

DRIM @ UA

# Further studies on the position-sensitive **THCOBRA FOR IMAGING PURPOSES**

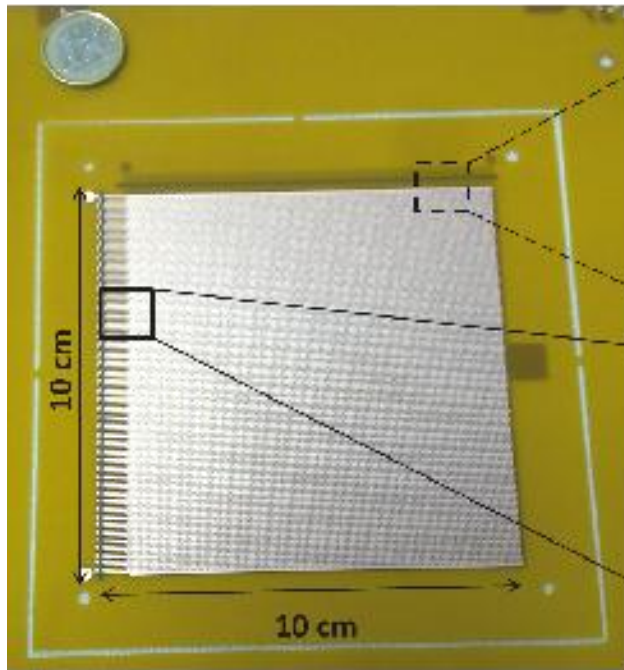
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J.F.C.A. Veloso

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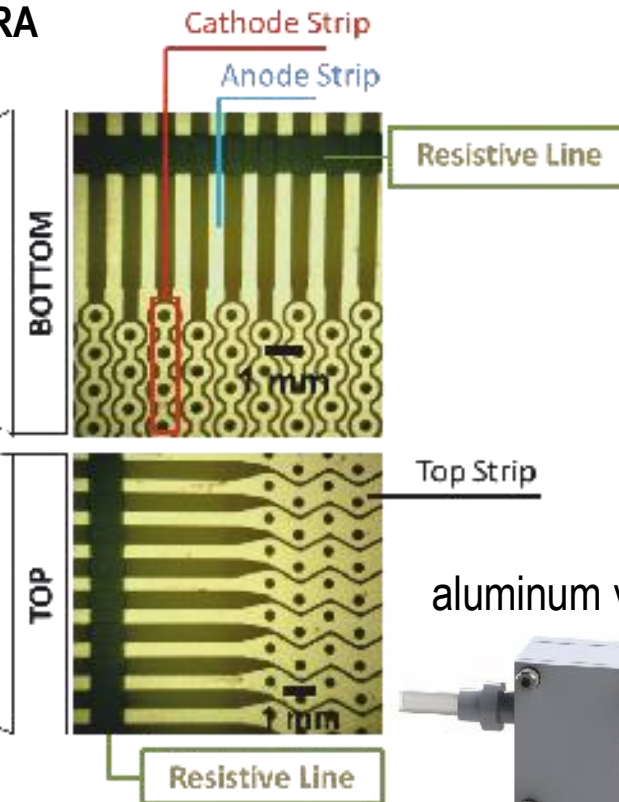
# Further studies on the position-sensitive THCOBRA FOR IMAGING PURPOSES

## THCOBRA structure and Detector Setup

### 10x10 cm<sup>2</sup> position sensitive THCOBRA



PCB board



### Double sided structure

- Top strips
- Anode and cathode strips on the bottom

### Sensitive Area

- 10x10 cm<sup>2</sup>

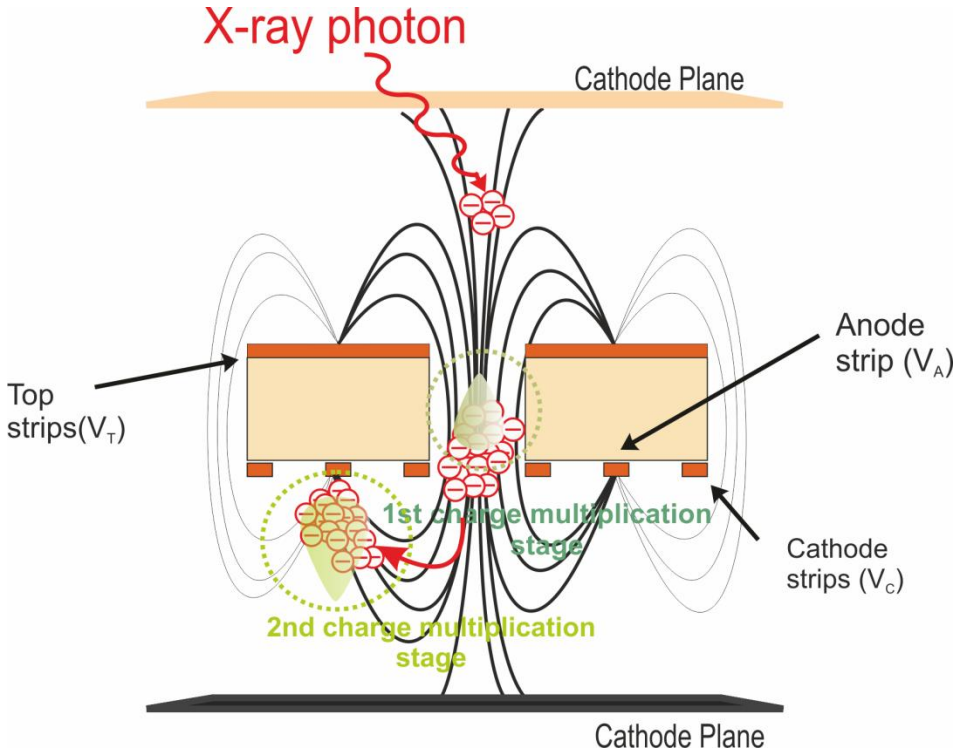
### Detector Setup

aluminum vessel with a Ne/5%CH<sub>4</sub> flow

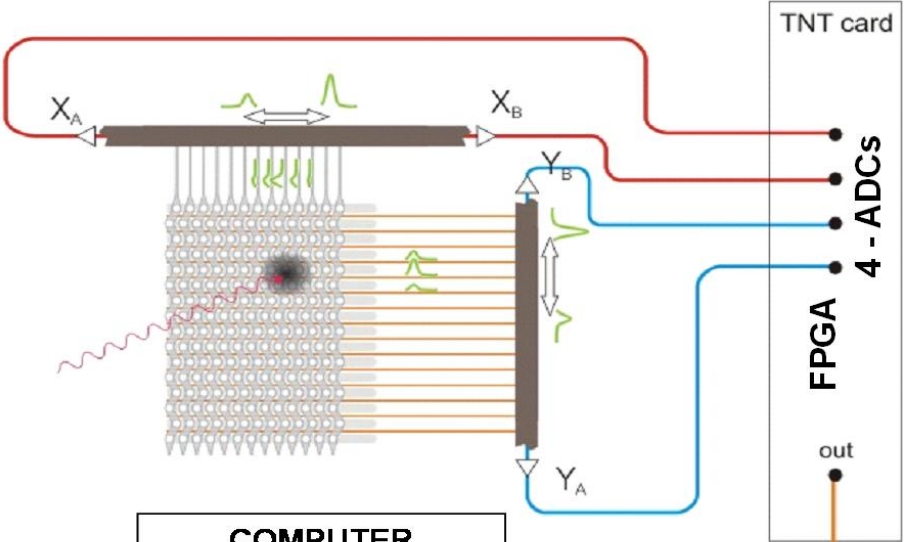


**Operation Principle**

• **Operation Principle**



• **2D-Imaging**



**COMPUTER**

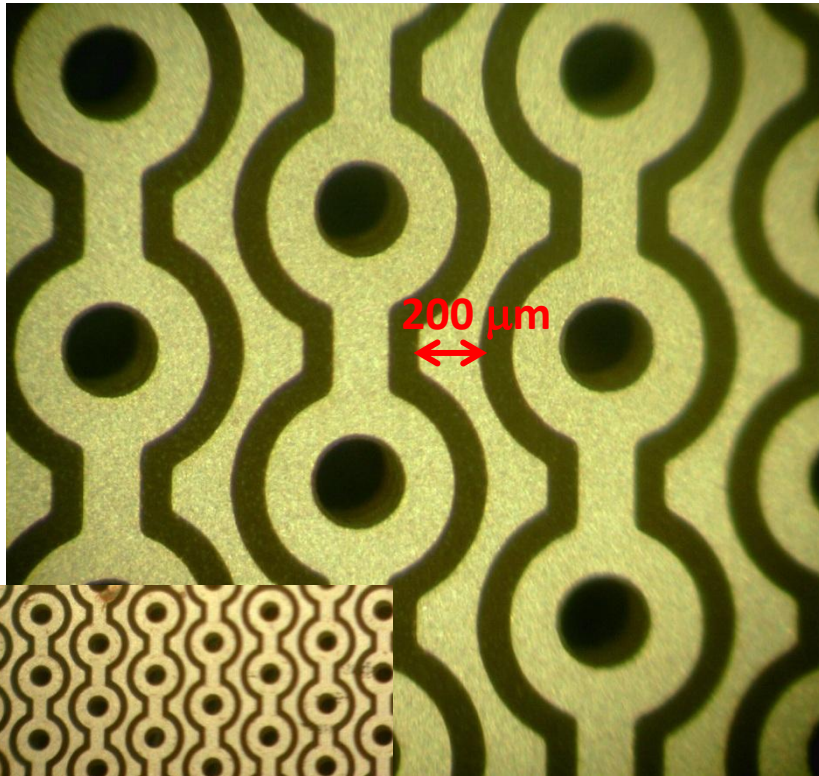
- Set time window
- $x = k \times \frac{x_A}{x_A + x_B}$
- $y = k \times \frac{y_A}{y_A + y_B}$
- **Energy** =  $l \times (y_A + y_B)$

**Image reconstruction**

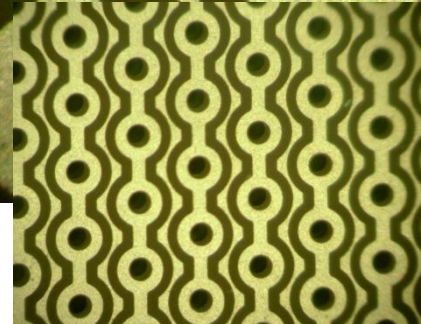
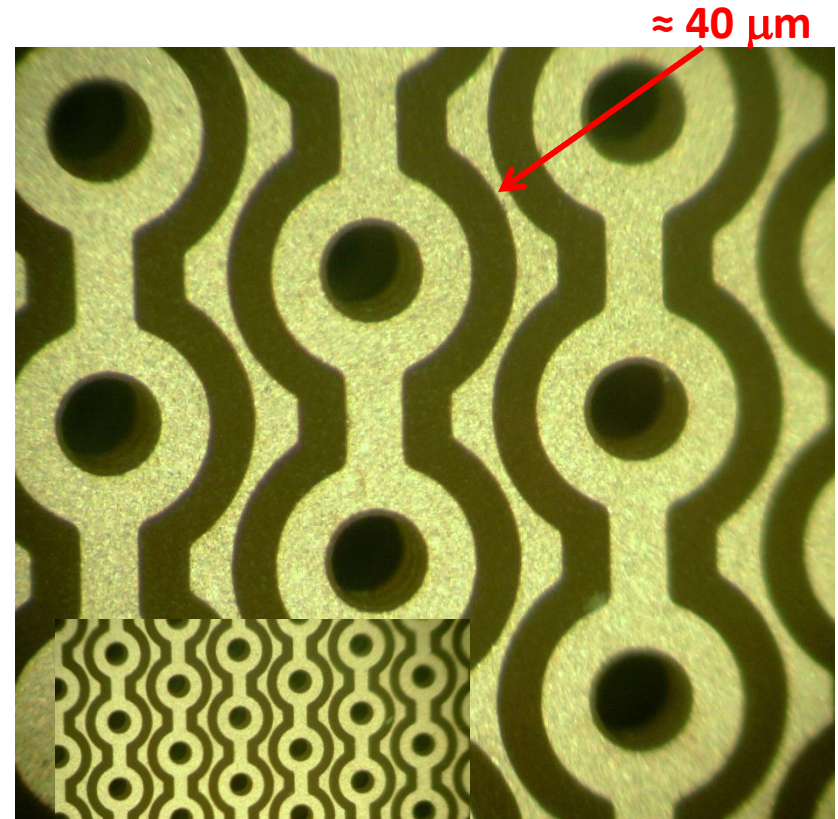
to computer through USB



- **Old THCOBRA**



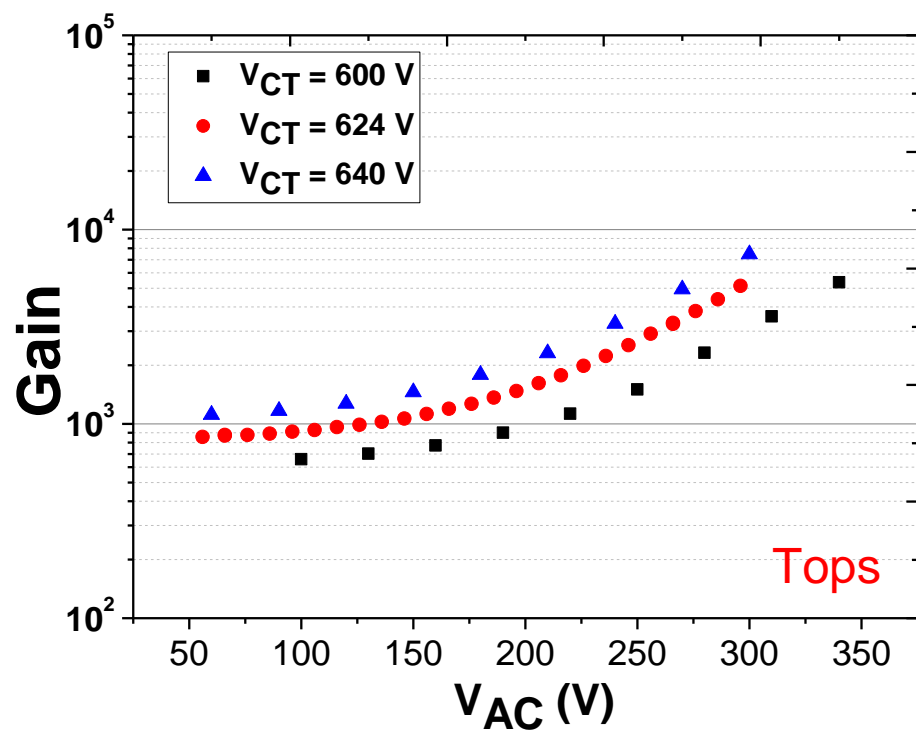
- **New THCOBRA: thinner anodes**



Gain as a function of the  $V_{AC}$ : NEW THCOBRA

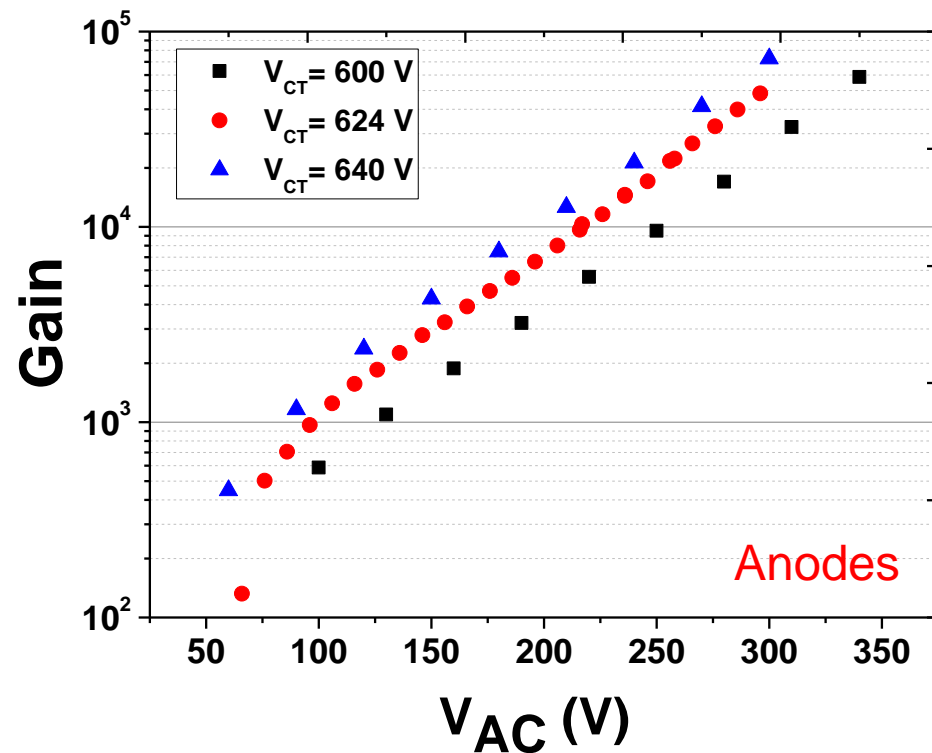
## TOPs

- Total gain close to  $10^4$



## Anodes

- Total gain close to  $10^5$

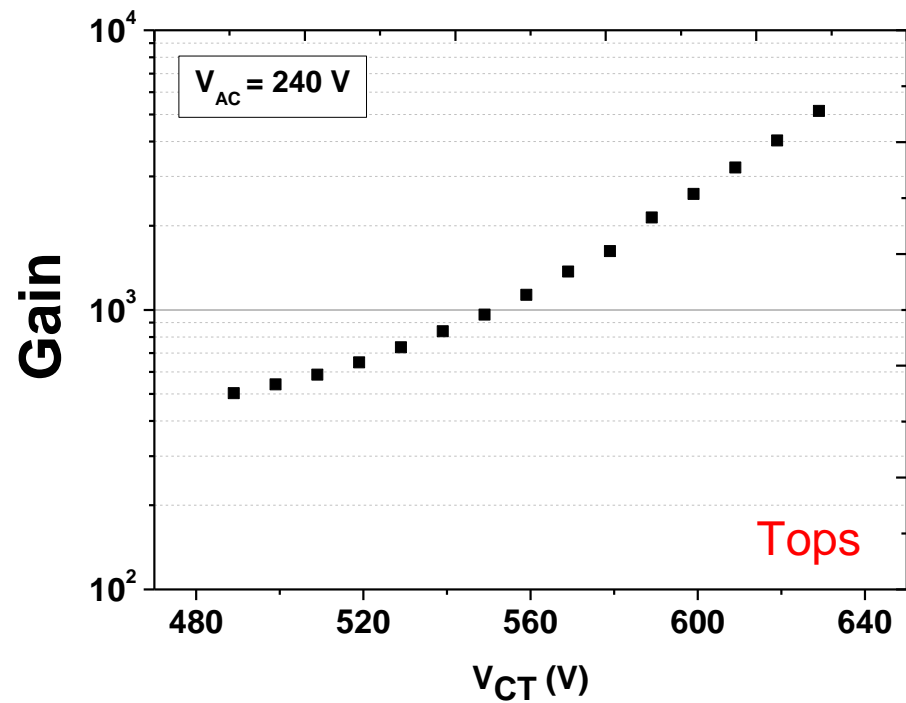


The gain in the TOPs is correspondent to the induced charge collected.

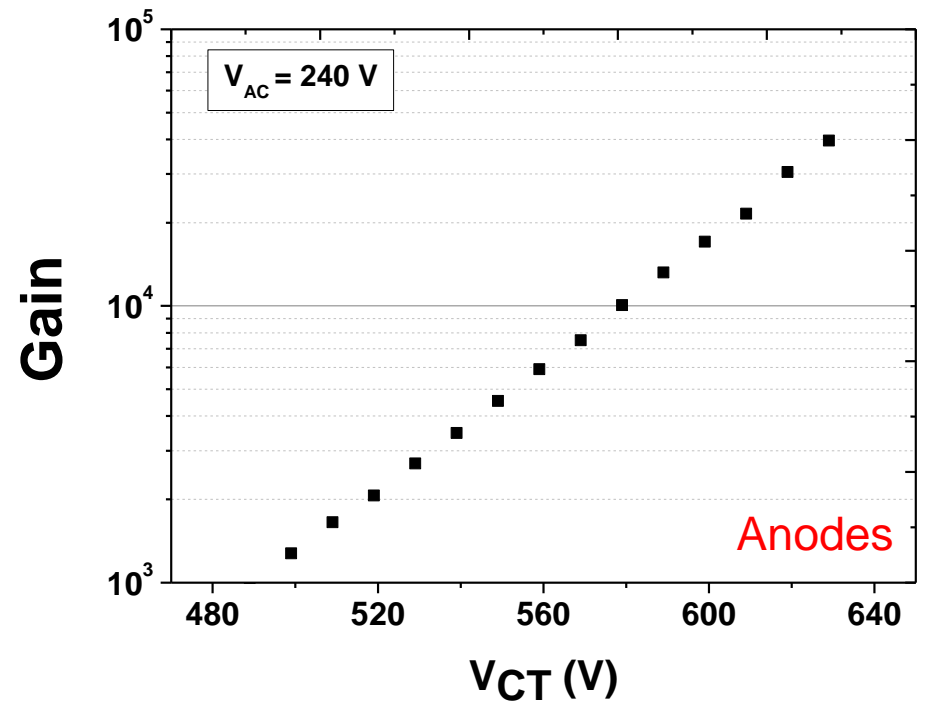
Gain as a function of the  $V_{CT}$  : NEW THCOBRA

Gain as a function of the  $V_{CT}$  with a  $V_{AC} = 240$  V

- Total gain close to  $10^4$



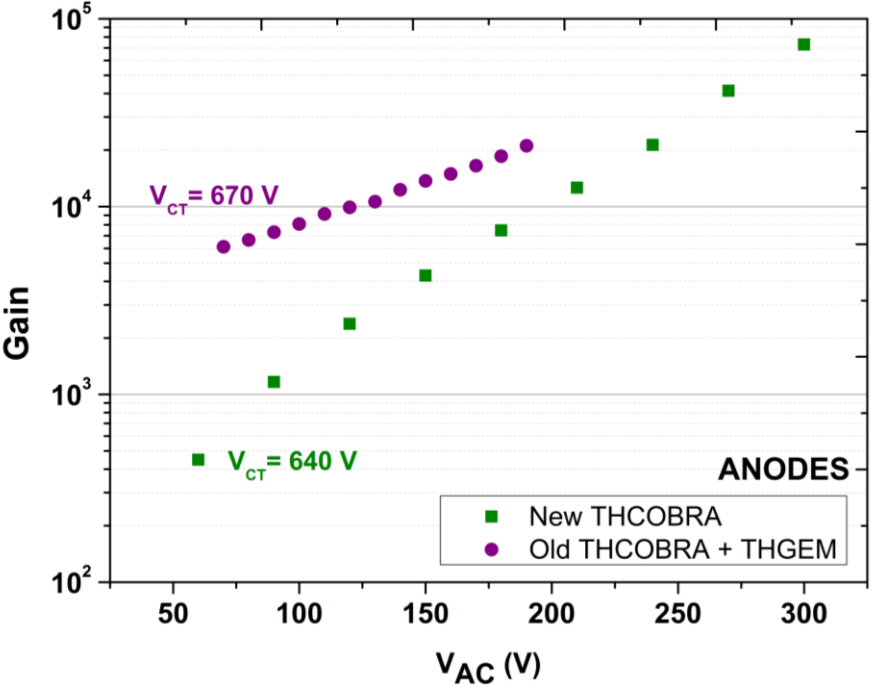
- Total gain close to  $10^5$



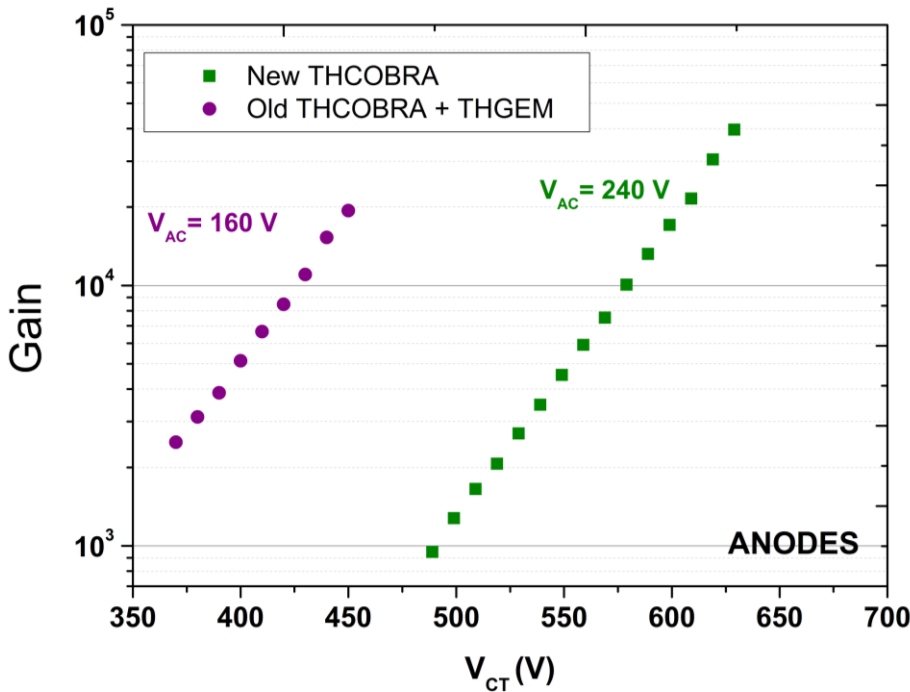
The increase of the gain is more evident with the  $V_{AC}$  increase than with the  $V_{CT}$

**OLD vs. NEW THCOBRA**

- Gain as a function of the  $V_{AC}$



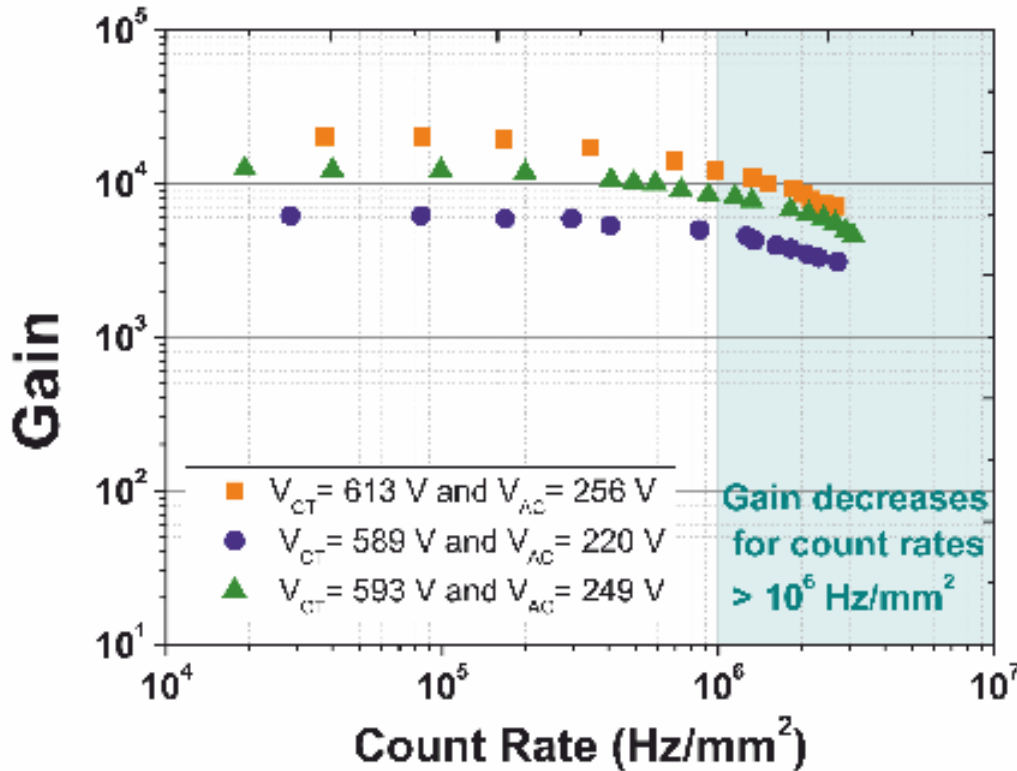
- Gain as a function of the  $V_{CT}$



Gain in the **New THCOBRA** increases **faster** than in the **Old THCOBRA**

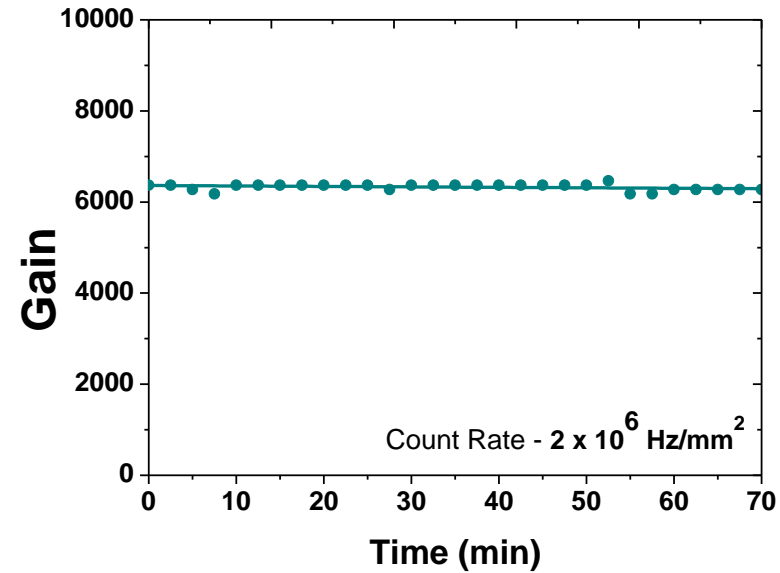
**Gain Stability and Count Rate : NEW THCOBRA**

- Gain vs. Count Rate



count rates  $\approx 1$  MHz/mm<sup>2</sup> gains  $> 5 \times 10^3$   
small variations on the gain occur

- Gain Stability



- **Very good operation stability**  
count rate  $\approx 2$  MHz/mm<sup>2</sup>  
gains  $> 10^3$



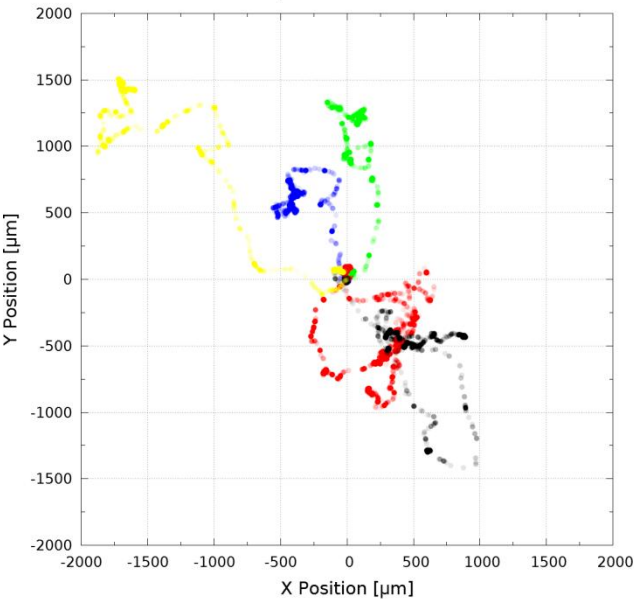
# Further studies on the position-sensitive THCOBRA FOR IMAGING PURPOSES

## Spatial Resolution

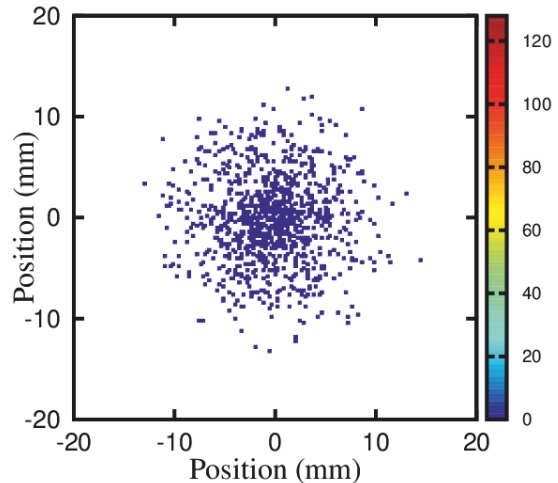
Influence of the photoelectron range in the spatial resolution of the detector **?!**

### DEGRAD PROGRAM (S. Biagi)

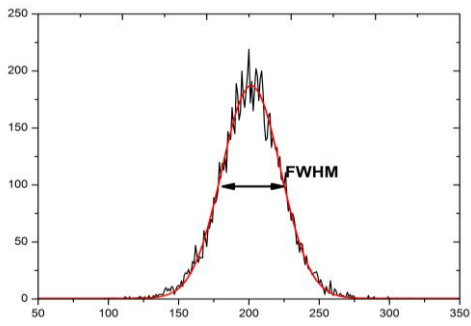
primary cluster  
spatial distribution  
in gas mixtures for  
X-rays



Average Position



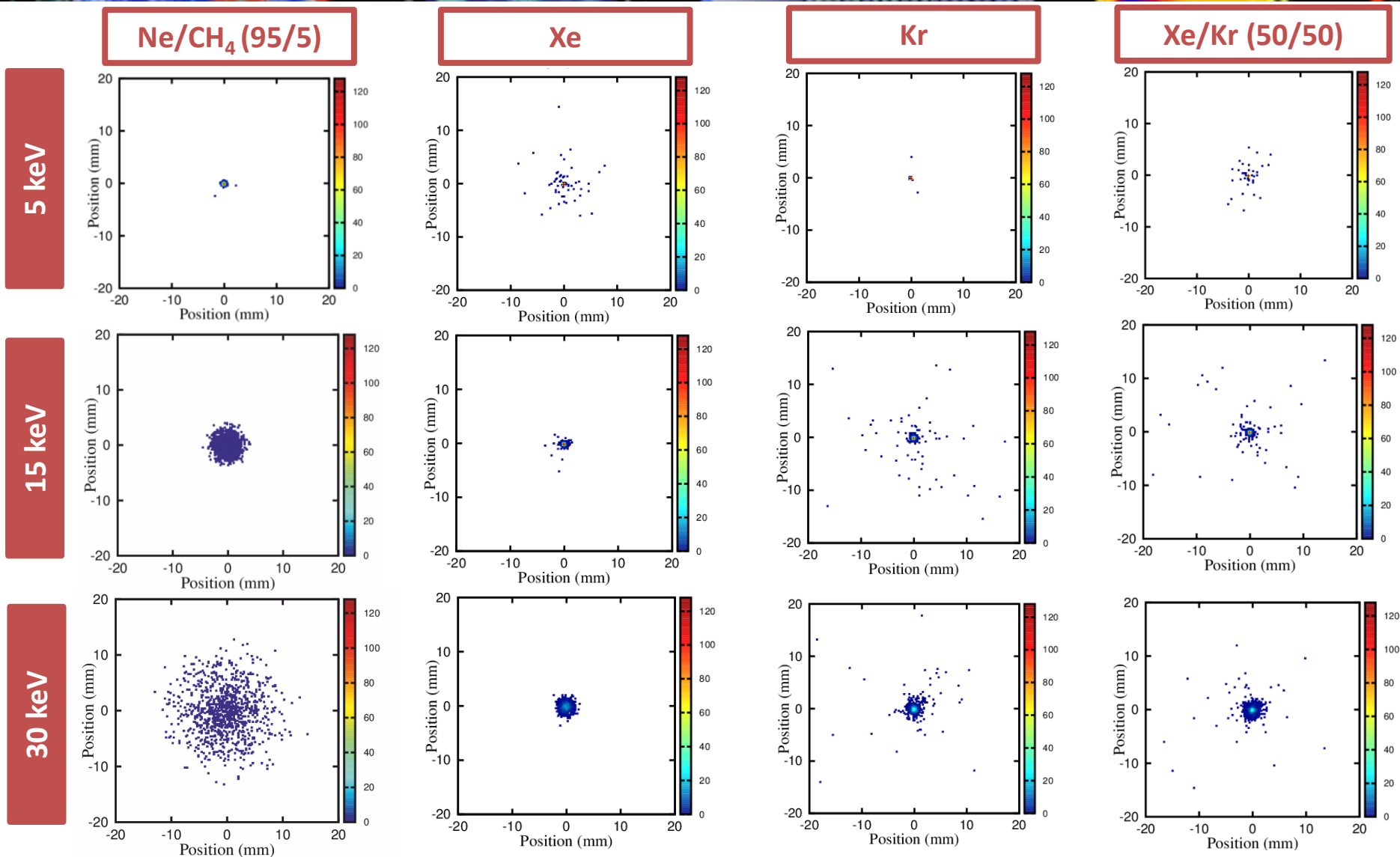
Projection 1D



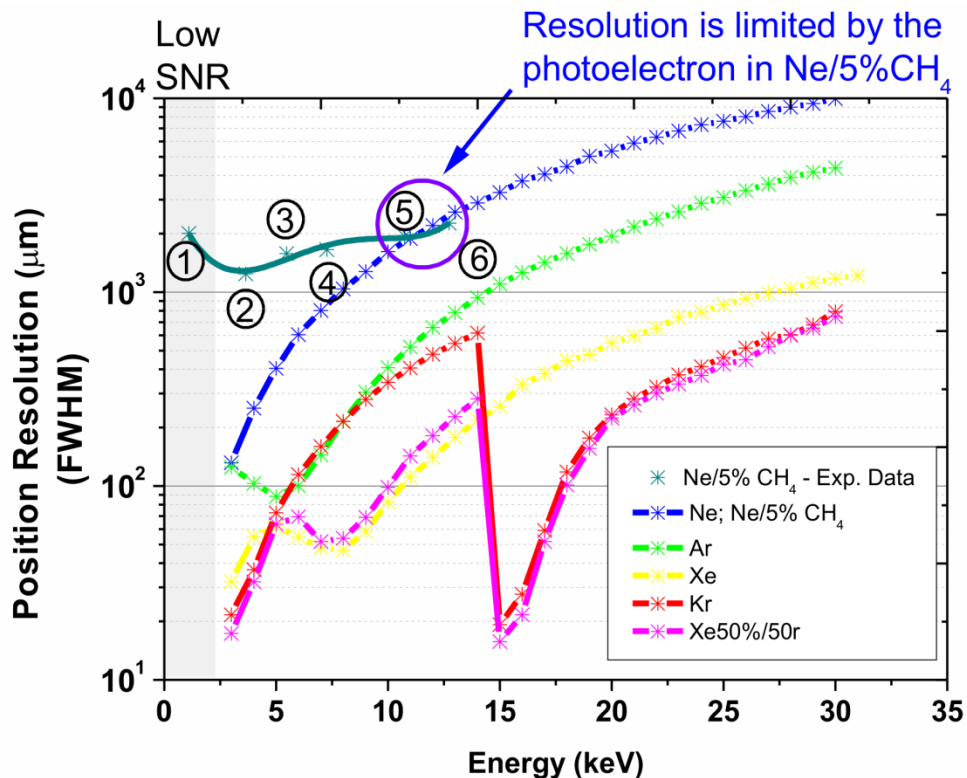
**Gaussian distribution  
FWHM corresponding to  
the uncertainty in the  
position of interaction.**

# Further studies on the position-sensitive THCOBRA FOR IMAGING PURPOSES

Cluster distribution as a function of the photon energy for different gases

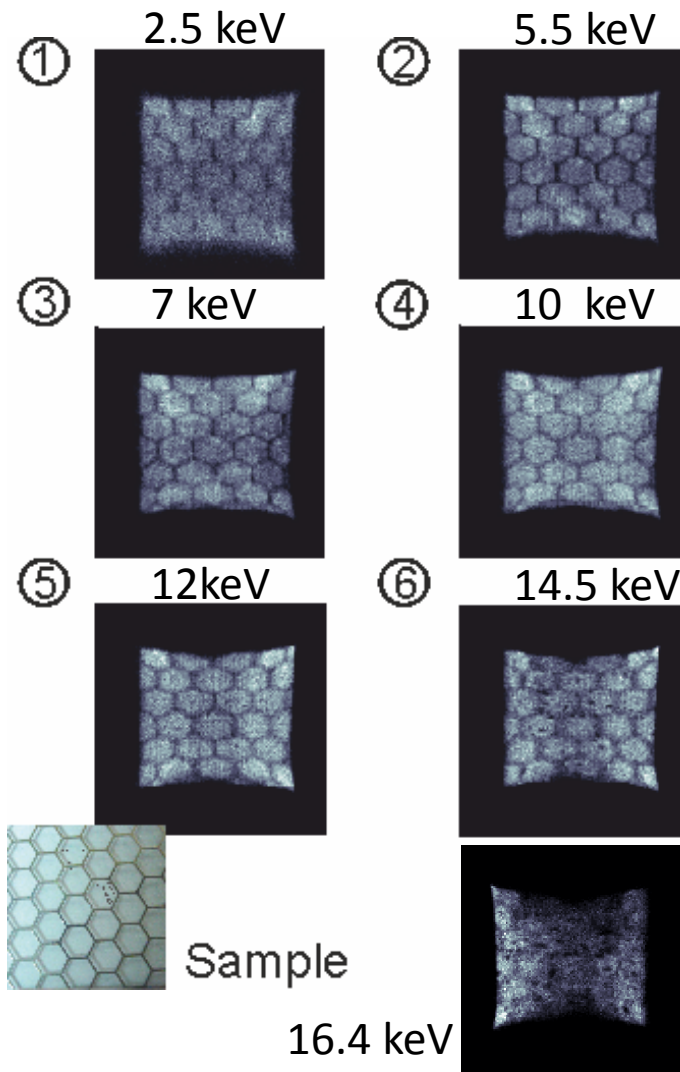


**Spatial Resolution**



Energies below 3 keV → spatial resolution limited by the low SNR achieved.

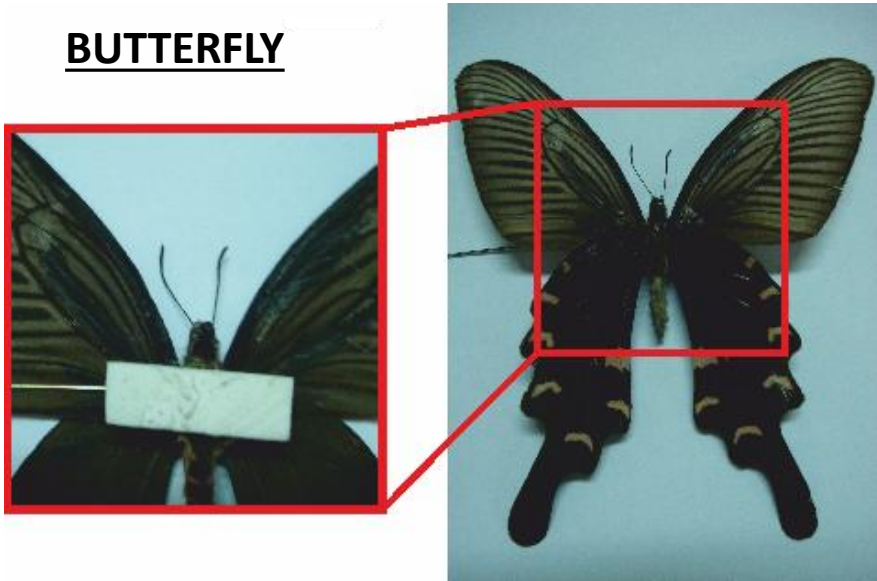
Energies above 10 keV → spatial resolution limited by the photoelectron range in Ne/5%CH4.



2D-Imaging example

## X-ray transmission image

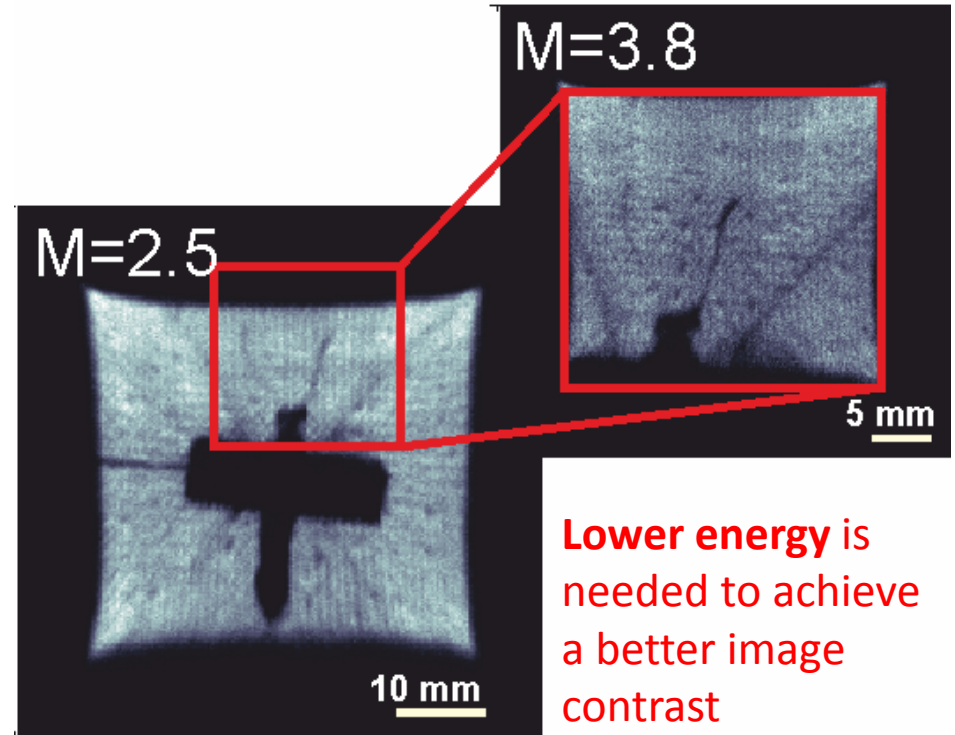
BUTTERFLY



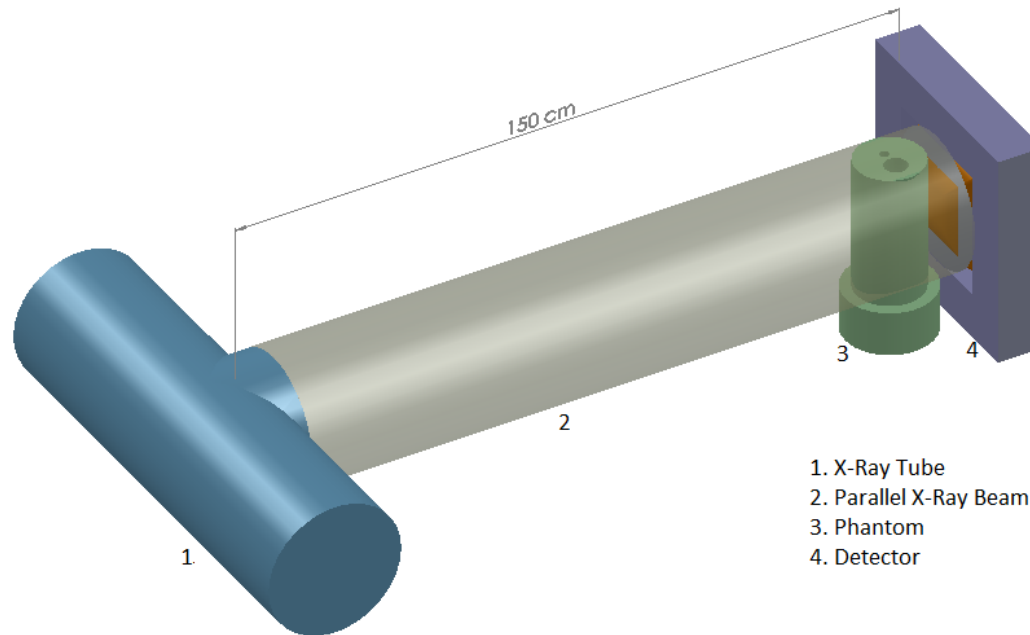
X-RAY TUBE OPERATION

5 kV

0.27 mA



## Computed Tomography System

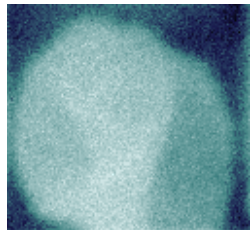
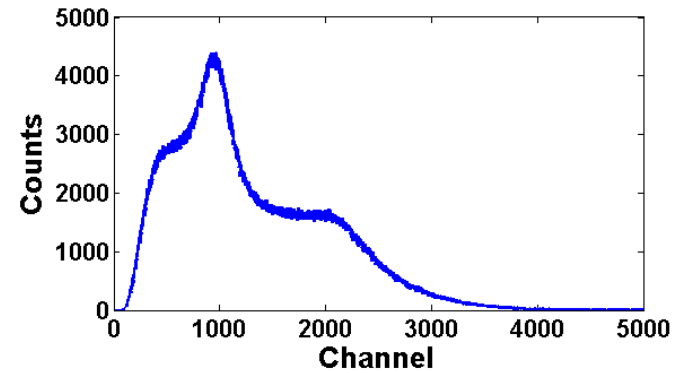
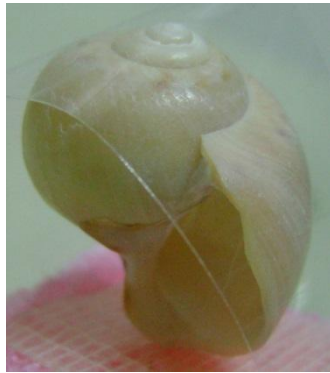


- Acquisition synchronized with rotational step motor:  
0.9° rotation step (400 views)

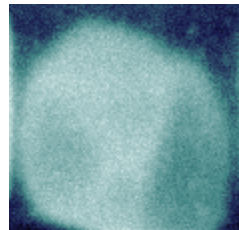
Computed Tomography system

## Computed Tomography Images

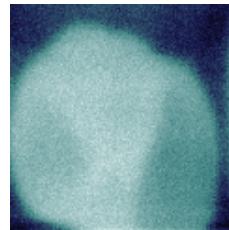
Sea Snail



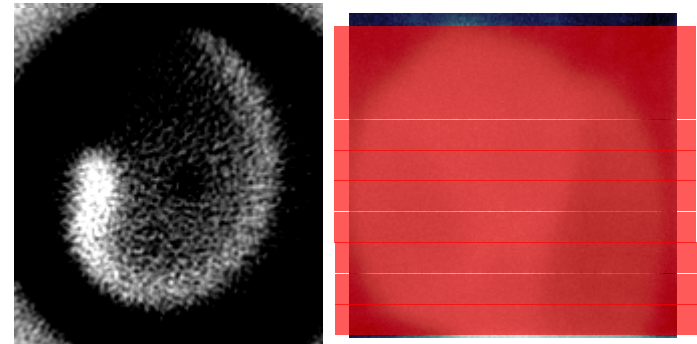
Low energy  
range



High energy  
range



Medium energy  
range



- Time of acquisition: 10 s/view  
400 views
- Low statistic

## Conclusion & Future Work

•THCOBRA detector shows very good potentialities for X-ray imaging operation. For the THCOBRA:

–Single photon counting capability

–Energy resolution of about 22% @ 5.9 keV

–Good energy linearity

–Sensitive areas can exceed 10x10cm<sup>2</sup>

–A **gain close to 10<sup>5</sup>** was achieved

–The 2D-THCOBRA operation shows to be very stable in terms of gain.

### - **Spatial resolution - limited by the photoelectron range (Degrad)**

Position resolution depends on the gas mixture and on the energy range

For the present case

- Low energy X-ray photons→main limiting factor is the SNR;
- Above 10 keV → **strongly** limited by the photoelectron range in Ne/5%CH<sub>4</sub>
- **Other heavy noble gases/mixtures (Xe, Kr, Xe50%/Kr50%) will be considered to reduce the photoelectron range and increase the position resolution for higher x-ray energies.**