RESTORING EFFICIENCY IN GEM SECTOR SEPARATIONS

Fabio Sauli

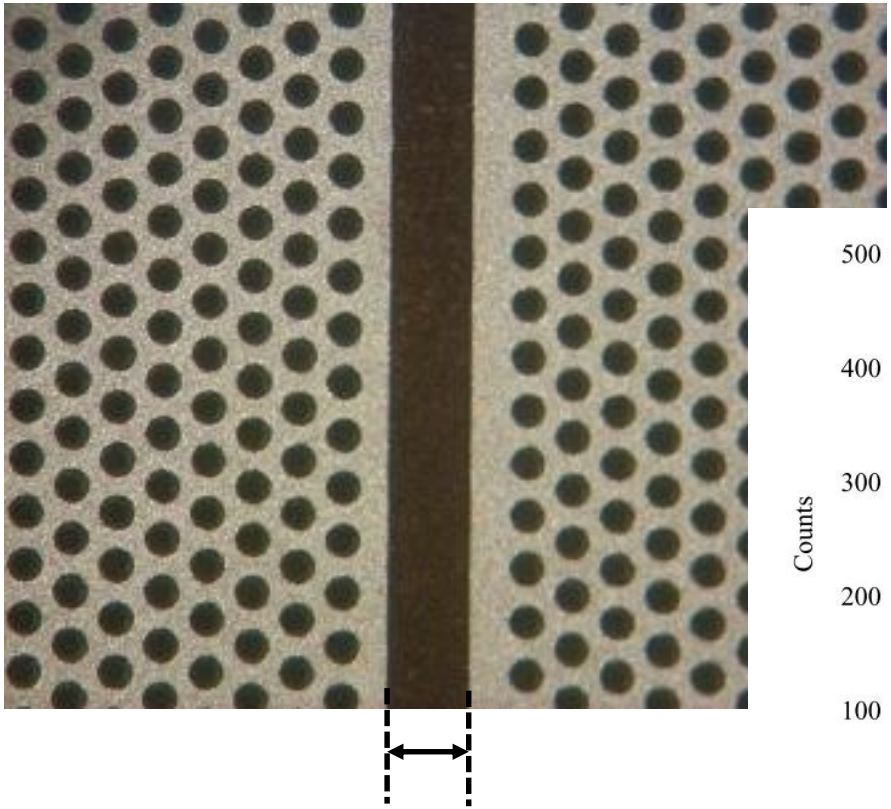
On behalf of the CERN GDD team

GEMs manufacture: Rui de Oliveira, Simon Williams (CERN-DT-EF)

DLC-coated Polymer: Yi Zhou (Hefei Univ.)

SECTORED GEMS TO REDUCE THE DISCHARGE ENERGY

Maximum safe surface ~ 100 cm^2

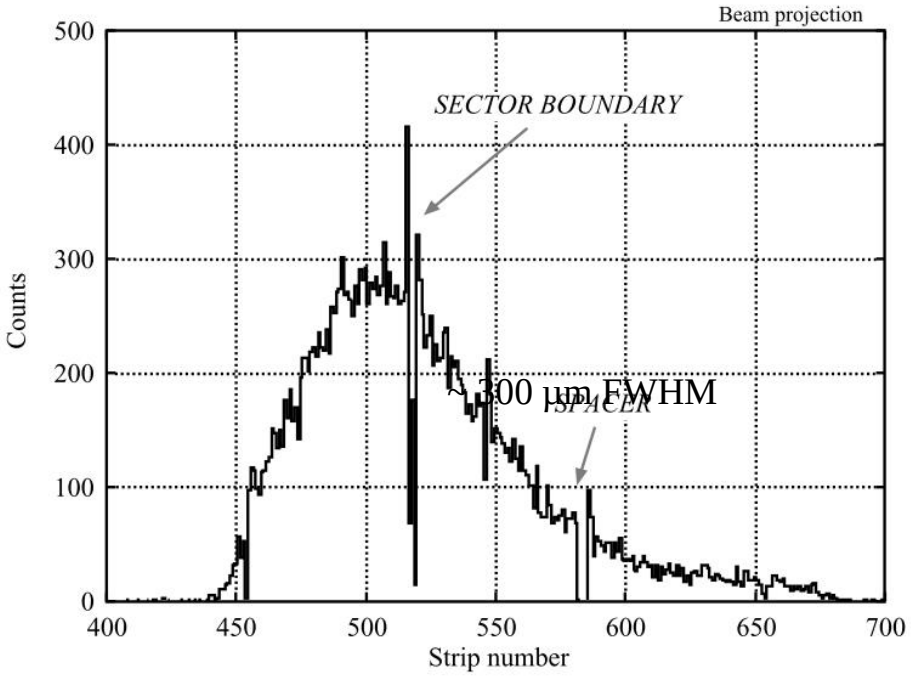


200 µm

COMPASS GEMs

FOR CHARGED PARTICLES;

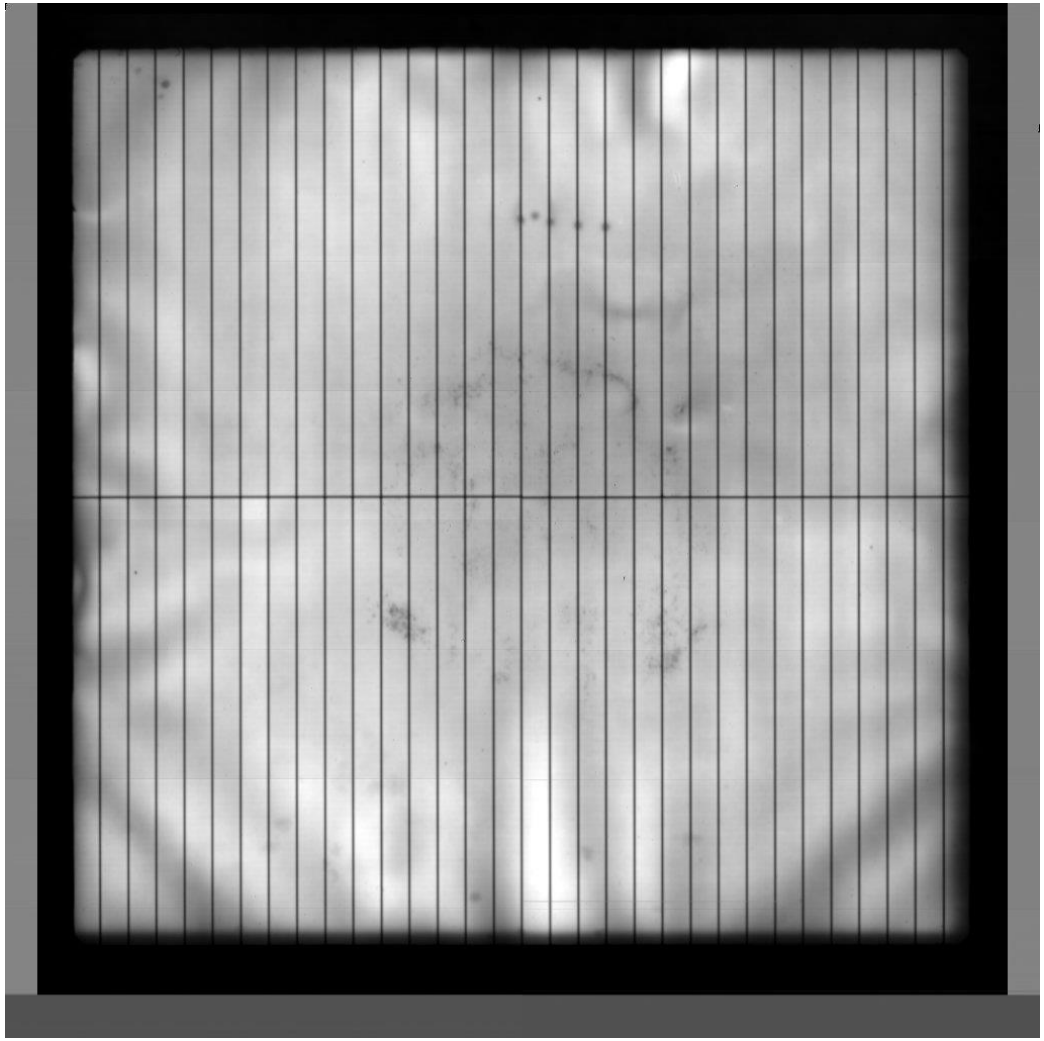
- Local distortions
- ~ 1% efficiency loss



TODAY'S TALK OF KONDO GNANVO: 60 SECTORS!

C. Altunbas et al, NIMA 490(2002)177

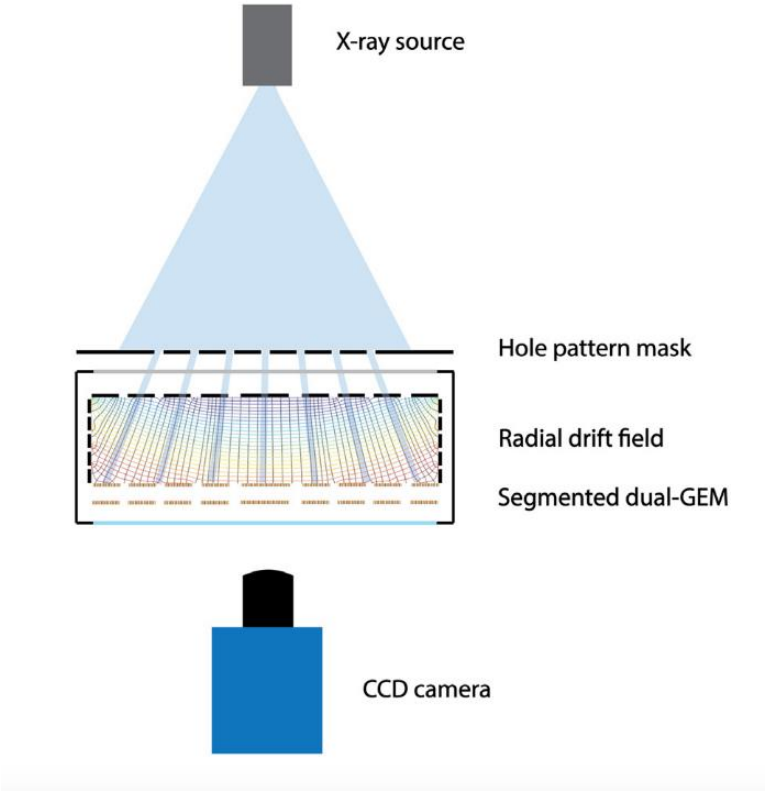
EFFECT OF SECTORS SEPARATION ON X-RAY DIGITAL RADIOGRAPHY FLOOD EXPOSURE



COURTESY OF Gunnar Norberg (C-RAD Imaging AG)

X-RAY DETECTION FOR CRYSTAL
DIFFRACTION AND FLUORESCENCE ANALYSIS:

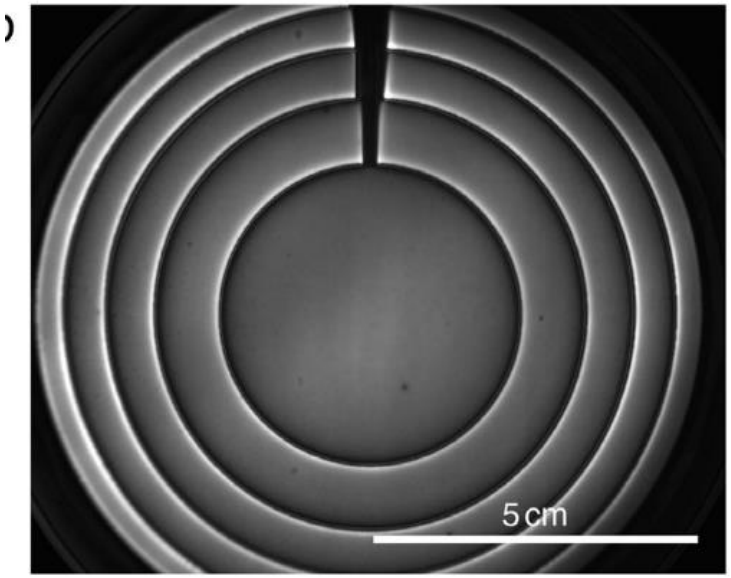
PLANISPHERICAL GEM
PARALLAX-FREE FOR HIGH EFFICIENCY



F. Brunbauer et al, NIMA 875 (2017) 16

Flood X-ray image:

Circular sectors at
graded potentials:

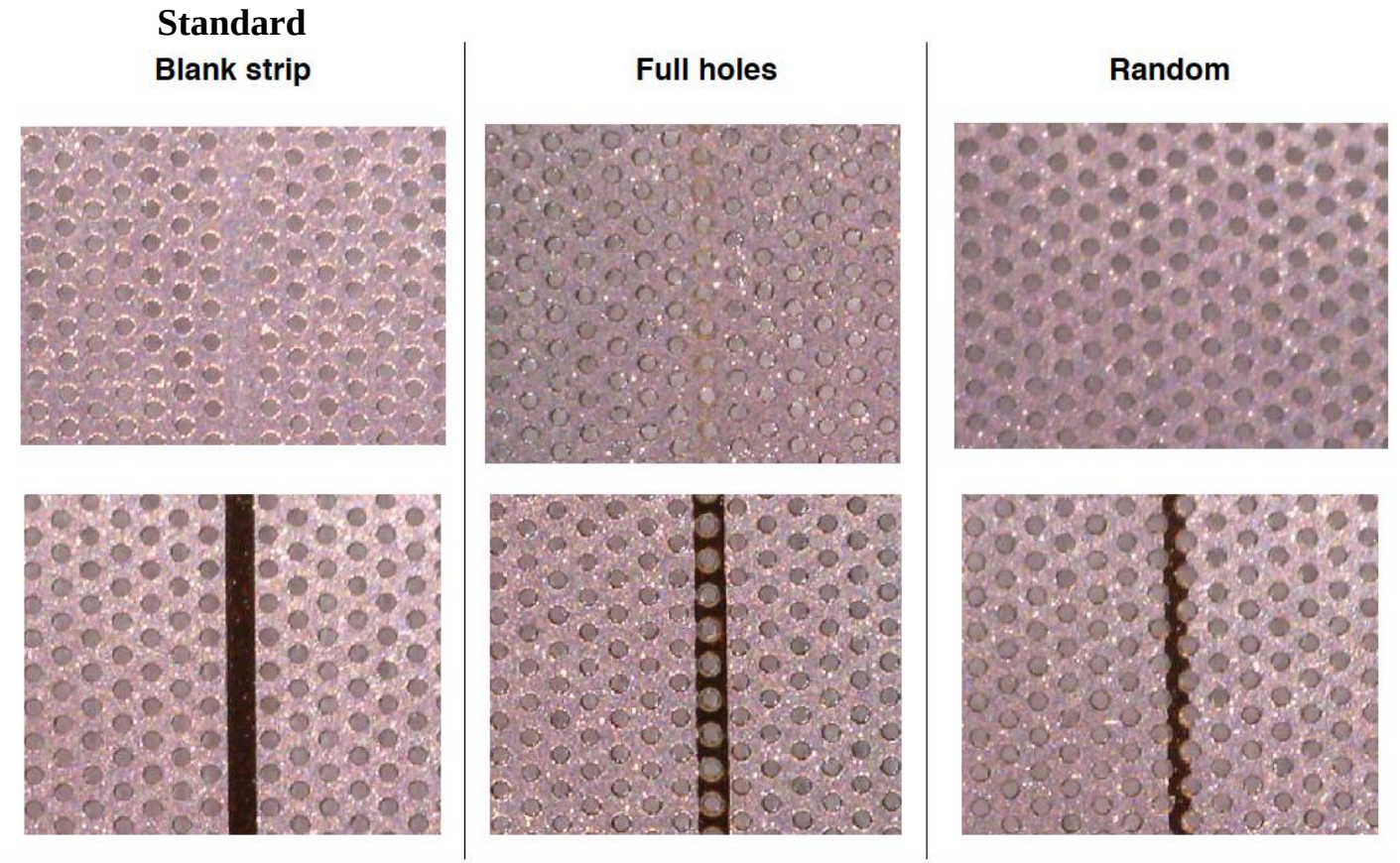


THE SOLUTION: KEEP THE HOLES IN THE SECTOR SEPARATIONS

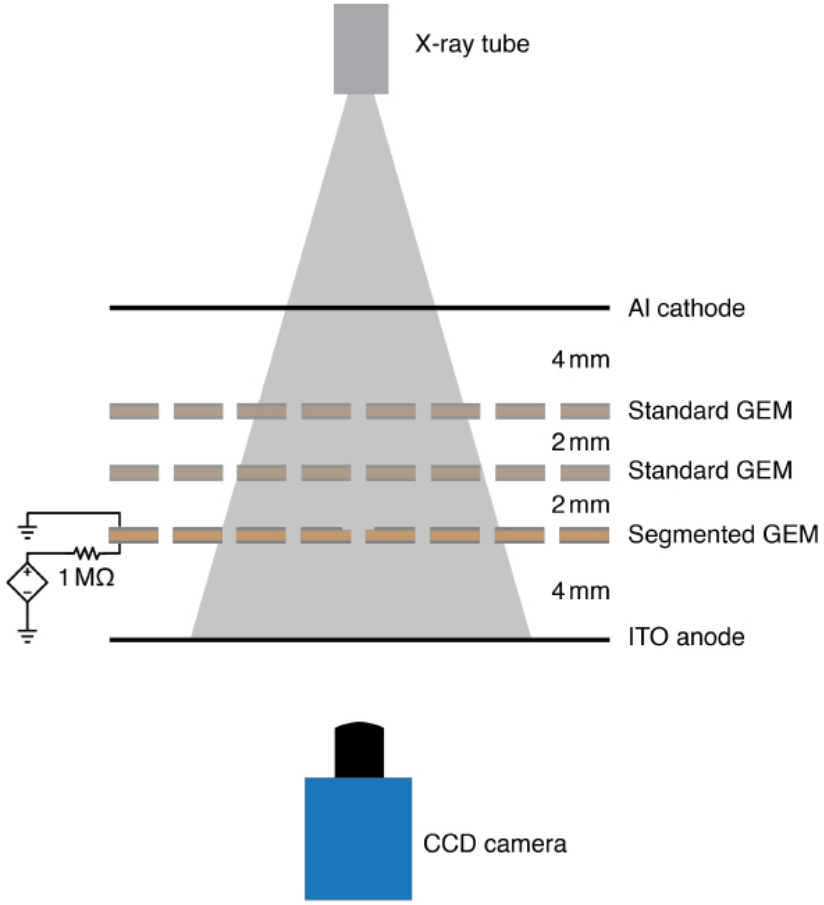
COMPARISON OF SECTORED GEMs

EQUAL HOLES DIAMETER EVERYWHERE

10x10 cm^2 GEMs with 100 µm sectors separations

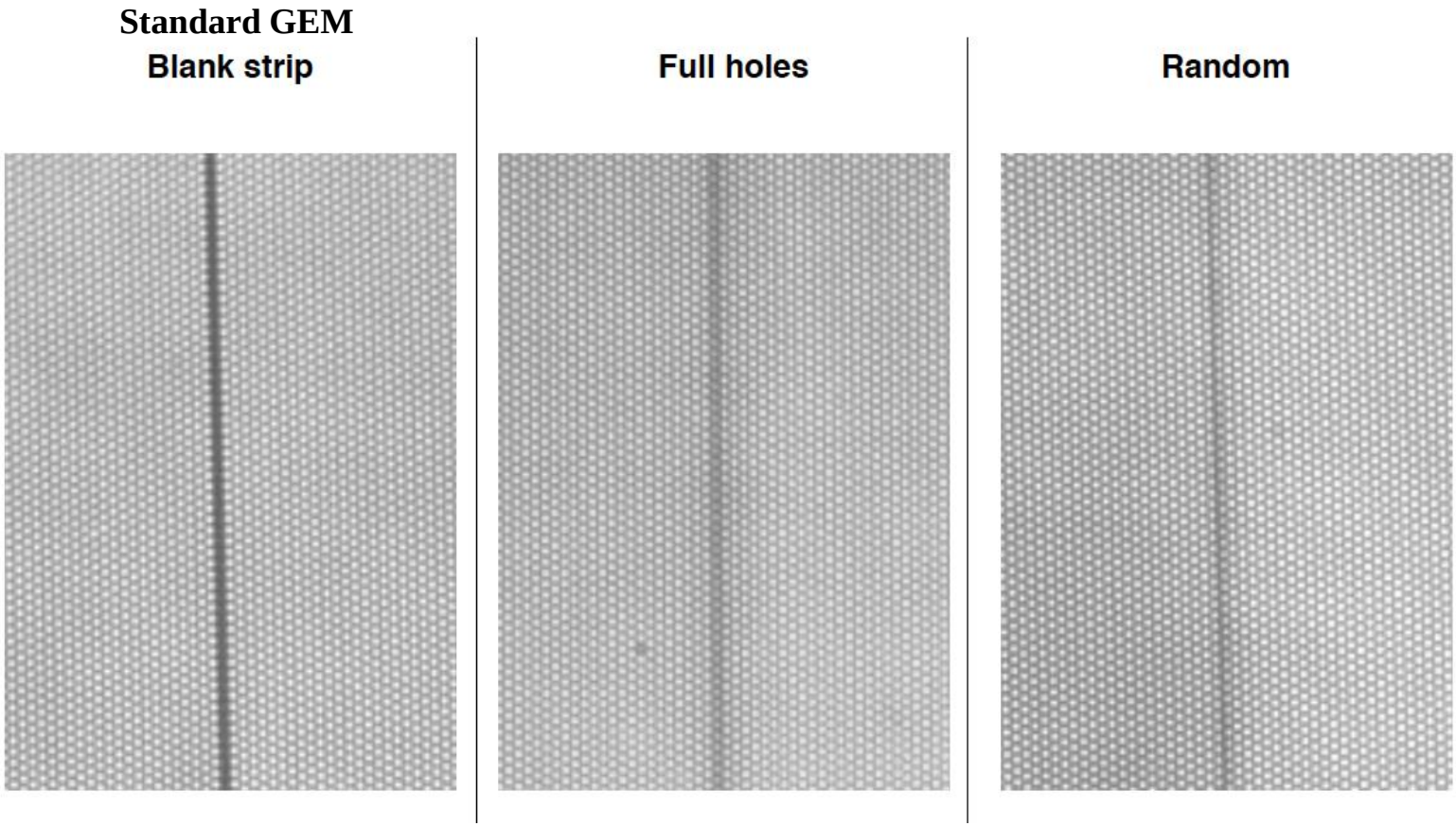


MEASUREMENTS:
STANDARD GDD TRIPLE-GEM WITH OPTICAL READOUT
Ar-CF_4 (80-20)



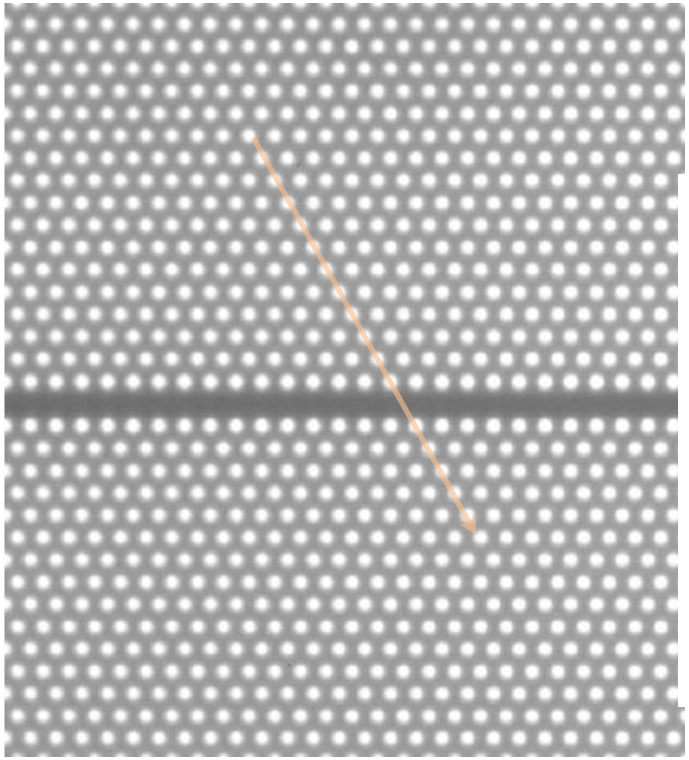
SECTORS UP
OR
SECTORS DOWN

OPTICAL GEM IMAGES UNDER X-RAY FLOOD EXPOSURE
SECTORS AT BOTTOM (TOWARDS CAMERA)

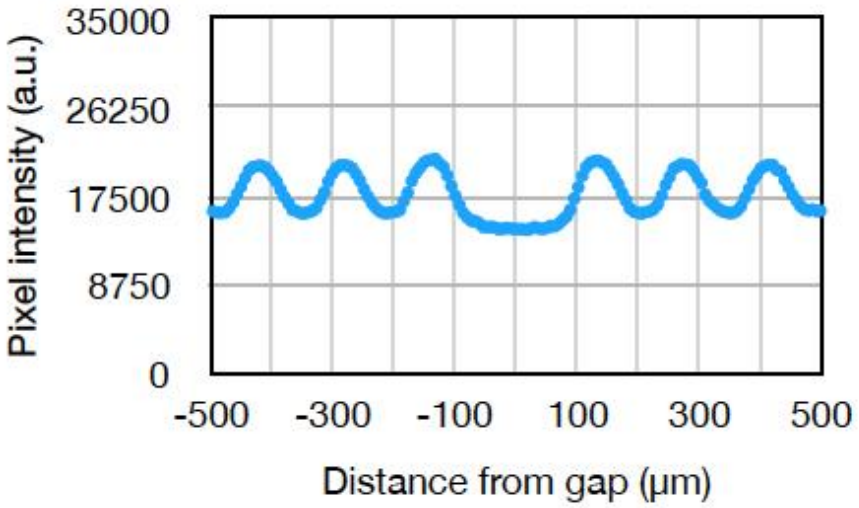


OPTICAL GEM READOUT: VERY GOOD RESOLUTION

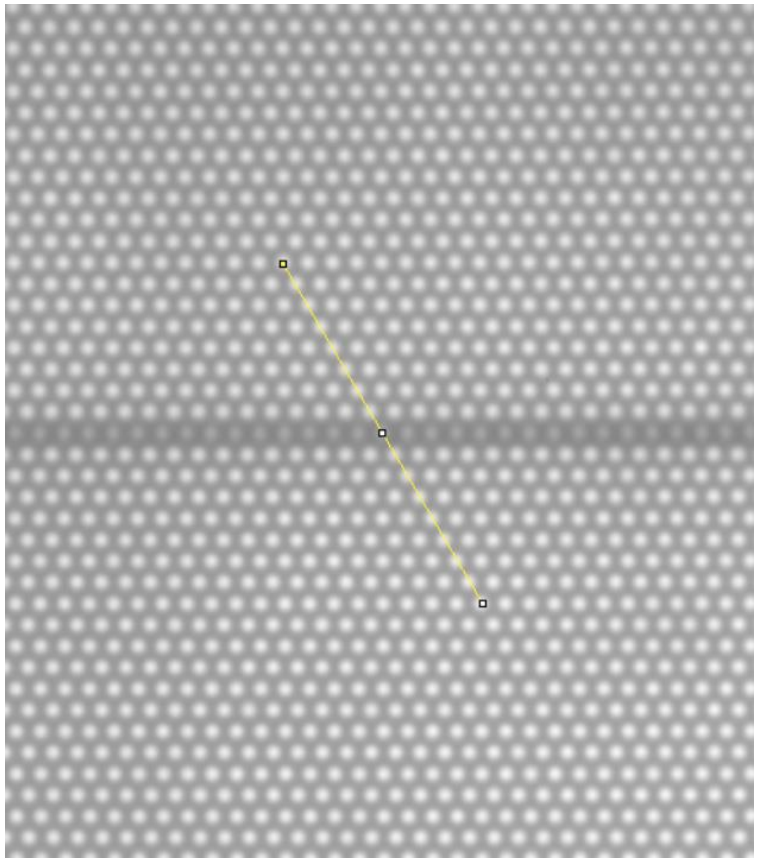
1-D PROFILES OF LIGHT INTENSITY



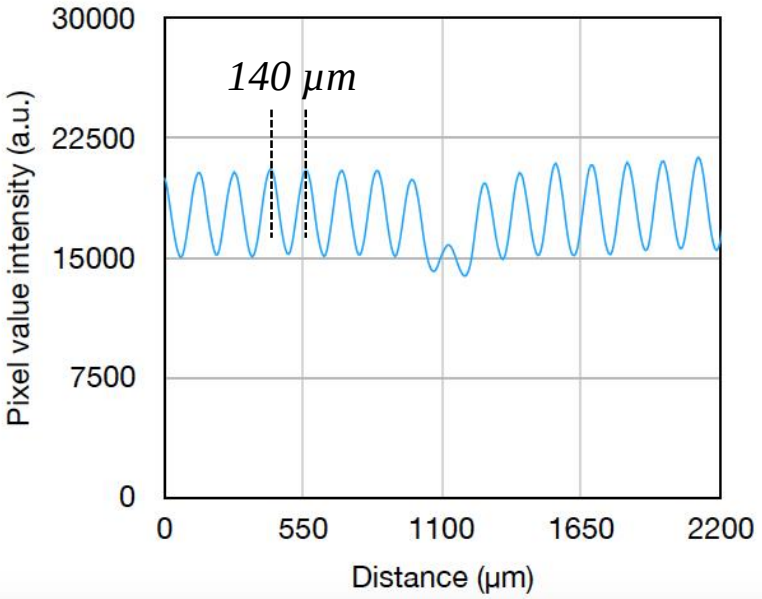
STANDARD “BLANK” SEPARATION



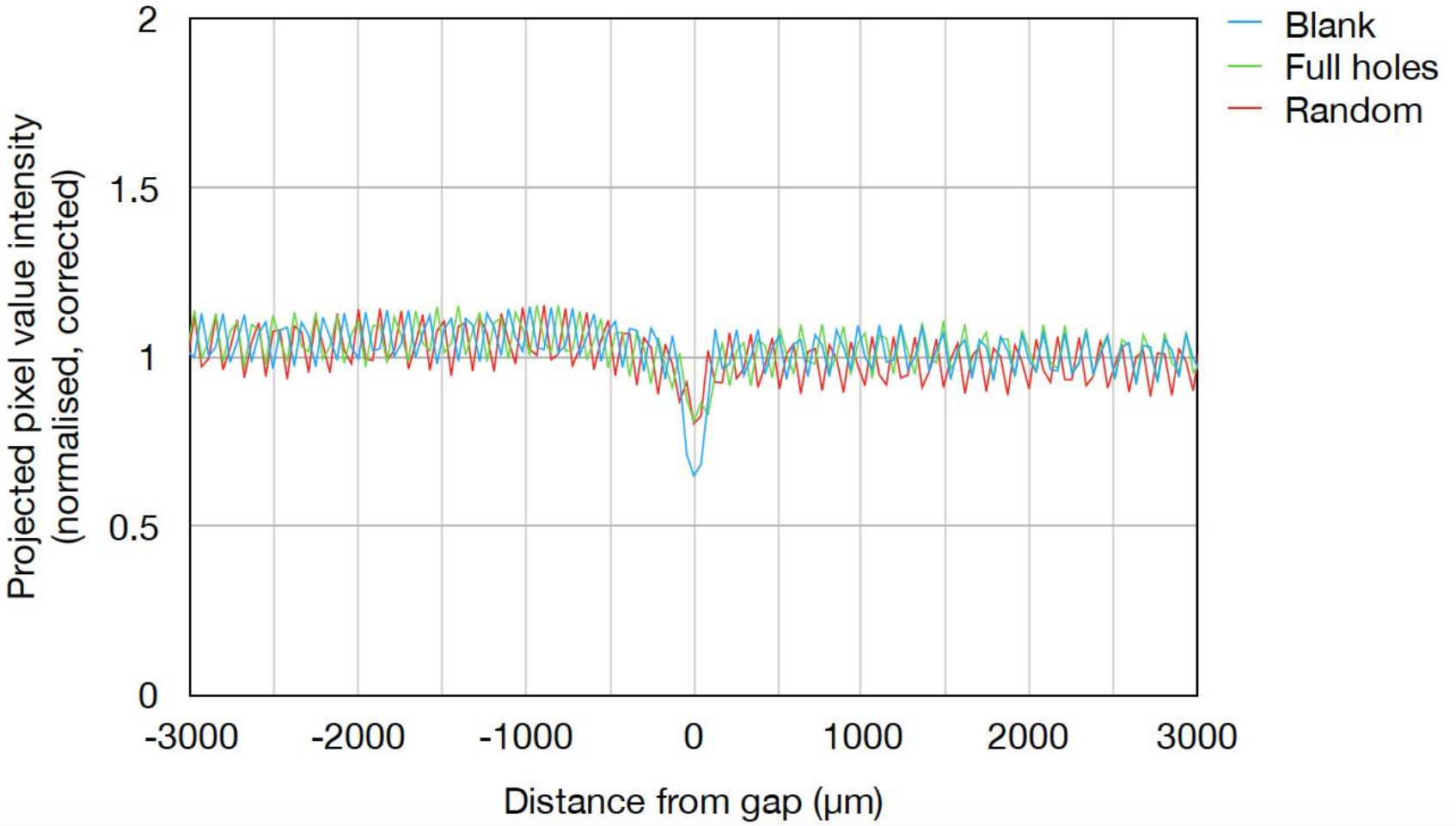
HIGHER RESOLUTION
BACKGROUND SUBTRACTED



FULL HOLES
SECTORS AT BOTTOM



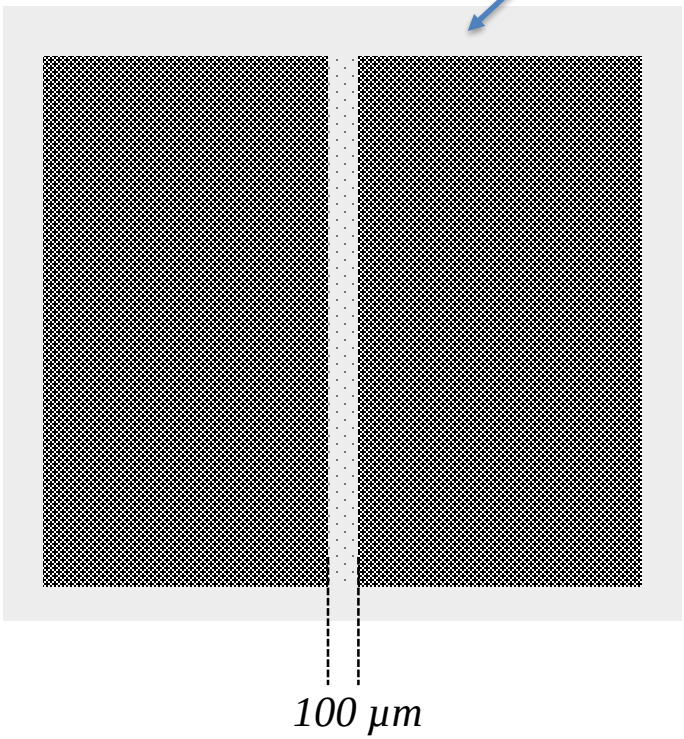
COMPARISON OF SECTOR SEPARATIONS



TO IMPROVE UNIFORMITY OF RESPONSE IN THE HOLES:

- RESISTIVE COATING OF THE SECTOR SEPARATIONS
- GEM MANUFACTURED ON DLC-COATED POLYMER

DLC-COATED POLYMER
NOMINAL $\rho \sim 10^9\ \Omega$ / square → 1 MΩ between sectors



SECTOR SEPARATIONS:
100 µm x 10 cm : 10^3 squares
MEASURED: ~ 3 MΩ between sectors

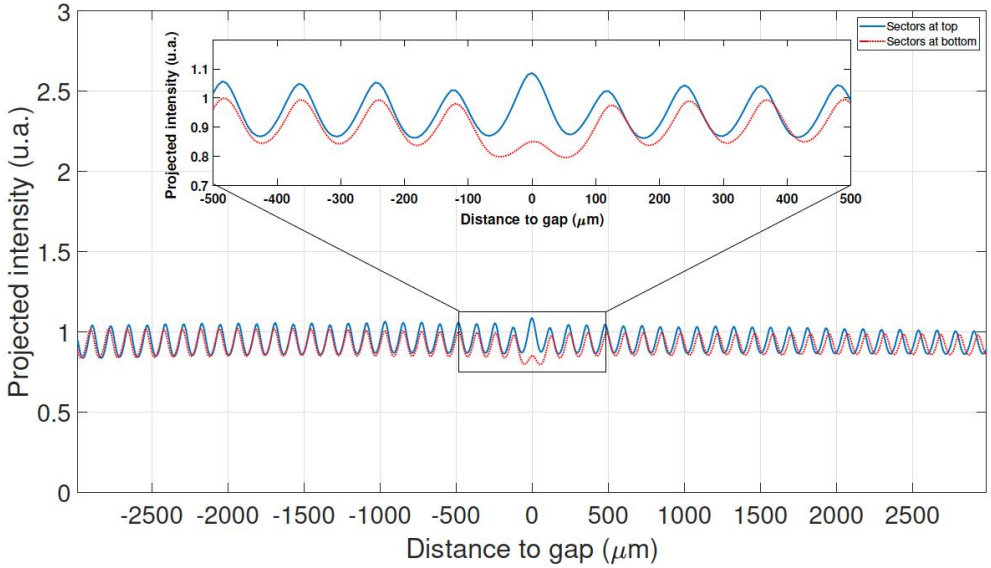
DLC GEMs AND µRWELL
(SEE RUI'S TALK IN W6)

Yi Zhou et al, NIMA927 (2019) 31

3-SECTORS DLC GEM 10x10 cm^2. ~ 3 MΩ BETWEEN SECTORS

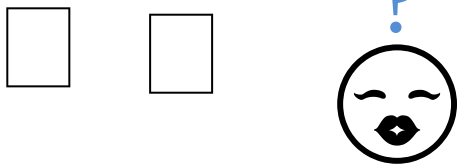
SECTORS AT BOTTOM

SECTORS AT TOP



Sectors at top

Sectors at bottom



SUMMARY:

- RESPONSE UNIFORMITY IN SECTORS SEPARATION RECOVERED WITH DLC GEM WITH SECTORS UP (TOWARDS CATHODE)
- DLC GEM MANUFACTURING PROCESS LABORIOUS (SAND BLASTING TO REMOVE DLC FROM HOLES) → SEE RUI'S PRESENTATION
- ONLY FEW % OF THE DLC EXPLOITED

OPEN QUESTIONS:

- IS THE GEM OPERATION AFFECTED BY THE PROCESS?
- WHY THERE IS A DIFFERENCE BETWEEN SECTORS DOWN-SECTORS UP?

(HOLES ASYMMETRY… SEE ALSO YESTERDAY'S PRESENTATION BY Djunes Janssens)

- IS THERE ANOTHER WAY TO MAKE ONLY THE SEPARATION RESISTIVE?

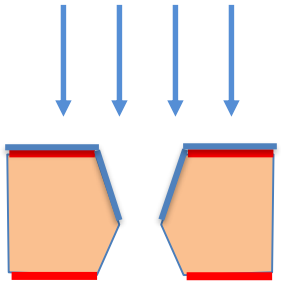
DLC COATING AFTER MANUFACTURING PROBABLY DOES NOT WORK

10x10 cm^2 → 10^6 holes 1 hole ~ 10 □

DLC 10^{10} Ω/□ → 1 kΩ between electrodes

POOR ADHERENCE OF DLC TO COPPER

UNLESS…
IS DLC SPUTTERING DIRECTIONAL?



….WORK TO BE CONTINUED!