Wissenschaftstag der Metropolregion Nürnberg, 20.7.2012

Verbesserte Brustkrebserkennung und -diagnostik mit Computertomographie
-
Ein Leitprojekt des MVEMN-Clusters

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CT Imaging

Hochauflösungs-CT der Brust mit niedriger Dosis
-
Leitprojekt BD-01 im Cluster Medical Valley EMN

CT Imaging GmbH, Erlangen, Henkestr. 81
(Spinoff des IMP im „Medical Valley Center")
Gründer & Gschf.: Willi Kalender

Das Vorhaben wird mit Mitteln des Bundesministeriums für Bildung und Forschung (BMBF) unter dem Förderkennzeichen 01EX1002 gefördert.

SPIEGEL ONLINE

„Katastrophe für die Frauen"

Performance of mammography in breast cancer screening:

Sensitivity 62% - 88%

Source: Carney et al. Annals of Internal Medicine 2003

Sensitivity 63% - 78%

Source: Report and metaanalysis of state-of-the-art breast cancer screening and monitoring approaches. Dep. of Radiology, Erasmus MC, Rotterdam 2009

2D-Projektions-Bildgebung Thorax	3D-CT-Bildgebung Lunge

Aufnahmen am selben Patienten!

Alle Strukturen entlang eines Strahls sind überlagert und können Details verdecken!

Nur die Strukturen in der interessierenden Schicht werden dargestellt.

Bildquelle: Prof. Michael Lell, Erlangen

Dedicated breast CT scanner at UC Davis
(since about 2005)

About 5 research groups active in the USA at present.

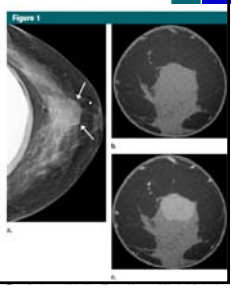
Cone-beam CT geometry

The Breast Tomography Project
University of California, Davis

Images: Courtesy of John Boone, UC Davis

Contrast-enhanced Dedicated Breast CT: Initial Clinical Experience[1]

Radiology



Conspicuity of malignant breast lesions, including ductal carcinoma in situ, is significantly improved at contrast-enhanced breast CT. Quantifying lesion enhancement may aid in the detection and diagnosis of breast cancer.

Prionas et al. Radiology 2010; 256:714-723

Requirements on breast CT

- Full 3D imaging capabilities
- High spatial resolution (min. 100 µm) for the detection of microcalcifications
- Good soft tissue delineation
- Dynamic scanning for the differentiation of benign and malignant lesions
- Dose levels similar to conventional mammography
- Integrated biopsy facility

... but without painful compression

High-resolution CT
Micro-CT scan of surgical specimens

DCIS specimen * embedded in parafin

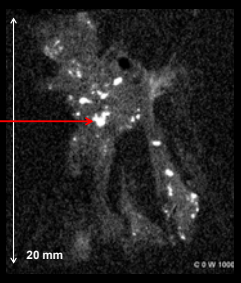
Micro-CT
40 µm resolution

* Specimen provided by M. Beckmann, Erlangen

Contrasts in breast tissue

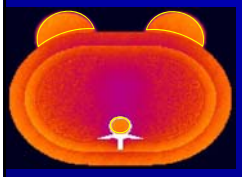
kV	Approx. CT values (HU)		
	Adipose (mean)	Tumor (mean)	Calcification (e.g.)
40	-440	-180	8200
60	-400	-160	6000
80	-350	-100	5000

gland - fat ~ 200 HU
gland – calcification > 5000 HU
@ 40 µm resolution

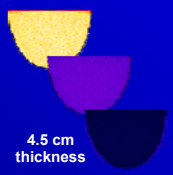


Dose assessment by Monte Carlo methods

CT	Breast CT	Mammography
120 kV	60 kV	30 kV



14 cm diameter



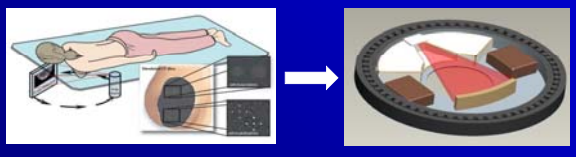
4.5 cm thickness

Determination of 3D dose distributions by simulations is established and confirmed by measurement. Applicable to breast CT, mammography and tomosynthesis in equal manner.

Monte Carlo software ImpactMC, CT Imaging GmbH

Breast CT scanner concept

Transition from
single-circle scan with flat detector
to
spiral scan with CT detector



Photon-counting energy-discriminating CdTe detector
100 % geometrical and absorption efficiency

Pre-clinical testing expected for 2012 !

Kalender WA et al. Eur Radiol 2012; 22(1):1-8

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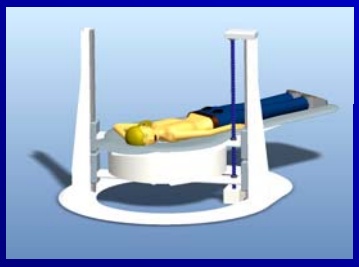
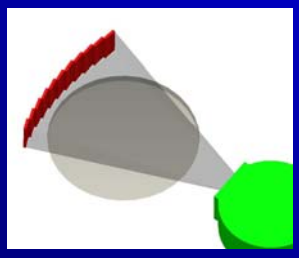
Patient- and biopsy-friendly spiral CT breast scanner



- Table height 50 - 150 cm
- Scan length arbitrary 25 cm in 12 s
- Easy patient access for biopsy and therapy

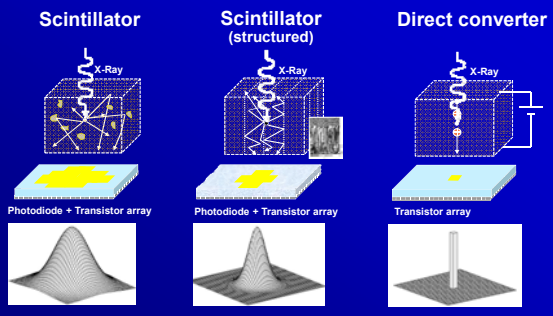
Kalender WA, Althoff F. Patent application 2010

Photon counting CdTe detector



- Curved detector built up scalable of discrete CdTe tiles with 100 µm pixel size
- Count rate: 10^8 ph./mm²/s
- Frame rate: 1000 proj./s
- Two thresholds for energy discrimination
- Detection efficiency and geometric efficiency close to 100 %

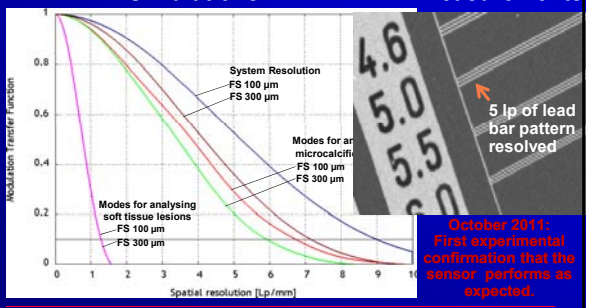
Detection principles



Point Spread Functions (PSF)

Spatial resolution

Simulations | Measurements



October 2011: First experimental confirmation that the sensor performs as expected.

Kalender WA et al. Eur Radiol 2012; 22(1):1-8

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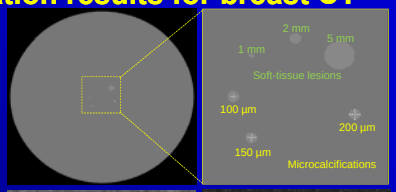
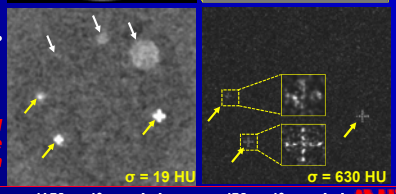
Simulation results for breast CT

Phantom
14 cm diameter
10 cm length



Scan parameters
2 s / 2000 proj. / 360°
100 µm FS /
Dose: 3 mGy AGD

Model-based iterative Reconstruction



(150 µm)³ voxel size (50 µm)³ voxel size

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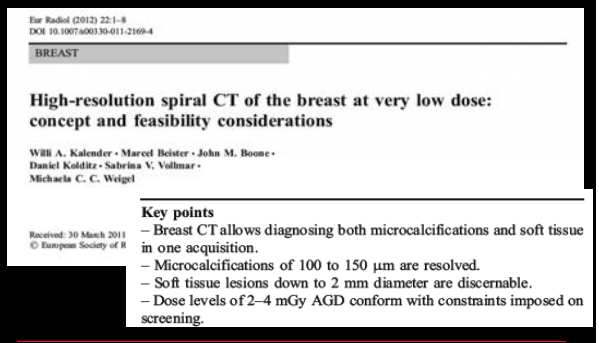
Dedicated CT of the breast



Eur Radiol (2012) 22:1–8
DOI 10.1007/s00330-011-2169-4

BREAST

High-resolution spiral CT of the breast at very low dose: concept and feasibility considerations

Willi A. Kalender · Marcel Beister · John M. Boone · Daniel Kolditz · Sabrina V. Vollmar · Michaela C. C. Weigel

Received: 30 March 2011
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Key points
– Breast CT allows diagnosing both microcalcifications and soft tissue in one acquisition.
– Microcalcifications of 100 to 150 µm are resolved.
– Soft tissue lesions down to 2 mm diameter are discernable.
– Dose levels of 2–4 mGy AGD conform with constraints imposed on screening.

Kalender WA et al. Eur Radiol 2012; 22(1):1-8

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Zusammenfassung

- Die ambitionierten Ziele des Projektes
  - verbesserte Brustkrebsfrühdiagnostik
  - Entwicklung innovativer Technologien

  erscheinen erreichbar.
- Erster Test des Gesamtsystems IV/2012
- Klinische Erprobung
  in Erlangen ab II/2013
  in Kooperation mit min. 5 Kliniken ab III/2013


Danke für Ihre Aufmerksamkeit!
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Molekulare Bildgebung 2012
Erlangen, 17.-19. Sept.
www.MoBi2012.de
Annual Meeting of the
Interdisciplinary Network Molecular Imaging (INMB)
Topics
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