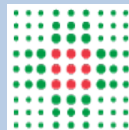


Corso TSRM-FISICI
Gestione
multidisciplinare
delle neoplasie in
situ della mammella

Roma 30 maggio 2018

Ruolo del Fisico Medico in un trial di tomosintesi

Valentina Ravaglia



Digital Breast Tomosynthesis (DBT)

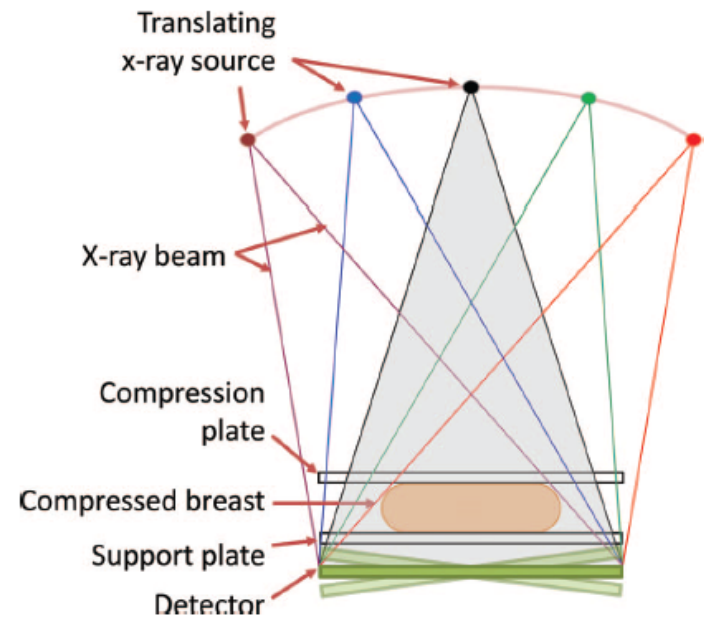
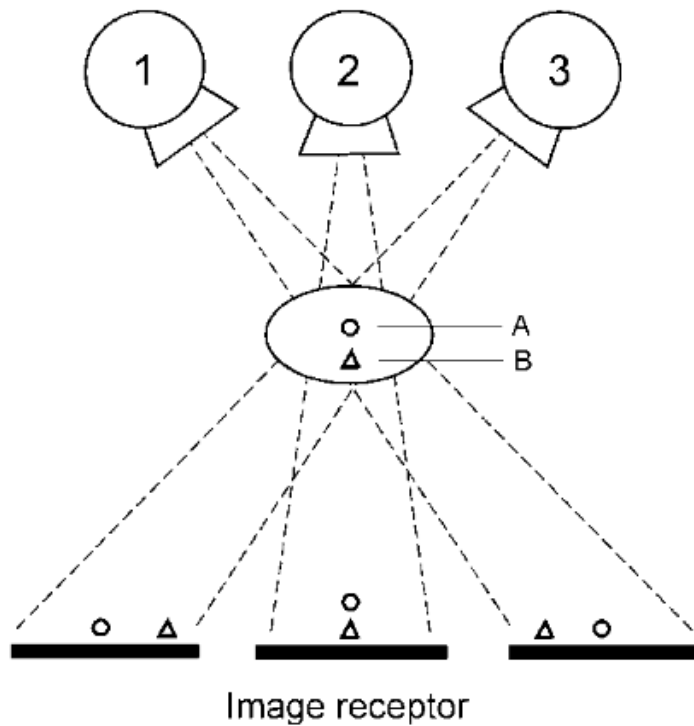


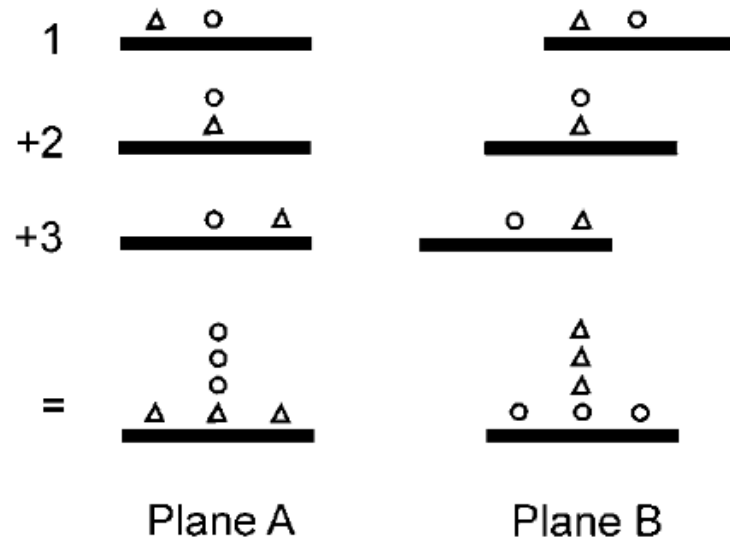
FIG. 1. Schematic of a breast tomosynthesis acquisition, in which a number of projection images is acquired of the compressed breast, while the x-ray source rotates around a center of rotation close or on the detector surface while the detector is either static or rotates, depending on the system design.

Sechopoulos, Med. Phys. 40 (1), 2013

Digital Breast Tomosynthesis (DBT)



(a)



(b)

Sechopoulos, Med. Phys. 40 (1), 2013

Digital Breast Tomosynthesis (DBT)

- ✓ **Proiezioni bidimensionali a bassa dose** per diverse angolazioni del tubo rx
- ✓ I dati acquisiti vengono **ricostruiti** in una serie di strati sottili ad alta risoluzione.

Vincoli

- ✓ **Dose totale all'organo accettabile** (~ dose mammografia)
- ✓ **Qualità dell'immagine** ricostruita adeguata
- ✓ **Tempo di scansione contenuto** (artefatti da movimento)

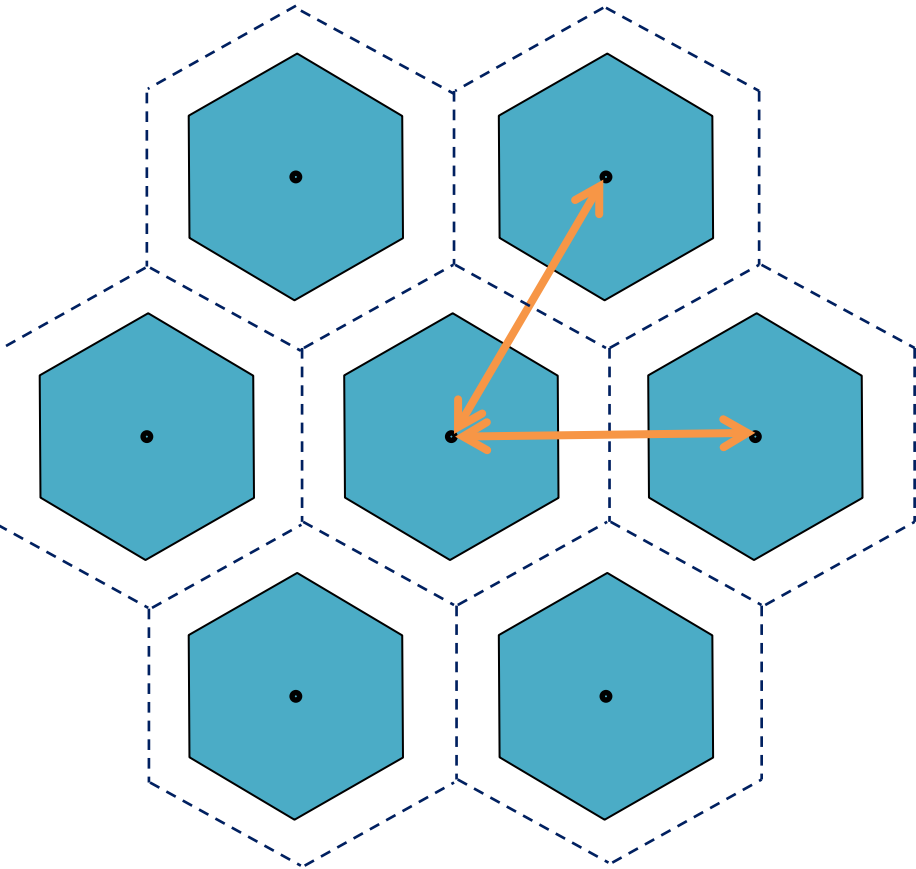
Fuji amulet Innovality



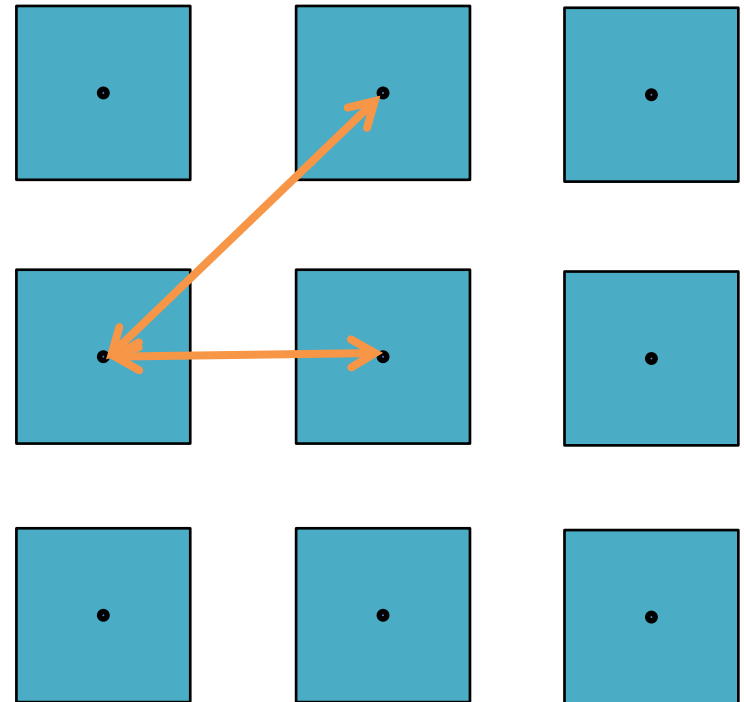
a:Se, pixel $50 \mu\text{m}$
W/AI
15 proiezioni,
range $15^\circ/40^\circ$
10-15sec

Tecnologia di acquisizione: aSe+HCP

Hexagonal Close Packing TFT



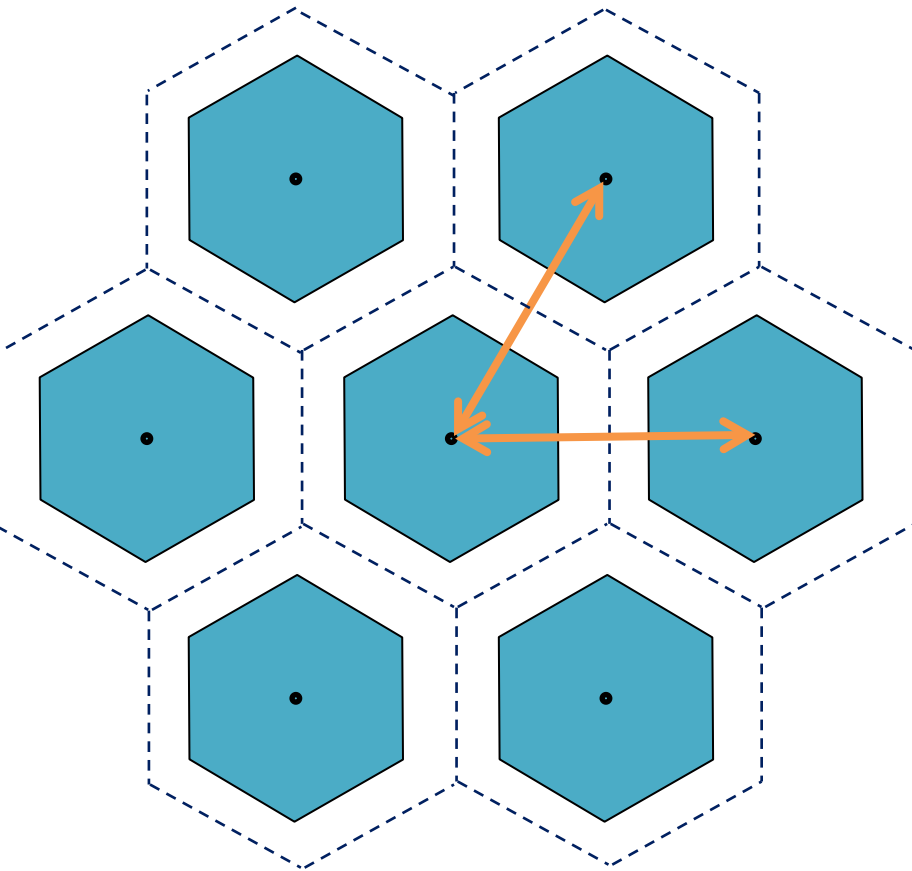
Square pixel



Courtesy: Andrea Zola , FUJIFILM Europe

Tecnologia di acquisizione: aSe+HCP

Hexagonal Close Packing TFT

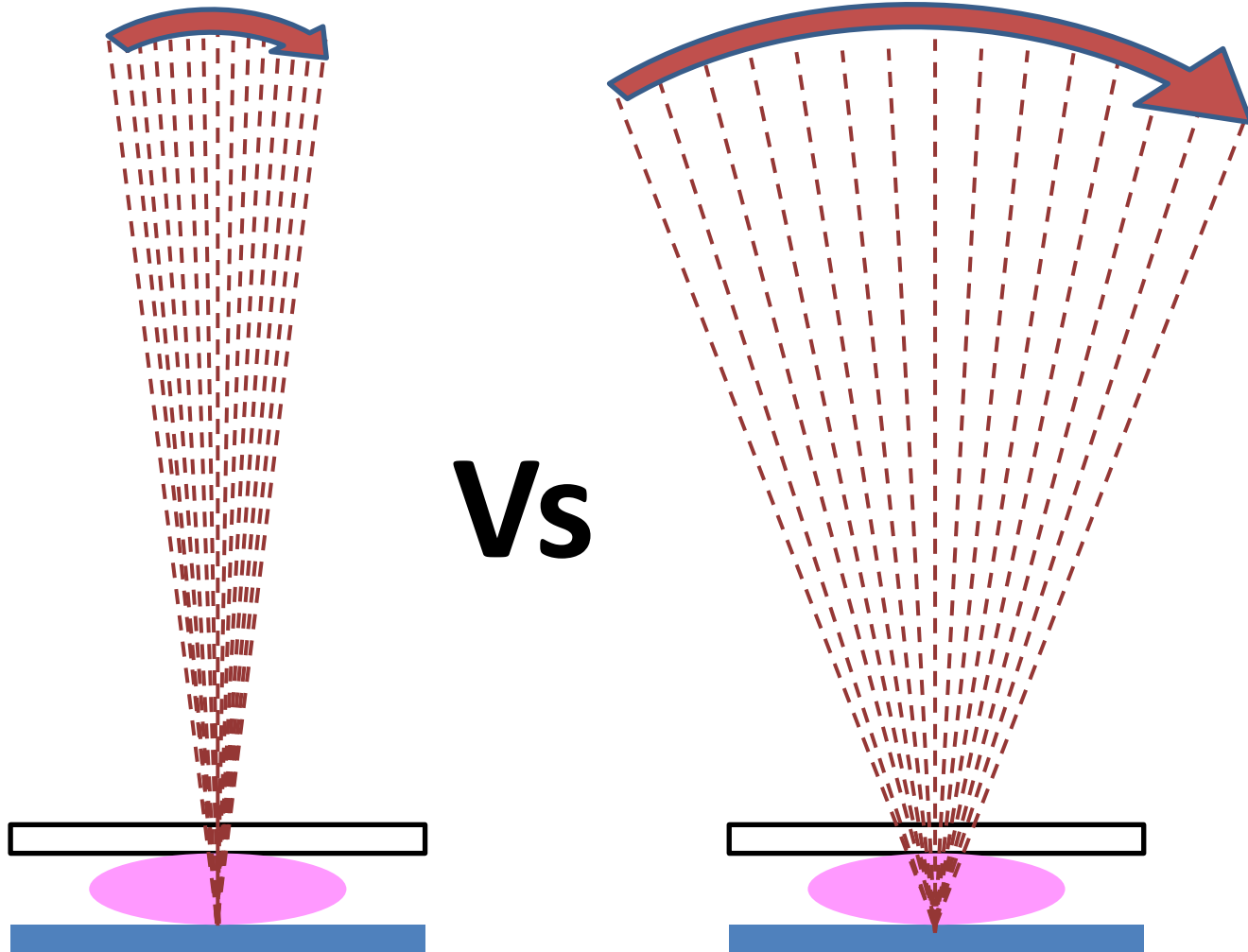


L'equidistanza tra i TFT permette di applicare diversi valori di **CAMPIONAMENTO**:

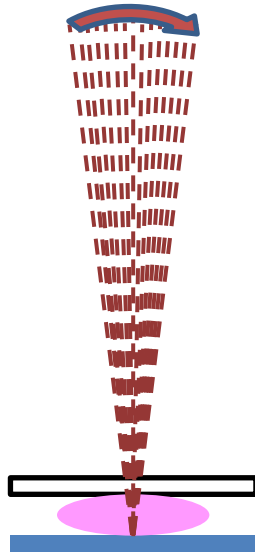
- Campionamento a 50μ
- Campionamento a 100μ
- Campionamento a 150μ

Courtesy: Andrea Zola , *FUJIFILM Europe*

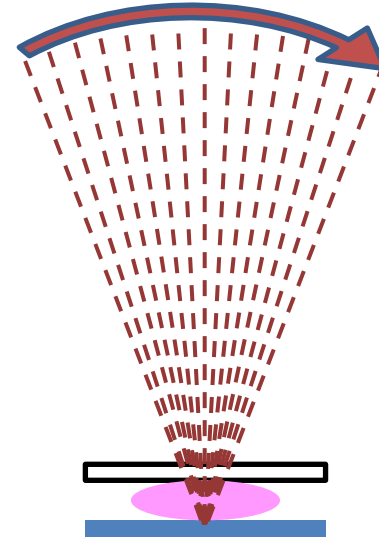
Angolo di pendolazione: 15° vs 40°



Modalità ST vs HR

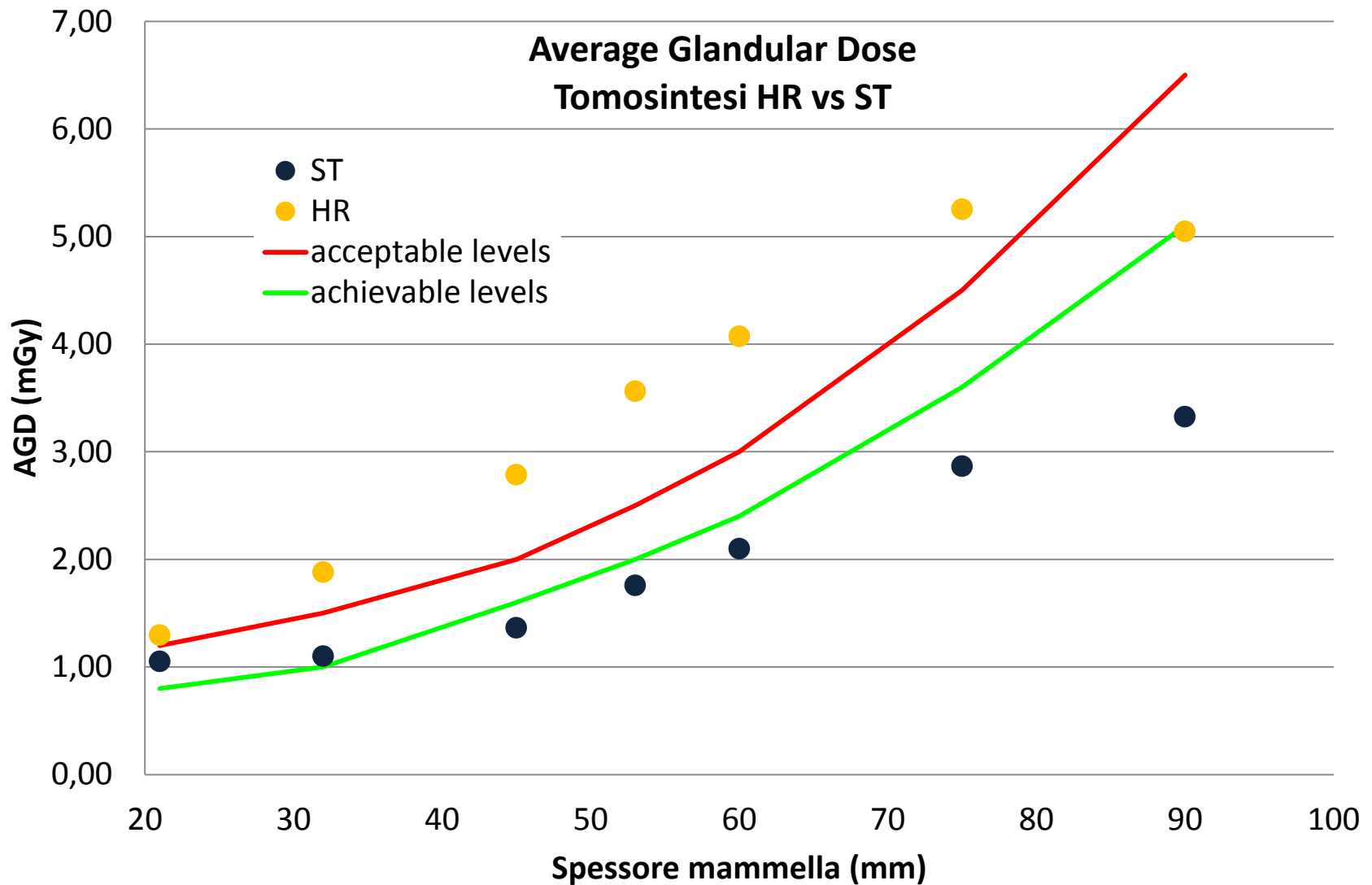


- ✓ Range di pendolazione 15°
- ✓ Campionamento a 150μ
- ✓ Tempo di acquisizione 10 sec
- ✓ Dose tomo \approx dose mammo



- ✓ Range di pendolazione 40°
- ✓ Campionamento a 100μ
- ✓ Tempo acquisizione 15 sec
- ✓ Dose tomo $\approx 2x$ dose mammo

Modalità ST vs HR



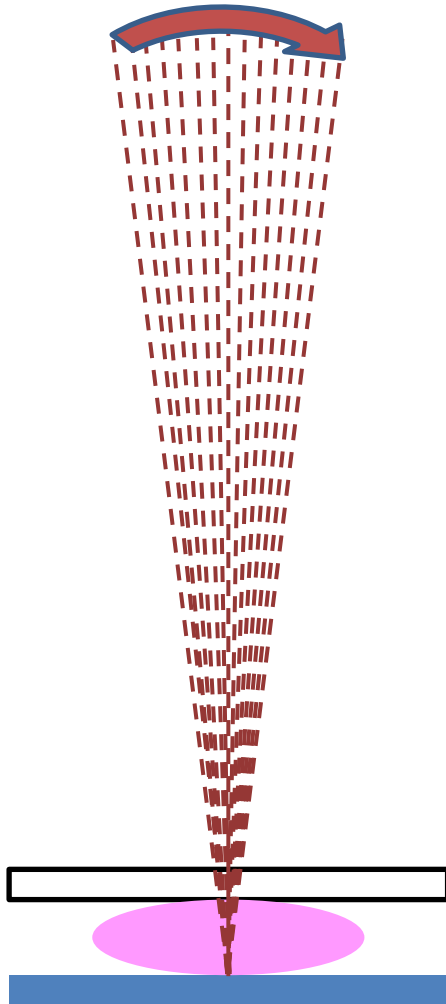
Trial clinico IRST

“Tomosintesi digitale della mammella in una popolazione aderente al programma di screening: indagine sulla variazione dell’angolo di acquisizione e sulla modulazione dei livelli di dose”



- ✓ Pazienti richiamate per approfondimento
- ✓ Doppia acquisizione ST e HR
- ✓ Stesso livello di dose per ST e HR

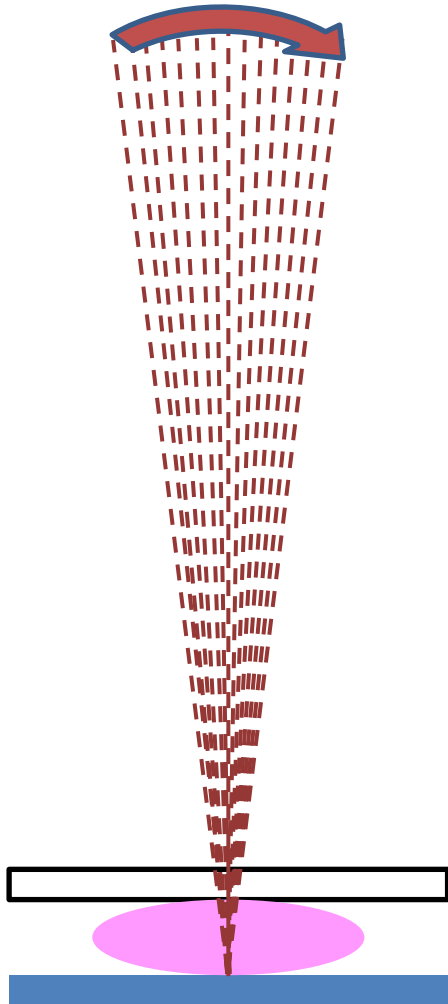
Trial clinico IRST



1

Acquisizione in automatico in
modalità ST

Trial clinico IRST



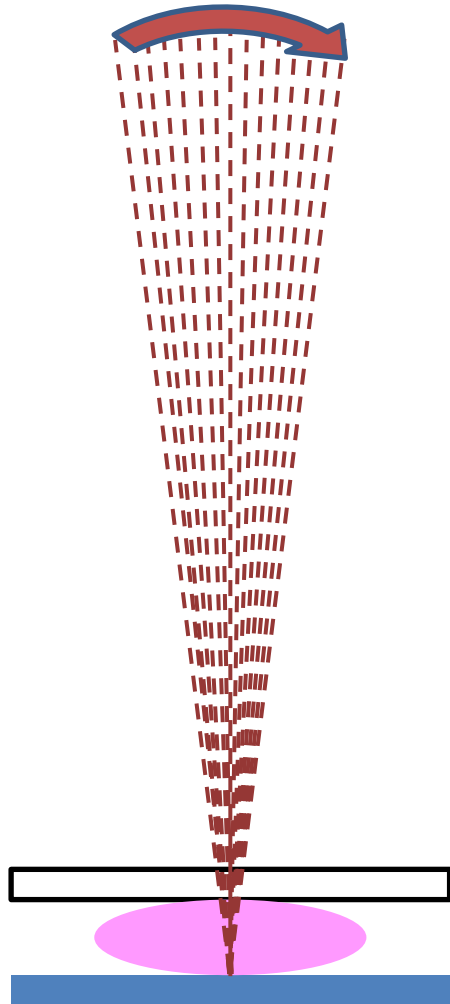
1

Acquisizione in automatico in
modalità ST

Es. mammella 6 cm

- ✓ WAI
- ✓ 33 kV
- ✓ 51 mAs
- ✓ AGD = 2,1 mGy

Trial clinico IRST



1

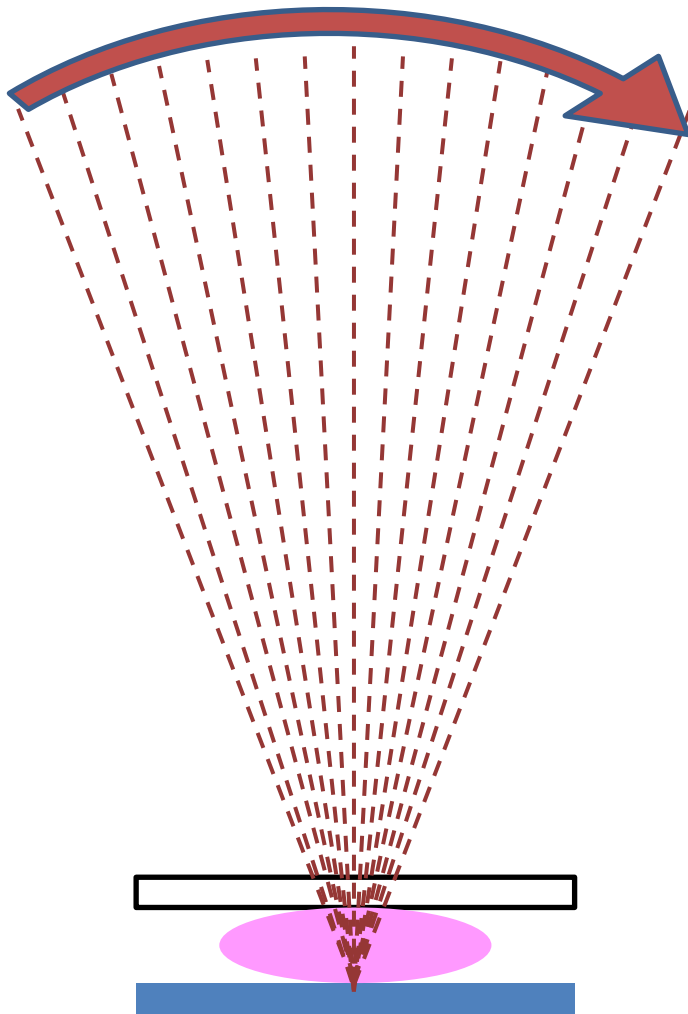
Acquisizione in automatico in
modalità ST

Es. mammella 6 cm

- ✓ WAI
- ✓ 33 kV
- ✓ 51 mAs
- ✓ AGD = 2,1 mGy

Proiezione Mammo
WRh
30 kV
92 mAs
AGD= 1,29 mGy

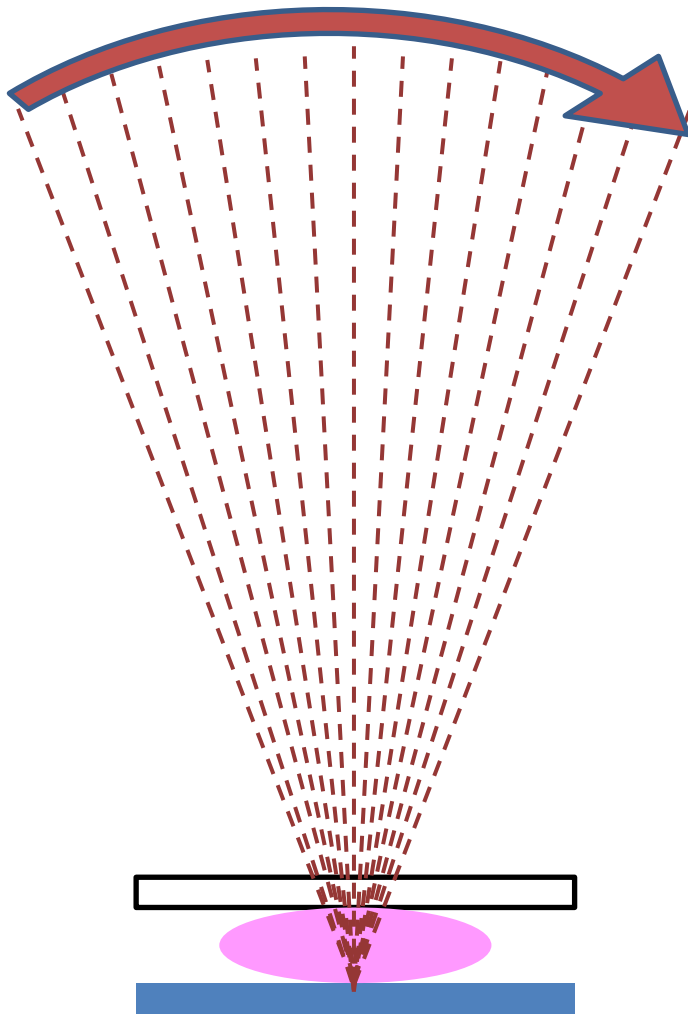
Trial clinico IRST



2

Acquisizione in manuale in modalità
HR

Trial clinico IRST



2

Acquisizione in manuale in modalità HR

Es. mammella 6cm

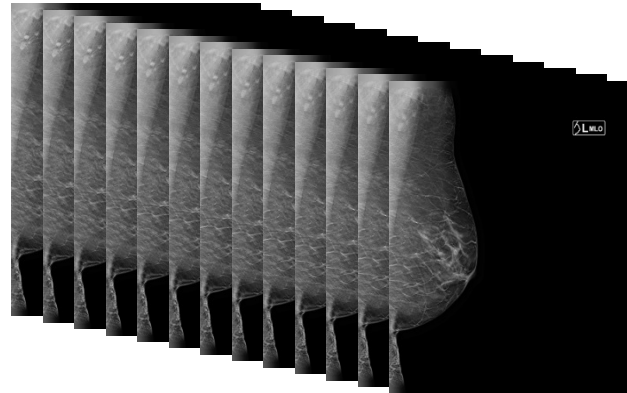
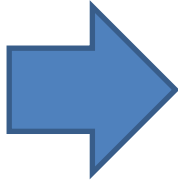
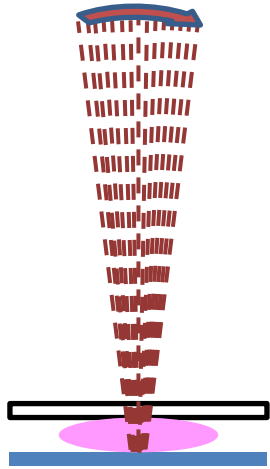
✓ WAI

✓ 33 kV

✓ 51 mAs+5% = 53 mAs

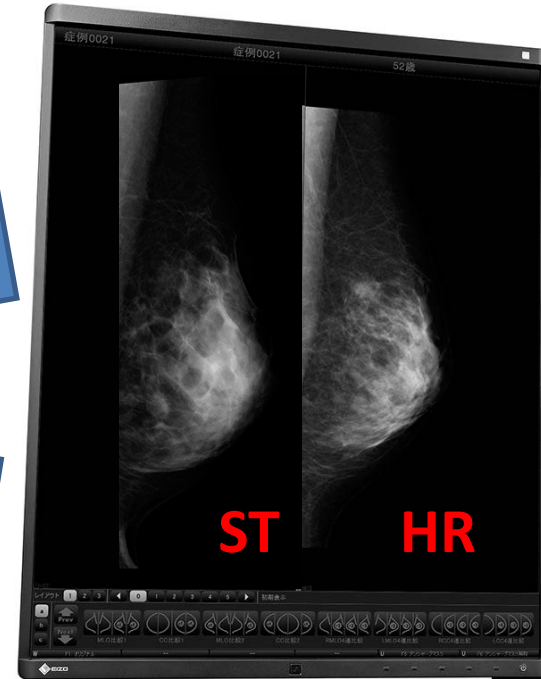
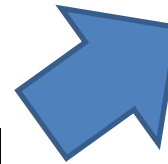
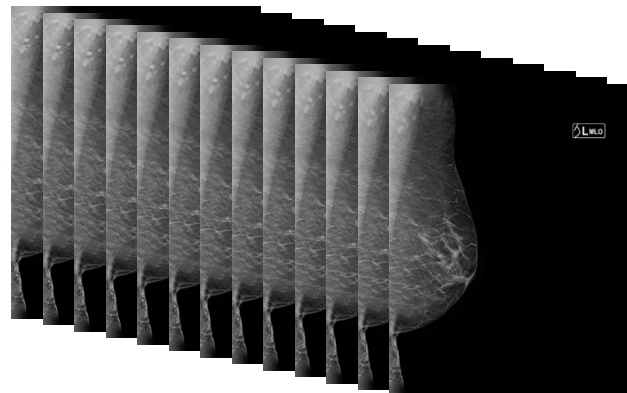
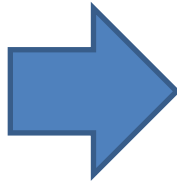
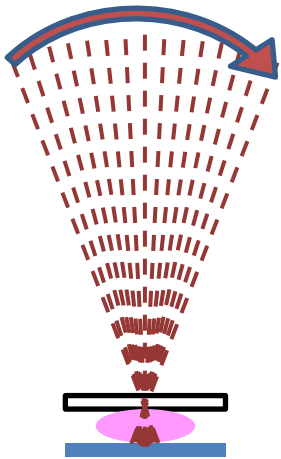
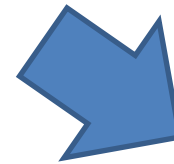
✓ AGD = 2,14 mGy \approx +2%

Trial clinico IRST



Immagini ricostruite

Fette 1 mm



Trial clinico IRST

Valutare la differenza tra le modalità di acquisizione HR e ST:

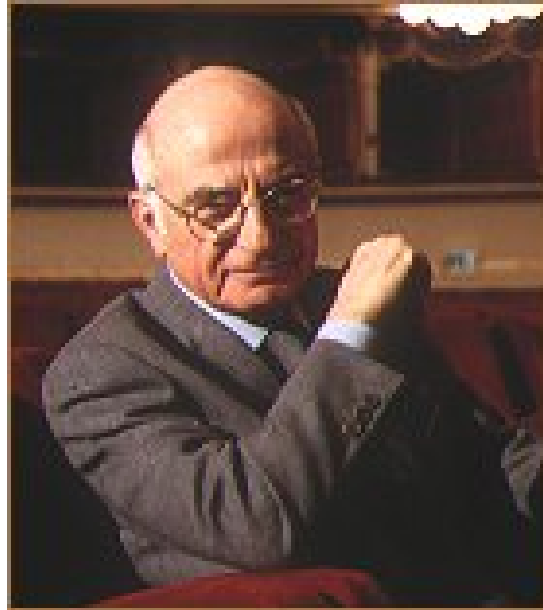
B - Lesione principale: valutazione con scala Likert	
B1 - Massa/Opacità nodulare	
B1.1	Visibilità
B1.2	Forma
B1.3	Nitidezza dei margini
B1.4	Densità
B2 - Calcificazioni	
B2.1	Visibilità
B2.2	Contorno
B2.3	Distribuzione
B3 - Distorsione architetturale	
B3.1	Visibilità
B3.2	Spicole
B3.3	Densità
B4 - Asimmetria	
B4.1	Visibilità
B4.2	Densità
B4.3	Dimensione
B5 - Eventuali altre caratteristiche della lesione principale	
B5.1	Visibilità Retrazione cutanea
B5.2	Visibilità Retrazione del capezzolo
B5.3	Visibilità Ispessimento cutaneo
B5.4	Visibilità Ispessimento trabecolare
B5.5	Visibilità Adenopatie ascellari

C - Confronto globale tra le due immagini DBT	
C1	Overall quality
C2	Contrasto complessivo delle strutture anatomiche
C3	Risoluzione sul piano delle strutture anatomiche
C4	Risoluzione verticale delle strutture anatomiche
C5	Confidenza nel conteggio di eventuali calcificazioni
C6	Contorno calcificazioni < 0.5 mm
C7	Contorno calcificazioni > 0.5 mm
C8	Visibilità Capezzolo
C9	Visibilità Vasi
C10	Visibilità Linfonodi ascellari

La domanda sorge spontanea...



La domanda sorge spontanea...



Qual'è il ruolo del fisico ??

Il ruolo del fisico

- ✓ DICOM HEADER
- ✓ Dose e qualità
- ✓ Database
- ✓ Risoluzione problemi acquisizione, invio e WS
- ✓ Texture analysis

Il ruolo del fisico

- ✓ **DICOM HEADER**
- ✓ Dose e qualità
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DICOM HEADER

0018,0015 Body Part Examined: BREAST

0018,0060 kVp: 33

0018,1000 Device Serial Number:

0018,1020 Software Versions(s): FDR-3000AWS Mainsoft V6.0.0001

0018,1110 Distance Source to Detector: 650

0018,1114 ---: 1

0018,1147 Field of View Shape: RECTANGLE

0018,1149 Field of View Dimensions(s): 296\236

0018,1150 Exposure Time: 790

0018,1151 X-ray Tube Current: 137

0018,1152 Exposure: 109

0018,1153 Exposure in uAs: 109370

0018,1164 Imager Pixel Spacing: 0.10\0.10

0018,1166 Grid: NONE

0018,1191 Anode Target Material: TUNGSTEN

0018,11A0 Body Part Thickness: 51

0018,11A2 Compression Force: 0

0018,1400 Acquisition Device Processing Description: TOMO MAX4.0 MAMMOGRAPHY

0018,1401 Acquisition Device Processing Code: 030F

0018,1405 Relative X-ray Exposure: 84

0018,1460 ---: 0

0040,0316 Organ Dose: 0.04929

0040,0318 Organ Exposed: BREAST

0040,0555 Acquisition Context Sequence:

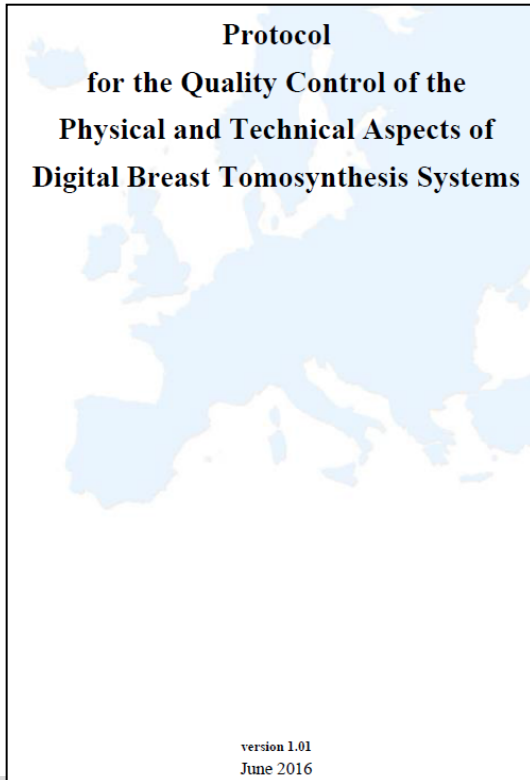
0040,8302 Entrance Dose in mGy: 13.779

Il ruolo del fisico

- ✓ DICOM HEADER
- ✓ **Dose e qualità**
- ✓ Database
- ✓ Risoluzione problemi acquisizione, invio e WS
- ✓ Texture analysis

Report

✓ Euref protocol for Quality control, v 1.1 (2016)



✓ Radiation dosimetry in digital breast tomosynthesis: TG 223 (2014)

Radiation dosimetry in digital breast tomosynthesis: Report of AAPM Tomosynthesis Subcommittee Task Group 223

Ioannis Sechopoulos^{a)}

Departments of Radiology and Imaging Sciences, Hematology and Medical Oncology and Winship Cancer Institute, Emory University, 1701 Uppergate Drive Northeast, Suite 5018, Atlanta, Georgia 30322

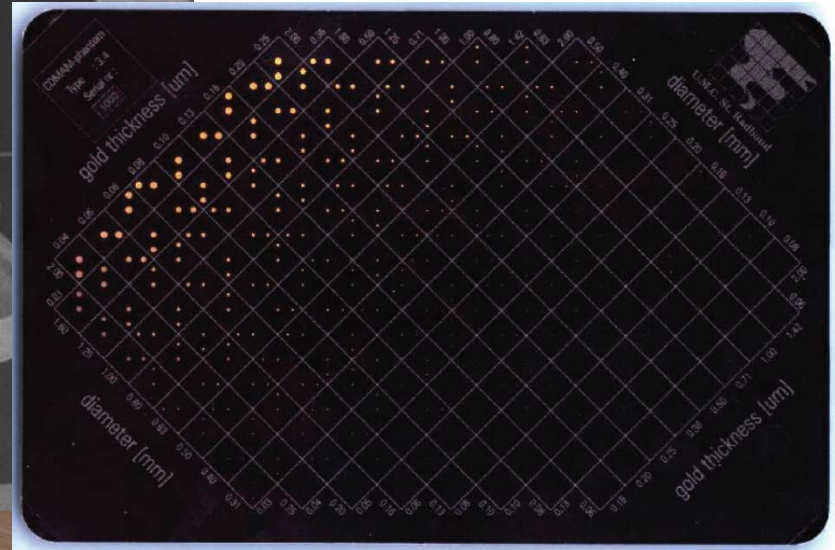
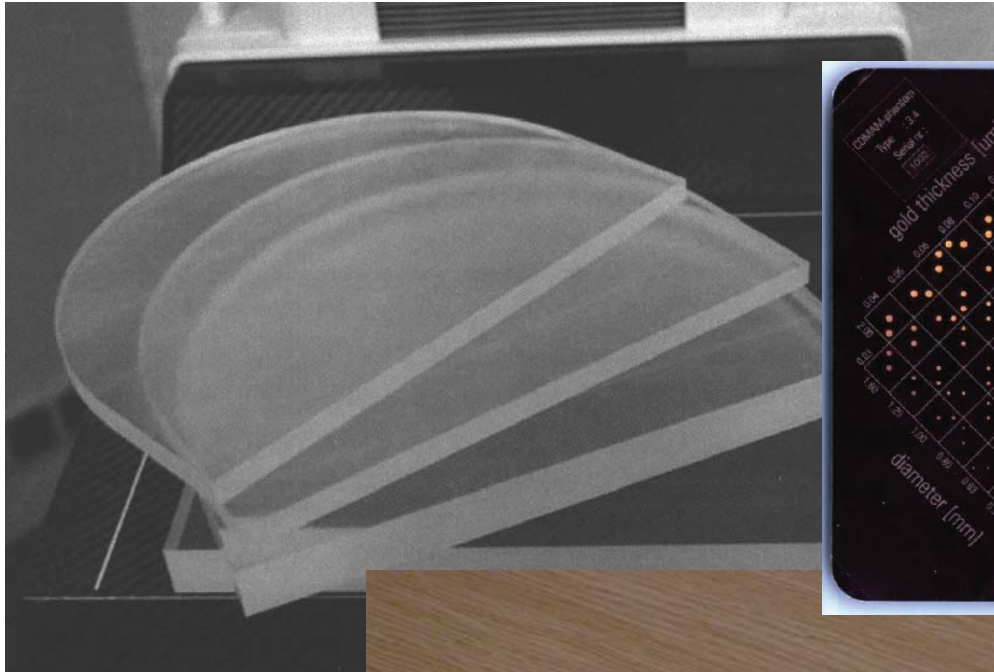
John M. Sabol

GE Healthcare, Global Diagnostic X-Ray, Mailstop W-701, 3000 North Grandview Boulevard, Waukesha, Wisconsin 53188

Johan Berglund

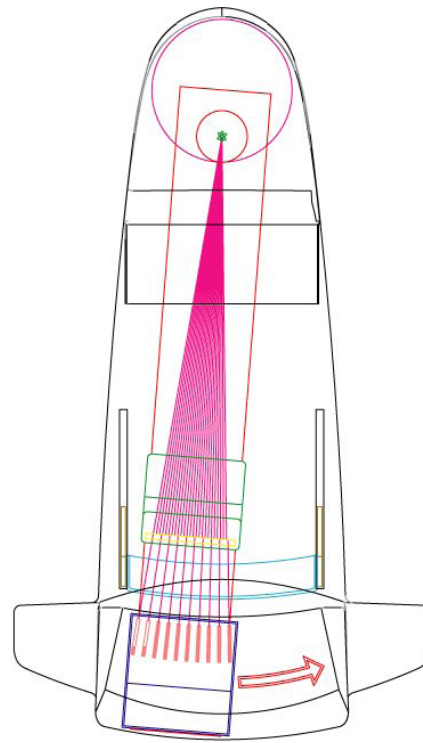
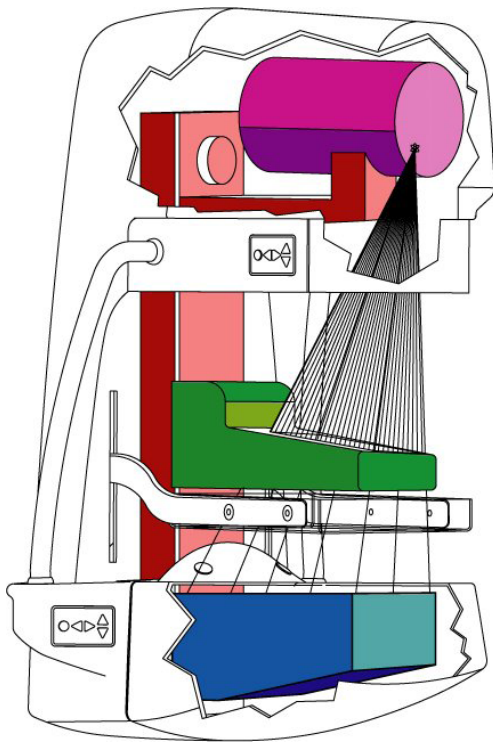
Research and Development, Philips Women's Healthcare, Solna, Sweden

Dose e qualità dell'immagine



Dosimetria per DBT

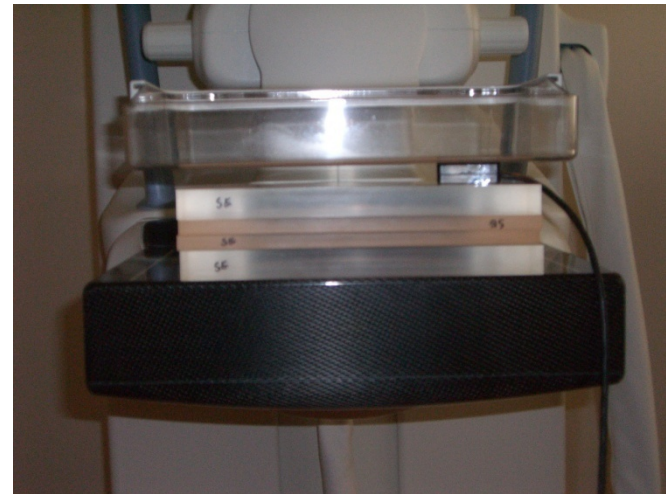
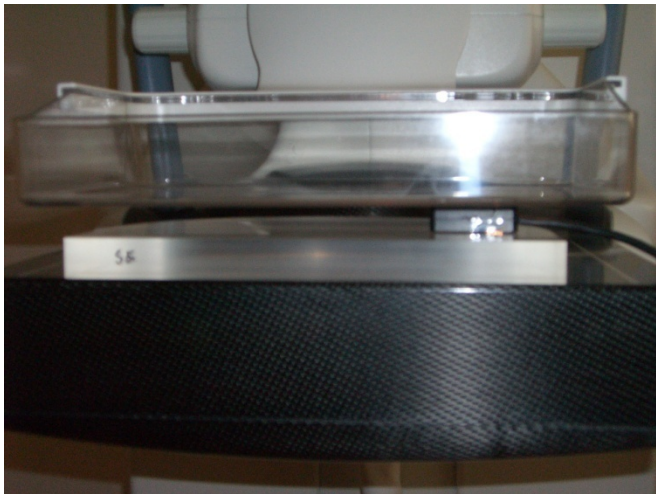
La dose dipende da:



- ✓ **Spessore e densità della mammella**
- ✓ **Qualità della radiazione**
- ✓ **Movimento tomografico:** angoli di proiezione, asse di rotazione, FDD.

Courtesy of David DANCE

Dosimetria per DBT



Dosimetria per DBT

Ci aspettiamo una dose \approx quella di 2 proiezioni di una mammografia 2D tradizionale

$$AGD = K(0^\circ) \cdot g \cdot c \cdot s \cdot T$$

≈ 1

$\approx 2x$ $\approx +6\%$ $\approx +10\%$

Dipende dalla geometria di esposizione (n. proiezioni, range angolare, ecc.)

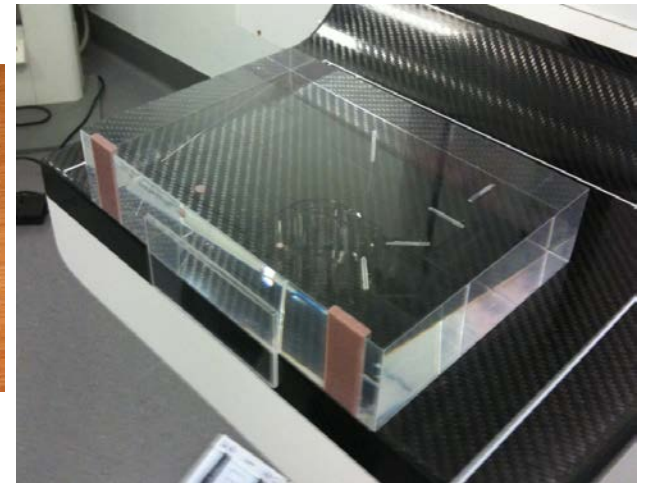
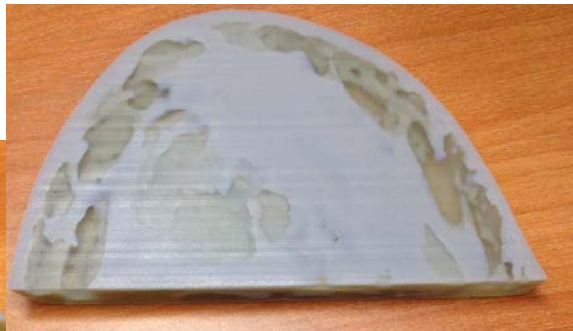
Qualità dell'immagine

✓ I vecchi fantocci 2D non sono ottimali

✓ Sviluppo di nuovi fantocci 3D



Courtesy: E. Samei, SPIE2013



Courtesy: H. Bosmans, Leuven

Il ruolo del fisico

- ✓ DICOM HEADER
- ✓ Dose e qualità
- ✓ **Database**
- ✓ **Risoluzione problemi acquisizione, invio e WS**
- ✓ Texture analysis

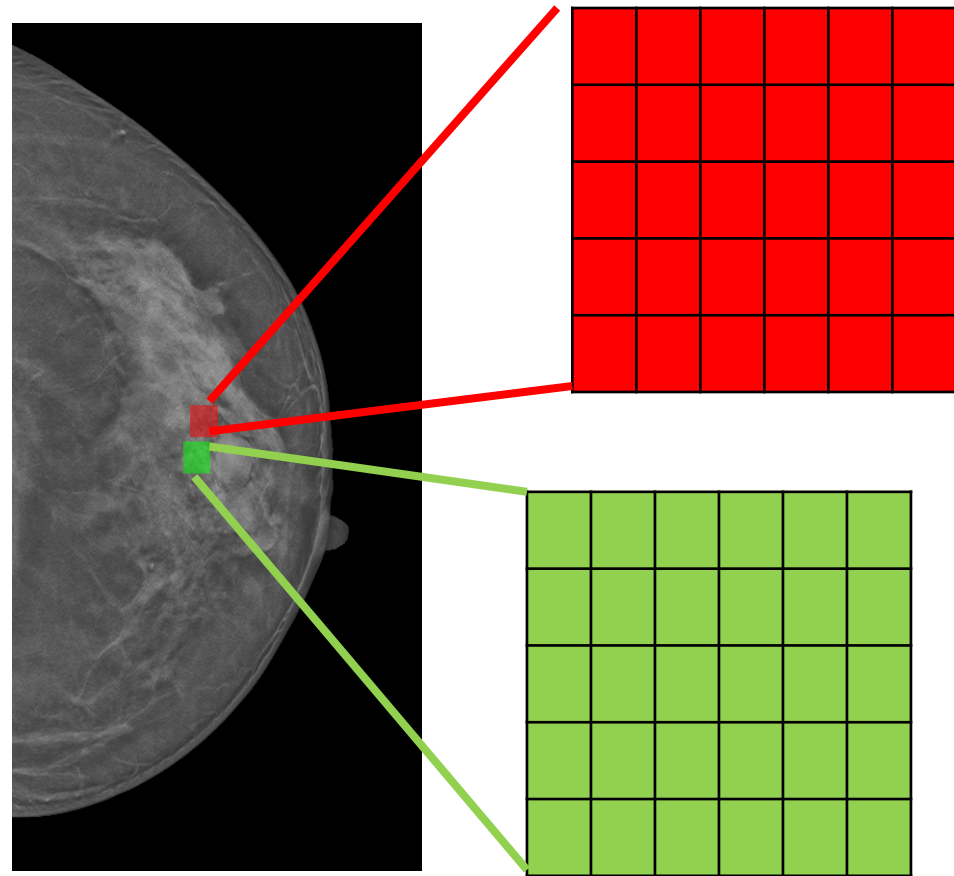
Il ruolo del fisico

- ✓ DICOM HEADER
- ✓ Dose e qualità
- ✓ Database
- ✓ Risoluzione problemi acquisizione, invio e WS
- ✓ **Texture analysis**

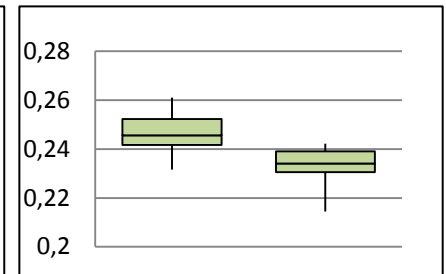
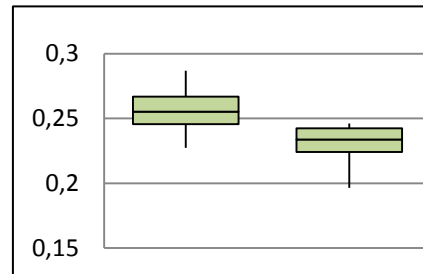
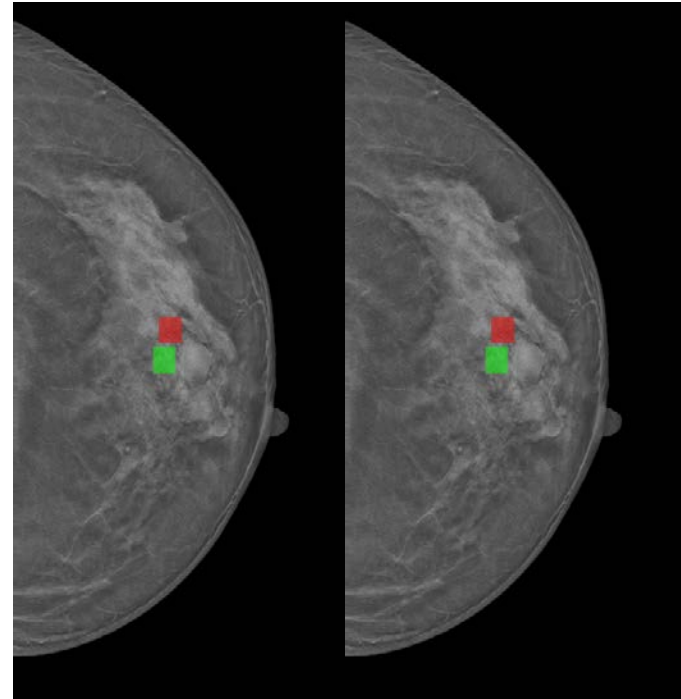
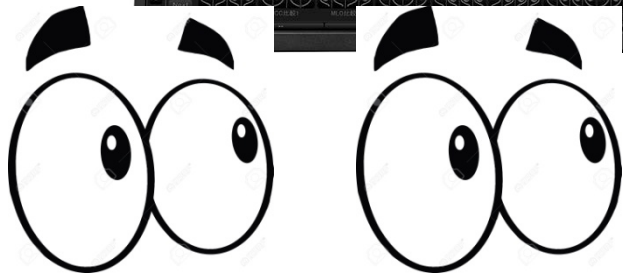
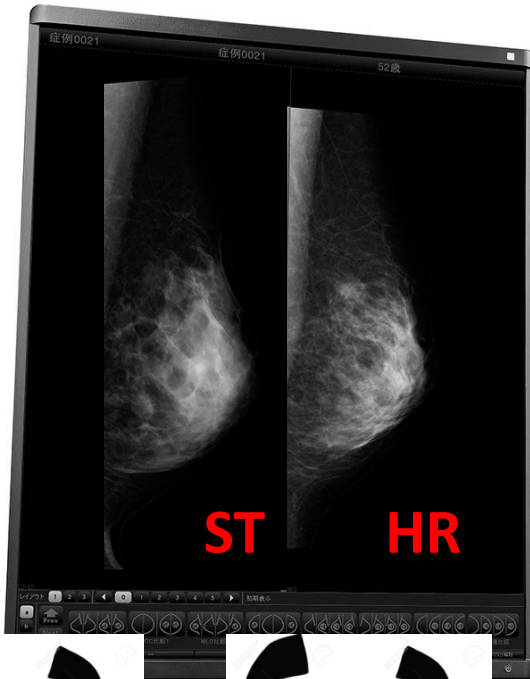
Texture analysis

Radiomics: Images Are More than Pictures, They Are Data¹

In the past decade, the field of medical image analysis has grown exponentially, with an increased number of pattern recognition tools and an increase in data set sizes. These advances have facilitated the development of processes for high-throughput extraction of quantitative features that result in the conversion of images into mineable data and the subsequent analysis of these data for decision support; this practice is termed *radiomics*. This is in contrast to the traditional practice of treating medical images as pictures intended solely for visual interpretation. Radiomic data contain first-, second-, and higher-order statistics. These data are combined with other patient data and are mined with sophisticated bioinformatics tools to develop models that may potentially improve diagnostic, prognostic, and predictive accuracy. Because radiomics analyses are intended to be conducted with standard of care images, it is conceivable that conversion of digital images to mineable data will eventually become routine practice. This report describes the process of radiomics, its challenges, and its potential power to facilitate better clinical decision making, particularly in the care of patients with cancer.



Texture analysis

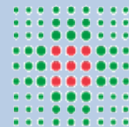


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delle neoplasie in
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Roma 30 maggio 2018

**Grazie per
l'attenzione**

***Valentina Ravaglia
Fisica Sanitaria – IRST Meldola***



SERVIZIO SANITARIO REGIONALE
EMILIA-ROMAGNA
Istituto Scientifico Romagnolo per lo Studio e la Cura dei Tumori

Istituto di Ricovero e Cura a Carattere Scientifico