Phantoms for X-ray breast imaging

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Campinas, Brazil

Three dimensional breast cancer models for X-ray Imaging research

HORIZON 2020
European Union funding
for Research & Innovation

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Our Institution

Credits: Lucas Rodolfo de Castro Moura - http://www.lrdronecampinas.com.br/

Funded in 1966

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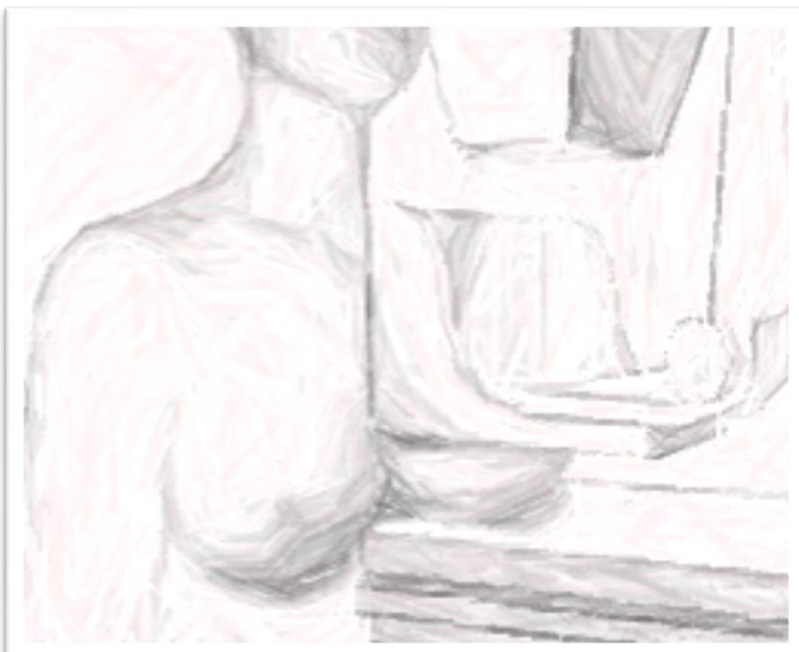
Outline

Phantoms for x-ray breast imaging

- Introduction
- Tissue-equivalente materials
- Physical phantoms
- Computational phantoms

MOTIVATION: Screening x Breast imaging



Adam ®

- Mammography is the most used technique for early detection
- Sensitivity
  - Fatty breasts: 81% to 93%
  - Dense breast: 57% to 71%
- Supplementary methods for breast screening
  - MRI
  - Ultrassond
- New x-ray breast imaging aiming to improve the detection sensivity and specifity

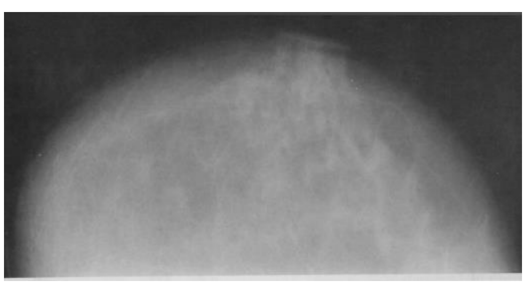
Historical advances of breast x-ray imaging

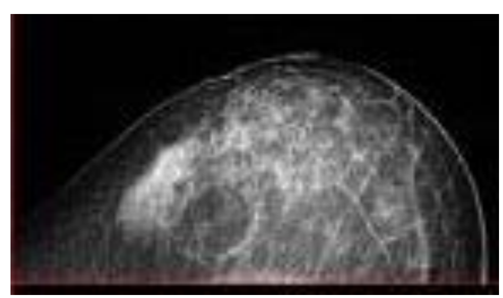
1950

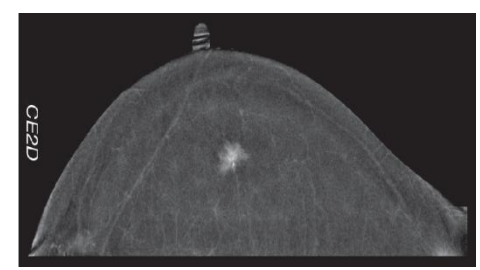
~60 years

2010
Lorad, Hologic/MicroDose,Sectra

Contrast enhanced Digital Mammography (CEDM)







Courtesy of K.H.Ng

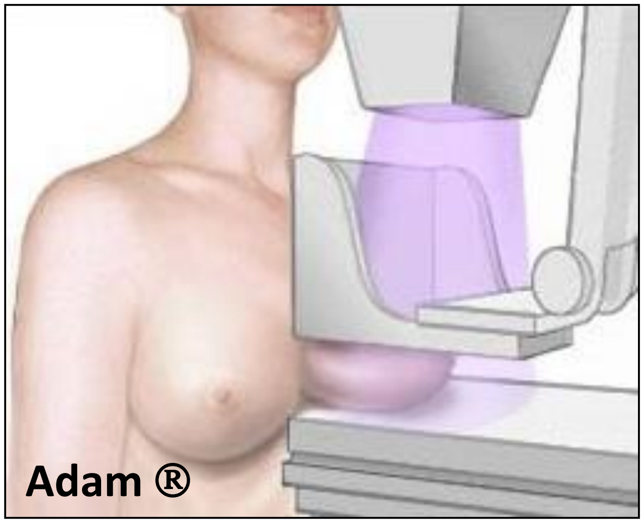
Courtesy of Hologic

Historical advances of breast x-ray imaging

2011
Digital Breast Tomosynthesis

Koning Corporation
2014
Breast CT

Why is necessary optimize and develop breast imaging techniques?



ABSORBED DOSE X IMAGE QUALITY

Optimization : Achieve images with the highest image quality with the lower dose deposited in the breast.


COUNTERTHINK
WHICH BUTTON DO I PUSH?
USUALLY WE JUST PUNCH 'EM BOTH.
DETECT CANCER
CAUSE CANCER
MAMMOGRAM 5000 CONTROL PANEL
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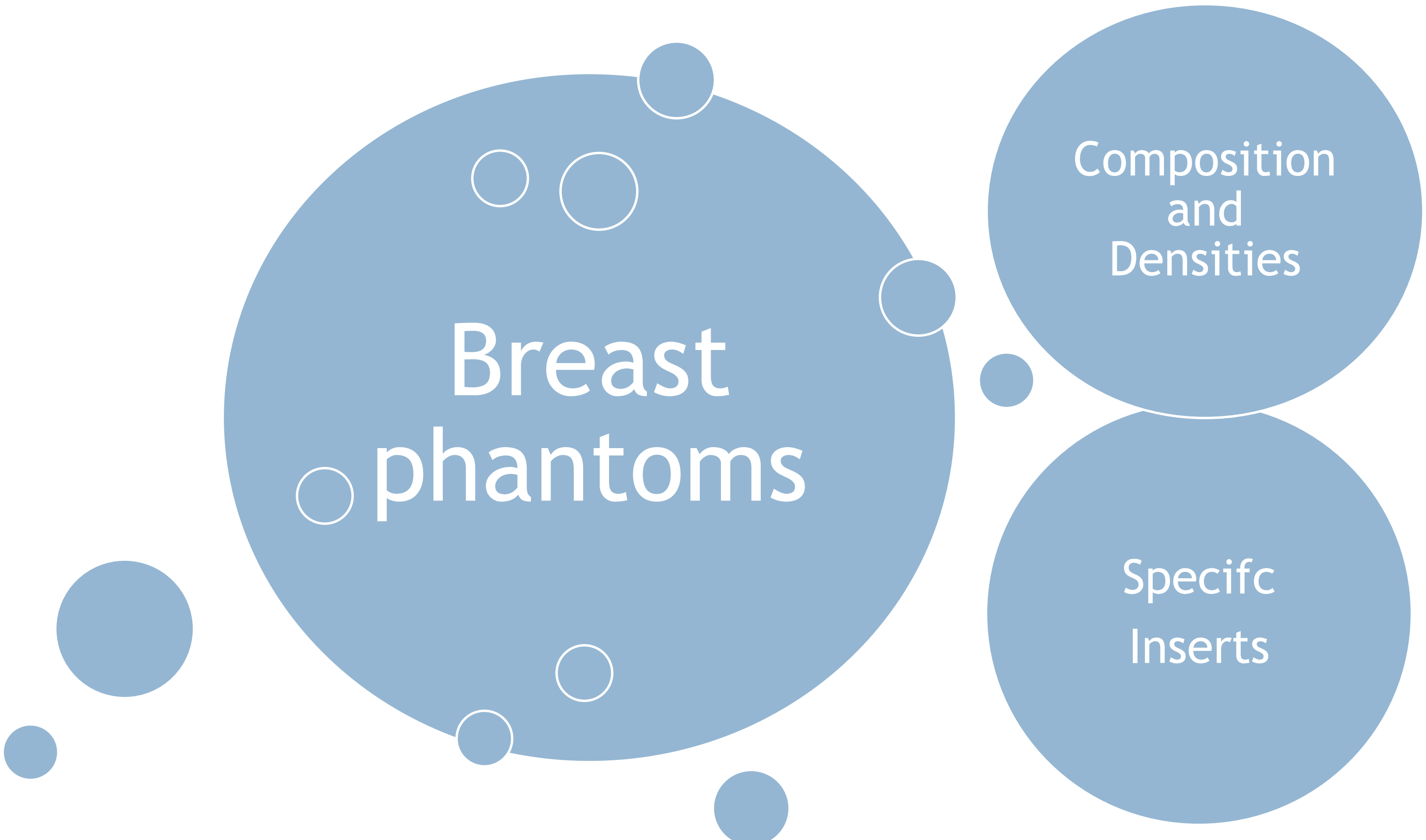
CONCEPT-MIKE ADAMS ART-DAN BERGER WWW.NATURALNEWS.COM

Motivation

How evaluate the image quality and dose in the breast?

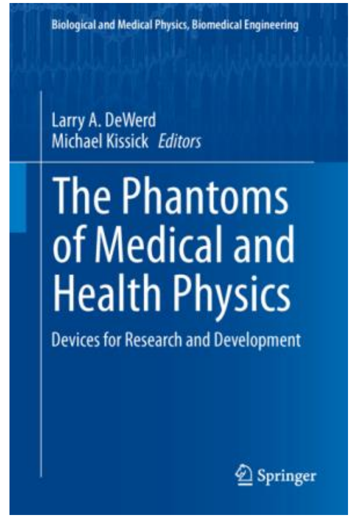
How new imaging techniques can be tested?



Book chapter: The Phantoms of Medical and Health Physics

Editors

Larry A. DeWerd and Michael Kissick



Book Chapter

Mammography Phantoms

Alessandra Tomal

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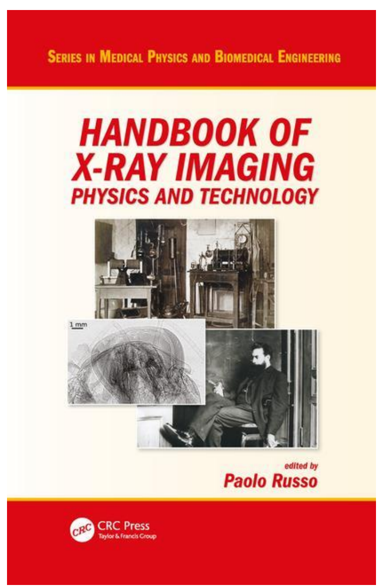
Editor

Paolo Russo



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Phantoms for Image Quality and Dose Assessment

Alessandra Tomal and Paulo Roberto Costa

CONTENTS

Motivation

Why is breast phantoms are important for breast imaging?

- Simulate the complex structure of the breast
- Quality Control and quality assurance
- Optmization of dose and image quality
- Detectability of masses and diferent structures
- Development and comparison of different imaging modalities

Motivation

Why is breast phantoms are important for breast imaging?

How breast phantoms can be classified?

- Mammography
- New imaging modalites

- Physical
- Computational

- Homogeneous
- Antropomorphic
- For image quality

Outline

Phantoms for x-ray breast imaging

- Introduction
- Tissue-equivalente materials
- Physical phantoms
- Computational phantoms

Characteristics of breast phantoms : Tissue-equivalente materials

Mammography, DBT, CEDM, CT

Tissue-equivalent materials (ICRU 44)

Ideally

The same attenuatting and scattering propertis as the tissue

X-ray imaging QA and QC

Linear attenuation coefficients within ±5%

Attenuation substantially different from those of body tissues

If strict simulation is unnecessary

Characteristics of breast phantoms : Tissue-equivalente materials

- Mass Density and Electron Density
- Effective Atomic Number
- Linear Attenuation Coefficient
- Refractive Index Decrement
- Other x-ray properties
- Moldable

Breast tissue-equivalent materials

- Commercial Plastic (e. g. PMMA, Teflon Polyethlene)
- Epoxy resin (e...
- ...ew plastics and Printing materials

SEVERAL WORKS AIMED TO CHARACTERIZE THE PROPERTIES OF BREAST PHANTOMS

Composition and Mass Density

Material	H (%)	C (%)	N (%)	O (%)	ρ (g/cm^3)
Adipose Tissue *	12.4±0.1	76.5±1.1	0.40±0.05	10.7±1.3	0.92±0.02
Glandular Tissue *	9.3±0.5	18.4±0.9	4.4±0.6	67.9±2.0	1.04±0.02
Adipose Tissue H	11.2	61.9	1.7	25.1	0.93
Glandular Tissue H	10.2	18.4	3.2	67.0	1.04

*Poletti et al. PMB 2002, 47: 47.

Composition and Mass Density

Material	H (%)	C (%)	N (%)	O (%)	ρ (g/cm^3)
Adipose Tissue	12.4±0.1	76.5±1.1	0.40±0.05	10.7±1.3	0.92±0.02
Glandular Tissue	9.3±0.5	18.4±0.9	4.4±0.6	67.9±2.0	1.04±0.02
PMMA	8.27±0.01	60.45±0.06	0.0	31.28±0.07	1.18±0.01
Nylon	10.08±0.03	62.70±0.07	11.39±0.03	15.83±0.13	1.13±0.02
Polyethylene	14.51±0.04	85.49±0.08	0.0	0.0	0.89±0.02
Polyacetate	7.03±0.01	57.0±0.06	0.0	35.97±0.07	1.19±0.02
CIRS: 30:70	11.78±0.06	75.12±0.07	0.66±0.03	12.14±0.24	0.97±0.01
50:50	11.10±0.05	72.74±0.09	1.04±0.04	14.82±0.26	0.98±0.01
70:30	11.72±0.06	73.78±0.07	1.30±0.04	12.44±0.25	1.01±0.01

Poletti et al. PMB 2002, 47: 47.

Chalenge tissue equivalent materials: Breast composition

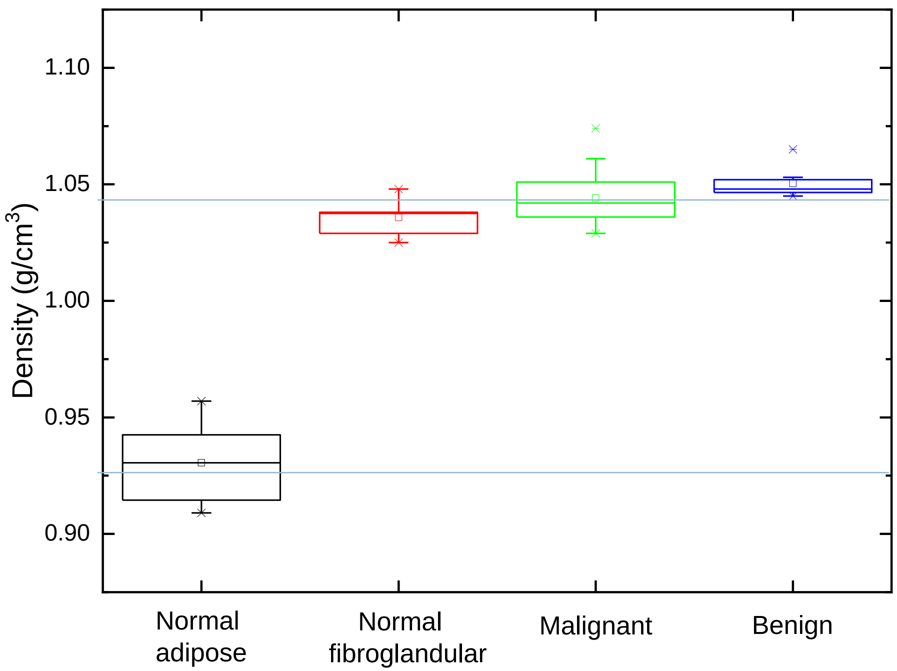
- Similarity (chemical composition and mass density) between the diferent tissues that compose the breast

- Few data available for breast tissues
  - Restrict to normal adipose and glandular breast tissues
  - Based on a limited number of samples

- Variability between women

Mass Density

- 100 breast tissue samples classifed as: Normal Adipose, Normal Fibroglandular, Neoplasic Benign and Malignant



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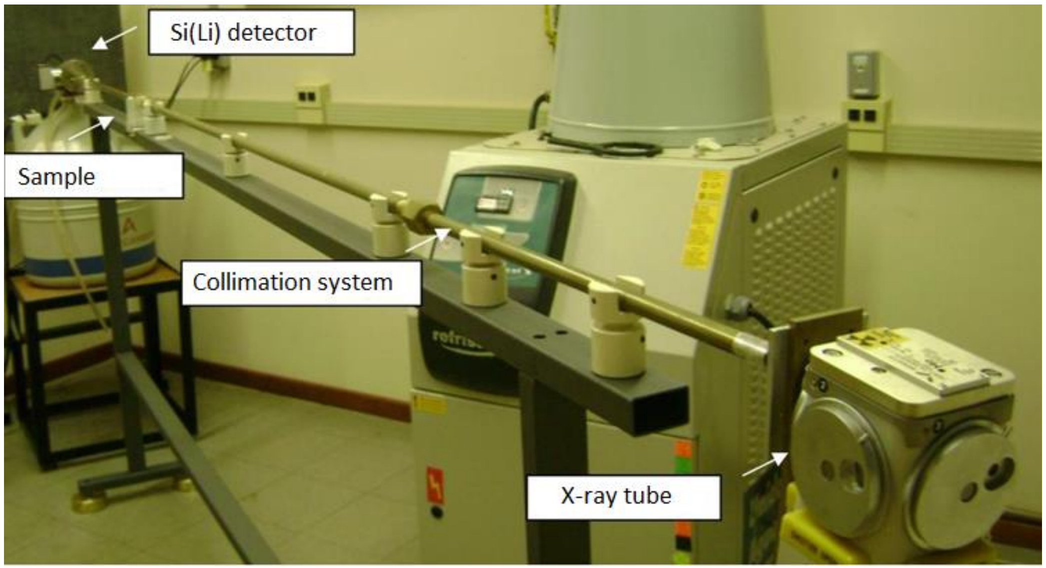
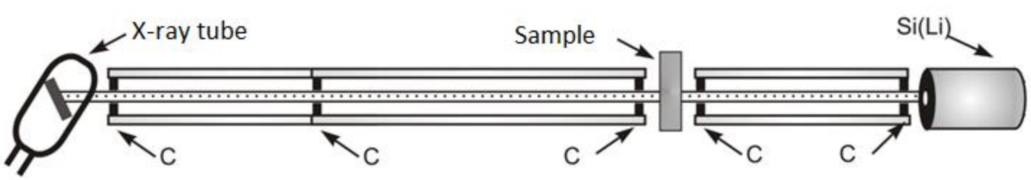
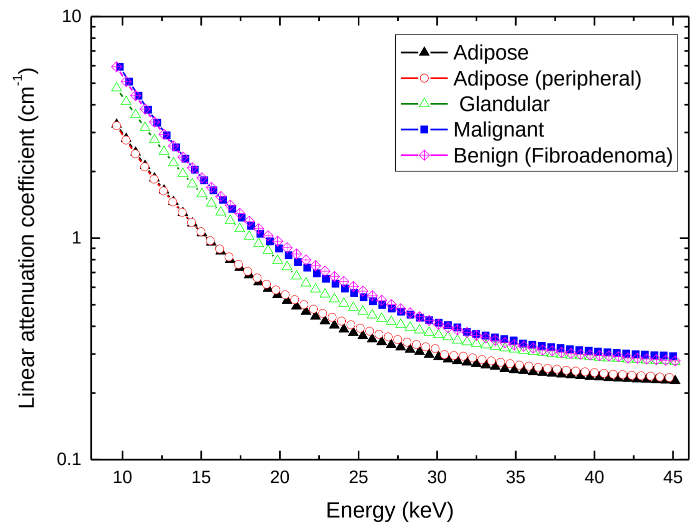
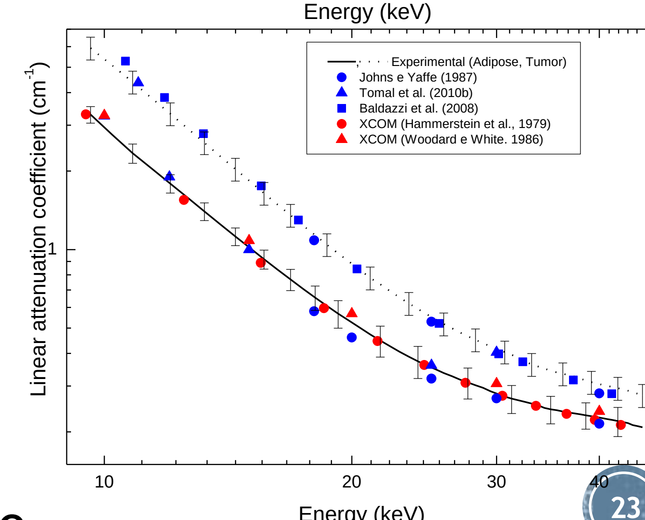
Linear attenuation coefficient



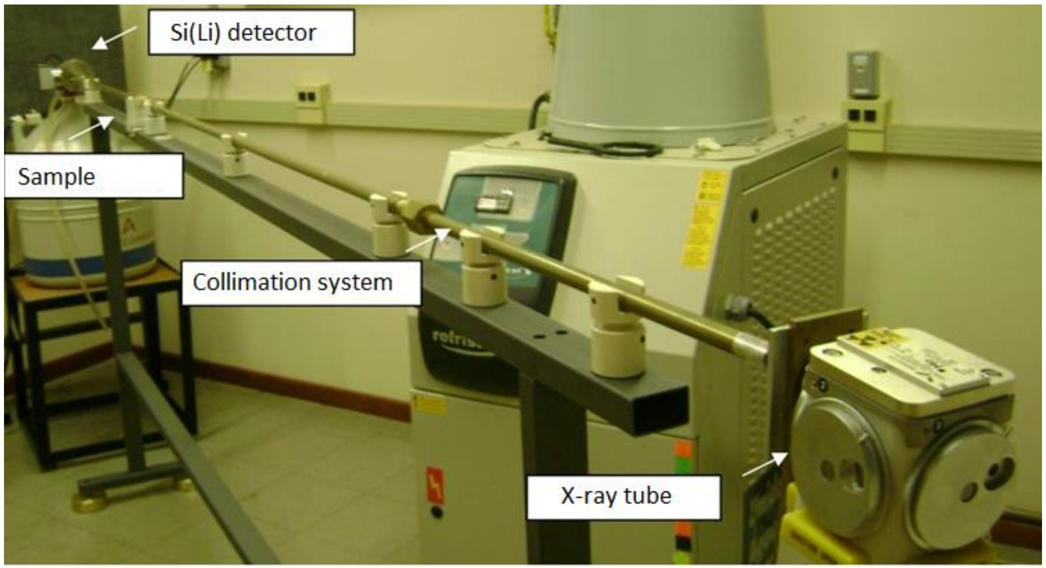


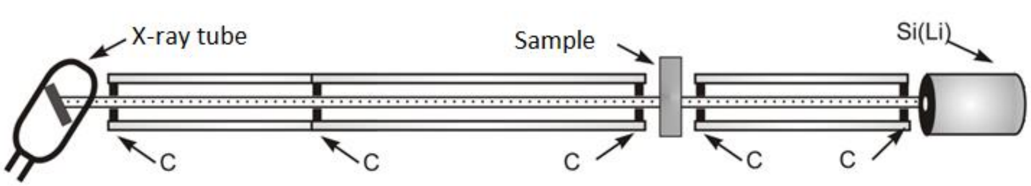


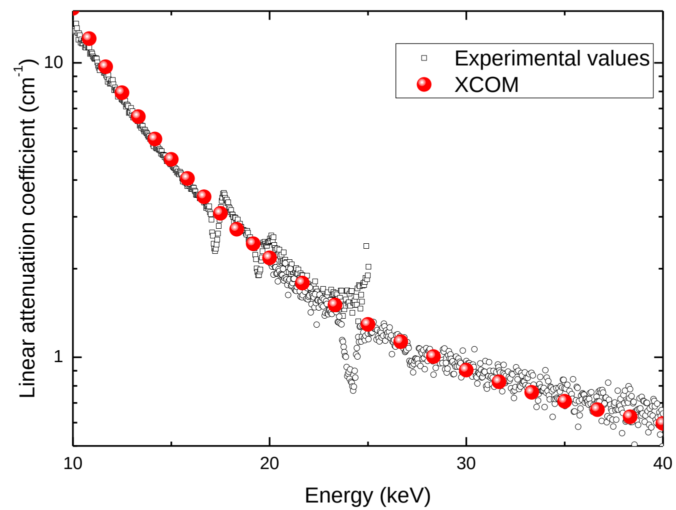


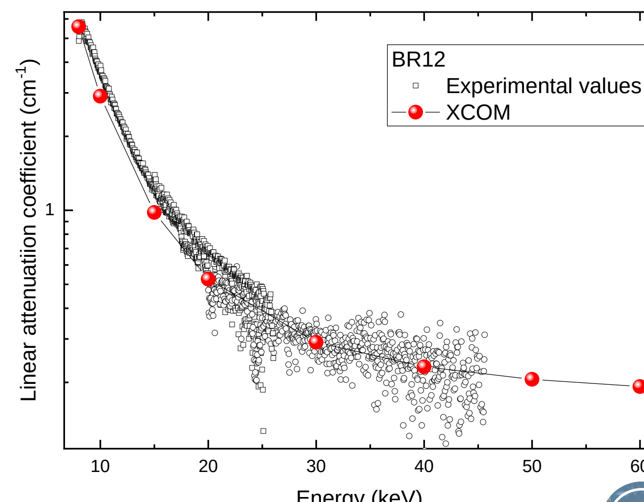
- A Tomal. PhD Thesis. University of São Paulo

Linear attenuation coefficient









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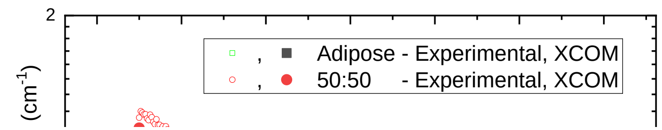
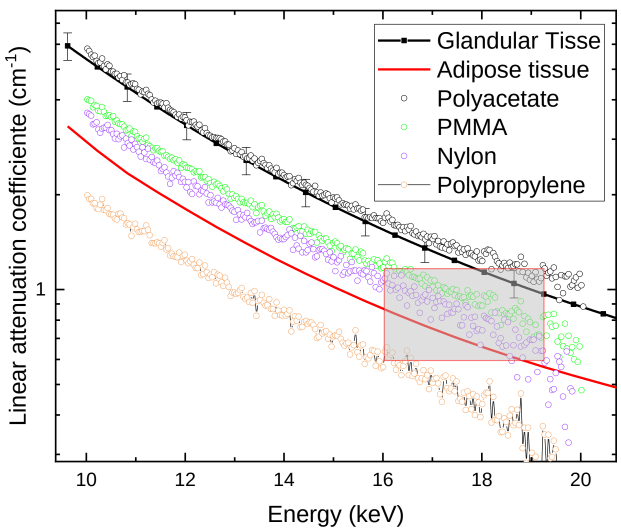
Linear attenuation coefficient

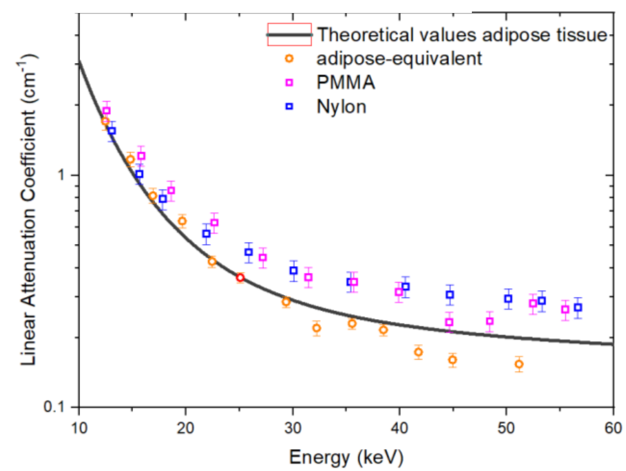


566 IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 60, NO. 2, APRIL 2013

Characterization of Tissue-Equivalent Materials Through Measurements of the Linear Attenuation Coefficient and Scattering Profiles Obtained With Polyenergetic Beams

Wender Geraldelli, Alessandra Tomal, and Martin E. Poletti





- A Tomal. Unpublished

Linear attenuation coefficient

X-ray characterization of breast phantom materials

J W Byng, J G Mainprize and M J Yaffe†

Department of Medical Biophysics and Radiology, University of Toronto and Imaging Research, Sunnybrook Health Science Centre, 2075 Bayview Avenue, Toronto, Ontario M4N 3M5, Canada

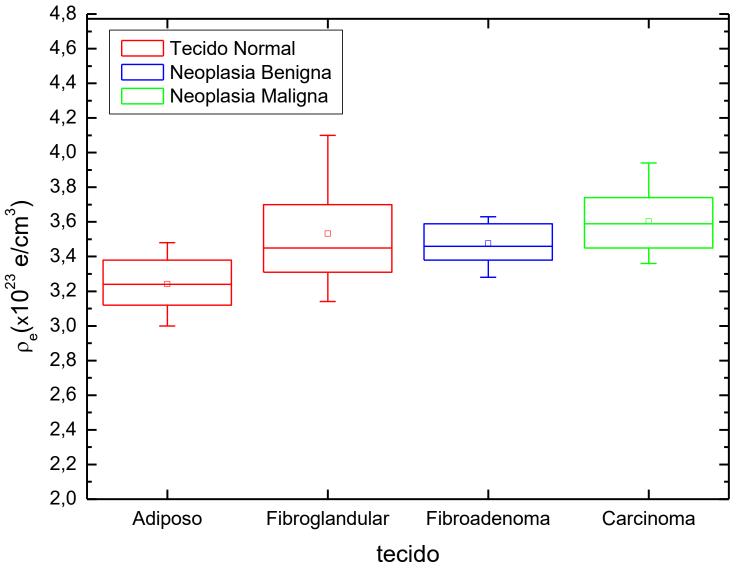
Received 14 October 1997

Abstract. A pulse-height spectroscopic technique is used to measure the linear attenuation coefficients of commercially available composite phantom materials designed to simulate the attenuation characteristics of breast fat and breast glandular tissue. The manufacturers have specified the composition of these materials with the goal of matching the linear attenuation coefficients of breast tissues, calculated using the mixture rule. Over the energy range 18 to 100 keV, measurements from these materials are in close agreement with manufacturers' predictions and with previously measured linear attenuation coefficients of breast tissue samples.

RMI:Fat(AP6)
RMI:Gland(MS11)
CIRS:Fat
CIRS:Gland

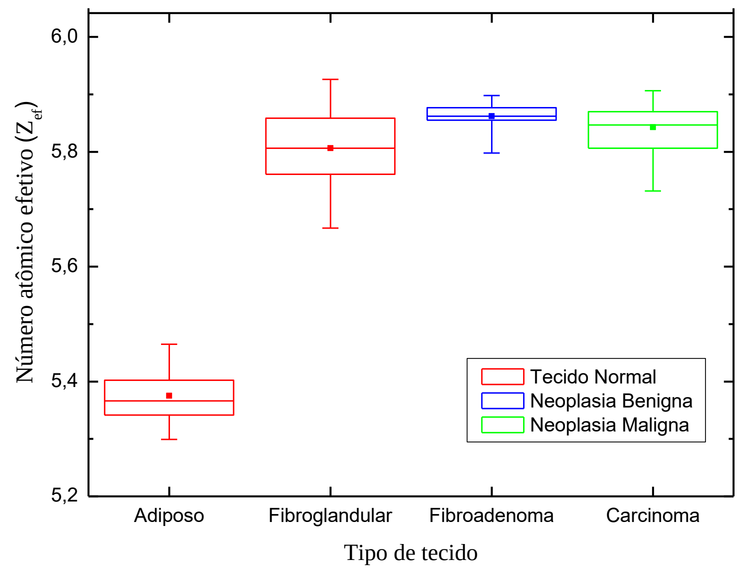
Electron Density and Effective Atomic Number

Eletron Density



Material	ρ_e ($x10^{23}$ cm^3)
BR12	3.168
PMMA	3.865
Nylon	3.329

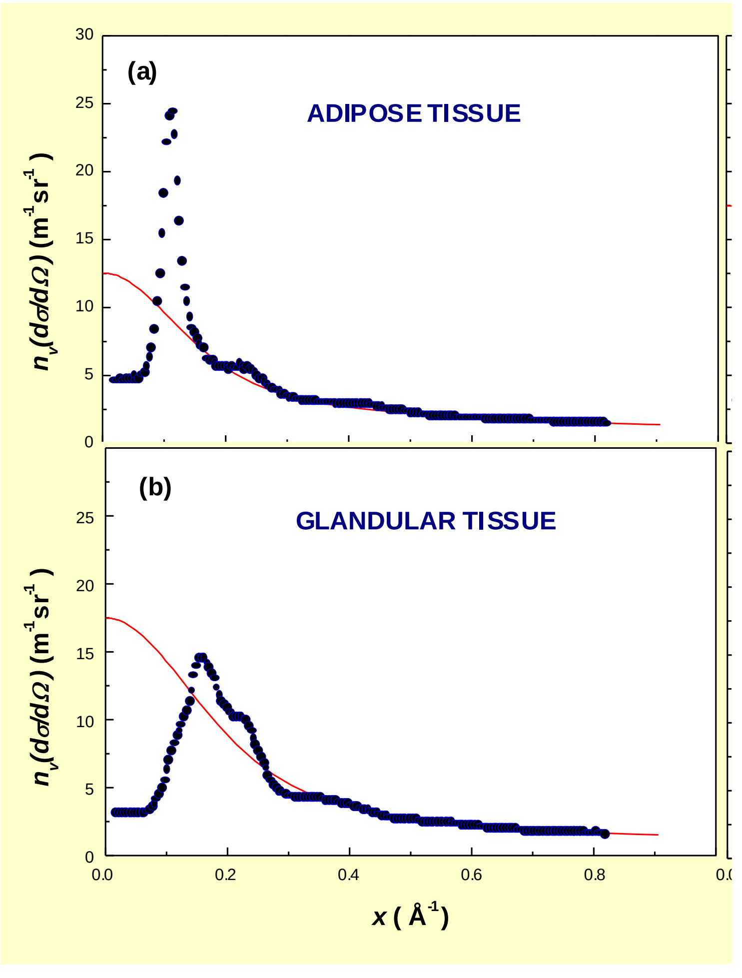
Effective Atomic Number

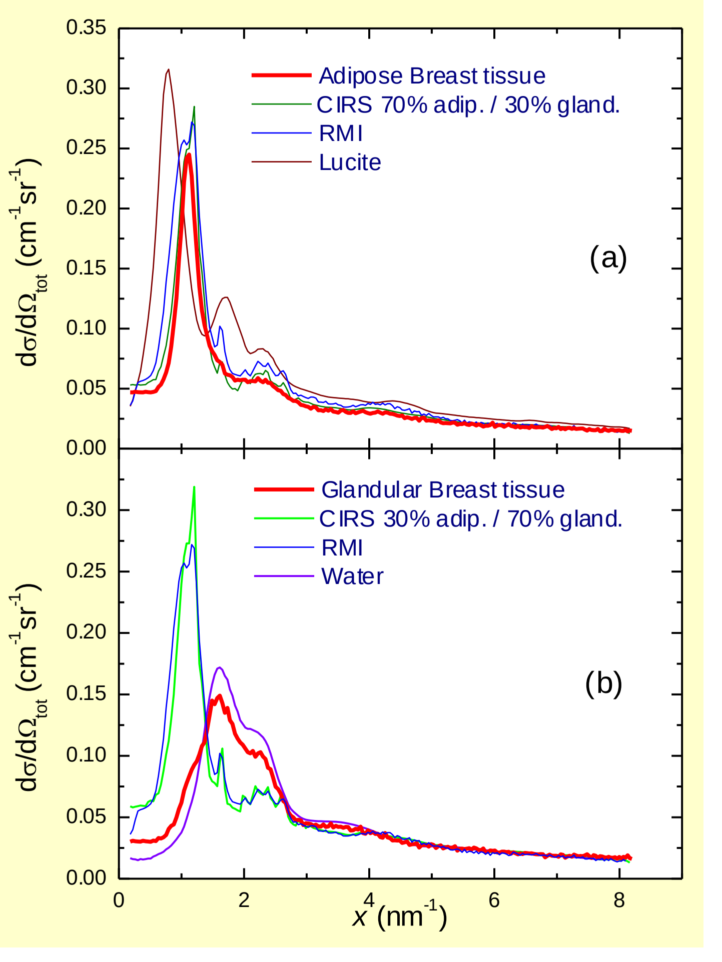


Material	Zeff
PMMA	5.53 ± 0.05
Nylon	5.34 ± 0.07

Courtesy of M. Antoniassi

Other: Scattering properties

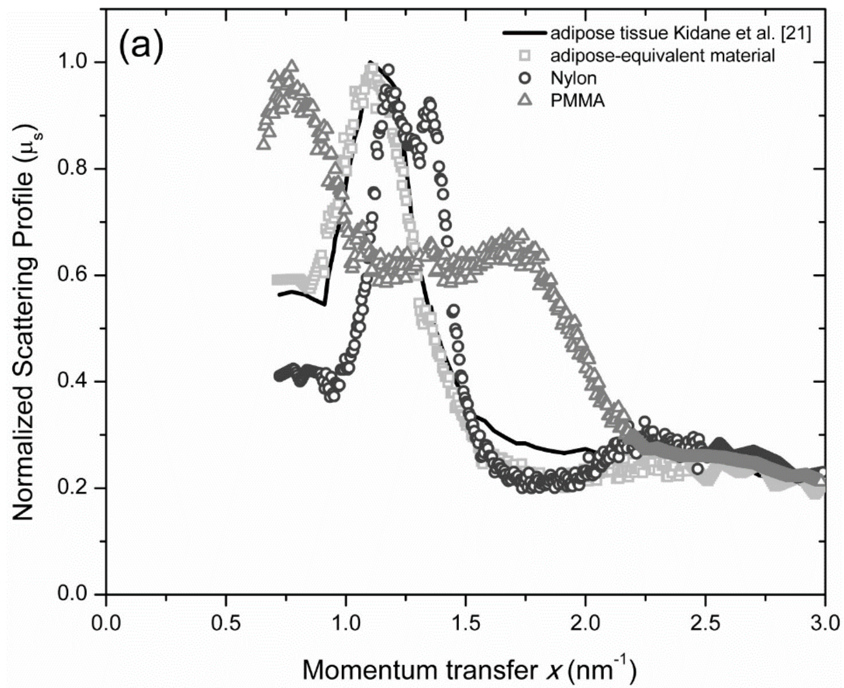




Courtesy of M. E. Poletti

M. E. Poletti, *et al*. Nucl. Instrum. Methods B. 213: 595-598, 2004.
M. E. Poletti, *et al*. Radiat. Phys. Chem. 71: 973-974, 2004.

Other: Scattering properties



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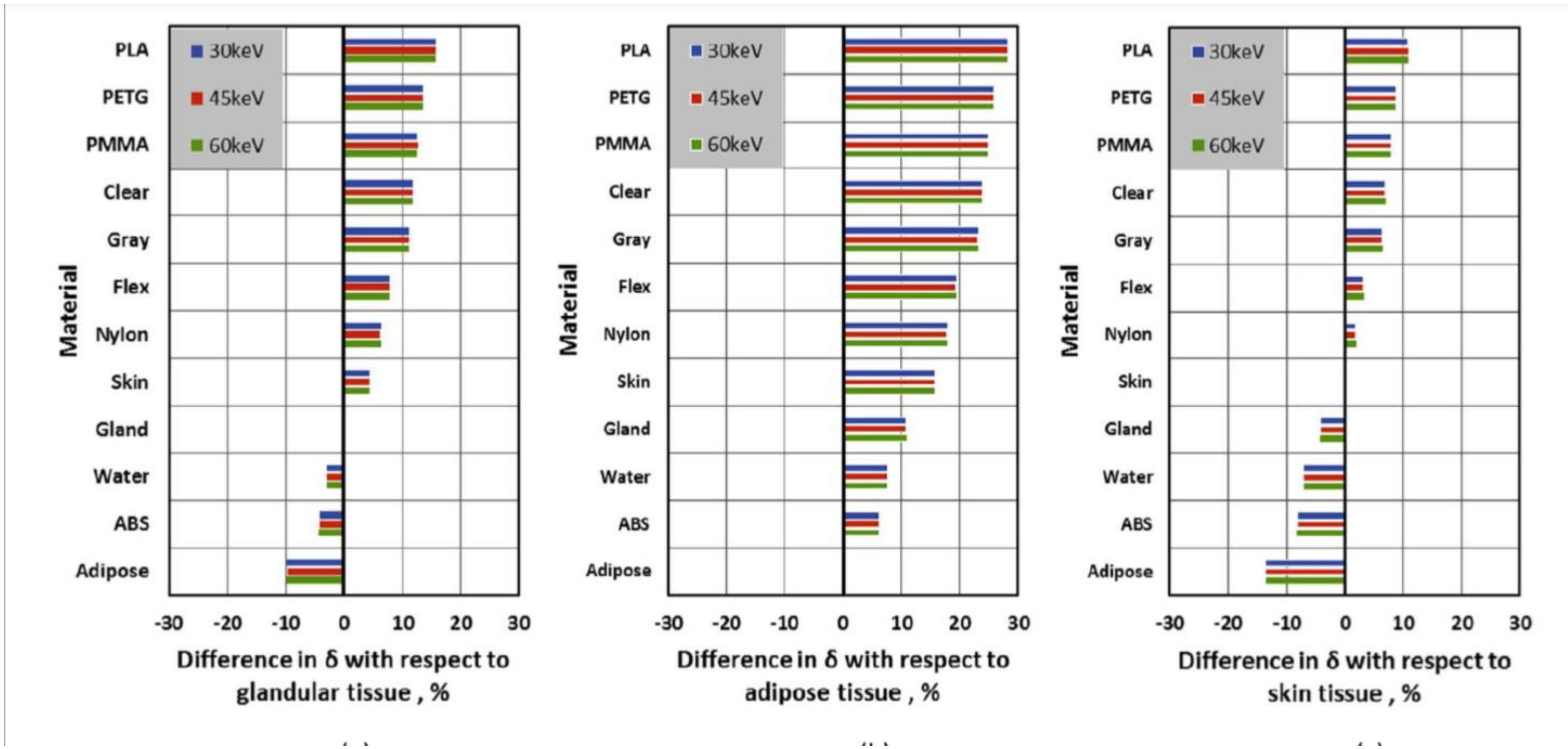
Refractive Index Decrement

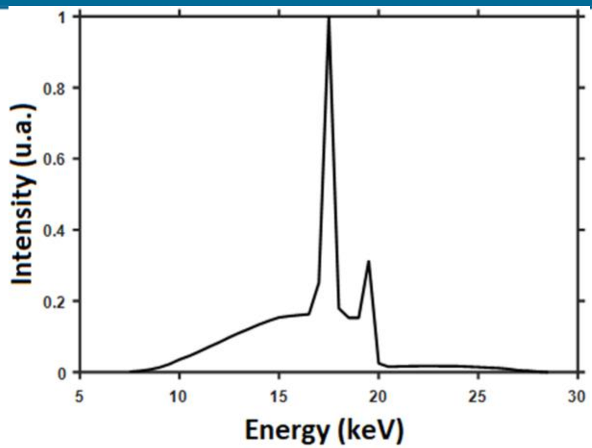


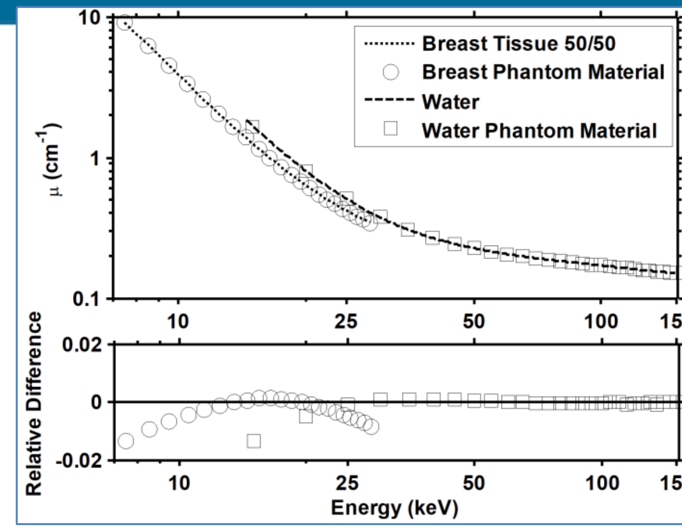
- Danail Ivanov et al 2018 Phys. Med. Biol. 63 175020

New materials

- Epoxy Resin
- Plastic
- Plastic for 3D printers

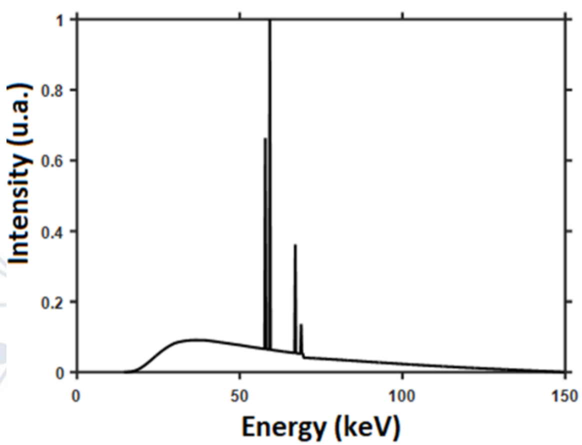
Tissue-equivalent materials





$$Q = \sum_i w(E_i)\left(\frac{\mu_{phantom}(q_j, \mu_j, E_i) - \mu_{ref}(E_i)}{\sigma_i}\right)^2$$

XCOM
NIST

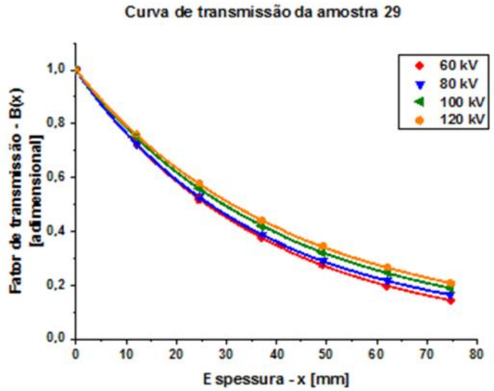


Mariano, L. Costa, P.R. **Development of a methodology for formulating radiologically equivalent materials to human tissues, MCMA2017**

Samples evaluation

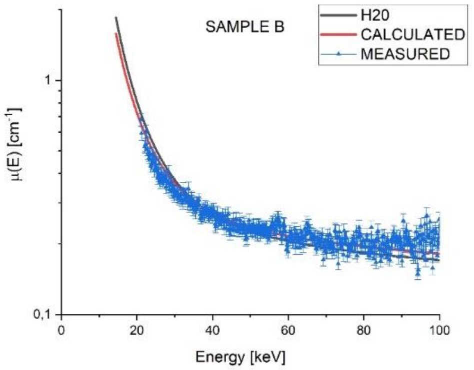
GRUPO DE DOSIMETRIA DAS RADIAÇÕES e FÍSICA MÉDICA
IFUSP - Instituto de Física da USP

Transmisison properties



X-ray spectrometry

DECT



Courtesy: Paulo. R Costa, USP

Outline

Phantoms for x-ray breast imaging

- Introduction
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- Computational phantoms

Breast phantoms classification

Physical

- Commercial
- New developents

Computational

- Homogeneous
- Antropomorphic

Breast phantoms: Physical

- Traditional and Commercial Phantoms for mammography
  - Dosimety
  - Imaging
  - Antropomorphic

- New comercial phantoms for breast imaging

- New developments for Phyisical Breast Phantoms

Breast phantoms for dosimetry

PMMA → BR12 → Resina epoxi

AEC checks

detector homogeneity

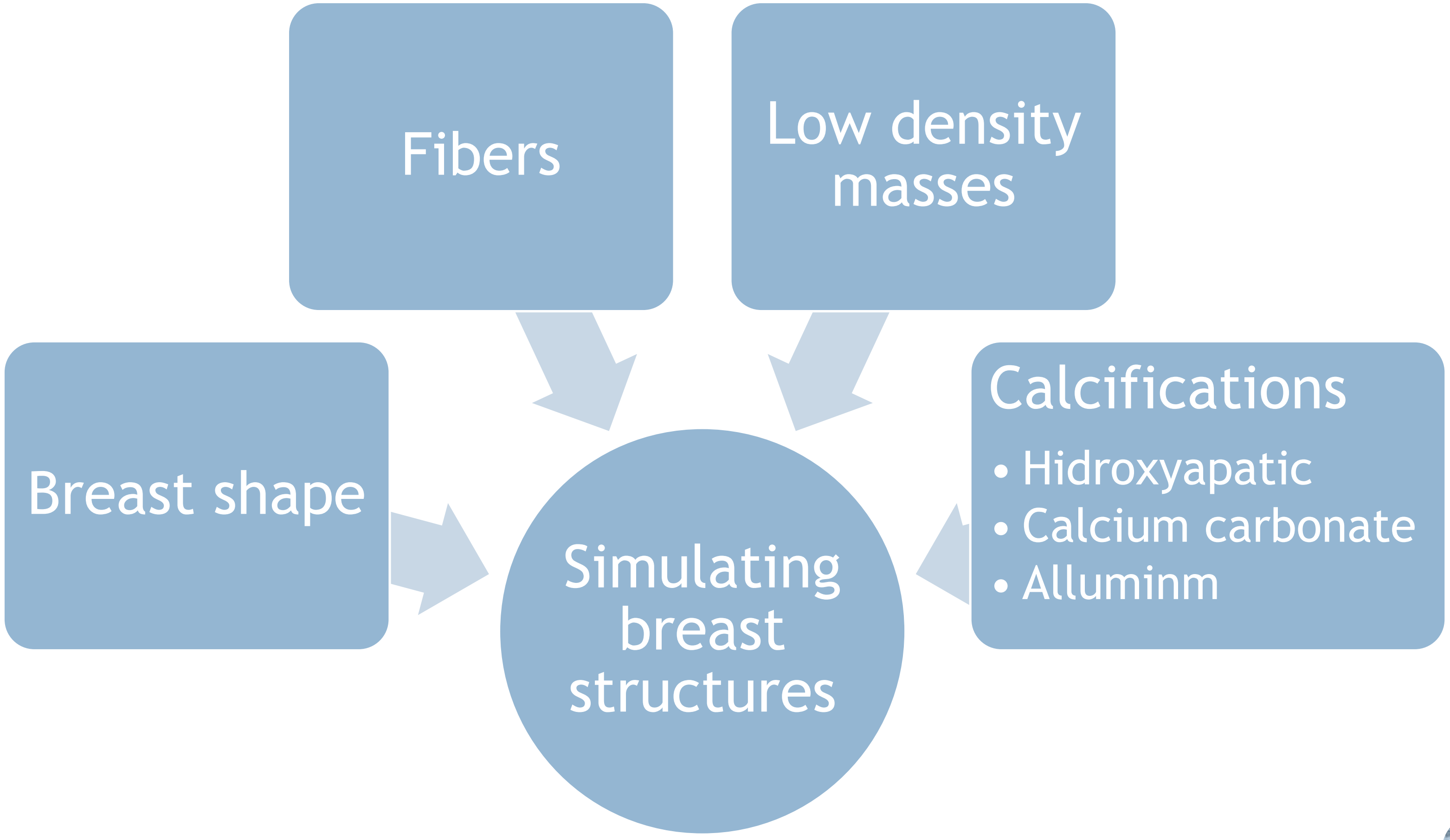
SNR

CNR

Gammex 456

CIRS 012A

Breast phantoms for imaging



Breast phantoms for imaging: Quality Assesment and Quality Control

Simulating breast structures or Artificial Details

- Low contrast objects
  - Masses
  - Fibers
  - Microcalcification
- High contrast patterns and Edges

Evaluation:

- Contrast and spatial resolution
- Noise
- Detectability thresholds (low and high contrast)

Breast phantoms for imaging: Quality Assesment and Quality Control

Simulating breast structures or Artificial Details

Low contrast objects
- Masses
- Fibers
- Microcalcification

High contrast patterns and Edges

Accreditation of mammographic equipments

Breast phantoms for imaging

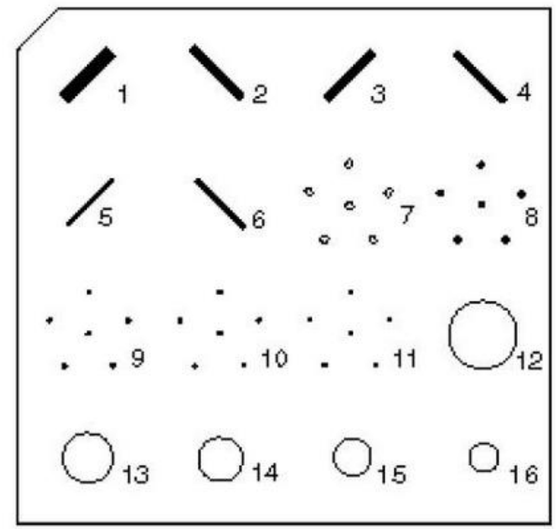
- Mammographic accreditation phantom
- Quality assurance phantom
- High Contrast Resolution Phantom
- Contrast-detail phantom
- Anthropomorphic phantom

Breast phantoms for Quality Control

- Simulating breast structures or Artificial Details
  - Low contrast objects
    - Masses
    - Fibers
    - Microcalcification
  - High contrast patterns and Edges
- Specif breast phantom
  - Detectablity thresholds

ACR Phantom

- Simulates a 50:50 breast of 4.5 cm
- Composed by PMMA wax box insert contains 16 sets of test objects (nylon fibers, microcalcifications – Al2O3 and lens-shaped masses)
- Detectability threshold → *score* of image quality → visible or invisible → accreditation



Gammex 456

Cirs 015

ACR Phantom: Digital mammography

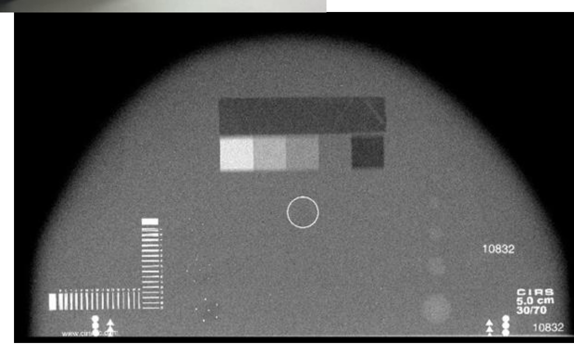
- ACR Phantom Prototype for digital mammography is based on the existing ACR Accreditation Phantom
- Different numbers and dimensions of inserts.
- The pass/fail criteria for subjective image quality assessment correspond to the same (effective) size as the screen–film mammography phantom

CIRS Model 086, ACR Digital Mammography (DM)

Antropomophic Phantoms for quality control: CIRS®

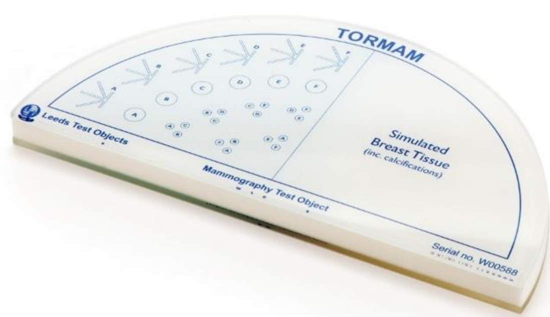
- Composed by epoxy-resin simulating
  - Different proportions of glandular:adipose tissues (20:80, 30:70, 50:50)
  - Adipose shielding
  - Low and high contrast structures mimicking pathological and artificial details

CIRS®: Models 010A, 010B, 010C

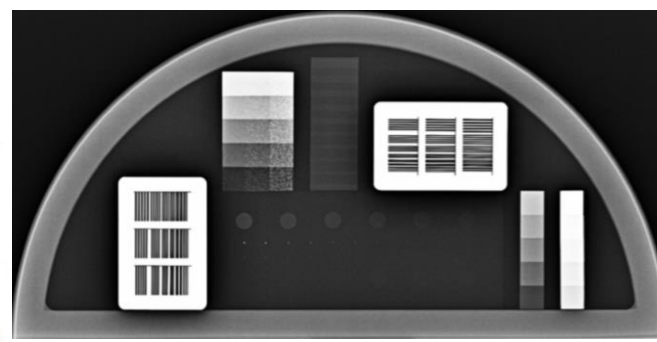


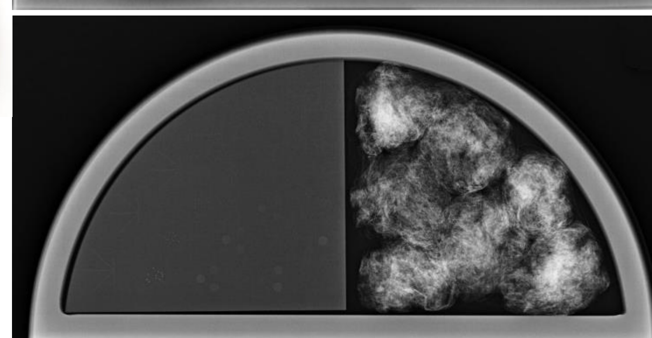
Antropomophic Phantoms for quality control: TOR[MAX] e TOR[MAM]

- TOR[MAX] and TOR[MAM]
  - PMMA Plates and a plate including different structures of high and low contrast
  - Evaluation of contrast, spatial resolution and detectability of small and large areas.
- TOR[MAM], image similar to the clinical practice



Courtesy of Leeds Test Objects Ltd.





TOR[MAX] e TOR[MAM]: Aplications

1992, The British Journal of Radiology, 65, 528–535

A preliminary investigation of the imaging performance of
photostimulable pho
new design of mamm

By A. R. Cowen, BSc, D. S. Brett
BSc, DMRD, FRCR

FAXIL, The University of Leeds, Dep

ELSEVIER

Nuclear Instruments and Methods in Physics Research A 477 (2002) 521 526

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

www.elsevier.com/locate/nima

of an a-Si : H-based X-ray imaging
igital mammography

1998 The British Institute of Radiology

Evaluation of digital breast tomosynthesis reconstruction algorithms using synchrotron radiation in standard geometry

K. Bliznakova and Z. Kolitsi
Department of Medical Physics, School of Medicine, University of Patras, Rio, Patras GR–26500, Greece

R. D. Speller
Department of Medical Physics and Bioengineering, University College London, London WC1E 6BT, United Kingdom

J. A. Horrocks
Clinical Physics Group, St. Bartholomew's Hospital, Barts and the London NHS Trust, London EC1A 7BE, United Kingdom

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N. Pallikarakis[a]
Department of Medical Physics, School of Medicine, University of Patras, Rio, Patras GR–26500, Greece

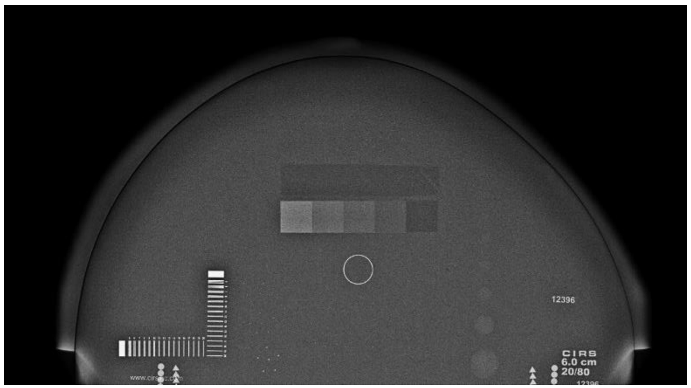
(Received 20 November 2009; revised 2 March 2010; accepted for publication 4 March 2010; published 30 March 2010)

hantom image quality in
ty study

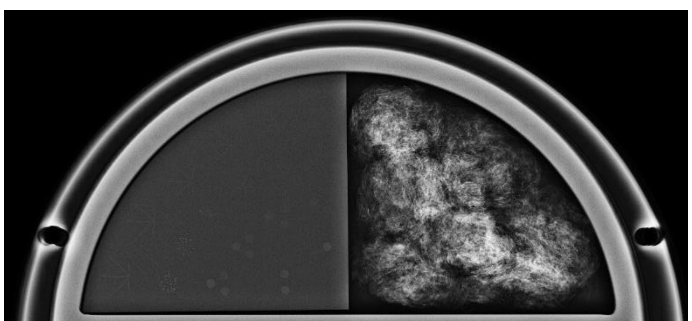
STELLANO SMITH, MA, MSc and

Joint Department of Physics, The Royal Marsden NHS Trust, Fulham Road, London SW3 6JJ, UK

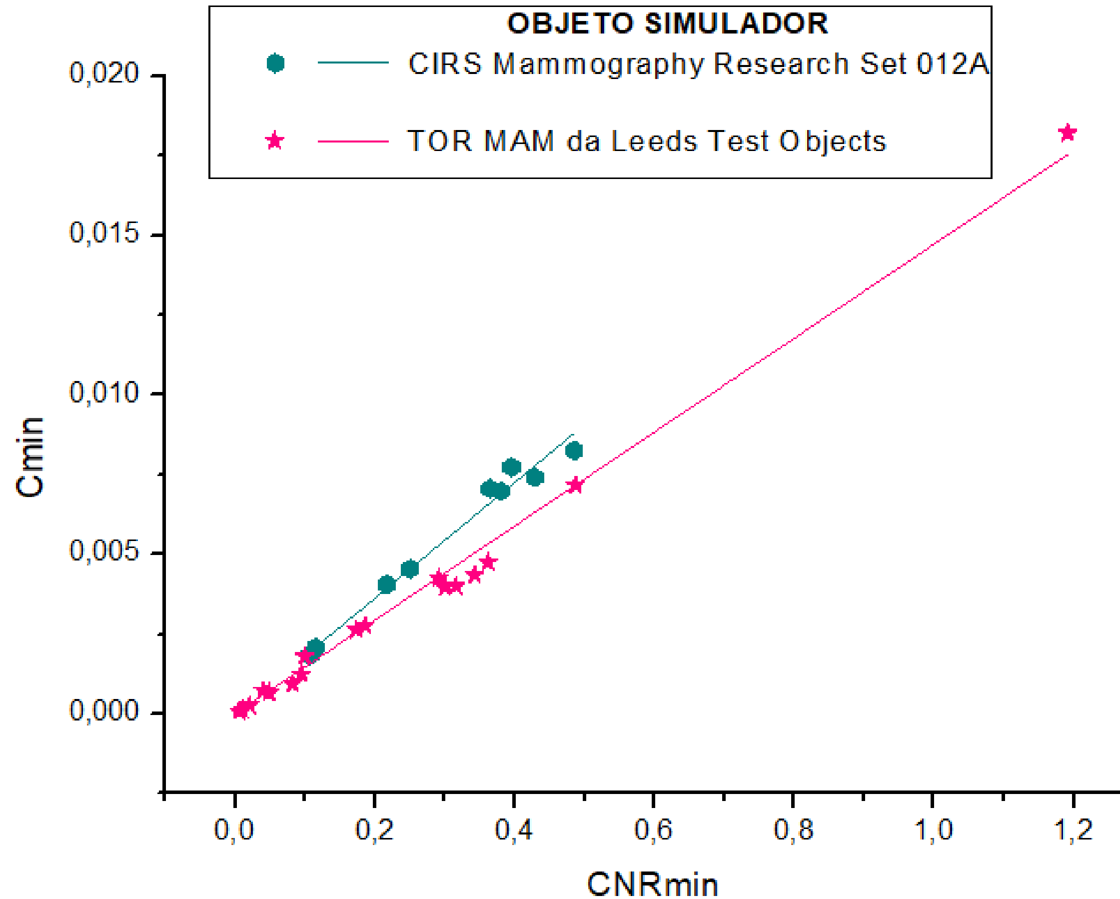
Subjetive x quantitative image quality



CIRS®: Model 010C



Leeds: Model TOR[MAM}



Mariana Yuamoto, Alessandra Tomal. Private Communication, 2017

Phantoms for quality control: Contrast-detail

- Effectiveness for visibility threshold of very small size objects under low-contrast conditions
- Discs of various thicknesses and diameters attached to a PMMA cover block.
- Test included in the European Protocol of QC in mammography

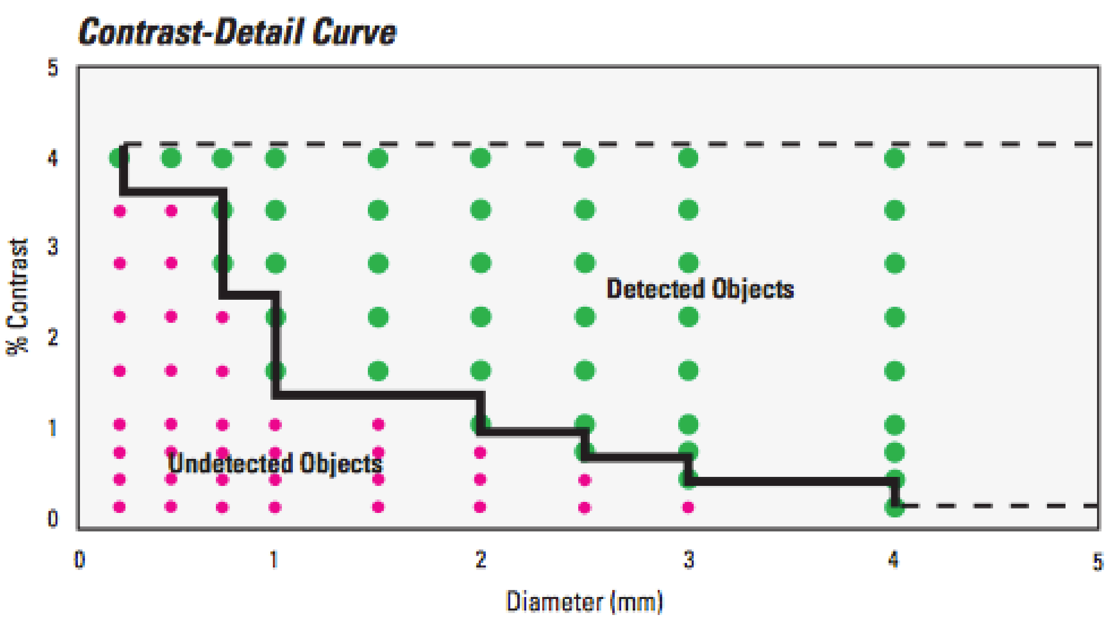
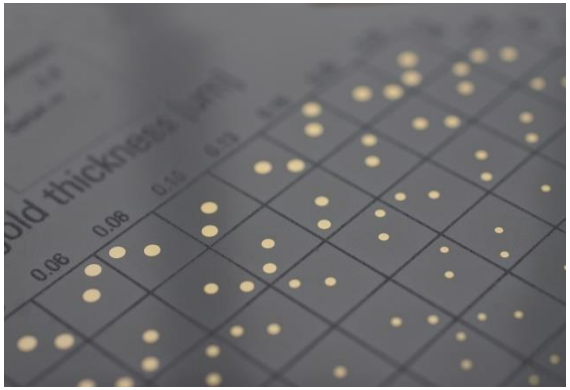


Figure 3. Contrast-detail phantom image scoring pattern.



ystems)

Contrast-detail phantom: applications

1995, *The British Journal of Radiology*, 68, 277–282

The use of a contrast–detail test object in the optimization of optical density in mammography

K J ROBSON, BSc, C J KOTRE, MSc, PhD and K FAULKNER, MSc, PhD

Regional Medical Physic
NE4 6BE, UK

Optimization of technique factors for a silicon diode array full-field digital mammography system and comparison to screen-film mammography with matched average glandular dose

Eric A. Berns[a)] and R. Edward Hendrick
The Lynn Sage Comprehensive Breast Center, Northwestern University Medical School, Chicago, Illinois 60611

Gary R. Cutter
Center for Research Design and Statistical Methods, University of Nevada, Reno, Nevada

(Received 14 May 2002; accepted for publication 16 December 2002; published 5 February 2003)

Suryana
Sechopoulos, I., & D'Orsi, C. J. (2007).
Detection of simulated microcalcifications in a phantom with digital mammography: Effect of pixel size. Radiology, 244, 130–137.

Contrast-detail phantom: low cost

INSTITUTE OF PHYSICS PUBLISHING PHYSICS IN MEDICINE AND BIOLOGY

Phys. Med. Biol. **49** (2004) 1423–1438 PII: S0031-9155(04)66795-9

A novel method for producing x-ray test objects and phantoms

C Theodorakou[1], J A Horrocks[2], N W Marshall[2] and R D Speller[3]

[1] Clinical Physics Group, St Bartholomew's Hospital, Queen Mary University, EC1A 7BE, London, UK
[2] Clinical Physics Group, St Bartholomew's Hospital, Barts and the London NHS Trust, EC1A 7BE, London, UK
[3] Department of Medical Physics and Bioengineering, University College London, WC1E 6JA, London, UK

The British Journal of Radiology, 78 (2005), 746–748
DOI: 10.1259/bjr/11930472

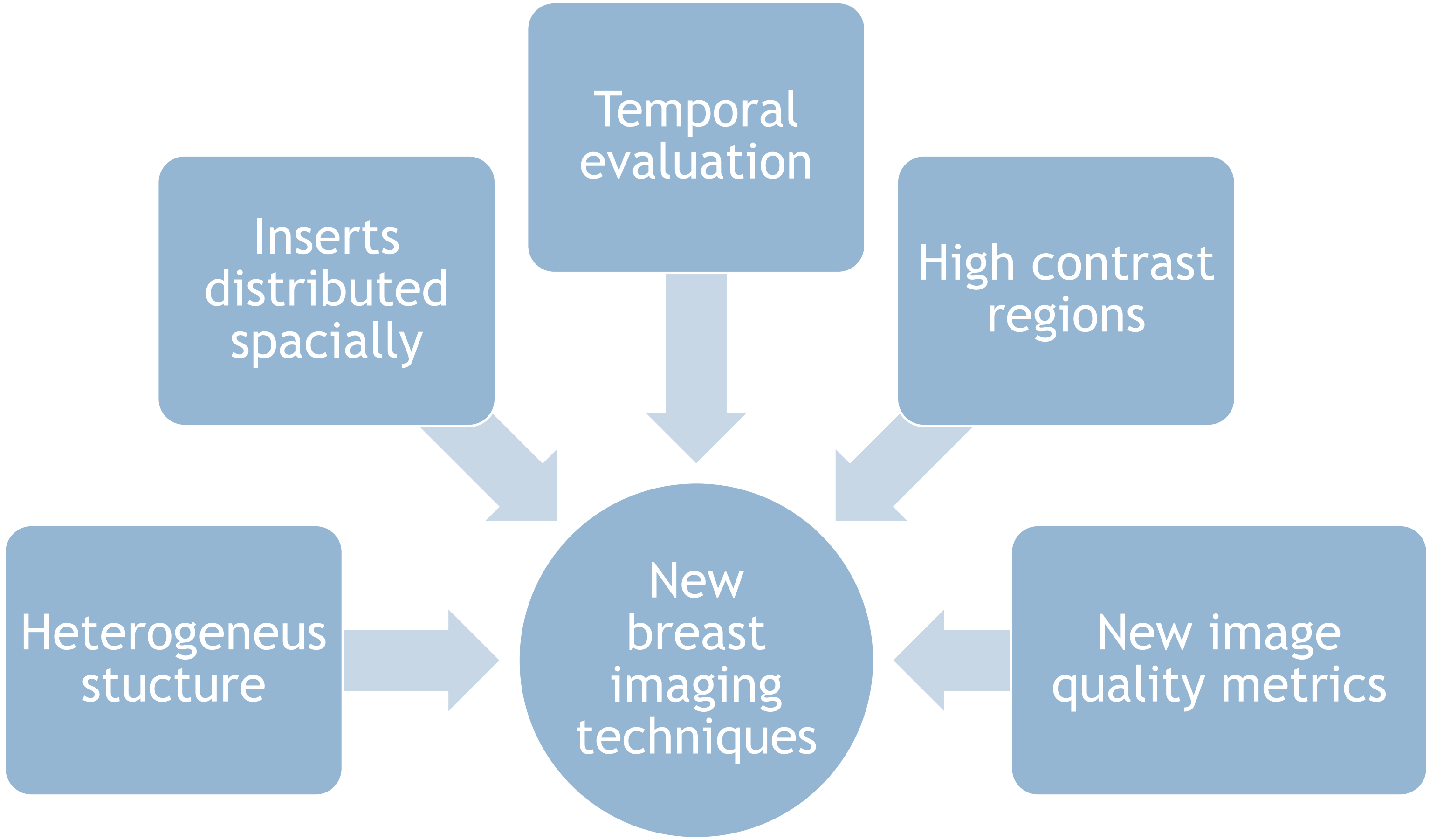
Short communication

A printed image quality test phantom for mammography

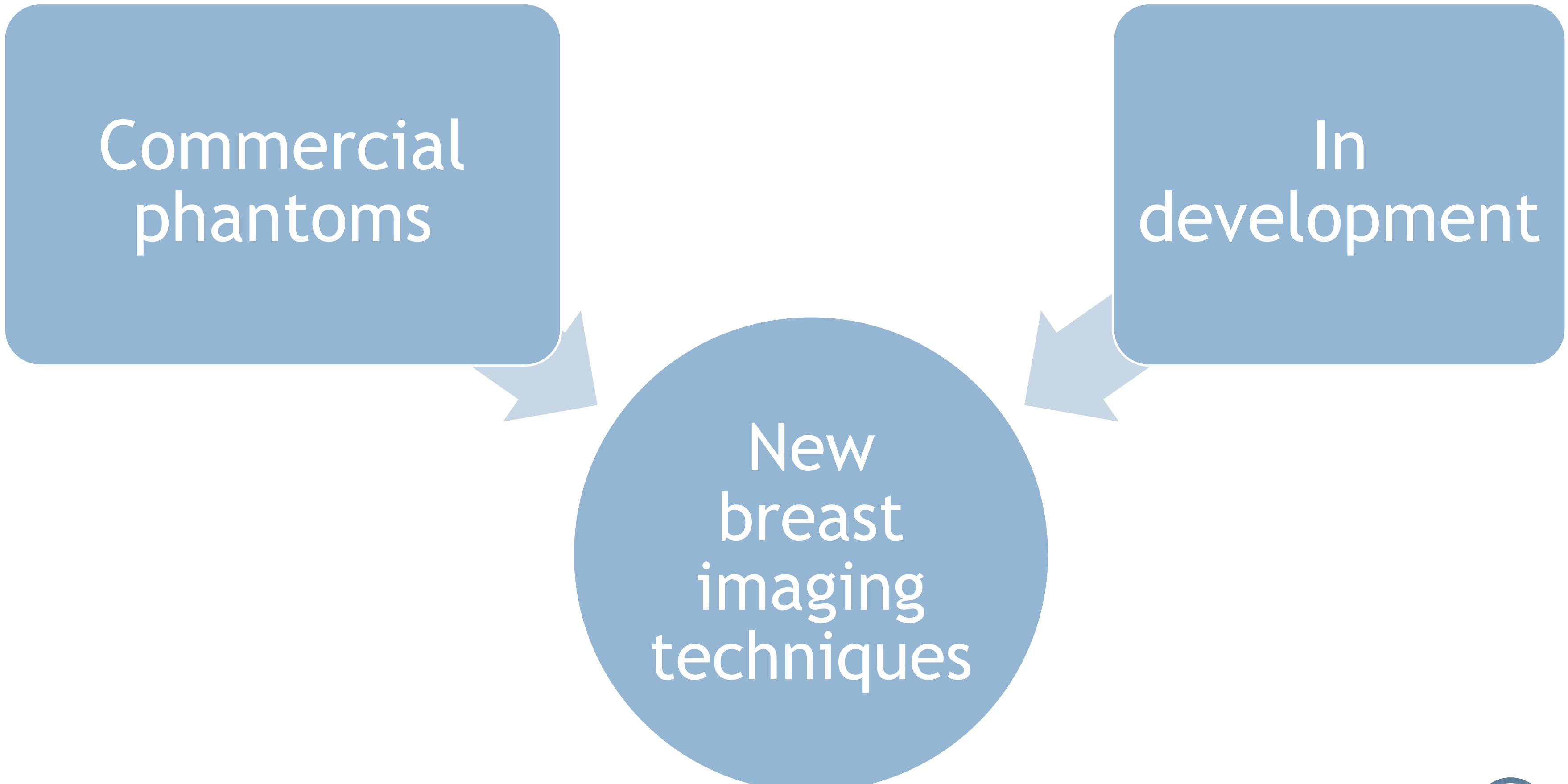
[1]C J KOTRE, PhD and [2]D J T PORTER, MSc

[1]*Regional Medical Physics Department, Newcastle General Hospital, Newcastle upon Tyne NE4 6BE and* [2]*Department of Medical Physics & Bioengineering, Raigmore Hospital, Inverness IV2 3UJ, UK*

New physical phantoms for breast imaging



New physical phantoms for breast imaging



Phantom for large area contrast

- PMMA phantom
  - Details:
    - Nylc
    - Poly
    - Tefl
    - Alur
    - Poly

Contents lists available at ScienceDirect

Radiation Physics and Chemistry

journal homepage: www.elsevier.com/locate/radphyschem

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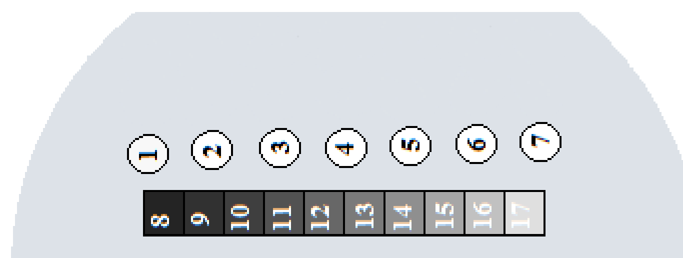
Experimental evaluation of the image quality and dose in digital mammography: Influence of x-ray spectrum

CrossMark

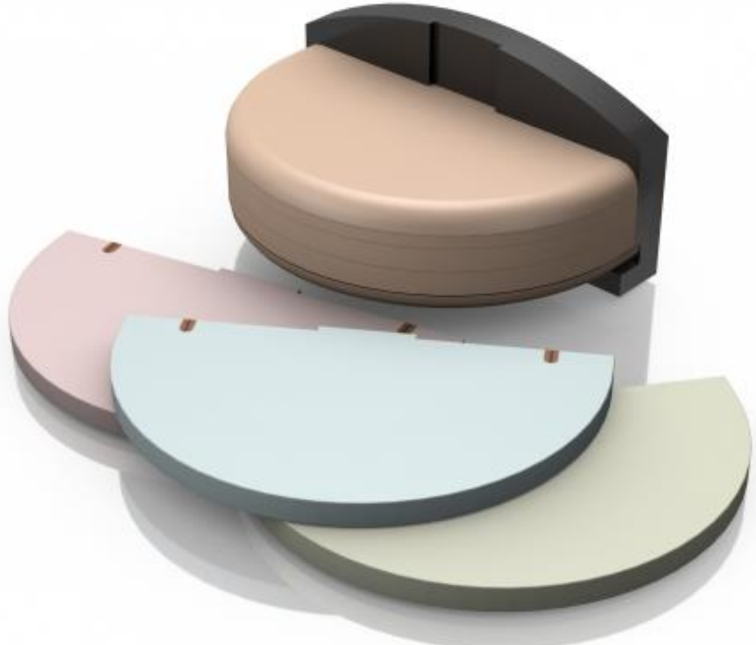
A. Tomal [a,*], A.M.M.M Perez [c], M.C. Silva [b], M.E. Poletti [c]

[a] Instituto de Física Gleb Wataghin, Universidade Estadual de Campinas, 13083-859 Campinas, SP, Brazil
[b] Hospital Albert Einstein, 05652-900 São Paulo, SP, Brazil
[c] Departamento de Física, FFCLRP, Universidade de São Paulo, 14040-901 Ribeirão Preto, SP, Brazil



Breast Tomosynthesis Phantom: CIRS

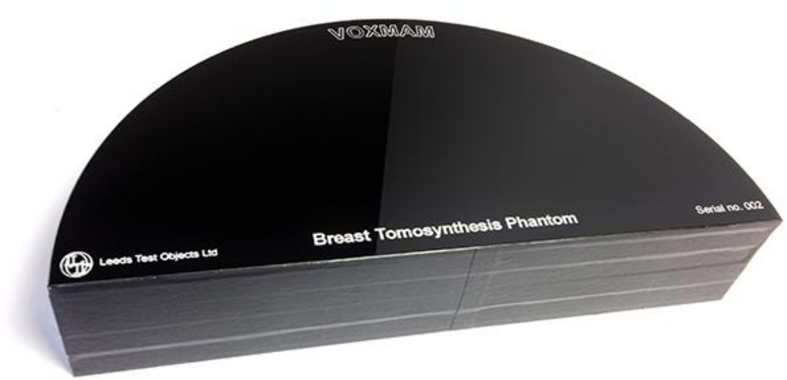
- Consist of eight homogeneous slabs made from breast-equivalent material in 50/50 ratio of gland and adipose tissue
- Include details for evaluate the image quality (Pixel Value Uniformity, Noise, Resolution in X, Y and Z directions, Geometric accuracy 3D, Artifact assessment and Visual detectability)



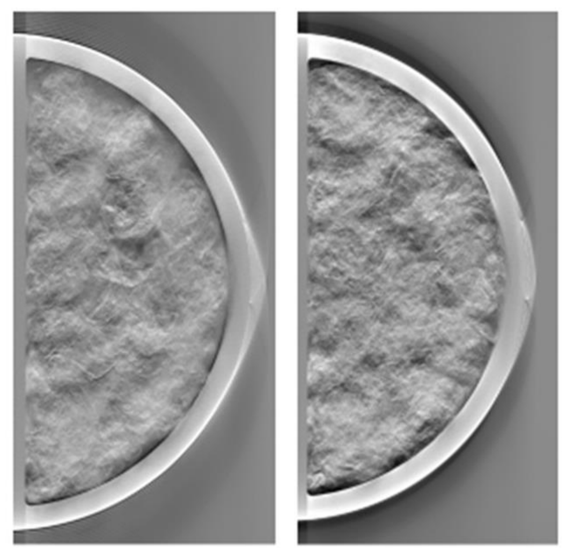
Courtesy of CIRS, model 021.

Breast Tomosynthesis Phantom: Leeds - VOX[MAM]

- Can be used for compare image quality between breast tomosynthesis systems
- Breast tissue equivalent material encased in PMMA
- Include groups of microcalcification



Courtesy of Leeds Test Objects Ltd.

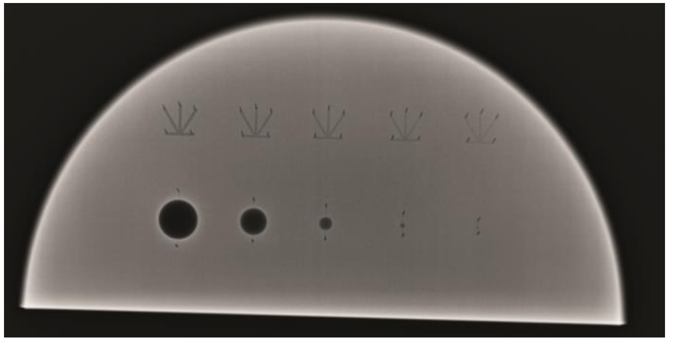


Contrast Enhanced Digital mammography phantom: Leeds - CEDM

- Phantom with voids into which contrast agent can be injected

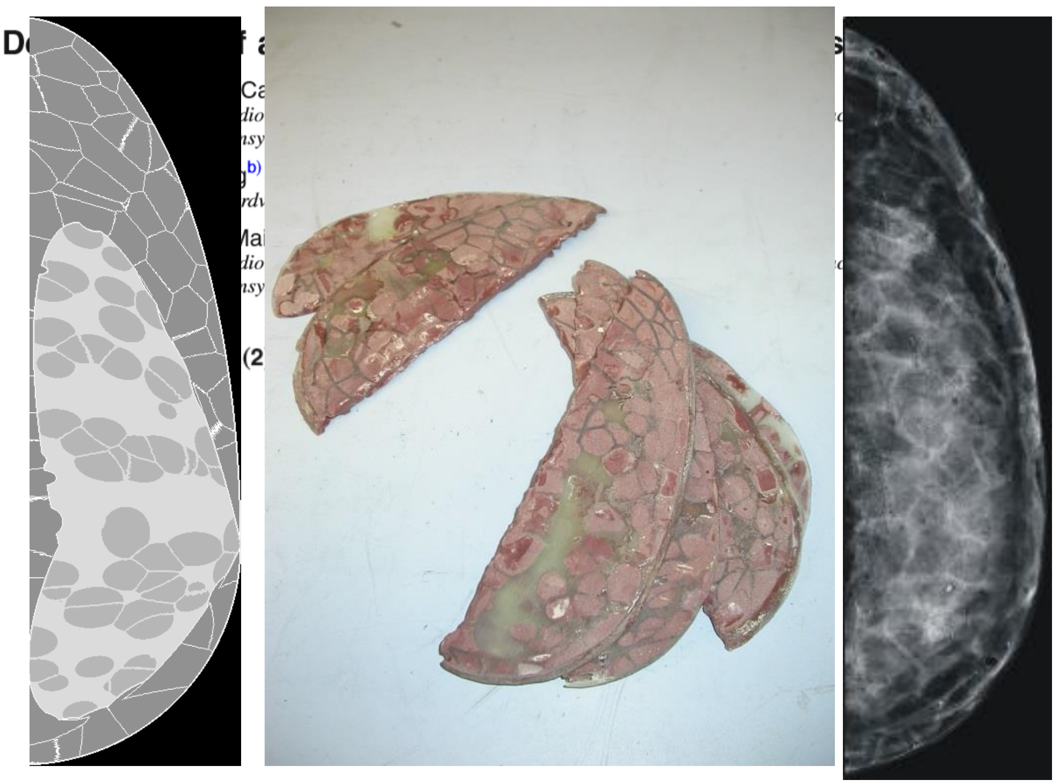
- Allows studdy the image quality , based on dual-energy technique

Courtesy of Leeds
Test Objects Ltd.



New Development: Physical Phantom Prototype

- Selection of the digital phantom equivalent
- 3D printing of dense tissue skeleton
  - 50% glandular
- Adipose compartments filled manually
  - A thin primer applied first
  - ~100% fat epoxy-based resin

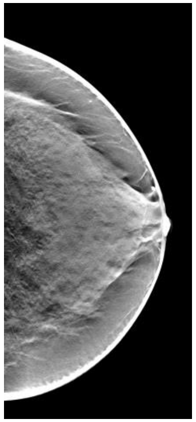


Courtesy of P.R. Bakic

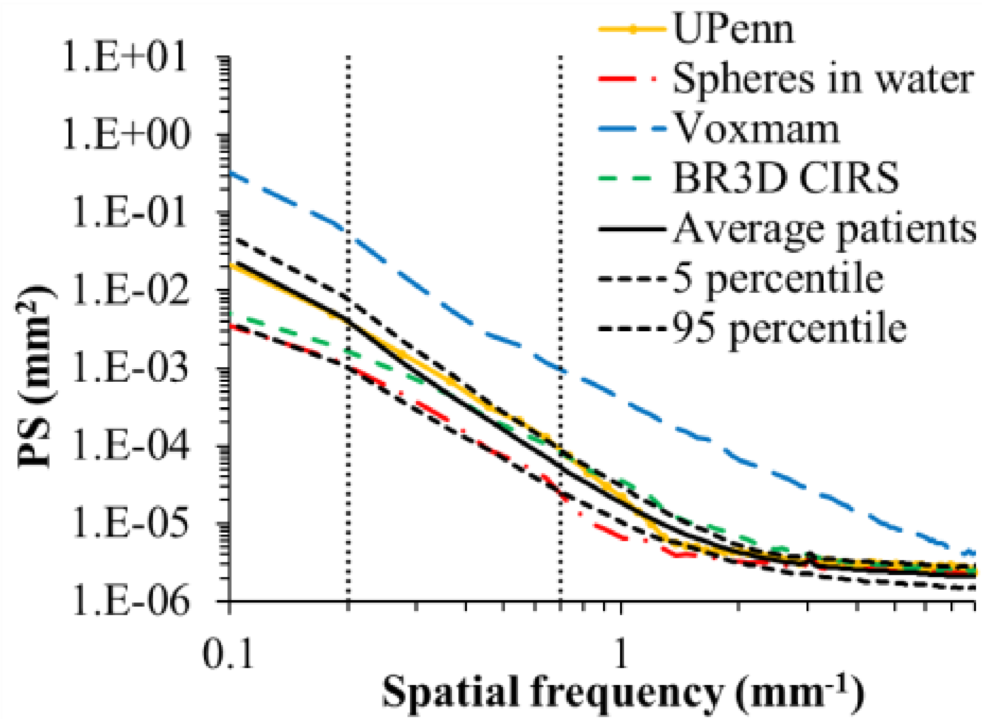
Phantom Validation

Power spectrum analysis: Phantom vs. patient comparison (Cockmartin, IWDM 2014)

Siemens



Siemens

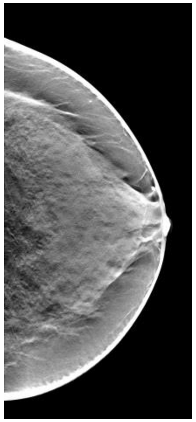


Mammographic (2D) Projection

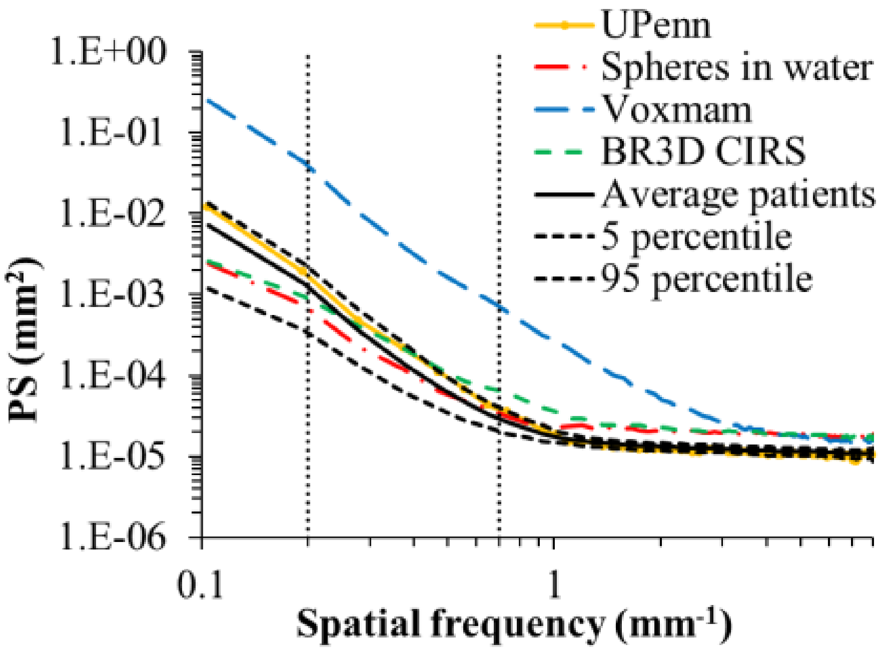
Phantom Validation

Power spectrum analysis: Phantom vs. patient comparison (Cockmartin, IWDM 2014)

Siemens



Siemens



Central Tomo Projection

Courtesy of P. R. Bakic

Outline

Phantoms for x-ray breast imaging

- Introduction
- Tissue-equivalente materials
- Physical phantoms
- Computational phantoms

Computational Phantoms

Physical Breast Phantoms

- Used in 2D mammography QC/QA
- Unstructured image background

3D Breast Computational Phantoms

- Adipose and Glandular Heterogenity
- Antropomorphic: Anatomic correlation
- Structured image background

Applications

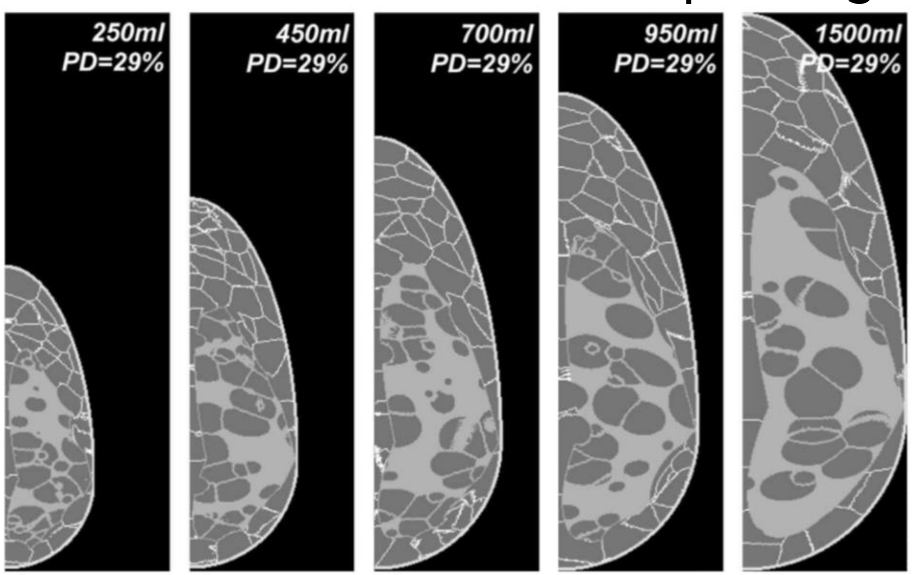
- Multimodality Imaging: 2D and 3D
  - Observer
  - Reconstruction
- Dosimetry

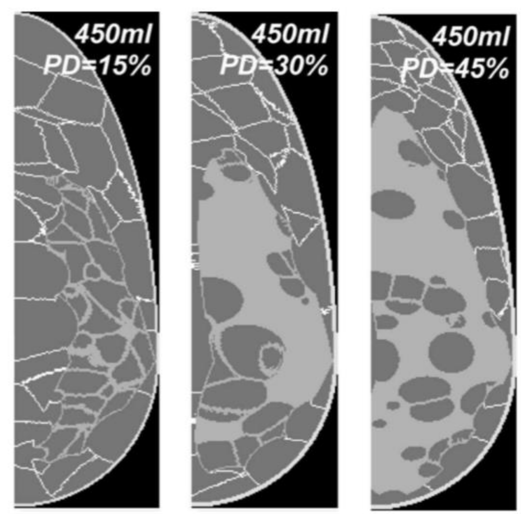
3D Anthropomorphic Breast Phantom

Development and characterization of an anthropomorphic breast software phantom based upon region-growing algorithm

Predrag R. Bakic,[a] Cuiping Zhang,[b] and Andrew D. A. Maidment
Department of Radiology, University of Pennsylvania, Philadelphia, Pennsylvania 19104

- Simulates the skin, regions of adipose and fibroglandular tissue, and the matrix of Cooper's ligaments and adipose compartments

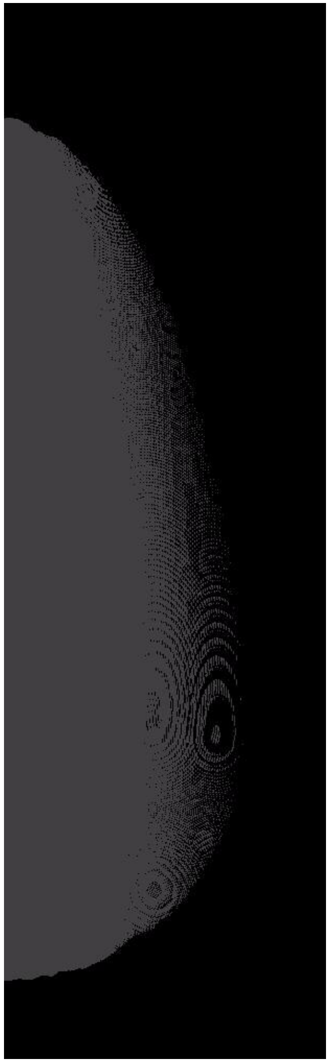




Courtesy of P.R. Bakik

Penn Software Breast Phantom

- Developd since 1996
- Software phantoms provide support for *Virtual Clinical Trials*
  - The known ground truth about simulated tissues
  - The flexibility to cover anatomic variations



Computational Phantom for x-ray imaging: BreastSimulator

www.sciedu.ca/jbgc Journal of Biomedical Graphics and Computing, June 2012, Vol. 2, No. 1

ORIGINAL RESEARCH

BreastSimulator: A software platform for breast x-ray imaging research

Kristina Bliznakova[1], Ioannis Sechopoulos[2], Ivan Buliev[3], Nicolas Pallikarakis[1]

1. Department of Medical Physics, School of Medicine, University of Patras, Greece. 2. Department of Radiology and Imaging Sciences and Winship Cancer Institute, Emory University School of Medicine, Atlanta, Georgia. 3. Department of Electronic Engineering and Microelectronics, Technical University of Varna, Varna, Bulgaria.

Breast Modeling Module: consists of several sub-modules that are utilized to model the different breast components: external shape, glandular and adipose tissue, breast lesion, skin, pectoralis and lymphatics.

Computational Phantom for x-ray imaging: BreastSimulator

www.sciedu.ca/jbgc Journal of Biomedical Graphics and Computing, June 2012, Vol. 2, No. 1

ORIGINAL RESEARCH

BreastSimulator: A software platform for breast x-ray imaging research

Kristina Bliznakova[1], Ioannis Sechopoulos[2], Ivan Buliev[3], Nicolas Pallikarakis[1]

(a) (b) (c) (d)

Courtesy of K. Bliznakova

Computational Phantom for x-ray imaging: BreastSimulator

Evaluation of an improved algorithm for producing realistic 3D breast software phantoms: Application for mammography

K. Bliznakova[a)]
Department of Medical Physics, School of Medicine, University of Patras, 26500 Rio-Patras, Greece

S. Suryanarayanan[b)] and A. Karellas[c)]
Department of Radiology and Winship Cancer Institute, Emory University School of Medicine, Atlanta, Georgia 30322

N. Pallikarakis
Department of Medical Physics, School of Medicine, University of Patras, 26500 Rio-Patras, Greece

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Original paper

Homogeneous vs. patient specific breast models for Monte Carlo evaluation of mean glandular dose in mammography

A. Sarno[a], G. Mettivier[a,*], F. Di Lillo[a], K. Bliznakova[b], I. Sechopoulos[c], P. Russo[a]

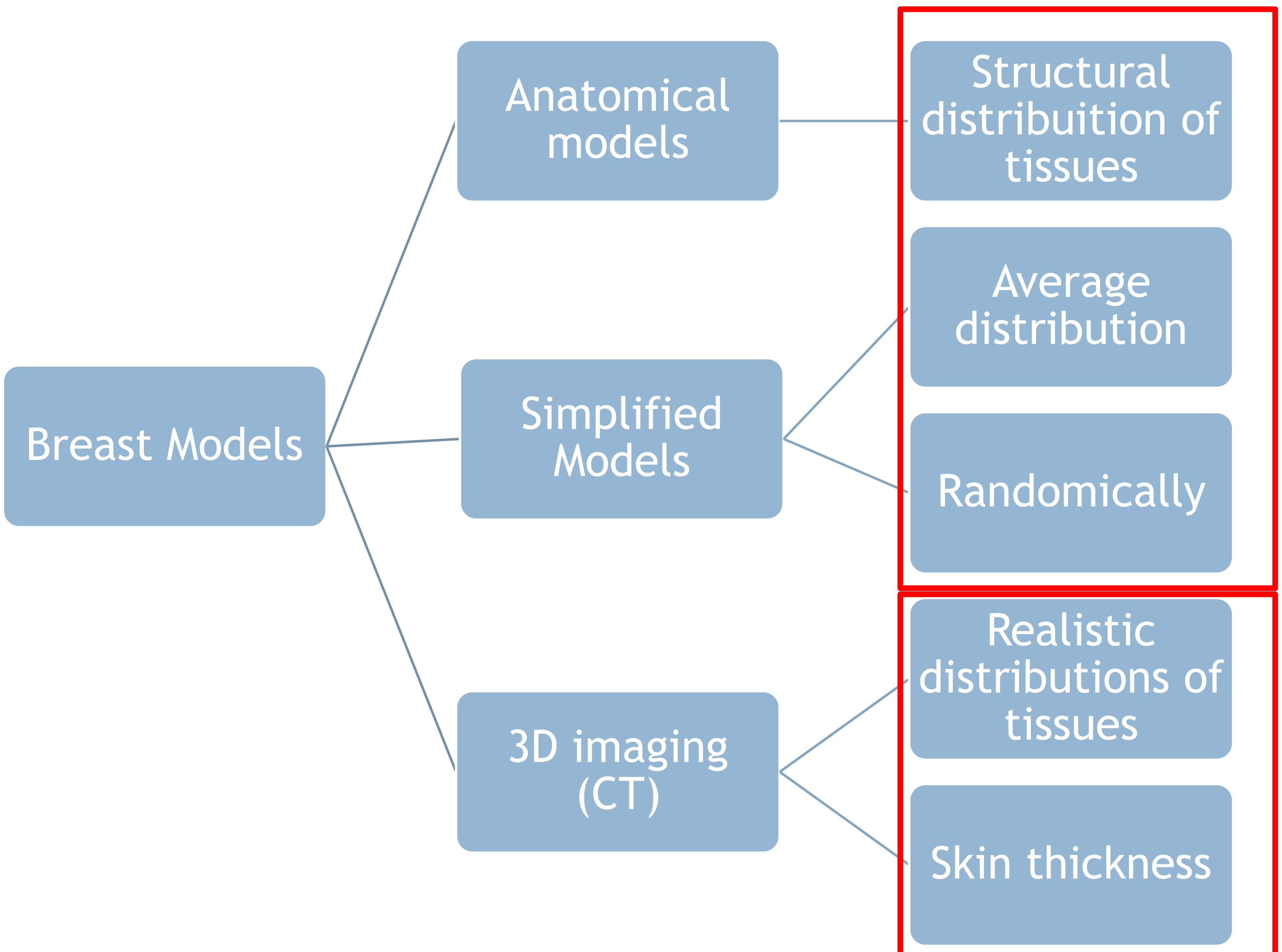
IOP Publishing | Institute of Physics and Engineering in Medicine Physics in Medicine & Biology

Phys. Med. Biol. **62** (2017) 6446–6466 https://doi.org/10.1088/1361-6560/aa6ca3

Evaluation of the *BreastSimulator* software platform for breast tomography

G Mettivier[1,6], K Bliznakova[2], I Sechopoulos[3,4], J M Boone[5], F Di Lillo[1], A Sarno[1], R Castriconi[1] and P Russo[1]

Sumary: Computational breast models

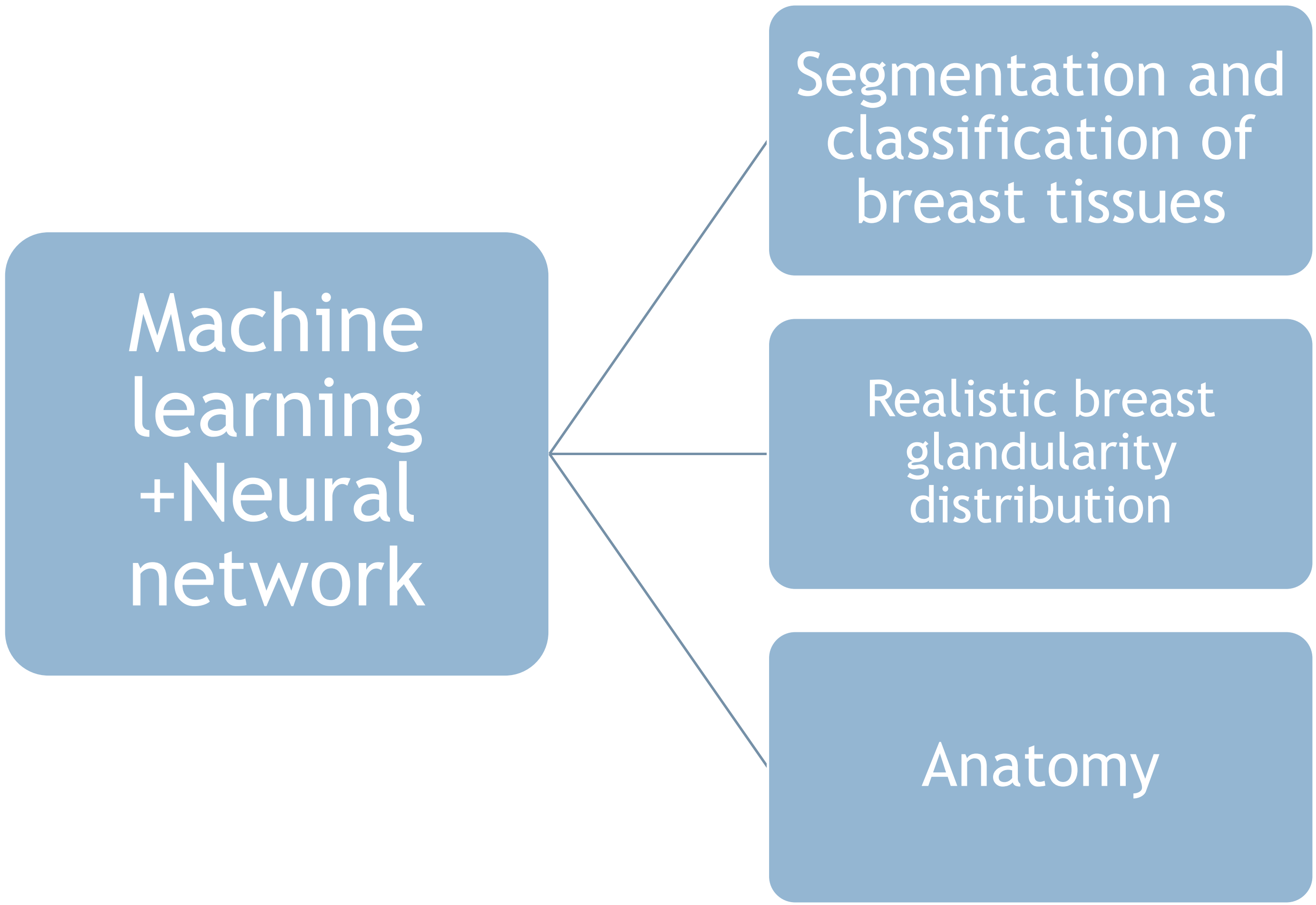


Average Women

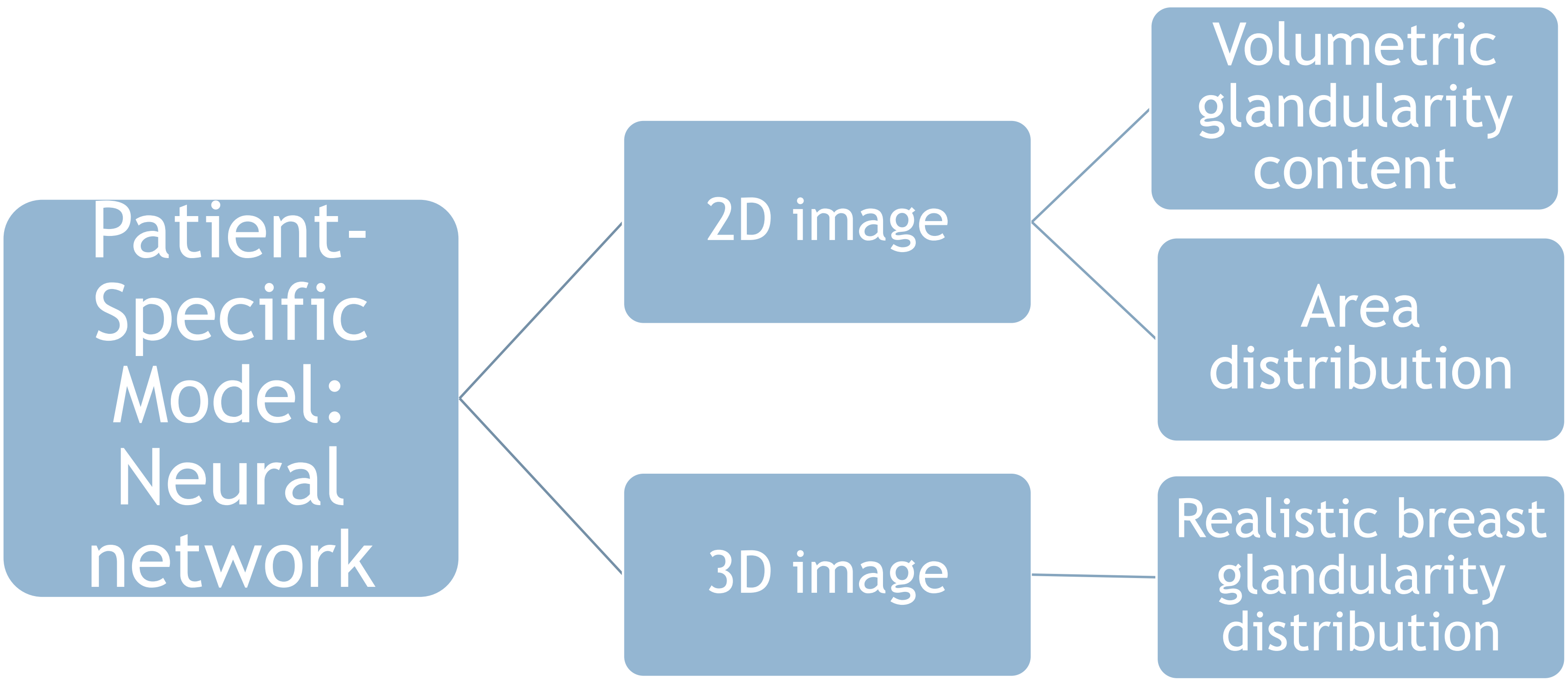
Patient-specific

Few data available

Work in progress: New computational breast models

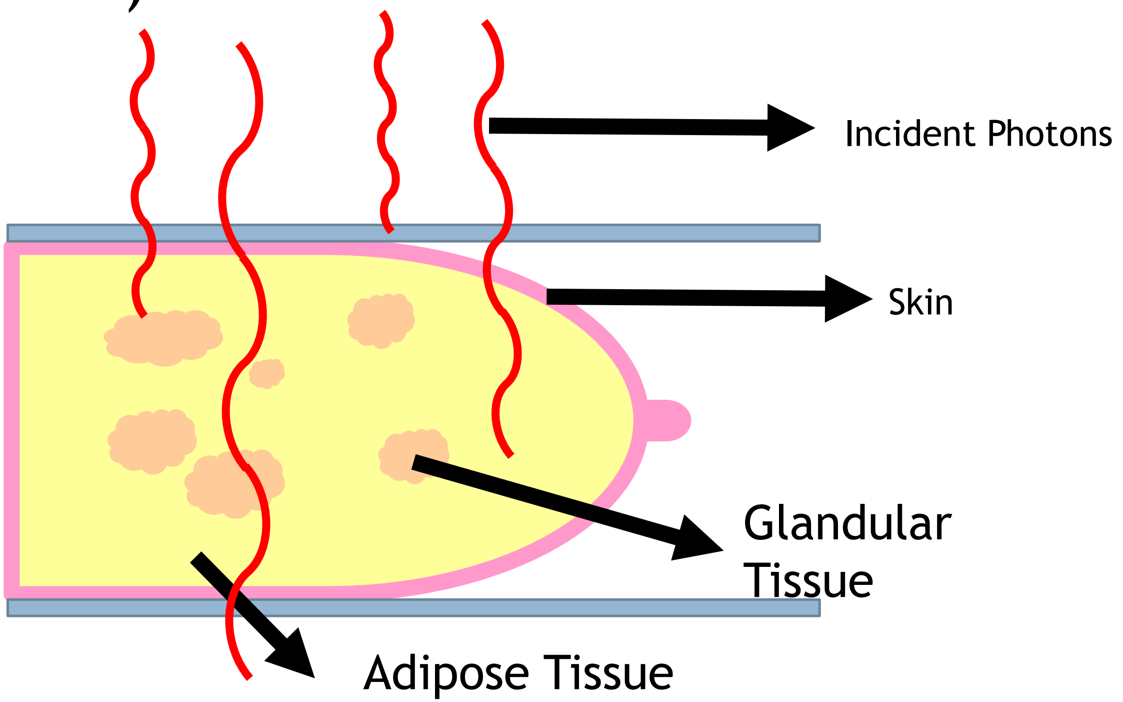


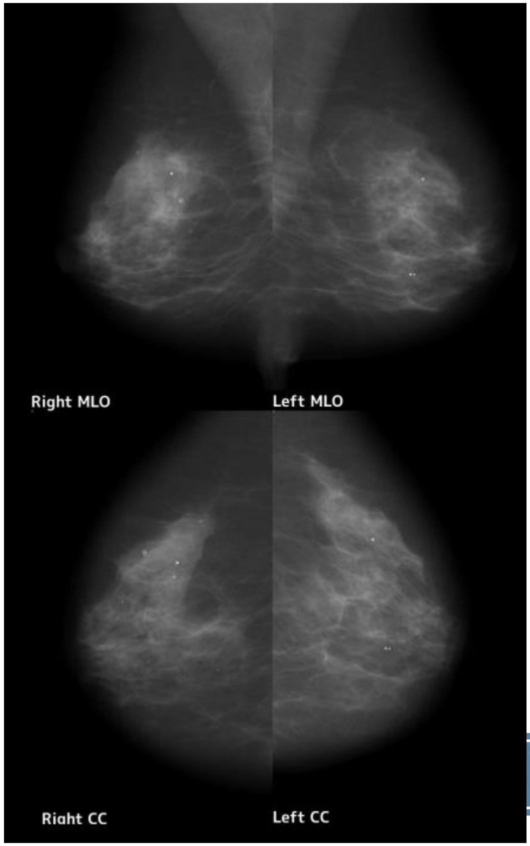
Work in progress: New computational breast models



Work in progress: New computational breast models

2D images: Neural networworks based on softwares for measurement of Volumetric Breast Density (VBD)





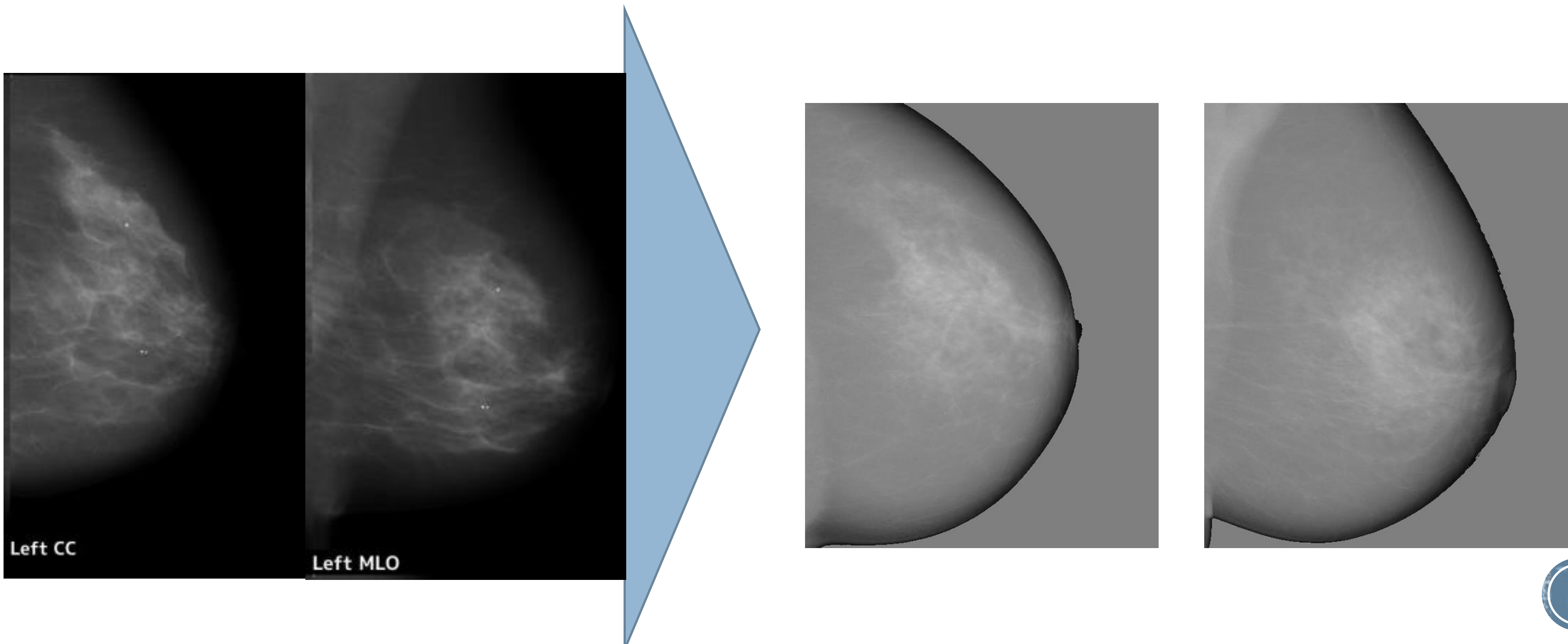
Work in progress: New computational breast models

Cohort

- 14,618 women who undertaken mammographic examination at Instituto de Radiologia (Inrad) da HCFM-USP and Instituto do Câncer de São Paulo between january/2012 and july/2016.
- 16,147 sudies: 64,048 images (left and right breast, CC and MLO view)
- Ethics comitee: CAAE 47878315.2.0000.5404

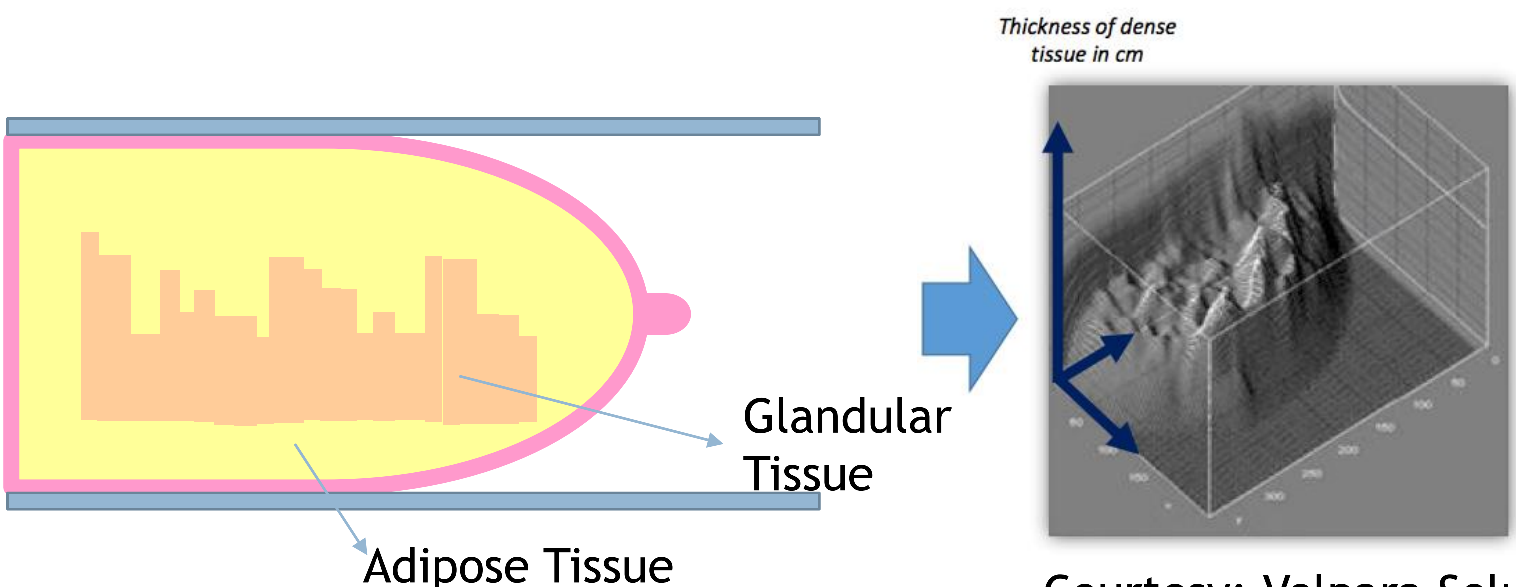
Work in progress: New computational breast models

2D images: Based on softwares for measurement of Volumetric Breast Density (VBD)



Work in progress: New computational breast models

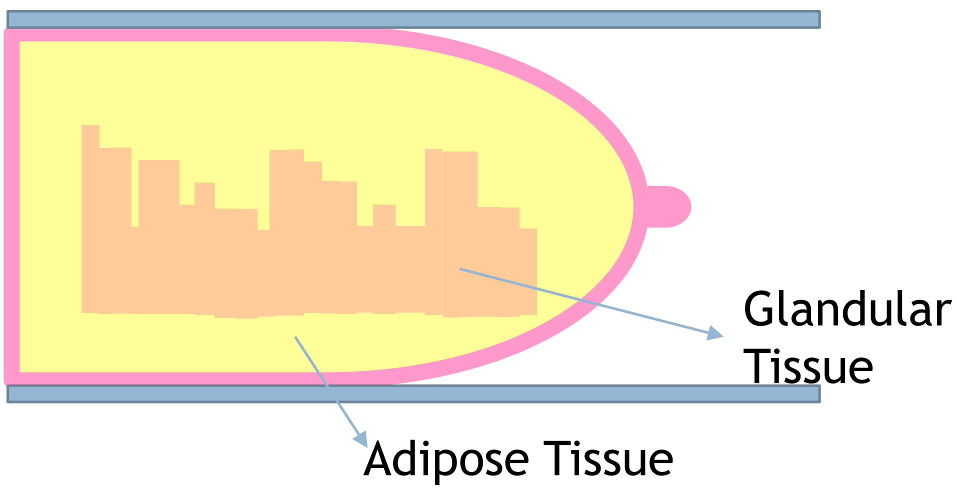
Based on softwares for measurement of Volumetric Breast Density (VBD)



Courtesy: Volpara Solutions

Work in progress: New computational breast models

Based on softwares for measurement of Volumetric Breast Density (VBD)



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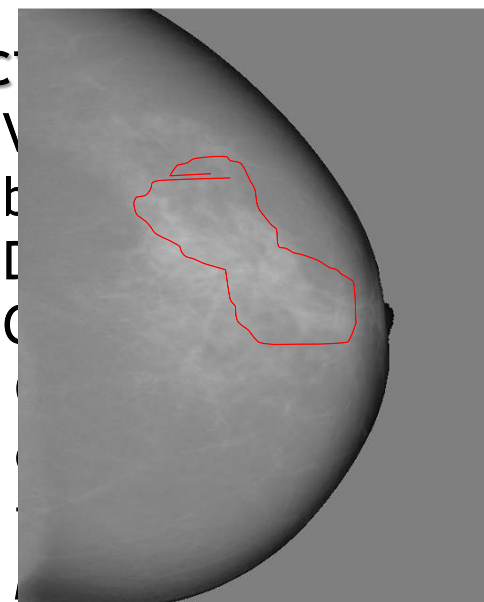

Work in progress: New computational breast models

Parameters to consider... Next steps

- Investigate de 3D structure based on breast tomosynthesis images
- Validate the model based on Neural Network
    - Compare with breast CT images
    - Compare with other computational breast models
- Construct computational breast phantom for breast dosimetry
- Aplly to patient-specific dosimetry

Summary

- Physical breast phantoms used for QA and QC in mammography
- Development of new x-ray imaging techniques

  More realistic physical phantom

  Complex 3D distribution of structures

  Clinical trial
- Computational phantom:

  New imaging techniques

  Multimodality imaging

  Anthropomorphic, structured design

Acknowledgement

UNICAMP

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Instituto de Física Gleb Wataghin

FAPESP

- Process 2016/15366-9
- Process 2015/21873-8

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

- Process 483170/2015-3

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Obrigado!

Thank You!

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