CMS Pixels: Status @ Fermilab

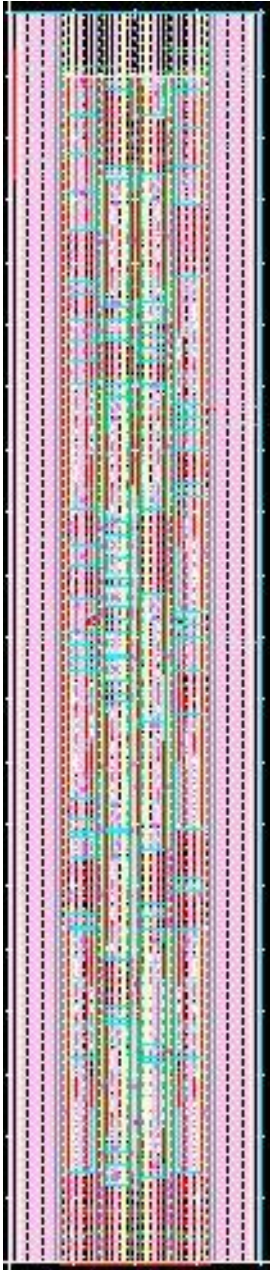
Farah Fahim, Gregory Deptuch, Jim Hoff, Alpana Shenai, Marcel Trimpl

Update

- Radiation tolerance tests of 130nm & 65nm are ongoing with U. Colorado using Sandia National Lab "Gamma Irradiation Facility" (Colbolt-60 source array).
- Design a CMS_pixel_testChip130 for 4.8mm x 4.8mm detector with an array of 30µm x 100µm on SINTEF "Phase-2" wafers recently delivered (to Purdue)
- Goal
  - 1. Demonstrate low (<1000e-) threshold operation in a moderate-sized array.
  - Test analog circuit ideas including self-trimming discriminators
  - Begin to understand how small a pixel is possible in 130nm
  - We also hope that the test chip will be useful for other prototype sensors such as diamond sensors that require low threshold operation for good performance

ASIC: CMS_pixel_testChip

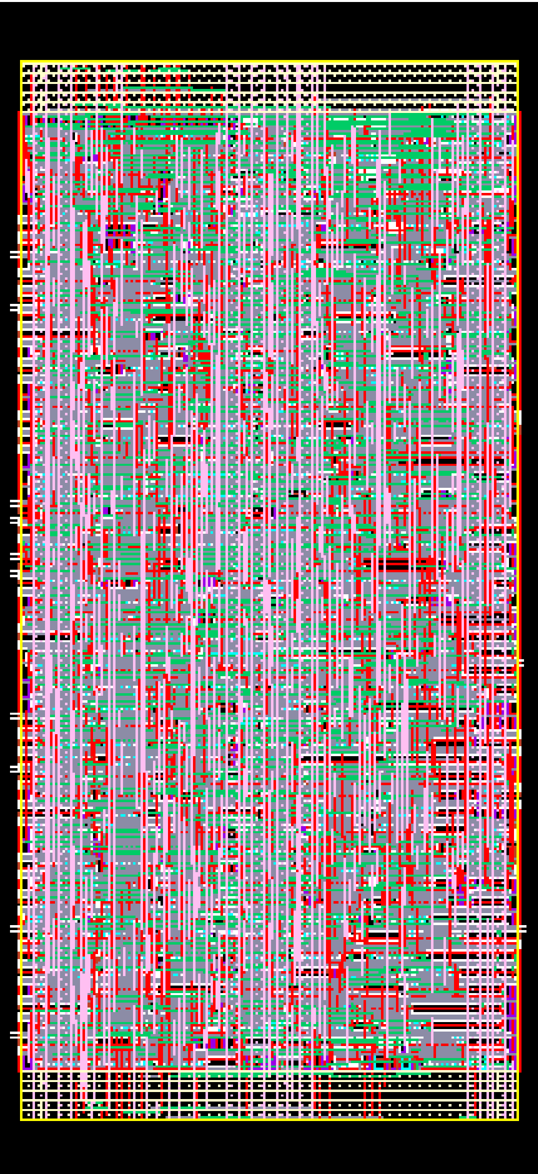
- Technology platform: GF130nm
- ASIC size: 5.5mm x 8.5mm
- Pixel size: 30µm x 100µm
- Analog part: 20µm x 100µm
- Digital Part: 10µm x 100µm
- Rows x Columns: 48 x 160
- Column pattern: A D D A A D D A
- 4 columns are grouped together to create a superColumn (192 pixels)
- Each ASIC has 40 super columns.
- Analog Pixel to include Preamplifier + 3bit Flash ADC + Hit Comparator (independent of ADC)



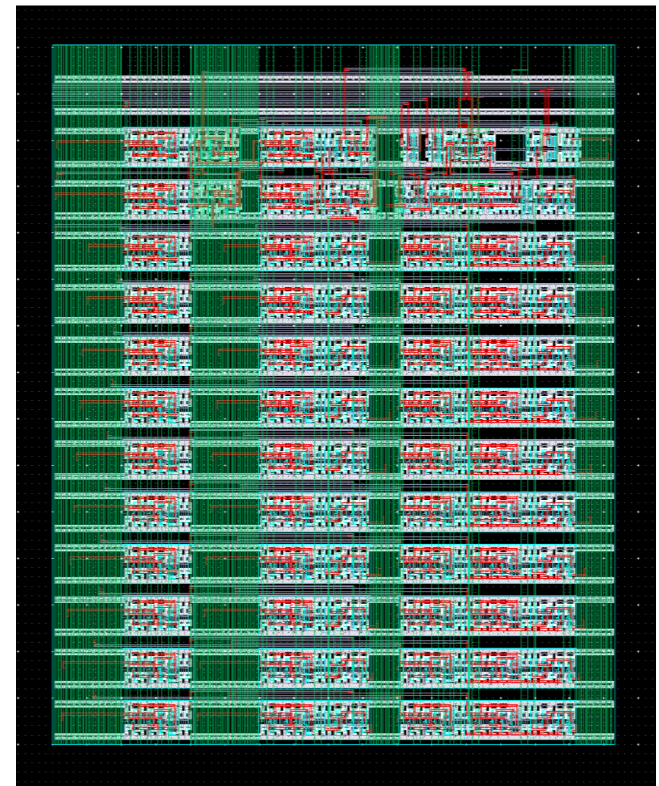
Digital Pixel

- Thermometric encoder
- Fischer tree sparsification
- Hit processor
- Mask/demask capability
- Functionality finalized. Simulations confirm performance
- Double pixel layout (20μm x 100μm)

Readout Electronics



- Conflux: Asynchronous data readout scheme with implicit multiplexing of data
- Uses a 4 phase handshaking protocol
- FIFO2 daisy: enables daisy chaining of data from every pixel to the output.
- Also used to communicate between the fischer tree and Conflux



Top Level view-pad layout

- 51 analog PADS on top (100µm pitch)
- 51 digital PADS at the bottom (100µm pitch)
- 34 spy PADS on the right for analog and digital superColumn outputs (240µm pitch)
- 34 PADS on left for testing chip-to-chip Conflux performance (240µm pitch)

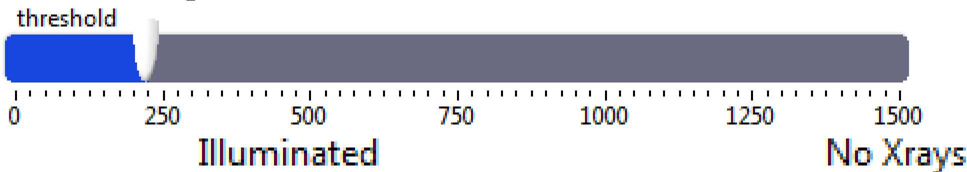
- Basic Floorplan. Missing a lot of components

CMS_testPixel to detector bump bonding:

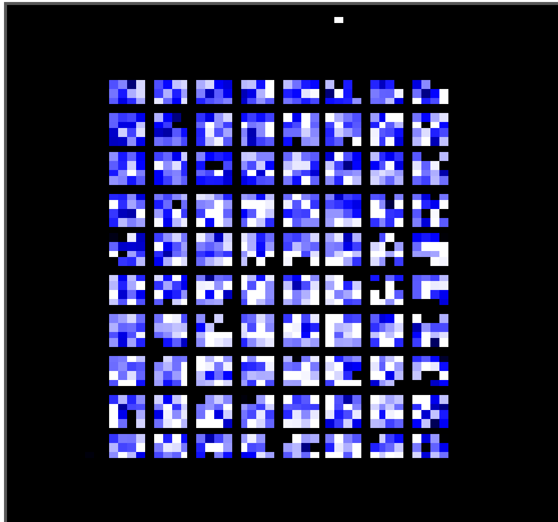
Results of investigating single ASIC to detector bump bonding using CVI

Results from other work at Fermi

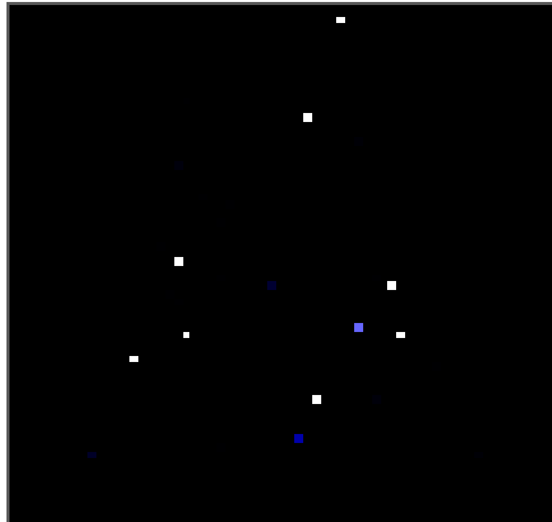
3D VIPIC1 - first X-rays seen with the chip bonded to a 32x38 pixels sensor



Illuminated



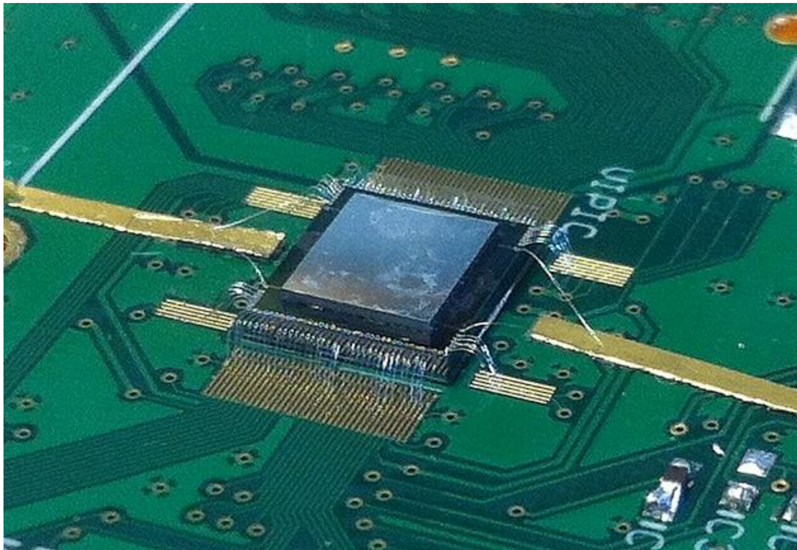
No Xrays



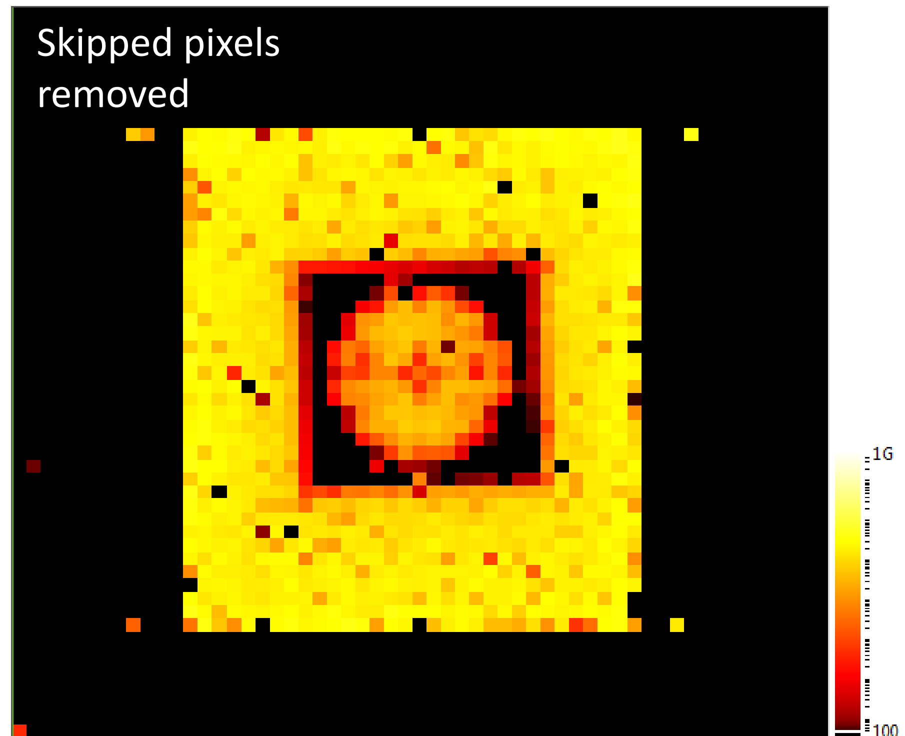
- VIPIC1 – bonded to 100x100 μm^2 32x38 pixels baby sensor
- Every 5th channel skipped because of pixel pitch mismatch: VIPIC1-80um, sensor-100μm
- Sensor bonded to VIPIC using Sn-Pb bump bonding with underfill by CvInc. Bumps deposited on dies
- Wire bonded by Albert last Friday night
- Detector still not biased (backplane left floating)
- ^{109}Cd 22keV source used

threshold ~200 (40mV) causes noise hits disappear (right reference sample plot) and only X-rays are visible; threshold ~1200 (240mV) no more signal visible; gain estimation ~40uV/e- (22keV –> 6100e/h)

3D VIPIC1 – more detailed results



- Detector biased at 120V (mask not shown)
- Detector tested using sources ^{109}Cd 22keV and ^{55}Fe 5.9keV



Transmission radiogram of a small W mask (2.5x2.5 mm^2) put on top of the sensor; back-side illumination of the fully depleted sensor using ^{55}Fe source, all signals integrated above noise, mask has features smaller than the sensor pitch, e.g. ϕ=75μm in the middle

Full sparsified readout from all 16 groups of 4x64 pixels used in the acquisition