The role of accelerated partial breast irradiation (APBI) in the treatment of early-stage breast cancer – review and Greater Poland Cancer Centre experience

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Druskininkai, Lithuania,

February 10 - 11th, 2012

The first information about breast cancer - Egyptian papyri prior to 5000 years ago.

The first written information about hereditary breast cancer - literature of ancient Rome - 100 AD

The name comes from Galen

Left breast cancer

Rembrandt van Rijn (1606-1669) *Bathseba*; Louvre, Paris, France;

Breast cancer and Art Joop A. van Dongen
NOWOTWORY Journal of Oncology • 2003 • volume 53, Number 1• 52–57

Left breast cancer

Jan Lys (1600-1657) *Vanitas*; Museum of Esztergom, Hungary;

Breast cancer and Art Joop A. van Dongen

NOWOTWORY Journal of Oncology • 2003 • volume 53, Number 1• 52–57

Francisco de Zurbaran (1598-1662); *SaintAgatha*; Musee Fabre, Montpellier, France.

Holy Agatha shows her breasts on a tray.

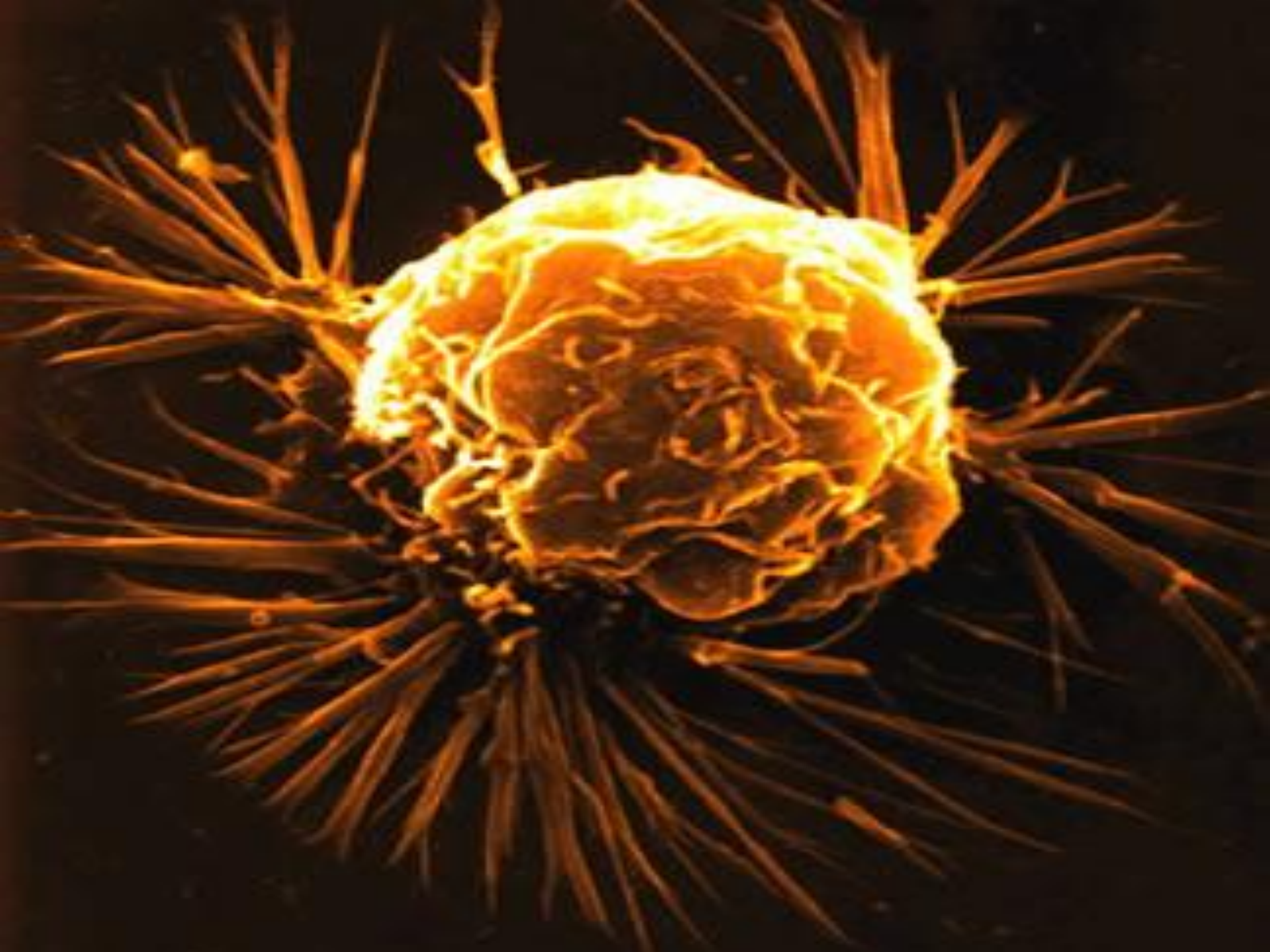
Henri Gervex (1852-I929) *Professor Pean teaching*; Musee d'Orsay, Paris, France.

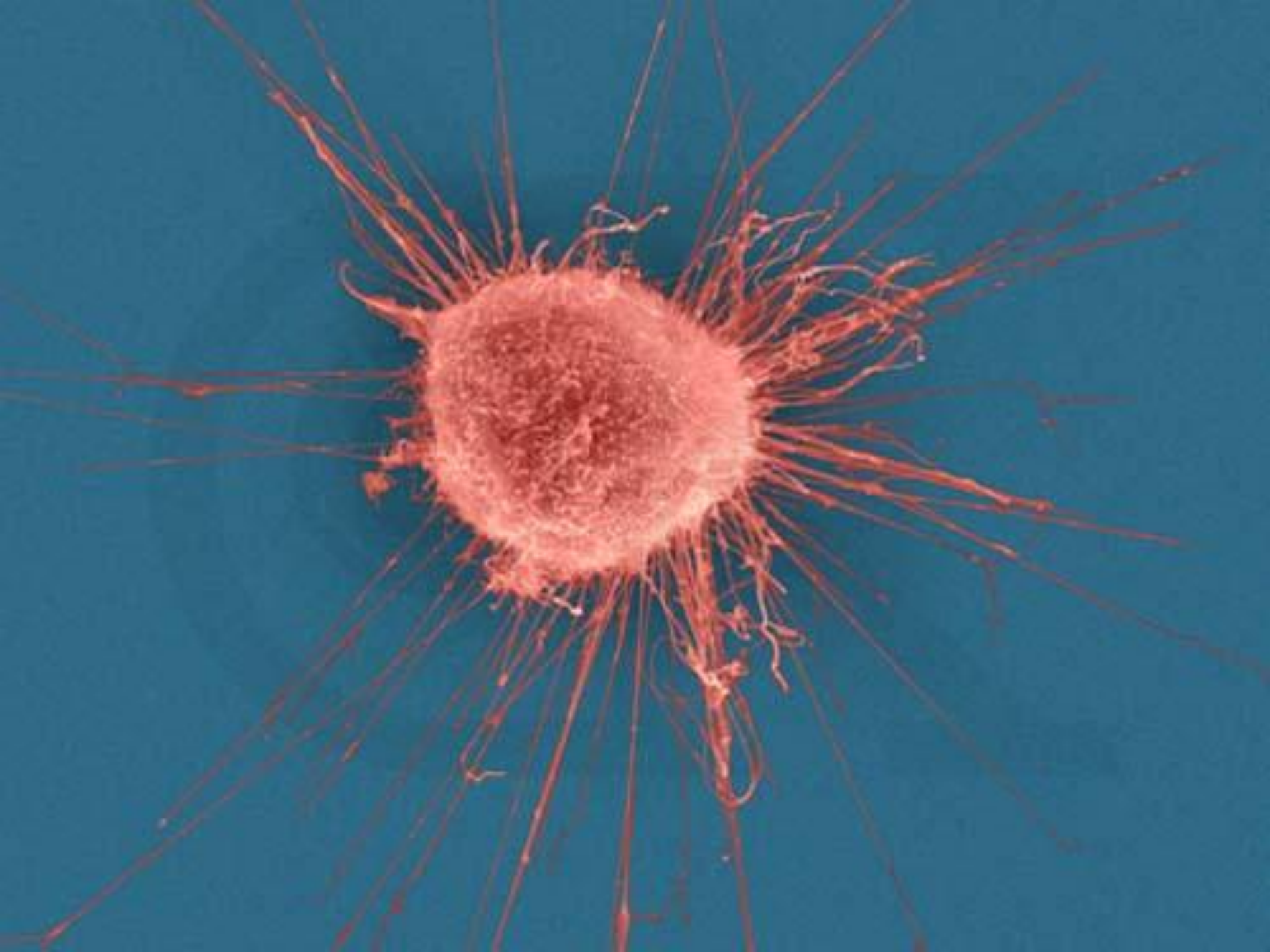
An excellent professor begins operation.

One of the first examples of radiation therapy for breast cancer, 1908

Georges Alexandre Chicotot (l9th/20th century); *Selfportrait*, Mus¯e de 1'Assistance Publique, Paris, France;

Breast cancer and ArtJoop A. van Dongen
NOWOTWORY Journal of Oncology • 2003 • volume 53, Number 1• 52–57





APBI

Stand alone, curative partial breast irradiation after breast conserving surgery

(Partial Breast Irradiation, (Accelerated Partial Breast Irradiation)

APBI

1. **Rationale**
2. Indications
3. Methods
4. Results
5. Trials
6. Future

Accelerated Partial Breast Irradiation leads to:

- an equivalent local control rates

- with less toxicity

compared with treatment with whole breast irradiation (WBI) of external beam (EBRT) after breast conserving surgical treatment (BCS) in a selected group of patients.

Results of studies comparing the effectiveness of local changes with subsequent removal of the WBI and APBI have shown that:

1. very high percentage of local recurrences arise in the immediate surroundings of the original location of the tumor.

This is the main argument for the use of brachytherapy alone after BCS in a strictly selected group of patients.

2. We observe shortening the time of treatment from 5-7 weeks with conventional RT to APBI (4-5 days) Especially important for working women, living in a large distance from the center and the patients in the older age group.

[Njeh, Rad Oncol 2010]

Japan

About 70% of patients receives RT after BCS (~ US).

Factors influencing the decision undergoing RT (BCT):

convenience, availability, cost, distance from the center of RT, no transport, no social assistance, difficulty in movement of patients, physician attitudes, age of the patient, fear of radiation.

Choice - mastectomy!

[Offeresen, RO 2009]

USA

1. It has been documented that socio-economic factors influence the patient's choice of breast conserving strategy, thus women with limited financial means and/or with long travel distances to the radiation department tend to choose mastectomy even though a lumpectomy was feasible.

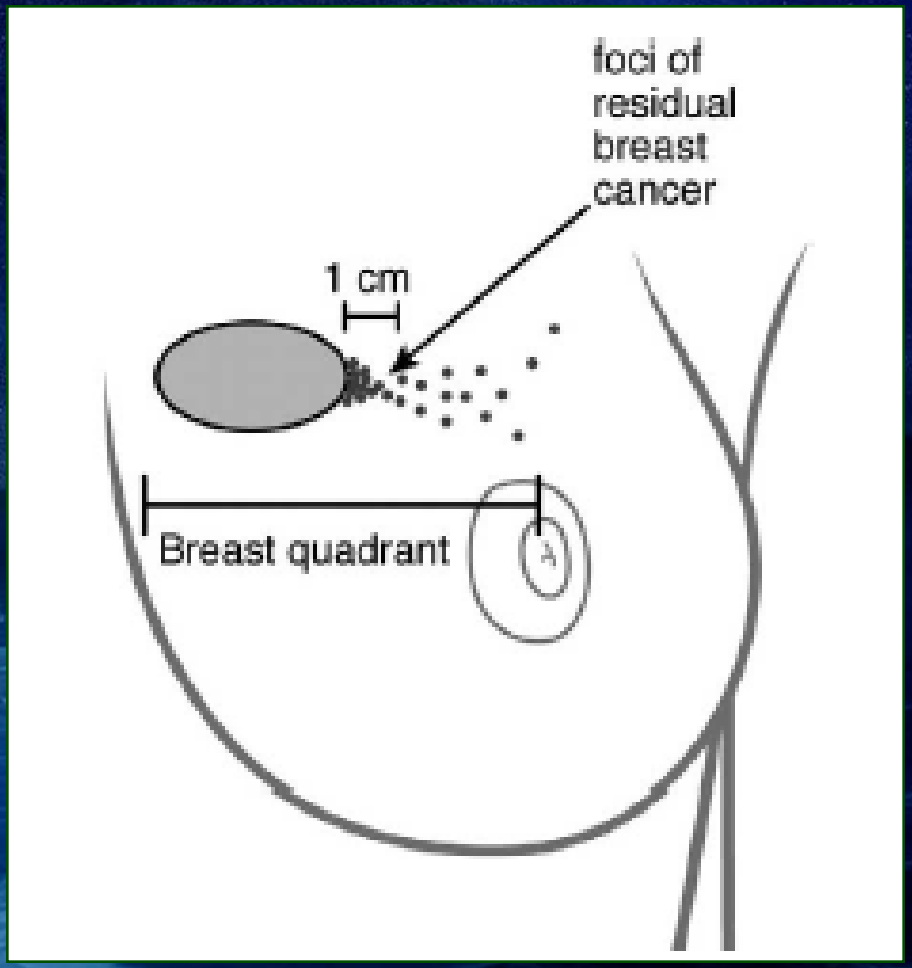
2. Also, in some areas up to 25% of older patients treated with lumpectomy do not receive irradiation for these reasons!

[Offeresen, RO 2009]

3. Lately, a study was presented based on more than 175,000 patients diagnosed with early breast cancer who were registered in the SEER database.

4. In the period 1992-2003 the rate of BCS was increased from 41% to 60%, whilst the rate of RT after BCS decreased from 79% to 71%, thus the authors conclude that the "declining rate of adequate local treatment may ultimately forecast an increased local recurrence rate after BCS".

> 80 - 90% (average) local recurrences occurs in the area of tumor bed



Ipsilateral local recurrence rate after radical WBI in groups of patients eligible for trials [Mannino, RO 2009]

Author, trial	Average follow-up	Local recurrence/total number of patients	Local recurrence rate
NSABP B-06 (1976-1984)	39 (5-95) months	110 (1108)	86% inside or near the operated quadrant, 14% spread in the breast
Uppsala-Orebro (1981-1988)	10 years	57 (381)	69% in tumor bed, 3.6% in the scar, 3.6% in the skin over the bed, 23.6% spread in the breast
Ontario Clinical Oncology Group (1984-1989)	43 months	131 (837)	86% in operated quadrant
Milan III (1987-1989)	9 years	75 (579)	85% near the scar, 15% in others quadrants
SweBCG 91-RT (1991-1997)	5 years	104 (1178)	90% in operated quadrant, 10% in other quadrants

Local recurrences rates outside involved quadrant or cancer of the second breast after WBI and BCS [Mannino, RO 2009].

Author, trial	Average observation time	Total local recurrences rate (%)	Recurrences rate outside of treated quadrant (%)	Recurrences rate in second breast (%)
Report of retrospective clinical studies (BCS + EBRT)				
Kurtz et al.	11(5-24) y	11	2	6
Freedman et al.	5 y	3	1	3
	10 y	7	2	7
	15 y	13	6	13
Krauss et al	5 y	2	0.1	4
	10 y	7	2	9
	15y	10	3	12
Veronesi et al.	8.5 y	6.8[a]	1.4	5[a]
Reported prospective randomized clinical trials (BCS + EBRT)				
NSABP B-06	39(5-95) months	2.7[c]	0.7[g]	9.4[c]
Uppsala-Orebro trial	10 y	8.5[c]	2.1[g]	10.5[c]
Scottish trial	5.7 y	5.8[c]	1.4[g]	1[c]
Milan III	9 y	5.4[c]	1.3[g]	3.4[c]
NSABP B-21	8 y	9.3[d]	2.3[g]	5.4[d]
SweBCG 91-RT	61(10-98) months	4.4[c]	1.1[g]	3.4[c]
GBCSG trial	5.9 years	4.2[c]	1[g]	2.1[c]
ABCSG study 8	53.8 months	0.5[c]	0.1[g]	0.5[c]

Early breast cancer

Patey mastectomy

BCS + SNB/ALND

BCS goals

1. 1. healing a patient, enhancening local cure rate,
2. good cosmetic effect.






APBI

1. Rationale
2. **Indications**
3. Methods
4. Results
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6. Future

The ABS and ASBS Selection Criteria for APBI and the Eligibility Criteria for NSABP B-39/RTOG 0413 and the GEC-ESTRO Trial [Strauss RO 2009].

	ABS	ASBS	NSABP B-39 RTOG 0413	GEC-ESTRO
Age	≥50	≥45	≥18	≥40
Histology	Unifocal, invasive ductal cancer	Invasive ductal cancer or DCIS	Invasive adenocarcinoma or DCIS	Invasive adenocarcinoma or DCIS
Tumor size	≤3 cm	≤3 cm	≤3 cm	≤3 cm
Surgical margins	Negative microscopic margins	Negative microscopic margins	Negative microscopic margins	≥2 mm margins or ≥5 mm for lobular histology or DCIS only
Number of involved lymph nodes	0	0	0 - 3	pN0 or pNmi

ESTRO

Radiotherapy and Oncology 94 (2010) 264–273

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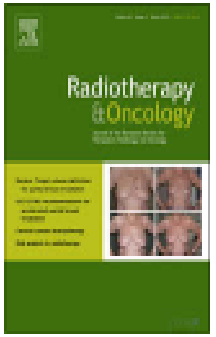
journal homepage: www.thegreenjournal.com



GEC-ESTRO Recommendations

Patient selection for accelerated partial-breast irradiation (APBI) after breast-conserving surgery: Recommendations of the Groupe Européen de Curiethérapie-European Society for Therapeutic Radiology and Oncology (GEC-ESTRO) breast cancer working group based on clinical evidence (2009)

Csaba Polgár[a,*], Erik Van Limbergen[b], Richard Pötter[c], György Kovács[d], Alfredo Polo[e], Jaroslaw Lyczek[f], Guido Hildebrandt[g], Peter Niehoff[h], Jose Luis Guinot[i], Ferran Guedea[j], Bengt Johansson[k], Oliver J. Ott[l], Tibor Major[a], Vratislav Strnad[l], On behalf of the GEC-ESTRO breast cancer working group

Table 8
GEC-ESTRO recommendations on patient selection for accelerated partial-breast irradiation.

Characteristic	A/low-risk group – good candidates for APBI	B/intermediate-risk group – possible candidates for APBI	C/high-risk group – contraindication for APBI
Patient age	>50 years	>40–50 years	⩽40 years
Histology	IDC, mucinous, tubular, medullary, and colloid cc.	IDC, ILC, mucinous, tubular, medullary, and colloid cc	–
ILC	Not allowed	Allowed	–
Associated LCIS	Allowed	Allowed	–
DCIS	Not allowed	Allowed	–
HG	Any	Any	–
Tumour size	pT1–2 (⩽30 mm)	pT1–2 (⩽30 mm)	pT2 (>30 mm), pT3, pT4
Surgical margins	Negative (⩾2 mm)	Negative, but close (<2 mm)	Positive
Multicentricity	Unicentric	Unicentric	Multicentric
Multifocality	Unifocal	Multifocal (limited within 2 cm of the index lesion)	Multifocal (>2 cm from the index lesion)
EIC	Not allowed	Not allowed	Present
LVI	Not allowed	Not allowed	Present
ER, PR status	Any	Any	–
Nodal status	pN0 (by SLNB or ALND[4])	pN1mi, pN1a (by ALND[4])	pNx; ⩾pN2a (4 or more positive nodes)
Neoadjuvant chemotherapy	Not allowed	Not allowed	If used

APBI = accelerated partial-breast irradiation; IDC = invasive ductal carcinoma; ILC = invasive lobular carcinoma; LCIS = lobular carcinoma in situ; DCIS = ductal carcinoma in situ; HG = histologic grade; EIC = extensive intraductal component; LVI = lympho-vascular invasion; ER = estrogen receptor; PR = progesterone receptor; SLNB = sentinel lymph node biopsy.

[4] ALND = axillary lymph node dissection (at least 6 nodes pathologically examined).

Recommendations GEC-ESTRO 2009 [Polgár, RO 2010]

1. 7 trials under way,

2. > 30.000 patients treated otside trials,

[Smith BD, Arthur DW, Buchholz TA, et al. Accelerated partial breast irradiation consensus statement from the American Society for Radiation Oncology (ASTRO). Int J Radiat Oncol Biol Phys 2009;74:987-1001]

3. Majority of results – interstitial HDR BT,

4. Based on 3 randomized trials and 19 non randomized prospective trials.

Polgar C, Van Limbergen E, Pötter R et al. Radiother Oncol (2010), doi:10.1016/j.radonc.2010.01.014

Recommendations GEC-ESTRO 2009 [Polgár, RO 2010]

Factors influencing qualification for APBI:

1. age
2. ILC/LCIS (i*nvasive lobular carcinoma, lobular carcinoma in situ*)
1. DCIS (d*uctal carcinoma in situ*)
2. grading (G)
3. tumor size (pT)
4. surgical margin
5. multitifocality and multicentricity
6. EIC (*extensive intraductal carcinoma*)
7. receptor status
8. LVI (*lympho-vascular invasion*)
9. nodal status (pN)
10. neoadjuvant chth.

Recommendations GEC-ESTRO 2009 [Polgár, RO 2010]

3 groups of patients after BCS:

LOW risk group– APBI outside trials, 

INTERMEDIATE risk group – APBI should be used in trials,

HIGH risk group – standard treatment – no APBI.

Polgar C, Van Limbergen E, Pötter R et al. Radiother Oncol (2010), doi:10.1016/j.radonc.2010.01.014

Recommendations GEC-ESTRO 2009 [Polgár, RO 2010]

Indications for APBI (Low risk group):

1. age > 50 lat
2. IDC (*invasive ductal carcinoma*), mucinous, tubular, medullary, colloid
3. concomitant LCIS
4. monofocal
5. monocentric
6. T_{1-2} (≤ 30 mm), pN0
7. G_{1-3}
8. ER, PgR ±
9. margin ≥ 2 mm

~~ILC~~
~~EIC~~
~~LVI~~
~~DCIS~~
~~chth~~

Polgar C, Van Limbergen E, Pötter R et al. Radiother Oncol (2010), doi:10.1016/j.radonc.2010.01.014

Recommendations GEC-ESTRO 2009 [Polgár, RO 2010]

Characteristic	A/low-risk group – good candidates for APBI	B/intermediate-risk group – possible candidates for APBI	C/high-risk group – contraindication for APBI
Patient age	>50 years	>40–50 years	⩽40 years
Histology	IDC, mucinous, tubular, medullary, and colloid cc.	IDC, ILC, mucinous, tubular, medullary, and colloid cc	–
ILC	Not allowed	Allowed	–
Associated LCIS	Allowed	Allowed	–
DCIS	Not allowed	Allowed	–
HG	Any	Any	–
Tumour size	pT1–2 (⩽30 mm)	pT1–2 (⩽30 mm)	pT2 (>30 mm), pT3, pT4
Surgical margins	Negative (⩾2 mm)	Negative, but close (<2 mm)	Positive
Multicentricity	Unicentric	Unicentric	Multicentric
Multifocality	Unifocal	Multifocal (limited within 2 cm of the index lesion)	Multifocal (>2 cm from the index lesion)
EIC	Not allowed	Not allowed	Present
LVI	Not allowed	Not allowed	Present
ER, PR status	Any	Any	–
Nodal status	pN0 (by SLNB or ALND[a])	pN1mi, pN1a (by ALND[a])	pNx; ⩾pN2a (4 or more positive nodes)
Neoadjuvant chemotherapy	Not allowed	Not allowed	If used

APBI = accelerated partial-breast irradiation; IDC = invasive ductal carcinoma; ILC = invasive lobular carcinoma; LCIS = lobular carcinoma in situ; DCIS = ductal carcinoma in situ; HG = histologic grade; EIC = extensive intraductal component; LVI = lympho-vascular invasion; ER = estrogen receptor; PR = progesterone receptor; SLNB = sentinel lymph node biopsy.

[a] ALND = axillary lymph node dissection (at least 6 nodes pathologically examined).

ASTRO

Int. J. Radiation Oncology Biol. Phys., Vol. 74, No. 4, pp. 987–1001, 2009

Printed in the USA.
0360-3016/09/$–see front matter

doi: 10.1016/j.ijrobp.2009.02.031

CONSENSUS STATEMENT

ACCELERATED PARTIAL BREAST IRRADIATION CONSENSUS STATEMENT FROM THE AMERICAN SOCIETY FOR RADIATION ONCOLOGY (ASTRO)

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Table 2. Patients "suitable" for APBI if all criteria are present

Factor	Criterion
Patient factors	
Age	≥60 y
BRCA1/2 mutation	Not present
Pathologic factors	
Tumor size	≤2 cm*
T stage	T1
Margins	Negative by at least 2 mm
Grade	Any
LVSI	No†
ER status	Positive
Multicentricity	Unicentric only
Multifocality	Clinically unifocal with total size ≤2.0 cm‡
Histology	Invasive ductal or other favorable subtypes§
Pure DCIS	Not allowed
EIC	Not allowed
Associated LCIS	Allowed
Nodal factors	
N stage	pN0 (i^-, i^+)
Nodal surgery	SN Bx or ALND‖
Treatment factors	
Neoadjuvant therapy	Not allowed

Abbreviations: APBI = accelerated partial-breast irradiation; LVSI = lymph–vascular space invasion; ER = estrogen receptor; DCIS = ductal carcinoma *in situ*; EIC = extensive intraductal component; LCIS = lobular carcinoma *in situ*; SN Bx = sentinel lymph node biopsy; ALND = axillary lymph node dissection.

Table 3. "Cautionary" group: Any of these criteria should invoke caution and concern when considering APBI

Factor	Criterion
Patient factors	
Age	50–59 y
Pathologic factors	
Tumor size	2.1–3.0 cm*
T stage	T0 or T2
Margins	Close (<2 mm)
LVSI	Limited/focal
ER status	Negative†
Multifocality	Clinically unifocal with total size 2.1–3.0 cm‡
Histology	Invasive lobular
Pure DCIS	≤3 cm
EIC	≤3 cm

Abbreviations as in Table 2.

Table 4. Patients "unsuitable" for APBI outside of a clinical trial if any of these criteria are present

Factor	Criterion
Patient factors	
Age	<50 y
BRCA1/2 mutation	Present
Pathologic factors	
Tumor size*	>3 cm
T stage	T3-4
Margins	Positive
LVSI	Extensive
Multicentricity	Present
Multifocality	If microscopically multifocal >3 cm in total size or if clinically multifocal
Pure DCIS	If >3 cm in size
EIC	If >3 cm in size
Nodal factors	
N stage	pN1, pN2, pN3
Nodal surgery	None performed
Treatment factors	
Neoadjuvant therapy	If used

Abbreviations as in Table 2.

AMERICAN BRACHYTHERAPY SOCIETY
BREAST BRACHYTHERAPY TASK GROUP

Martin Keisch, M.D., Douglas Arthur, M.D., Rakesh Patel, M.D., Mark Rivard, PhD., Frank Vicini, M.D.

February, 2007

Breast Brachytherapy as a Boost –

Brachytherapy is appropriate to use to deliver additional conformal boost dose to the surgical bed plus margin following standard whole breast radiotherapy. Ideally chosen when the physician believes that boost dose delivery to the target is better accomplished with brachytherapy as opposed to electrons and would be dependent on the size/shape/location of the lumpectomy cavity in relationship to the size/shape of the breast.

Accelerated Partial Breast Irradiation (APBI) –

The American Brachytherapy Society supports protocol enrollment of patients whenever possible and appropriate for the individual patient. In those situations where it is not possible, conservative guidelines should be applied and are detailed below.

ASTRO recommendations

Indications for APBI (Low risk group):

1. age ≥ 60 lat
2. IDC, mucinous, tubular, medullary, colloid
3. concomitant LCIS
4. monofocal
5. monocentric
6. T_1 (≤ 20 mm)
7. pN0 (i-, i+)
8. G_{1-3}
9. ER, PgR +
10. margin ≥ 2 mm

~~BRCA1/2 mutacja~~
~~ILC~~
~~EIC~~
~~LVI~~
~~DCIS~~
~~chth~~

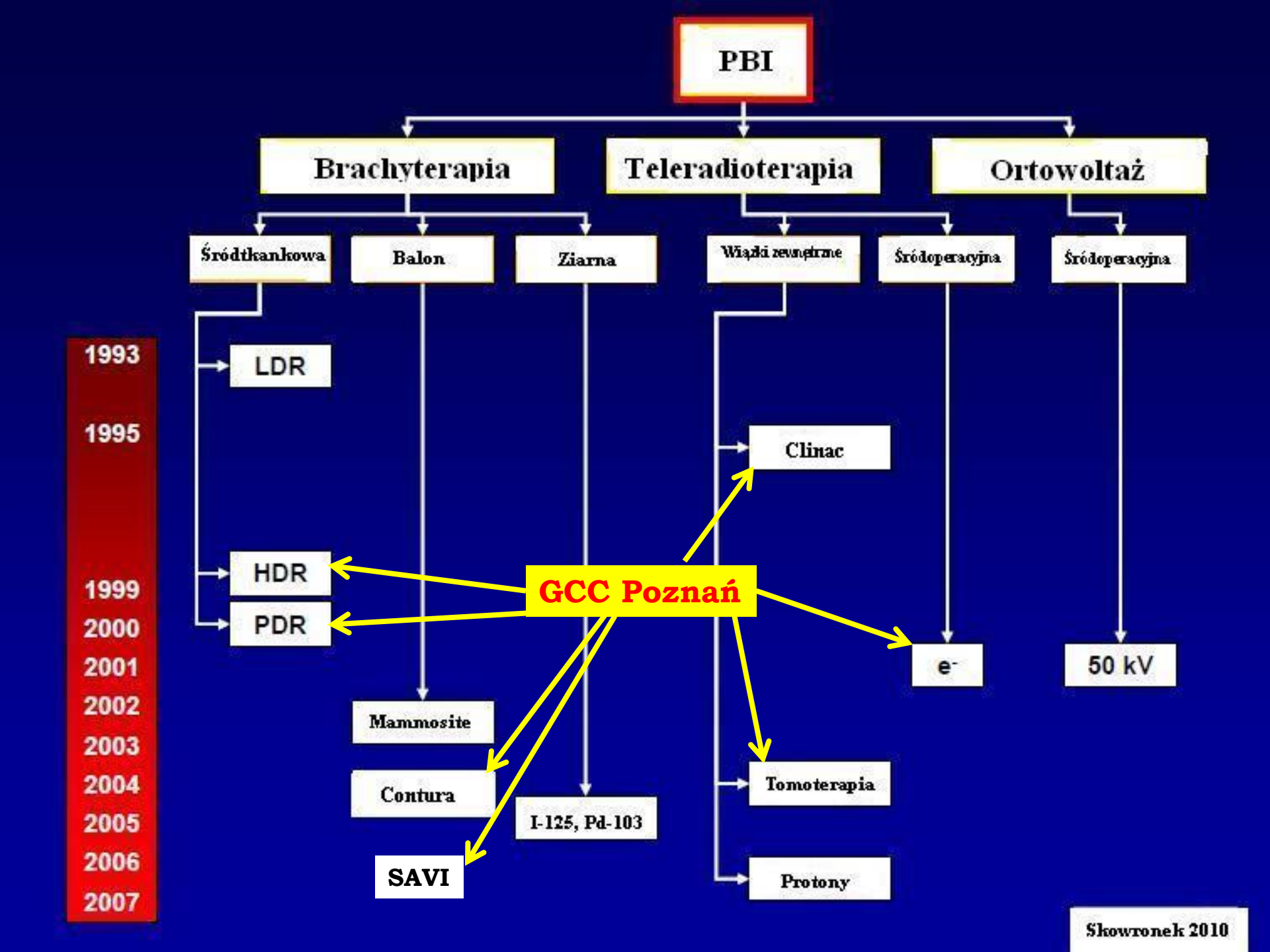
Smith BD et al. APBI consensus statement from ASTRO. Int J Radiat Oncol Biol Phys 2009; 74(4):987-1001.

Contraindications

1. Stage III or IV clinical stage,
2. No evaluation of surgical margins,
3. EIC),
4. Paget's disease or infiltration, or other changes in skin,
5. Simultaneous contralateral breast cancer (or in history),
6. Other tumors (less than 5 years of eligibility for the study). Exception of skin cancer, 0 or Ist cervical cancer (cured) according to FIGO,
7. Pregnancy or lactation period,
8. Connective tissue disorders, collagen diseases, genetic or metabolic extending with hypersensitivity to radiation such as Ataxia teleangiectasia or similar,
9. Disorder or mental illness,
10. Anticipated technical difficulty of performing BT.

APBI

1. Rationale
2. Indications
3. **Methods**
4. Results
5. Trials
6. Future


PBI
Brachyterapia
Teleradioterapia
Ortowoltaż
Śródtkankowa
Balon
Ziarna
Wiązki zewnętrzne
Śródoperacyjna
Śródoperacyjna
1993
1995
1999
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2001
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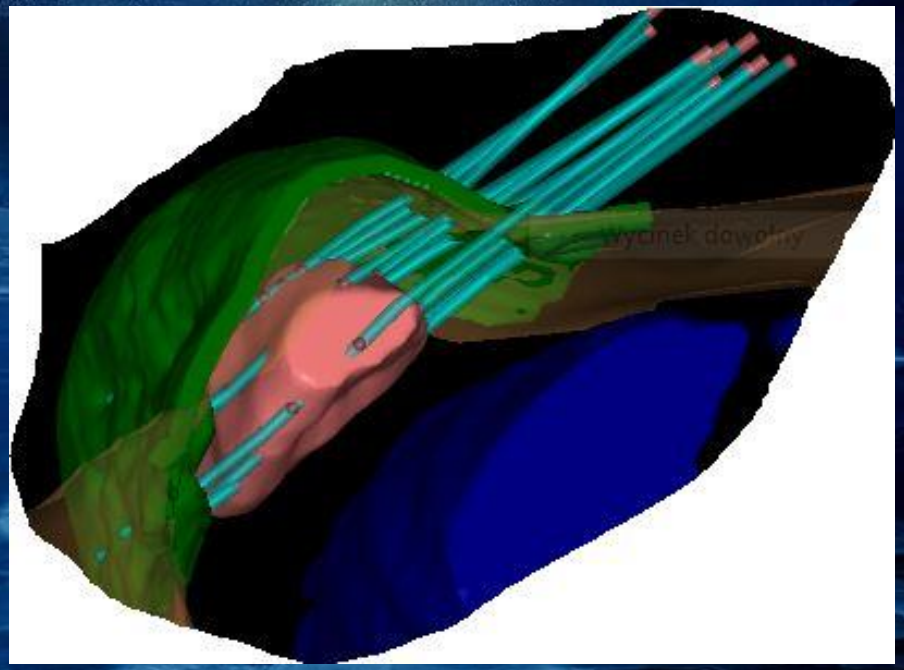
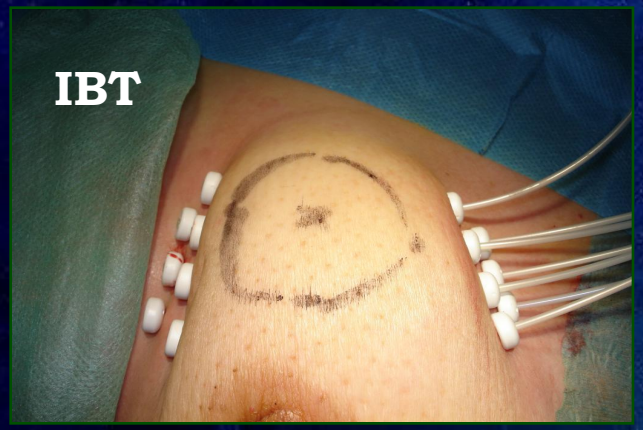
2003
2004
2005
2006
2007
LDR
HDR
PDR
Mammosite
Contura
SAVI
I-125, Pd-103
Clinac
Tomoterapia
Protony
e-
50 kV
GCC Poznań
Skowronek 2010

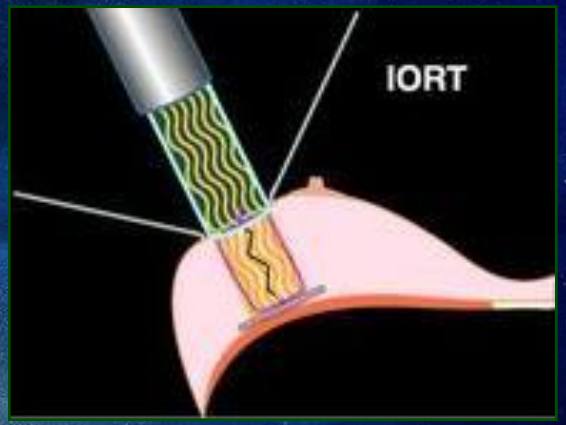
Methods (techniques)

1. Interstitial BT (HDR, PDR, seeds),
2. Balloon BT (HDR),
3. 3D EBRT, IMRT,
4. IORT (electrons, photons),
5. Tomotherapy.



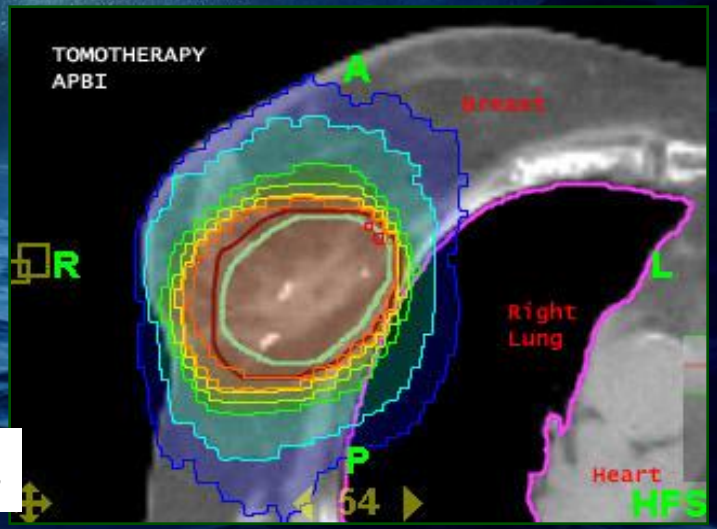
Methods



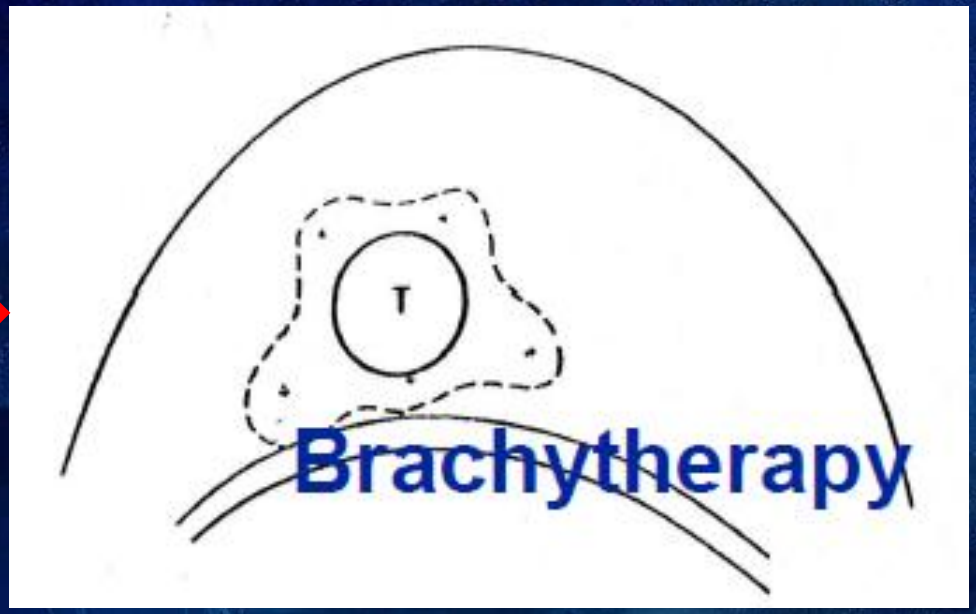


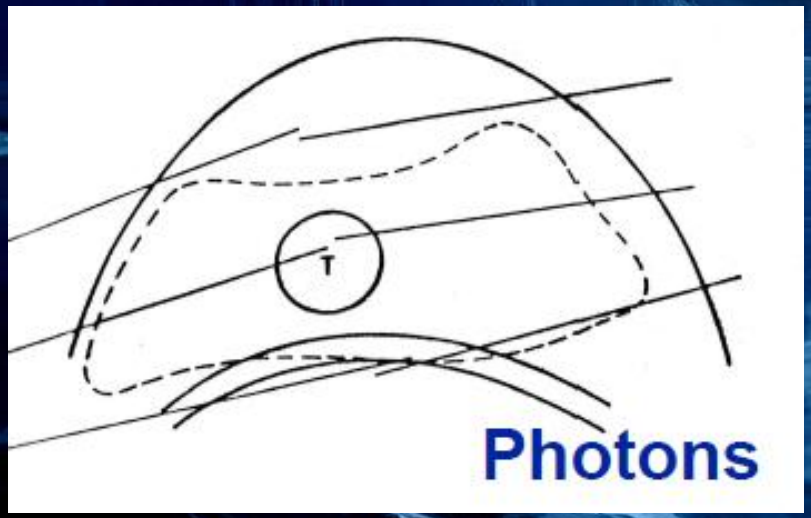
PBRT

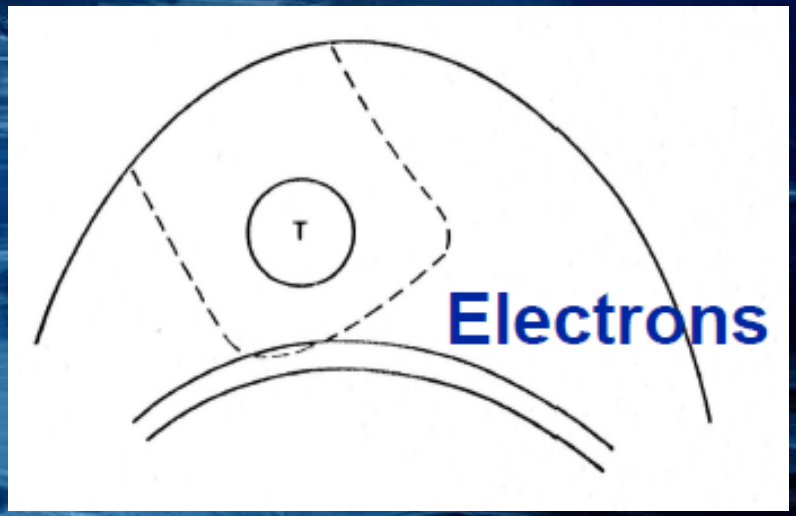
photons



Conformal dose coverage - as the smallest volume, as the best protection for the skin …







Benefits of brachytherapy

1. **more conformal treatment:**
   better dose distribution,
   lower skin dose,
   better cosmetic result,
   smaller volume,

2. **treatment more economical:**
   shorter,
   larger numbers of patients,

3. **better comfort for the patient (?).**

Interstitial BT

1. Selected group of patients (currently ongoing RTOG 95-17 study, until 2011),
2. T1, T2 (tumor <3 cm), N0, N1 (up to 3 nodes, at least 6 nodes removed), M0,
3. Clips placed surgically,
4. No infiltration of the node capsule, disseminated intraductale component,
5. Negative surgical margins,
6. Monofocality,
7. Time from surgery less than 6 weeks.

Applicators

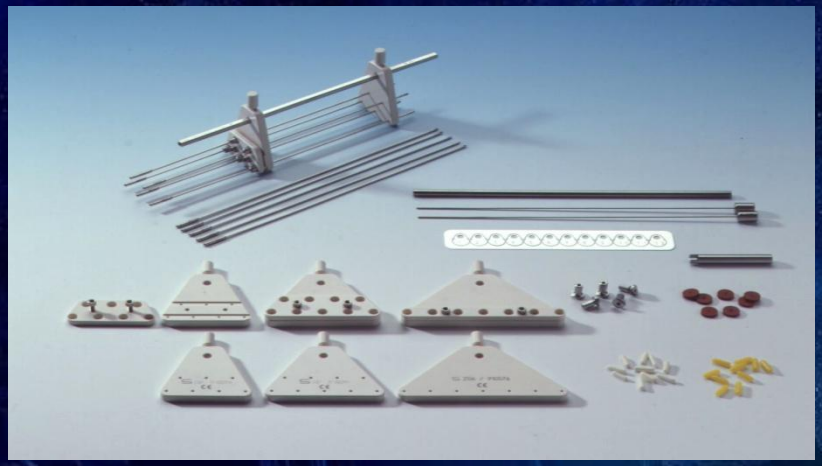
1. steel needles (history)

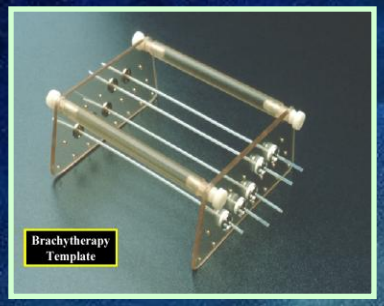
2. flexible applicators,

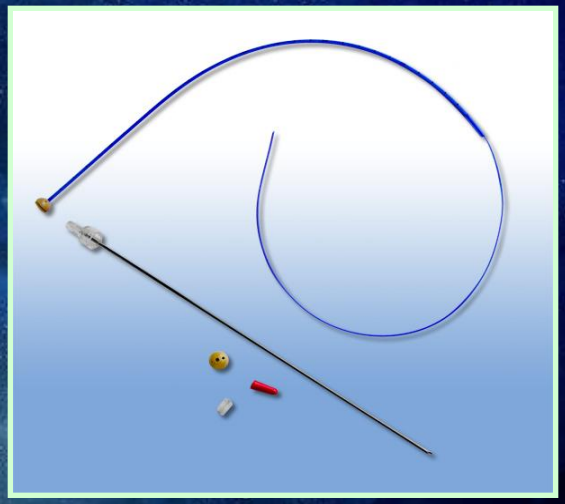
3. ballons:
   - MammoSite (1, 5, 8 channels)
   - Contura (5 channels)
   - SAVI
   - ClearPath

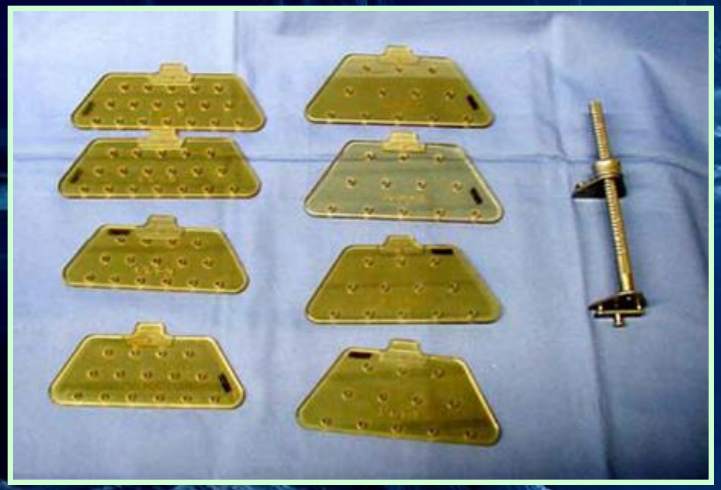
4. Axxent electronic brachytherapy system

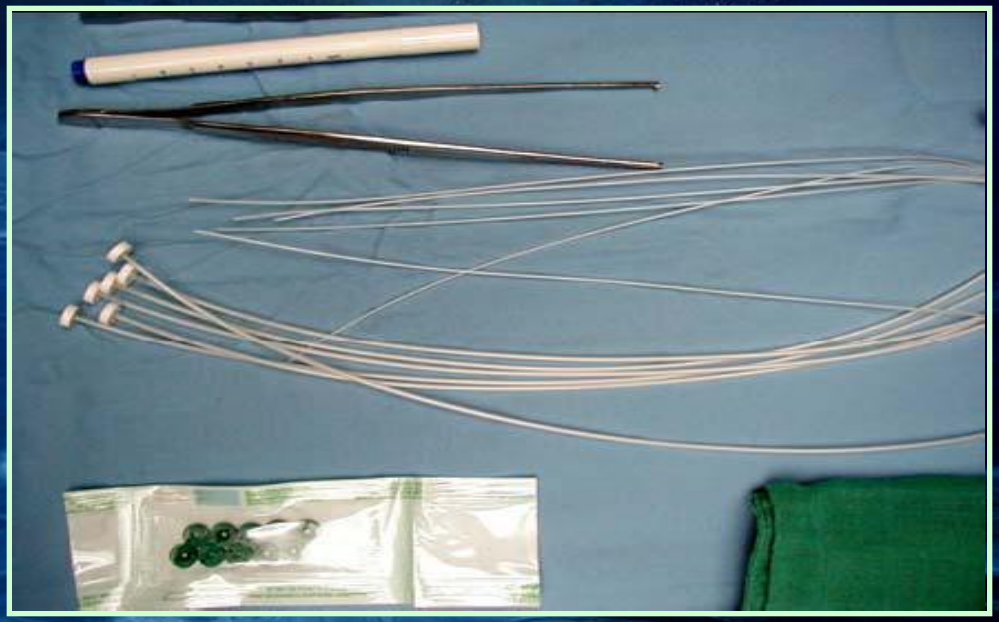
Applicators







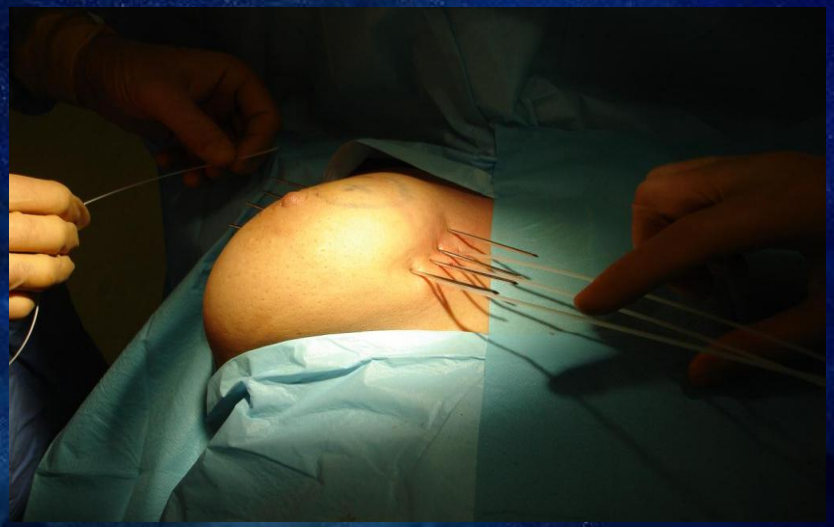




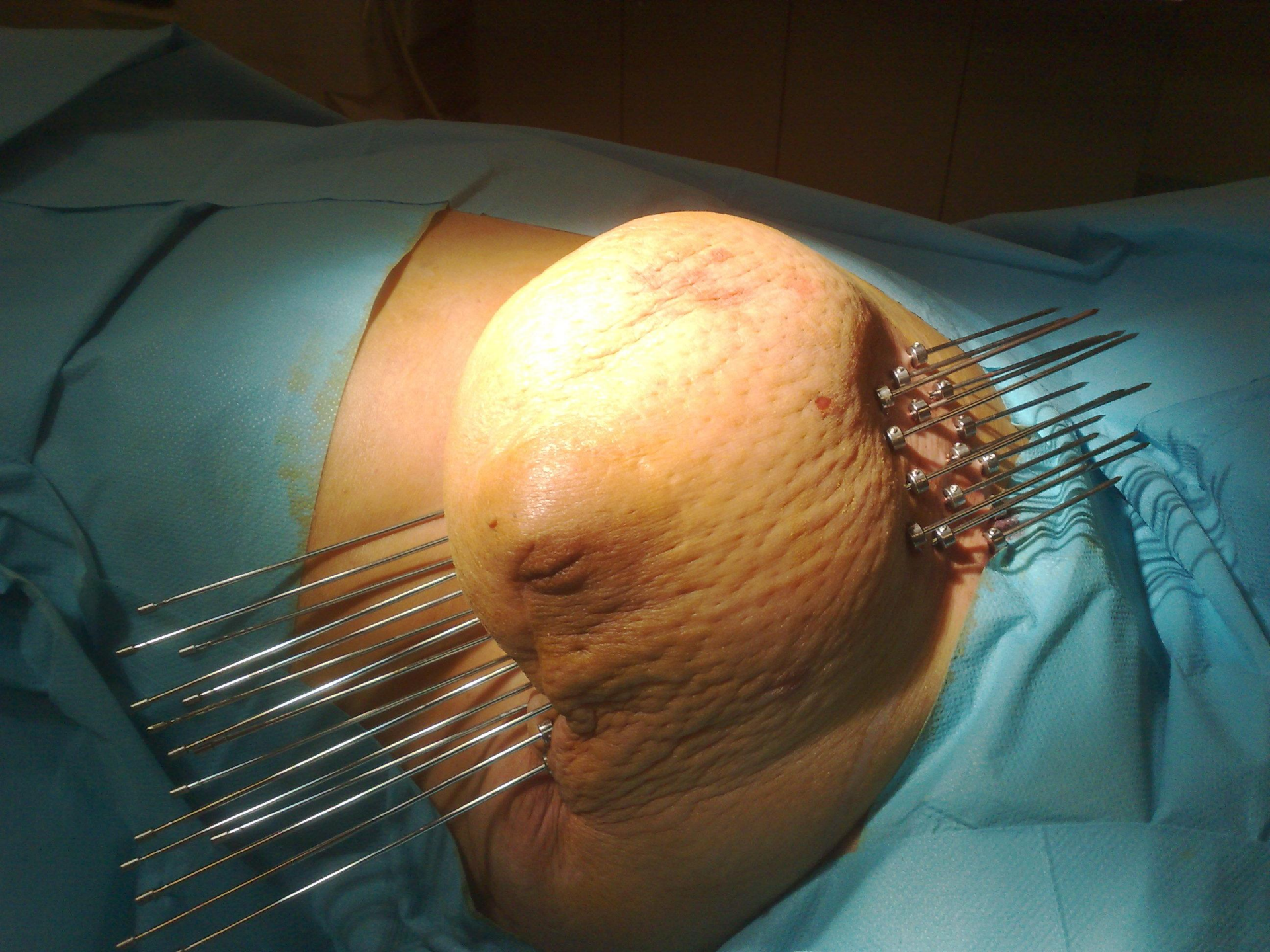
BCS, left breast cancer, 6 steel needles with templates visible – tumor located in upper external quadrant

History…

Breast cancer, interstitial BT



Breast cancer, interstitial BT



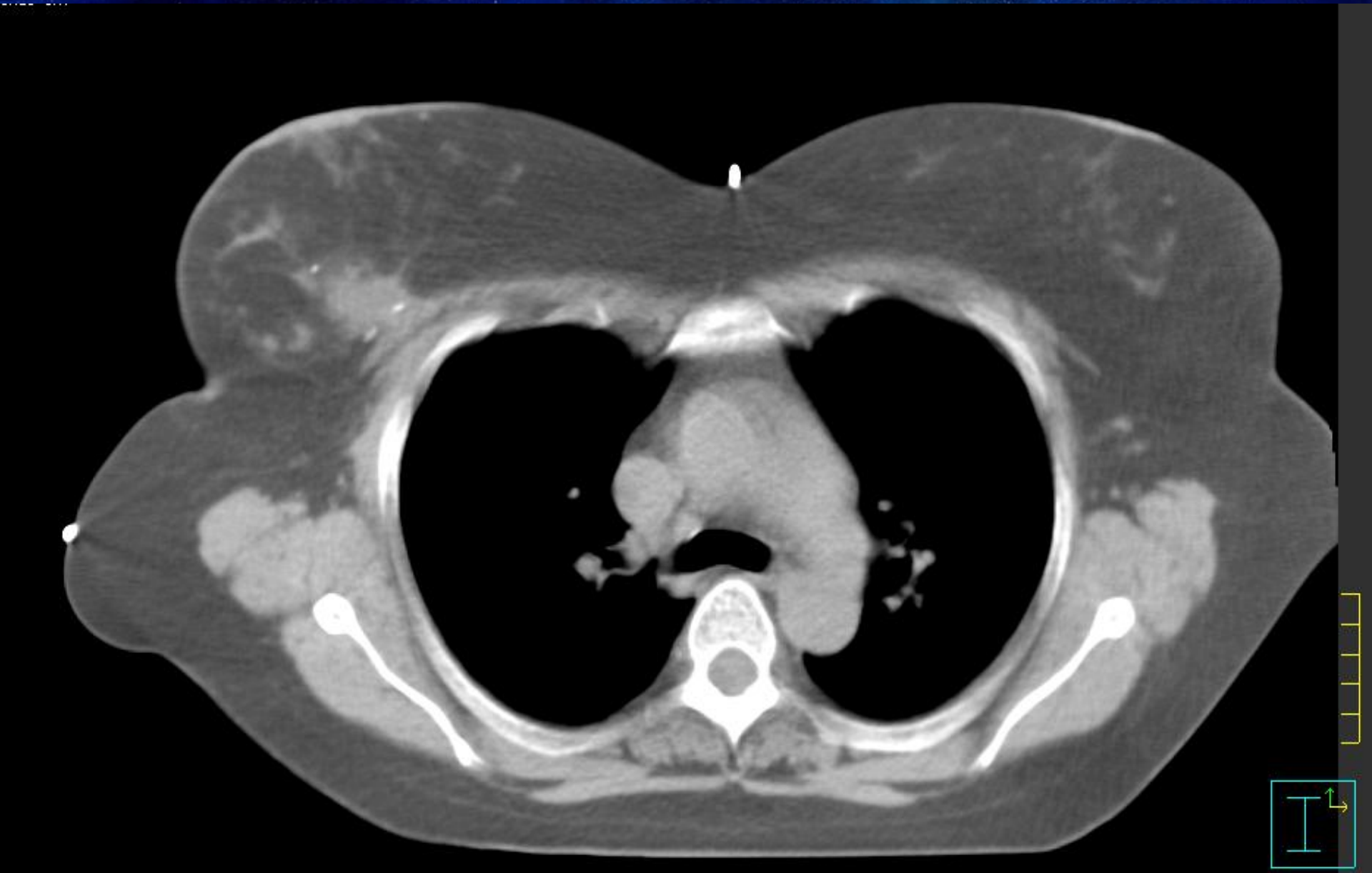

1


2

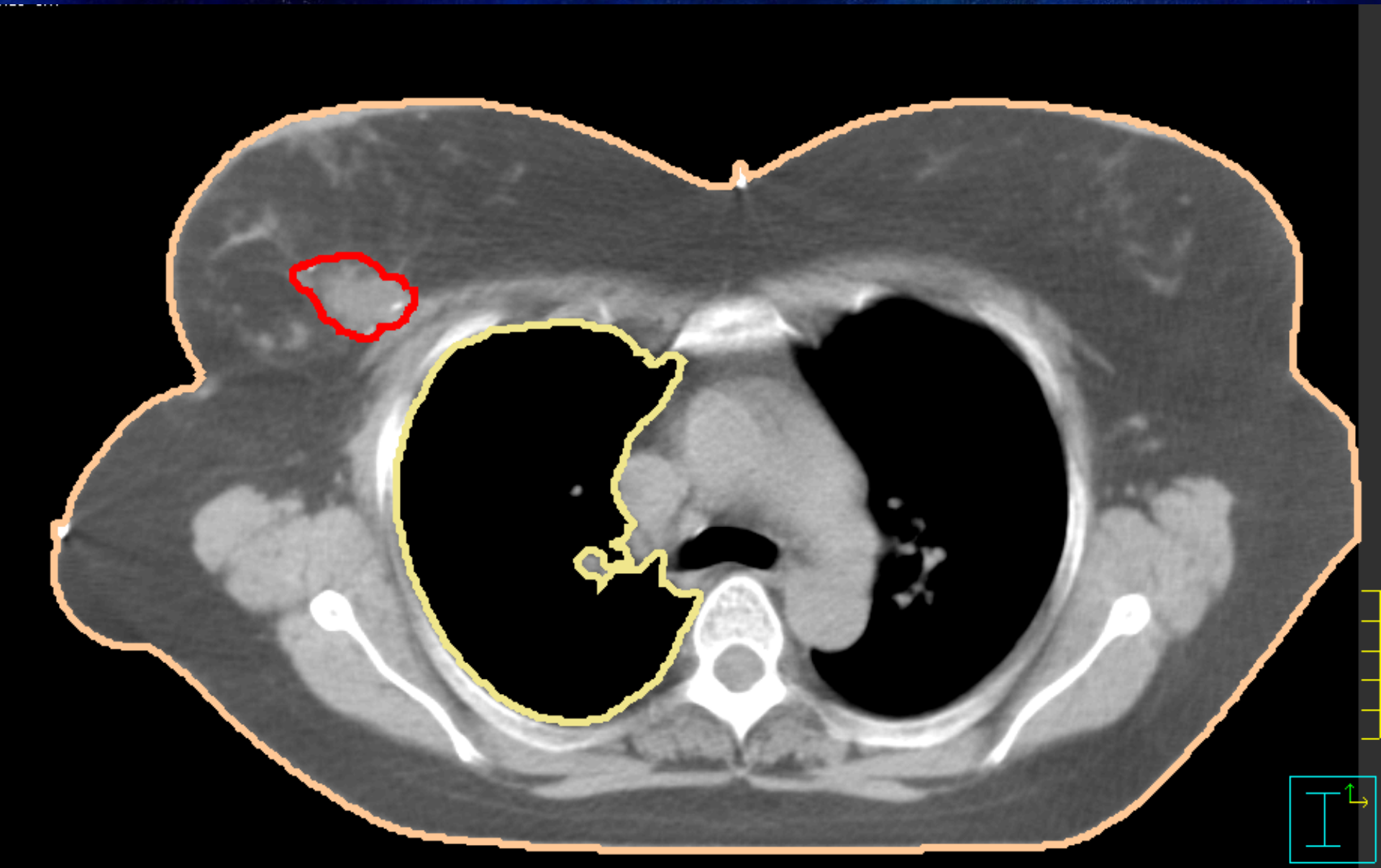

3


4

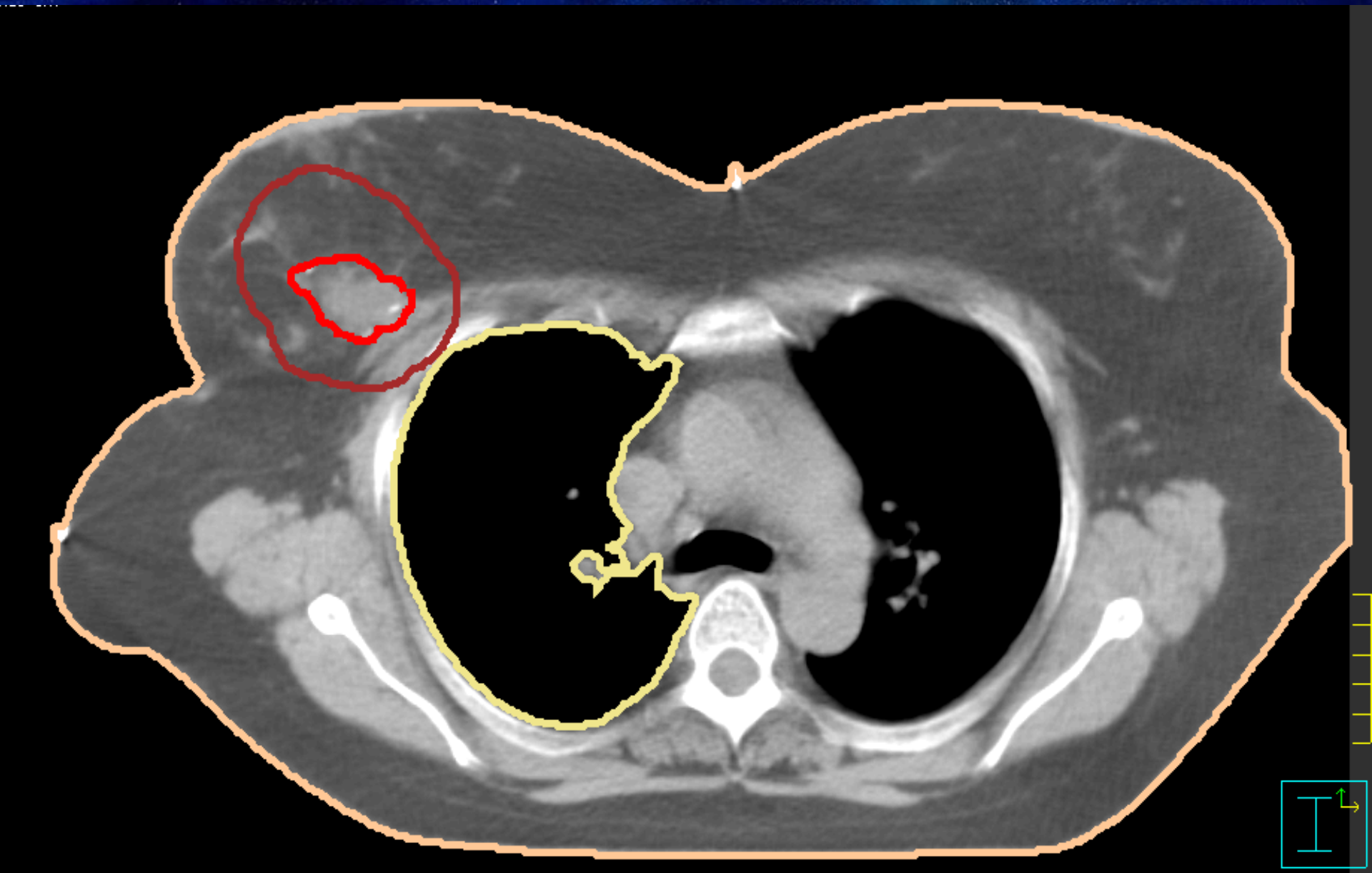
APBI - CTV



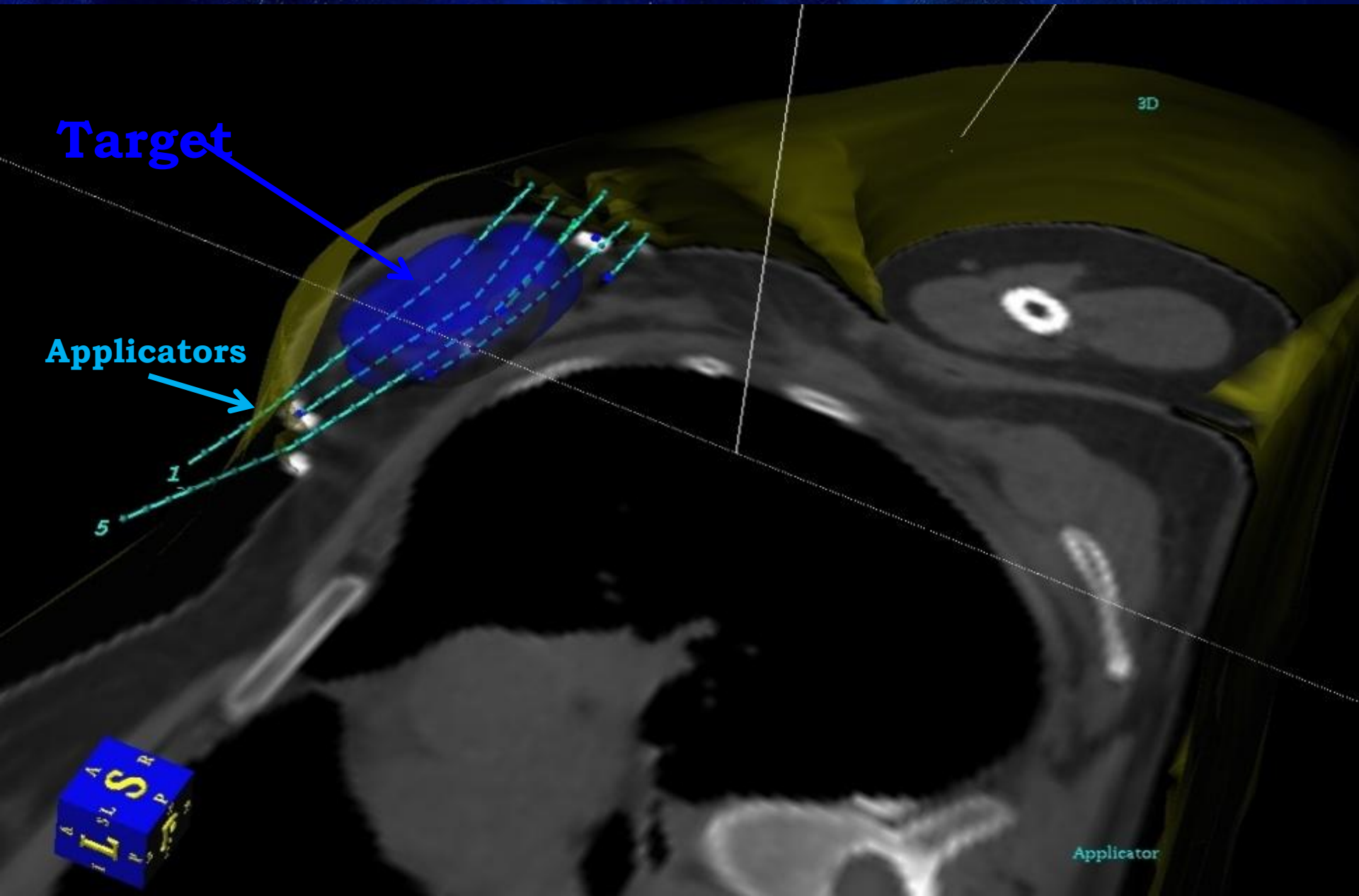
APBI - CTV

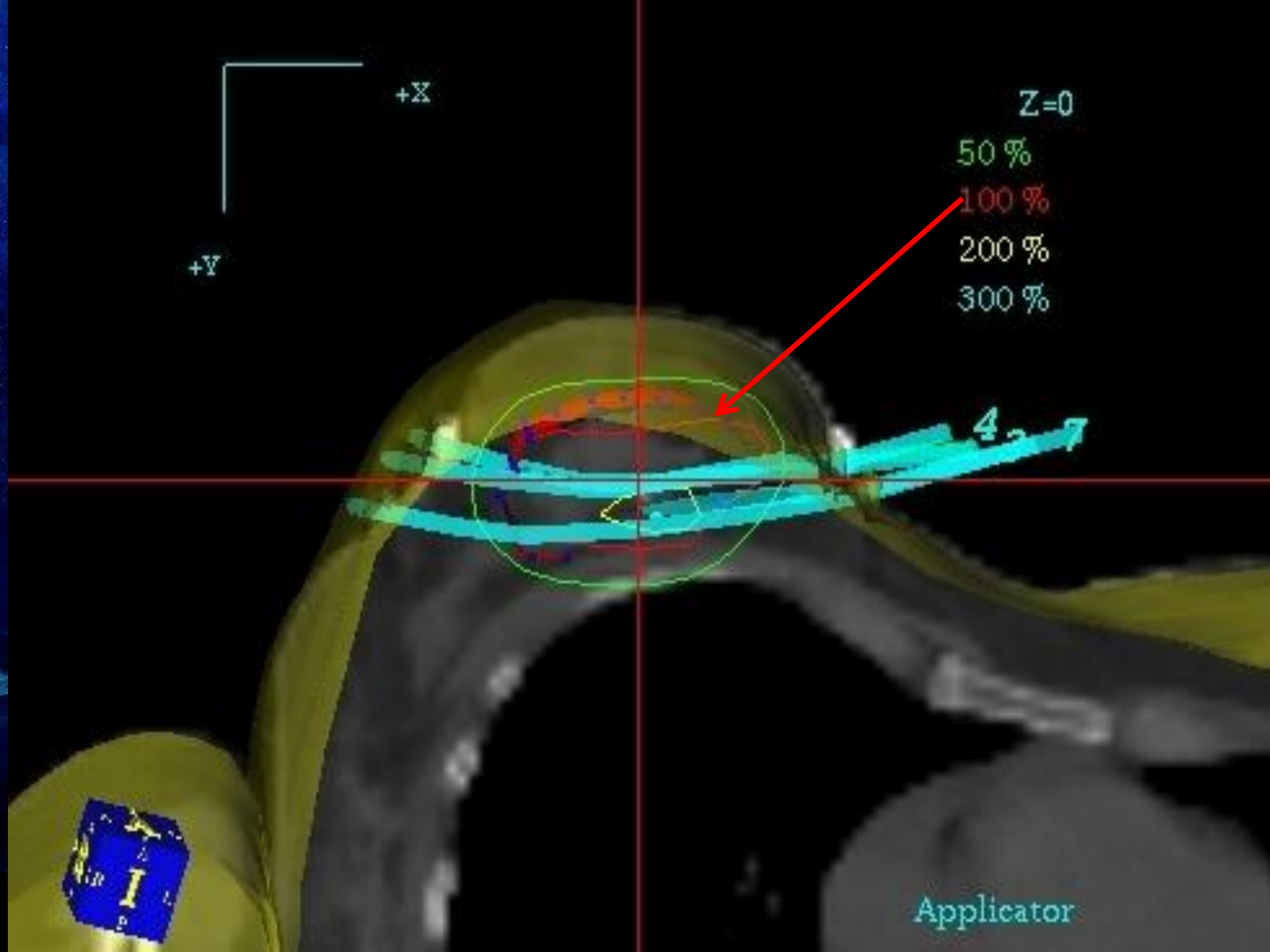


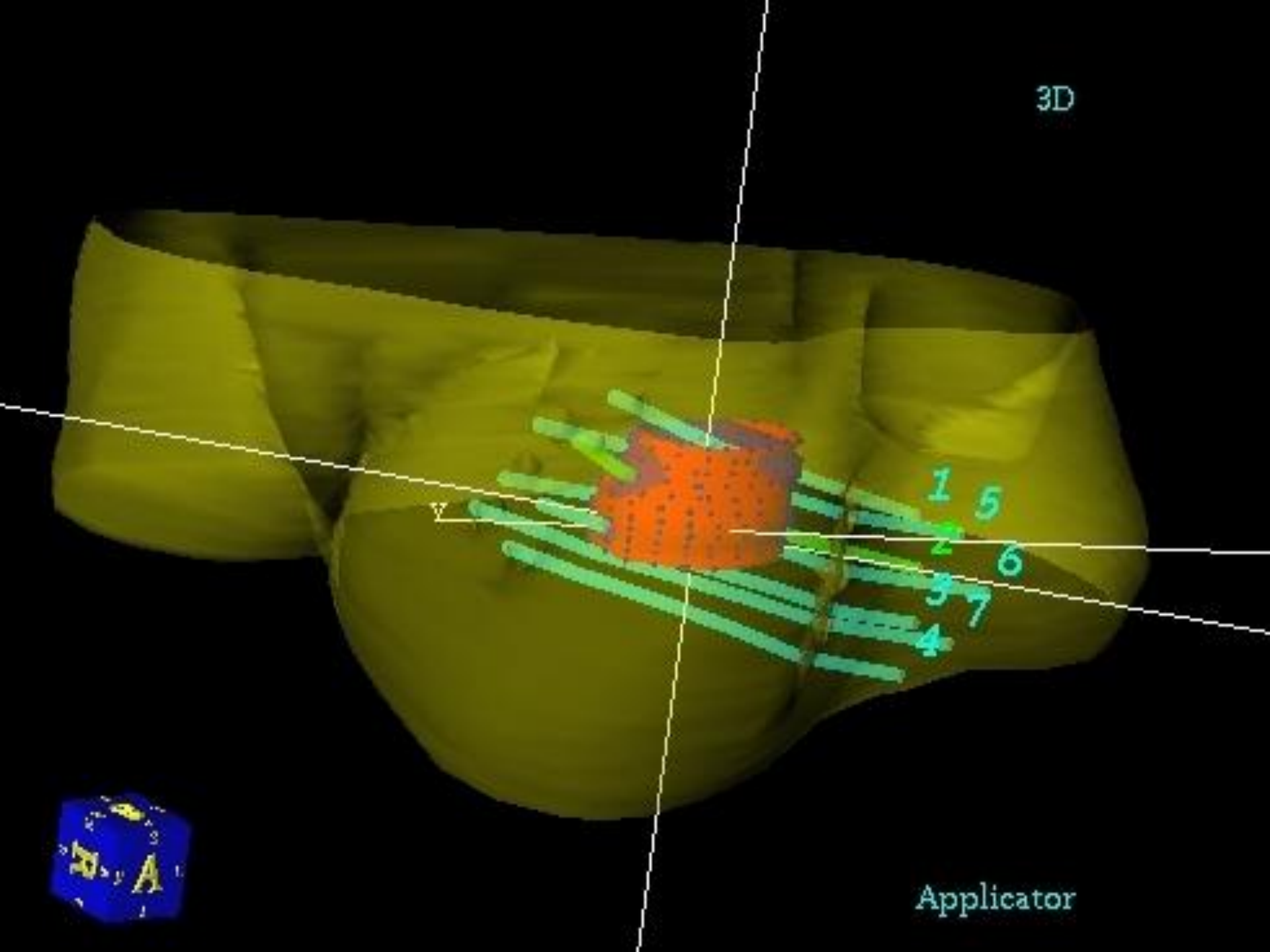
APBI - CTV

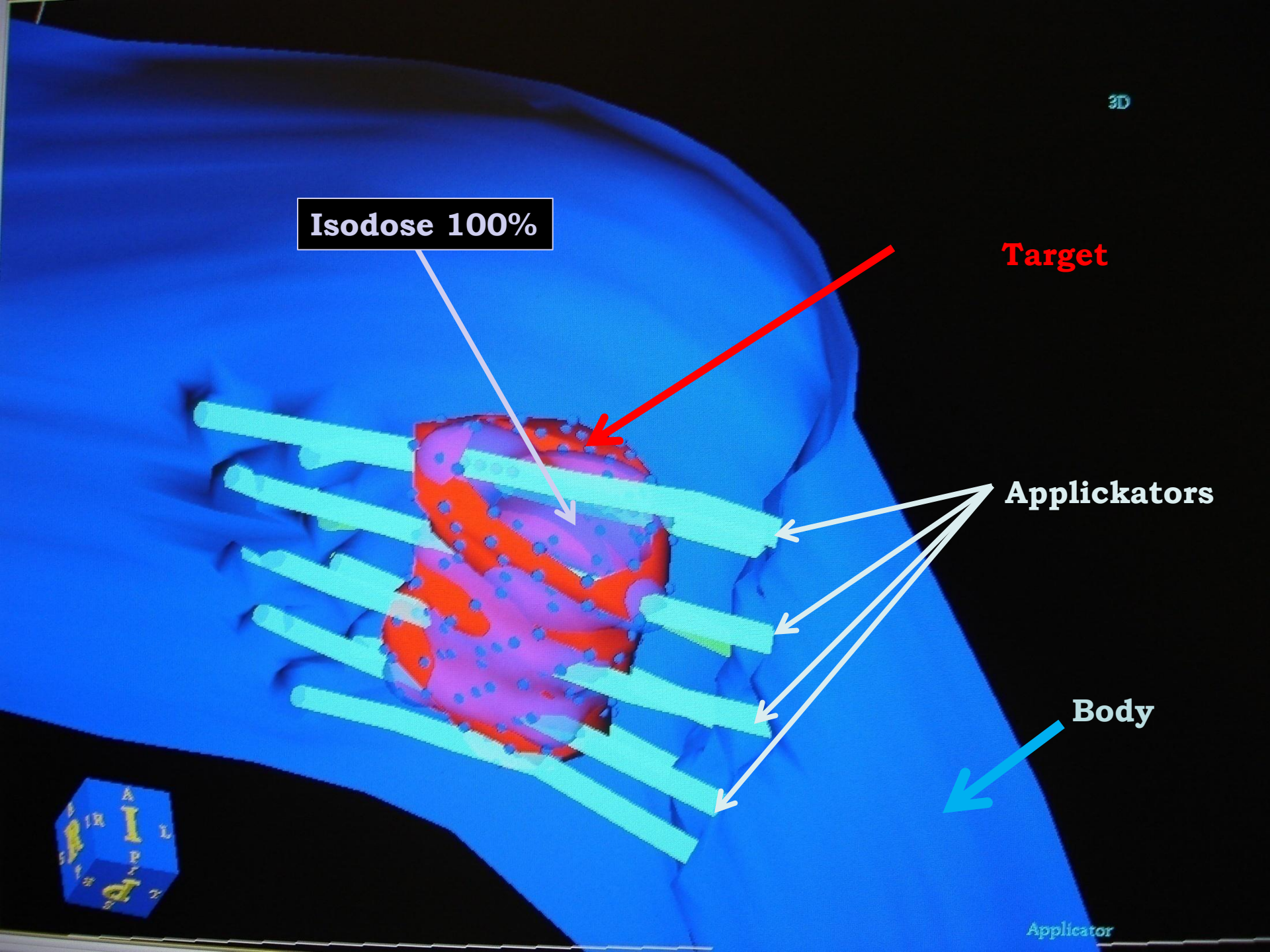


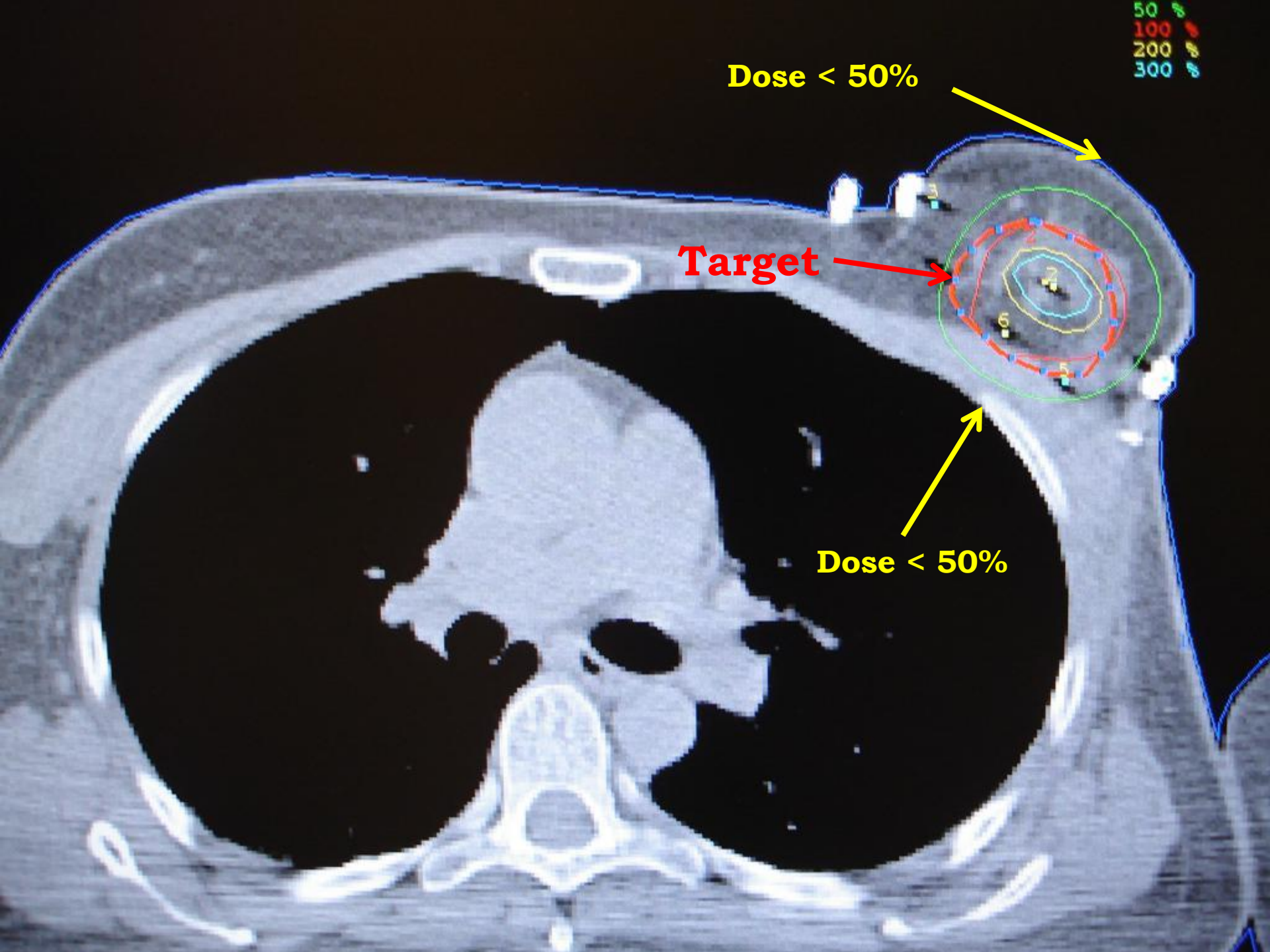
3D treatment plan



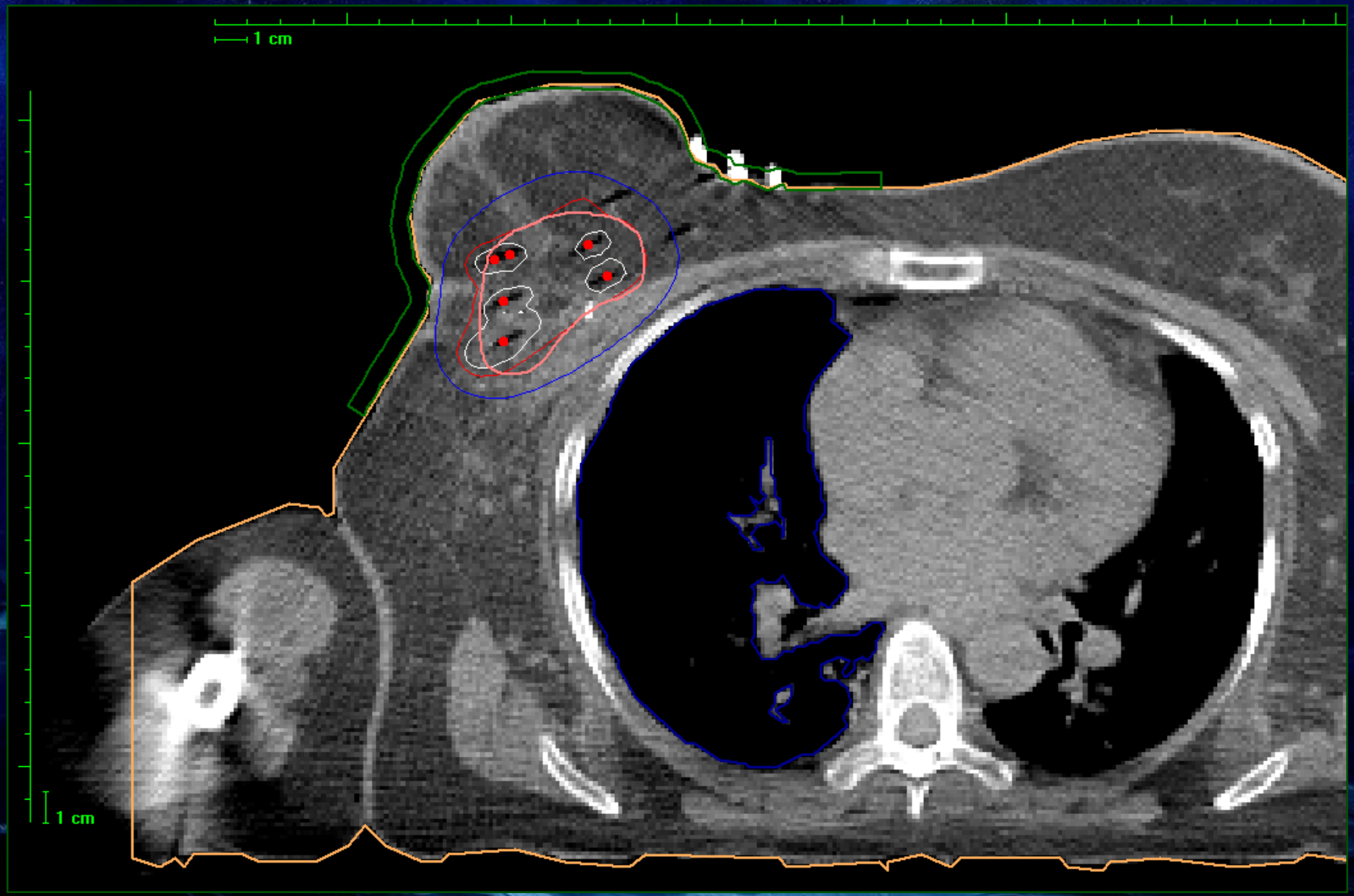

+X
+Y
Z=0
50 %
100 %
200 %
300 %
Applicator


3D
1
5
2
6
3
7
4
Applicator


Isodose 100%
Target
Applickators
Body
3D
Applicator


50 %
100 %
200 %
300 %
Dose < 50%
Target
Dose < 50%

Optimization



Constraints in DVH acc. to ABS

$D_{90} \geq 90\ \%$

V_{150}: interstitial BT < 70 ml, balloon < 50 ml

V_{200}: interstitial BT < 20 ml, balloon < 10 ml

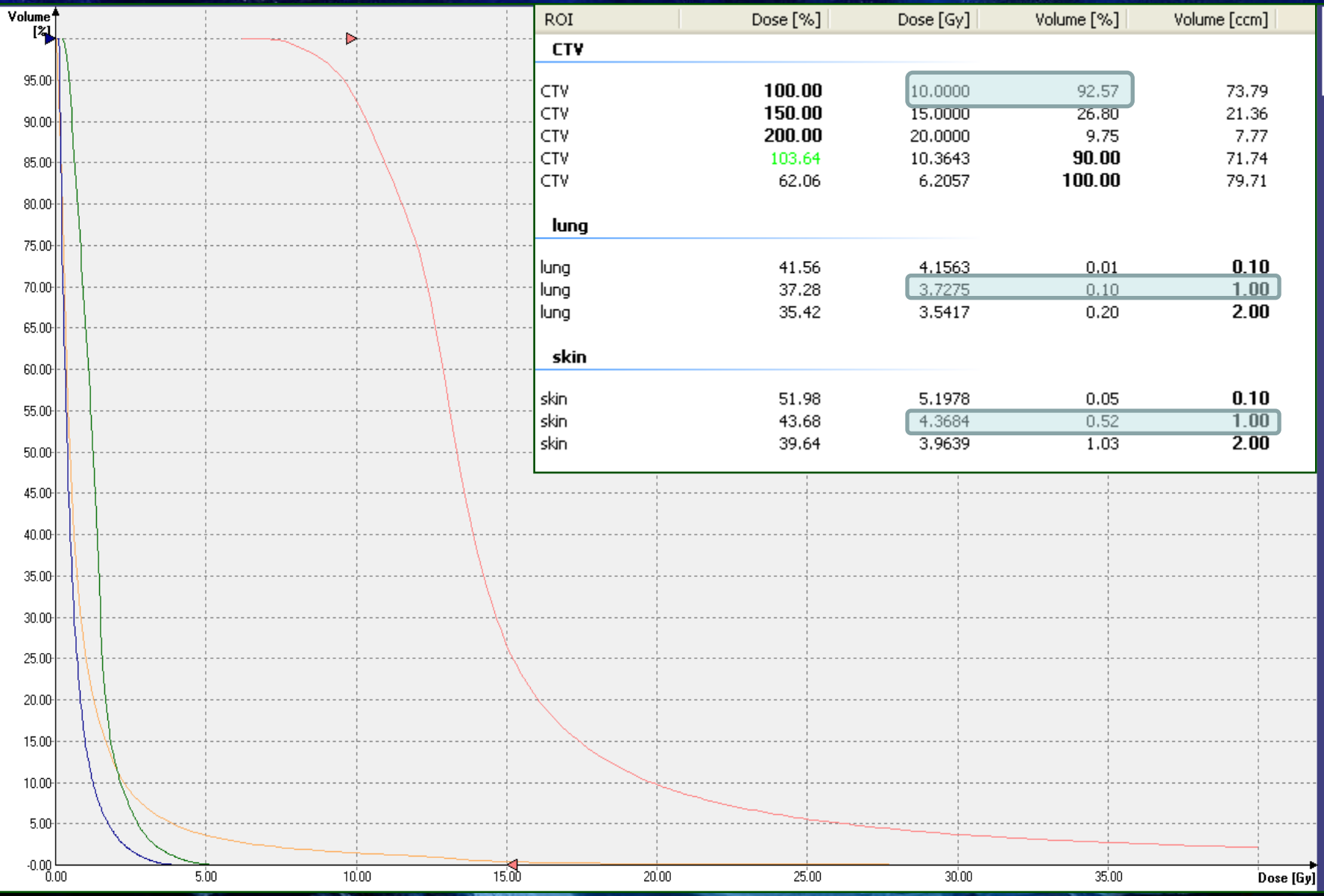
DHI > 0,75

DHI = 1 – V150/V100

skin D_{max}: balloon < 145 %

interstitial BT < 100 %

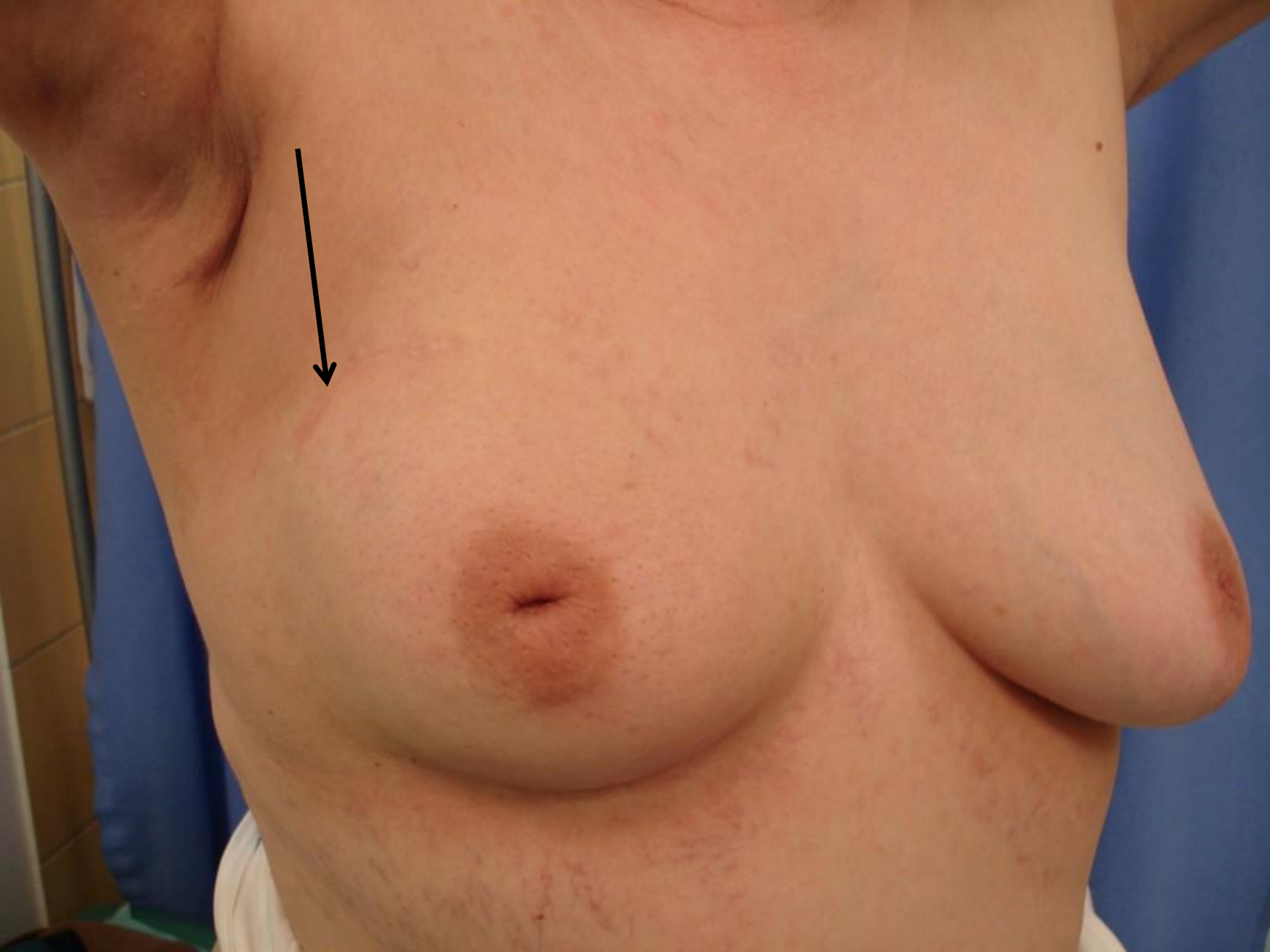
Evaluation of DVH



ROI	Dose [%]	Dose [Gy]	Volume [%]	Volume [ccm]
CTV				
CTV	**100.00**	10.0000	92.57	73.79
CTV	**150.00**	15.0000	26.80	21.36
CTV	**200.00**	20.0000	9.75	7.77
CTV	103.64	10.3643	**90.00**	71.74
CTV	62.06	6.2057	**100.00**	79.71
lung				
lung	41.56	4.1563	0.01	**0.10**
lung	37.28	3.7275	0.10	**1.00**
lung	35.42	3.5417	0.20	**2.00**
skin				
skin	51.98	5.1978	0.05	**0.10**
skin	43.68	4.3684	0.52	**1.00**
skin	39.64	3.9639	1.03	**2.00**

Factors influencing cosmetic effect

1. location of the tumor (KGZ vs other),
2. tumor size (T1 vs. T2),
3. radiotherapy technique,
4. irradiation of regional lymph nodes,
5. dose fractionation,
6. dose rate,
7. systemic adjuvant therapy.



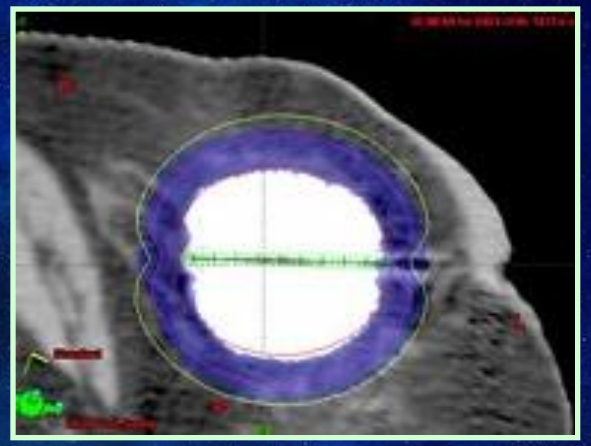
Balloons

1. Modified type of HDR brachytherapy,
2. Catheter with a balloon placed in the tumor bed,
3. Balloon filled with liquid so as to adhere to the walls of the lodge,
4. Cross-CT (after full histopathology and after healing of the wound),
5. Treatment duration - 5 days (10 after 3.4 Gy fr, twice daily every 6 h, at a distance of 1 cm outside from the balloon wall),

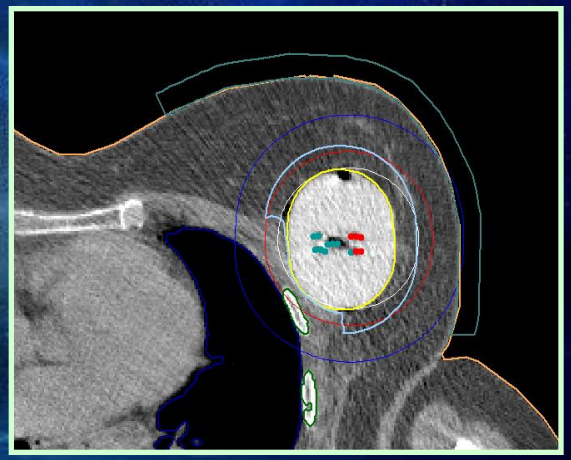
Contraindications:

small breast, the tumor is located close to the ribs, tumor was lower than 5 mm.

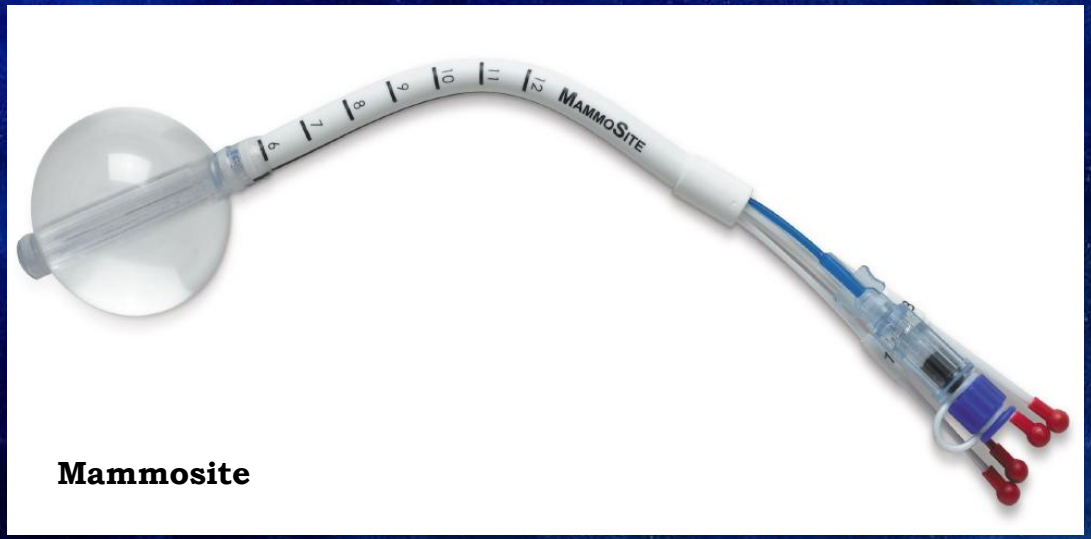

MammoSite




Contura

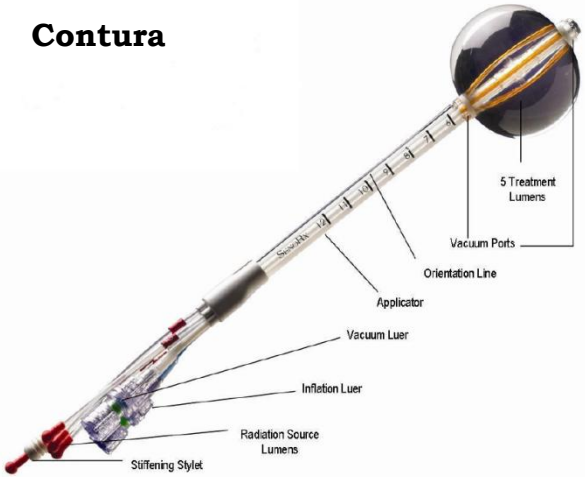



SAVI

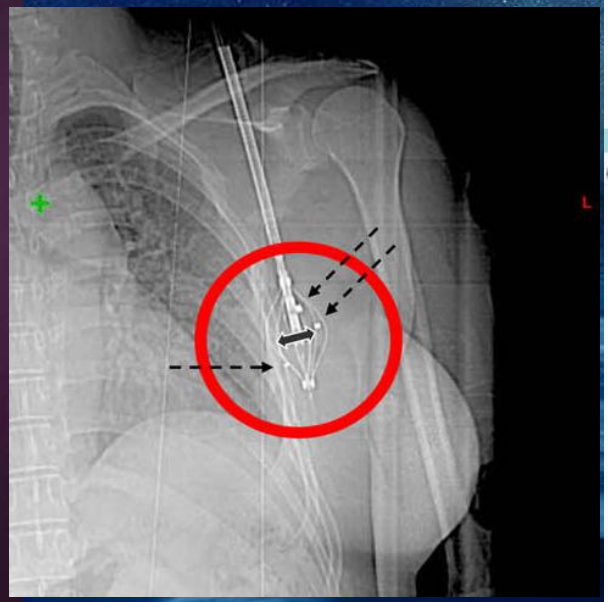


Mammosite

Contura



Strut Adjusted Volume Implant



ClearPath

MammoSite

1. MammoSite applicator can be positioned in the tumor bed during tumorectomy or later, under the control of US (the presence of histopathological diagnosis),

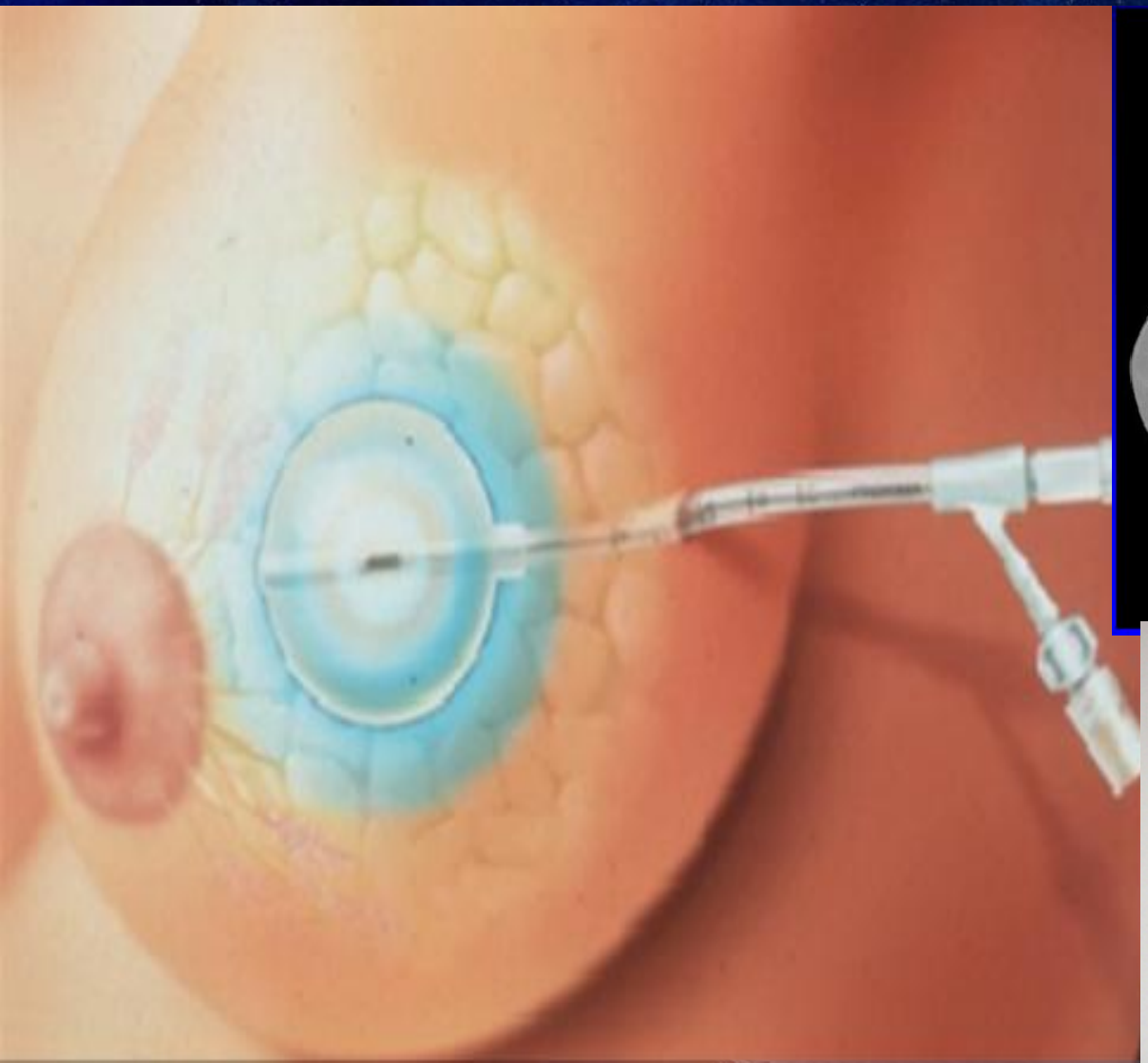
2. Important - the impact of such factors as:
   - Volume of the tumor bed,
   - The shape of the box,
   - The size of surgical margin,

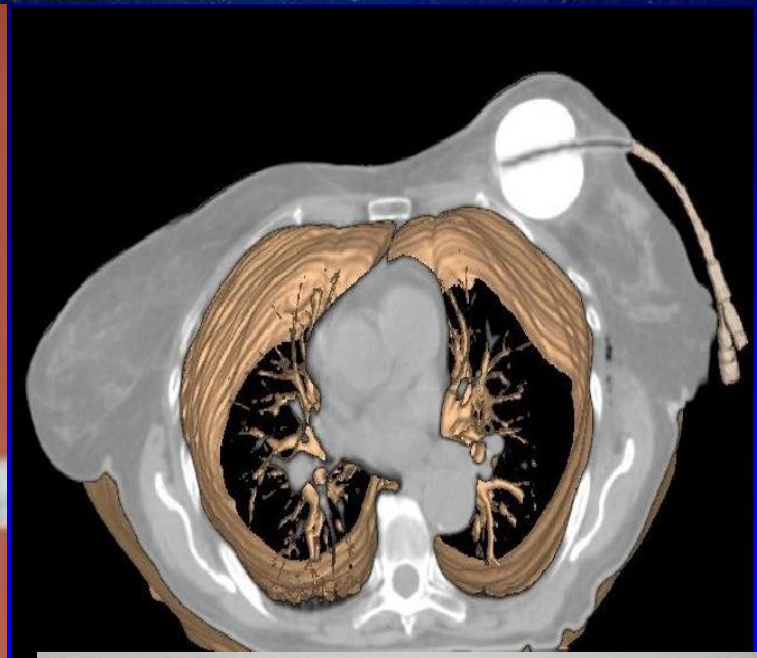
   The volume of the tumor bed should be at least 30 cm3 to obtain the proper dose distribution,

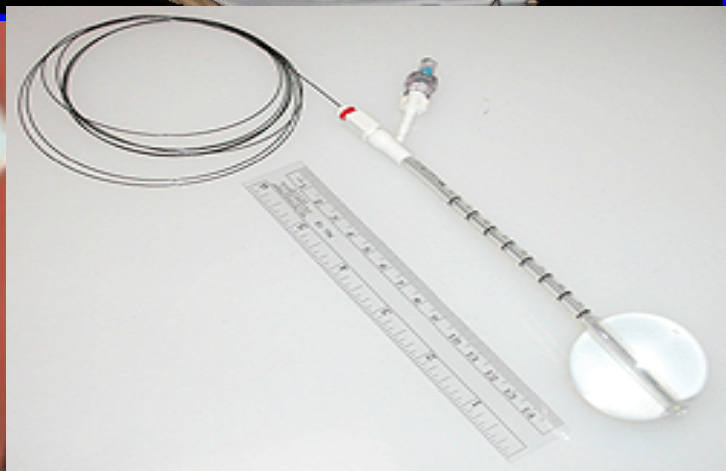
3. Published treatment results so far suggest a satisfying cosmetic results (80% to 93% of patients),

4. In some cases, we observed early radiation skin reactions similar to the standard treatment of EBRT.

The method of MammoSite, a schematic picture of an applicator placed in the bed of the tumor, the cross section at the level of the chest, visible implanted balloon applicator endeda flexible box placed in the bed, view of the applicator, which in the course of treatment is combined with the brachytherapy unit.

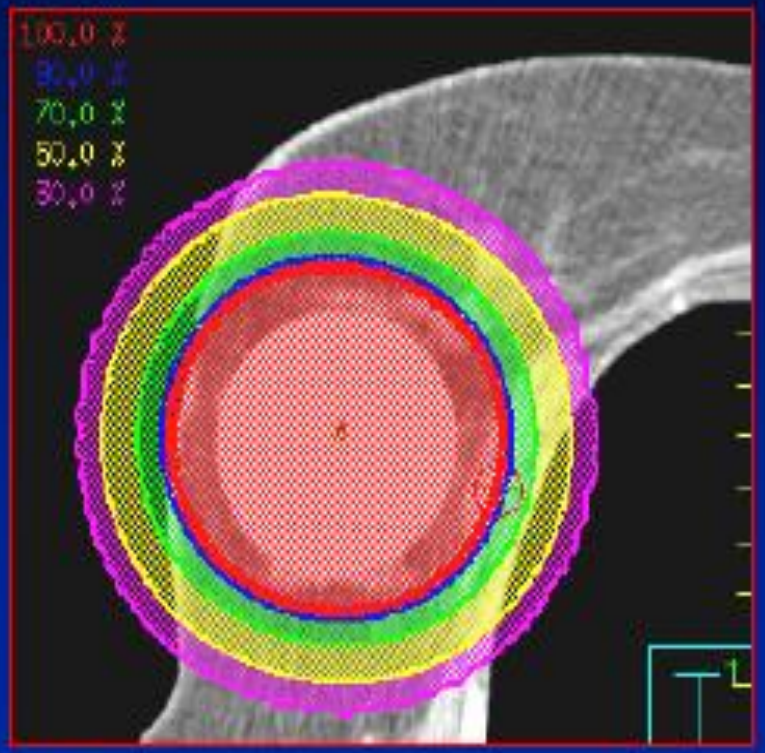






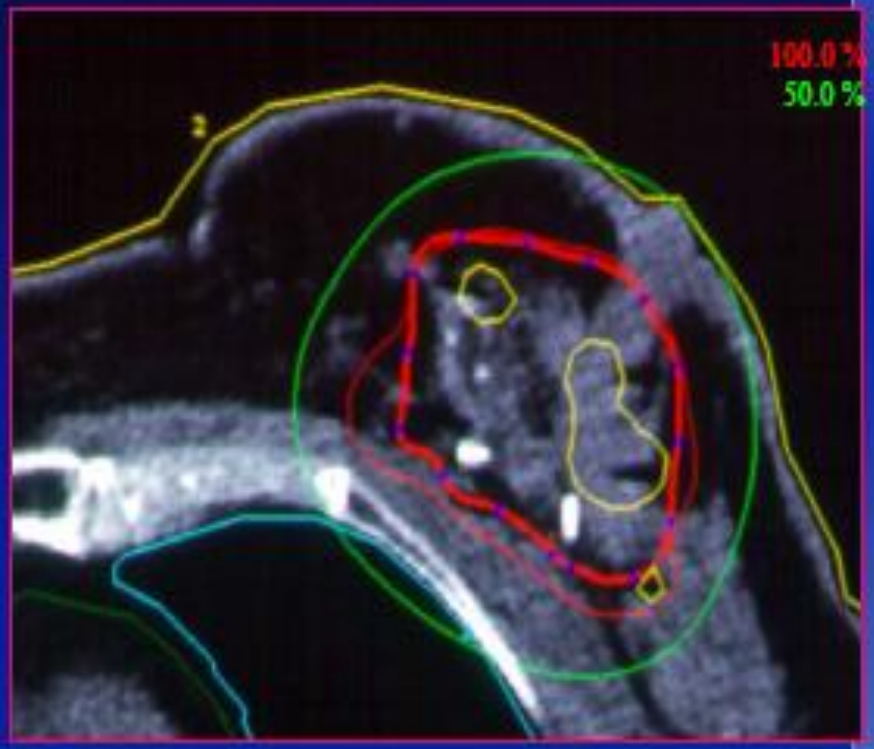
Comparison of dose distributions

MammoSite



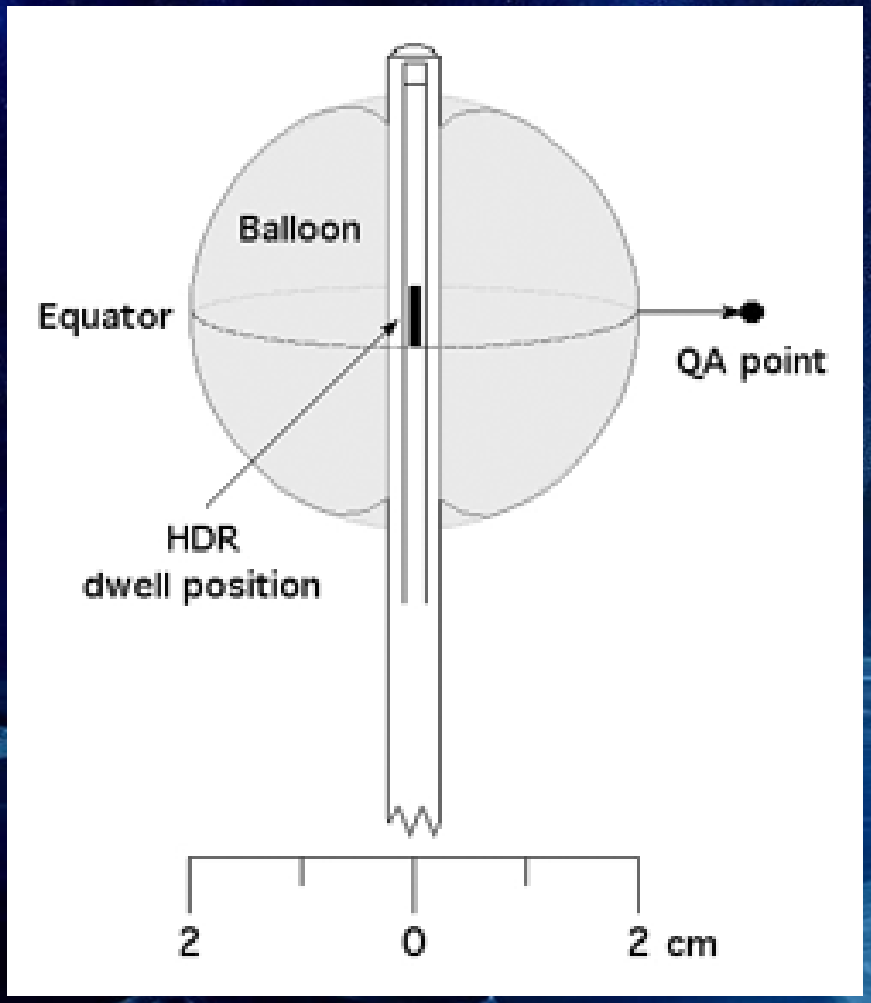
Max. skin dose > 100%

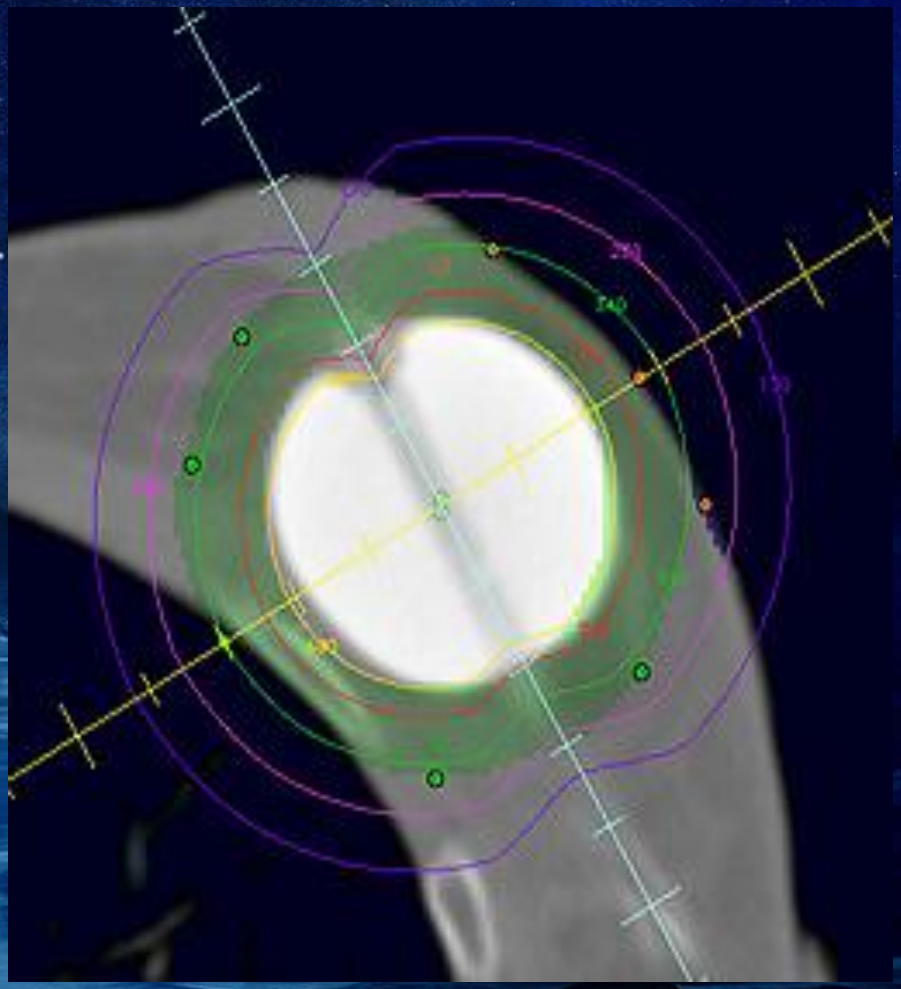
Interstitial brachytherapy



Max. skin dose = 50%

Mammosite – scheme, dose distribution





Breast: HDR = Black, MammoSite = Red, 3D-CRT = Green

D.W. Weed et al. / Brachytherapy 4 (2005) 121–129

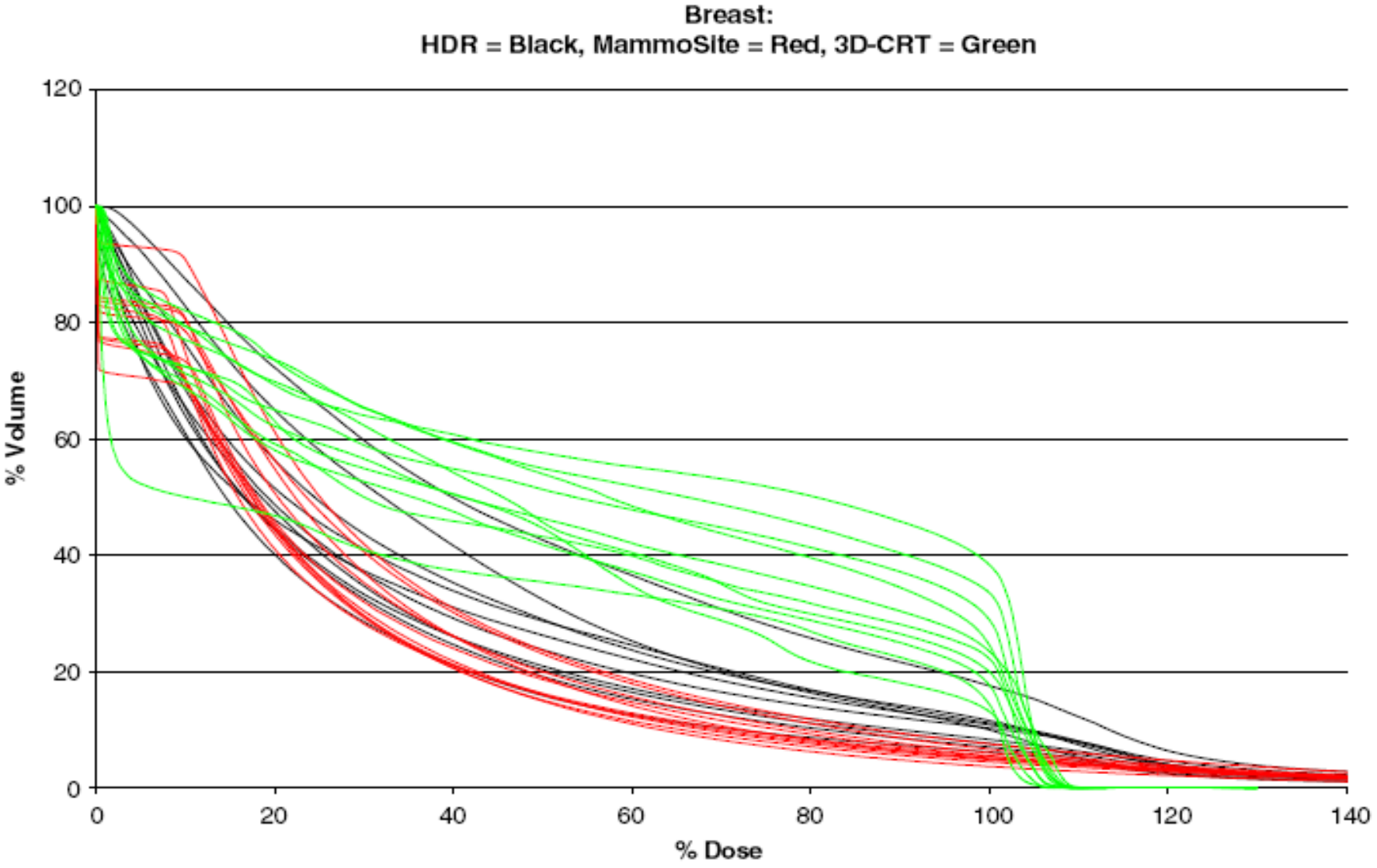


Fig. 2. Percentage of breast tissue receiving percentage of the prescribed dose.

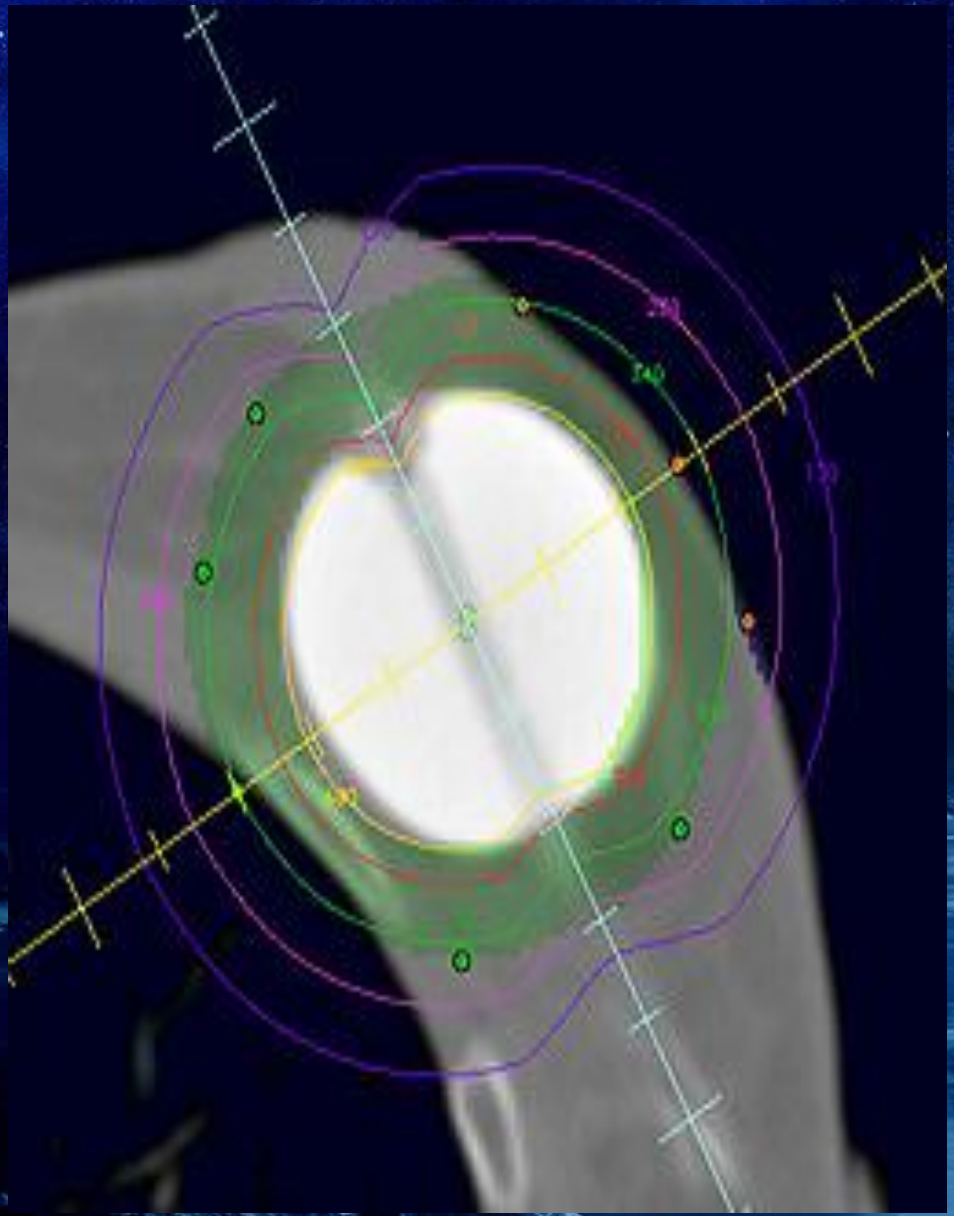
Contura

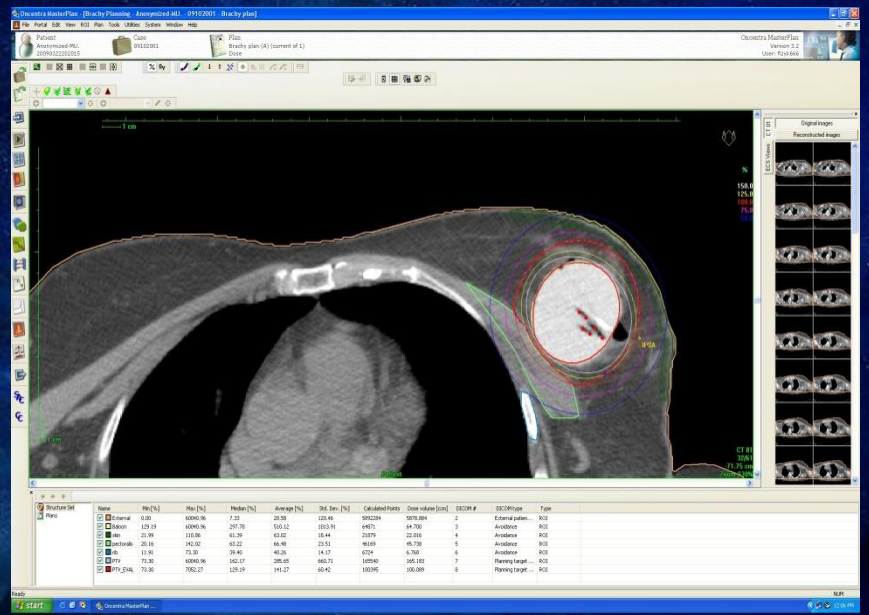

Contura™
Multi-Lumen Balloon - MLB
5 Treatment Lumens
Vacuum Ports
Orientation Line
Applicator
Vacuum Luer
Inflation Luer
Radiation Source Lumens
Stiffening Stylet

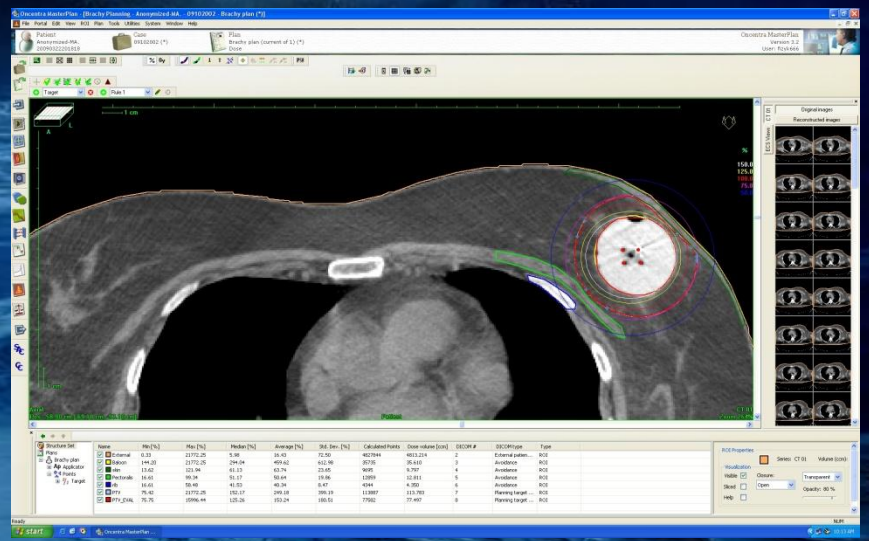

7 8 9 10 11 12 SenoRx


Rx

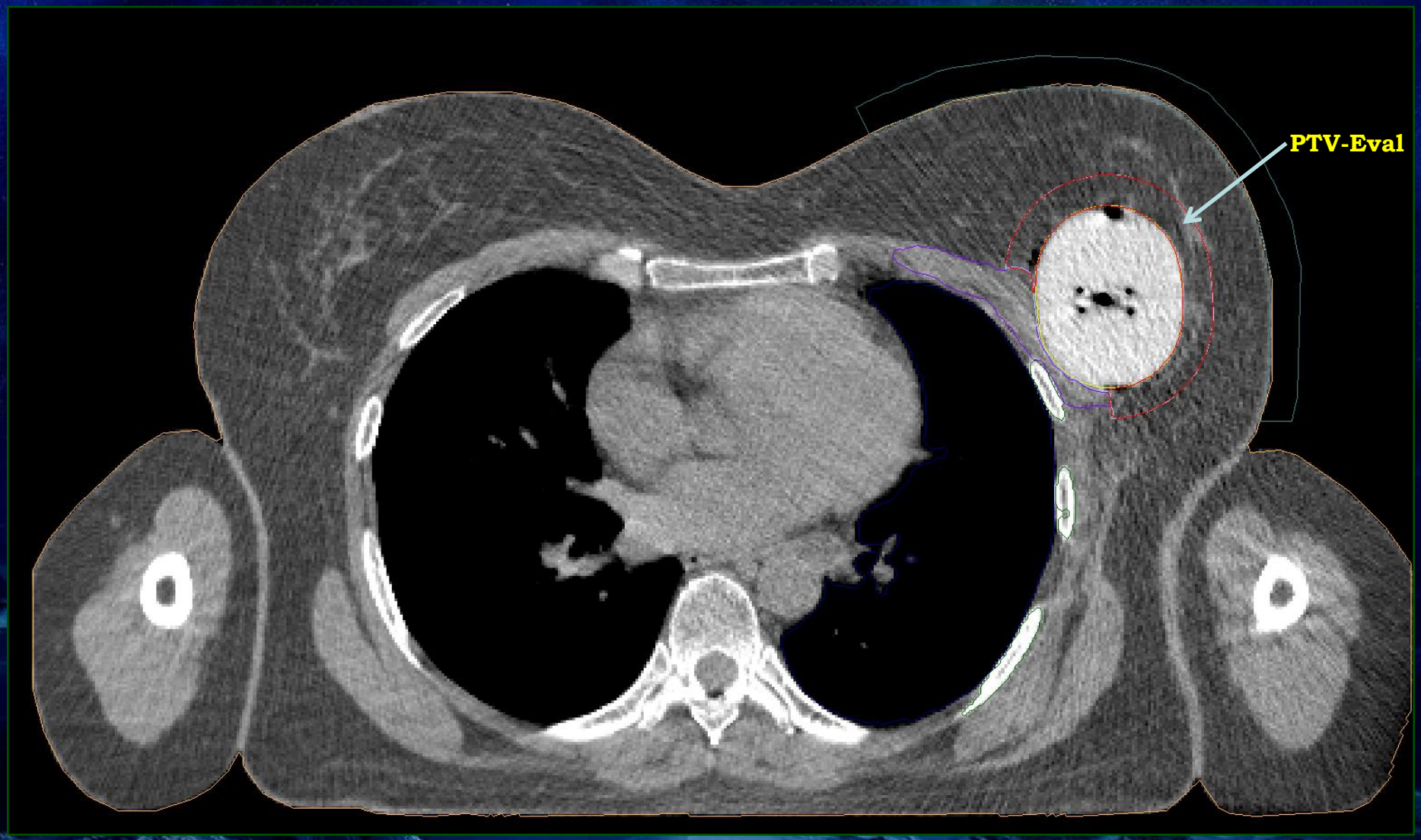

7 8 9 10 11 12



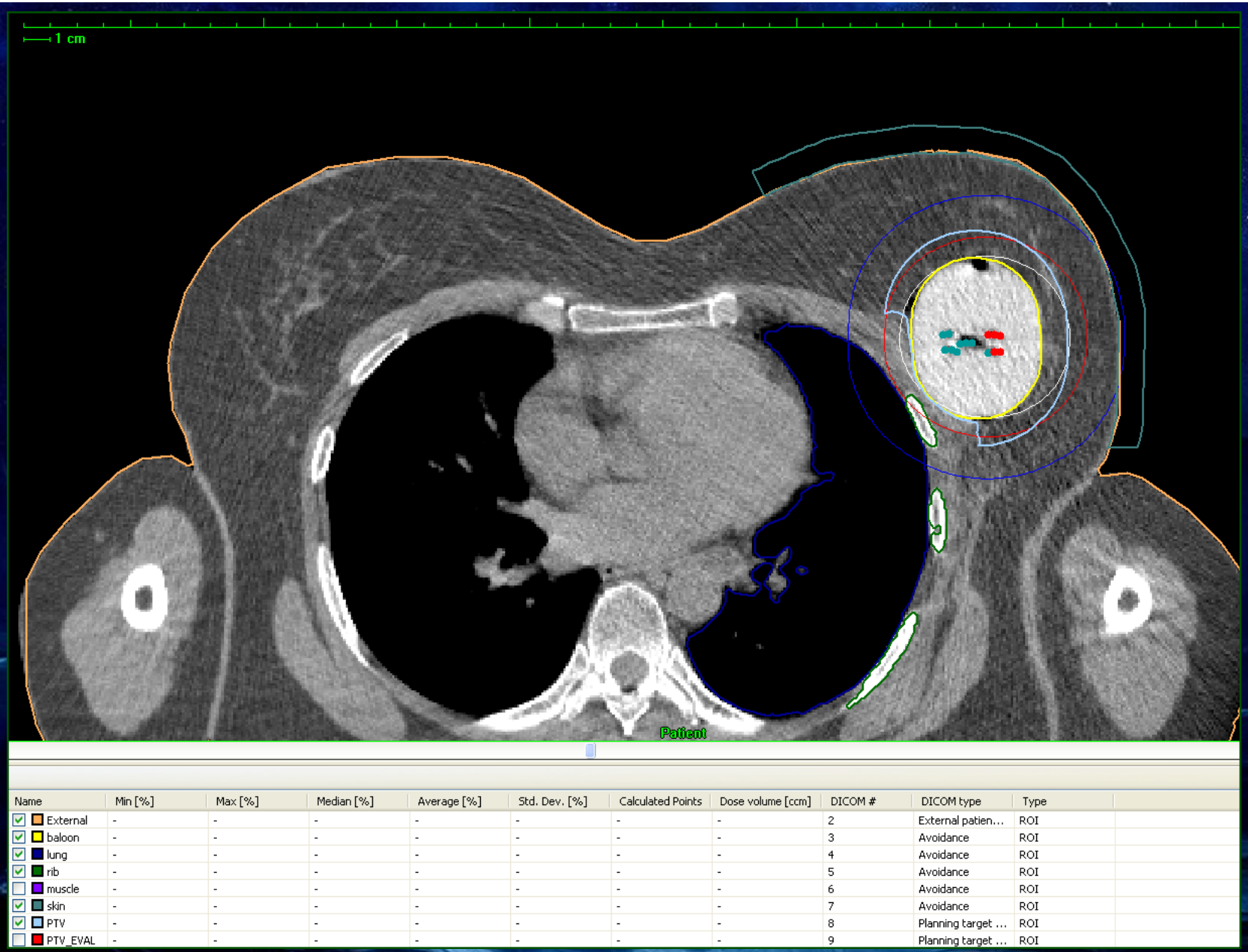




Treatment planning – Contura

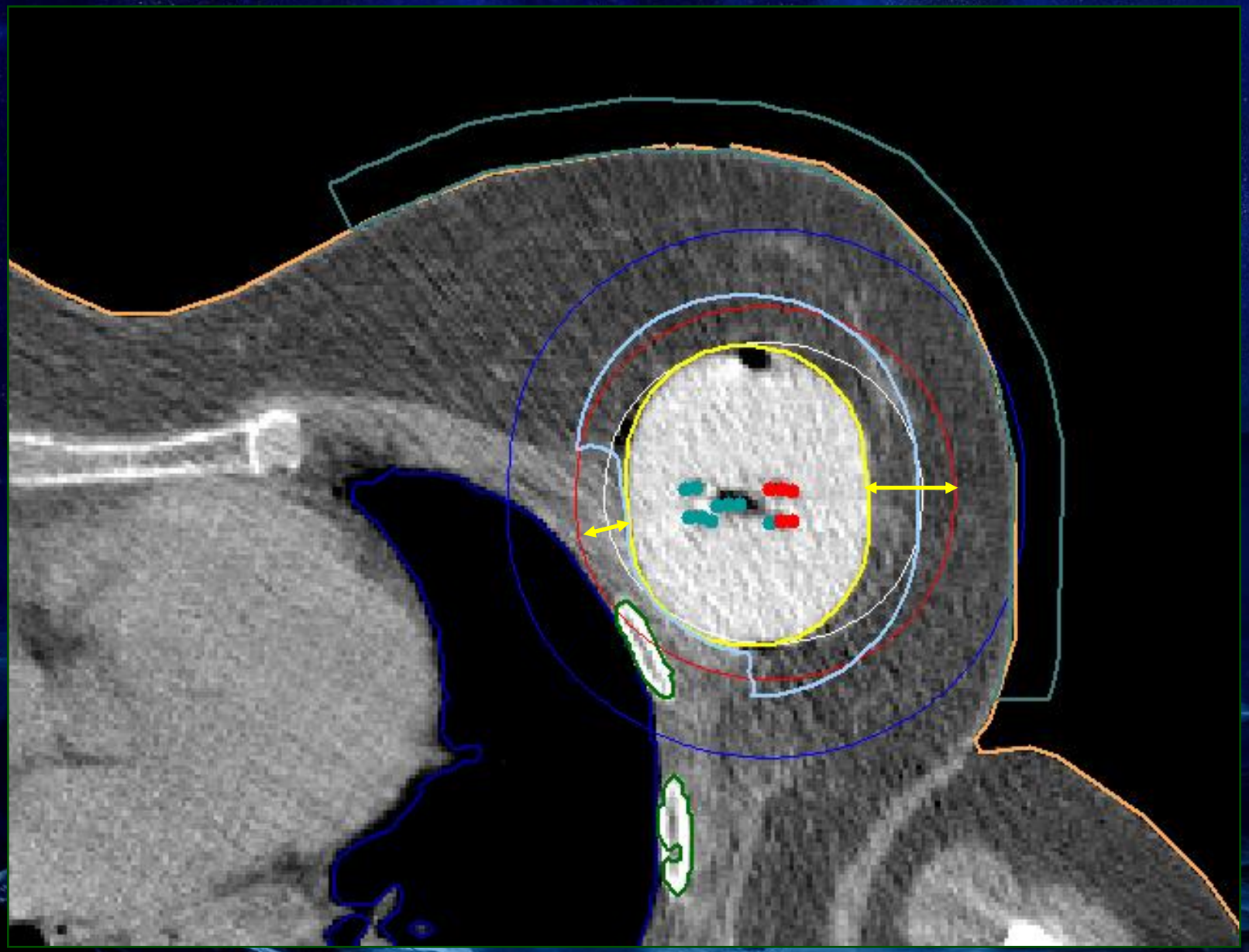


Treatment planning – Contura

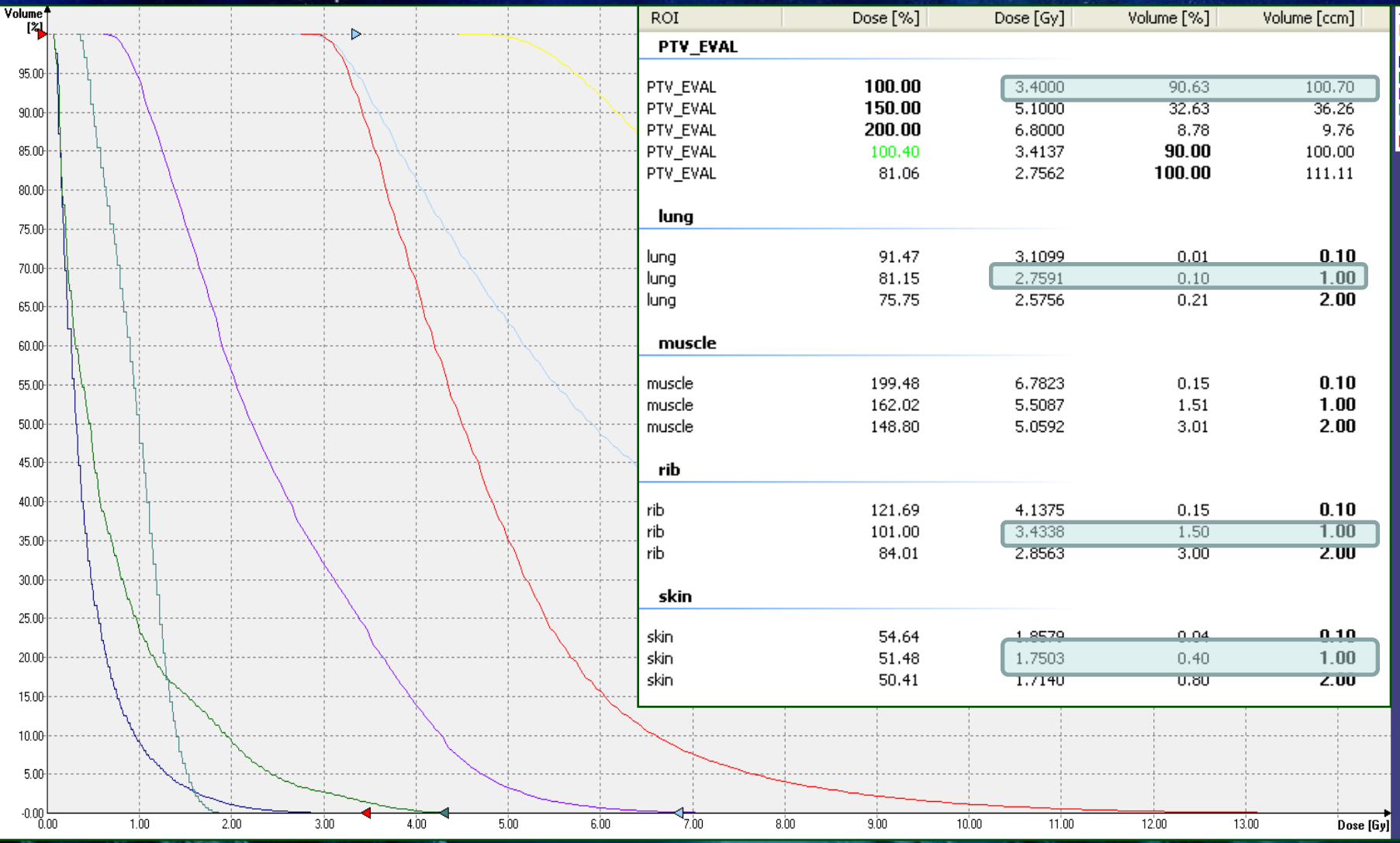


Name	Min [%]	Max [%]	Median [%]	Average [%]	Std. Dev. [%]	Calculated Points	Dose volume [ccm]	DICOM #	DICOM type	Type
External	-	-	-	-	-	-	-	2	External patien...	ROI
baloon	-	-	-	-	-	-	-	3	Avoidance	ROI
lung	-	-	-	-	-	-	-	4	Avoidance	ROI
rib	-	-	-	-	-	-	-	5	Avoidance	ROI
muscle	-	-	-	-	-	-	-	6	Avoidance	ROI
skin	-	-	-	-	-	-	-	7	Avoidance	ROI
PTV	-	-	-	-	-	-	-	8	Planning target ...	ROI
PTV_EVAL	-	-	-	-	-	-	-	9	Planning target ...	ROI

Treatment planning – Contura

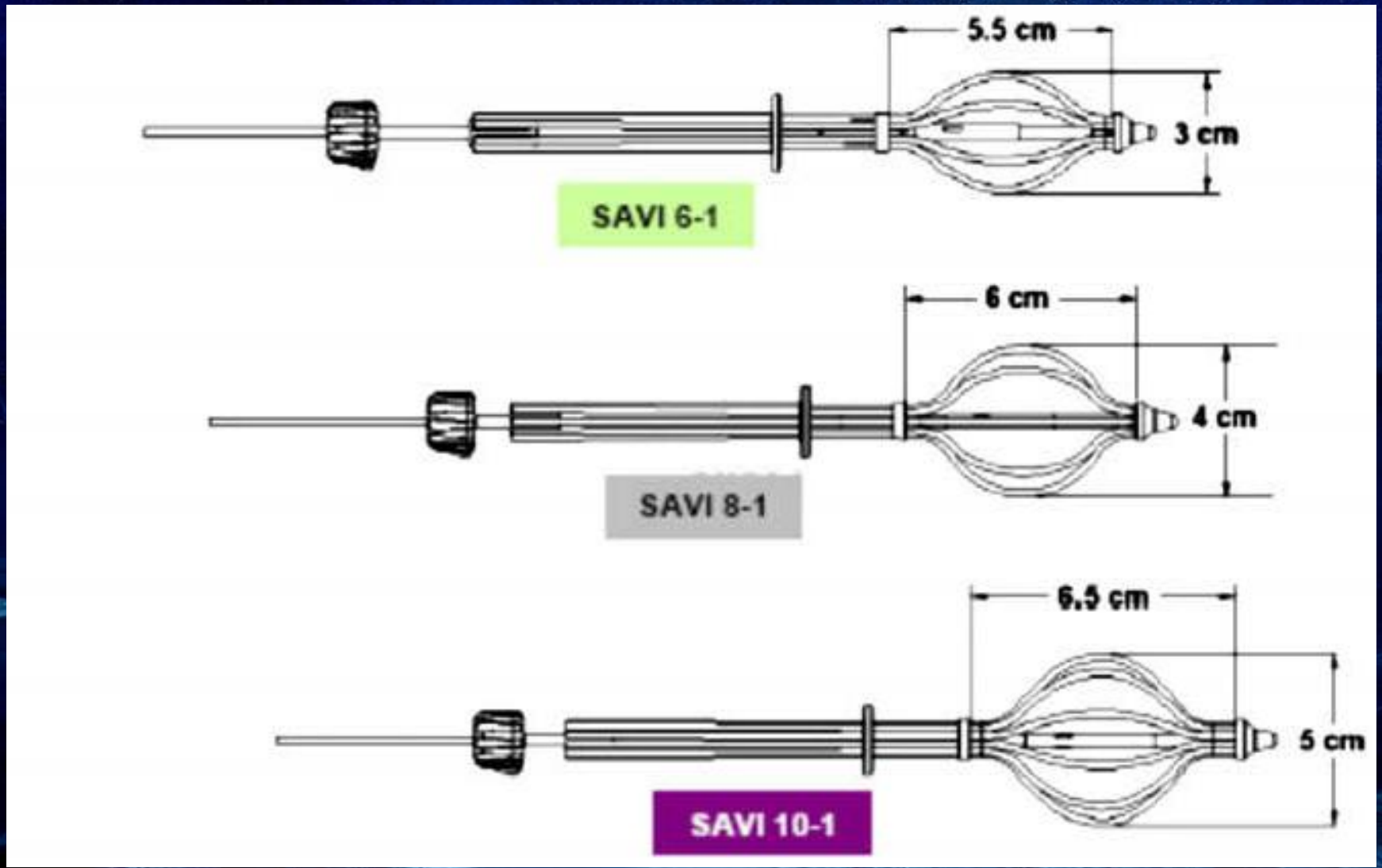


Evaluation of DVH



ROI	Dose [%]	Dose [Gy]	Volume [%]	Volume [ccm]
PTV_EVAL				
PTV_EVAL	**100.00**	3.4000	90.63	100.70
PTV_EVAL	**150.00**	5.1000	32.63	36.26
PTV_EVAL	**200.00**	6.8000	8.78	9.76
PTV_EVAL	100.40	3.4137	**90.00**	100.00
PTV_EVAL	81.06	2.7562	**100.00**	111.11
lung				
lung	91.47	3.1099	0.01	**0.10**
lung	81.15	2.7591	0.10	**1.00**
lung	75.75	2.5756	0.21	**2.00**
muscle				
muscle	199.48	6.7823	0.15	**0.10**
muscle	162.02	5.5087	1.51	**1.00**
muscle	148.80	5.0592	3.01	**2.00**
rib				
rib	121.69	4.1375	0.15	**0.10**
rib	101.00	3.4338	1.50	**1.00**
rib	84.01	2.8563	3.00	**2.00**
skin				
skin	54.64	1.8579	0.04	**0.10**
skin	51.48	1.7503	0.40	**1.00**
skin	50.41	1.7140	0.80	**2.00**

SAVI aplikator



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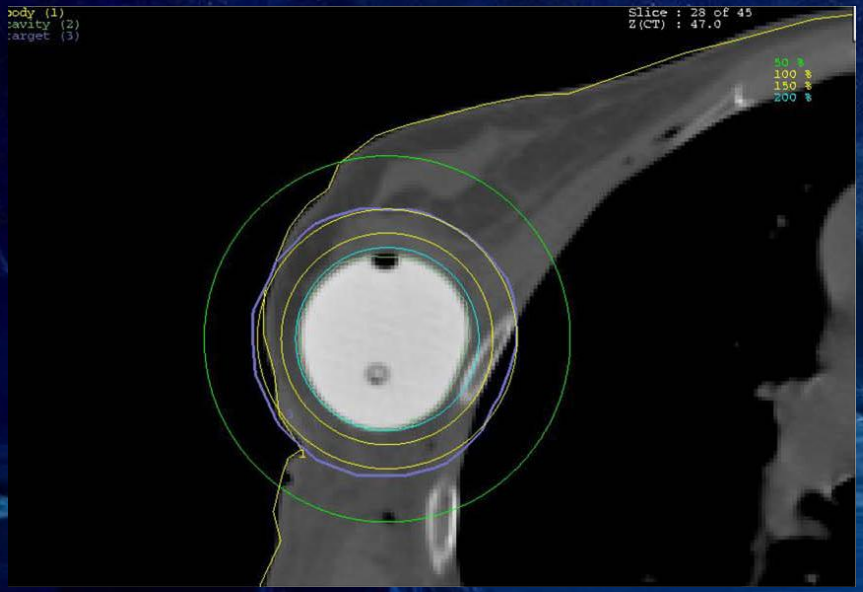
journal homepage: www.thegreenjournal.com

Partial breast irradiation

Clinical implementation of a new HDR brachytherapy device for partial breast irradiation

Daniel J. Scanderbeg, Catheryn Yashar, Roger Rice, Todd Pawlicki*

Department of Radiation Oncology, UC San Diego, La Jolla, USA

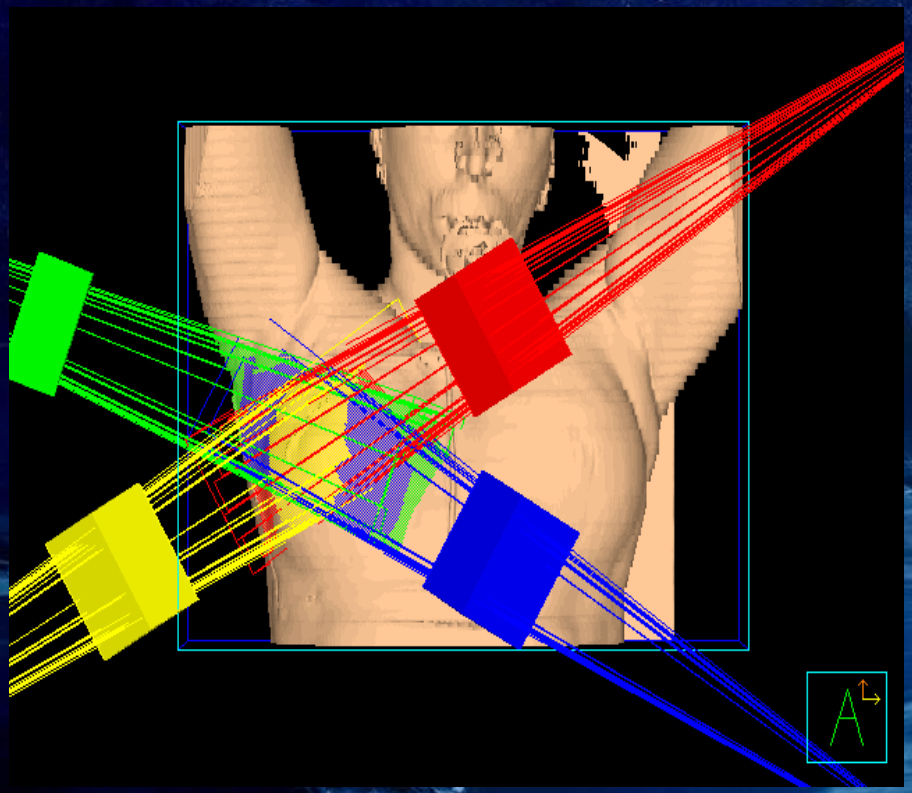


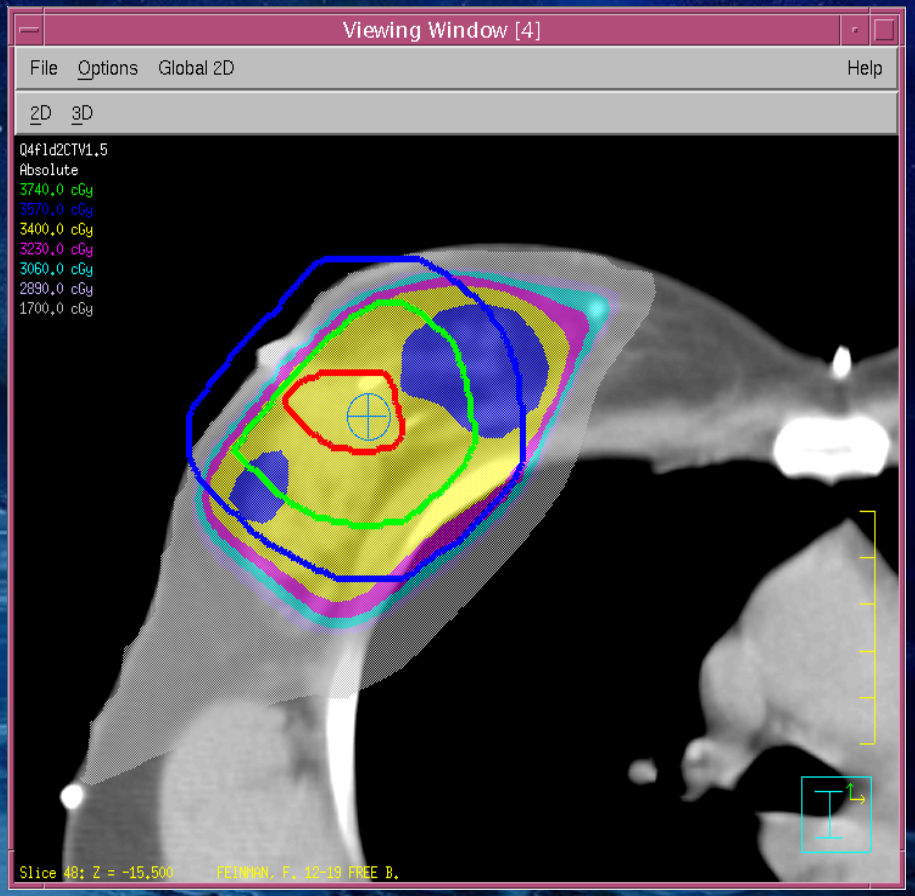
Comparison between the cavity and PTV drawn, as well as the isodose distribution, with a CED (A), mimicking a balloon device, and with a SAVI (B). Moving from the periphery in, the outer most line is the 50% isodose line, the next two lines are the 100% Isodose line and PTV, followed by the 150% isodose line, 200% isodose line, and the

3D-EBRT

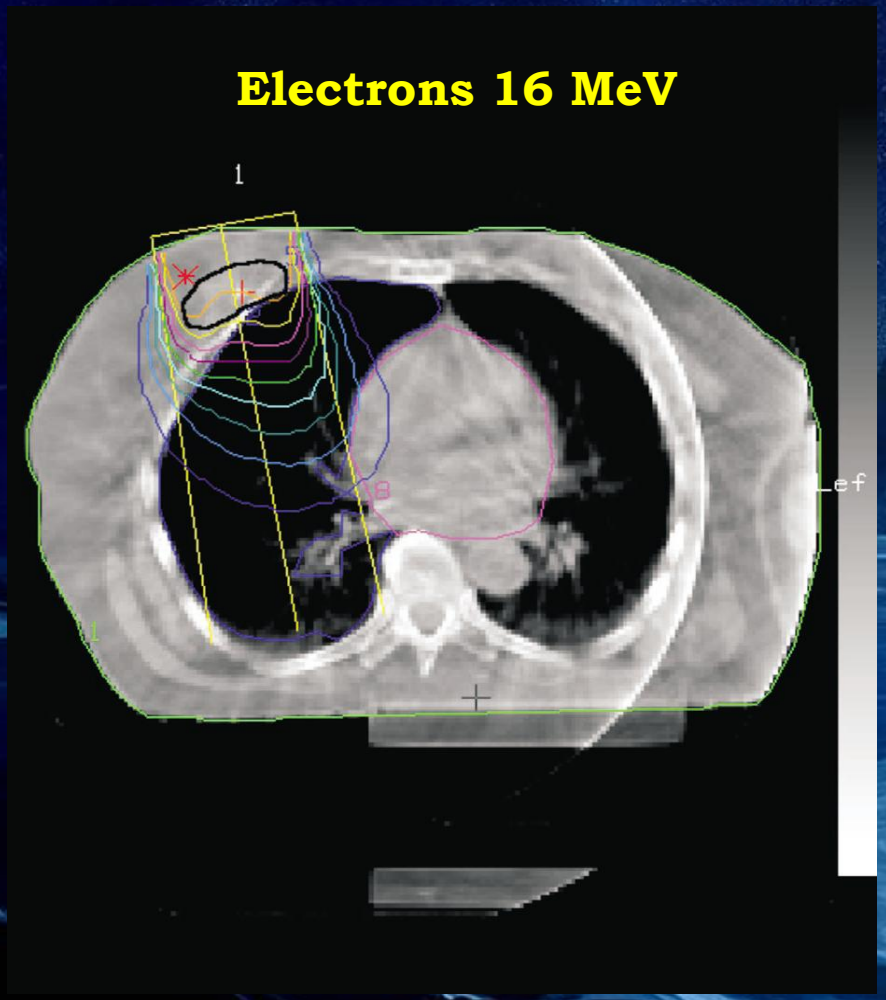
1. Only one non-invasive method of APBI,
2. It was introduced at William Beamont Hospital in 2003,
3. The advantage - universal access to accelerators,
4. In the CT scans are done every 3-5 mm, covering the breast and then send via computer network system to treatment planning,
5. 4-6 titanium clips,
6. On the scans CTV is determined, which includes a tumor bed and a margin of healthy tissue and critical organs (1.5 cm),
7. In addition, the margin should include the respiratory mobility of 0.5 cm when defining PTV,
8. Treatment planning,
9. Treatment: 10 x 3.85 Gy fractions to a dose of 38.5 Gy.

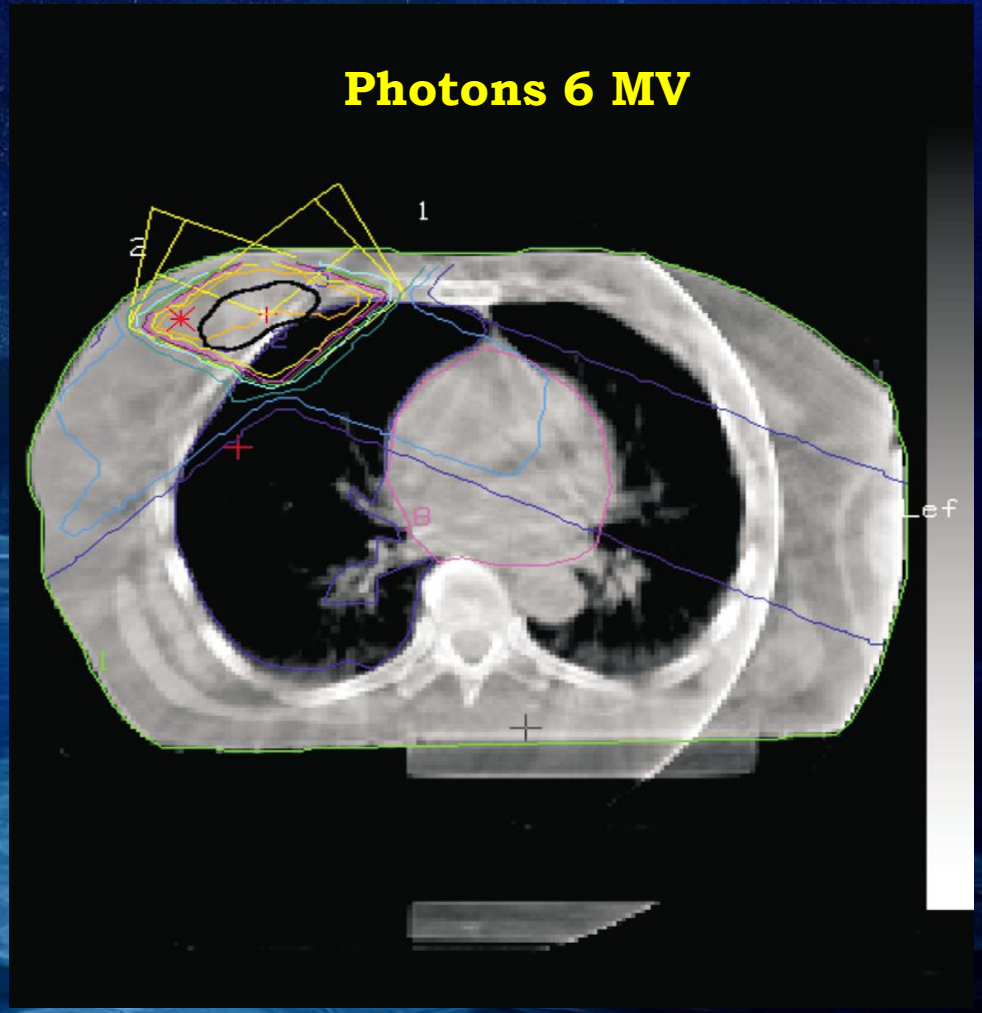
EBRT – 3DRT and IMRT





Example of dose distribution in tumor irradiation with RBRT after BCS using a 16 MeV electron beam (A) and 6 MV photons (B)





Positives of EBRT [Njeh, Rad Oncol 2010]

1. Non-invasive technique, without second anesthesia - reduces the risk of complications,

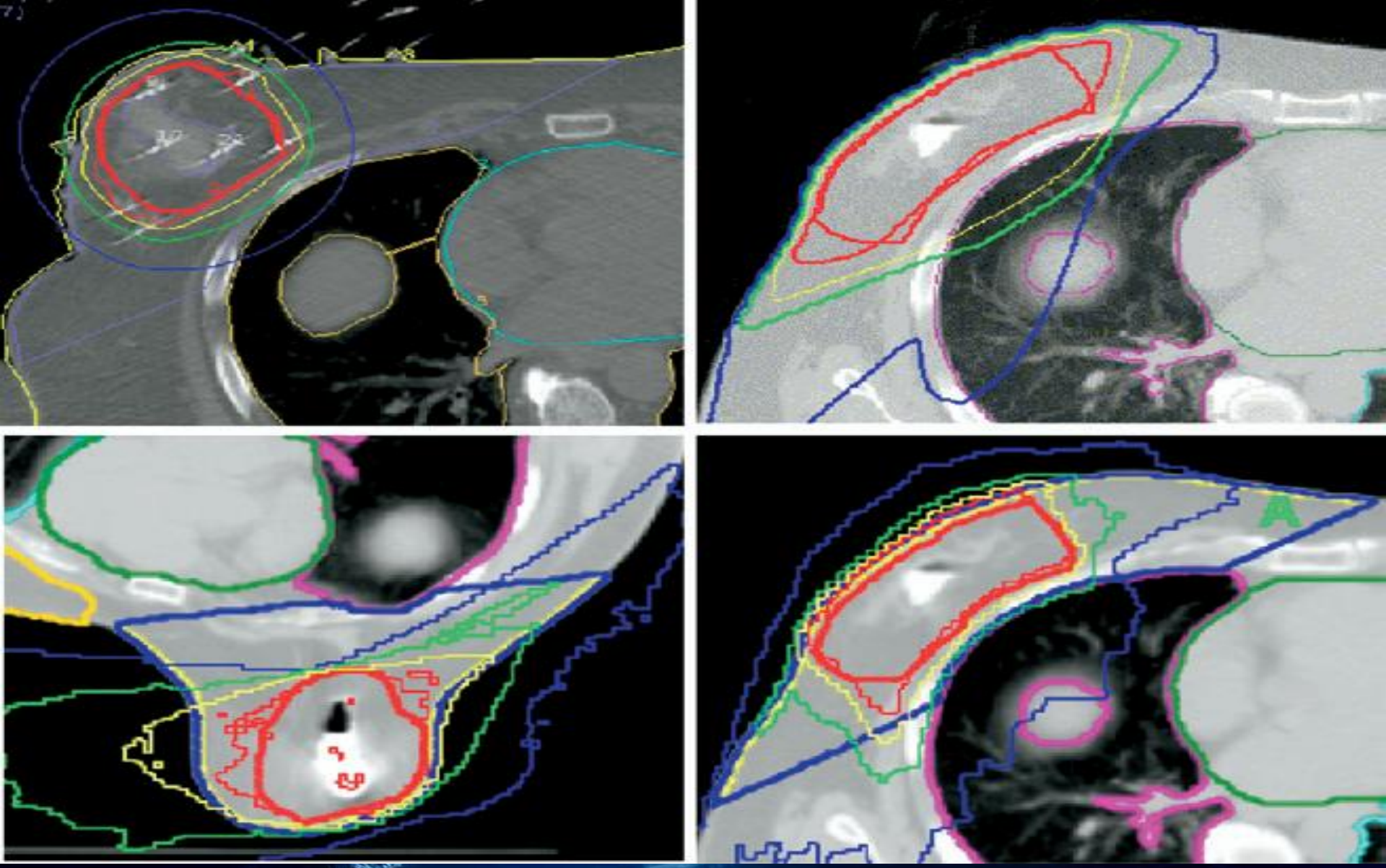
2. Treatment after receiving the final result of histopathology,

3. The wide availability of 3D EBRT techniques,

4. The technique is easier to manage, QA less restrictive,

5. Results of treatment between the centers are easy to compare because the rules are widely known, compatible hardware, required less experience treatment (physicians charisma),

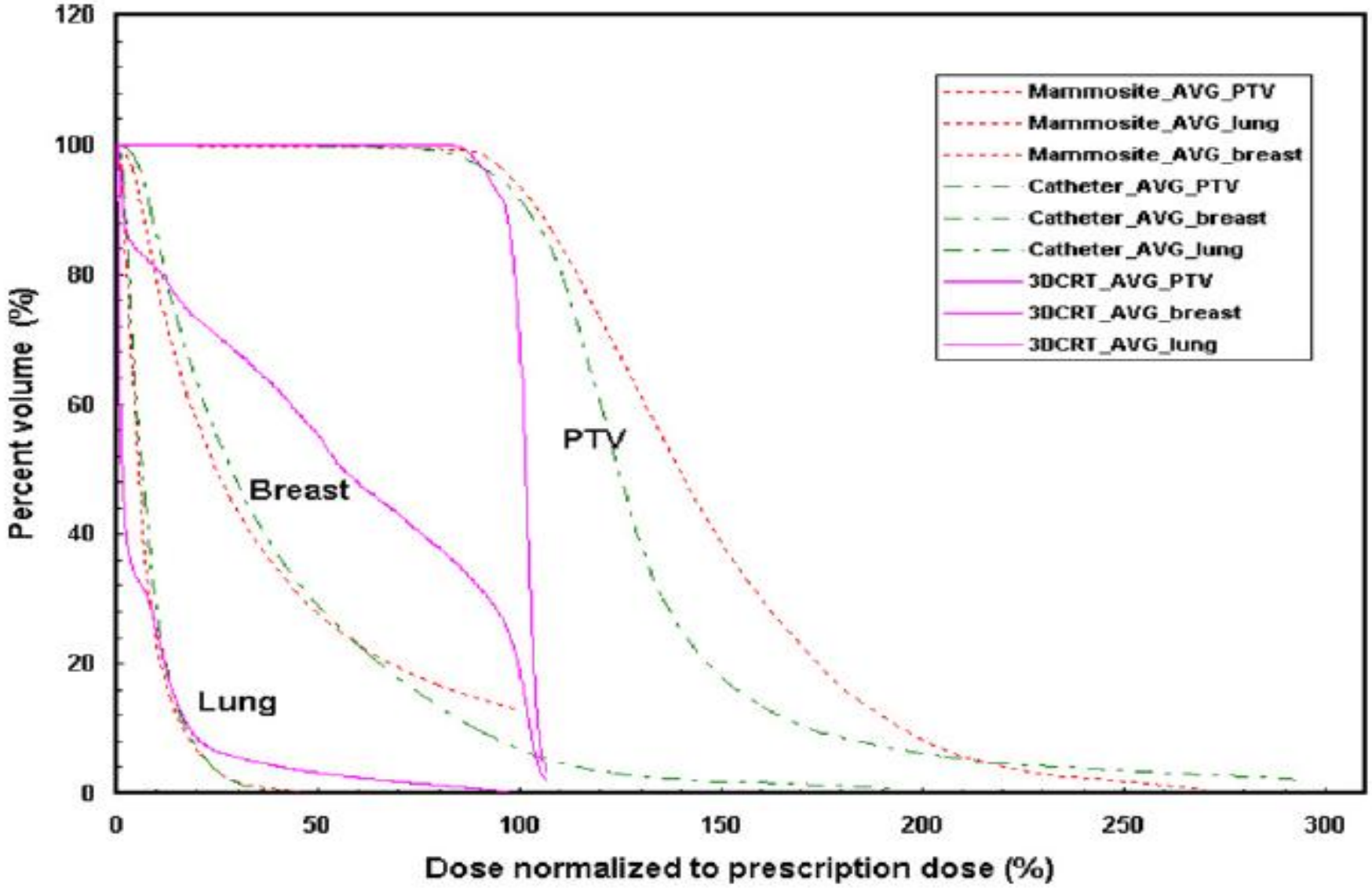
6. Dose homogeneity is better than in BT.



Various techniques treatment plans: brachytherapy (top left), 3D EBRT (top right), tomotherapy prone (face down) (bottom left), tomotherapy supina (back) (bottom right). Tumor bed is enhanced with Omnipaque contrast. Visible isodoses - 100% (red), 75% (yellow), 50% (green), 25% (blue). [Patel, IJORB 2007]

Comparison of 3 APBI techniques

Joseph Bovi, X. Sharon Qi, Julia White, X. Allen Li. Treatment effectiveness based upon biological models. Radiotherapy and Oncology 84 (2007) 226–232



BT – interstitial, Mammosite, electrons

Table 8. NSABP B-39/RTOG 04-13 guidelines for target and normal tissue constraints

Treatment technique	Determination factors	Dose constraints
Interstitial brachytherapy	Dose homogeneity	DHI ≥0.75 DHI = $(1 - V_{150\%}/V_{100\%})$ $V_{150\%}$ ≤70 cm^3 $V_{200\%}$ ≤20 cm^3
	Skin	Skin D_{max} ≤100%
	Ipsilateral breast*	$V_{\geq 50\%}$ ≤60%
	Target	≥90% of the prescription dose covers ≥90% of the PTV_EVAL
MammoSite	Tissue-balloon conformance	Volume of trapped air/PTV_EVAL <10%
	Balloon symmetry	Deviation of ≤2 mm from expected dimensions
	Minimum balloon surface–skin distance	Ideal: ≥7 mm Acceptable: 5–7 mm if D_{max} to skin ≤145%
	Ipsilateral breast*	$V_{150\%}$ ≤50 cm^3 $V_{200\%}$ ≤10 cm^3 $V_{\geq 50\%}$ ≤60%
	Target	≥90% of the prescription dose covers ≥90% of the PTV_EVAL (after accounting for volume of trapped air)
External beam	Ipsilateral breast*	$V_{\geq 50\%}$ ≤60% $V_{100\%}$ ≤35%
	Contralateral breast	D_{max} ≤3%
	Ipsilateral lung	$V_{30\%}$ <15%
	Contralateral lung	$V_{5\%}$ <15%
	Heart (right-sided tumors)	$V_{5\%}$ <5%
	Heart (left-sided tumors)	$V_{5\%}$ <40%
	Thyroid	D_{max} ≤3%
	Target	D_{max} ≤120% ≥90% of the prescription dose covers ≥90% of the PTV_EVAL

Abbreviations: DHI = Dose homogeneity index; PTV_EVAL = planning target volume used to evaluate dose coverage.

IORT

1. Since 2000, two randomized clinical trials (TARGIT and ELIOT) for intraoperative brachytherapy are conducted.
2. In this method, the RT is used during BCS, making the total treatment time shortened.
3. It allows you to precisely locate the tumor bed.
4. The expected effect of a cosmetic treatment is good due to the sparing of the skin.

TARGIT:

5. IORT using a device that generates X-rays of low energy 50kV.
6. One fraction of 20 Gy at a distance of 2 mm outside from the surface of the applicator.
7. In the operating room after quadrantectomy spherical applicator is established which varies in size from 1.5 to 5 cm depending on the size of the removed quadrant.
8. Irradiation takes 20-25min.

??????????

????

IORT

Inne techniki!!!

ELIOT:

1. Radioterapia śródoperacyjna, z użyciem przyspieszacza liniowego Novac7 lub Mobetron, generującego wiązkę elektronów o mocy 3-12MeV.
2. Dawka promieniowania zadana na izodozę 90%, znajdującą się w odległości 1,5-3cm od powierzchni aplikatora wynosi 21Gy.
3. Badanie Eliot bazuje na definicji powstania lokalnej wznowy opisywanej w dwóch wcześniejszych badaniach klinicznych: Milan III Trial i Milan I Trial.

IORT

Device	Energy	Dose
Intrabeam	X-Rays 50 kV	5 Gy/1 cm, 10 Gy – 0,5 cm, 20 Gy on the surface of applicator, 25 – 30 minutes, preparating time 10 – 12 minutes
Novac - 7	Electrons 4 – 12 MeV	20 Gy, 3 – 5 minutes, preparating time 20 minutes
Mobetron	Electrons 4 – 12 MeV	21 Gy, 3 – 5 minutes, preparating time 20 minutes

IORT

1. Ongoing randomized clinical trials (PBI vs. WBRT in terms of assessing the percentage of local recurrence, overall survival, cosmetic effect)

2. TARGIT (Intrabeam,163 patients)
3. ELIOT (Novac 7, 337 patients)

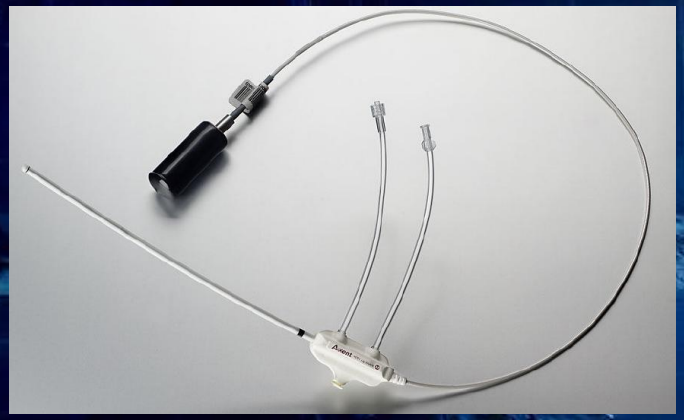

INTRABEAM


B
INTRAOP


A

Axxent electronic brachytherapy (eB) system (Xoft, Fremont, CA)

- It is a modified form of balloon-based brachytherapy.
- It is similar to the MammoSite system, consisting of a that is inserted into the lumpectomy cavity by means of a percutaneous approach. balloon catheter
- The Axxent electronic brachytherapy system is novel in that it uses an electronic 50 kilo-voltage x-ray source rather then an iridium-192 (192Ir) high-dose-rate (HDR) source.
- The X-ray source consists of a miniature x-ray tube that is inserted into the balloon catheter and delivers the radiation therapy to the patient.



APBI

1. Rationale
2. Indications
3. Methods
4. **Results**
5. Trials
6. Future

The results of APBI in a strictly selected group of patients with the time of observation (follow-up) over 4 years [Polgar, RO 2010]

Author, trial	Technique	Average observation time (years)	LR (%)	LR (%)/year
HNIO, Budapest I	HDR	11,1	8.9	0.80
WBH, Michigan	LDR/ HDR	9,7	5.0	0.52
Örebro Med. Centre	PDR	7,2	5.9	0.83
RTOG 95–17	LDR/ HDR	7	6.1	0.91
HNIO, Budapest II	HDR/ EBRT	6,8	4.7	0.69
Ochsner Clinic	LDR/ HDR	6,25	2	0.32
Ninewells Hospital	LDR	5,6	0	0
Germany–Austria	PDR/ HDR	5,25	2.9	0.55
FDA Trial, USA	Mammo Site	5,2	0	0
Kiel-HNIO	Mammo Site	5	0	0
University Navarra	HDR	4,4	3.8	0.86
Wisconsin University	HDR/ Mammo Site	4	2.9	0.72
Kansas University	LDR	4	0	0
All patients		4-11,1	3.8	0-0.91

Results of recent clinical experience with interstitial brachytherapy with more than 5 years follow up [F Njeh, Radiat Oncol 2010]

Author	No of cases	Follow up interval(years)	Dose rate /pt no	Scheme	Total dose(Gy)	5- year LR(%)	Good/Exc ellent cosmesis
Strnad et al.	274	5.25	PDR/HDR	PDR= 0.6 Gy/hr HDR = 4 Gy x8	PDR= 50 Gy HDR = 32 Gy	2.9%	90%
Antonucci et al.	199	9.6	LDR/HDR	LDR 0.52 Gy/h x96 hours HDR = 4 Gy x8 HDR = 3.4 Gyx10	LDR = 50 Gy HDR = 32 Gy HDR = 34 Gy	5%	99%
Johansson et al.	50	7.2	PDR	50Gy/5	50 Gy	4%	56%
Arthur et al.	99	7	LDR/HDR	LDR = 3.5 -5 days HDR = 3.4 Gy x10	45 Gy (LDR) 34 Gy (HDR	4%	n/a
Polgar et al.	128	6.8	HDR	5.2 Gy x7	36.4 Gy	4.7%	77%
King et al	51	6.25	LDR/HDR	LDR = 4 days HDR = 4 Gy x8	45 Gy (LDR) 32 Gy (HDR)	3.9%	75%
Otto et al.	274	5.25	PDR/HDR	PDR 5 days , 0.6 Gy/hr HDR = 4 Gy x8	49.8 Gy (PDR) 32 Gy (HDR)	2.9%	92%
Polgar et al.	45	11.1	HDR	4.33 Gy x7 5.2 Gy x7	30.3 Gy 36.4 Gy	4.4%	78%

Brachytherapy with ballons – results [Offeresen, RO 2009]

Institute	Technique, doses	N =	Follow-up	The eligibility criteria	Recurrences (ipsilateral)
American Society Of Breast Surgeons MammoSite Breast Brachytherapy Trial	34 Gy/ 10 fr / 5 days	1255	2,5 y	>45 y T<2cm N0, negative margins, ductale, witdth min. 3 cm, no EIC, application < 10 weeks below surgery	2 y recurrence rate - 1,11 % , 3 y recurrence rate - 1,79 %
Texas Cancer Clinic San Antonio	34 Gy/ 10 fr / 5-7 days	67	1,1 y	> 45 y T<3cm N0, negative margin,	NA
Kaiser Pernamente Los Angeles Medical Center	34 Gy/ 10 fr / 5-7days	51	1,3 y	> 45 r.ż. T<2cm N0, negative margin, ductale	0
Rush University Medical Center, Chicago	34 Gy/ 10 fr / 5-7 days	78	2,2 y	> 45 r.ż. T<3cm N0, negative margin,	7,1%
Medical University Of South Carolina	32 Gy/ 10 fr / 5-7 days	37 patients (7 DCIS)	0,5 y	Every age, pTis-pT2N1, negative margin,	NA
Tufts New England	34 Gy/ 10 fr / 5-7 days	38	1,4 y	Every age T<3cm, ductale or DCIS N0, negative margins > 1mm	NA
European MammoSite trial	34 Gy/ 10 fr / 5-7 days	28	1,2 y	> 60 r.ż. T<2cm, ductale, margins > 5mm, ER+, distance from the balloon surface area 7mm, no EIC	0

Local recurrences after Mammosite [Strauss, RO 2009]

Center, the study	N =	Follow-up (months)	Local recurrences rate (%)
ASBS TRIAL	1440	30	1,04
FDA TRIAL	43	65	0
Tufts/Medical College Virginia/Rhode Island	28	19	0
St. Vincent Cancer Center	31	11	0
Rush University Medical Center	70	26	5,7
Kaiser Permanente	40	13	0
Medical University South Carolina	90	24	2,2
ASBS DCIS TRIAL	191	7	0
Wiliam Beaumont	80	22	2,5
European TRIAL	44	14	0
International TRIAL	23	20	0
Western Pensylwania Hospital	55	24	3,6
Oscar Lambret Center	25	13	0

APBI - 3D EBRT – results [F Njeh, Radiat Oncol 2010]

Author	No of cases	Follow up (months)	Fractionation scheme	IBF	Good/Excellent cosmesis
Vicini et al.	52	54	3.85 Gy x 10 (bid)	6%	n/a
Vicini et al.	91	24	3.85 Gy x 10 (bid)	0%	90%
Chen et al.	94	51	3.85 Gy x 10 (bid)	1.1%	89%
Taghian et al.	99	36	3.2 Gy x 4 (bid)[$]	2%	97%
Formenti et al.	10	36 (minimum)	5.0, 5.5, 6.0 Gy x 5 (10 days)	0%	100%
Formenti et al.	47	18	6.0 Gy x5 (10 days)	0%	n/a
Magee et al.	353	96 (mean)	5.0 - 5.31 Gy x 8(10 days)[&]	25%	n/a
Leonard et al.	55	34 median	3.85 cGy x10 (bid)	0%	n/a
Hepel et al.	60	15	3.85 Gy x 10 (bid)	n/a	81.7%
Jagsi et al.	34	>24	3.85 Gy x 10	n/a	79.5%

APBI – IORT results [F Njeh, Radiat Oncol 2010]

Author	No of cases	Median follow up interval(months)	Technique	IBF	Good/Excellent cosmesis
Lemanski et al.	42	30	Electrons	4.8%	100%
Veronesi et al.	590	20	Electrons	0.5%	n/a
Mussari et al.	47	48	Electrons	0%	92%
Vaidya et al.	25	24	Photons	0%	n/a
Vaidya et al.	854	48	Photons	1.2% (95%CI = 0.53-2.71) $	n/a

Comparison of PBI techniques [Offeresen RO 2009]

	3D CRT	Interstitial brachytherapy HDR LDR, PDR	MammoSite	Targit, 50 kV X-rays	IORT, electrons
Coverage of target	Best	Variable	Good	Good	Good
Thickness of cavity wall irradiated	PTV = tumor bed + 20-25 mm. Often 5 mm to field edge from PTV	1-2 cm	Dose prescribed to 1 cm from surface of applicator	Dose prescribed to 1 mm from surface of applicator5-7 Gy 10 mm from applicator	Dose prescribed to 90% isodose line. 80% isodose at 13 mm (3 MeV)-24 mm(9 MeV)
Dose homogeneity	Best	Fair	Fair	Fair	Fair
Sparing of normal breast / other organs	Least	Good	Good	Best	Varies with location
Skin dose	Least	Least	Variable	Least (can shield)	Least
Technical feasibility for various size, shape or location of cavity	Suitable for virtually all cases	Not suitable if inadequate tissue or near axilla	Not suitable for large/irregular cavities, or at the periphery of the breast	Not suitable for large/irregular cavities, or at the periphery of the breast	Not suitable for tumors near brachial plexus/axilla or skin
Expertise required	Average	High	Average	High	Very high
Potential for wide spread use	Very good	Fair	Very good	Fair	Limited
Main drawback	Relatively higher dose to normal tissue and breathing motion	Adequacy of target coverage in some cases and wider applicability	Cavity shape and size. Although easy to use, stringent QA is required. Skin dose may be high	Very limited depth irradiated; cavity shape and size. Histology not available	Wider applicability. Histology not available. Based on quadrantectomy

Local failure rates after APBI brachytherapy

Authors	N	Clinical stage	BT – methods, dose	Average follow-up	Local recurrence (LR) rate [%]	LR/years [%]
Vicini	133	T<3 cm, N0-1bi, SM >2mm	LDR/HDR 50/32-34 Gy	3.2 y	0%	0%
Kuske	150	<4 cm, N0-1bi, SM	LDR/HDR 45/32-34 Gy	3.8 y	1.3%	0.3%
Perera	39	<4.5 cm, N0-1, SM	HDR 37.2 Gy	1.7 y	2.6%	1.5%
Johansson	43	<5 cm, N0-1, SM	PDR 50 Gy	2.8 y	2.3%	0.8%
Polgar	87	<2 cm, N0-1a	HDR 30.3 – 36.4 Gy	2.8 y	2.3%	0.8%

APBI

1. Rationale
2. Indications
3. Methods
4. Results
5. **Trials**
6. Future

Ongoing trials APBI

1. 7 trials
2. APBI vs. WBRT after BCS
3. Differences:
techniques,
doses,
PTV definition!!!!

Mannino M, Yarnold J. Accelerated partial breast irradiation trials: Diversity in rationale and design. Radiat Oncol 2009; 91:16-22.

WBRT – Whole Breast RadioTherapy
BCT – Breast Conserving Therapy

Trials

1. ELIOT (Electron Intraoperative Therapy)	2000
2. TARGIT (TARGeted Intraoperative radioTherapy)	2000
3. European Brachytherapy Breast Cancer GEC-ESTRO Working Group Trial	2004
4. NASBP B39 / RTOG 0413 Trial	2005
5. RAPID (Randomised Trial of APBI)	2006
6. IRMA (Innovazioni nella Radioterapia della MAmmella)	2007
7. IMPORT (Intensity Modulated and Partial Organ Radiotherapy) Low Trial	2006

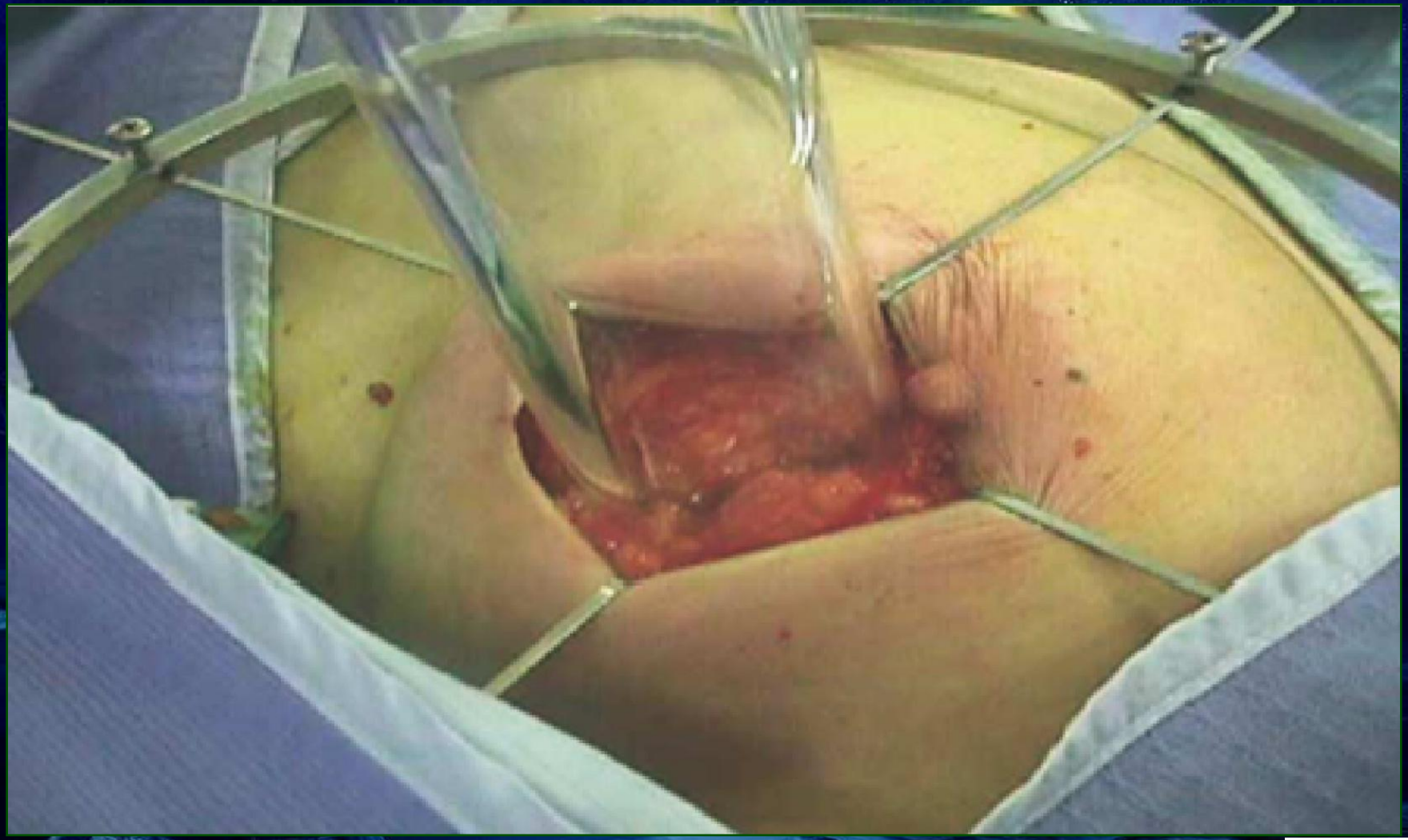
ELIOT

1. 4-12 MeV electrons,
2. 21 Gy - 90% isodosis10-30 mm outside bed,
3. Milan III trial: efect WBI after mastectomy:
   85% IBTR in scar without RT,
4. Milan I trial: BCT vs. mastectomy:
   Similar recurence rate (%) in other quadrants compared with second breast,
5. WBI is not necessary and does not prevent relapses in other quadrant (new tumors).

IBTR – Ipsilateral Breast Tumor Relapse

2000

ELIOT



2000

TARGIT

1. max. 50 kV, applicator 1,5 – 5 cm in tumor bed,

2. 20 Gy in 2 mm behind bed surface,

3. 90% IBTR around tumor bed regardless of surgical margin and WBI,

4. M (+) ↑ risk of IBTR.

IBTR – Ipsilateral Breast Tumor Relapse

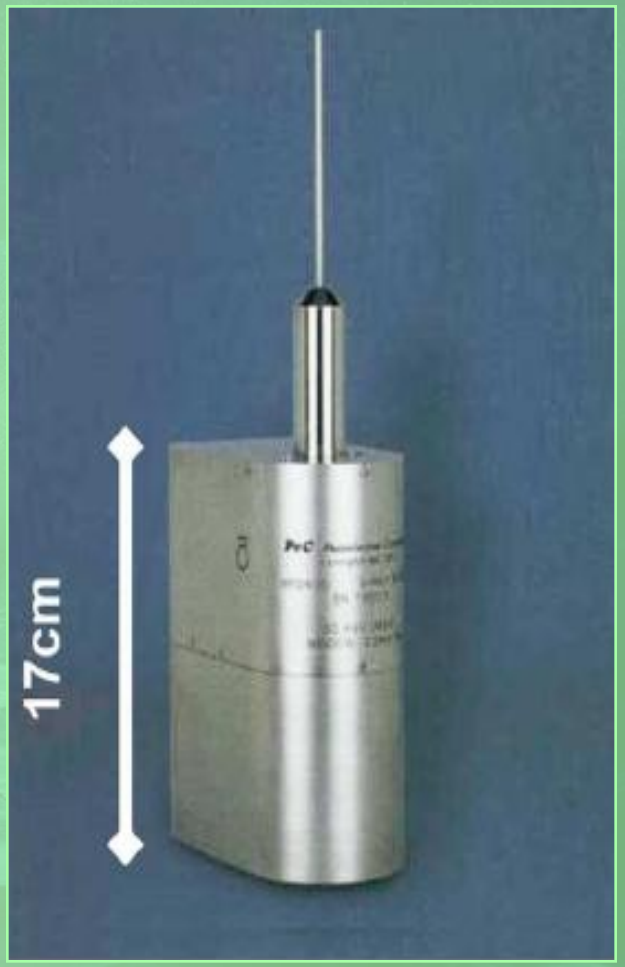
2000

TARGIT hypothesis

1. Multicentrical cancer tumors remain sleeping and overall are not responsible for IBTR,
2. IBTR derived from genetically unstable morphologically normal cells adjacent to the tumor,
3. RT inhibits the growth of the above mentioned cells around the bed,
4. RT should be limited to the area where the presence of the above mentioned cells is most likely.

IBTR – Ipsilateral Breast Tumor Relapse

TARGIT



2000

GEC-ESTRO Trial

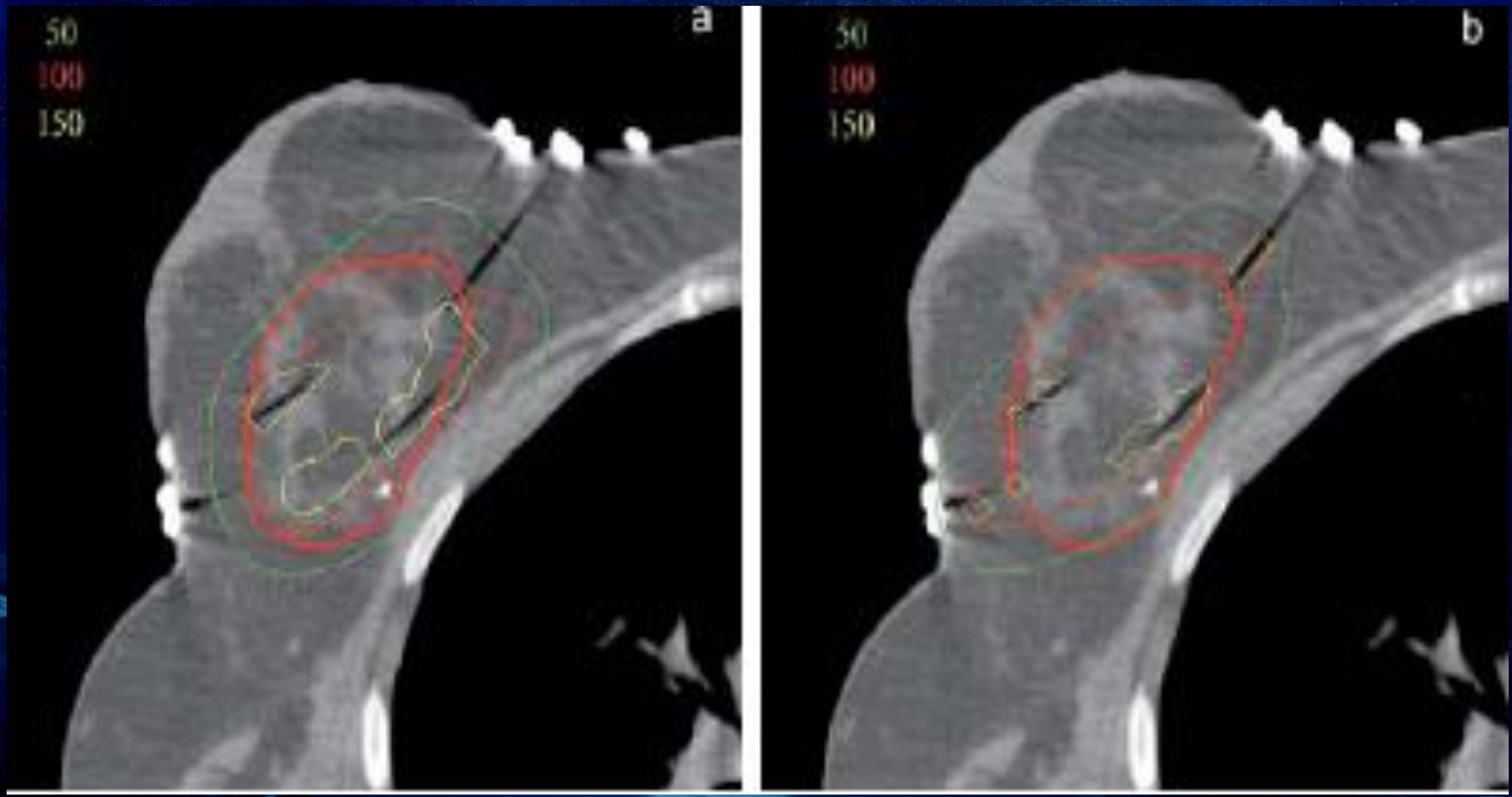
3 fractionation schemas:

1. **HDR – 32 Gy / 8 fr., 4 Gy twice daily**
2. **HDR – 30,3 Gy / 7 fr., 4,33 Gy twice daily**
3. **PDR – 50 Gy / 0,6 – 0,8 Gy every hour**
4. **PTV = tumor bed + 20 – 30 mm margin**
5. **II phase Trials II: Germany-Austria and Hungary (most IBTRs occurs in close proximity to the bed, the risk of IBTR in another quadrant is low and independent of the RT.**

IBTR – Ipsilateral Breast Tumor Relapse

2004

GEC-ESTRO Trial



2004

NASBP B39 / RTOG 0413 Trial

1. **Multi-catheter BT vs. MammoSite vs. 3DCRT**
   choice depends on center possibility

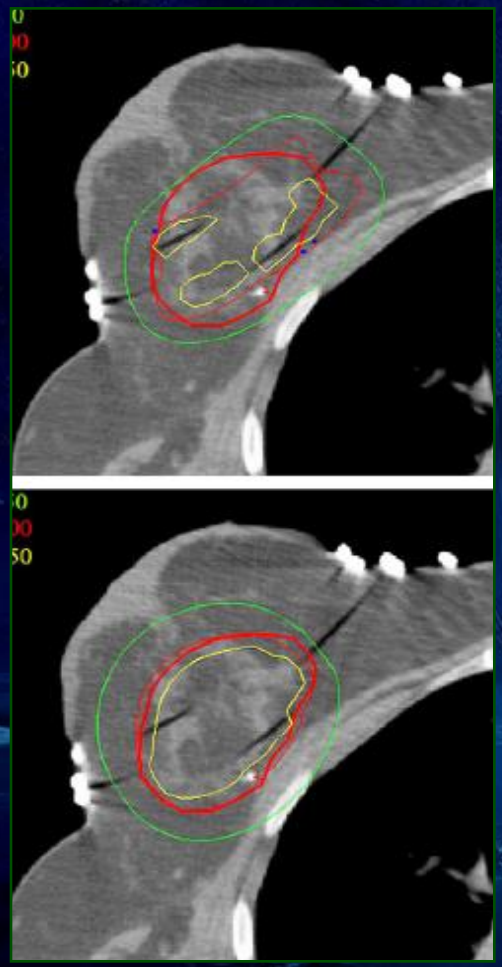
BT and 3DCRT:
bed + 15 mm = CTV + 10 mm = PTV (3DCRT)

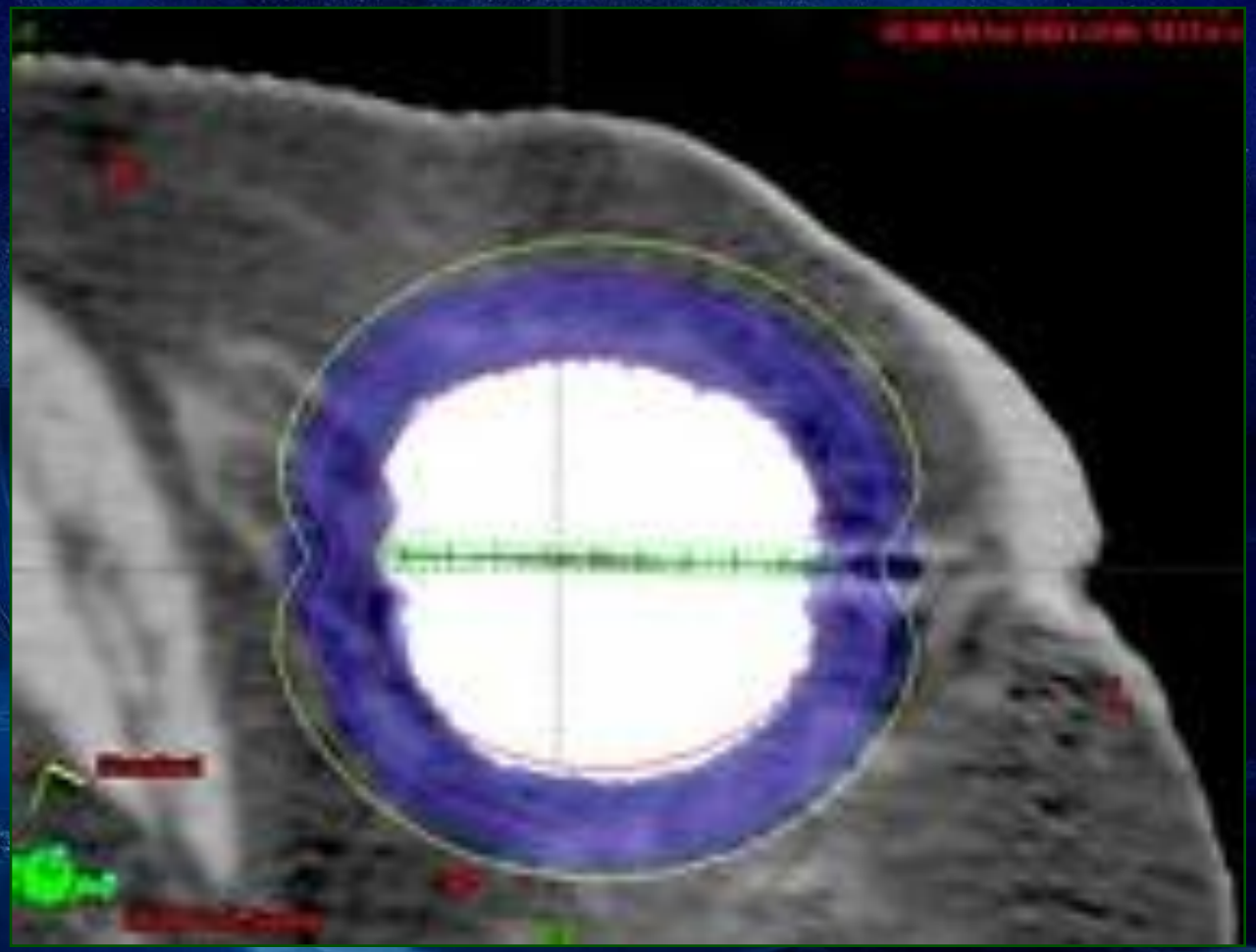
MammoSite:
10 mm from balloon surface – V balloon = PTV

2. **BT and MammoSite: 34 Gy / 10 fr. twice daily**
3. **3DCRT: 38,5 Gy / 10 fr. twice daily**

2005

NASBP B39 / RTOG 0413 Trial





2005

NASBP B39 / RTOG 0413 Trial

Control arm – WBI, dose:

50 – 50.4 Gy ± boost till 60.0 – 66.6 Gy

Current recruitment is 4300 patients

2005

RAPID

WBRT vs. 3DCRT (PBPTV)

38,5 Gy / 10 fr. twice daily / 5 – 8 days

Justification ibid. excl. TARGIT study

OCOG. Ontario Clinical Oncology Group (OCOG), Canadian Institutes of Health
Research (CIHR), Canadian Breast Cancer Research Alliance. RAPID:
Randomized Trial of Accelerated Partial Breast Irradiation; 2008.
Available from: http://clinicaltrials.gov/ct2/show/NCT00282035.
http://clinicaltrials.gov/ct2/show/NCT00282035

2006

IRMA

WBRT vs. 3DCRT (PBPTV)

GTV + 15 mm = CTV + 5 mm = PTV

38,5 Gy / 10 fr. twice daily / 5 days

Justification ibid. excl. TARGIT study

Available from:
http://groups.eortc.be/radio/res/irma/synopsis_trial_irma1.pdf
. http://clinicaltrials.gov/ct2/show/NCT00282035

2007

IMPORT Low Trial

3 control arms: 1 control i 2 APBI
established multi-segment tangential beam

40 Gy / 15 fr., 2,66 Gy WBI vs. PBPTV
40 Gy / 15 fr. PBPTV + 36 Gy / 15 fr. rest of breast

6 clips + 15 mm = CTV + 10 mm = PTV

Yarnold J, Coles C. On behalf of the IMPORT LOW Trial Management Group: Intensity Modulated and Partial Organ Radiotherapy. Randomised trial testing intensity modulated and partial organ radiotherapy following breast conservation surgery for early breast cancer. Trial Protocol, version 4. Sutton, Surrey, UK: The Institute of Cancer Research, Royal Cancer Hospital; 2008. p. 1-74.

2006

Trial	PTV	Fractionation
ELIOT	bed + 10-30 mm	21 Gy
TARGIT	2 mm outside bed	20 Gy
GEC-ESTRO	bed + 20-30 mm	32 Gy/8 fx/twice daily HDR 30,3 Gy/7 fx/twice daily HDR 50 Gy/0,6-0,8 every 1h PDR
RTOG 0413	bed + 15 mm BT + 10 mm 3DCRT balloon + 10 mm Msite	34 Gy/10 fx/twice daily BT/MSite 38,5 Gy/10 fx/twice daily 3DCRT 50-50,4 Gy ± 10-16,6 Gy WBRT
RAPID	No data	38,5 Gy/1 fx/twice daily /5-8 days
IRMA	GTV + 15 + 5 mm	38,5 Gy/1 fx/twice daily /5 days
IMPORT Low	6 clips + 15 + 10 mm	40 Gy/15 fx/2,66 Gy WBRT or PBRT 36/40 Gy/15 fx WBRT/PBPTV

The collected results of brachytherapy trials recognized by the eligibility criteria and with the quality of treatment

Institution	Dose rate	Total dose (Gy)	Median Follow-up (mo)	Ipsilateral breast failure (%)	Elsewhere failure (%)
William Beaumont Hospital [34]	LDR/HDR	50/32–34	65	2.5 (5/199)	1.5 (3/199)
Ochsner Clinic [22, 38]	LDR/HDR	45/32–34	84	2.5 (4/160)	1.2 (2/160)
German-Austrian study* [31]	PDR/HDR	50/32	13	0 (0/160)	0 (0/160)
Massachusetts General Hospital [24]	LDR	50–60	23	0 (0/48)	0 (0/48)
Virginia Commonwealth University [17]	LDR/HDR	45/34	42	0 (0/44)	0 (0/44)
Örebro Medical Centre, Sweden [20]	PDR	50	34	2.3 (1/43)	NR
Tufts University [37]	HDR	34	33	3.0 (1/33)	3.0 (1/33)
University of Kansas [23]	LDR	20–25	47	0 (0/25)	0 (0/25)
Ninewells Hospital, Dundee, UK [30]	LDR	46–55	67	0 (0/11)	0 (0/11)
National Institute of Oncology, Hungary					
Total [28, 38]	HDR/ELE	30.3–36.4/50	46	3.7 (6/164)	3.0 (5/164)
Present study	HDR	30.3–36.4	81	6.7 (3/45)	6.7 (3/45)
Phase III study [28, 38]	HDR/ELE	36.4/50	30	2.5 (3/119)	1.7 (2/119)
All patients				1.9 (17/887)	1.3 (11/844)

Abbreviations: LDR = low dose rate; HDR = high dose rate; PDR = pulsed dose rate; NR = not reported; ELE = electrons.

* Vratislav Strnad, M.D., Ph.D., verbal communication, January 2004.

APBI

1. Rationale
2. Indications
3. Methods
4. Results
5. Trials
6. **Future**

Permanent implants?

Protons?

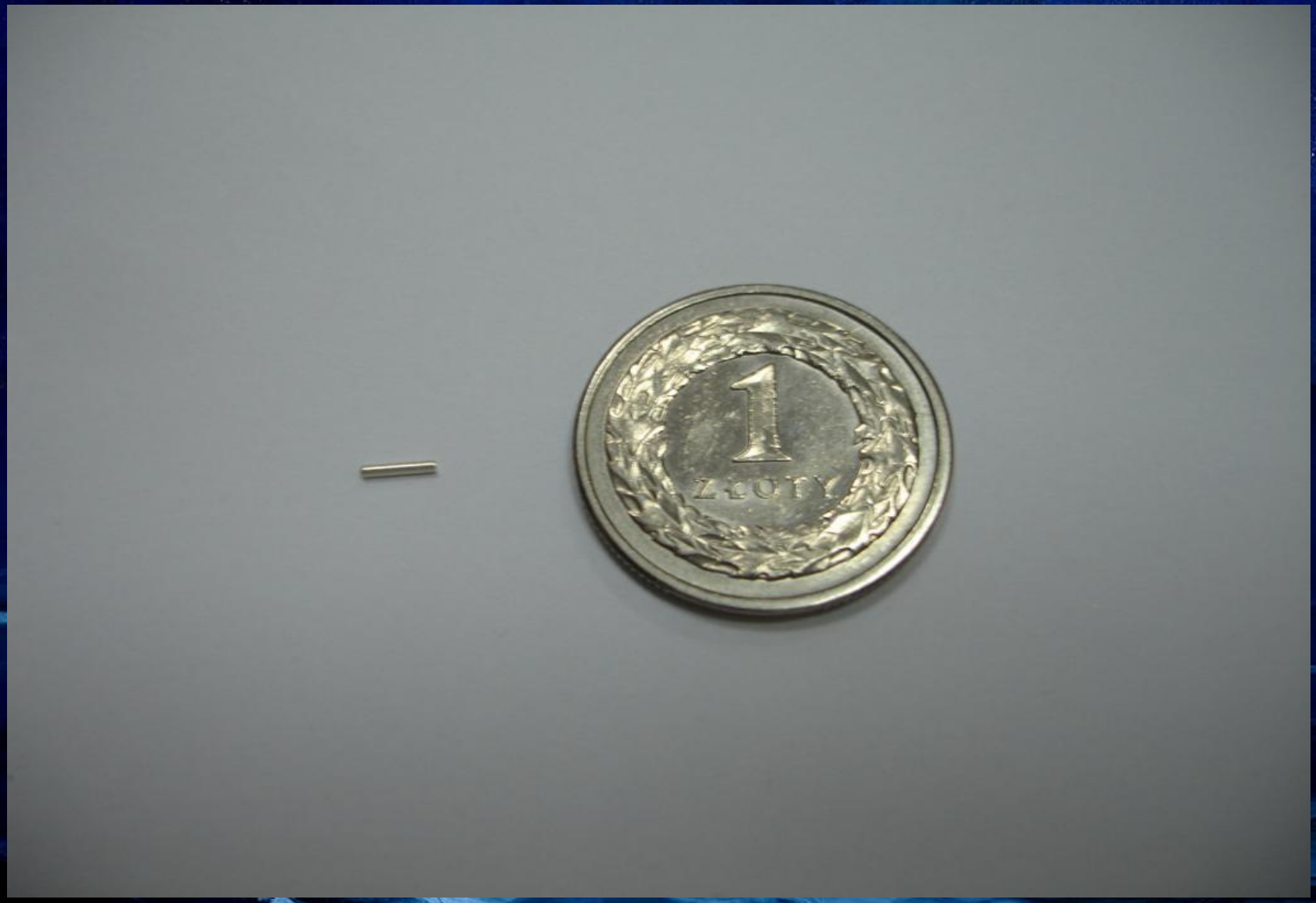
New trials?

RT without BCS?

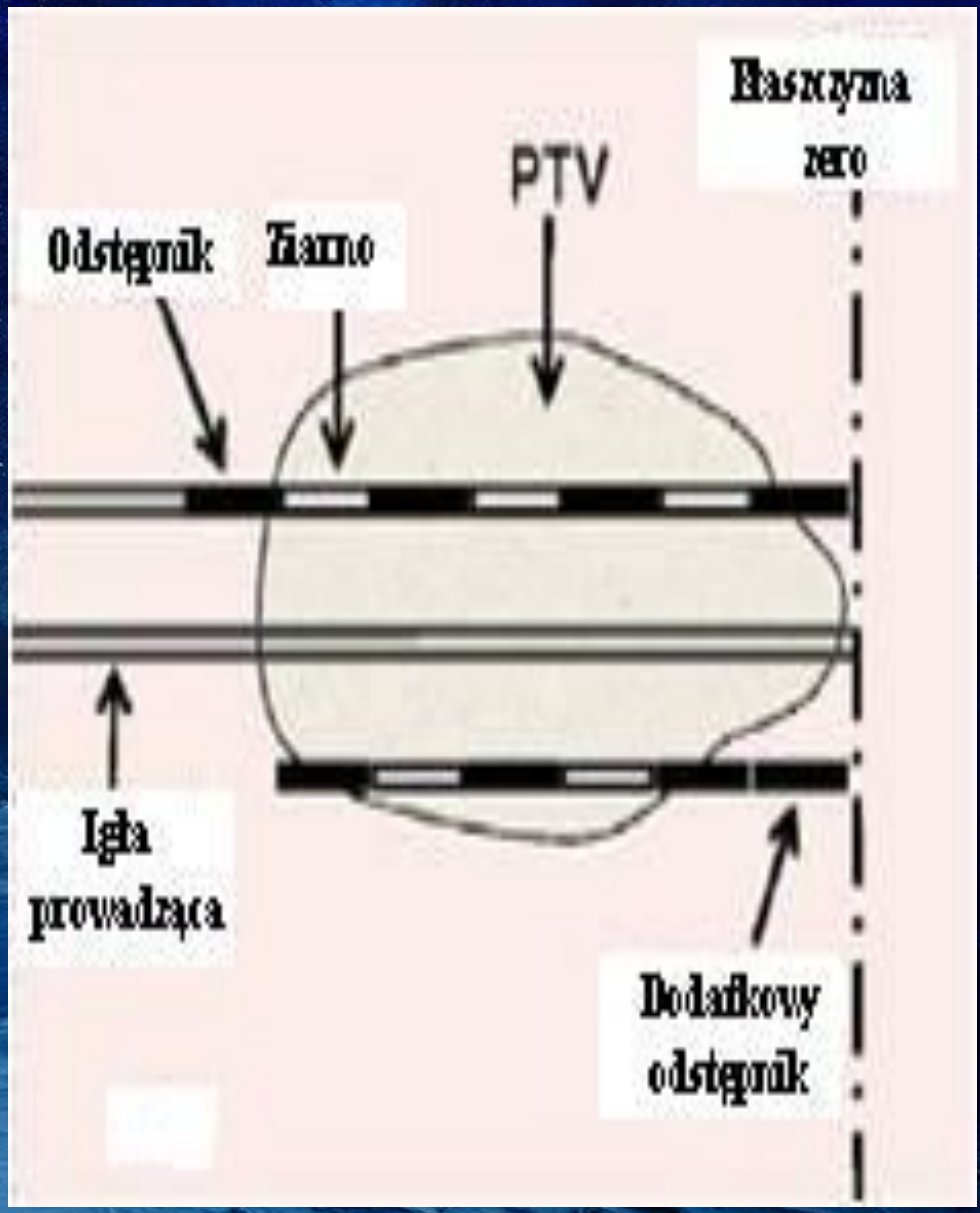
Costs vs results?

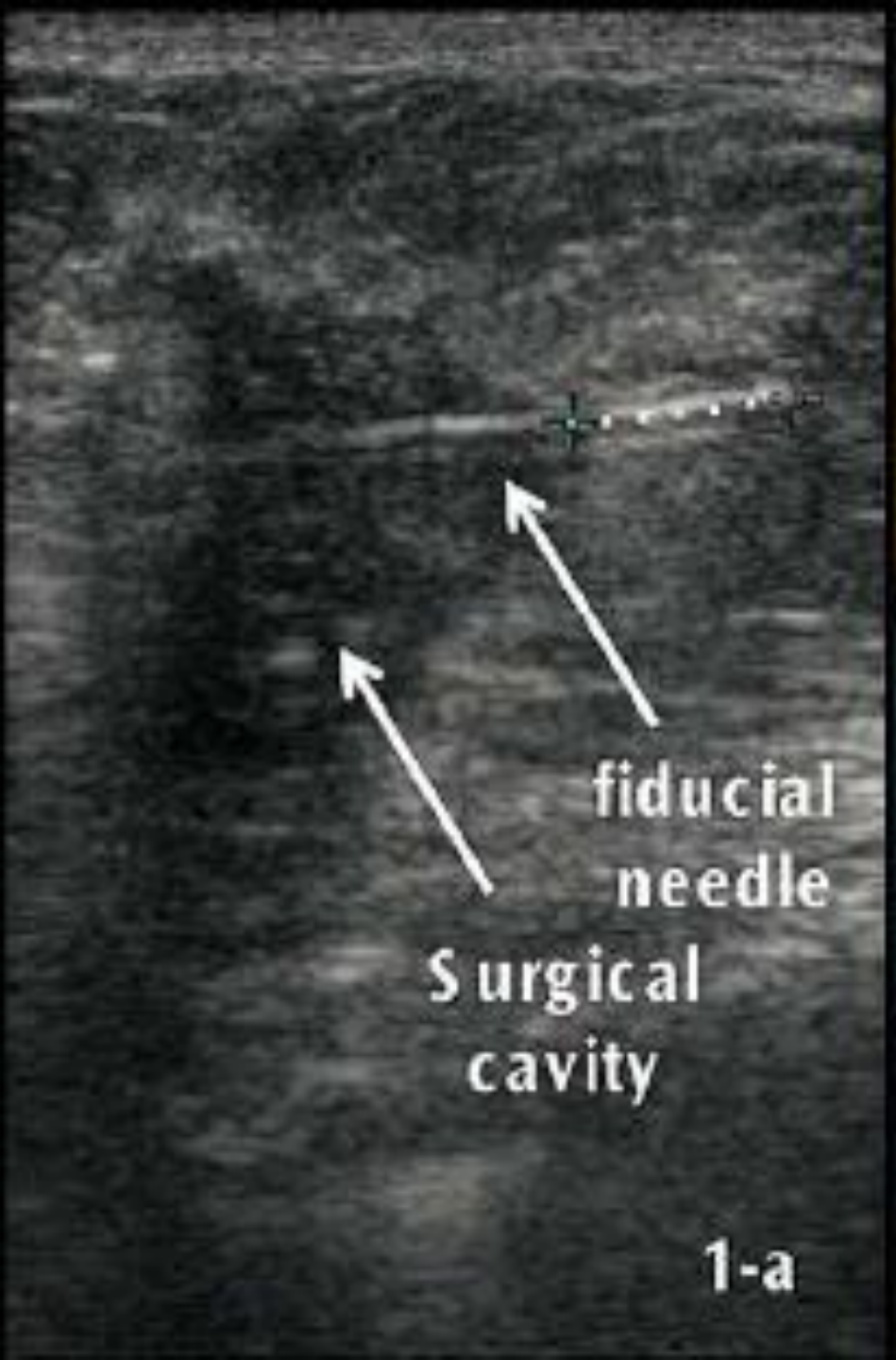
Targeted therapies?

Permanent implants



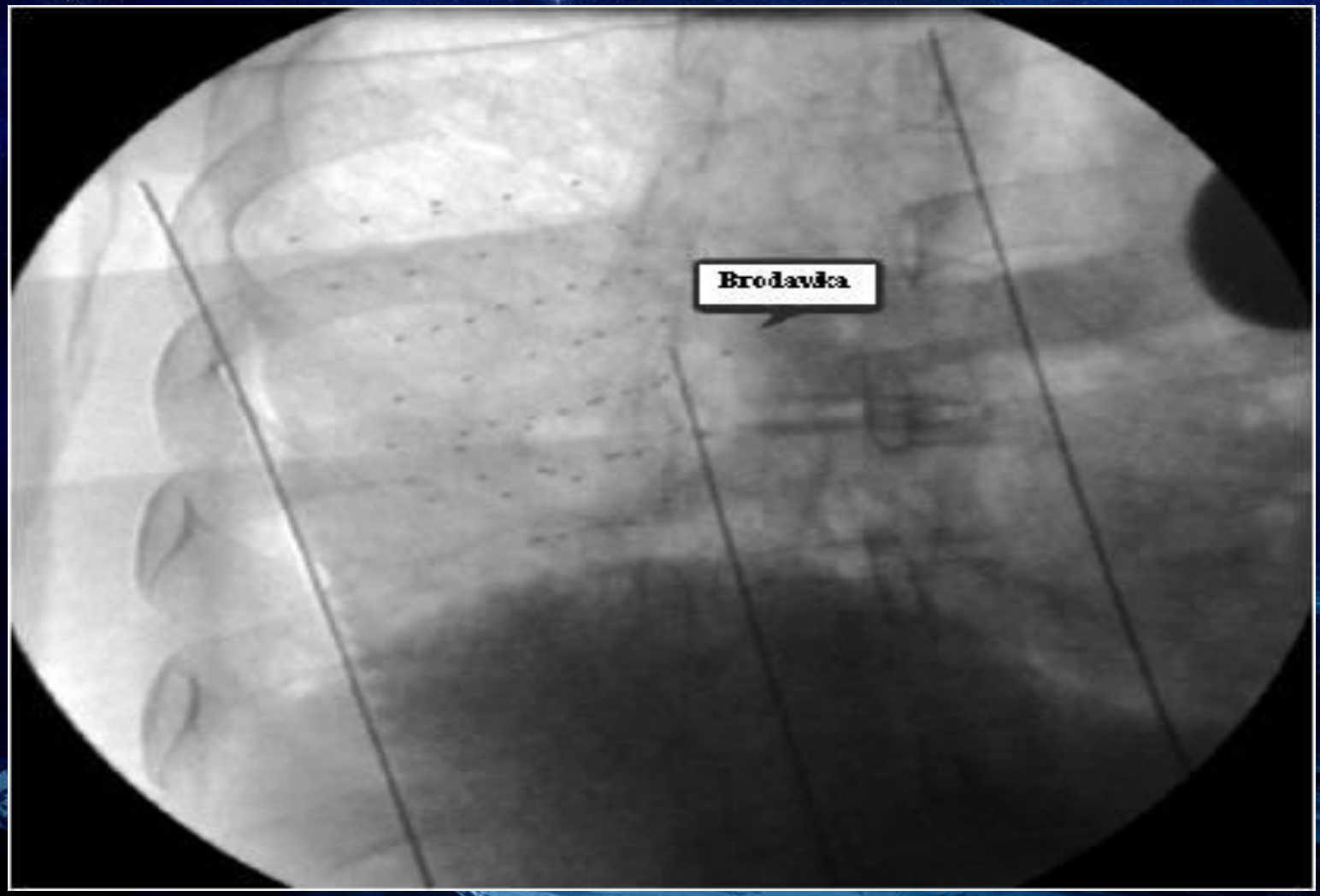

2-a


PTV
Odstępnik
Igła prowadząca
Dodatkowy odstępnik

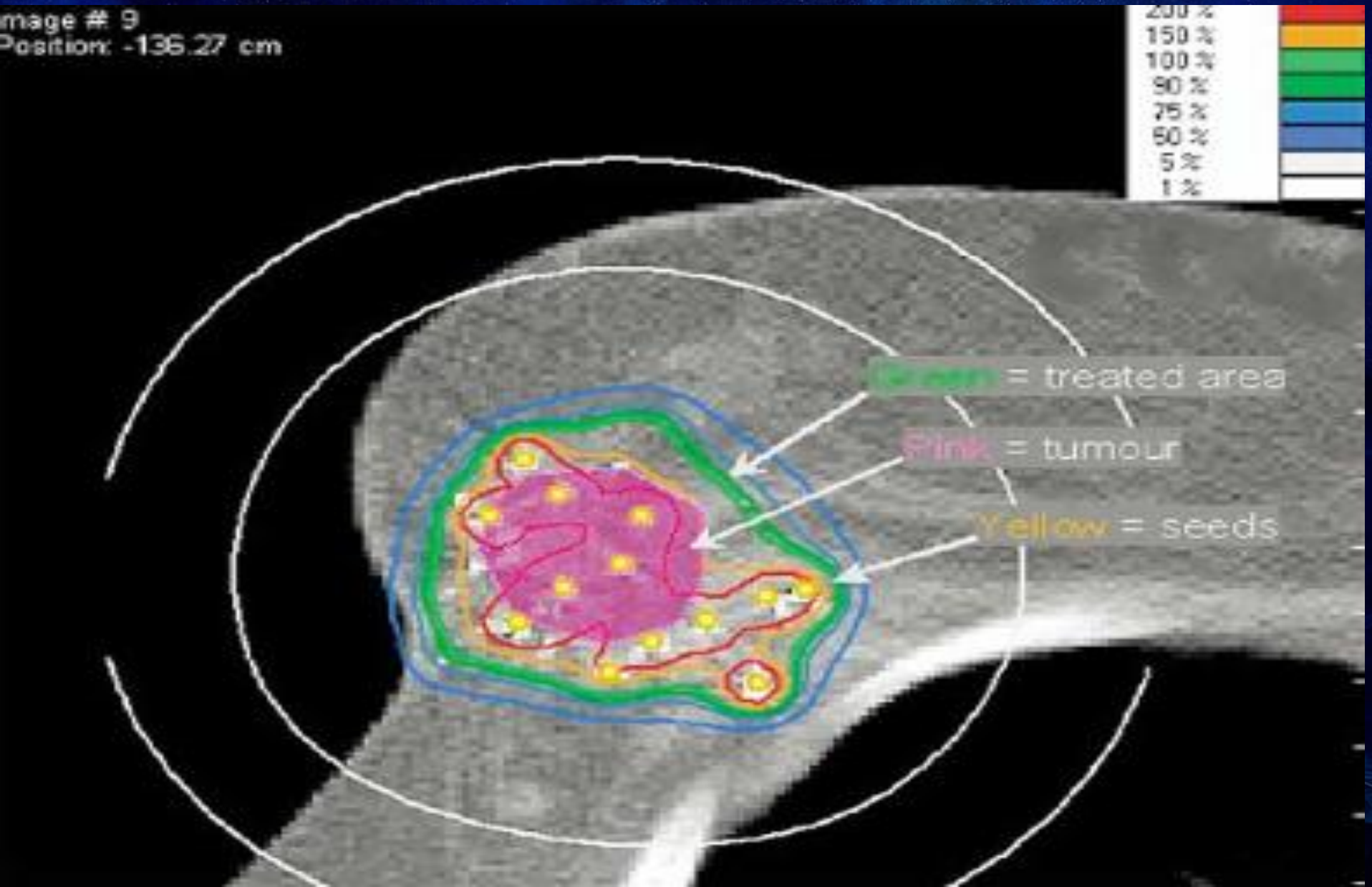

fiducial needle
Surgical cavity
1-a


1-b

X-ray after seeds implantation. The two outer lines are the external boundaries of breast, central line specifies nipple. The tumor was located between the upper and soft lower outer quadrant of right breast.

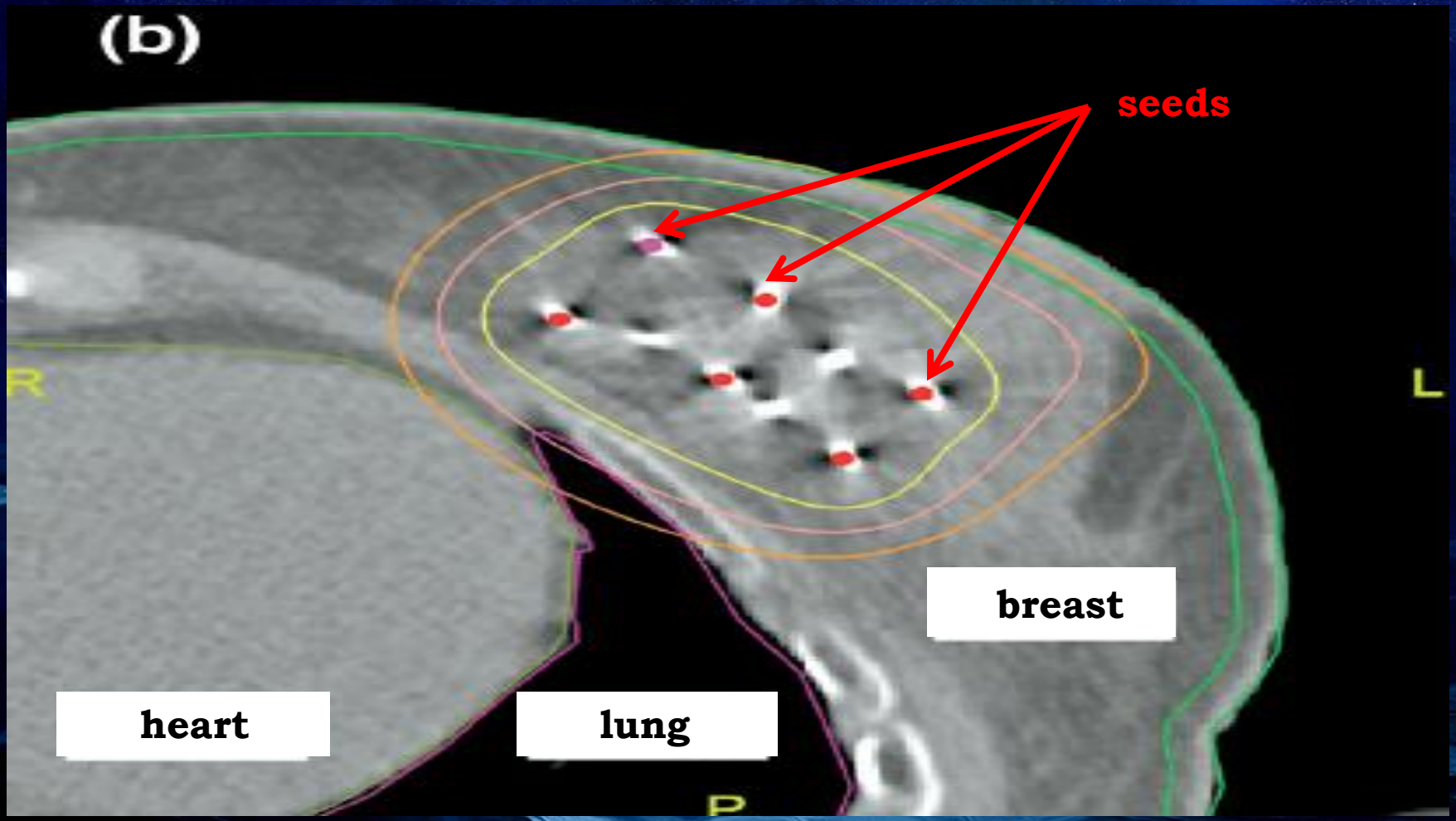


Treatment plan – isodoses, tumor bed and target outlined, seeds visible



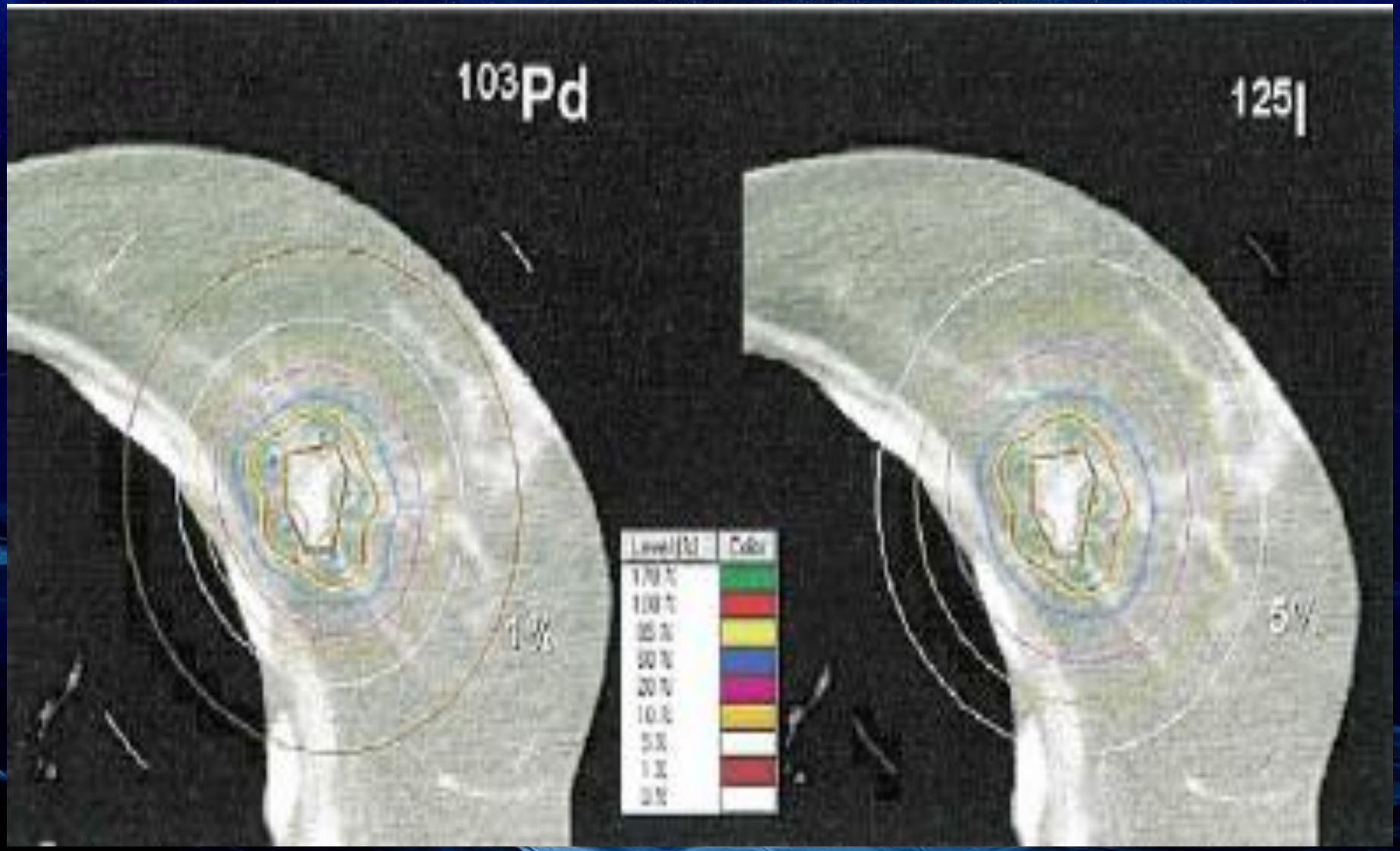
Dozymetry – post-planning

skin – light green, lung – rosa, heart – dark green. Red points - seeds. Yellow referential isodose - 50 Gy. Light rose – dose 30 Gy; light orange - 20 Gy. Good protection of skin, heart and lung (OaR's)



Example of use of two different isotopes implanted into the tumor bed. The same number of isotopes in both cases, the same nominal activity. The treatment plan was prepared assuming the same coverage of PTV isodose healing. Isodose 1% is just below the skin for Pd-103, the isotope I-125 corresponds to isodose 5%.

B. KELLER *et al.* 103Pd vs. 125I for a breast permanent seed implant.
Int. J. Radiation Oncology Biol. Phys., Vol. 62, No. 2, pp. 358–365, 2005



Seeds in breast cancer treatment – first reports

Autor	Liczba chorych	Izotop (implant stały)	Cel pracy	Kwalifikacja chorych	Wnioski
Pignol i wsp. (IJRBP, 2006;64) Toronto	16	Pd-103 90 Gy (CTV + 1cm)	Samodzielna BT po BCS	Guz ≤ 3mc, Margines ≥ 2 mm, Brak ca „in situ”, Naczynia limfatyczne (-), węzły chłonne (-).	LC 100%, 46% odczyn I st. wg skali CTC, dobra tolerancja leczenia
Jansen i wsp. (IJRBP, 2007,67)	15	I-125	„Boost” po EBRT – chore z ryzykiem wznowy miejscowej	Margines nieznany lub < 2 mm, G3, T1-2 N0-1.	Może być zalecana u chorych wymagających szczególnej ochrony OAR, np. po kardiotoksycznej chemioterapii
Keller i wsp. (IJRBP, 2005; 62)		Pd-103 vs I-125	Badanie ekspozycji i dawki efektywnej w otoczeniu chorej		Pd-103 – mniejsza dawka dla otoczenia
Pignol i wsp. (IJORB 2009;73) Toronto	67	Pd-103 90 Gy (CTV + 1,5 cm)		Guz ≤ 3mc, Margines ≥ 2 mm, Brak ca „in situ”, Naczynia limfatyczne (-), węzły chłonne (-).	The feasibility, safety, and tolerability of PBSI compares favorably with that of external beam and other partial breast irradiation techniques


Surgery
Radiotherapy
Chemiotherapy
Immunotherapy
Gene therapy
Adjuvant therapy

Thank you