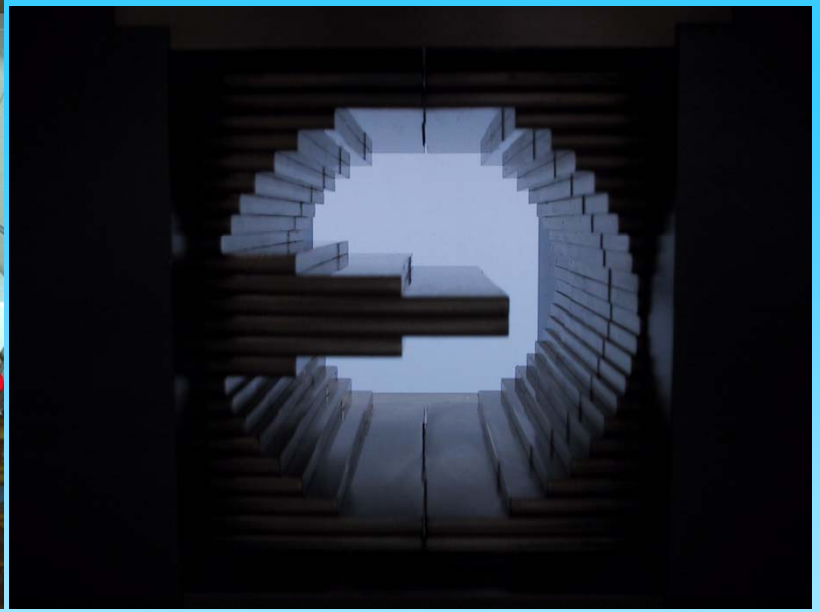
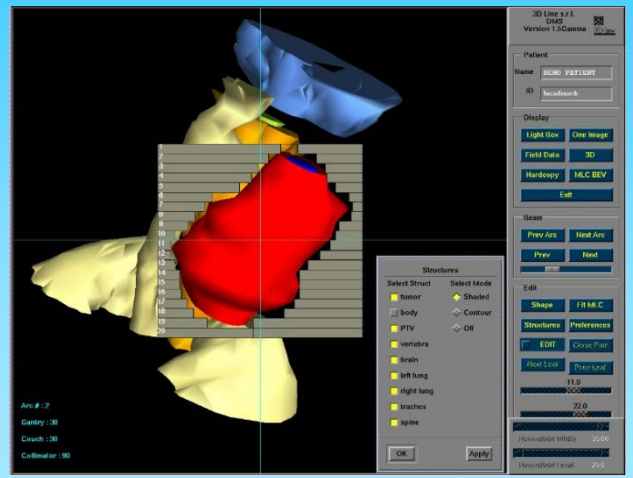
OIRM – S. ANNA

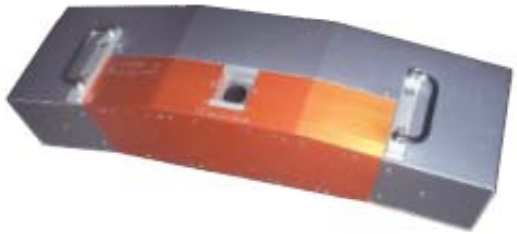
DynART – IMAT 1997-2008



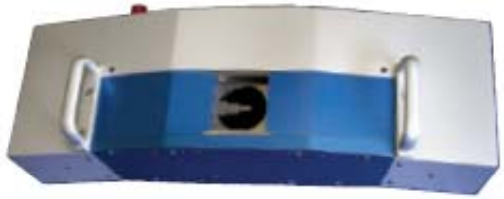


Sistemi in commercio

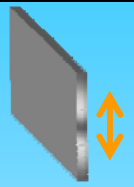
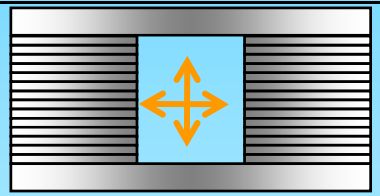
L'ARANCIO



L'AZZURRO



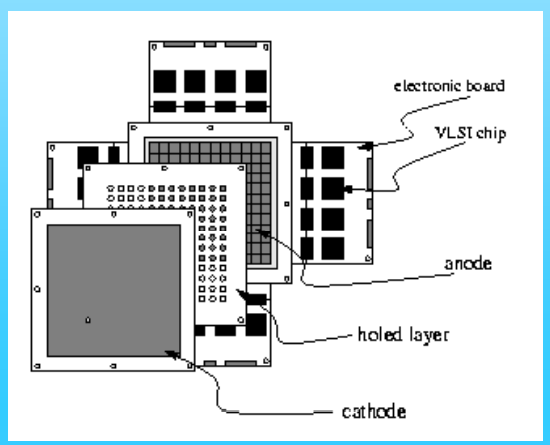
IL VERDE

✓ Leaf- & Field Size	L'Arancio	L'Azzurro	Il Verde
 Mechanical Isocenter	1,9 mm 3 mm	3,3 mm 5 mm	4,6 mm 7 mm
	80 mm	80 mm	70 mm
	70x70 mm	100x120 mm	140x170 mm

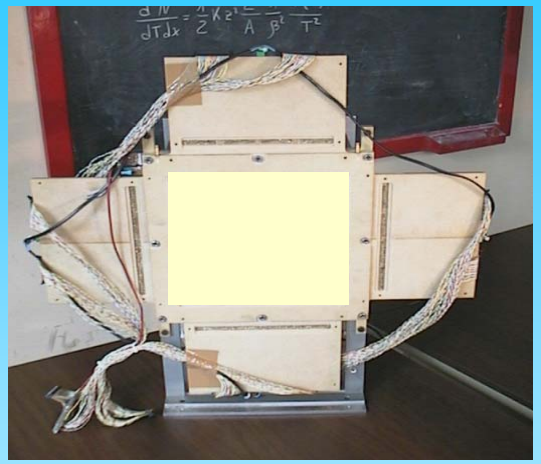
DOSIMETRIA DMLC

TPS verification - Treatment QC

PIXEL IONIZATION CHAMBER

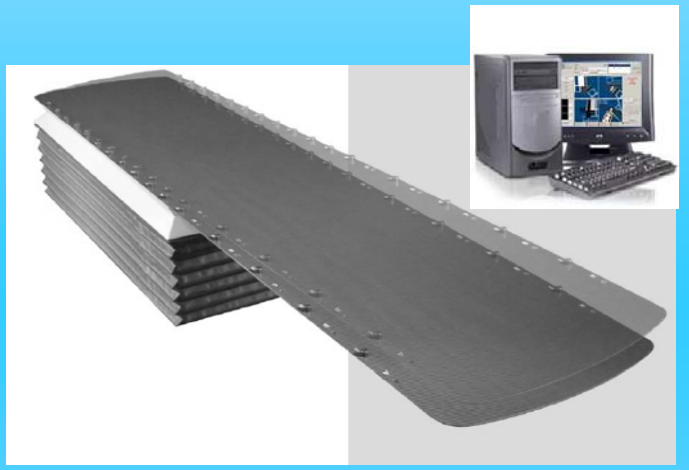


- ⇨ Segmented electrode (1024 7.5 mm square pixels)
- ⇨ 64 channel VLSI electronic circuit
- ⇨ microprocessor with operative system VxWorks
- ⇨ REAL TIME DATA (50 μs for 1024 channels)
- ⇨ SUPERIOR SPATIAL RESOLUTION
- ⇨ QUALITATIVE COMPARISON

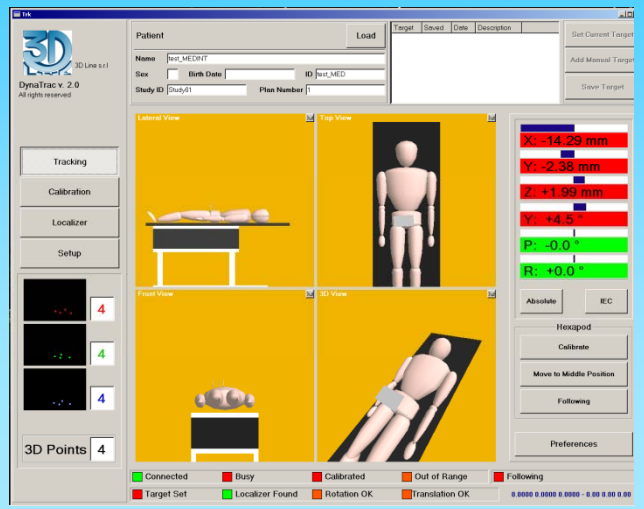


Sistemi attualmente in uso
OIRM S.Anna

	Positioning Accuracy	Range of Linear Motion	Range of Angulation	Weight Limits
HexaPOD Couch Top	+/- 0.2mm	Vertical +/- 40mm Lateral +/-30mm Longitudinal +/-30mm	Tilt +/-3° Roll +/-3° Rotation +/-3°	192kg
HexaPOD Couch	+/- 0.2mm	Vertical +/-100mm Lateral +/-60mm Longitudinal +/-60mm	Tilt +/-3° Roll +/-3° Rotation +/-3°	192kg



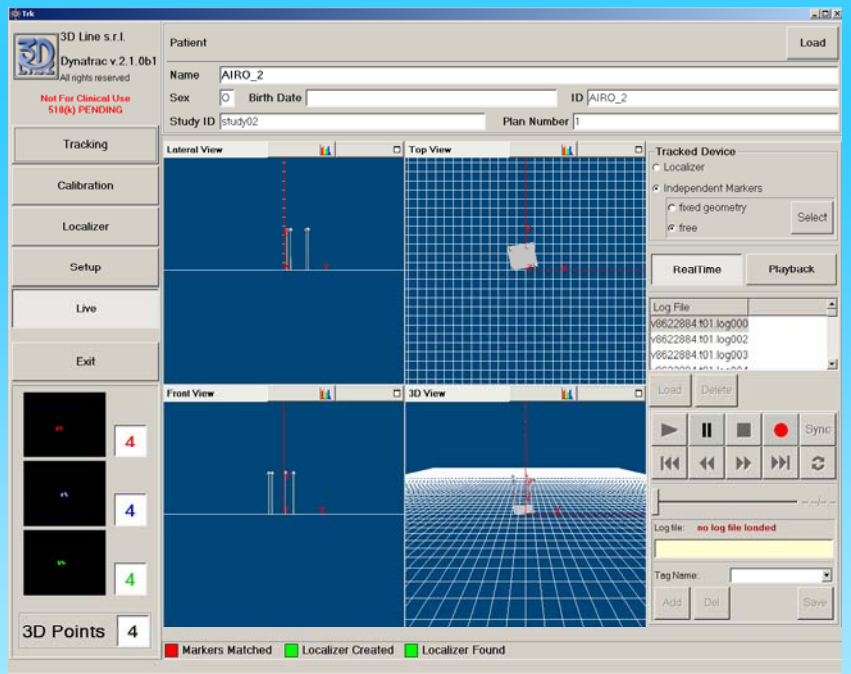
5 mm leaves
11 cm max field

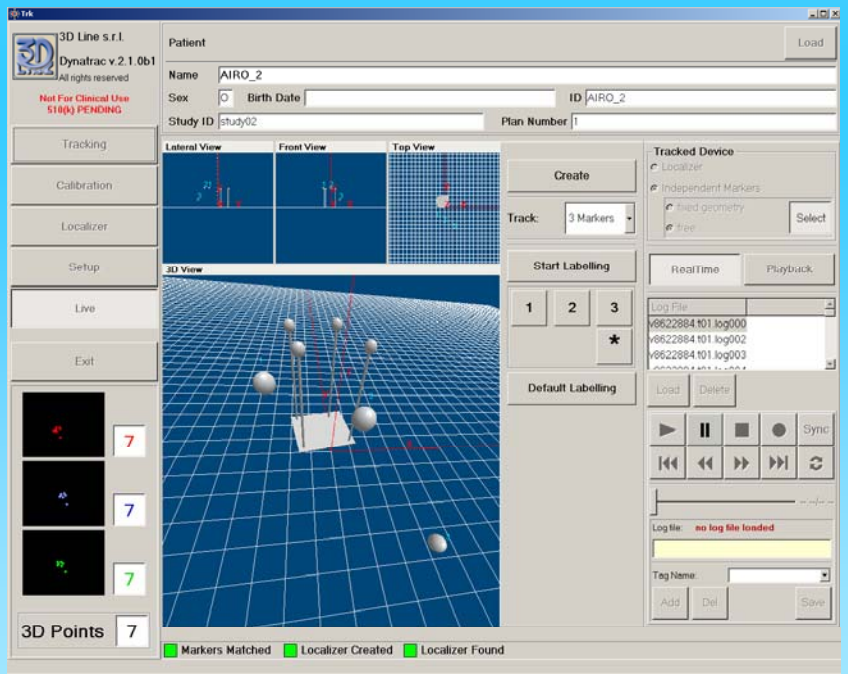


OIRM – S. Anna

STEREO polmonari 2000 – 2008

Utilizzo del sistema Freedom per il controllo del movimento dell'organo

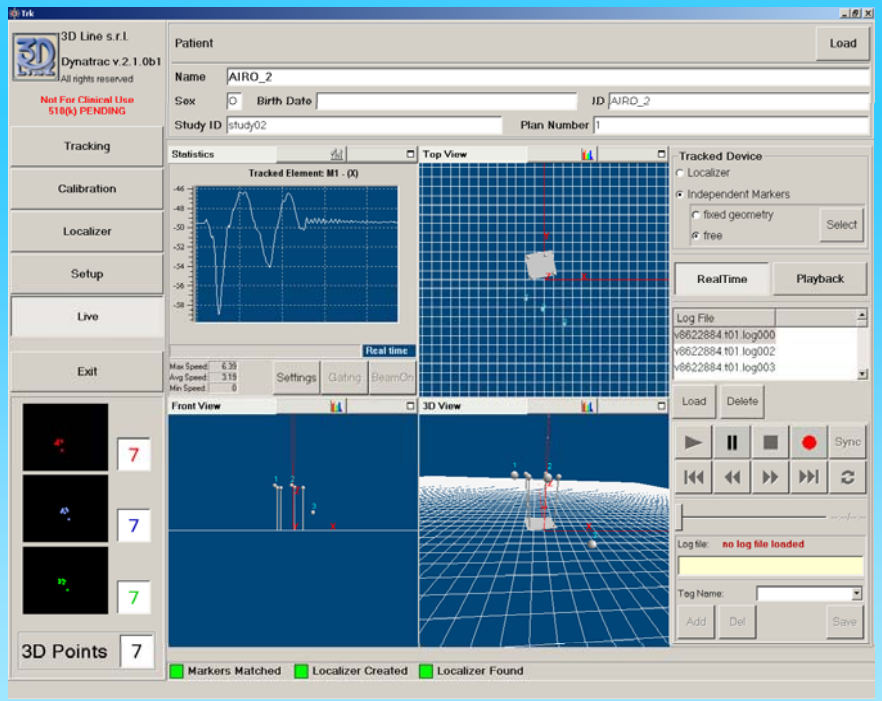


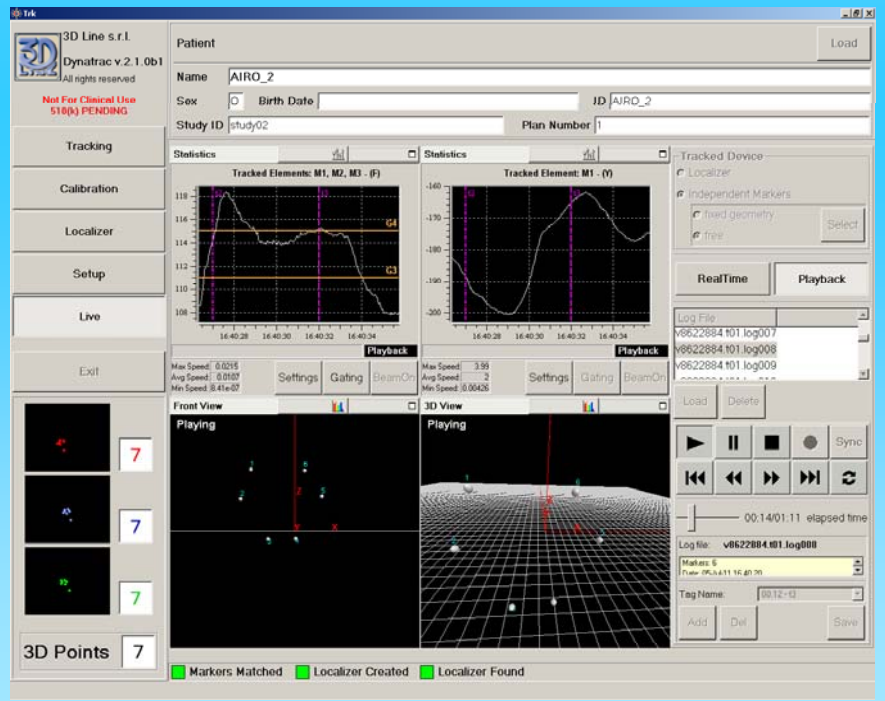


OIRM – S. Anna

STEREO polmonari 2000 – 2008

Utilizzo del sistema Freedom per il controllo del movimento dell'organo



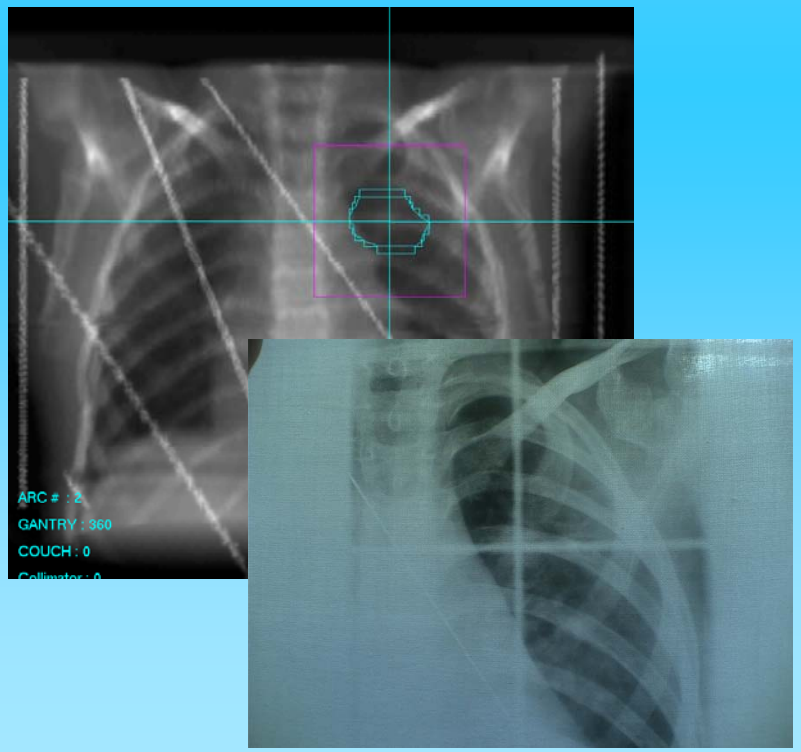


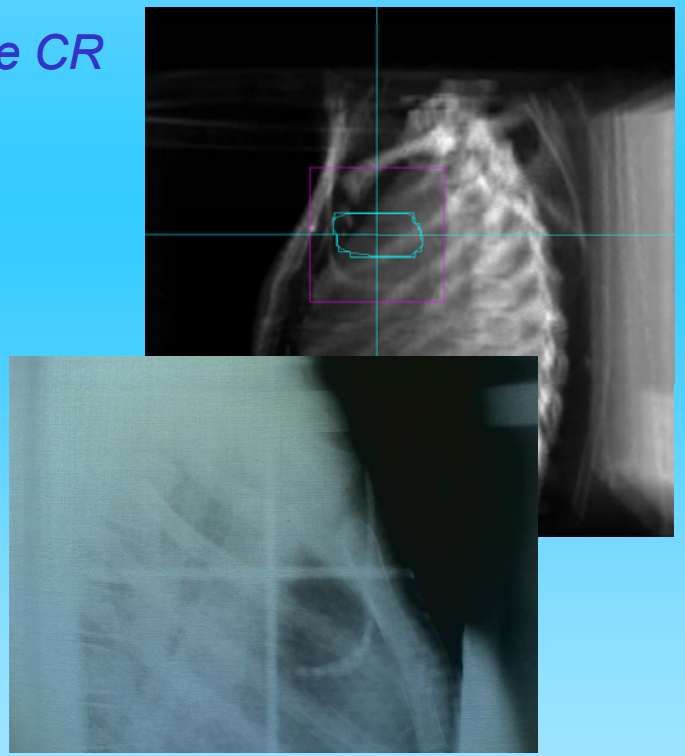
OIRM – S. Anna

STEREO polmonari 2000 – 2008

Localizzazione stereotassica

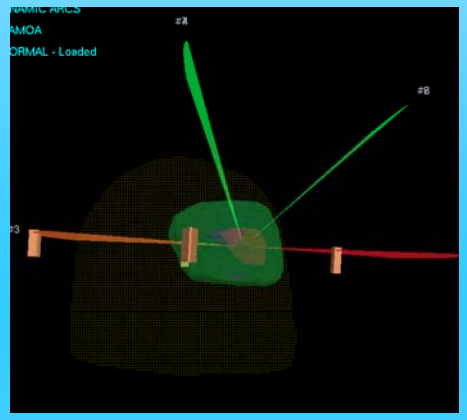
Verifica localizzazione stereotassica mediante CR

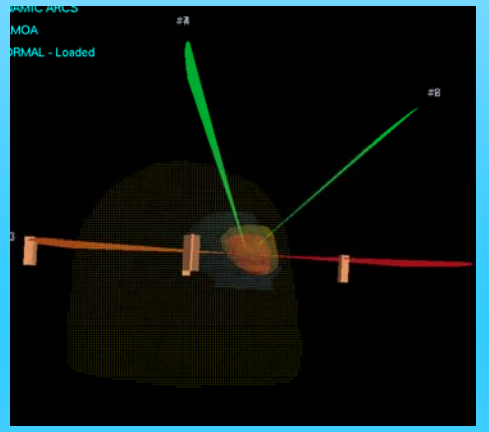




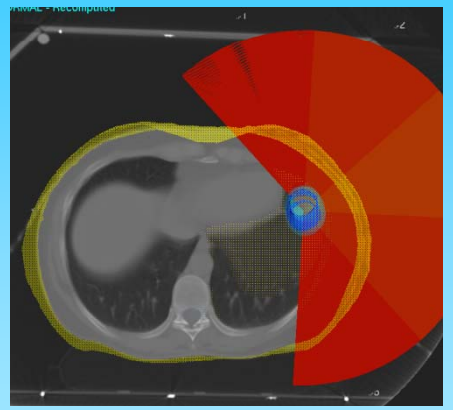
Geometrie di trattamento

SNC: DYNART, IMAT(SIB)





POLMONE: IMAT



PROSTATA:IMAT, VMAT “manuale”

OIRM – S. Anna

IMAT, VMAT PROSTATA 2007 – 2008

- *25 pazienti studiati*
- *17 trattati con IMAT nel 2007, 8 trattati con VMAT nel 2008*

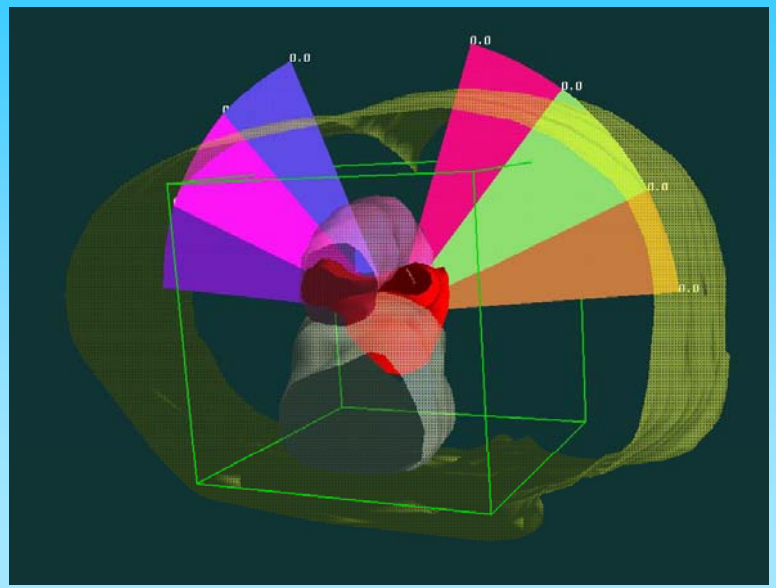
Parametri CONFRONTO DOSIMETRICO:

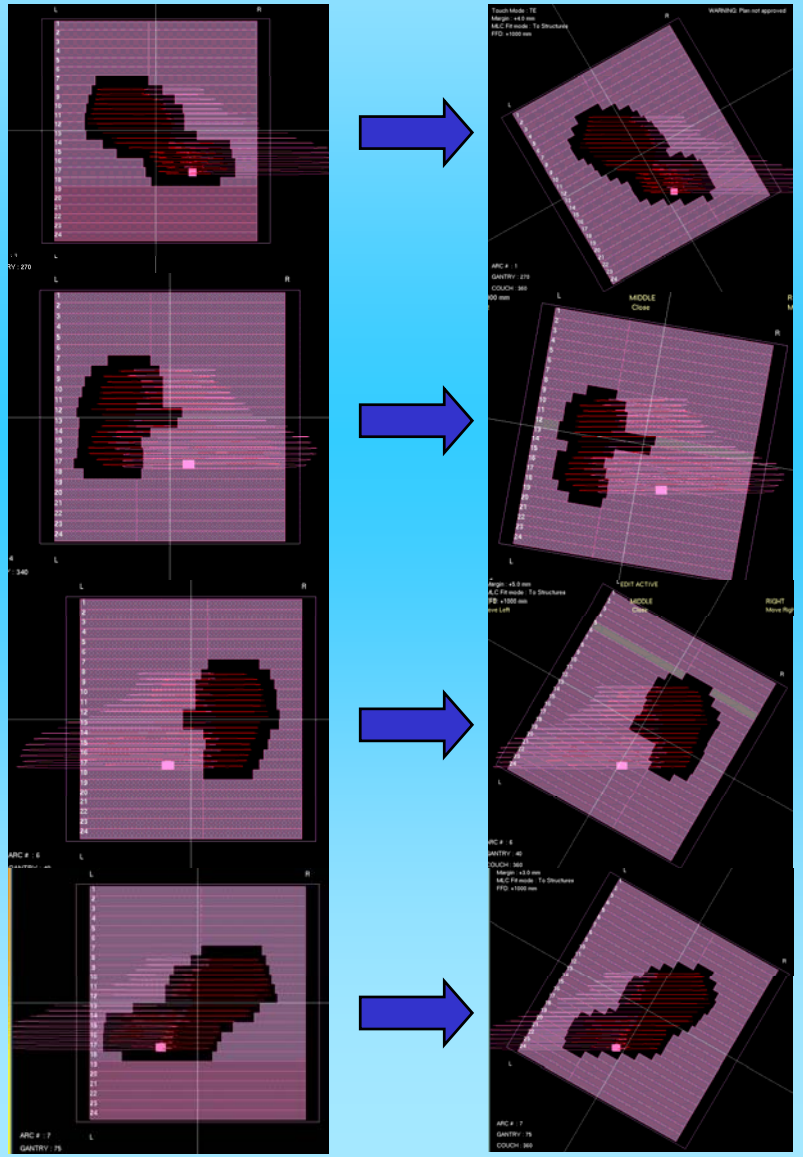
- *MIGLIOR CONFORMAZIONE*
- *AUMENTO DOSE MINIMA, MINORE DOSE MAX*
- *RISPARMIO OAR*

OIRM – S. Anna

IMAT, VMAT PROSTATA 2007 – 2008

- *25 pazienti studiati*
- *Tecnica: IMAT / VMAT*
- *2 archi 65-70°*
- *Evoluzione tecnica (“manual” VMAT)*





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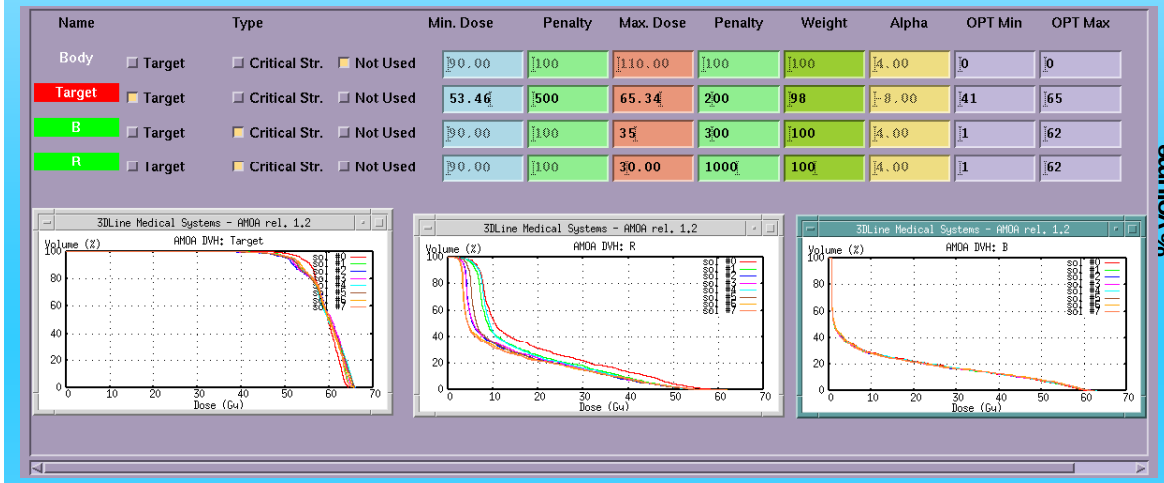
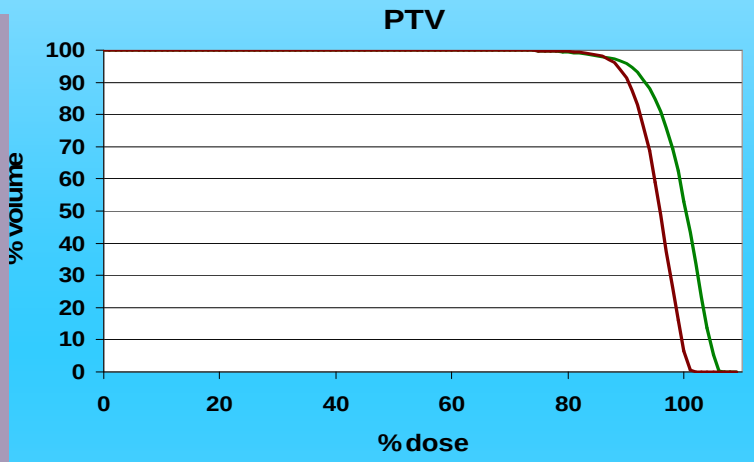
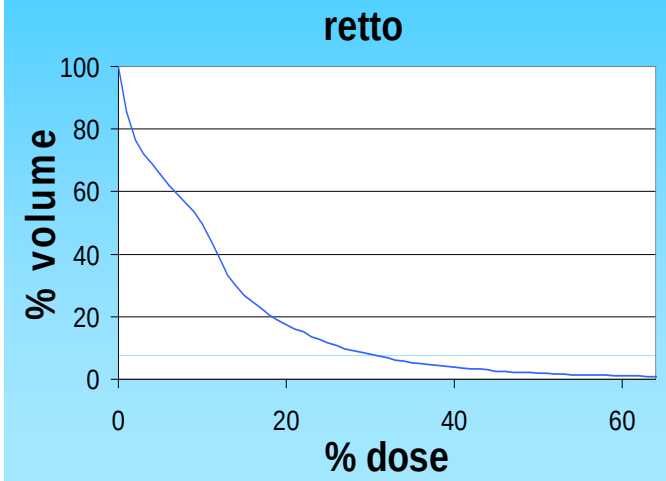
IMAT PROSTATA 1997 – 2008





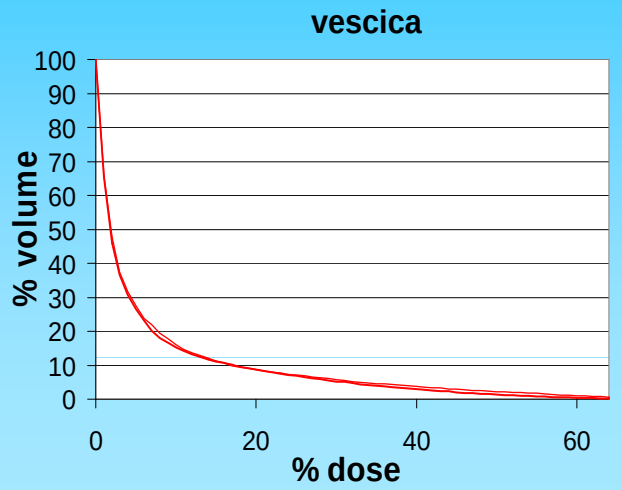


$CN_{PTV}(90)$

EUD_{PTV}

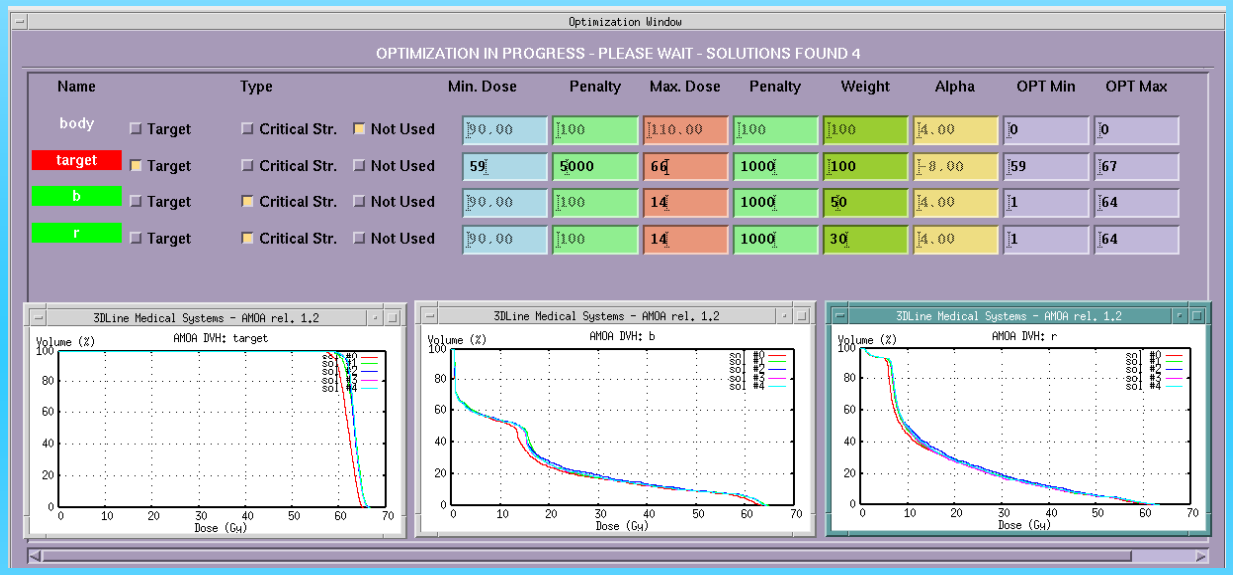
$D_{(V30retto)} D_{(V50retto)} D_{(V70retto)}$

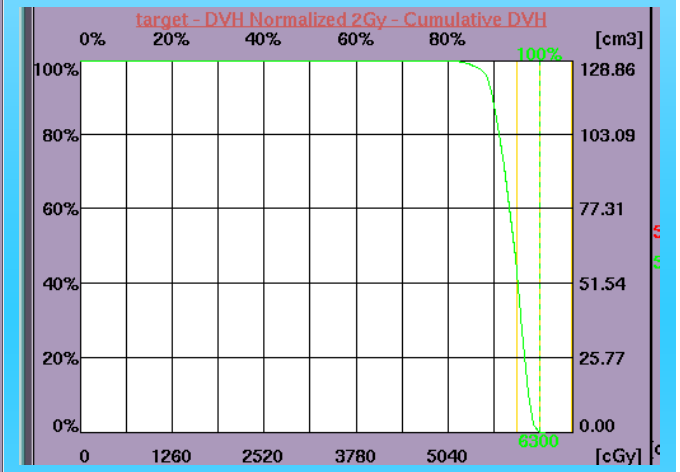
$D_{(V50vescica)}$

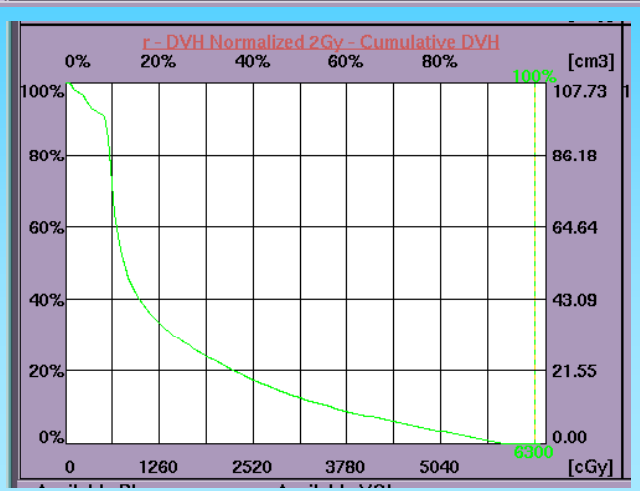


OIRM – S. Anna

VMAT PROSTATA 2007 – 2008





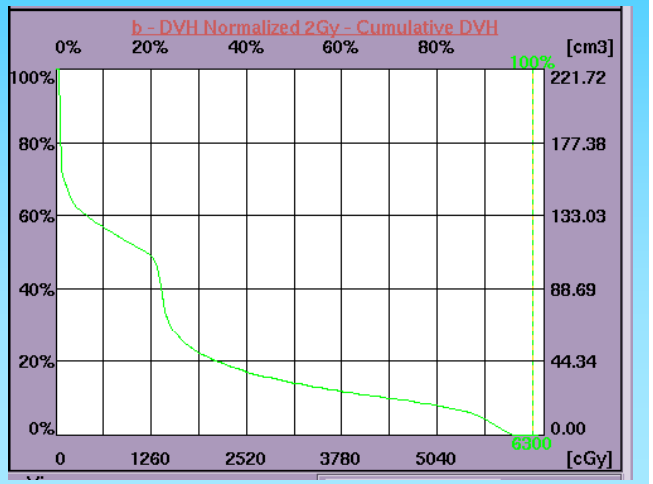


$CN_{PTV}(90)$

EUD_{PTV}

$D_{(V30retto)} D_{(V50retto)} D_{(V70retto)}$

$D_{(V50vescica)}$

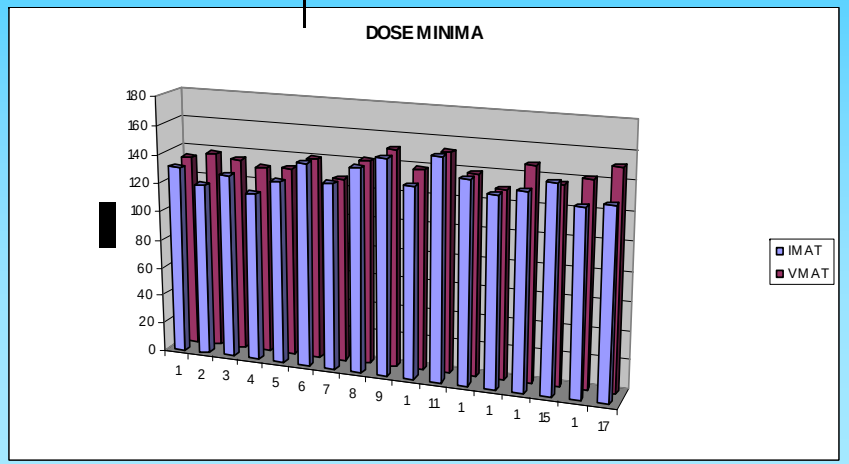


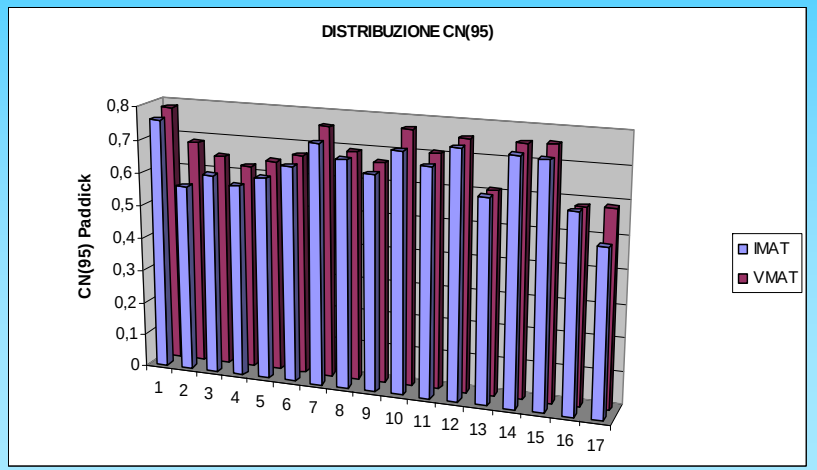
OIRM – S. Anna

CONFRONTO DOSIMETRICO IMAT vs VMAT

Analisi retrospettiva 17 pazienti trattati nel 2007

	IMAT	VMAT	p
CN (95)	0.66 ± 0.02	0.69 ± 0.02	<0.001
Dmin	134 ± 5	139 ± 4	0.036
Dmax	197 ± 2	194 ± 2	<0.001
Dmean	172 ± 2	177 ± 2	0.001





OIRM – S. Anna

CONFRONTO DOSIMETRICO

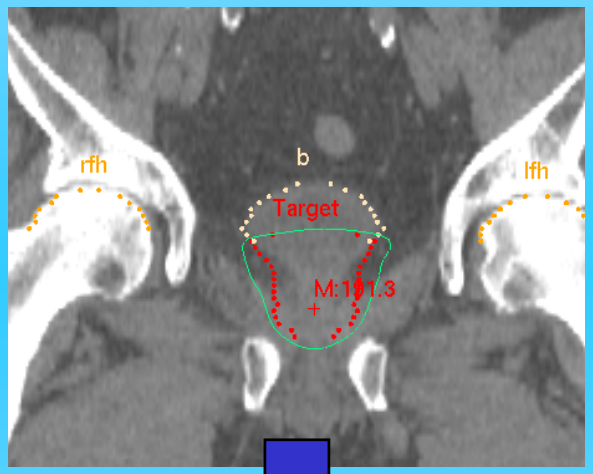
17 pazienti IMAT 2007 vs 8 pazienti VMAT 2008

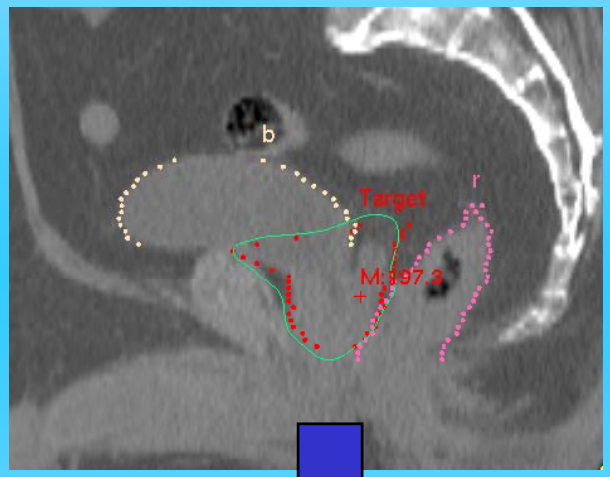
	IMAT	VMAT	
CN (95)	0.66 ± 0.02	0.72 ± 0.03	
Dmin	134 ± 5	149 ± 6	cGy/seduta
Dmax	197 ± 2	192 ± 3	cGy/seduta
Dmean	172 ± 2	180 ± 1	cGy/seduta
D30R	85 ± 8	63 ± 10	cGy/seduta
D50R	57 ± 5	43 ± 7	cGy/seduta
D70R	30 ± 4	21 ± 4	cGy/seduta
D50V	37 ± 11	11 ± 8	cGy/seduta

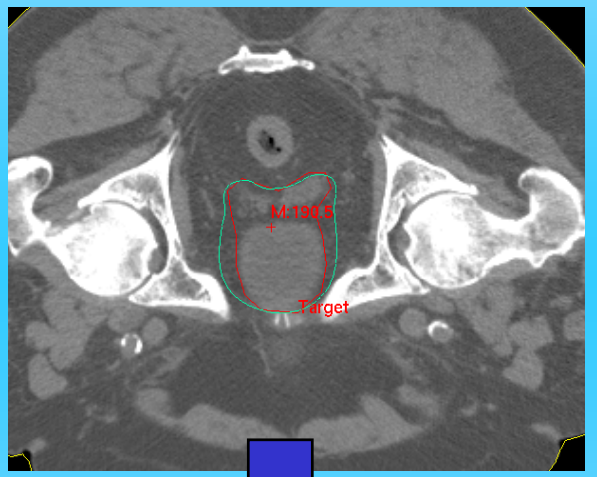
OIRM – S. Anna

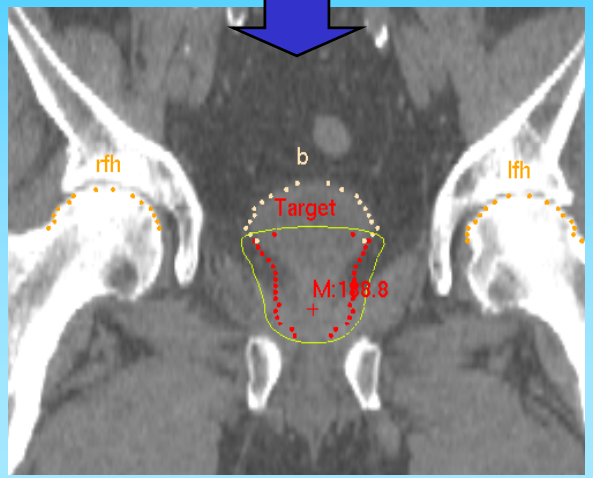
CONFRONTO DOSIMETRICO

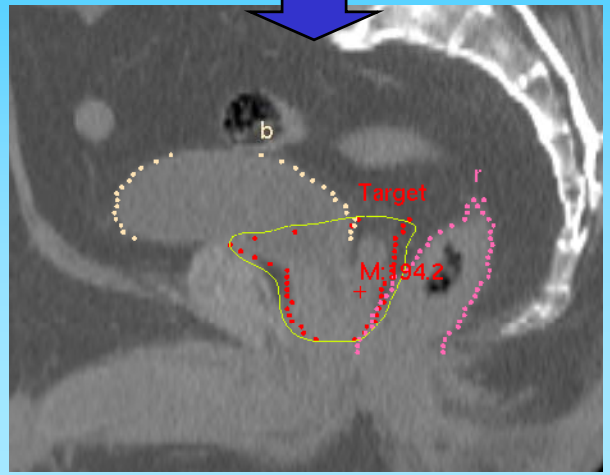
17 pazienti IMAT 2007 vs 8 pazienti VMAT 2008

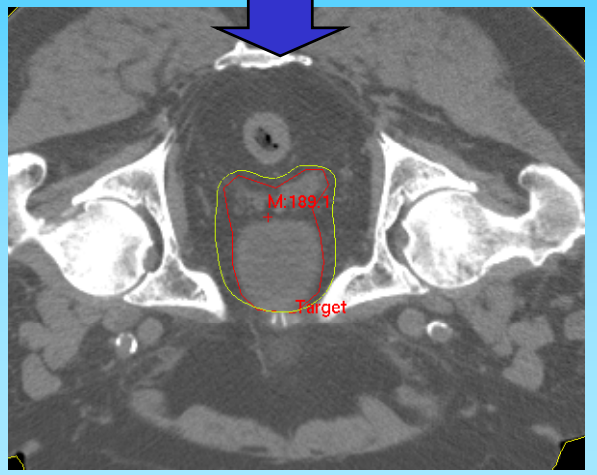








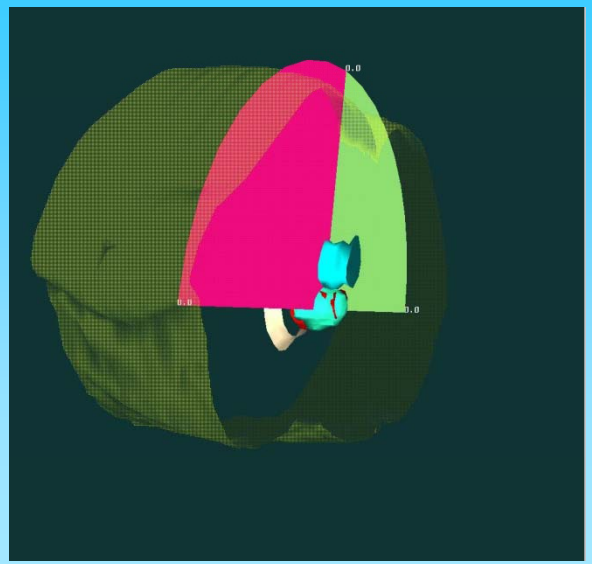


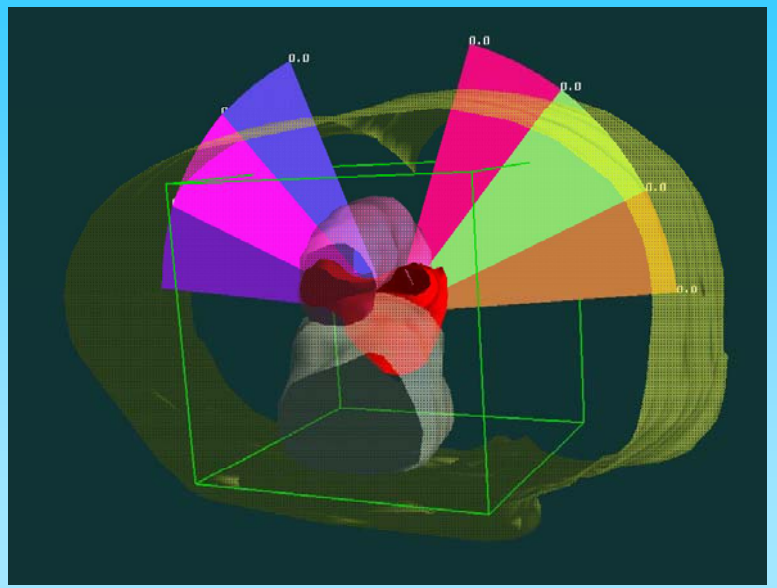


OIRM – S. Anna

DYNART-IMAT PROSTATA 1998 – 2008

- *271 pazienti*
- *Tecnica: DYNART - IMAT (2 archi CONFORMATI E MODULATI 65-70°)*
- *Dose: 66 – 81 Gy*
- *Evoluzione tecnica (“manual” VMAT)*





OIRM – S. Anna

DYNART-IMAT PROSTATA 1997 – 2008

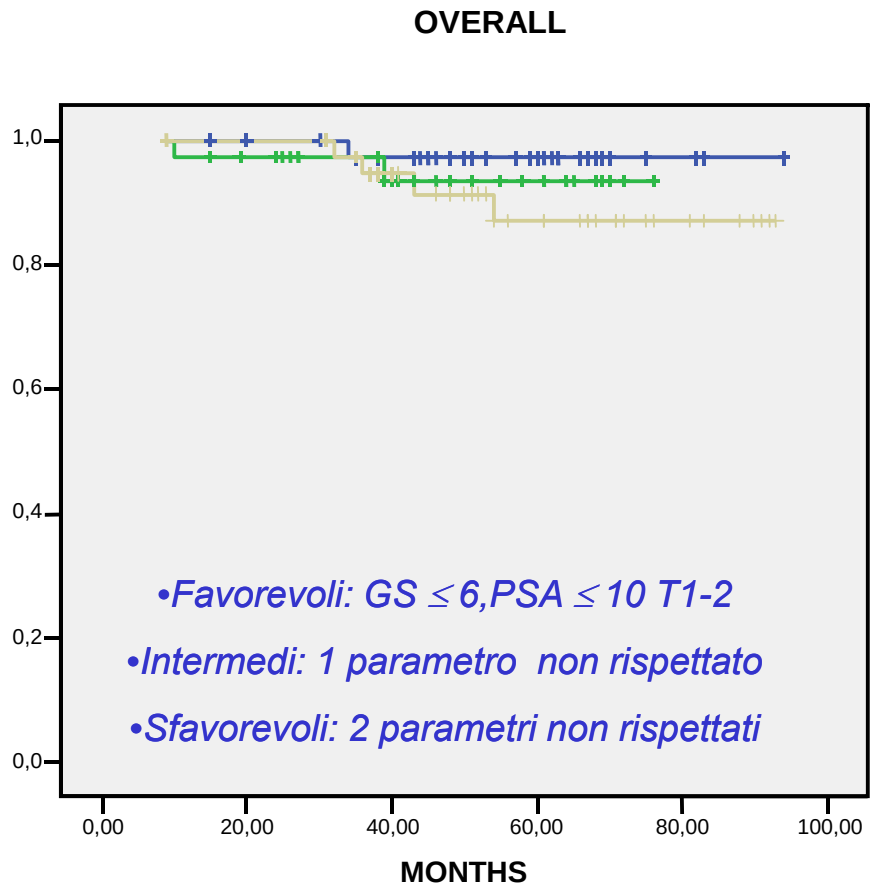
ANALISI STATISTICA

- DESEASE FREE / SURVIVAL vs DOSE TOTALE
- EFFETTI ACUTI / TARDIVI RETTO vs $DOSE_{V30/V50/V70}$ RETTO
- EFFETTI ACUTI / TARDIVI VESCICA vs $DOSE_{V50}$ VESCICA

127 pazienti non operati (T1-T3 N0 M0) trattati dal 1999 al 2005

Eta' media e mediana anni 71 (range 55-84)

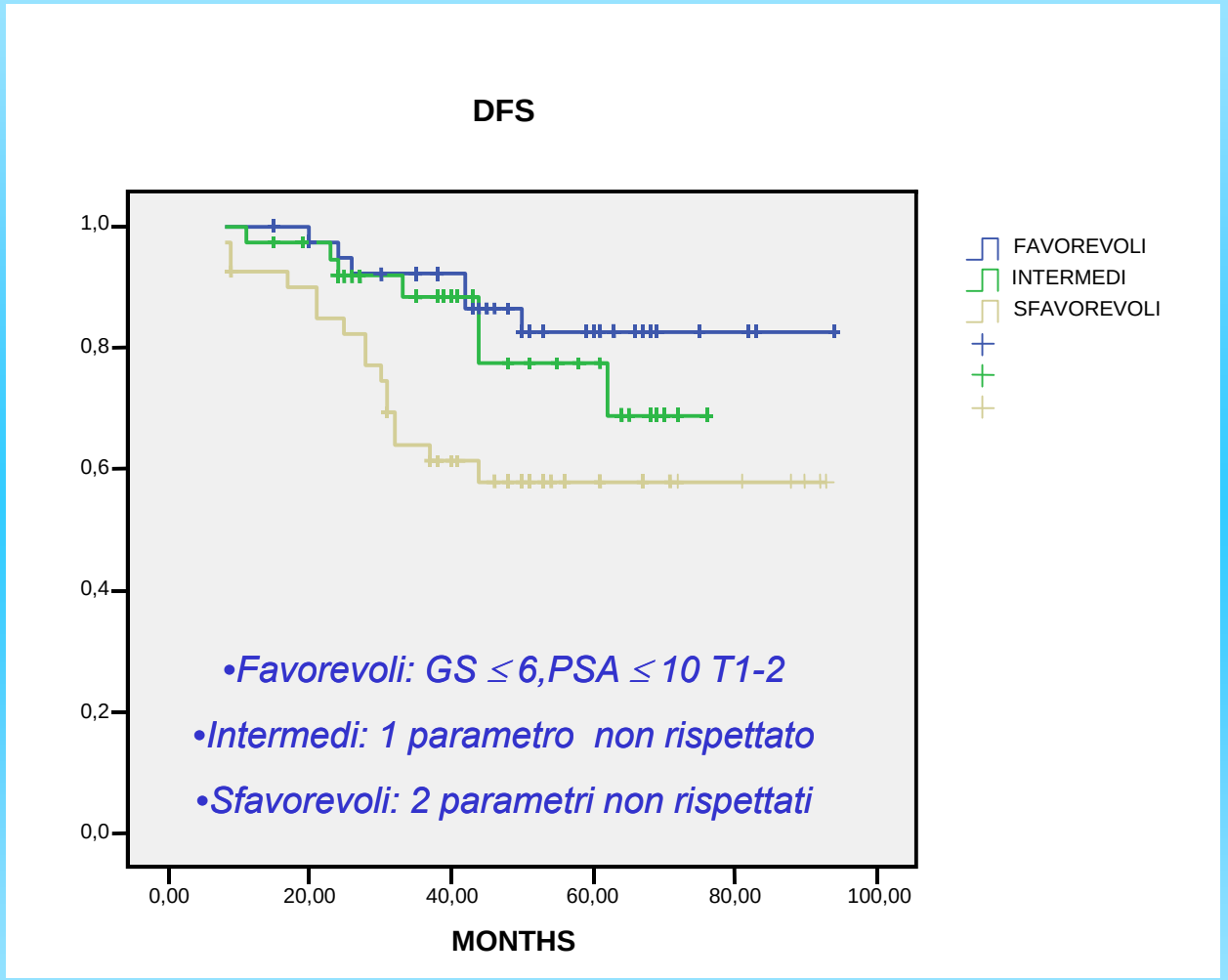
Follow up medio 50 mesi (range 24-94), mediana 51


OVERALL
1,0
0,8
0,6
0,4
0,2
0,0
0,00
20,00
40,00
60,00
80,00
100,00
MONTHS
FAVOREVOLI
INTERMEDI
SFAVOREVOLI
•Favorevoli: GS ≤ 6,PSA ≤ 10 T1-2
•Intermedi: 1 parametro non rispettato
•Sfavorevoli: 2 parametri non rispettati

97.5%

94.7%

90%

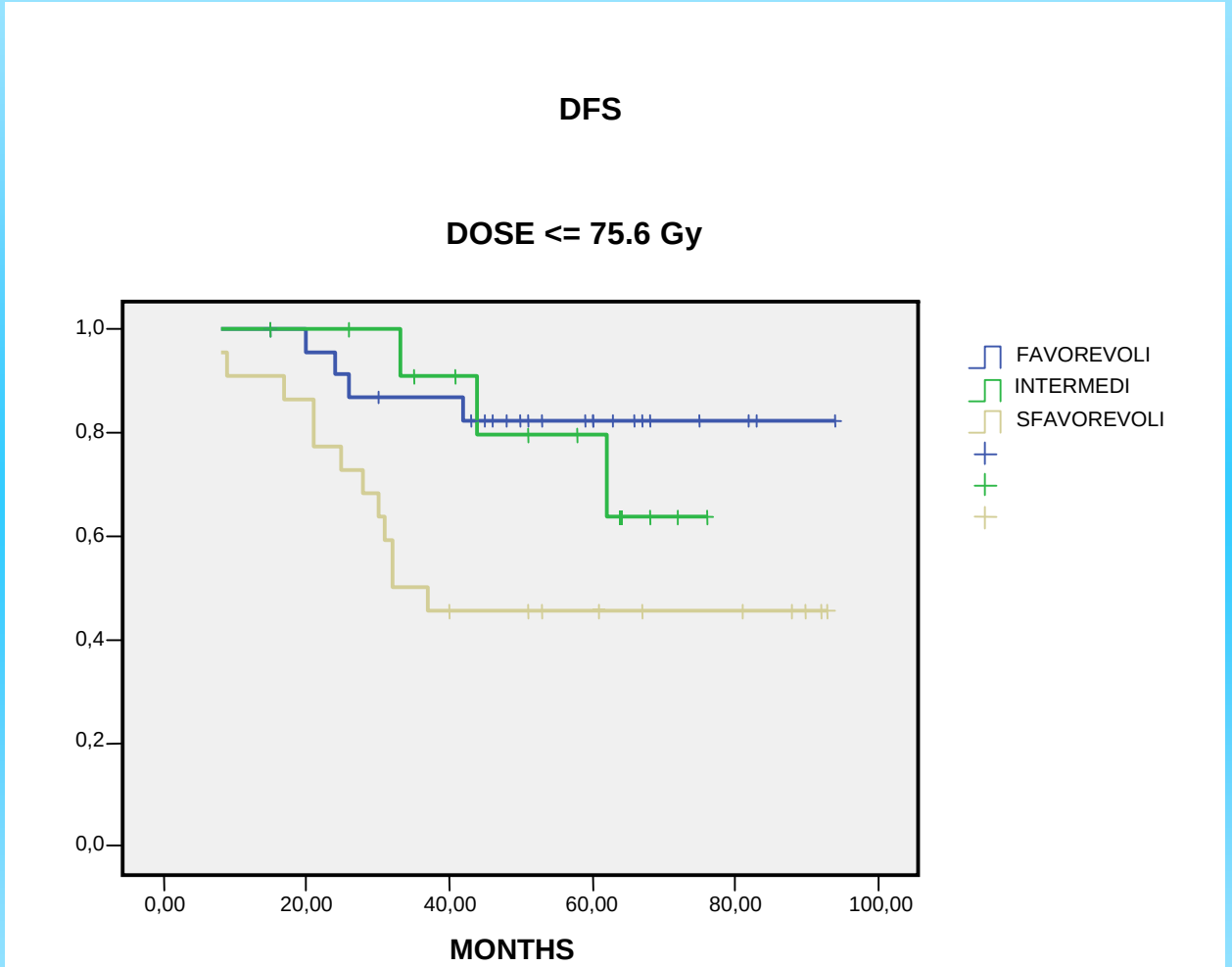


85%

81.6%

60%

P=0.016

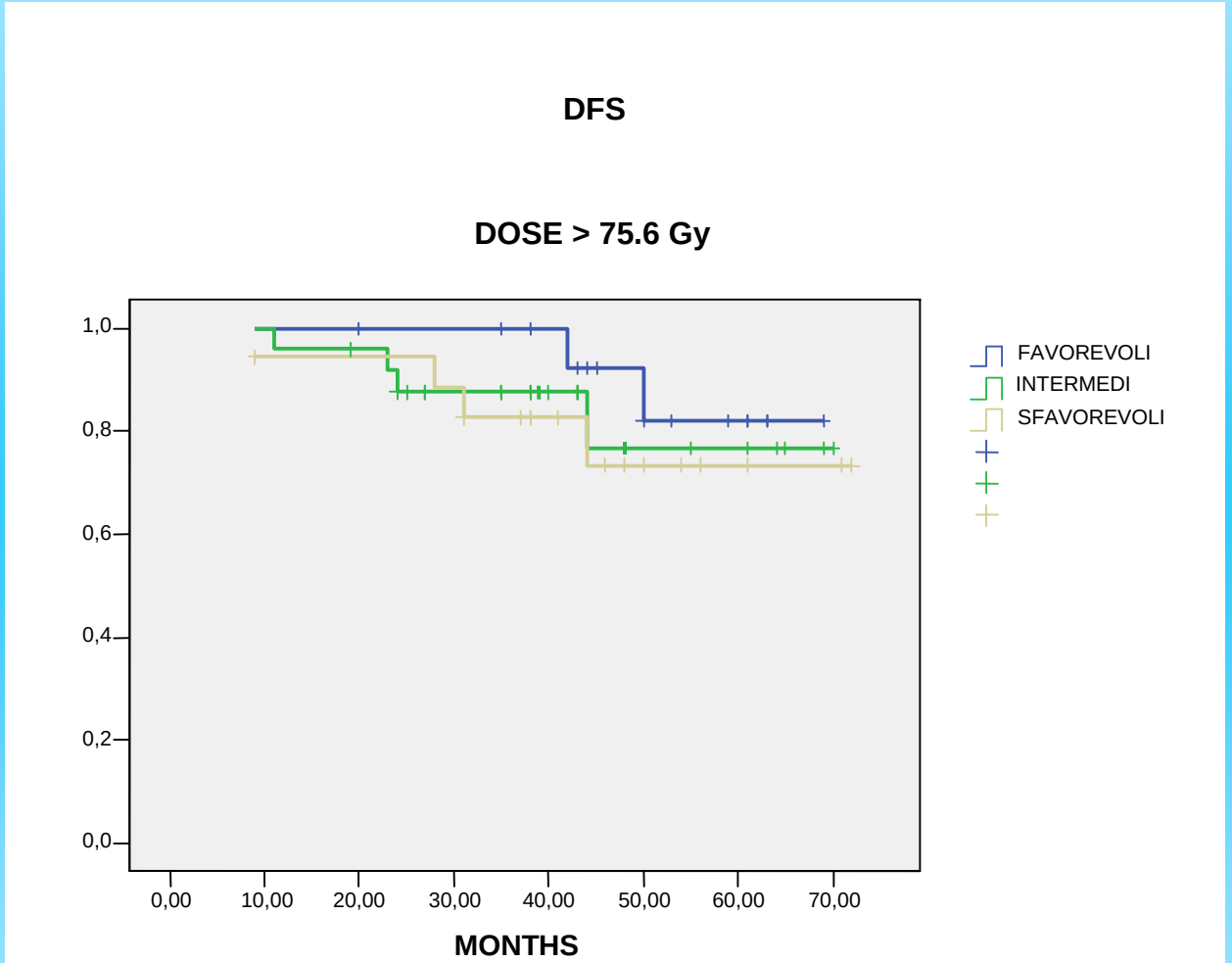


83.3%

76.9%

45.5%

P=0.017

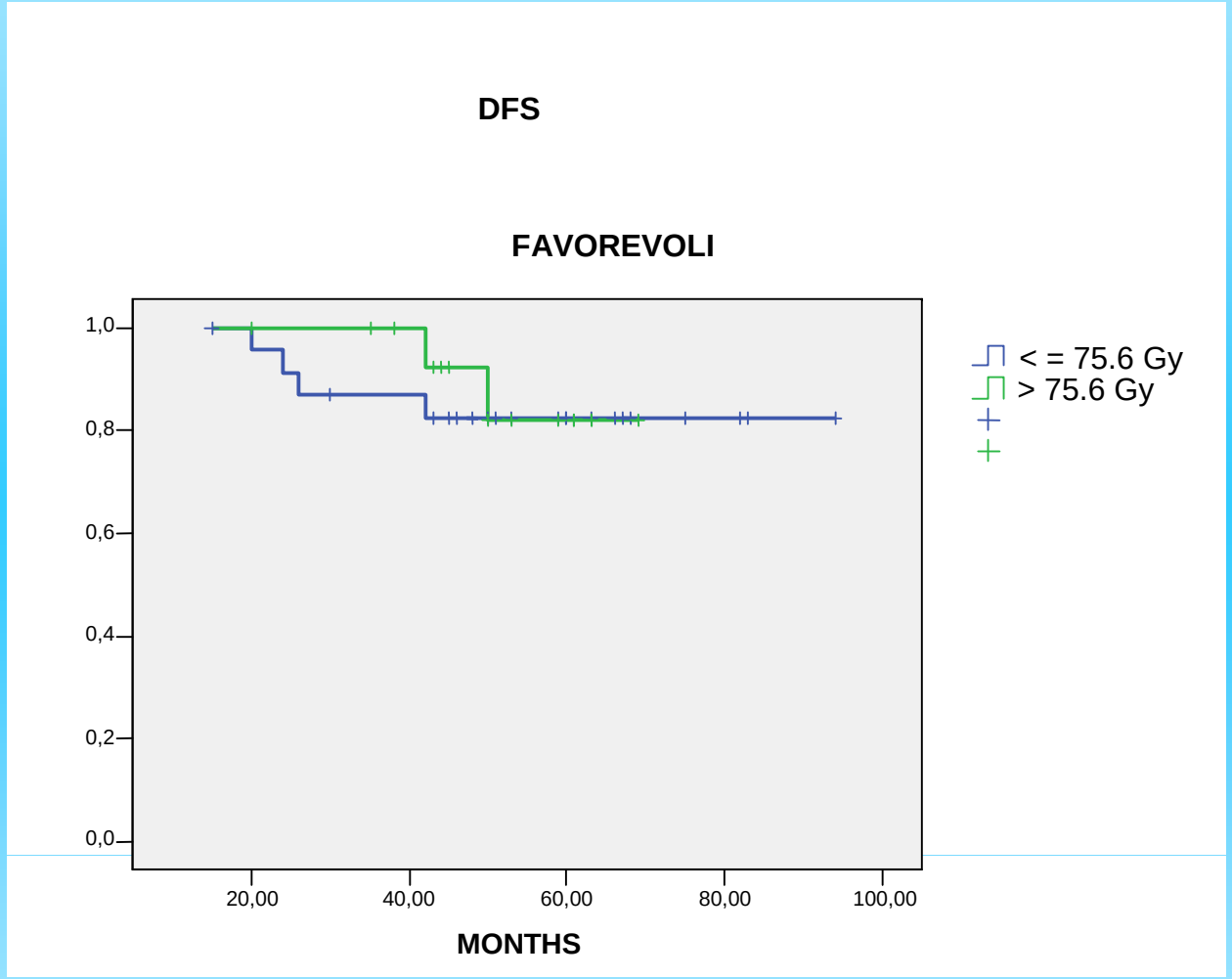


87,5%

84%

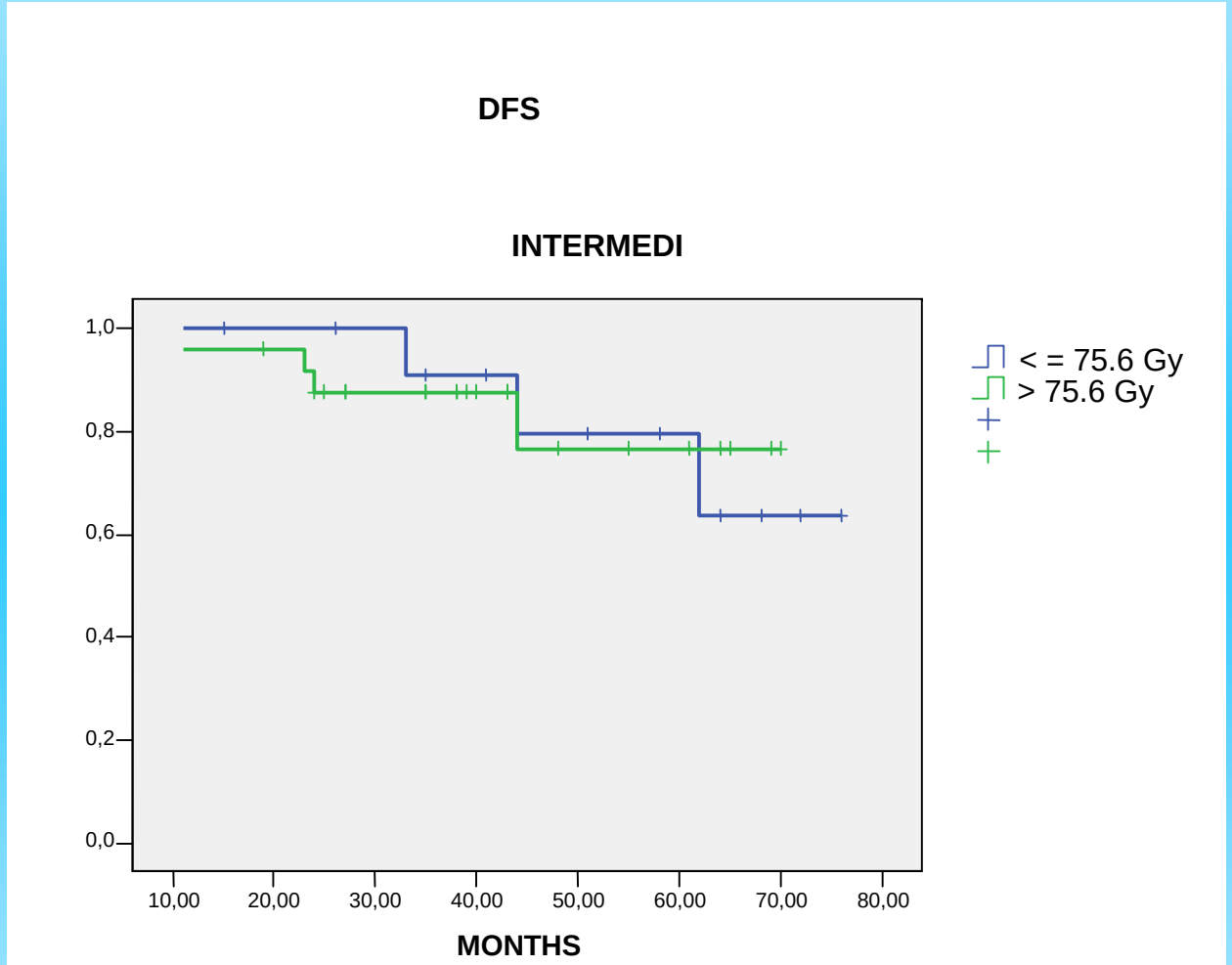
77.8%

P=0.017


DFS
FAVOREVOLI
1,0
0,8
0,6
0,4
0,2
0,0
20,00
40,00
60,00
80,00
100,00
MONTHS
< = 75.6 Gy
> 75.6 Gy

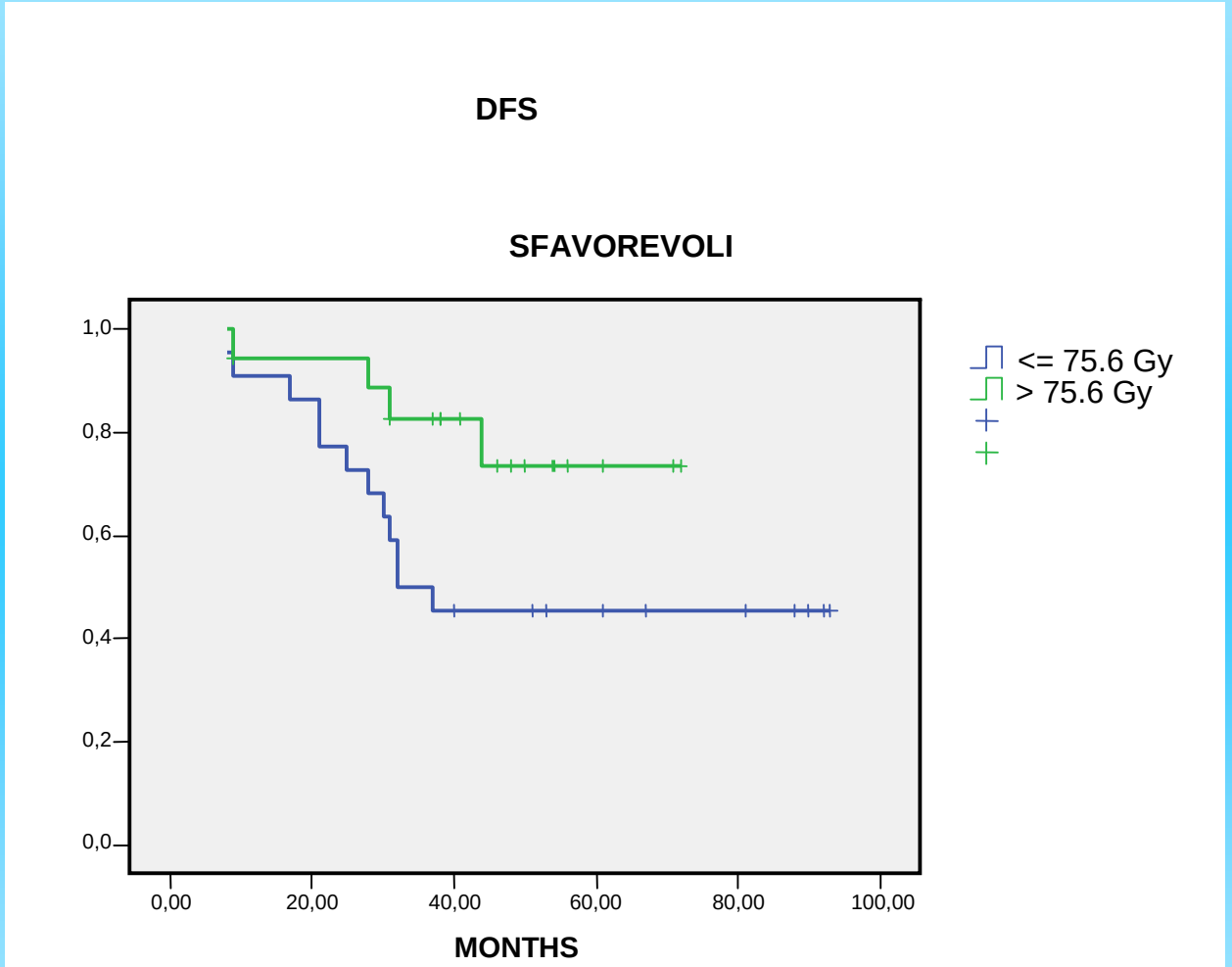
87,5%

83.3%


DFS
INTERMEDI
1,0
0,8
0,6
0,4
0,2
0,0
10,00
20,00
30,00
40,00
50,00
60,00
70,00
80,00
MONTHS
< = 75.6 Gy
> 75.6 Gy

84%

76.9%


DFS
SFAVOREVOLI
1,0
0,8
0,6
0,4
0,2
0,0
0,00
20,00
40,00
60,00
80,00
100,00
MONTHS
<= 75.6 Gy
> 75.6 Gy

77.8%

45.5%

EFFETTI ACUTI

Grado tossicità	Gastointestinale	DR30	DR50	DR70	Urinario	DV50
0	105 (82,7%)	21	13	7	106 (83,5%)	12
1	22 (17,3%)	26	15	8	21 (16,5%)	12
2	0				0	
3	0				0	

EFFETTI TARDIVI

Grado tossicità	Gastointestinale	DR30	DR50	DR70	Urinario	DV50
0	119 (93,7%)	20	10	5	96 (75,6%)	9
1	5 (3,9%)	30	17	10	27 (21,2%)	15
2	3 (2,4)	20	10	2	4 (3,2%)	6
3	0				0	

OIRM – S. Anna

Trattamenti stereotassici cerebrali 1997-2008

1050

- Radiochirurgie **603**
  - Maligne **553**
  - Benigne **37**
  - Pediatrici **13**
  - Coll Multilamellari **177**
  - Coll Circolari **426**
    - Immobilizzazione invasiva **140 [1 (3mm)]**
    - Immobilizzazione non invasiva **286**
- Radioterapie Frazionate **447**
  - Maligne **271**
  - Benigne **125**
  - Pediatrici **51**

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SRS and fSRT 1997-2008

Evoluzione delle tecniche

- Collimatori conici
- Collimatori micromultilamellari dinamici

DYNART ➡ IMAT

Definizione di criteri di scelta tra tecniche differenti

- Indici geometrici e/o radiobiologici

⬇

Protocolli di trattamento differenti

SIB

Evoluzione tecnica: CONFRONTO

collimatori circolari - multilamellari

Target irregolare 1° caso :Astrocitoma anaplastico: Volume 8.8 cc

Geometria di irradiazione

- *isocentri multipli (4) e diametri differenti (20, 18 e 2 da 30 mm) per collimatori circolari*
- *Geometria regolare (1 solo isocentro) con DMLC*

Prescrizione

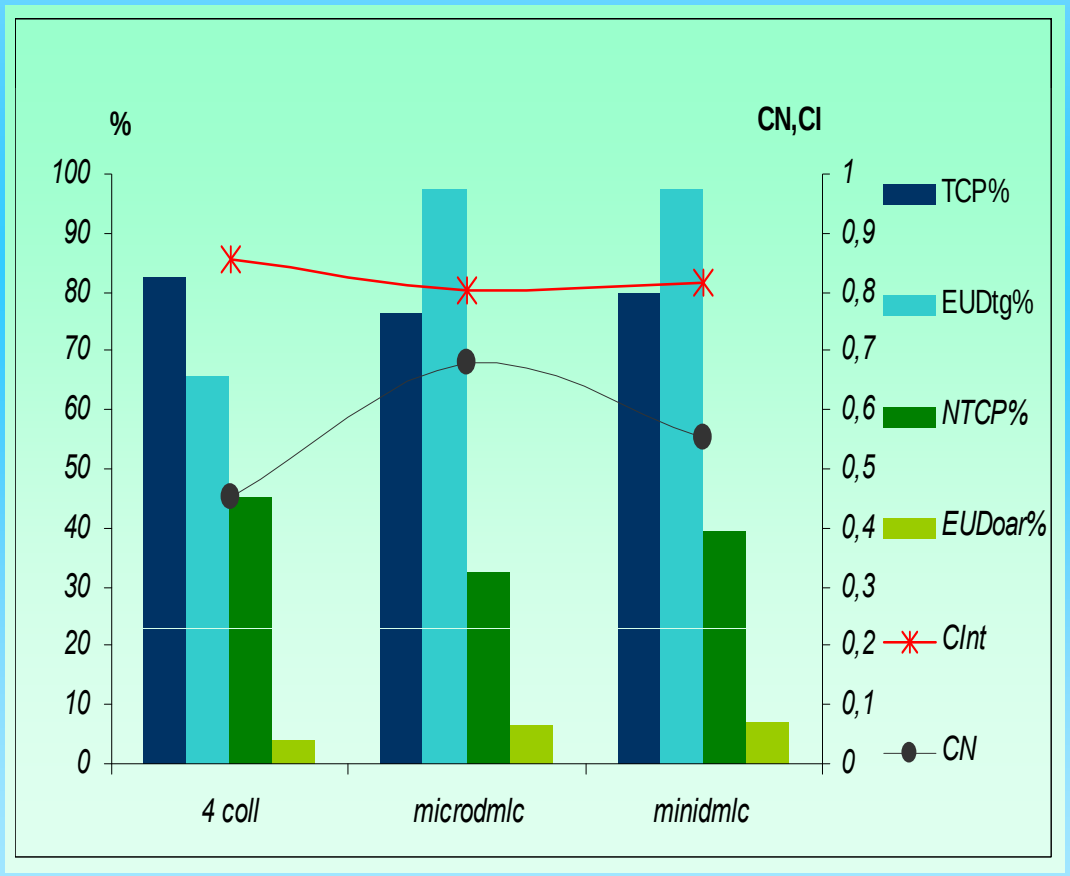
15 Gy su isodose:

- *⇒55% per collimatori circolari*
- *⇒90% per microDMLC*
- *⇒85% per miniDMLC*

Evoluzione tecnica: CONFRONTO

collimatori circolari - multilamellari

Target irregolare 1° caso :Astrocitoma anaplastico: Volume 8.8 cc



TARGET
MicroDMLC > EUD
> CN

ORGANI A RISCHIO
MicroDMLC < NTCP
Collimatori Circolari < EUD

Parametri radiobiologici lesione

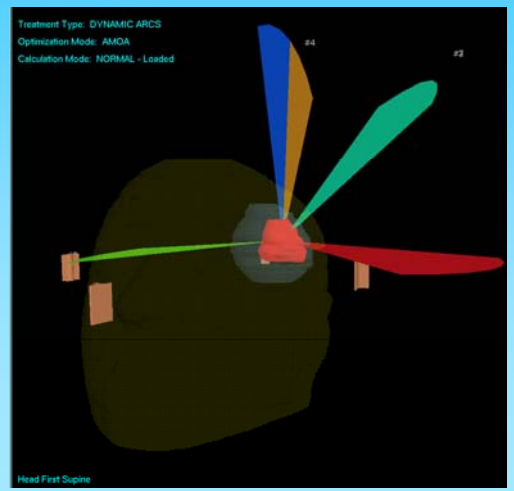
α/β=8,4 TD_{50}=11,3 Gy γ_{50}=0,75

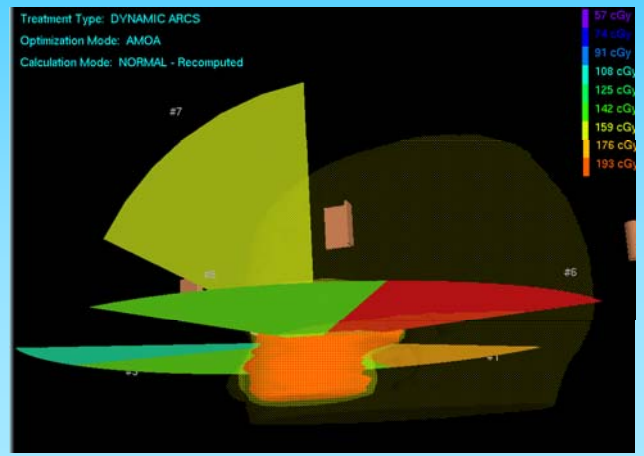
Evoluzione tecnica 2007 - 2008

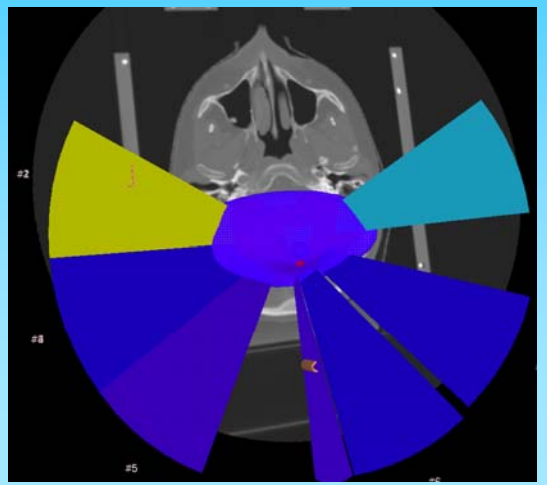
DYNART ⇨ IMAT

Radioterapie Frazionate **64**

- Maligne **48**
  - DYNART **38**
  - IMAT **10**
- Benigne **8**
  - DYNART **6**
  - IMAT **2**
- Pediatrici **8**
  - DYNART **5**
  - IMAT **3**







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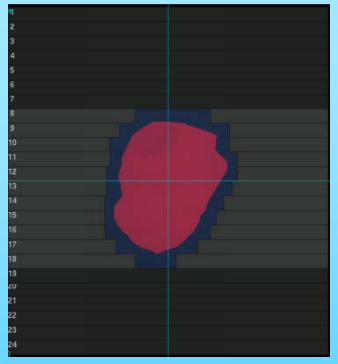
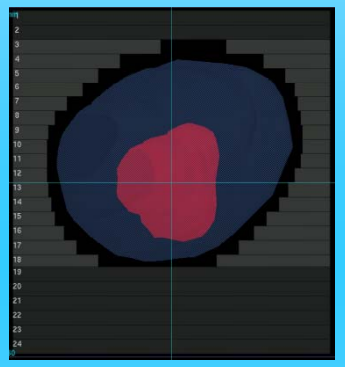
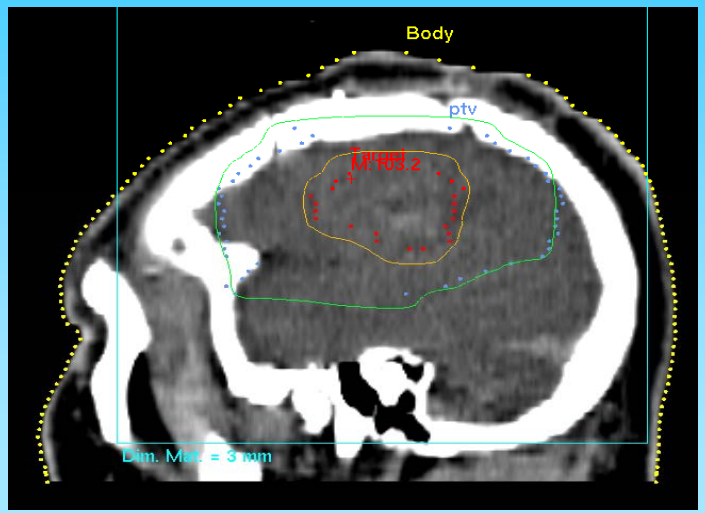
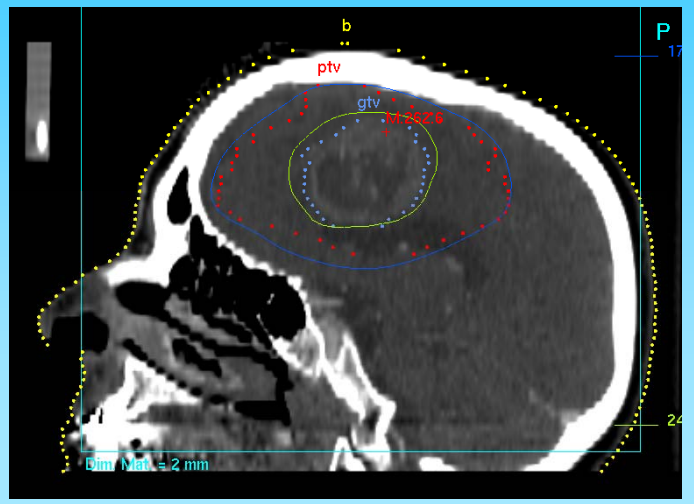




- *10 pazienti trattati (6 maschi 4 femmine)*
- *Performance status: ECOG 0-1 Età media 56 anni*
- *Tecnica: VMAT (4 archi CONFORMATI E RIPETUTI)*
- *Dose: 82,50 Gy (CTV) 59,40 Gy (PTV) in 33 sedute*
- *Dose per frazione: 2.5 Gy (CTV) 1.8 Gy (PTV)*





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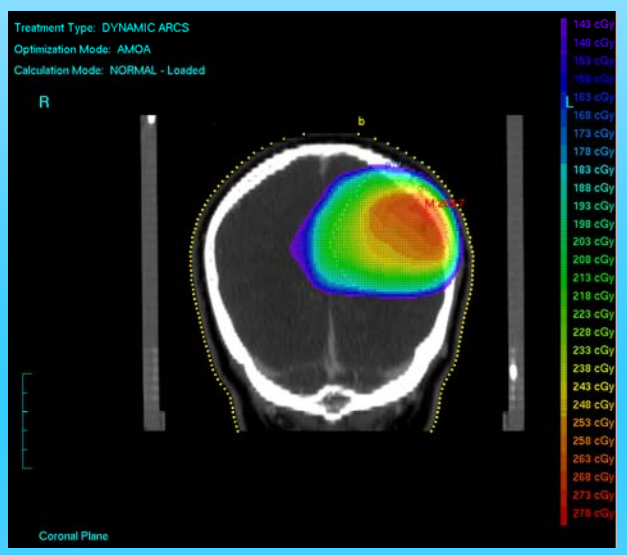
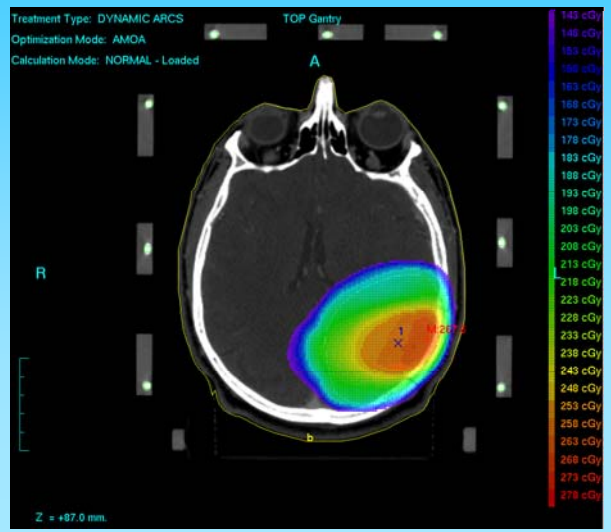
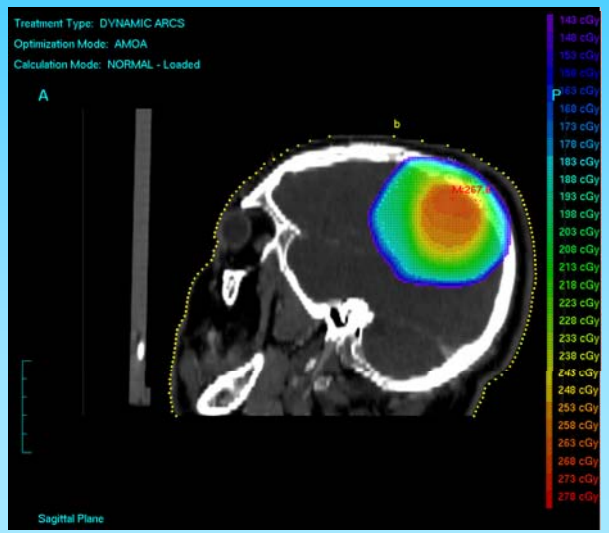
SIB 2007 – 2008

- *data set immagini: fusione CT-MR*
- *definizione GTV: contrast-enhancing in MR*

  (GTV madio 43 ± 7 cc)
- *definizione CTV : GTV + 2 cm*
- *definizione PTV : CTV + 0,5 cm*







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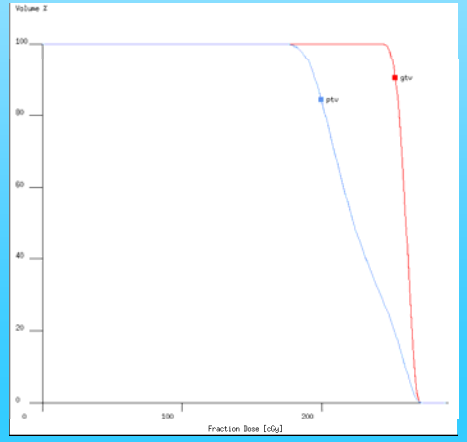
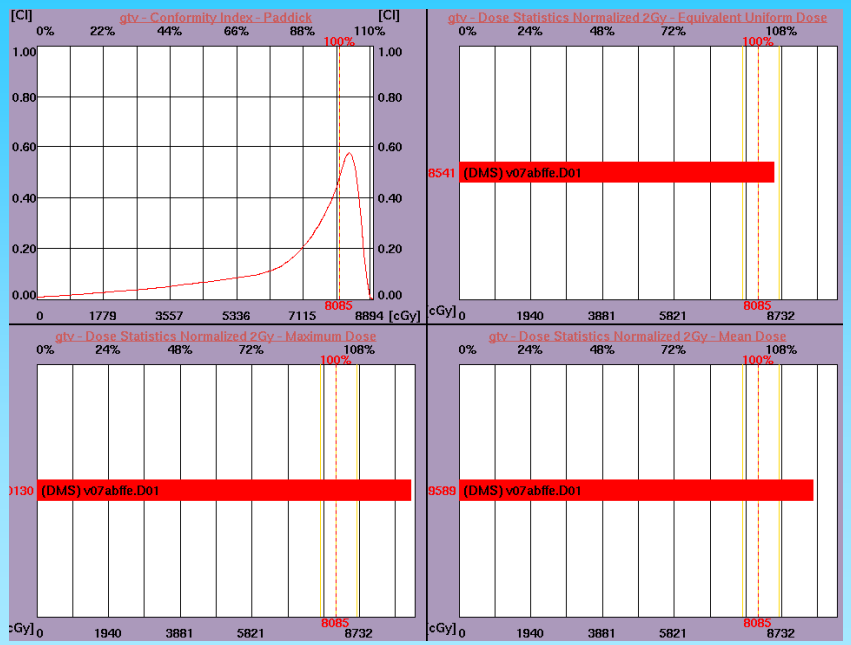
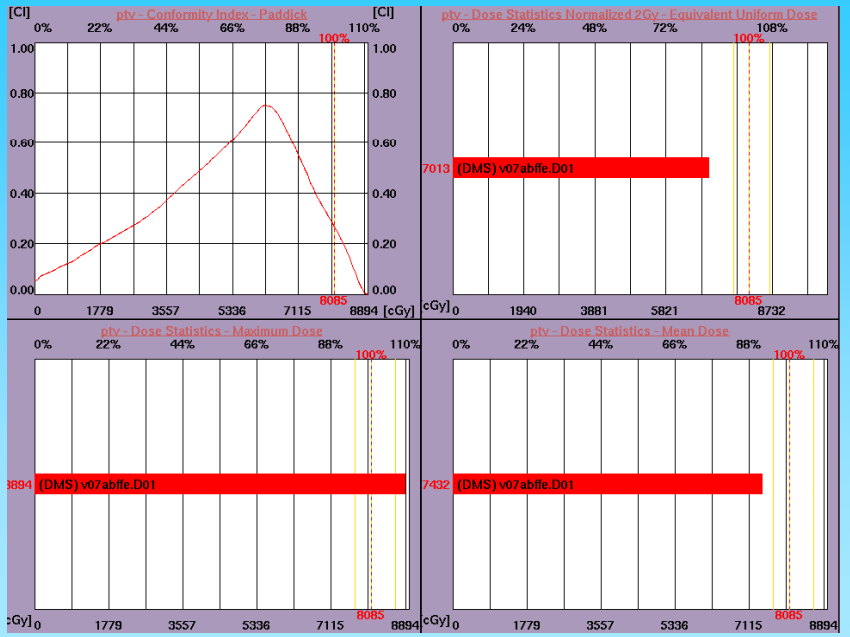
SIB 2007 – 2008

- *Paddick CI medio: 0,65 ± 0,03 per PTV e GTV*
- *EUD(ptv) media (α/β = 10): 71,19 ± 1,65 Gy*
- *EUD(ctv) media (α/β = 10): 79,09 ± 1,69*







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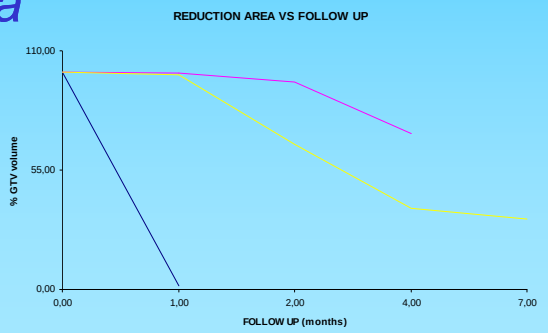
SIB 2007 – 2008

TOLLERANZA

- *Tutti i pazienti hanno completato il trattamento nel tempo previsto*
- *Nessun paziente ha richiesto terapia steroidea durante il trattamento e nei 3 mesi successivi*

FOLLOW UP medio 5 (1-12 mesi)

1 paziente in progressione ha richiesto terapia steroidea
4 pazienti risultano stabili
2 pazienti sono in RP con 25-50% riduzione area CE
3 pazienti sono in RP con > 70% riduzione area CE
Tutti i pazienti sono vivi ad oggi



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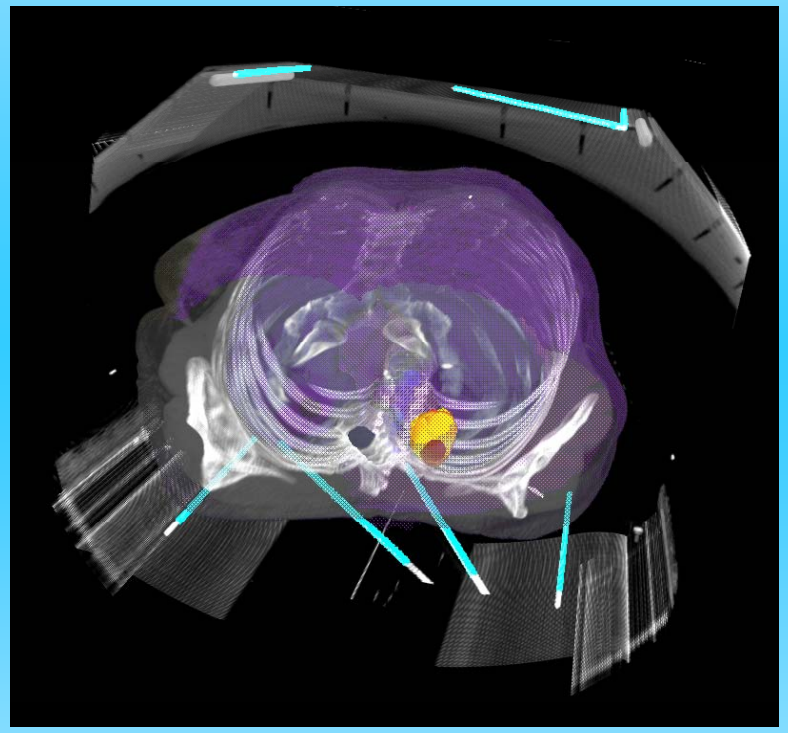
SBRT polmonare 2000 – 2008



- *20 pazienti (5 pediatrici)*
- *Tecnica: IMAT (1-2 archi modulati 180-225°)*
- *Dose: 24 - 45 Gy*
- *Frazionamento: 1- 3 sedute / settimana*
- *Localizzazione stereotassica*
- *Determinazione dei volumi con fusione di immagini*
- *Utilizzo del sistema Freedom per il controllo del movimento dell'organo*

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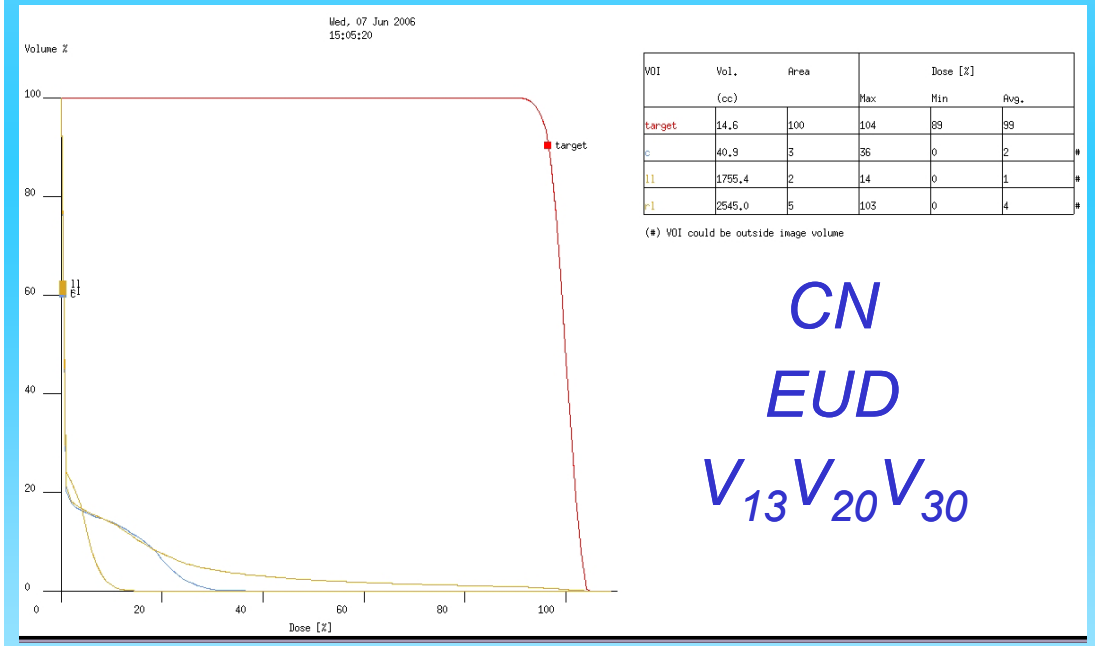
SBRT polmonare 2000 – 2008

Tecnica: IMAT



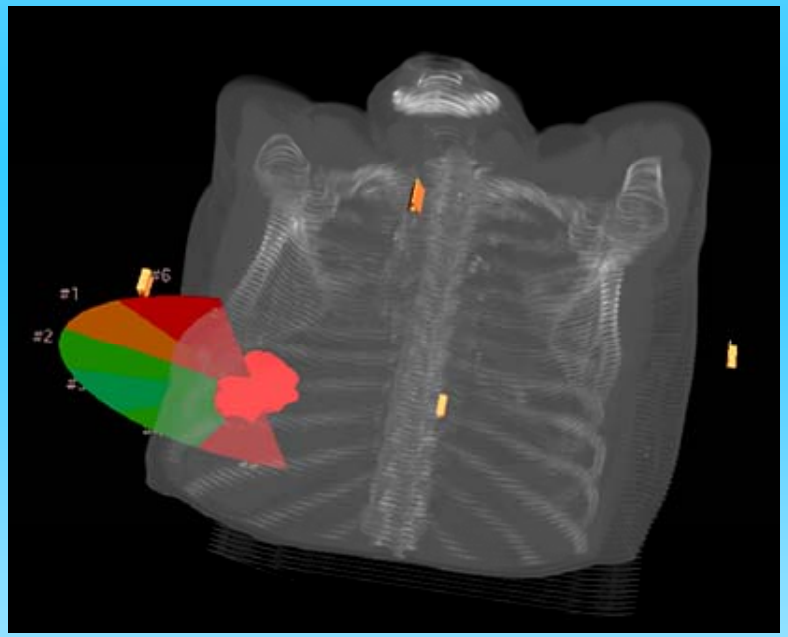
VOI	Vol. (cc)	Area	Dose [%] Max	Min	Avg.	
target	14.6	100	104	89	99	
c	40.9	3	36	0	2	#
ll	1755.4	2	14	0	1	#
rl	2545.0	5	103	0	4	#

(#) VOI could be outside image volume

CN

EUD

$V_{13}V_{20}V_{30}$



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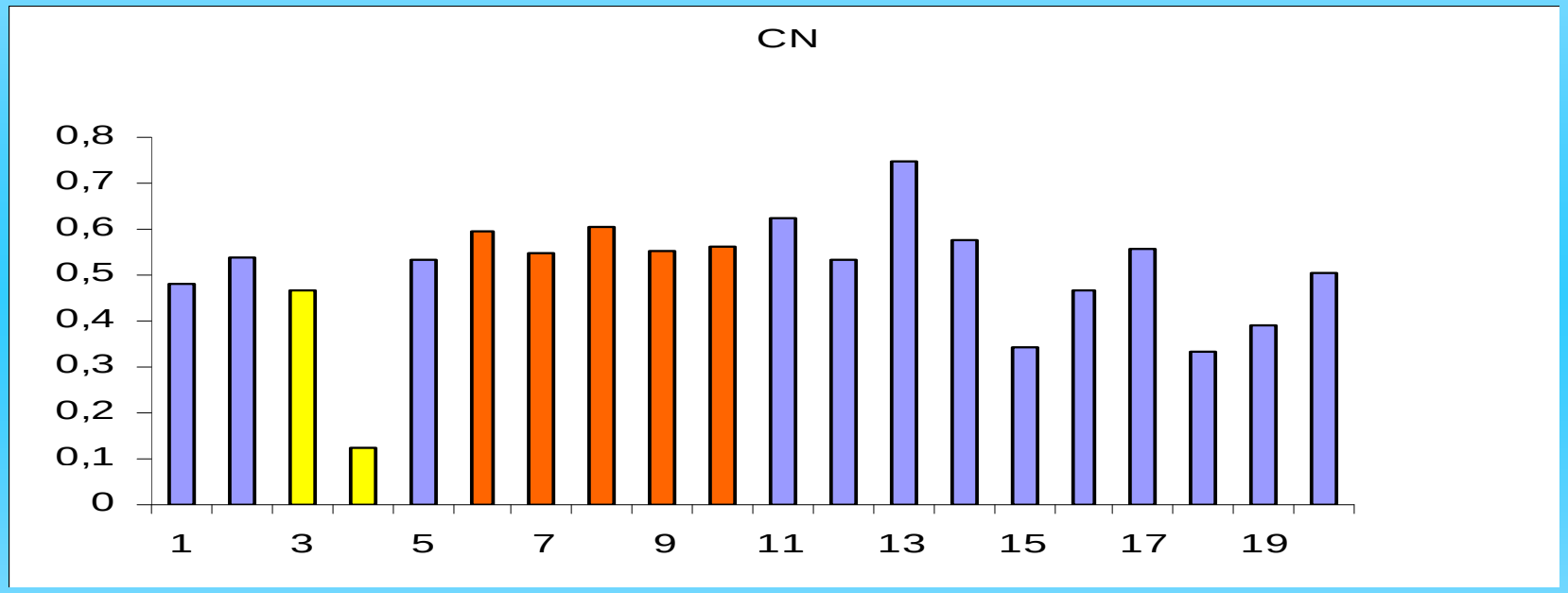

µMLC

mMLC

Conico 2 iso

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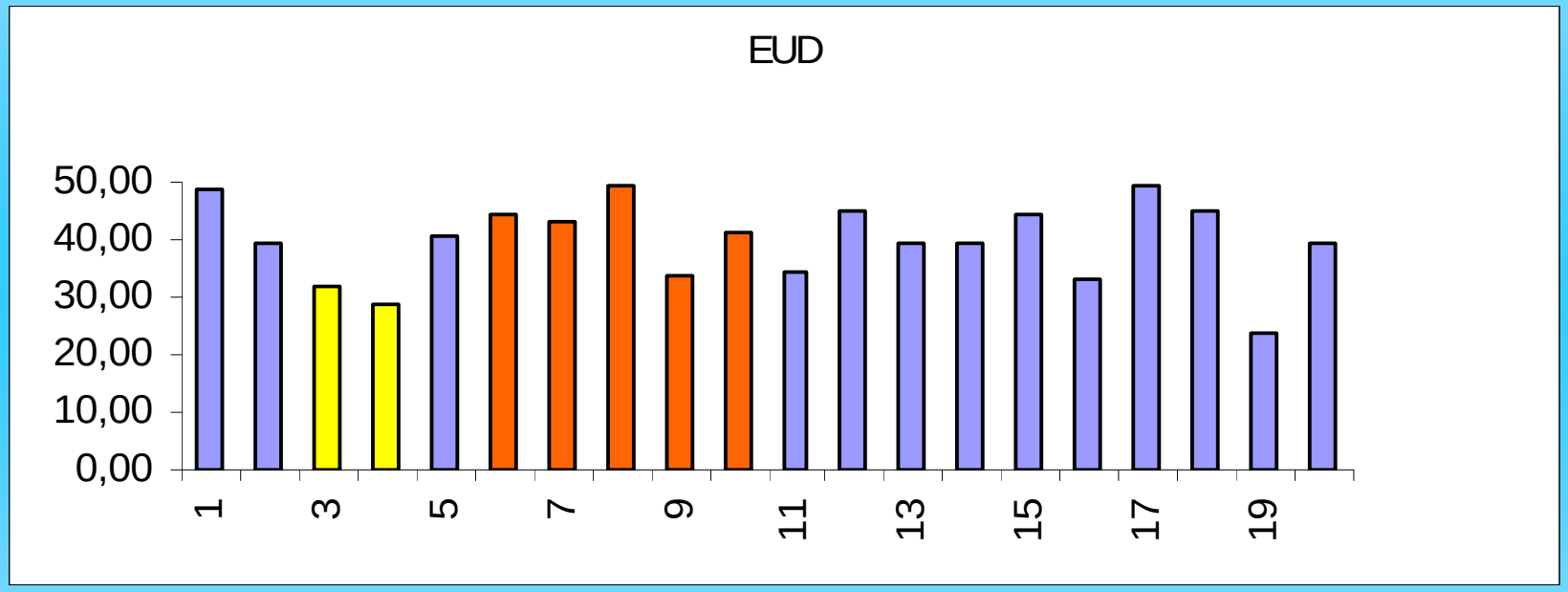

µMLC

mMLC

Conico 2 iso

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Localizzazione stereotassica

Sistema di localizzazione Ergo SCT

Caratteristiche della lesione	Trattamento	Sistema di Immobilizzazione (errore mm)	Sistema di allineamento (errore mm)	Imaging (errore mm)	Errore di localizzazione totale mm
Lesione secondaria	Radioterapia stereotassica	Maschera (1.75 ± 1.6)	Tracking ottico (0.15± 0.069)	TC (1.28± 0.2)	2.17 ± 1.61

Dimensioni pixel

Spessore della fetta

Spaziatura tra le fette

TC assiale

TC elicoidale

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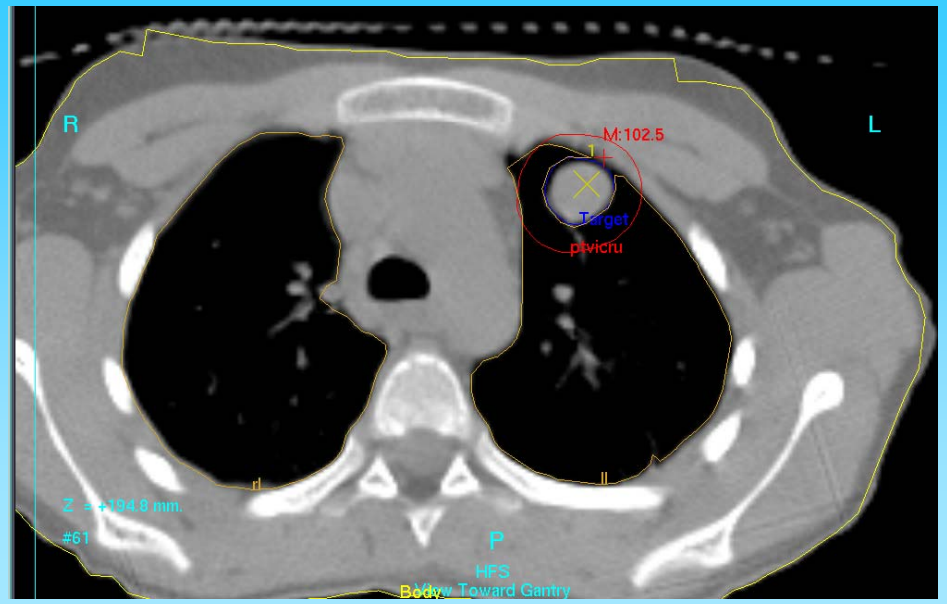
Determinazione dei volumi da ref. ICRU 62

Rad & Onc 48 (1998) 71-77

ICRU 62 ⇒ PTV = CTV + SM + OM



SM

2.17 ± 1.61 mm

OM

Medio-lat 2.04 mm

Cranio-caud 3.9 mm

Dorso-ventr 2.4 mm

Ekberg et al., 1998

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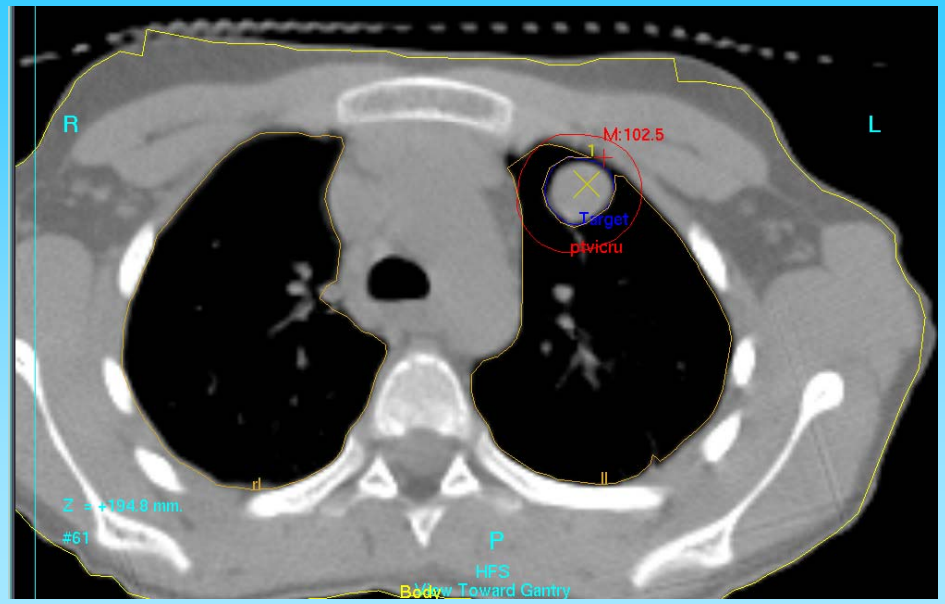
THEORICAL PTV ⇒ CTV + SOM



Medio-lat 3 mm

Cranio-caud 4.5 mm

Dorso-ventr 3.3 mm

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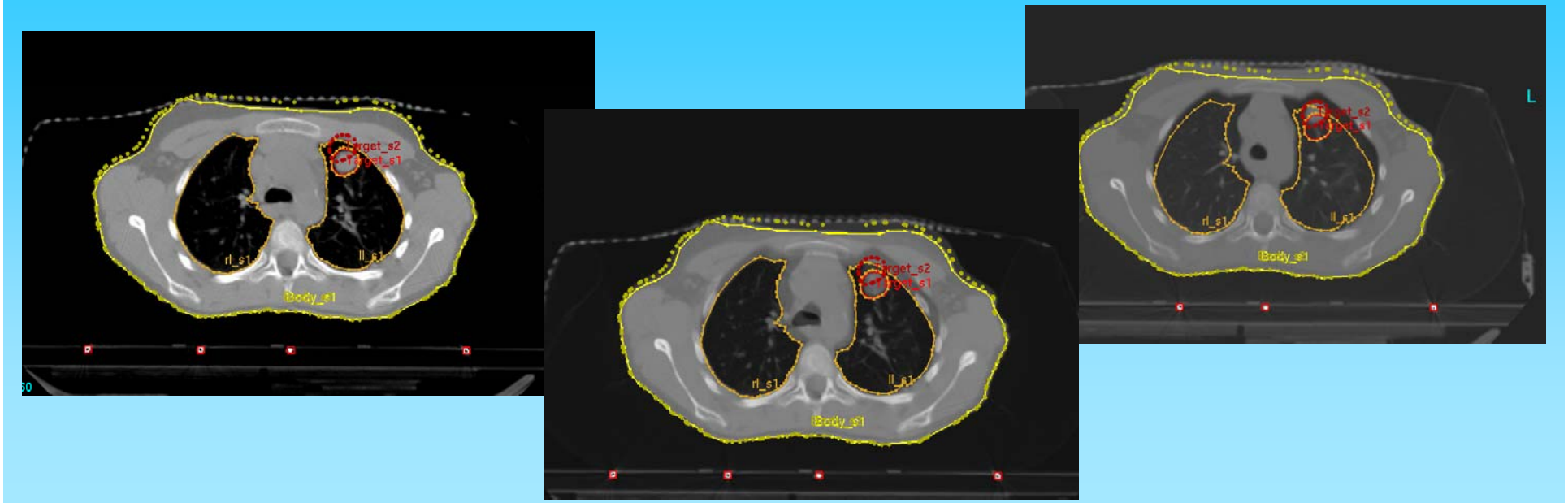
Determinazione dei volumi con fusione di immagini

ICRU 62 ⇒ PTV = CTV + SM + OM ⇒ PTV = CTVmot + SM

Acquisizione 3 serie di immagini in 3 fasi respiratorie

Fusione utilizzando i fiduciali stereotassici e definizione PTV



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Determinazione dei volumi con fusione di immagini

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SBRT polmonare 2000 – 2008

Determinazione dei volumi con fusione di immagini

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Determinazione dei volumi con fusione di immagini

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Determinazione dei volumi con fusione di immagini

OIRM – S. Anna

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Determinazione dei volumi con fusione di immagini

OIRM – S. Anna

SBRT polmonare 2000 – 2008

Determinazione dei volumi con fusione di immagini

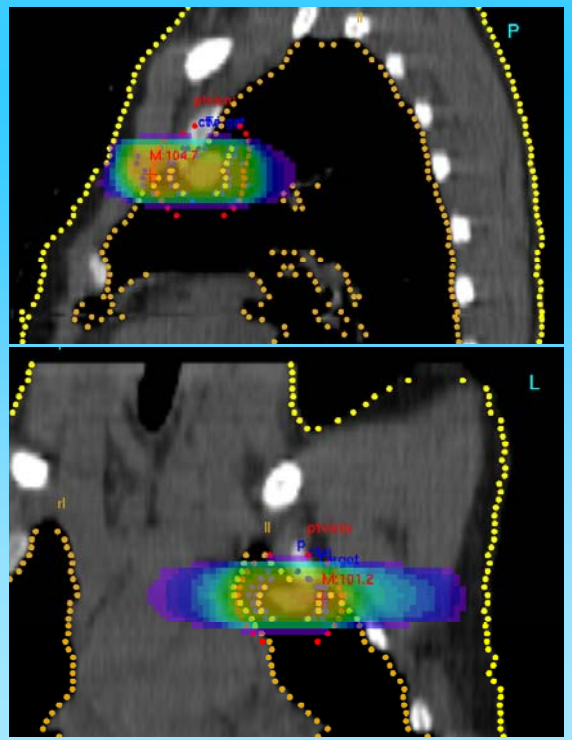
OIRM – S. Anna

SBRT polmonare 2000 – 2008

FUSIONE

EUD_{ptv} = 42,07 Gy

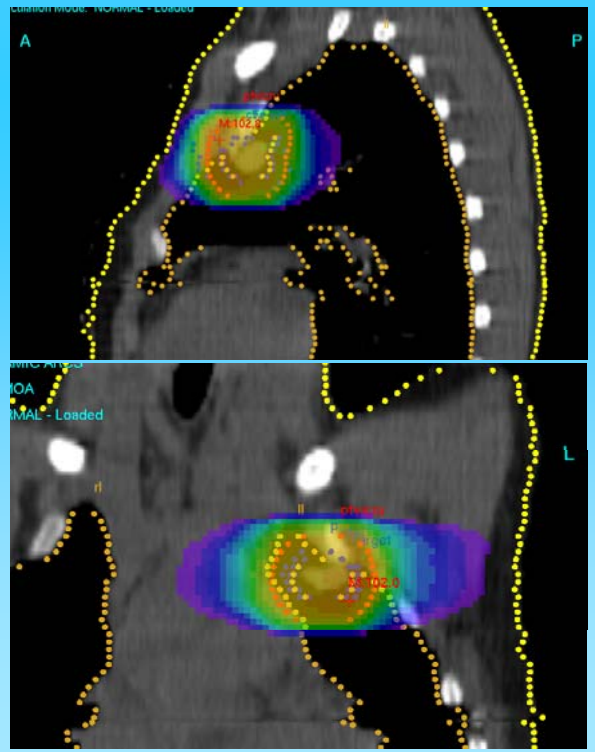
CN(90) = 0.667



STANDARD

EUD_{ptv} = 43,40 Gy

CN(90) = 0.747



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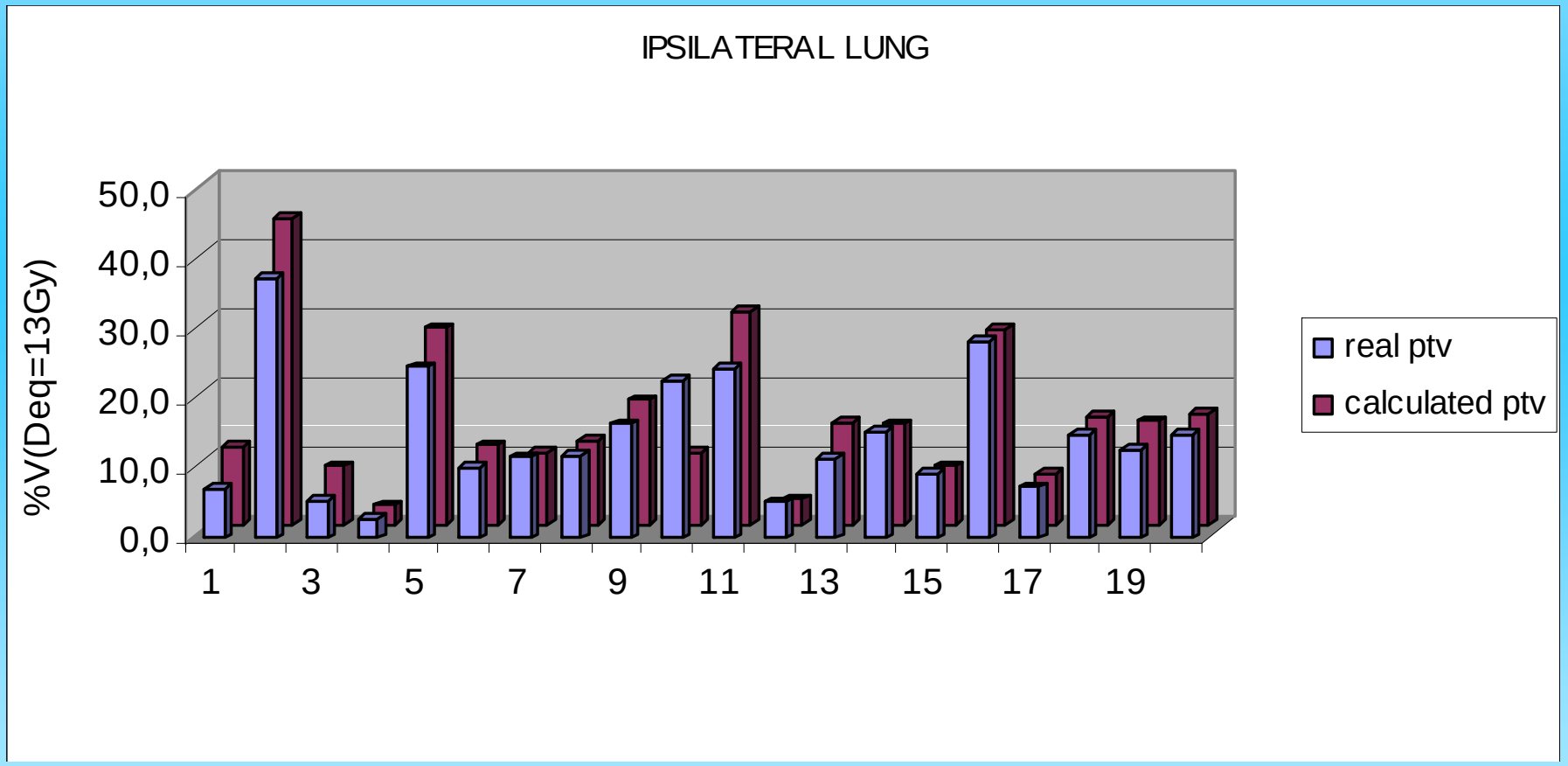
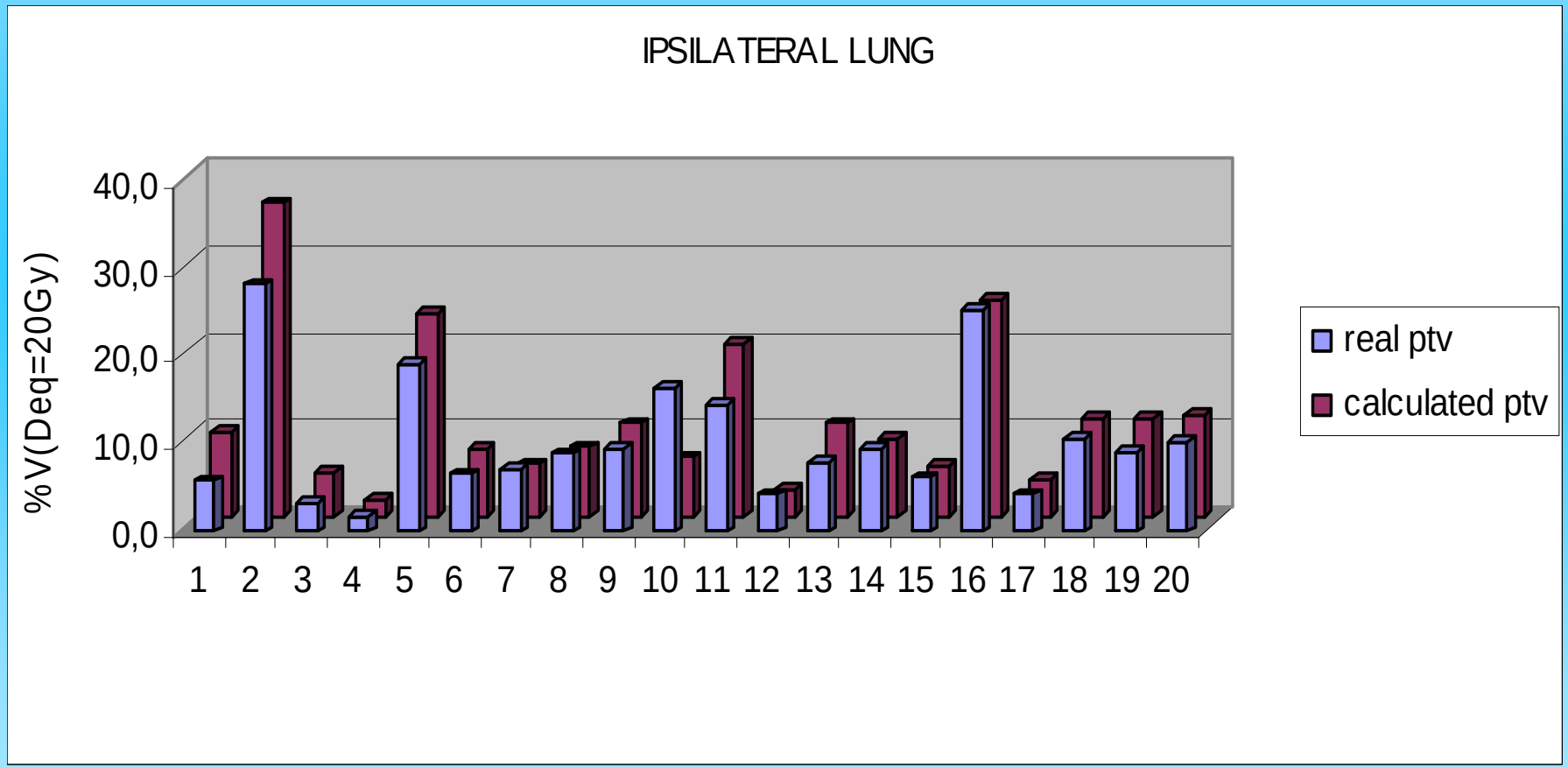
SBRT polmonare 2000 – 2008



P<0.001

OIRM – S. Anna

SBRT polmonare 2000 – 2008



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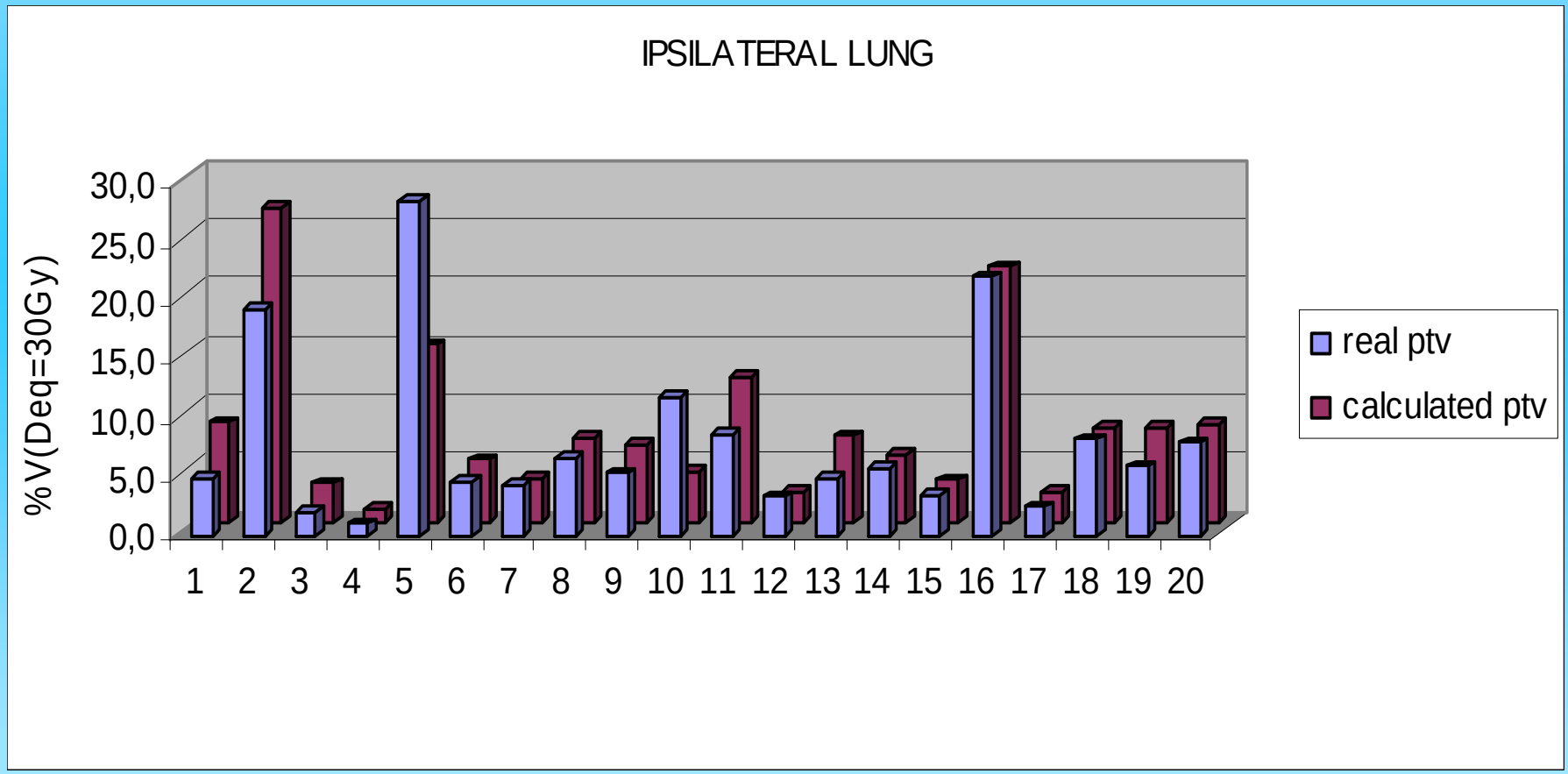
OIRM – S. Anna

SBRT polmonare 2000 – 2008



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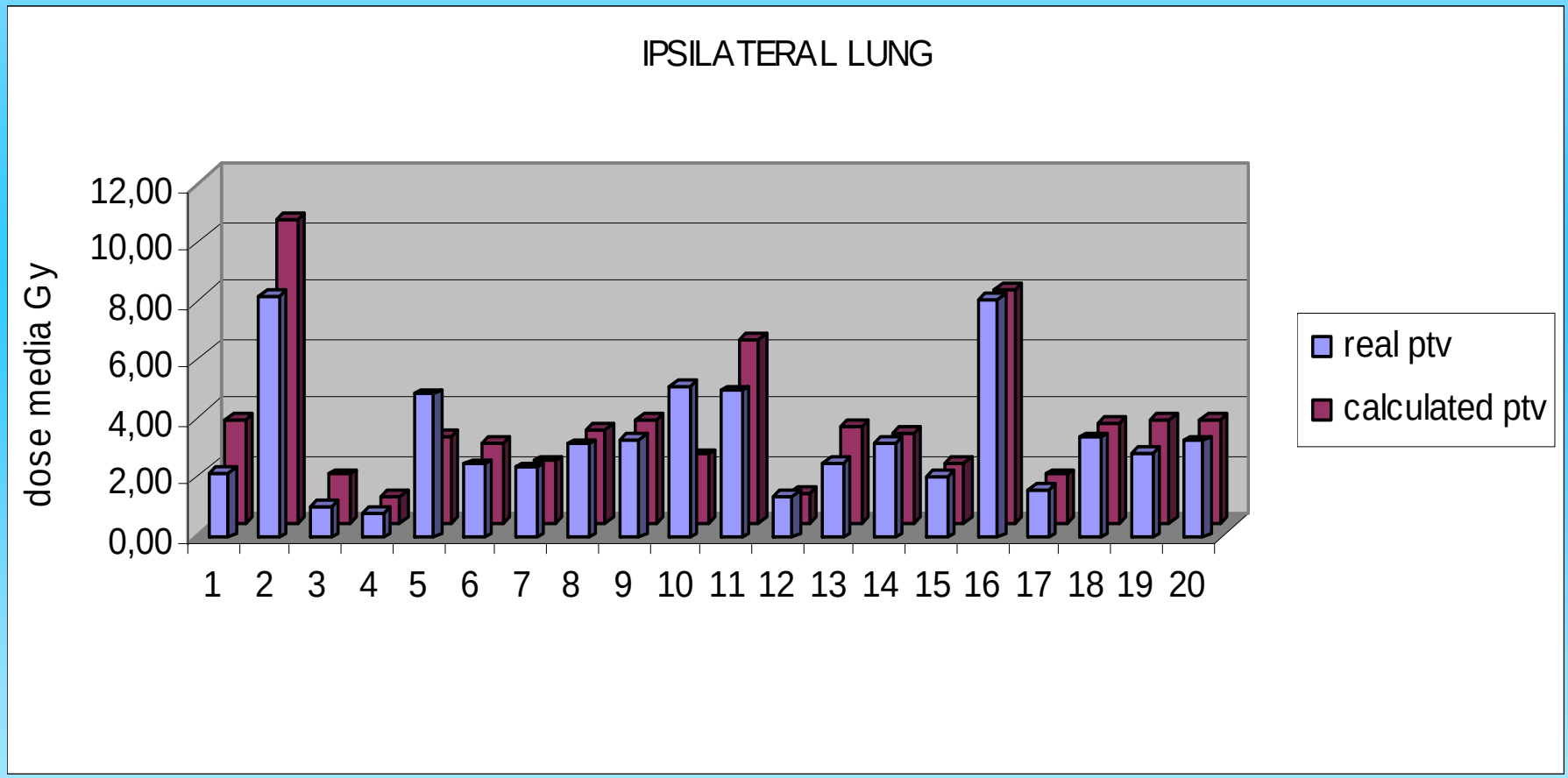
OIRM – S. Anna

SBRT polmonare 2000 – 2008



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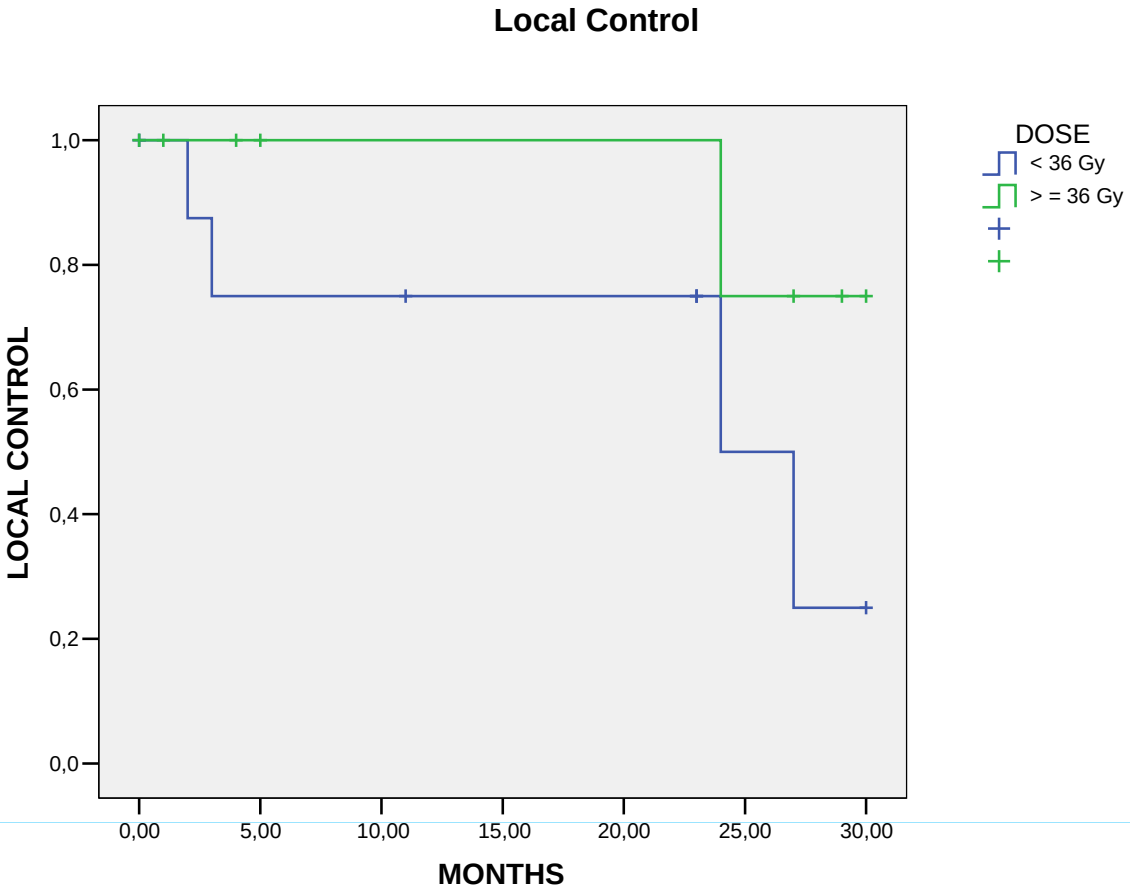
OIRM – S. Anna

SBRT polmonare 2000 – 2008



87,5%

55,6%