X-Ray Associates of New Mexico, P.C.

EMERGING BREAST IMAGING TECHNOLOGIES

MICHAEL N. LINVER, MD, FACR

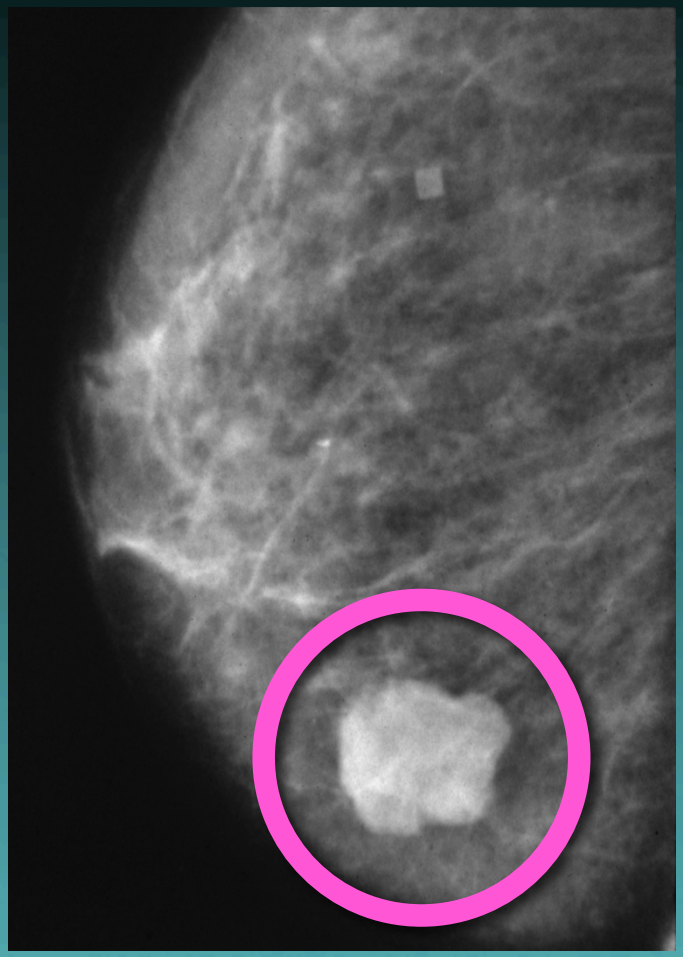
NEW TOOLS IN BREAST IMAGING

- Full Field Digital Mammography
  - ➡ Tomosynthesis, Digital Subtraction
- Optical Scanning
  - ➡ Thermography, Infrared Imaging, Opto-Acoustic Imaging
- Ultrasound
  - ➡ Elastography, 3D Ultrasound
- Artificial Intelligence
  - ➡ For Mammography and Tomosynthesis

NEW TOOLS IN BREAST IMAGING

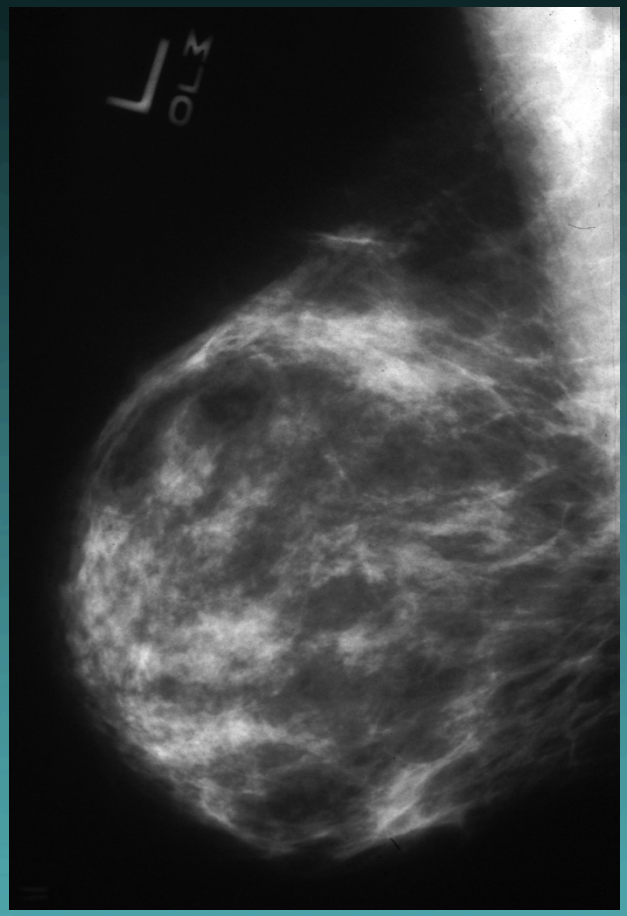
- Full Field Digital Mammography
  - ➡ Tomosynthesis, Digital Subtraction

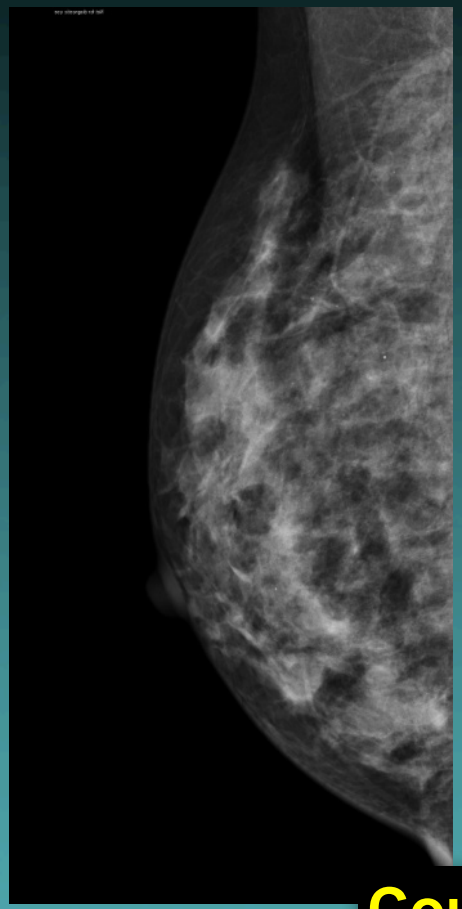
- When tumors are in tissue of a different x-ray density, they are easy to see on mammography

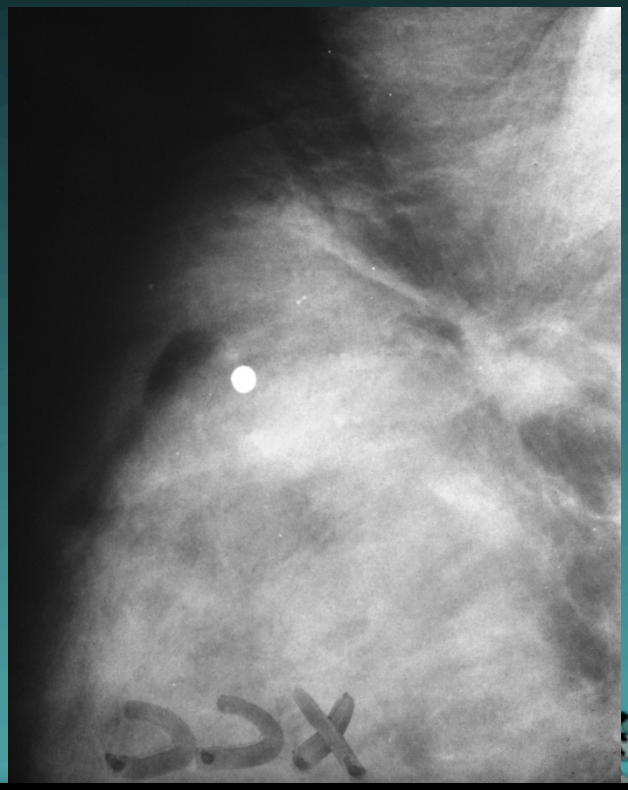


Courtesy Dr. David Dershaw

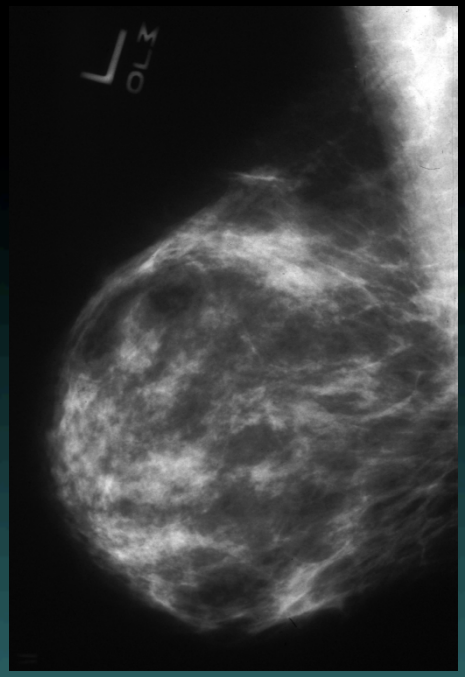
- **Breasts come in different densities on mammograms, and the denser ones can make it difficult to see some cancers.**







Courtesy Dr. David Dershaw



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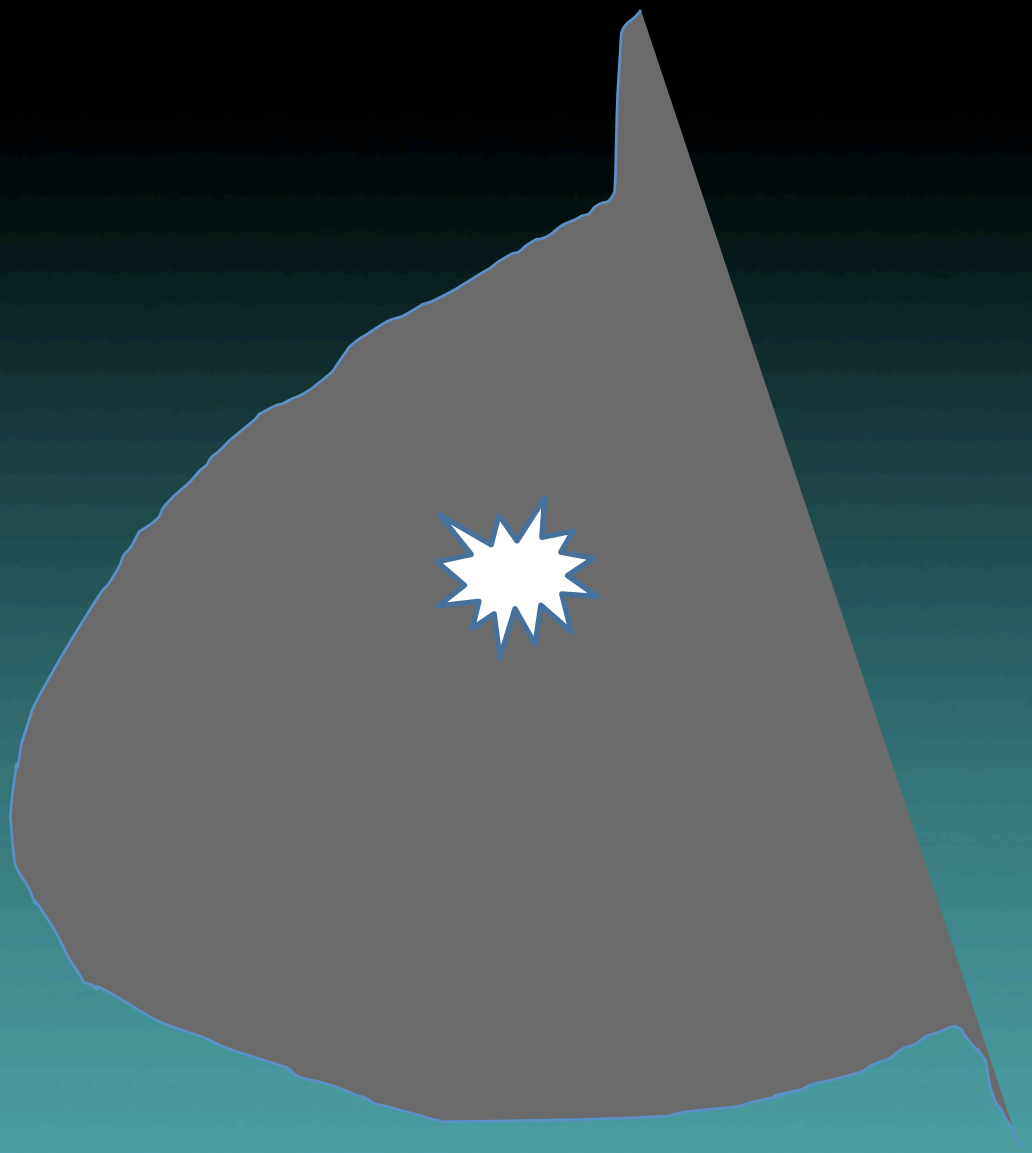

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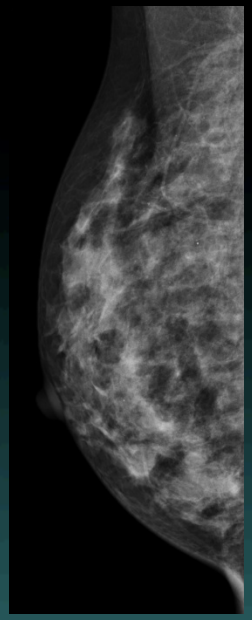
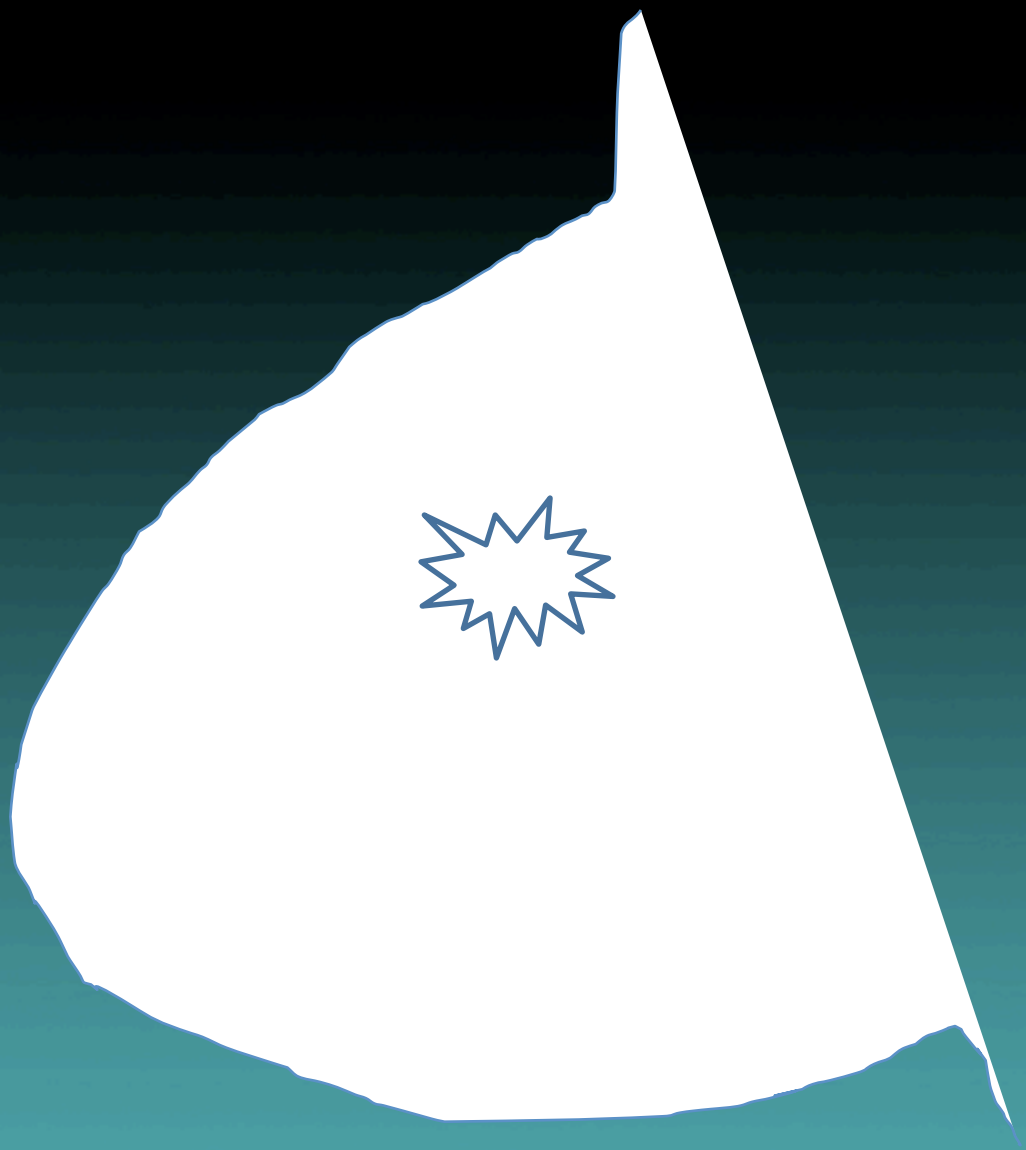
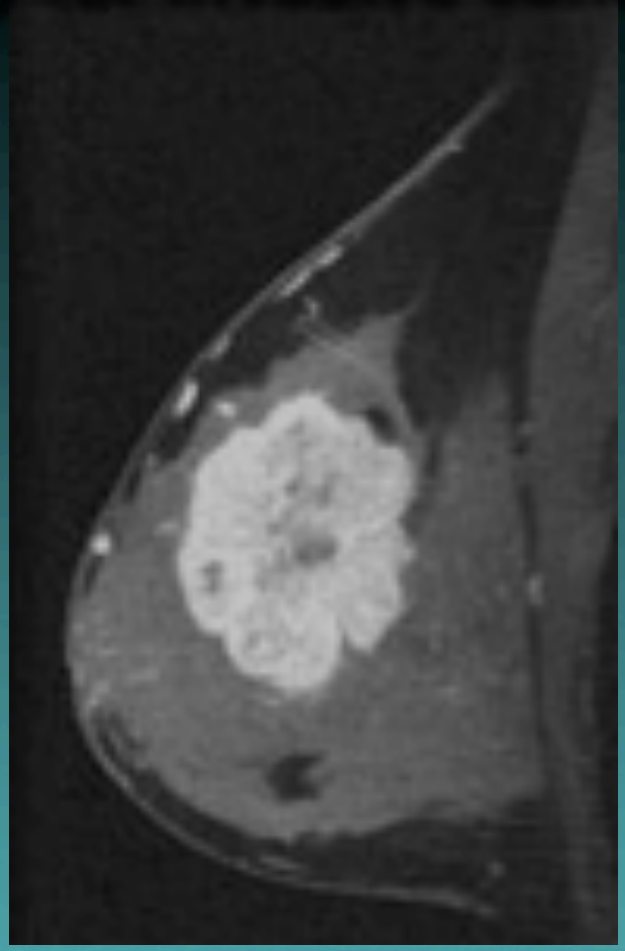




Courtesy Dr. David Dershaw

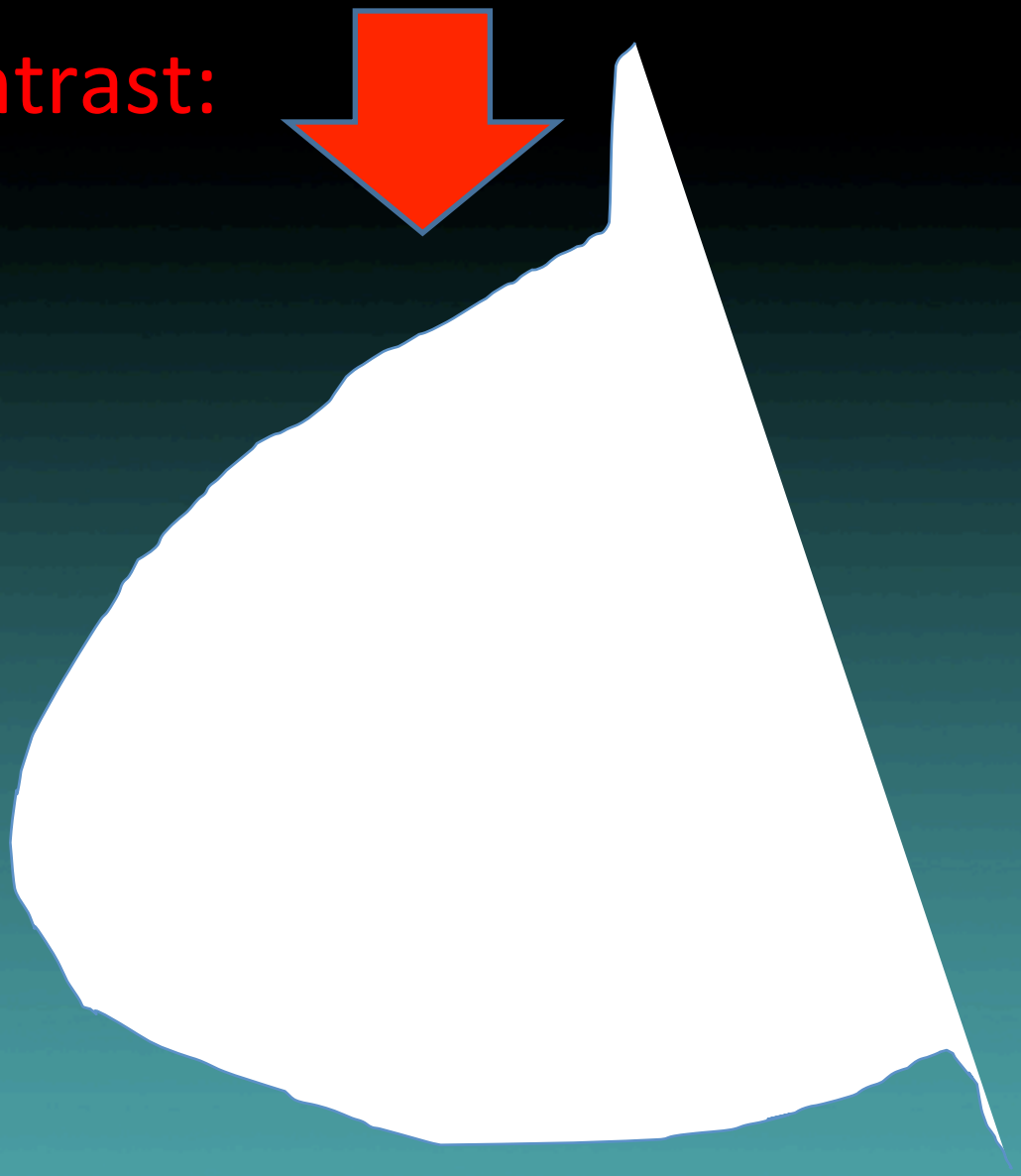
Courtesy Dr. David Dershaw

- Compared to mammography with ~85% sensitivity, contrast-enhanced MRI improves sensitivity for invasive cancer, approaching 100%

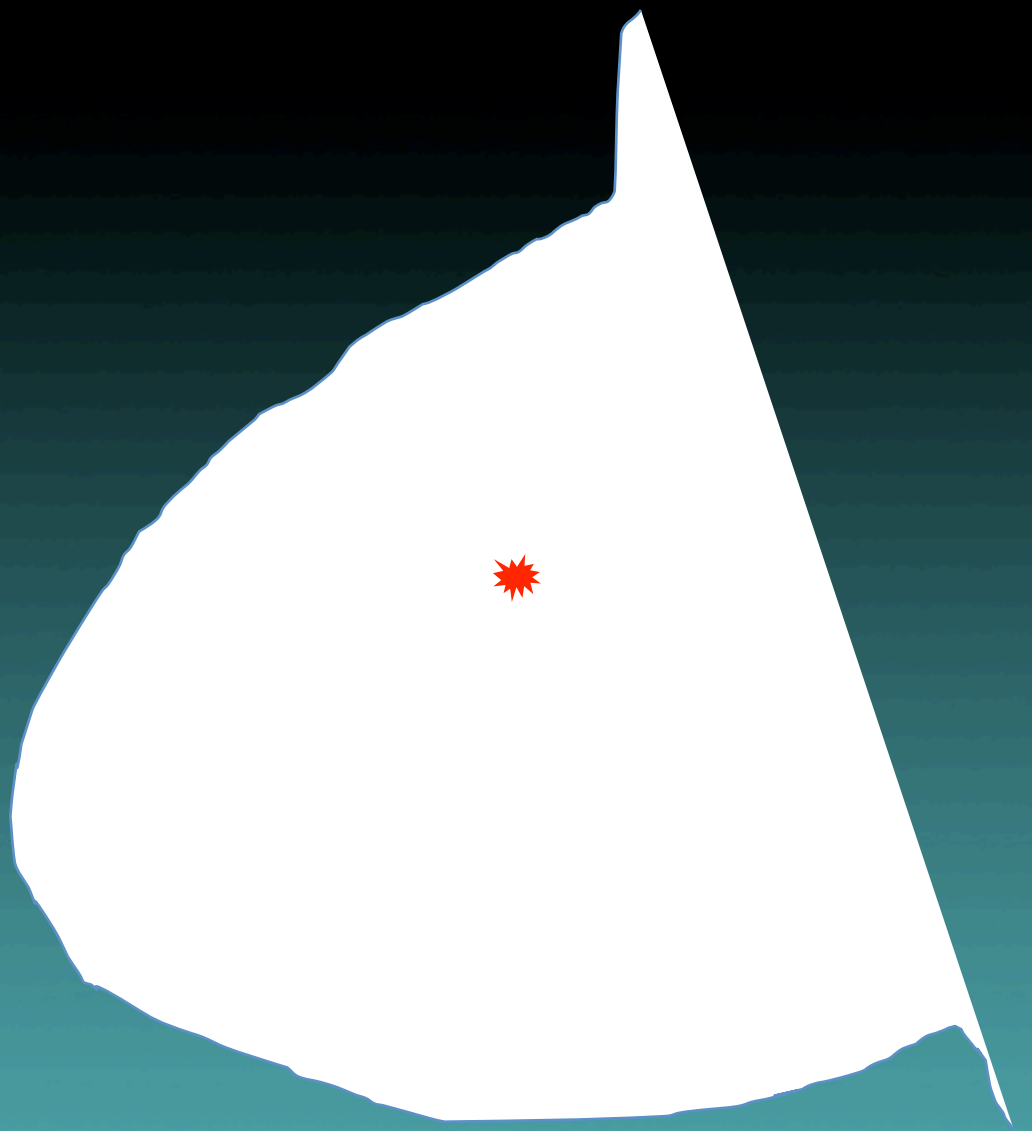


Courtesy Dr. David Dershaw

Inject contrast:



Courtesy Dr. David Dershaw



Courtesy Dr. David Dershaw

- MRI is able to detect close to 100% of invasive breast carcinoma and 40-80% of DCIS.

- Mammography detects no more than 75% of breast cancers and some series suggest less than 50% of DCIS.

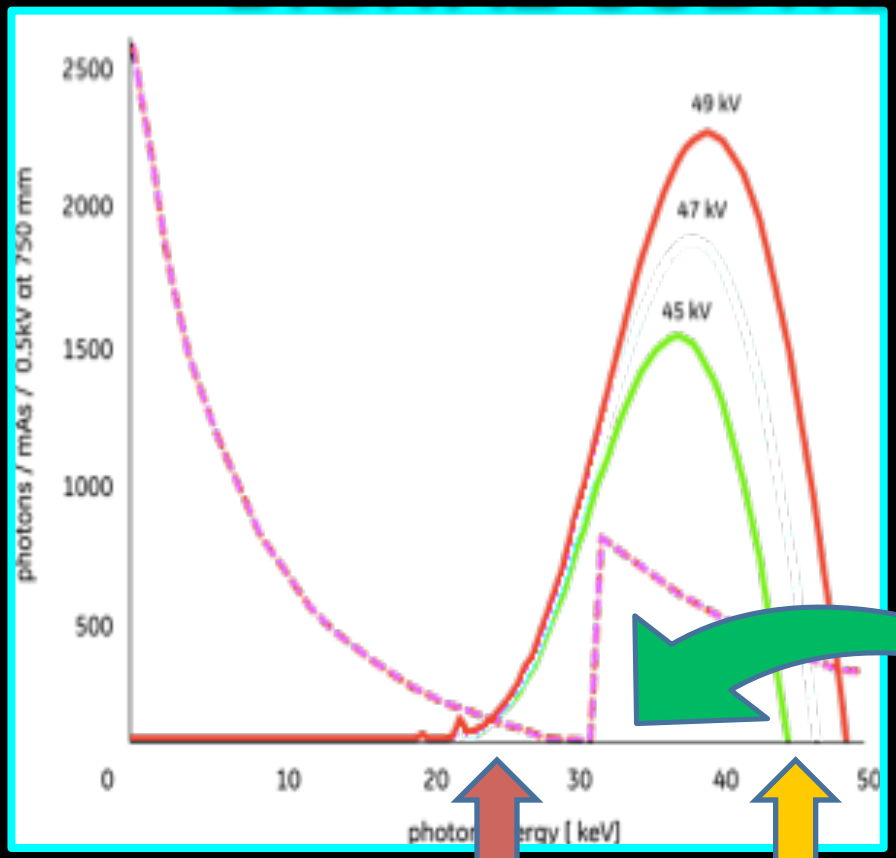
- MRI is useful in breast imaging due to its ability to map blood flow.

- Could flow maps obtained using digital mammographic technology approach the usefulness of MRI?

CONTRAST ENHANCED DIGITAL MAMMOGRAPHY (CEDM) DESIGN

- ➡ BILATERAL STUDY with single MLO and CC image of each breast: dual energy CEDM
- Each breast imaged at a different time point with high and low kVp.
- No dynamic information
- Normal mammogram obtained as part of study

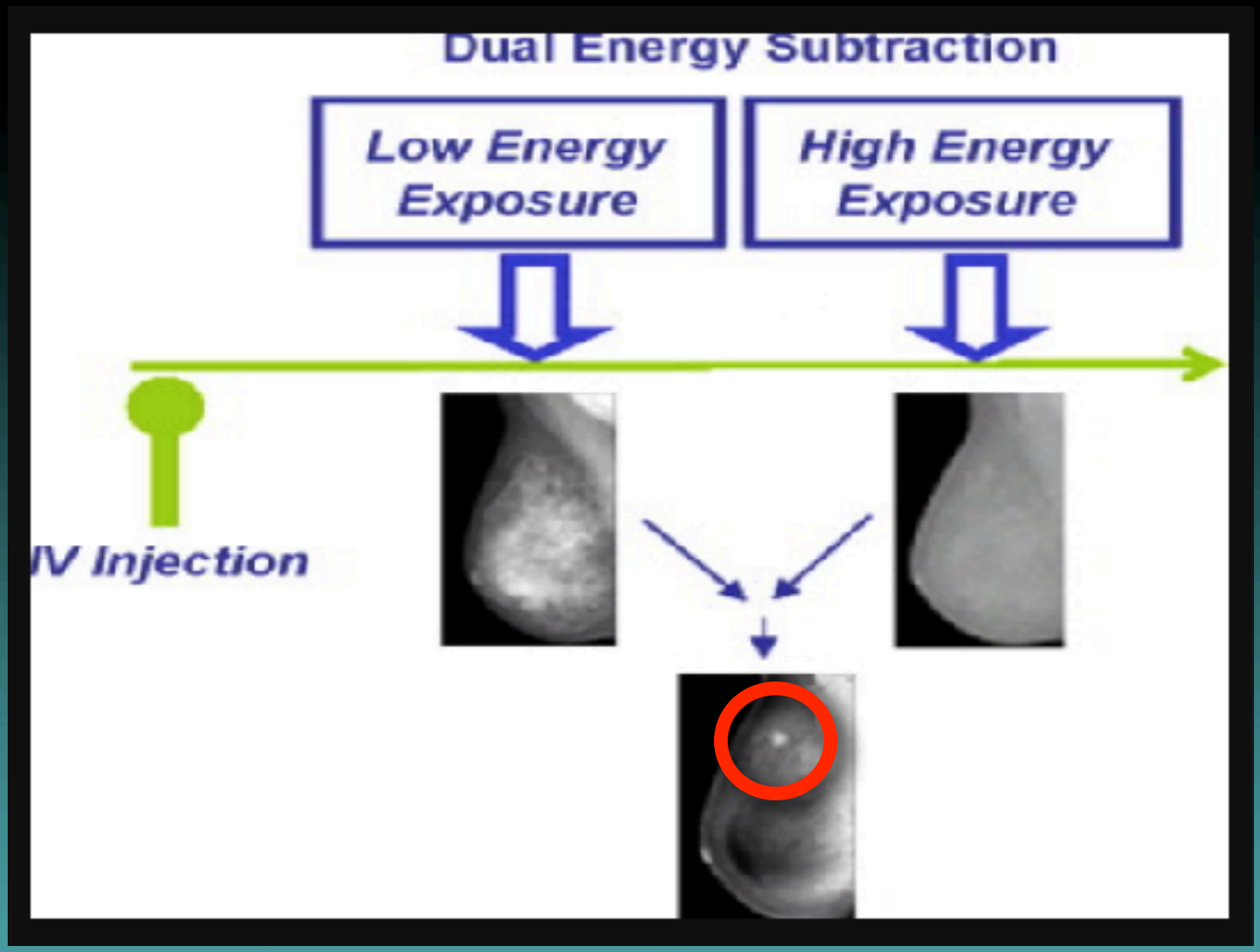
DUAL-ENERY CONTRAST-ENHANCED DIGITAL SUBTRACTION



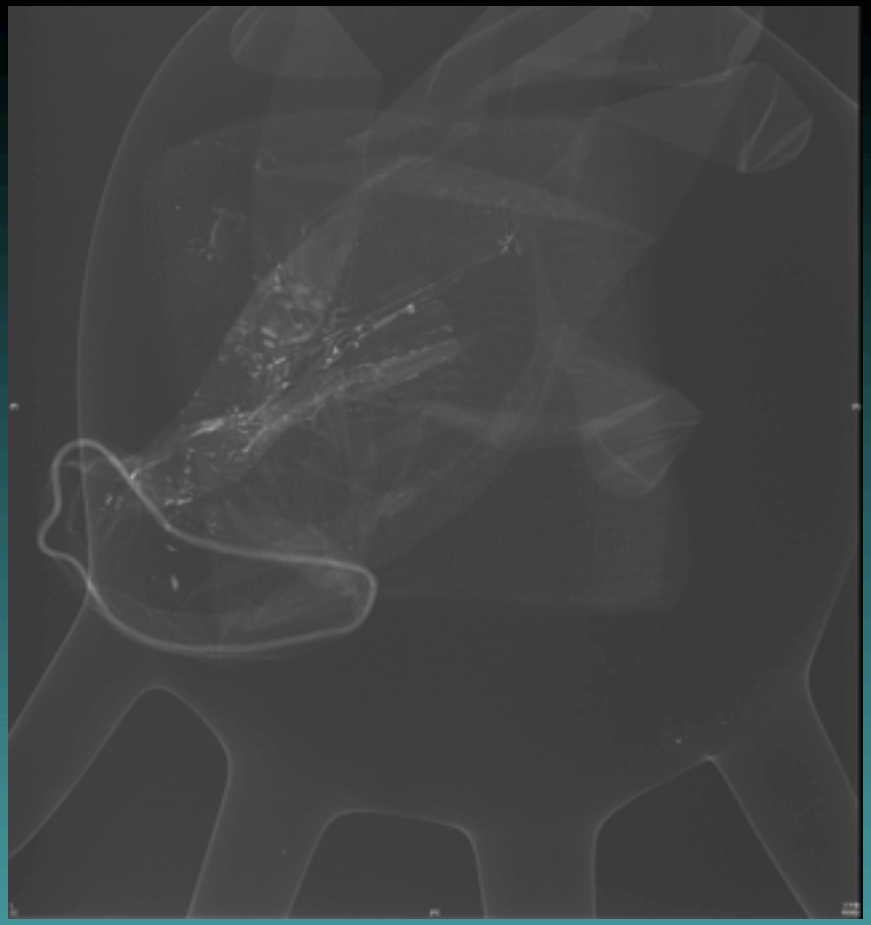
Iodine K-edge
33 Kev

kVp range for low energy (diagnostic) mammography

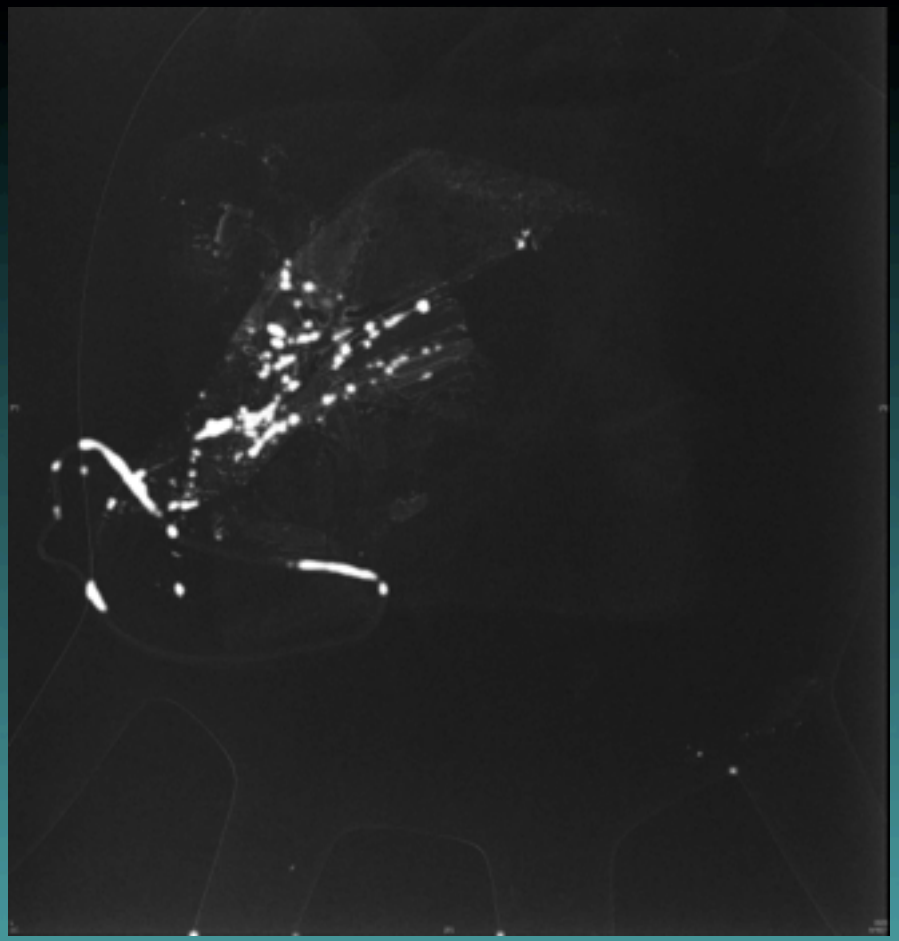
kVp range for high energy mammography


Dual Energy Subtraction
Low Energy Exposure
High Energy Exposure
IV Injection

Rubber glove phantom filled with saline and painted with Omnipaque 350



Low energy (25 kV)



High energy (49 kV)

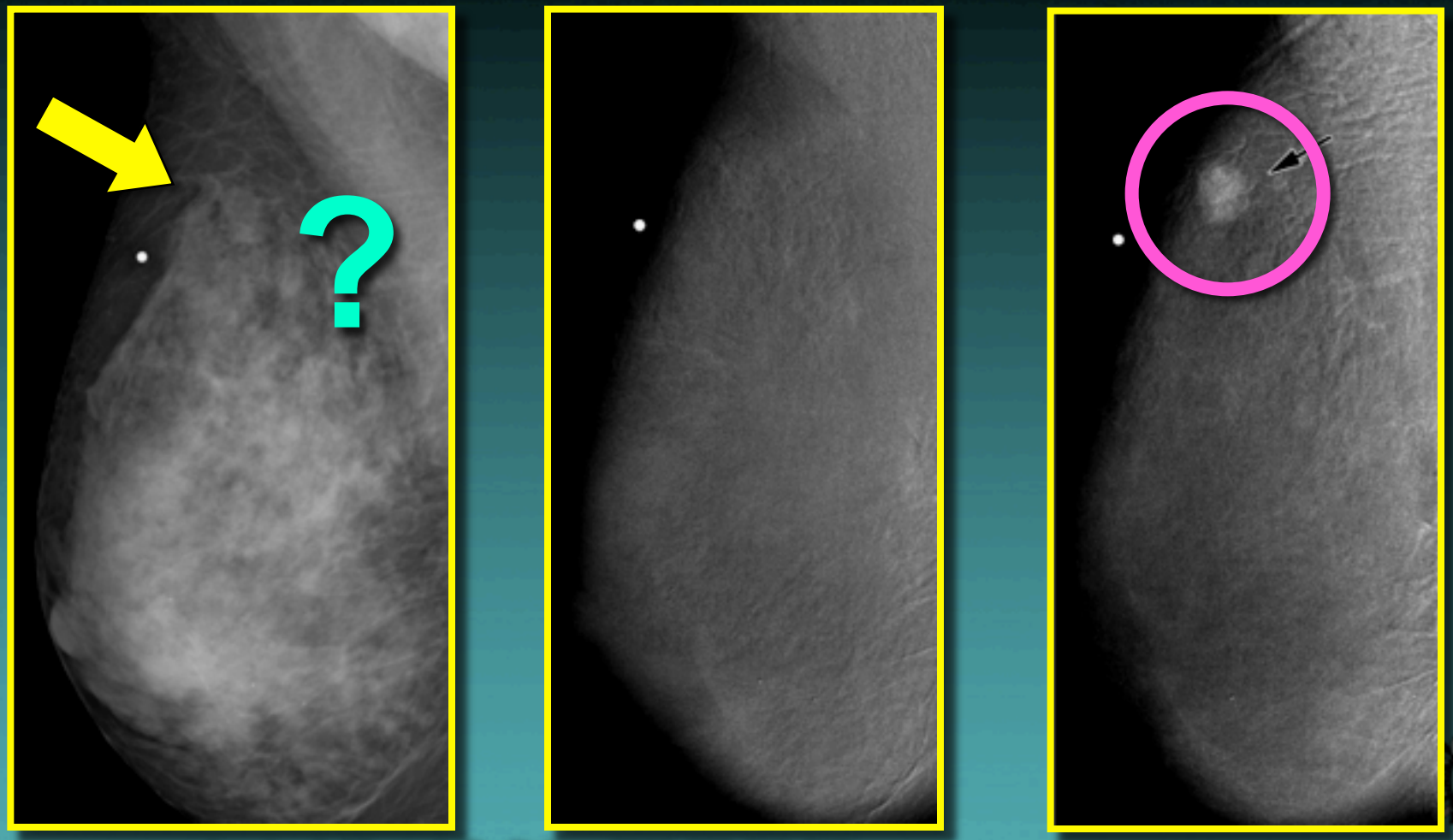
Courtesy Dr. David Dershaw

DUAL-ENERY CONTRAST-ENHANCED DIGITAL SUBTRACTION: INVASIVE LOBULAR CARCINOMA

Diagnostic mammogram (lump)

Pre-contrast dual energy

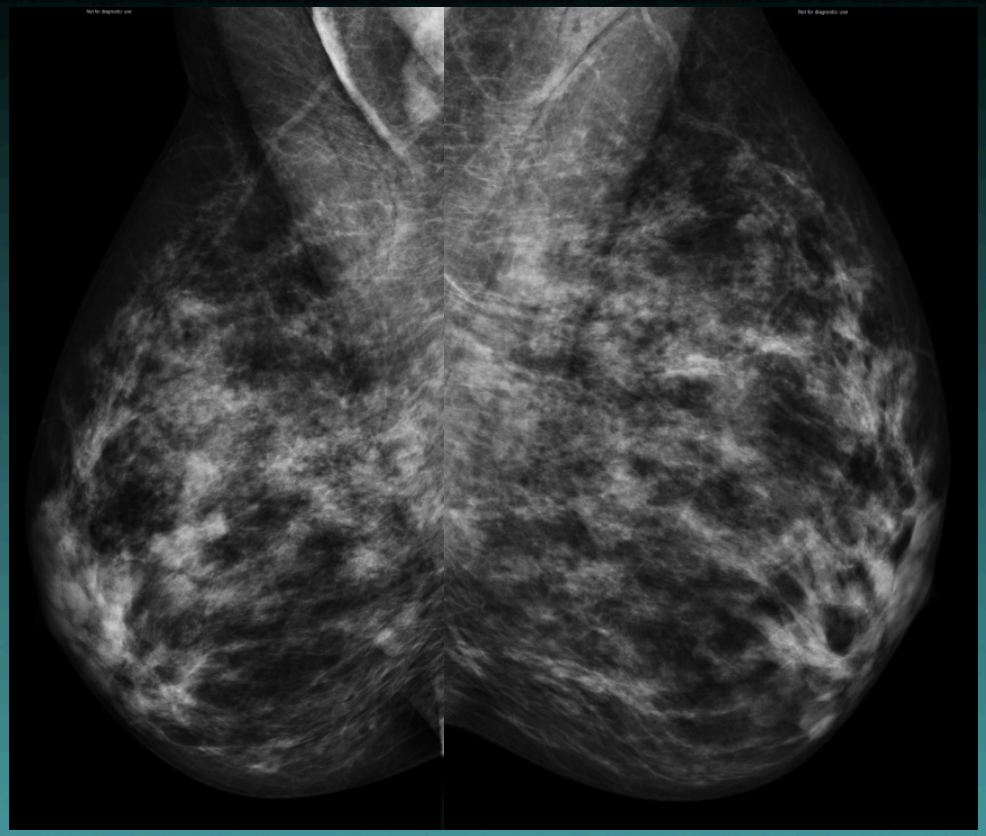
Post-contrast dual energy

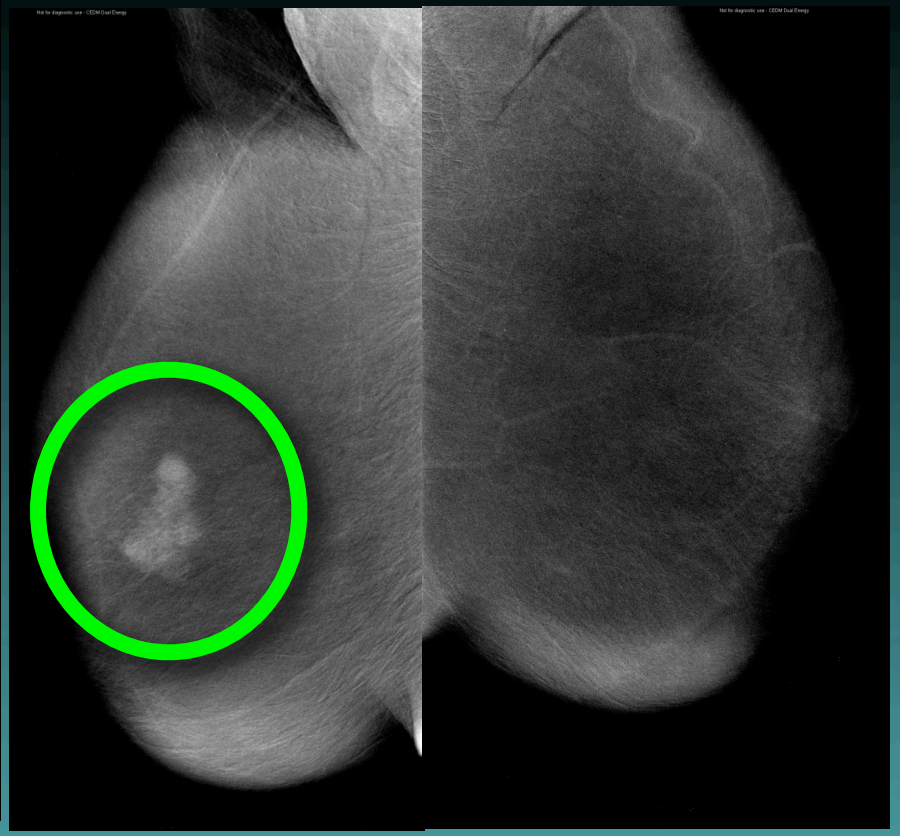


Lewin, J. M. et al. Radiology 2003;229:261-268

SCREENING MAMMOGRAM

CONTRAST ENHANCED





Courtesy Dr. David Dershaw

CONTRAST ENHANCED DIGITAL MAMMOGRAPHY: POTENTIAL USES

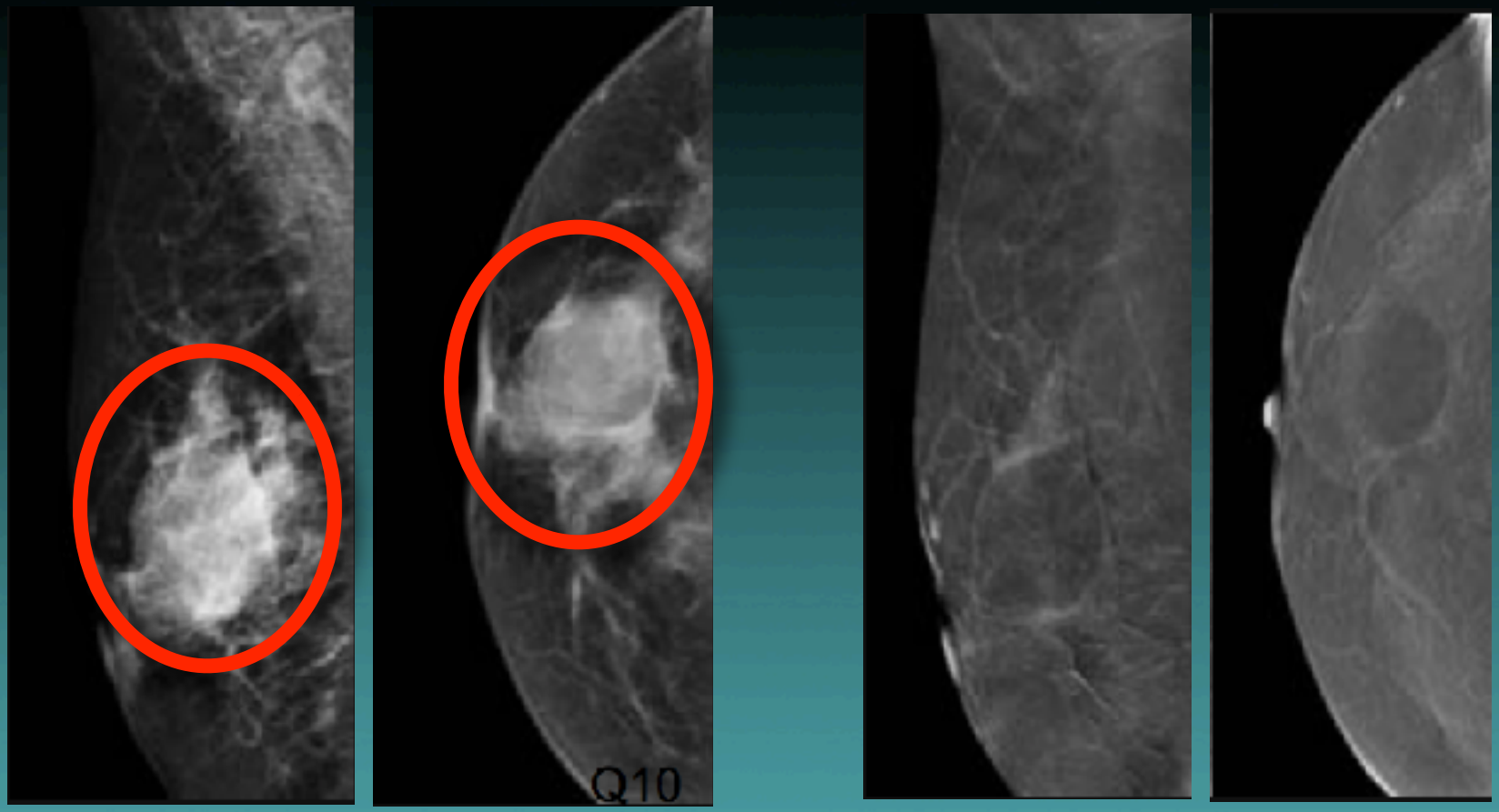
- Workup of indeterminate mammographic lesions
- Pre-op evaluation of extent of disease in pt. newly diagnosed with breast cancer
- Assessing response to chemotherapy
- Screening

CONTRAST ENHANCED DIGITAL MAMMOGRAPHY: POTENTIAL USES

- Workup of indeterminate mammographic lesions

SCREENING MAMMOGRAM

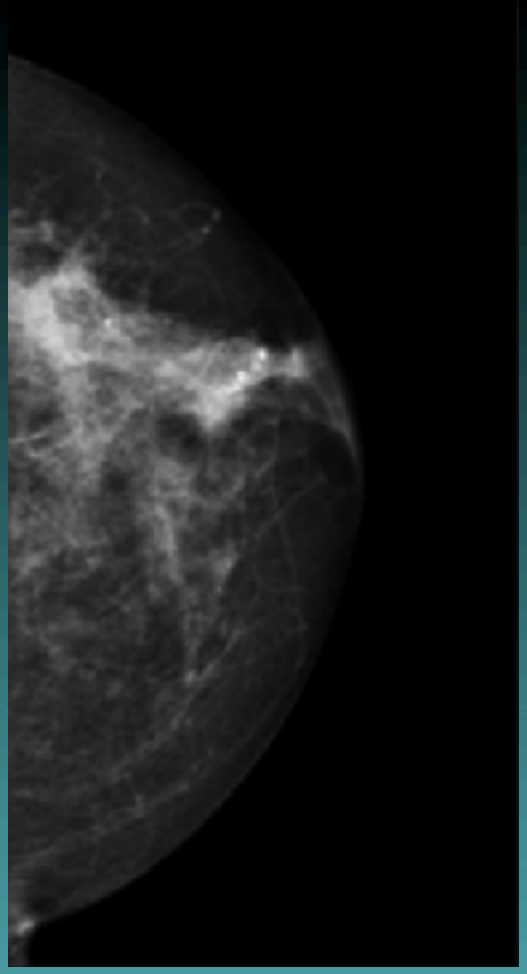
CONTRAST ENHANCED

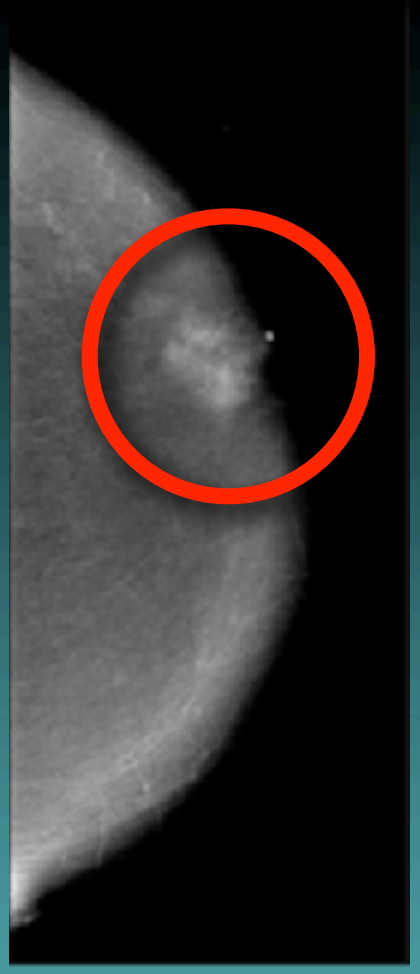


DIAGNOSIS: BENIGN (CYST)!

SCREENING MAMMOGRAM

CONTRAST ENHANCED





DIAGNOSIS: CANCER

CONTRAST ENHANCED DIGITAL MAMMOGRAPHY: POTENTIAL USES

- Workup of indeterminate mammographic lesions
- **Pre-op evaluation of extent of disease in pt. newly diagnosed with breast cancer**

EXTENT OF TUMOR IN INVOLVED BREAST

CONTRAST ENHANCED

BREAST MRI

Courtesy Dr. David Dershaw

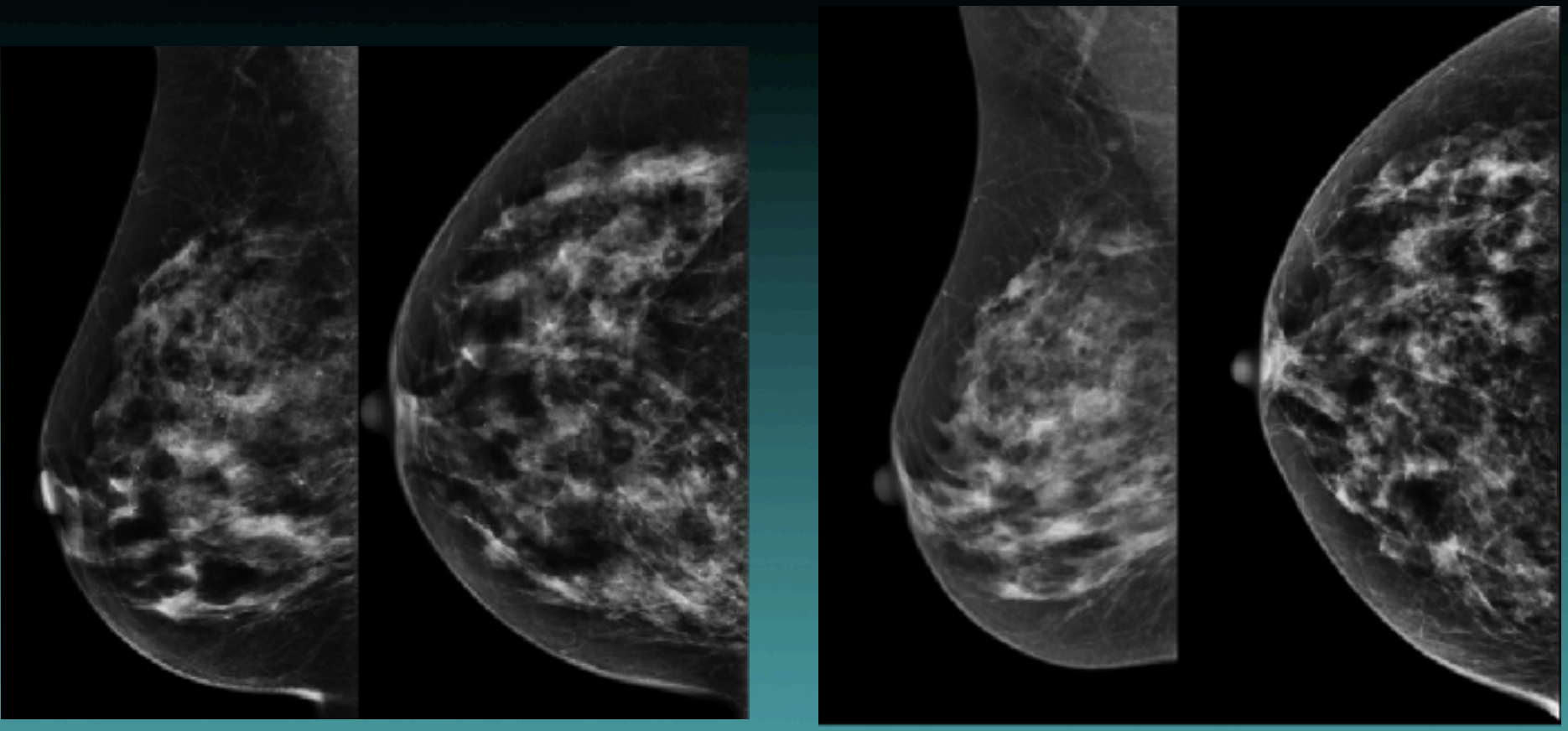
CONTRAST ENHANCED DIGITAL MAMMOGRAPHY: POTENTIAL USES

- Workup of indeterminate mammographic lesions
- Pre-op evaluation of extent of disease in pt. newly diagnosed with breast cancer
- Assessing response to chemotherapy
- **Screening**

50 y.o. high risk pt (previous LCIS)

SCREENING MAMMO
PREVIOUS YEAR

SCREENING MAMMO
CURRENT STUDY



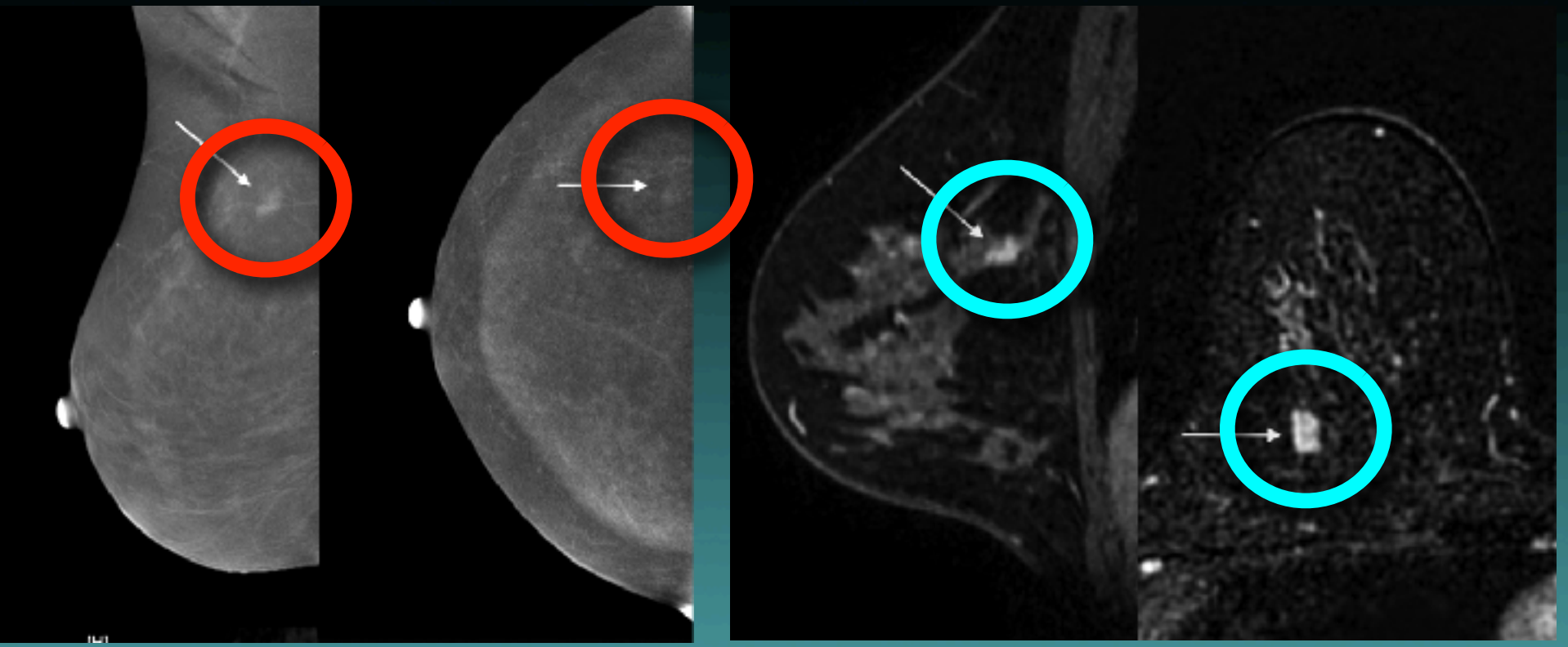
NO CHANGE, NO ABNORMALITY SEEN

Jochelson M et al. Europ J Rad 2017;97: 37-43

50 y.o. high risk pt (previous LCIS)

SCREENING CEDM

SCREENING MRI



INVASIVE LOBULAR CARCINOMA

Jochelson M et al. Europ J Rad 2017;97: 37-43

CONTRAST ENHANCED DIGITAL MAMMOGRAPHY: POTENTIAL ADVANTAGES

- Done at same time as routine mammography
- Low cost
- 1.2 x radiation dose
- Improved sensitivity and specificity

CEDM: WHAT ARE THE LIMITATIONS?

- Radiation dose is 20-25% greater than a routine mammogram, the equivalent of one extra image.
- Requires injection of iodinated contrast.
- False positives
- Biopsy of CEDM-only finding:

  Biopsy system now available!!

CEDM: WHAT ARE THE LIMITATIONS?

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IODINATED CONTRAST REACTIONS VS. GADOLINIUM REACTIONS

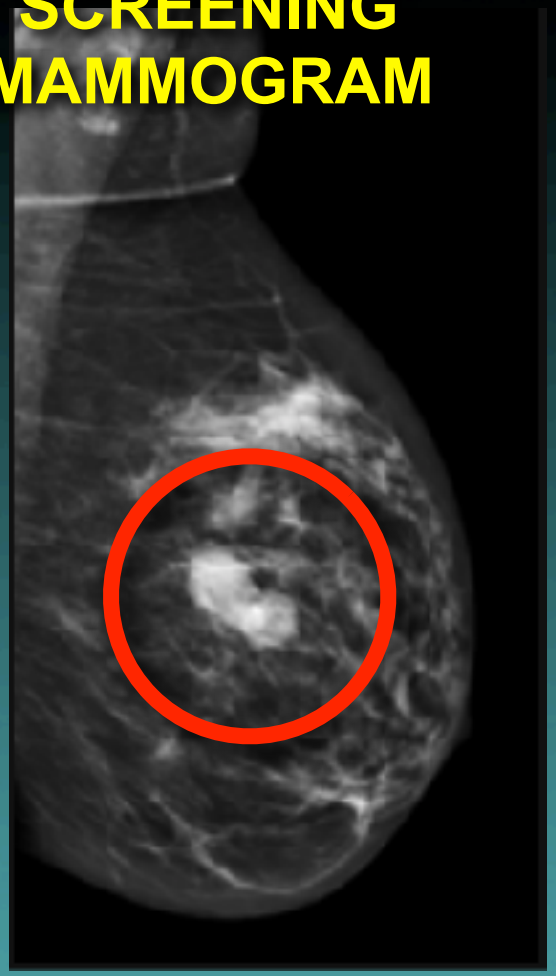
	Iodinated	Gadolinium
Mild	2-31/1000	.7-24/10000
Serious	4/1,000	1.5/1000
Death	1/100,000	1/100,000

CEDM: WHAT ARE THE LIMITATIONS?

- Radiation dose is 20-25% greater than a routine mammogram, the equivalent of one extra image.
- Iodinated contrast administration.
- False positives

FALSE POSITIVE STUDY

SCREENING MAMMOGRAM

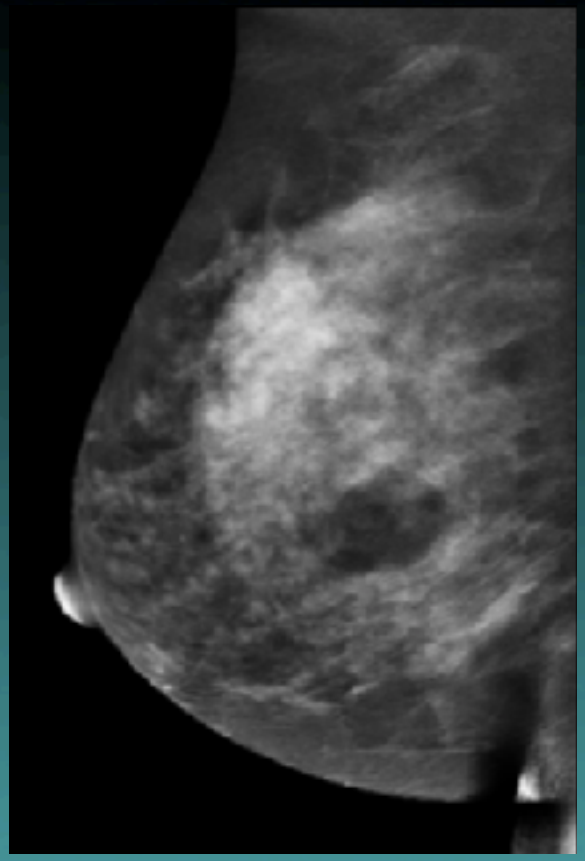


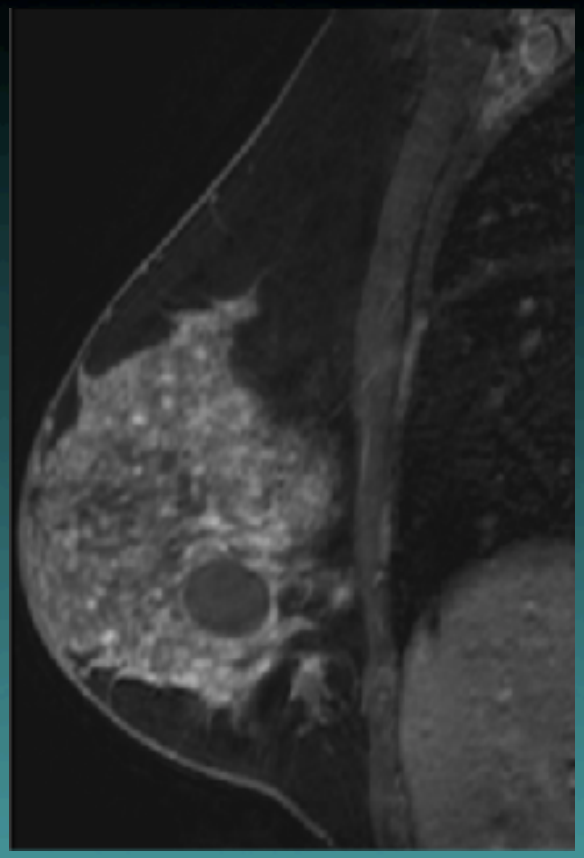
CONTRAST ENHANCED

BIOPSY: FIBROADENOMA

SCREENING MAMMOGRAM

BREAST MRI





BACKGROUND PARENCHYMAL ENHANCEMENT (BPE)

CEDM: WHAT ARE THE LIMITATIONS?

- Radiation dose is 20-25% greater than a routine mammogram, the equivalent of one extra image.
- Requires injection of iodinated contrast.
- False positives
- **Biopsy of CEDM-only finding**

  Biopsy system now available!!

HOW TO BIOPSY A LESION SEEN ON CEDM

➡ If biopsy guidance system for CEDM is not yet available:

- Correlate with mammo/sono
- Do “second look” (focused) sono
- Do MRI

(After biopsy with clip placement, repeat CEDM is recommended to confirm biopsy accuracy.)

How does CEDM compare with digital mammography in cancer detection?

CANCER DETECTABILITY WITH CEDM

Author	# cancers	% CEDM seen	% mammo	% other
Dromain Gustave-Roussey Eur Radiol 2011	80	92% (74/80)	78%	
Diekman Charite, Berlin Eur J Radiol 2011	30	62%	43%	
Jochelson Sloan-Kettering, NY Radiology 2013	26	96%	85%	MRI: 96%

CONCLUSION:

CEDM is far superior to digital mammography in the detection and staging of breast cancer

How does CEDM compare with Breast MRI in cancer detection?

BILATERAL CONTRAST ENHANCED DIGITAL MAMMOGRAPHY (CEDM) VS. MRI

	Mammo	MRI	CEDM
Index CA	42/52 (81%)	50/52 (96%)	50/52 (96%)
Additional ipselat CA		22/25 (88%)	14/25 (56%
Contralateral CA		0/1	0/1
TOTAL	**42/78 (54%)**	**72/78 (92%)**	**64/78 (82%)**

	Mammo	MRI	CEDM
False positives		13	2

52 PATIENTS WITH KNOWN CANCER

Jochelson M et al. Radiology 2013;266: 743-751

CONCLUSION:

CEDM is slightly inferior to MRI in the detection of breast cancer and multicentricity, but it is less likely to discover suspicious lesions that require biopsy and are found to be benign (False Positives).

SUMMARY: DIGITAL SUBTRACTION MAMMOGRAPHY

- Finds more cancers than mammography with fewer false positives
- Enhancement of cancers may be less time-dependent than on MRI
- Main uses right now: Dx tool after mammo or US; Staging when MRI is not available
- Cannot exclude carcinoma with 100% reliability: perhaps 4-8% false negatives.
- There is now biopsy capability currently available

FUTURE STUDY TOPICS FOR CEDM

- Is it worthwhile as a screening tool? If so, at what intervals? (1 yr? 3 yrs?)
- Can it replace screening ultrasound?
- Can it replace ulltrasound to evaluate lumps?
- Can it be used for preoperative or post-therapy staging?
- How good is it in the treated breast?
- What is the frequency of false positives?

STAY TUNED!

NEW TOOLS IN BREAST IMAGING

- Full Field Digital Mammography
  - ➡ Tomosynthesis, Digital Subtraction
- Optical Scanning

NEW TOOLS IN BREAST IMAGING

- Full Field Digital Mammography
  - ➡ Tomosynthesis, Digital Subtraction
- **Optical Scanning**

OPTICAL SCANNING

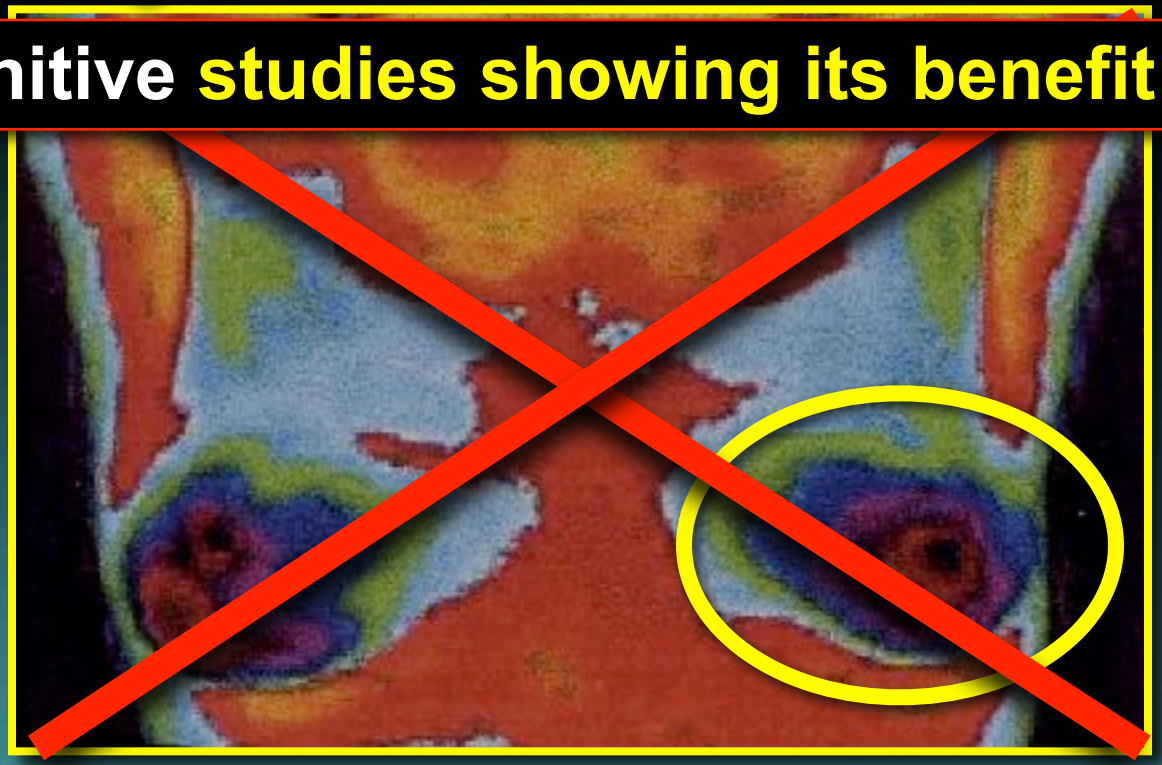
- Infrared scanning- Thermography
- Diffuse Optic Tomography
  - ➡ Laser CT, DOBI Light Scanning
- Updated Infrared Imaging
- Opto-Acoustics

OPTICAL SCANNING

- Infrared scanning- Thermography
  - ➡ Found to be worthless for screening

THERMOGRAPHY: Works on distribution of blood flow and attendant heat, detected by infrared light source

No definitive studies showing its benefit to date



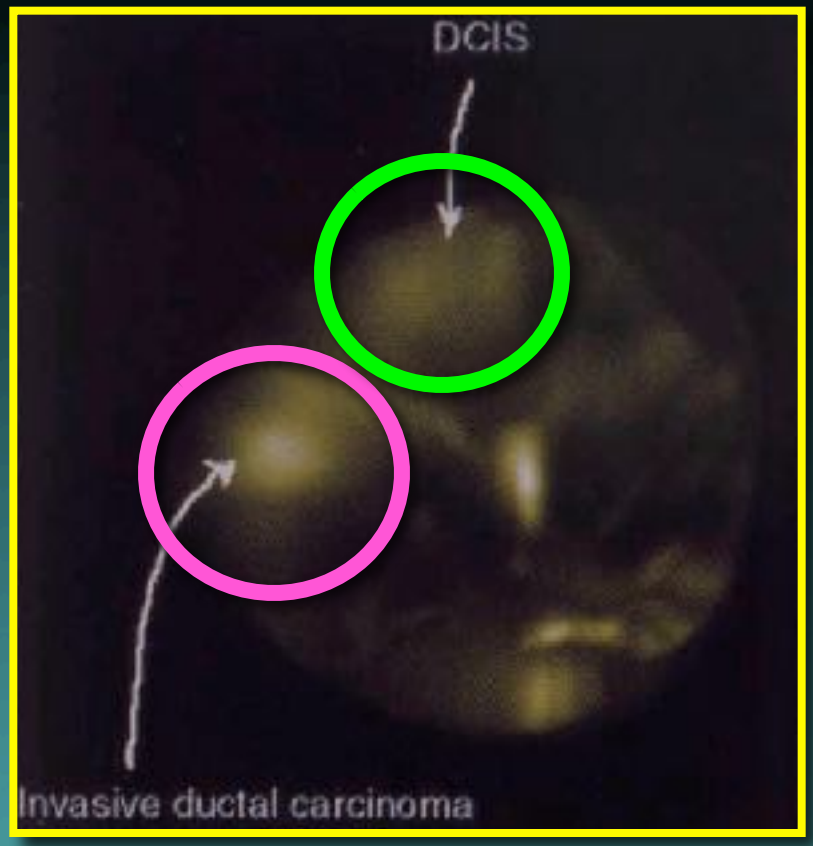
Breast Cancer Screening - Thermography is Not an Alternative to Mammography: FDA Safety Communication

Date Issued: June 2, 2011

OPTICAL SCANNING

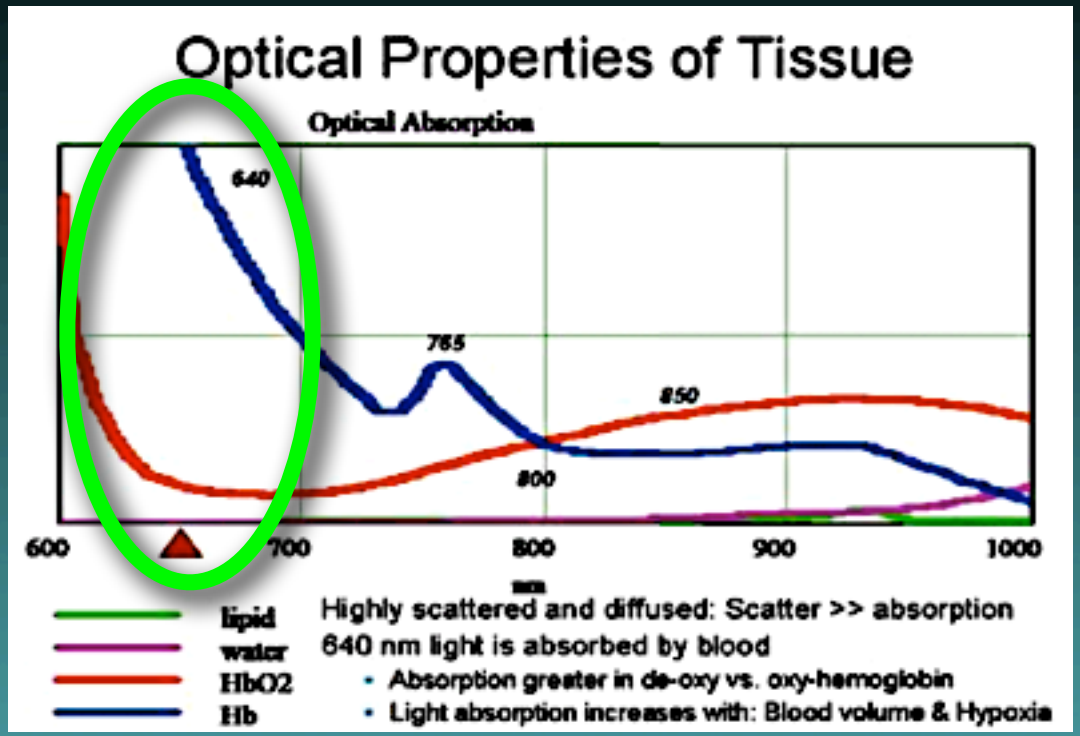
- Infrared scanning- Thermography
  - ➡ Found to be worthless for screening
- Diffuse Optic Tomography
  - ➡ Laser CT, DOBI Light Scanning
  - ➡ NOT very successful

LASER DETECTION: Near infrared laser transmitted; reflected & refracted off cancers differently than benign tissue



No definitive studies showing its benefit to date

DOBI (Dynamic Optical Breast Imaging): Diodes emit red light with wavelength of 640 nm through the breast, and light is recorded on CCD camera



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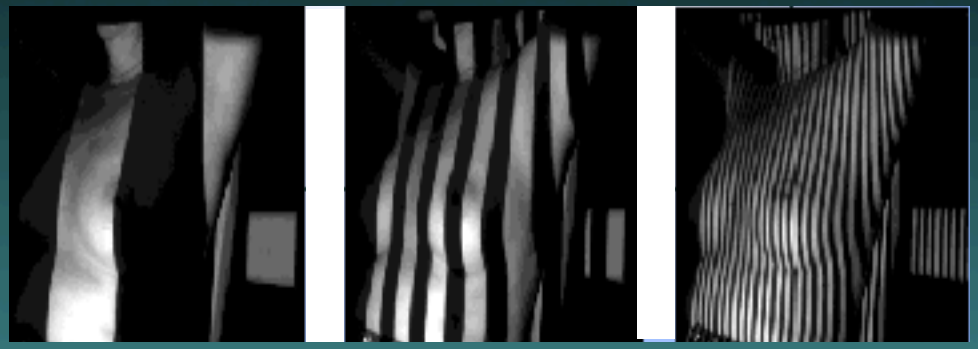
OPTICAL SCANNING

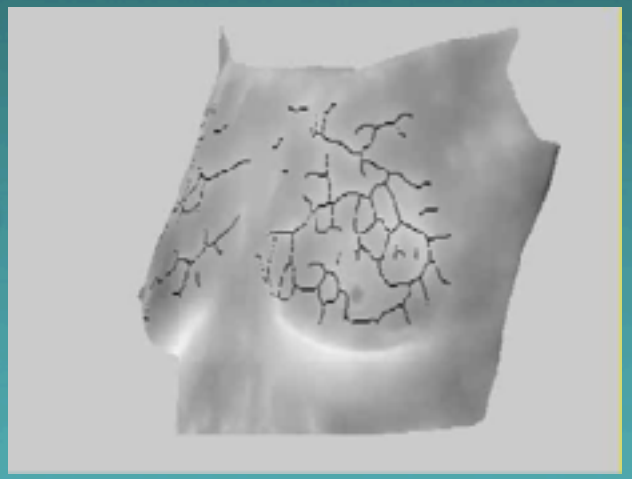
- Infrared scanning- Thermography
  - ➡ Found to be worthless for screening
- Diffuse Optic Tomography
  - ➡ Laser CT, DOBI Light Scanning
  - ➡ NOT very successful
- **Updated** Infrared Imaging
  - ➡ Now coupled to multiparametric computer analysis

The MIRA System

MIRA utilizes dual-head proprietary *Structured Light Projection* infrared imaging technology to construct 3D vascular maps of the breasts

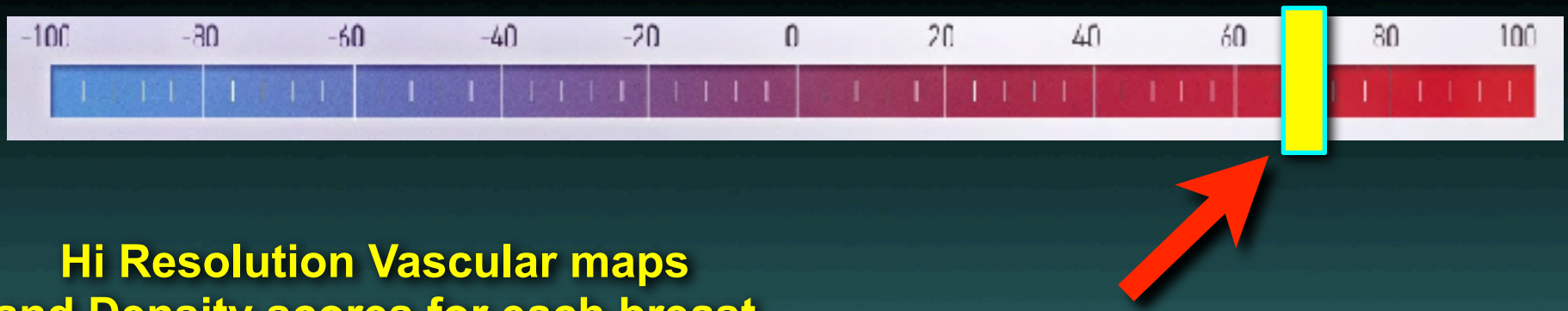


The maps are analyzed to measure vascular asymmetry, vascular density, vessel dimensions, and more

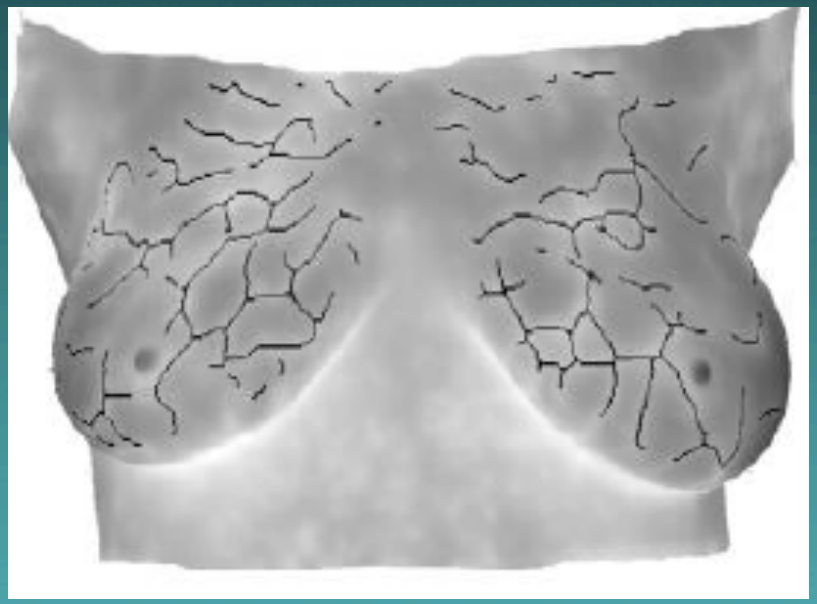


Analysis Results are Easy to Interpret

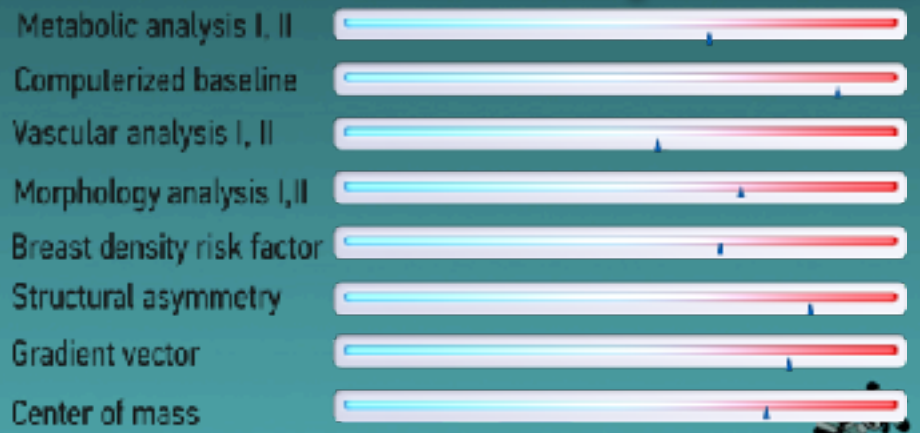
MIRA Score: Overall likelihood of cancer being present in this patient



Hi Resolution Vascular maps and Density scores for each breast



MIRA Scores for individual parameters

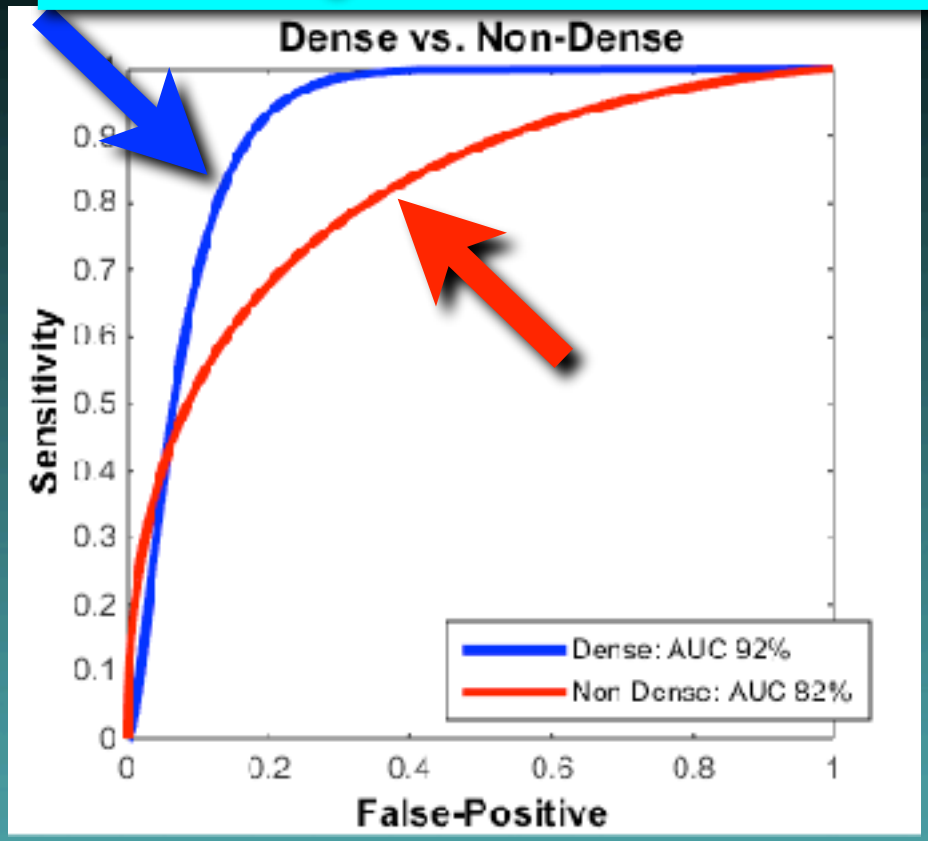


Multicenter Prospective Study II

Breast Density Analysis

Blind study, 114 subjects (58 verified cancers)

Currently not available due to lack of research funding



	Dense	Non-Dense
Sensitivity	96%	84%
Specificity	76%	64%
PPV	77%	73%
NPV	96%	78%
AUC	92%	82%

OPTICAL SCANNING

- Infrared scanning- Thermography
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- Diffuse Optic Tomography
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  - ➡ NOT very successful
- Updated Infrared Imaging
  - ➡ Now coupled to multiparametric computer analysis
- **Opto-Acoustics**
  - ➡ **A promising Fusion technology**

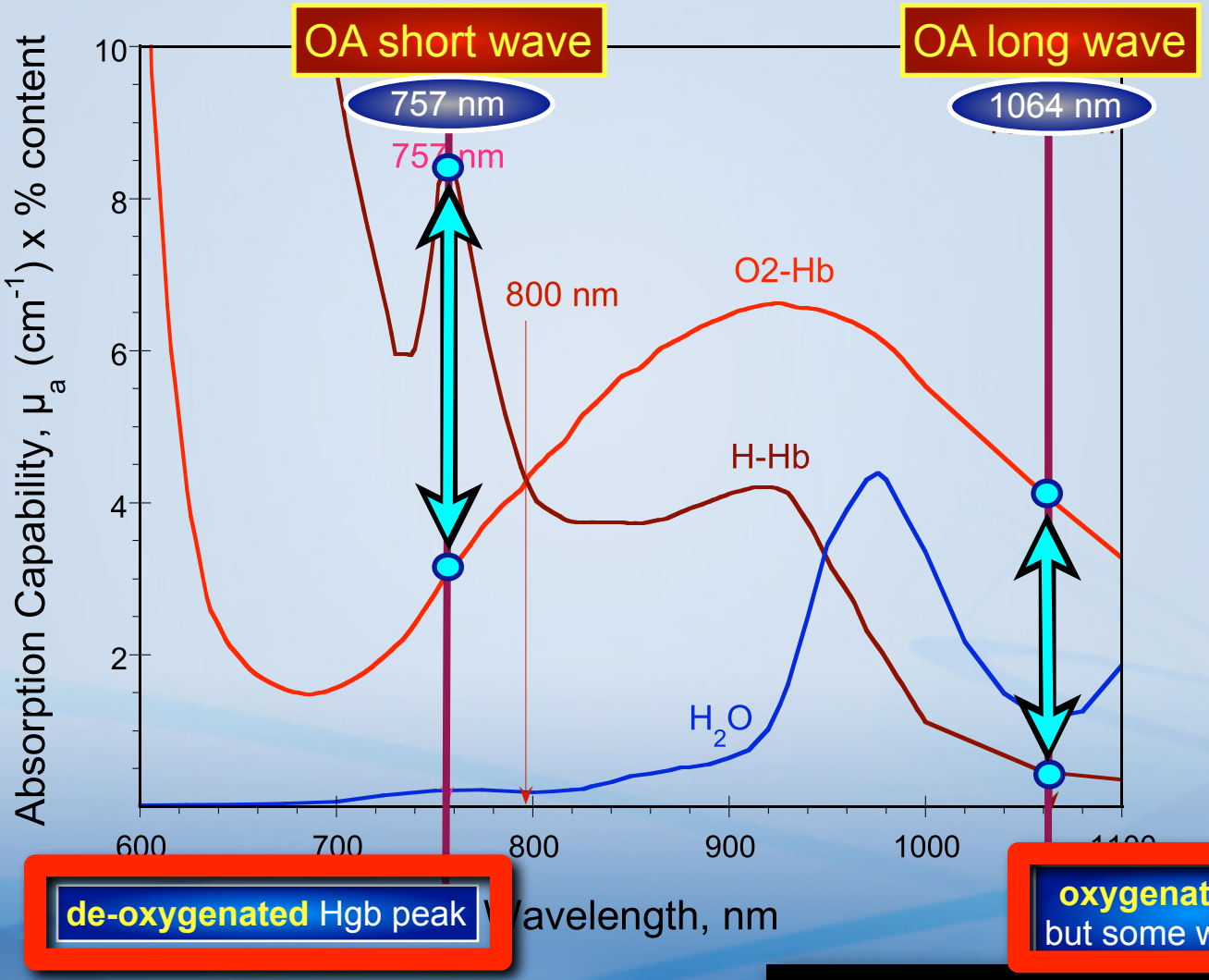
Opto-Acoustics
The Basic Assumptions

- Opto-acoustics - functional imaging
  - Cancers are metabolically more active, and therefore, de-oxygenate blood more than either:
    - normal tissues or
    - benign lesions
  - Opto-acoustics can demonstrate relatively greater de-oxygenation that occurs within malignant lesions

Courtesy Dr. Tom Stavros

Optical Absorption within Breast Tissues

- at two laser wavelengths



Courtesy Dr. Tom Stavros

Opto-Acoustics System

Using Opto-Acoustics (OA) gets around limitations of diffuse optic tomography

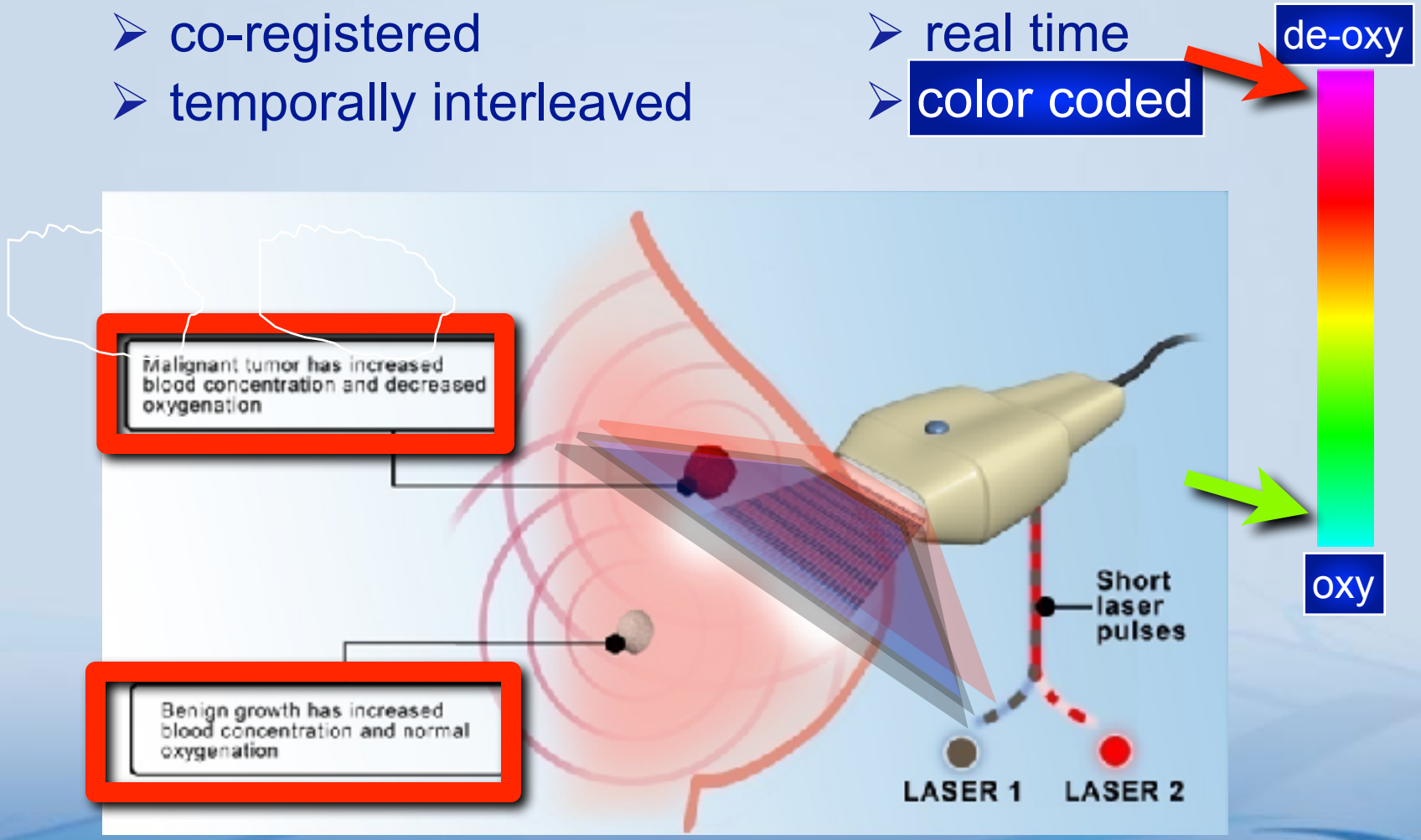
- Fusion of function with morphology:
  - function - optics, real time dual wavelength laser light
  - morphology - OA and real time B-mode gray scale US
- Combines best of optic and US worlds
  - optics - high contrast resolution
  - ultrasound - high spatial resolution & better penetration

Opto-acoustic approach
"light in and ultrasound out"

Courtesy Dr. Tom Stavros

Opto-Acoustic (OA) and Ultrasound Images

- co-registered
- temporally interleaved
- real time
- color coded



Courtesy Dr. Tom Stavros

Opto-Acoustic (OA) and Ultrasound Images

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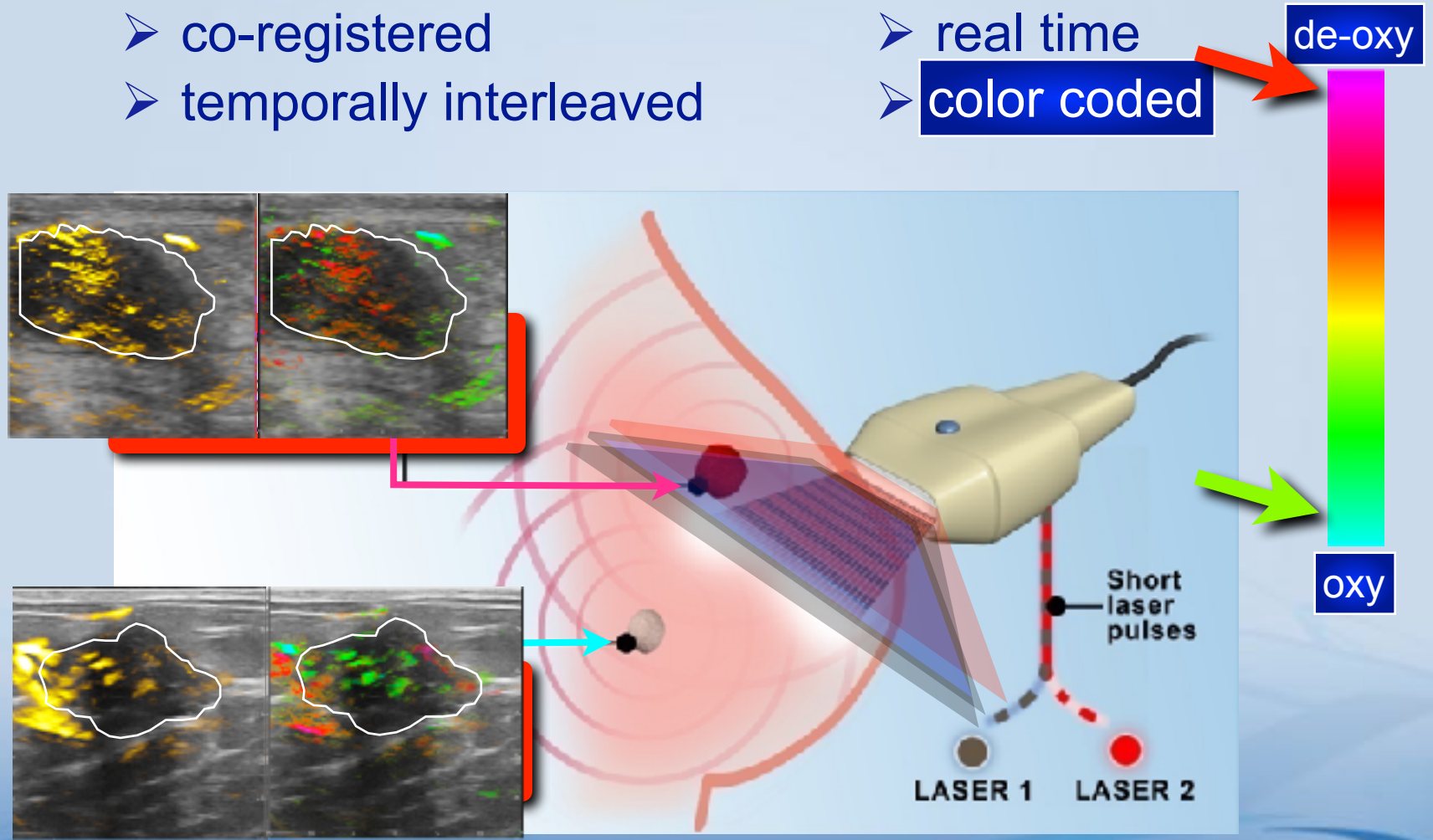
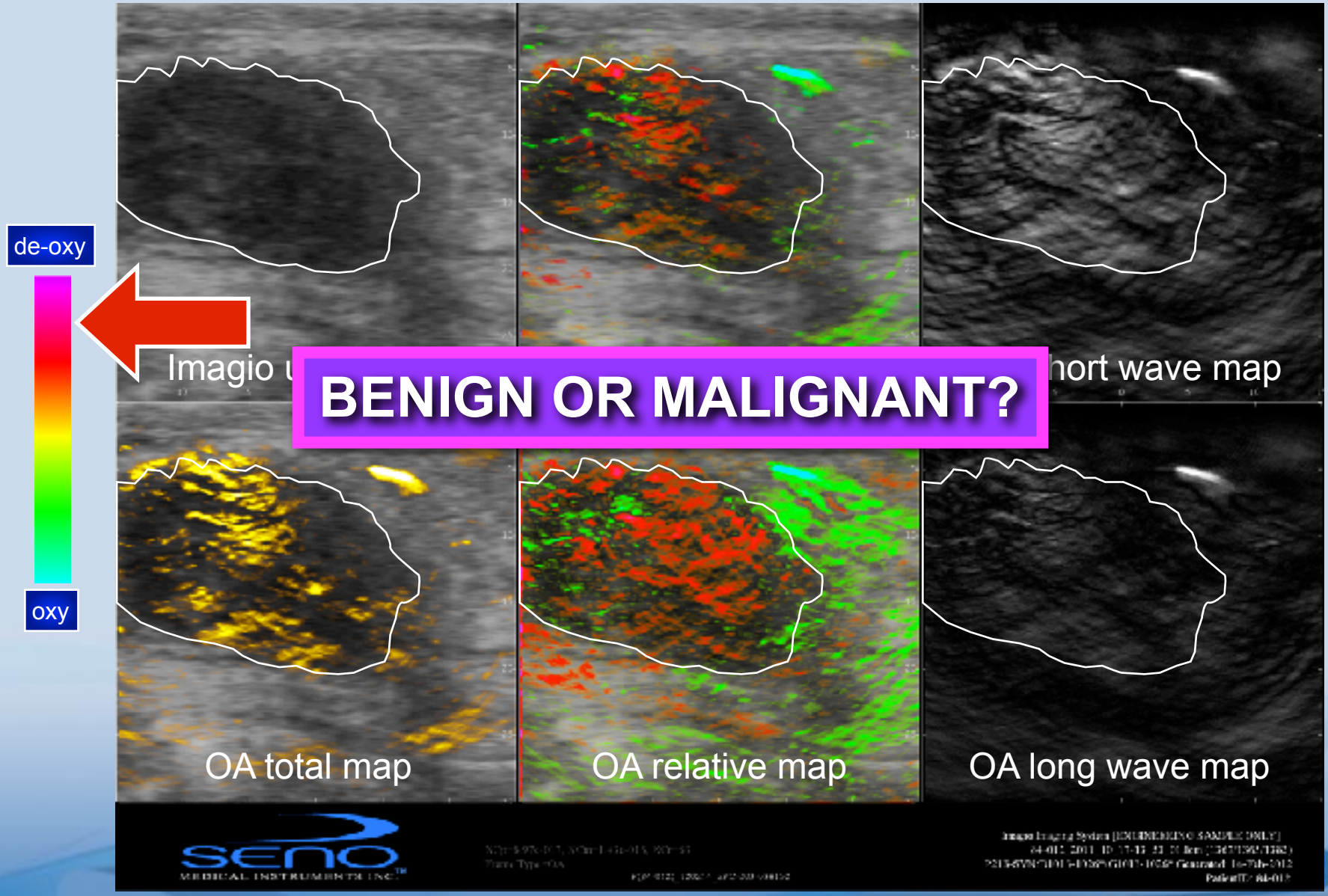


"IMAGINATION IS JUST THE BEGINNING."

Courtesy Dr. Tom Stavros

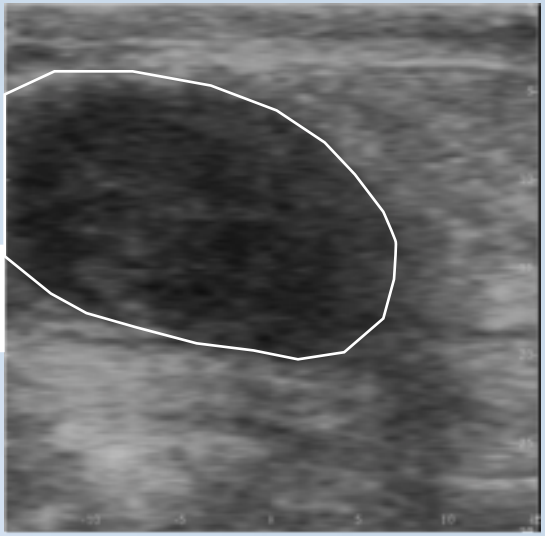
Internal Findings - IDC, gr 3 - OA ff #1



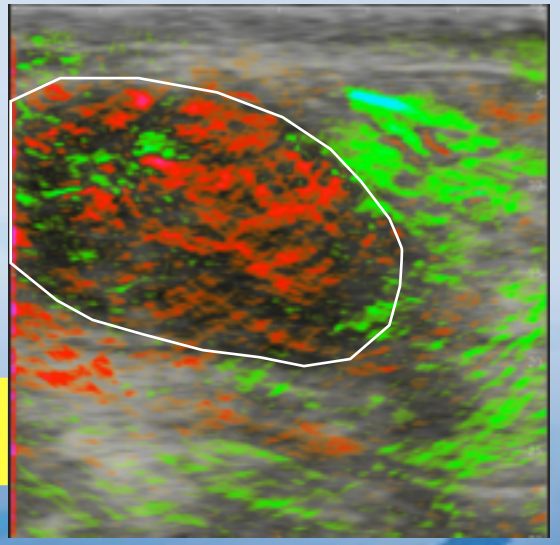
"IMAGINATION IS JUST THE BEGINNING."

Courtesy Dr. Tom Stavros

US appearance overlaps that of benign lesions



but the OA appearance does not look benign



Courtesy Dr. Tom Stavros

Thus we need to look at both:

...internal (primarily function) OA findings...

...and...

...external (primarily morphologic) OA findings...

...in order to optimize OA sensitivity

NOW COMMERCIALLY AVAILABLE!

NEW TOOLS IN BREAST IMAGING

- Full Field Digital Mammography
  - ➡ Tomosynthesis, Digital Subtraction
- Optical Scanning
  - ➡ Thermography, Infrared Imaging, Opto-Acoustic Imaging
- Ultrasound
  - ➡ Elastography, 3D Ultrasound

NEW TOOLS IN BREAST IMAGING

- Full Field Digital Mammography
  - ➡ Tomosynthesis, Digital Subtraction
- Optical Scanning
  - ➡ Thermography, Infrared Imaging, Opto-Acoustic Imaging
- **Ultrasound**
  - ➡ **Elastography, 3D Ultrasound**

BREAST ULTRASOUND: NEW TECHNIQUES

- Elastography
- 3-D Ultrasound Imaging

WHAT IS ELASTOGRAPHY?

➡ **METHODOLOGY:**

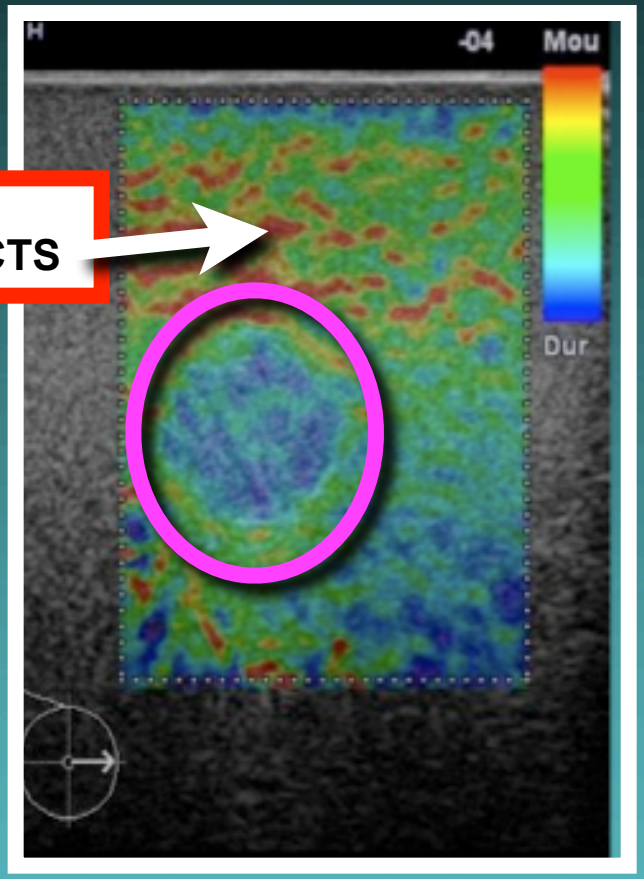
- Mechanical force induced to tissue (external or internal force)
- Measurements of tissue displacements (with US or MRI)
- Estimation of tissue stiffness- Qualitative (strain) or Quantitative (estimation)

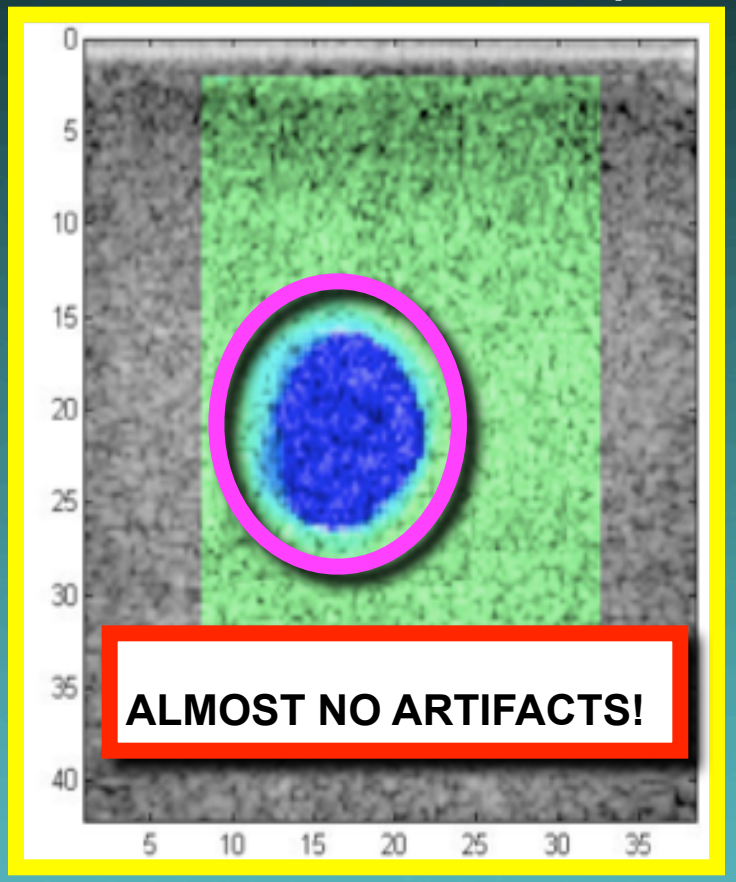
COMPARISON OF ELASTOGRAPHY METHODS

Static vs. Shearwave

Reversed color scale for comparison

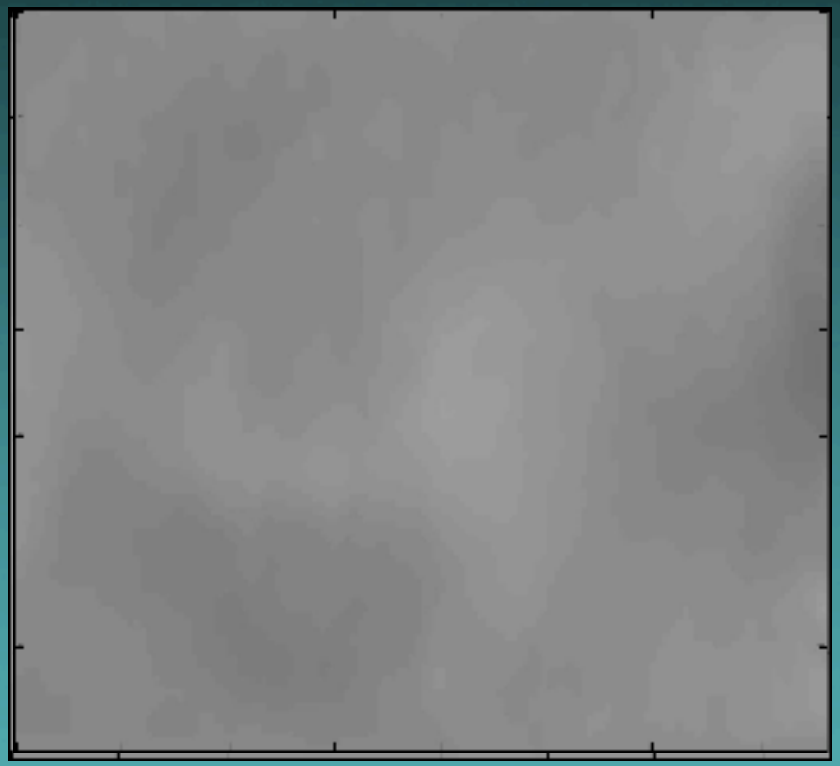
kPa

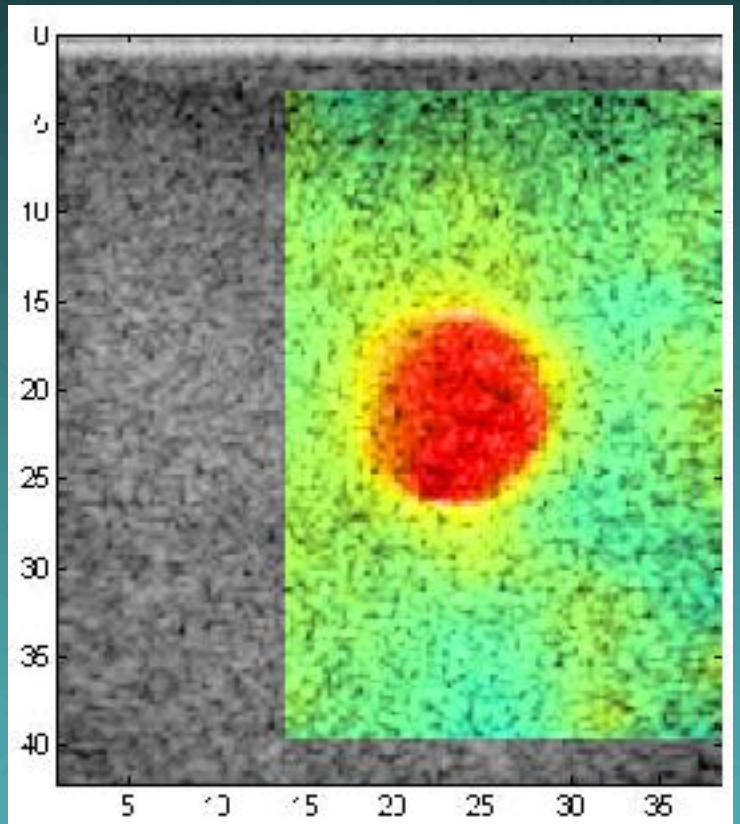


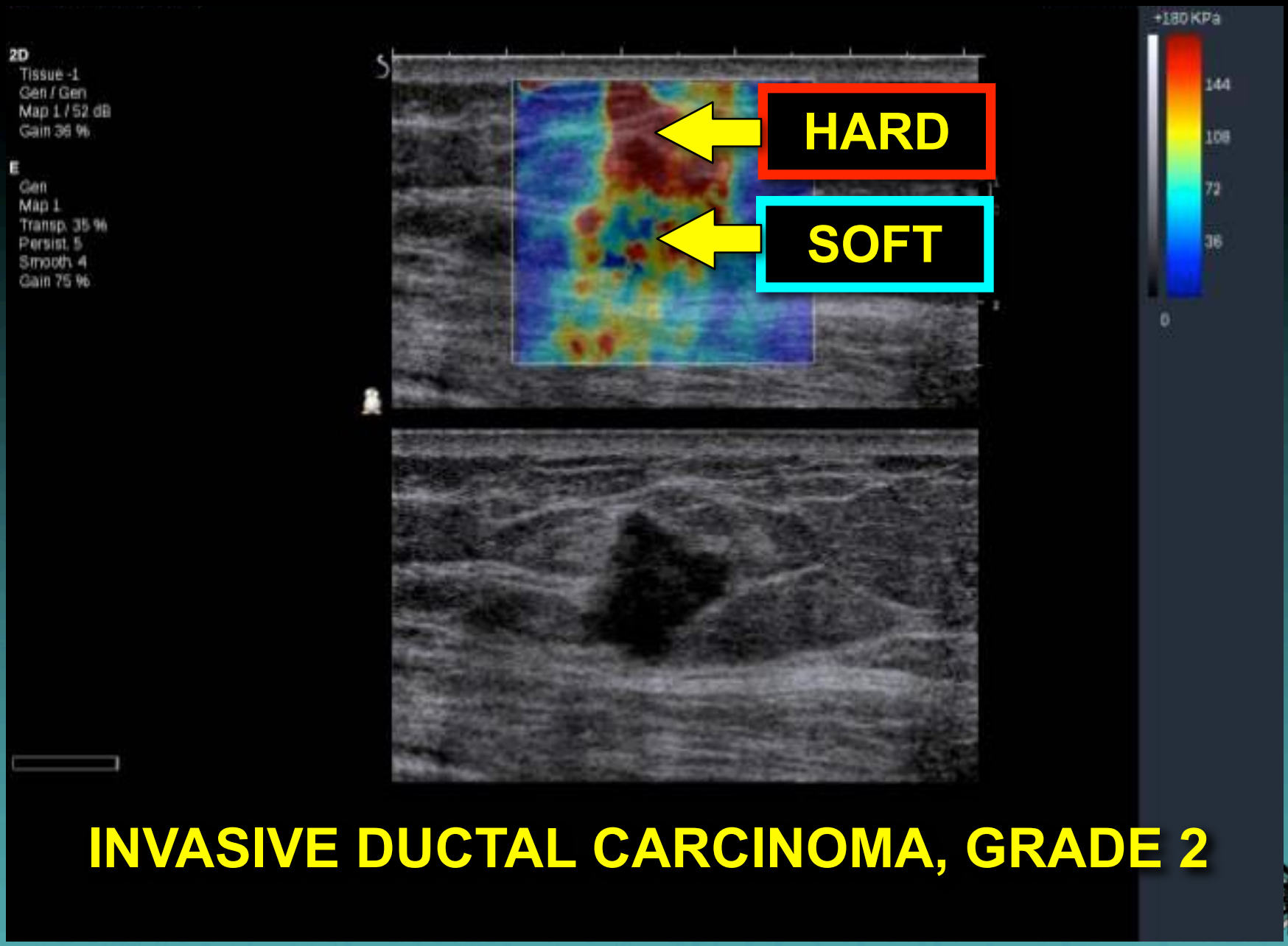


THE TECHNOLOGY

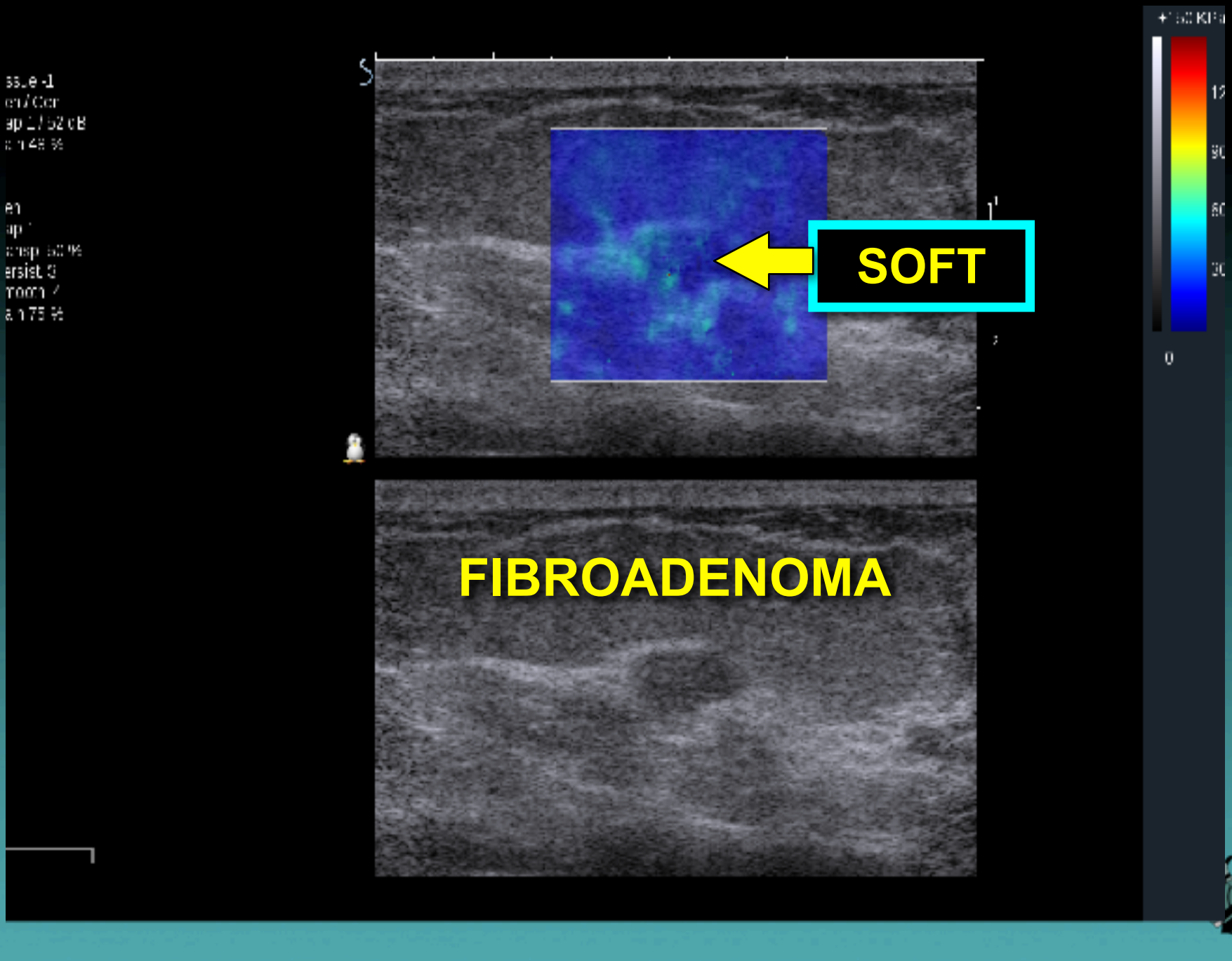
- New ShearWave Elastography Mode
- Mechanical constraint generated by acoustic pulse (user-independent and reproducible)







INVASIVE DUCTAL CARCINOMA, GRADE 2


SOFT
FIBROADENOMA

BREAST ULTRASOUND: NEW TECHNIQUES

- Elastography
- 3-D Ultrasound Imaging

3D ULTRASOUND: APPLICATIONS

- Showing spiculation better
- Distinguishing artifactual shadowing from a shadowing malignancy
- Showing DCIS components and intraductal components
- Assessing complex cysts
- Identifying anatomy

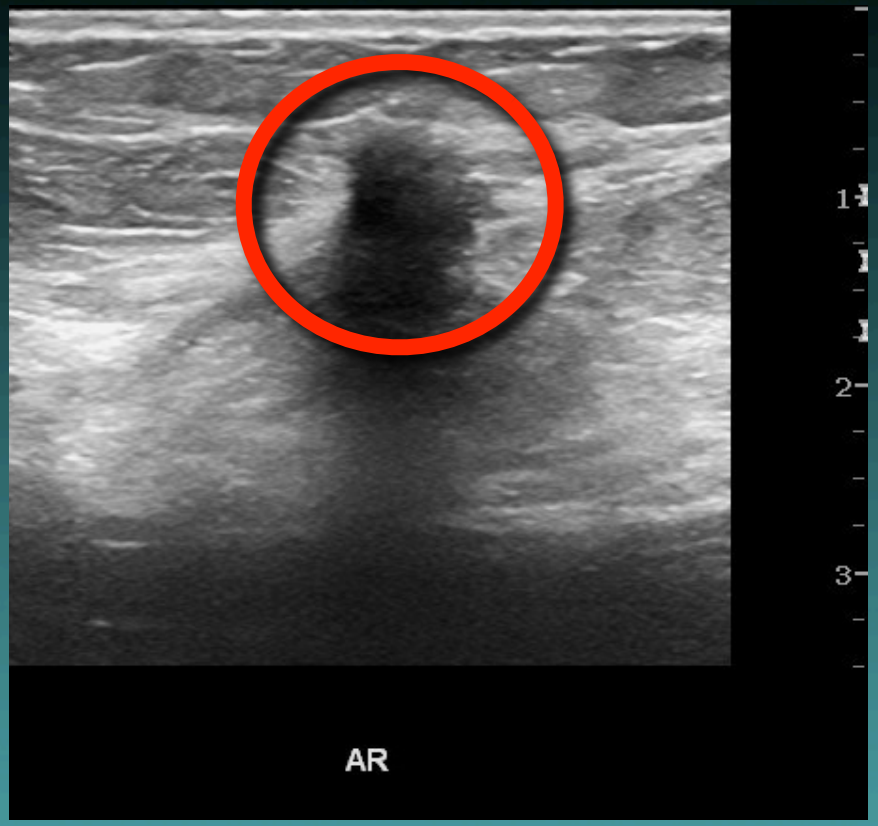
3D ULTRASOUND: APPLICATIONS

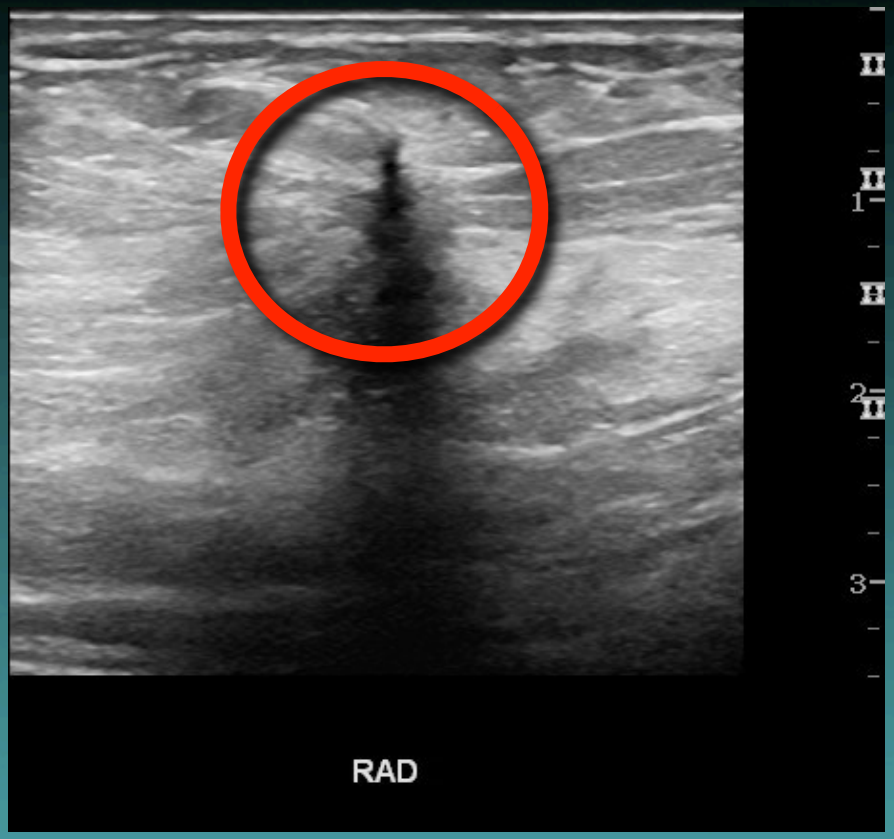
- Showing spiculation better

3D ULTRASOUND FOR SPICULATIONS

- Spicules are best seen in the CORONAL plane
- The path of low resistance for invasion is the coronal plane
- Spicules more numerous & prominent within tissue planes of the breast, which are coronally oriented
- 3D imaging in the coronal plane shows spicules very well

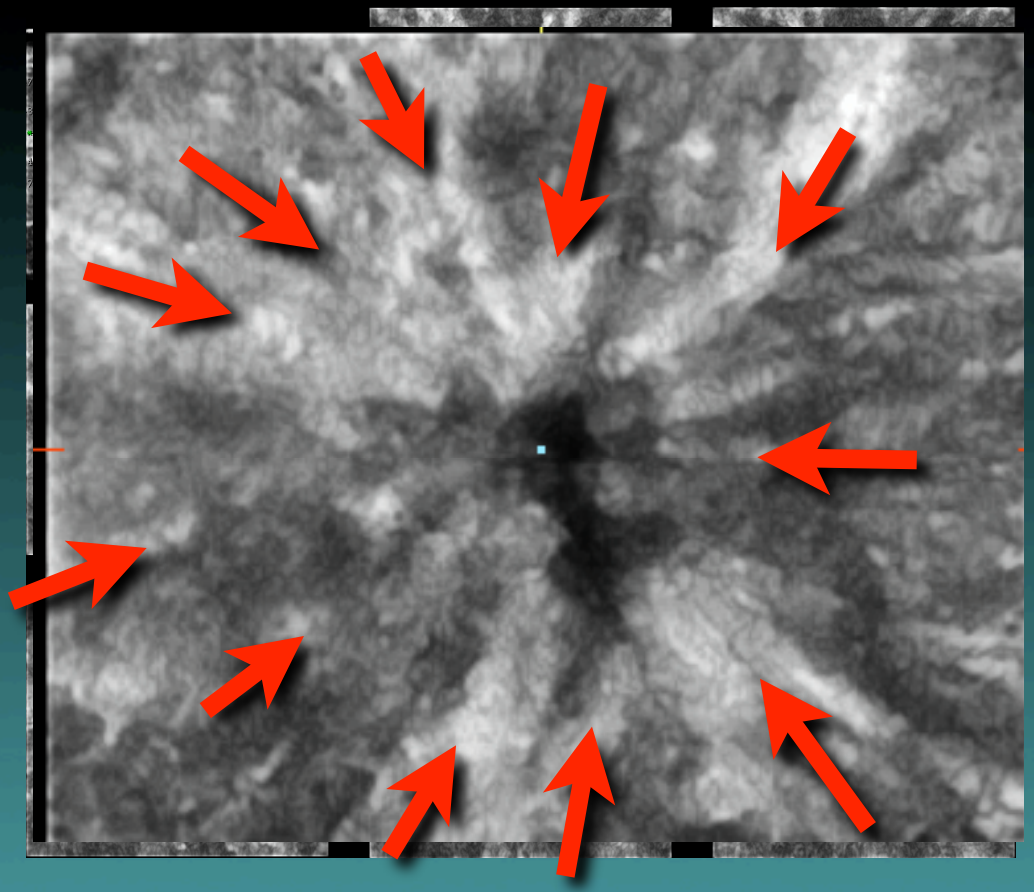
2D ULTRASOUND





Courtesy Dr. Tom Stavros

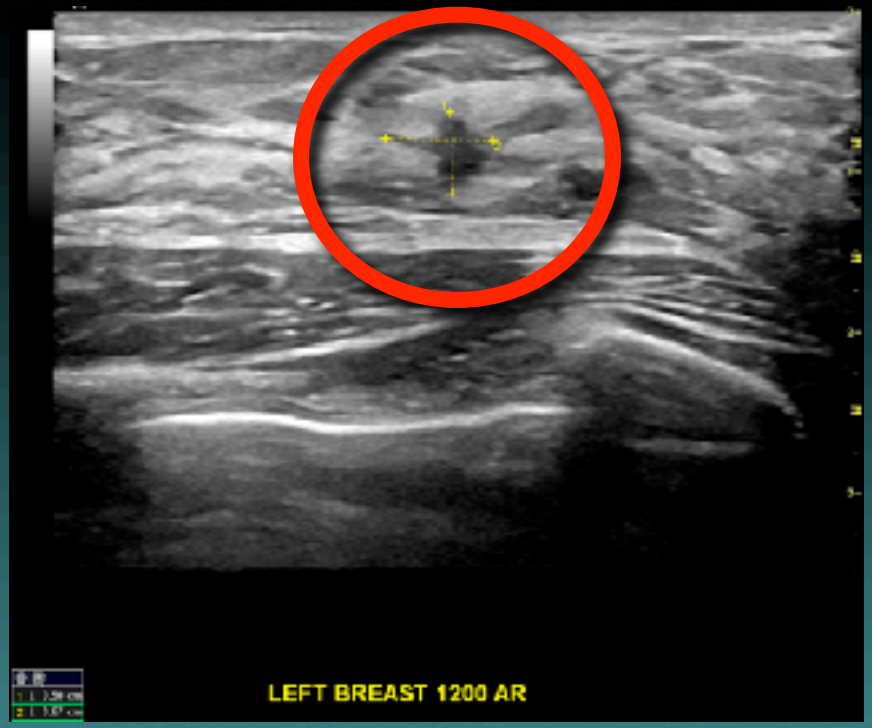
3D ULTRASOUND: SAME LESION

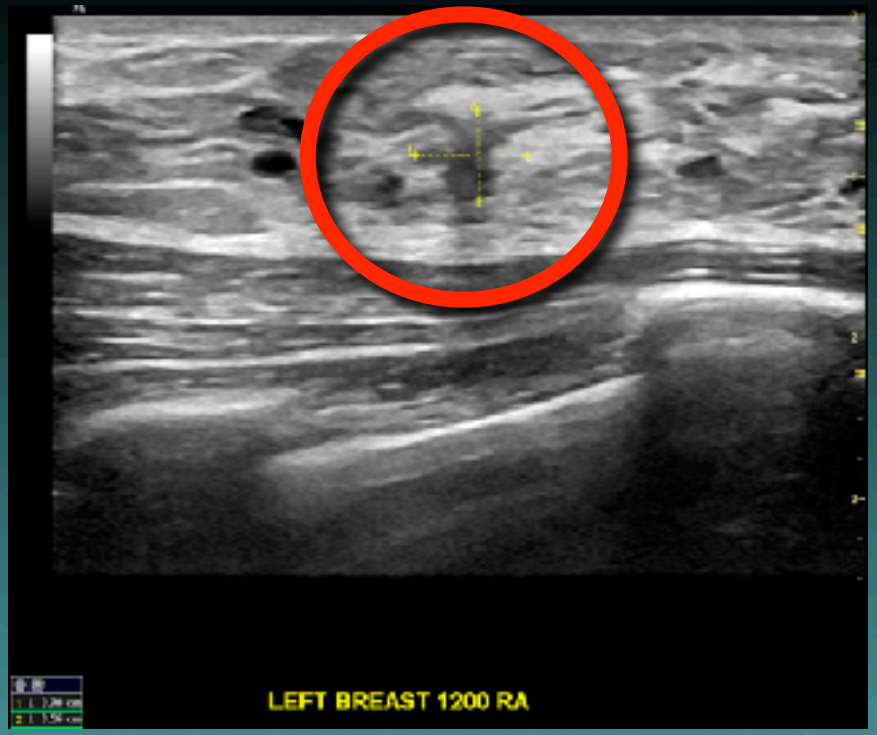


Most spicules hyperechoic & superficial

Courtesy Dr. Tom Stavros

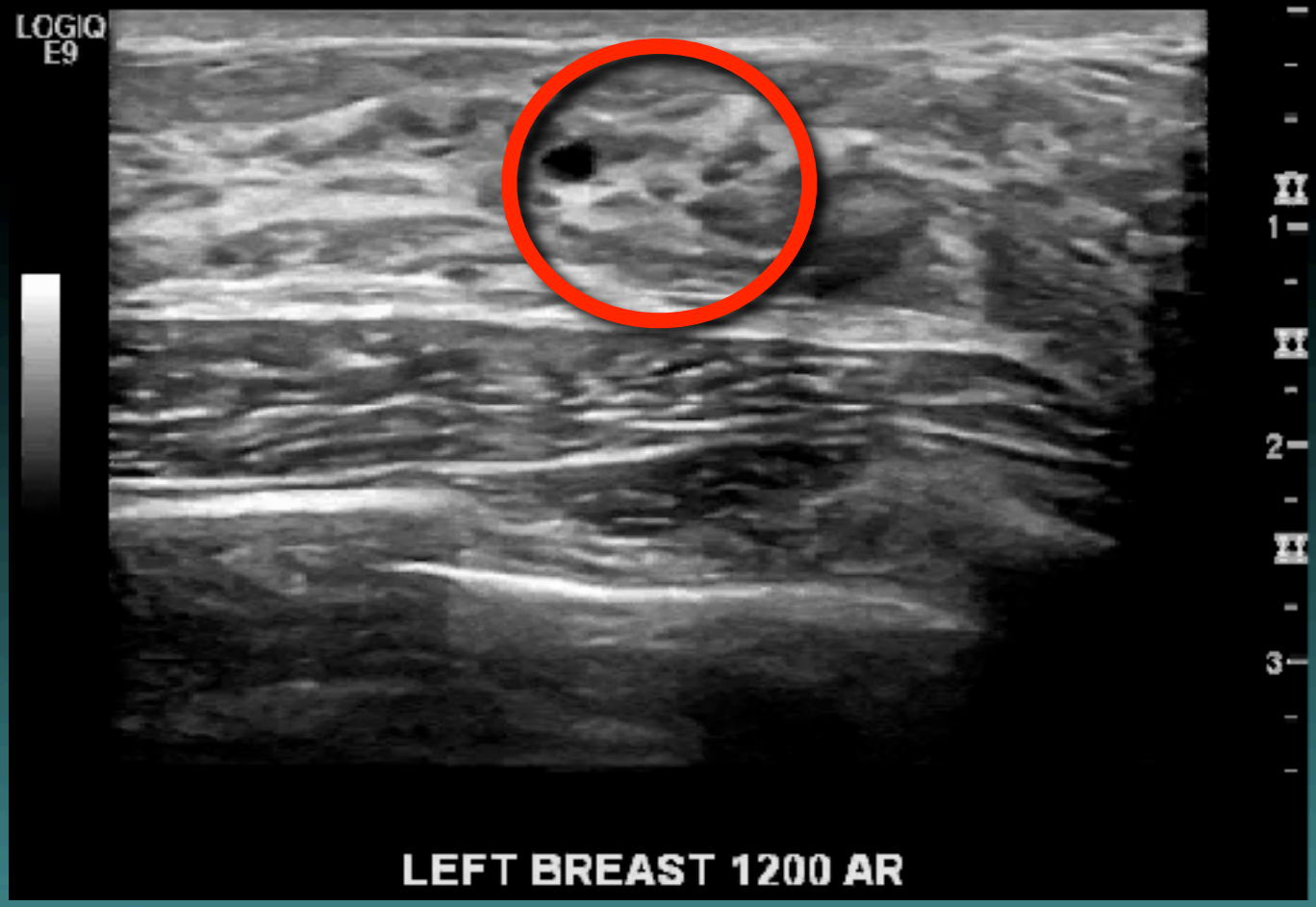
2D: Suggesion of an irregular mass





2D Video Sweep is helpful here

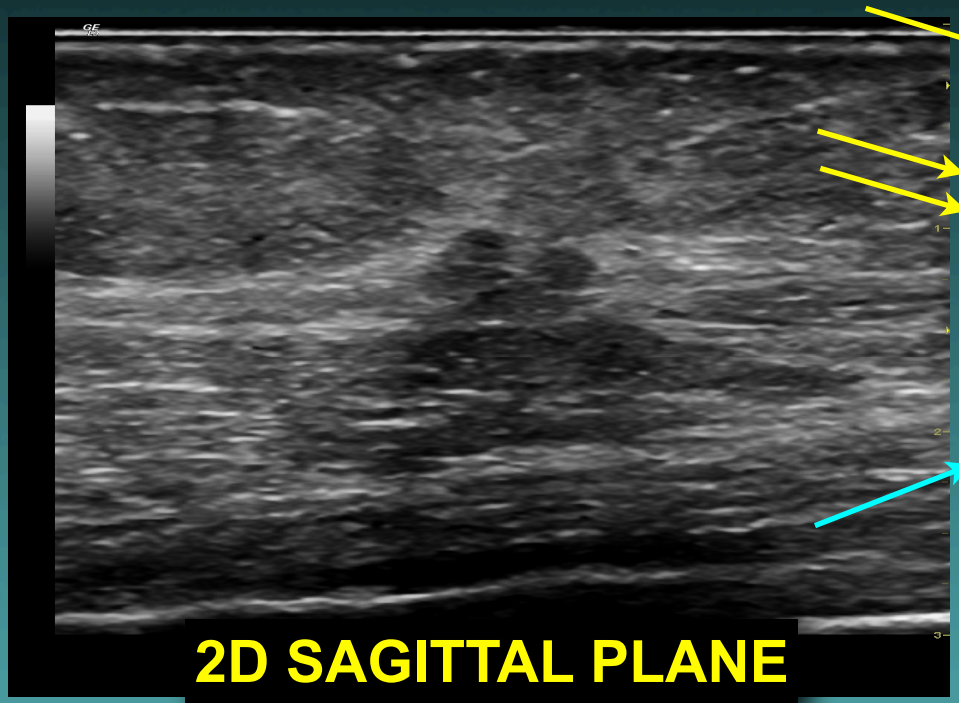
Courtesy Dr. Tom Stavros

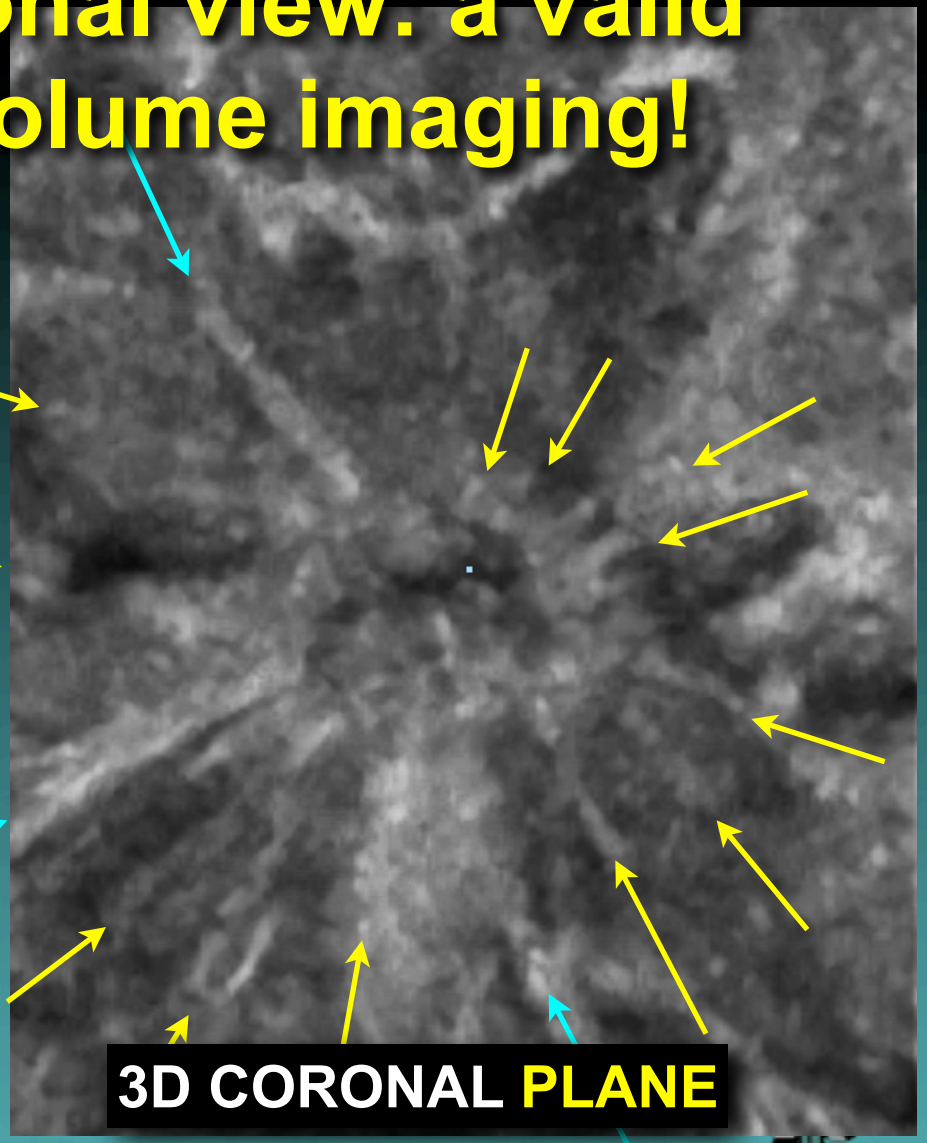


2D Video Sweep shows radiating ducts, & suggests that 3D analysis would be worthwhile

Courtesy Dr. Tom Stavros

Sometimes, spiculations are seen ONLY on the coronal view: a valid arguement for volume imaging!



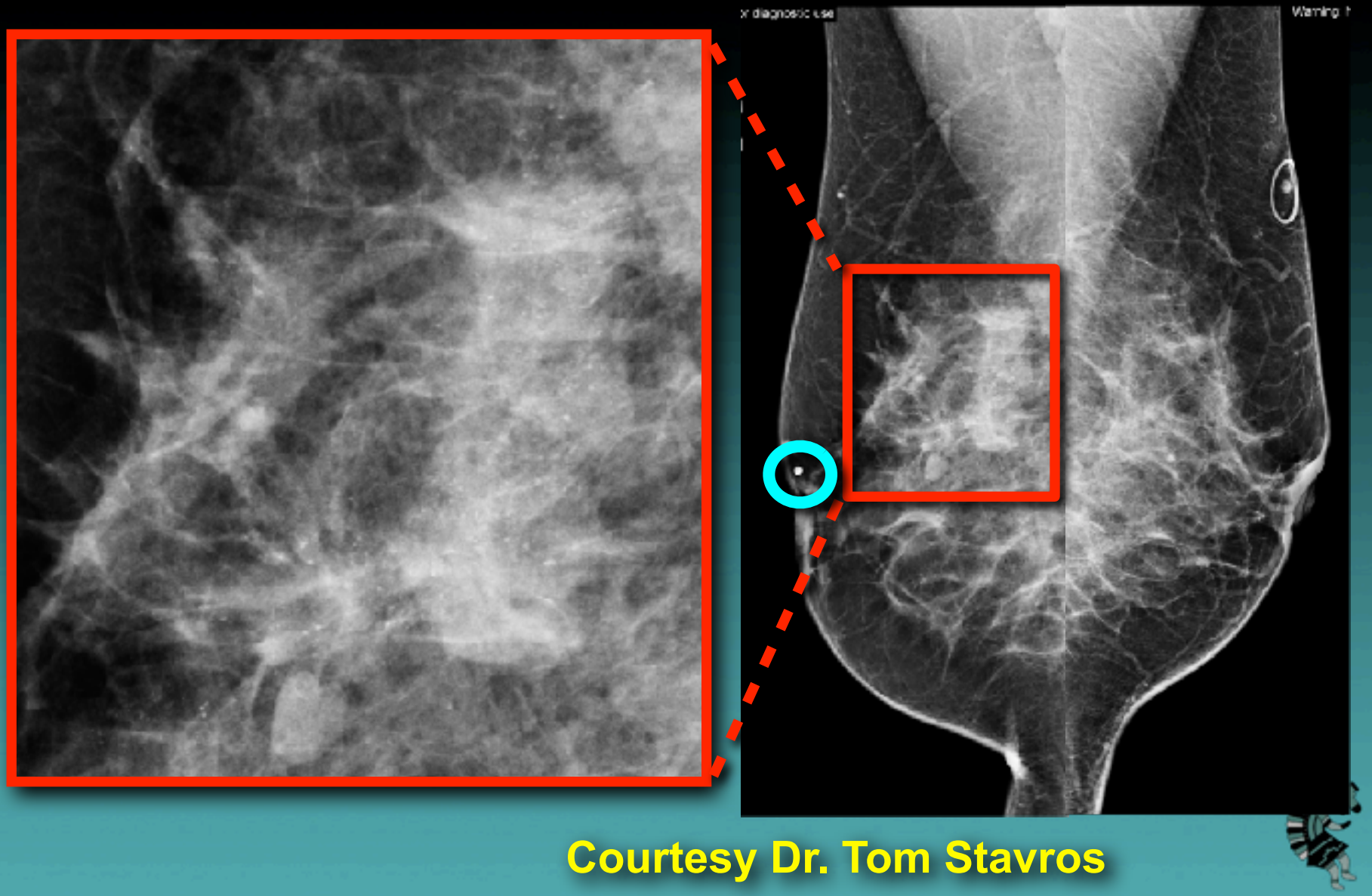


Courtesy Dr. Tom Stavros

3D ULTRASOUND: APPLICATIONS

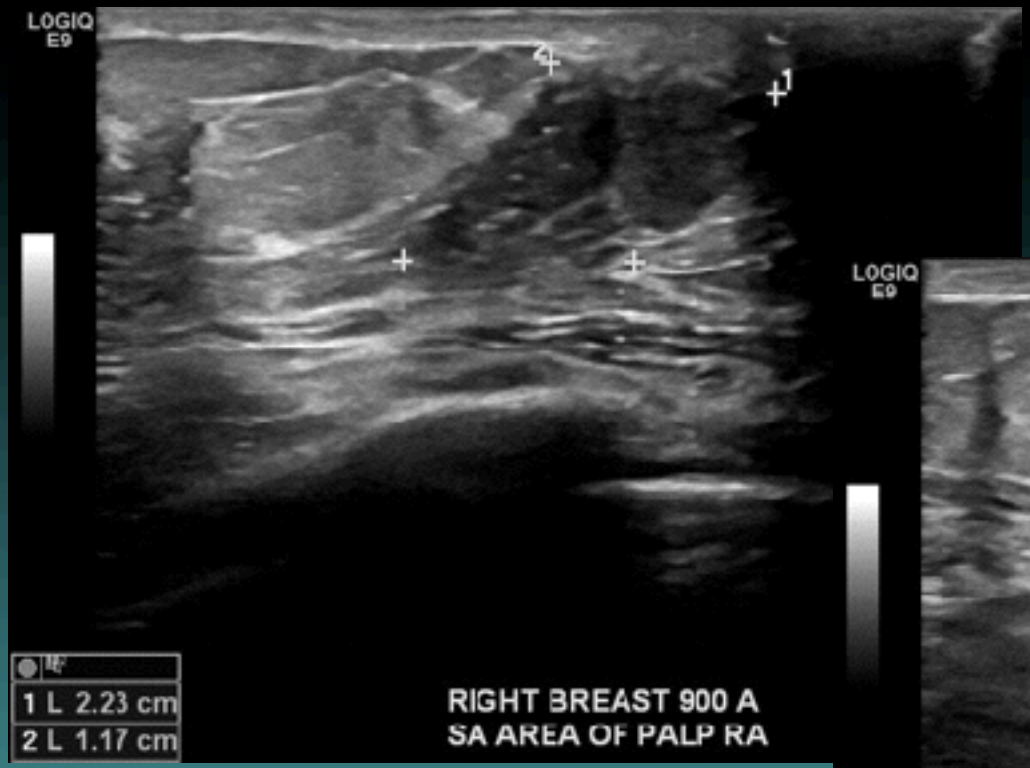
- Showing spiculation better
- Distinguishing artifactual shadowing from a shadowing malignancy
- **Showing DCIS components and extensive intraductal components**

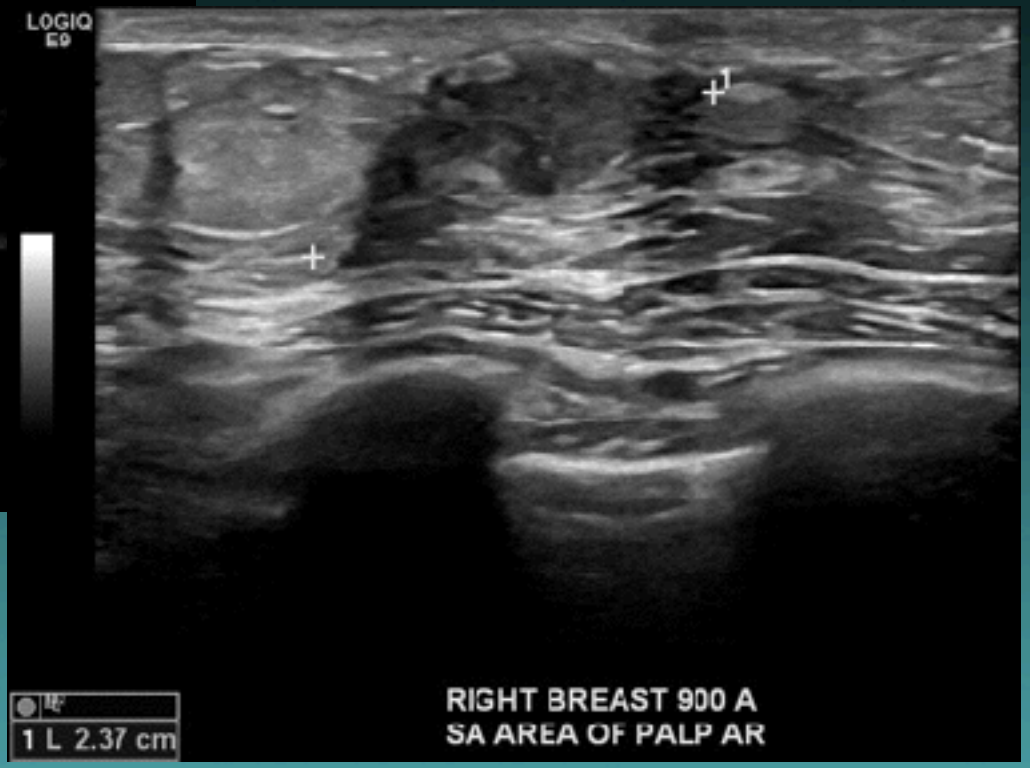
Palpable lump on Right



Courtesy Dr. Tom Stavros

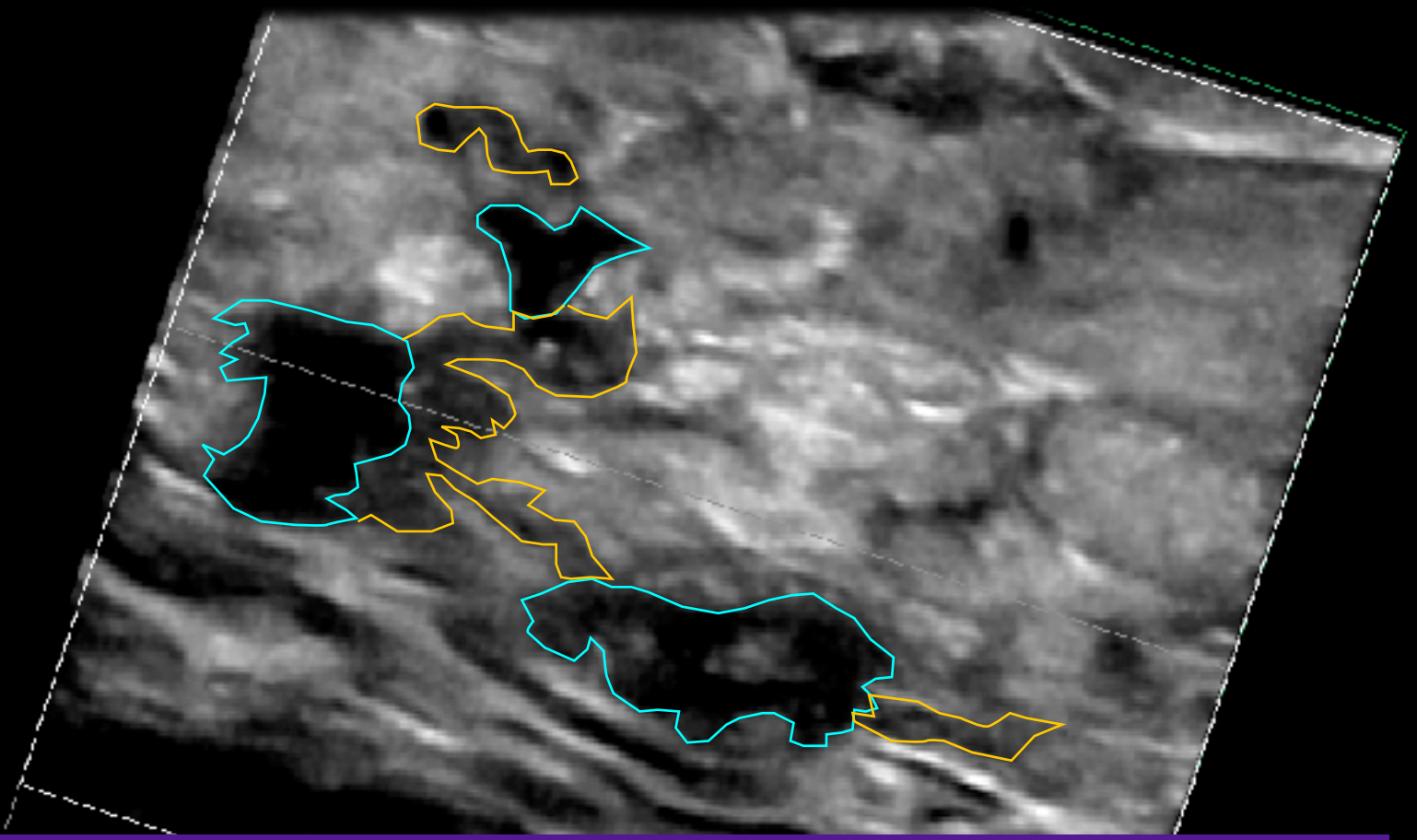
Mass seen on 2D Ultrasound





Courtesy Dr. Tom Stavros

3D: Virtual Rescan Plane



Multifocal IDC with DCIS bridges

Courtesy Dr. Tom Stavros

NEW TOOLS IN BREAST IMAGING

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  - ➡ Tomosynthesis, Digital Subtraction
- Optical Scanning
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- Ultrasound
  - ➡ Elastography, 3D Ultrasound
- Artificial Intelligence
  - ➡ For Mammography and Tomosynthesis

NEW TOOLS IN BREAST IMAGING

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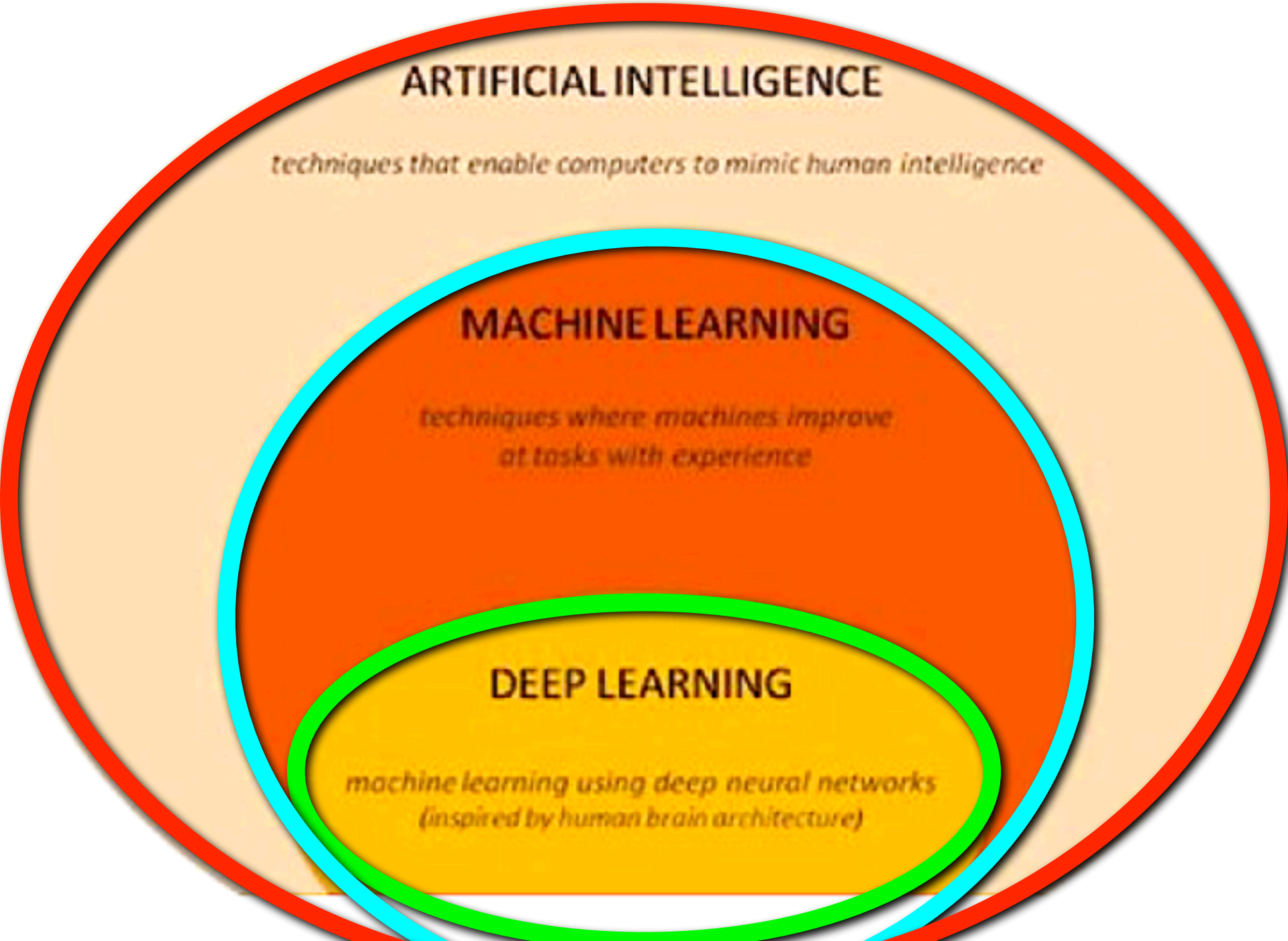
  - ➡ Elastography, 3D Ultrasound
- **Artificial Intelligence**
  - ➡ **For Mammography and Tomosynthesis**

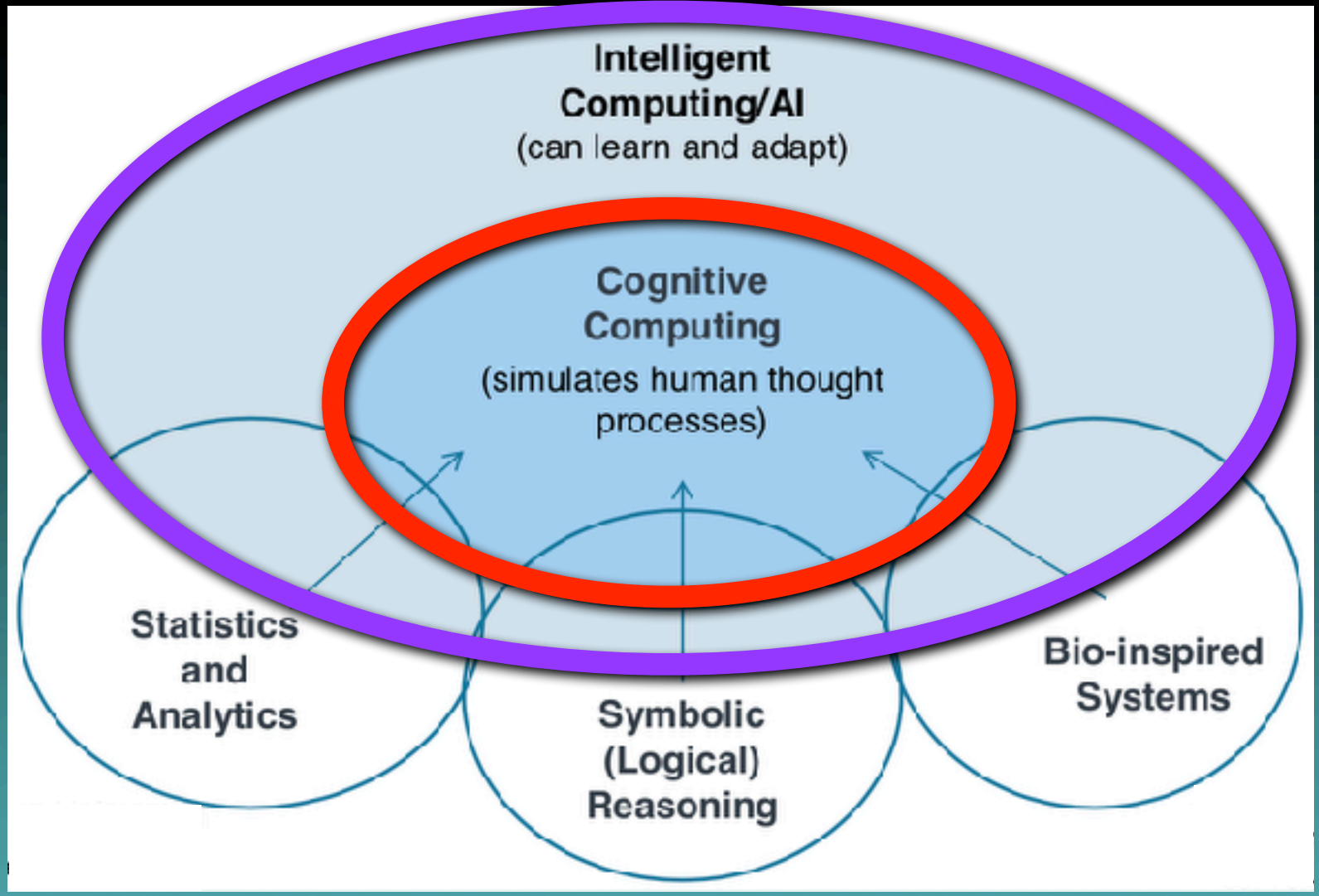
WHAT IS AI?

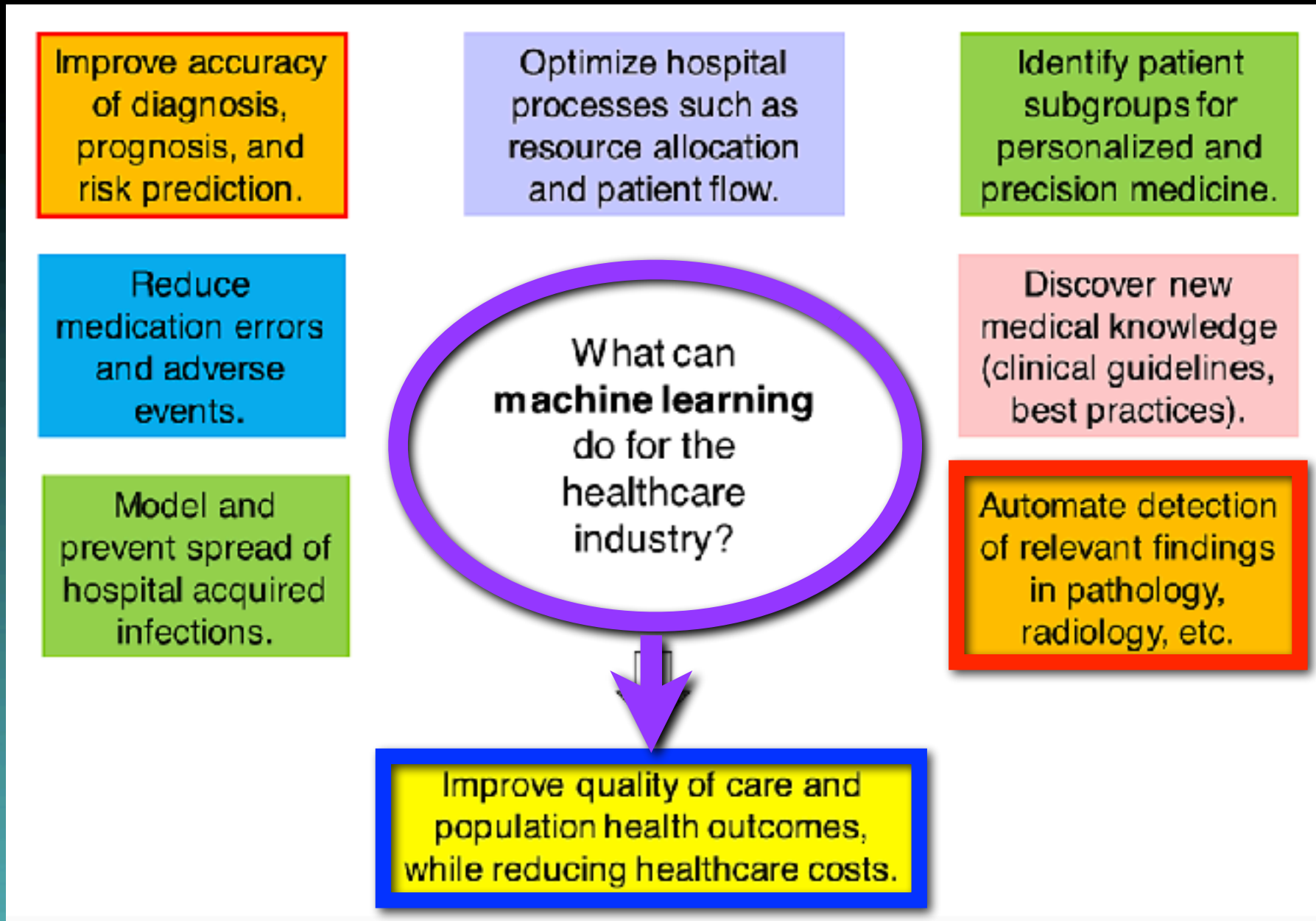
Development of computer systems able to perform tasks that normally require human intelligence


ARTIFICIAL INTELLIGENCE
techniques that enable computers to mimic human intelligence
MACHINE LEARNING
techniques where machines improve at tasks with experience
DEEP LEARNING
machine learning using deep neural networks (inspired by human brain architecture)


AI

AI- THE BROADER PICTURE

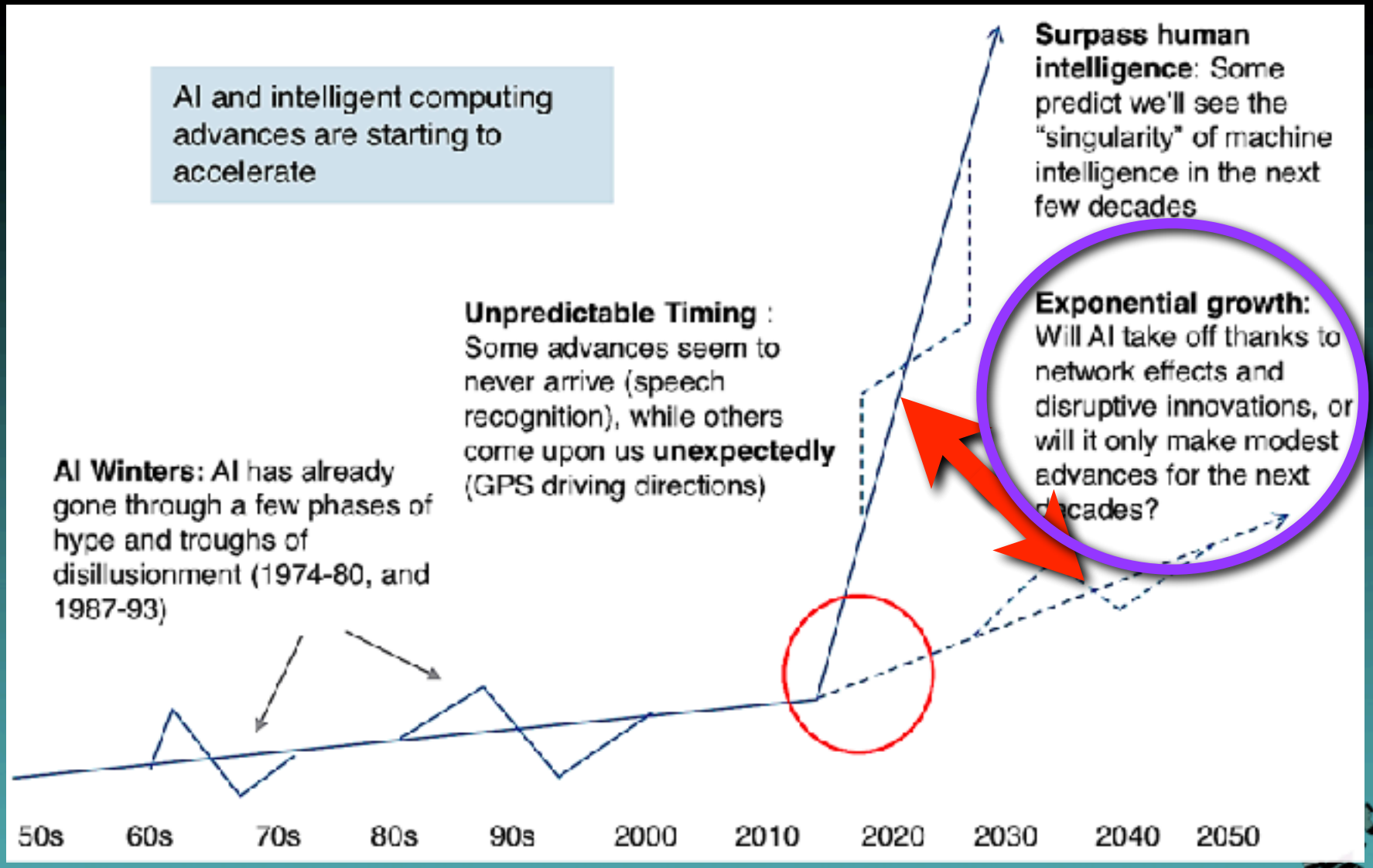



Improve accuracy of diagnosis, prognosis, and risk prediction.
Optimize hospital processes such as resource allocation and patient flow.
Identify patient subgroups for personalized and precision medicine.
Reduce medication errors and adverse events.
What can machine learning do for the healthcare industry?
Discover new medical knowledge (clinical guidelines, best practices).
Model and prevent spread of hospital acquired infections.
Automate detection of relevant findings in pathology, radiology, etc.
Improve quality of care and population health outcomes, while reducing healthcare costs.

Automatic **detection** of anomalies and patterns is especially valuable when the key to diagnosis is a tiny piece of the patient's health data.

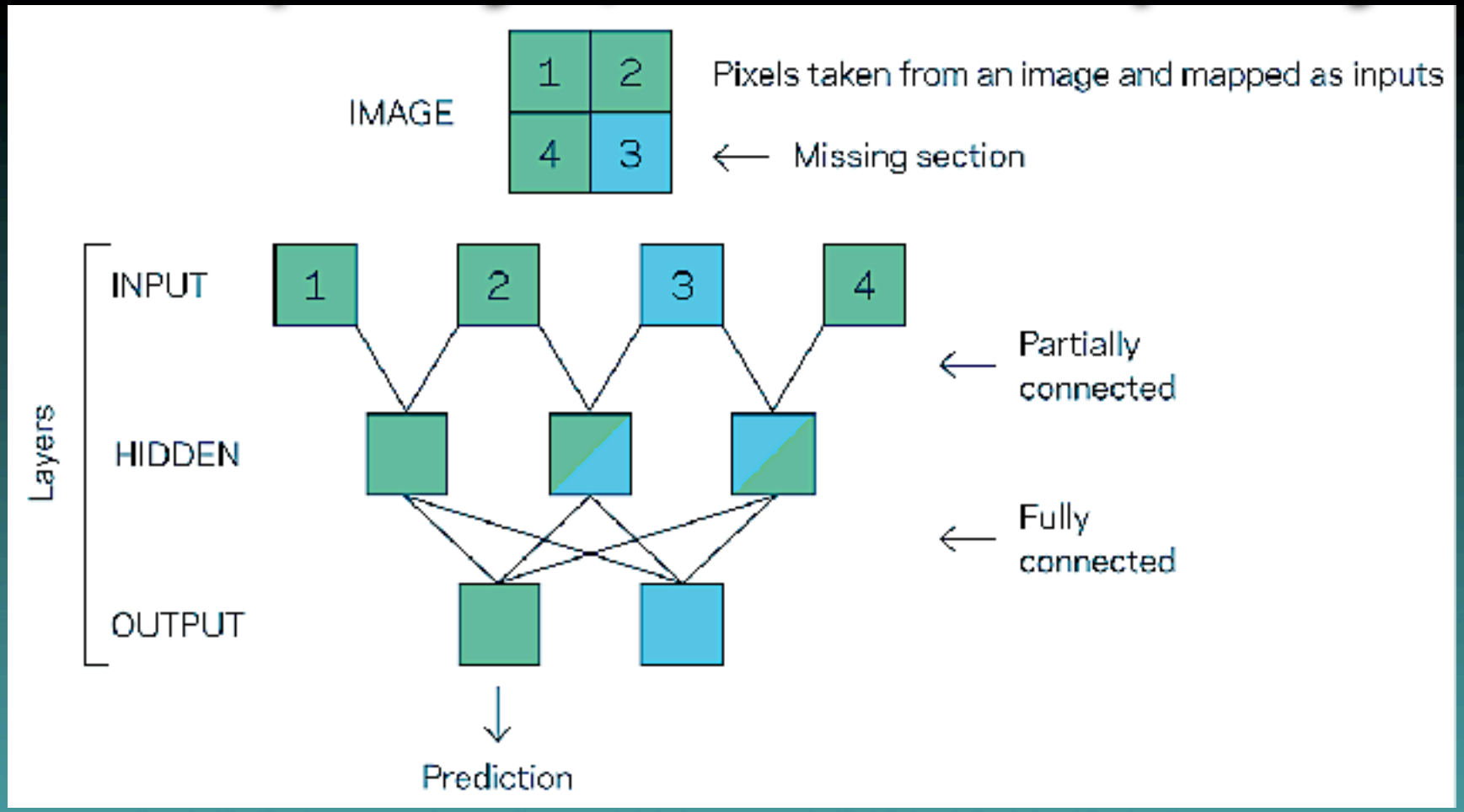
Detection is also valuable when key patterns of interest are discovered by **integrating** information across many patients, and might not be visible from a single patient's data.

Automate detection of relevant findings in pathology, radiology, etc.

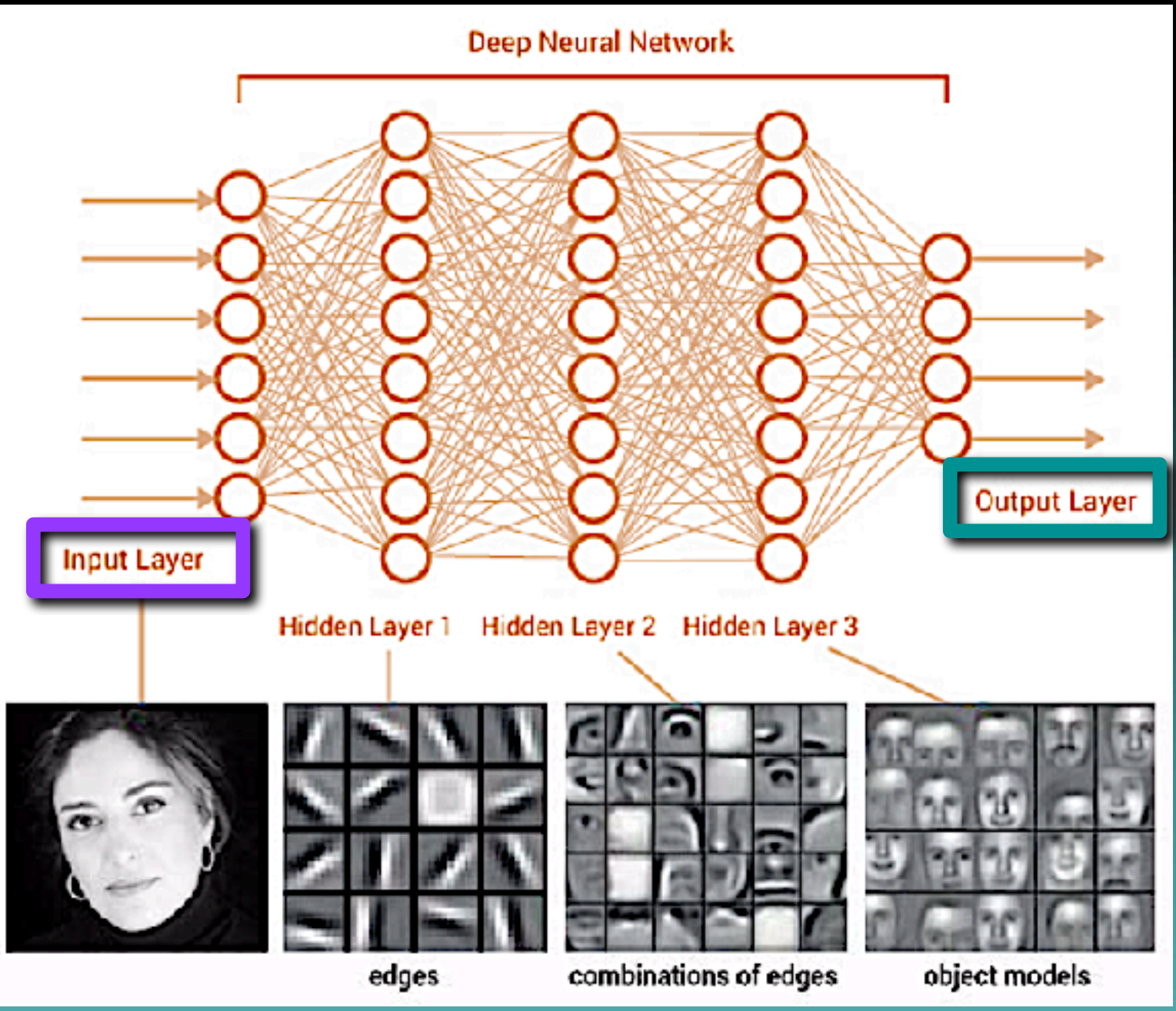

AI and intelligent computing advances are starting to accelerate
Surpass human intelligence: Some predict we'll see the "singularity" of machine intelligence in the next few decades
Unpredictable Timing : Some advances seem to never arrive (speech recognition), while others come upon us unexpectedly (GPS driving directions)
Exponential growth: Will AI take off thanks to network effects and disruptive innovations, or will it only make modest advances for the next decades?
AI Winters: AI has already gone through a few phases of hype and troughs of disillusionment (1974-80, and 1987-93)
50s
60s
70s
80s
90s
2000
2010
2020
2030
2040
2050

Machine Learning: Neural Network

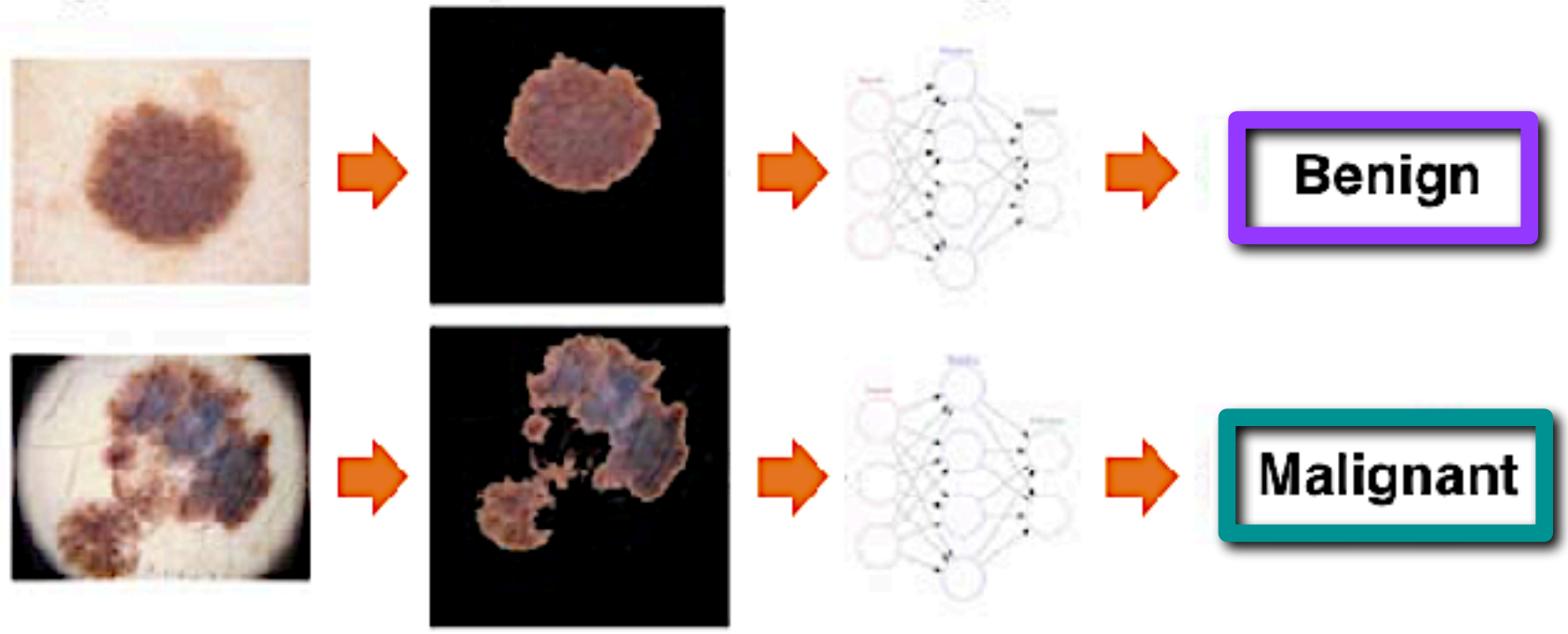
One input layer, and One Output layer



Deep Learning: At least 2 other Hidden Neural Network layers in between


Deep Neural Network
Input Layer
Output Layer
Hidden Layer 1
Hidden Layer 2
Hidden Layer 3
edges
combinations of edges
object models

AI APPLICATION FOR SKIN CANCER DETECTION



Kalouche S. Vision-Based Classification of Skin Cancer Using Deep Learning. Stanford University.

AI APPLICATIONS IN BREAST IMAGING

- CAD
- FIRST READ OF SCREENING MAMMOGRAMS
- SYNTHETIC 2D MAMMOGRAPHY
- BREAST DENSITY CATEGORIZATION FOR BREAST CANCER RISK

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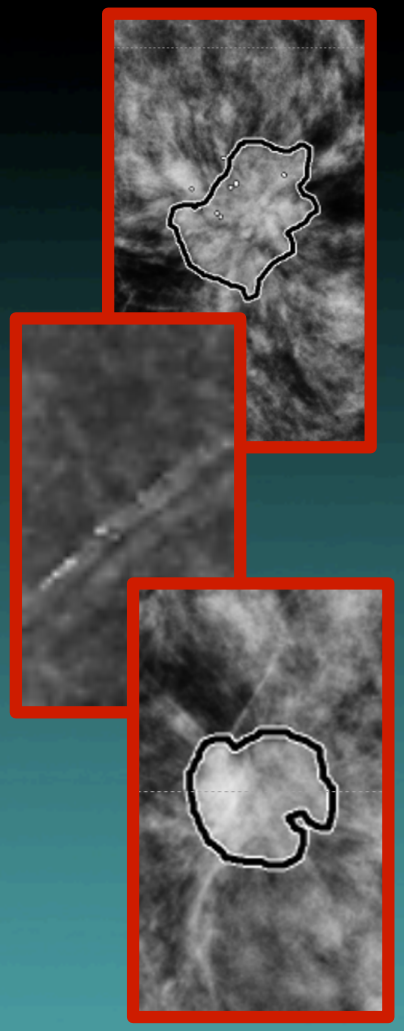
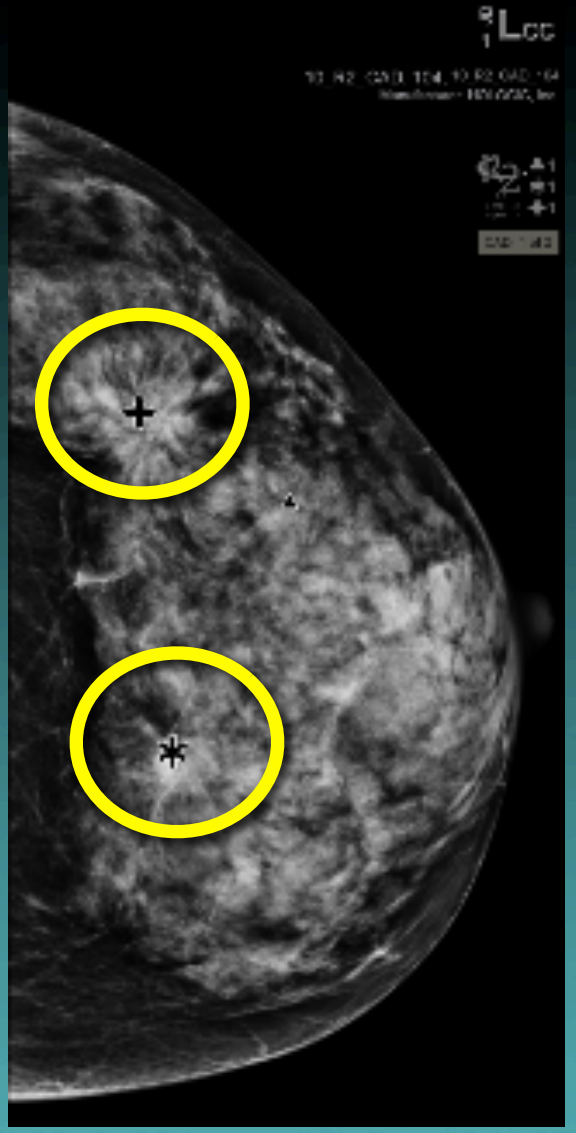
AI APPLICATIONS IN BREAST IMAGING

CAD systems- Constantly improving over the past 20 years

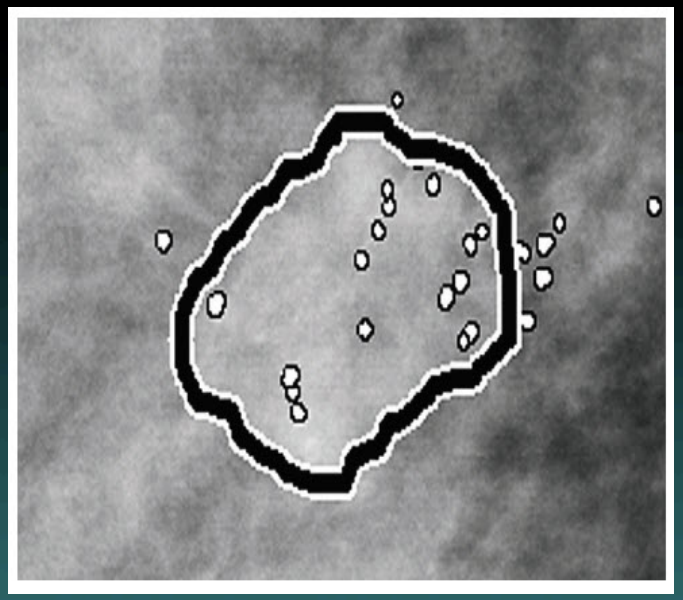


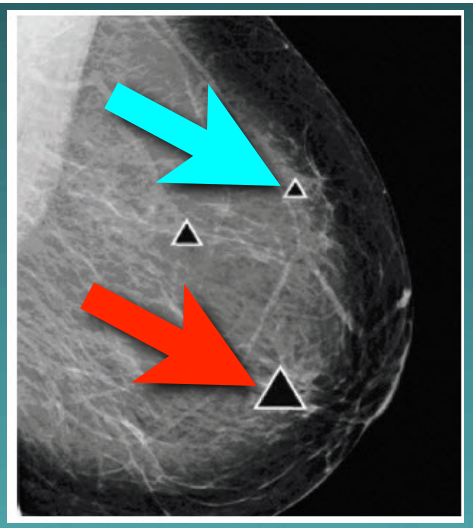


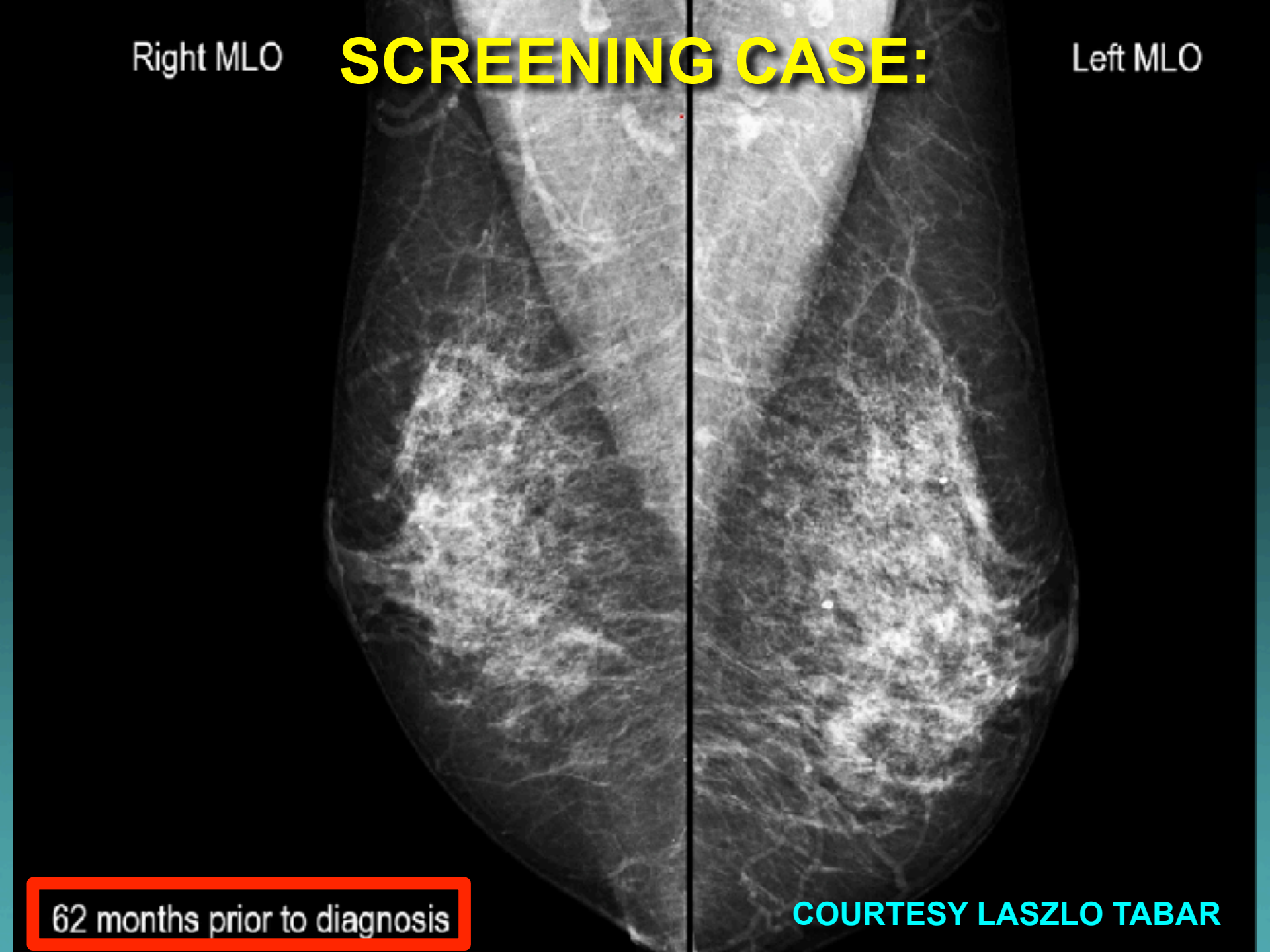
AI APPLICATIONS IN BREAST IMAGING

CAD systems- Now very sophisticated:

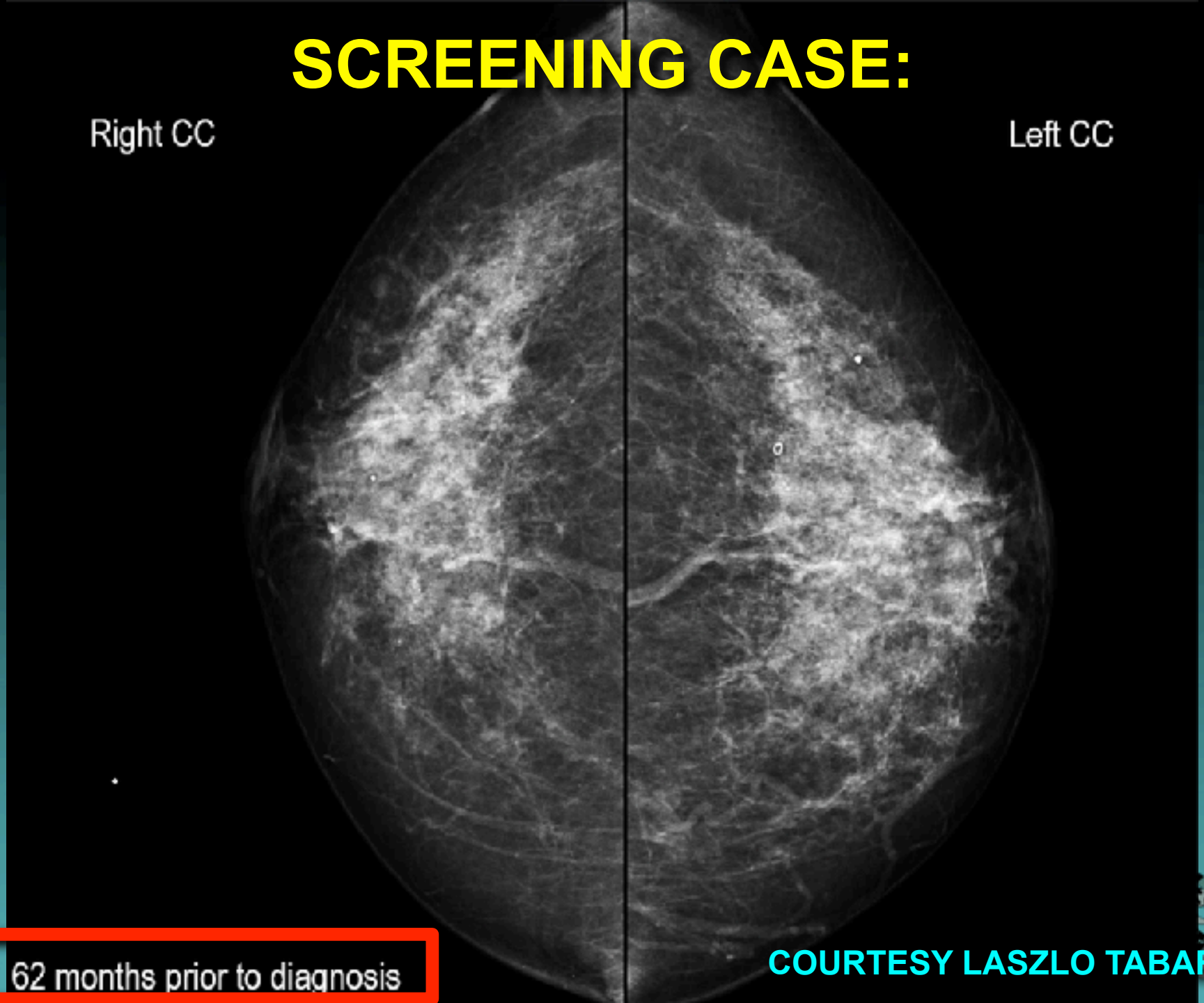
Markings are sized according to the likelihood of malignancy!






Right MLO
SCREENING CASE:
Left MLO
62 months prior to diagnosis
COURTESY LASZLO TABAR

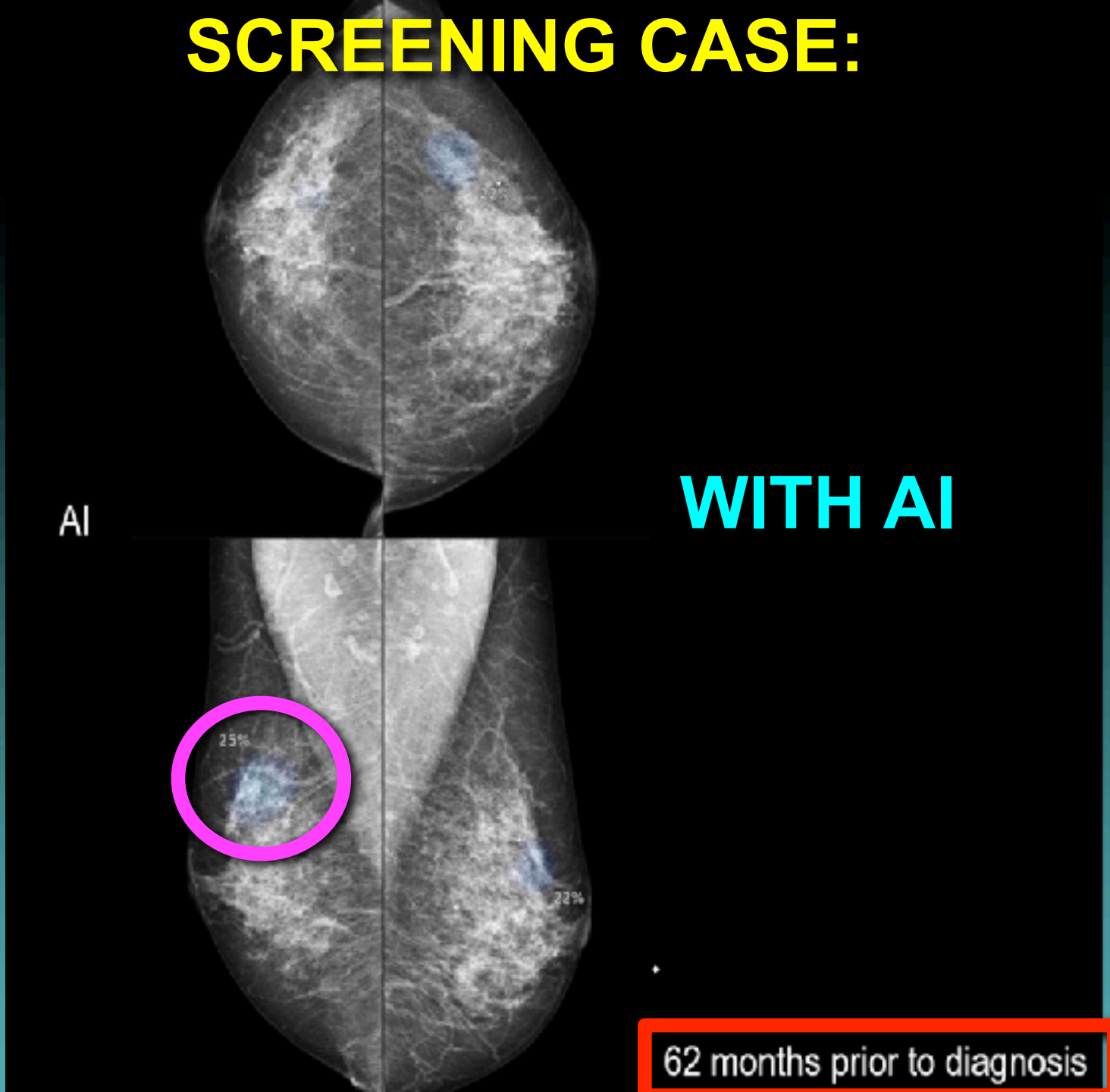
SCREENING CASE:



62 months prior to diagnosis

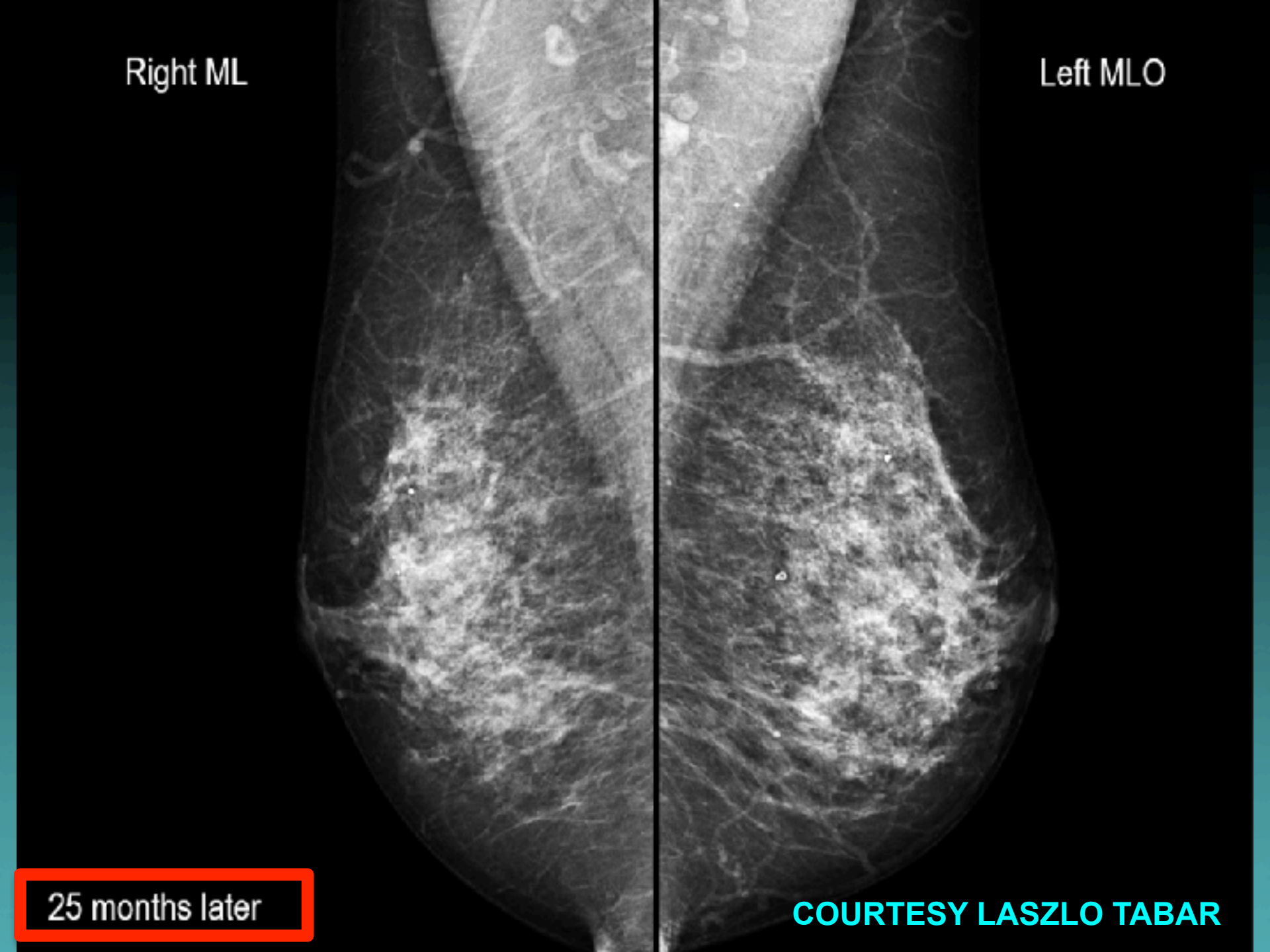
COURTESY LASZLO TABAR

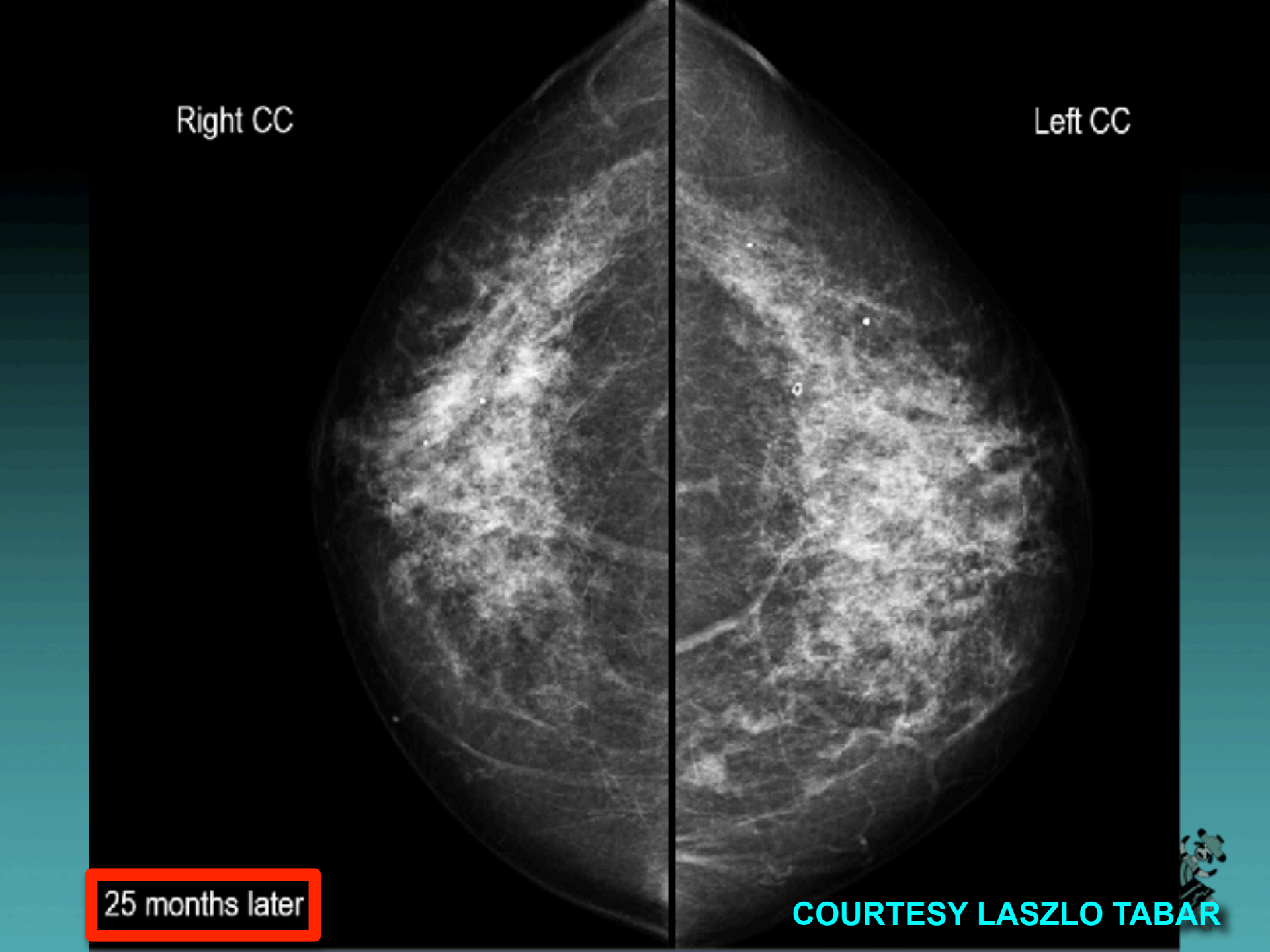
SCREENING CASE:

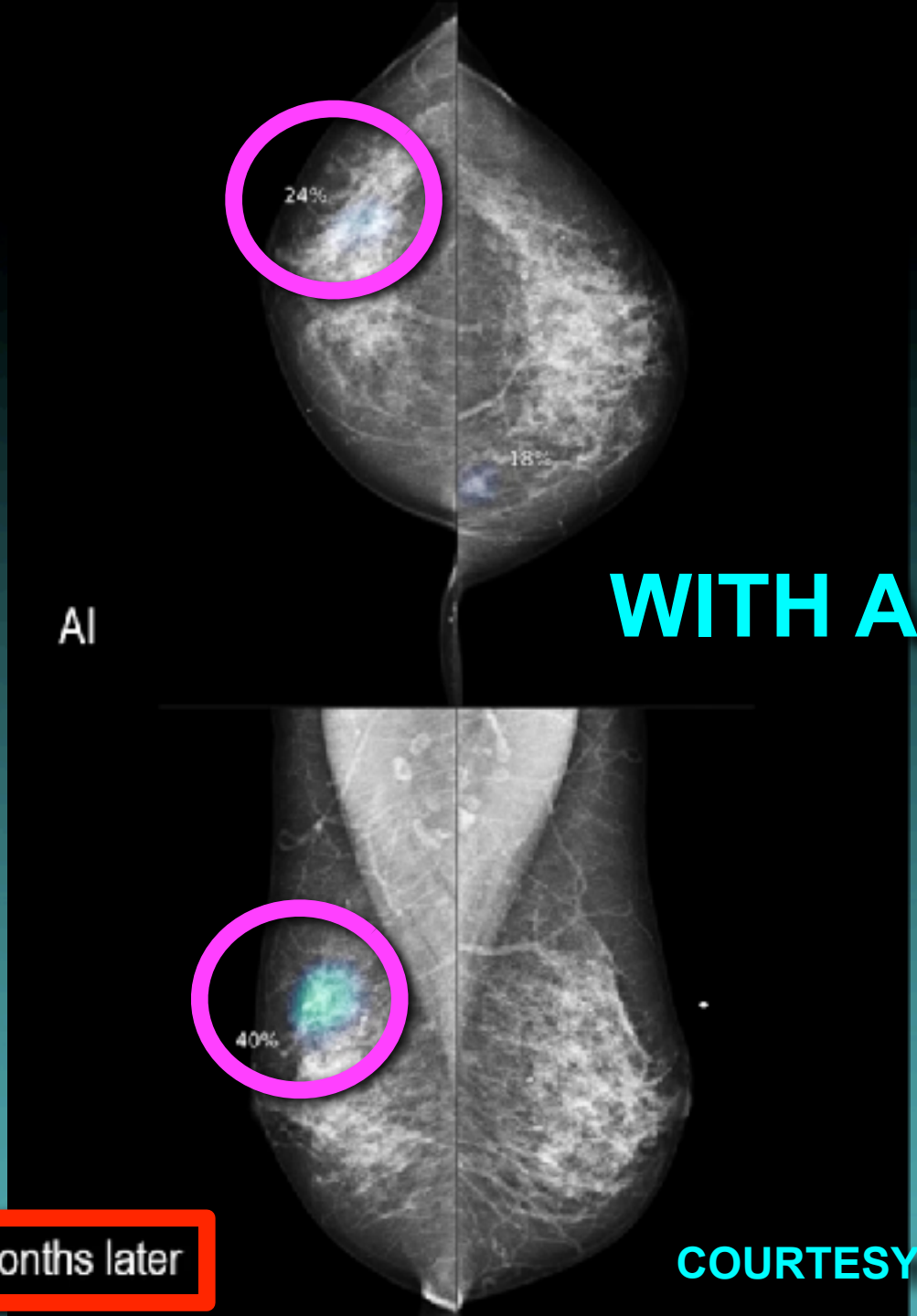


WITH AI

62 months prior to diagnosis


Right ML
Left MLO
25 months later
COURTESY LASZLO TABAR

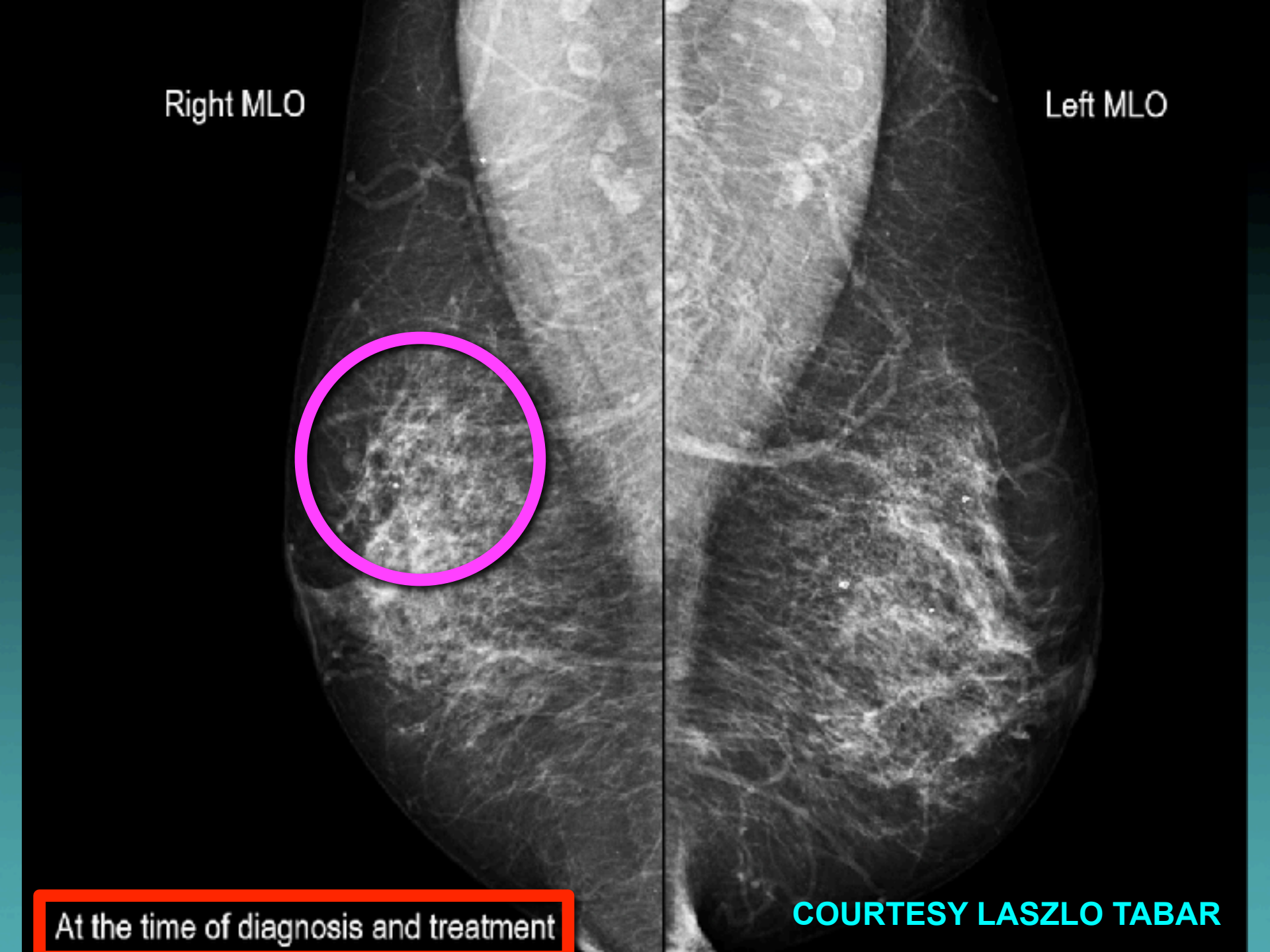

Right CC
Left CC
25 months later
COURTESY LASZLO TABAR

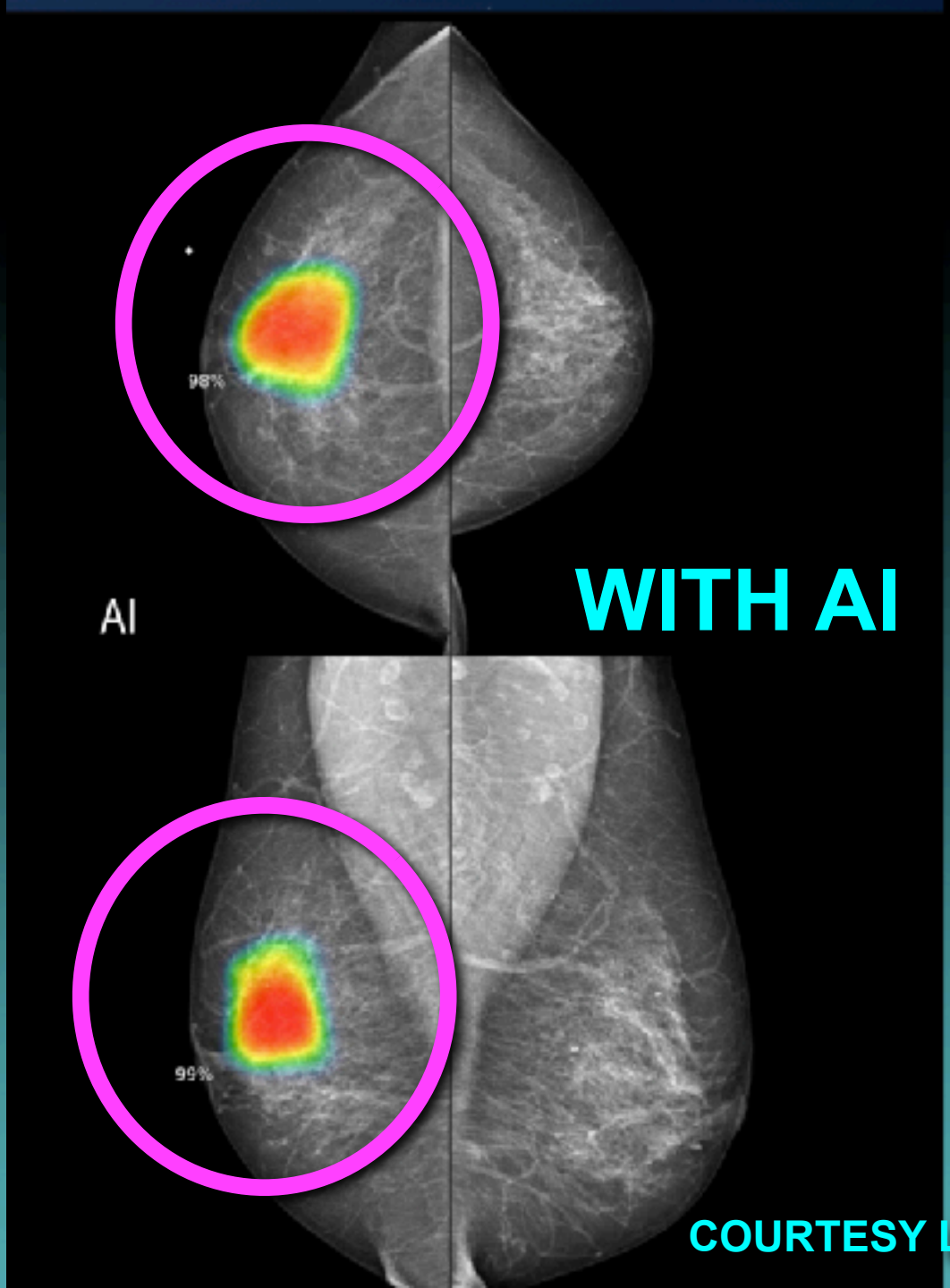


WITH AI

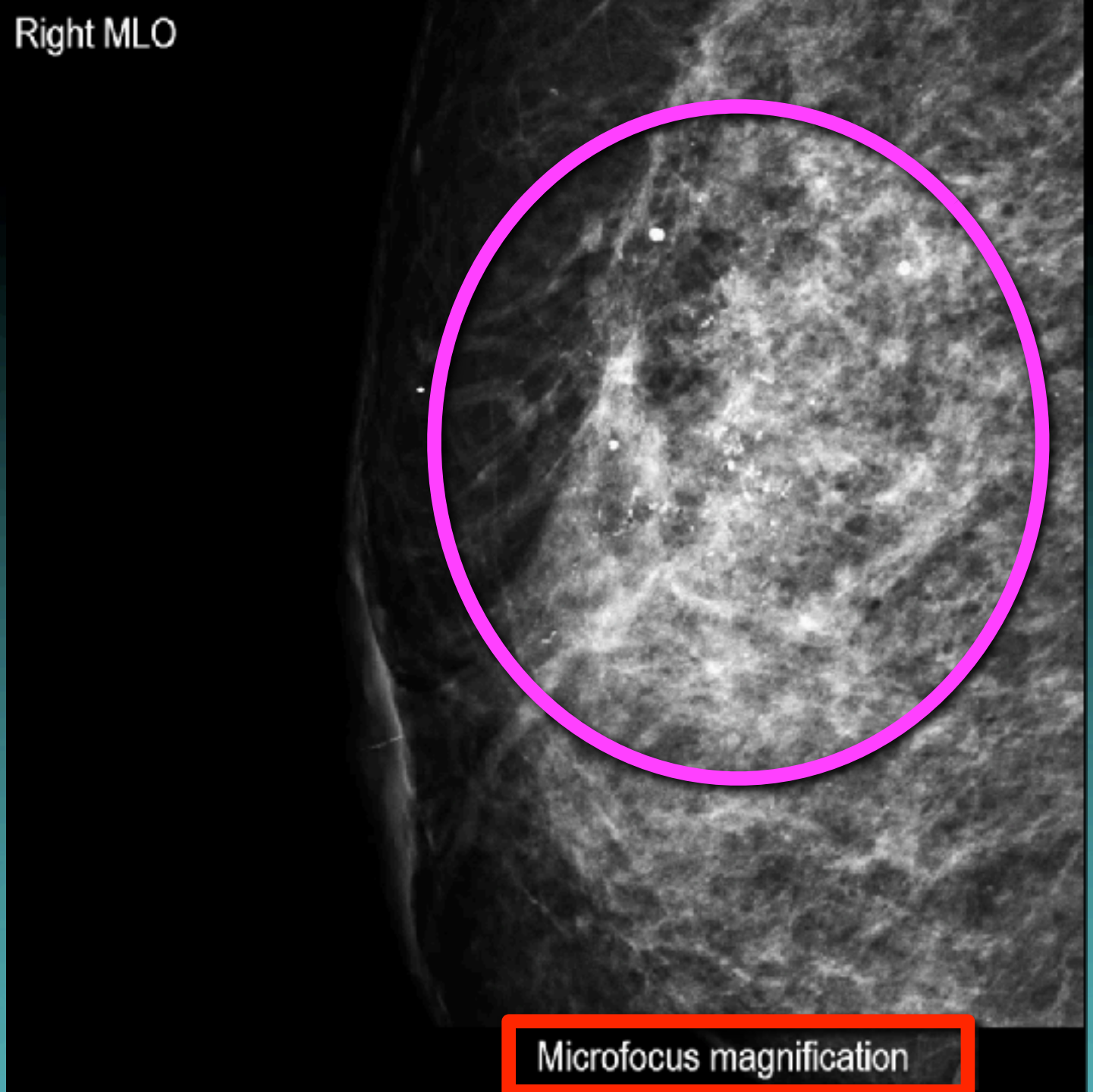
25 months later

COURTESY LASZLO TABAR

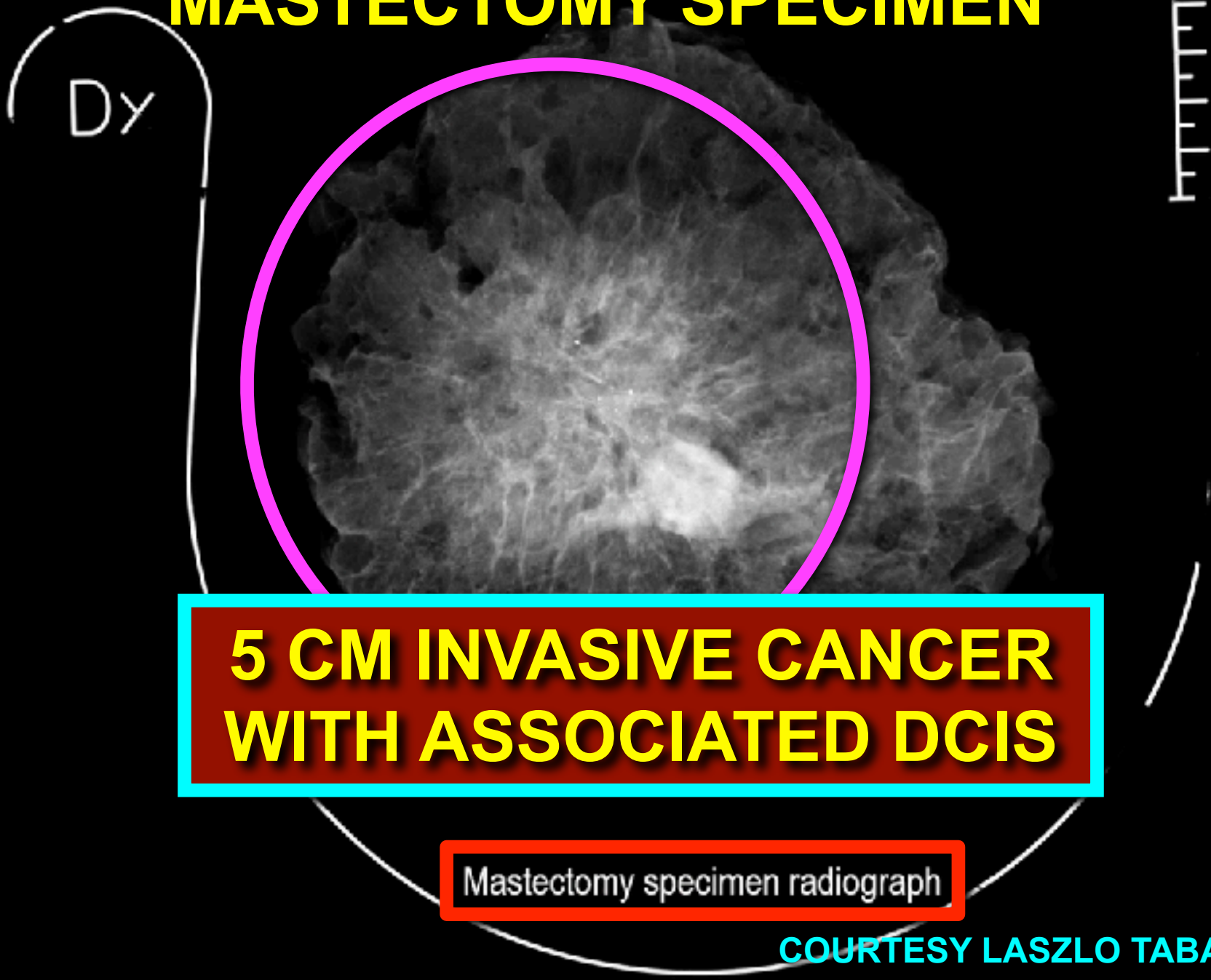

Right MLO
Left MLO
At the time of diagnosis and treatment
COURTESY LASZLO TABAR



COURTESY LASZLO TABAR


Right MLO
Microfocus magnification

MASTECTOMY SPECIMEN



5 CM INVASIVE CANCER WITH ASSOCIATED DCIS

Mastectomy specimen radiograph

COURTESY LASZLO TABAR

AI APPLICATIONS IN BREAST IMAGING

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AI APPLICATIONS IN BREAST IMAGING

Direct interpretation of screening mammograms!

Stand-Alone Artificial Intelligence for Breast Cancer Detection in Mammography: Comparison With 101 Radiologists

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STUDY IN JNCI ON DIRECT AI INTERPRETATION OF MAMMOGRAMS

- 101 radiologists interpreted 2652 mammograms (653 malignancies), as did AI
- Each exam given score of 1 to 10 level of suspicion by AI & by radiologists, independently
- ROC Area under curve (AUC, accuracy) HIGHER FOR AI (.84 versus .81) than for radiologists
- AI had higher sensitivity than 58% of rads!
- AI had higher AUC than 62% of radiologists
- HOWEVER, AI's performance was consistently LOWER than the best radiologists

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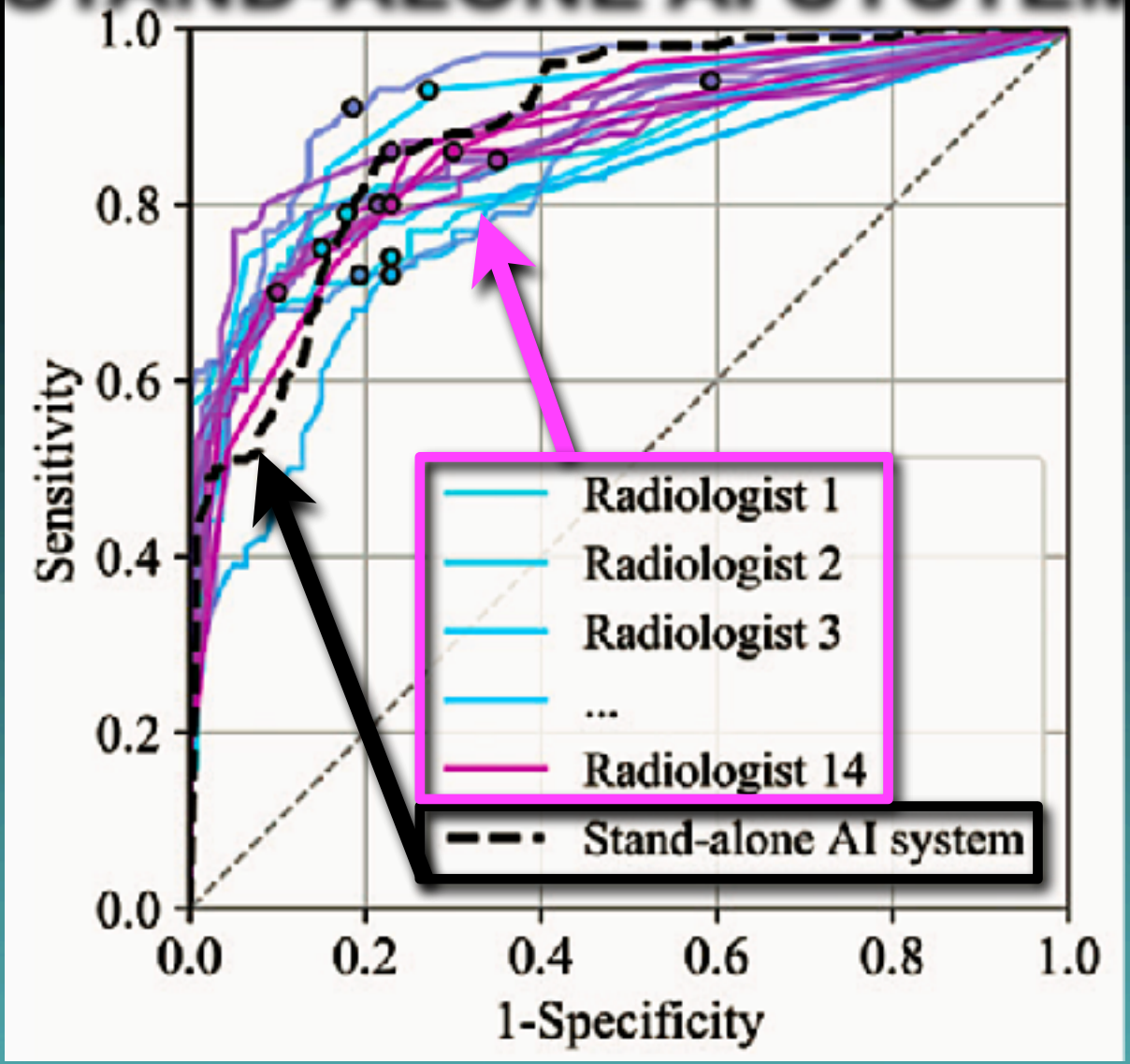
ROC CURVES OF RADIOLOGISTS VS. STAND-ALONE AI SYSTEM



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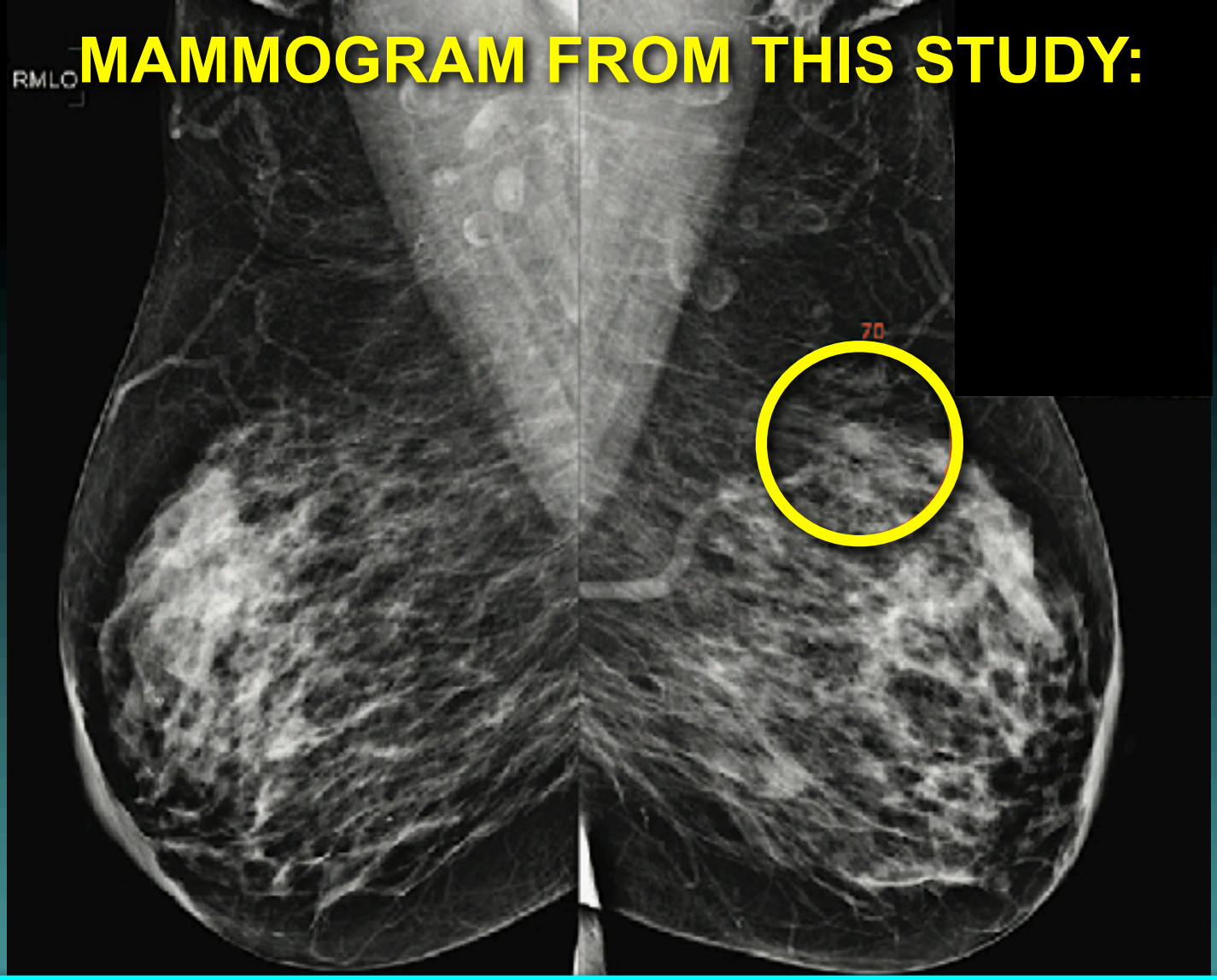
MAMMOGRAM FROM THIS STUDY:



IDC- Found by 4 of 14 radiologists WITHOUT AI
Found by 11 of 14 radiologists WITH AI

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STUDY IN JNCI ON DIRECT AI INTERPRETATION OF MAMMOGRAMS

- These findings suggest that AI could be utilized in situations where there is a lack of experienced or specialized breast imagers
- Findings also suggest that AI tuned to a high sensitivity could be utilized to "pre-screen" and eliminate studies deemed to have a very low likelihood of malignancy
- This could reduce radiologists' workload of cases to be interpreted without impacting their accuracy

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AI APPLICATIONS IN BREAST IMAGING

- CAD
- FIRST READ OF SCREENING MAMMOGRAMS
- **SYNTHETIC 2D MAMMOGRAPHY**
- BREAST DENSITY CATEGORIZATION FOR BREAST CANCER RISK

AI APPLICATIONS IN BREAST IMAGING

Synthesized 2D Image

How does it work?

- Perform a standard tomosynthesis scan (existing system)
- Reconstruct tomosynthesis slices (existing system)
- Synthesize 2D image (C-View)
  - Similar to Maximum Intensity Projection (MIP) as done with MRI images

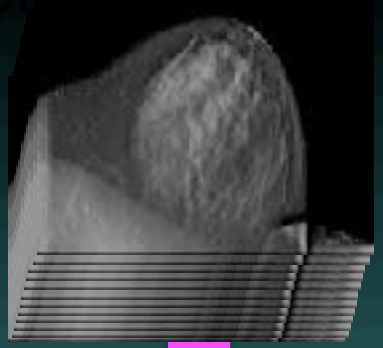
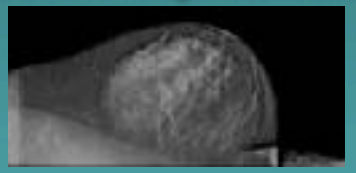
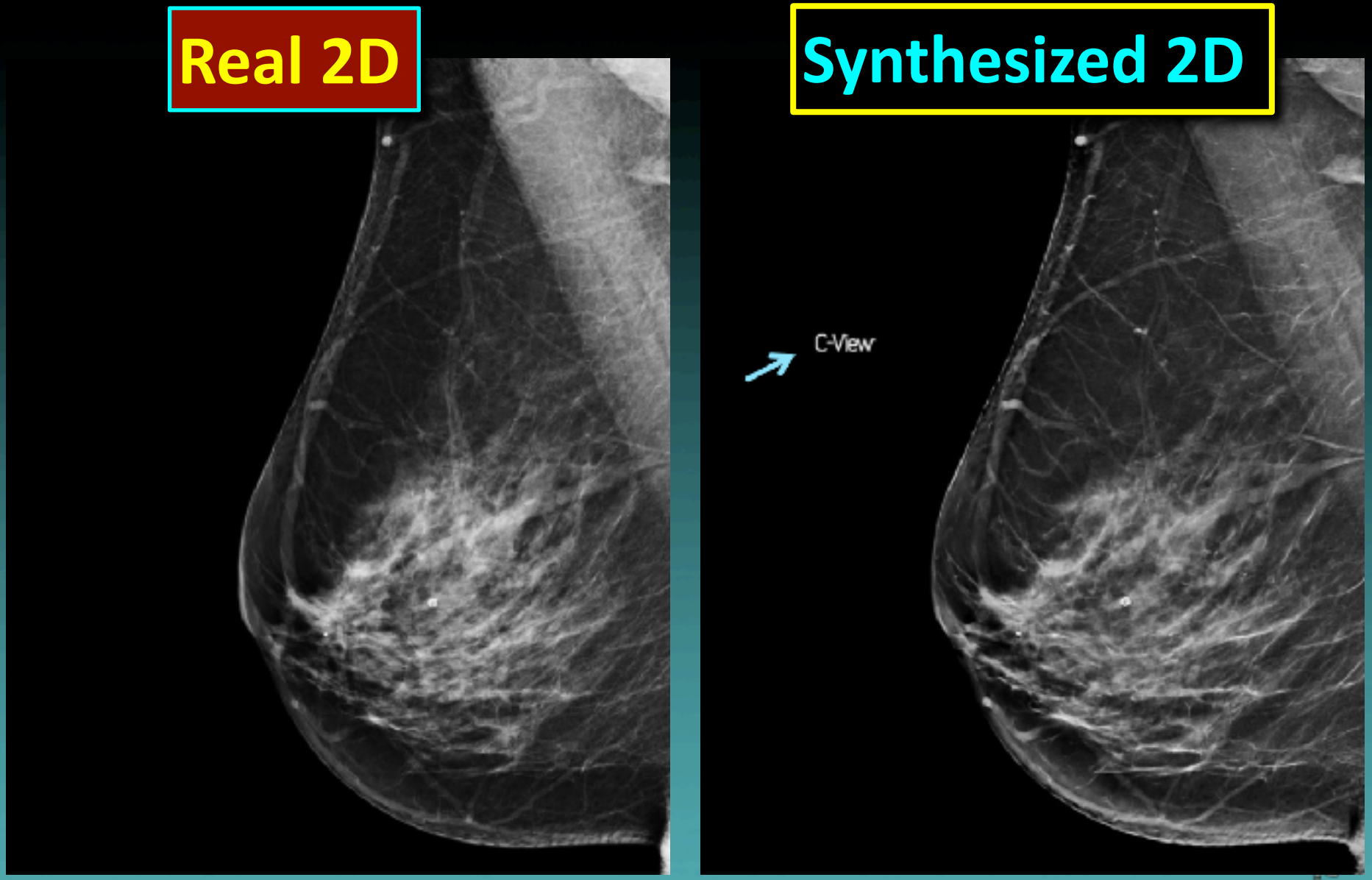


Image Summation



Synthesized 2-D View

AI APPLICATIONS IN BREAST IMAGING

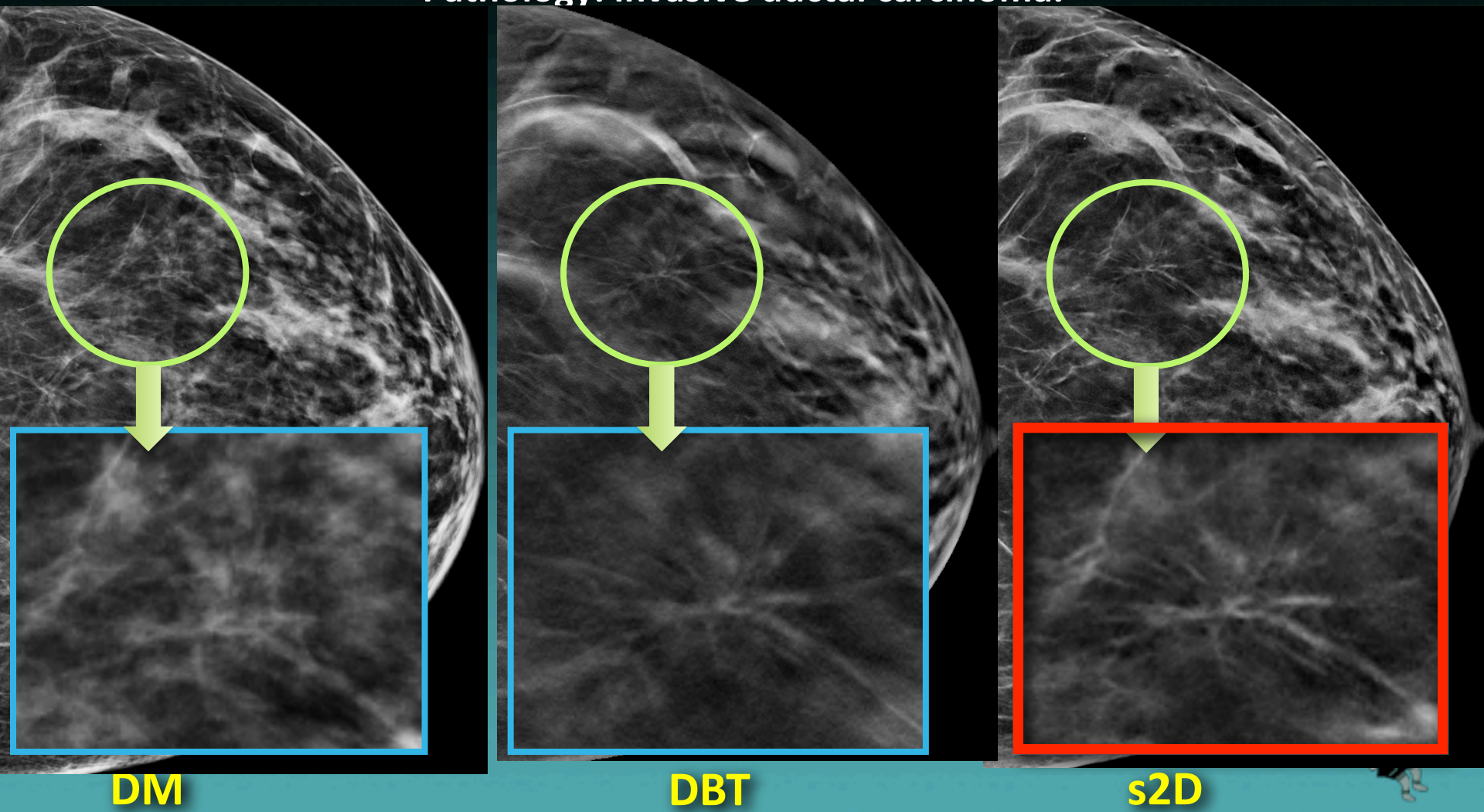


AI APPLICATIONS IN BREAST IMAGING

Arch. Distortion on s2D and DBT

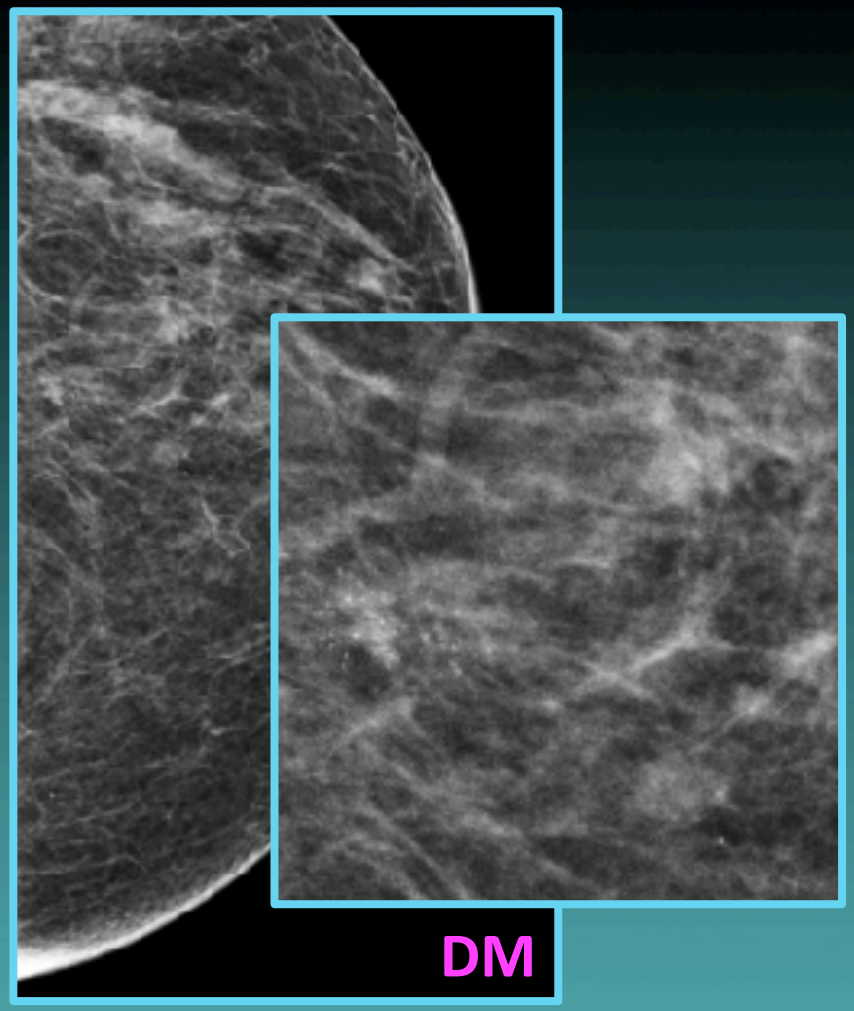
51 yo architectural distortion seen well only on s2D/DBT

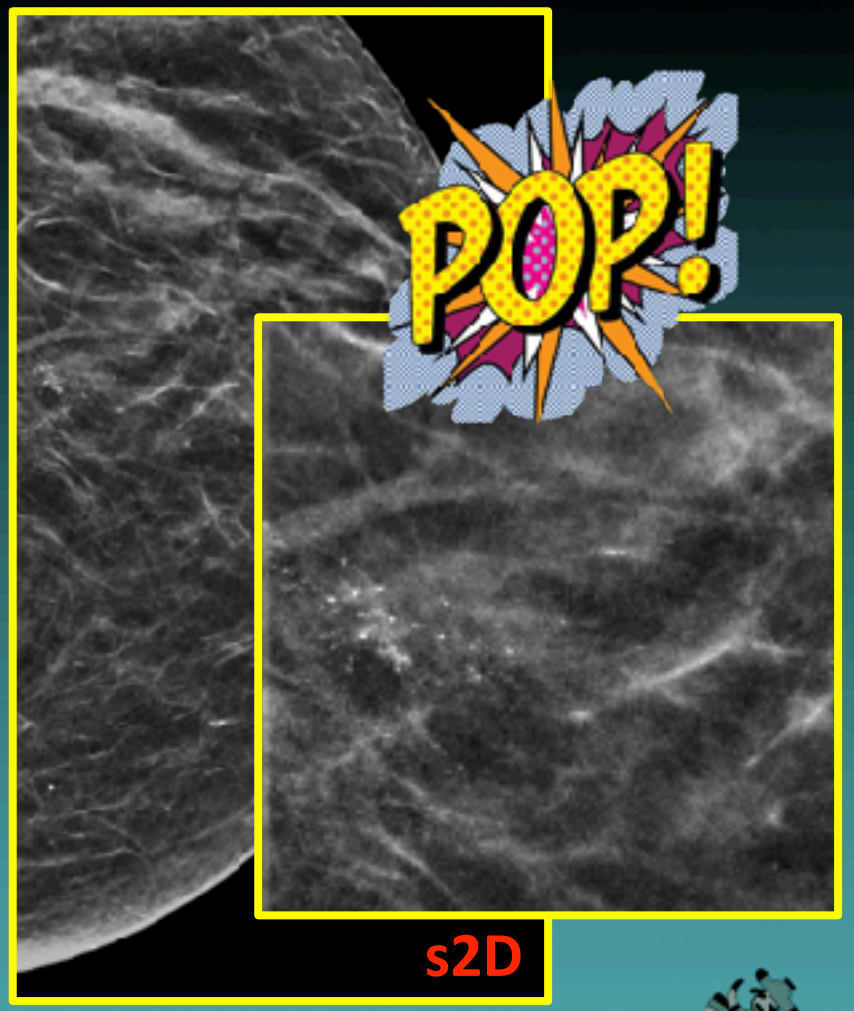
Pathology: invasive ductal carcinoma.



AI APPLICATIONS IN BREAST IMAGING

Synthetic 2D with Tomosynthesis

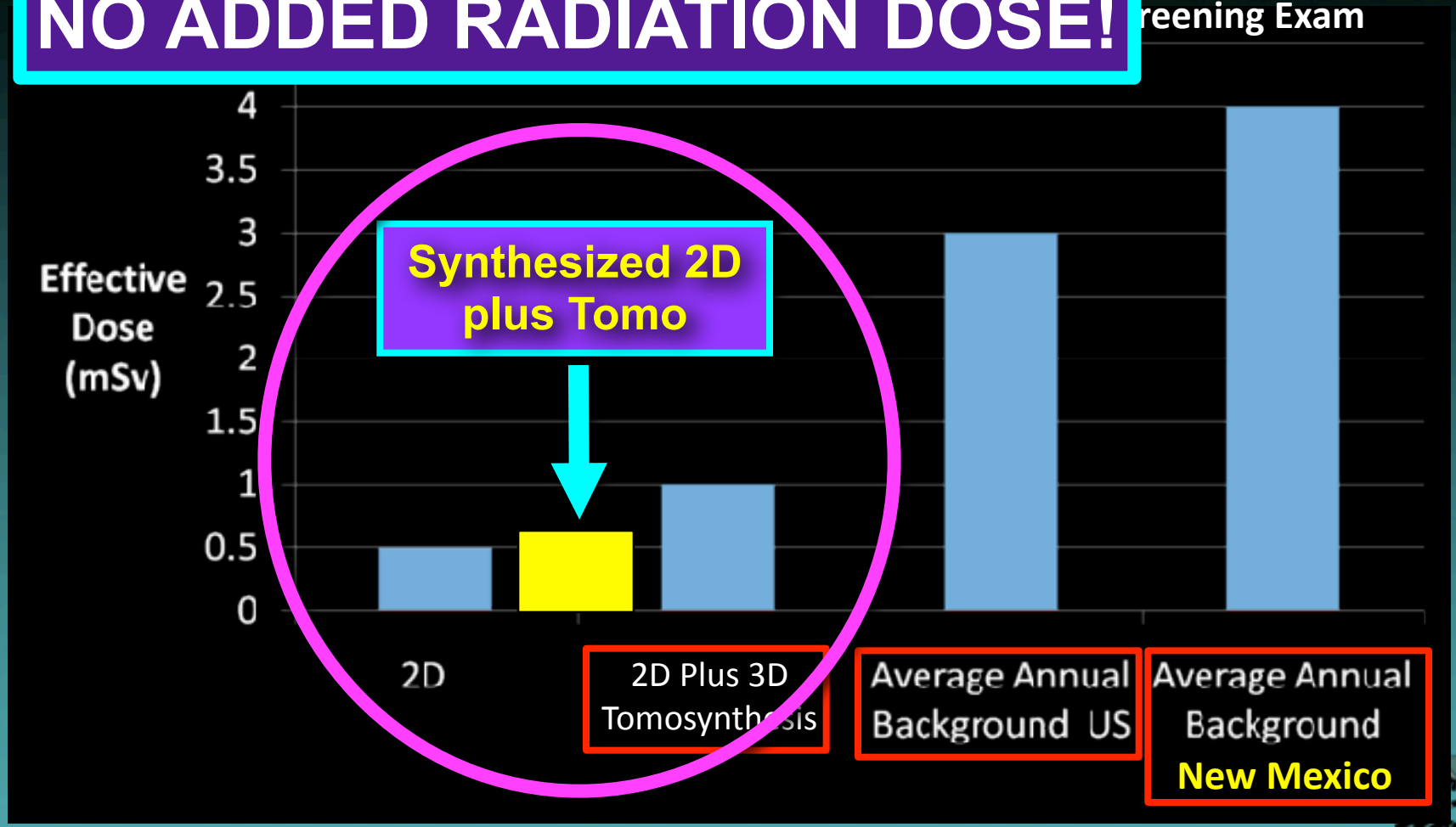




Pathology: Ductal Carcinoma *in situ* (DCIS)

RADIATION DOSE WHEN SYNTHETIC VIEW IS ADDED TO TOMOSYNTHESIS VIEW:

NO ADDED RADIATION DOSE!



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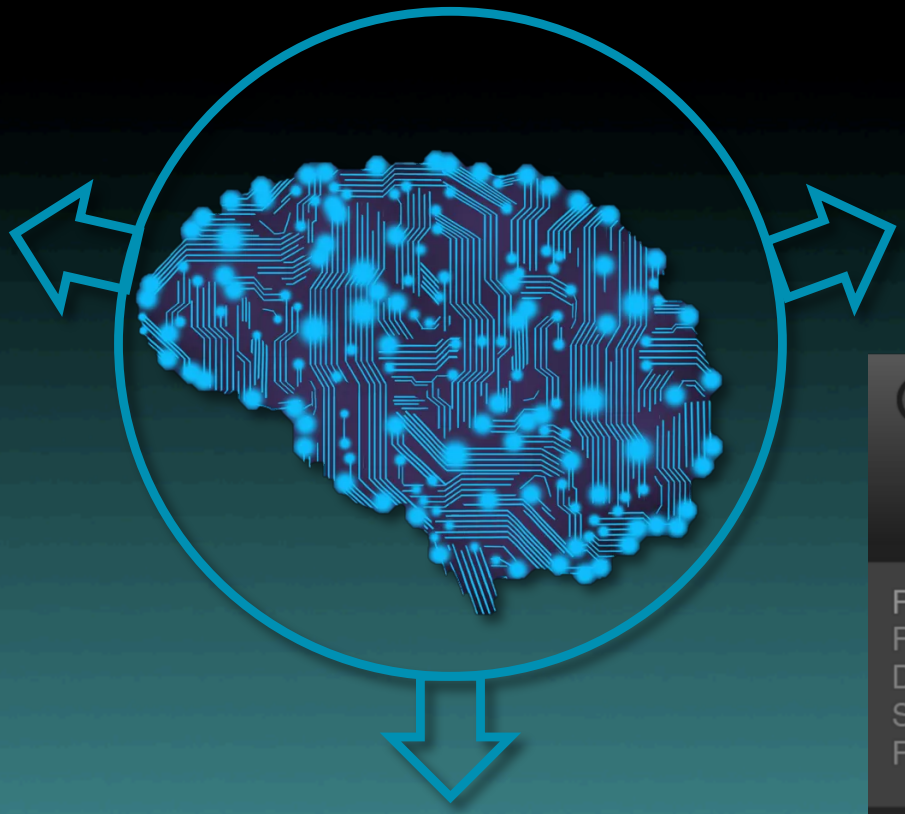
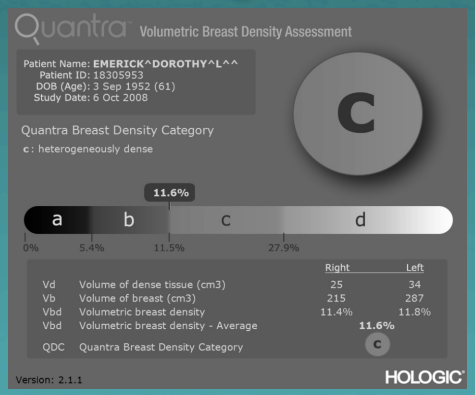
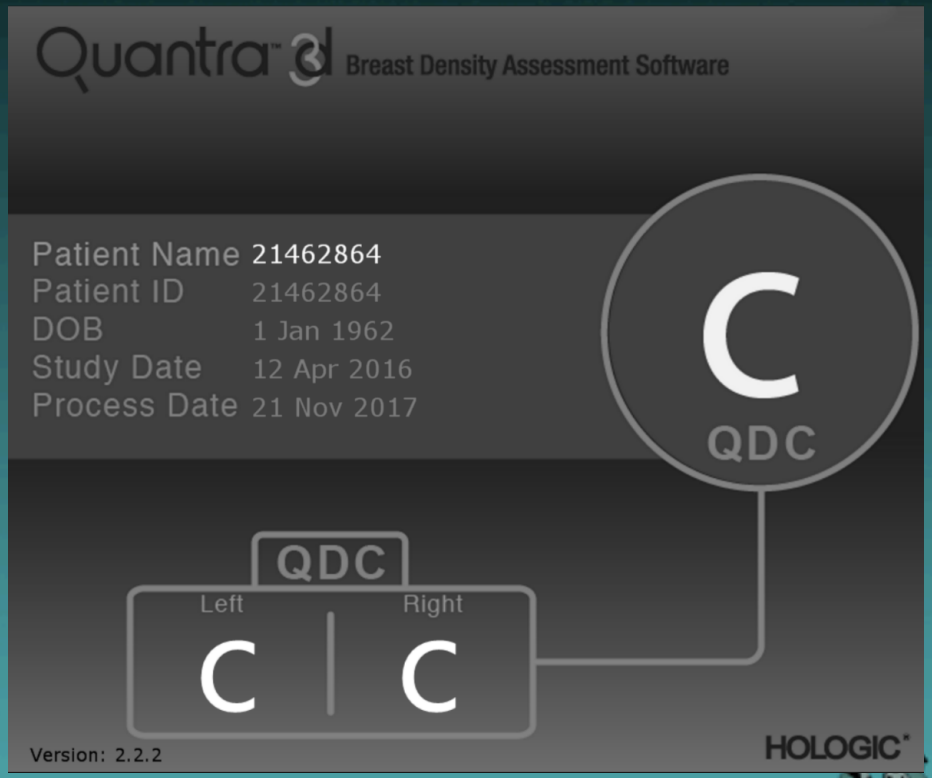


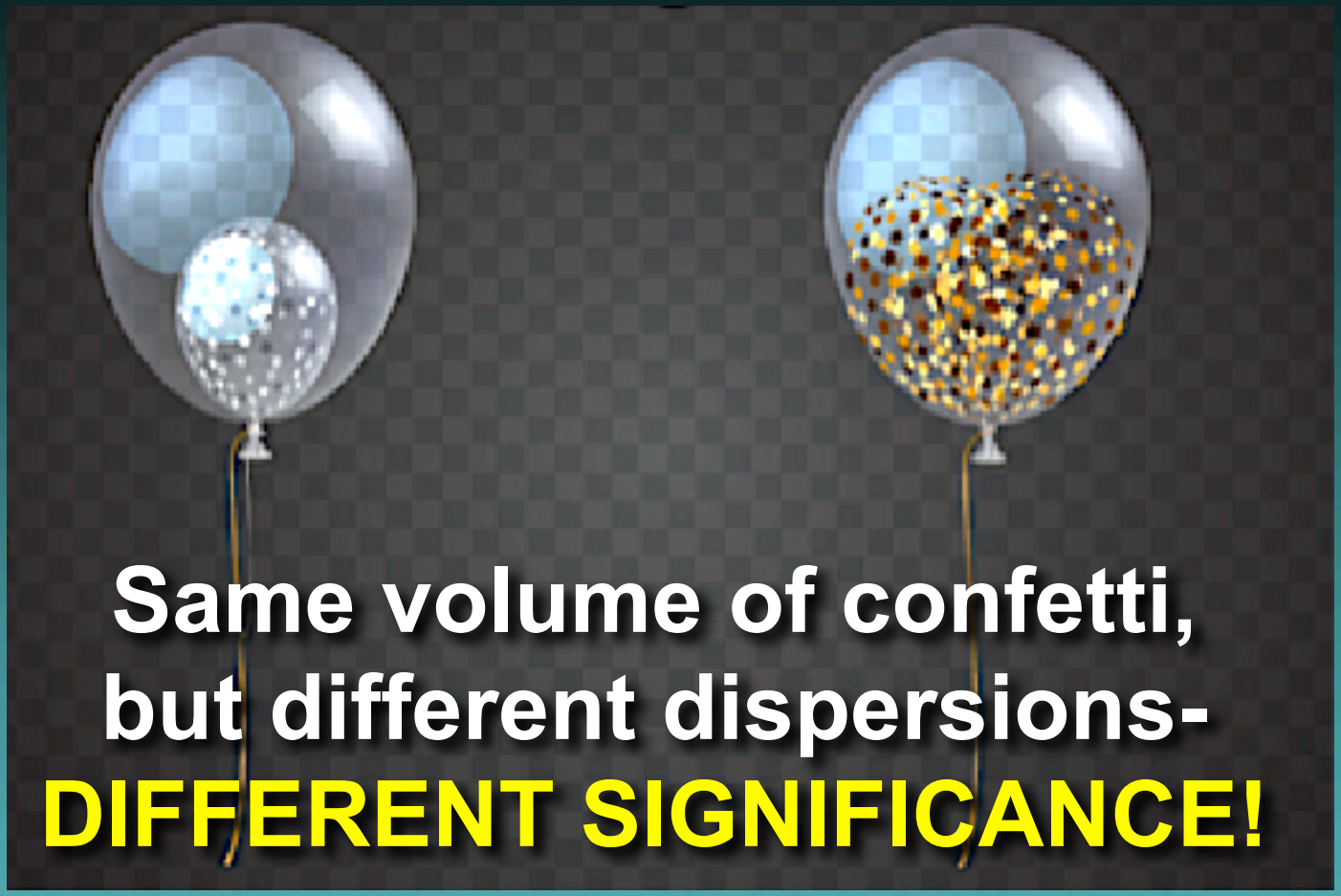
Breast density categorization



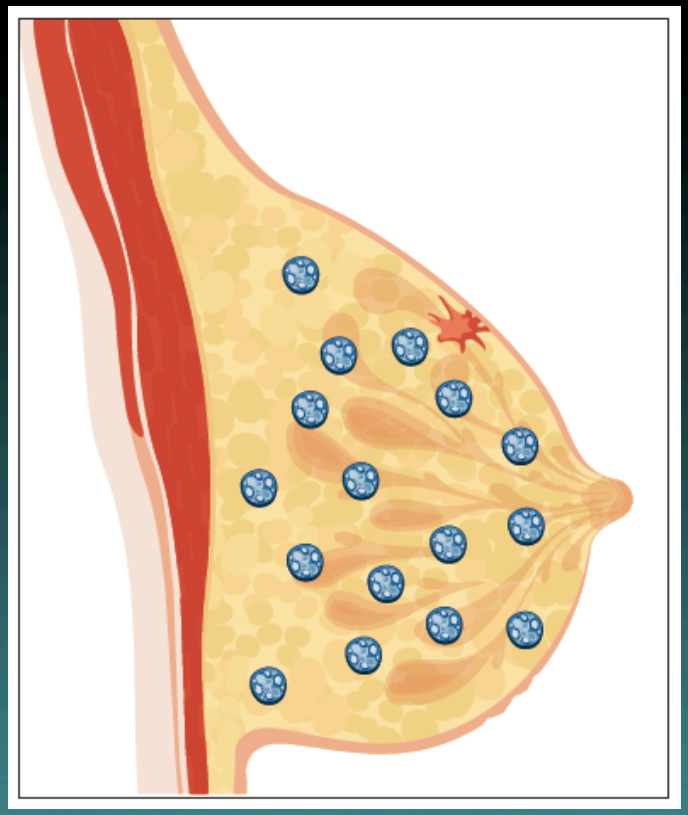


AI APPLICATIONS IN BREAST IMAGING

AI can measure actual DISPERSION of dense breast tissue, not just volume!



AI APPLICATIONS IN BREAST IMAGING



Same volume of glandular tissue,
but different dispersions-
DIFFERENT BREAST CANCER RISK!

SUMMARY OF AI APPLICATIONS IN BREAST IMAGING

- CAD
- FIRST READ OF SCREENING MAMMOGRAMS
- SYNTHETIC 2D MAMMOGRAPHY
- BREAST DENSITY CATEGORIZATION FOR BREAST CANCER RISK
- MUCH, MUCH MORE: Device optimization analytics, positioning & motion algorithms, "smart" machines for further analyses, etc.

AI IS OUR FUTURE!


THE FUTURE LOOKS BRIGHT AND INTERESTING FOR BREAST IMAGING!
IT IS A PRIVILEGE & A PLEASURE TO BE PART OF IT, AS WE CONTINUE SKYWARD!