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TITLE: Optimization of Technique Factors for Full-Field Digital Mammography and Comparison of Optimized Techniques to Screen-Film Mammography

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13. ABSTRACT (Maximum 200 Words)

The technical objectives of this study are to determine optimum techniques for a flat-panel Cesium-iodide silicon-diode full-field digital mammography system and to compare those optimized techniques to screen-film mammography at equal breast doses.

This grant was moved from the University of Colorado Health Sciences Center to Northwestern University Medical School with final approval being in January 2001. There was approved delay in both the work and the contract administration. My training and experience will continue at Northwestern with Dr. Hendrick and at Colorado State University with Dr. Park (academic advisor). I will be able to fulfill the requirements of this research contract as my responsibilities include research and clinical activities in the section of breast imaging.

To this point, phantom testing of image quality by matching dose has been performed on both the film-screen and digital mammography. Technical data has been collected on both units, a computer program has been written to calculate dose, and a computer program has been written to calculate techniques for the digital for a given film-screen dose. Digitally acquired contrast-detail phantoms were printed, scored, and prepared for analysis. There are no reportable outcomes at this time.

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Annual Summary Report

Award Number: DAMD17 – 99-1-9144

PI: R. Edward Hendrick, Ph.D. - Mentor
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Introduction

The technical objectives of this study are to determine optimum techniques for a flat-panel Cesium-iodide silicon-diode full-field digital mammography system and to compare those optimized techniques to screen-film mammography at equal breast doses. Optimum techniques will be determined for the full range of compressed breast thicknesses and breast compositions. Optimization will be done by maximizing low-contrast lesion detectability in tissues of interest, especially glandular tissues, while keeping exposure times sufficiently short and mean glandular breast doses equal to those of screen-film mammography. The effect of full-field digital user-selectable technique factors, including tube target material, filtration material, kVp setting, and mAs setting, on detector signal-to-noise ratios (SNR), contrast-to-noise ratios, low-contrast lesion detection, and radiation dose will be independently quantified. Once optimum technique factors for this full-field digital mammography system are obtained for each breast thickness and composition, those optimum techniques will be compared to optimum techniques for screen-film mammography under the constraint of equal average glandular breast doses.

Description of training and research accomplishments

This grant was initially awarded July 1, 1999 at the University of Colorado Health Sciences Center (UCHSC). In October of 2000, Dr. Hendrick and myself both took positions at Northwestern University Medical School (NUMS) and began the process of transferring the award to our new institution. This transfer took 16 months to complete and involved a substantial amount of time and effort to get completed. As of January

2001 all transfer paperwork was completed and the award is officially in the Office of Research and Sponsored Programs at NUMS. During this transition to Northwestern, there were several months where work was not performed due to logistical and equipment issues. I was assured by my contracting officer at the USAMRAA that this delay would not affect my research contract as no paperwork or guidance documents were sent to either institution during the transition.

I remain a graduate student at Colorado State University while working at Northwestern University under the guidance of Dr. Hendrick. My preliminary exam is scheduled for April 19, 2001, with a final exam to be held after completion of the dissertation.

My position at Northwestern is in the Department of Radiology in the Breast Imaging Section, which includes a combination of clinical and research responsibilities. My current areas of research focus on applications of digital mammography. This will allow me the time and resources to continue work on this award.

Key Accomplishments

- Phantom testing was performed on the film-screen mammography unit to determine the optimized technique parameters. This included optimization of optical density while minimizing patient dose.
- Four optimized images of the contrast detail phantom were produced on the film-screen unit at 2, 4, 6, and 8 cm thicknesses. See Appendix A for image technique data.
- Medical physics testing was performed on the film-screen mammography unit to obtain data for calculation of average glandular dose. This included measuring the half-value layer and output for each allowed target, filter and kVp combination. See Appendix B.
- Medical physics testing was performed on the GE Senographe 2000D full-field digital mammography unit to obtain data for calculation of average glandular doses. This included measuring the half-value layer and output for each target, filter, and kVp combination. See Appendix B.

- Using the data measured above, a computer program was written to calculate average glandular dose for any set of technique factors on the digital mammography unit. An example output of the computer program is illustrated in Appendix C.
- Using the data measured above, a computer program was written to match the average glandular dose from one mammography machine to another machine by calculating the corresponding technique factors. An example output of the computer program is presented in Appendix D.
- Using this program, techniques were calculated for 2, 4, 6, and 8 cm phantom thicknesses for the digital that match the four film-screen images listed above. This produced a list of mAs values for each target-filter at each kVp for each phantom thickness (2, 4, 6, and 8 cm). See Appendix E.
- Phantom images were acquired on the digital mammography unit using the calculated techniques that match the film-screen dose.
- Signal and noise measurements were made on each acquired phantom for analysis. This was done by placing a region of interest (ROI) at the same place on each phantom and recording the mean signal value and the standard deviation. See Appendix F.
- The phantom images acquired on the digital unit were printed and randomly scored by six trained individuals. The scores for each film were recorded for analysis. See Appendix F.

List of Reportable Outcomes

- What remains to be done is to analyze the data comparing the film-screen contrast-detail scores to the digital contrast-detail scores. Other analysis will include looking at reader variability and effects of target-filter, HVL, signal-to-noise ratio, and exposure time on image quality between the two modalities.

- A paper is in preparation comparing screen-film and digital mammography performance in terms of image quality and breast dose.

Appendix A

Film-Screen Phantom Data

Date: 3/10/1999

	2 cm	4 cm	6 cm	8 cm
Target/Filter:	Mo/Mo	Mo/Mo	Mo/Rh	Rh/Rh
kVp:	25	25	27	28
mAs:	16	85	168	283
HVL:	0.3492	0.3429	0.4213	0.4315
Average Glandular Dose (mrad):	38.9	126.38	234.97	384.77
Optical Density:	1.56	1.66	1.58	1.59

Appendix B

Entrance Exposure Measurements

21-Jan-99

mAs = 100

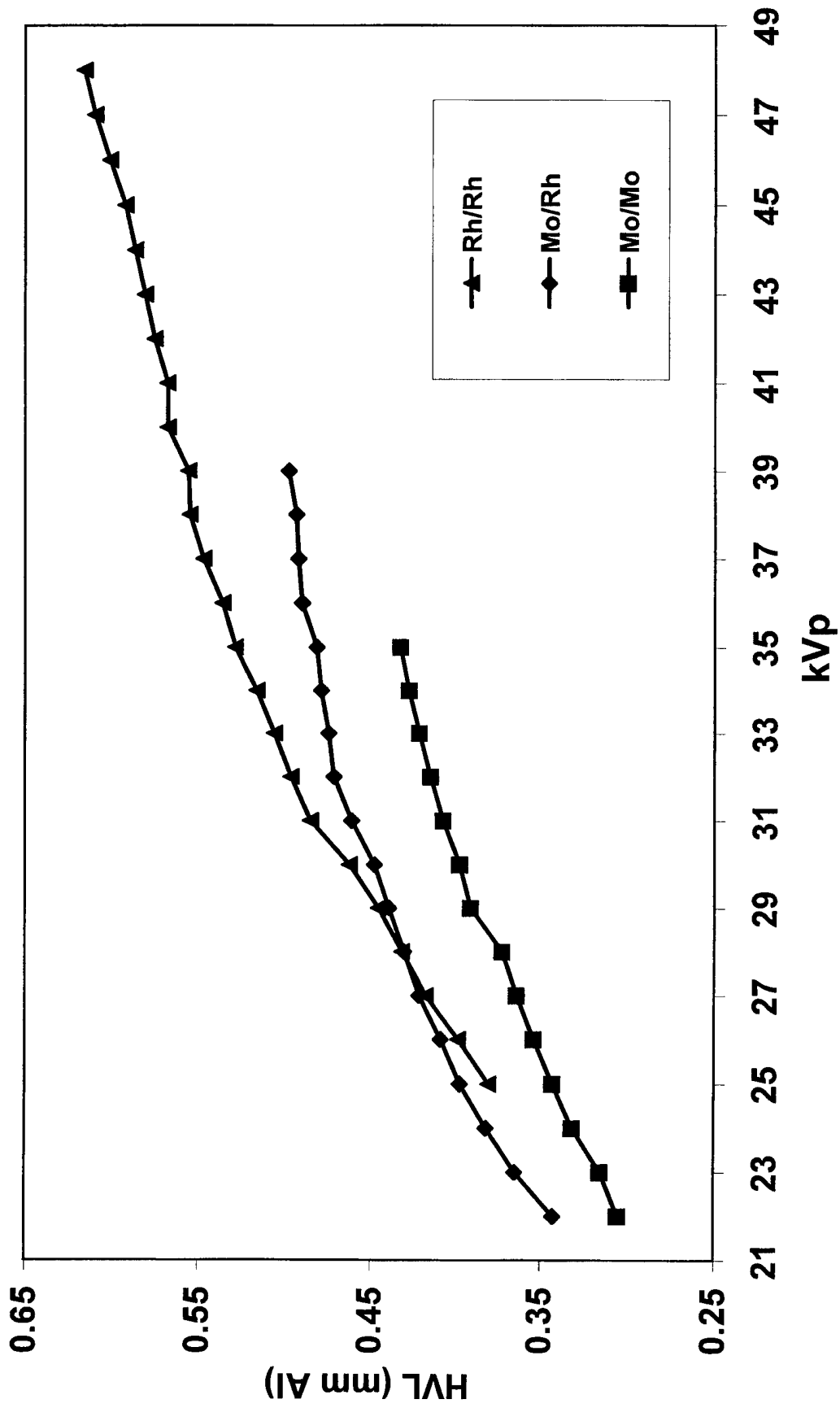
kVp	DMR			Digital		
	Mo/Mo	Mo/Rh	Rh/Rh	Mo/Mo	Mo/Rh	Rh/Rh
22	542	417		503	378	
23	632	495		594	458	
24	733	586		694	547	
25	843	684	687	799	641	662
26	958	786	780	912	741	753
27	1083	893	881	1031	843	851
28	1211	1008	987	1156	952	955
29	1346	1125	1097	1286	1065	1063
30	1484	1245	1213	1419	1180	1175
31	1627	1367	1328	1559	1299	1292
32	1771	1492	1450	1701	1421	1412
33	1923	1623	1575	1846	1545	1536
34	2077	1755	1704	1998	1676	1664
35	2236	1894	1835	2152	1807	1796
36		2034	1971		1940	1930
37		2175	2111		2076	2067
38		2319	2252		2216	2207
39		2465	2395		2360	2347
40			2539		2501	2493
41			2688			2644
42			2840			2790
43			2990			2940
44			3150			3100
45			3290			3250
46			3450			3390
47			3610			3560
48			3770			3720
49						3880

HVL Measurements

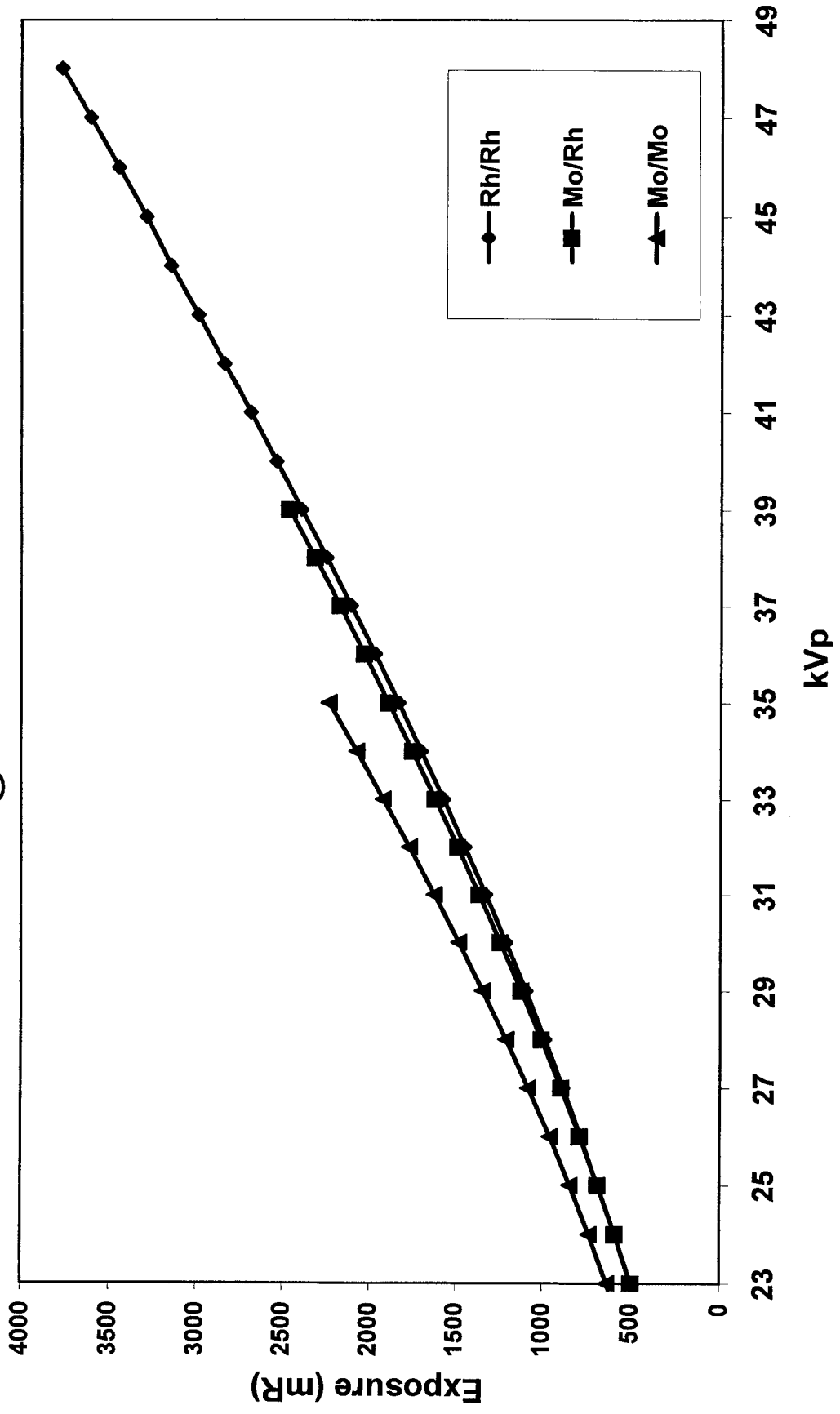
21-Jan-99

kVp	DMR			Digital		
	Mo/Mo	Mo/Rh	Rh/Rh	Mo/Mo	Mo/Rh	Rh/Rh
22	0.3050	0.3425		0.3005	0.3352	
23	0.3153	0.3649		0.3105	0.3590	
24	0.3314	0.3819		0.3268	0.3775	
25	0.3429	0.3971	0.3804	0.3397	0.3938	0.3761
26	0.3540	0.4086	0.3984	0.3522	0.405	0.3938
27	0.3638	0.4213	0.4172	0.3617	0.4200	0.4122
28	0.3724	0.4303	0.4315	0.3712	0.4254	0.4274
29	0.3910	0.4393	0.4454	0.3877	0.4355	0.4413
30	0.3974	0.4478	0.4624	0.3958	0.4427	0.4585
31	0.4072	0.4612	0.4849	0.4007	0.4593	0.4794
32	0.4145	0.4714	0.4960	0.4098	0.4632	0.4916
33	0.4213	0.4744	0.5055	0.4178	0.4683	0.5049
34	0.4274	0.4787	0.5157	0.4229	0.4764	0.5139
35	0.4325	0.4813	0.5283	0.4294	0.4784	0.5281
36		0.4897	0.5358		0.4816	0.5354
37		0.4918	0.5470		0.4914	0.5423
38		0.4929	0.5549		0.4932	0.5535
39		0.4973	0.5557		0.4971	0.5578
40			0.5677		0.4997	0.5634
41			0.5678			0.5659
42			0.5753			0.5746
43			0.5809			0.5830
44			0.5866			0.5782
45			0.5922			0.5931
46			0.6012			0.6000
47			0.6098			0.6067
48			0.6160			0.6149
49						0.6199

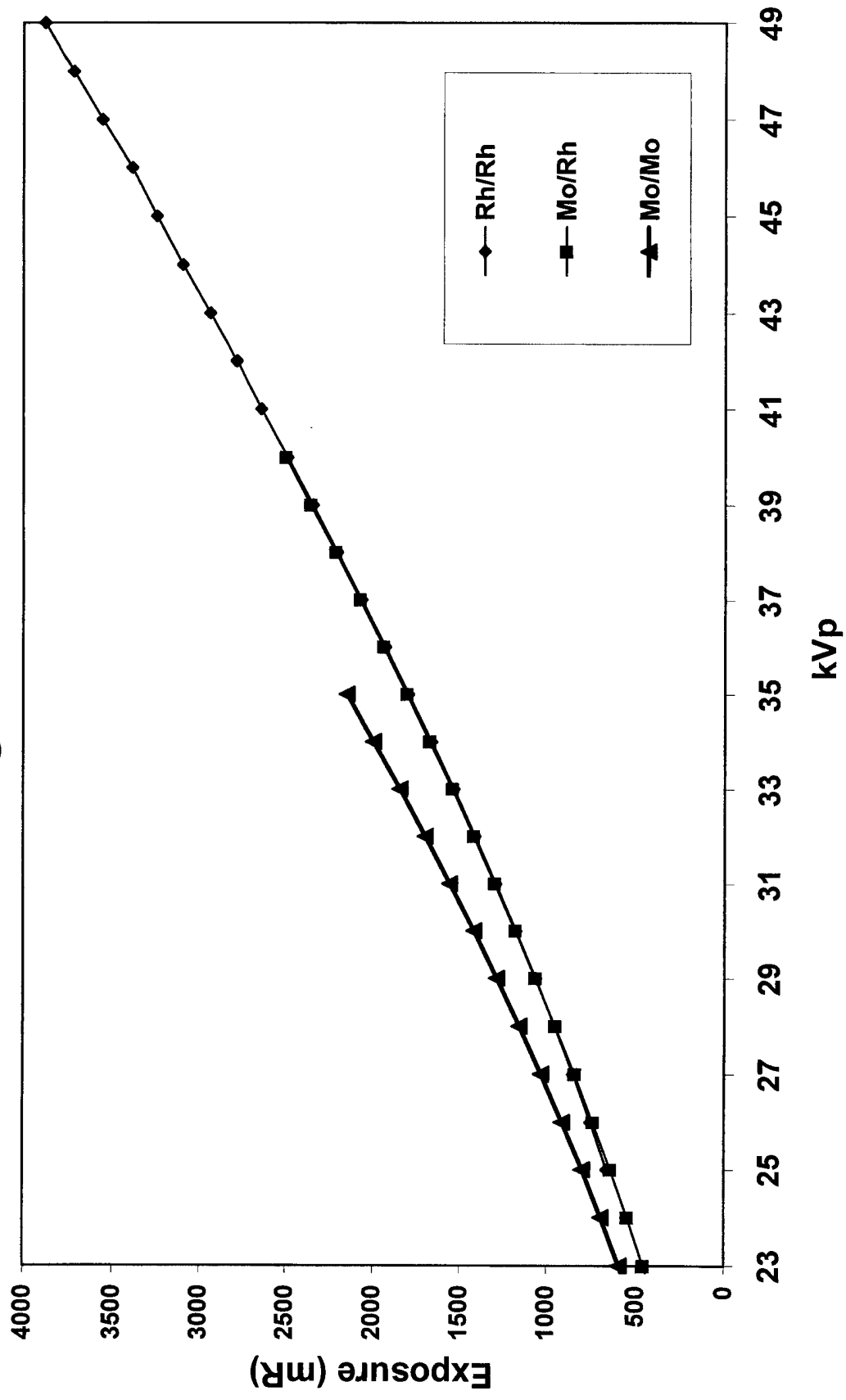
HVL vs. kVp Conventional Film-Screen DMR



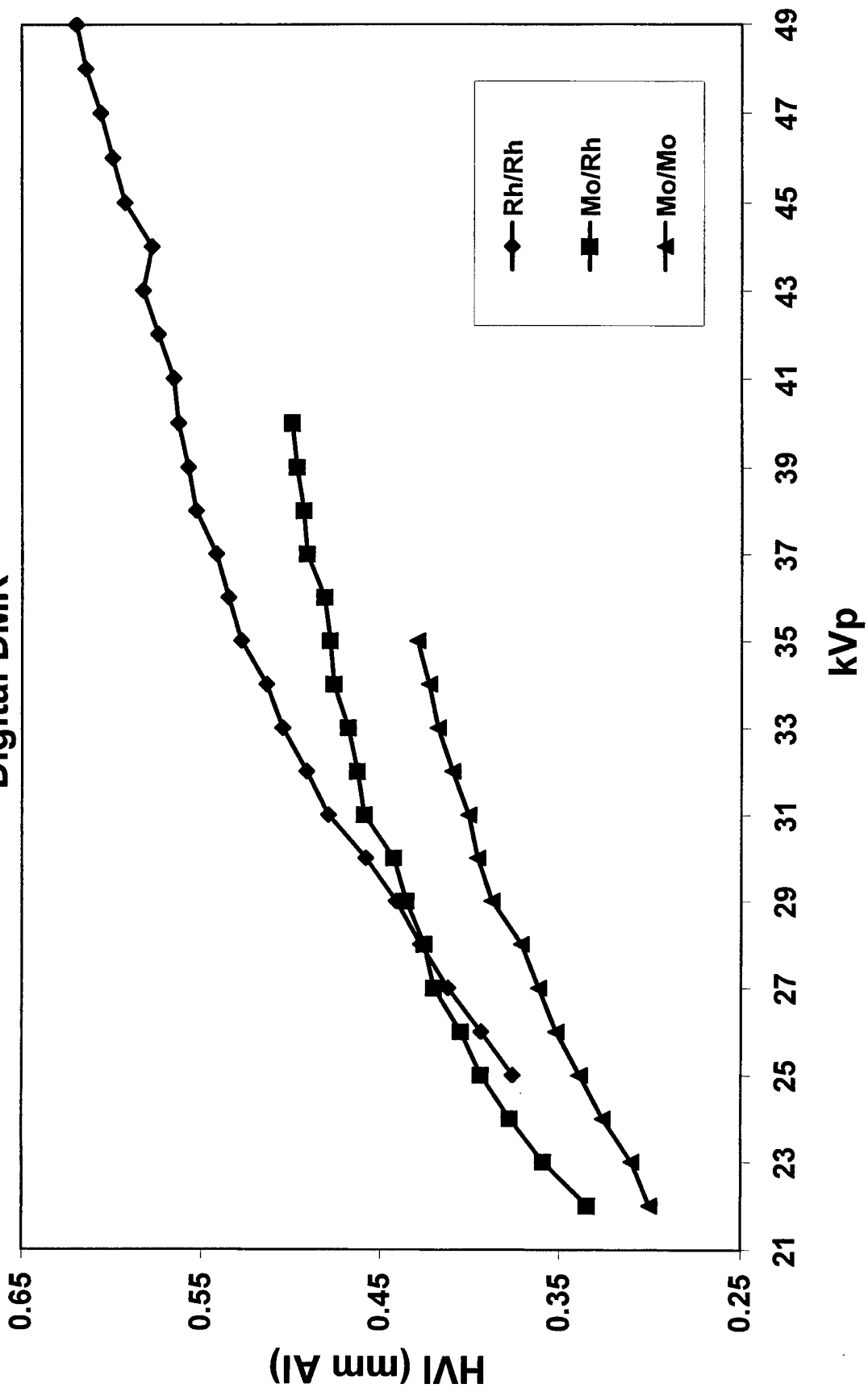
Exposure vs. kVp
Conventional Film-Screen DMR
@ 100 mAs



Exposure vs. kVp
Digital
@ 100 mAs

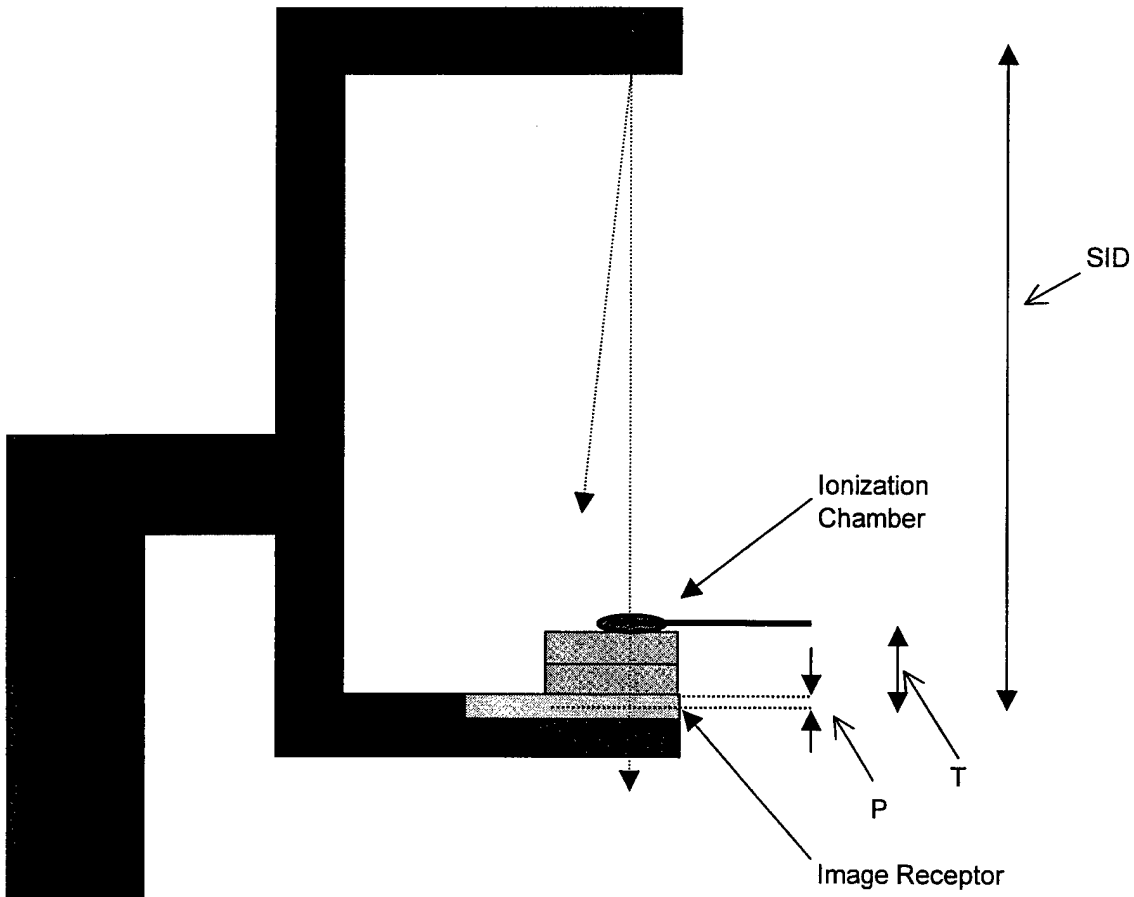


HVL vs. kVp Digital DMR



Appendix C

Mammography Unit Dose Measurement Setup



SID: Source to image receptor distance.

P: Distance between image receptor and breast support plate.

T: Thickness between breast support plate and center of ionization chamber.

Average Glandular Dose Calculation Program

Compressed Breast Thickness (mm)	42
Target/Filter (Mo/Mo, Mo/Rh, Rh/Rh)	Mo/Mo
kVp	26
Composition (100F, 50/50, 100G)	50/50
mAs	100
HVL (mm Al)	0.35
SSD (mm)	660
P(mm) = Distance from IR to Support Plate	16.85
Density Setting	0

D_{gN} (mrad/R)	175.5
Distance from support plate that entrance X measurements were made at (mm):	45
Entrance X at 45 mm from support plate	1000
mAs at 45 mm from support plate	100
mR/mAs at 45 mm from support plate	10.00
ESE - Entrance X (mR) at 42 mm from support plate at 100 mAs	990.04
AGD (mrad) = D_{gN} * ESE	173.74

DgN Calculation

Mo/Mo Mo/Mo Mo/Mo Mo/Rh Mo/Rh Mo/Rh Rh/Rh Rh/Rh Rh/Rh
 100% Fat 50/50 00% Gland. 100% Fat 50/50 00% Gland. 100% Fat 50/50 100% Gland.

Thickness (cm)	4.2
T/F (Mo/Mo, Mo/Rh, Rh/Rh)	Mo/Mo
kVp	26
Comp. (100F, 50/50, 100G)	50/50
HVL (mm Al)	0.35
D_{gN} (mrad/R)	175.5

	Mo/Mo 100% Fat	Mo/Mo 50/50	Mo/Mo 00% Gland.	Mo/Rh 100% Fat	Mo/Rh 50/50	Mo/Rh 00% Gland.	Rh/Rh 100% Fat	Rh/Rh 50/50	Rh/Rh 100% Gland.
a	10.43	7.40	5.56	13.61	9.63	7.22	9.54	6.12	4.22
b	5.36	5.15	4.88	5.60	5.44	5.23	5.73	5.63	5.43
c	0.53	0.59	0.62	0.52	0.59	0.64	0.57	0.68	0.76
u	147.43	140.27	122.87	119.29	130.02	118.76	94.41	129.64	124.24
v	6.99	7.02	7.02	6.86	6.89	6.91	6.86	6.87	6.90
w	0.24	0.31	0.37	0.20	0.28	0.34	0.17	0.25	0.31

D_{gN}	224.1	175.5	140.4	229.0	180.5	145.4	233.5	185.4	150.9
-----------------------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Concatenated T/F & Composition:	Mo/Mo	Mo/Rh	Rh/Rh
Mo/Mo50/50	175.5	xxx	xxx

Appendix D

Multiple Technique Dose Matching Program

3/25/2001

Patient: _____

Patient ID: _____

Date: _____

Film-Screen - Initial Technique

Comp. Breast Thickness (mm)	42
Target/Filter	Mo/Mo
kVp	26
Composition (100F, 50/50, 100G)	50/50
mAs	78
HVL (mm Al)	0.354
SSD (mm)	660
P(mm) = Dist. from IR to Support Plate	16.85
Density Setting	
D_{gN} (mrad/R)	177.2
Dist. from support plate to ion chamber (mm):	45
Ent. X at 45 mm from support plate	N/A
mAs at 45 mm from support plate	100
mR/mAs at 45 mm from support plate	9.58
Ent. X (mR) at 42 mm from support plate at 78 mAs	739.80
AGD (mrad) = $D_{gN} \cdot ESE$	131.13

	Mo/Mo	Mo/Rh	Rh/Rh
kVp	mAs	mAs	mAs
22	178.2	203.5	
23	144.7	157.3	
24	116.8	125.5	
25	96.9	102.9	100.8
26	81.5	86.6	84.6
27	69.9	73.5	71.3
28	60.7	64.2	60.9
29	52.3	56.1	52.7
30	46.4	49.8	45.7
31	41.7	43.7	39.7
32	37.4	39.6	35.4
33	33.7	36.0	31.8
34	30.7	32.7	28.9
35	28.0	30.2	26.4
36		27.9	24.5
37		25.5	22.8
38		23.8	21.2
39		22.0	20.0
40		20.5	18.7
41			17.6
42			16.4
43			15.2
44			14.3
45			13.1
46			12.1
47			11.1
48			10.2
49			9.4

Digital - Matched Technique

Comp. Breast Thickness (mm)	42
Target/Filter	Mo/Mo
kVp	26
Composition (100F, 50/50, 100G)	50/50
mAs	81.5
HVL (mm Al)	0.3522
SSD (mm)	660
P(mm) = Dist. from IR to Support Plate	16.85
Density Setting	N/A
D_{gN} (mrad/R)	176.5
Dist. from support plate to ion chamber (mm):	45
Ent. X at 45 mm from support plate	N/A
mAs at 45 mm from support plate	100
mR/mAs at 45 mm from support plate	9.12
Ent. X (mR) at 42 mm from support plate at 81.4820056137612 mAs	735.72
AGD (mrad) = $D_{gN} \cdot ESE$	131.13

Appendix E

Mammography Technique and Dose Matching Program

Patient: 2 cm
 Patient ID#: 5010013
 Date: 1/29/1999

DMR - Initial Technique

Thickness (cm)	2
T/F (Mo/Mo, Mo/Rh, Rh/Rh)	Mo/Mo
kVp	25
Comp.(100F, 50/50, 100G)	50/50
Entrance X (mR)	124.5
HVL (mm Al)	0.3429
Average Glandular Dose (mrad)	38.88
Density Setting	0
mAs	16
mR/mAs	7.78
mA	100
Exposure Time (sec.)	0.16
D _{gN} (mrad/R)	312.3

DIGITAL - Matched Technique

Thickness (cm)	2
T/F (Mo/Mo, Mo/Rh, Rh/Rh)	Mo/Mo
kVp	25
Comp.(100F, 50/50, 100G)	50/50
Entrance X (mR)	125.5
HVL (mm Al)	0.3397
Average Glandular Dose (mrad)	38.88
Density Setting	0
mAs	17.0
mR/mAs	7.38
mA	100
Exposure Time (sec.)	0.17
D _{gN} (mrad/R)	309.9

Digital DMR Matched Techniques

	Mo/Mo	Mo/Rh	Rh/Rh
kVp	mAs	mAs	mAs
22	30.3	35.7	
23	24.8	28.0	
24	20.3	22.5	
25	17.0	18.6	18.3
26	14.4	15.8	15.6
27	12.5	13.5	13.3
28	10.9	11.8	11.5
29	9.4	10.3	10.1
30	8.4	9.2	8.9
31	7.6	8.1	7.8
32	6.8	7.3	7.0
33	6.2	6.7	6.3
34	5.7	6.1	5.8
35	5.2	5.6	5.3
36		5.2	4.9
37		4.8	4.5
38		4.5	4.2
39		4.2	3.9
40		3.9	3.6
41			3.4
42			3.2
43			2.9
44			2.7
45			2.5
46			2.3
47			2.1
48			1.9
49			1.7

Mammography Technique and Dose Matching Program

Patient: 4 cm

Patient ID#: 5010014

Date: 1/29/1999

DMR - Initial Technique

Thickness (cm)	4
T/F (Mo/Mo, Mo/Rh, Rh/Rh)	Mo/Mo
kVp	25
Comp.(100F, 50/50, 100G)	50/50
Entrance X (mR)	705.0
HVL (mm Al)	0.3429
Average Glandular Dose (mrad)	126.37
Density Setting	0
mAs	85
mR/mAs	8.29
mA	100
Exposure Time (sec.)	0.85
D _{gN} (mrad/R)	179.3

DIGITAL - Matched Technique

Thickness (cm)	4
T/F (Mo/Mo, Mo/Rh, Rh/Rh)	Mo/Mo
kVp	25
Comp.(100F, 50/50, 100G)	50/50
Entrance X (mR)	710.9
HVL (mm Al)	0.3397
Average Glandular Dose (mrad)	126.37
Density Setting	0
mAs	90.4
mR/mAs	7.86
mA	100
Exposure Time (sec.)	0.90
D _{gN} (mrad/R)	177.8

Digital DMR Matched Techniques

	Mo/Mo	Mo/Rh	Rh/Rh
kVp	mAs	mAs	mAs
22	166.2	189.9	
23	134.9	146.9	
24	108.9	117.3	
25	90.4	96.3	94.5
26	76.1	81.0	79.3
27	65.3	68.9	66.9
28	56.7	60.1	57.2
29	48.9	52.5	49.5
30	43.4	46.7	43.0
31	39.0	41.0	37.4
32	35.0	37.2	33.3
33	31.6	33.8	29.9
34	28.8	30.7	27.3
35	26.3	28.3	24.8
36		26.2	23.0
37		24.0	21.5
38		22.4	20.0
39		20.8	18.8
40		19.4	17.6
41			16.6
42			15.4
43			14.3
44			13.5
45			12.3
46			11.4
47			10.5
48			9.6
49			8.8

Mammography Technique and Dose Matching Program

Patient: 6 cm

Patient ID#: ; & 5010016

Date: 1/29/1999

DMR - Initial Technique

Thickness (cm)	6
T/F (Mo/Mo, Mo/Rh, Rh/Rh)	Mo/Rh
kVp	27
Comp.(100F, 50/50, 100G)	50/50
Entrance X (mR)	1576.2
HVL (mm Al)	0.4213
Average Glandular Dose (mrad)	234.97
Density Setting	0
mAs	168
mR/mAs	9.38
mA	100
Exposure Time (sec.)	1.68
D _{gN} (mrad/R)	149.1

DIGITAL - Matched Technique

Thickness (cm)	6
T/F (Mo/Mo, Mo/Rh, Rh/Rh)	Mo/Rh
kVp	27
Comp.(100F, 50/50, 100G)	50/50
Entrance X (mR)	1580.5
HVL (mm Al)	0.42
Average Glandular Dose (mrad)	234.97
Density Setting	0
mAs	178.5
mR/mAs	8.86
mA	100
Exposure Time (sec.)	1.78
D _{gN} (mrad/R)	148.7

Digital DMR Matched Techniques

kVp	Mo/Mo mAs	Mo/Rh mAs	Rh/Rh mAs
22	444.7	508.7	
23	360.8	389.5	
24	290.6	308.7	
25	240.6	251.6	243.4
26	201.8	210.9	202.9
27	172.7	178.5	170.2
28	149.4	155.5	144.9
29	128.4	135.5	124.8
30	113.6	120.1	107.9
31	101.7	105.2	93.4
32	90.9	95.1	83.0
33	81.9	86.3	74.3
34	74.4	78.0	67.6
35	67.7	71.7	61.5
36		65.9	56.9
37		59.9	53.0
38		55.2	49.1
39		50.7	46.2
40		46.7	43.2
41			40.6
42			37.8
43			35.1
44			33.2
45			30.5
46			28.5
47			26.3
48			24.4
49			22.7

Mammography Technique and Dose Matching Program

Patient: 8 cm
 Patient ID#: 5010018
 Date: 1/29/1999

DMR - Initial Technique

Thickness (cm)	8
T/F (Mo/Mo, Mo/Rh, Rh/Rh)	Rh/Rh
kVp	28
Comp.(100F, 50/50, 100G)	50/50
Entrance X (mR)	3140.5
HVL (mm Al)	0.4315
Average Glandular Dose (mrad)	384.77
Density Setting	0
mAs	283
mR/mAs	11.10
mA	75
Exposure Time (sec.)	3.77
D _{gN} (mrad/R)	122.5

Digital DMR Matched Techniques

	Mo/Mo	Mo/Rh	Rh/Rh
kVp	mAs	mAs	mAs
22	920.9	1062.0	
23	745.5	807.5	
24	599.9	636.9	
25	496.5	517.5	500.3
26	416.1	432.8	414.9
27	355.7	365.9	347.0
28	307.3	318.7	294.9
29	263.8	277.8	253.8
30	233.0	246.3	219.1
31	208.4	215.8	189.6
32	186.0	195.1	168.3
33	167.3	177.0	150.4
34	151.9	159.8	136.4
35	138.1	146.6	123.7
36		134.5	114.1
37		121.6	105.8
38		111.6	97.8
39		101.6	91.5
40		92.7	85.3
41			79.9
42			74.3
43			69.0
44			65.3
45			60.1
46			56.2
47			52.1
48			48.4
49			45.1

DIGITAL - Matched Technique

Thickness (cm)	8
T/F (Mo/Mo, Mo/Rh, Rh/Rh)	Rh/Rh
kVp	28
Comp.(100F, 50/50, 100G)	50/50
Entrance X (mR)	3166.8
HVL (mm Al)	0.4274
Average Glandular Dose (mrad)	384.77
Density Setting	0
mAs	294.9
mR/mAs	10.74
mA	75
Exposure Time (sec.)	3.93
D _{gN} (mrad/R)	121.5

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Appendix F

Contrast Detail Results

2 cm

Thickness:

Date: 3/3/1999

Patient ID:

5010013

F/S Techniques:

T/F: Mo/Mo

kVp: 25

mAs: 16

hvl: 0.3429

AGD: 38.9 mrad

Film/Screen CD Scores										
Jane	Ed	Eric	Brian	Lori	Julio	Min	Max	Mean	Std. Dev.	Count
13.610	13.609	14.806	12.754	13.606	14.100	12.75	14.81	13.75	0.68	6

Image #	HVL	kVp	mAs	Target/Filter	Mean Signal	St. Dev.	SNR	FFDM CD Scores						Std.				
								Jane	Ed	Eric	Brian	Lori	Julio	Min	Max	Mean	Dev.	Count
A47	0.3105	23	25	MoMo	756.42	10.92	69.27	14.038	13.748	14.176	12.320	13.318	13.105	12.32	14.18	13.45	0.69	6
A13	0.3522	26	14	MoMo	812.93	12.33	65.93	13.468	13.750	14.356	12.895	12.895	12.895	12.90	14.36	13.38	0.60	6
A70	0.3958	30	8	MoMo	864.01	15.14	57.07	13.043	13.043	13.749	12.470	12.898	13.321	12.47	13.75	13.09	0.43	6
A31	0.4229	34	5	MoMo	990.59	14.37	68.93	12.329	13.039	12.755	11.620	11.751	11.391	11.39	13.04	12.15	0.66	6
A71	0.359	23	28	MoRh	882.07	11.77	74.94	13.675	14.038	14.671	12.966	13.243	13.351	12.97	14.67	13.66	0.62	6
A20	0.405	26	16	MoRh	1005.51	13.71	73.34	12.904	11.411	13.609	11.466	13.039	13.464	11.41	13.61	12.65	0.97	6
A11	0.4427	30	9	MoRh	1024.53	16.01	63.99	12.474	12.760	13.325	11.188	11.749	12.049	11.19	13.33	12.26	0.76	6
A30	0.4784	35	5	MoRh	1109.76	14.8	74.98	12.755	13.320	12.755	12.041	13.039	12.470	12.04	13.32	12.73	0.44	6
A1	0.4997	40	4	MoRh	1253.19	15.91	78.77	12.045	12.755	12.614	10.124	12.896	11.680	10.12	12.90	12.02	1.04	6
A3	0.3761	25	18	RhRh	1047.23	13.73	76.27	13.895	13.820	13.963	12.541	13.963	14.069	12.54	14.07	13.71	0.58	6
A69	0.4413	29	10	RhRh	1259.22	17.95	70.15	13.324	13.040	13.183	11.188	12.753	12.895	11.19	13.32	12.73	0.78	6
A54	0.5049	33	6	RhRh	1367.24	19.14	71.43	12.194	11.469	13.114	11.046	12.331	11.751	11.05	13.11	11.98	0.73	6
A44	0.5423	37	4	RhRh	1517.03	18.03	84.14	13.039	12.614	13.181	9.845	12.259	11.894	9.85	13.18	12.14	1.22	6
				Min:	756.42	10.92	57.07	12.05	11.41	12.61	9.85	11.75	11.39					
				Max:	1517.03	19.14	84.14	14.04	14.04	14.67	12.97	13.96	14.07					
				mean:	1068.44	14.91	71.48	13.01	12.99	13.50	11.67	12.78	12.64					
				Std. Dev:	226.26	2.50	6.90	0.65	0.82	0.65	0.99	0.62	0.83					
				Count:	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00					

Contrast Detail Results

4 cm

Thickness:

Date: 3/3/1999

Patient ID:

5010014

F/S Techniques:

T/F: Mo/Mo
 kVp: 25
 mAs: 85
 hvl: 0.3429
 AGD: 126.38 mrad

Film/Screen/CD Scores						
Jane	Ed	Eric	Brian	Lori	Julio	Count
13.541	12.906	13.261	11.976	12.189	13.114	6
Min	Max	Mean	Std. Dev.	Count		
11.98	13.54	12.83	0.62	6		

Image #	HVL	kVp	mAs	Target/Filter	Mean Signal	St. Dev.	SNR	CD Scores					Min	Max	Mean	Std. Dev.	Count		
								Jane	Ed	Eric	Brian	Lori						Julio	
A9	0.6199	49	9	RhRh	3404.44	30.15	112.92	12.330	11.471	13.188	11.399	12.899	12.189	11.40	13.19	12.25	0.73	6	
A29	0.583	43	14	RhRh	3132.47	29.16	107.42	13.393	13.963	13.391	11.678	13.391	13.783	11.68	13.96	13.27	0.82	6	
A62	0.5535	38	20	RhRh	2646.92	26.1	101.41	13.825	14.383	14.381	12.611	13.958	13.675	12.61	14.38	13.81	0.65	6	
A28	0.5139	34	28	RhRh	2314.41	25.23	91.73	13.824	13.614	14.389	12.616	14.210	13.786	12.62	14.39	13.74	0.62	6	
A61	0.4413	29	50	RhRh	1968.16	21.47	91.67	14.499	14.389	14.813	13.044	14.775	14.638	13.04	14.81	14.36	0.66	6	
A59	0.3938	26	80	RhRh	1696.35	19.24	88.17	15.238	14.106	14.249	12.333	13.120	14.958	12.33	15.24	14.00	1.10	6	
A21	0.4971	39	20	MoRh	1868.27	20.12	92.86	13.470	13.329	13.891	11.333	13.459	13.748	11.33	13.89	13.21	0.94	6	
A32	0.4784	35	28	MoRh	1663.31	18.4	90.40	13.966	15.096	15.236	13.039	14.389	14.529	13.04	15.24	14.38	0.80	6	
A68	0.4427	30	45	MoRh	1441.18	16.8	85.78	14.393	14.668	14.950	12.480	12.325	12.753	12.33	14.95	13.59	1.20	6	
A52	0.405	26	80	MoRh	1328.93	15.85	83.84	13.968	13.755	14.669	12.326	13.401	13.969	12.33	14.67	13.68	0.78	6	
A53	0.359	23	140	MoRh	1083.65	14.07	77.02	14.220	14.318	15.195	12.406	14.311	14.171	12.41	15.20	14.10	0.91	6	
A8	0.4229	34	28	MoMo	1395.41	16.78	83.16	14.251	13.893	14.315	12.613	12.760	10.900	10.90	14.32	13.12	1.31	6	
A10	0.4007	31	40	MoMo	1316.77	15.93	82.66	13.828	13.830	14.671	12.120	13.961	13.036	12.12	14.67	13.57	0.88	6	
A42	0.3712	28	56	MoMo	1129.75	15.03	75.17	13.954	14.530	14.523	12.899	13.671	14.385	12.90	14.53	13.99	0.64	6	
A23	0.3005	22	160	MoMo	772.32	11.85	65.17	14.174	13.963	14.171	12.259	13.610	13.608	12.26	14.17	13.63	0.72	6	
A22	0.3268	24	110	MoMo	950.21	13.17	72.15	14.173	14.731	14.943	12.471	14.589	14.309	12.47	14.94	14.20	0.89	6	
				Min:	772.32	11.85	65.17	12.33	11.47	13.19	11.33	12.33	10.90						
				Max:	3404.44	30.15	112.92	15.24	15.10	15.24	13.04	14.78	14.96						
				mean:	1757.03	19.33	87.60	13.97	14.00	14.44	12.35	13.68	13.65						
				Std. Dev:	768.24	5.64	12.55	0.61	0.82	0.58	0.51	0.69	1.02						
				Count:	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00						

Contrast Detail Results

6 cm

Thickness:

Date: 06/16/99

Patient ID:

5010015 & 5010016

F/S Techniques:

T/F: Mo/Rh
 kVp: 27
 mAs: 168
 hvl: 0.4213
 AGD: 234.97 mrad

Film/Screen/CD Scores						
Jan	Ed	Eric	Brian	Lori	Julio	
11.045	11.696	11.765	10.626	10.903	11.620	
Min	Max	Mean	Std. Dev.	Count		
10.63	11.77	11.28	0.48	6		

Image #	HVL	kVp	mAs	Target/Filter	Mean Signal	St. Dev.	SNR	CD Scores						Min	Max	Mean	Std. Dev.	Count	
								Jan	Ed	Eric	Brian	Lori	Julio						
A64	0.6199	49	22.5	RhRh	3973.69	33.91	117.18	12.824	13.824	12.824	12.116	13.114	12.824	12.12	13.82	12.92	0.55	6	
A49	0.6	46	28	RhRh	3696.65	31.11	118.83	13.255	13.248	13.108	12.470	12.750	13.108	12.47	13.26	12.99	0.31	6	
A24	0.5782	44	32	RhRh	3417.07	30.08	113.60	13.614	13.189	12.754	11.328	13.176	13.179	11.33	13.61	12.87	0.80	6	
A26	0.5659	41	40	RhRh	3019.11	28.83	104.72	12.894	13.039	13.390	12.400	12.613	12.895	12.40	13.39	12.87	0.34	6	
A72	0.5535	38	56	RhRh	2571.07	25.67	100.16	12.965	13.614	13.108	12.188	12.188	12.825	12.19	13.61	12.81	0.55	6	
A14	0.5281	35	63	RhRh	2158.91	24.06	89.73	13.683	13.968	13.398	11.909	12.903	13.506	11.91	13.97	13.23	0.74	6	
A56	0.4916	32	80	RhRh	1764.92	21.29	82.90	13.041	13.331	13.181	11.344	13.039	13.181	11.34	13.33	12.85	0.75	6	
A51	0.4585	30	110	RhRh	1742.91	21.26	81.98	13.185	13.755	13.326	12.683	13.185	13.750	12.68	13.76	13.31	0.40	6	
A46	0.4274	28	140	RhRh	1506.68	19.38	77.74	12.753	13.331	12.470	11.764	13.331	13.185	11.76	13.33	12.81	0.62	6	
A16	0.3939	26	200	RhRh	1347.95	18.05	74.68	13.044	14.171	13.181	12.609	13.181	13.173	12.61	14.17	13.23	0.51	6	
A19	0.4997	40	45	MoRh	1895.64	20.55	92.25	12.031	12.898	12.613	11.900	12.048	12.754	11.90	12.90	12.37	0.43	6	
A63	0.4849	36	63	MoRh	1515.25	18.99	79.79	12.189	12.620	12.616	11.768	13.464	13.604	11.77	13.60	12.71	0.71	6	
A76	0.4764	34	80	MoRh	1449.31	18.69	77.54	11.894	13.826	12.474	12.189	12.616	12.966	11.89	13.83	12.66	0.68	6	
A73	0.4427	30	125	MoRh	1261.74	17.84	70.73	12.338	13.476	12.330	11.340	13.318	13.176	11.34	13.48	12.66	0.81	6	
A45	0.42	27	180	MoRh	1081.66	16.44	65.79	12.466	13.039	12.821	11.906	12.899	13.111	11.91	13.11	12.71	0.45	6	
A15	0.3938	25	250	MoRh	986.23	17.52	56.29	12.188	12.620	12.471	11.764	12.611	13.033	11.76	13.03	12.45	0.43	6	
A33	0.3352	22	500	MoRh	682.53	12.83	53.20	12.189	13.111	11.754	11.619	12.544	12.826	11.62	13.11	12.34	0.59	6	
A78	0.4294	35	63	MoMo	1261.37	17.08	73.85	11.905	13.119	11.908	11.200	11.478	11.623	11.20	13.12	11.87	0.67	6	
A79	0.4178	33	80	MoMo	1161.2	17.48	66.43	11.913	12.759	11.896	9.994	12.036	12.036	9.99	12.76	11.77	0.93	6	
A39	0.4007	31	100	MoMo	1028.79	15.08	68.22	12.188	12.194	12.191	11.621	12.624	12.475	11.62	12.62	12.22	0.34	6	
A2	0.3877	29	125	MoMo	880.73	15.36	57.34	11.325	13.184	12.611	11.335	12.321	12.466	11.33	13.18	12.21	0.74	6	
A60	0.3522	26	200	MoMo	726.16	13.79	52.66	12.050	13.043	12.114	12.256	12.893	12.614	12.05	13.04	12.50	0.42	6	
A36	0.3268	24	280	MoMo	604.2	12.23	49.40	12.193	12.761	12.046	10.919	12.754	12.966	10.92	12.97	12.27	0.75	6	
A38	0.3005	22	450	MoMo	519.4	12.36	42.02	11.488	12.340	12.194	10.415	11.625	12.478	10.42	12.48	11.76	0.77	6	
Min:					519.40	12.23	42.02	11.33	12.19	11.75	9.99	11.48	11.62						
Max:					3973.69	33.91	118.83	13.68	14.17	13.40	12.68	13.46	13.75						
mean:					1677.22	20.00	77.79	12.48	13.19	12.62	11.71	12.70	12.91						
Std. Dev:					986.22	6.07	21.65	0.63	0.51	0.50	0.66	0.53	0.47						
Count:					24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00					

Contrast Detail Results

8 cm

Thickness:

Date: 10/08/99

Patient ID:

5010018

F/S Techniques:

T/F: Rh/Rh
 kVp: 28
 mAs: 283
 hvl: 0.4315
 AGD: 384.77 mrad

Film/Screen/CD Scores						
Jane	Ed	Eric	Brian	Lori	Julio	Count
8.859	10.206	10.704	8.859	8.294	9.986	6
Min	Max	Mean	Std. Dev.	Count		
8.29	10.70	9.48	0.94	6		

Image #	HVL	kVp	mAs	Target/Filter	Mean Signal	St. Dev.	SNR	CD Scores					Min	Max	Mean	Std. Dev.	Count	
								Jane	Ed	Eric	Brian	Lori						Julio
A7	0.6199	49	45	RhRh	4048.43	33.22	121.87	11.623	12.759	13.044	10.833	12.754	12.329	10.83	13.04	12.22	0.84	6
A4	0.6	46	56	RhRh	3616.57	30.3	119.36	12.626	13.191	12.906	12.556	12.616	13.183	12.56	13.19	12.85	0.29	6
A65	0.583	43	71	RhRh	3152.01	28.15	111.97	12.051	12.623	13.330	11.619	12.609	13.181	11.62	13.33	12.57	0.65	6
A57	0.5578	39	90	RhRh	2259.47	22.88	98.75	11.770	13.119	12.684	11.629	12.616	12.971	11.63	13.12	12.46	0.62	6
A40	0.3532	36	110	RhRh	1737.29	20.49	84.79	10.913	13.326	12.549	10.913	12.899	12.690	10.91	13.33	12.22	1.04	6
A37	0.5139	34	140	RhRh	1605.5	19.86	80.84	11.184	13.609	12.906	10.338	12.606	12.469	10.34	13.61	12.19	1.20	6
A12	0.4413	29	250	RhRh	1168.95	17.08	68.44	11.346	11.914	11.770	11.063	12.400	12.188	11.06	12.40	11.78	0.50	6
A6	0.3761	25	500	RhRh	849.42	14.77	57.51	10.625	12.408	11.908	10.779	12.118	11.480	10.63	12.41	11.55	0.73	6
A17	0.4997	40	90	MoRh	1684.08	20.04	84.04	9.853	10.928	9.788	9.706	10.408	11.133	9.71	11.13	10.30	0.62	6
A58	0.4914	37	125	MoRh	1416.49	18.22	77.74	10.625	12.475	11.341	11.059	12.400	12.613	10.63	12.61	11.75	0.85	6
A55	0.4764	34	160	MoRh	1087.74	15.76	69.02	8.515	10.976	10.126	9.428	9.628	10.265	8.52	10.98	9.82	0.84	6
A35	0.4632	32	200	MoRh	973.72	15.18	64.14	10.061	11.486	10.776	8.438	11.344	11.626	8.44	11.63	10.62	1.22	6
A25	0.4355	29	288	MoRh	800.97	13.81	58.00	9.710	11.848	11.703	9.573	11.260	11.130	9.57	11.85	10.87	0.99	6
A48	0.42	27	360	MoRh	690.99	13.82	50.00	8.385	11.779	11.544	8.103	12.760	12.336	8.10	12.76	10.82	2.04	6
A80	0.3775	24	600	MoRh	544.99	12.1	45.04	8.935	10.428	11.500	9.993	11.685	10.573	8.94	11.69	10.52	1.01	6
A74	0.4294	35	140	MoMo	1118.86	16.28	68.73	9.075	11.568	9.781	9.144	9.926	10.641	9.08	11.57	10.02	0.95	6
A67	0.4178	33	160	MoMo	864.53	14.24	60.71	8.378	10.708	9.790	9.845	10.495	8.865	8.38	10.71	9.68	0.91	6
A27	0.3958	30	225	MoMo	650.67	12.77	50.95	7.813	10.223	9.433	7.385	8.513	9.433	7.39	10.22	8.80	1.08	6
A50	0.3617	27	360	MoMo	498.63	11.88	41.97	7.243	10.290	9.436	8.585	9.286	10.641	7.24	10.64	9.25	1.23	6
A5	0.3268	24	600	MoMo	346.72	8.78	39.49	6.410	10.223	9.015	6.410	8.935	8.660	6.41	10.22	8.28	1.54	6
Min:					346.72	8.78	39.49	6.41	10.22	9.02	6.41	8.51	8.66					
Max:					4048.43	33.22	121.87	12.63	13.61	13.33	12.56	12.90	13.18					
mean:					1455.80	17.98	72.67	9.86	11.79	11.27	9.87	11.36	11.42					
Std. Dev:					1051.01	6.43	24.81	1.72	1.12	1.40	1.54	1.46	1.39					
Count:					20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00					