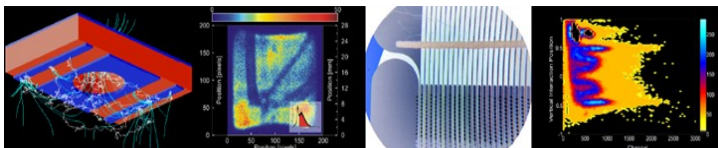


# Position sensitive VUV gas photomultiplier with a simple readout

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T. Lopes, C. Azevedo, F. Pereira and A. Silva

I3N – Physics Department, University of Aveiro, Aveiro, Portugal

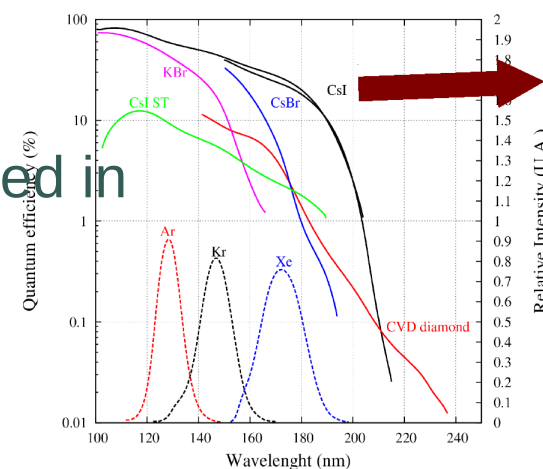


DRIM - Radiation Detection and Medical Imaging Group



# Motivation

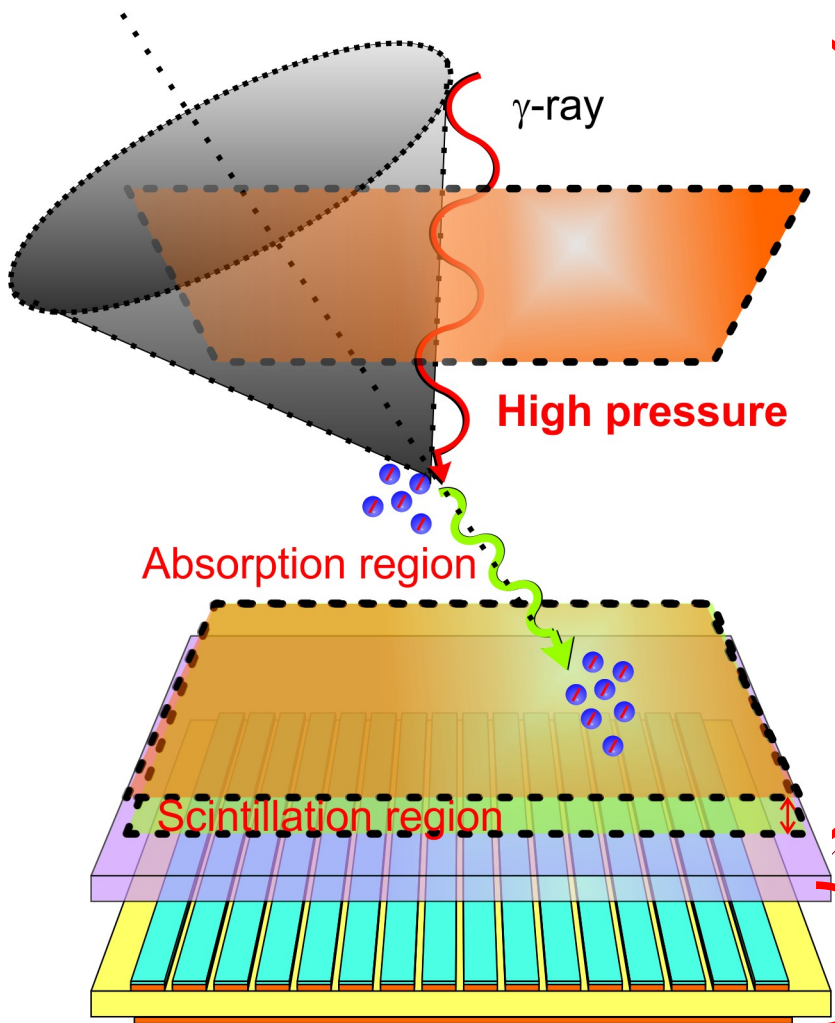
- CsI based solid photocatode produced in the top of a first structure in a triple cascade configuration.
  - Allow single photodetection in the VUV region
  - High detection efficiency
  - *A simple method for position readout was implemented*
  - *Good ion feedback reduction*
- Perfect match to read scintillation light produced in electroluminescent processes in noble gases
- Adequate for RICH – light readout
- Other VUV detection





Gaseous Compton Camera

How we will do it

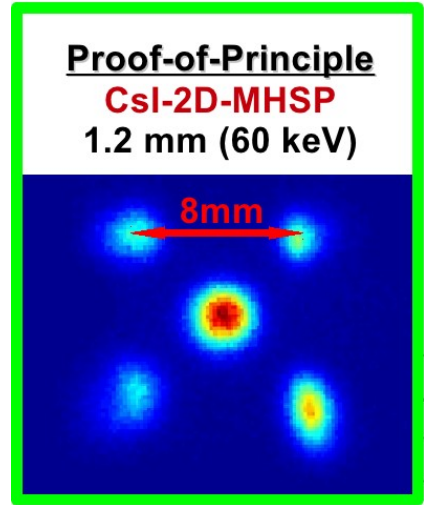


GSPC

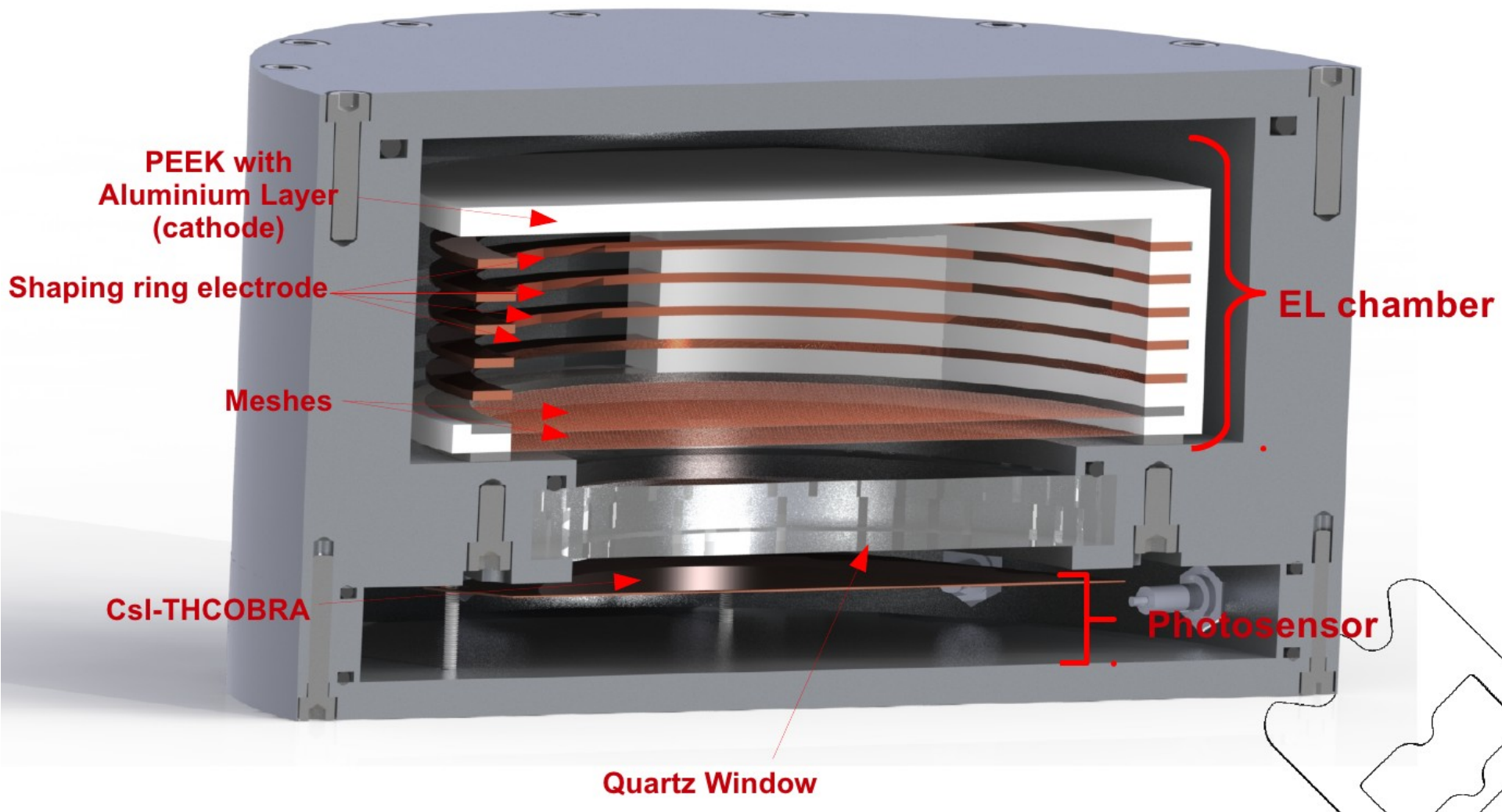
Quartz window

Position Sensitive Photosensor

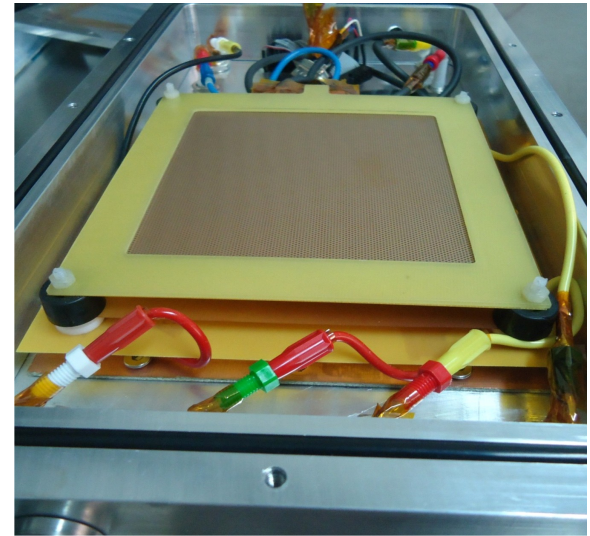
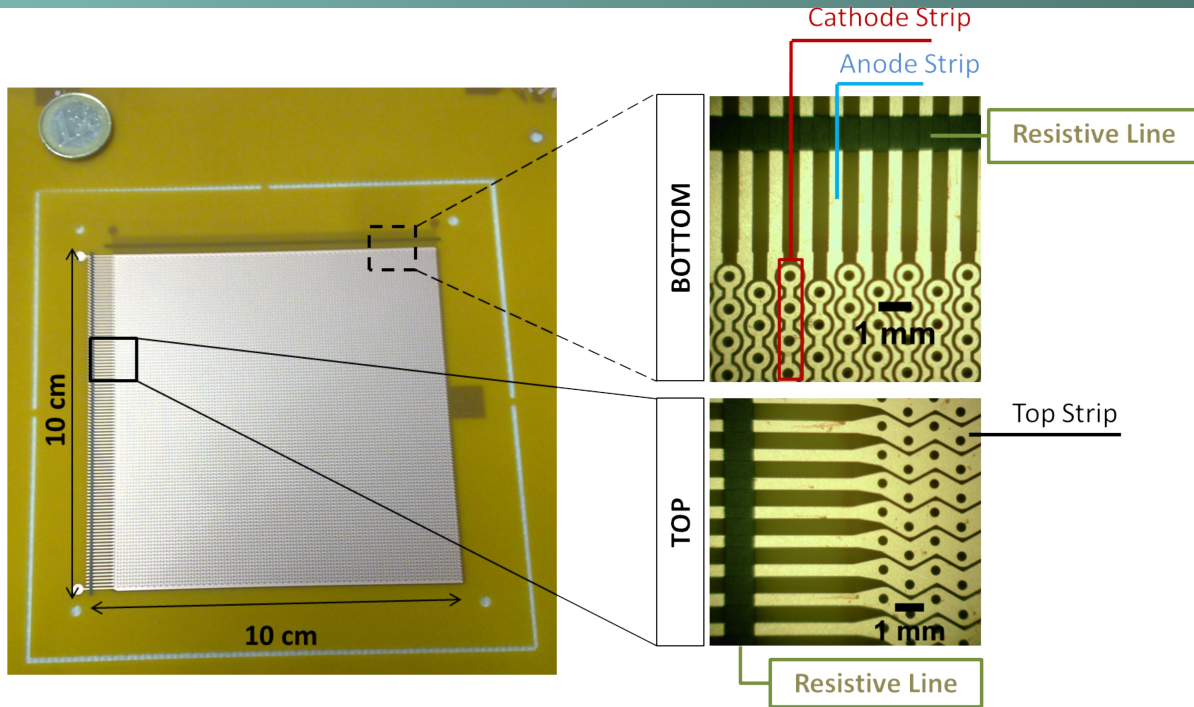
- **Micropatterned Gaseous Detectors**
- **Large area**
- **Position sensitive**
- **Low Cost**
- **4 electronic channels**
- **CsI photocathodes**



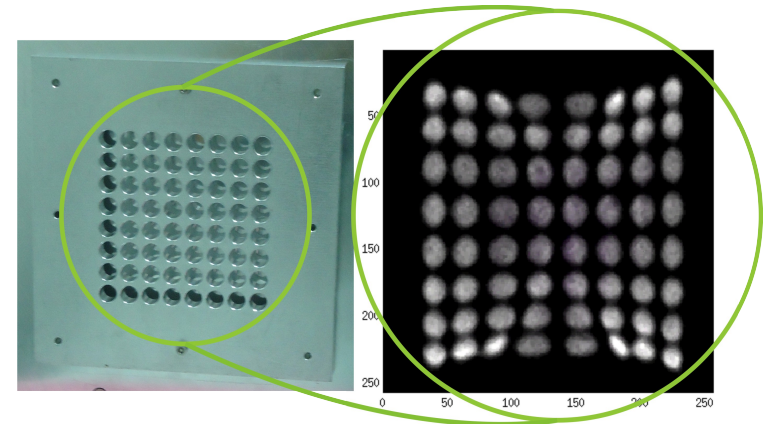
# Gaseous Compton Camera – vessel is ready



# 2D-THCOBRA Structure – new x-ray detector

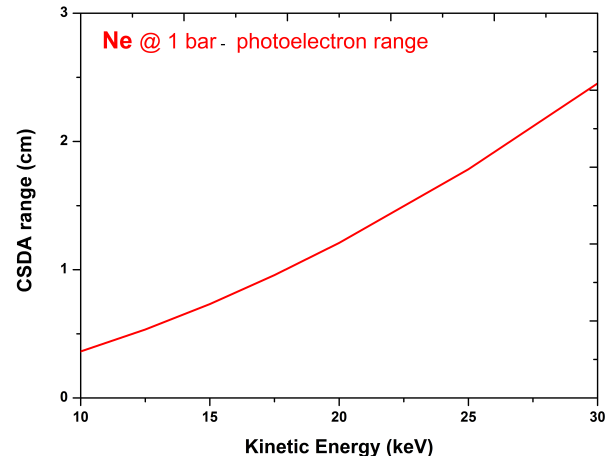
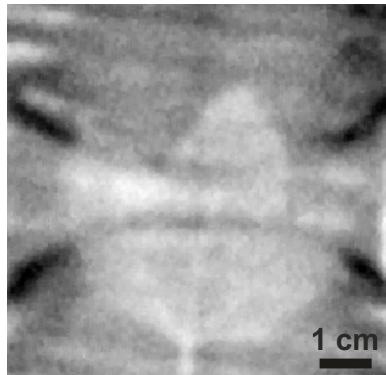


- Similar to a Thick-MHSP
- High gain  $\sim 10^4$
- $R_{FWHM} < 500 \mu\text{m}$



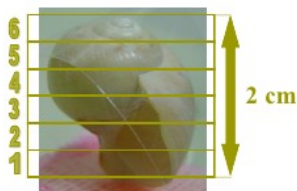
# 2D-THCOBRA Structure – new x-ray detector @ UA

## X-ray image

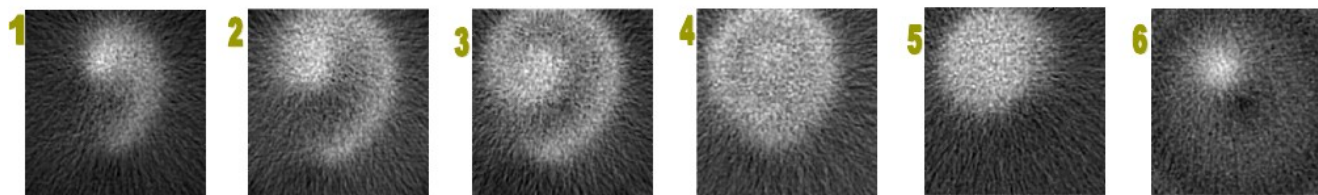
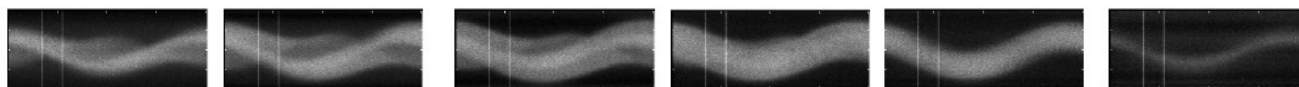


## CT image

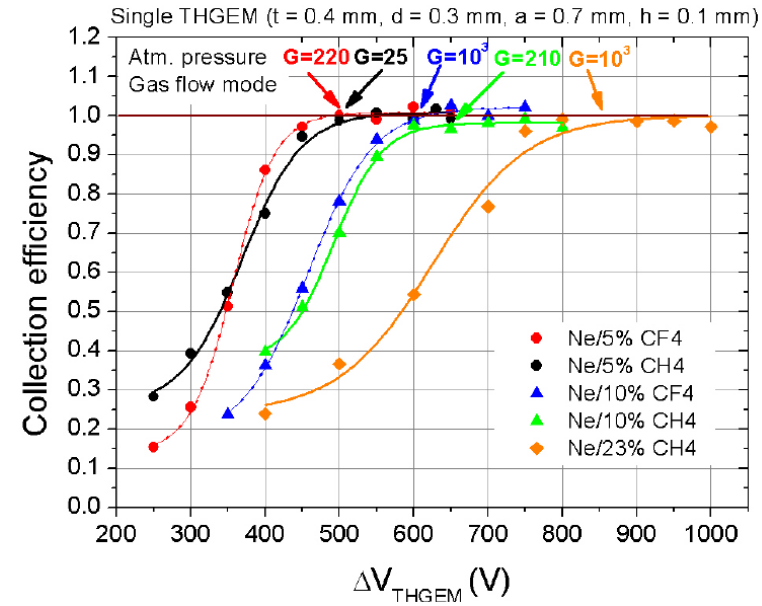
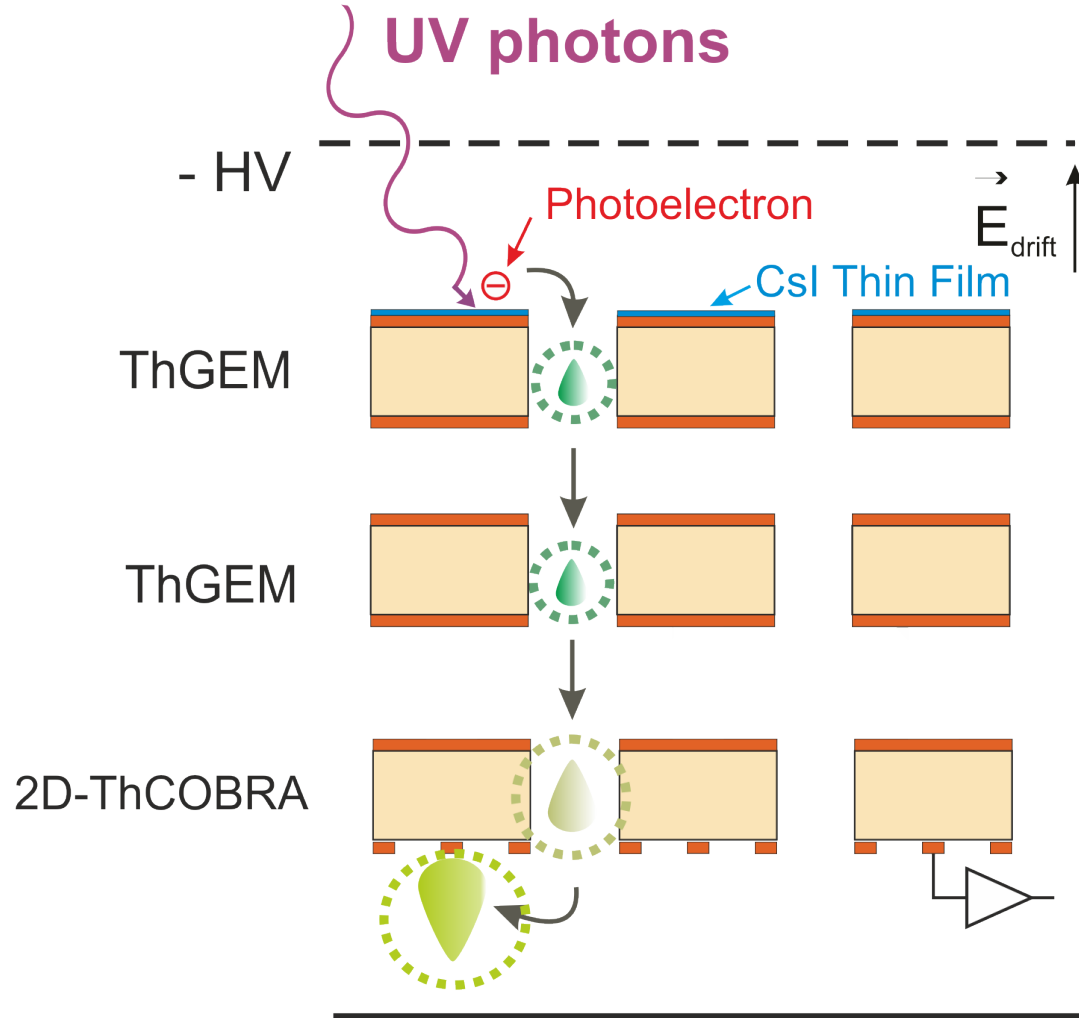
Sea Snail



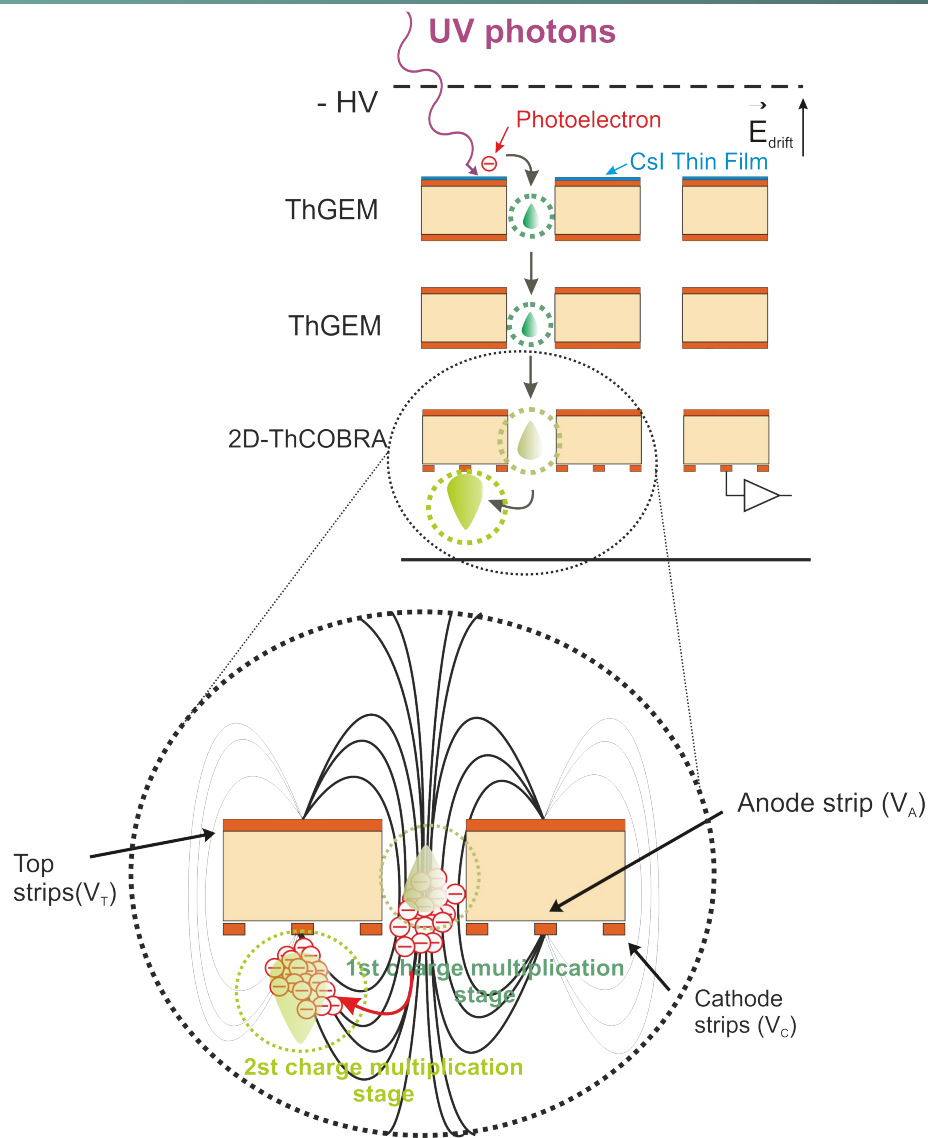
kV=35kVp  
200 views  
 $T_{aq} = 10$  s/view



# VUV photodetector configuration

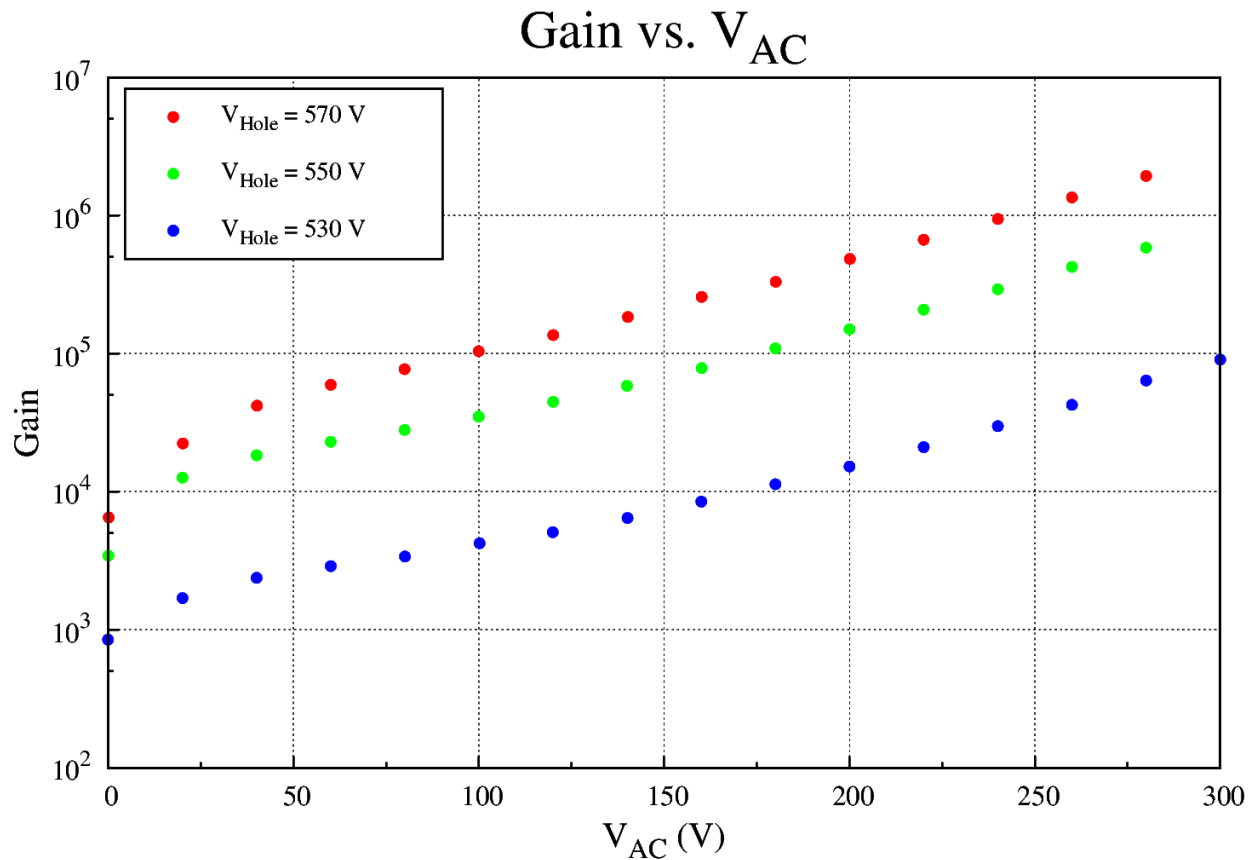


# VUV photodetector configuration – THCOBRA details



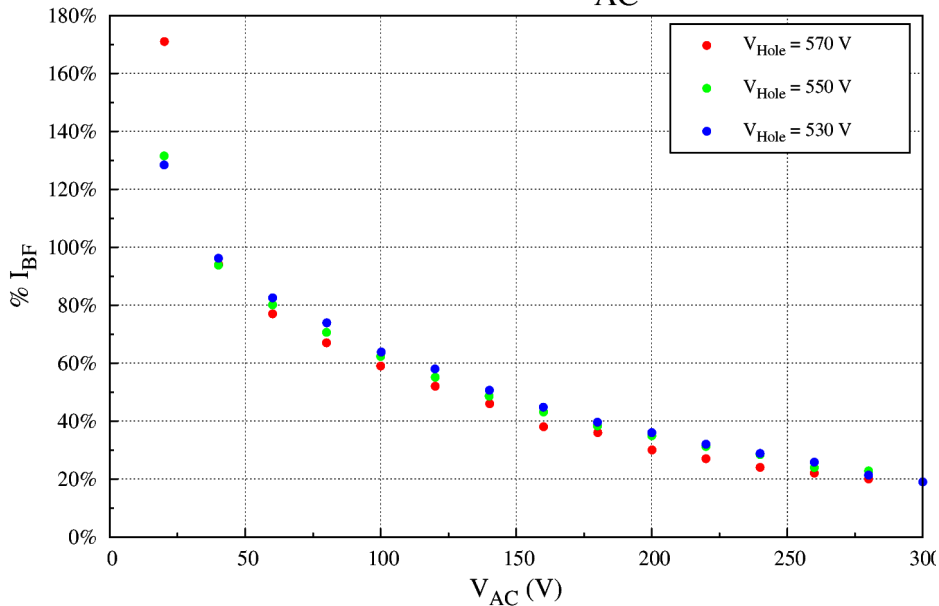


# Detector Gain as a function of $V_{AC}$ and $V_{CT}$

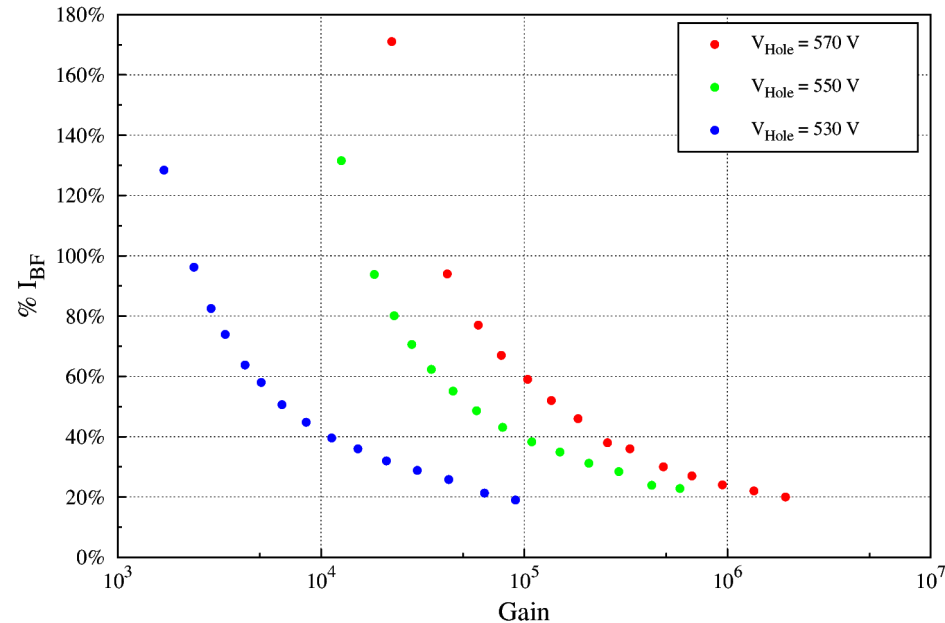


# Ion back flow as a function of $V_{AC}$ and detector Gain

% IBF vs.  $V_{AC}$



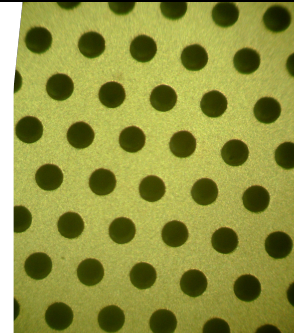
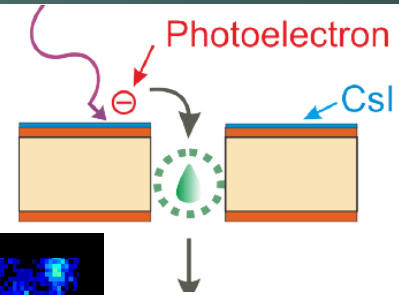
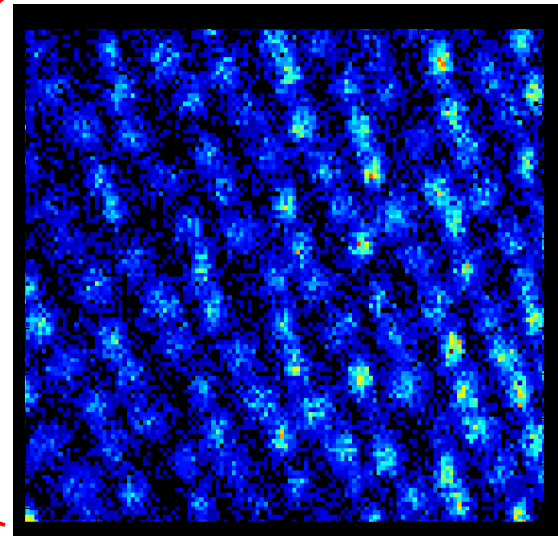
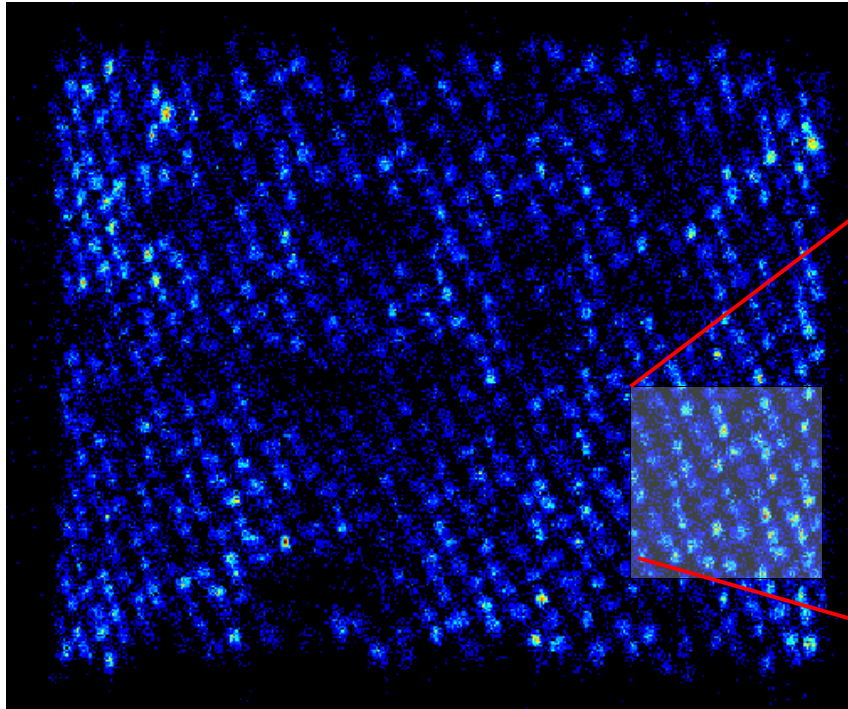
%IBF vs. Gain



- Ion back flow of about 20% (fair for low / medium rate)
- Additional configuration can be implemented for further improvement

# Full illumination – single photon response

- Area = 25x25 mm<sup>2</sup> - Hole  $\varnothing$  = 300  $\mu$ m



- Intensity distribution - nonuniform

- nonuniformity of:
- CsI efficiency
  - Gain

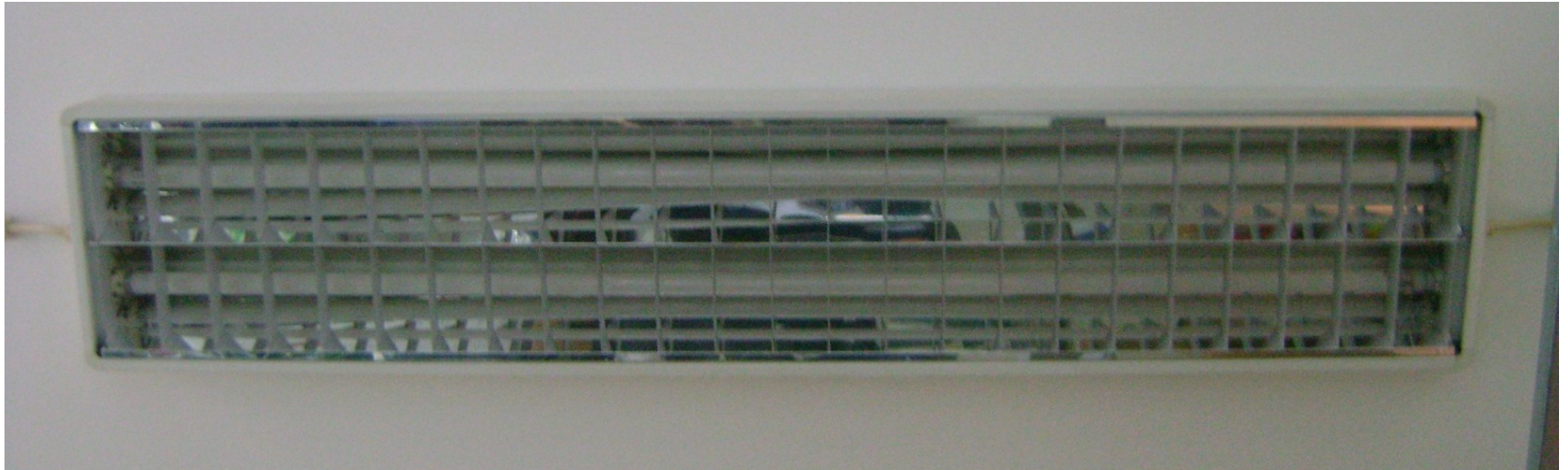




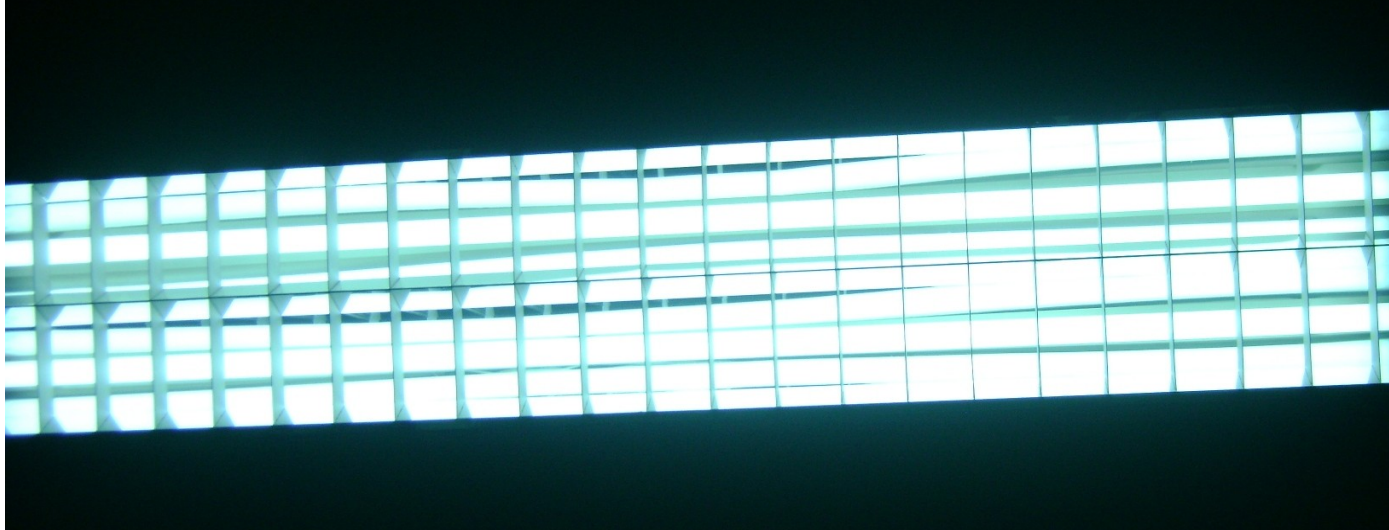
# Illumination

**What type of illumination was used ?**

# Of course, a *standard* one

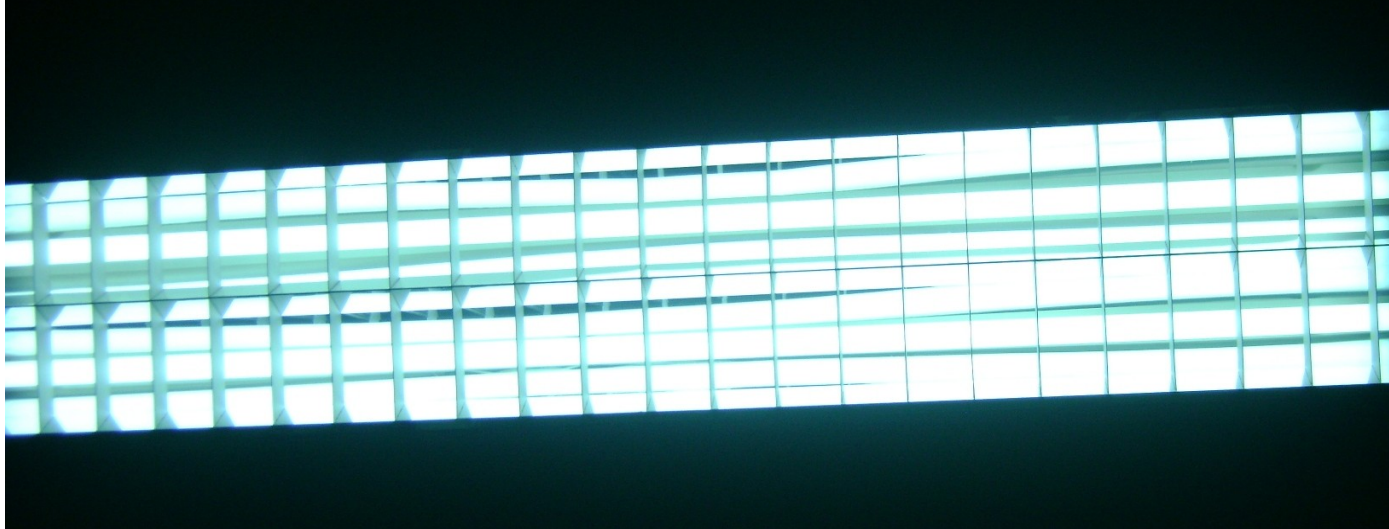


Of course, a *standard* one



**Can provide count rates of VUV photons as high as 5kHz**

# Of course, a *standard* one



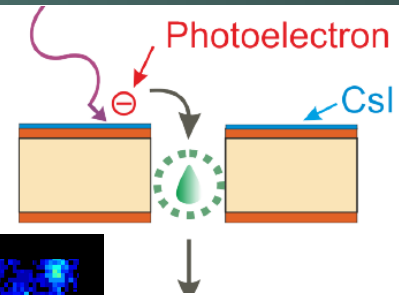
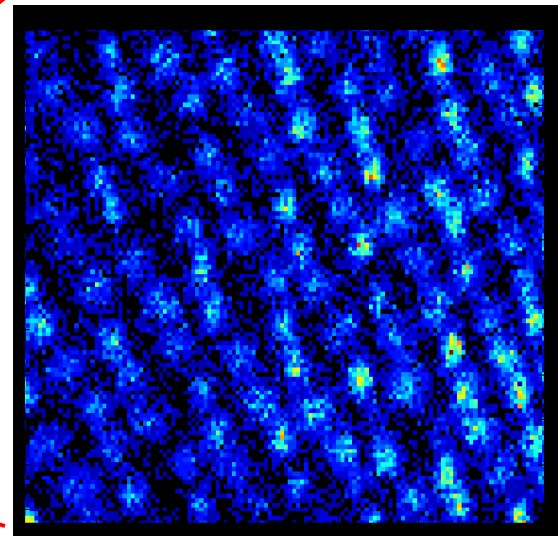
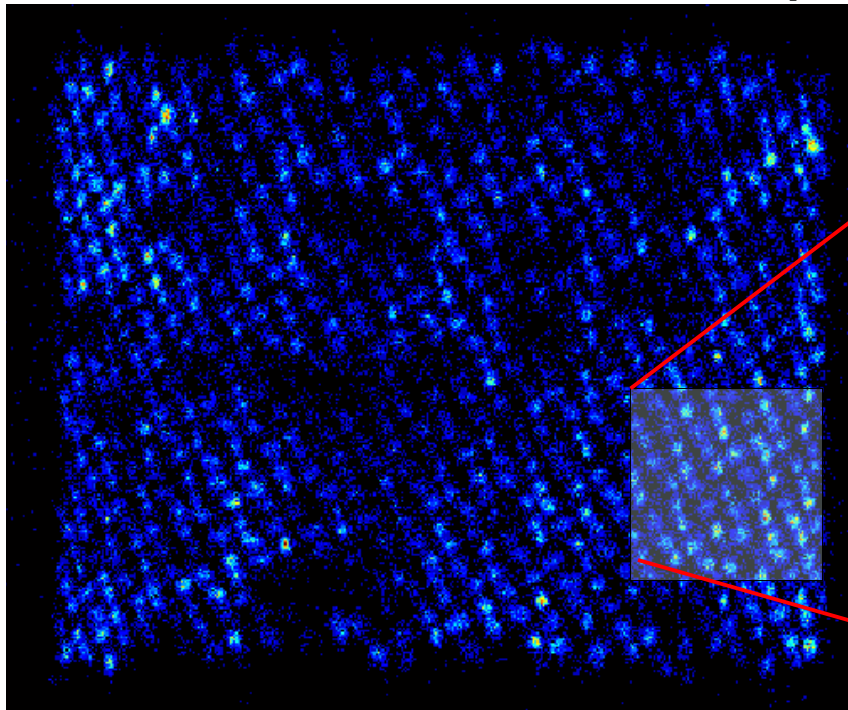
**Can provide count rates of VUV photons as high as 5kHz**

**Also a Hg lamp us used for high count rate:**

**- count rates higher than 100 kHz were measured with no sparks**

# Full illumination – single photon response

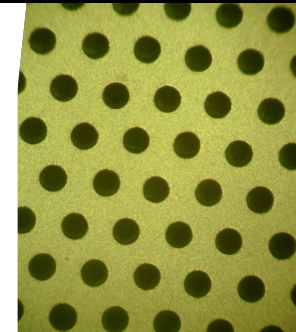
- Area = 25x25 mm<sup>2</sup> - Hole  $\varnothing$  = 300  $\mu$ m



- Intensity distribution - nonuniform

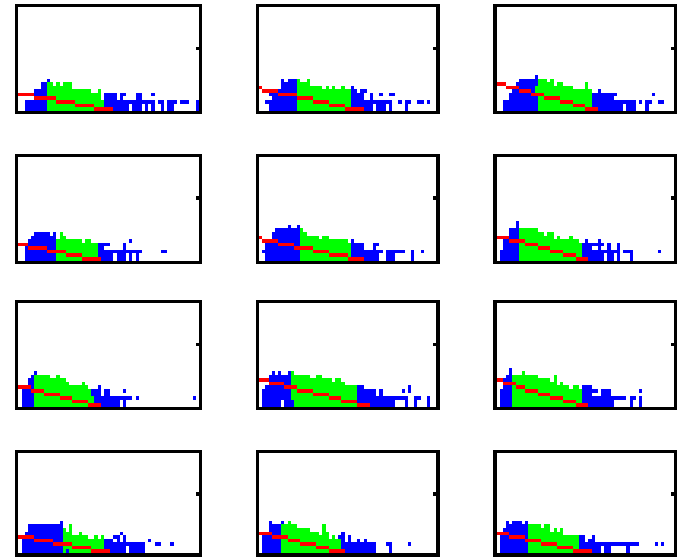
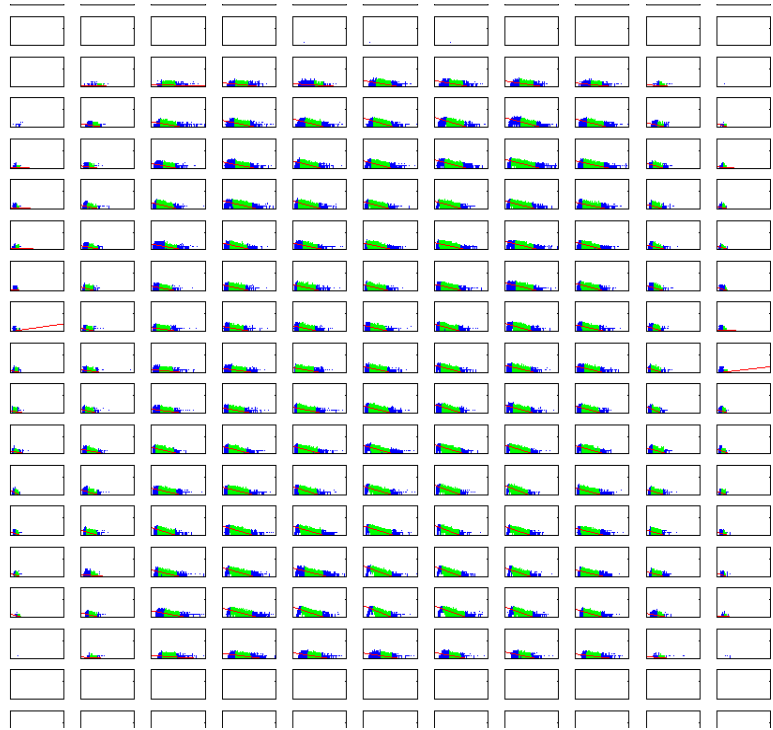
nonuniformity of:

- CsI efficiency
- Gain



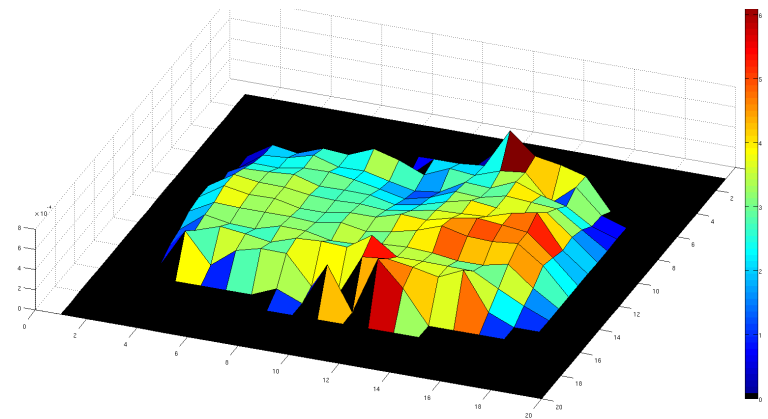


# Full illumination – 20x20 matrix of local polya distribution

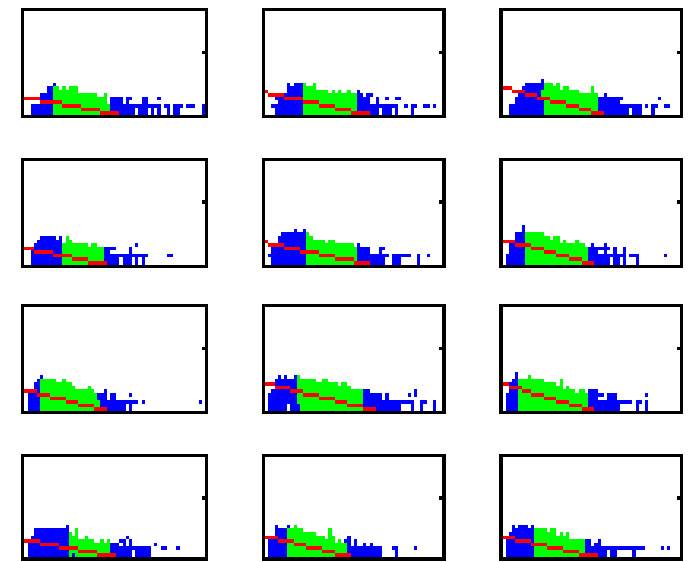
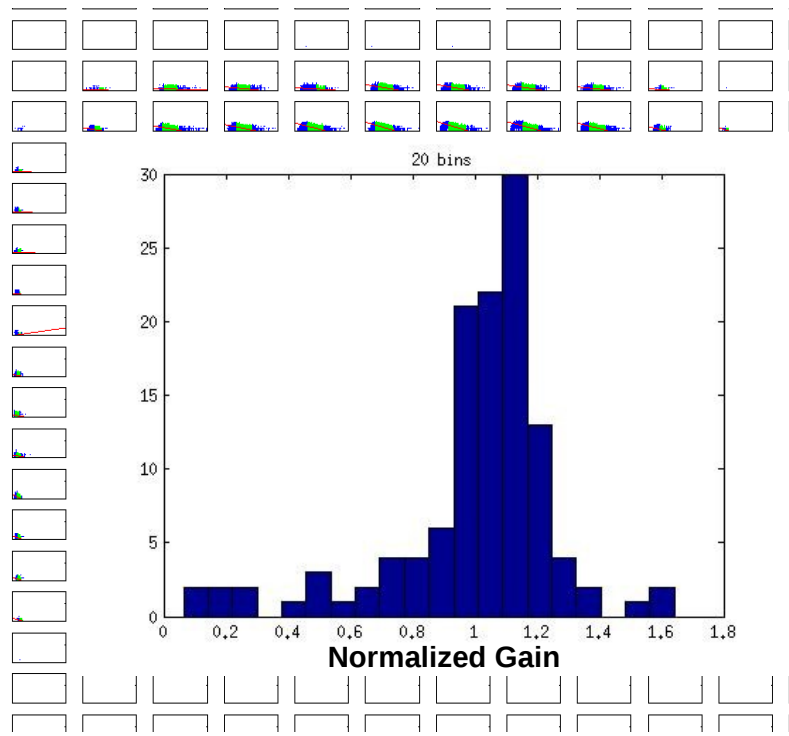


**Polya distribution for each element  
(~1.5 x 1.5 mm<sup>2</sup>) of the matrix**

**Gain distribution →**

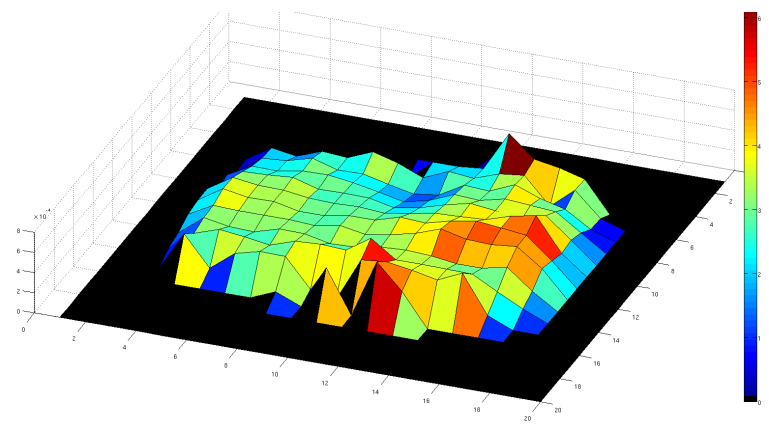


# Full illumination – 20x20 matrix of local polya distribution



**Polya distribution for each element (~1.5 x 1.5 mm<sup>2</sup>) of the matrix**

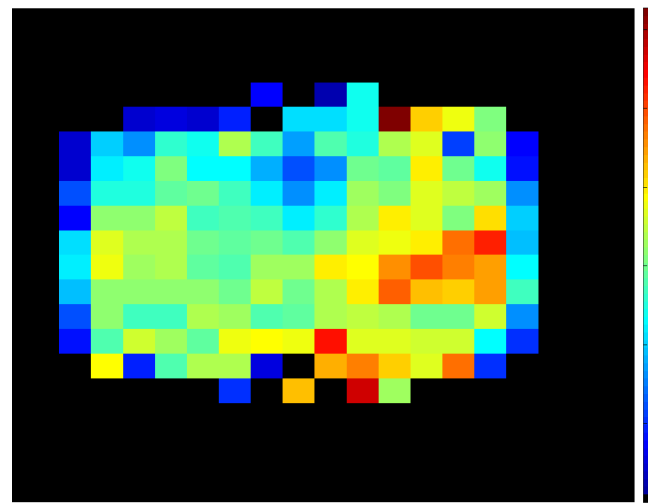
**Gain distribution →**



# Full illumination – single photon response

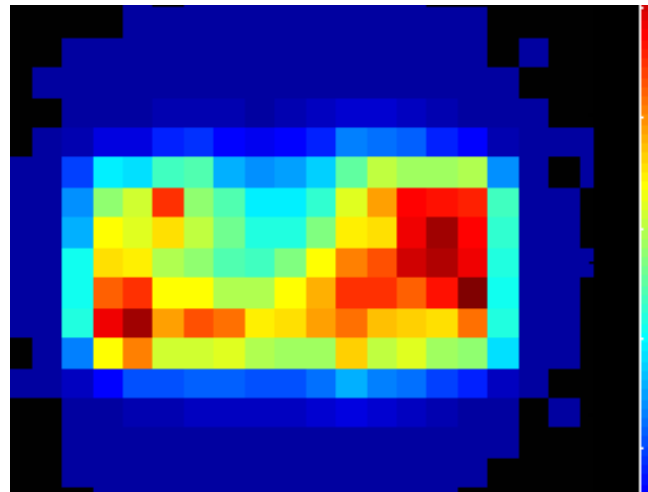
## Gain distribution

(along the detector area)



## Intensity distribution

(Plotted with the same pixel size as the gain distribution)



# Conclusions

- A single VUV-photon counting with position capability was developed:
  - Simple readout – 4 preamps
  - Position resolution - below 500  $\mu\text{m}$  (FWHM)
  - Count rate capability – hundreds of kHz (max. tested)
- 2D THCOBRA shows to be adequate for the purpose
- It was found that:
  - local variations on the Intensity distribution have some correlation with the Gain distribution
  - Intensity variation are mainly due to Gain variation instead of the CsI nonuniformity



# Acknowledgements

- Members of the Radiation Detection and Medical Imaging Group from University of Aveiro
- Funding projects:  
PTDC/FIS/113005/2009 and CERN/FP/123604/2011 from FCT and program COMPETE