### Charge Sharing Studies With a Laser Setup

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20/05/2008, Calice-Maps RAL

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#### Outline



The setup

- Introduction
- Results per threshold value
- Lower threshold ring effect
- Samplers
- 2 Comparison with full simulation
- Response uniformity per threshold
  Uniformity in x
  - Uniformity in y



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#### Laser setup

- Many thanks to Matt for setting everything up, and Paul for taking the data !
- In the following:
  - 10 bunch crossings (BX) per bunch train (BT),
  - laser fires at 2.5  $\mu$ s (7<sup>th</sup> BX),
  - 1000 BT per position,
  - X-Y stage moved by 5 μm steps, in x and y,
  - $150 \times 150 \mu m^2$  area scanned, centred on a given pixel,
  - several threshold values studied,
  - x-y 2D-histogram with bin content = signal recorded in the studied pixel when the laser was fired in (x,y).
  - display the results for all 9 pixels.

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### Random pixels, low threshold

Centre pixel: 60,29 (Peds [-8,-11,-2,13,16,-53,12,9,47] TU)





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## Higher threshold : expected behaviour (!)

#### Threshold 80 TU ----38 -720 740 Enline C Pipel 56, 29 response to sca Playi 66, 29 response to aca Plasi 61, 29 response to scan Threah 80 TL Threah Spirit Threah 80 TU 44 Pipel 59, 20 response to sca Collow TUB Plasi 66, 20 response to acar Plasi 61, 20 response to scan Threah 80 TL Threah 80 TL 492 480 -740 -720 44

#### Threshold 85 TU



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## Results, continued...

Threshold 85 TU ----Piael 66, 30 response to scal -440 482 -240 -720 740 340 Callins T Pipel 56, 29 response to sca Piael 66, 29 response to sca Plasi 61, 29 response to scan Threah 85 TU Threah 85 TU Threah 85 TU 44 480 .0 720 74 COLUMN 111 Pizel 59, 20 response to sca Plasi 66, 20 response to acar Plasi 61, 20 response to scan Threah 85 TU Threah 85 TU Thread \$5 Th 492 480 -740 -720 -740

#### Threshold 90 TU



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## Results, continued...

Threshold 90 TU -----440 482 -240 -720 740 340 Calling C Pipel 56, 29 response to sca Piael 66, 29 response to sca Plasi 61, 29 response to scan Threah 50 TL Thread Spirit Threah 90 TU 44 480 720 Californ TUR Entries 612 Pizel 59, 20 response to sca Plasi 66, 20 response to acar Plasi 61, 20 response to scan Threah 50 TL Thread 50 Ti Threah 90 TU 492 480 -740 -720 44

#### Threshold 100 TU



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## Results, continued...

Threshold 110 TU ----Pipel 56, 30 response to sca Piael 66, 30 response to sca Plani 61, 30 response to sca Threah 114 TU 440 200 48 -240 -720 740 340 Calling C Pipel 56, 29 response to sca Plast 66, 29 response to sca Plasi 61, 29 response to scan Threah 114 TU Threah 110 TU Threah 110 TU 44 480 200 336 740 the she she Latin II Pizel 59, 20 response to sca Plasi 66, 20 response to acar Plasi 61, 20 response to scan Threah 110 TU Threah 110 TU Threah 110 TU 492 480 -740 -720 -740 53 .

#### Threshold 120 TU



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### Low threshold: more sensitive outside of the pixel ??

#### Threshold 20 (4) and 40 (24) TU Entries 1205751 Pixel 60, 29 response to scan 641 1600 Thresh 20 TU .660 1400 -680 1200 1000 -700 -720 600 -740 400 -760 201 Entries 218700 Pixel 60, 29 response to scan 900 Thresh 40 Tu 800 700 500 -720 400 300 -740 200

## Threshold 60 (13) TU, pixel 61,30



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### Random sampler pixels, low thresholds

#### Centre pixel: 103,39





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### Random sampler pixels, high thresholds



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  - Uniformity in y



### Full simulation, by comparison ...

#### GDS full simulation



#### GDS assuming perfect p-well



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### Full simulation, by comparison ... , continued...

#### GDS full simulation



#### GDS assuming perfect p-well



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## Full simulation, by comparison ... , continued...

#### GDS full simulation



#### GDS assuming perfect p-well



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Uniformity in x Uniformity in y

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Uniformity in x Uniformity in y

## Uniformity in x: duplicating the central pixel

# Threshold 60 TU : double counting



# Threshold 80 TU : double counting



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Uniformity in x Uniformity in y

### Uniformity in x, continued...

# Threshold 85 TU : inefficiencies near the edges



## Threshold 90 TU : inefficiencies near the edges



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Uniformity in x Uniformity in y

### Uniformity in x, continued...

# Threshold 100 TU : inefficiencies near the edges



## Threshold 110 TU : inefficiencies near the edges



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Uniformity in x Uniformity in y

## Uniformity in y: duplicating the central pixel

## Threshold 60 TU : double counting



## Threshold 80 TU : inefficiencies near the edges



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Uniformity in x Uniformity in y

### Uniformity in y, continued...

# Threshold 85 TU : inefficiencies near the edges



# Threshold 90 TU : inefficiencies near the edges



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Uniformity in x Uniformity in y

### Uniformity in y, continued...

# Threshold 100 TU : inefficiencies near the edges



## Threshold 110 TU : inefficiencies near the edges



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### Rising and falling edges for central pixel



Fit with  $\int_{a}^{b} Gauss(m, \sigma) = c \times TMath :: Erf(\frac{x-m}{\sqrt{2} \times \sigma})(+c)$ 

Threshold (TU)	$\sigma_{\it rise}~(\mu {\rm m})$	$\sigma_{\mathit{fall}}~(\mum)$
40	$\textbf{4.92} \pm \textbf{0.23}$	$\textbf{3.96} \pm \textbf{0.28}$
60	$\textbf{2.91} \pm \textbf{0.16}$	$\textbf{2.98} \pm \textbf{0.16}$
80	$\textbf{4.15} \pm \textbf{0.20}$	$\textbf{2.88} \pm \textbf{0.16}$
85	$5.92\pm0.49$	$\textbf{3.67} \pm \textbf{0.18}$
90	$5.29\pm0.42$	$\textbf{3.52}\pm\textbf{0.14}$

 $\Rightarrow$  Upper limit on laser spot size: 3  $\mu$ m.

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## Conclusions

- Charge spread is very limited.
- Charge collection uniform (or saturated ?) inside the pixel.
- At very low threshold: appearance of a ring more efficient than the inside.
- Sharp loss of efficiency at increasing threshold (within 5 TU  $\Rightarrow$  40% loss).
- Full simulation shows diodes whatever scenario : not compatible with observation ?
- A threshold of about 65 TU (compared to "absolute 0") gives best performance in terms of uniformity in x and y if we believe the pixels tested.
- Laser size estimated at 3  $\mu$ m.

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