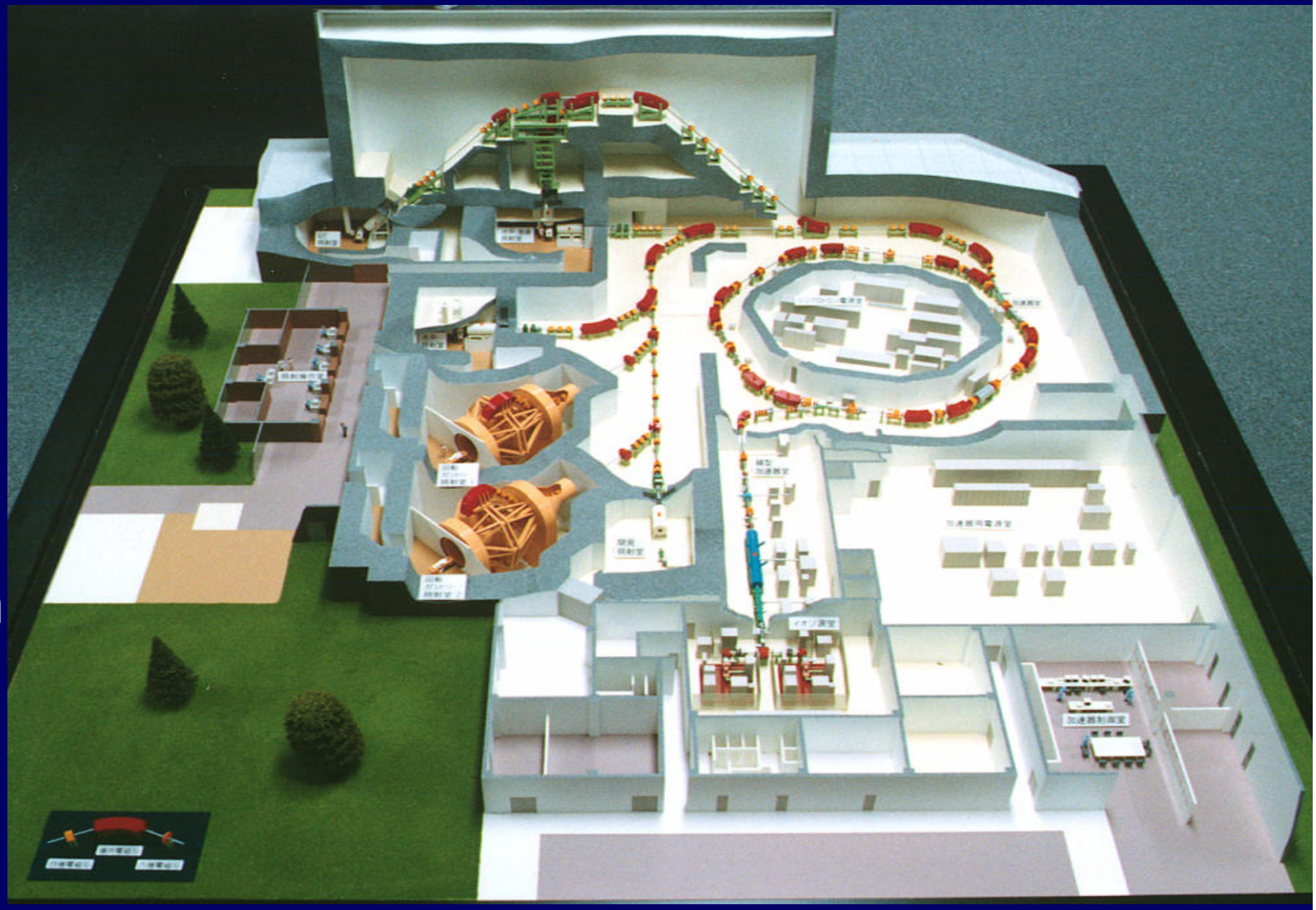
System

Ion source

Accelerator

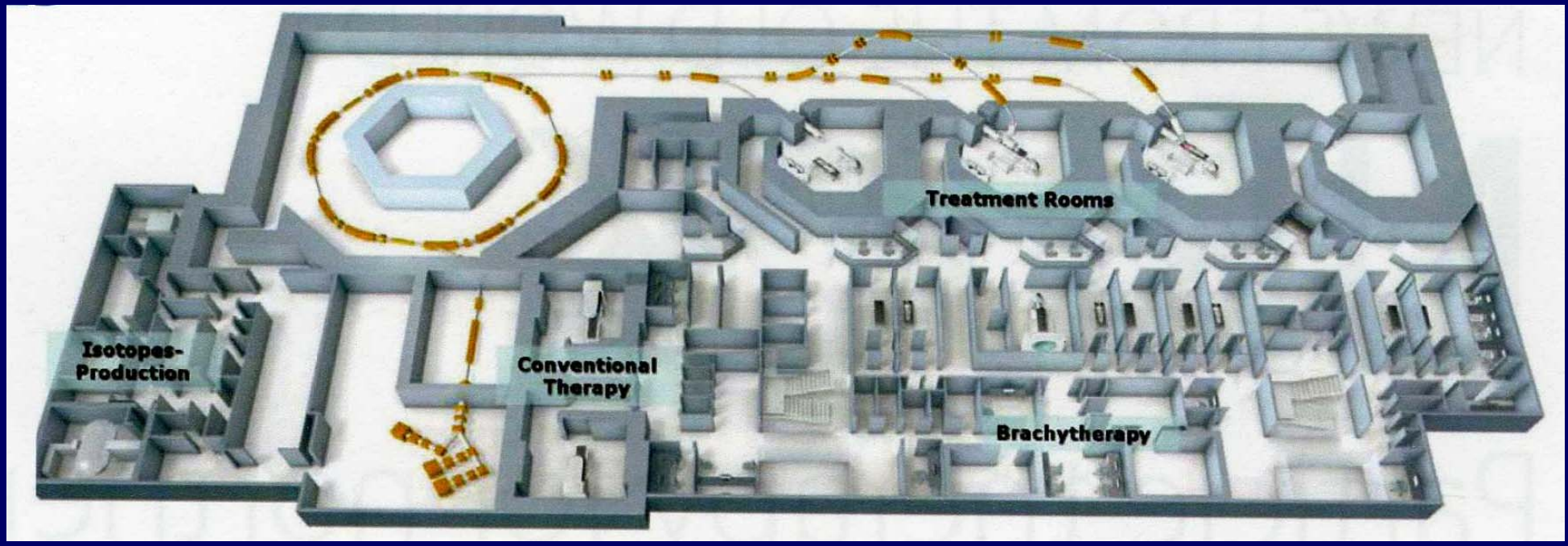
HEB transport

Treatment room



Outer view of the NRocK as planned. **(KIEL)**

SIEMENS – Synchroton – P : 250 MeV C12 : 430 Rev



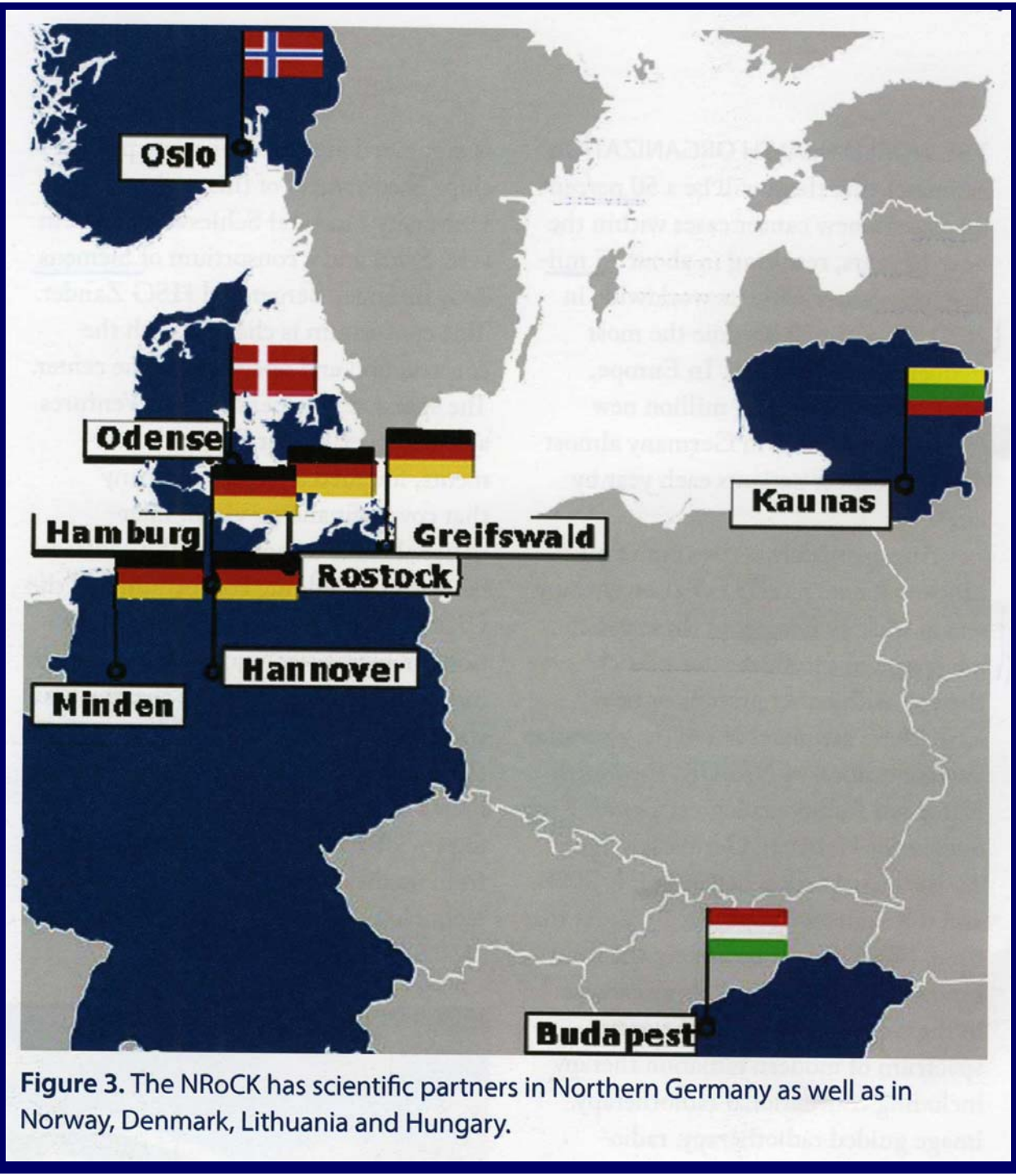
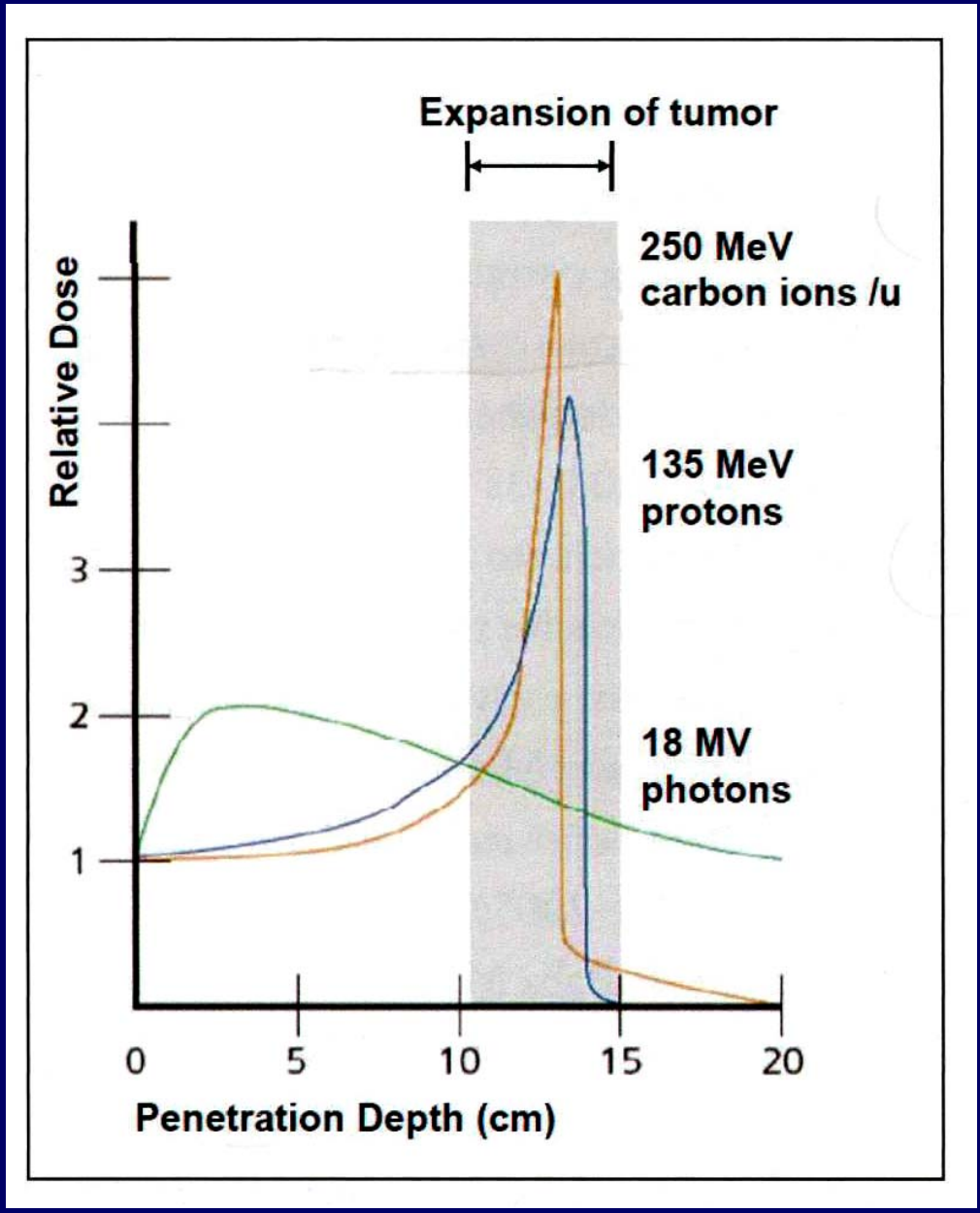
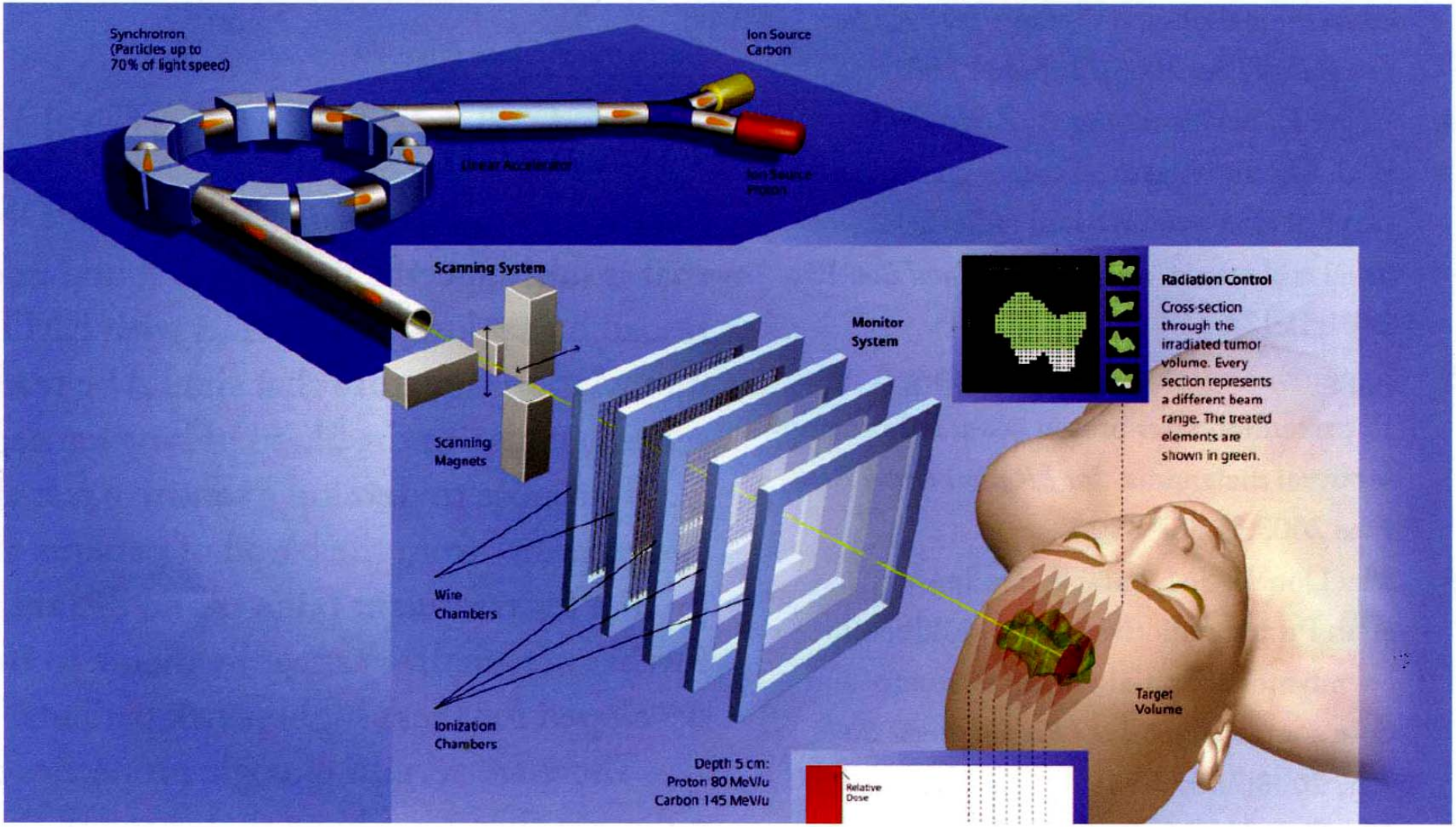


Figure 3. The NRoCK has scientific partners in Northern Germany as well as in Norway, Denmark, Lithuania and Hungary.

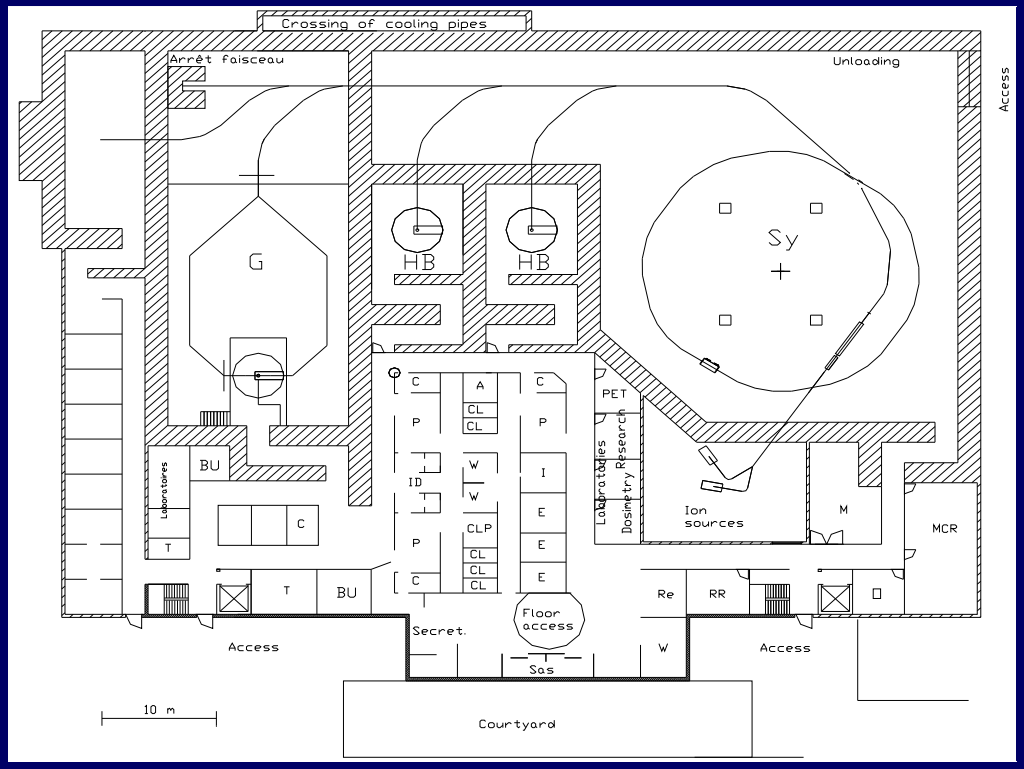

Expansion of tumor
250 MeV
carbon ions /u
135 MeV
protons
18 MV
photons
Relative Dose
1
2
3
0
5
10
15
20
Penetration Depth (cm)



3-D scanning of the ion beam: With the raster scan method

Université Claude Bernard Lyon1

Building (new design)



ETOILE

ELSEVIER
MASSON

Disponible en ligne sur www.sciencedirect.com

ScienceDirect

Cancer/Radiothérapie 12 (2008) 141

CANCER
RADIOTHÉRAPIE

http://france.elsevier.com/direct/CANRAD/

Éditorial

Sécurité et transparence
Au cœur de la culture des oncologues radiothérapeutes

En France, chaque année, environ 200 000 patients bénéficient d'une radiothérapie sous le contrôle de 600 oncologues radiothérapeutes. La radiothérapie participe directement à 40 % des guérisons observées actuellement en cancérologie : elle est à la base des traitements conservateurs (œil, larynx, sein, rec-

des traitements qu'ils dispensent. L'ouvrage accessible aux professionnels et au grand public, témoigne de leur volonté de transparence : il s'est orienté essentiellement sur les questions de qualité des traitements, de gestion du risque et de respect des doses de tolérance aux organes à risque, et sa légitimité se fonde

J.P. Gérard, M. Bolla

Cancer/Radiothérapie 12 (2008) 141

SOMMAIRE (362 pages)

Parcours du patient

- Infrastructure – équipement
- Radiobiologie
- Dose : contrôle - Tolérance OAR
- **Radioprotection :** Justification

optimisation

- **Sécurité** - qualité (pédiatrie, grossesse)

Procédure 35 localisations

Prescription **volume/dose : OAR**

Préparation - technique traitement

Consensus d'expert

Deuxième cancer après RXT chez l'adulte

- Survie – guérison : 30 ans après RT
- < 100 mSv (0.1 Gy) : extrapolation ?
- RR : adulte : 1.1
  enfant : 6
  RetinoBl : 35
  Hiroshima 30 ans : 1.4
  " 50 ans : 1.03

J. Doyen – Cancer/Radioth. 2010;14:255-262
H. Suit – Radiat. Res. 2007;167:12-42
M. Tubiana – Radiath. Oncol. 2009;91:4-15

Deuxième cancer après RXT chez l'adulte

- Registre (SEER) : 15 % 2ième cancer
  France : 320.0000/an : 48.000 2ième cancer

- Cancer entre 30 et 50 ans : 80.000/an
  - 50 % survie 30 ans
  - 20 % feront un 2ième cancer : 8.000
  - si RT : RR1.1 : 21 % : 400 (200) ?

- Après 50-60-70 ans : ???

J. Doyen – Cancer/Radioth. 2010;14:255-262

2010 – 2020 = where to go for RXT

- Mobile Target – IGRT

  lung – liver etc…

- . Brachytherapy : radionuclide. X 50 Kv

- Stereotactic RXT

  brain – extracranial

- Proton

- Light Ion = C12 – Helium

Physics + Biology

Better Geographical Targeting

to increase :

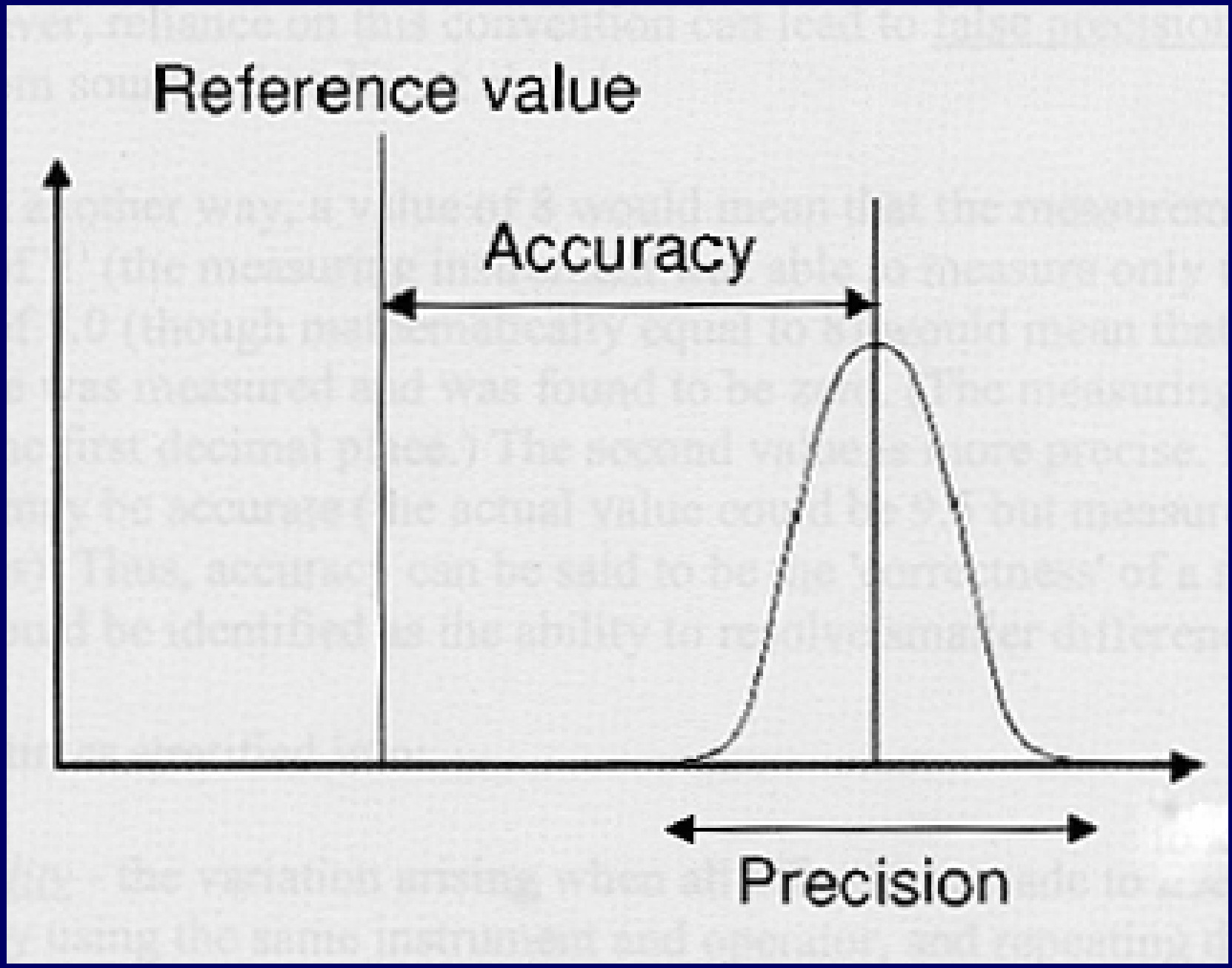
. Conformality

. Therapeutic ratio

(cost-benefit ratio)

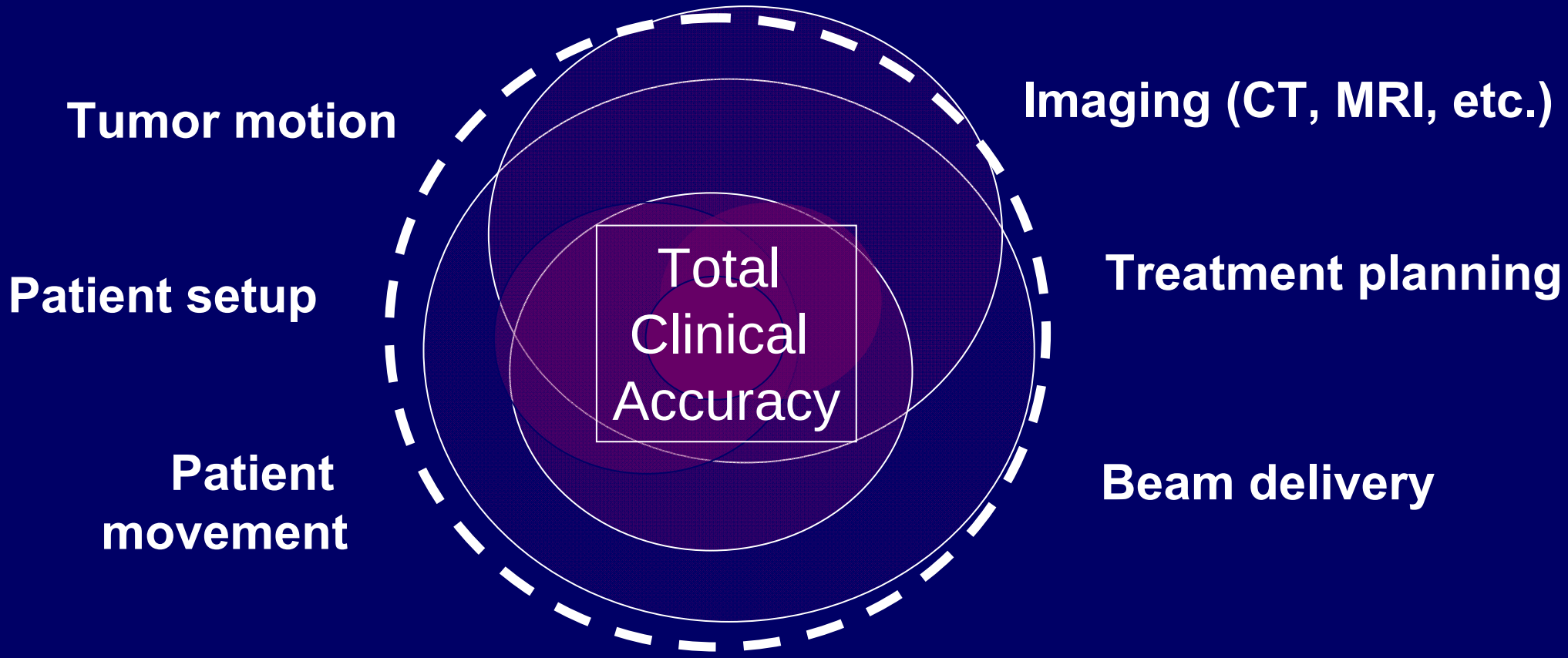
IDEAL = 100 % in tumour (Dose – Gy)

0 % in normal tissue


Reference value
Accuracy
Precision

Defining Accuracy

- Traditional Definition: Mechanical Accuracy
- New Definition: Total Clinical Accuracy



Dose escalation

In a "small volume"

Improve local control

("acceptable" toxicity)

Toxicité cérébrale - Volume
M.A.V. Kjelberg

Diam. Clin. (cm)	Dose (Gy)
1.5	25
2	20
2.5	15

Proton – Réirradiation – Mélanome choroïde

- Nice – 1991 – 2009 : 977 pts (60 Gy/4F)
- Récidive (poursuite évolutive) : 54 (5 %)
- 2ième irradiation Protons : 26 (60 Gy/4F)

  - enucleation : - récidive : 2
    - toxicité : 3 (11%)
  - globe conservé 21 (80 %) suivi médian 15 ans
    - A.V. moyenne 3/10ième
    - toxicité : GNV : 9 %
      cataracte : 6 %
      macula : 2 %

2010 – 2030 - changes +++

- Population : industrialized – BRIC – developing

  Ageing : 5-10 % ≥ 80 years (F = 5M : 60 000 Kc ?)

- Cancer in France :

  - 400.000/y

  - RXT : 200.000 - initial : 150.000

    - meta : 50.000

  50 - 60.000 ≥ 80 y

Increased need for Radiotherapy

-one cancer out of two needs RXT

- Population increase : 2020 : 8 Billions

  (300/100.000) : 24 millions cancer/year

  12 millions RXT : 24.000 linacs (1/500)

- Population ageing : 2010-2030

  people above 65yx2

  people above 80yx3 (surgery ⇲)

- Metastatic chronic phase : RXT ↗

  Oligo meta : brain – lung – liver etc …

Radiotherapy - 2010 – 2030 (France)

- RC3D : 100.000 patients

  RCMI : 50.000 (H & N – Prostate)

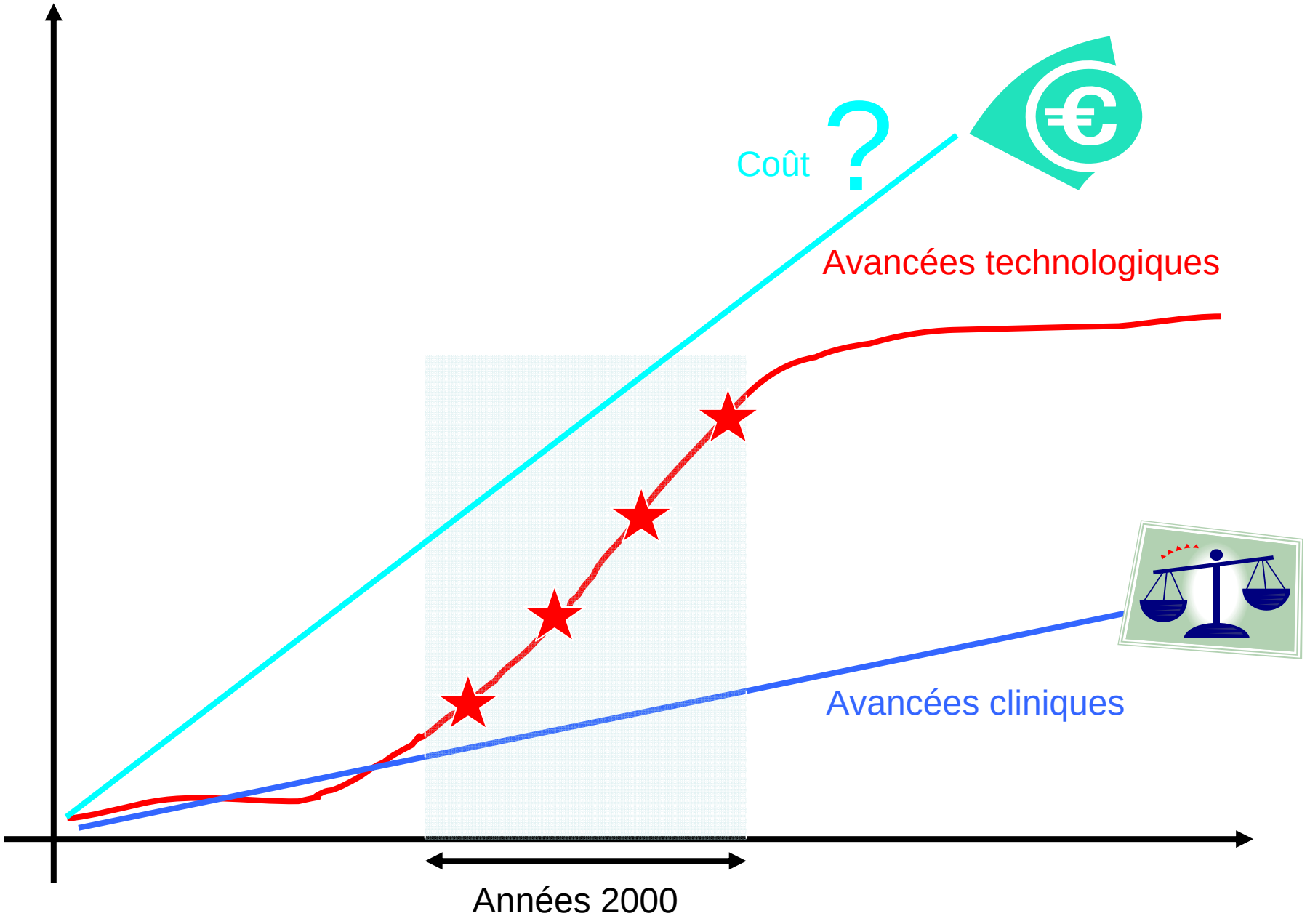
  Mobile – IGRT : 20.000

  Proton : 5.000 ? 10.000 ?

  C12 : 1.500 ? 3.000 ?

- More cure : 50-55 % - Lower Toxicity

  More organ preservation – better palliation


Coût ?
Avancées technologiques
Avancées cliniques
Années 2000

S W O T

- Force : la dose RX (OAR)
- Opportunité : - le vieillissement > 85
  - le coût/efficience
- Faiblesse : la cible : ou ?
  la biologie
- Menace : “Les autres” (alternative) lobby money
  - chir. Endo. - Med Nucl (déchet)
  - Th. Mol. ciblée … (Big Pharma)

Cancer Treatment 2010 - 2030

- Surgery ++
- Medical Treatment (Molecular biology: TMC)
  - chemo. Hormono
  - Biotarget drug (Mol. Signature)

Radiotherapy : Accuracy – High LET

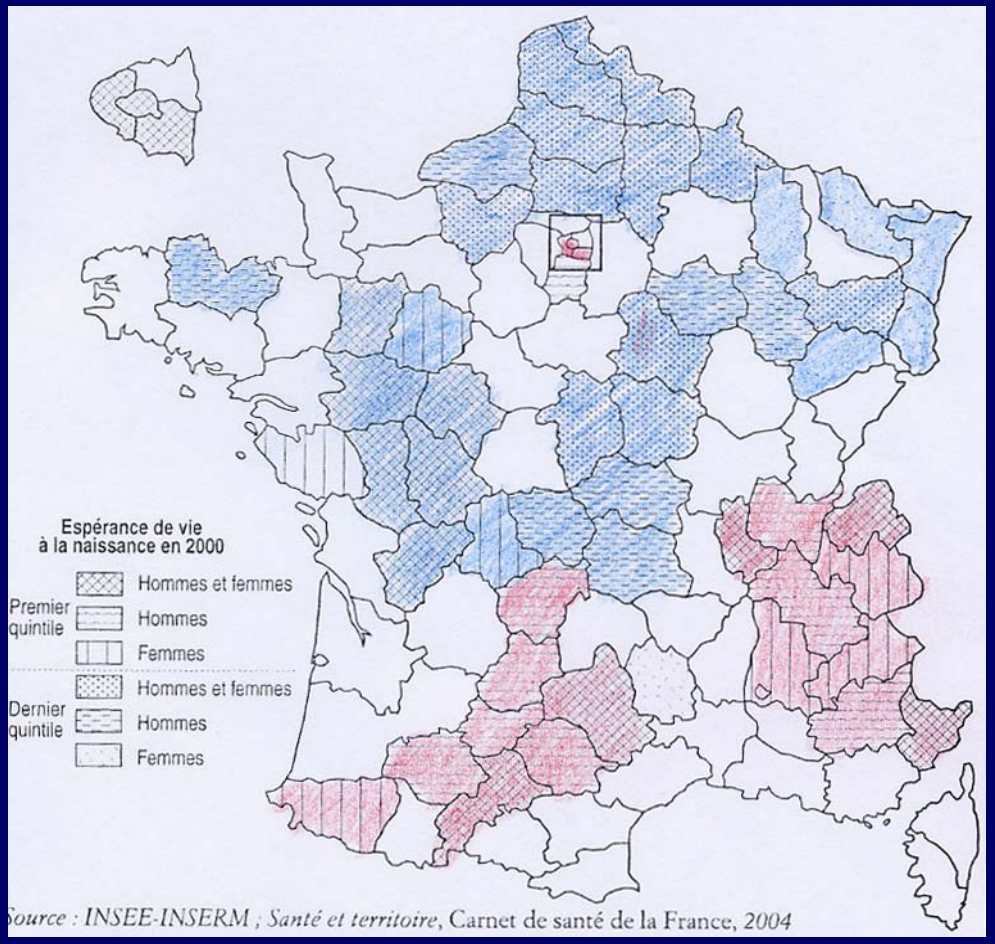
"Bio modulation" ?

- Global approach of patient

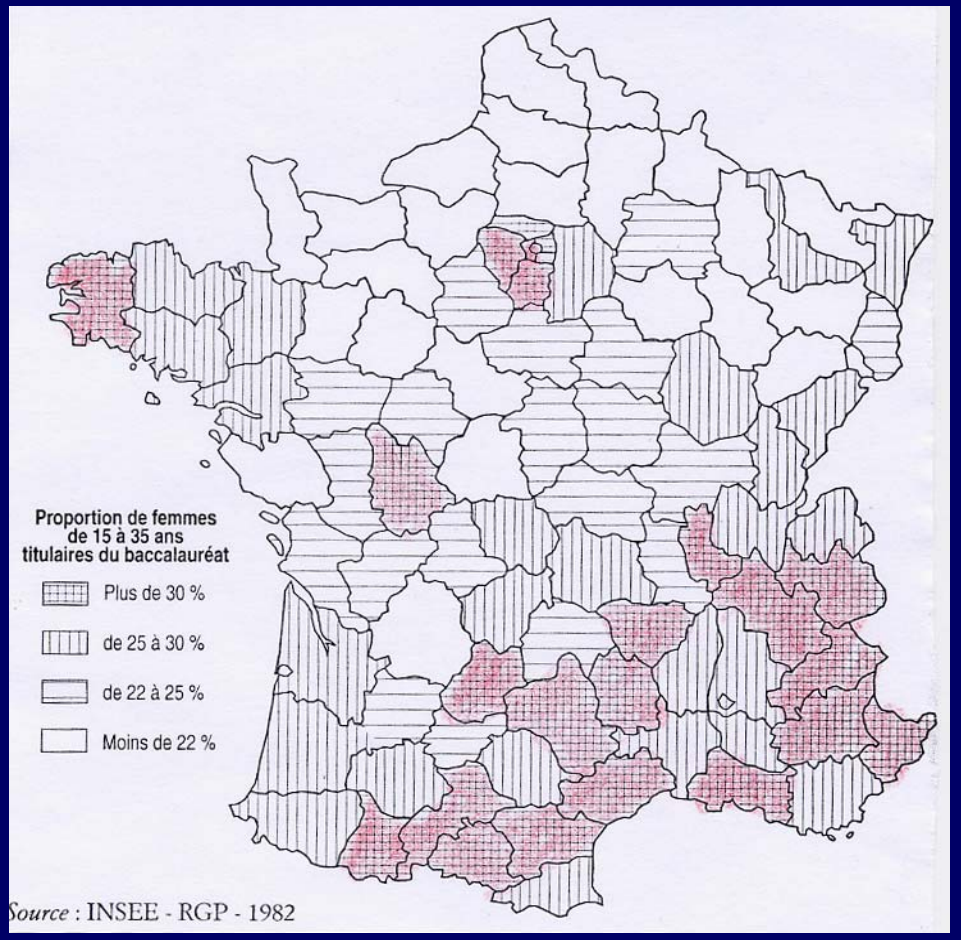
Tailored individualised Treatment of Tumor

Complexity - Hyperspecialization

Espérance de vie en 2000



Femmes avec BAC 1982



J de Kervasdoué. Les prêcheurs de l'Apocalypse - Plon 2007

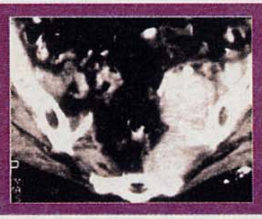
SPECIAL FEMMES

LE QUOTIDIEN DU MEDECIN

www.quotimed.com
N° 8327 - CAHIER 2
VENDREDI 7 MARS 2008

INFECTIONS A VIH
Pas de réponse préventive adaptée
PAGE 7

FEMMES ENCEINTES
Le suivi par le généraliste
PAGE 8



CANCER DE L'OVAIRE
Des signes d'appel inconstants
PAGE 10

La femme est l'avenir de la prévention

La prévention est un attribut féminin, les femmes sont plus attentives que les hommes à leur santé et à celle de leur famille, elles s'approprient davantage les messages préventifs et c'est souvent par elles que passe l'observance médicamenteuse : pour ce numéro « spécial femmes » consacré à la prévention et au dépistage, les praticiens (en majorité des praticiennes) interrogés par « le Quotidien » sont quasi unanimes. Avis aux décideurs (souvent des hommes) des campagnes de santé publique

PAGES 3 A 5

Le dépistage du cancer

L'HISTOIRE DU JOUR

Lait de femme

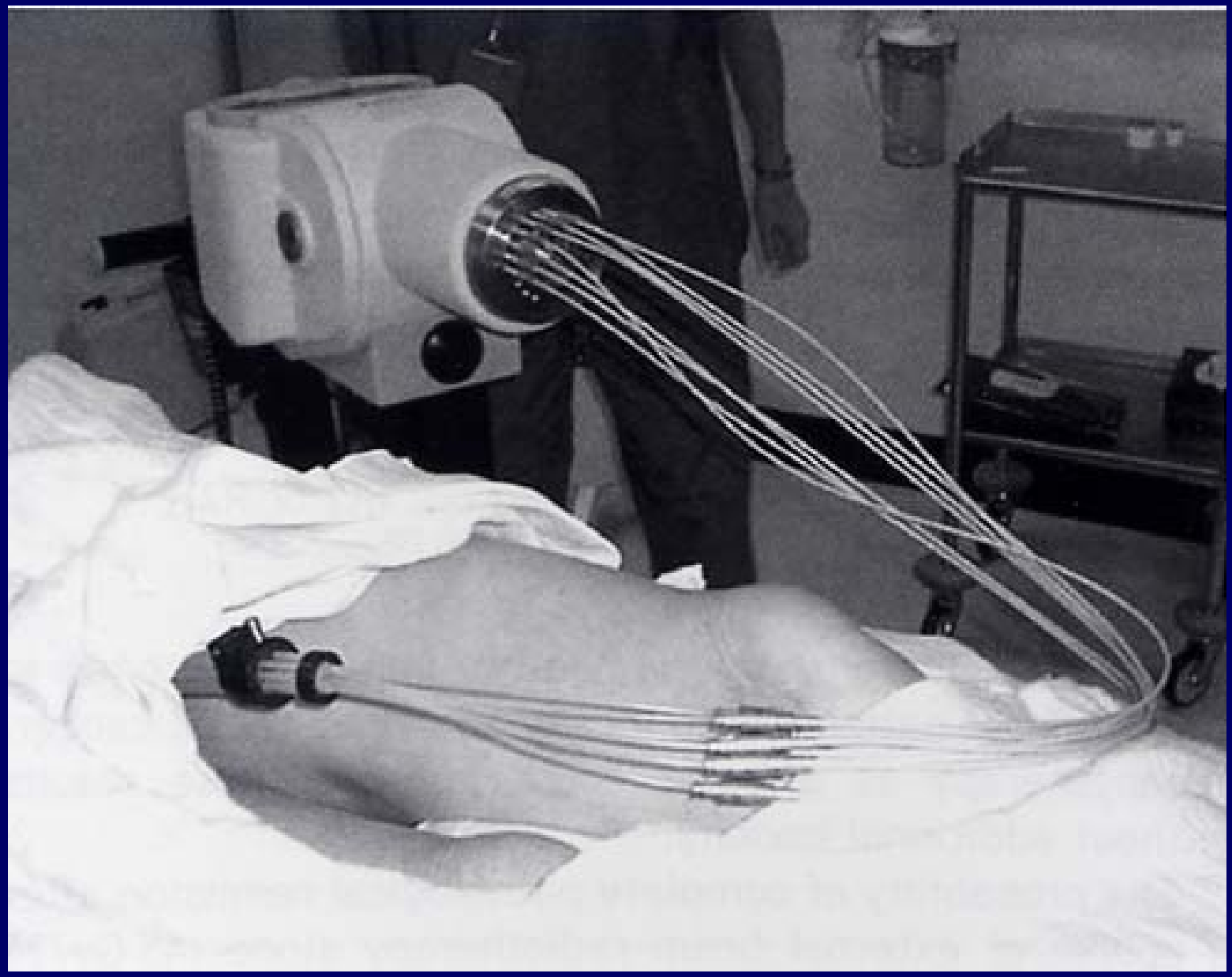
« Un des premiers signes de la décadence de l'Empire romain fut l'abandon de l'allaitement maternel » : voilà ce qu'écrit A. Deray il y a cent cinquante ans*. Jules César disait : *« Les dames romaines ne font-elles plus d'enfants ? Je ne leur vois entre les bras que des chats ou des chiens. »* Démosthène demanda la condamnation d'une femme qui faisait allaiter son enfant par une femme étrangère. A Sparte, une loi imposait à tout homme de saluer une femme allaitant son enfant. *« Marc-Aurèle voulait que toutes les femmes allaitassent leurs enfants pour être mères tout entières et non à demi. »* Antonin le Pieux lui-même saluait les femmes qui donnaient le sein à leur enfant ; il leur faisait distribuer des récom-

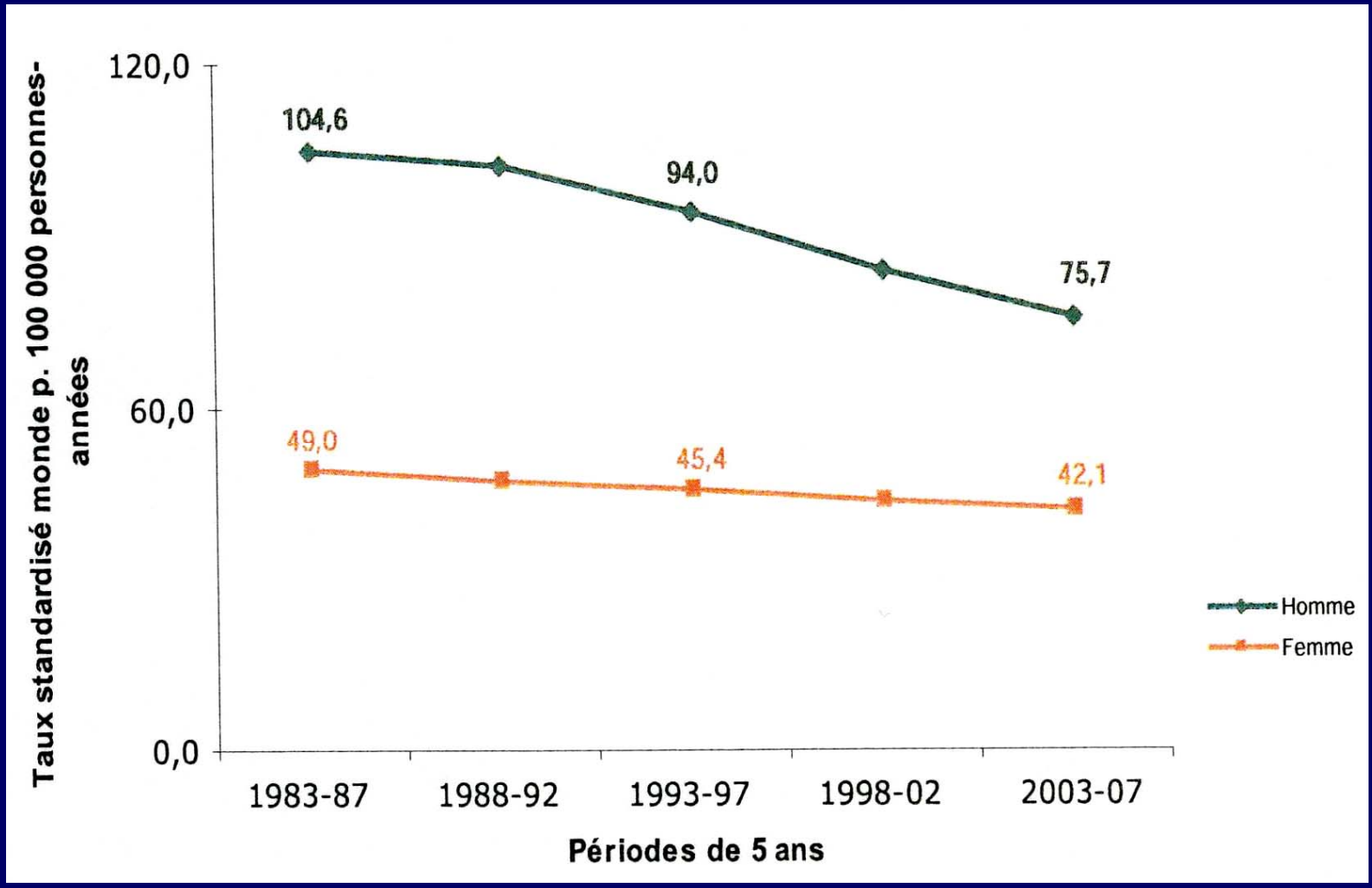
Be prepared - proactive

- Technology innovation ++ :Interactive collaborat.
  - Scientists (CNRS,IN2P3) – engineors
- Trained professionals
  - Doctors – Physicist – Technicians …
- Legal Frame – Financial support
  - Political will

VISION for the patients…


merci




120,0
60,0
0,0
Taux standardisé monde p. 100 000 personnes-années
104,6
94,0
75,7
49,0
45,4
42,1
1983-87
1988-92
1993-97
1998-02
2003-07
Périodes de 5 ans
Homme
Femme

DIU High Tech : "you are right"

- Le meilleur moyen de bien soigner …
- Complexité : équipe – physicien (PSRPM)

"se voir, se parler“

- Cliniciens d’abord :

"3 ans – 5 ans – toute une vie“

- Surveillance clinique (long cours)

Rechercher – Phase III : dose/volume/temps

Grand – gros – petit volume

Anatomie (++) : chirurgie – radiothérapie

"géographical miss" : erreur balistique

Anatomie 2D – (lymphatique ++)

Informatique : **Anatomie 3D** (CT Scan, IRM, Pet CT)

Tumeur - champ 2D 3D **volume ++**

Aire du disque = πR^2

Volume sphère = 4/3 πR^3

4/3 π # (4.18) sphère 2 cm diamètre = $4 \times 1^3 = 4\ cm^3$

Volume : 4/3 pi r^3

- Surface sphère : 4 pi r^2 – surface disque: pi r^2
- Sphère 2 cm diamètre : volume : 4 cm^3

  Sphère 4 cm “ : volume : 25 cm^3

  Sphère 6 cm “ : volume : 85 cm^3 (tennis :6.5)
- Cylindre 6 cm diamètre x 12 cm haut :

  340 cm3

  (8 cm diam x 12 cm Ht : 600 cm3)

Temps de doublement des tumeurs

- **Diamètre x 2 volume x 8**

  - T 2 cm diamètre volume = 4 cm^3
  - T 4 cm " volume = 32 "

- **Diamètre = + 1 cm volume x 2 (3-6)**

  - T 3 cm diamètre volume = 14 cm^3
  - T 4 cm " volume = 32 "
  - 5 " " = 64 "
  - 6 " " = 110 "

Cm3 = cc = ml - 1 litre = 1000 cc

Champ vs volume (pelvis)

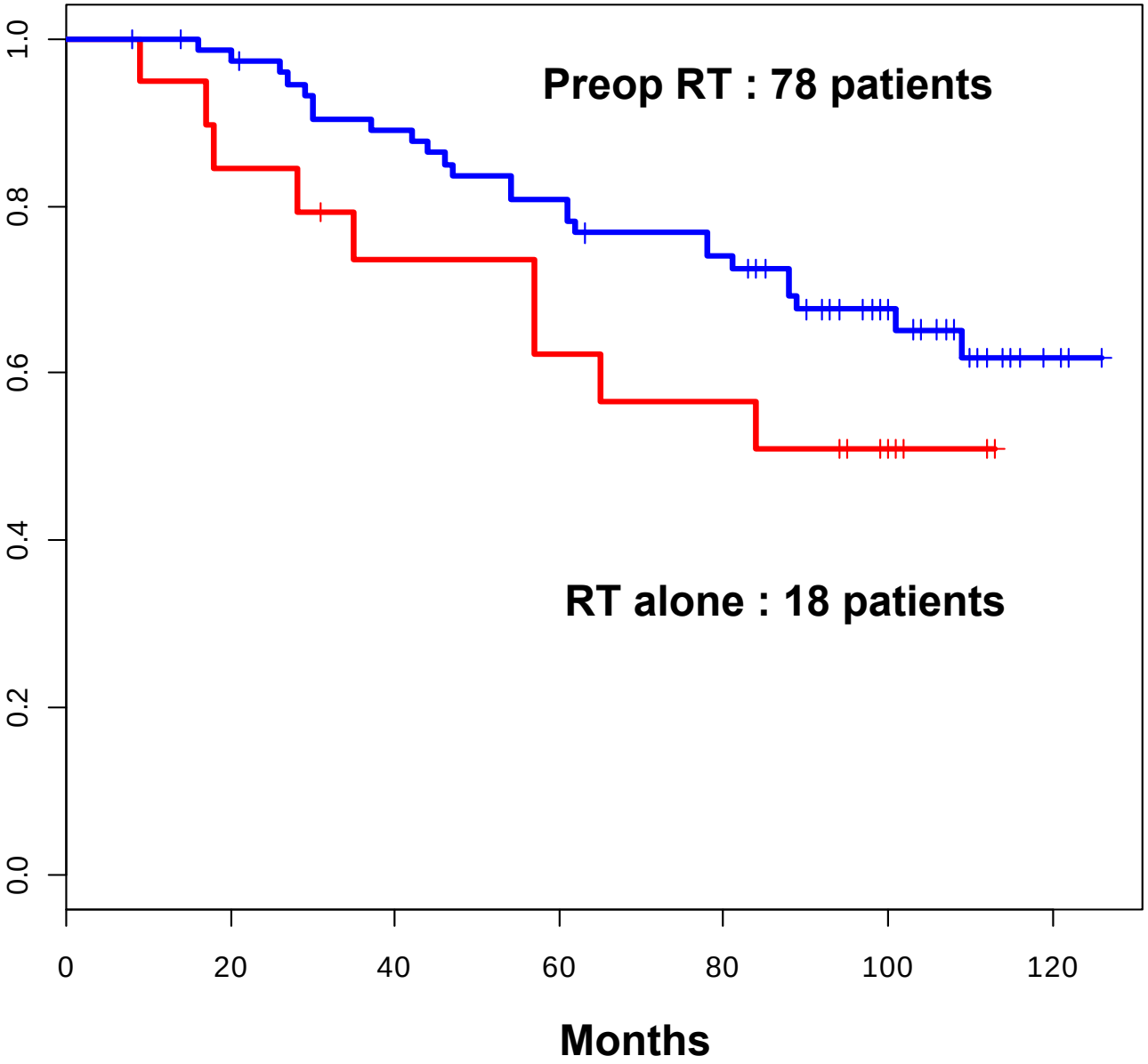
Côté (cm)	volume (PTV) (litre)
10 x 10 (10)	1
12 x 12 (12)	1.7
14 x 14 (14)	2.7
15 x 15 (15)	3.4

Clinical complete response : ypCR
Molecular Biology – Predictive ?

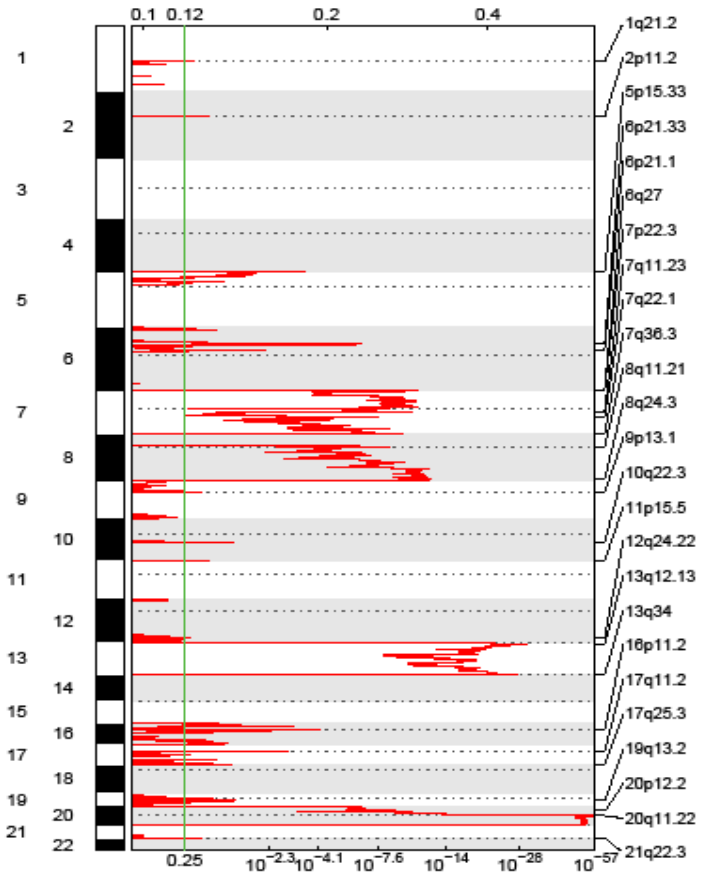
- Lyon 1998-2001 : 98 pts
  - preop RT-CT + surgery : 78 (T3)
  - RXT alone for cure : 18 (T2-3)
- Biopsies before + during RXT
  - . DNA expression : affimetrix chips®
  - . CGH HR : Illumina Beadchip®

Bioinformatic analysis

Survie globale des patients M0 en fonction du type de traitement

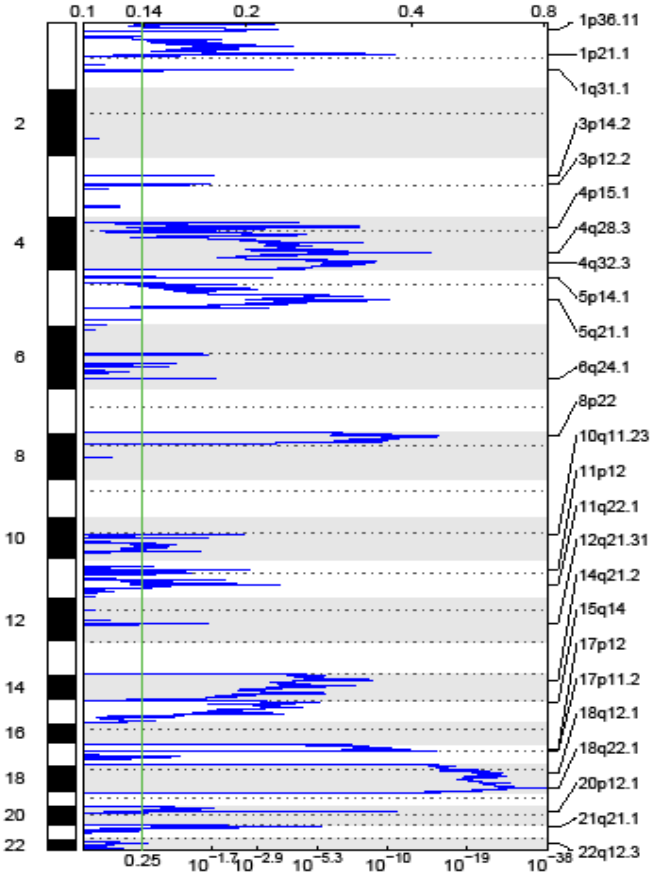


GAINS



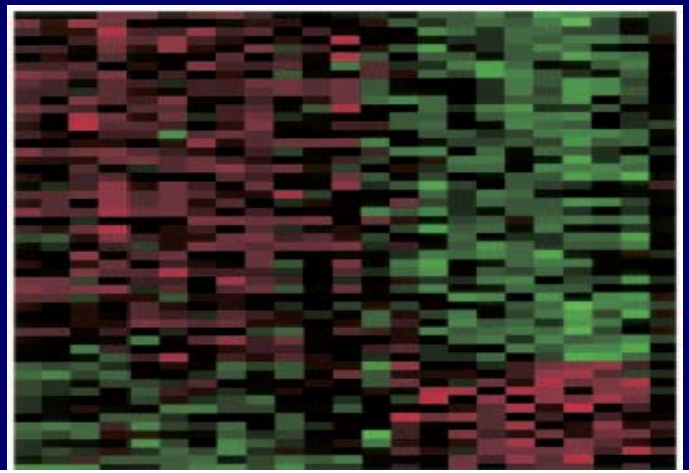
Les plus fréquents :
7q36 (56%), +8q24 (48%), +13q12 (73%), +13q34 (77%), +20q11 (47%)

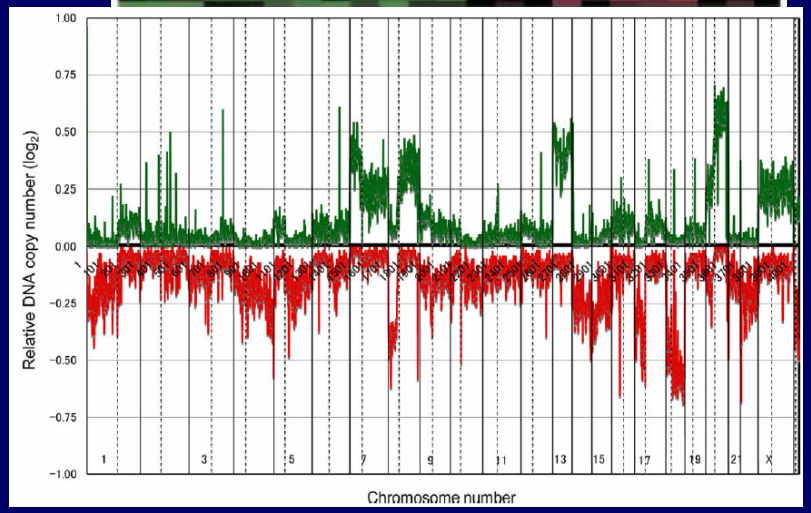
PERTES



Les plus fréquentes :
1p21 (51%), 4q28 (55%), 5q21 (49%), 8p22 (45%), 14q21 (44%),-17p11 (56%), 18q22 (87%), 20p12 (36%)

Génome, Transcriptome : « portrait moléculaire » et cancer du rectum





Jérôme Doyen, interne de radiothérapie, étudiant master 2


B

ROENTGEN

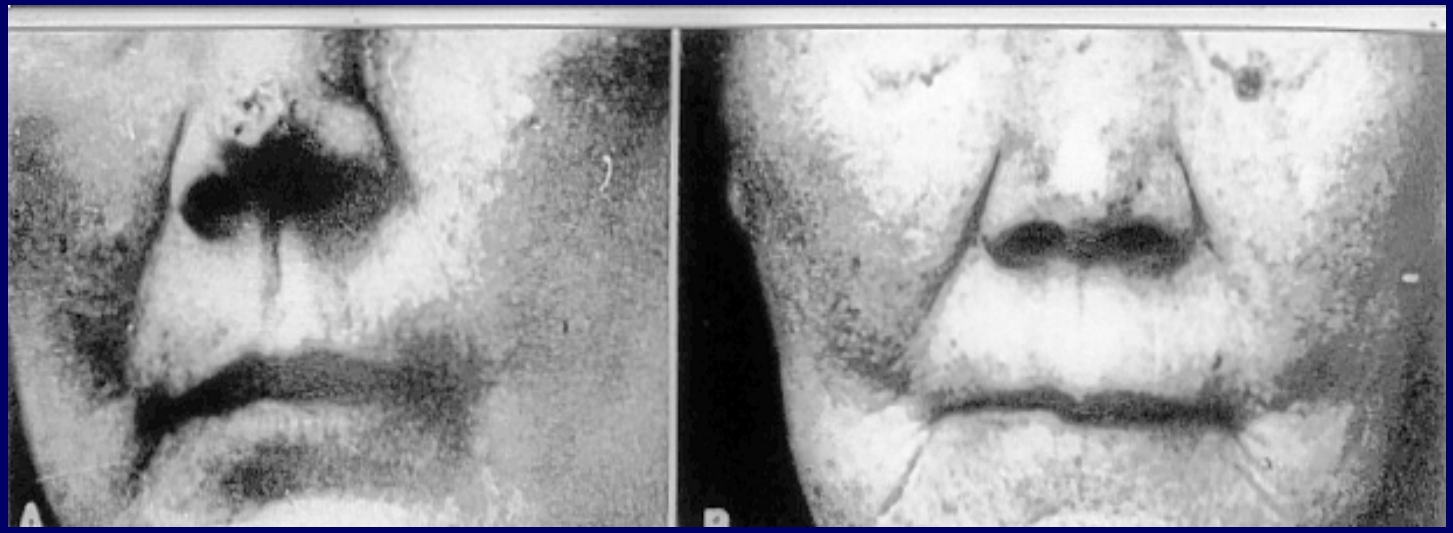
26 décembre 1895

VICTOR DESPEIGNES 1896

Observation concernant un cas de cancer de l'estomac traité par les rayons Rontgen

par le Docteur Victor Despeignes, ancien chef de travaux à la Faculté de Médecine de Lyon.

Lyon Médical 26 Juillet 1896:428-506



1902

1912

STOCKHOLM