VIPIC: a 3D Read Out Chip at the Fermilab Test Beam Facility

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Outline

- Silicon tracking telescope
- CAPTAN Data Acquisition (DAQ)
- Software architecture
- VIPIC architecture
- Results
Radiation Hard detectors

Radiation-hard tracking detectors are being developed for the Large Hadron Collider (LHC) experiments to withstand the increased radiation expected from the High-Luminosity LHC (HL-LHC) upgrade.

The detectors currently in use in the innermost barrel layer of the CMS pixel tracker will receive fluences up to the order of $10^{15} \text{n}_{\text{eq}}/\text{cm}^2$ dose in their lifetime.

After the HL-LHC upgrade, the new detectors in this layer are estimated up to receive 20 times more ($2 \times 10^{16} \text{n}_{\text{eq}}/\text{cm}^2$) this amount!
Sensors: Pixels vs Strips

Pixels:
- Low resolution (cell size is $100 \times 150 \ \mu m^2$)
- Small coverage area ($1.6 \times 1.6 \ \text{cm}^2$)

Strips:
- High resolution (60 \ \mu m \ \text{pitch})
- Big coverage area ($4 \times 4 \ \text{cm}^2$)
Telescope
CAPTAN

Compact And Programmable daTa Acquisition Node

- Flexible boards designed of data acquisition
- FPGA based
- Distributed architecture
- Independent nodes
- Easy access via Gigabit ethernet
Board Interface

• The architecture used is the Xilinx MicroBlaze soft core

• Ethernet packets are exchanged by UDP protocol to achieve high bandwidth efficiency

• All data and commands are encoded as 32 bit words
DAQ architecture
XDAQ

- **XDAQ** is an open source project to provide a simple, consistent and integrated distributed programming environment for *Data Acquisition*

- Developed at **CERN** and extensively used in **CMS**

- The framework builds upon industrial standards, open protocols and libraries
PxSuite Software

- Web GUI
- User
- Supervisor
- FEC Supervisor
- FED Supervisor
- FEC Interface
- CAPTAN Interface
- FED Interface
- Sensor Interface
- CAPTAN
- Sensors
New 3D technology Read Out Chip (ROC) developed by Gregory Deptuch’s group at Fermilab

Originally designed for high timing resolution X-ray Photon Correlation Spectroscopy

We are developing the Firmware and Software to test this ROC in the test beam.
The strips have an internal time stamp counter. The VIPIC do not, the time stamp is added by the CAPTAN when the data is sent out.
Timing issues

• Input clock half of the 54 MHz of the accelerator
• 48-bit Time Stamp Counter
• Each hit has only an 8 bits counter
• Strips and VIPIC share the same clock and trigger events

The actual timestamp is reconstructed offline merging the 48 bit counter with the 8 bits of the hit
Read Out Latency: VIPIC vs strips

The VIPIC has a wider read out latency variance than the strips
Preliminary results

- The inefficiency is likely due to the DAQ
- Thanks to this study a new improved version will be implemented for the next test beam run
Preliminary results
My other tasks

• I improved the configuration and made it more flexible with the introduction of JSON

• I prepared the software interface for the digital version of CMS ROC (PSI46Dig)

• I fixed minor bugs in the PxSuite software
Thanks for your attention