ОТ НАУКАТА КЪМ СЪВРЕМЕННАТА МЕДИЦИНА

(ПРОТОННА ТЕРАПИЯ)

Bulgarian Teaching Programme
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Genève, Switzerland

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РАДИОТЕРАПИЯ
(Терапия с йонизиращи лъчения)

Основна цел:
Ликвидиране на жизнеспособността на туморните клетки в даден орган или система на човешкото тяло чрез аплициране на необходимата канцерицидна доза при минимално облъчване на заобикалящите Областта подлежаща на Лъчелечение /ОПЛЛ/ здрави органи и тъкани.

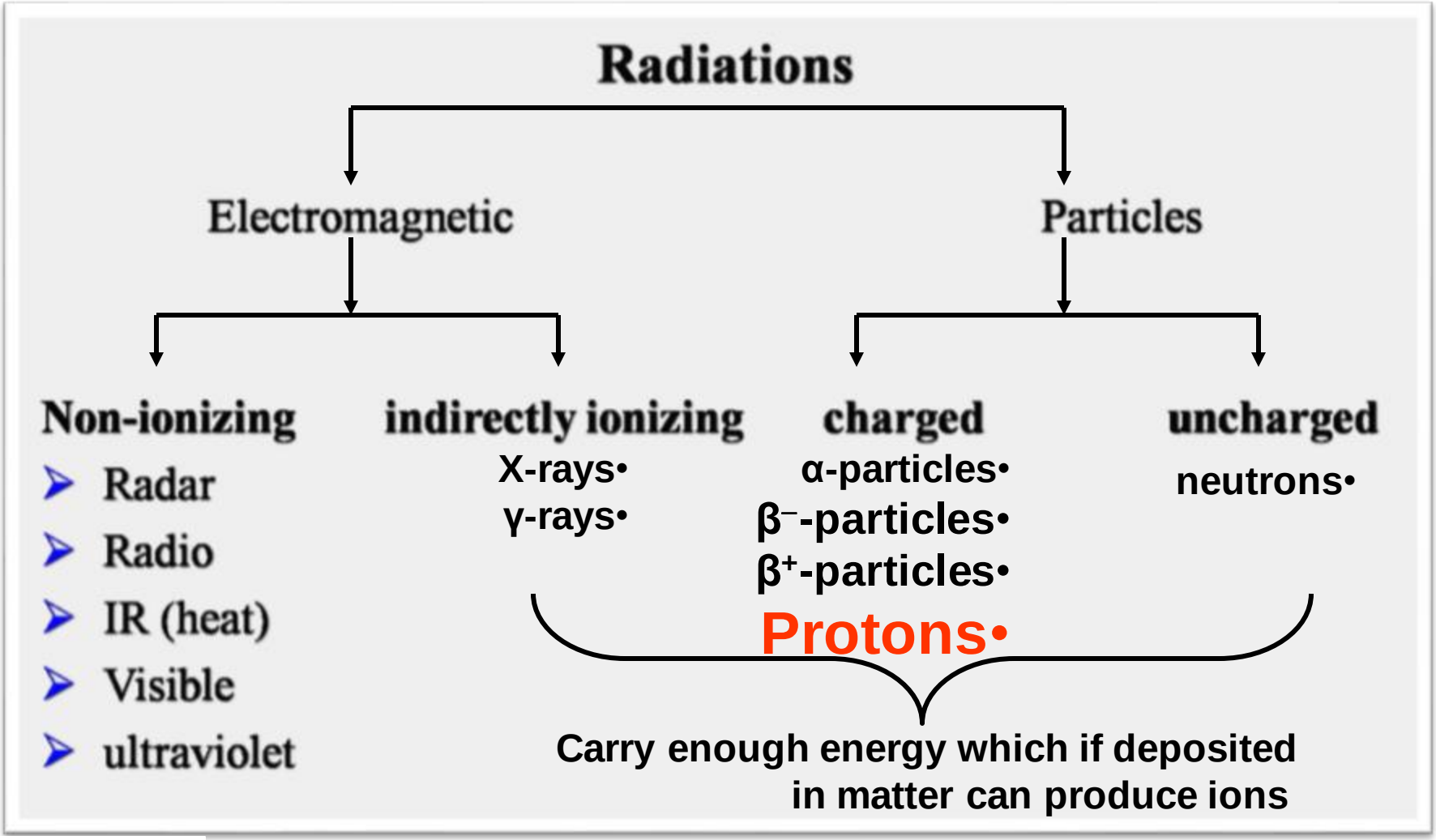
Постигане унищожаването на туморния процес без да се причиняват увреждания на организъм.

Хирургия

РАДИОТЕРАПИЯ

Химиотерапия

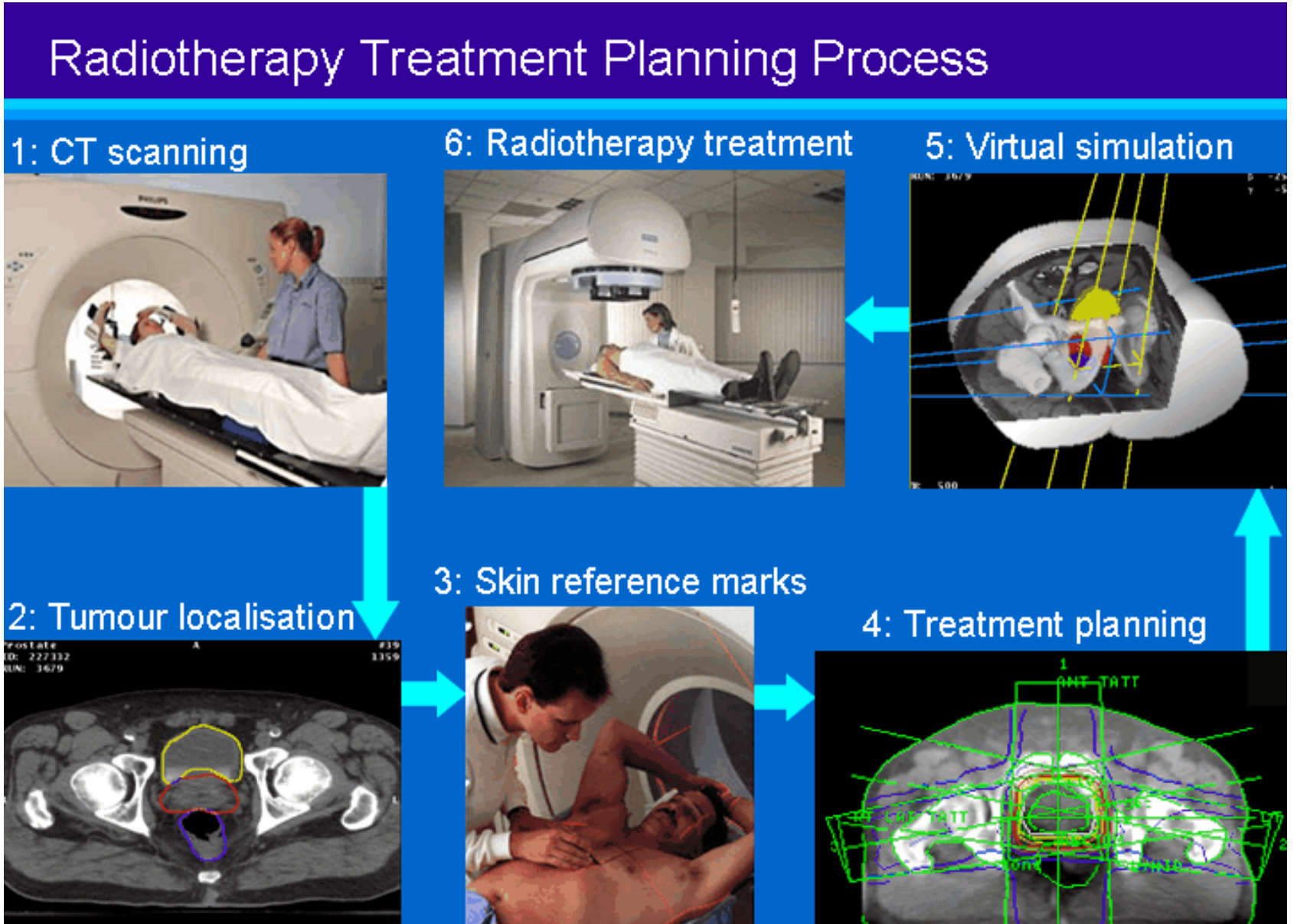
Видове Йонизиращи Лъчения



История на Радиотерапията

1895 - Откриване на X лъчи - Vilhem K. Roentgen.
1898 - Откриване на Radium – Maria Curie.
1928 - H&N Cancer клинични резултати.
1950 - Начало на радиотерапията с γ лъчи (Co-60).
1954 - Начало на протонната терапия at Berkeley.
1961 - Linear Accelerator (LINAC) at Standford, USA
1968 - Gamma - knife radio surgery at Uppsala, Sweden
1971 - Copmuted Tomography.
1980 - Multi Leaves Collimator (MLC).
1988 - Intensity - Modulated Radiotherapy (IMRT).
2000 - Image Guided Radiotherapy (IGRT).

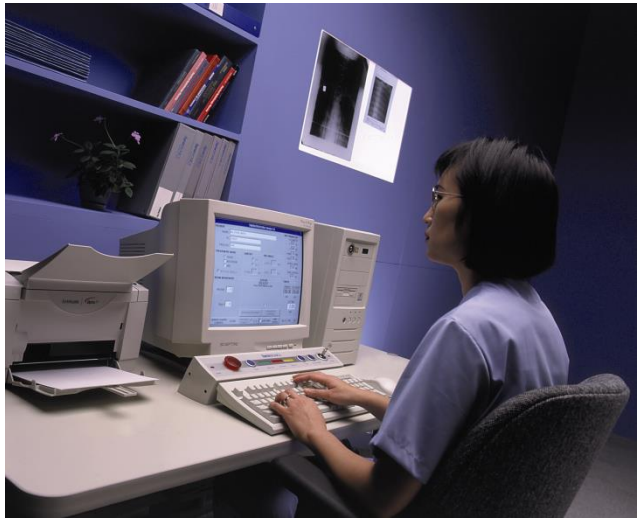
РАДИОТЕРАПИЯ

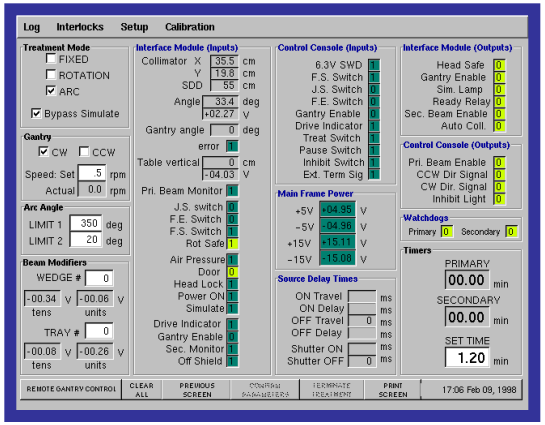


1996 -"Theratronics"

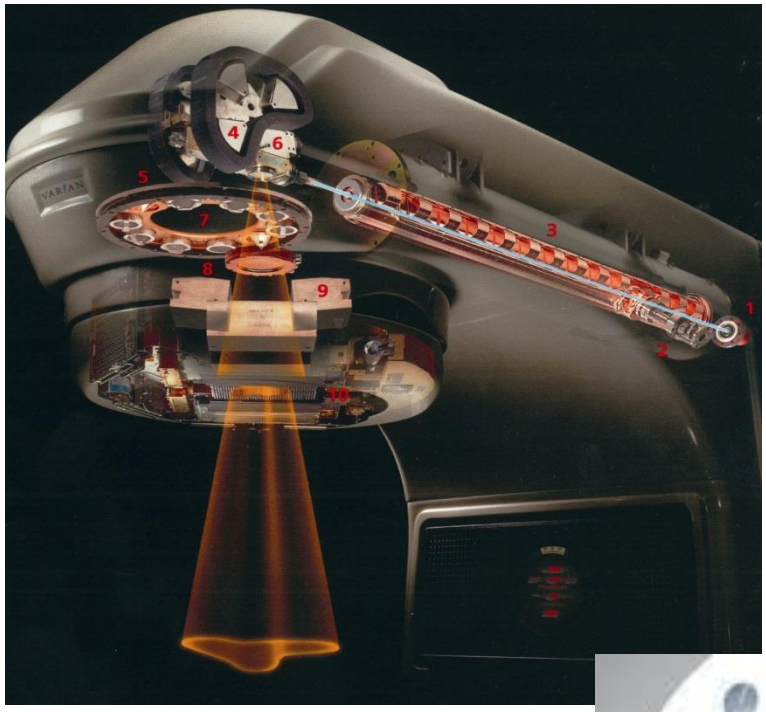
50 години борба с рака

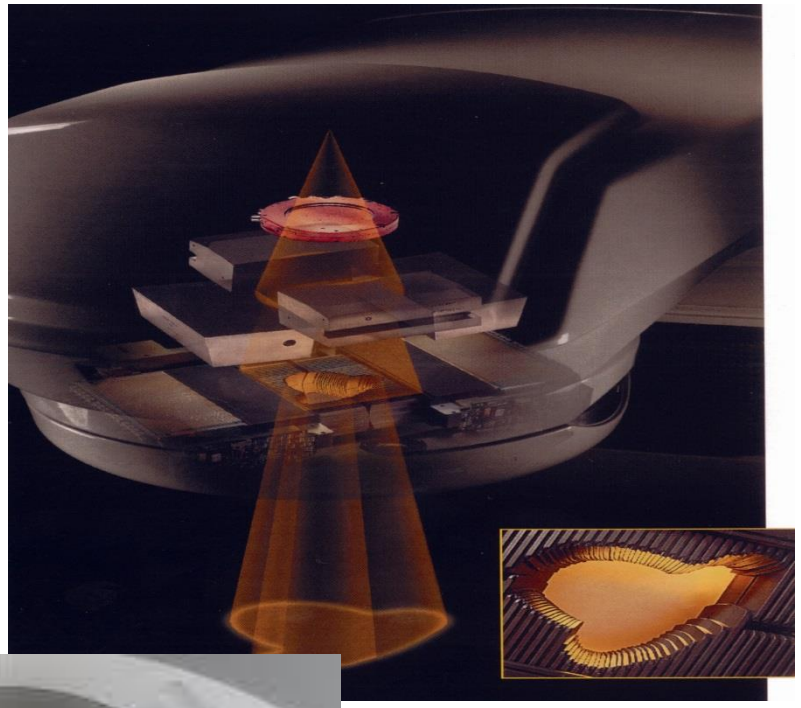
(първият апарат за радотерапия) "THERATRON"





Линеен Ускорител с МЛС

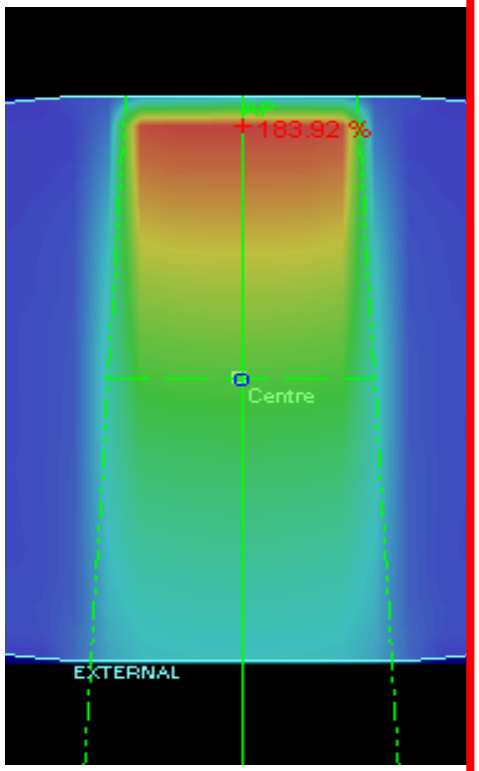


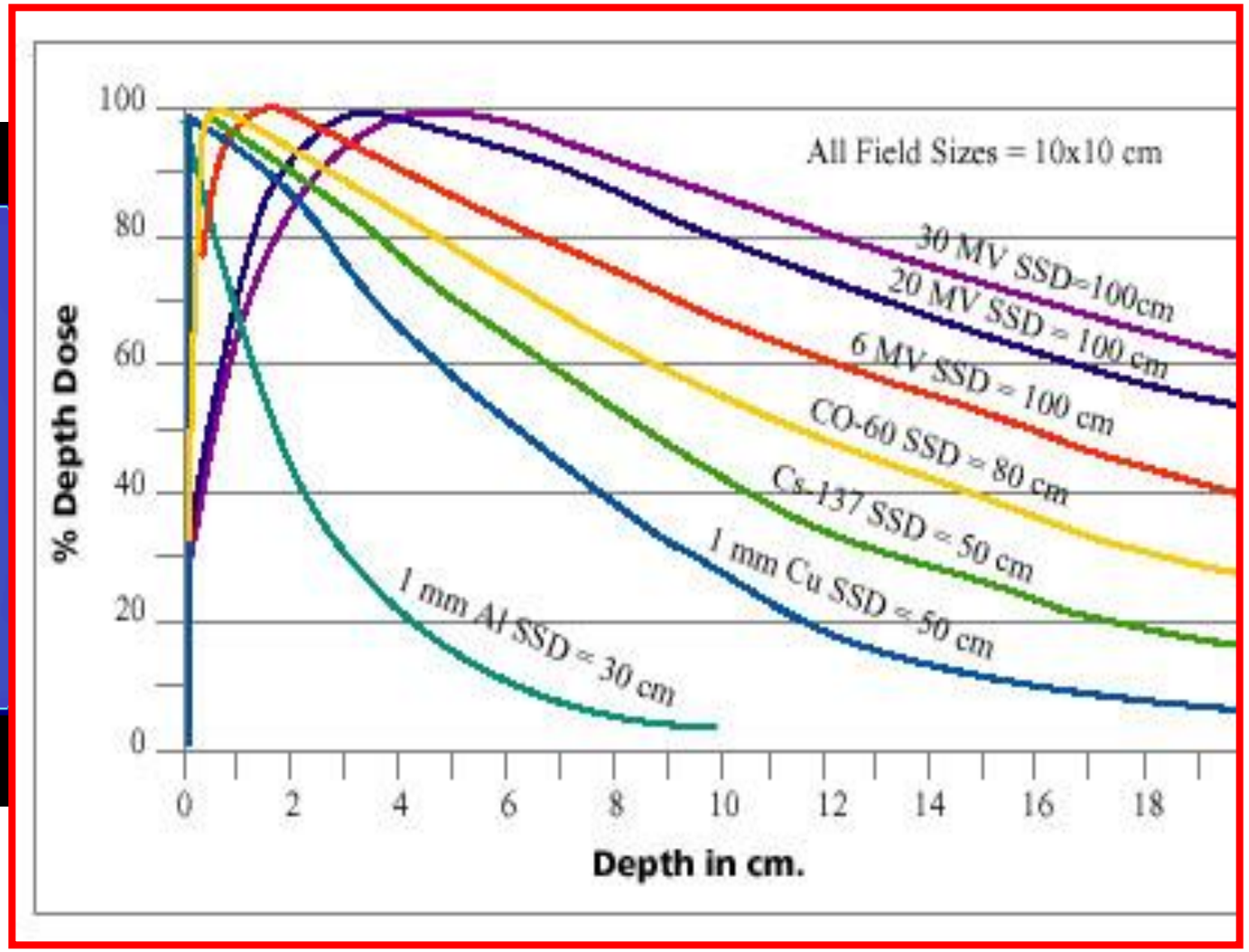


Съвременна радиотерапия с **X rays**

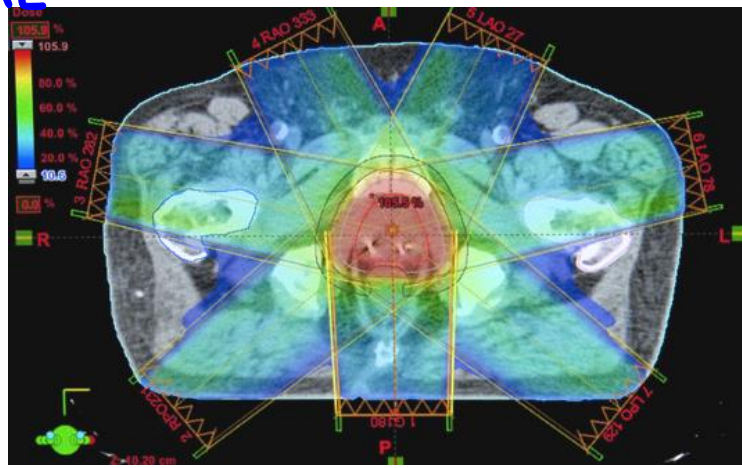
VARIAN Linac
X rays

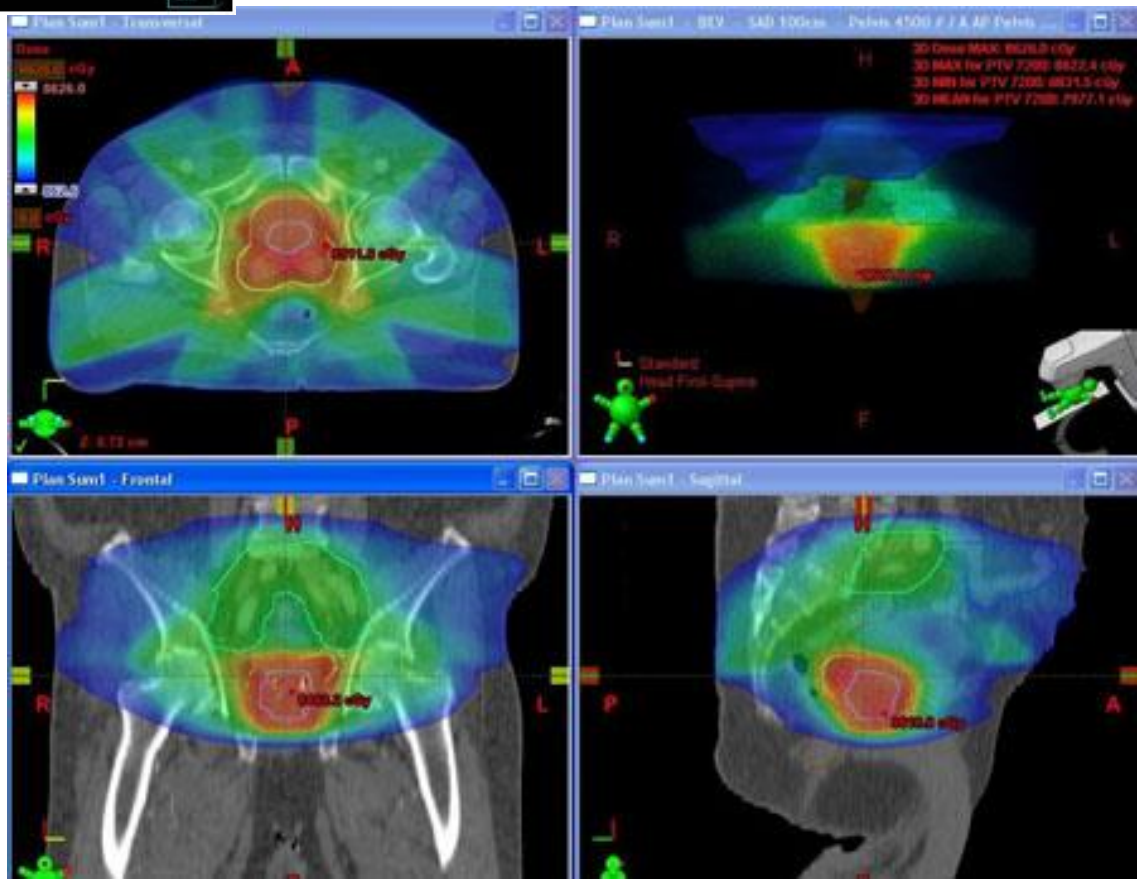
Проникватална способност на фотонните лъчения в зависимост от Енергията



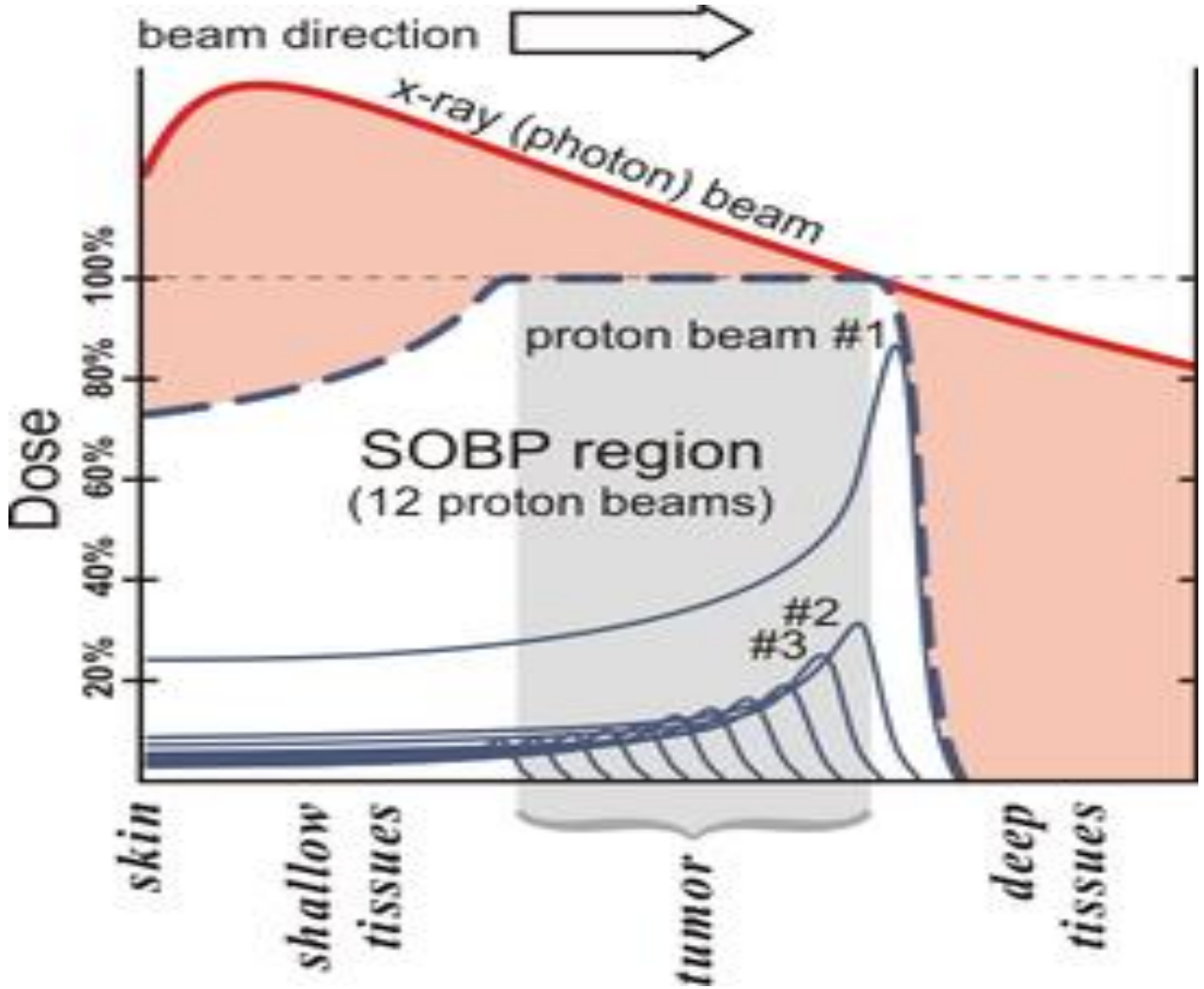


РАДИОТЕРАПИЯ при CA GL. PROSTATAE

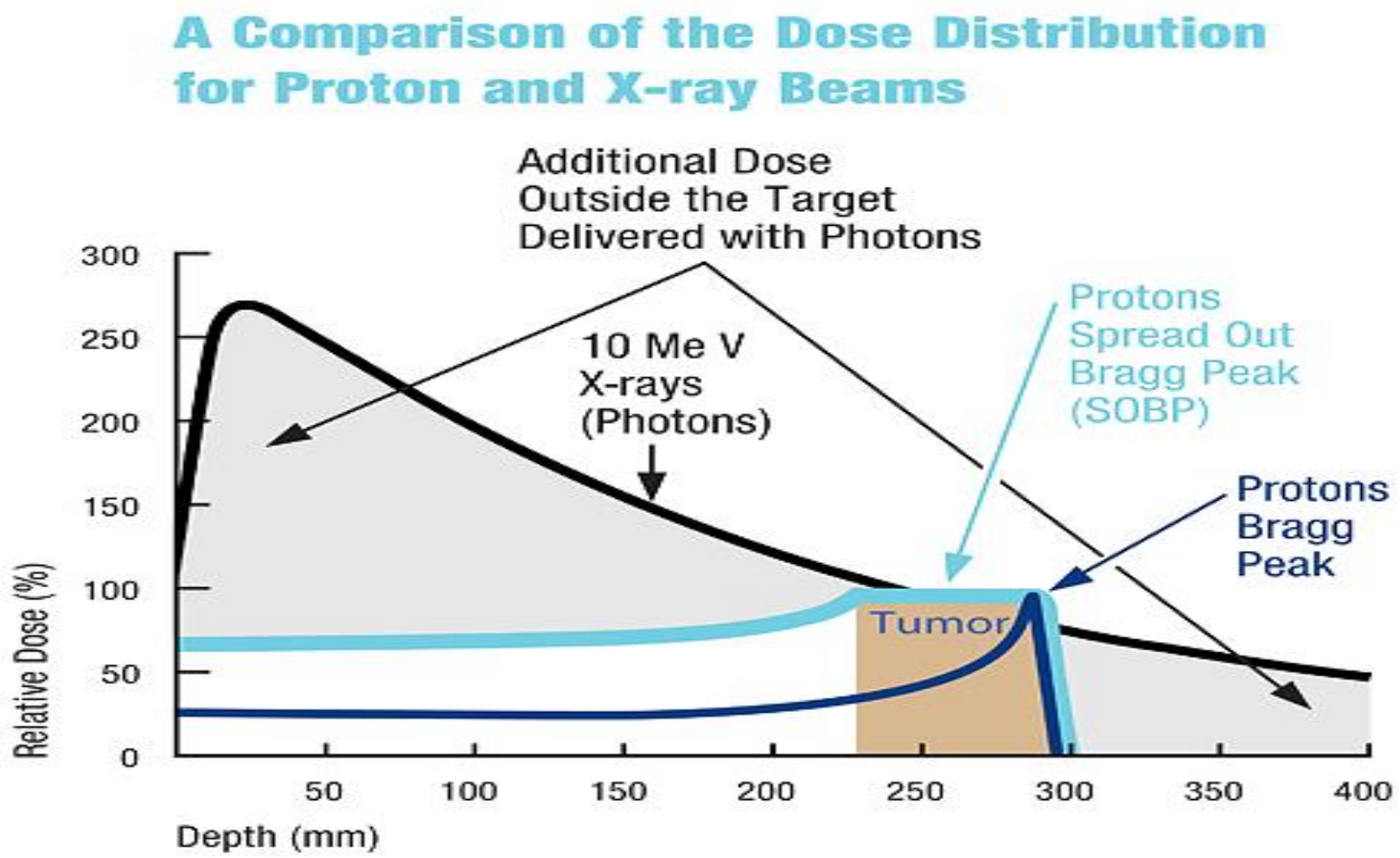




ЗАЩО ПРОТОННА ТЕРАПИЯ? ? ?



ЗАЩО ПРОТОННА ТЕРАПИЯ? ? ?



Физични аргументи за използването на протонните снопове в радиотерапията

- обратен профил на дозното разпределение в дълбочина т.е. увеличава се предадената енергия с проникването в дълбочина (явлението Bragg peak)

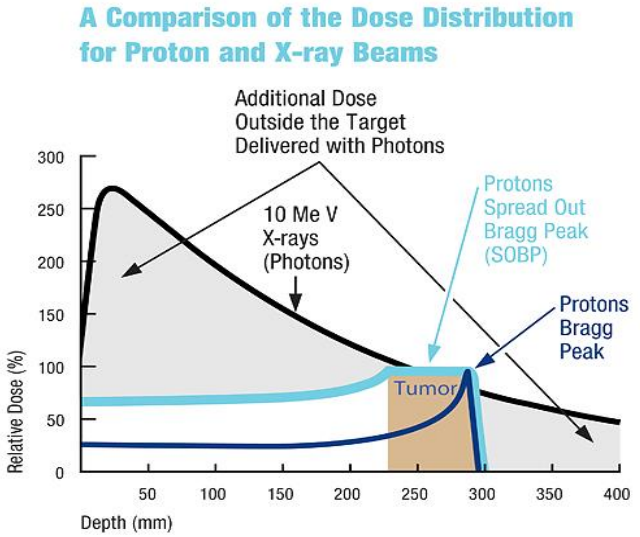
- **ниска йонизационна способност**

- **енергетично модулиране на Bragg peak – получаване на (Spread-out Bragg Peak)**

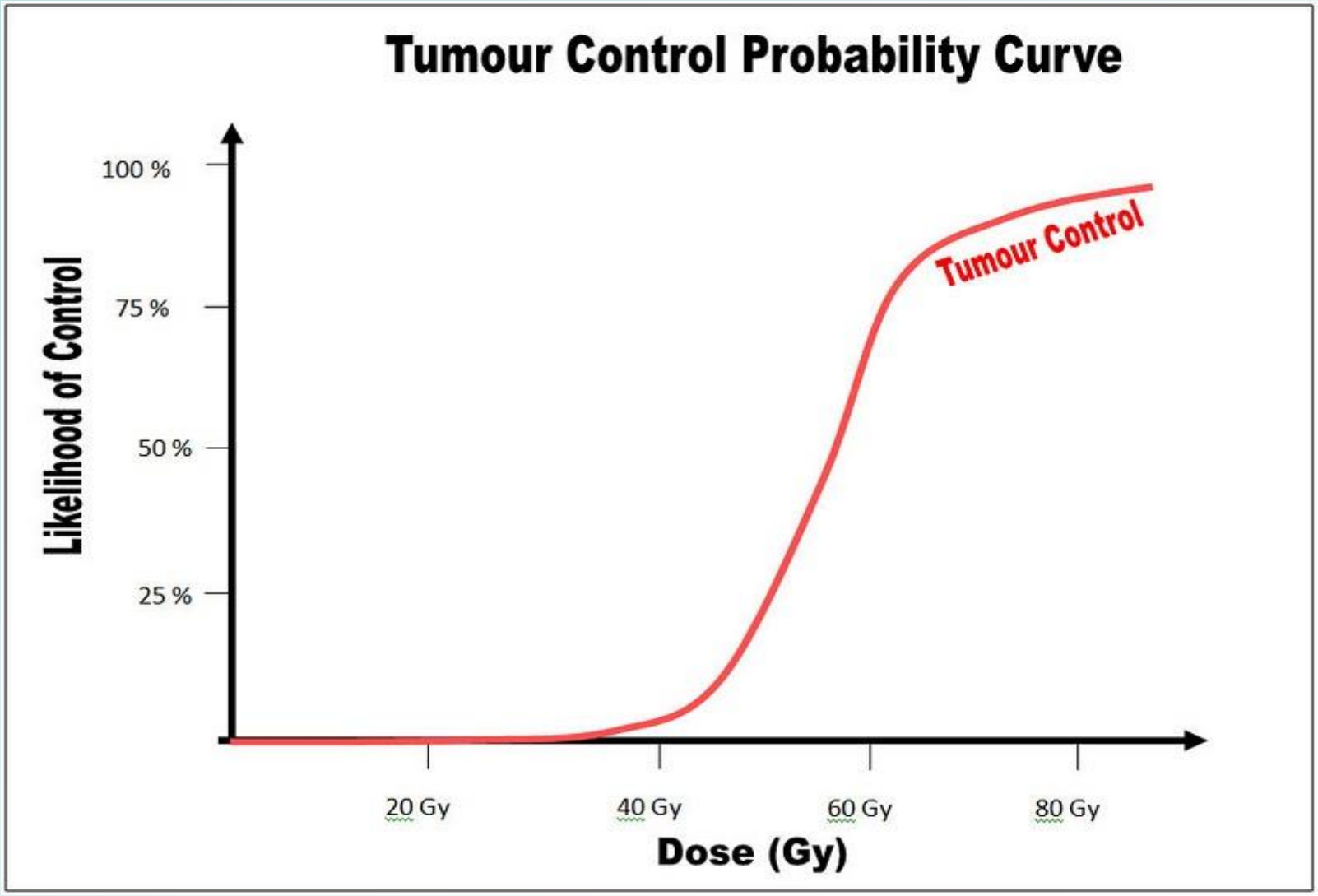
- значително запазване на кожния ефект

- тясна полусянка

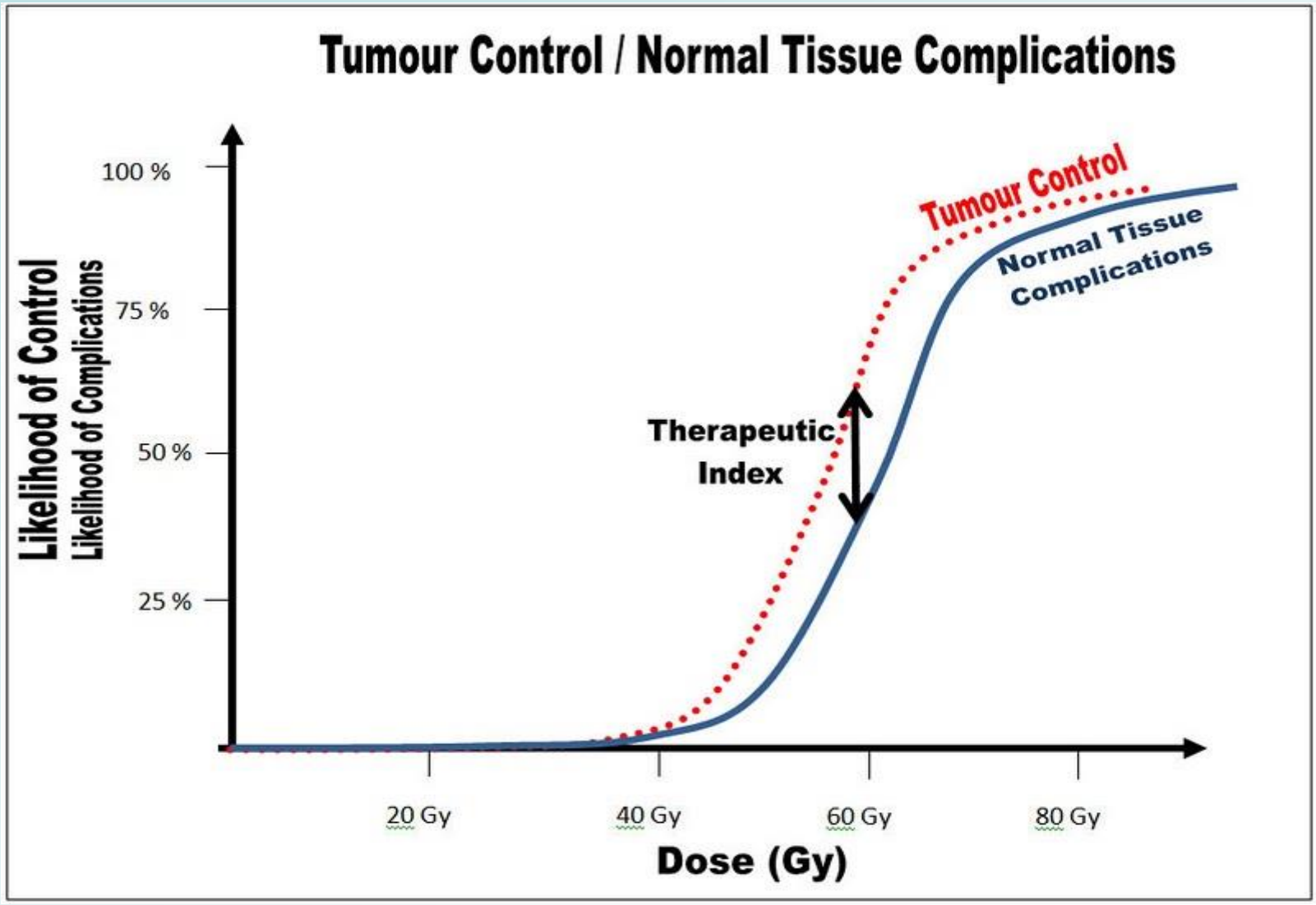
- здравите тъкани получават значително по-ниска доза от облъчвания туморен обем



Вероятност за туморен контрол (TPC)



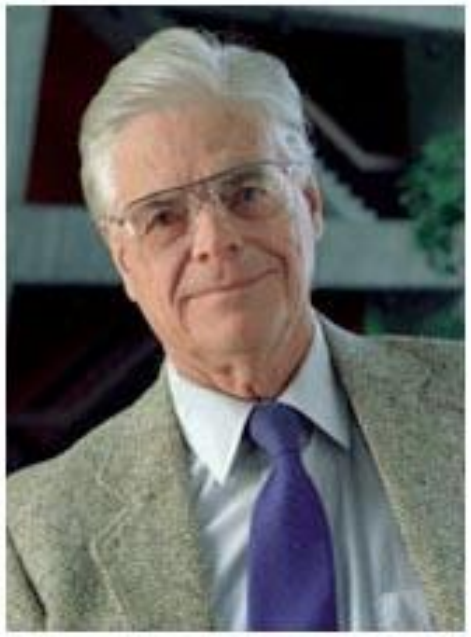
Вероятност за туморен контрол (TPC) и усложнения на здравите тъкани (NTPC)



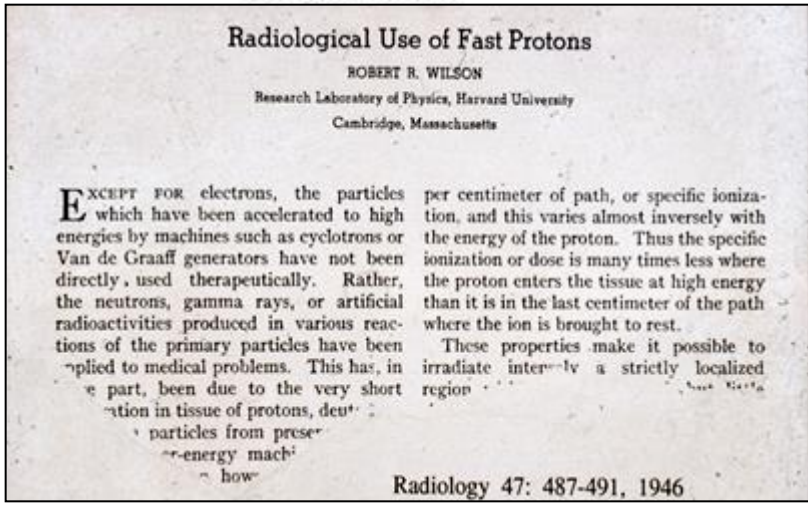
НАЧАЛО на ПРОТОННАТА ТЕРАПИЯ

"A man with a vision "

- 1946 - Prof.Robert Wilson - Harvard physicist.
- Протоните могат да имат клинично приложение.
- Максимална доза лъчение може да се реализира в дълбочина.
- Протонната терапия осигурява максимална защита на здравите тъкани.



Robert Wilson



Radiological Use of Fast Protons

ROBERT R. WILSON

Research Laboratory of Physics, Harvard University

Cambridge, Massachusetts

EXCEPT FOR electrons, the particles which have been accelerated to high energies by machines such as cyclotrons or Van de Graaff generators have not been directly used therapeutically. Rather, the neutrons, gamma rays, or artificial radioactivities produced in various reactions of the primary particles have been applied to medical problems. This has, in part, been due to the very short ...tion in tissue of protons, deu... particles from prese... ...-energy mach... ... how

per centimeter of path, or specific ionization, and this varies almost inversely with the energy of the proton. Thus the specific ionization or dose is many times less where the proton enters the tissue at high energy than it is in the last centimeter of the path where the ion is brought to rest.

These properties make it possible to irradiate inter...ly a strictly localized region ...

Radiology 47: 487-491, 1946

История на Протонната терапия (1)

1938 - *Неутронна терапия* at Berkeley Lab
(J. Lawrence and R.S. Stone)
1946 - Предложение за протонна терапия by Robert Wilson in Harvard Cyclotron Laboratory
1954 - Първо клинично приложение in Berkeley.
1957 - Начало на Европейският опит Uppsala, Sweden.
1968 - Протонна установка at JINR, Dubna, Russian Federation.
1969 - Протонна установка at Mosskow, Russian Federation .
1972 - Неутронна терапия at MD Anderson, USA.
1974 - pi meson beam at Los Alamos, USA.

История на Протонната терапия (2)

1975 - Протонен център at St. Petersburg,
Russian Federation.
1975 - Протонен център at Harvard.
(pioneers eye cancer treatment with protons)
1979 - Протонен център Chiba, Japan.

1988 - Proton therapy approved by FDA.

1989- Протонен център at Clatterbridge, UK.

1990 - Particle Therapy Cooperative Group.

1990 - First hospital-based facility at Loma Linda, USA.
1991 - Протонен център at Nice and Orsay, France.

История на Протонната терапия (3)

1993 - Протонна терапия at Cape Town, South Africa.

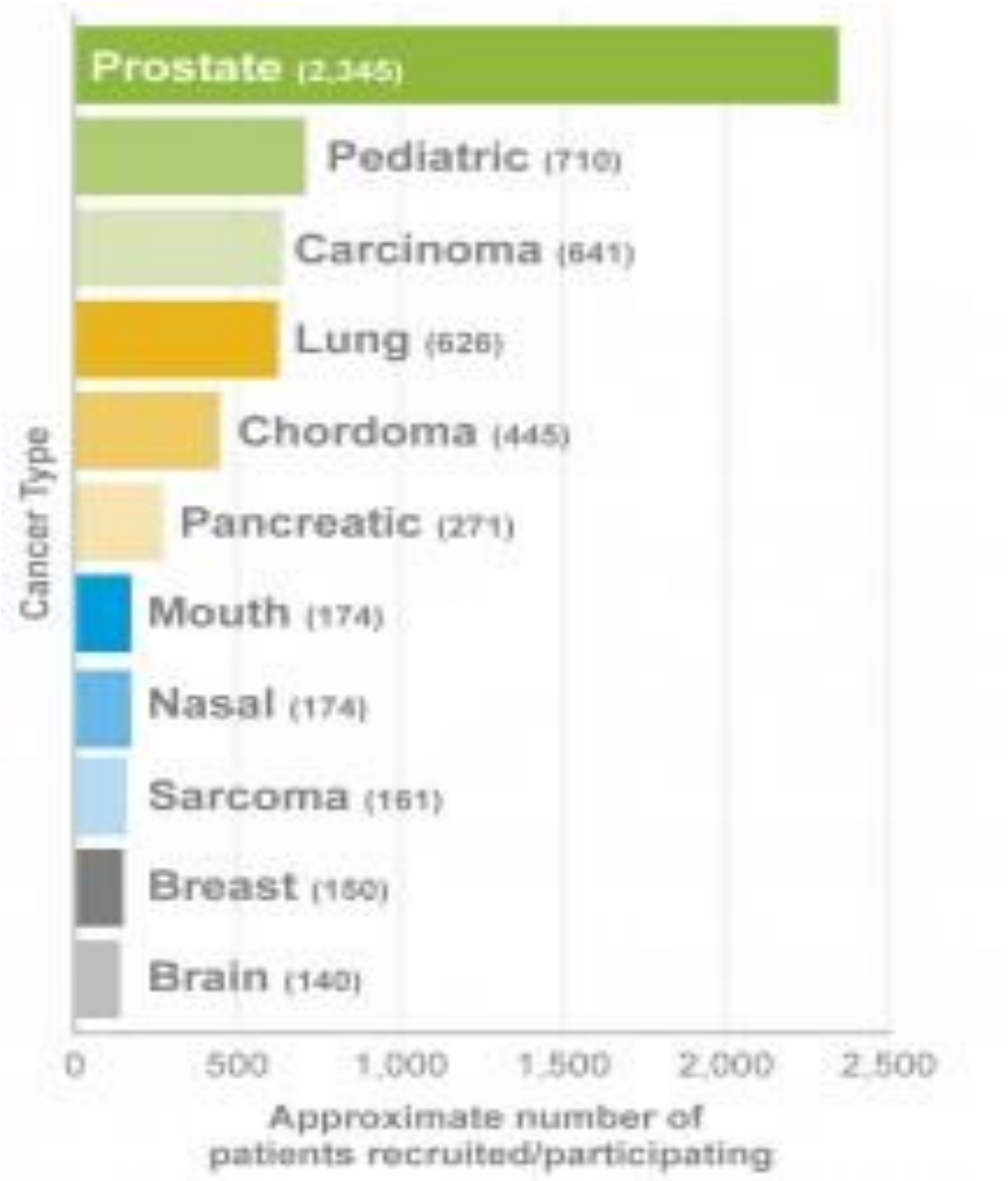
1996 - PSI proton facility at Villigen, Switzerland.

1998 - Протона терапия at Berlin, Germany.
2001 - Протонен център Massachusetts, USA.
2006 - Протонен център MD Anderson opens, USA.
2007 - Протонен център, Jacksonville, Florida, USA.
2008 - Неутронна терапия re-stated at Fermilab, USA.
2012 - Протонен център, Prague, Czech Republic.

Клинични предимства на протонната терапия

- ❑ висока точност на аплицираната доза
- ❑ висок туморен контрол
- ❑ незначителни увреждания на здравите тъкани
- ❑ липса на странични ефекти
- ❑ ниска вероятност (риск) от вторичен карцином
- ❑ неинвазивна терапия

Клинични проучвания в протонната терапия



Клинично Доказани Резултати

- карцином на простата
- ЦНС тумори, хордома и хондросаркома
- детски тумори
- тумори в областта на глава и шия
- дребно клетъчен белодробен карцином - (NSCL)
- Arteriovenous malformation (AVM)
- Ocular (uveal) melanoma

Доказани клинични предимства на протонната терапия в сравнение с останалите форми на радиотерапия

- Висока точност на аплицираната лечебна доза (висока лечебна доза - 75 - 80 - 90Gy).

- Сигнификантно по-добро дозно разпределение в клиничния мишенен обем.

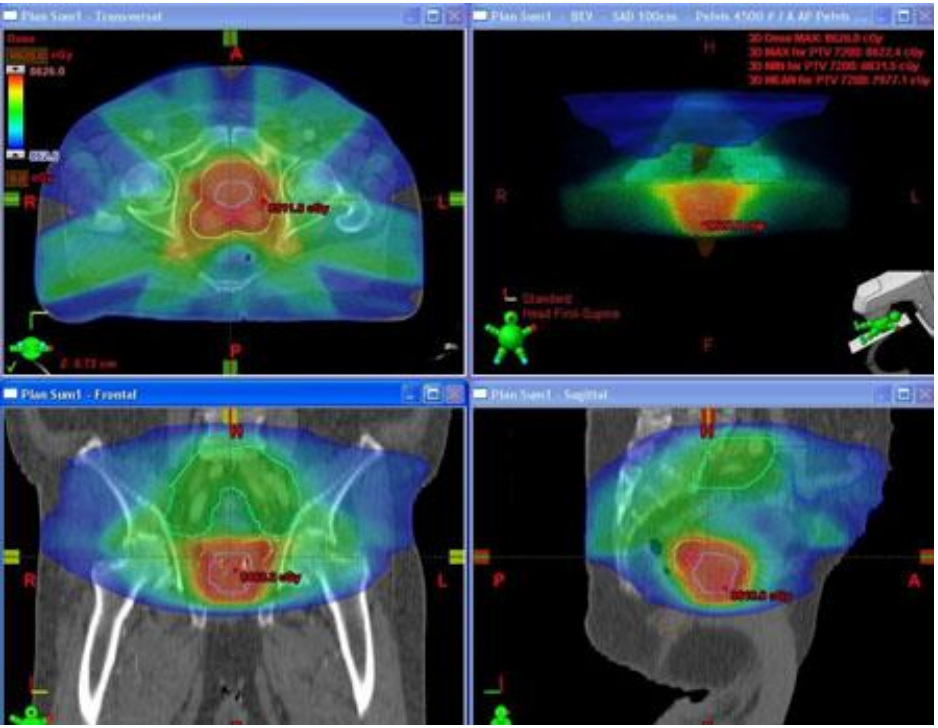
- Висок туморен контрол.

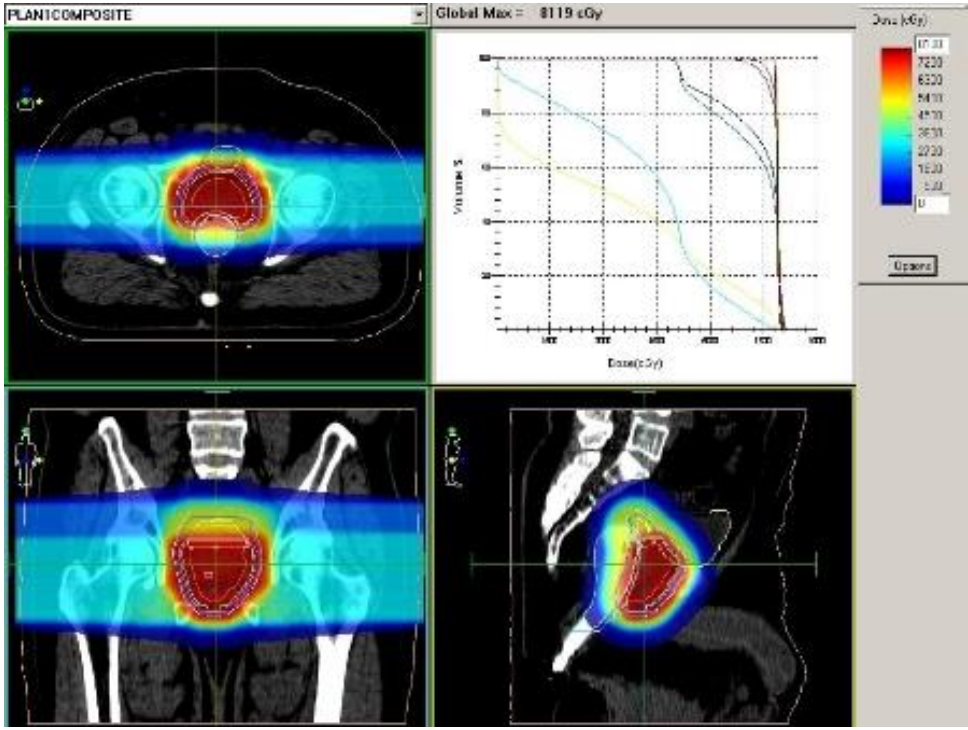
- Значително по-добро запазване на здравите тъкани.

РАДИОТЕРАПИЯ при CA GL. PROSTATAE

IMRT с Х лъчи

Proton Therapy

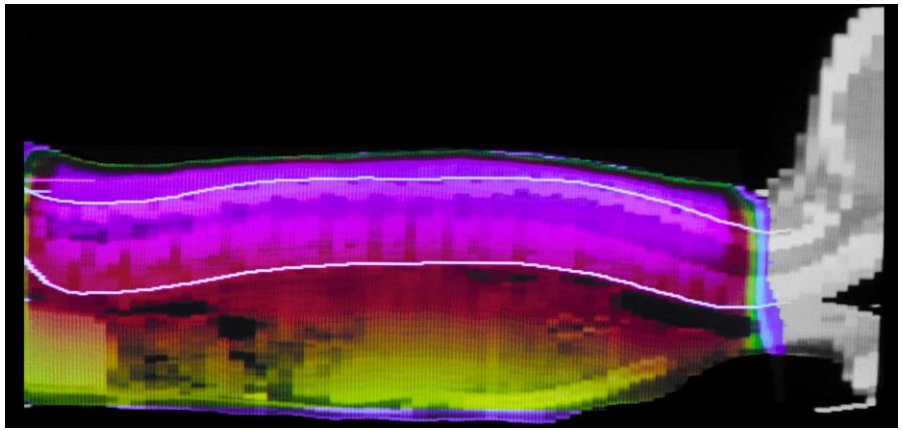




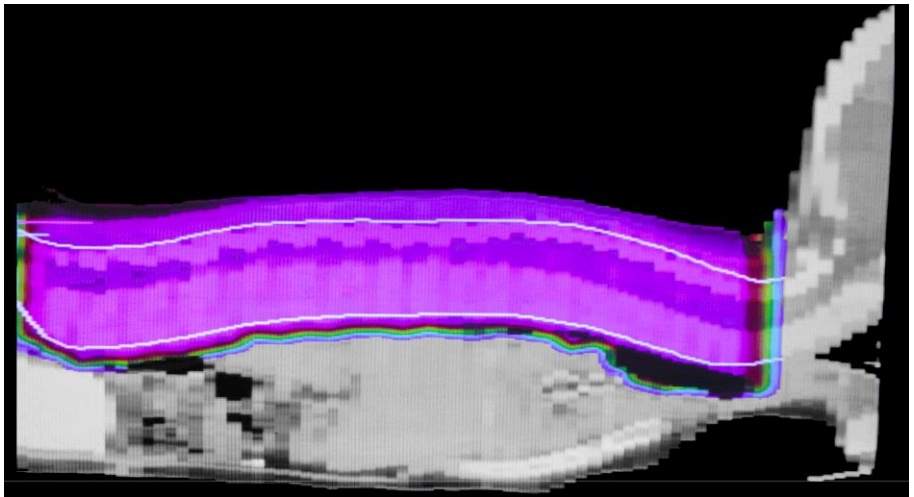
Протонна терапия

Радиотерапия при Cancer Pediatric Decease (Medulloblastoma)

IMRT с Х лъчи



Протонна терапия



Протонна терапия

Радиотерапия при Lung cancer

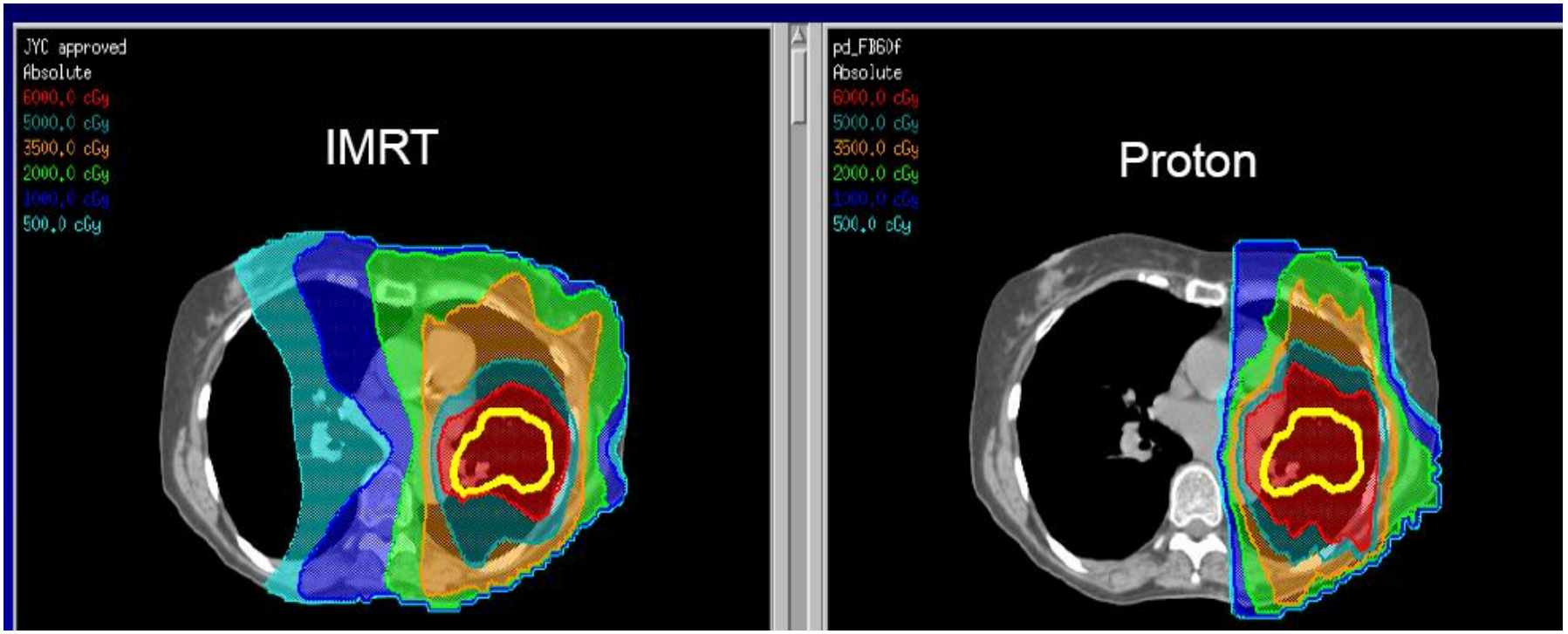
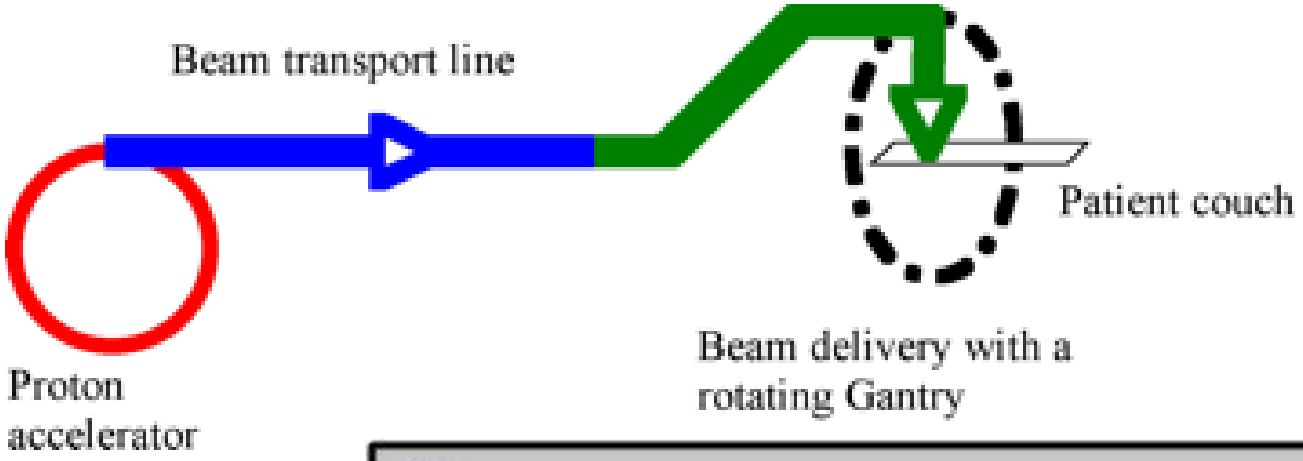
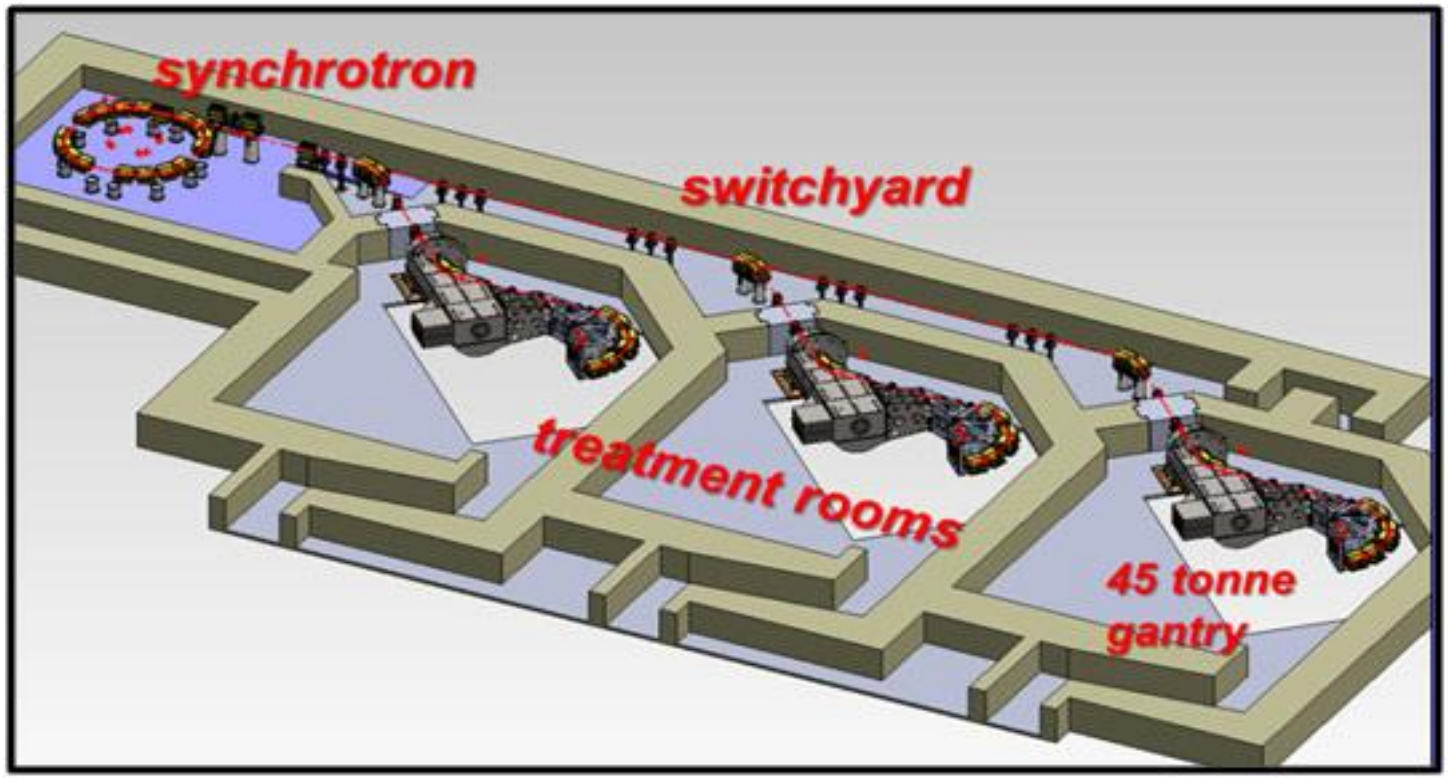


СХЕМА НА ПРОТОНЕН ЦЕНТЪР





Cyclotron

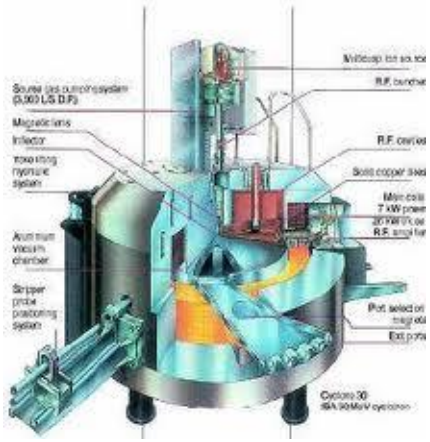
Beam Transport System

Universal Nozzle

Patient Positioning System

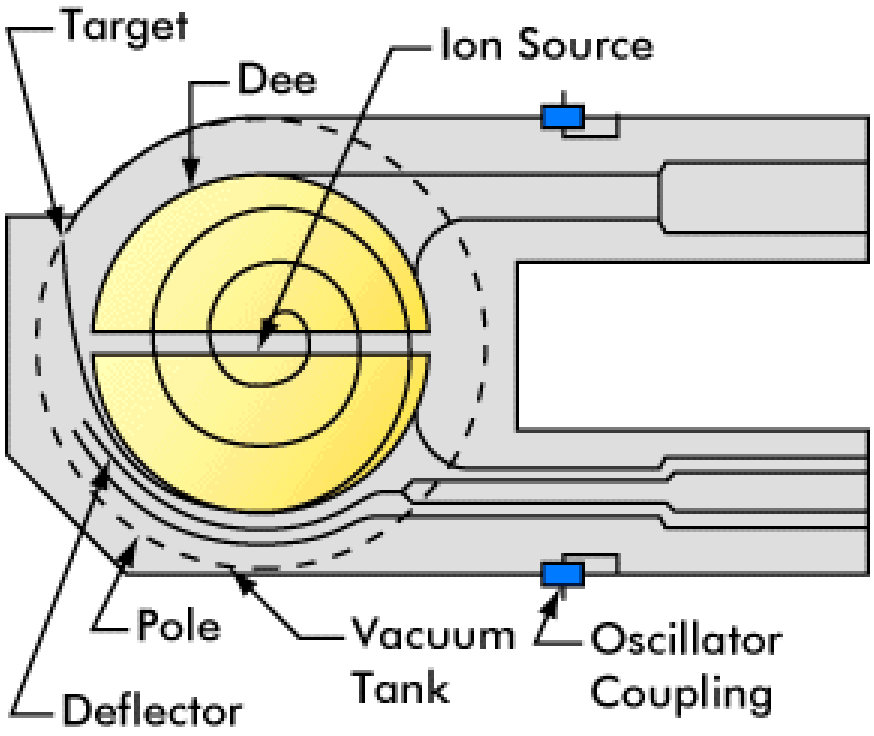
Център за протонна терапия

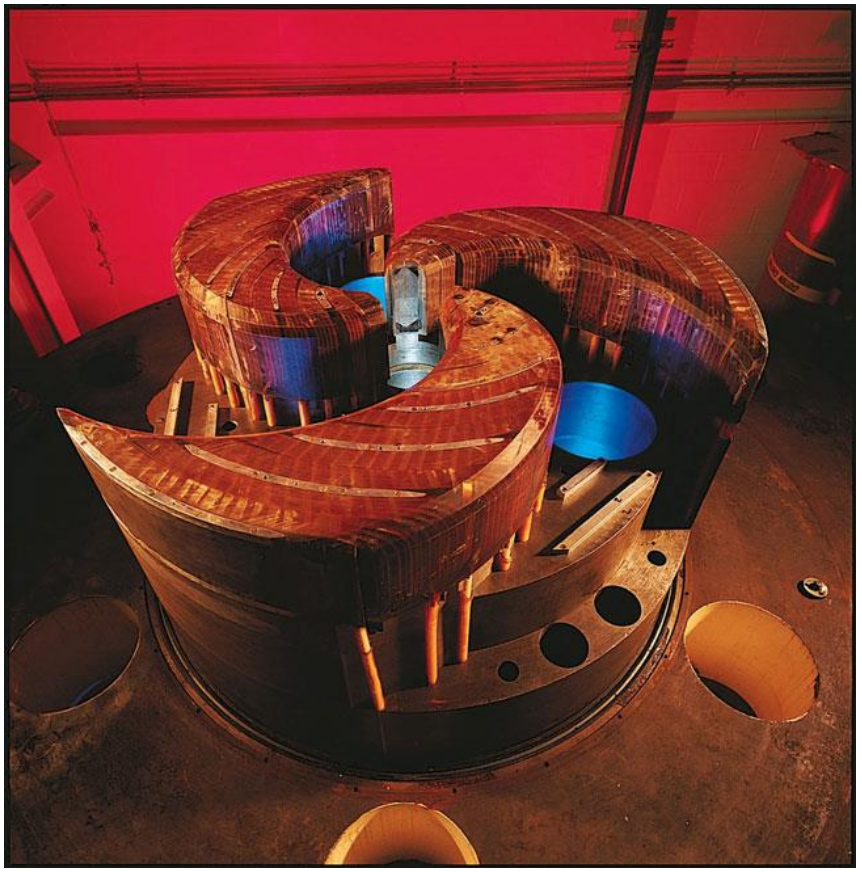
- Ускорител на протонни снопове
- Транспортна система на протонните снопове
- Процедурно помещение
- Gantry
- Пациентна маса



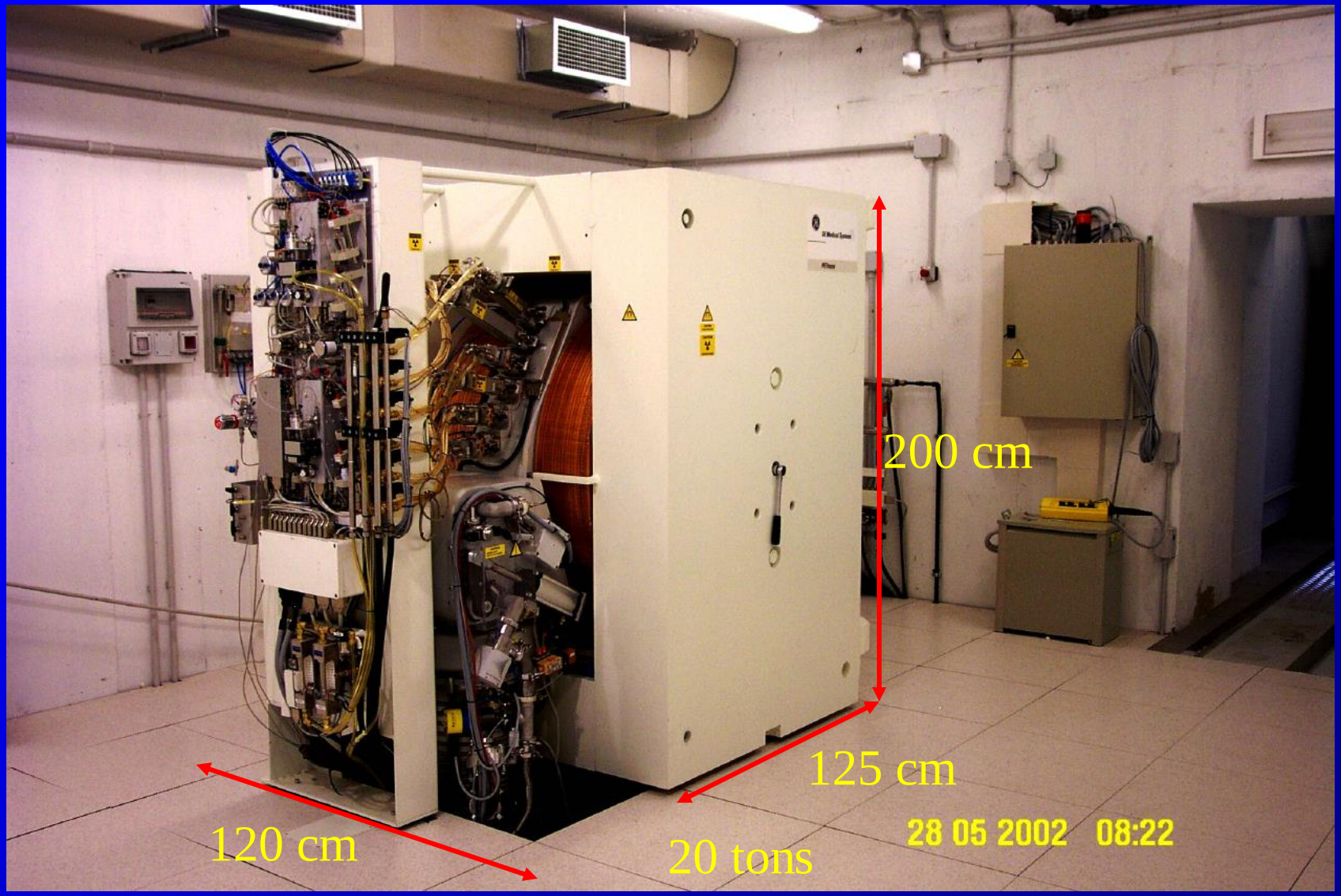
Ускорител на протонни снопове

ЦИКЛОТРОН

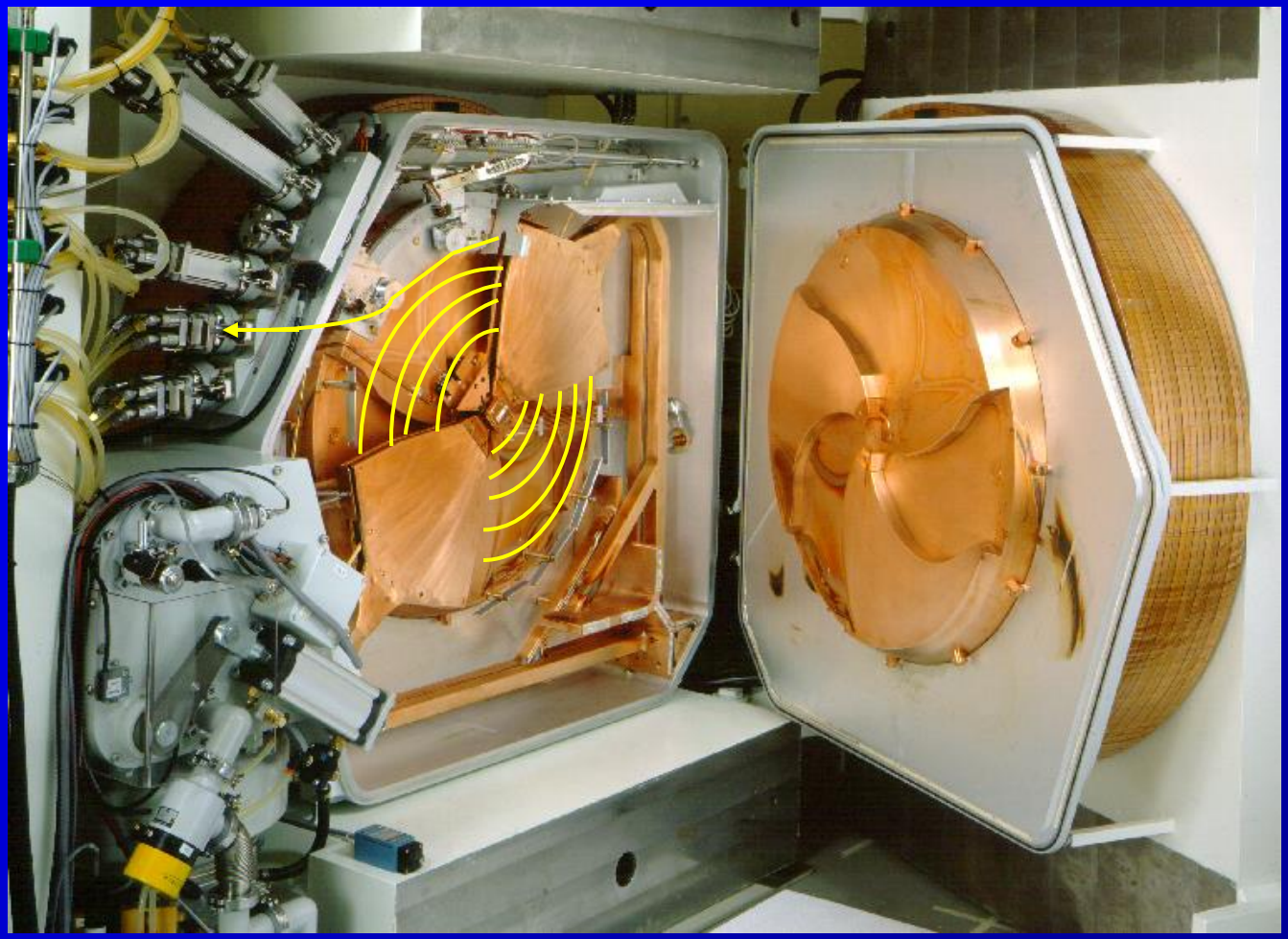

Target
Dee
Ion Source
Pole
Vacuum
Tank
Oscillator
Coupling
Deflector



The PETtrace cyclotron



Beam acceleration



Principal models of cyclotron for biomedical uses

Cyclotron	E_{max} (MeV)	Particles	I_{max} (microA)	N. Max Targets	Dual beam	Ion Source	Self Shield
Advanced TR19	19	H- (D- opt)	150	8	Y	Ext, filament	opt
Siemens Eclipse	11	H-	80	8	Y	Int, filament	Y
GE MiniTrace	10	H-	60	6	Y (2° target fixed)	Int, PIG	Y
GE PetTrace	16.5	H- (D- opt)	80	6	Y	Int. PIG	opt
IBA Cyclone 18/9	18	H- (D- opt)	80	8	Y	Int. PIG	opt

ПРОБЕГ НА ПРОТОНИТЕ ВЪВ ВОДА

energy (MeV)	*range in water (cm)*
70	4.0
100	7.6
150	15.5
200	25.6
250	37.4

C230 key specifications

- Compact isochronous cyclotron

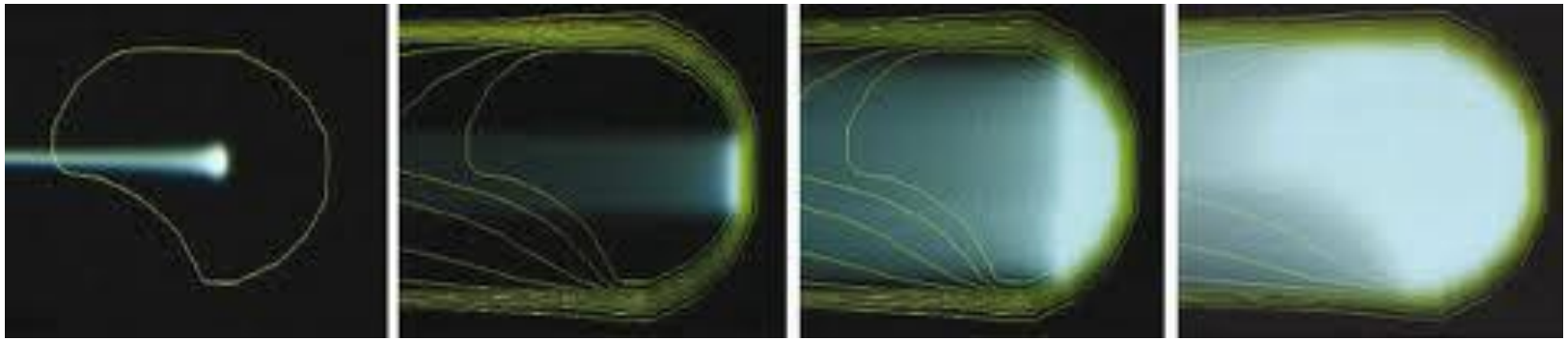
- 235 MeV proton energy
- 300 nA beam current, quasi-continuous
- Typical efficiency : 55 %

- Approx. weight: 220 T
- Diameter: 4.3 m

- Conventional magnet coil: 1.7 - 2.2 T
- RF Frequency: 106 MHz
- Dee voltage: 55 to 150 kV peak

ПРОТОНЕН СНОП

Клиничен мишенен обем



НАЧИНИ ЗА ФОРМИРАНЕ НА КЛИНИЧНИ ПРОТОННИ СНОПОВЕ

Single Scattering: Delivers a uniform proton dose in small fields with only one scatterer.

Double Scattering: Accepts any energy at nozzle entrance within the 70-235 MeV range.
Reduces the distal falloff. Reduces the lateral penumbra and the radiation level.

Passive Scaterring

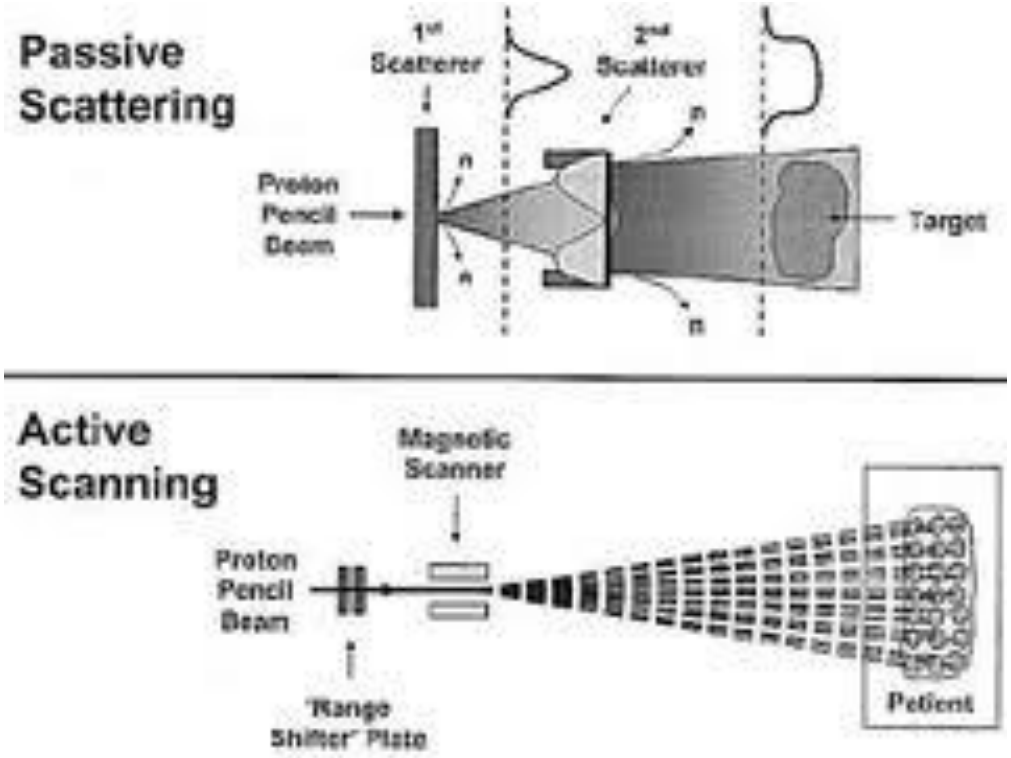
Uniform Scanning: The beam spot is moved by magnetic scanning and allows several mini-irradiations.
Full modulation, field uniformity, very safe treatment.

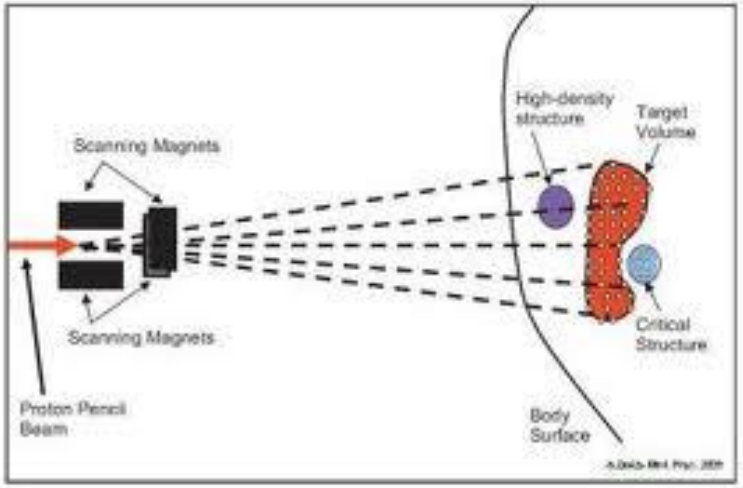
Pencil Beam Scanning: Slice-by-slice irradiation of the target with millimetre precision.
Primary advantages include: multiple fast repainting, no use of aperture, no compensator devices, dose uniformity, intensity modulation (IMPT).

Active Scanning

НАЧИНИ ЗА ФОРМИРАНЕ НА КЛИНИЧНИ ПРОТОННИ СНОПОВЕ

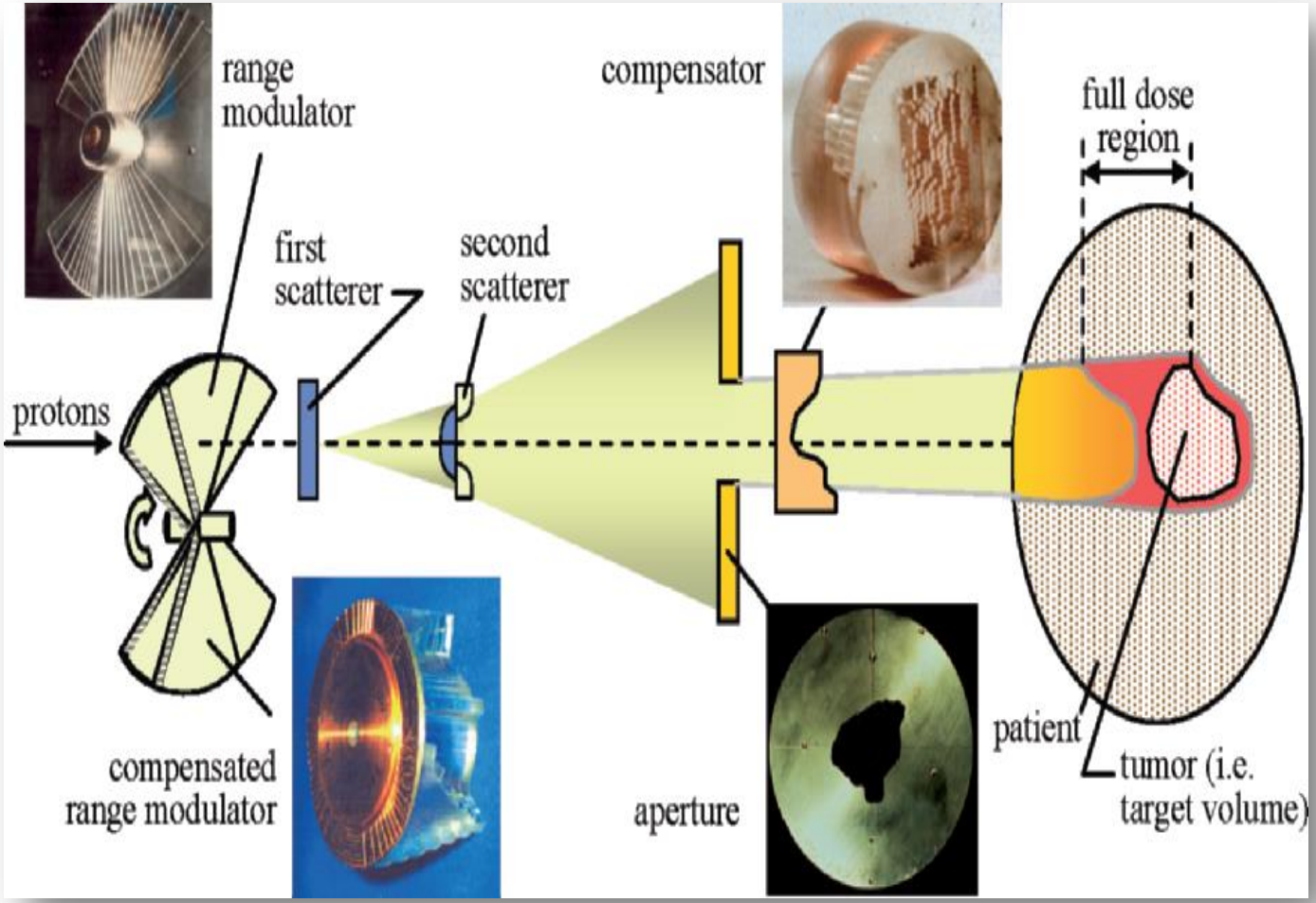
I. Пасивно разсейване
II. Активно сканиране





ФОРМИРАНЕ НА ПРОТОННИЯ СНОП ЗА КЛИНИЧИНО ПРИЛОЖЕНИЕ

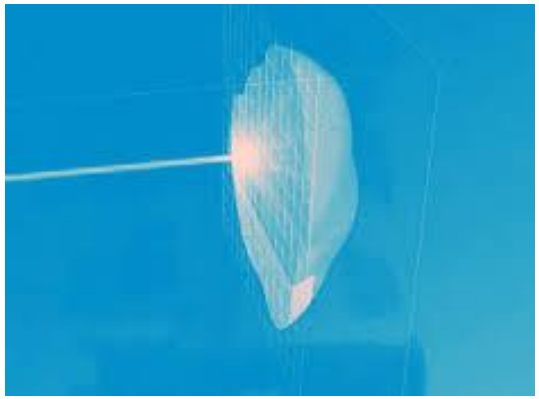
I. Пасивен

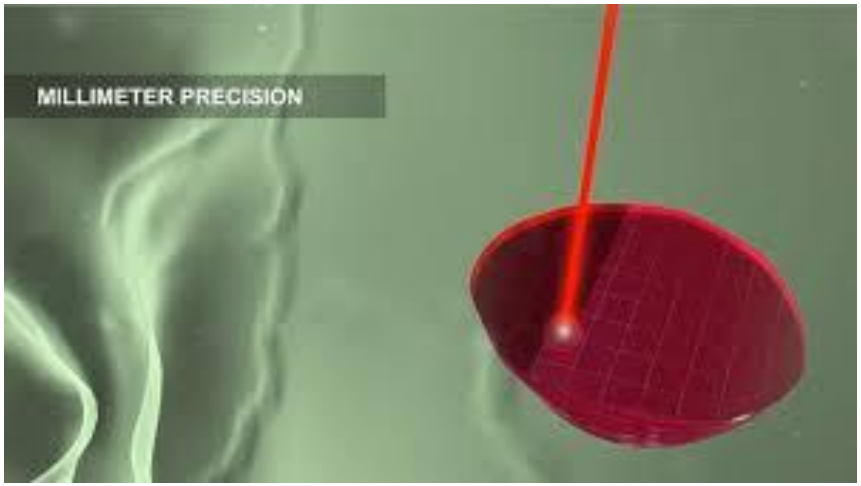


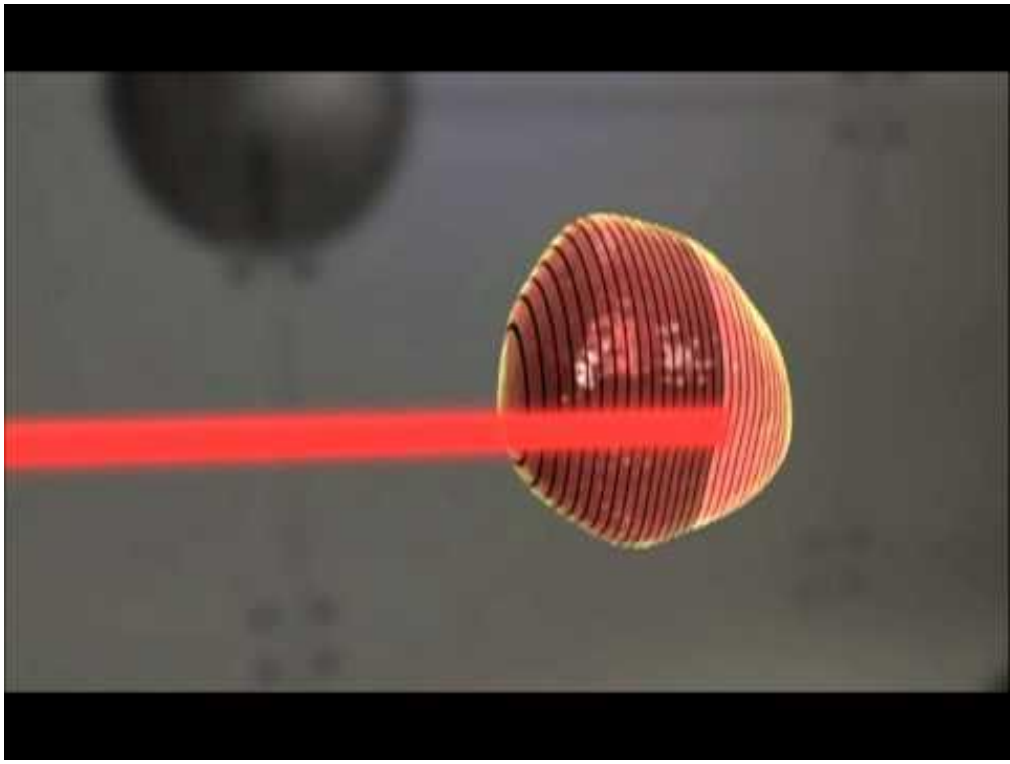
ФОРМИРАНЕ НА ПРОТОННИЯ СНОП ЗА КЛИНИЧИНО ПРИЛОЖЕНИЕ

II. Активно сканиране

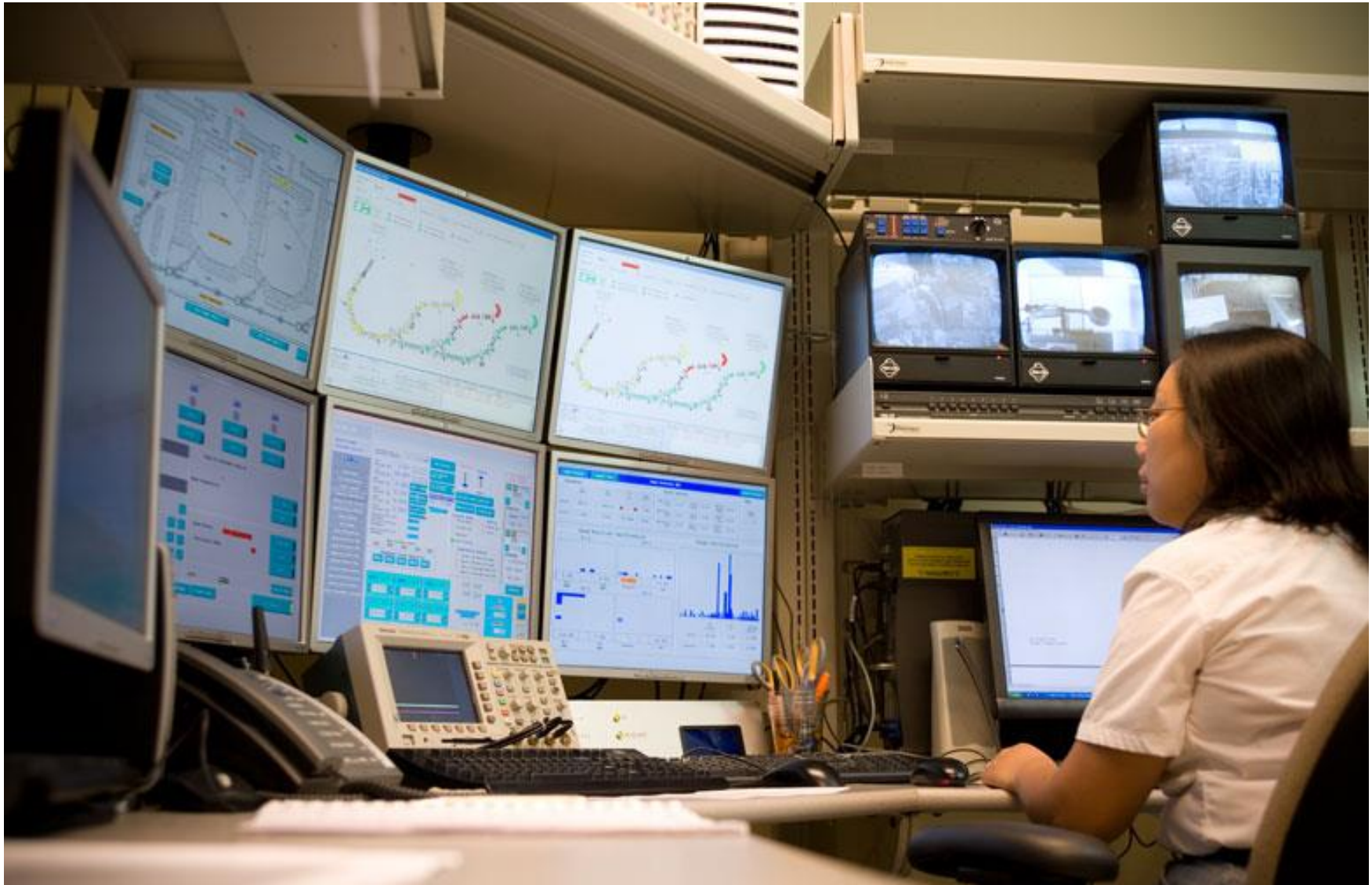
(Pensil Beam Scannig)



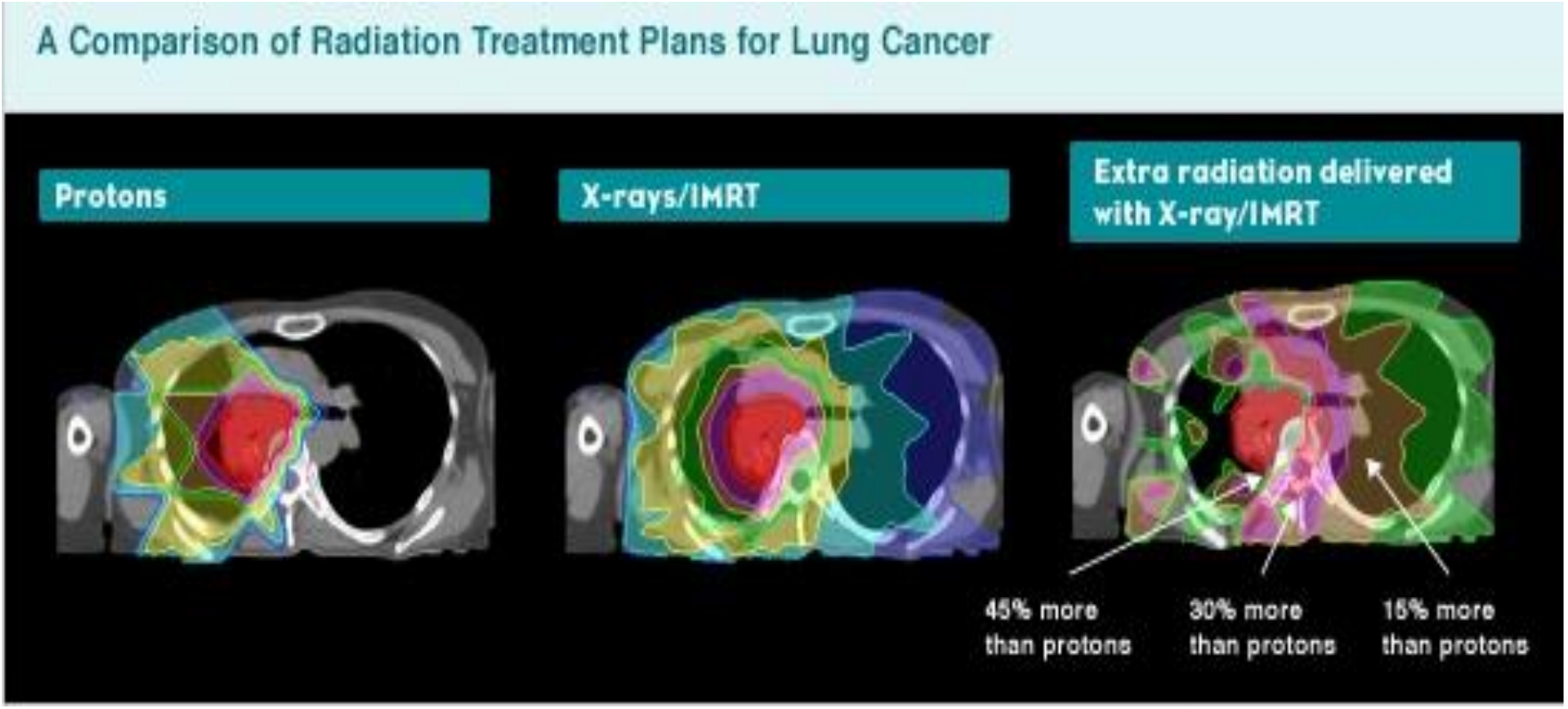




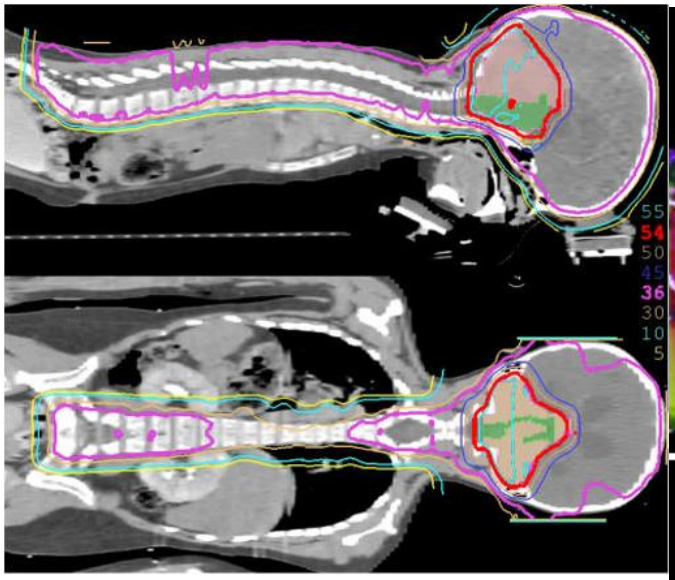
Control room of Proton Therapy Center

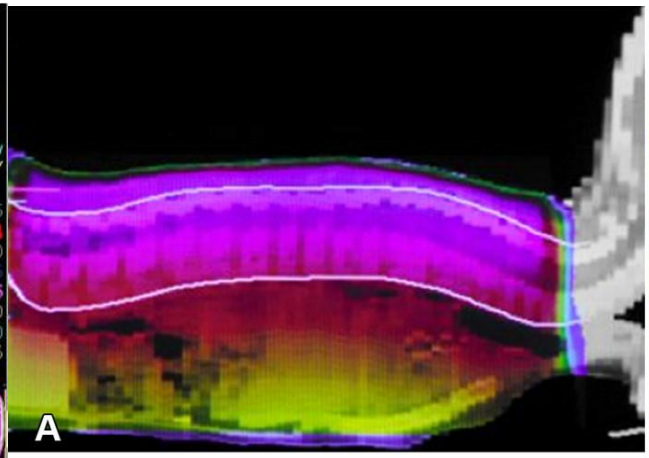


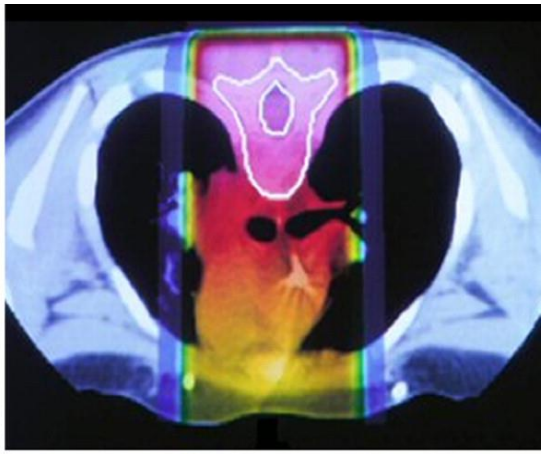
PROTON THERAPY for Lung CA

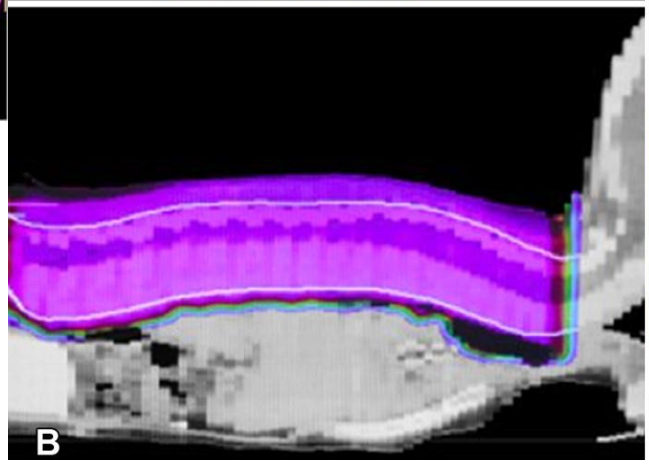


PROTON THERAPY for Pediatric deceases (Medulloblastoma)

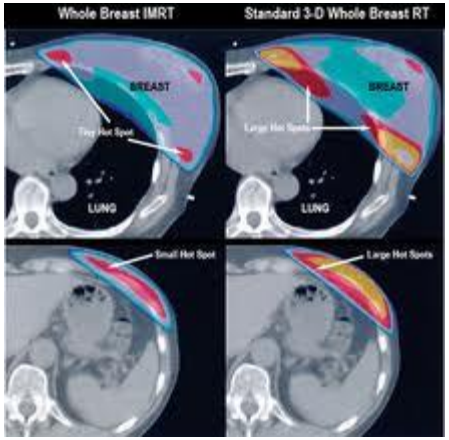


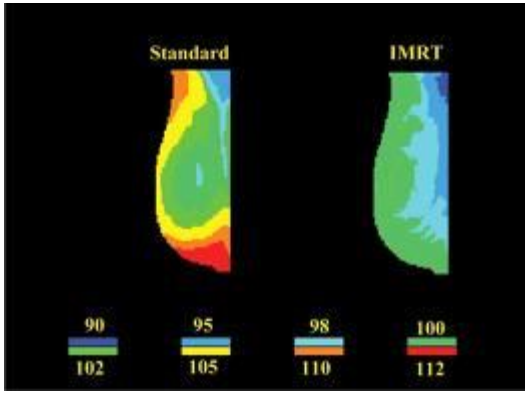




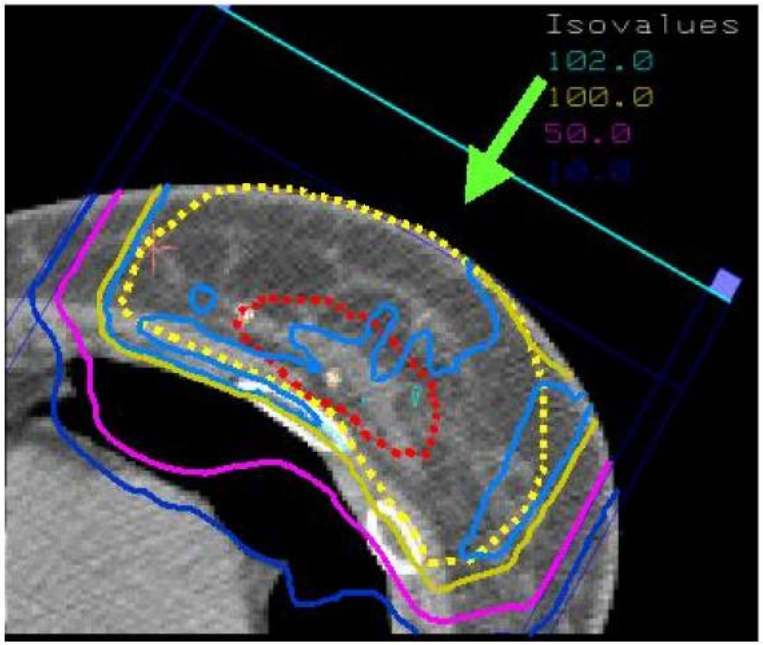


РАДИОТЕРПИЯ ПРИ Breast Cancer

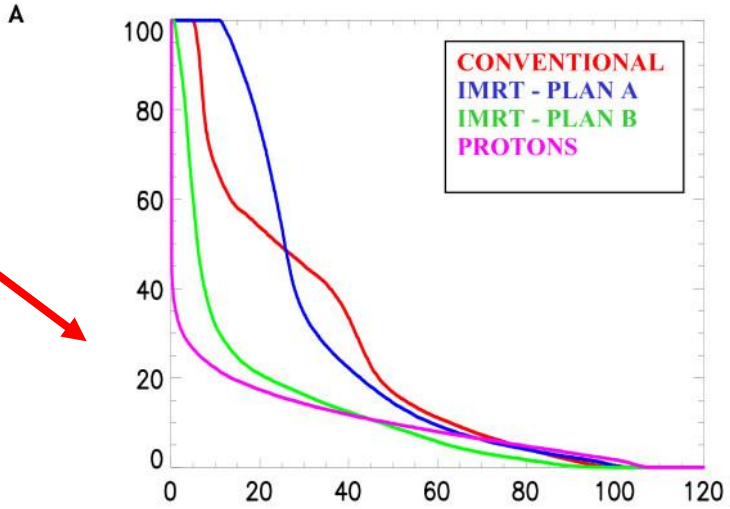




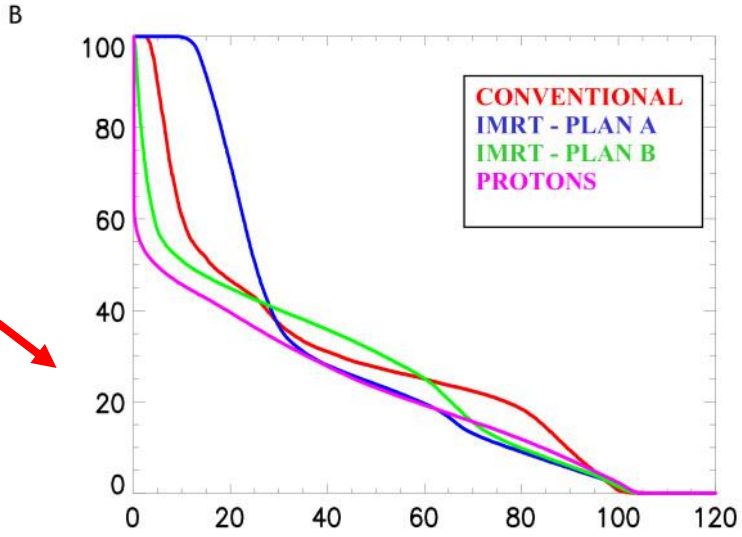
PROTON THERAPY for Breast Cancer



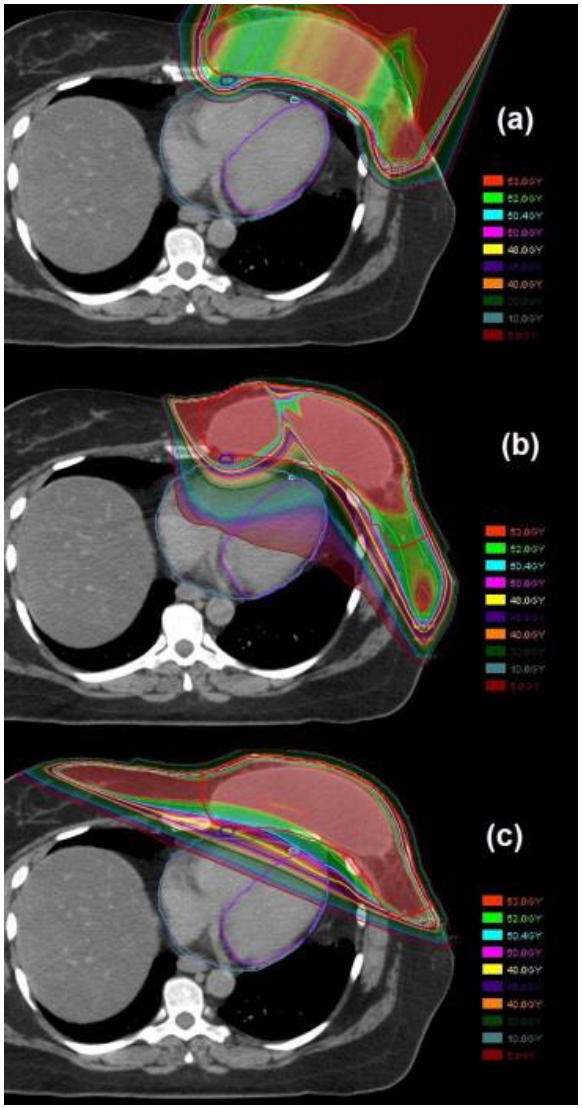
Heart



Lung



Radiation Therapy Planning with Photons and Protons for Early and Advanced Breast Cancer, Available on: http://hcp.obgyn.net/breast-health-and-breast-care/content/article/



Proton Therapy for Breast Cancer After Mastectomy: Early Outcomes of a Prospective Clinical Trial

International Journal of Radiation Oncology, Biology, Physics; 2013, 86(3), 484 - 490.

Chest wall and regional lymph nodes

(гръдна стена и регионерни лимфни възли)

Treatment Volume		Average mean Dose	Treatment Volume		Dose in %
V100	Heart	0.44Gy	V20	Heart	0.0%
V100	Left ventricle	0.09Gy	V20	Left ventricle	13.0%
V100	Lung	6.00Gy	V20	Lung	0.0%

Eugen B. Hug, M.D. - medical director and chief medical officer for ProCure Treatment Center

http://www.itnonline.com/article/proton-therapy-research-advancements

ПРОТОННАТА ТЕРАПИЯ ДНЕС

През последните 20 години общият брой на лекуваните пациенти и клиничните протонни центрове са както следва:

- 1990 - 16 proton centers, 11 682 patients
- 1995 - 25 proton centers, 19 373 patients
- 2000 - 30 proton centers, 31 838 patients
- 2005 - 39 proton centers, 48 386 patients
- 2009 - 30 proton centers, 78 275 patients
- 2010 - 32 proton centers, 84 492 patients
- 2011 - 39 proton centers, 96 537 patients
- 2012- 42 proton centers, 108 238 patients

В близките 5 години се планират да бъдат открити **нови 25 клинични протонни центрове.**

n organization for those interested in proton,
ght ion and heavy charged particle radiotherapy

ticle therapy facilities in operation (incl. patient statistics):

, WHERE	COUNTRY	PARTICLE	S/C*, MAX. ENERGY (MeV)	BEAM DIRECTIONS	START OF TREATMENT	TOTAL PATIENTS TREATED	DATE OF TOTAL
, Moscow	Russia	p	S 250	1 horiz.	1969	4246	Dec-10
tersburg	Russia	p	S 1000	1 horiz.	1975	1386	Dec-12
Villigen	Switzerland	p	C 250	1 gantry**, 1 horiz.	1996	1409	Dec-12
a	Russia	p	C 200*****	1 horiz.	1999	922	Dec-12
ala	Sweden	p	C 200	1 horiz.	1989	1267	Dec-12
erbridge	England	p	C 62	1 horiz.	1989	2297	Dec-12
Linda	CA, USA	p	S 250	3 gantry, 1 horiz.	1990	16884	Dec-12
	France	p	C 65	1 horiz.	1991	4692	Dec-12
	France	p	C 230	1 gantry,2 horiz.	1991	5949	Dec-12
- iThemba Labs	South Africa	p	C 200	1 horiz.	1993	521	Dec-11
ealth PTC, Bloomington	IN,USA	p	C 200	2 gantry***, 1 horiz.	2004	1688	Dec-12
F	CA,USA	p	C 60	1 horiz.	1994	1515	Dec-12
C, Chiba	Japan	C-Ion	S 800/u	horiz.***,vertical****	1994	7331	Jan-13
MF, Vancouver	Canada	p	C 72	1 horiz.	1995	170	Dec-12
HMI), Berlin	Germany	p	C 72	1 horiz.	1998	2084	Dec-12
Kashiwa	Japan	p	C 235	2 gantry***	1998	1226	Mar-13
C,Hyogo	Japan	p	S 230	1 gantry	2001	3198	Dec-11
C,Hyogo	Japan	C-Ion	S 320/u	horiz.,vertical	2002	788	Dec-11
C(2), Tsukuba	Japan	p	S 250	2 gantry	2001	2516	Dec-12
C, MGH Boston	MA,USA	p	C 235	2 gantry***, 1 horiz.	2001	6550	Oct-12
-LNS, Catania	Italy	p	C 60	1 horiz.	2002	293	Nov-12
Shizuoka Cancer Center	Japan	p	S 235	3 gantry, 1 horiz.	2003	1365	Dec-12
TC, Koriyama-City	Japan	p	S 235	2 gantry, 1 horiz.	2008	1812	Dec-12
C, Zibo	China	p	C 230	2 gantry, 1 horiz.	2004	1078	Dec-12
nderson Cancer Center, Houston	TX,USA	p	S 250	3 gantry***, 1 horiz.	2006	3909	Dec-12
TI, Jacksonville	FL,USA	p	C 230	3 gantry, 1 horiz.	2006	4272	Dec-12
Ilsan	South Korea	p	C 230	2 gantry, 1 horiz.	2007	1041	Dec-12
C, Munich	Germany	p	C 250	4 gantry**, 1 horiz.	2009	1377	Dec-12
ure PTC, Oklahoma City	OK,USA	p	C 230	1 gantry, 1 horiz, 2 horiz/60 deg.	2009	1045	Dec-12
Heidelberg	Germany	p	S 250	2 horiz.**	2009	252	Dec-12
Heidelberg	Germany	C-Ion	S 430/u	2 horiz.**	2009	980	Dec-12
n, Philadelphia	PA,USA	p	C 230	4 gantry, 1 horiz.	2010	1100	Dec-12
C, Gunma	Japan	C-Ion	S 400/u	3 horiz., vertical	2010	537	Dec-12
CAS, Lanzhou	China	C-Ion	S 400/u	1 horiz.	2006	194	Dec-12
Proton Center, Warrenville	IL,USA	p	C 230	1 gantry, 1 horiz, 2 horiz/60 deg.	2010	840	Dec-12
TI, Hampton	VA, USA	p	C 230	4 gantry, 1 horiz.	2010	489	Dec-12
AN, Krakow	Poland	p	C 60	1 horiz.	2011	15	Dec-12
oolis PTRC, Ibusuki	Japan	p	S 250	3 gantry	2011	490	Dec-12
O, Pavia	Italy	p	S 250	3 horiz./1 vertical	2011	58	Mar-13
O, Pavia	Italy	C-Ion	S 400/u	3 horiz./1 vertical	2012	22	Mar-13
ure Proton Therapy Center, Somerset	NJ., USA	p	C 230	4 gantry	2012	137	Dec-12
Czech r.s.o., Prague	Czech Republic	p	C 230	3 gantry,1 horiz.	2012	1	Dec-12
A, Proton Therapy, a ProCure Center, le	WA., USA	p	C 230	4 gantry	2013	1	Mar-13

= Synchrotron (S) or Cyclotron (C)

n beam scanning

th spread beam and beam scanning

egraded beam

nt statistics of particle therapy facilities worldwide (no. of patients treated in facilities in operation and in closed facilities);
ecieved from centers worldwide per end of 2012 (pdf-file for download prepared by PTCOG Secretary)

WHERE		PARTICLE	FIRST PATIENT	PATIENT TOTAL	DATE OF TOTAL	
Canada	Vancouver (TRIUMF)	p	1995	170	Dec-12	ocular tumors only
Czech Rep.	Prag (PTCCZ)	p	2012	1	Dec-12	
China	Wanjie (WPTC)	p	2004	1078	Dec-12	
China	Lanzhou	C ion	2006	194	Dec-12	
England	Clatterbridge	p	1989	2297	Dec-12	ocular tumors only
France	Nice (CAL)	p	1991	4692	Dec-12	ocular tumors only
France	Orsay (CPO)	p	1991	5949	Dec-12	4748 ocular tumors
Germany	Berlin (HMI)	p	1998	2084	Dec-12	ocular tumors only
Germany	Munich (RPTC)	p	2009	1377	Dec-12	
Germany	HIT, Heidelberg	C ion	2010	980	Dec-12	
Germany	HIT, Heidelberg	p	2010	252	Dec-12	
Italy	Catania (INFN-LNS)	p	2002	293	Nov-12	ocular tumors only
Italy	Pavia (CNAO)	p	2011	42	Dec-12	
Italy	Pavia (CNAO)	C ion	2012	3	Dec-12	
Japan	Chiba (HIMAC)	C ion	1994	7331	Jan-13	72 with scanning
Japan	Kashiwa (NCC)	p	1998	1226	Mar-13	
Japan	Hyogo (HIBMC)	p	2001	3198	Dec-11	
Japan	Hyogo (HIBMC)	C ion	2002	1271	Dec-11	
Japan	Tsukuba (PMRC, 2)	p	2001	2516	Dec-12	
Japan	Shizuoka	p	2003	1365	Dec-12	
Japan	Koriyama-City	p	2008	1812	Dec-12	
Japan	Gunma	C ion	2010	537	Dec-12	
Japan	Ibusuki (MMRI)	p	2011	490	Dec-12	
Korea	Ilsan, Seoul	p	2007	1041	Dec-12	
Poland	Krakow	p	2011	15	Dec-12	ocular tumors only
Russia	Moscow (ITEP)	p	1969	4300	Dec-12	estimated
Russia	St. Petersburg	p	1975	1386	Dec-12	
Russia	Dubna (JINR, 2)	p	1999	922	Dec-12	
South Africa	iThemba LABS	p	1993	521	Dec-11	
Sweden	Uppsala (2)	p	1989	1267	Dec-12	
Switzerland	Villigen-PSI, incl OPTIS2	p	1996	1409	Dec-12	498 ocular tumors
USA, CA.	UCSF - CNL	p	1994	1515	Dec-12	ocular tumors only
USA, CA.	Loma Linda (LLUMC)	p	1990	16884	Dec-12	
USA, IN.	Bloomington (IU Health PTC)	p	2004	1688	Dec-12	
USA, MA.	Boston (NPTC)	p	2001	6550	Oct-12	
USA, TX.	Houston (MD Anderson)	p	2006	3909	Dec-12	
USA, FL	Jacksonville (UFPTI)	p	2006	4272	Dec-12	
USA, OK.	Oklahoma City (ProCure PTC)	p	2009	1045	Dec-12	
USA, PA.	Philadelphia (UPenn)	p	2010	1100	Dec-12	
USA, NY.	New Jersey ProCure PTC)	p	2012	137	Dec-12	
USA, IL.	CDH Warrenville	p	2010	840	Dec-12	
USA, VA.	Hampton (HUPTI)	p	2010	489	Dec-12	
				88448	**Total**	
			thereof	10316	C-ions	
				78132	protons	

Total for all facilities (in operation and out of operation):

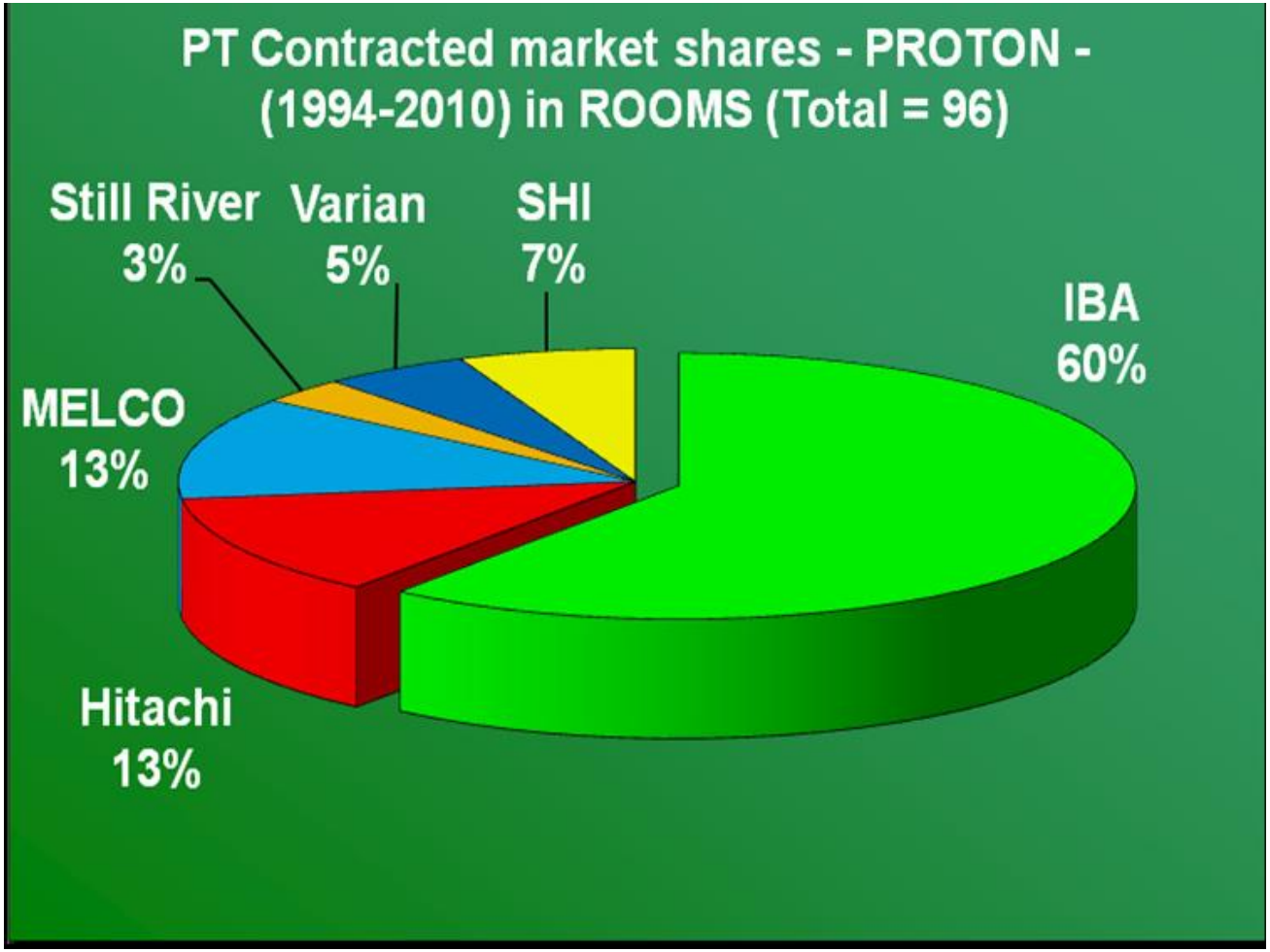
2054 He
1100 pions
10756 C-ions

organization for those interested in proton, ion and heavy charged particle radiotherapy

e therapy facilities in a planning stage or under construction:

ame	COUNTRY	PARTICLE	MAX. CLINICAL ENERGY (MeV)	BEAM DIRECTION	NO. OF TREATMENT ROOMS	START OF TREATMENT PLANNED
RCN, ated"	Austria	p, C-ion	430/u synchrotron	1 gantry (only for protons) 1 fixed beam, 1 fixed 0 + 90 deg	3	2015
ntic "	Italy	p	230 cyclotron	2 gantries 1 horiz fixed beam	3	2013
ersity Shanghai CC"	China	p, C-ion	430/u synchrotron	3 fixed beams	3	2014
TC, Flint, Michigan"	USA	p	250/330 synchrotron	3 gantries	3	2013
en"	Germany	p	230 cyclotron	3 gantries, 1 horiz fixed beam	4	2013
chou"	China	C-ion	400/u synchrotron	4 horiz, vertical, oblique, fixed beams	4	2013
urg"	Germany	p, C-ion	430/u synchrotron	3 horiz fixed beams 1 fixed beam 0 + 45 deg	4	20137
nois PT Res.Institute, W. Chicago, IL"	USA	p	250 SC cyclotron	2 gantries, 2 horiz fixed beams	4	20137
g Memorial Hospital, Taipei"	Taiwan	p	235 cyclotron	4 gantries, 1 experimental room	4	20137
MAT, Tosu-Shi"	Japan	C-ion	400/u synchrotron	3 horiz/vertical fixed beams	3	2013
ctural Hospital PTC, Fukui City"	Japan	p	235 synchrotron	2 gantries, 1 horiz fixed beam	3	20147
Protvino"	Russia	p	250 synchrotron	1 horiz fixed beam	1	?
tislava	Slovak Rep.	p	72 cyclotron	1 horiz fixed beam	1	?
Ruzomberok"	Slovak Rep.	p	250 synchrotron	1 horiz fixed beam	1	?
ng	China	p	230 cyclotron	1 gantry, 1 horiz fixed beam	2	?
linic, Uppsala"	Sweden	p	230 cyclotron	2 gantries	2	2014
ish, CO"	USA	p	250 SC synchro-cyclotron	1 gantry	1	2013
ton Therapy Center, San Diego, CA"	USA	p	250 SC cyclotron	3 gantries, 2 horiz fixed beams	5	2013
Proton Center, Seoul"	South Korea	p	230 cyclotron	2 gantries	2	2014
od Johnson, New Brunswick"	USA	p	250 SC synchro-cyclotron	1 gantry	1	2014
University, Oklahoma City, OK"	USA	p	250 SC synchro-cyclotron	1 gantry	1	2014
on, Orlando, FL"	USA	p	250 SC synchro-cyclotron	1 gantry	1	2014
Oncology, Jacksonville, FL"	USA	p	250 SC synchro-cyclotron	1 gantry	1	2014
ine Lacassagne, Nice"	France	p	230 SC synchro-cyclotron	1 gantry	1	2014
Krakow"	Poland	p	235 cyclotron	1 gantry	1	20147
obersee, Galgenen	Switzerland	p	230 cyclotron	4 gantries, 1 horiz fixed beam	5	2016
enter for Proton Therapy, Knoxville, TN"	USA	p	230 cyclotron	3 gantries	3	2014
Therapy Center, Shreveport, LA	USA	p	230 cyclotron	1 gantry	1	2015
Proton Beam Therapy Center, Rochester,	USA	p	250 synchrotron	4 gantries	4	2015
Proton Beam Therapy Center, Phoenix,	USA	p	250 synchrotron	4 gantries	4	2016
, Delft	Netherland	p	?	? gantries	?	?
apy Center, OncoRay, Dresden"	Germany	p	230 cyclotron	1 gantry	1	2014
pital, Proton Therapy Center, Nagano"	Japan	p	235	1 gantry	1	2014
ton Therapy Center, Nagoya City, Aichi"	Japan	p	250 synchrotron	2 gantries, 1 horiz fixed beam	3	2013
Medical City, Riyahdi	Saudi Arabia	p	250 cyclotron	4 gantries	4	20157
itute of New York, New York, NY	USA	p	230 cyclotron	4 gantries	4	20157

nstruction



Yves Jongen, IBA, Louvain-la-Neuve, Belgium,
In Proceedings of CYCLOTRONS 2010, Lanzhou, China.

Towards a novel, low-cost PT accelerator

- Lower cost & standardized Proton Therapy System
- Compact treatment room and small footprint
- Shorter installation time on site
- Operator less
- Reduced maintenance

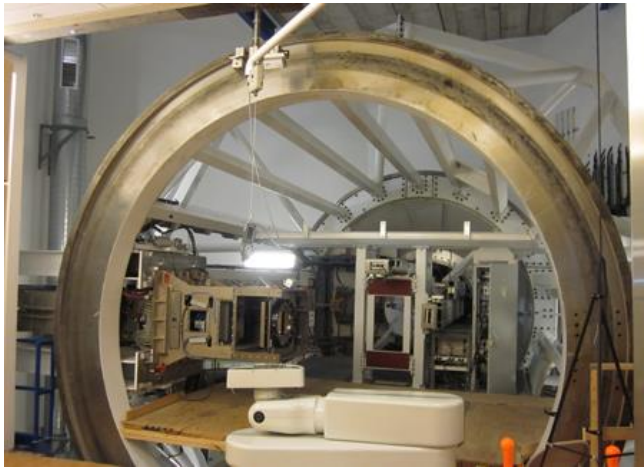
Proteus One : low cost, smaller footprint

A quite popular solution…

20 facilities including IBA equipement, 64 treatment rooms in total


SEATTLE
CANCER CARE
ALLIANCE
PROTON
THERAPY


SEATTLE
CANCER CARE
ALLIANCE
Fred Hutchinson Cancer Research Center
UW Medicine
Seattle Children's
Proton Therapy
A ProCure Center



- Протонната терапия е следващата логична стъпка в развитието на радиотерапията, подобрявайки дозното разпределение.

- Протонната терапия е сериозно предизвикателство за професионалистите, работещи съвременни форми на радиотерапията.

- Днес протонната терапия е атрактивна, прецизна и модерна форма на радиотерапията.

ПЕРСПЕКТИВИ ЗА РАЗВИТИЕ

- Последни постижения в ядрените и информационните технологии.
- Последни постижения в CERN.

The recent technical innovations in proton therapy – modulation of pencil proton beams, intensity modulated proton therapy (IMPT) and grid proton therapy **(reducing a radiation beam diameter from 1 mm to 25 μm)** – will allow us to really accurately "paint" the dose to the tumor and spare critical structures, much as we do with intensity-modulated photon therapy (IMRT), but also to further reduce the dose compared to IMRT [1,2].

[1] COMBS, S.E., JAKEL, O., HABERER, T., DEBUS, J., Particle therapy at the Heidelberg Ion Therapy Center (HIT) / Integrated research/driven university-hospital-based radiation oncology service in Heidelberg, Germany, Radiother. Oncol. 95 1 (2010 Apr.) 41-44.
[2] LOMAX, T., Grid therapy: the IMPT approach, 2012
Available from: http://medicalphysicsweb.org/cws/article/research/49072

PAUL SCHERRER INSTITUT

PSI

Paul Scherrer Institute, Villigen, Switzewrland

ACCEL for PROSCAN at PSI
One of the very first best place for protontherapy in Europe

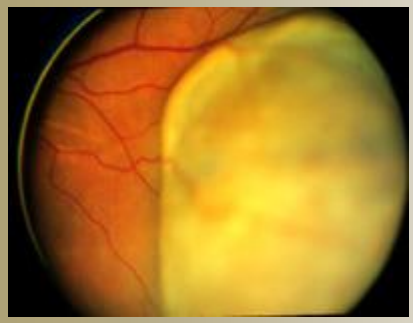
- March 22, 2007 - the second generation (ACCEL), Paul Scherrer Institute, VILLIGEN, Switzewrland.

- The world's first commercial superconducting cyclotron for routine medical use.

Proton-Radiotherapy: Eye tumors

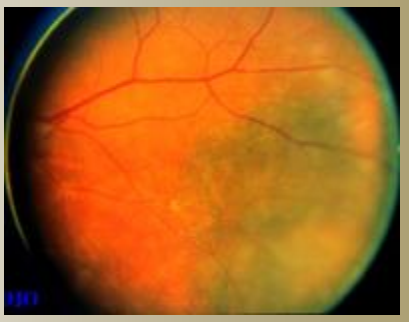
Fundus of the eye

PRIOR to therapy



Fundus of the eye

AFTER therapy



Local Tumor Control (at actuarial 10 years and depending in size and site)

- **98 % (PSI, > 4700 patients)**
- **95.7% (MGH/MEEI)**

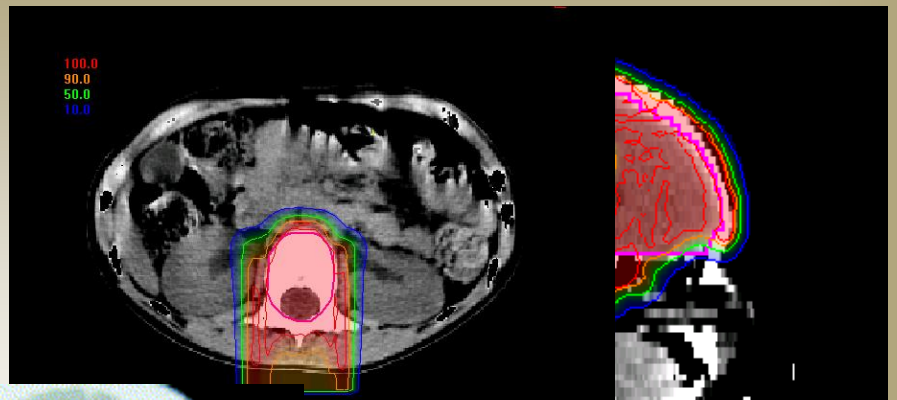
Retention of the eye: depending on tumor size and location, about 70-97% (PSI)

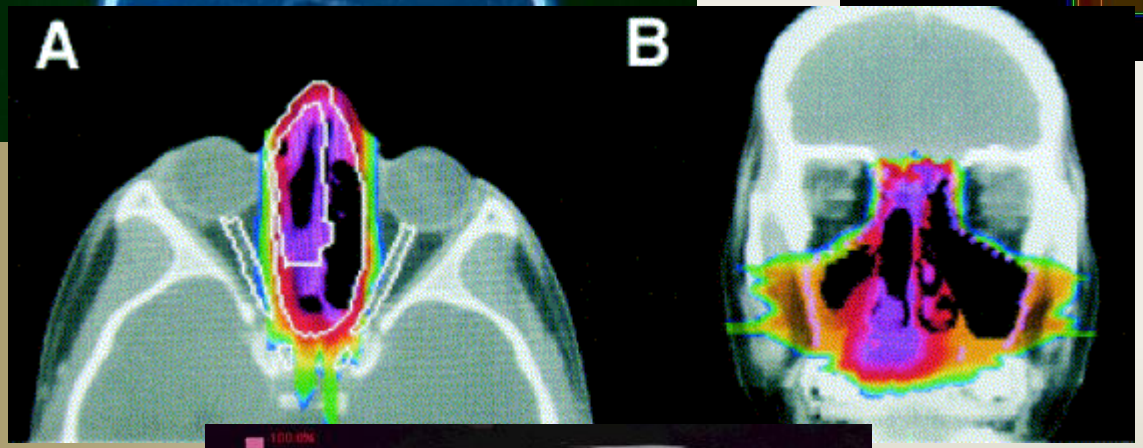
E. Hug

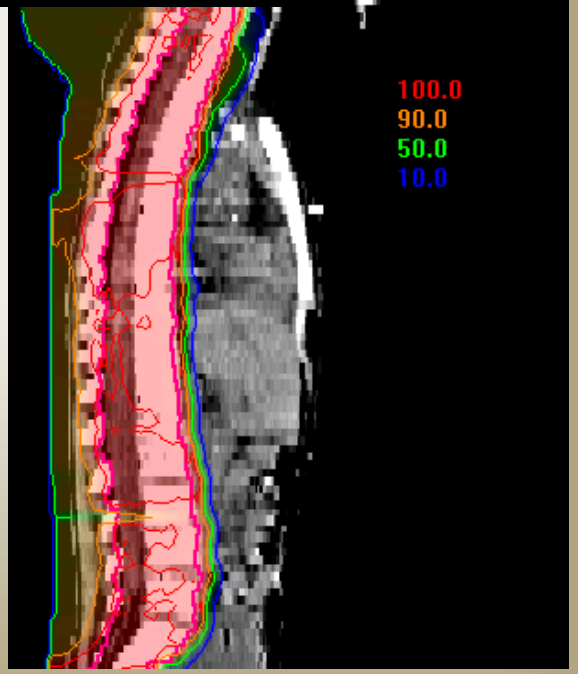
Universität Zürich

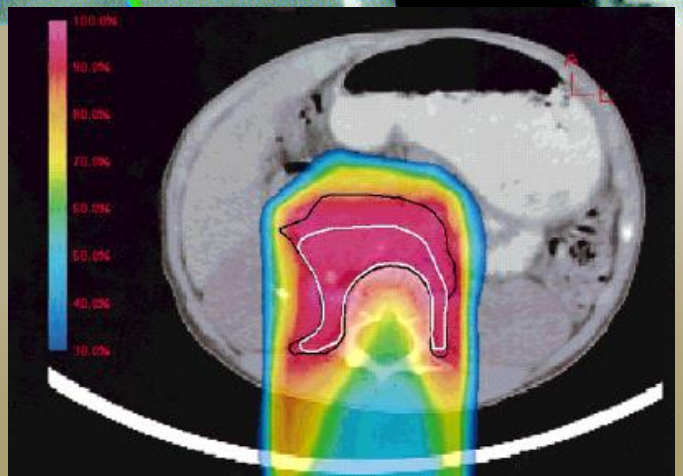
Pädiatrische Protonen- Radiatiotherapie

PAUL SCHERRER INSTITUT PSI









E. Hug

TREATMENT TECHNOLOGY

PROJECT PARTNERS

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Proton Therapy Center

At PTC we are passionate about improving the lives of all people.
We are passionate about curing cancer, and improving the quality of our patient's lives.

Welcome to the pages of the Proton Center in Prague!

We are an advanced clinical centre with the newest and highly exact technology **for treatment of patients with cancer.** Being actively used since 1992, **proton therapy** significantly improves and extends treatment of tumours near vital structures with minimal damage to healthy tissue and risk of secondary complications. **Proton therapy** is one of the methods of therapy for malignant tumours that offers the best prospects in the 21st century. The experts assume that amongst **the curative therapies**, proton therapy will have a stronger position.

Another child celebrates the completion of his therapy treatment at PTC in Prague!

The beat of a drum once again symbolises the end of treatment for 10 year old Tom*. He has completed proton therapy treatment for medulloblastoma, a malignant brain tumour.

This type of cancer is particularly suitable for proton therapy because radiation must be given near sensitive areas of the body - the brain and spinal cord. Proton radiation is much more accurate and safer than other cancer treatment options - the tumour can be treated without damaging surrounding tissues of the body.

He attended the Proton Therapy Center in Prague for a total of 30 treatments. He celebrated the end of his treatment last Friday with his family, doctors and staff from the Proton Therapy Center, and is looking forward to returning to school after he completes his final course of chemotherapy.

Mother's feedback:

"The Proton Therapy Center in Prague clearly has a team of experienced professionals who use advanced proton technology to treat cancer. Everyone here is so kind to us - the staff are always smiling and do anything and everything they can to help. I feel that our son is in excellent hands here, and the pleasant atmosphere here has a positive impact on my son - I feel so relieved that he is relaxed and happy here."

Congratulations Tom! We wish you and your family all the best for the future!

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Dr.Damien Bertrand, IBA
http//: www.iba-protontherapy.com

http//: Slideshare.net (slide 62 and 63)

http//: Google

http//: Wikipedia

БЛАГОДАРЯ ВИ
ЗА ВАШЕТО ВНИМАНИЕ!

THANK YOU VERY MUCH
FOR YOUR ATTENTION!