

Silicon Telescope

Caleb Fangmeier

Hardware

Readout

Firmware

Outlook

– FPIX-Phase 2 Upgrade Meeting –
High-Precision Silicon Strip Telescope

Caleb Fangmeier

University of Nebraska - Lincoln

Sept 27, 2016

Telescope Overview

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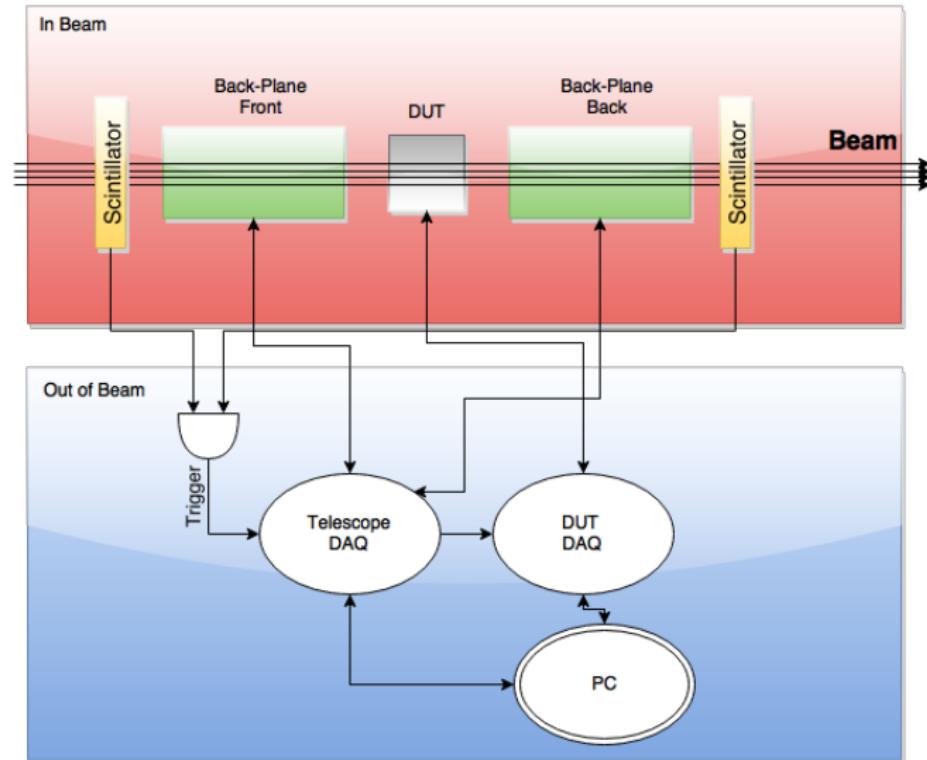
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Back-Plane Board (“Motherboard”)

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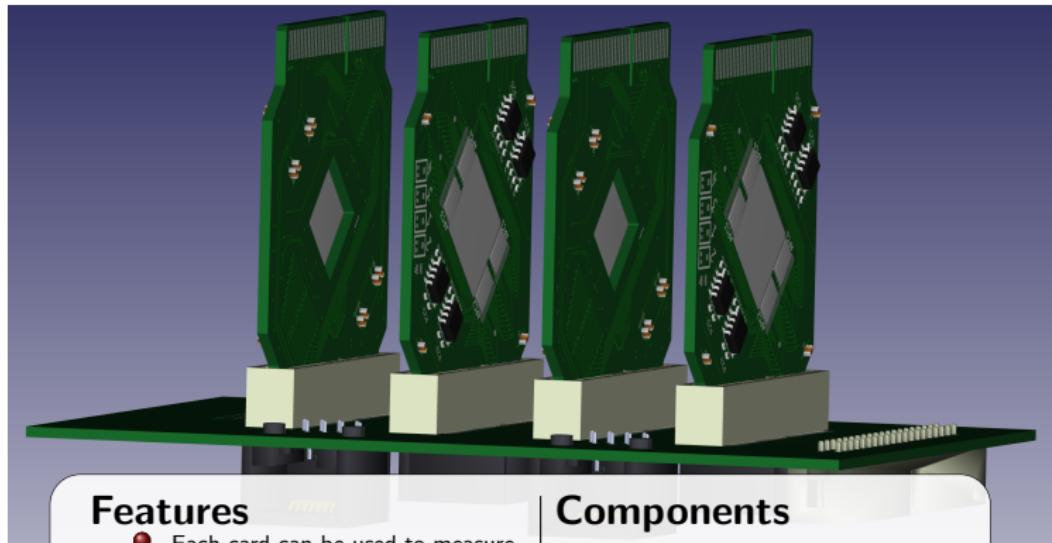
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Features

- Each card can be used to measure either x or y track position
- Configuration shown has alternating x and y measurements
- Shared control signals for synchronous data taking
- Individual output channels for fast readout
- Fast readout is critical to minimize downtime

Components

- 4×Sensor Cards, each with
 - 1×512-channel micro-strip sensor
 - 4×APC-128
 - 4×AD8138 buffer amplifiers
 - 4× V_{analog} trimmer potentiometers
- 4×RJ-45 Ports
- 1×40-Pin 0.1in Header

Analog Pipeline Chip - 128

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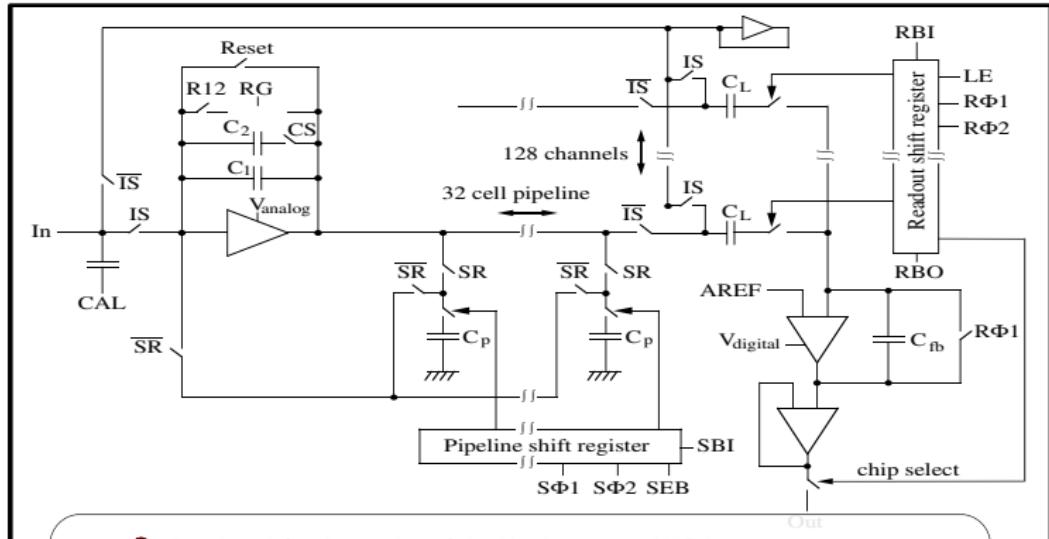
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- Developed for the tracker of the H1 detector at HERA
- Serializes the analog pulse-heights of 128 channels to dramatically reduce the number of required I/O lines
- Capable of sampling waveform data from a strip sensor at upwards of 20MHz
- Features a very good signal-to-noise ratio of 40
- Low noise combined with inter-strip charge-sharing give each layer of the detector a measurement precision of $\approx 1\mu\text{m}$

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Features

- Generates the control signals needed by the APC-128s
- 32 ADC Channels to read out all APC128s in parallel, minimizing dead time
- FPGA Board with associated USB hardware enables high-speed communication with online software
- Handles external triggering from a variety of sources via a translator mezzanine card

Components

- 1×Opal Kelly ZEM4310 with
 - Cyclone IV FPGA
 - 128MB RAM
 - USB-3.0
 - 2×HSMC Connectors
- 8×AD9219 40MHz/10 bit ADCs
- 8×RJ-45 Ports
- 2×40-Pin 0.1in Header
- Bias-voltage control relay
- On-board power regulation

Readout: In-Beam

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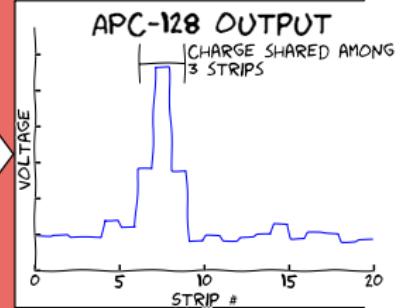
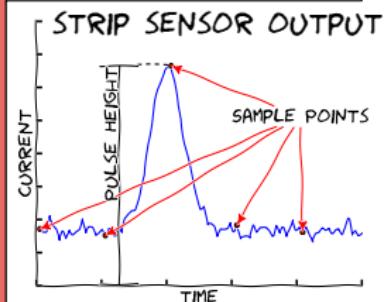
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In-Beam Electronics



Readout: DAQ Board

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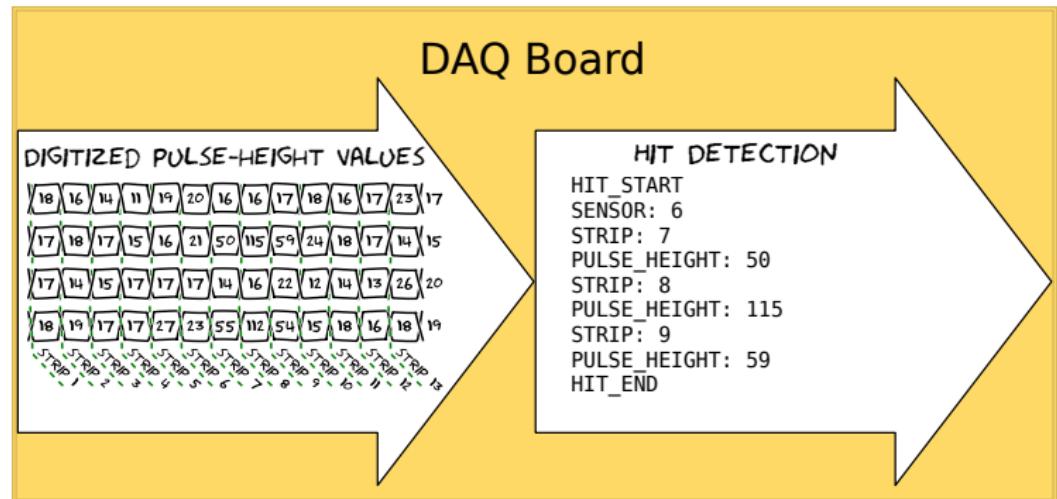
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Readout: PC

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Desktop PC

EVENT CONSTRUCTION

```
EVENT_START
TIMESTAMP: 123453234.12345
SENSOR_1_POSITION: 1.254 mm
SENSOR_2_POSITION: 6.231 mm
...
SENSOR_8_POSITION: 1.25 mm
EVENT_END
```

OFFLINE ANALYSIS

- TRACK RECONSTRUCTION
- ALIGNMENT
- PERFORMANCE MEASUREMENTS



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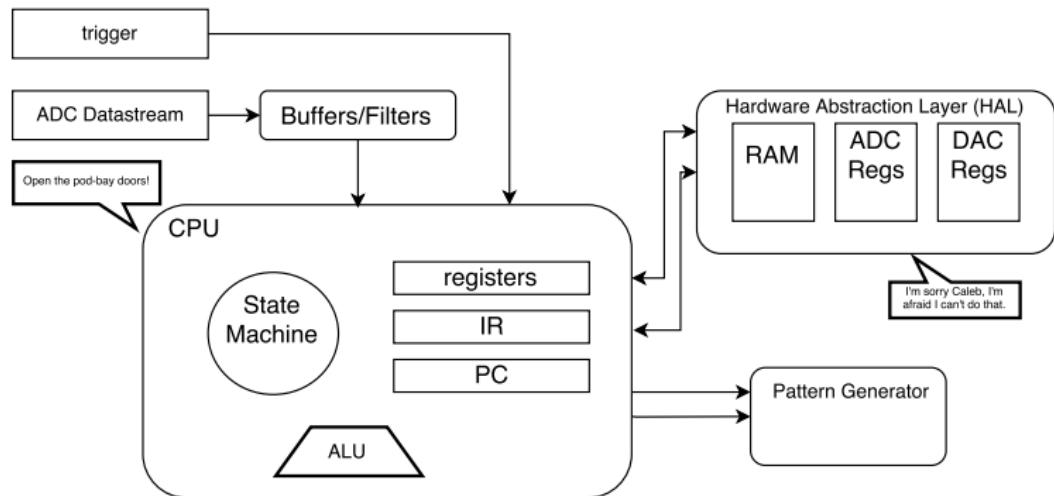
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- System design and parts selection
- APC-128 readout chain proof of concept
- Circuit design and PCB Layout
- Assembly and offline testing (in progress)
- FPGA Firmware development and testing (in progress)
- Online/Offline software development (in progress)
- Commissioning runs with UNL Diocles electron beam

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Firmware:

[https://github.com/cfangmeier/VFPIX-telescope-Code/
tree/master/DAQ_Firmware](https://github.com/cfangmeier/VFPIX-telescope-Code/tree/master/DAQ_Firmware)

Software:

[https://github.com/cfangmeier/VFPIX-telescope-Code/
tree/master/DAQ_Software](https://github.com/cfangmeier/VFPIX-telescope-Code/tree/master/DAQ_Software)

Hardware:

<https://github.com/cfangmeier/VFPIX-telescope-PCB>

ICHEP Poster

https://github.com/cfangmeier/Documents/blob/master/Research/ICHEP_2016_Poster/main.pdf?raw=true