

Towards ps and fs diffraction with the XPAD detector

S. Hustache-Ottini¹, J.-C. Clemens², C. Laulhé¹, K. Medjoubi¹, S. Ravy¹







2

iWoRID 2011 - 140 - July 5th



XPAD3 features







- ✓ Detection substrate : Si (S) or CdTe (C)
- \checkmark Submicron technology (IBM 0.25 μ m)
- \checkmark Pixel size : 130 × 130 μ m²
- ✓ Threshold adjustable : 4.5-35 keV (S)/
 60 keV (C)
- \checkmark Power consumption : 40 μW / pixel

- ✓ 80 × 120 pixels / chip
- \checkmark 1 × 1.7 cm²
- \checkmark 10⁷ photons/s/mm² (random)
- ✓ 12 bit rotating counter (overflow read out)
 for 28 bit dynamics
- \checkmark read out in less than 2 ms



Pump probe experiments

Excitation of the sample (laser, electric field, ...): the pump Study of the de-excitation (changes in the diffraction pattern) with Synchrotron Radiation (SR): the probe

Stroboscopic acquisition to get enough statistics



Mechanical chopper to select the X-ray bunch : slow, expensive, complicated to synchronize

iWoRID 2011 - 140 - July 5th

Pump probe experiments with an electronic chopper

To get rid of the slow mechanical chopper : use of an electronic chopper by gating the counters of each pixel of XPAD on a selected SR bunch





Test experiment with a single XPAD3.2 chip (june 2010)



Increasing the delay of the gate / RF of the storage ring



Repetition rate 847 kHz = revolution frequency of the storage ring

It works, but with some limitations ...

iWoRID 2011 - 140 - July 5th





The signal induced on the pixel depends on the position

Influence of the sensor 1. Charge sharing





The comparator is not a Constant Fraction Discriminator

Transit time in the pixel measured with a pulser = delay of an infinite gate / pulser for which half of the pulses are counted



iWoRID 2011 - 140 - July 5th



Influence of the sensor 2. Depth of interaction

. , *π*α

Charge induced at t after the interaction

 $Q(t) = \int i(t) dt = q \left[\Phi_w y(0) - \Phi_w y(t) \right]$

.

Where Φ is the weighting potential :

$$\Phi w(x,y) = \frac{1}{\pi} \arctan \left[\frac{\sin \pi y \times \sinh \frac{\pi}{2}}{\cosh \pi x - \cos \pi y \times \cosh \frac{\pi a}{2}} \right]$$

Γ





iWoRID 2011 - 140 - July 5th



Qualitative and simple simulations including both effects Comparison with data



Remark : same threshold setting for both energies

iWoRID 2011 - 140 - July 5th



First "real" experiment on Cristal







002 reflection,

•Acquisition time 20 s, kphi oscillation 0.35°





Preliminary results

iWoRID 2011 - 140 - July 5th



✓ Proof of feasibility of chopperless pump-probe experiments with XPAD3.2

✓ Most important limitation : interaction of incoming X-rays in the silicon sensor

- Charge sharing
- Depth of interaction

 \checkmark 8-bunch mode or hybrid mode at Soleil : 147 ns bunch spacing = limit case to separate bunches

✓ November 2011 : 10 kHz Laser on Cristal + XPAD3.2 imager (8 modules, 56 chips)



iWoRID 2011 - 140 - July 5th



Thank you !

iWoRID 2011 - 140 - July 5th



Qualitative and simple simulations including both effects Comparison with data





iWoRID 2011 - 140 - July 5th









100 ns 90 ns 75 ns

iWoRID 2011 - 140 - July 5th















