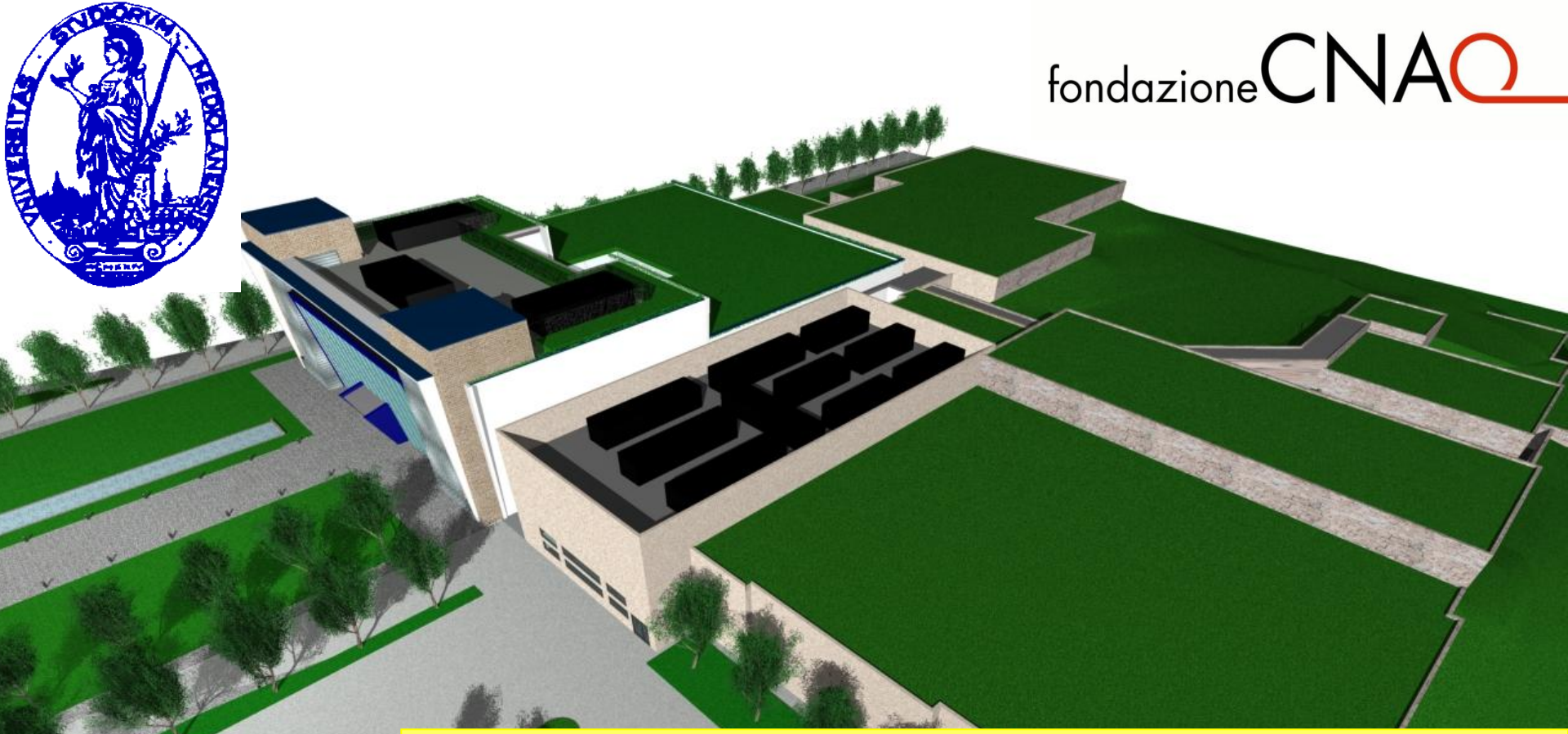


Hadron Therapy in Clinical Perspective

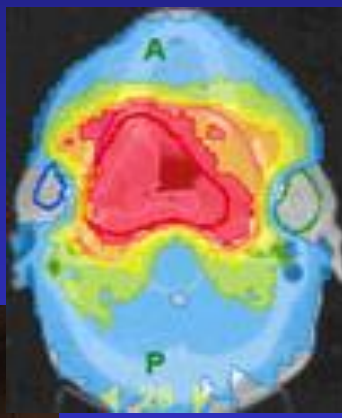
Roberto Orecchia

Erice, 12 May, 2010

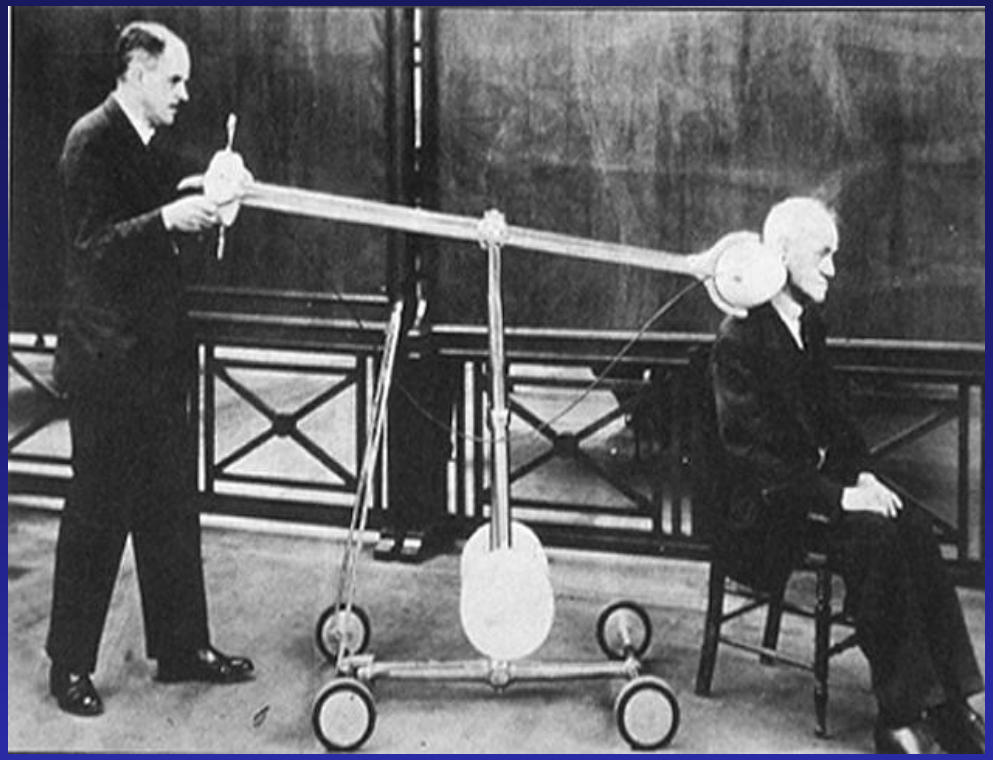
Introduction

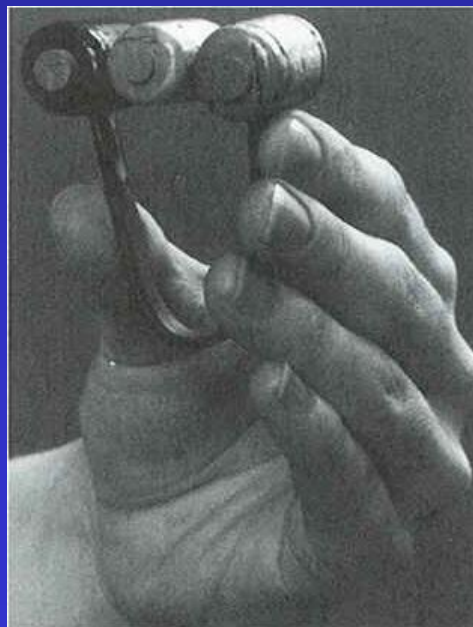
110 years after ……..

From 50 to 65% of cancer patients receive RT



Radium

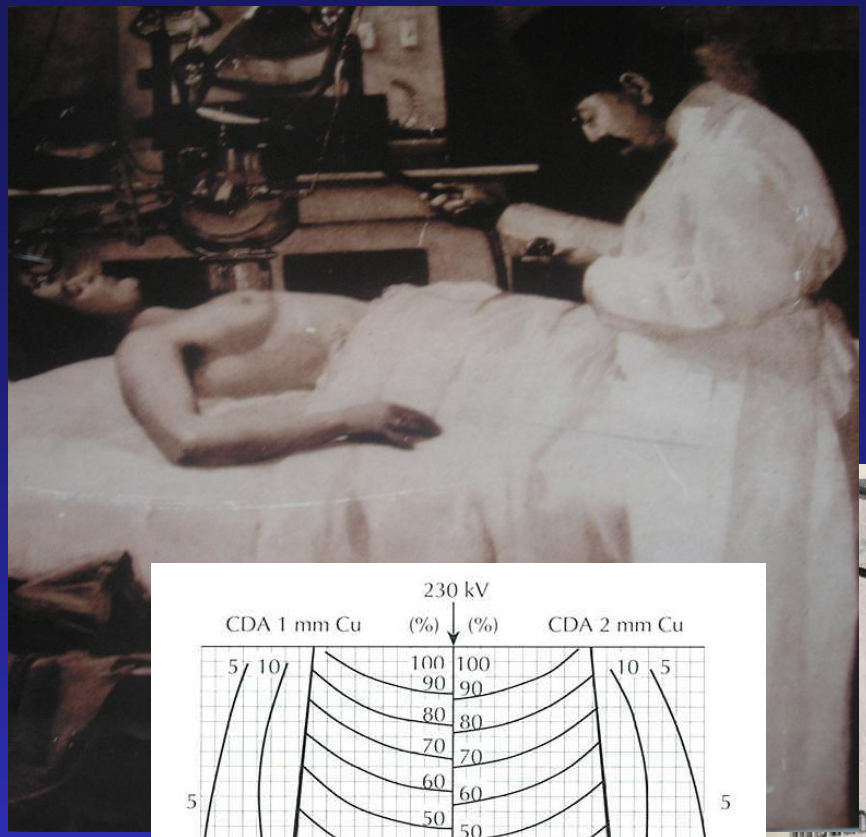


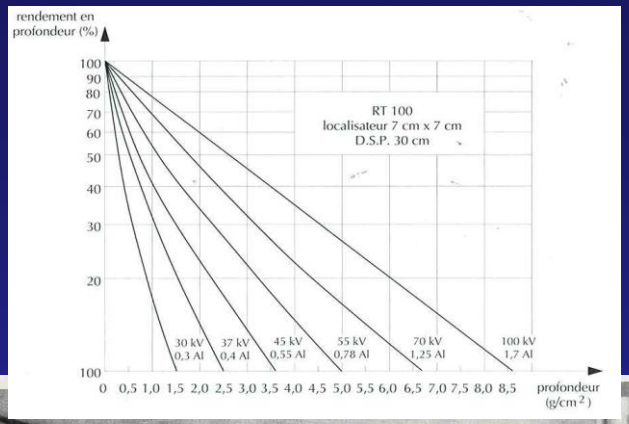


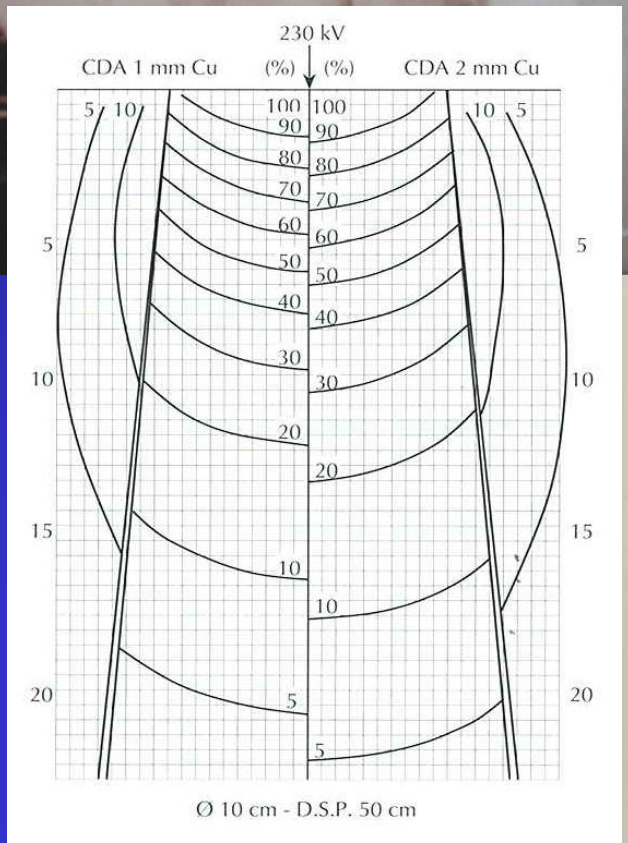
Paris schedule cervix uteri

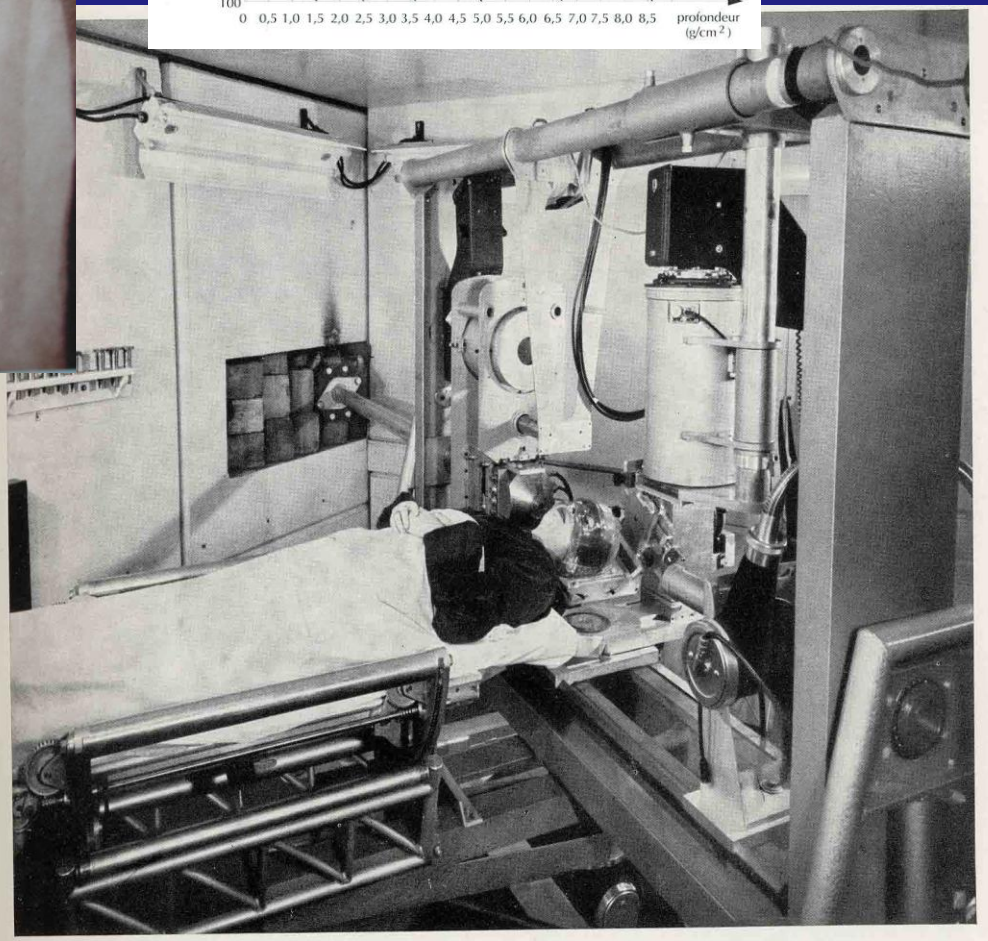
Continous treatment for 120 hours
Uterine tube of 33.3 mg radium
Two vaginal cylindrical corks: 13.3 mg radium each

Orthovoltage

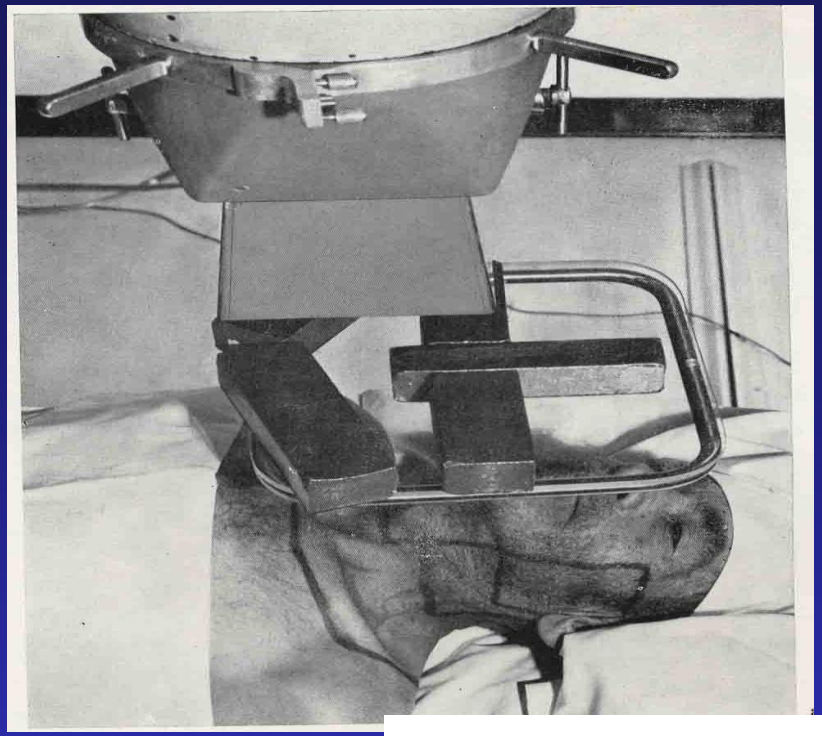


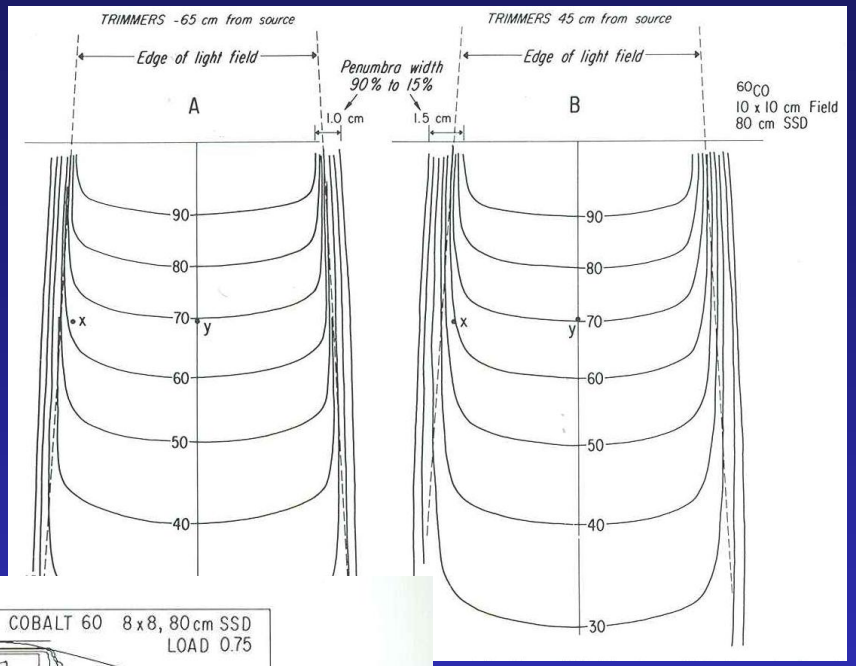


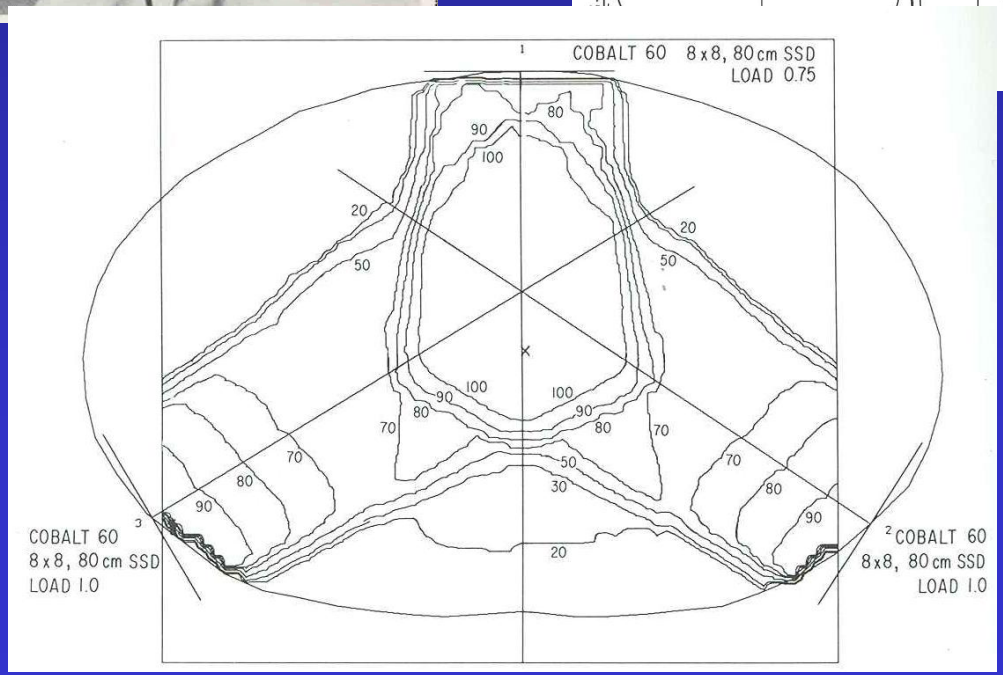




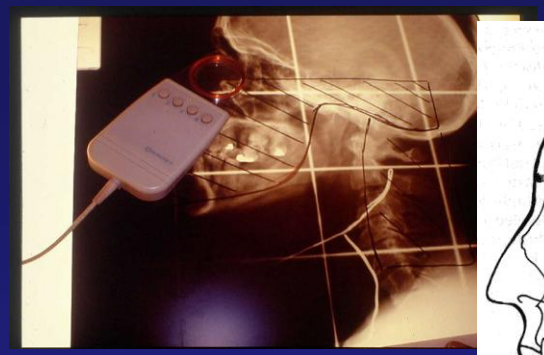
Megavoltage

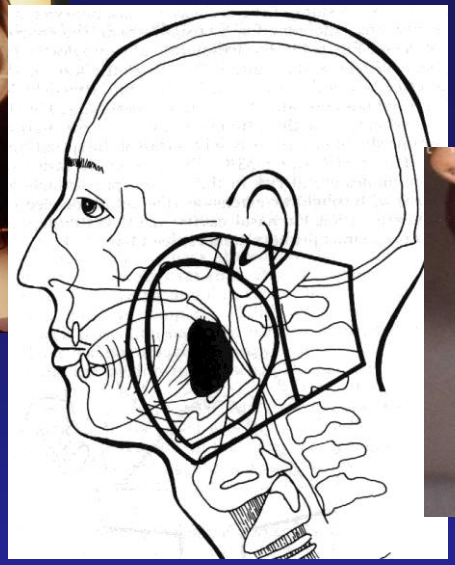




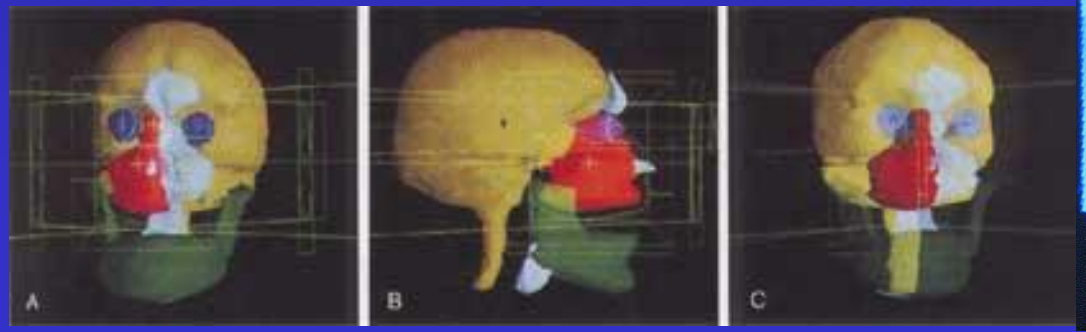


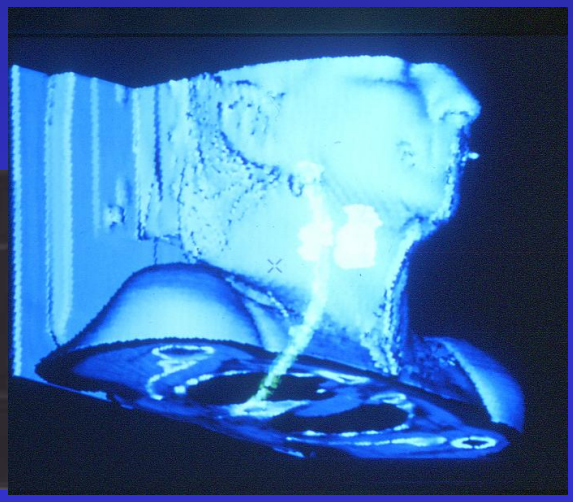
From 2-D



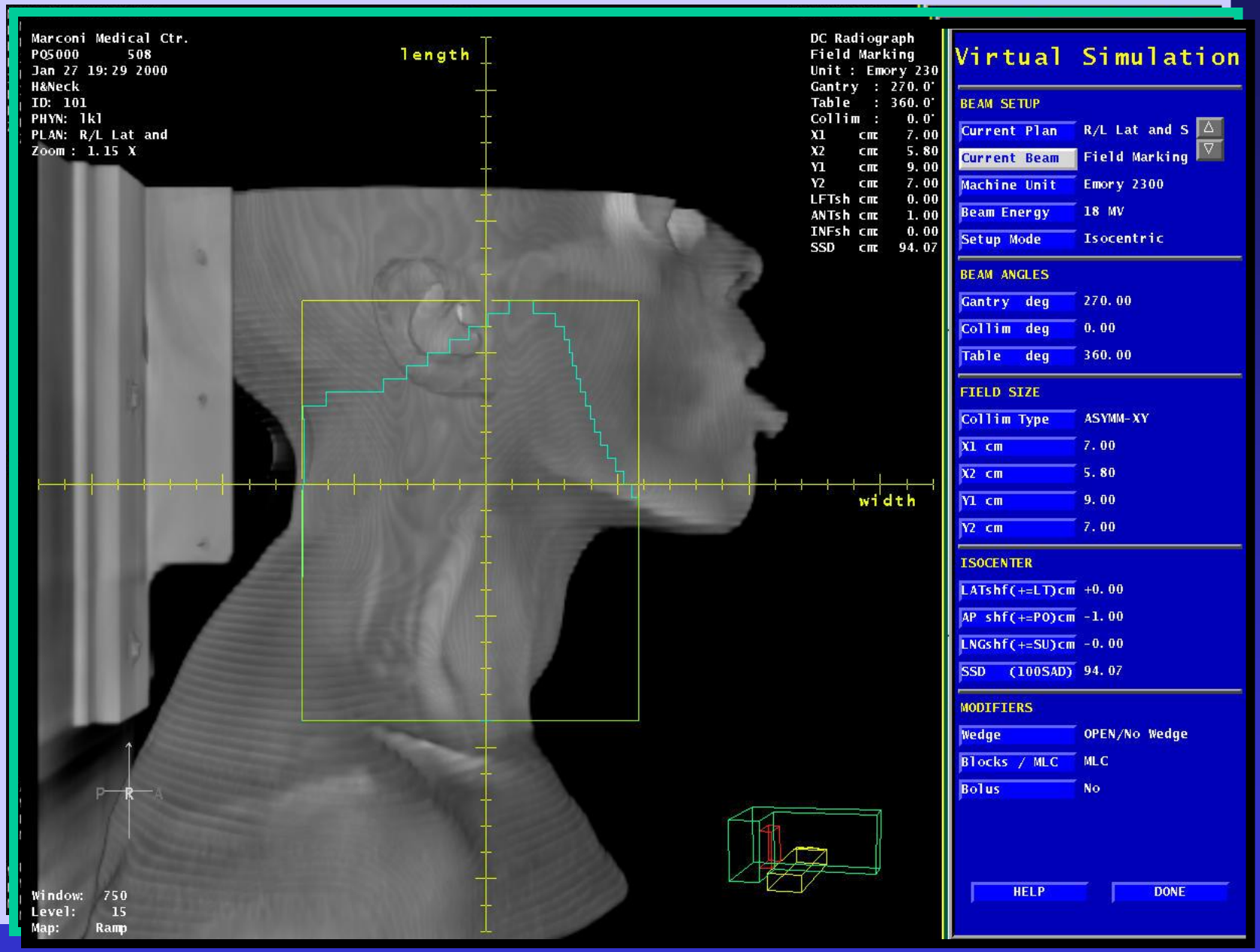


To 3-D





H&N DCR's


Marconi Medical Ctr.
PQ5000 508
Jan 27 19:29 2000
H&Neck
ID: 101
PHYN: lkl
PLAN: R/L Lat and
Zoom : 1.15 X
length
width
DC Radiograph
Field Marking
Unit : Emory 230
Gantry : 270.0°
Table : 360.0°
Collim : 0.0°
X1 cm 7.00
X2 cm 5.80
Y1 cm 9.00
Y2 cm 7.00
LFTsh cm 0.00
ANTsh cm 1.00
INFsh cm 0.00
SSD cm 94.07
P R A
Window: 750
Level: 15
Map: Ramp
Virtual Simulation
BEAM SETUP
Current Plan R/L Lat and S
Current Beam Field Marking
Machine Unit Emory 2300
Beam Energy 18 MV
Setup Mode Isocentric
BEAM ANGLES
Gantry deg 270.00
Collim deg 0.00
Table deg 360.00
FIELD SIZE
Collim Type ASYMM-XY
X1 cm 7.00
X2 cm 5.80
Y1 cm 9.00
Y2 cm 7.00
ISOCENTER
LATshf(+=LT)cm +0.00
AP shf(+=PO)cm -1.00
LNGshf(+=SU)cm -0.00
SSD (100SAD) 94.07
MODIFIERS
Wedge OPEN/No Wedge
Blocks / MLC MLC
Bolus No
HELP
DONE

H&N Treatment Plans

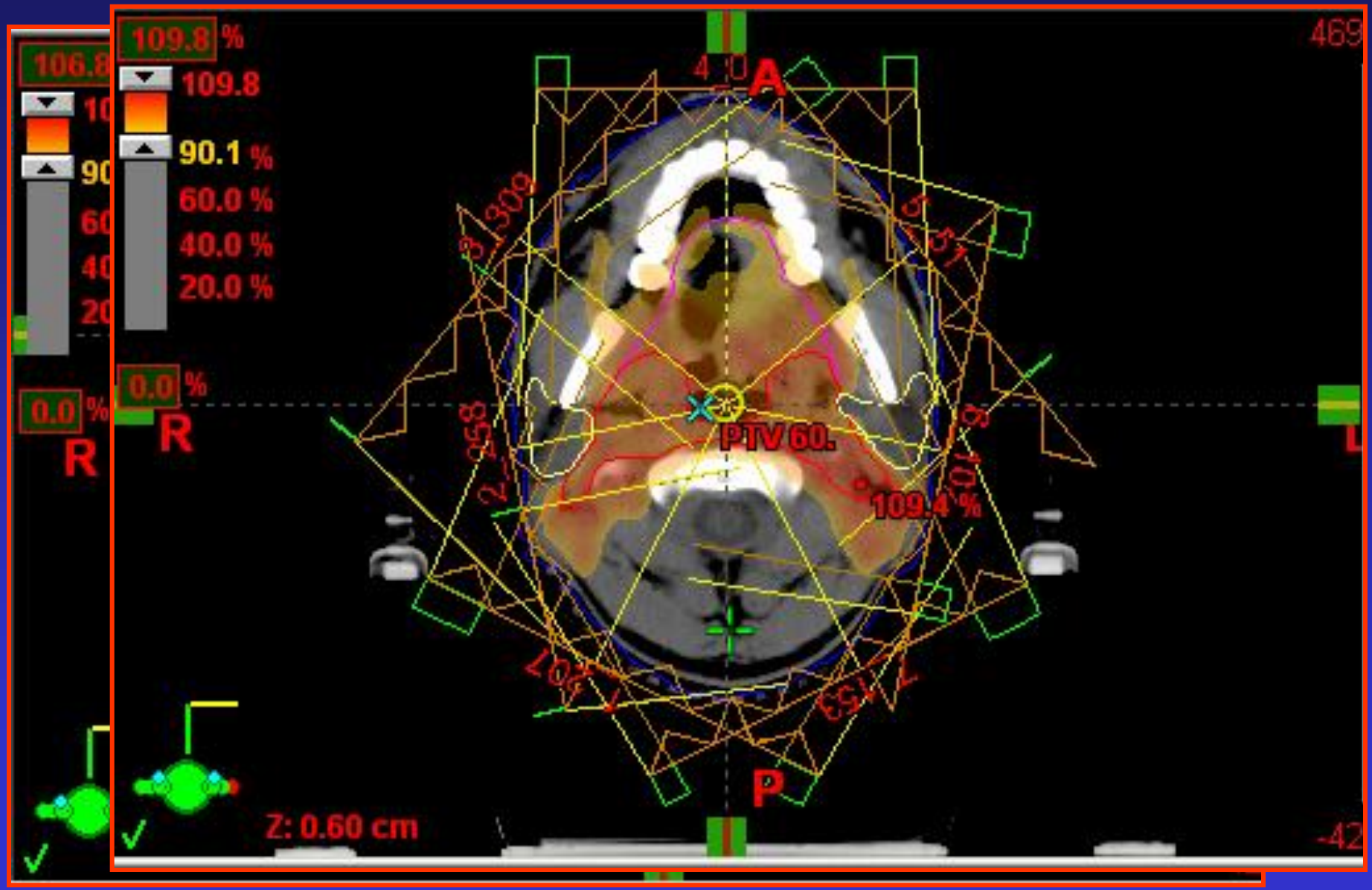


Image –Guided IMRT

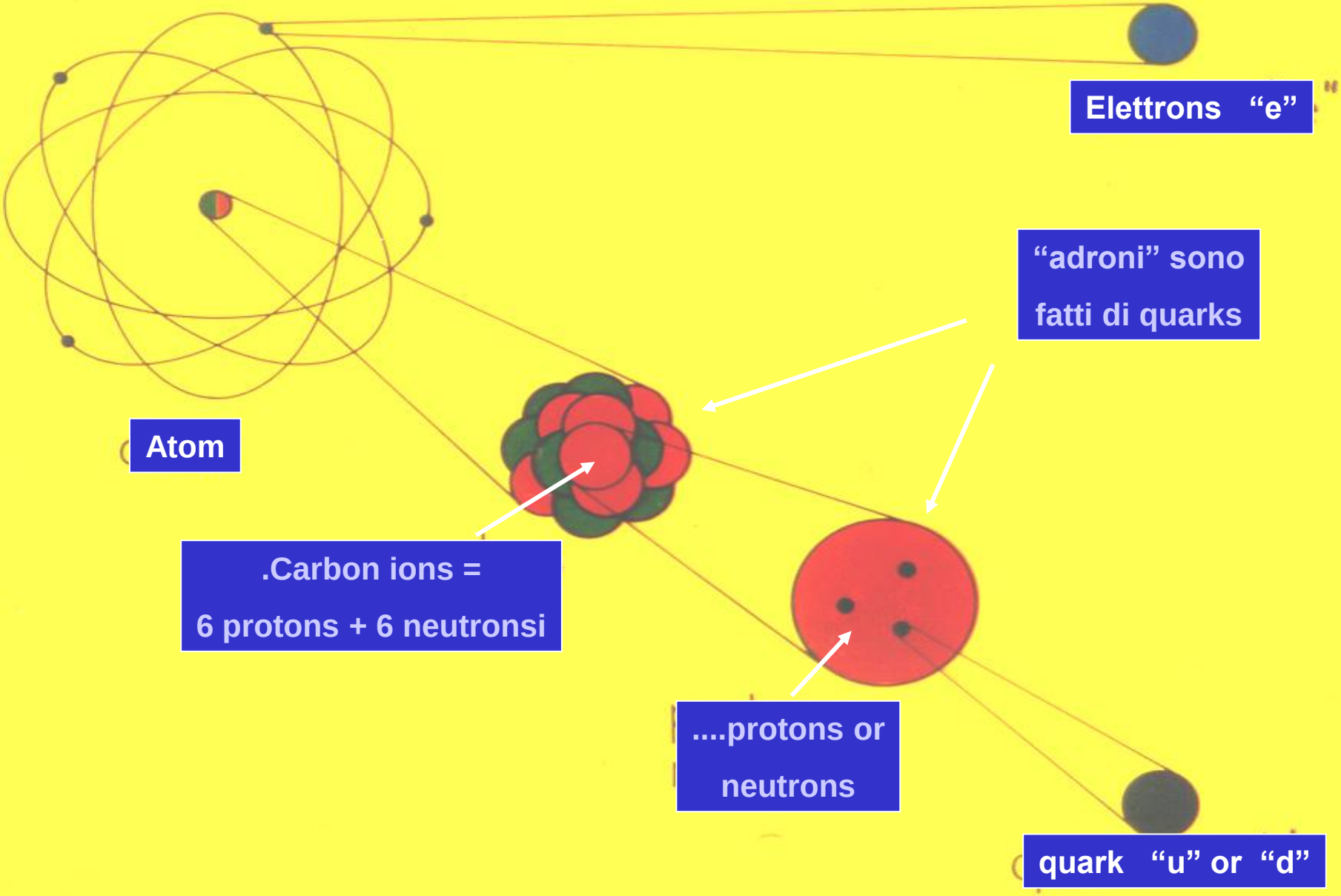
Pencil Beam

Fan Beam

Cone Beam


Future
Directions

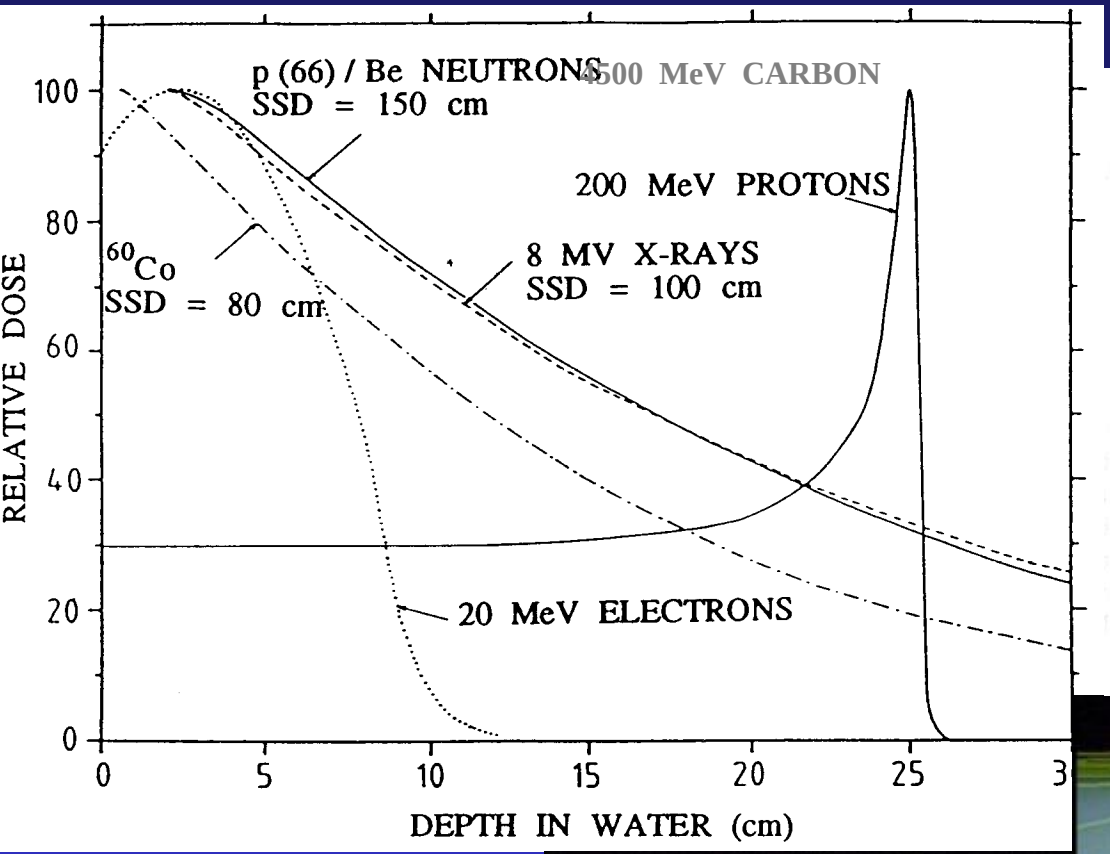
Hadrons

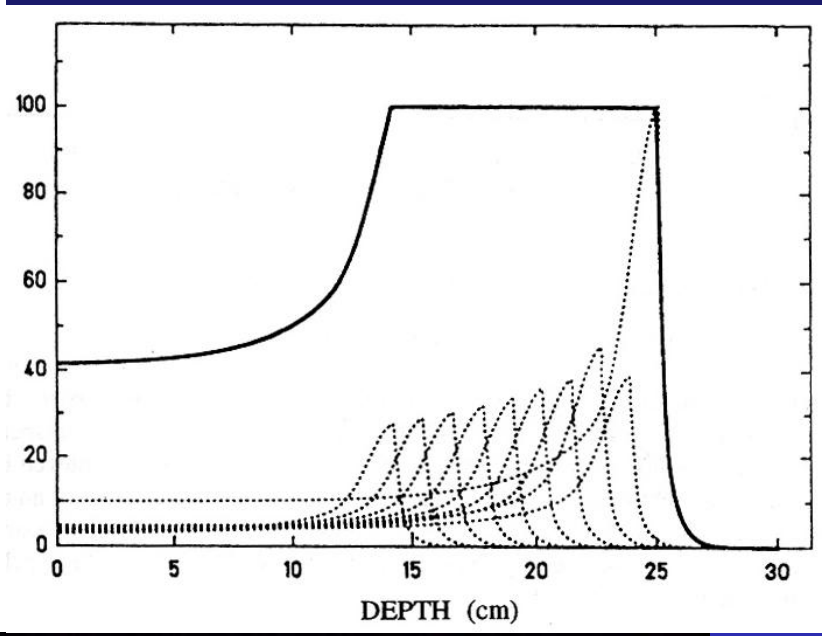

Elettrons “e”
“adroni” sono fatti di quarks
Atom
.Carbon ions = 6 protons + 6 neutronsi
....protons or neutrons
quark “u” or “d”

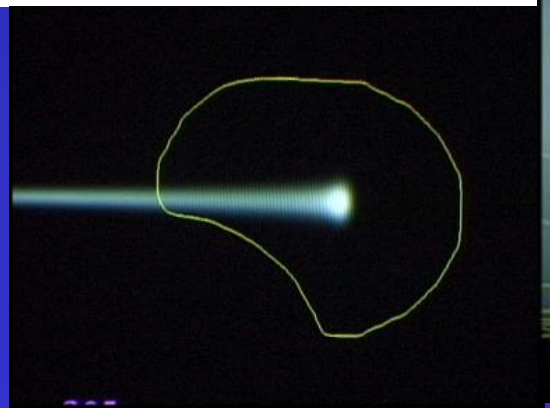
Hadrontherapy:

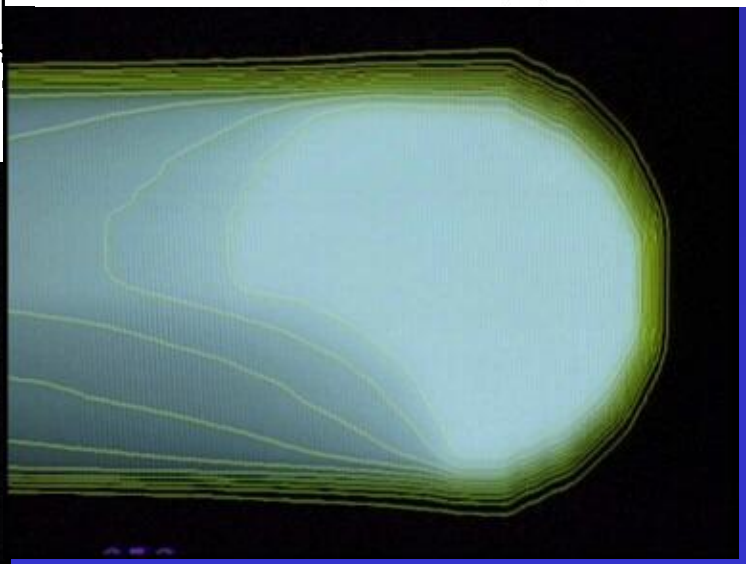
Why?

Physical selectivity

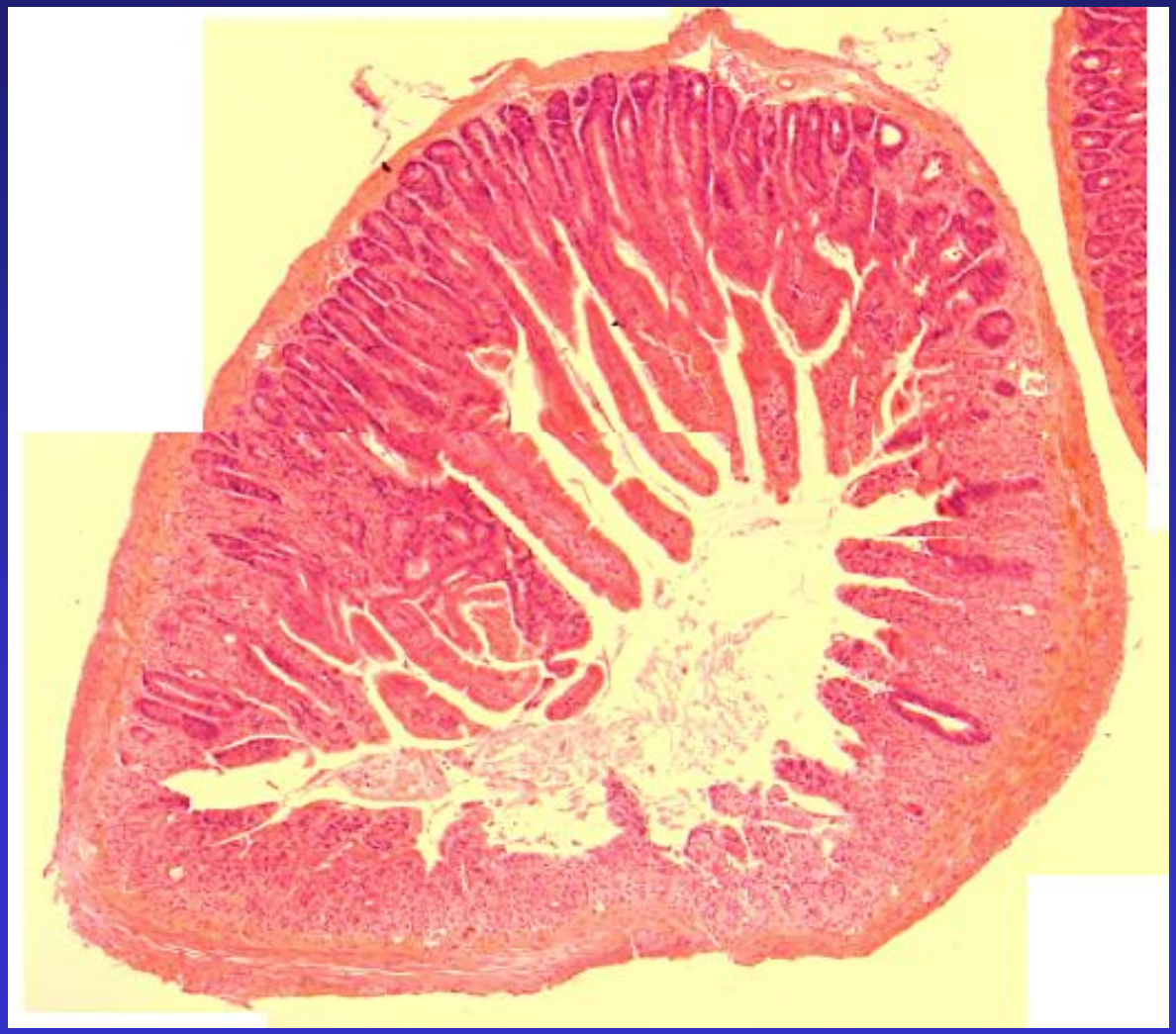








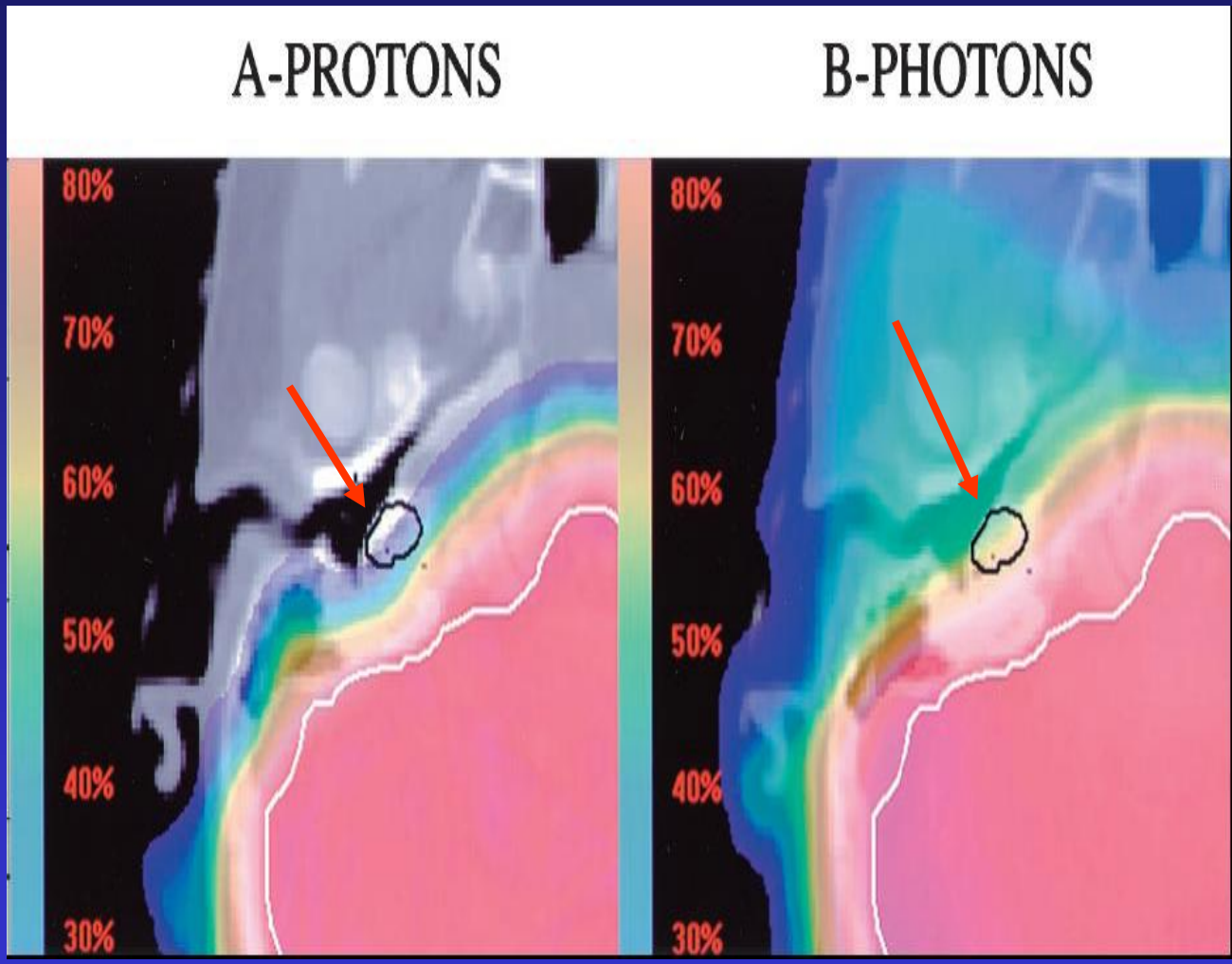
Bragg Pick in mouse bowel



Advantage of Protons

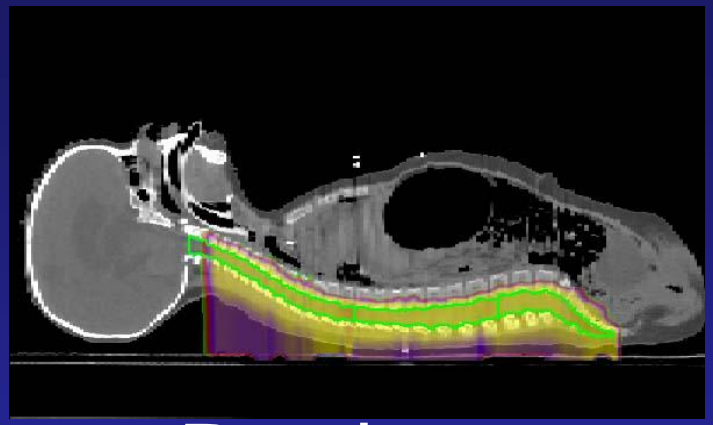
- 9 children primary CNS malignancies
- Choclea:

  average mean of 25 4% of the prescribed dose from PRT; 75 6% from photons
- 40% of temporal lobe volume was completely excluded using protons; with photons 90% of the temporal lobe received 31% of the dose

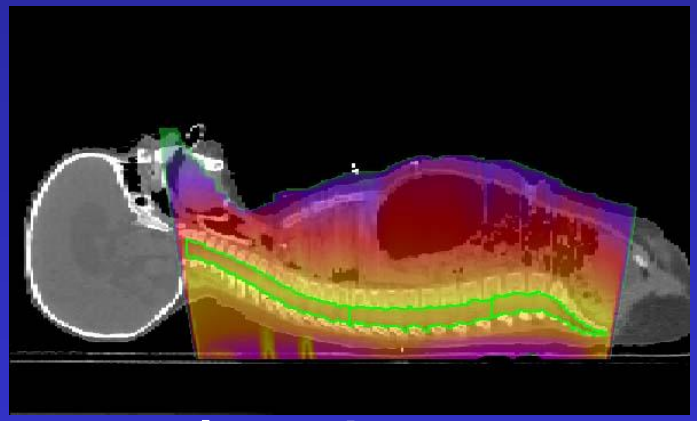


Linn R, 2000

Advantage of Protons



Protons

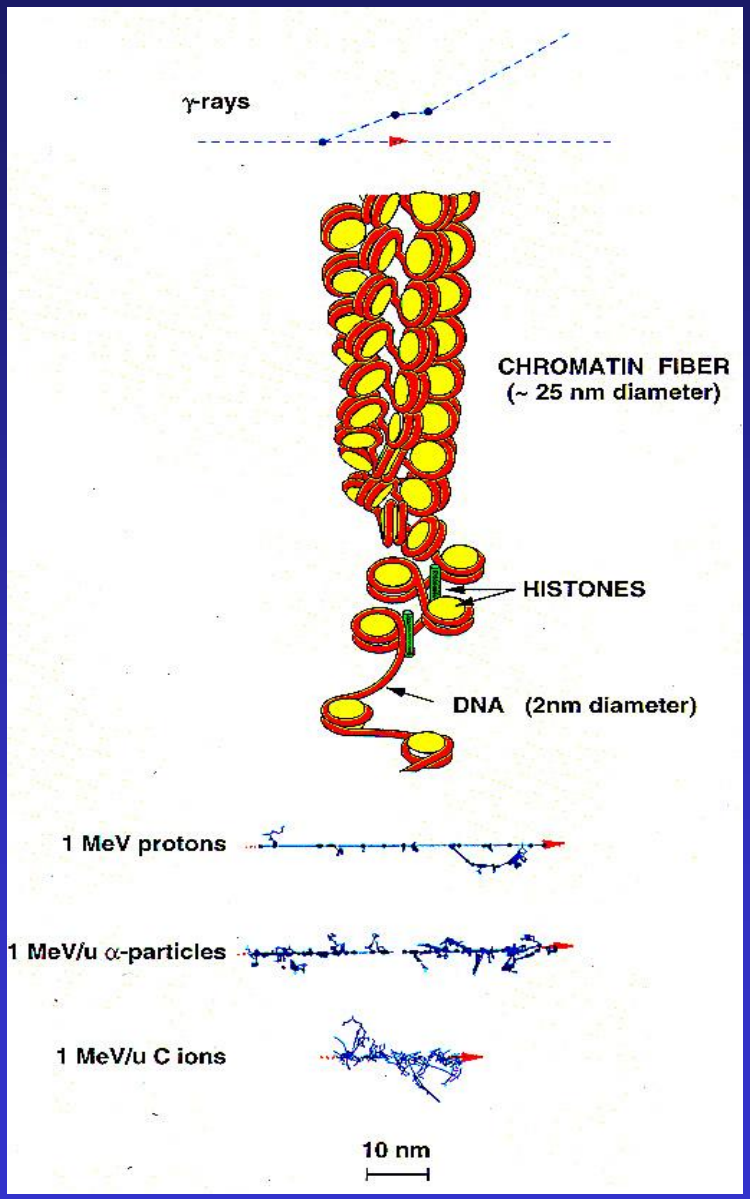


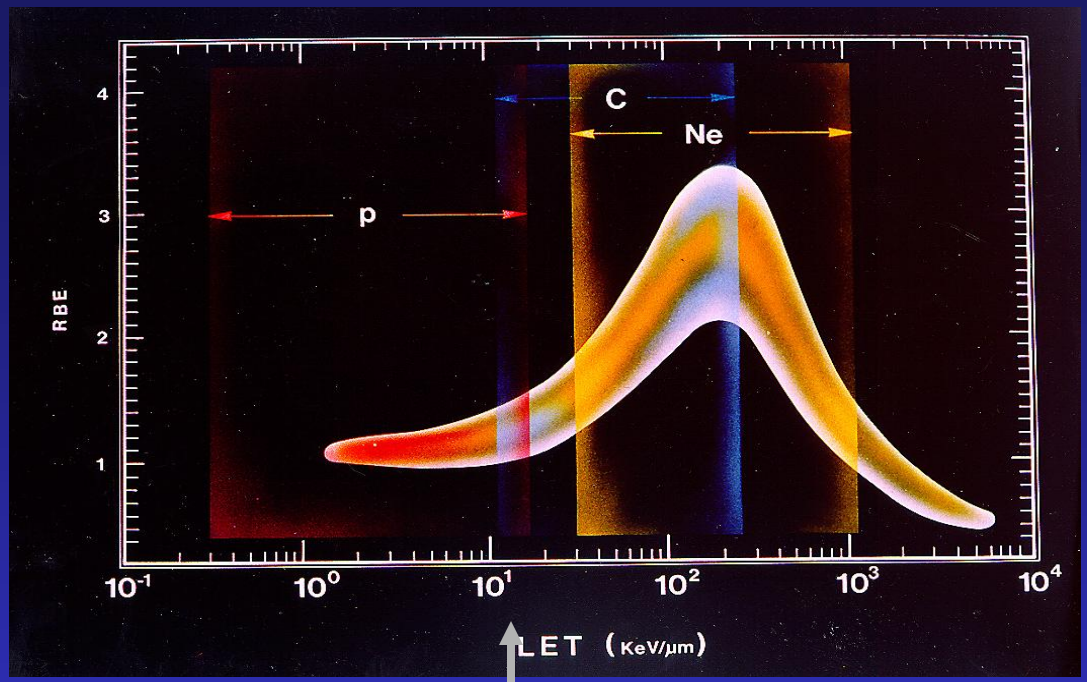
Photons

	X-ray	IMRT	Proton
CTV	90%	90%	**90%**
Heart	18.2	17.4	**0.1**
Right lung	3.5	21.9	**0.1**
Esophagous	11.9	32.1	**10.2**
Stomach	3.7	20.6	**0.1**
Right kidney	3.3	29.8	**0.1**
Transvers colon	2.6	18.0	**0.1**

***ST Clair WH**, 2004*

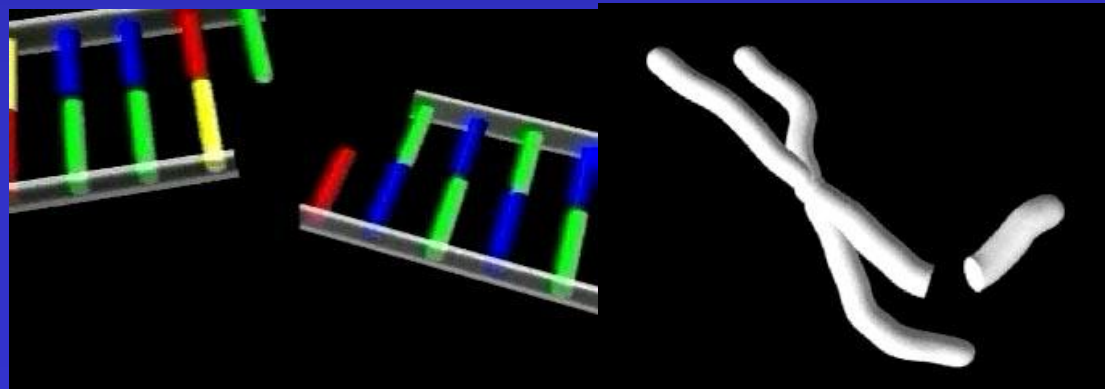
Biological selectivity. RBE



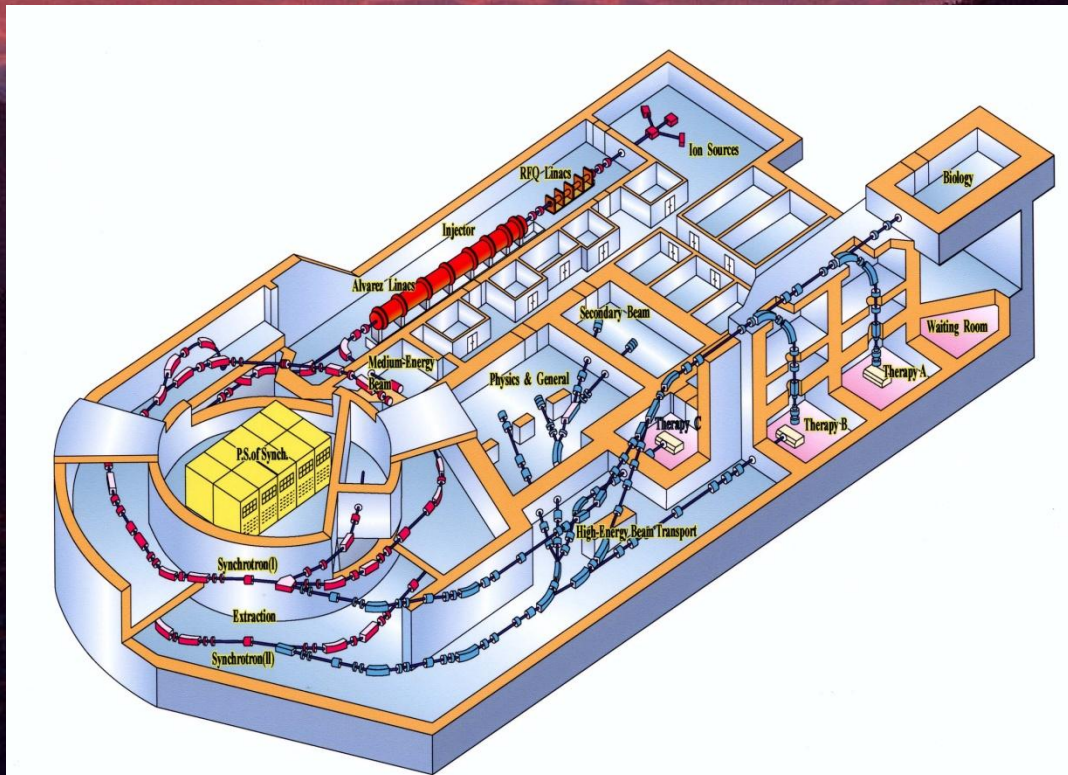


10 – 20 keV/μm = 100 – 200 MeV/cm =

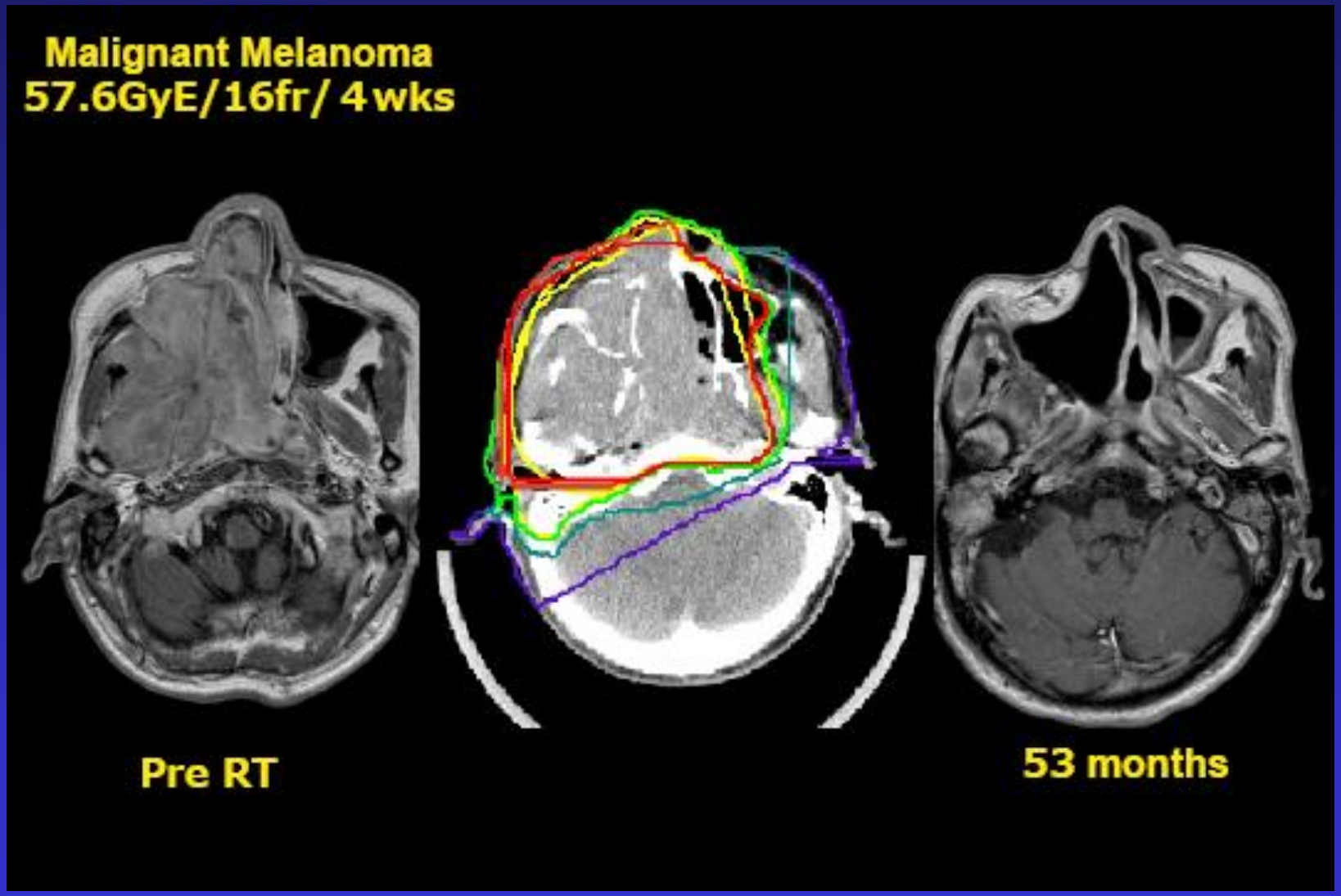
20 – 40 eV/(2 nm)



Chiba-NIRS


Ion Sources
RFQ-Linacs
Injector
Alvarez Linacs
Secondary Beam
Medium-Energy Beam
Physics & General
P.S.of Synch.
Synchrotron(I)
Extraction
Synchrotron(II)
High-Energy Beam Transport
Therapy C
Therapy B
Therapy A
Waiting Room
Biology

Carbon ion RT at NIRS



Hadrontherapy:

To whom?

WORLD WIDE CHARGED PARTICLE PATIENT TOTALS
January 2005

WHO	WHERE	WHAT	DATE FIRST RX	DATE LAST RX	RECENT PATIENT TOTAL	DATE OF TOTAL
Berkeley 184	CA. USA	p	1954	— 1957	30	
Berkeley	CA. USA	He	1957	— 1992	2054	
Uppsala (1)	Sweden	p	1957	— 1976	73	
Harvard	MA. USA	p	1961	— 2002	9116	
Dubna (1)	Russia	p	1967	— 1996	124	
ITEP, Moscow	Russia	p	1969		3785	Dec-04
Los Alamos	NM. USA	π^-	1974	— 1982	230	
St. Petersburg	Russia	p	1975		1145	April-04
Berkeley	CA. USA	ion	1975	— 1992	433	
Chiba	Japan	p	1979		145	Apr-02
TRIUMF	Canada	π^-	1979	— 1994	367	
PSI (SIN)	Switzerland	π^-	1980	— 1993	503	
PMRC (1), Tsukuba	Japan	p	1983	— 2000	700	
PSI (72 MeV)	Switzerland	p	1984		4182	Dec-04
Uppsala (2)	Sweden	p	1989		418	Jan-04
Clatterbridge	England	p	1989		1372	Dec-04
Loma Linda	CA. USA	p	1990		9585	Nov-04
Louvain-la-Neuve	Belgium	p	1991	– 1993	21	
Nice	France	p	1991		2555	April-04
Orsay	France	p	1991		2805	Dec-03
iThemba LABS	South Africa	p	1993		468	Nov-04
MPRI (1)	IN USA	p	1993	– 1999	34	
UCSF - CNL	CA USA	p	1994		632	June-04
HIMAC, Chiba	Japan	C ion	1994		1796	Feb-04
TRIUMF	Canada	p	1995		89	Dec-03
PSI (200 MeV)	Switzerland	p	1996		209	Dec-04
G.S.I Darmstadt	Germany	C ion	1997		198	Dec-03
H. M. I, Berlin	Germany	p	1998		546	Dec-04
NCC, Kashiwa	Japan	p	1998		300	Oct-04
Dubna (2)	Russia	p	1999		296	Dec-04
HIBMC, Hyogo	Japan	p	2001		483	Dec-04
PMRC (2), Tsukuba	Japan	p	2001		492	July 04
NPTC, MGH	MA USA	p	2001		973	Dec-04
HIBMC, Hyogo	Japan	C ion	2002		30	Dec-02
INFN-LNS, Catania	Italy	p	2002		82	Oct-04
WERC	Japan	p	2002		19	Oct-04
Shizuoka	Japan	p	2003		100	Dec-04
MPRI (2)	IN USA	p	2004		21	July -04
Wanjie, Zibo	China	p	2004		1	Dec-04
					1100	pions
					4511	ions
					40801	protons
				TOTAL	46412	all particles

Overall hadrontherapy patients

Protons: > 55 000

Ions: > 6000

Neutrons (20 000)

Pions (1 000)

Published Data in the years

STUDIES / YEARS	CLINIC	PHYSICS	BIOLOGY	TOTAL
2004-2007	100	41	21	162
2000-2003	46	29	18	93
1995-1999	27	33	8	68

2008-2010:
“Heavy Charged Particles”
577 papers

EBM?

VOLUME 26 · NUMBER 2 · JANUARY 10 2008
JOURNAL OF CLINICAL ONCOLOGY
COMMENTS AND CONTROVERSIES

Should Randomized Clinical Trials Be Required for Proton Radiotherapy?

Michael Goitein, *Department of Radiation Oncology, Harvard M*
James D. Cox, *Division of Radiation Oncology, The University*

VOLUME 25 · NUMBER 8 · MARCH 10 2007
JOURNAL OF CLINICAL ONCOLOGY
REVIEW ARTICLE

Proton Therapy in Clinical Practice: Current Clinical Evidence

Michael Brada, Madelon Pijls-Johannesma, and Dirk De Ruysscher

Radiotherapy and Oncology 86 (2008) 142–147
www.thegreenjournal.com

Special communication

Randomized controlled trials in health technology assessment: Overkill or overdue?

Søren M. Bentzen*

Departments of Human Oncology, Medical Physics, Biostatistics and Medical Informatics, University of Wisconsin School of Medicine and Public Health, Madison, WI, USA

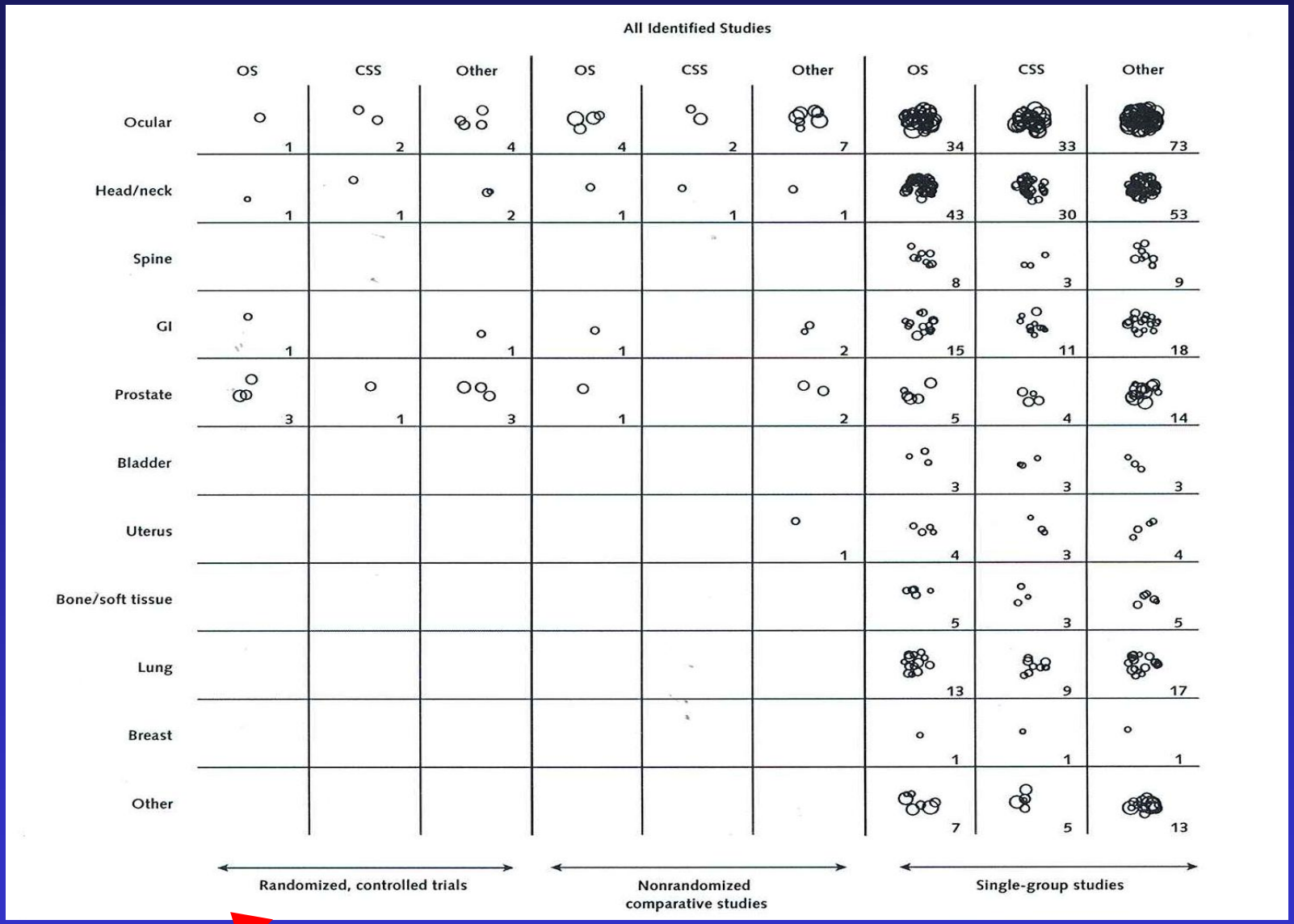
Radiotherapy and Oncology 83 (2007) 105–109
www.thegreenjournal.com

Editorial

Proton beam therapy – Do we need the randomised trials and can we do them?

Bengt Glimelius[a,b,*], Anders Montelius[a]

[a]*Department of Oncology, Radiology and Clinical Immunology, Uppsala University Hospital, Uppsala, Sweden,* [b]*Department of Oncology and Pathology, Karolinska Institutet, Stockholm, Sweden*



Terasawa T et al. Systematic review: Charged-Particle Radiation Therapy for Cancer Ann Intern Med 2009; 151: 556-65

Category A

- All the tumors in which the use of **hadrontherapy is clearly demonstrated to be advantageous**, being the only way to give a curative dose to the target volume minimizing the incidence of severe side effects

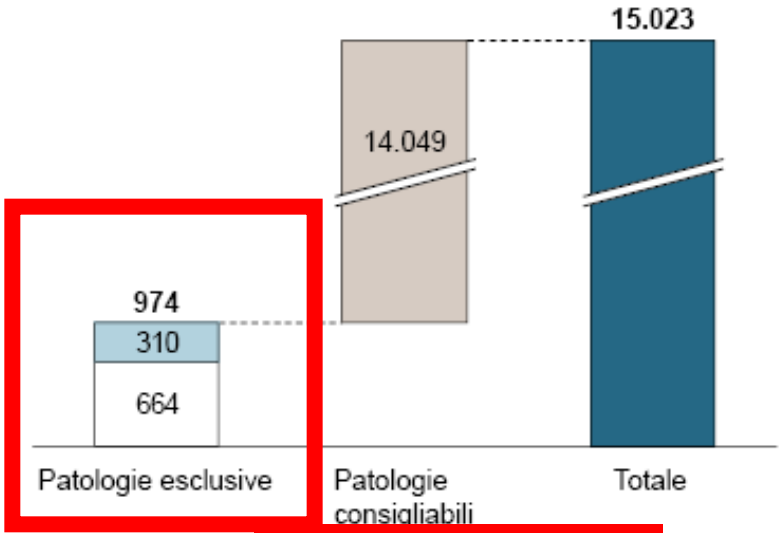
Category B

- A great variety of tumors characterized mainly by a local evolution, with a limited probability of distant spread, and therefore **potentially cured** if the locoregional control can be obtained

Working Group 2003, 2008, 2009

Estimated 15.000 new eligible patients in Italy

for protons (2008)



High priority

- Le principali patologie esclusive sono il melanoma uveale (corrispondendi al 47% delle patologie elettive), i cordomi della base cranica e della colonna vertebrale, i condrosarcomi dell'estremità cefalica e del tronco, i meningiomi della base cranica, i tumori paraspinali, gli schwannomi dei nervi cranici, gli adenomi ipofisari e i tumori solidi pediatrici
- Le principali patologie consigliabili, su cui risulta particolarmente vantaggioso ,sono i tumori alla prostata, al pancreas, ai polmoni e al fegato
- In futuro si prevede una crescente estensione del campo di applicazione della terapia a protoni ad altre patologie anche non oncologiche

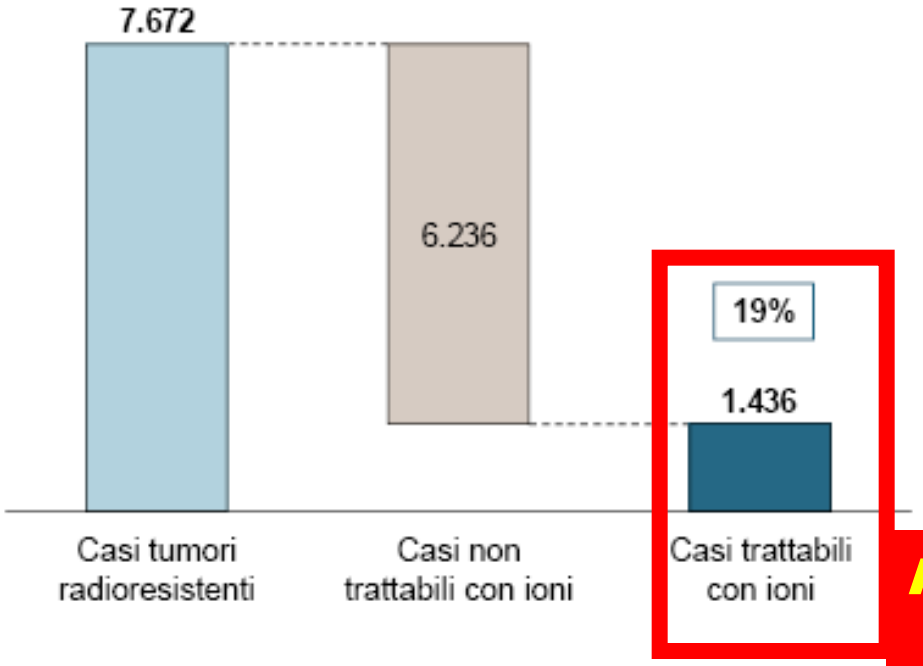
Category A. First Priority. Protons

Tumours	*New pts / year*	*N. Pts eligible for protons*	*% eligible for protons*
Uveal melanoma	310	310	100%
Chordoma	45	45	100%
Chondrosarcoma	90	90	100%
Meningioma (base of skull)	250	125	50%
Paraspinal tumours	140	140	100%
Schwannoma (cranial nerves)	300	45	15%
Pituitary adenoma	750	75	10%
Paediatric solid tumours	960	**144**	**15%**
TOTAL	1'885	974	

Working Group 2003, 2008, 2009

Estimated 7.000 patients with "radioresistant tumors" in Italy (2008)

About 20% of these tumors should be treated by ions



- Le terapie con ioni di carbonio potrebbero essere adottate in quasi 20% dei casi di alcune categorie di tumori radioresistenti
- Le principali patologie neoplastiche trattabili con ioni sono: i tumori delle ghiandole salivari, i melanomi mucosi delle VADS, i adenocarcinomi dei seni paranasali, i sarcomi ossei e dei tessuti molli e i epatocarcinomi/tumori pancreatici e delle vie biliari
- Ad oggi l'applicazione della terapia a ioni Carbonio è piuttosto limitata, tuttavia in futuro si prevede una crescente estensione

High priority

Fonte: Airo

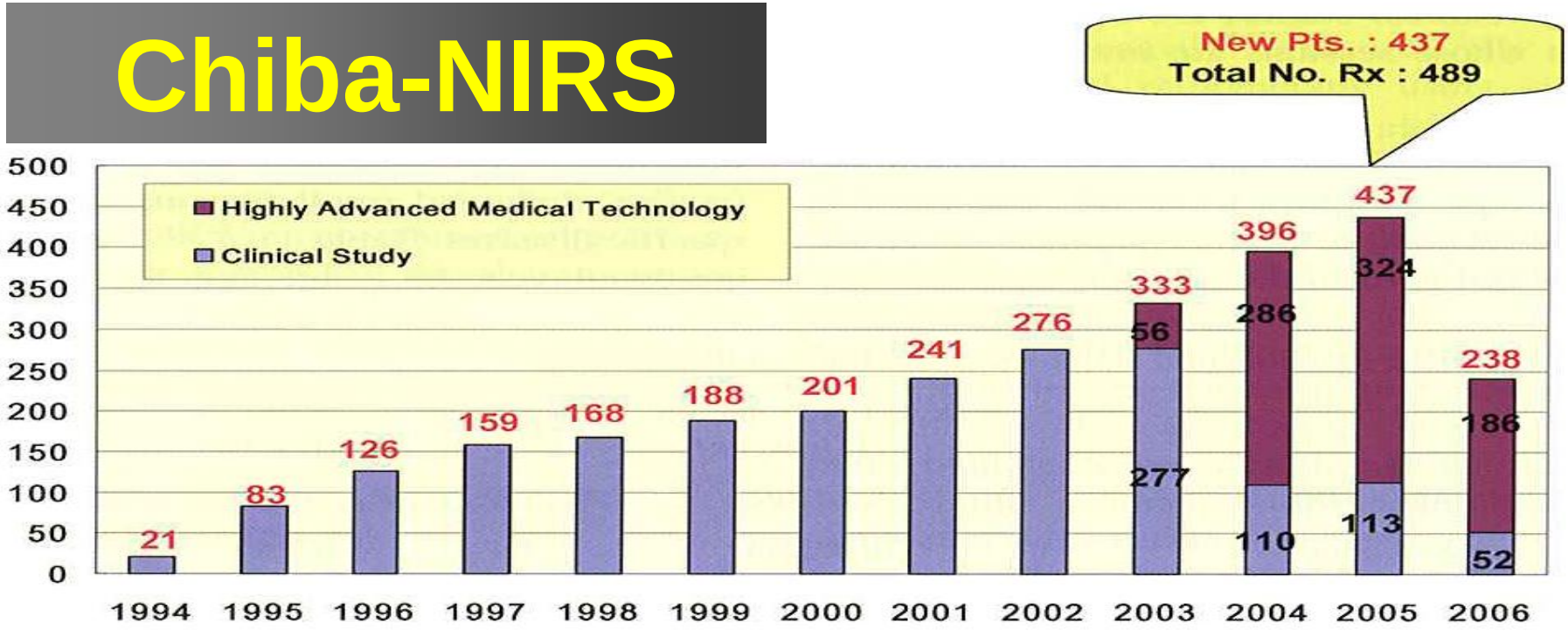
Category A. First Priority. C-ions

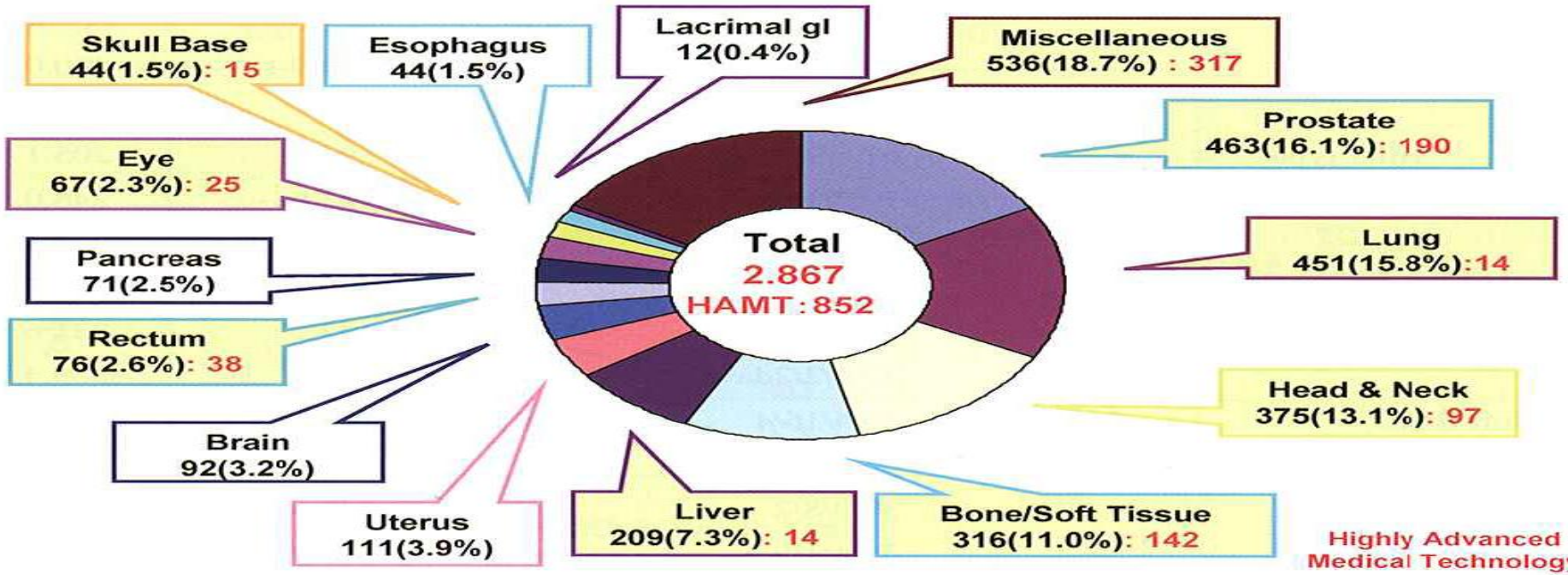
Tumours	*New pts / year*	*N. eligible for carbon ions*	*% eligible for carbon ions*
Salivary gland tumours	620	310	50%
ENT mucosal melanoma	30	30	100%
Adenoca sinuses	450	45	10%
Soft tissue sarcoma	1’360	136	10%
Bone sarcoma	520	104	20%
Liver/Pancreas/BT carcinomas	4500	450	10%
Recurrent tumours		225	
TOTAL	7672	**1436**	

EU Patients for Hadrontherapy

country	year of evaluation	patients	% of irradiated pts / year
Austria	2003	2.044	~ 13%
Czech Republic, Slovakian Republic Slovenia, Hungaria	2003 (by MedAustron)	8.700	~ 12%
Italy	2003	~ 15.000 hadrons	~ 12%
France	2003	77/532 pts (1-d –analysis)	~ 14%
Germany	1998	~ 8.000	~ 7%

Chiba-NIRS


New Pts. : 437
Total No. Rx : 489
Highly Advanced Medical Technology
Clinical Study
500
450
400
350
300
250
200
150
100
50
0
21
83
126
159
168
188
201
241
276
333
56
277
396
286
110
437
324
113
238
186
52
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

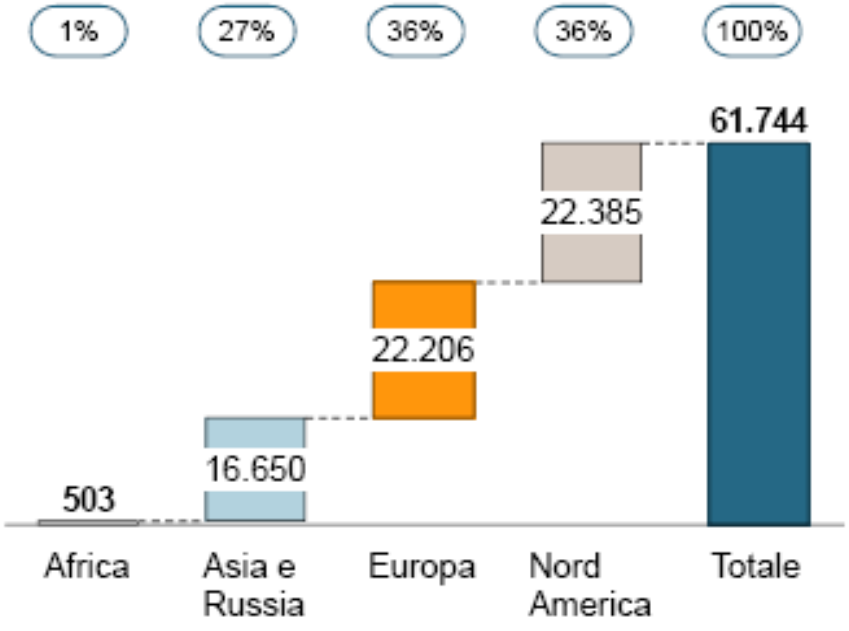

Skull Base
44(1.5%): 15
Esophagus
44(1.5%)
Lacrimal gl
12(0.4%)
Miscellaneous
536(18.7%) : 317
Prostate
463(16.1%): 190
Eye
67(2.3%): 25
Pancreas
71(2.5%)
Rectum
76(2.6%): 38
Brain
92(3.2%)
Uterus
111(3.9%)
Liver
209(7.3%): 14
Bone/Soft Tissue
316(11.0%): 142
Head & Neck
375(13.1%): 97
Lung
451(15.8%):14
Total
2.867
HAMT : 852
Highly Advanced
Medical Technology

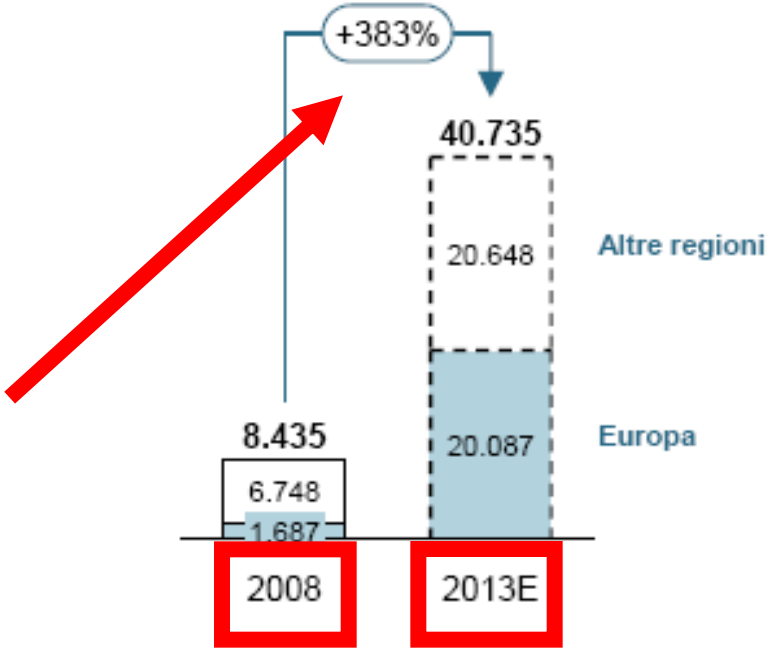
Hadrontherapy:

How much?

Development of Hadrontherapy

Up to day, more than 60.000 patients have been treated. This number is expected to be strongly increased



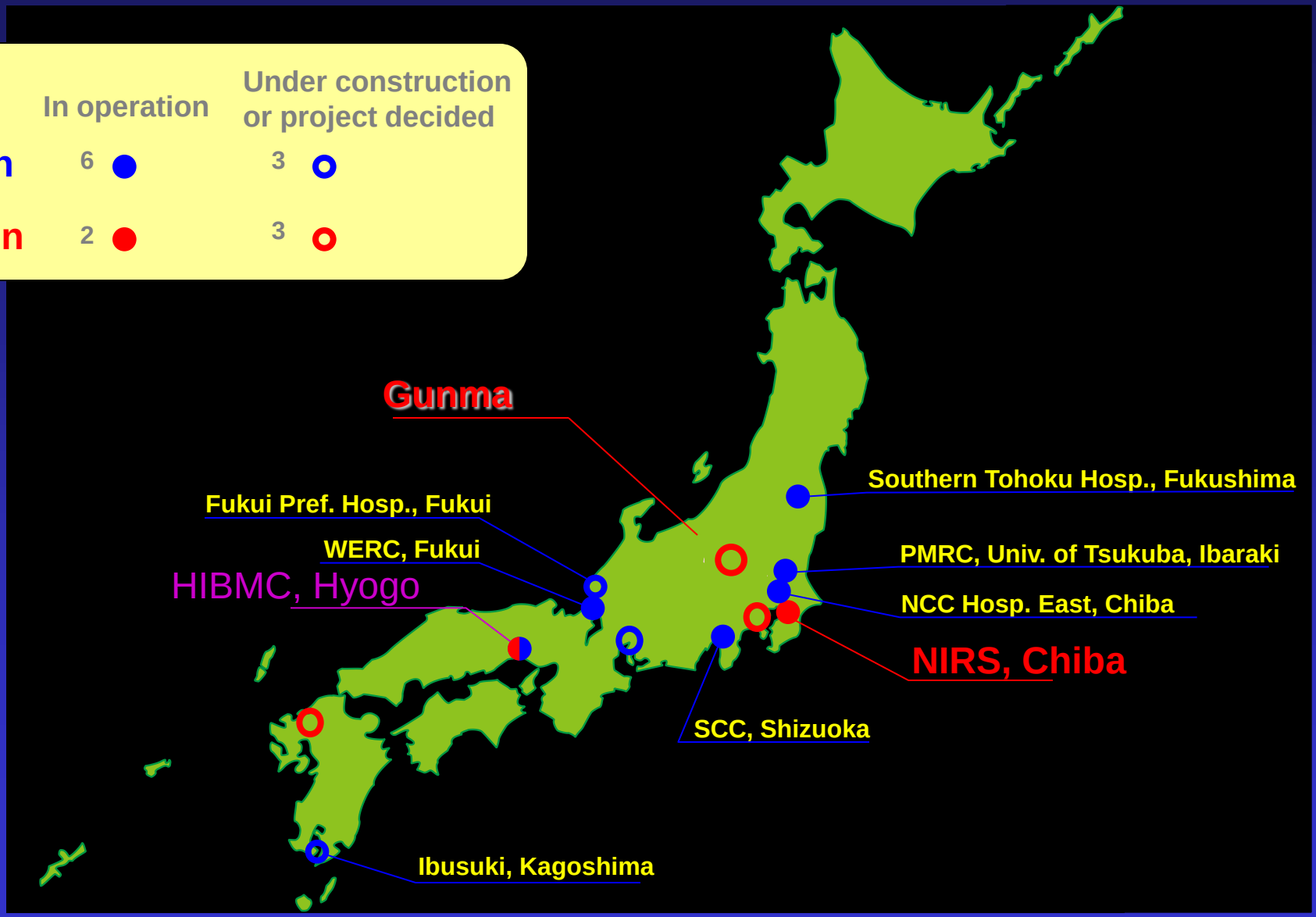


1) Stima al 2013 effettuata considerando una media di 400 pazienti/anno per sala di trattamento

Fonte: PTCOG (Particle Therapy Co-Operative Group)

Hadrontherapy in Japan

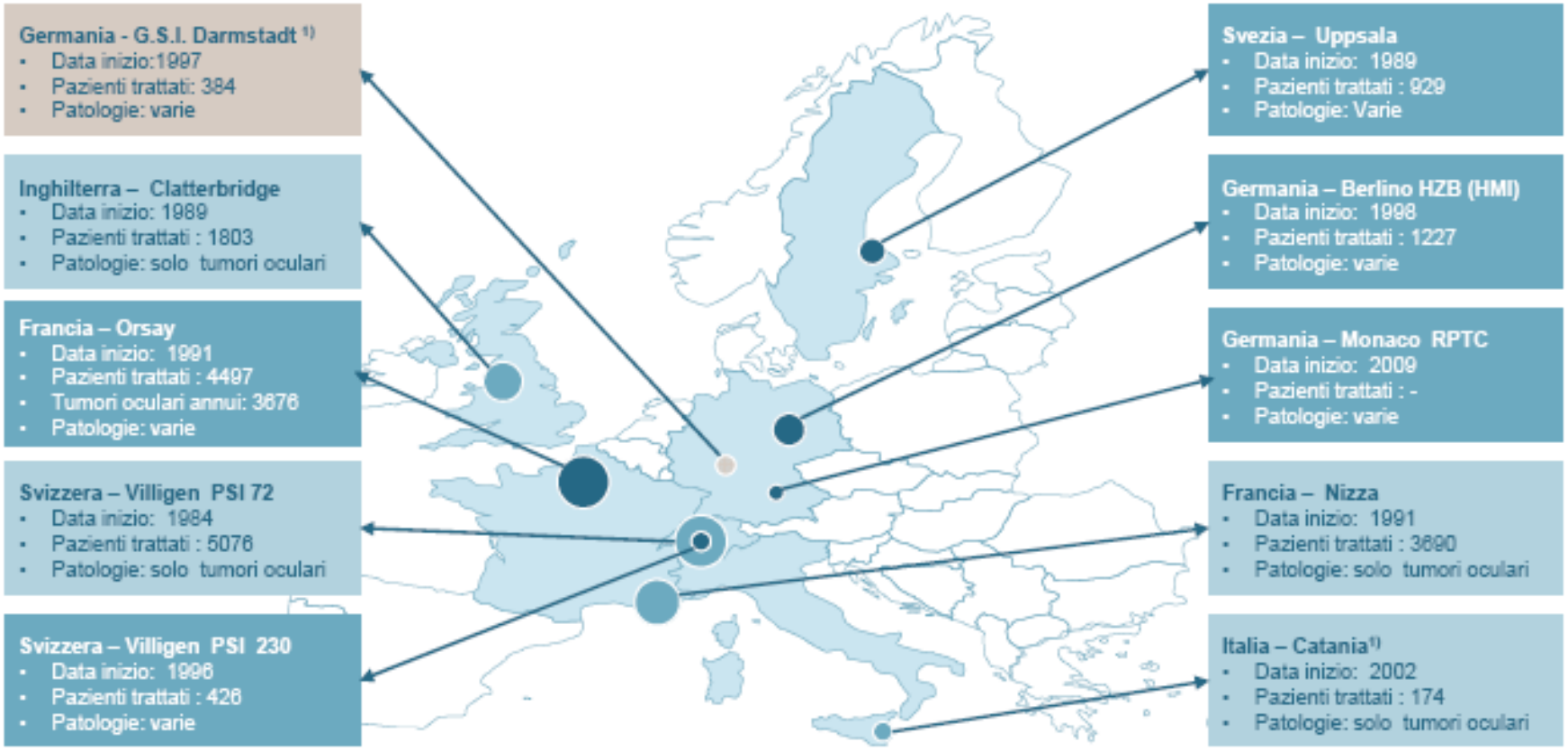
	In operation	Under construction or project decided
Proton	6 ●	3 ○
Carbon	2 ●	3 ○



More than 20 centers in the next 5 years

10 centers of hadrontherapy, 9 with protons are currently working in Europe

Centri di adroterapia attivi in Europa [2008]



1) Dati 2007

Fonte: PTCOG (Particle Therapy Co-Operative Group)

In the next 4 years other 14 centers will be opened. Five will offer both proton and C-ion therapy

Nuovi Centri di Adroterapia

A Germania e Austria

- Germania, Koeln:
  - Inizio: n.d.
  - # di sale: 5
- Germania, Essen:
  - Inizio:2010
  - # di sale: 4
- Germania, Heidelberg:
  - Inizio: 2010
  - # di sale: 3
- Germania, Marburg:
  - Inizio: 2010
  - # di sale: 4
- Germania, Kiel :
  - Inizio: 2012
  - # di sale: 3
- Austria, Wiene:
  - Inizio: 2013
  - # di sale: 3

B Europa dell'Est

- Slovacchia, Bratislava:
  - Inizio probabile: 2010
  - # di sale:1
- Slovacchia, Ruzomberok:
  - Inizio: 2010
  - # di sale: 1
- Russia, Protvino:
  - Inizio: 2010
  - # di sale: 1
- Svezia, Uppsala:
  - Inizio probabile 2012
  - # di sale: 2

C Italia

- Italia, Pavia:
  - Inizio probabile: 2010
  - # di sale: 3-4
- Italia, Trento:
  - Inizio probabile: 2011
  - # di sale: 2

D Francia e Svizzera

- Francia, Orsay:
  - Inizio: 2010
  - # di sale: 3
- Svizzera, Villigen:
  - Inizio: 2009
  - # di sale: 1+2

1) Le date di Inizio indicate sono quelle presenti sul sito del *Particle Therapy Co-Operative Group*, presumibilmente l'apertura dei centri sarà spostata di qualche anno

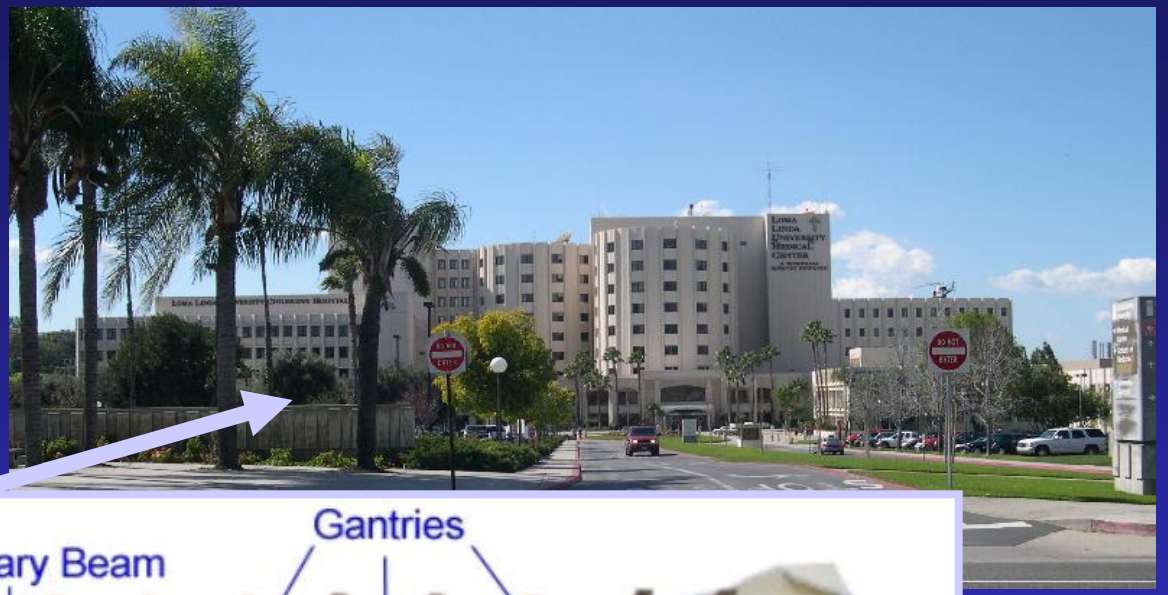
MIL-0101-08512-004-065-01

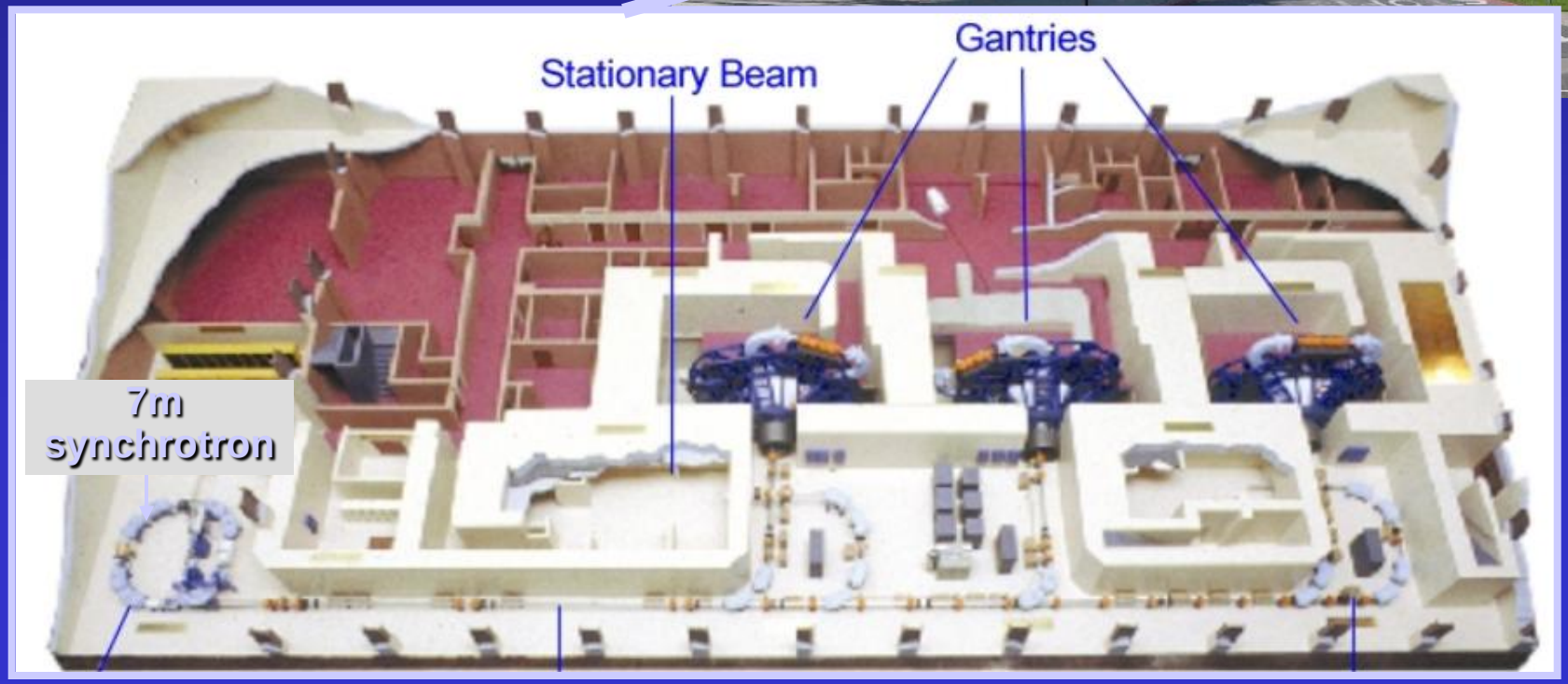
Hadrontherapy:

Which?

Loma Linda University Medical Center: first patient 1992

- First hospital-based proton-therapy centre
- 2005:160 sessions/day



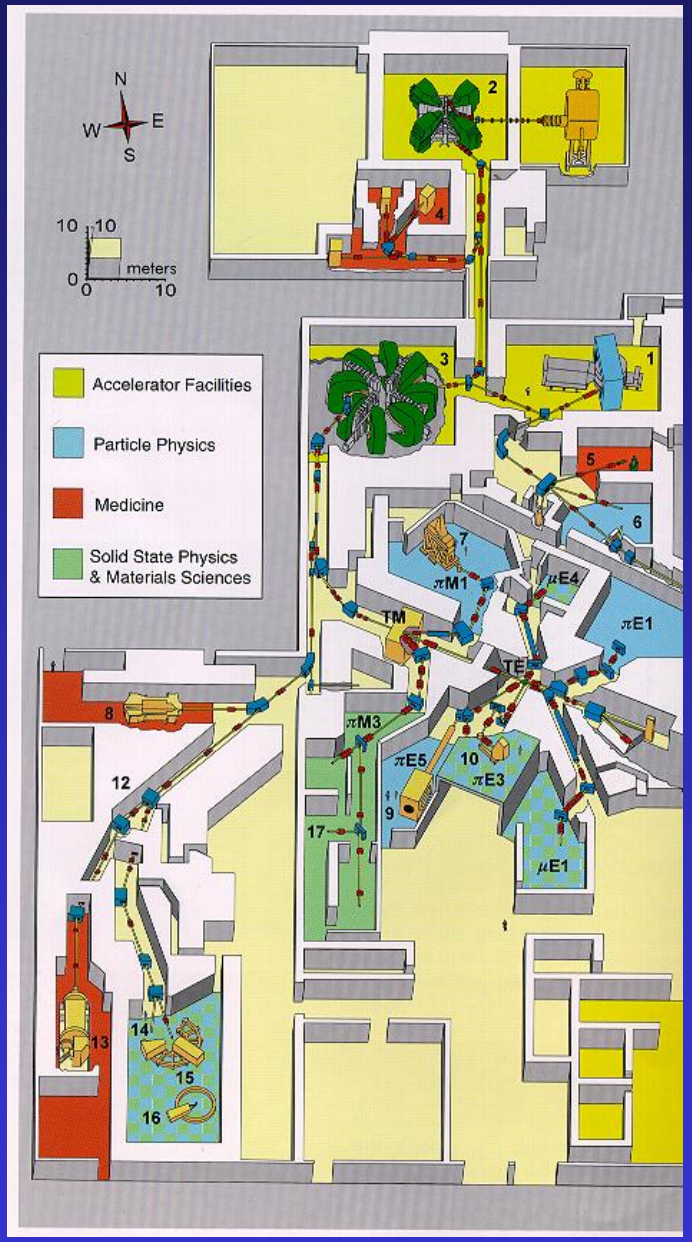


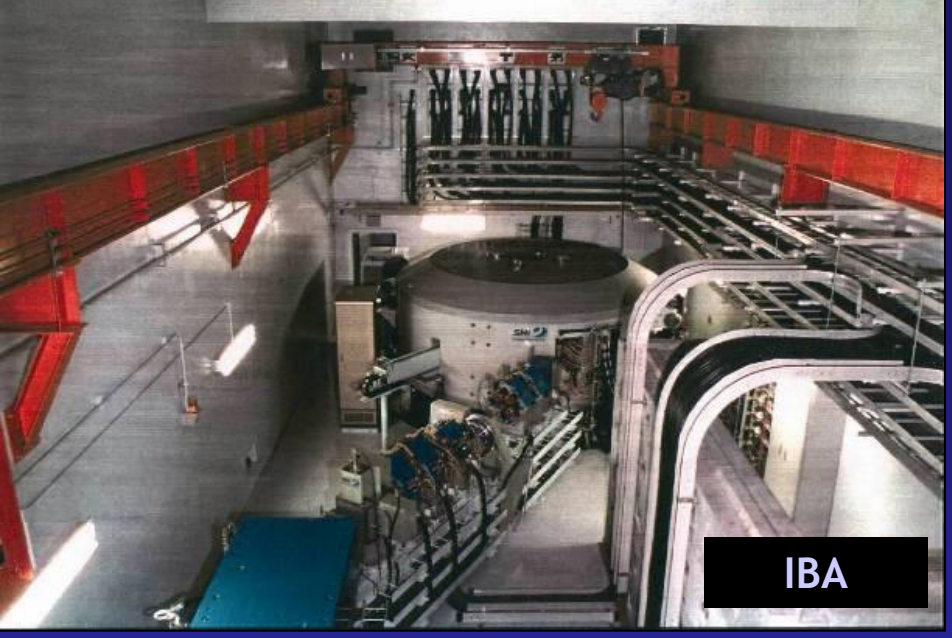
Europe: first active system at PSI → PROSCAN

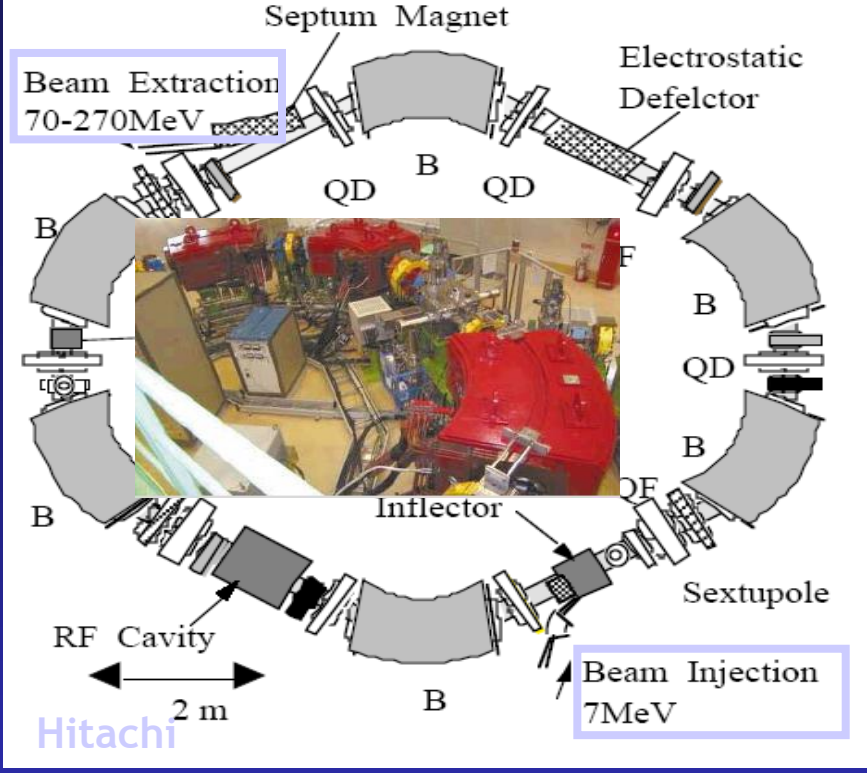
PSI Villigen

Optis – eye: 4000 patients

PSI Gantry: 250 patients




IBA


Septum Magnet
Beam Extraction
70-270MeV
Electrostatic
Defelctor
B
QD
QD
B
F
B
QD
B
QF
B
Inflector
Sextupole
RF Cavity
2 m
B
Beam Injection
7MeV
Hitachi


Mitsubishi


ACCEL
Accel/Varian

PIANTE

DATI DIMENSIONALI:

AREA	mq 18.000
SUPERFICIE COPERTA	mq 5.650
ALTEZZA IN GRONDA	m 11,50
SUPERFICIE PROTONTERAPIA	mq 9.330
SUPERFICIE SERVIZI SANITARI	mq 4.270
PARCHEGGI 225+225 p.a.	mq 6.130

PIANO INTERRATO

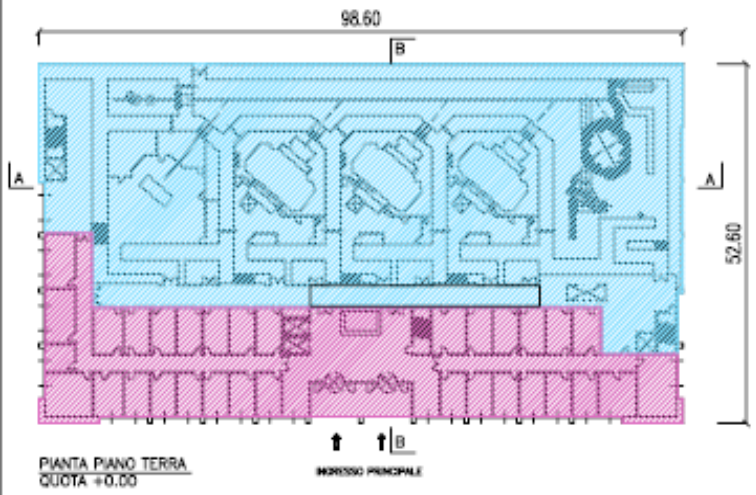
SUPERFICIE PROTONTERAPIA mq 3.580
SUPERFICIE SERVIZI SANITARI mq 1.600

PIANO TERRA

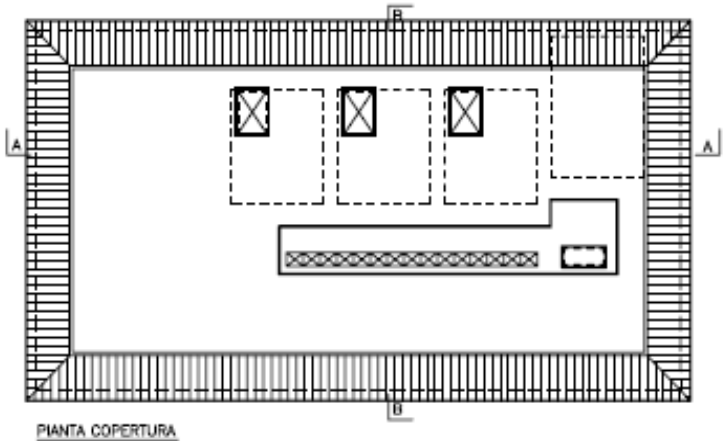
SUPERFICIE PROTONTERAPIA mq 2.825
SUPERFICIE SERVIZI SANITARI mq 1.570

PIANO PRIMO

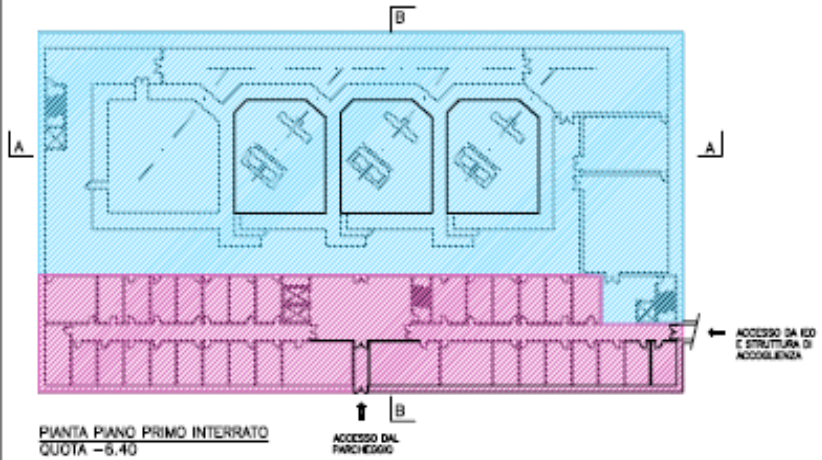
SUPERFICIE PROTONTERAPIA mq 2.925
SUPERFICIE SERVIZI SANITARI mq 1.100



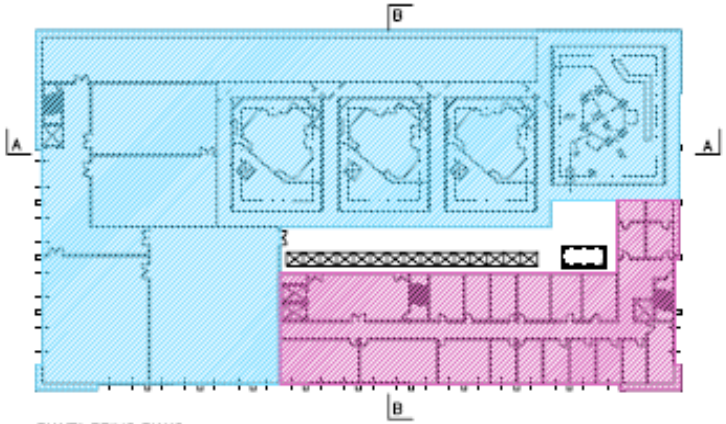
PIANTA PIANO TERRA
QUOTA +0.00



PIANTA COPERTURA
QUOTA +11.90



PIANTA PIANO PRIMO INTERRATO
QUOTA −6.40



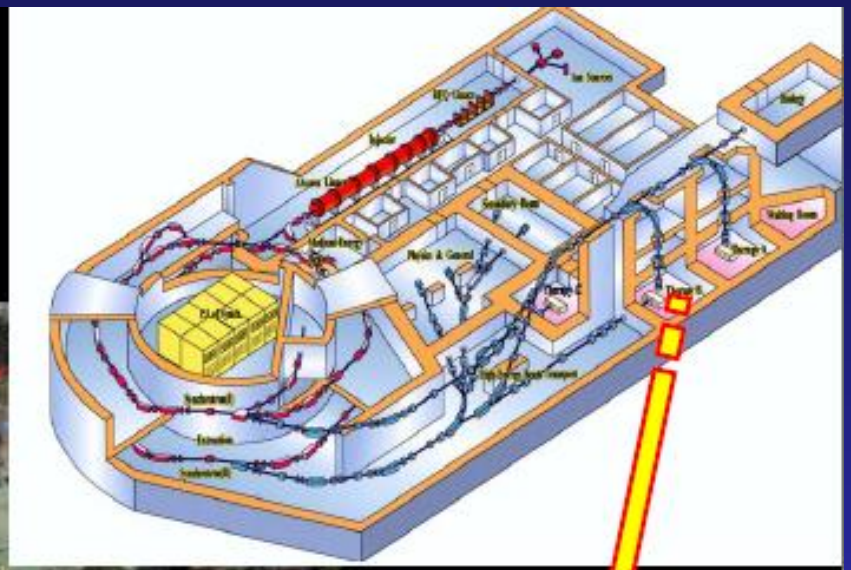
PIANTA PRIMO PIANO
QUOTA +5.50

NORD

ISTITUTO EUROPEO DI ONCOLOGIA I.R.C.C.S.
VIA G. RIPAMONTI, 435 – MILANO

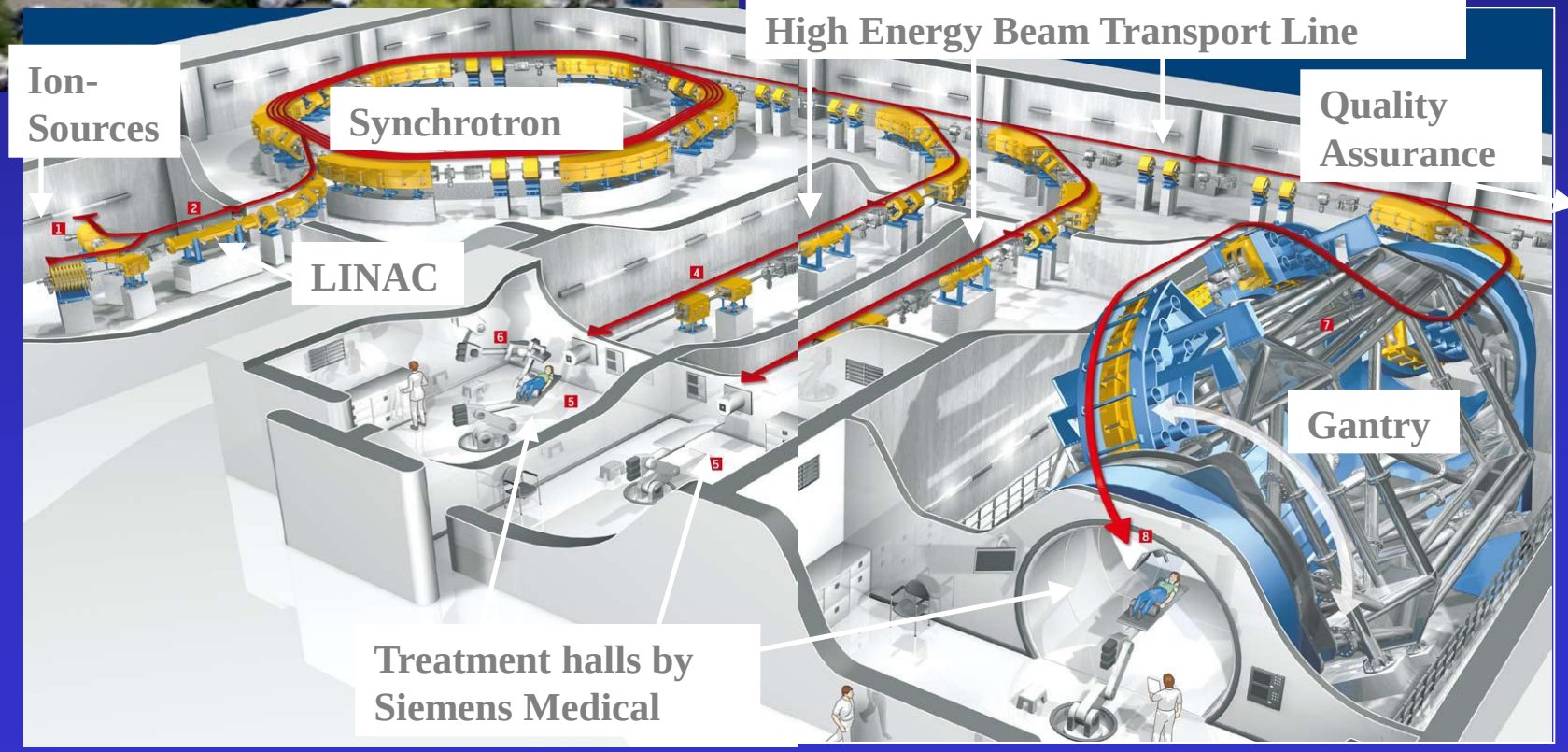
PMCK 07/11/2005

HIMAC
(Heavy Ion Medical Accelerator in Chiba)



HIT ad Heidelberg

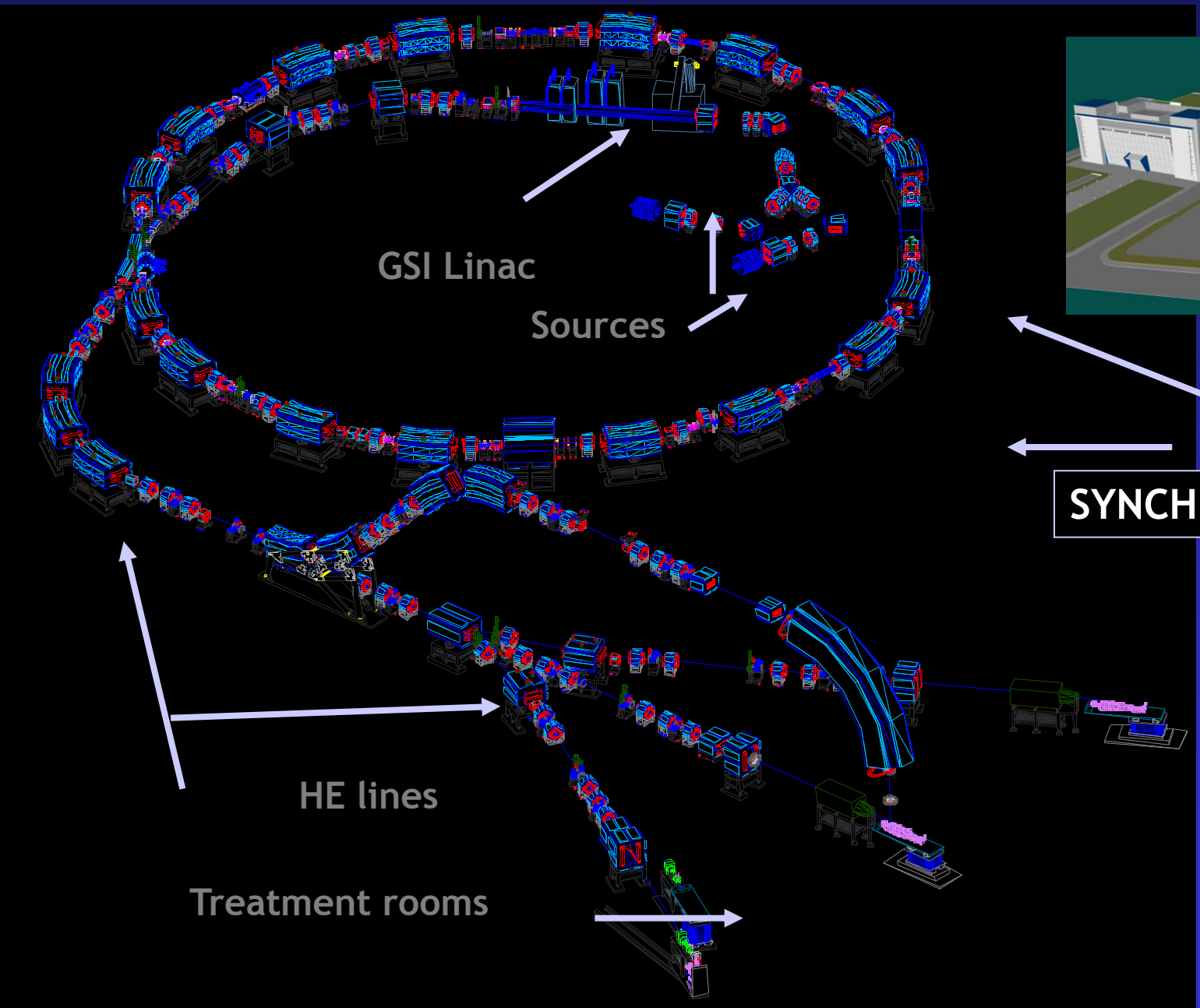
Siemens Medical: Marburg+Kiel



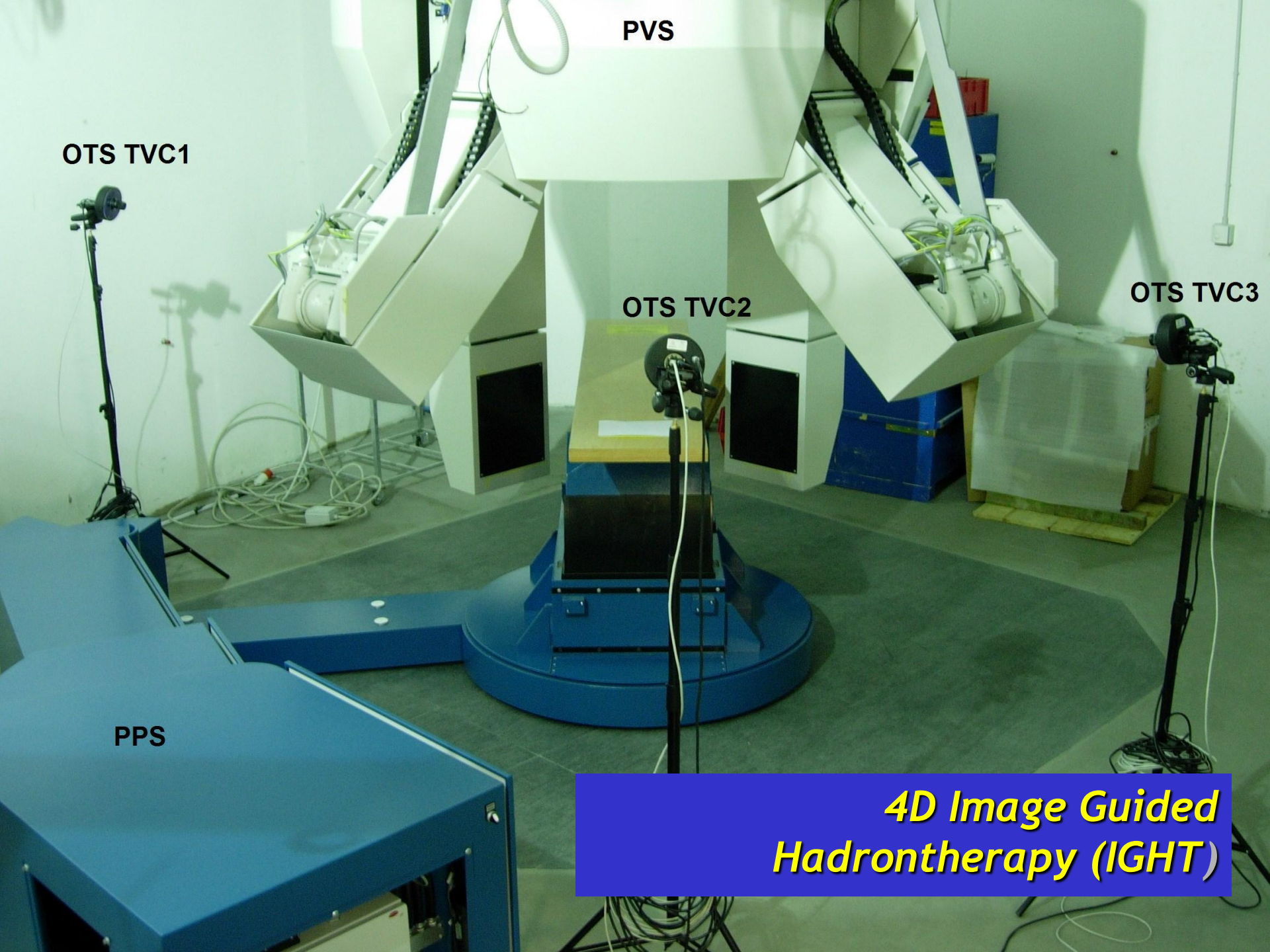
fondazione CNAO

15th February 2010

The "core" of CNAO



SYNCHROTRON



4D Image Guided Hadrontherapy (IGHT)

Results

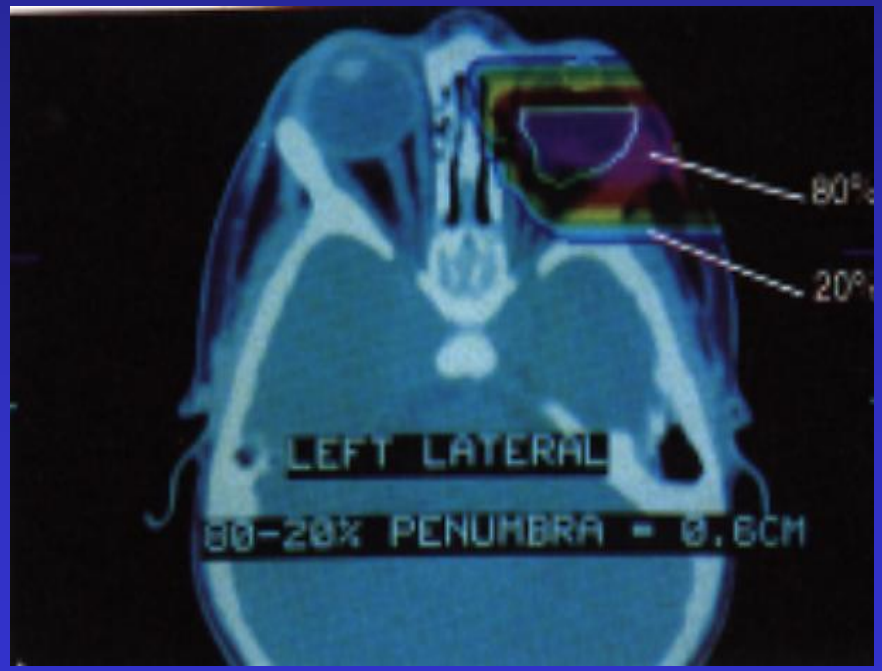
UVEAL MELANOMA

- More than 10,000 patients treated
  (MGH/HCL Boston, PSI Villingen, Nice & Orsay, Clatterbridge)

- 5y-LC rate >95%

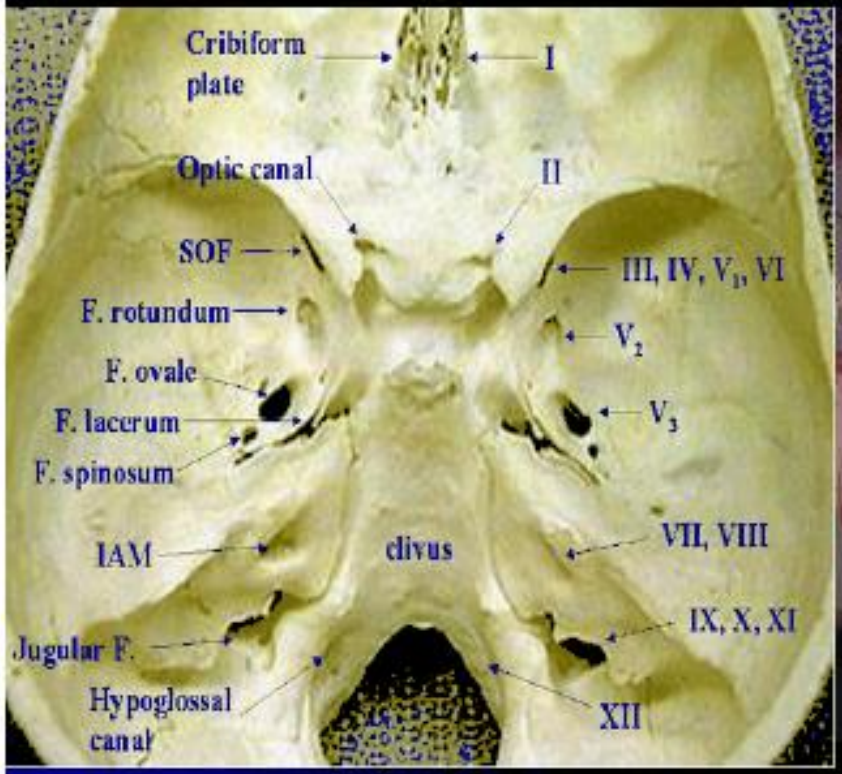
- Eye preservation >90%

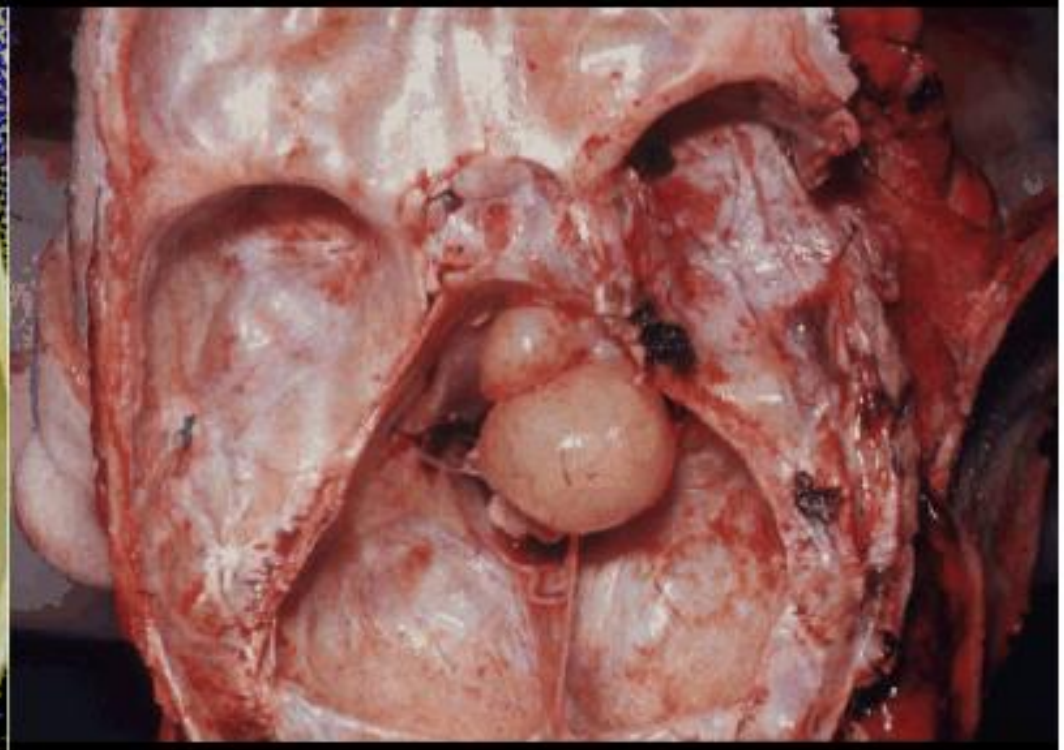
- Visual acuity >45%



Chordoma: Base of Skull

- Base of skull chordomas account for ~1/3 of chordomas

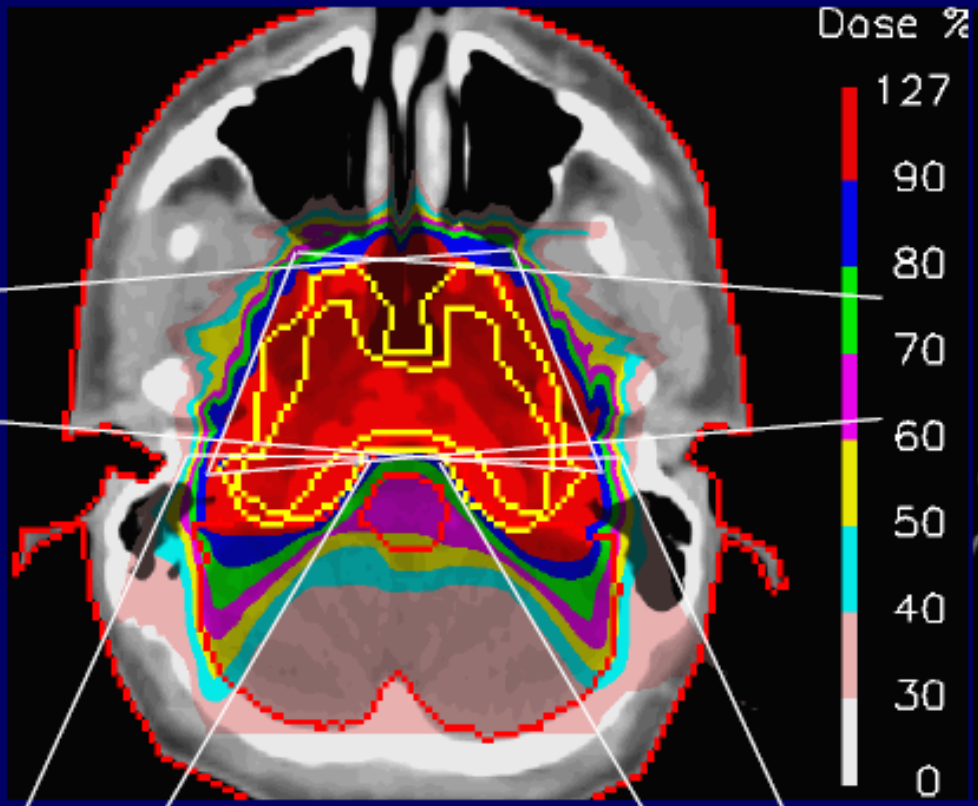




Passive scattering - MGH

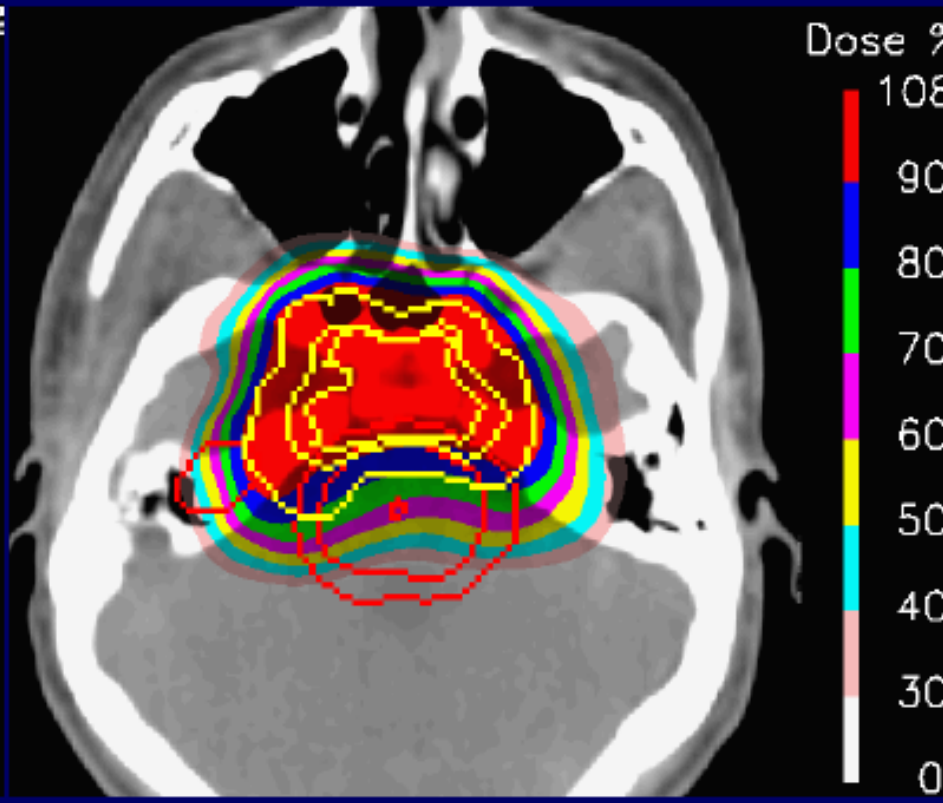
Field patching

Matching distal and lateral field edges



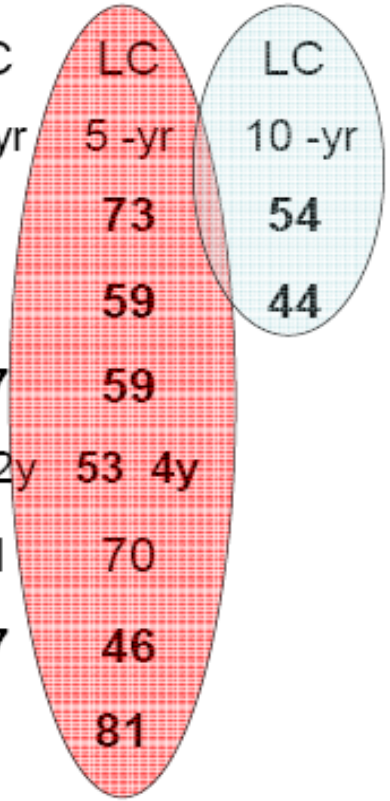
Courtesy of MGH

Spot-scanning technique - PSI



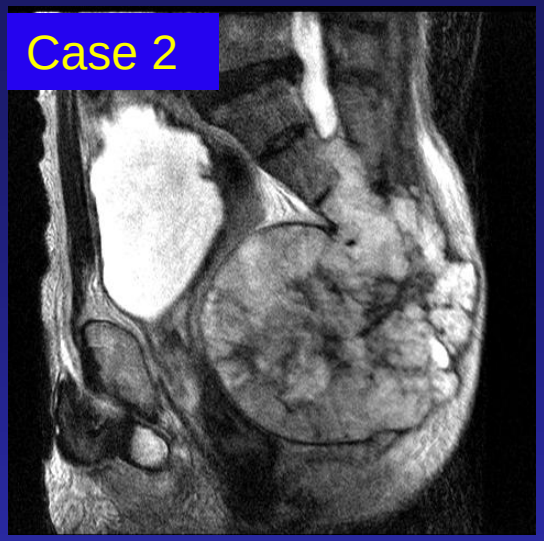
Skull Base *Chordomas:* Proton series

	n	Radiation	Mean dose	LC 3 -yr	LC 5 -yr	LC 10 -yr
Munzenrider, 1999	**290**	**PT, RT**	**76**		**73**	**54**
Terahara, 1999	**115**	**PT, RT**	**69**		**59**	**44**
Hug, 1999	**33**	**PT, RT**	**71**	**67**	**59**	
Noel, 2005	**100**	**PT, RT**	**67**	**86 2y**	**53 4y**	
Schulz-Ertner, 2007	**96**	***Carbon, RT***	**60***	**81**	**70**	
Igaki, 2004	**13**	**PT, RT**	**72**	**67**	**46**	
Ares 2008	**42**	**PT**	**74**		**81**	



*at 3.0 CGE per fraction

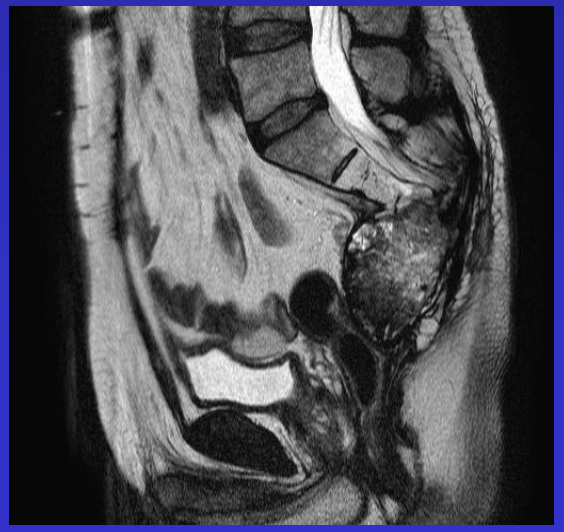
Chordoma of the sacrum



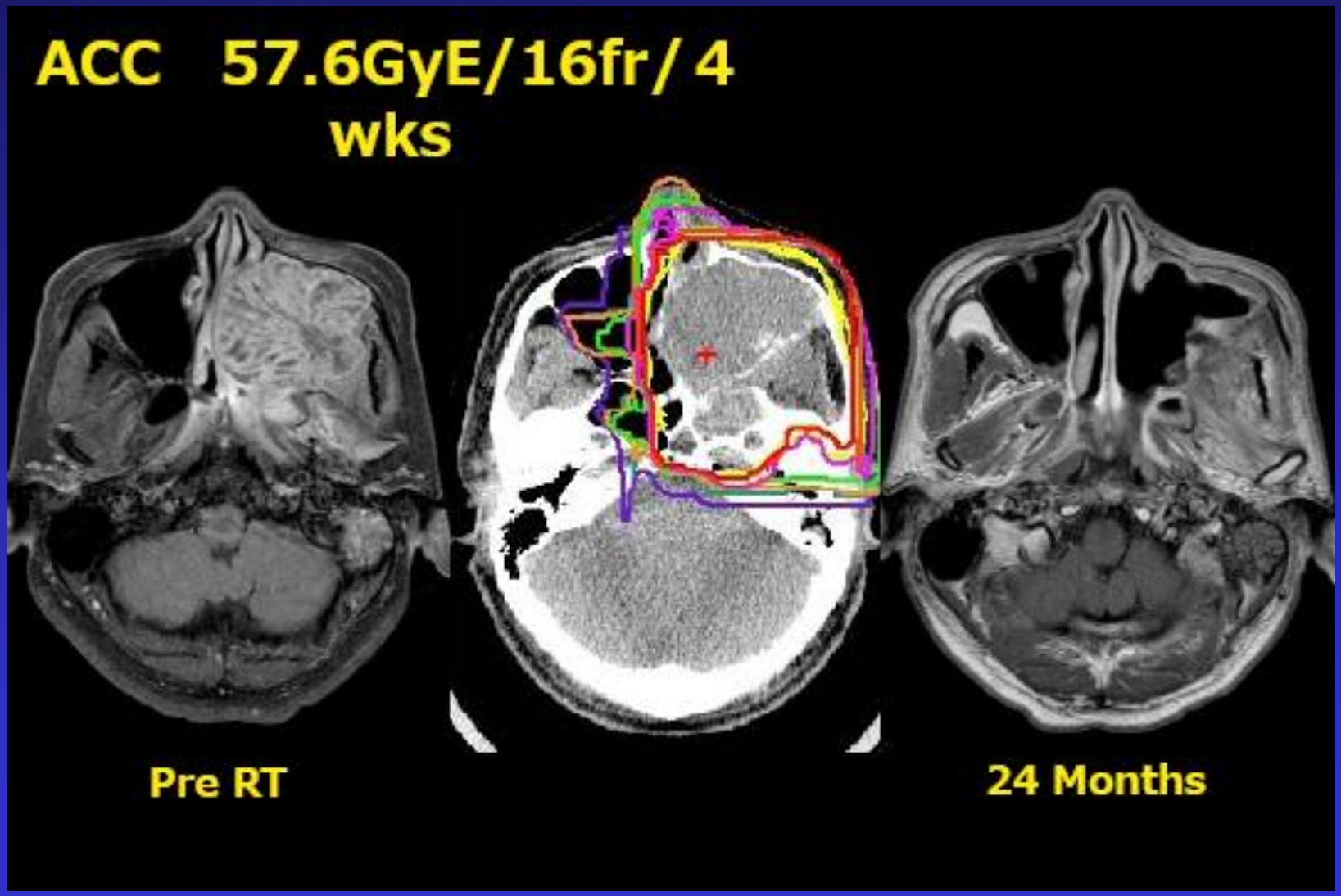
4 years

4 years

4.5 years



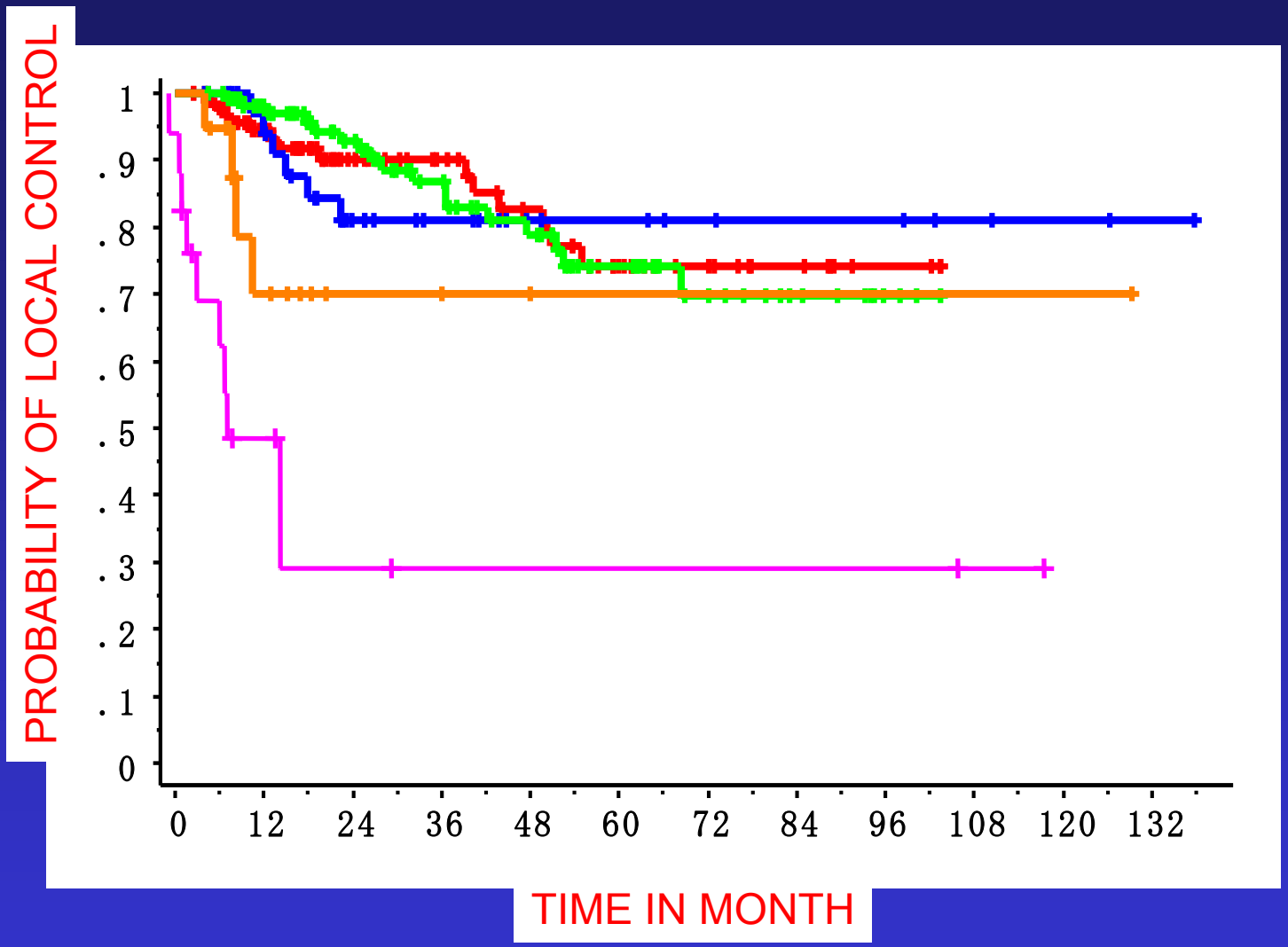
Carbon ion RT at NIRS



Histology/Site	ParaNasal Sinus	Nasal Cavity	Salivary Gland	Oral Cavity	Orbita	Pharynx	Thyroid	Ears	Others	Total
Adenoid Cystic Carcinoma	32	12	19	22	15	17		3		120
Malignant Melanoma	27	51	2	12	7	3		0		102
Adenocarcinoma	13	6	6	2	7	4		2		40
Squamous Cell Carcinoma	6	1		3	1	4		4		19
Papillary Adenocarcinoma	1			1			11			13
Mucoepidermoid Ca.	2	1	5			3				11
Osteosarcoma	3					1			2	6
Acinic Cell Carcinoma			6							6
Undifferentiated Carcinoma	1				4					5
Others	6		4	3	4	4			6	27
Total	91	71	43	43	38	36	11	9	7	349

T3: 53 (14.3%); T4: 151 (43.0%)

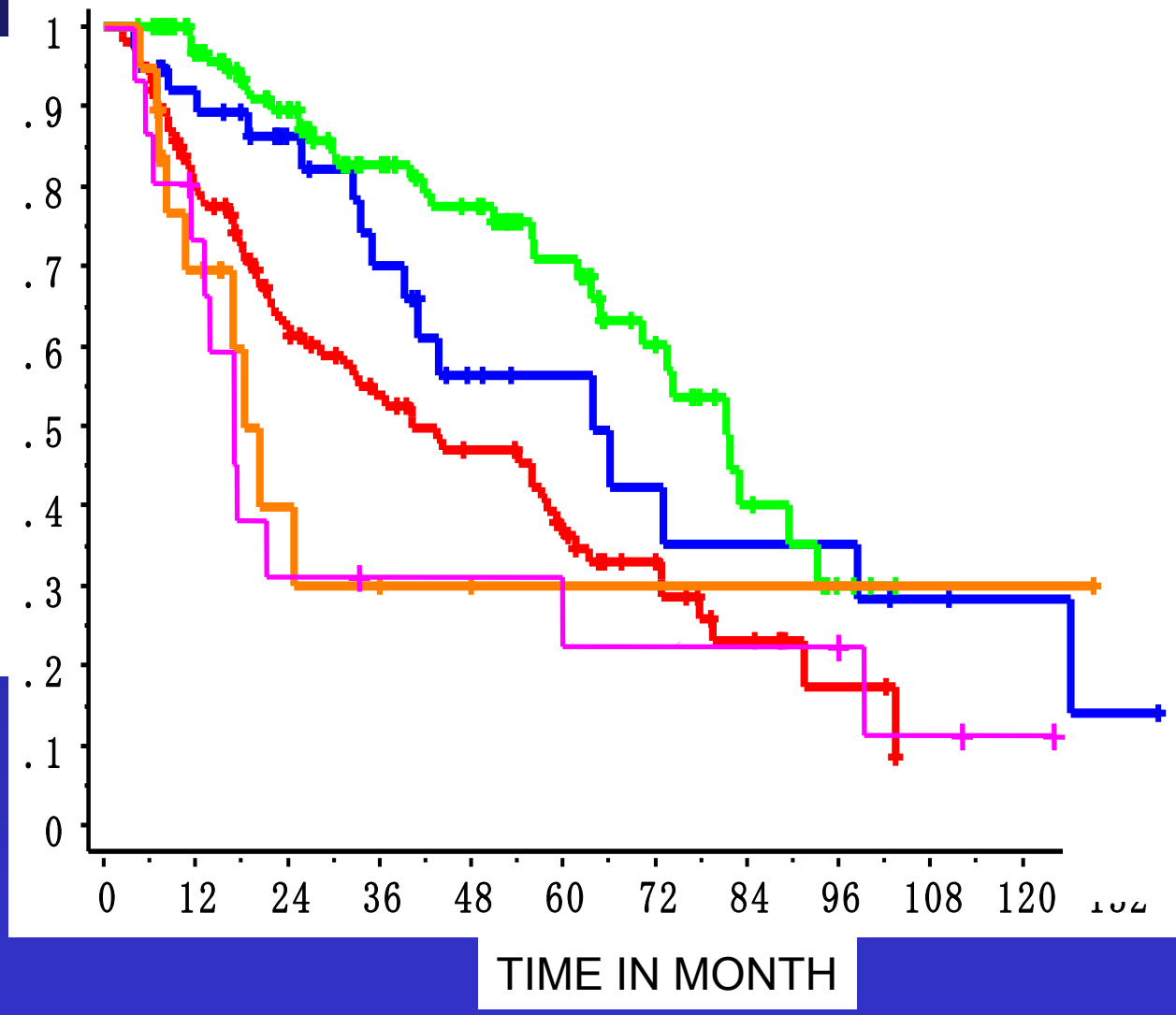
9602 All cases (325patients, 328 sites)



5-Year LC Rate
ADENO (38)
81%
ACC (107)
74%
MMM (100)
74%
SCC(19)
70%
Sarcoma (17)
29%

9602: Local Control by Histology

9602 All cases (325patients, 328 sites)



5-Year OS

ADENO (38)

56%

ACC (106)

68%

MMM (100)

36%

SCC(19)

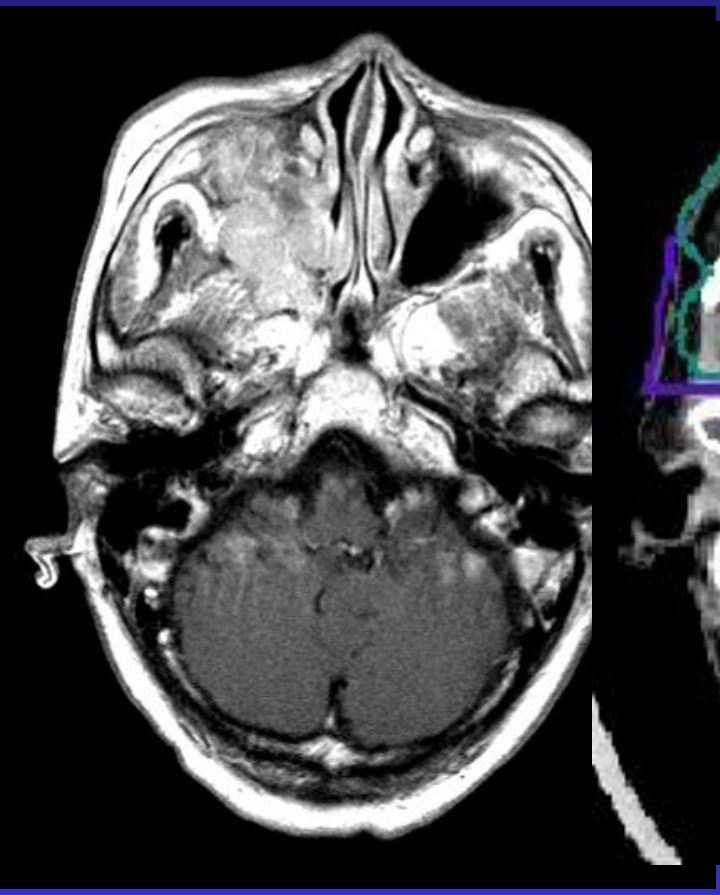
30%

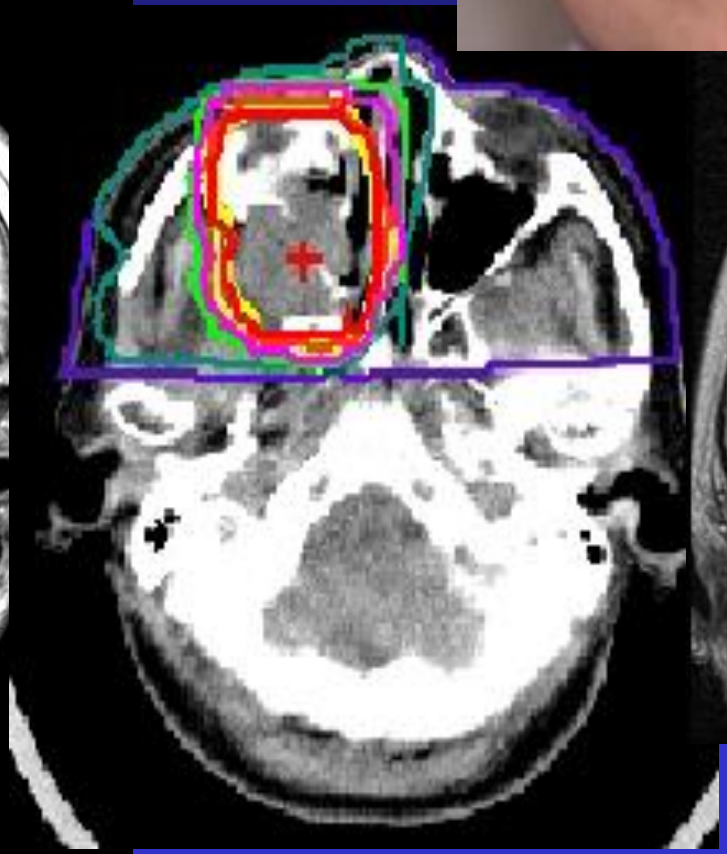
Sarcoma (17)

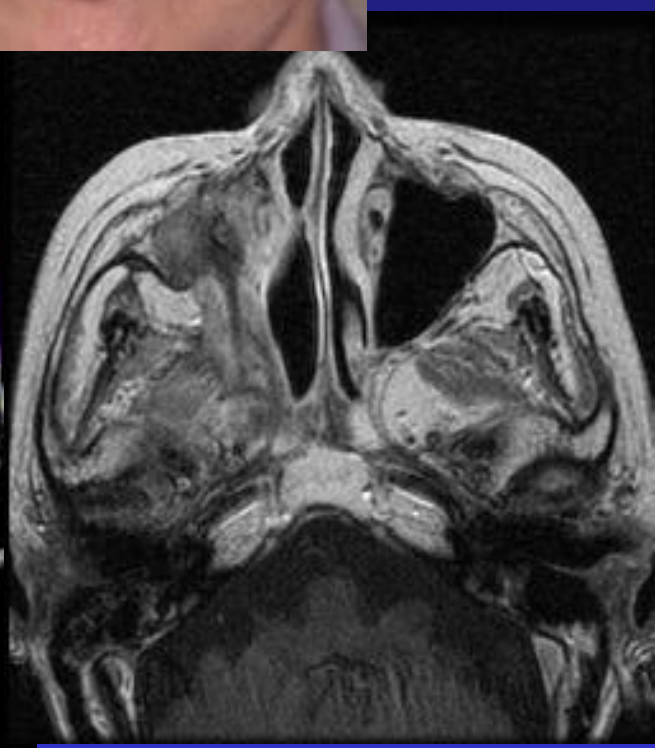
30%

9602: Survival by Histology

Hemangiopericytoma

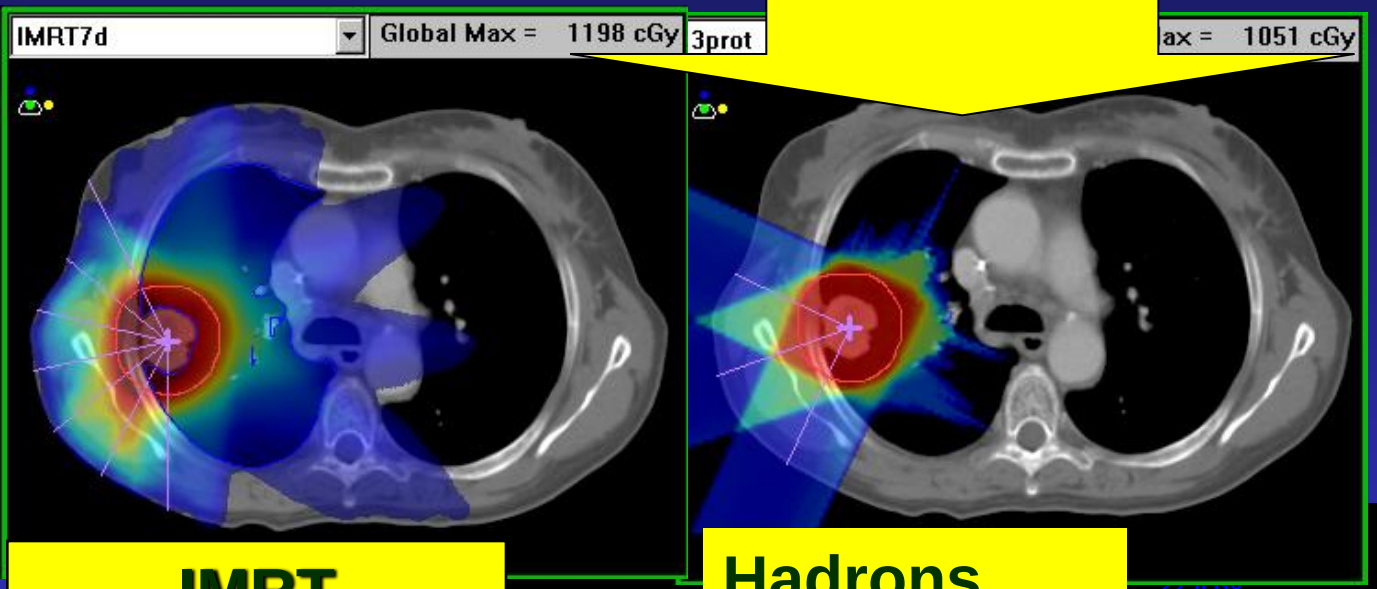






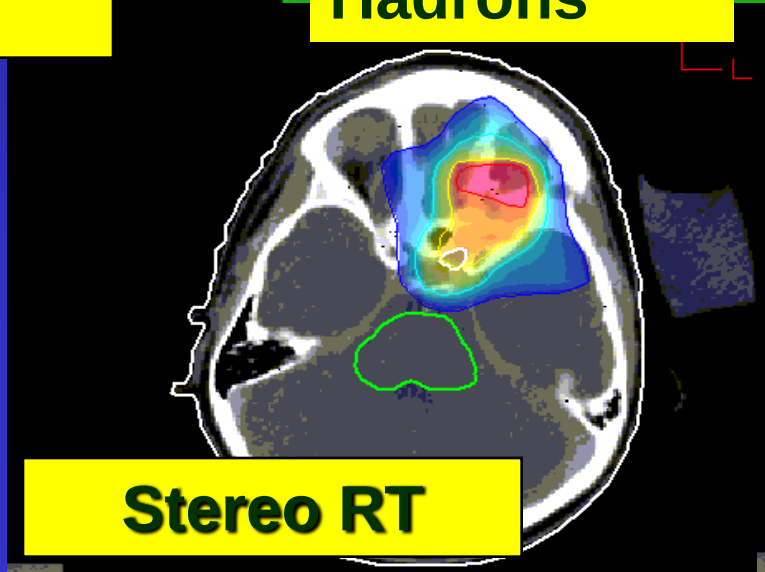
Pre RT | 70.4 GyE/16f./4 wks | 5 years

Other endpoints in Results

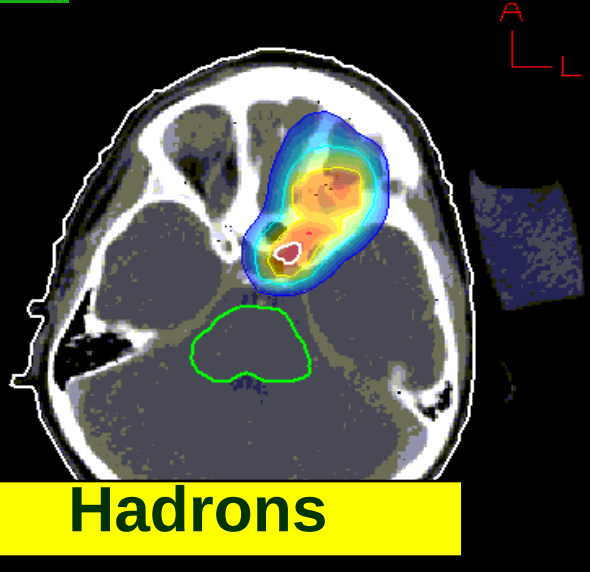


IMRT

Hadrons



Stereo RT

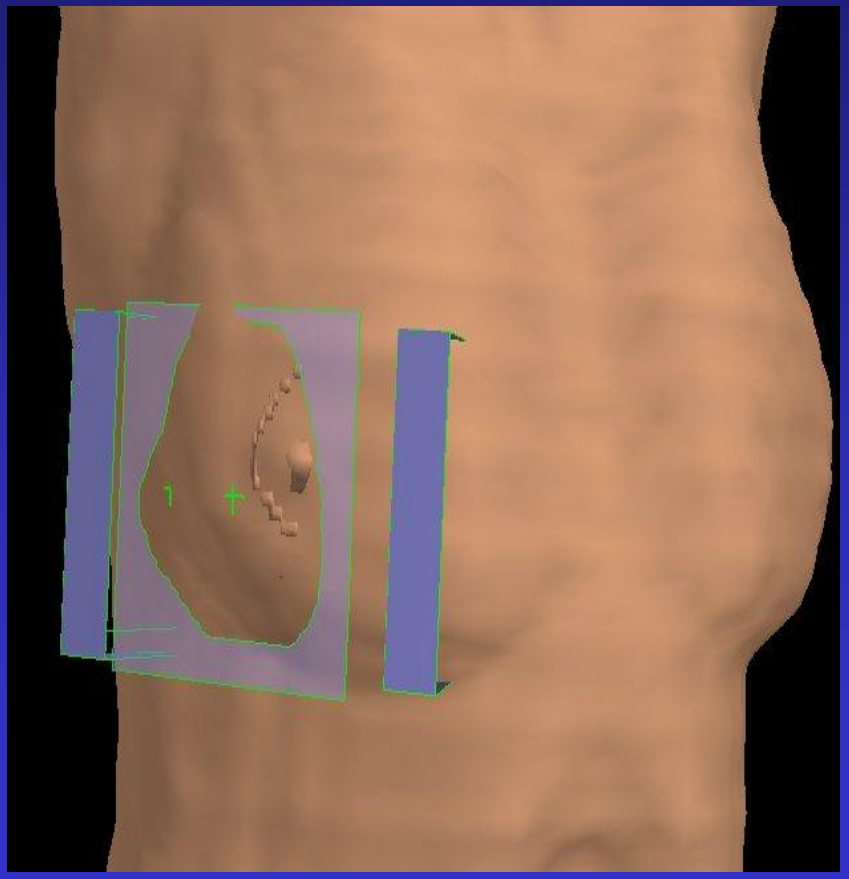


Hadrons

COMPARISON

APBI: Protons

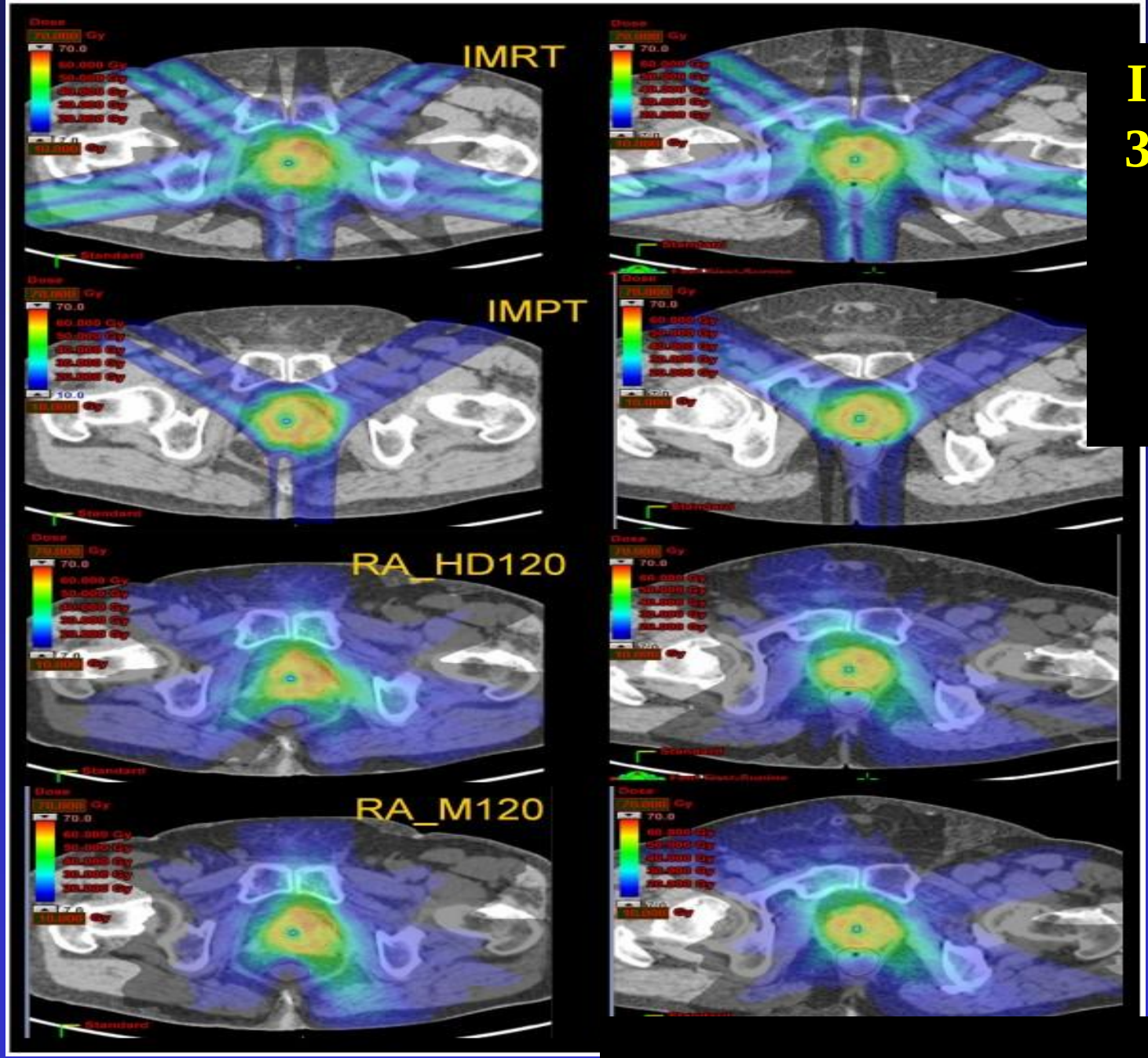
APBI: Photons / Electrons
MGH technique



Comparison between APBI using Protons vs Photons/electrons technique
Doses to **HEART**

	3 D photons/e	3D protons	P-value
Max dose (Gy)	5.3	2.9	0.0001
Mean dose (Gy)	0.3	0.04	0.0001
D20 (Gy)	0.4	0.0	0.0001
D10 (Gy)	0.7	0.0	0.0001
D5 (Gy)	1.1	0.1	0.0001

D20 → Dose received by 20% of the tissue



Integral Dose 3 times higher for all photon's techniques

Weber DC et al, Radiat Oncol, 2009; 4:34

Chung CS et al (Harvard & MGH, Boston).

Comparative analysis of second malignancy in patients treated with proton therapy versus conventional photon therapy.

50 th ASTRO Meeting, Boston, 2008

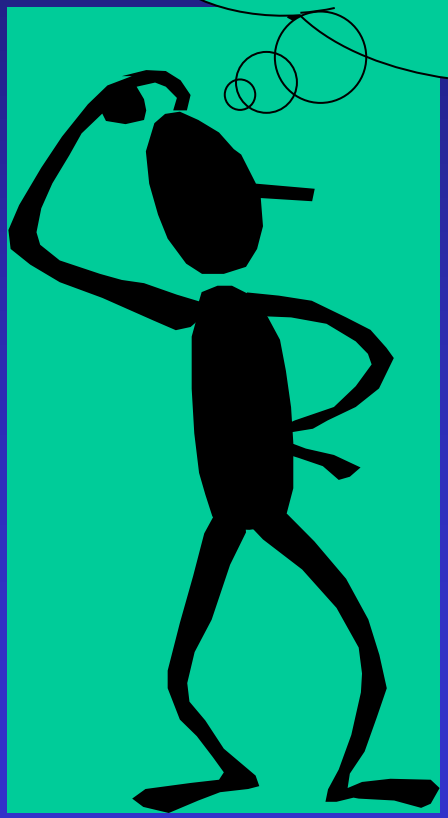
" treatment with photon therapy was significantly associated with an increased risk of a second malignancy (1.87 to 3.98, p<0.0001)"

Hadrontherapy:

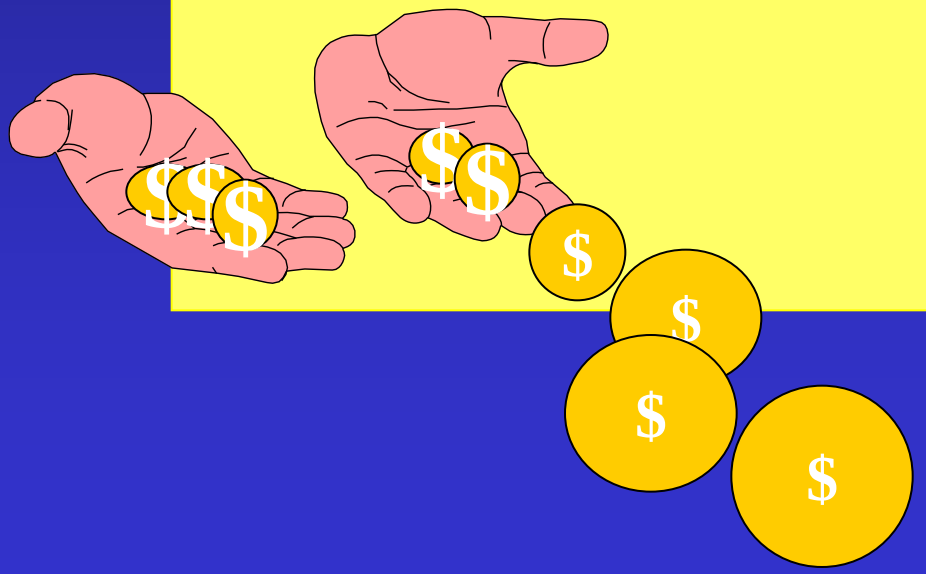
Cost?

Yes, it's fine!

But too expensive



Hadrons



Radiother Oncol. 2010 Jan 25. [Epub ahead of print]

How costly is particle therapy? Cost analysis of external beam radiotherapy with carbon-ions, protons and photons.

Peeters A, Grutters JP, Pijls-Johannesma M, Reimoser S, De Ruysscher D, Severens JL, Joore MA, Lambin P.
Maastricht Radiation Oncology (MAASTRO Clinic), The Netherlands; Department of Clinical Epidemiology and Medical Technology Assessment, University Hospital Maastricht, The Netherlands.

PURPOSE: Particle therapy has potentially a better therapeutic ratio than photon therapy. However, investment costs are much higher. This study provides an estimation and comparison of the costs of these therapies.

METHODS: Within an extensive analytical framework capital and operational costs, cost per fraction, and four tumor specific treatment costs are calculated for three facilities: combined carbon-ion/proton, proton-only, and photon.

RESULTS: Capital costs for the combined, proton-only and photon facilities are: euro 138.6 million, euro 94.9 million, euro 23.4 million. Total costs per year are: euro 36.7 million, euro 24.9 million, euro 9.6 million. Cost per fraction is: euro 1128 (euro 877-1974), euro 743 (euro 578-1300), euro 233 (euro 190-407). Cost ratio particle/photon therapy is 4.8 for the combined and 3.2 for the proton-only facility. Particle treatment costs vary from euro 10,030 (c-ion: lung cancer) to euro 39,610 (proton: head & neck tumors). Cost difference between particle and photon therapies is relatively small for lung and prostate cancer, larger for skull-base chordoma and head & neck tumors

CNAO.
Estimated Cost per Cycle

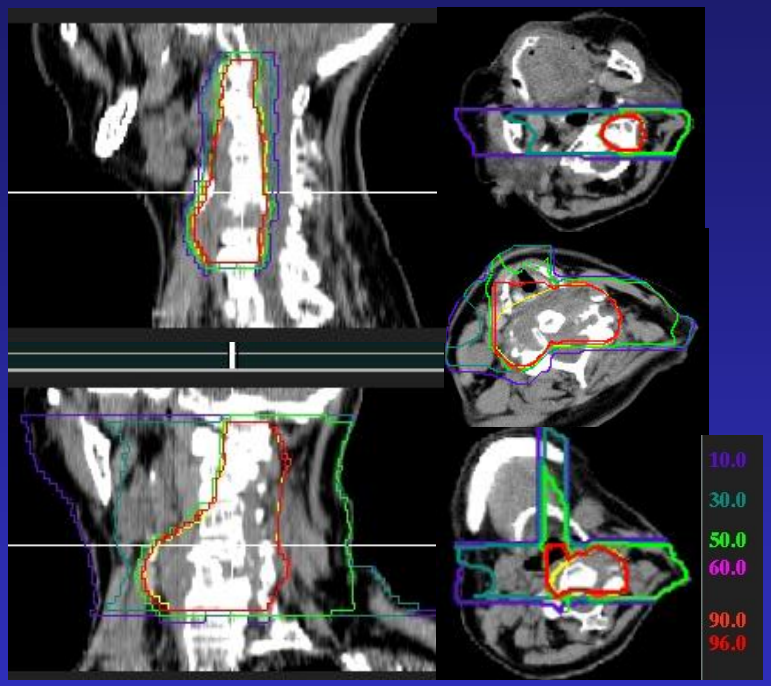
				Euro
Proton/C12 therapy				
Stereotactic	Reimbursement rate per patient (EUR)			16.500
Boost	Reimbursement rate per patient (EUR)			11.500
Entire cycle	Reimbursement rate per patient (EUR)			26.000

Only cost or cost-effectiveness?

Treatment		Treatment costs in €
Conventional photon RT	Treatment planning	1200
	Treatment delivery	2300
Carbon ion RT	Planning + delivery	20000
Neurosurgical resection	Surgery	11000
	Hospitalization	12600
Total costs for conv. RT		**27100**
Total costs for ion RT		**43600**

5-Year local control rate	Cost of primary therapy in €	Cost of recurrencies in €	Total costs in €	
			Scenario A	Scenario B
35% (conv. RT)	27100	52956	80056	-
50% (conv. RT)	27100	40735	67835	-
60% (Carbon RT)	43600	32588	76188	72188
70% (Carbon RT)	43600	24441	68041	64041

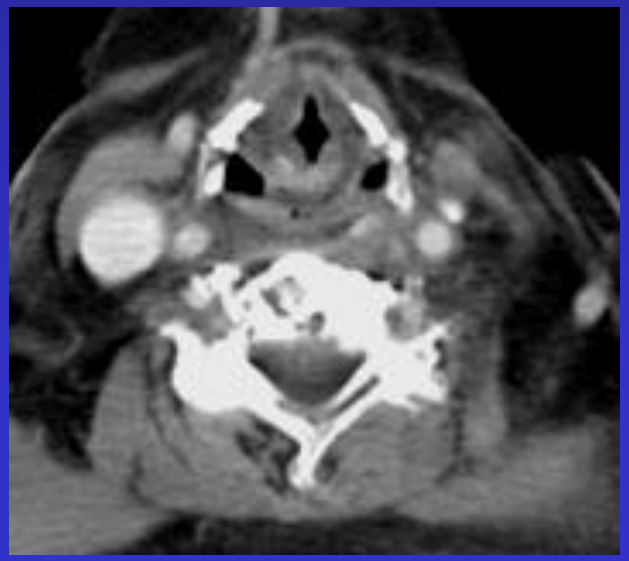
Sarcoma of the cervical spine



64 GyE/16 fx/4weeks
Patch technique

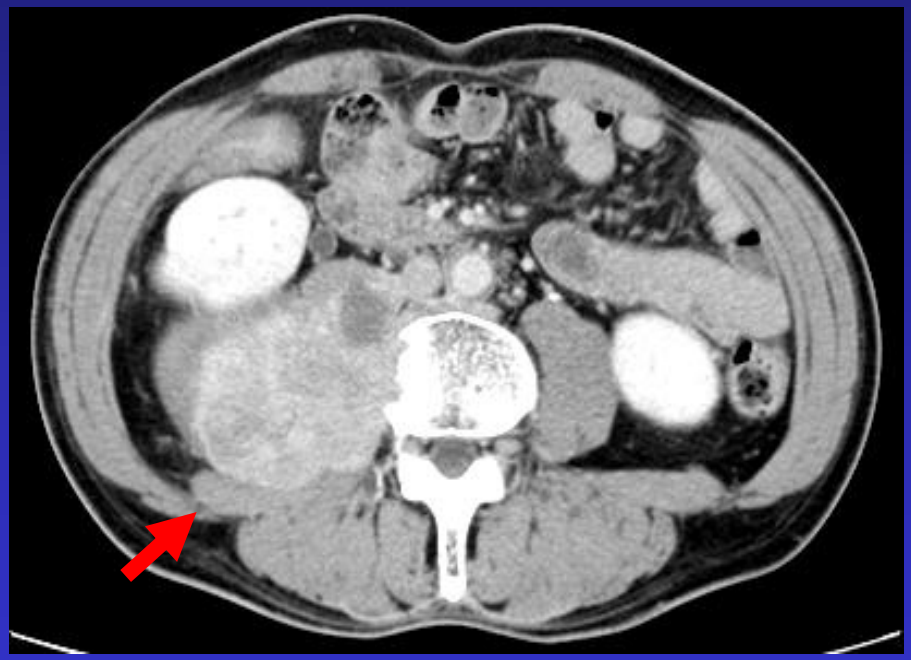
Before

7 years after

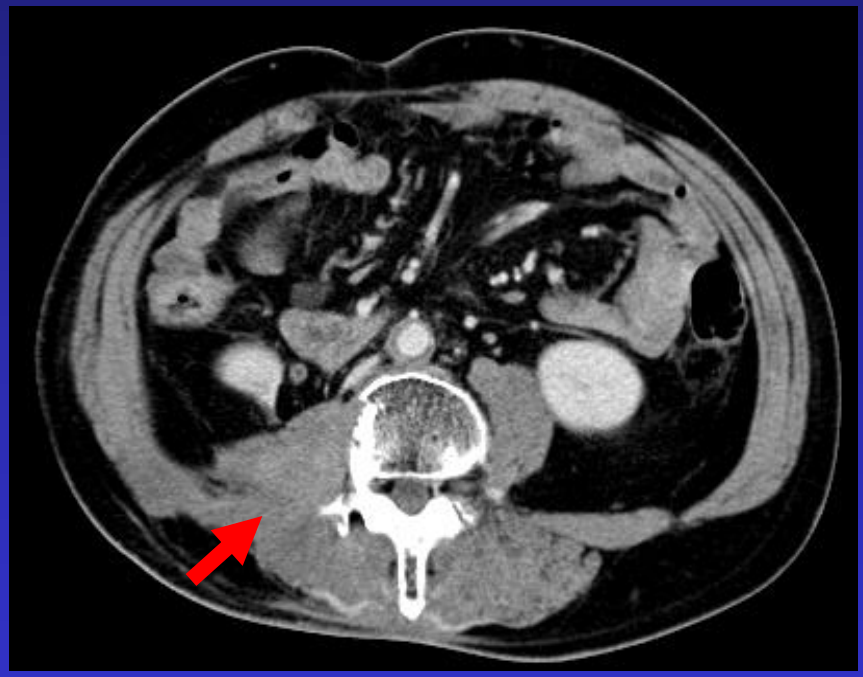


(Lancet Oncology 2006)

Retro-peritoneal rhabdomyosarcoma



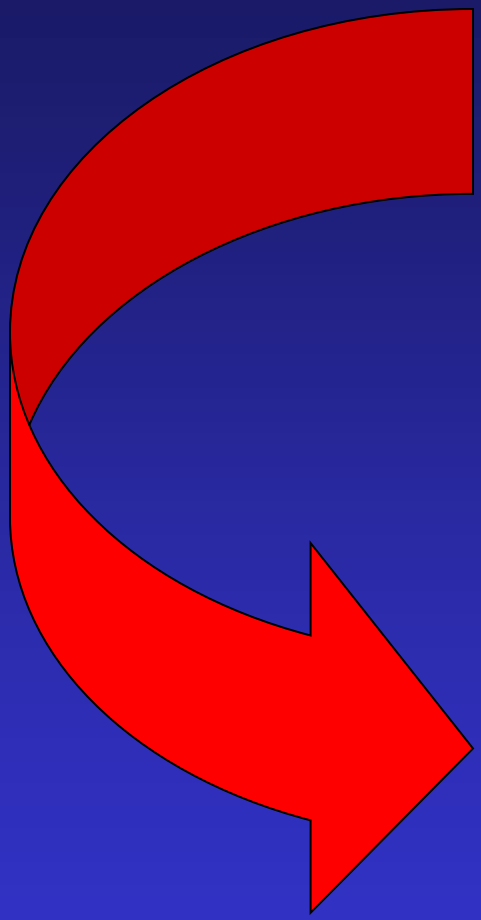
Before



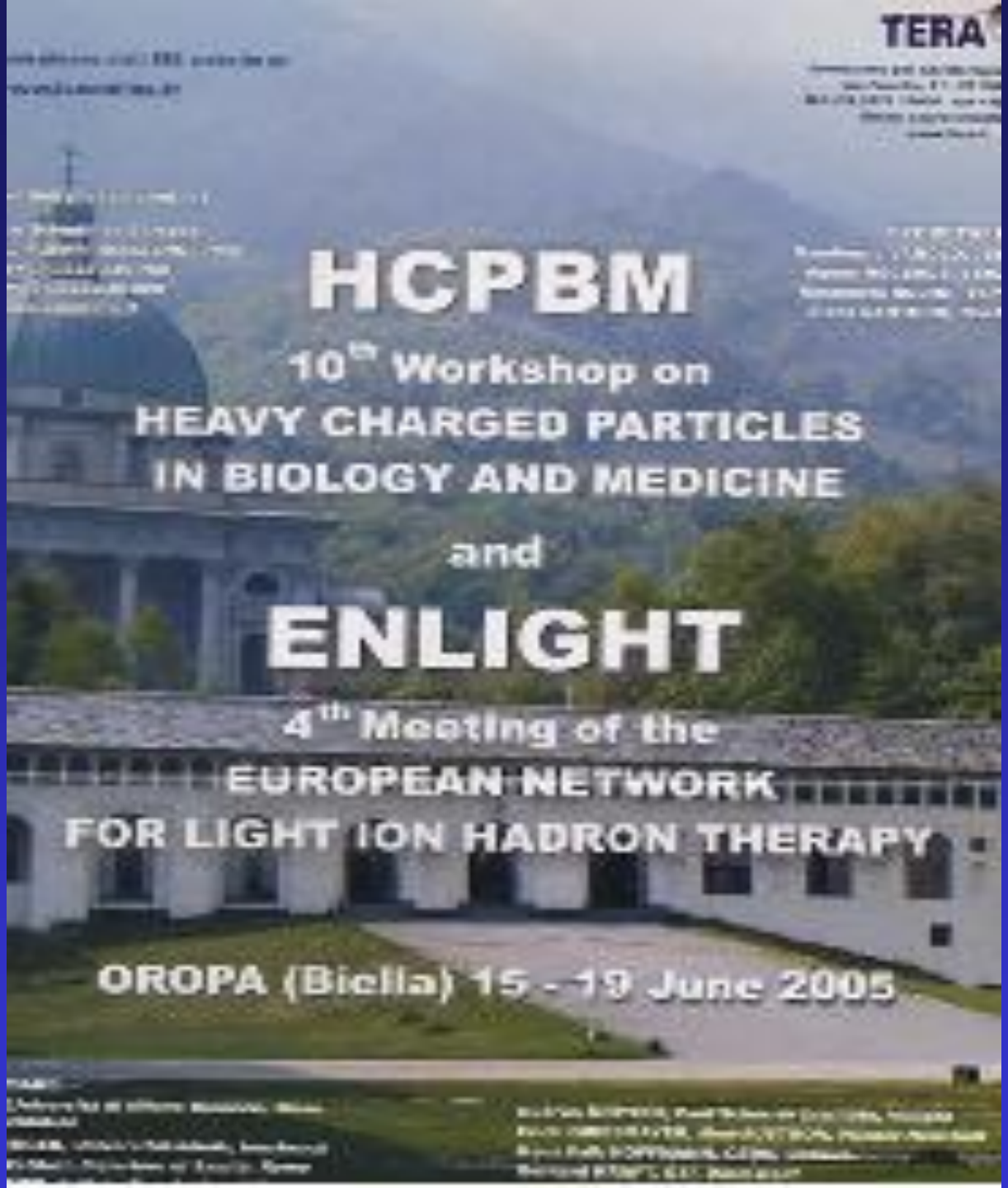
After 5 years

Conclusions

What we know today on hadrons?

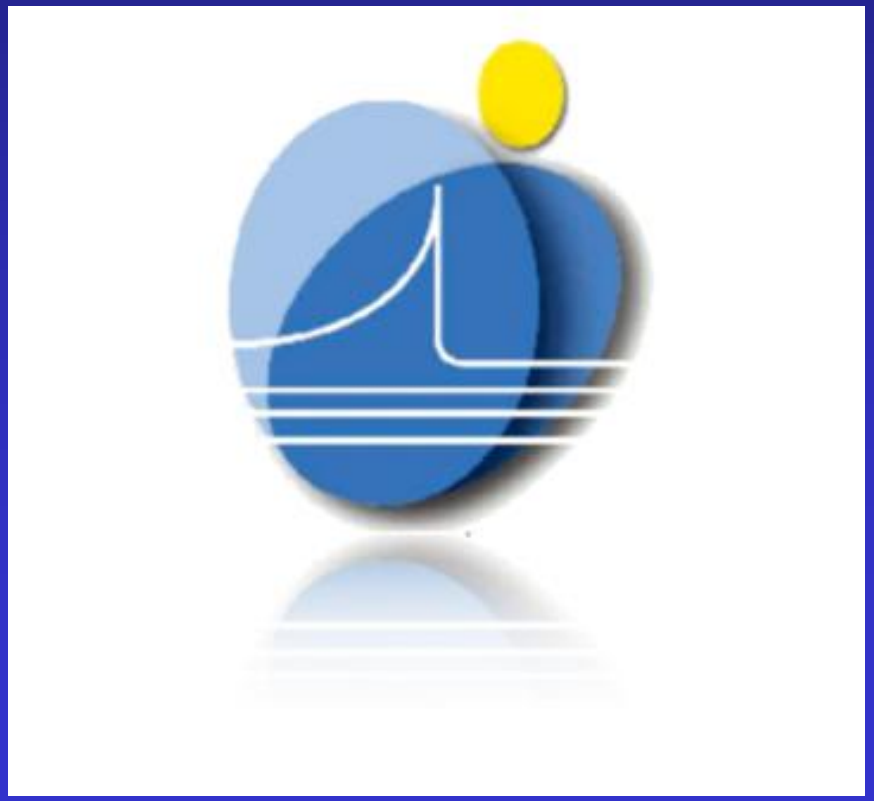


- Ideal dose distribution
- Excellent results in specific tumour sites
- Al least equivalent results in almost all cancer, including radioresistant tumours
- Less morbibdity, in principle


TERA
HCPBM
10th Workshop on
HEAVY CHARGED PARTICLES
IN BIOLOGY AND MEDICINE
and
ENLIGHT
4th Meeting of the
EUROPEAN NETWORK
FOR LIGHT ION HADRON THERAPY
OROPA (Biella) 15 - 19 June 2005

PARTNER

Particle Training Network for European Radiotherapy



ULICE

Union of Light Ion Centers in Europe

Envision

European NoVel Imaging Systems for ION therapy

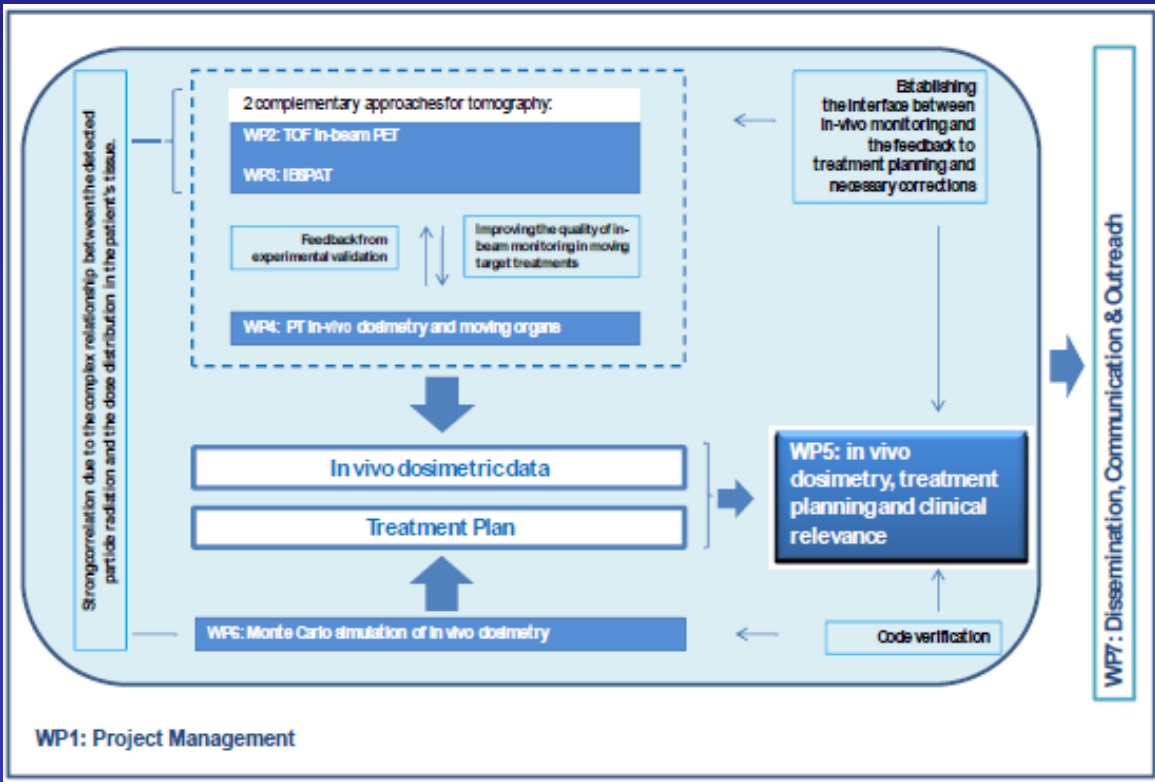
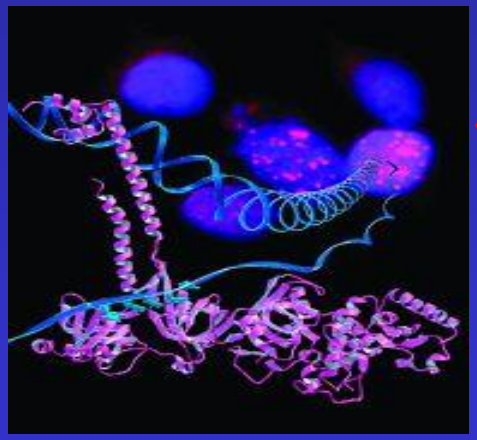


Figure 5: Structure of ENVISION activities and interlinkage between WPs

Therapy on individuals



Thank you very much for your attention !!!!!