New detectors for Molecular Breast Imaging (NewMBI)

Sara Gaitán Domínguez, José Manuel Udías Moinelo, Paula Ibáñez

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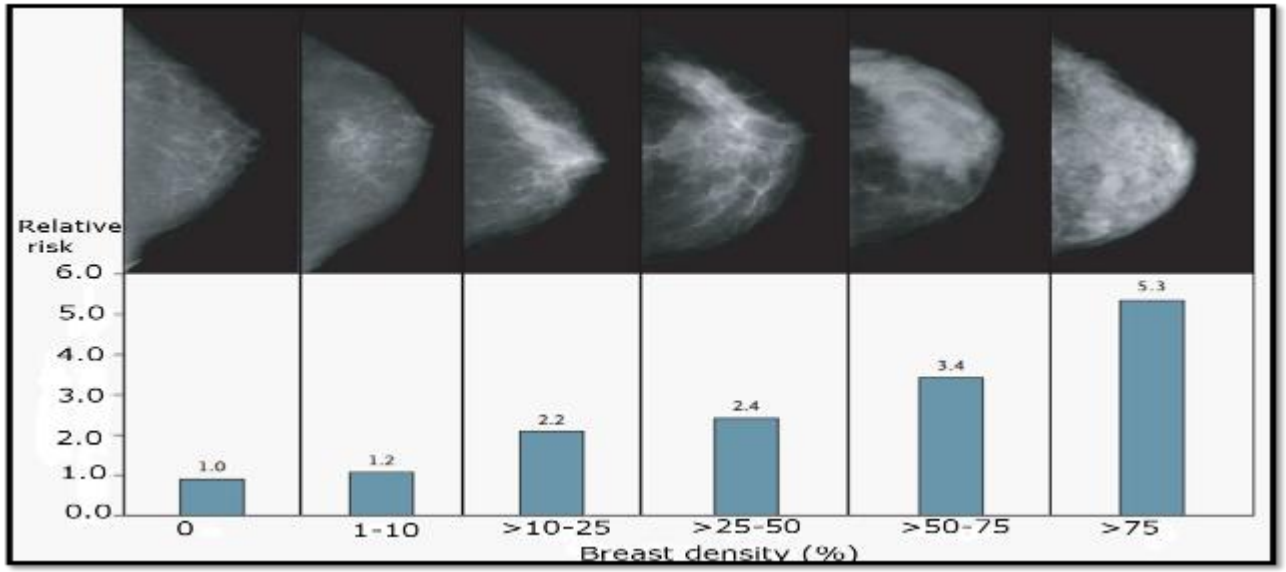
Introduction

- Breast cancer is the most common cancer for woman in all the World. Early detection allows the disease to be treated in the initial stages. Screening programs (mamography) are much less effective in dense breast.



[1]Santen and Mansel, 2005; Jovanovic, 2008

	Tasa de detección del cáncer de mama en mujeres con mama densa	Exposición relativa a la radiación	Tiempo necesario para hacer la imagen	Coste	Necesidad de catéter intravenoso	Potencial de reacción al contraste
Imagen molecular de mama (MBI)	****	**	****	**	Sí	Muy baja
Mamografía 2D	*	*	*	*	No	Ninguna
Tomosíntesis	**	*	*	*	No	Ninguna
Mamografía con contraste	****	*	**	**	Sí	Sí
Ecografía mamaria	**	Ninguna	***	**	No	Ninguna
Resonancia magnética con contraste (MRI)	*****	Ninguna	****	****	Sí	Sí

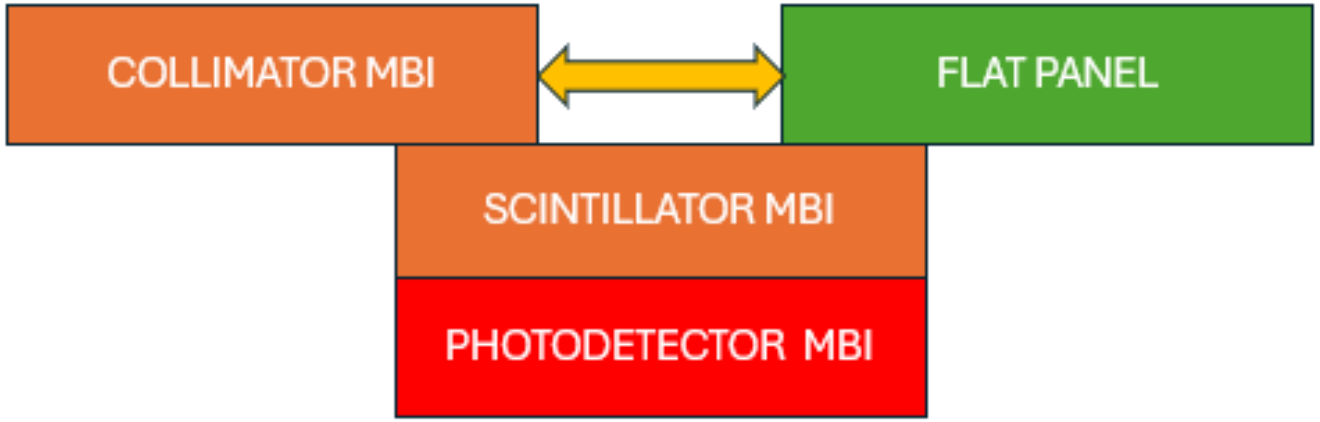
[2]Rauch, Gaiane M. n.d. “Molecular Breast Imaging.” SNMMI. Accessed September 7, 2022

New generation of MBI

We propose a new generation of detectors for breast cancer screening that are cheap, comfortable and accesible and that have high specificity and sensitivity.

NewMBI would combine Mammography and MBI in the same machine.

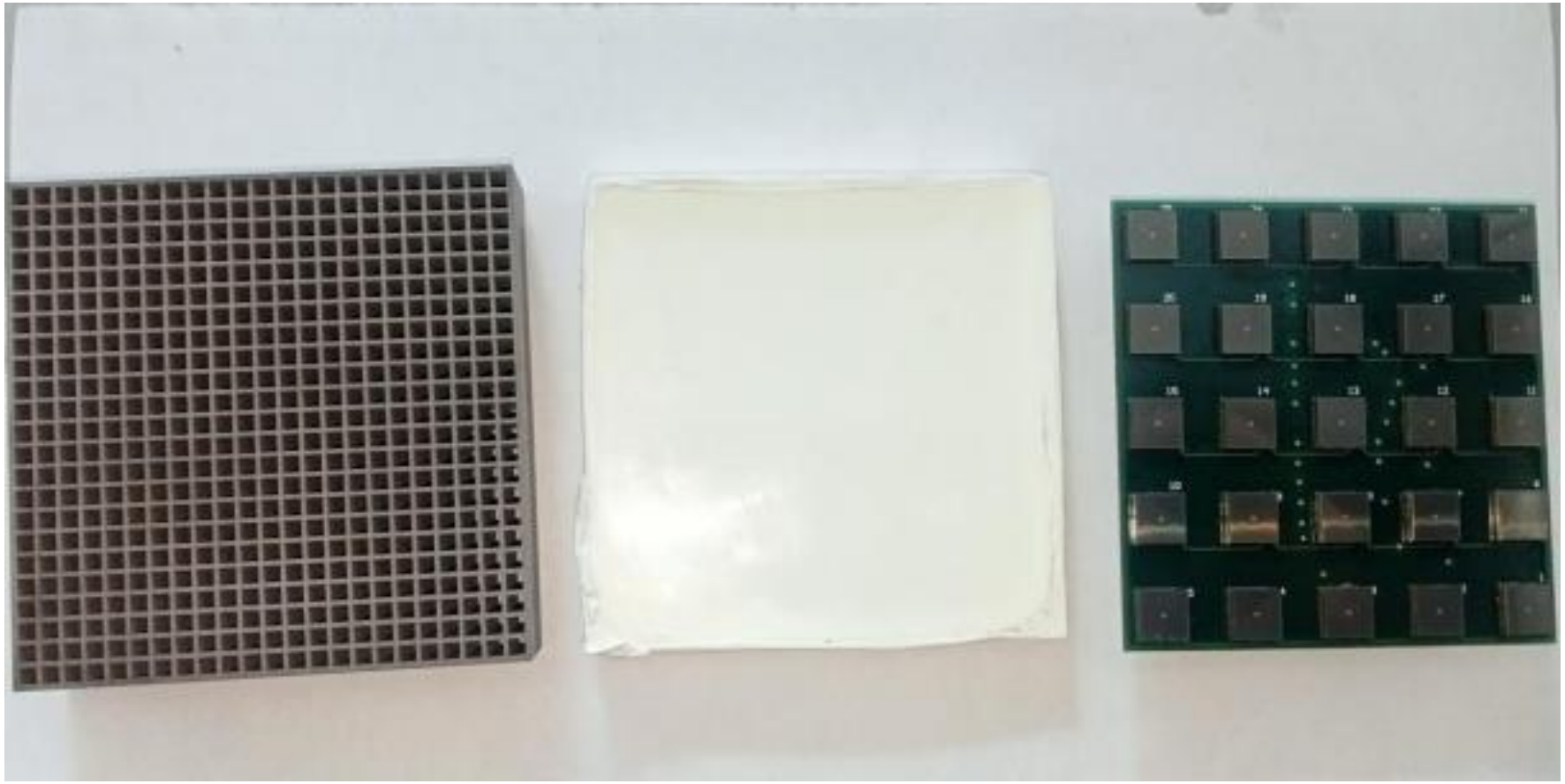
This work is part of a collaboration between **GFN(UCM) and SEDECAL Molecular imaging** in the framework of **DI2M and NEW-MBI projects**



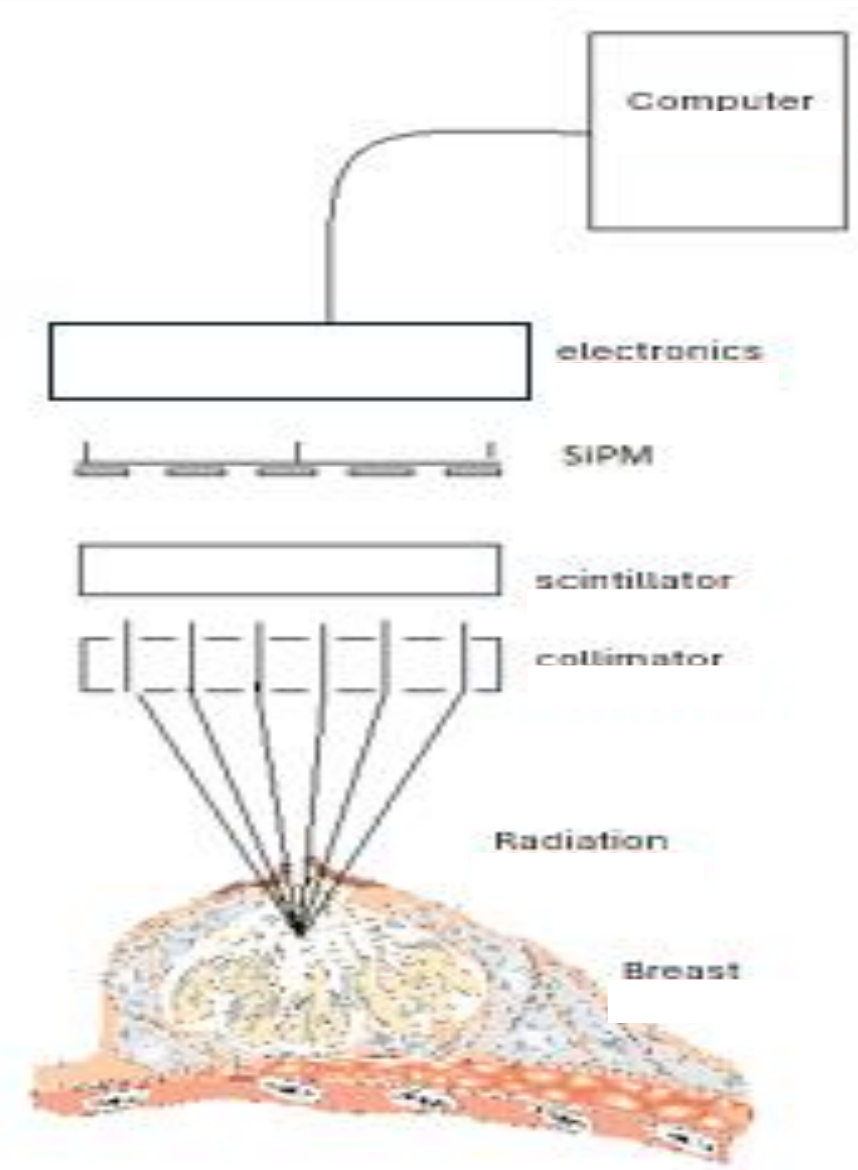
Inexpensive gamma-camara for MBI: Concept

Tiled detector, composed of 9 to 16 tiles, each of 6x6cm2. Makes the colimator and scintillator much cheaper. Use of a continuous and relatively inexpensive detector

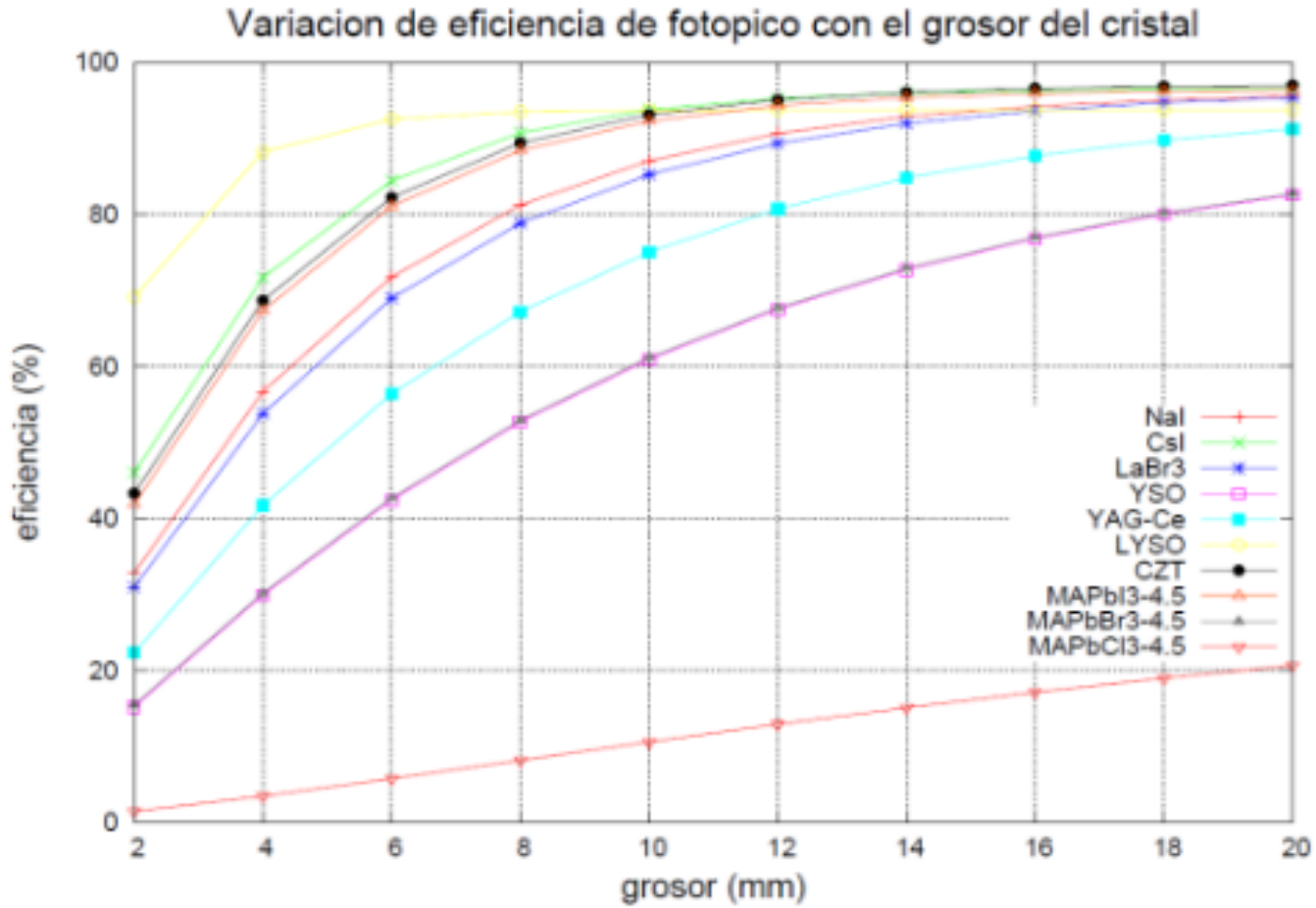
Use SiPM photodetectorr with high sensitivity and photon detection efficiency (PDE), covering just 25% of the Surface of the scintillator



Components of new-MBI

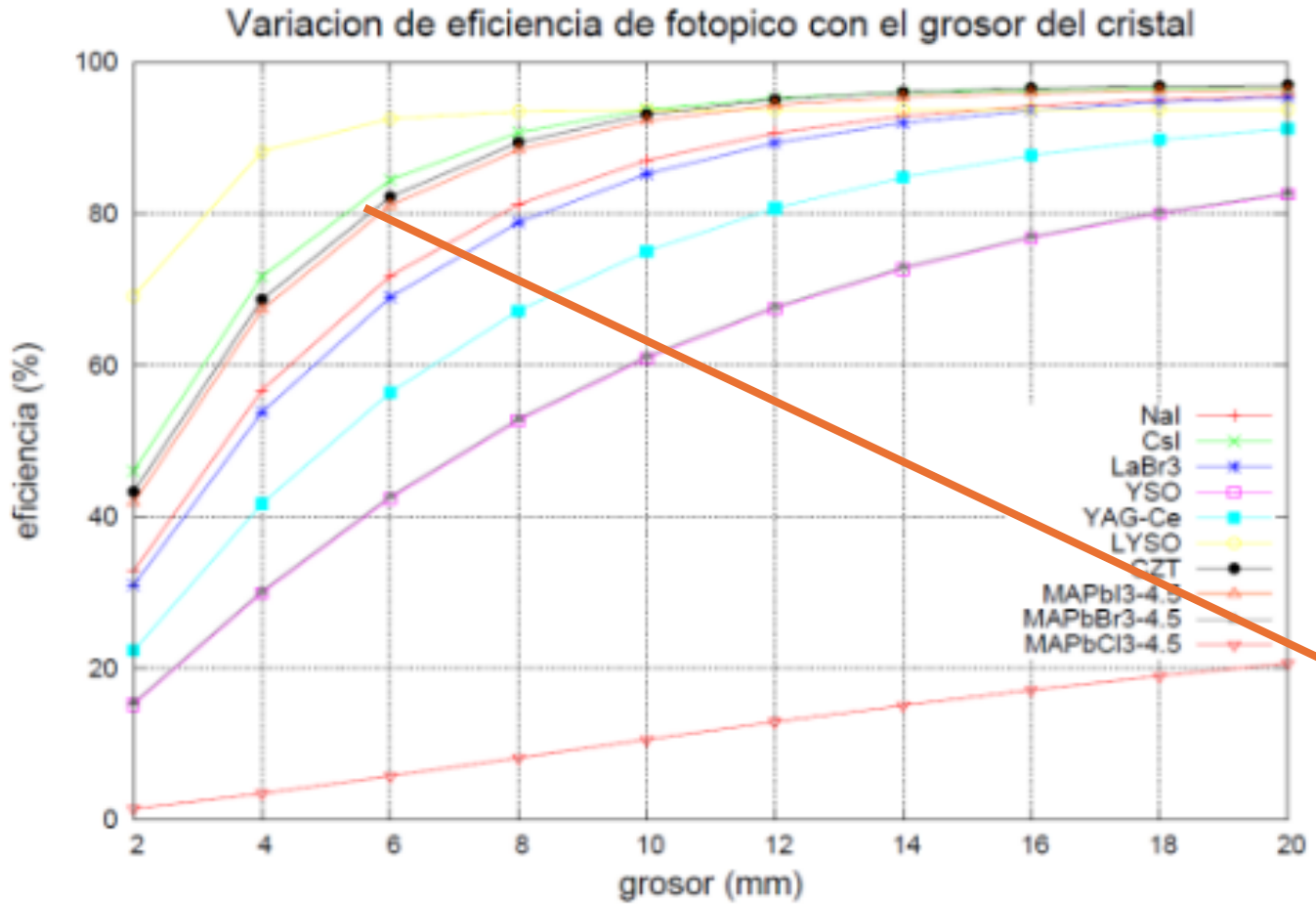


Components of new-MBI



Price/cm^3	
YAG-Ce:	1200 euros
YAP-Ce:	2400 euros
YSO-Ce:	600 euros
LaBr-Ce:	1400 euros
LYSO:	900 euros
Ce-GAG:	8000 euros
NaI:	75 euros
CsI:	180 euros
CaF2:	2500 euros

Components of new-MBI



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Collimator. MC simulations

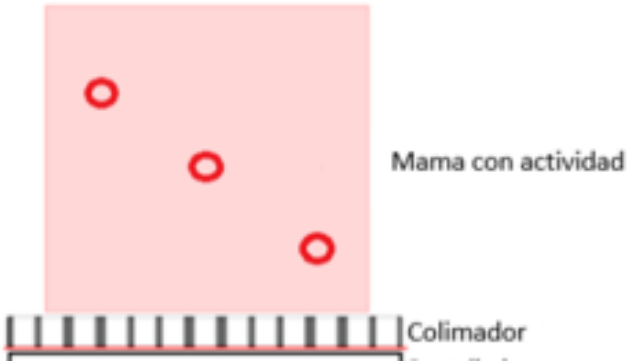
- Very Fast Hibrid MC code developed in GFN-UCM

Goals:

1. Resolution of 10mm
2. Sensitivity of $4x10^4$ Cps/mCi
3. 0.8mm wall thickness

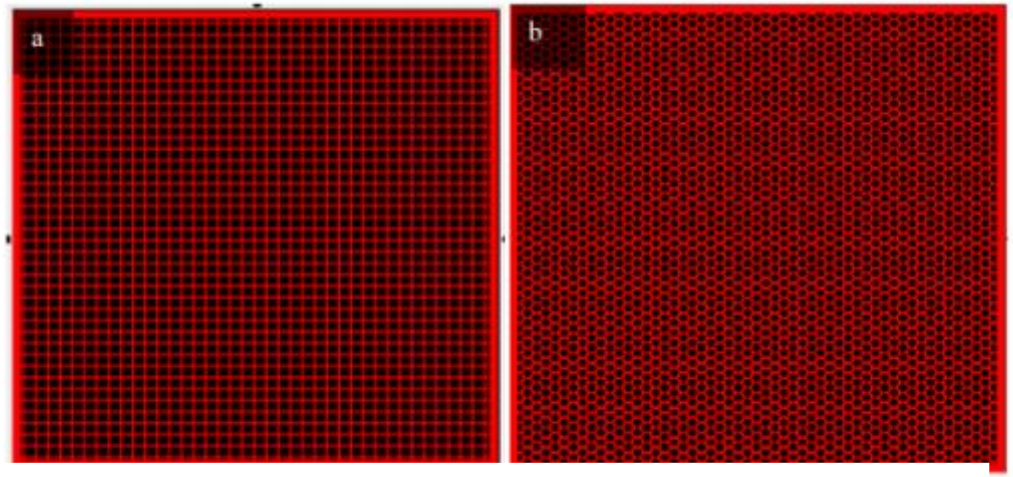
Simulation

- 3 sources with 200MBq
- 1.25mm of radius each
- At a Depth of 10, 30 and 50 mm



Collimator

1. Tungsten/lead
2. Square/hexagonal



a) Square b) hexagonal

3. Dimensions [3]

[3]A. L. Weinmann, C. B. Hruska, and M. K. O'Connor, "Design of optimal collimation for dedicated molecular breast imaging systems," Med Phys, vol. 36, no. 3, pp. 845–856, 2009, doi: 10.1118/1.3077119.

Collimator. MC simulations

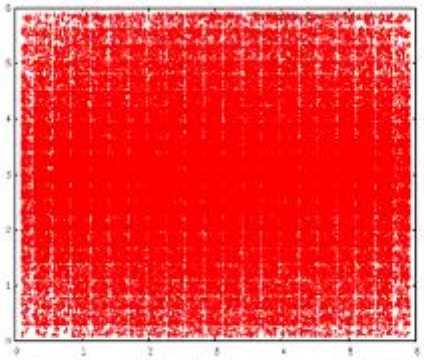


Figura 29. Distribución espacial de colimador cuadrado con d = 2.54 mm, x = 0.3 mm, l = 25 mm.

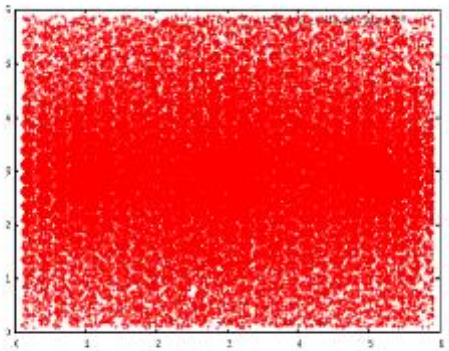
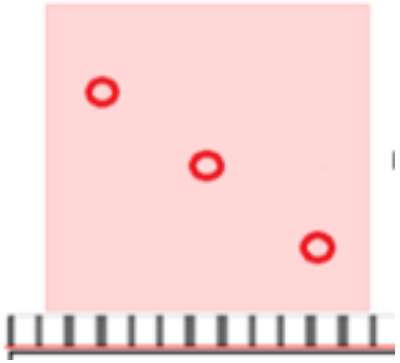
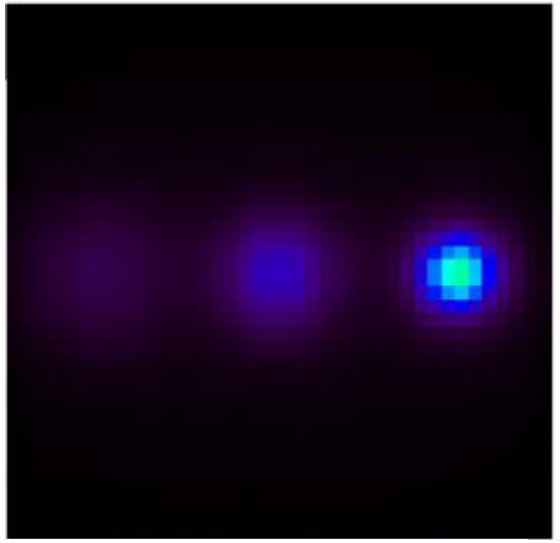


Figura 31. Distribución espacial de colimador hexagonal con d = 2.54 mm, x = 0.3 mm, l = 25 mm.





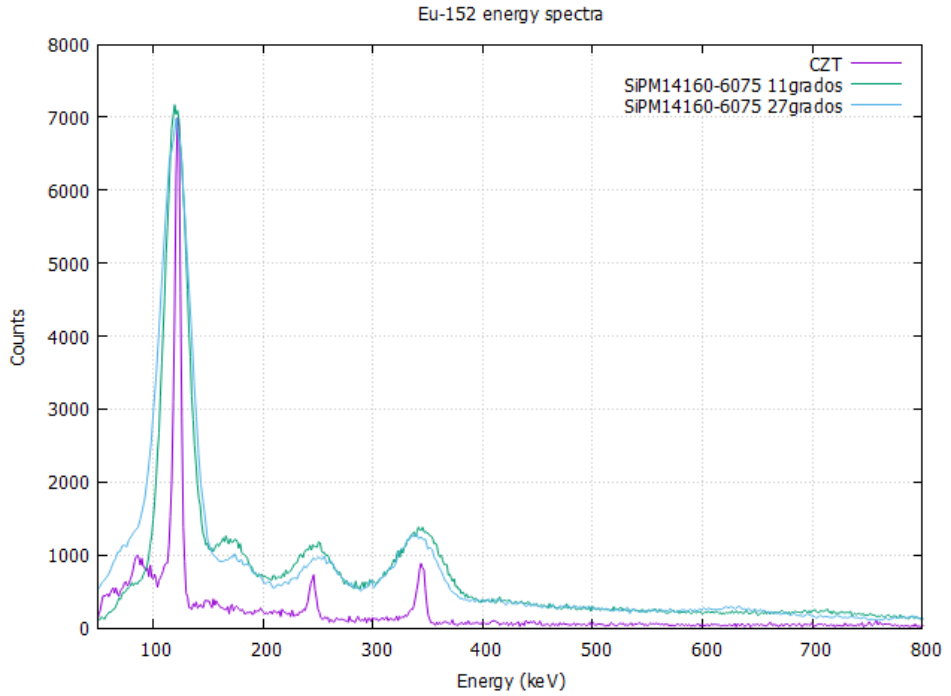
After collimator

Nº	Diameter (mm)	Wall thickness (mm)	Length (mm)	Spacial resolution (mm)	Sensitivity [x10^4 (Cps/mCi)]
1	2.50	0.80	15.00	10.45	4.68
2	2.70	0.80	12.00	15.01	12.10
3	2.00	0.80	12.00	9.76	4.24
4	1.60	0.80	9.00	9.66	4.28

individual SiPM Hamamatsu S14160-6075HS

Experimental set up

Results

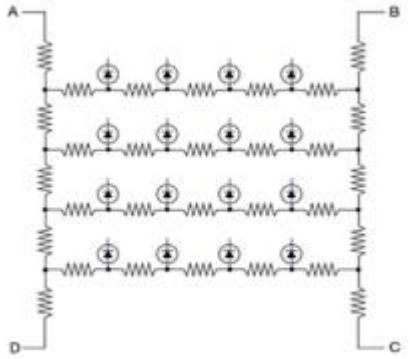


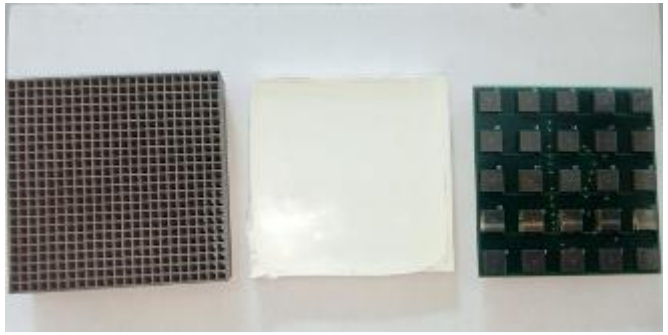
	FWHM (%)		
	122 keV	**245 keV**	**344 keV**
CZT	5.5	2,9	2,3
SiPM 11º	18,5	13,1	12,4
SiPM 27º	22,9	14,2	13,2

Preliminary tests

SiPM matrix. 5x5 Hamamatsu S14160-6075HS. DPC

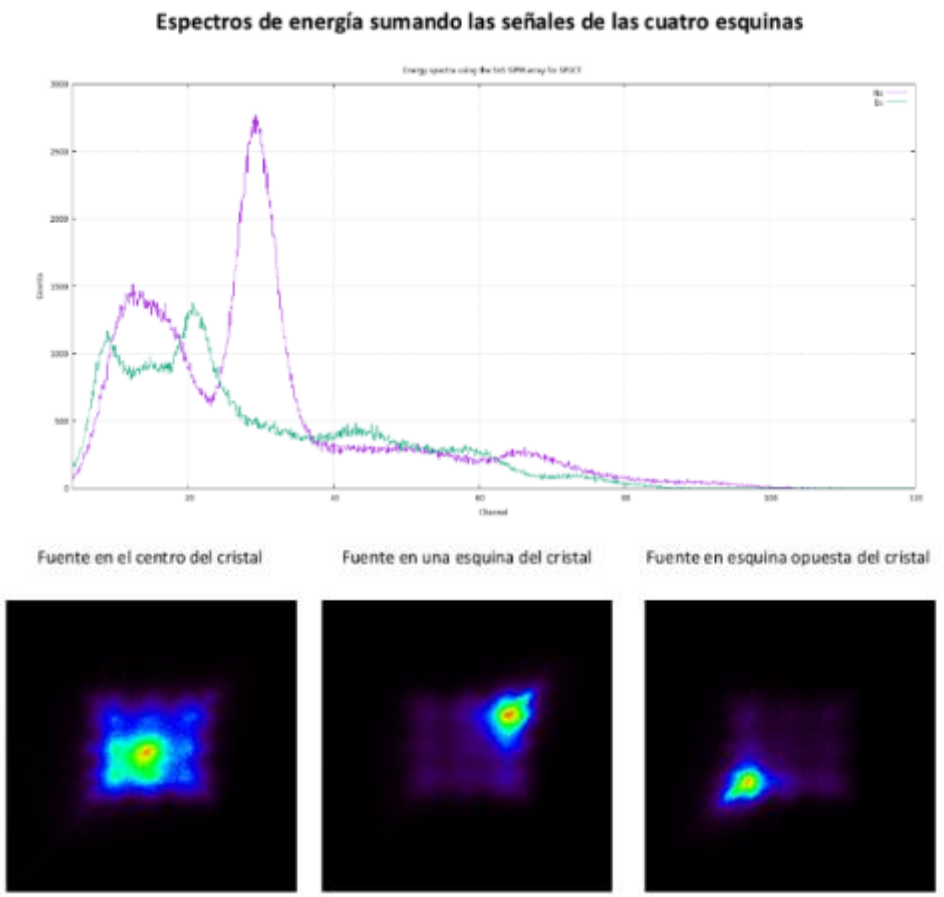
Discretized positioning circuit



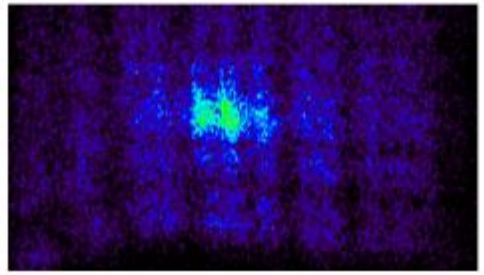


Tiled detector, 6x6x0.8 cm2, 12 to 16 tiles for a full detector. This is the main ingredient to make a very inexpensive the gamma-camera

Without collimator



With collimator



Conclusions

- We are working on a new gamma-camera aimed to be integrated into combined/mammography system
- MC simulations allow to optimize the collimator parameters to improve spatial resolution and sensivity of the detection sistem
- Square hole collimator gives us better resolution/sensitivity trade-off than the hexagonal hole collimator
- The material of the collimator is important for its performance. A tungsten collimator represents a slightly higher cost than a lead collimator, but it offers greater benefits in attenuating scattered photons and has a higher capacity to focus gamma rays. Tungsten is a more resistant and durable material than lead
- With a prelimirary DPC read-out, we are able to detect the different positions where a point source is placed, keeping good energy resolution with relatively small number of SiPM

THANK YOU

Acknowledgments:

- “Nueva generación de dispositivos de imagen molecular en mama (NewMBI)” Ref CPP2021-008751.