

**Rontgenveckan 2013**  
**Uppsala 4.september 2013**

# **Tomosyntes**

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**25 min**

## **Innhold:**

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- **Hva er tomosyntes ?**
  - **Tomosyntes i klinisk utredning**
  - **Tomosyntes i screening**
  - **Tomosyntes: Erfaringer fra  
Oslo Tomosynthesis Screening Trial (OTST)**
  - **Konklusjon**
- 

### **Disclosure:**

**Oslo Tomosynthesis Screening Trial**

Equipment and support for additional reading provided by Hologic, Inc.

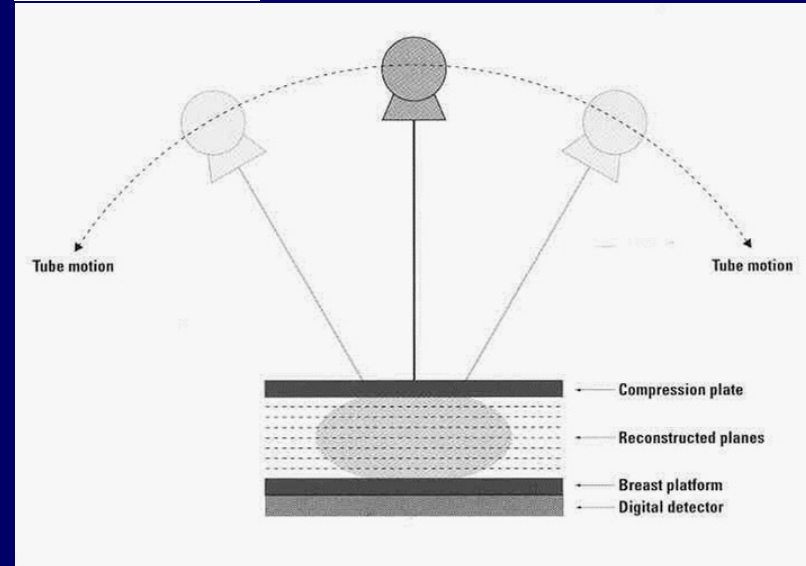
# Tomosynthesis ( "3D Mammography" )

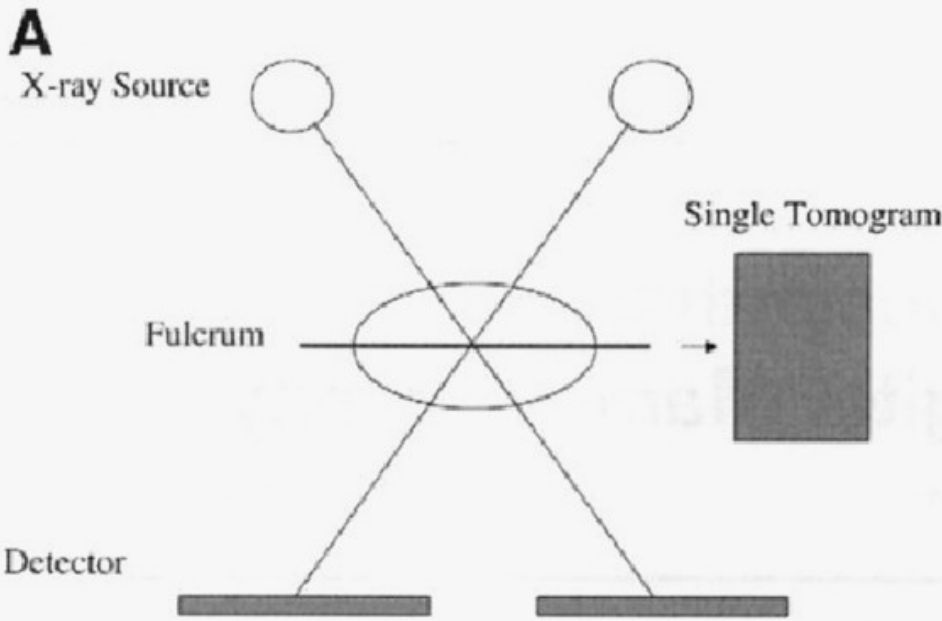


**Dimensions ( Hologic )**

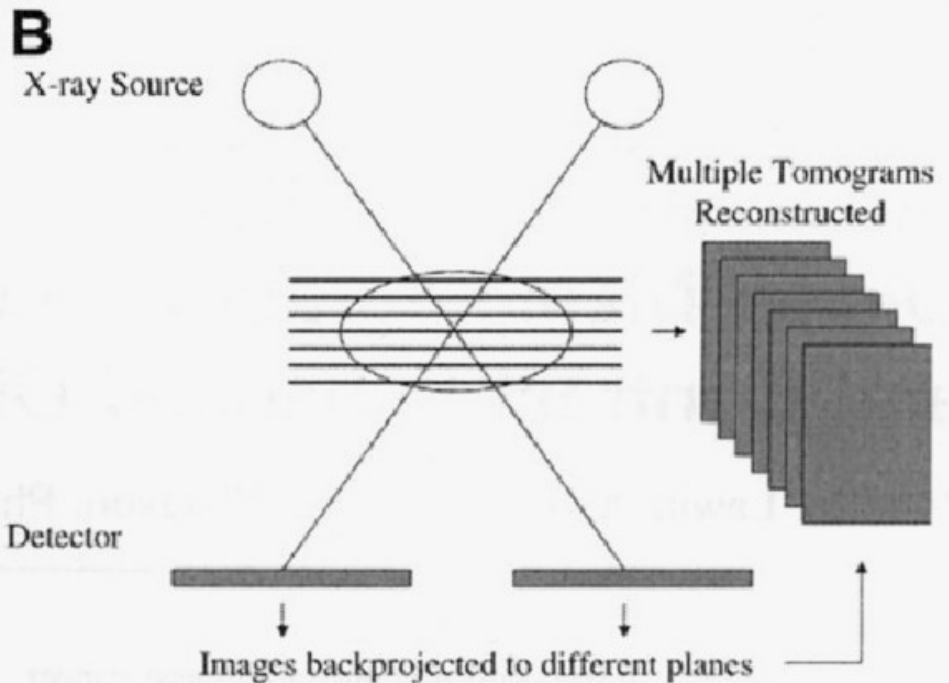


**Screening unit Oslo  
("Galleriet")**





## A) Conventional linear tomography

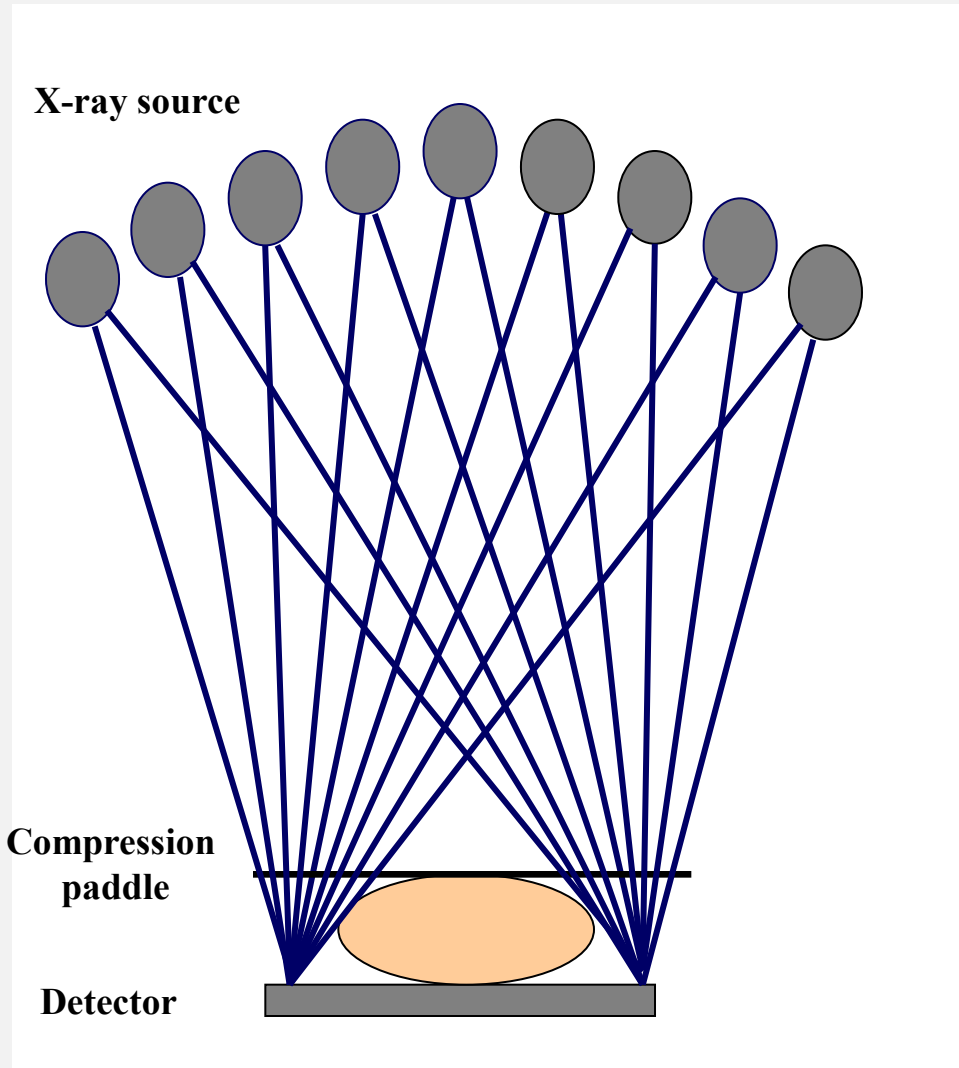


## B) Tomosynthesis with a digital detector:

- Multiple images are acquired
- Tomosynthesis provides tomograms of the entire object

# Digital Breast Tomosynthesis (DBT / “3D mammography”) :

## ACQUISITION



- X-ray tube moves through a proscribed arc of excursion
- Fifteen low-dose projection images are acquired during a 4-second sweep
- Images are reconstructed into stack of images spaced at 1 mm apart
- Total dose same as 2D

## A) Potential role of DBT in the clinical setting

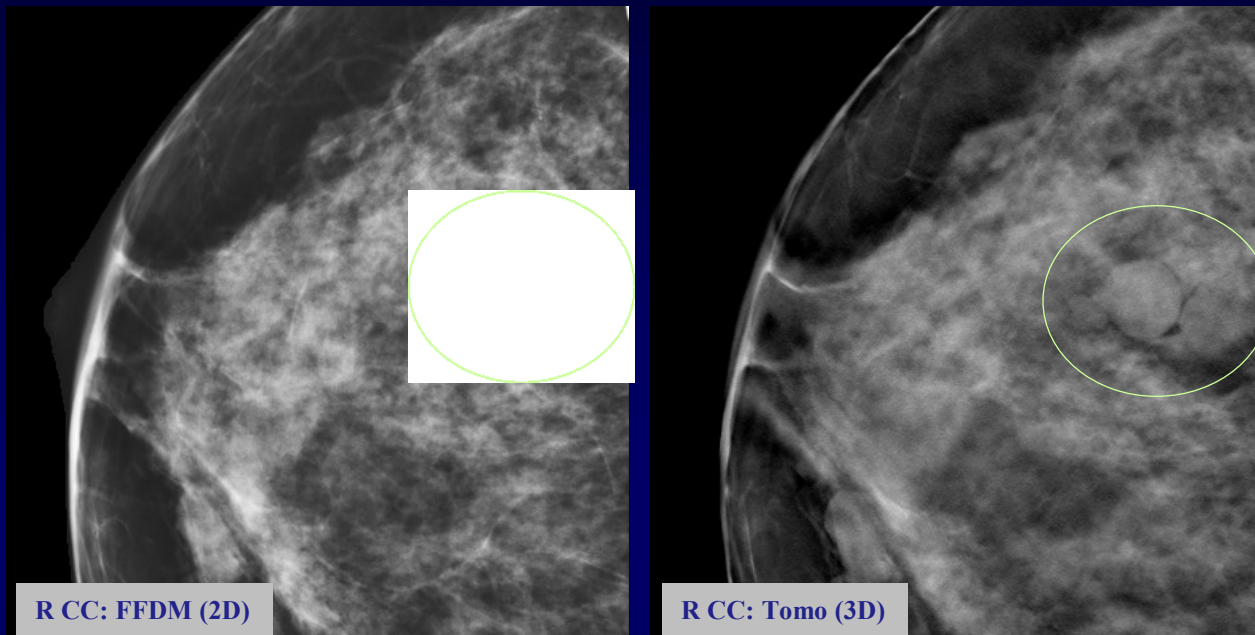
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- **Microcalcifications:**
  - **FFDM slightly more sensitive than DBT for detection (Spangler ML: AJR 2011;196:320)**
  - **Demonstrated with equal or greater clarity on DBT (Kopans D: Breast J 2011;17:638)**
- **Tumor size assessment:**
  - **DBT superior to FFDM (Fornvik B: Acta Radiol 2010;51:240)**
- **Specificity increased when used adjunctively with FFDM:**
  - **(Poplack SP: AJR 2007;189:616)**
  - **(Gur D: AJR 2009;193:586)**
- **Mass characterization:**
  - **Superior cancer visibility and conspicuity (Andersson I: Eur Radiol 2008;18:2817)**

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**i.e., DBT might have a great potential in mammography screening !!**

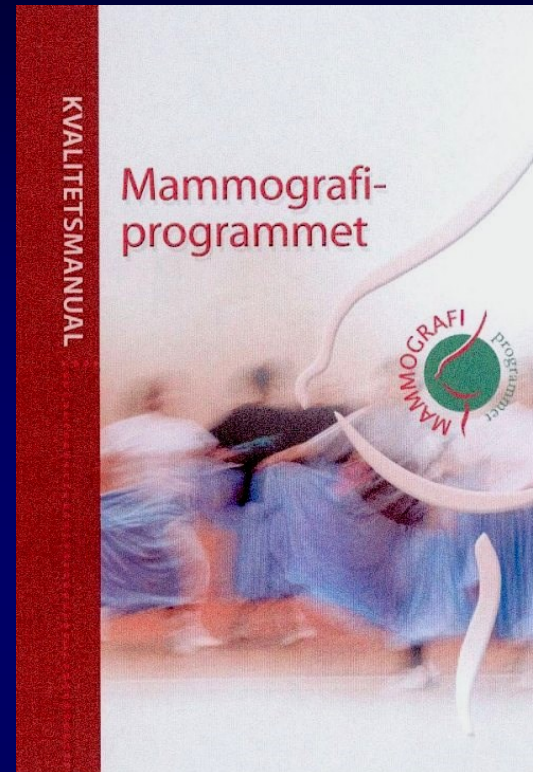
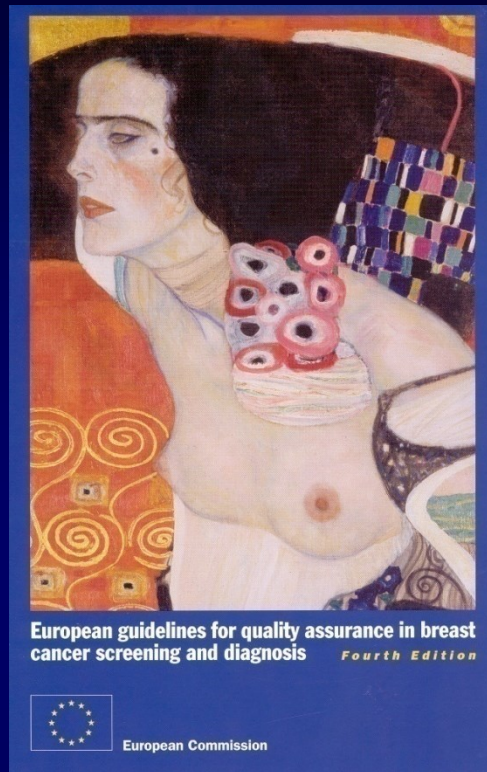
## Tomosynthesis: Potential for increased specificity



### Clinical studies showing lower call-back rate:

- **Bernardi D: Breast Cancer Res Treat 2012;133:267-271**
- **Gur D: Am J Roentgenol AJR 2009;193:586-591**
- **Michell MJ: Clin Radiol 2012;67:976-981**
- **Poplack SP: Am J Roentgenol AJR 2007;189:616-623**
- **Rafferty EA: Radiology 2013;266:104-113**

# DBT in European mammography screening and potential for increased specificity



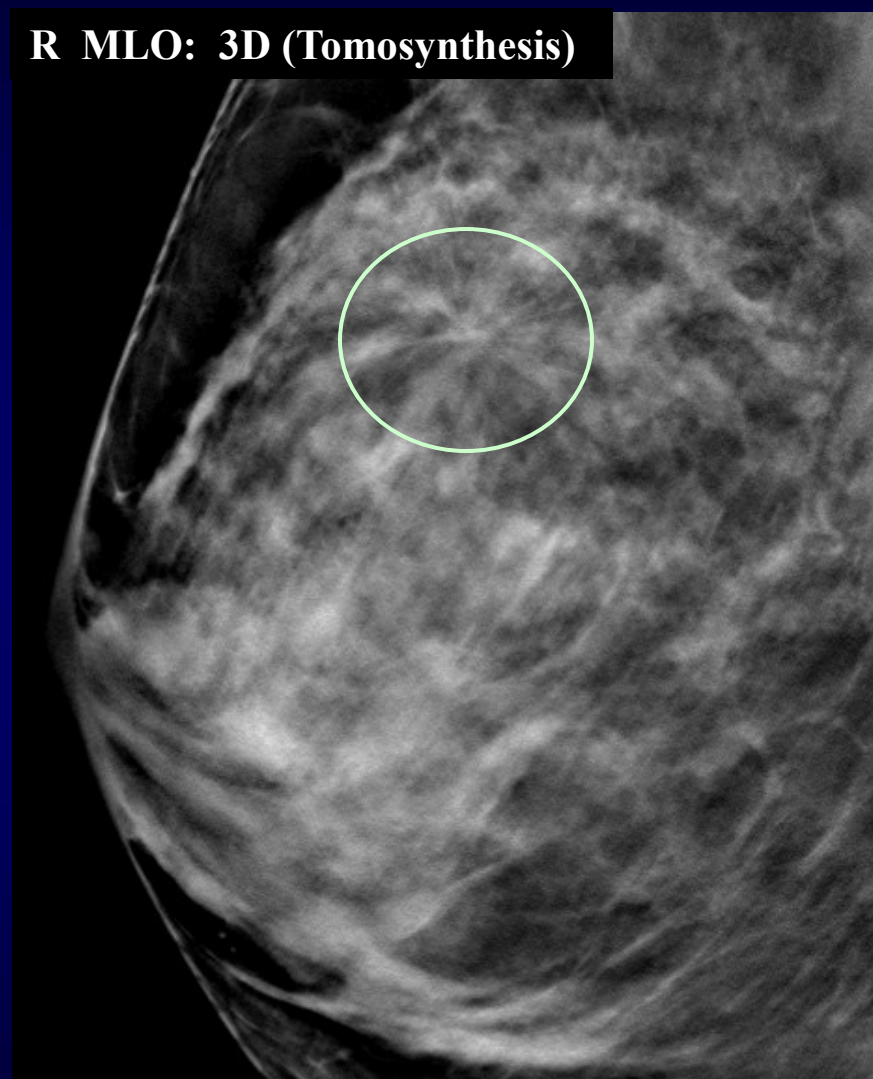
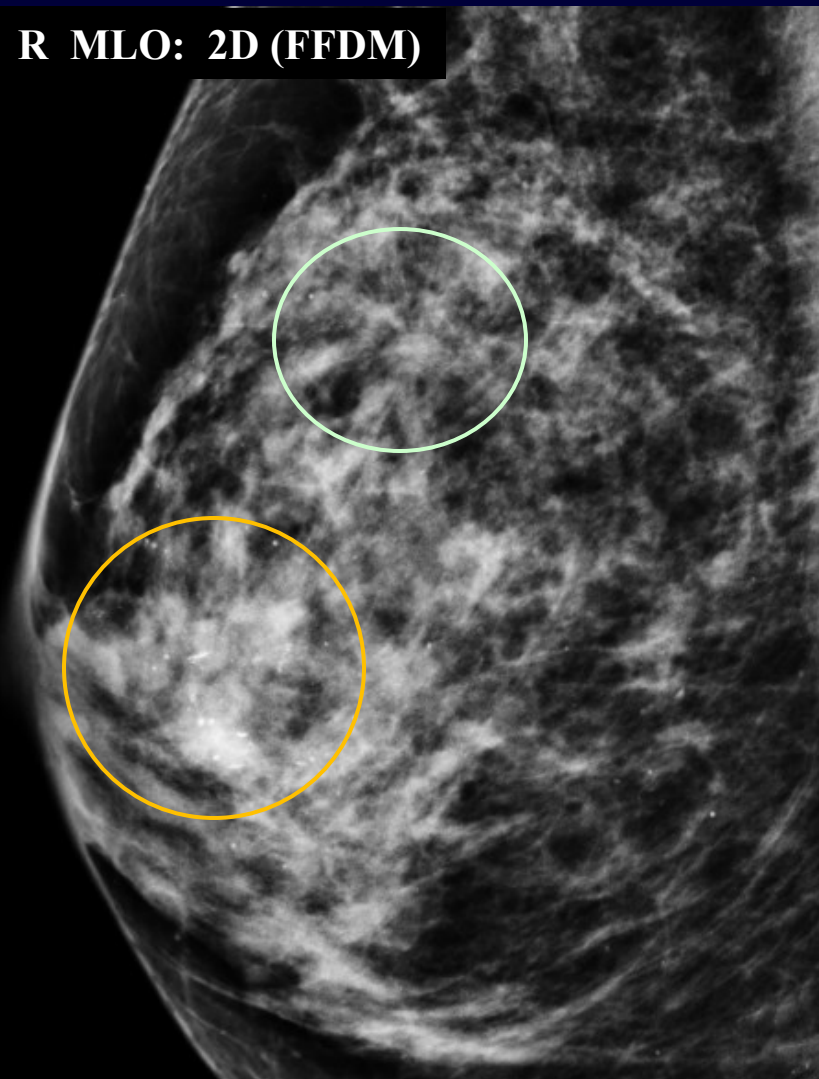
## European guidelines for quality assurance in mammography screening

### Performance indicator "Recall rate"

	Acceptable level	Desirable level
<b>Initial screening examinations</b>	< 7 %	< 5 %
<b>Subsequent screening examinations</b>	< 5 %	< 3 %



## B) Potential role of DBT in mammography screening



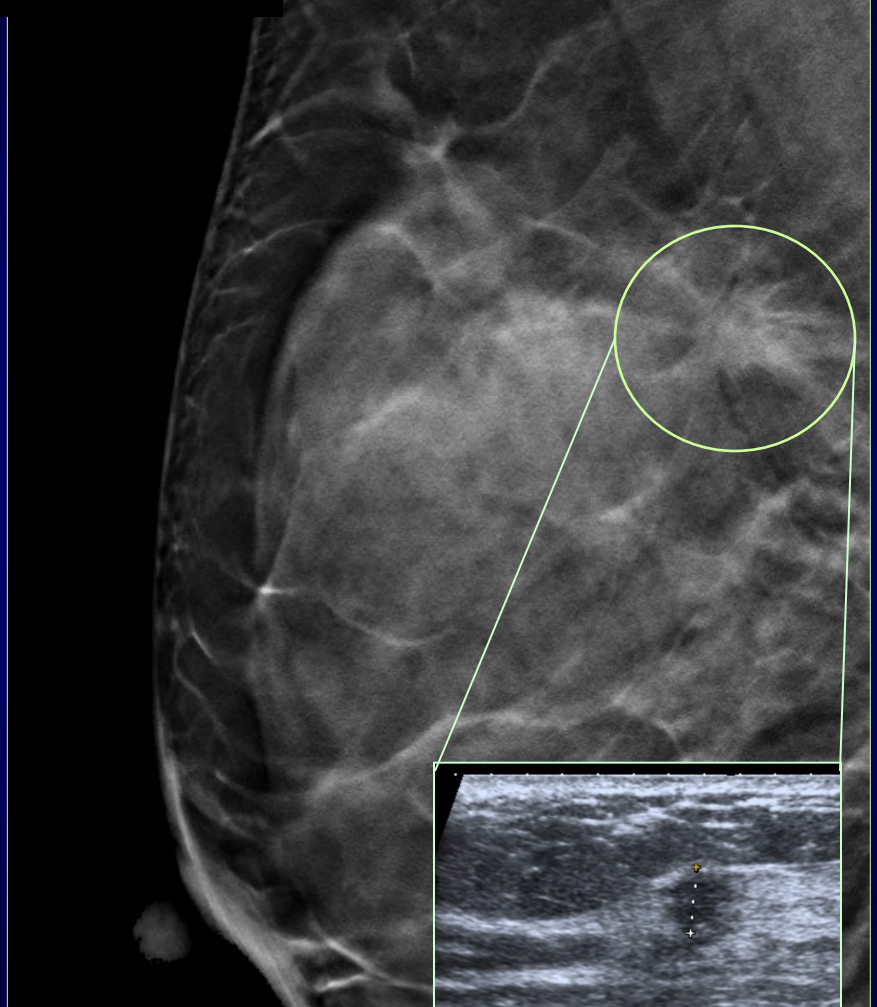
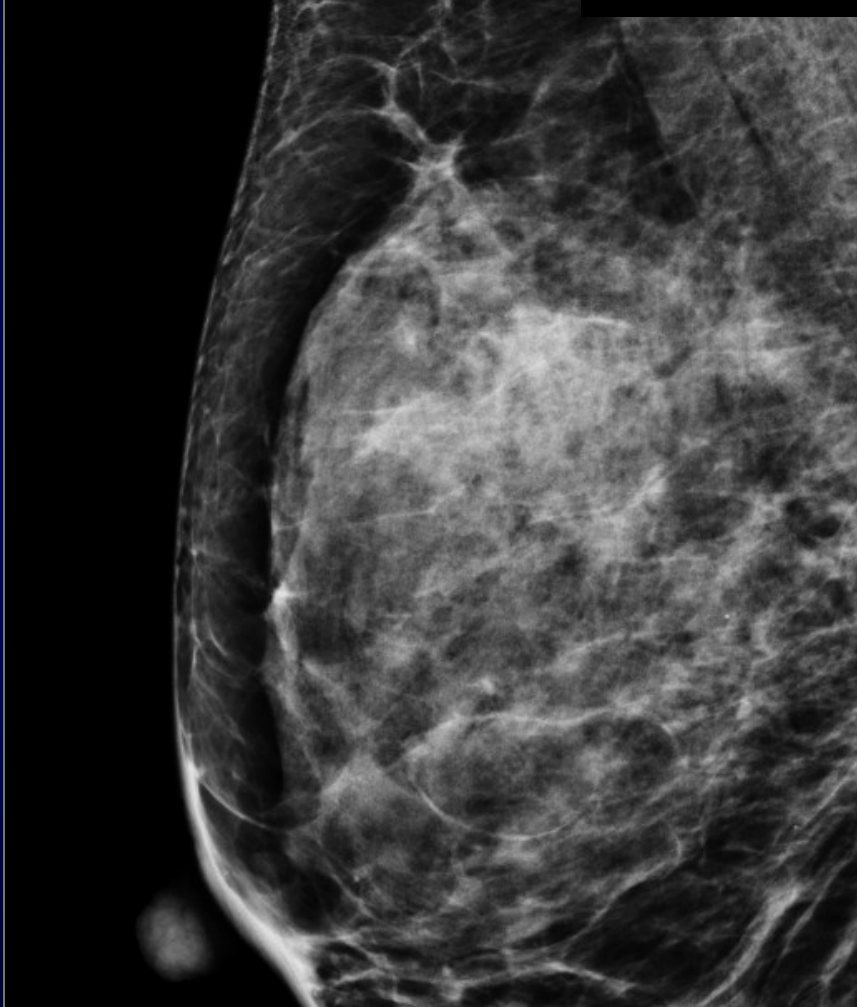
**Invasive lobular carcinoma (ILC) : 2 mm, gr. 1  
( + LCIS 20 mm and ALH / LCIS )**

# Indication for tomosynthesis: **Dense breast parenchyma**

Screen 2D R MLO 13.01.11

**Tubular carcinoma 6 mm**

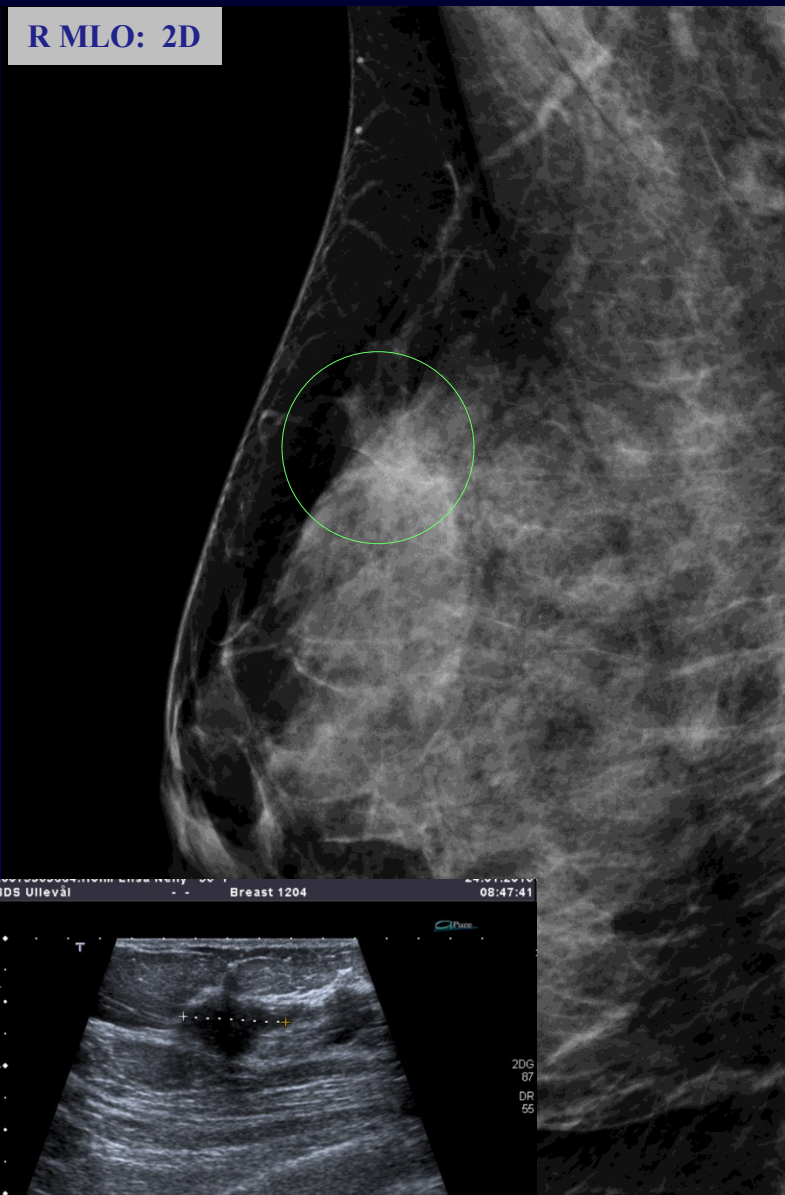
Screen TOMO R MLO 13.01.11



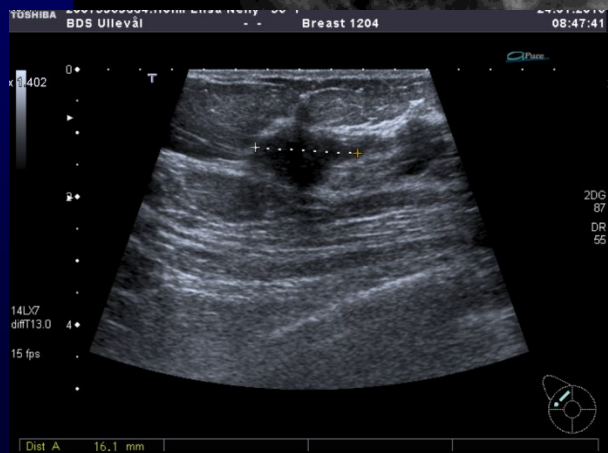
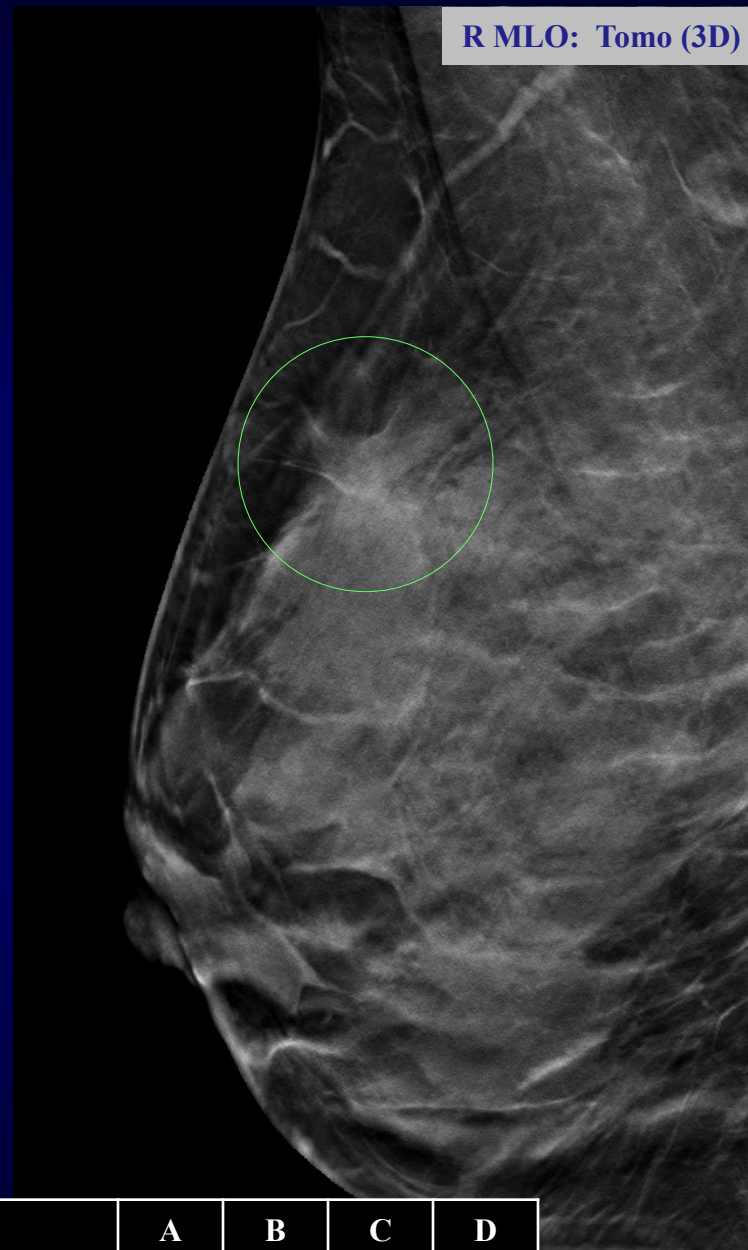
Reader Arm	A	B	C	D
Score (NBCSP)	1	1	4	1

# OTST: Cancer right breast

R MLO: 2D

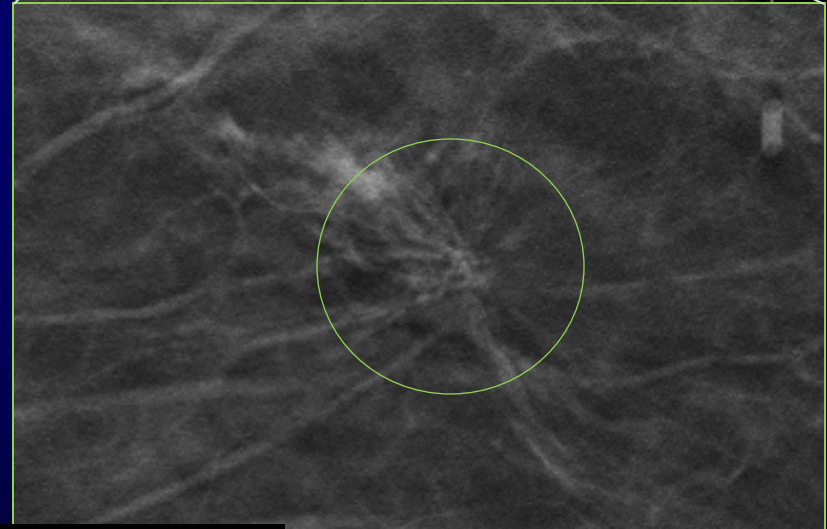
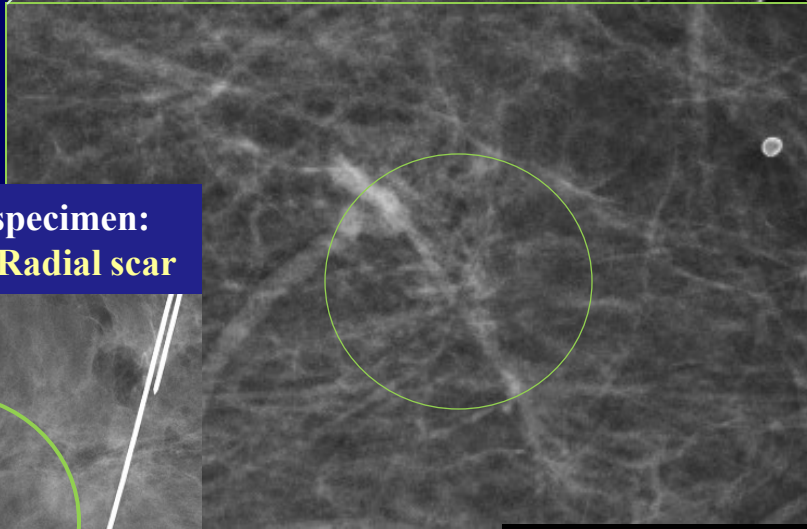
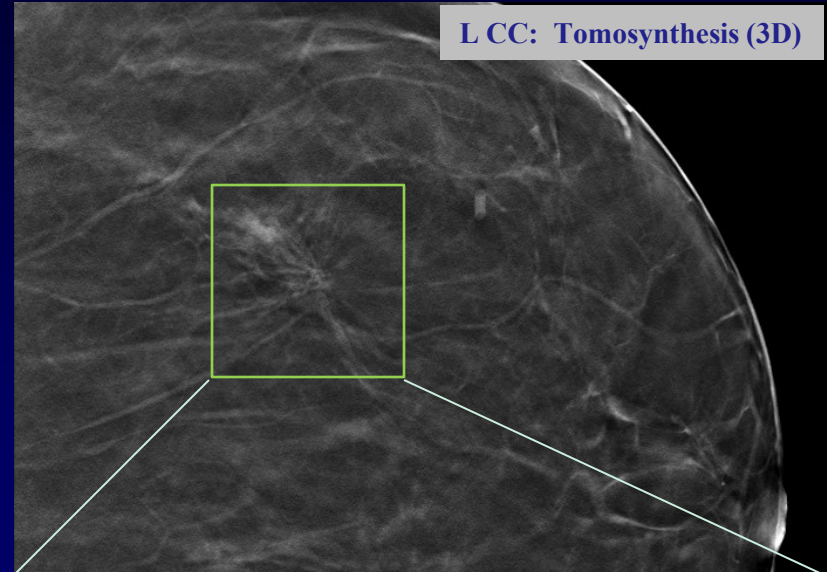
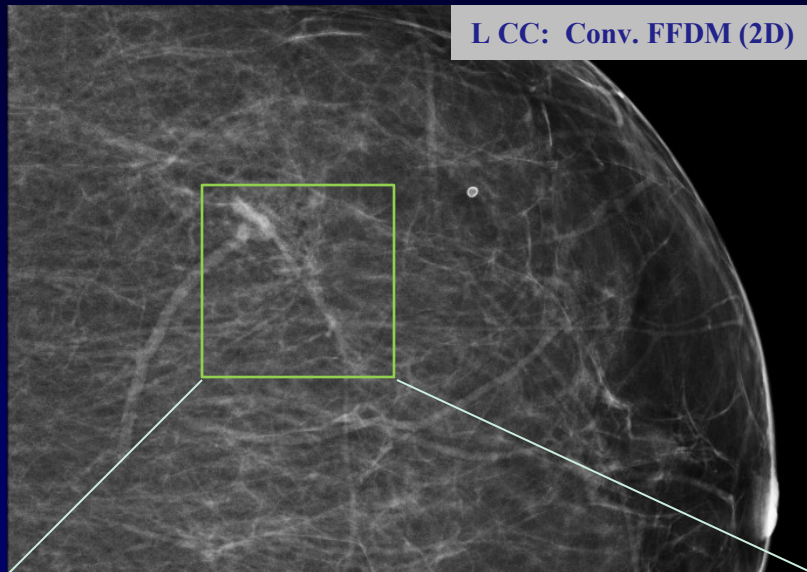


R MLO: Tomo (3D)

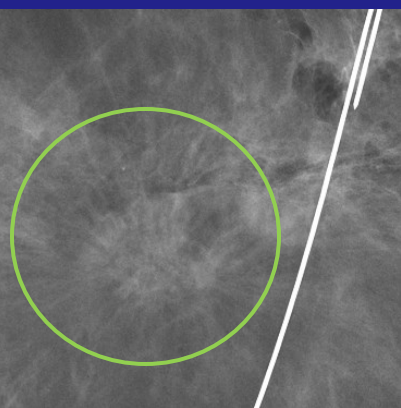


Radiologist	A	B	C	D
Score (NBCSP)	1	1	1	2

# Indication for tomosynthesis: Fatty breasts ??



**Surgical specimen:  
Histology: Radial scar**



## Oslo Tomosynthesis Screening Trial

Radiologist	A	B	C	D
Score (NBCSP)	1	1	3	4

# Tomosynthesis in breast cancer screening

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## Images to be included:

- One view TOMO (mlo)?
- One view 2D + one view TOMO?
- Two view 2D + one view TOMO?
- Two view TOMO?
- Two view 2D + two view TOMO?

## Why do we need 2D (+ TOMO):

- 2D should maximize mc detection (TOMO: "Thin-slice-effect")
- Comparison with priors is facilitated if currents includes 2D
- Externals may request current 2D

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## Experience from experimental clinical studies so far:

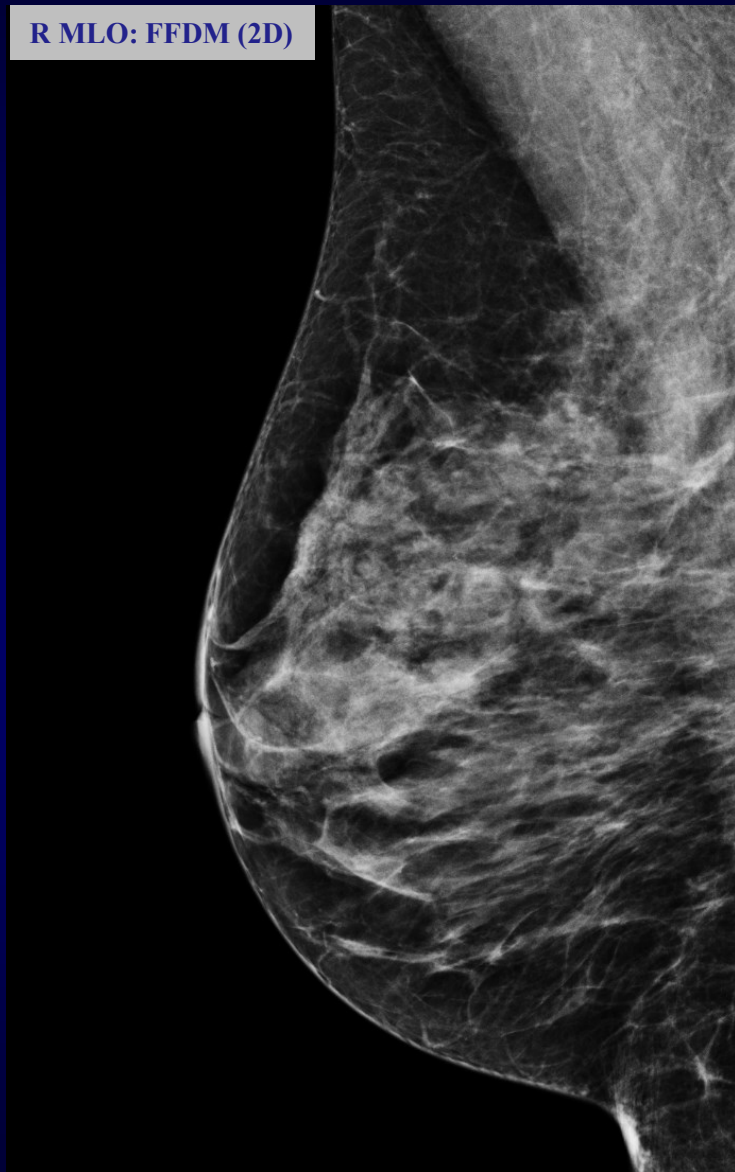
Two view FFDM 2D (MLO + CC) plus two view TOMO (MLO + CC) is optimal !

However: This means a "double" radiation dose !

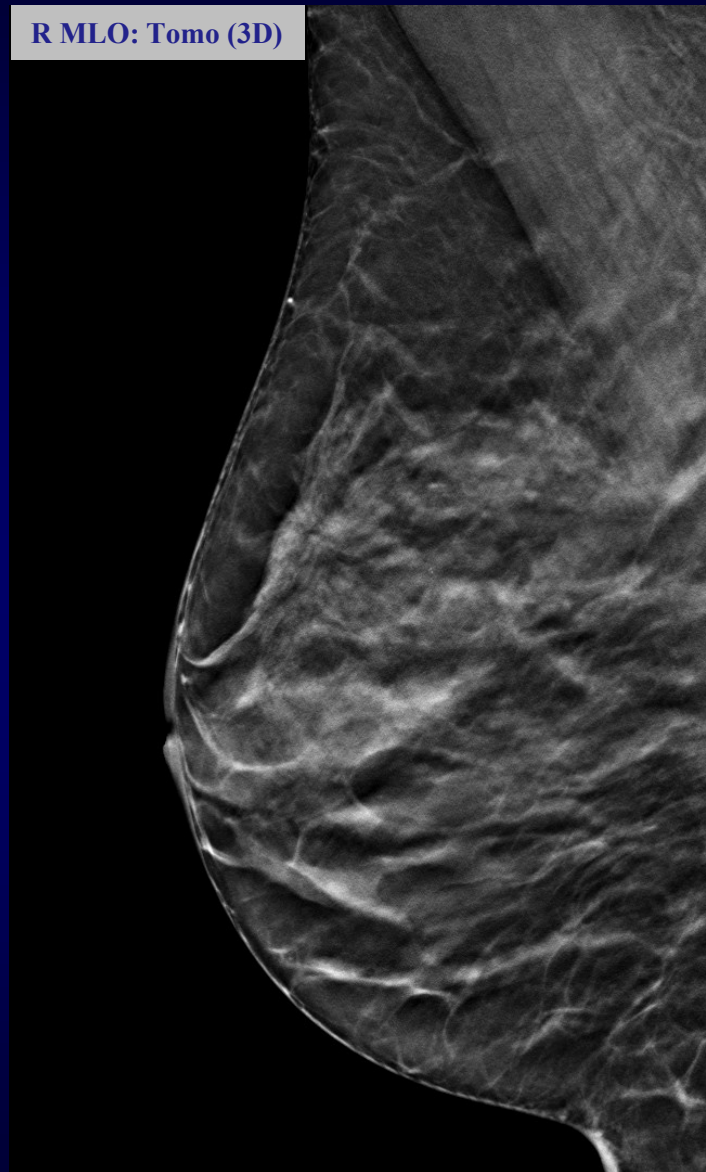
**Synthetic C-Views may substitute for FFDM images  
(when combined with tomosynthesis)  
without additional radiation dose !!**

Do you see the distortion ?

R MLO: FFDM (2D)

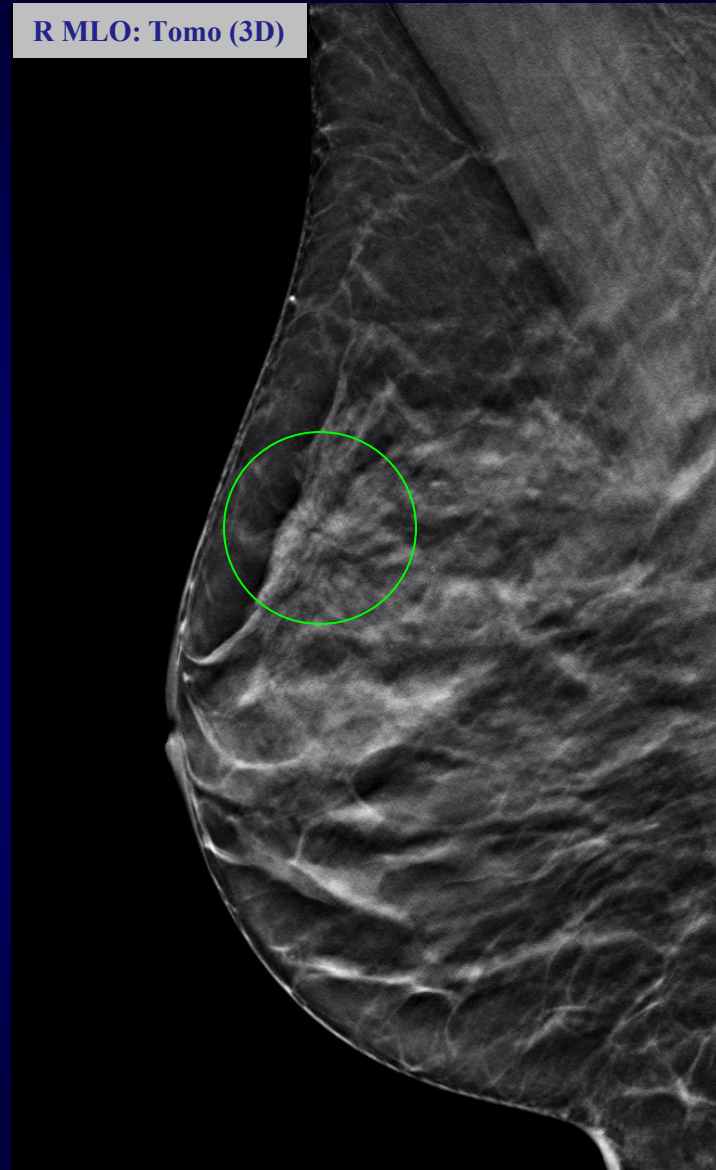
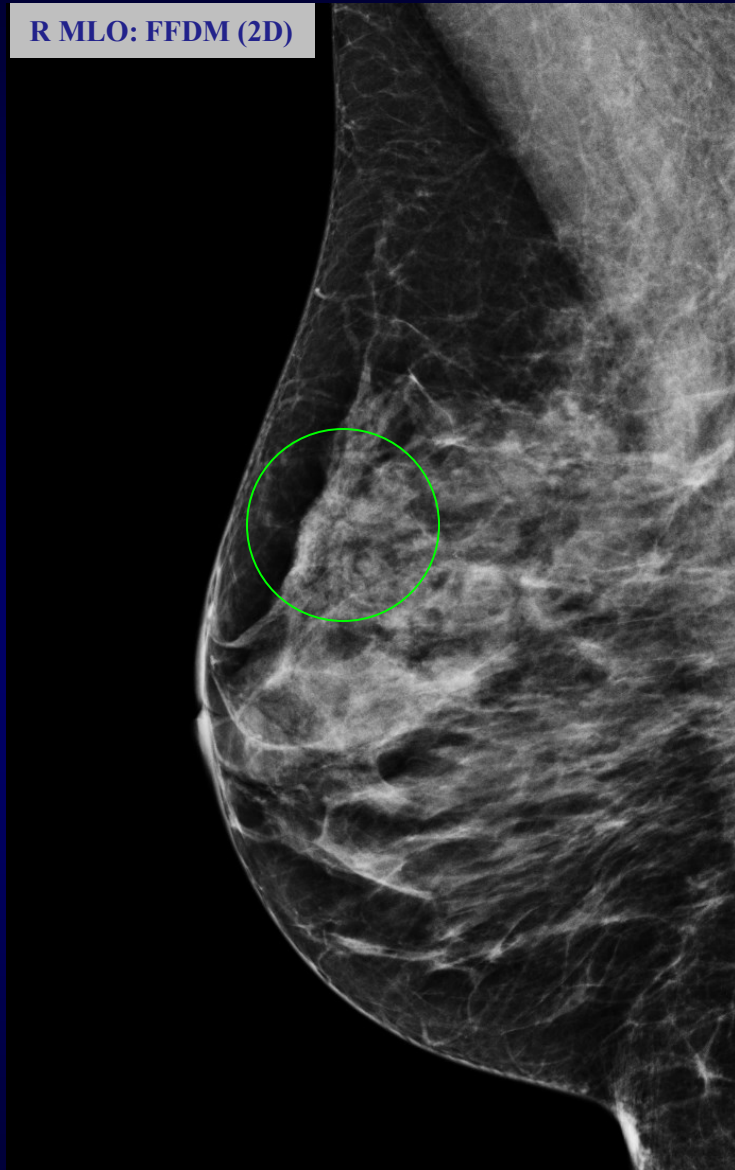


R MLO: Tomo (3D)



Do you see the distortion ?

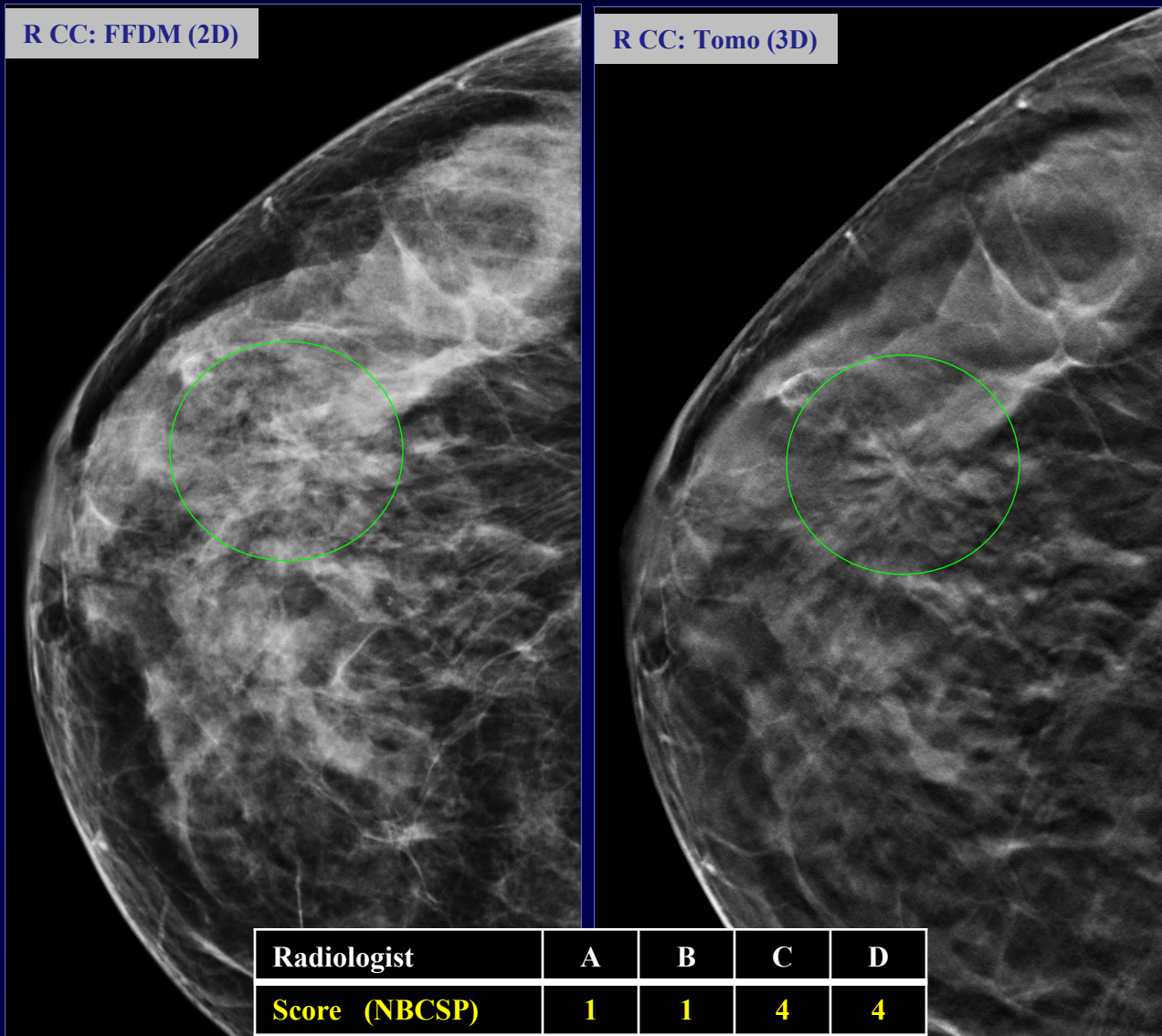
b)



Not easy to detect on the tomosynthesis MLO view !

# OTST: Radial scar (+ fibrocystic changes)

c)

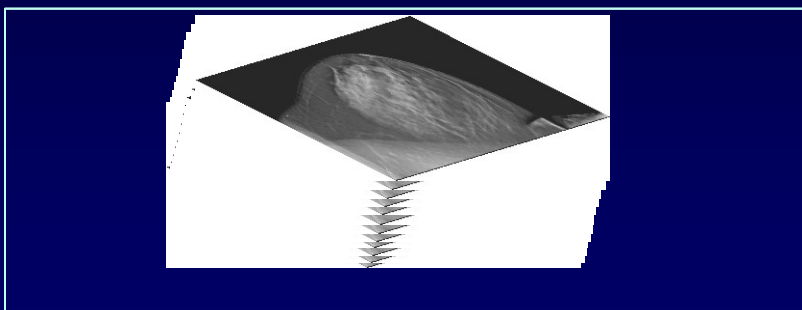


Distortion obvious on tomosynthesis CC view !

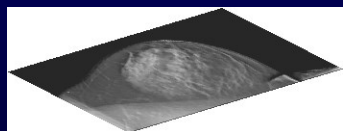


## *Synthetic 2D generation:*

Tomosynthesis reconstructed slices



Synthesized Projection

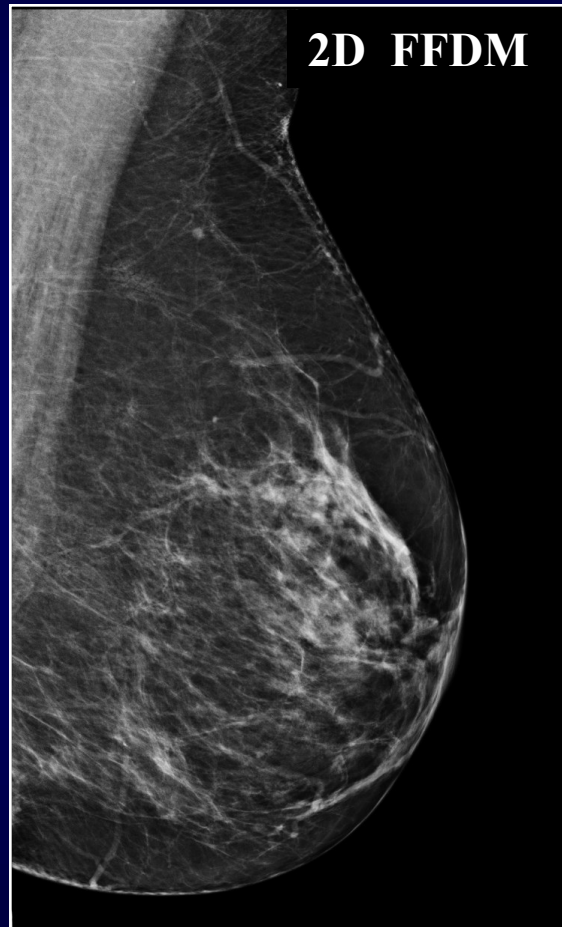


Synthetic 2D image

**Synthetic 2D image (called C-View by Hologic) shows a roadmap of the important features from tomosynthesis slices**



*Synthetic 2D image*



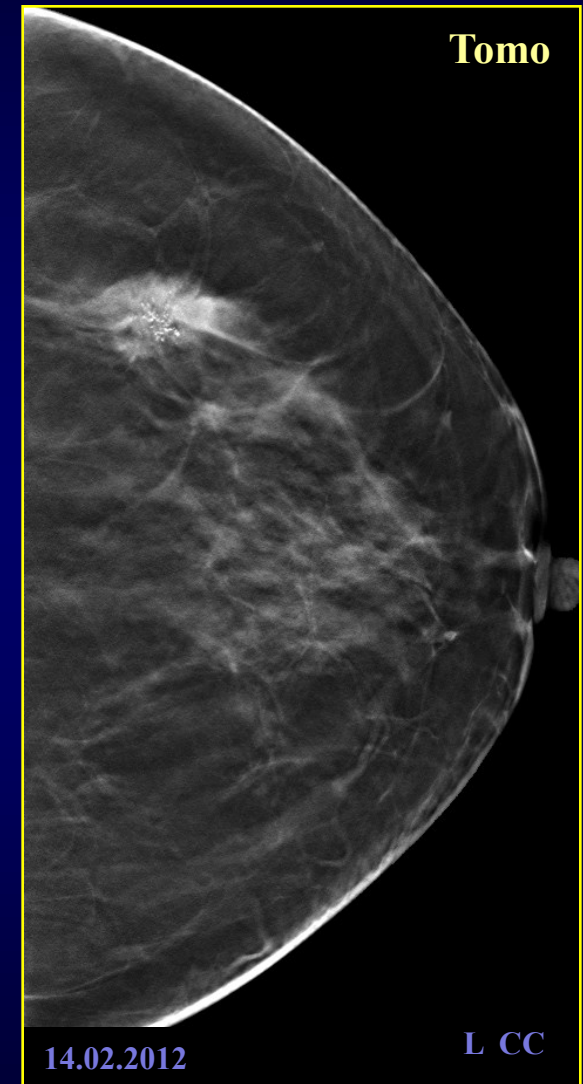
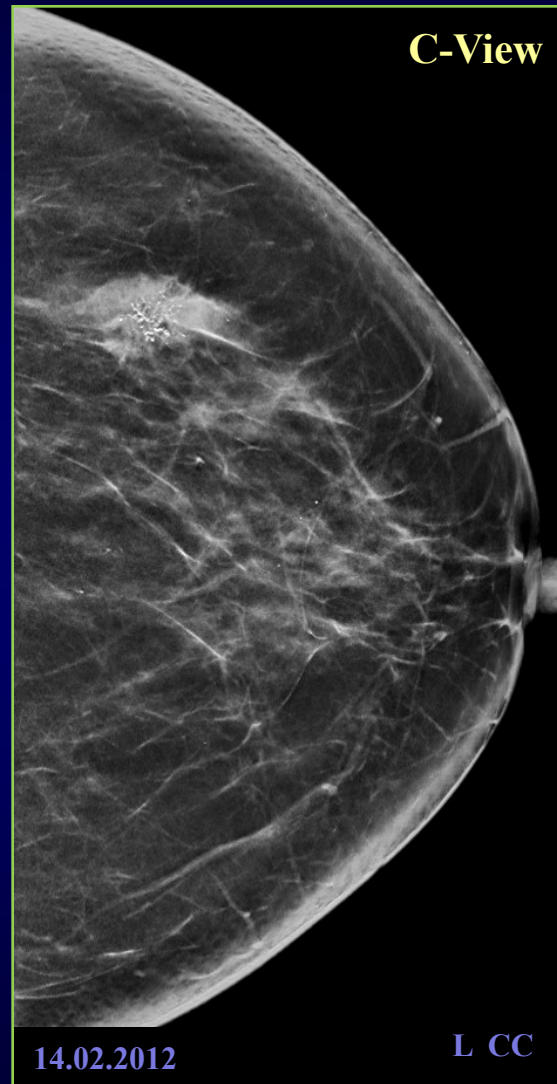
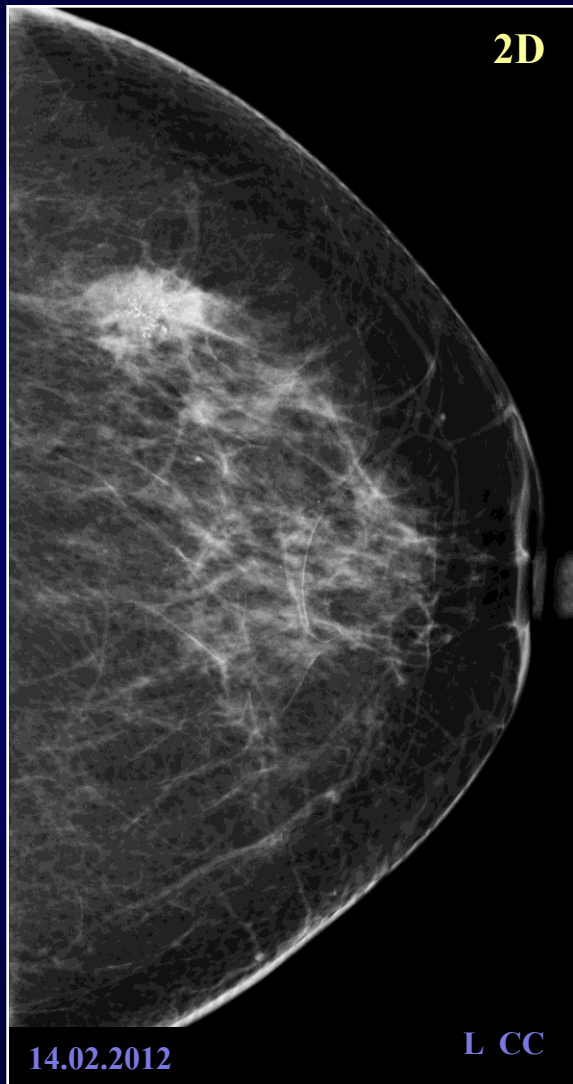
Left MLO 15.02.2012



Left MLO 15.02.2012

# C-views and diagnostic performance:

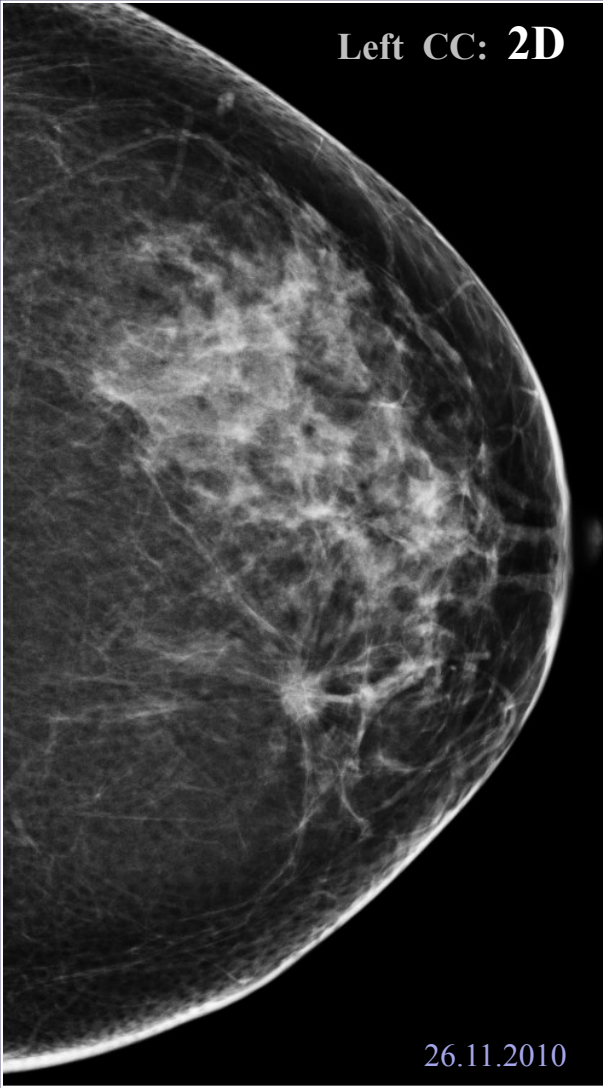
Do we see the same on C-View as on conventional 2D FFDM and tomosynthesis (3D) ?



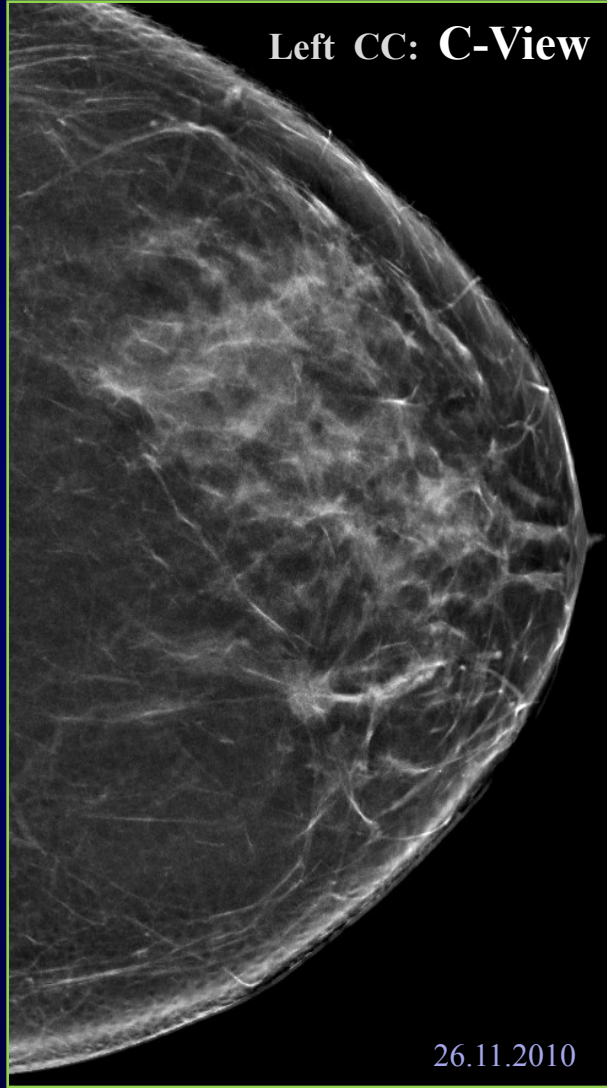
*Synthetic 2D image*



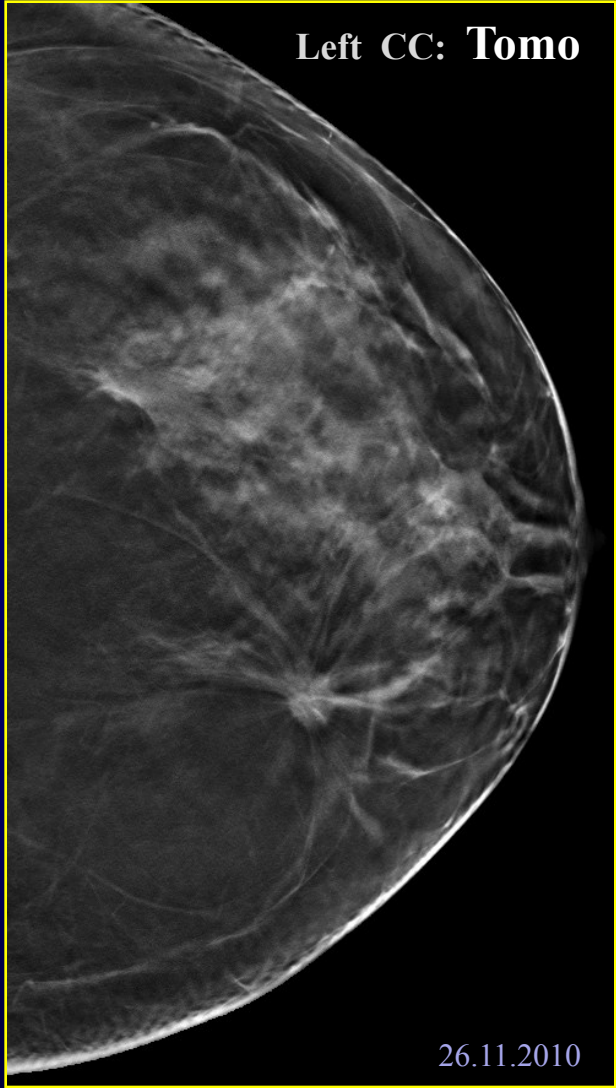
Left CC: **2D**



Left CC: **C-View**



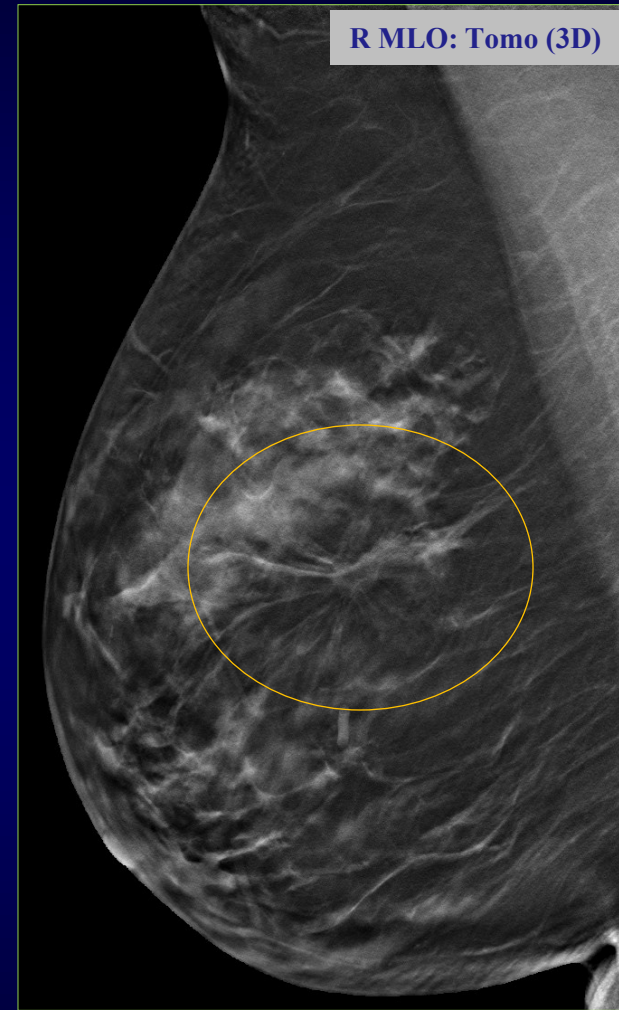
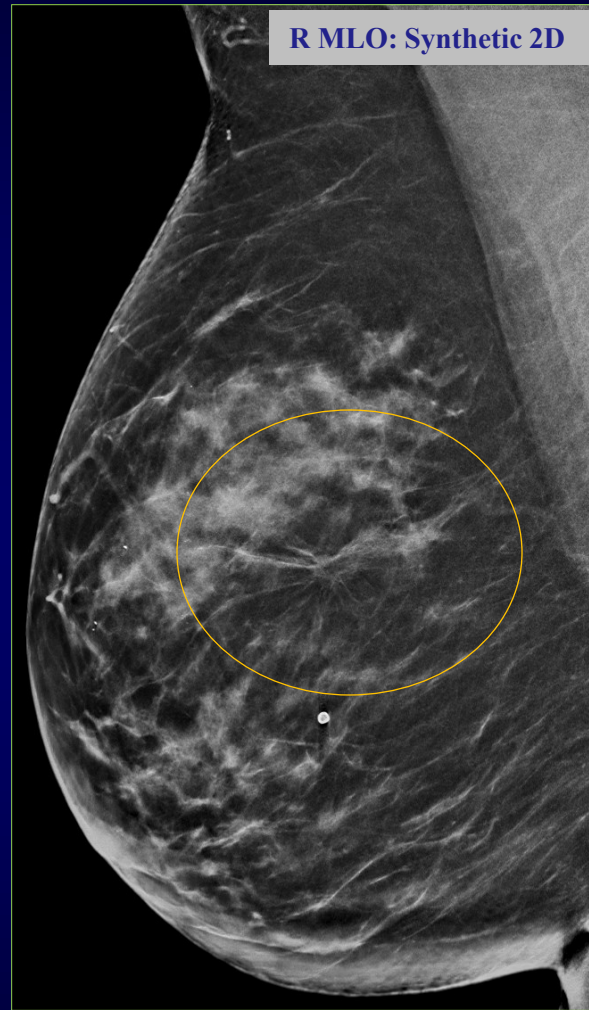
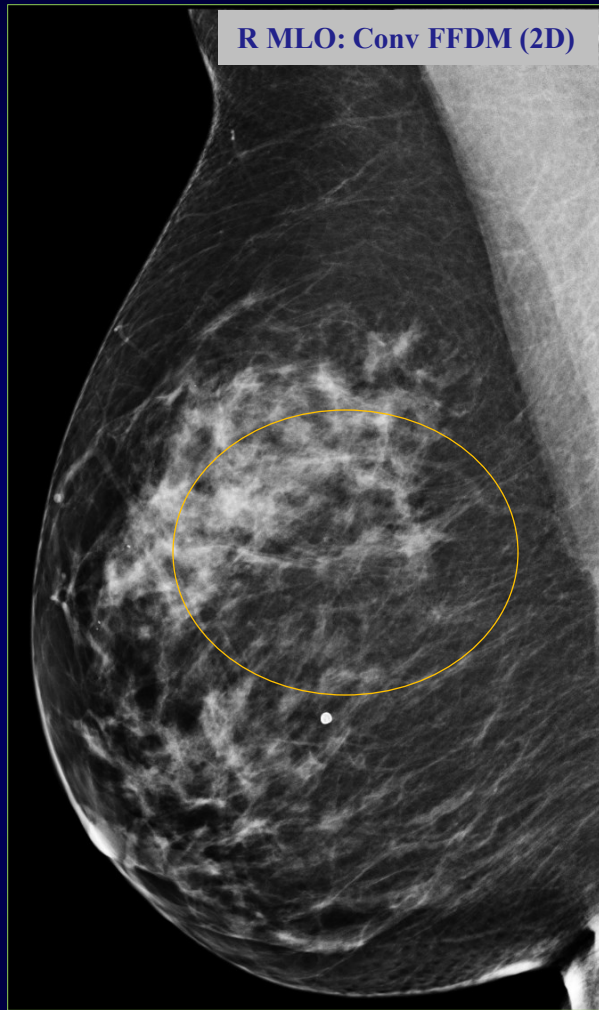
Left CC: **Tomo**



**Invasive ductal carcinoma 9 mm**

# Invasive lobular carcinoma (ILC) G1, 12 mm (+ DCIS G3)

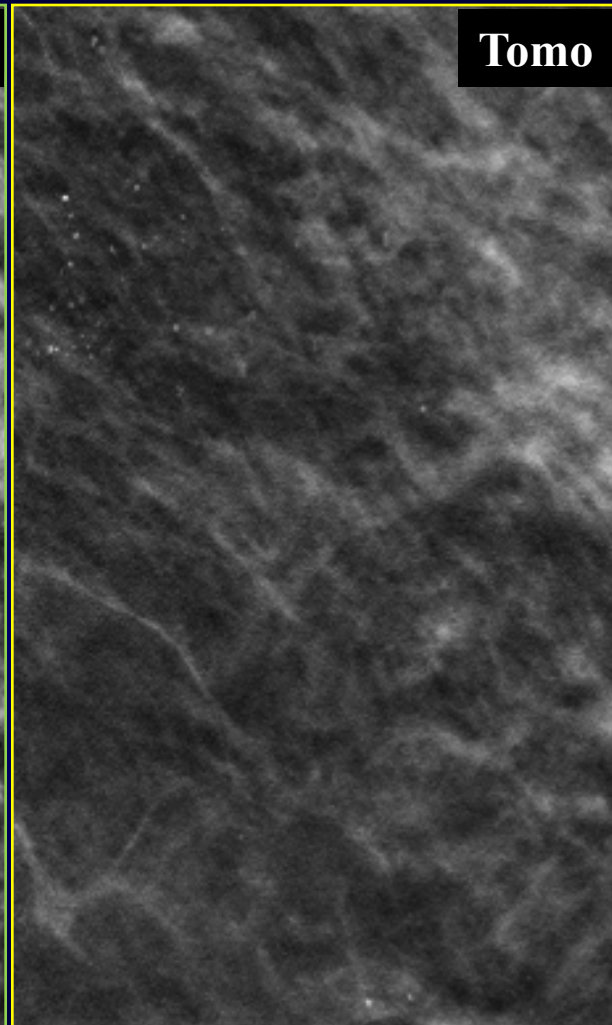
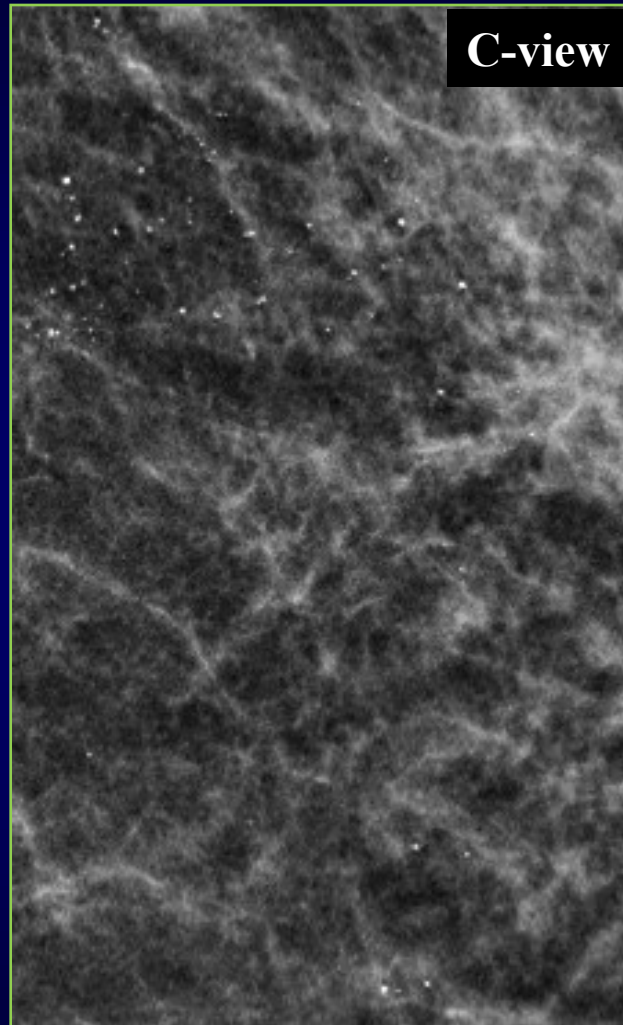
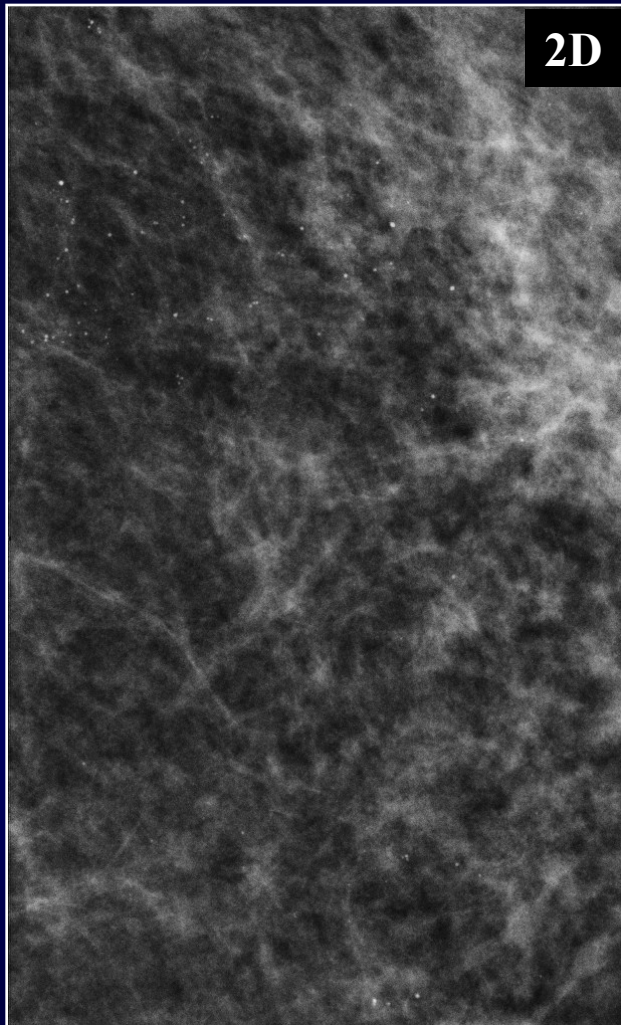
## *Synthetic 2D image*



Reader Arm	A	B	C	D
Score (NBCSP)	1	1	3	4

# Microcalcifications

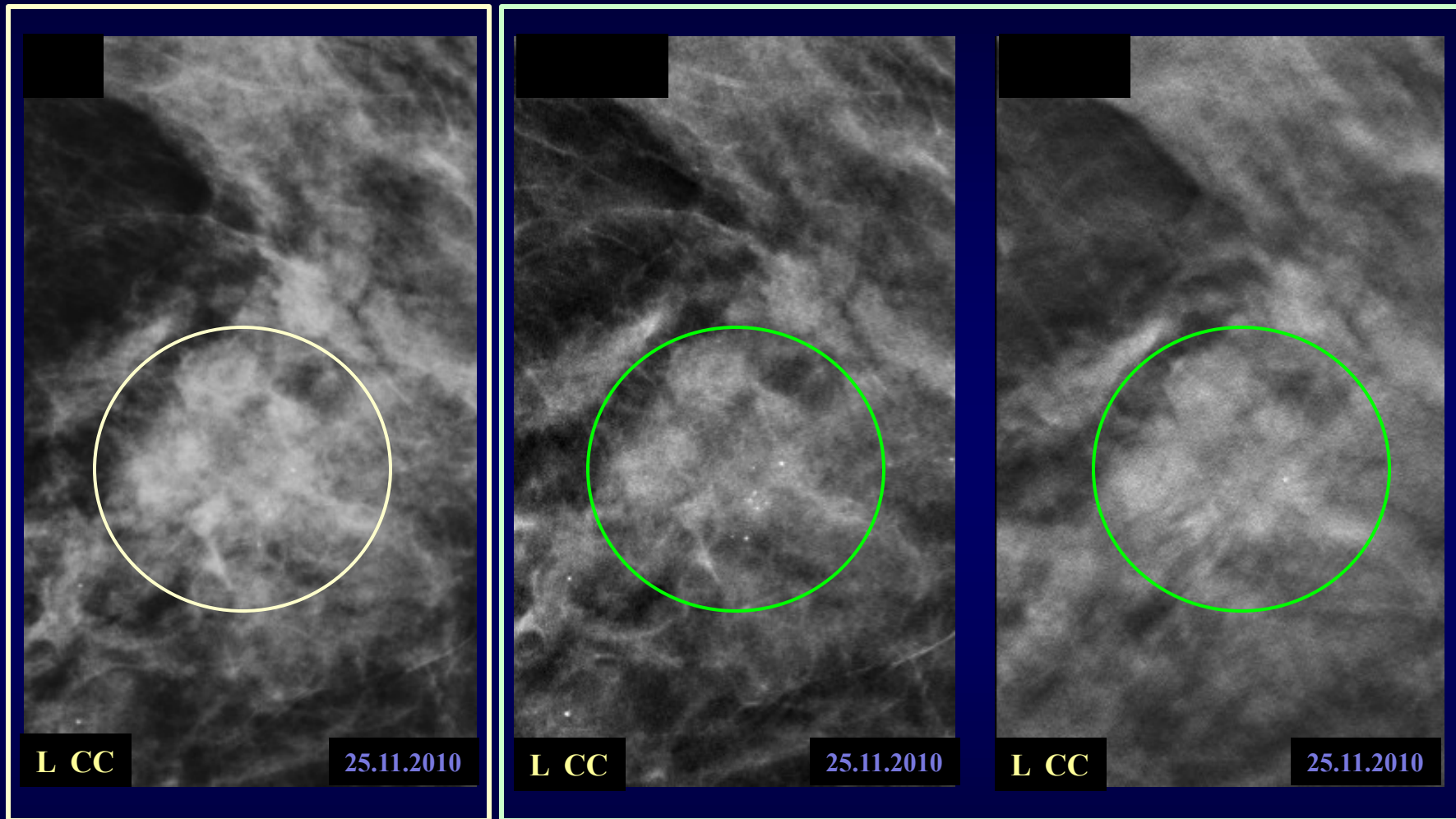
*Synthetic 2D image*



**Synthetic 2D (C-view):  
Highlighting**

**Tomo:  
"Thin-slice-effect"**

**Oslo Tomosynthesis Screening Trial: DCIS gr. 1 , 40 mm**



**Conventional 2D**

vs.

**Synthetic 2D + tomosynthesis**

## **Tomosynthesis in the Oslo Breast Cancer Screening Program (DBT)**

**This study is currently recruiting participants.**

**ClinicalTrials.gov Identifier: NCT01248546**

- *Estimated Enrollment: 25,000*
  - *Study Start Date: November 2010*
  - *Estimated Primary Completion Date: December 2012*  
*(Final data collection date for primary outcome measure)*
- 

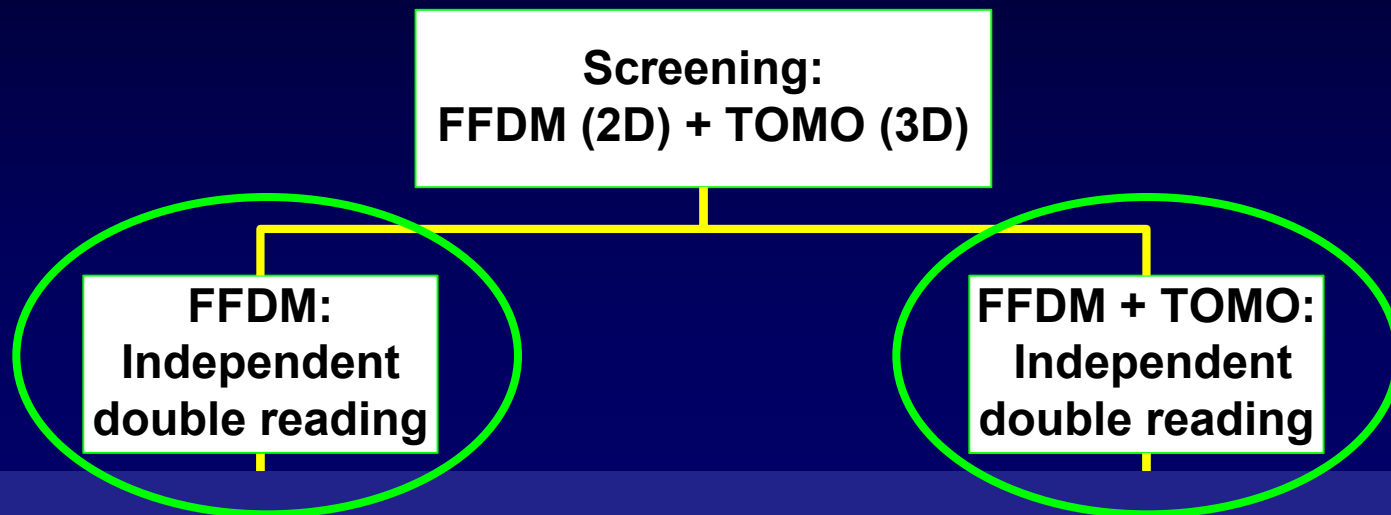
### **Oslo Tomosynthesis Screening Trial:**

- **Part of the Norwegian Breast Cancer Screening Program**
- **Age group 50-69 years**
- **Two-view (CC and MLO) mammography**
- **Independent double reading with consensus (arbitration)**
- **5-point rating scale (1=normal/benign; 2-5=positive score)**
- **On-line reporting directly into the database of the Norwegian Cancer Registry**



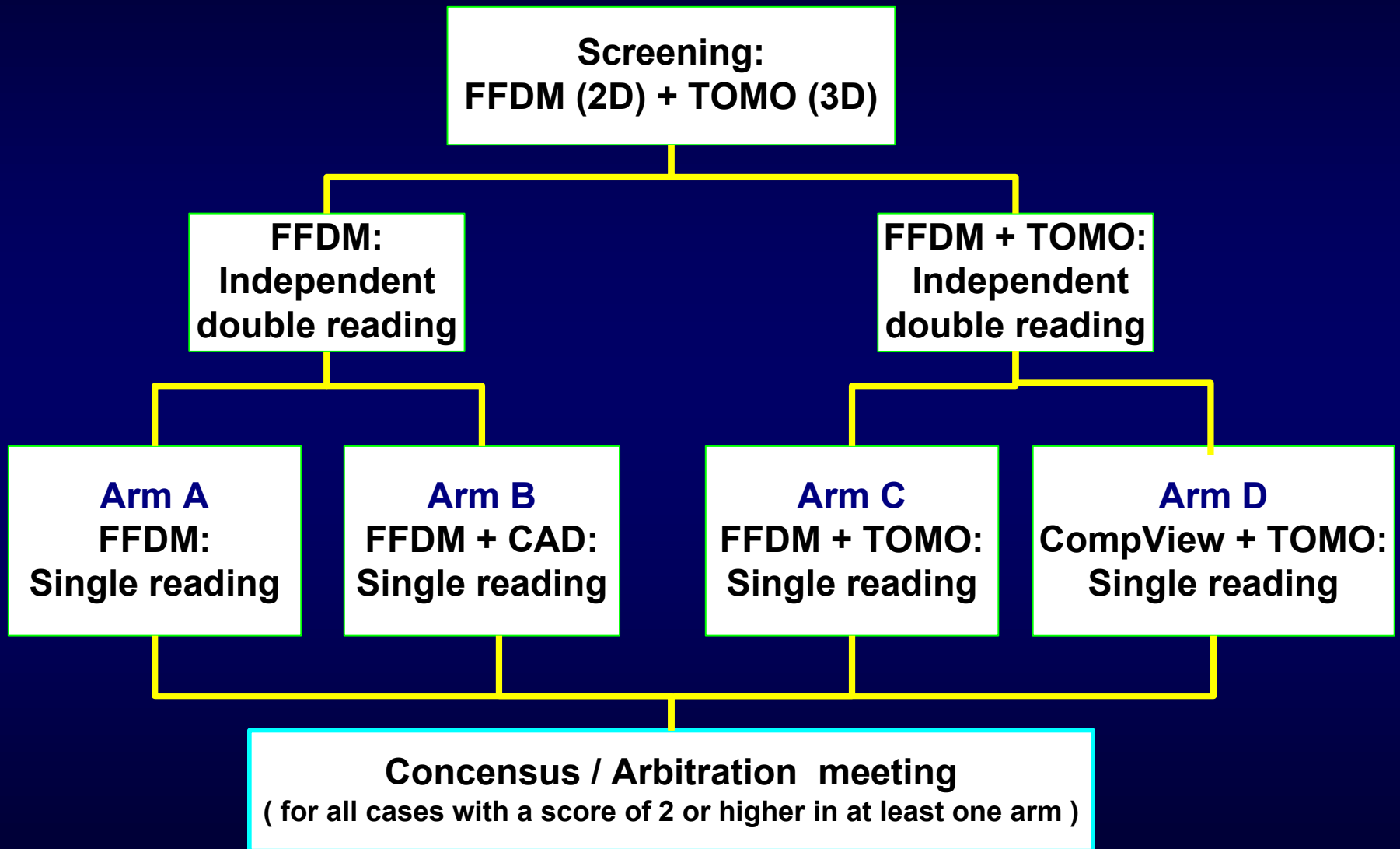
# Oslo Tomosynthesis Screening Trial ( OTST )

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# Oslo Tomosynthesis Screening Trial ( OTST )

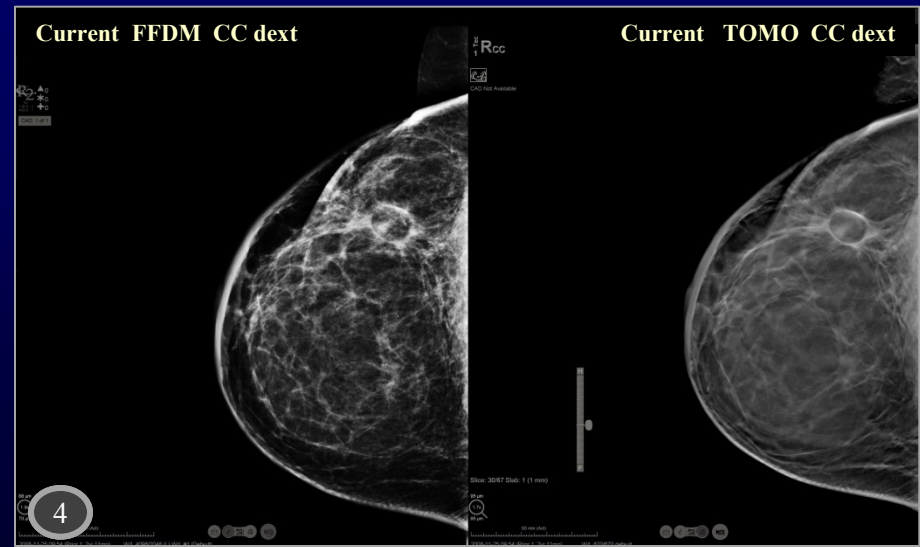
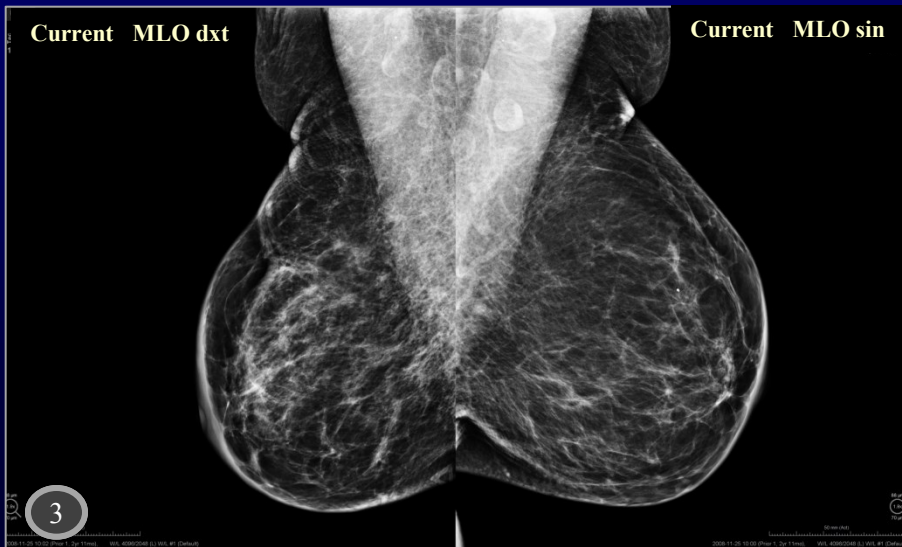
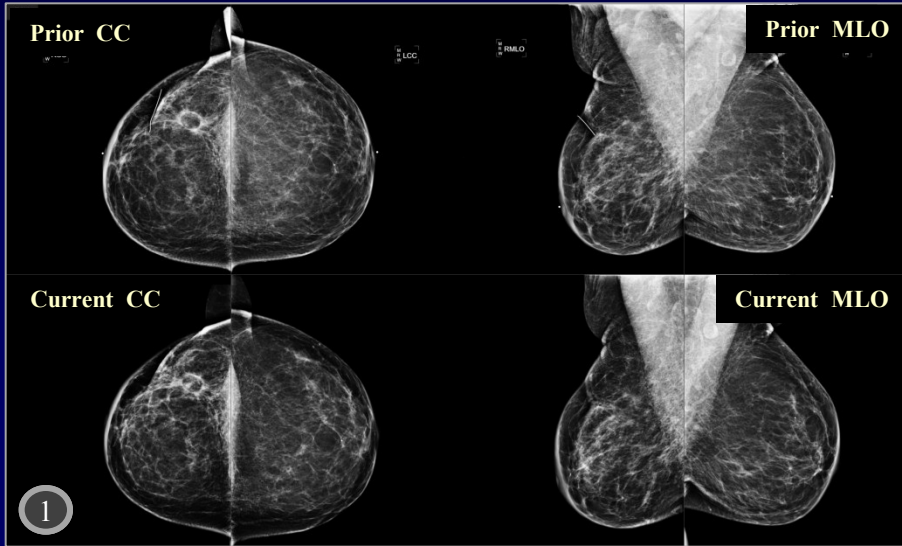
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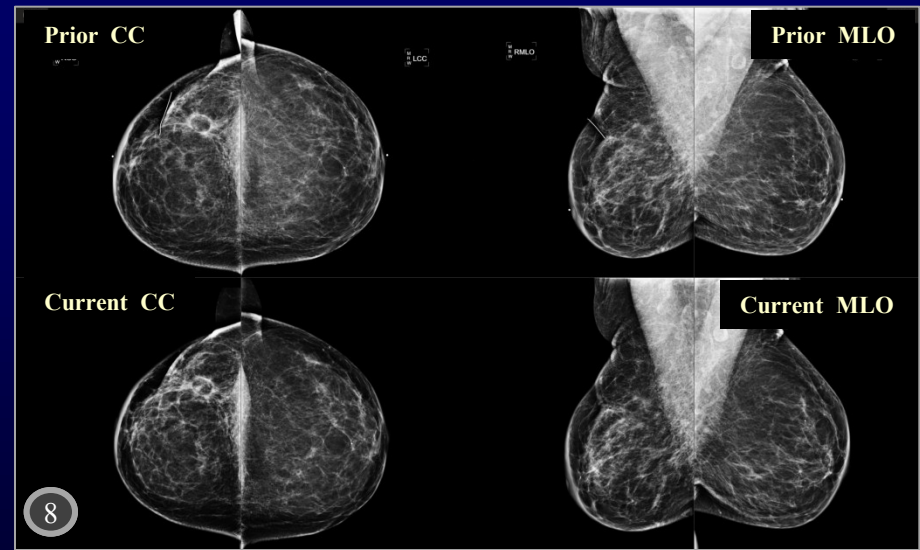
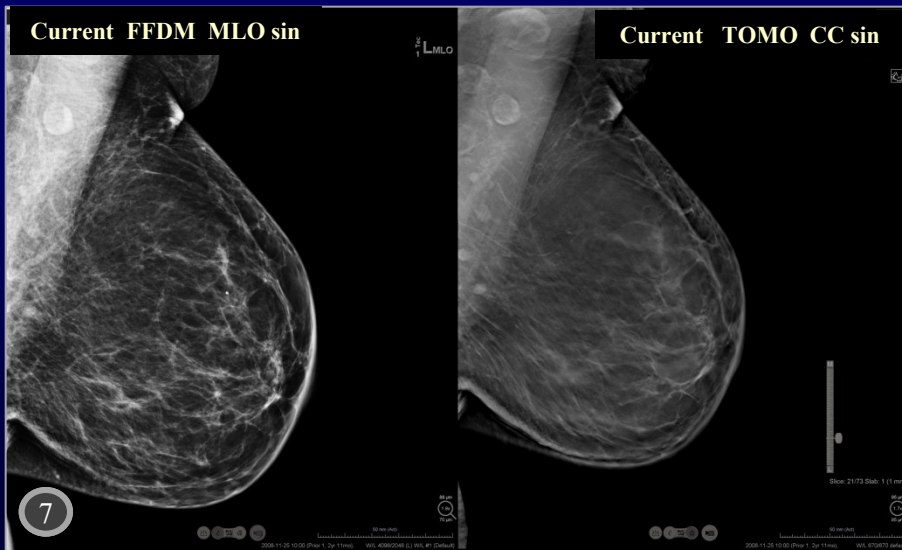
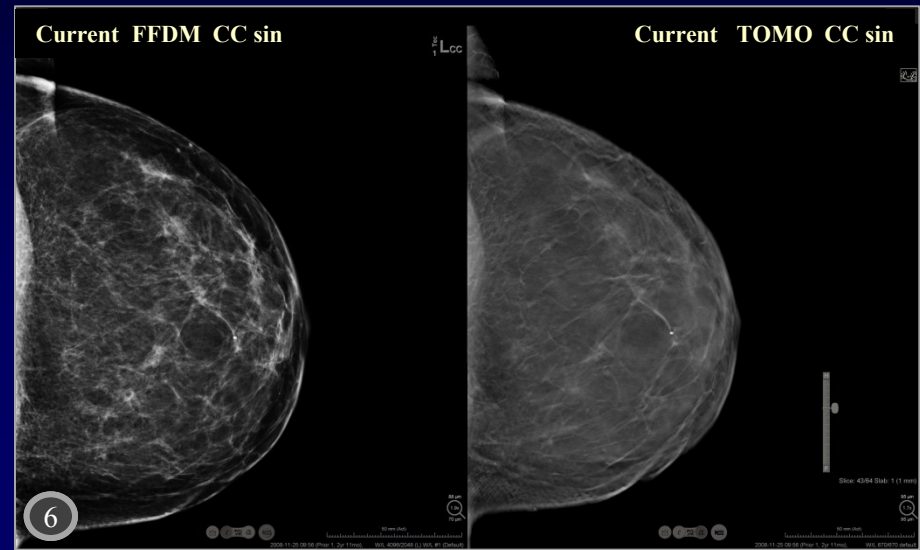
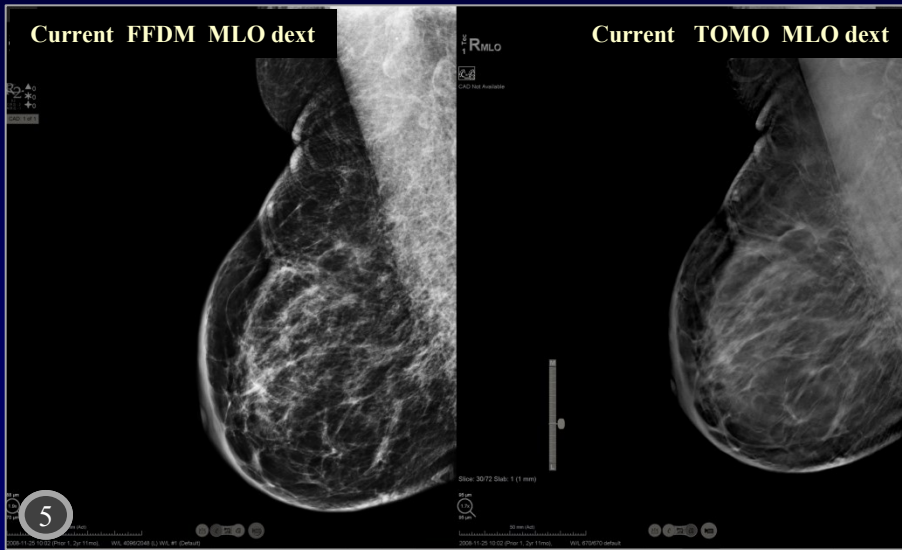
**DBT: Breast cancer screening in women with dense breast parenchyma:**

a)

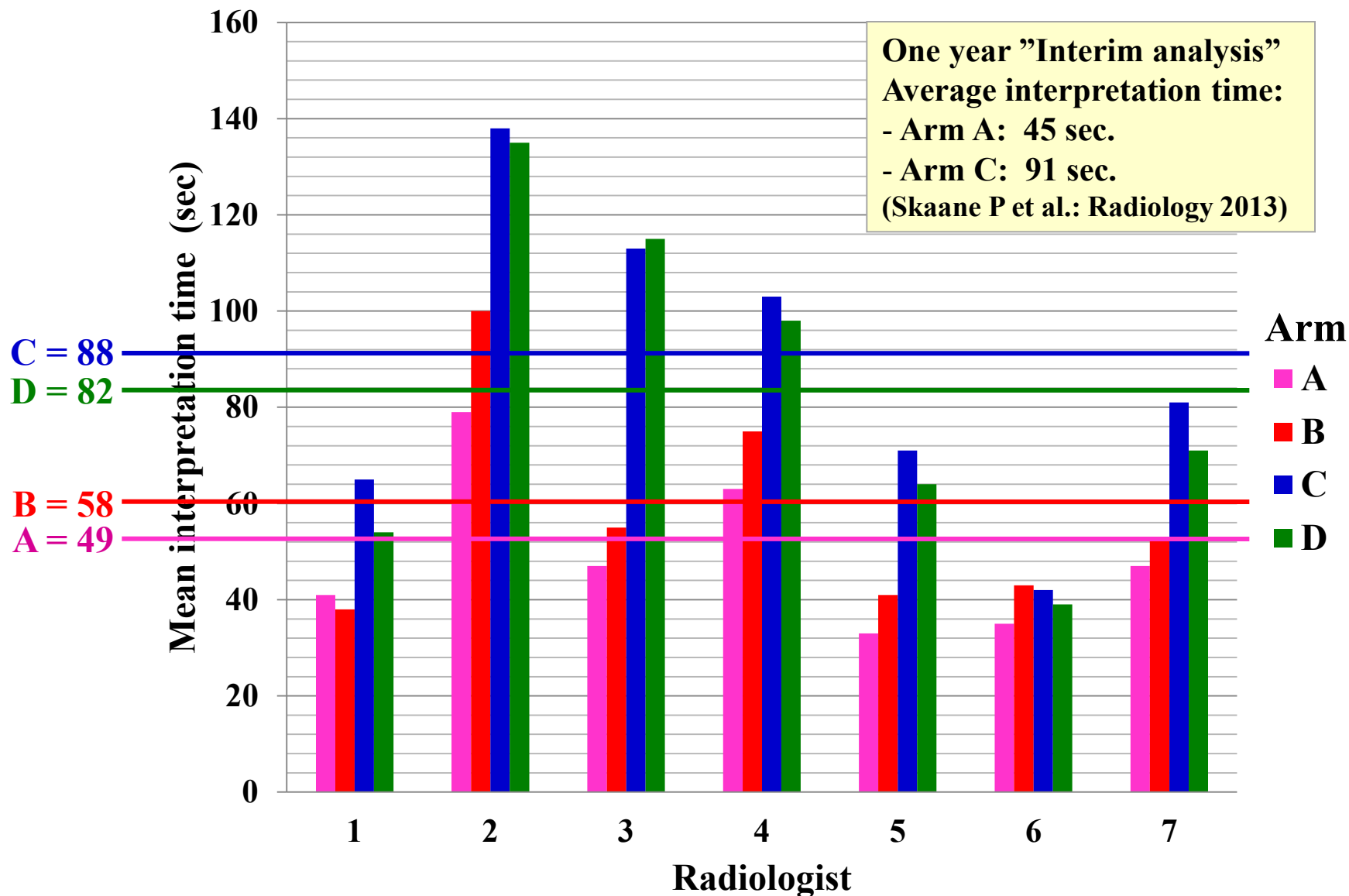
**OTST: Batch reading "combo mode" (FFDM + DBT)  
Hanging protocol step 1 - 4**



# OTST: Batch reading "combo mode" (FFDM + DBT) Hanging protocol step 5 - 8



# Mean interpretation time\* (sec.) for study arm A – D for the 7 radiologists



\*Outliers (interpretation times < 20 sec. and > 200 sec.) excluded

# Oslo Tomosynthesis Screening Trial (OTST): First year results \*

**Women 2D + (2D+3D): n = 12, 631**  
**Malignancy: n = 130**  
**Malignancy rate: 1.03%**

Excl. 10 women with malignancy:  
- 2 palp. cancer (clin recall)  
- 3 Interval cancers (IC)  
- 5 Lymphomas/metastases

**Arm A (2D): n =12,621**  
**Cancers: n = 77**  
**Cancer detection rate: 0.61%**

**Arm C (2D + 3D): n = 12,621**  
**Cancers: n = 101**  
**Cancer detection rate: 0.80%**

**Relative increase in cancer detection ( 2D+TOMO ) vs. ( 2D ): 31%**

# Oslo Tomosynthesis Screening Trial (OTST): First year results

## Cancer detection in the 4 arms stratified on the mammographic features

Mammographic feature	FFDM 2D				2D + TOMO				Double reading		
	Arm A		Arm B		Arm C		Arm D		A+B	C+D	Diff.
	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Pos		
Circumscr. mass	2	7	0	9	0	9	4	5	9	9	0
Spiculated mass	15	28	13	30	6	37	8	35	33	42	9
Distortion	12	8	15	5	4	16	3	17	9	20	11
Asymm. density	2	4	4	2	2	4	3	3	4	5	1
Calcifications	3	26	4	25	4	25	6	23	28	29	1
Calc + density	10	4	8	6	4	10	3	11	7	14	7
Total	44	77	44	77	20	101	27	94	90	119	29

Arm A: FFDM (2D)

Arm B: 2D + CAD

Arm C: 2D + Tomosynthesis (3D)

Arm D: Synthetic 2D + 3D

Relative increase in cancer detection using double reading (2D+TOMO=C+D) vs. (2D=A+B):  
**32%**

## **Screening:** Studies comparing FFDM and Digital Breast Tomosynthesis DBT (May 2013)

<b>Study</b>	<b>Population ( n )</b>	<b>Study design</b>	<b>Examination mode</b>	<b>Reading mode</b>
<b>Trento/Verona (STORM)1</b>	<b>7,292</b>	<b>Prospective; paired</b>	<b>2D: 2-view 3D: 2-view</b>	<b>Double; Sequential</b>
<b>Oslo (OTST) 2</b>	<b>12,631</b>	<b>Prospective; paired</b>	<b>2D: 2-view 3D: 2-view</b>	<b>Double; Independent</b>
<b>TOPS Compr. Breast 3 Center, Houston, TX</b>	<b>2D: 13,856 3D: 9,499</b>	<b>Retrospective; non-paired</b>	<b>2D: 2-view 3D: 2-view</b>	<b>Single; Independent</b>
<b>Malmö (MBTST) 4</b>	<b>5,700</b>	<b>Prospective; paired</b>	<b>2D: 2-view 3D: 1-view</b>	<b>Double; Sequential</b>
<b>Yale University 5 (New Haven, CT)</b>	<b>2D: 8,355 3D: 4,936</b>	<b>Retrospective; non-paired</b>	<b>2D: 2-view 3D: 2-view</b>	<b>Single; Independent</b>

- 1) Trento/Verona: Screening with Tomosynthesis OR standard Mammography (STORM):  
Ciatto S et al.: Lancet Oncol, 2013**
- 2) Oslo Tomosynthesis Screening Trial (OTST):  
Skaane P et al.: Eur Radiol, 2013**
- 3) TOPS Comprehensive Breast Center, Houston, Texas  
Rose SL et al.: Am J Roentgenol AJR 2013**
- 4) Malmö Breast Tomosynthesis Screening Trial (MBTST):  
Interim analysis; presented at Satellite Symposium, ECR Vienna, 2013**
- 5) Yale New Haven University Hospital, New Haven, CT:  
Interim analysis: presented at the ARRS Annual Meeting, Washington, 2013**



**Studies comparing FFDM (2D) and Digital Breast Tomosynthesis (DBT)  
in breast cancer screening (May 2013)**



Study	Popul. ( n )	Cancer ( n )		Cancer ( n / 1,000 )		Cancer: Rel. increase (%)
		2D	3D	2D	3D	
Trento/Verona (STORM) 1	7,292	39	59	5.3	8.1	51 %
Oslo (OTST) 2	12,631	90	119	7.1	9.4	32 %
TOPS Compr. Breast Center, Houston, TX 3	2D: 13,856 3D: 9,499	56	51	4.0	5.4	32 %
Malmö (MBTST) 4	5,700	-	-	4.7	6.8	45 %
Yale University 5 (New Haven, CT)	2D: 8,355 3D: 4,936	38	25	4.6	5.1	12 %

- 1) Trento/Verona: Screening with Tomosynthesis OR standard Mammography (STORM):  
Ciatto S et al.: Lancet Oncol, 2013
- 2) Oslo Tomosynthesis Screening Trial (OTST):  
Skaane P et al.: Eur Radiol, 2013
- 3) TOPS Comprehensive Breast Center, Houston, Texas  
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- 5) Yale New Haven University Hospital, New Haven, CT:  
Interim analysis: presented at the ARRS Annual Meeting, Washington, 2013

## **Digital Breast Tomosynthesis (DBT)**

### **Conclusions: Tomosynthesis and breast cancer screening**

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- **Tomosynthesis plus synthesized 2D makes combined 2D and 3D (“combo mode”) possible with approximately the same radiation dose as conventional 2D FFDM**
  - **Tomosynthesis plus 2D significantly increase the cancer detection rate as compared with 2D FFDM alone**
  - **Tomosynthesis plus 2D has the potential to reduce the recall rate**
  - **The additional interpretation time for tomosynthesis plus 2D as compared with 2D alone is acceptable for implementation in organized high-volume breast cancer screening**
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**Thank you very much  
for your time !**

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