"Accurate boost" or Simply Accuboost

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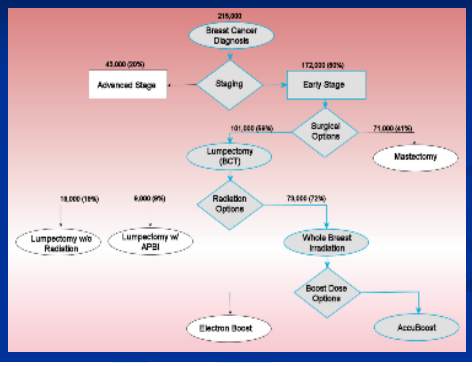
Disclosure:
Advisory board

Items to be discussed

- Technology
- Clinical reasons for such technology
- Dosimetry
- Comparison with Electrons and 3D-CRT
- Acceptance testing
- Clinical cases
- Questions

Big picture on management of Breast Cancer

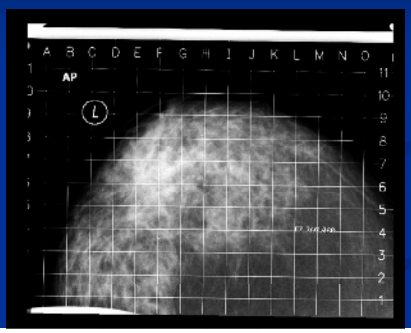


Accuboost System components

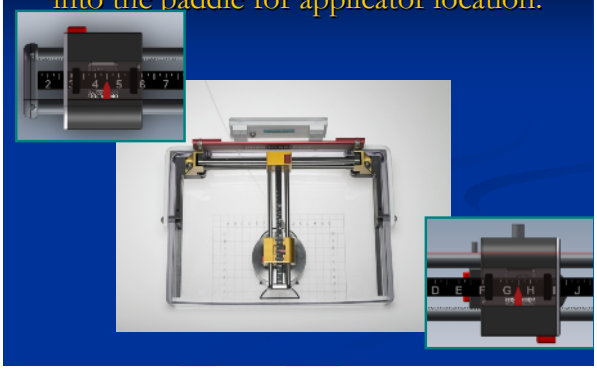
- Mammography unit
- CR for films
- Overlays for Tx field
- Applicators
- HDR unit.
- Nomogram for Tx time

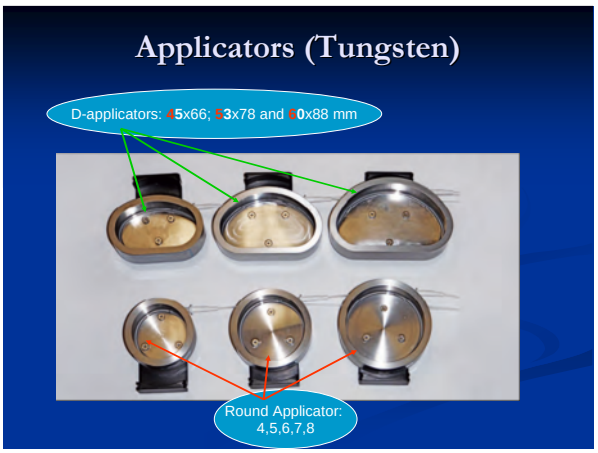
Treatment system setup

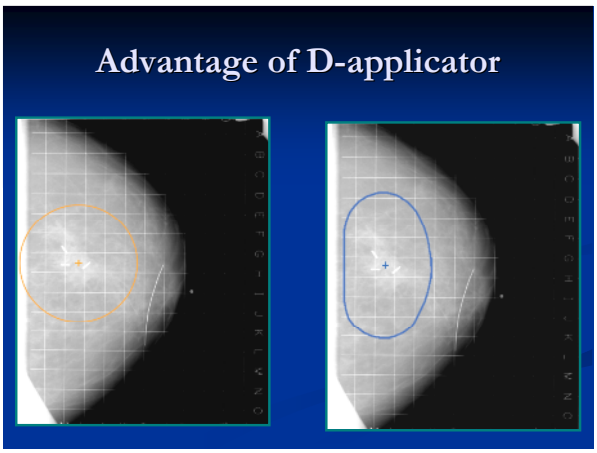
Why Mammography? undeniably, the best method to image/localize the lumpectomy site. "Gold Standard"

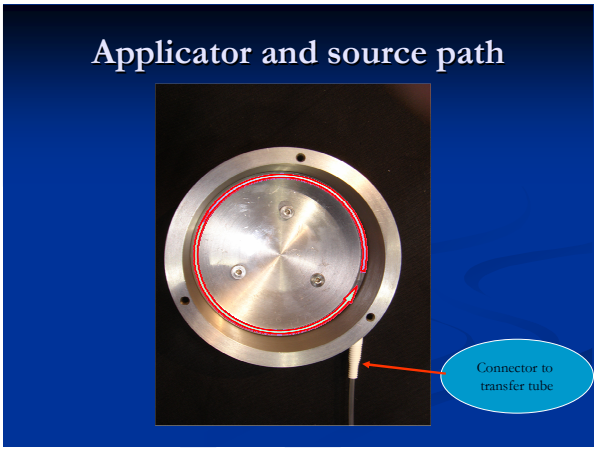


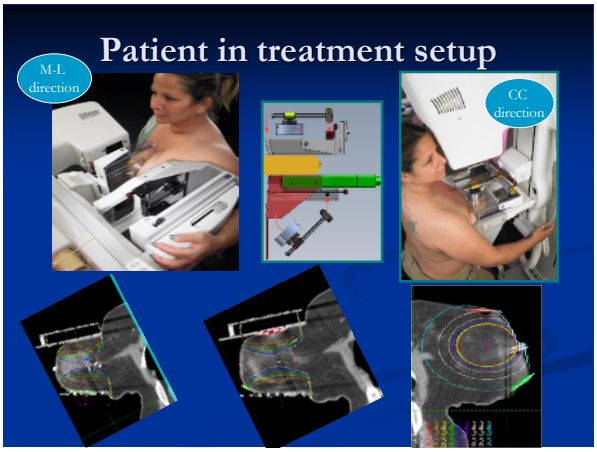
An alphanumeric radiopaque grid built into the paddle for applicator location.




Applicators (Tungsten)
D-applicators: 45x66; 53x78 and 60x88 mm
Round Applicator: 4,5,6,7,8


Advantage of D-applicator


Applicator and source path
Connector to transfer tube


Patient in treatment setup
M-L direction
CC direction

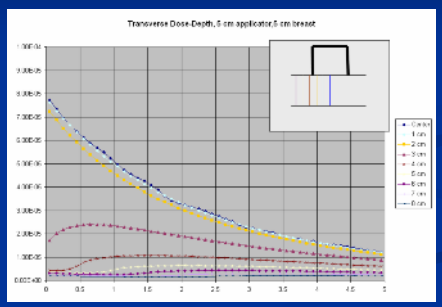
Dosimetry of Accuboost

Dosimetry

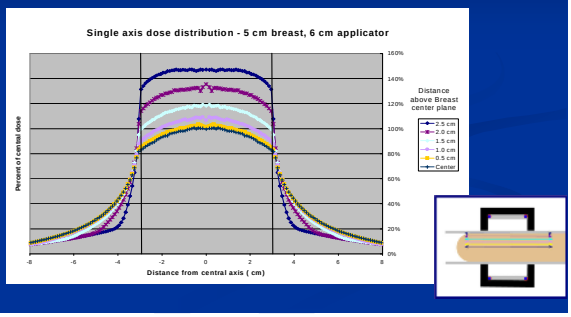
- MCNP5 based
- Work of Mark Rivard Ph.D.
- Breast Thicknesses from 30 to 80 mm
- Applicators Ranging from 40 to 80 mm
- All materials accurately modeled, including ICRU 44 Breast Tissue definition…. Not solid water analog

•(Med Phys 36(11) 5027—5032)

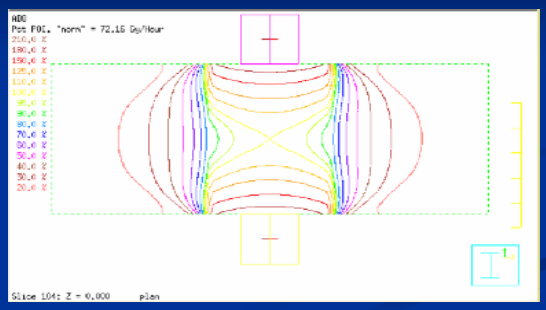
Monte Carlo
Data – Transverse Dose-Depth Distribution- Single Side



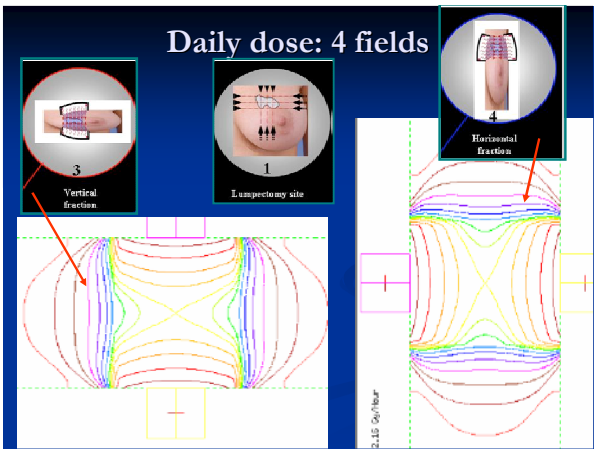
Monte Carlo
Data – Single Axis Radial Dose Distribution



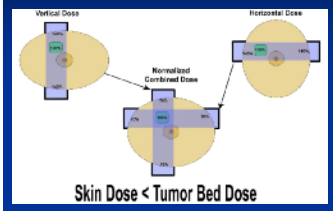
Dose distribution: opposed fields

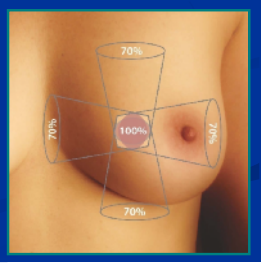


Daily dose: 4 fields



Resulting dose





When treating an APBI patient with 4 opposed fields (perpendicular), the skin dose In relation to the prescribed dose) is expected to be:

25%	1.	120%
25%	2.	50%
25%	3.	100%
25%	4.	70%

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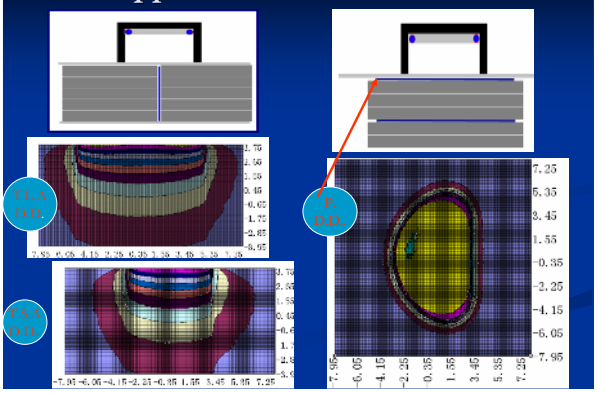
D applicator: dose distribution



The D-Applicator is used for the following reason

- 25% 1. Appropriate geometrical dose coverage
- 25% 2. The advantage of the dose distribution
- 25% 3. The better access to lumpectomy cavity close to the chest wall
- 25% 4. Shorter treatment time

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Resulting dose distribution from four fields

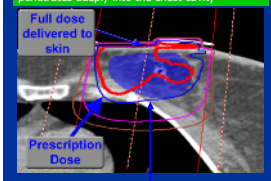
Resulting Dose distribution for an Offset lesion

Reasons for the technology

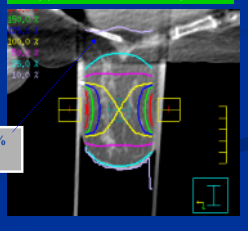
- Reduce Dose to the heart and lung
- Less dose to surrounding normal tissue
- Conformal and Uniform Dose to target
- No geometric miss, excellent localization
- Ability to incorporate surgical and pathological information with respect to "margin at risk". This leads to great flexibility in target design such that the boost can be as precise as a "targeted re-excision"
- Lower skin, rib and pectoralis muscle dose
- Non-Invasive technology
- Easy to implement and use

Reduction of dose to heart and lung

Conventional Electron Boost – 90% isodose line grazes the lung & 50% isodose line penetrates deeply into the chest cavity



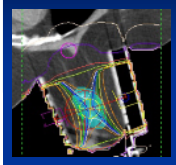
AccuBoost – The 10% isodose line barely penetrates the chest cavity



Full dose to the rib

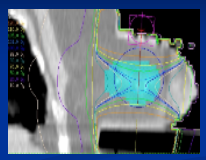
Less than 20% to the rib

Electrons vs. Accuboost

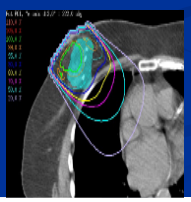


AccuBoost

<= APBI =>



Electrons– APBI =>



Three-Dimensional Dose Modeling of the AccuBoost Mammograq-Based Imagi-Guided Not-Invasive Breast Brachytherapy System for Partial Breast Irradiation

S.Sinobamsi,[1,2] J. R. Hiatt,[2] M. J. Rivard,[1] J. T. Hepel,[1,2] G. A. Cardarelli,[2] S. O'Leary,[1] D. E. Waatz.[1,2]

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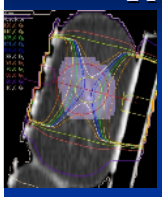
Electrons vs. Accuboost

	PTV vol (cc)	PTV V110 (cc)	PTV V100 (cc)	PTV Dmax (Gy)	PTV Dmin (Gy)	PTV Dmean (Gy)	PTV D90 (%)	PTV D50 (%)
Accuboost median	44 (31—74)	21.1 (19.2-26.7)	54.6 (30.8-37.9)	2.3 (2.2-2.6)	1.8 (1.7-1.9)	2.1 (2—2.1)	93.8 (93.0-94.4)	100.8 (100.2-103)
Electrons	118 (70-202)	13.1 (8.3-27.3)	88.4 (75.0-95.7)	2.2 (2.3-2.4)	1 (0.9-1.5)	2.1 (2.1-2.2)	102.3 (94.7-104.3	107.3 (104.4-108.6)
p-value	0.02	N/S	0.01	N/S	0.04	N/S	N/S	0.02

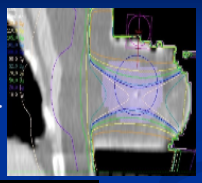
	Chest Wall Dose (%)	Max. Lung Dose (%)	Max. Skin Dose (%)
Accuboost Median	30.8 (24.0-53.6)	18 (13.1-20.2)	91.2 (81.5-100)
Electrons	106.1 (104.4-108.6)	99.9 (73.2-105.2)	115.2 (113.2-121.4)
p-value	0.01	0.02	0.01

3D-CRT vs. Accuboost From S. Sioshansi Poster



AccuBoost

<= APBI =>



3D-CRT– APBI =>

3D-CRT vs. Accuboost

	PTV vol (cc)	PTV V110 (cc)	PTV V100 (cc)	PTV Dmax (Gy)	PTV Dmin (Gy)	PTV Dmean (Gy)	PTV D90 (%)	PTV D50 (%)
Accuboost median	78 (58—119)	22.2 (18.9—25.6)	54.4 (47.7—56.4)	45.4 (42.7—48.6)	33.9 (29.3—33.5)	39.5 (37.1—40.0)	93.1 (91.3--93.7)	100.8 (99.9-102.2)
3D-CRT Median	222 (201-360)	0 (0—0)	51.8 (34.8—62.1)	40.0 (39.7—40.6)	32.0 (30.0—33.3)	38.6 (38.2—38.6)	97.6 (97.1—98.1)	100.5 (95.1-100.5)
p-value	0.01	N/A	NS	0.05	NS	NS	0.02	NS

	Chest Wall Dose (%)	Max. Lung Dose (%)	Max. Skin Dose (%)
Accuboost Median	32.4 (27.4—88.4)	18.7 (17.5—25.4)	94.8 (76.5—101.1)
3D-CRT Median	99.9 (95.1—100.5)	91.9 (88.4—98)	104 (103.5—106)
p-value	0.01	0.02	0.04

Summary of comparison

- AccuBoost median max skin dose is 25% lower than electron boost and 10% less than 3D-CRT.
- AccuBoost delivers 70-80% less dose to the chest wall and lungs. PTV coverage is comparable between the techniques.
- There is NSS difference between electron boost and AccuBoost boost for the V110, Dmax, Dmean, or D90.
- Electron boost plans have a lower median Dmin than AccuBoost boost (1.0 Gy vs 1.8 Gy, p=0.039), but higher V100 and D50.
- The only significant difference between the APBI techniques is slightly higher median D90 with 3DCRT (97.6% vs 93.1% p=0.016) and higher Dmax with AccuBoost (45.4 Gy vs. 40 Gy p=0.055).

One of the major advantages of Accuboost over 3D external beam is

25% 1. The dose reduction to the chest wall
25% 2. The dose reduction to the lung
25% 3. The dose reduction (maximum dose) to the skin
25% 4. All the above

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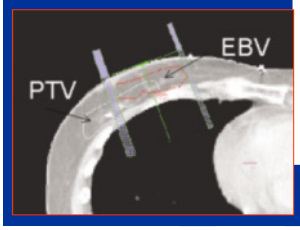
Geometric miss? Boost setup

- CT imaging
- U/S imaging
- Clips
- Scars
- Others

CT OPTION (Electron and 3 D CRT)

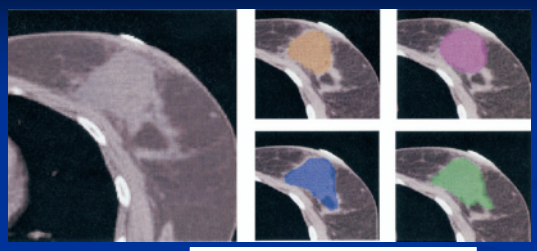
- Clinical setup with CT not accurate
- Geometric miss




Breast Boost: Are We Missing the Target?

A Dosimetric Comparison of Two Boost Techniques

CT Original image on left
Delineation by 4 "breast expert" MD's on right




VARIABILITY AMONG BREAST RADIATION ONCOLOGISTS IN DELINEATION OF THE POSTSURGICAL LUMPECTOMY CAVITY

U/S Option (External beam)

Princess Margaret study:

54 pts had U/S boost loc

1) 65% had the clips inside the boost field
2) 28% marginal
3) 7% inadequate (clips outside U/S field)

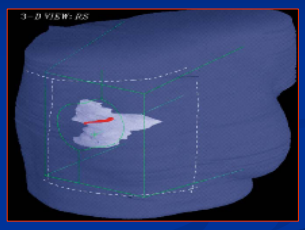
Ringash J, Whelan T, et al Radiother Oncol 2004

Clips option

- Not easily visible in U/S
- Obvious with Mammography
- Good reference for cavity identification and delineation: very helpful

Scar option

- Alone not reliable for cavity identification
- Red: scar
- Light bleu: Cavity
- Green: electron field



KEVIN S. OH, M.D. et al
Int. J. Radiation Oncology Biol. Phys., Vol. 66, No. 3, pp. 680–686, 2006

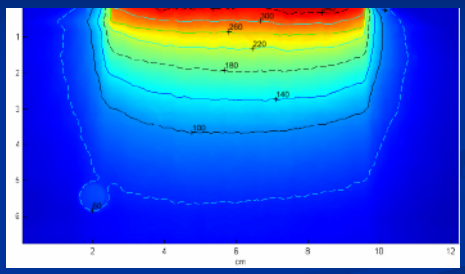
Accuboost option

- Mammography used to localize target
- Breast is immobilized with compression
- No margin of error
- Breathing motion eliminated
- No target movement during treatment

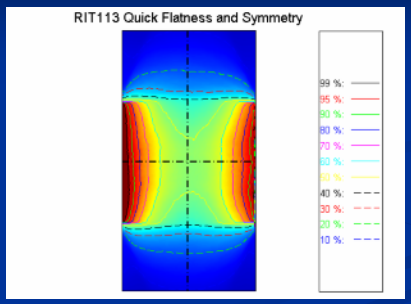
Acceptance testing for Accuboost

- Dose profiles and distributions with films (Gafchromic Film)
- Verification of Applicators sizes, connections, dwell points
- Output factor (Gy/min)
- Verification of Treatment time
- Plate Separation (compression thickness)
- Applicator Catheters (inspection and replacement)
- Training for staff (therapists, dosimetrists) for the use and interpretation of the Mammo. unit
- Mammography & CR Systems
  - Calibrated on Site by Mammography system installer
  - Form DD2579 filed with the state by ART, not for mammography but for localization only
  - Typically - Facility adds one radiation emitting device to its license and monitoring protocols

Dosimetry: single field

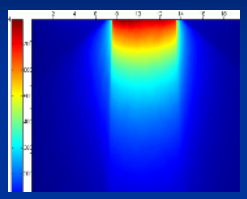


Opposed field

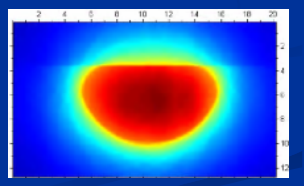


D-Applicator

Dose Distribution – Gafchromic Film D60



Transverse Dose Distribution
Short Axis

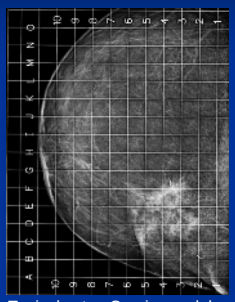


Planar Dose Distribution
3 cm depth

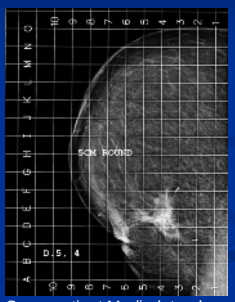
Output verification

Applicator (cm)	# dwell points	Total Dwell time (sec)	Activity (Ci)	Reading (C)	Output factor	Manufacturer O.F.	% difference
Round 5-1	15	381	4.139	0.469	4.60	4.73	2.8
Round 5-2	15	381	4.139	0.466	4.57	4.73	3.5
Round 6-1	18	405	4.139	0.469	4.32	4.45	3.0
Round 6-2	18	405	4.139	0.471	4.34	4.45	2.5
Round 7-1	21	434.7	4.138	0.474	4.07	4.15	2.0
Round 7-2	21	434.7	4.138	0.475	4.08	4.15	1.7
D 4.5-1	19	343.9	9.904	0.950	10.27	10.46	1.9
D 4.5-2	19	343.9	9.904	0.947	10.24	10.46	2.1
D 5.3-1	22	371.8	9.897	0.953	9.53	9.68	1.6
D 5.3-2	22	371.8	9.897	0.953	9.53	9.68	1.6

Setup for clinical cases

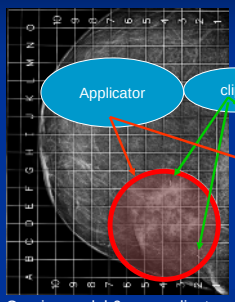


Typical setup Cranio-caudal

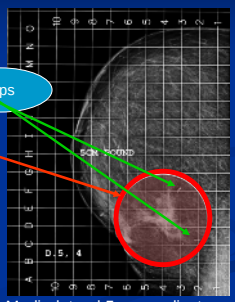


Same patient Medio-lateral

Selection of applicators



Cranio-caudal 6 cm applicator



Medio-lateral 5 cm applicator

Exclusion for Accuboost

- Cavity too large
- Patients cannot tolerate compression
- Cavity not easily identified
- Cavity too close to chest wall (even with D applicators)

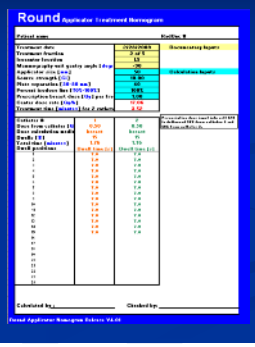
Accuboost treatment

- Prior to external beam: easier on patients
- Possibility of discomfort if to close to post-op.
- Half way trough the external beam: possibility of discomfort (?)
- Boost one or two days per week within the course of WBI?

Treatment time calculation

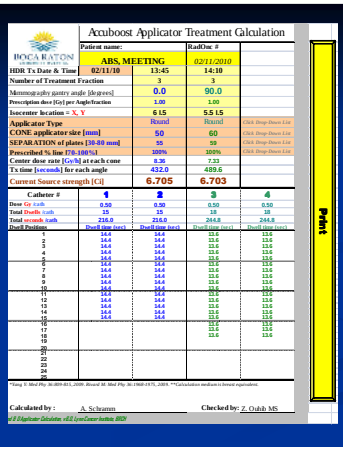
- Based on Monte Carlo (MCNP version 5) simulation
- Backed by calibrated NIST traceable ionization chamber measurements
- For 4-8 cm diameter applicators
- For 3-8 cm thick breast
- Options for breast tissue or polystyrene

Treatment time calculation: use of nomogram



Round Applicator Treatment Nomogram

Patient name		RadOnc #
Treatment date	2/28/2009	Documentary Inputs
Treatment fraction	2 of 5	
Isocenter location	L5	
Mammography unit gantry angle [degrees]	-90	
Applicator size [mm]	50	Calculation Inputs
Source strength [Ci]	10.00	
Plate separation [30-80 mm]	40	
Percent isodose line [70%-100%]	100%	
Prescription breast dose [Gy] per fraction	1.00	
Center dose rate [Gy/h]	17.06	
Treatment time [minutes] for 2 catheters	3.52	



Accuboost Applicator Treatment Calculation

	Patient name:		RadOne #	
	ABS, MEETING		02/11/2010	
HDR Tx Date & Time	02/11/10	13:45	14:10	
Number of Treatment Fraction		3	3	
Mammography gantry angle [degrees]		0.0	90.0	
Prescription dose [Gy] per Angle/fraction		1.00	1.00	
Isocenter location = X, Y		6 15	5.5 15	
Applicator Type		Round	Round	Click Drop-Down List
CONE applicator size [mm]		50	60	Click Drop-Down List
SEPARATION of plates [30-80 mm]		55	59	Click Drop-Down List
Prescribed % line [70-100%]		100%	100%	Click Drop-Down List
Center dose rate [Gy/h] at each cone		8.36	7.33	
Tx time [seconds] for each angle		432.0	489.6	
Current Source strength [Ci]		6.705	6.703	

Catheter #	1	2	3	4
Dose Gy /cath	0.50	0.50	0.50	0.50
Total Dwells /cath	15	15	18	18
Total seconds /cath	216.0	216.0	244.8	244.8
Dwell Positions	Dwell time [sec]	Dwell time [sec]	Dwell time [sec]	Dwell time [sec]
1	14.4	14.4	13.6	13.6
2	14.4	14.4	13.6	13.6
3	14.4	14.4	13.6	13.6
4	14.4	14.4	13.6	13.6
5	14.4	14.4	13.6	13.6
6	14.4	14.4	13.6	13.6
7	14.4	14.4	13.6	13.6
8	14.4	14.4	13.6	13.6
9	14.4	14.4	13.6	13.6
10	14.4	14.4	13.6	13.6
11	14.4	14.4	13.6	13.6
12	14.4	14.4	13.6	13.6
13	14.4	14.4	13.6	13.6
14	14.4	14.4	13.6	13.6
15	14.4	14.4	13.6	13.6
16			13.6	13.6
17			13.6	13.6
18			13.6	13.6
19				
20				
21				
22				
23				
24				
25				

*Yang T. Med Phy. 26:809-813, 2000. Record M. Med Phy. 26:1968-1975, 2009. **Calculation medium is brown equivalent.

Calculated by : A. Schramm Checked by: Z. Oshib MS

v4.0 Applicator Calculator, v4.0 LynnCancer Institute, BRDV

Print

Treatment time calculation

- Number of dwell points: 3 x applicator size for round one
- Different for D- applicators
- All dwell points should be used
- Step size equal 1 cm
- Source indexer 1500 mm for Nucletron system

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Questions??