



Proposte di tesi in im3D

# Outline

- **Introduction**
- Colorectal cancer
- Breast cancer

# im3D S.p.A. Who we are

- **im3D** is a company based in Torino (Italy) developing innovative medical imaging solutions for **cancer early diagnosis** and prevention
- Research activities started in **2004** on Computer Aided Diagnosis (CAD) for virtual colonoscopy: **CAD COLON**
- 2009 – A large prospective multicenter clinical trial proved **CAD COLON increases exam sensitivity**
- A second product was launched at **RSNA 2010**: **CAD BREAST DTS**, the first commercial CAD system for Breast Tomosynthesis



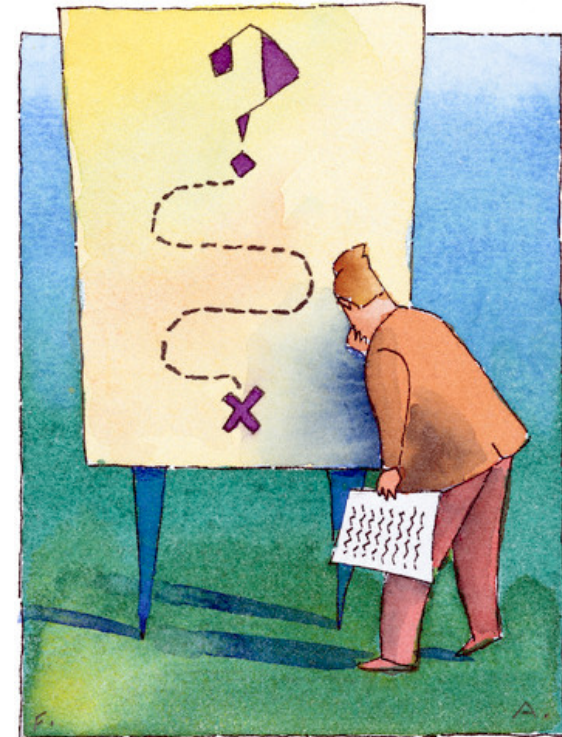
# im3D S.p.A. Who we are

- im3D Clinic, a sister company, started in 2010 to run oncologic **screening trials** and to offer **organized screening** and corporate prevention **services**, using im3D technologies
- In July 2010, the **first im3D Clinic Screening Center** was inaugurated as a spin-off of the University of Torino

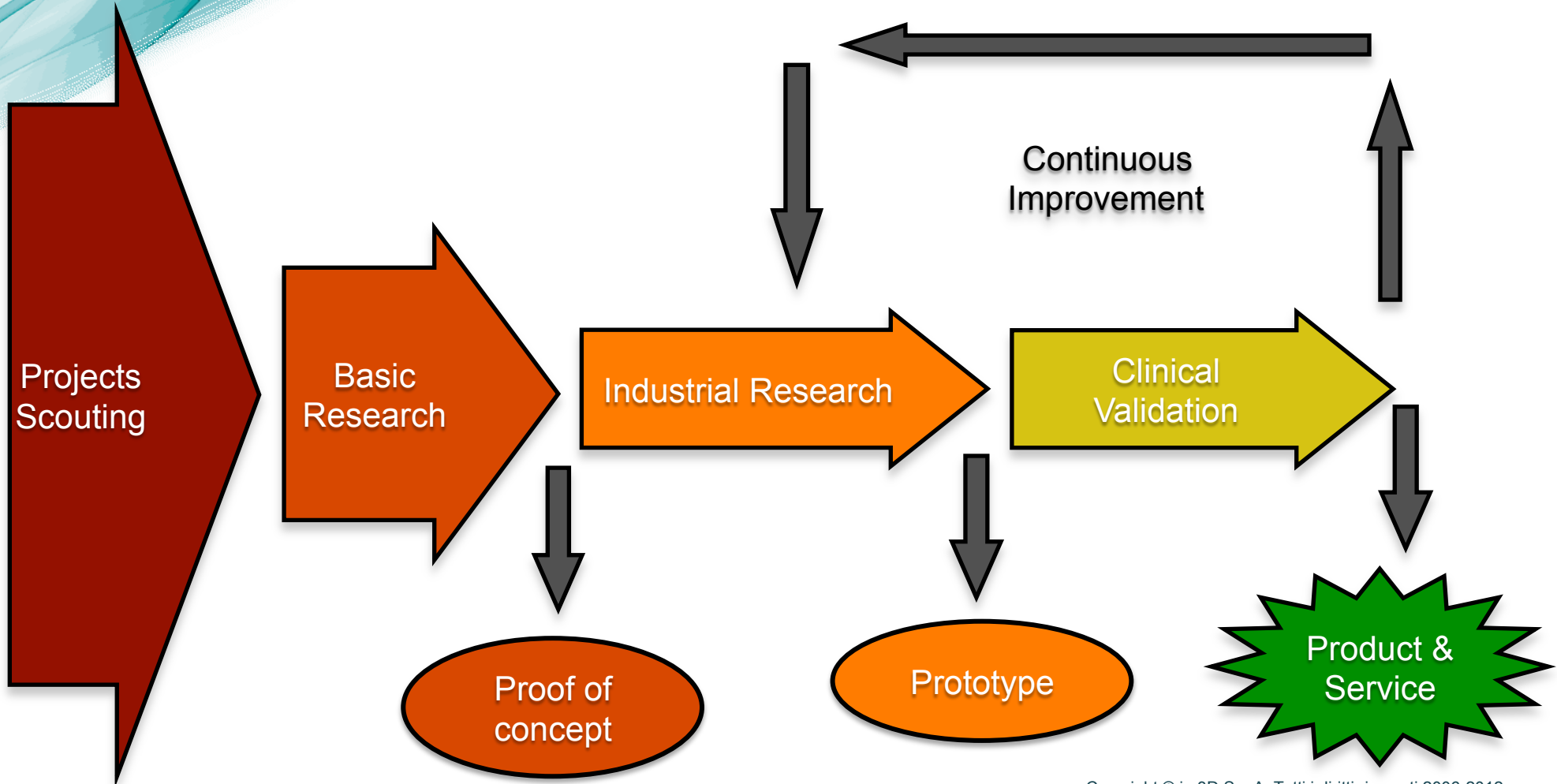


# im3D Research What we do

- We design, develop and validate state of the art solutions for the **early detection** of the main **cancer** pathologies
- All our solutions have built in **artificial intelligence components** (CAD)
- Behind each of our products there are years of **scientific, clinical** and **software research**
- We **translate** our know-how & technologies (CAD, teleradiology, ...) into high quality and efficient **screening services**



# im3D Research The R&D process

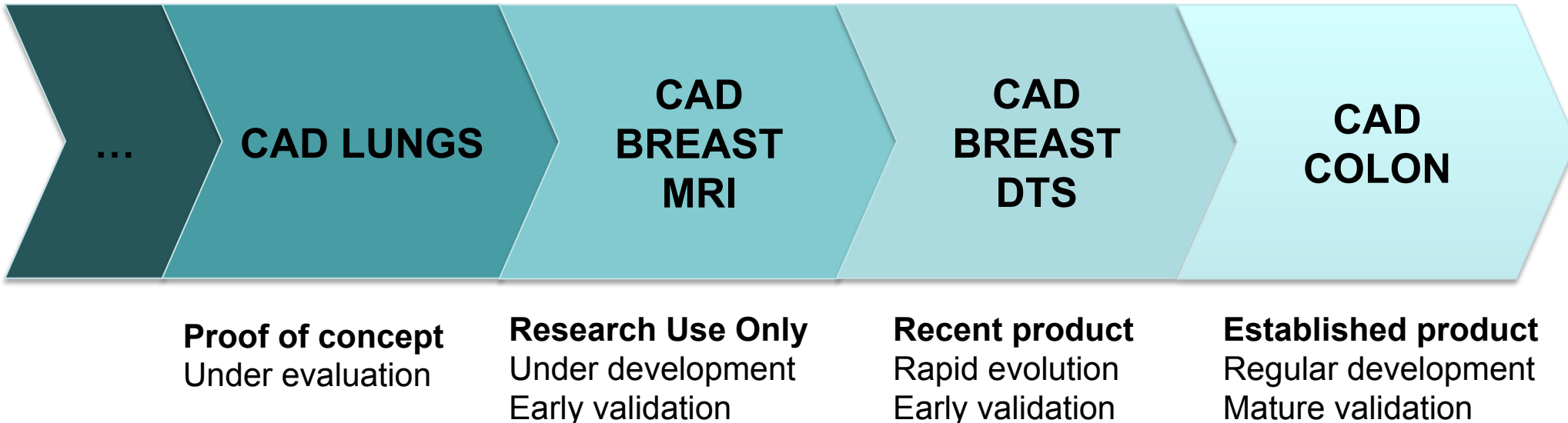


## im3D Research Few numbers

- **2** marketed **CAD systems**
- **4** pre-market research **projects**
- **5** multicenter **clinical trials** concluded or ongoing
- **2** issued **European patents**, **1 US patent**, > 3 patents pending
- > **70 scientific communications** in national and international congresses and journals
- > **15 research collaborations** with imaging and clinical research groups. Among others: IRCC, Università di Torino, La Sapienza, IEO, AAPM, UC Irvine, Politecnico di Torino, Heidelberg University, Kings College London, ...



# im3D Research Main R&D projects





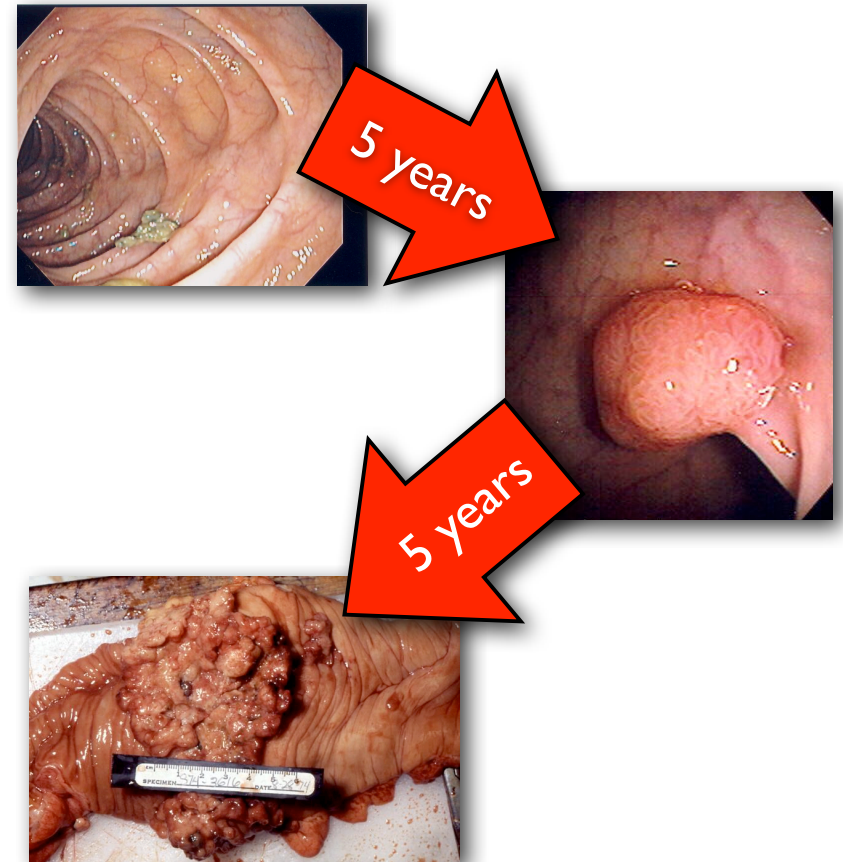
# Outline

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# Colorectal cancer

- Colorectal cancer (CRC) is the **second most diagnosed** form of cancer in Europe
- The **second cause of death from cancer**
- **5-year survival** rate around **56%**
- Cancer generally develops starting from **polyps**
- Polyps are mostly **asymptomatic**

**CRC can be prevented** by detecting and removing polyps



# Virtual colonoscopy

## What is it?

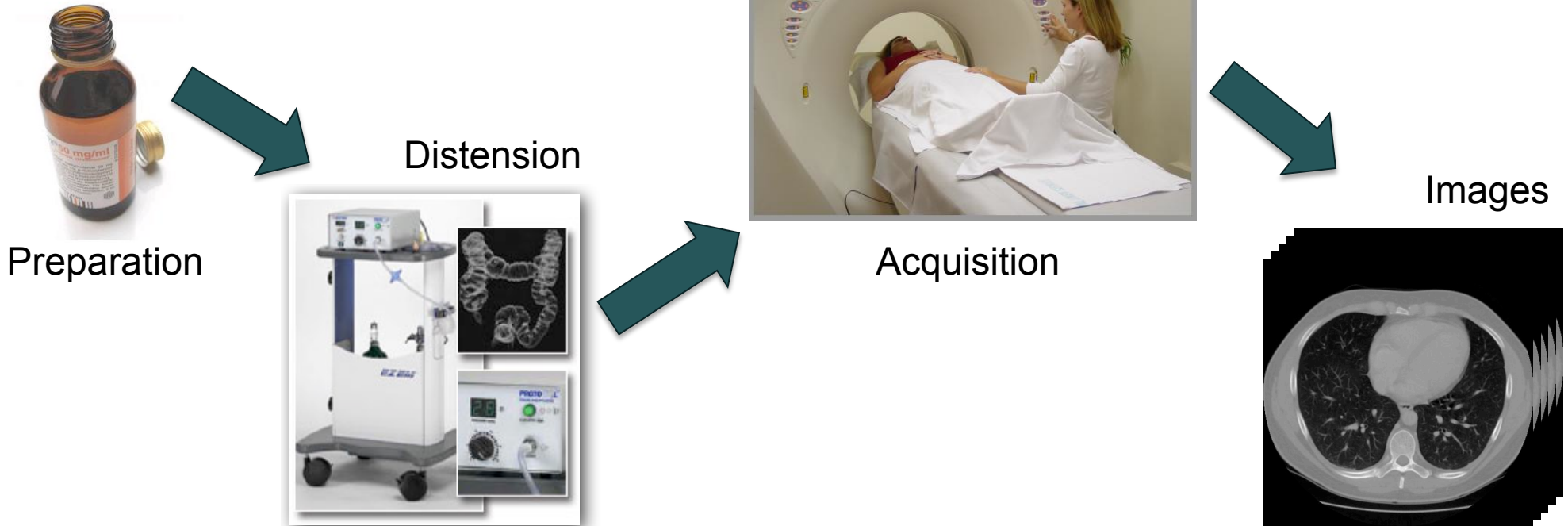
- Virtual Colonoscopy (VC) is a **non-invasive** examination allowing an endoluminal view of the colon similar to conventional colonoscopy, but with no need to introduce any endoscopic probe
- Virtual Colonoscopy can examine the **whole colon** and its pathologies at an early stage without risks
- Virtual Colonoscopy is an accurate, safe and well tolerated technique, **officially suggested as a screening option** for the prevention of colorectal cancer

Because no  
one likes to be in a  
compromising position...



# Virtual colonoscopy

## How the exam is performed



# Virtual colonoscopy Acquisition



- **Prone** and **supine** image acquisition
  - **≥ 4 slices** scanner
  - Tube current **50-100 mAs**
  - Slice thickness 1.2-2.5mm with **0.6-1.5mm** reconstruction interval
- 
- Overall effective dose **2-4mSv** (annual exposure of airline pilots or living 3 years in Paris)

# VC validation path An established technique



**Screening and Surveillance for the Early Detection of Colorectal Cancer and Adenomatous Polyps, 2008: A Joint Guideline from the American Cancer Society, the US Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology**

Bernard Levin, David A. Lieberman, Beth McFarland, Robert A. Smith, Durado Brooks, Kimberly S. Andrews, Chiranjeev Dash, Francis M. Giardiello, Seth Glick, Theodore R. Levin, Perry Pickhardt, Douglas K. Rex, Alan Thorson, Sidney J. Winawer and for the American Cancer Society Colorectal Cancer Advisory Group, the US Multi-Society Task Force, and the American College of Radiology Colon Cancer Committee  
*CA Cancer J Clin* 2008;58;130-160; originally published online Mar 5, 2008;

- **2008** – VC is included in the **ACS guidelines** as a suggested exam for **CRC screening**
- **2010** – **Pres. Obama execute VC**, in place of conventional colonoscopy, as part of its presidential routine periodic physical examination
- **Today** – VC is **commonly used** for diagnosis and prevention in hundred clinical centers in Europe and USA

# Virtual colonoscopy

## Current indications

- **Prevention** (CRC screening): average risk men or women over 50 years of age
- **Diagnosis**: patients with bowel symptoms (pain, bleeding, ...)
- Completion of an **incomplete conventional colonoscopy** exam
- Elderly patients and other subjects with **contraindications for conventional colonoscopy** (cardiopathy, chronic bronchitis, etc.)

The screenshot displays the 'CAD-COLON' software interface, an oncology workstation for colon cancer diagnosis. The interface is divided into several functional areas:

- Top Bar:** 'CAD-COLON' logo, 'ONCOLOGYWORKSTATION' text, and the 'im3D MEDICAL IMAGING LAB' logo.
- Left Panel (Patient Data & Tools):**
  - Patient Info:** Name (Piero), Cognome (Pallino), ID (15183), Data esame (12.04.2005), Ora esame (10h.16min).
  - Navigation:** 'Scelta del paziente', 'Ordinamento dei segmenti', 'Zona sospette' (CAD/Manuali), 'Sottrazione elettronica', 'Finestra dei grigi', 'Lettura attenuazione ROI', 'Piani di taglio', 'Misura', 'Aggiungi marcatura', 'Fotografia', 'Zoom', 'Spostamento immagine', 'Referto', 'Esci dal programma'.
- Central Area (CT Scans):**
  - AXIALE (Axial):** Shows two axial CT slices. The left slice has a cursor position of x=50, y=120, z=220. The right slice has a cursor position of x=50, y=120, z=220. Both slices show technical parameters: intensità 50 HU, kvolt 120, ma 70, passo elicoidale 1.3, collimazione 5 mm.
  - CORONALE (Coronal):** Shows a coronal CT reconstruction of the colon.
  - SAGITTALE (Sagittal):** Shows a sagittal CT reconstruction of the colon.
- Right Panel (3D Models & Metrics):**
  - 3D Models:** 'PRONO' and 'SUPINO' views of the colon model.
  - Metrics Table:**

Segmento	INIZIO	FINE	INCLINAZIONE	DISTANZA PERCORSO	PERCENTUALE PERCORSO
P	18	1.8			
F	25	0.8			
V	32	0.3			
I	45	0.6			
S	60	0.9			
G	73	0.8			
O	79	3.1			
U	97	2.5			
A	103	0.6			
H	150	15			
K	189	0.4			
G	232	1.1			
  - 3D Surface Models:** Two 3D surface renderings of the colon, one in a proximal view and one in a distal view, with a red polypoid lesion highlighted by a white circle.



# The role of im3D CAD Speed and confidence

- Increases exam **sensitivity (+10%)**, especially for small lesions
- Reduces **reading times (25min → 6min)**
- Increases reader **confidence** (second look)
- Helps reducing errors due to **fatigue** or distraction (high workloads)



# The role of im3D CAD

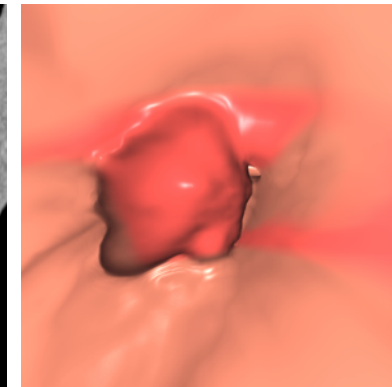
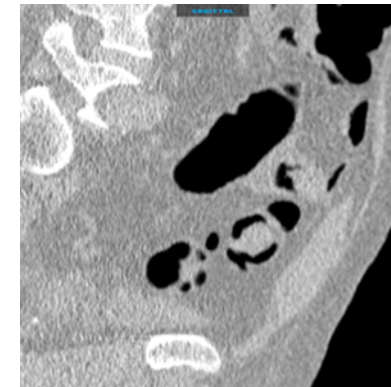
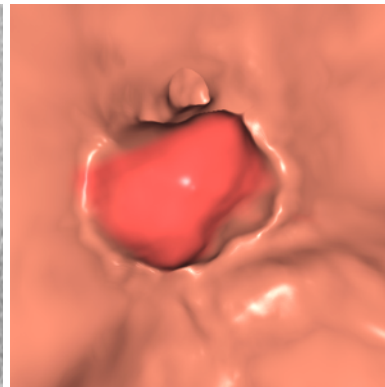
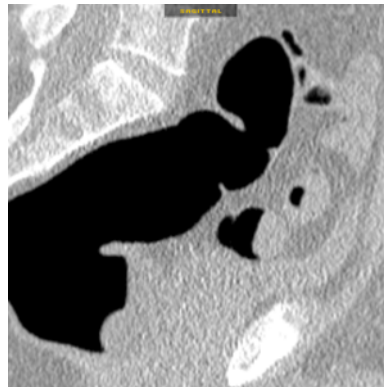
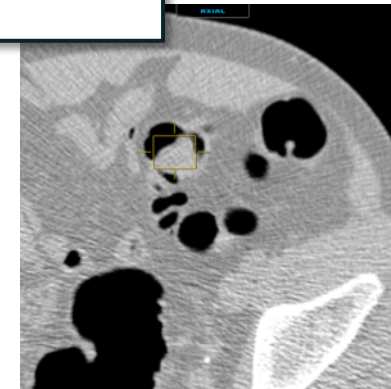
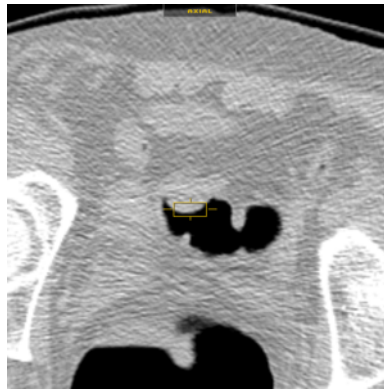
## Examples: mass

**Missed by radiologist,  
found by CAD**

Prone

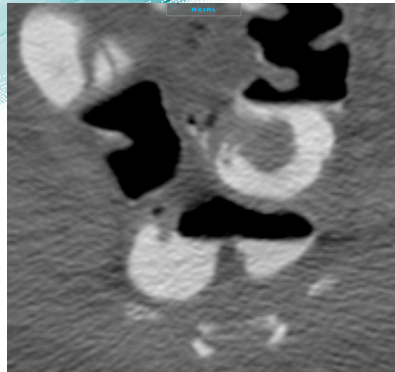
Supine

- 3 cm vegetating lesion
- Sigmoid colon
- Cancer

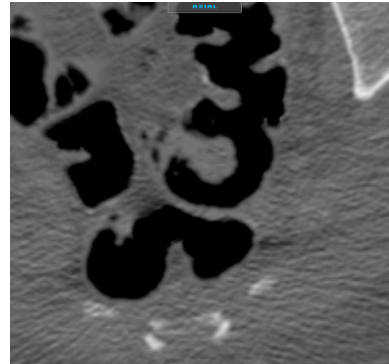


# im3D CAD COLON behind the scene

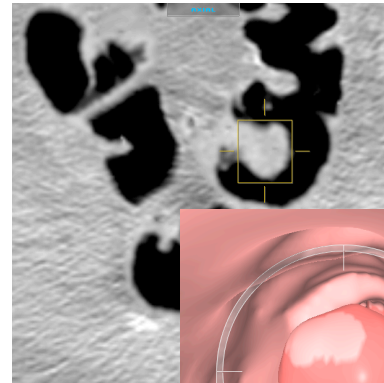
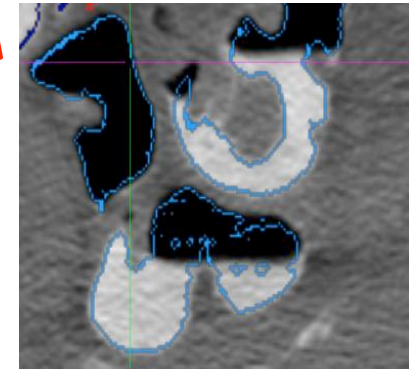
## The CAD pipeline



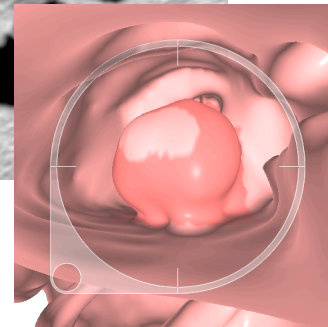
Digital  
Cleansing



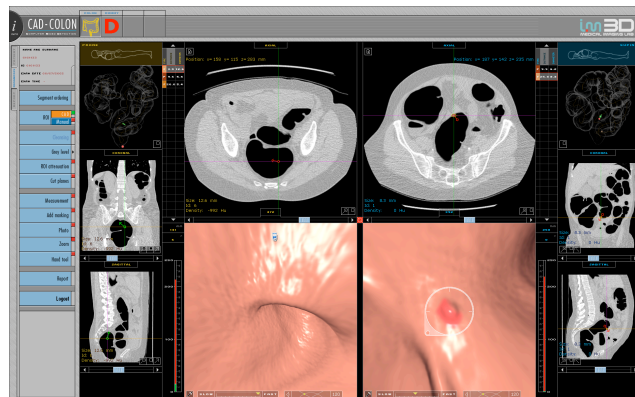
Colon surface  
extraction



Candidates  
segmentation



Candidates  
discrimination



# im3D CAD COLON validation path

## The clinical practice

### CADIMPACT – 2009

## Material & Methods

- 10 Clinical centers
- **Low dose** protocol, **fecal tagging** prep.
- **651 participants** at various risks (OC confirmation)
- Reading with **CAD as a second reader**
- **205 polyps**  $\geq 6\text{mm}$  (106  $\geq 10\text{mm}$ )

## Results

Observable	Radiologist	+ CAD
Sens. $\geq 6\text{mm}$	75%	80%*
Sens. 6-9mm	65%	74%*
Sens. $\geq 10\text{mm}$	84%	85%
Specificity	90%	90%

\* Statistically significant ( $p < 0.005$ )

# CAD COLON validation path

## The screening trials

### PROTEUS – Ongoing

- **First screening** trial ever performed with virtual colonoscopy supported by CAD
- **26,000** average risk **subjects** invited in 2 Italian Regions (Piemonte & Veneto)
- Standardized low dose protocol, light exam preparation and CAD first reader
- Response, detection rate and cost-effectiveness comparison between **VC and Flex. Sigmo.** (current screening test)
- Integrated in the **public healthcare** system and in partnership with the epidemiologic regional agencies
- **Telediagnosis** based: distributed image acquisition, centralised (quality monitored) reading

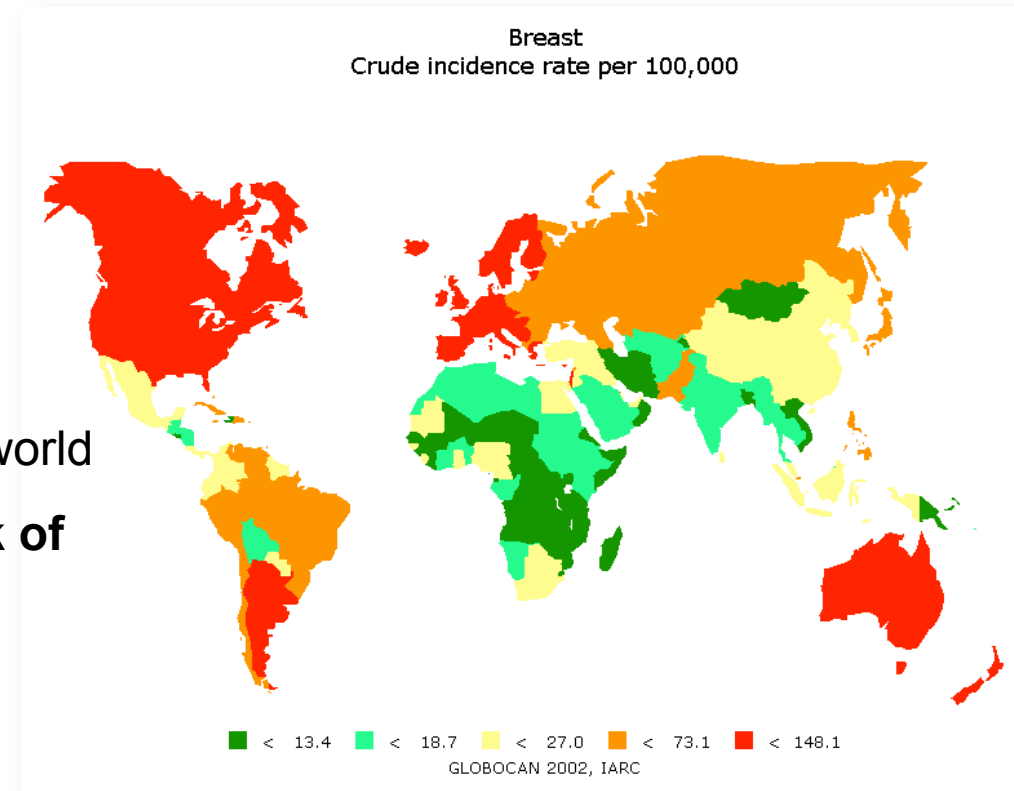


# Outline

- Introduction
- Colorectal cancer
- **Breast cancer**

# Breast cancer Social impact

- The **most common** cancer in women
- The **second cause of cancer death** in women
- **1.1 million** new cases every year in the world
- In Europe women have **10% lifetime risk** of developing breast cancer.



# The exam

## Current technology

### Mammography

- **Mammography** is the **reference examination**, both for screening and symptomatic patients, and has proven its effectiveness over the years
- Still, it has well known **limitations** in terms of sensitivity and specificity:



#### Sensitivity

In **dense breasts**, common in young women (under 50) and a known risk factor, sensitivity can easily drop under 50%, missing 1 every 2 cancers

#### Specificity

**Tissue superposition**, due to the breast compression and the 2D nature of the technique, introduces frequent false positives



# The exam Next technology Digital Breast Tomosynthesis

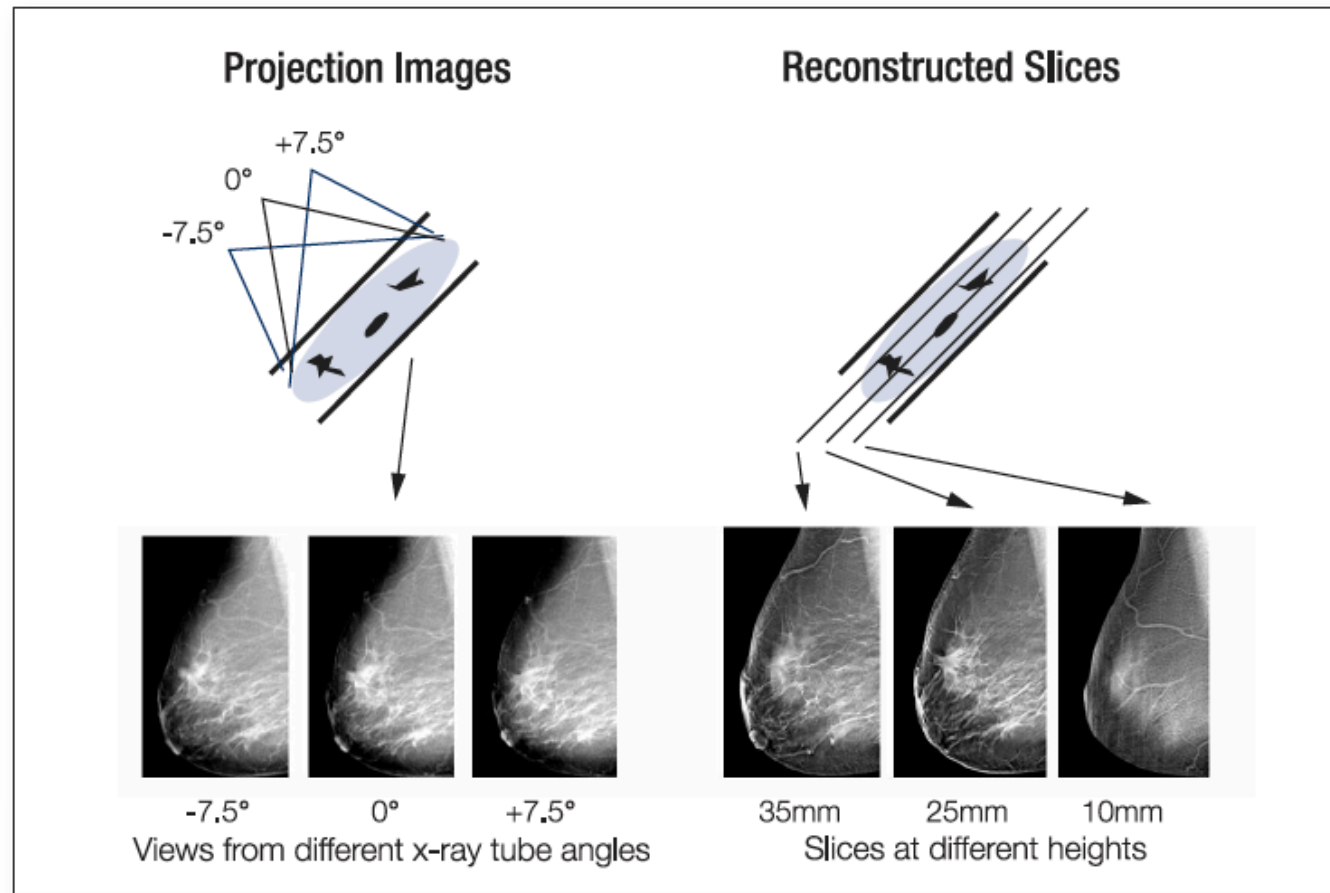
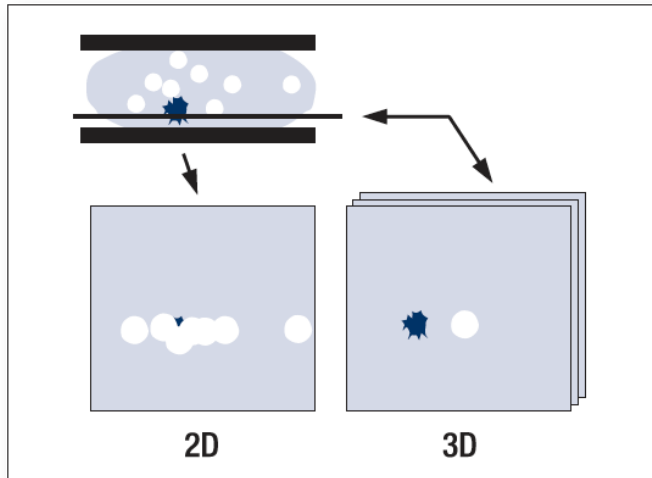
- A novel **3D imaging technique**, where a breast volumetric image is reconstructed, starting from a small set of ultra-low dose mammography projections
- The mammography apparatus is modified to allow the **X-ray source to rotate by a small angular range**, and to acquire projections at different angles
- Clinical studies have proven tomosynthesis to be **very promising** for the solution of the current main mammography limitations



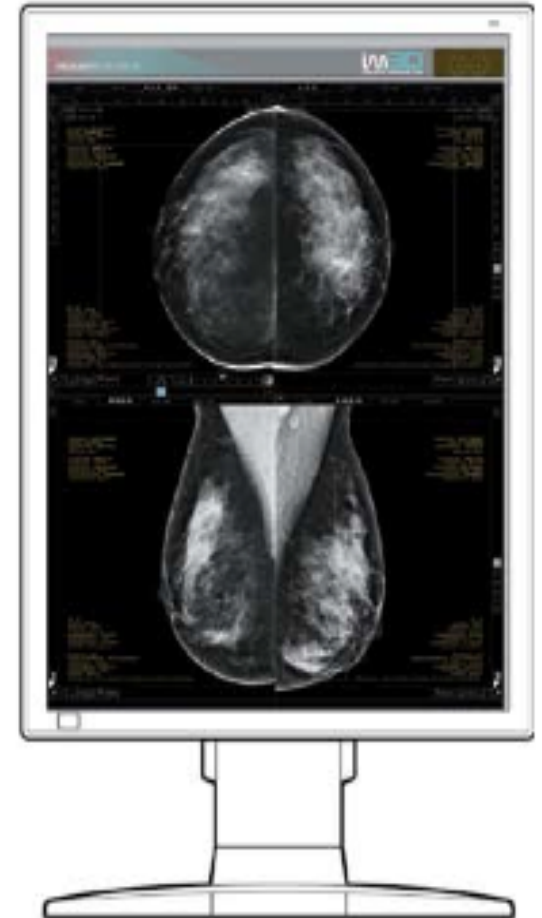
# The exam

## The 3D step forward

### Digital Breast Tomosynthesis



# Our product im3D CAD BREAST DTS



# im3D CAD BREAST DTS

## CAD for breast tomosynthesis

- **Large number of images** (slices) for each breast, potentially increasing the radiologist reading time and chances of perceptual errors
- Advantages determined by CAD are expected in:
  - Reading **speed** and **confidence**
  - **Sensitivity**

Launched at RSNA 2010, is the **first breast tomosynthesis CAD** system commercially available



- Partecipazione all'attività di ricerca legata al **disegno, implementazione e validazione** di algoritmi per **sistemi reali** di supporto alla diagnostica oncologica, in **stretta collaborazione** con i ricercatori im3D (image processing, pattern recognition, analisi dati, programmazione, ricerca bibliografica e brevettuale, pubblicazioni, ecc.)
- Partecipazione alla conduzione di studi di **validazione clinica** di innovative **tecniche diagnostiche** e sistemi di supporto alla diagnosi in ambito oncologico, in stretta collaborazione con i **ricercatori** im3D (analisi statistica dei dati, gestione dei dati, ricerca bibliografica, pubblicazioni, ecc.)