

Development of GEM Readout Electronics for Particle Tracking and X-Ray Imaging

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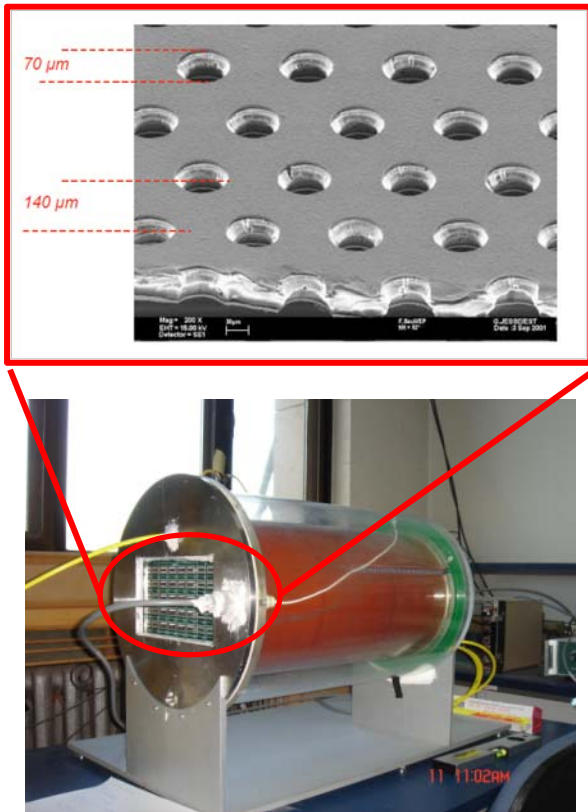
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Introduction

- *What's the Requirements*
 - TPC vs. X-ray Imaging
 - Two Readout Schemes
 - CASA/Waveform Sampling/DSP
 - Switched FET Array
 - Summary
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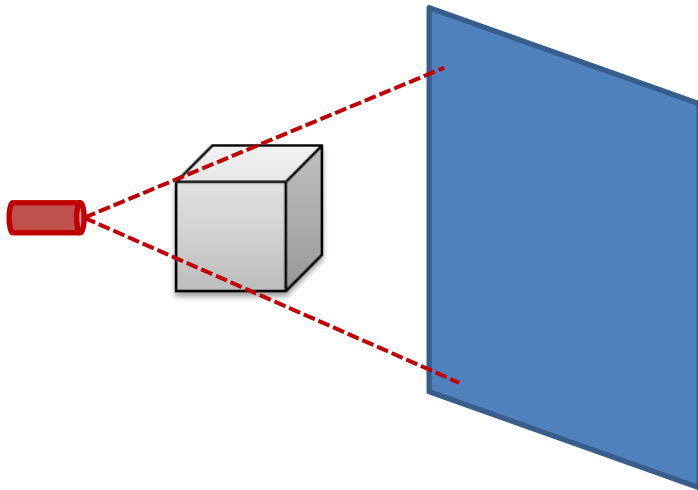
GEM based Time Projection Chamber



GEM-TPC @ Tsinghua

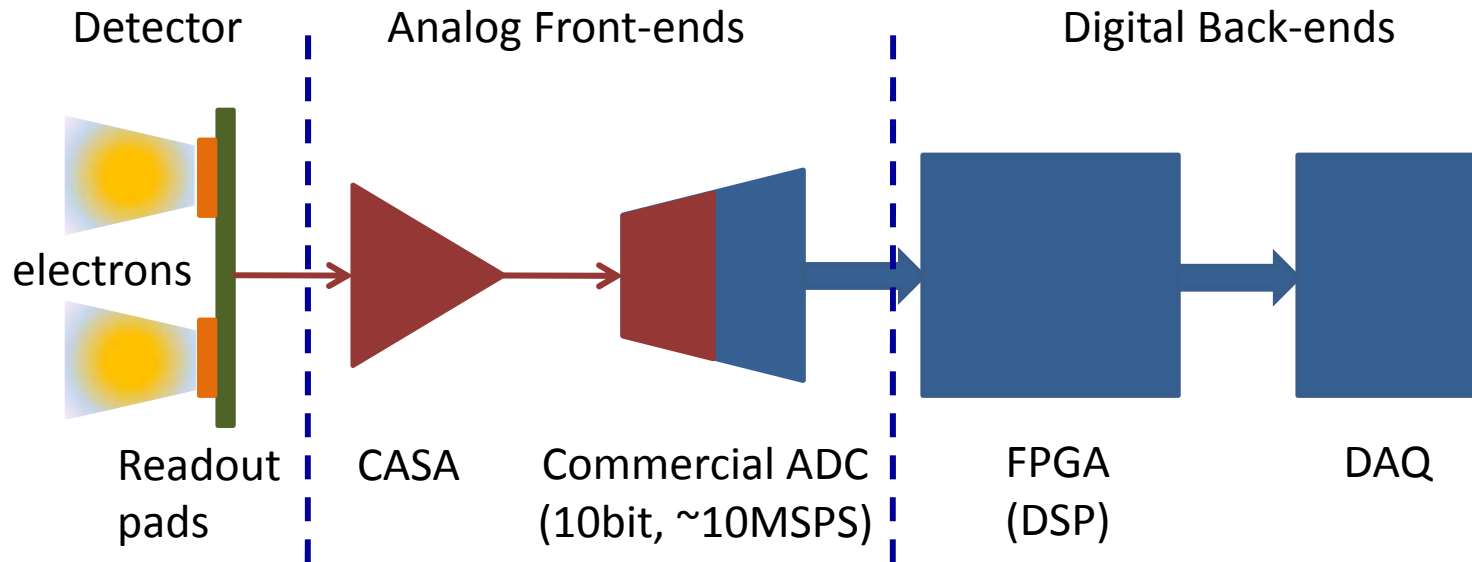
- Measurement of ion particle tracks in 3D
- Single particle detection
- Amplitude and timing needed
- $1 \sim 10$ channels/cm²

X-Ray Imaging

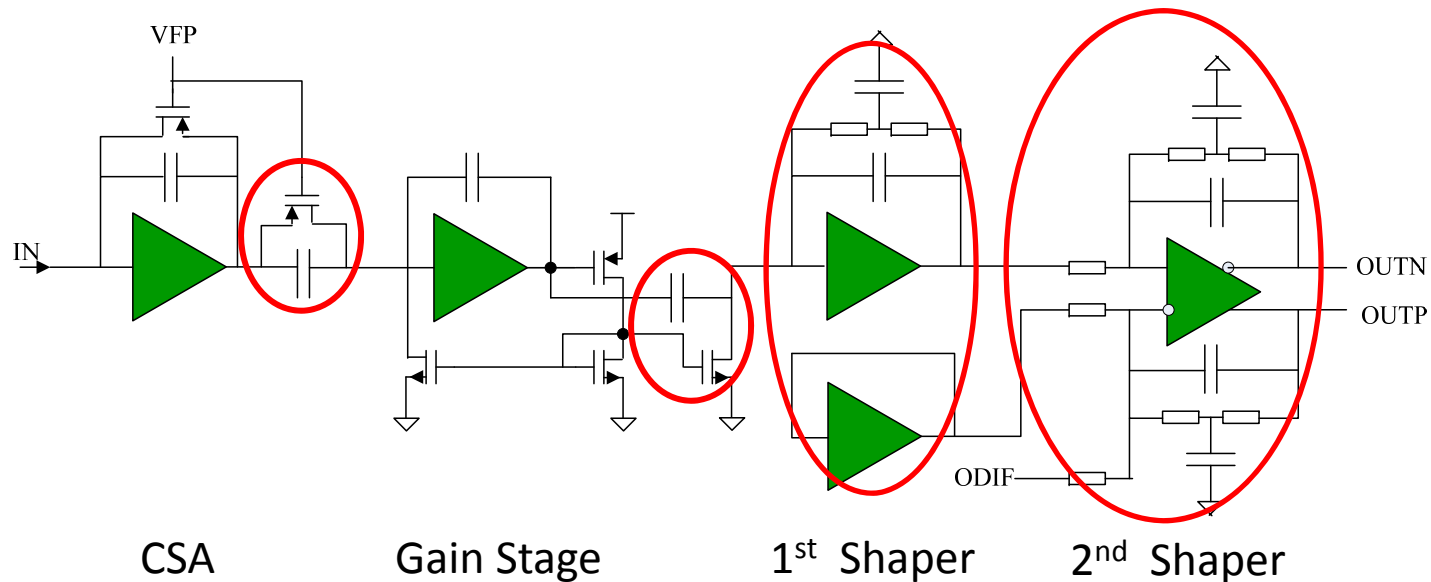


- 10~100keV photons
 - Integration or photon counting
 - Only amplitude needed
 - 1~100 channels/cm²
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Readout Electronics for Particle Tracking



CASA: the Front-end ASIC



Variable value of C, giving different charge gain, together with matched size of the MOS transistor

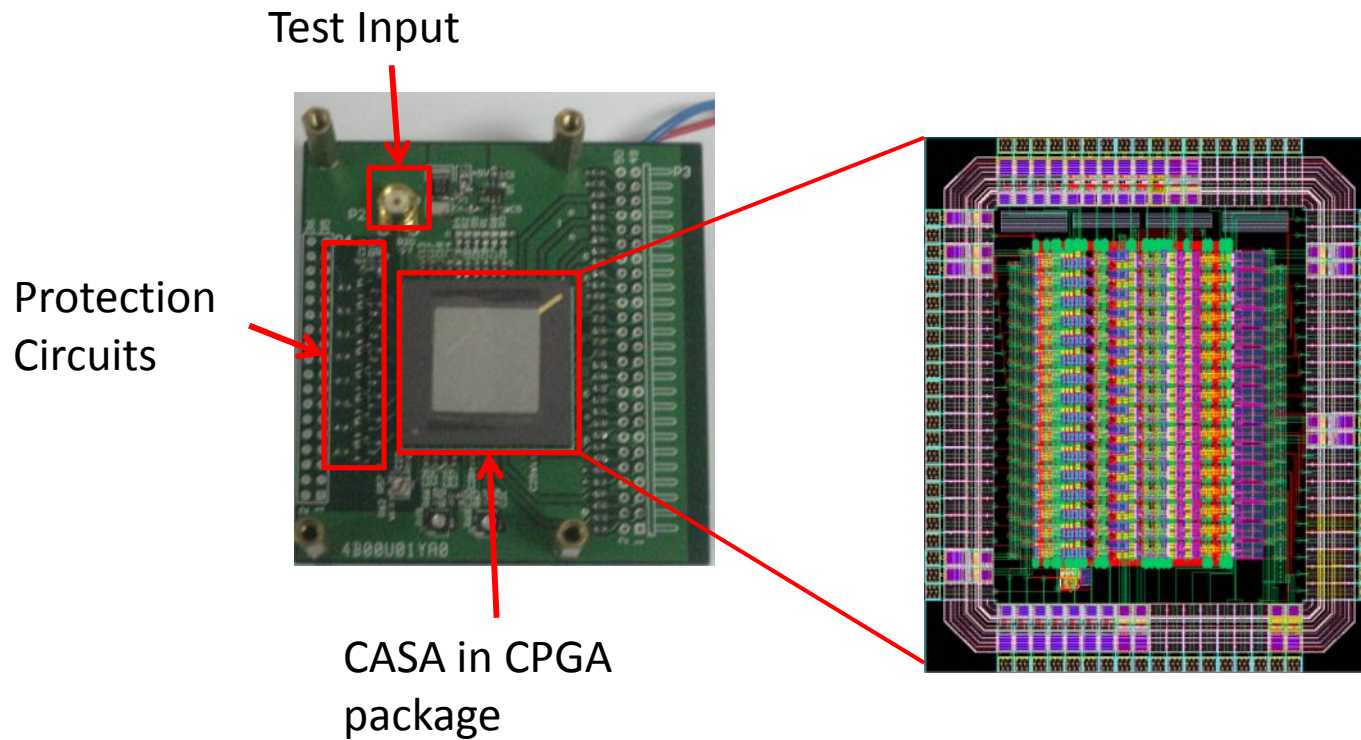
A dummy shaper amplifier, transfer signals to differential

A fully differential amplifier, with class-AB output stage

Specifications

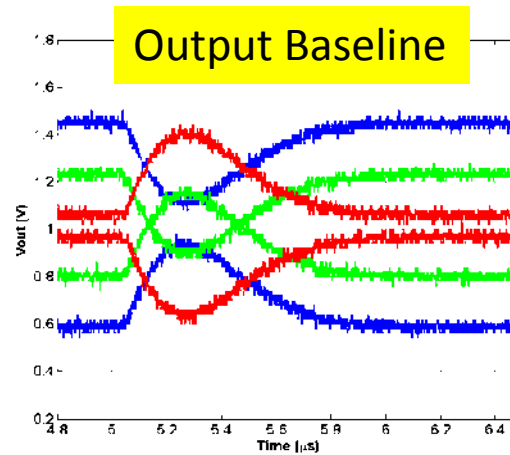
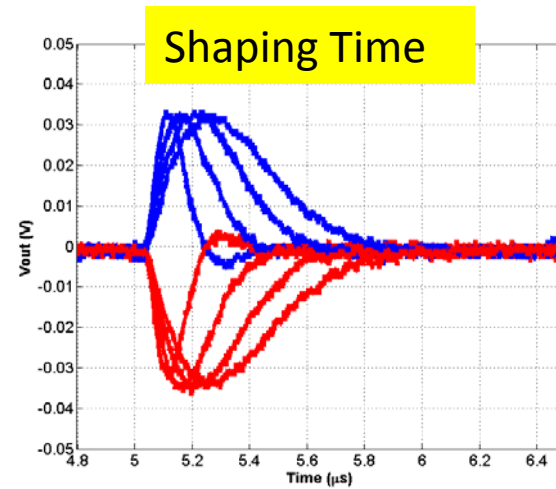
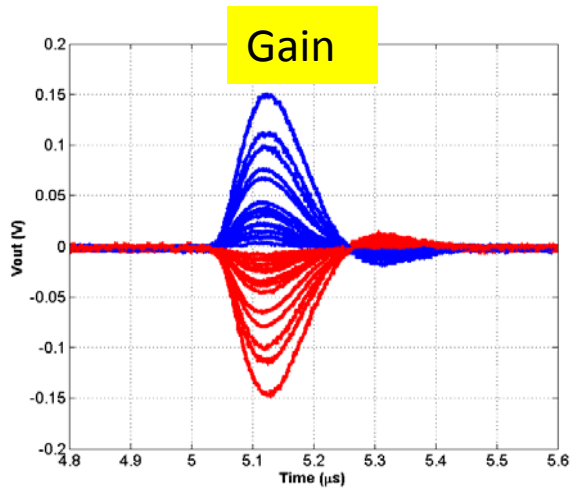
Input Charge	10-1500fC
<i>SNR</i> for MIP	>20:1
Gain (Differential)	1-28mV/fC, adjustable
Shaping Time (<i>t</i>)	25-100ns, adjustable
Output Swing	2 V p-p, differential
Drive Load	10pF
Crosstalk	<1%
Power Consumption	<10mW/ch

Front-End Board

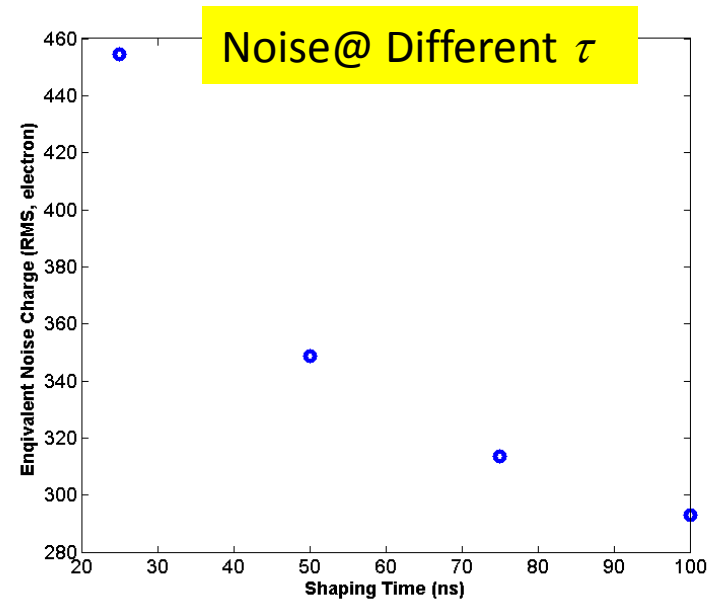
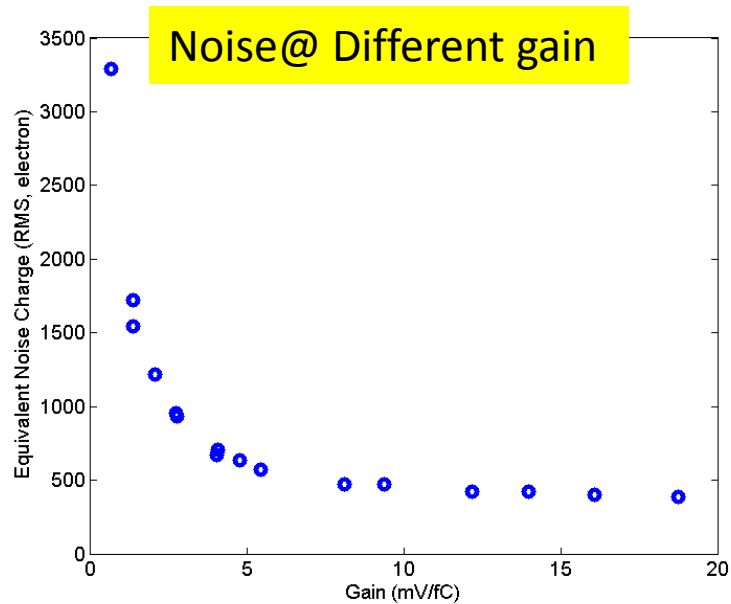


Power: 8.9 mW/ch
Crosstalk: <0.98%

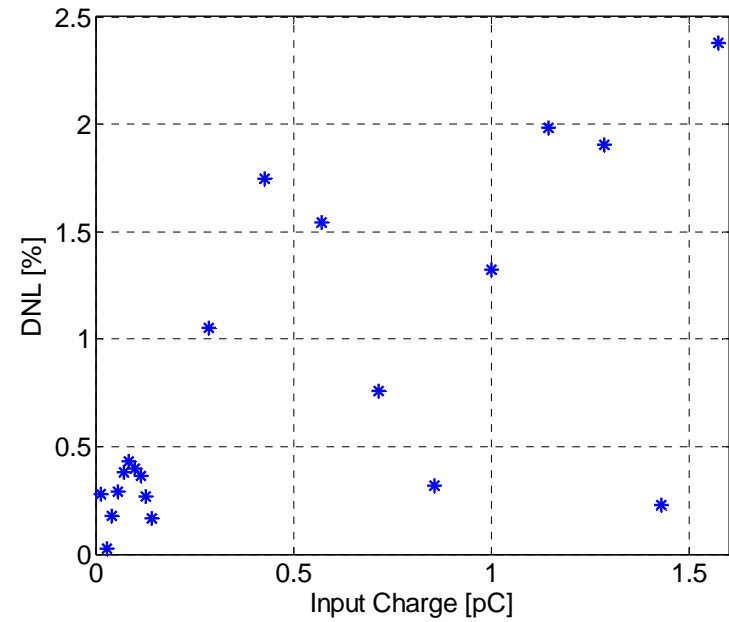
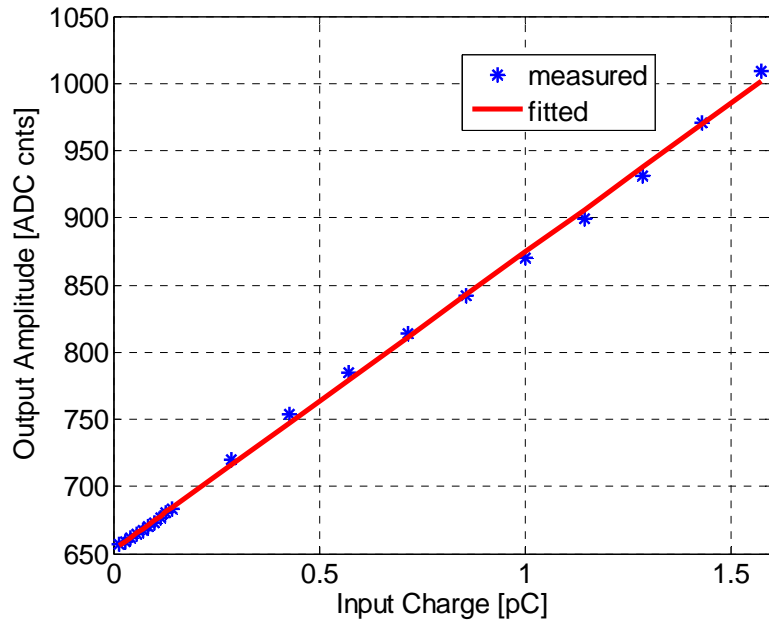
Programmability



Noise Performance

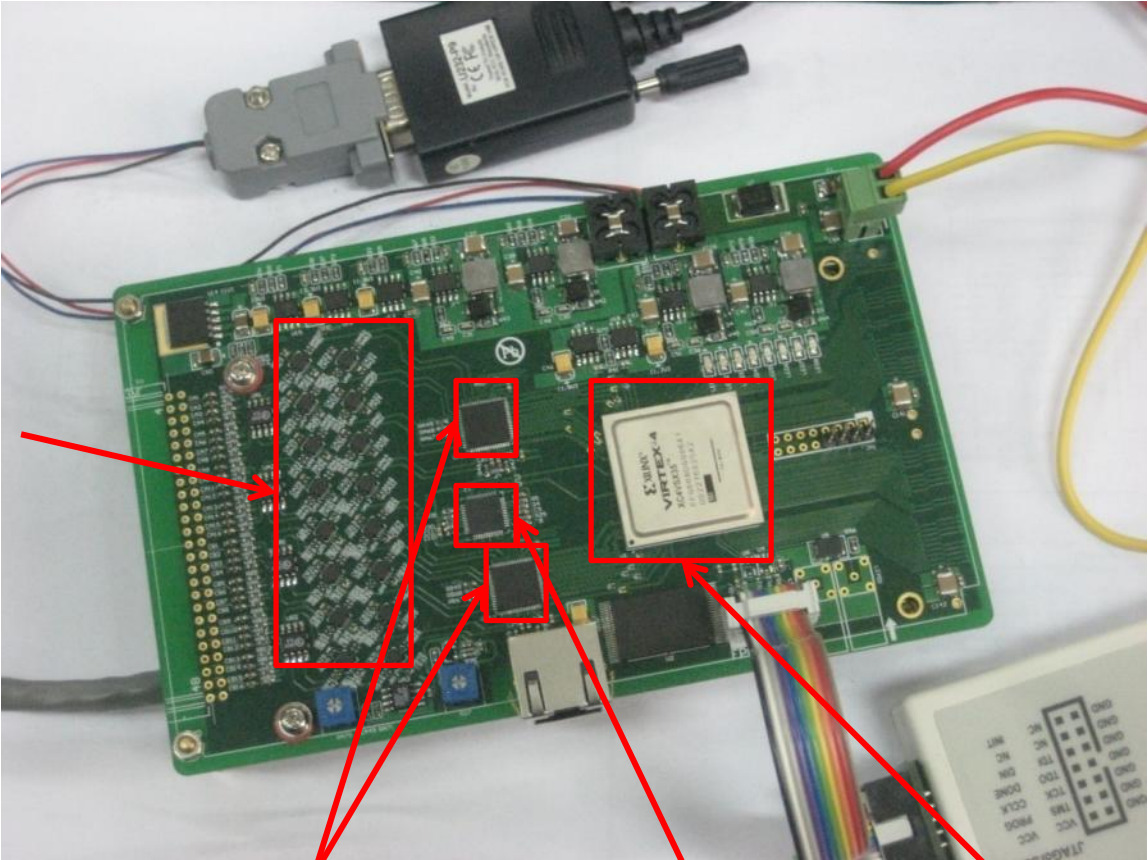


Linearity



Sampling and DSP Board

Input Buffer

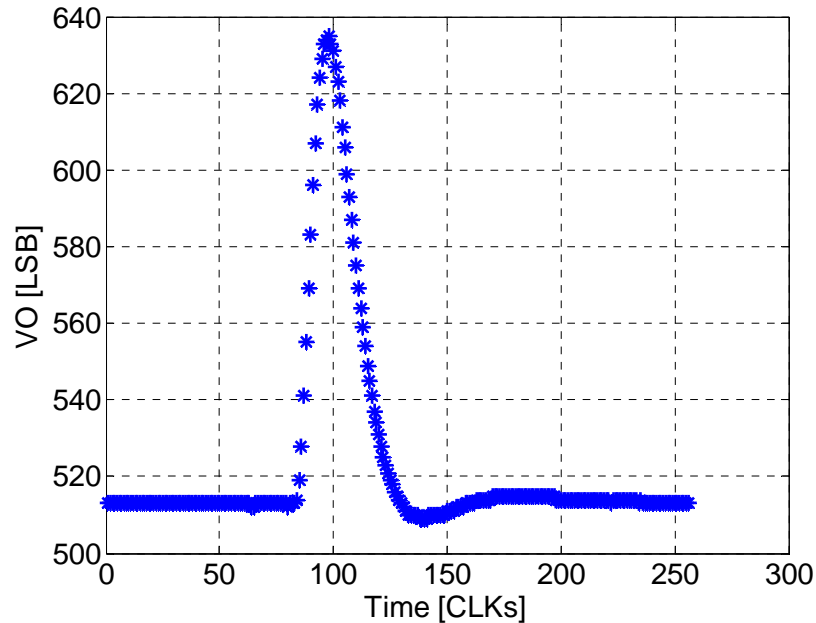


AD9212

CLK

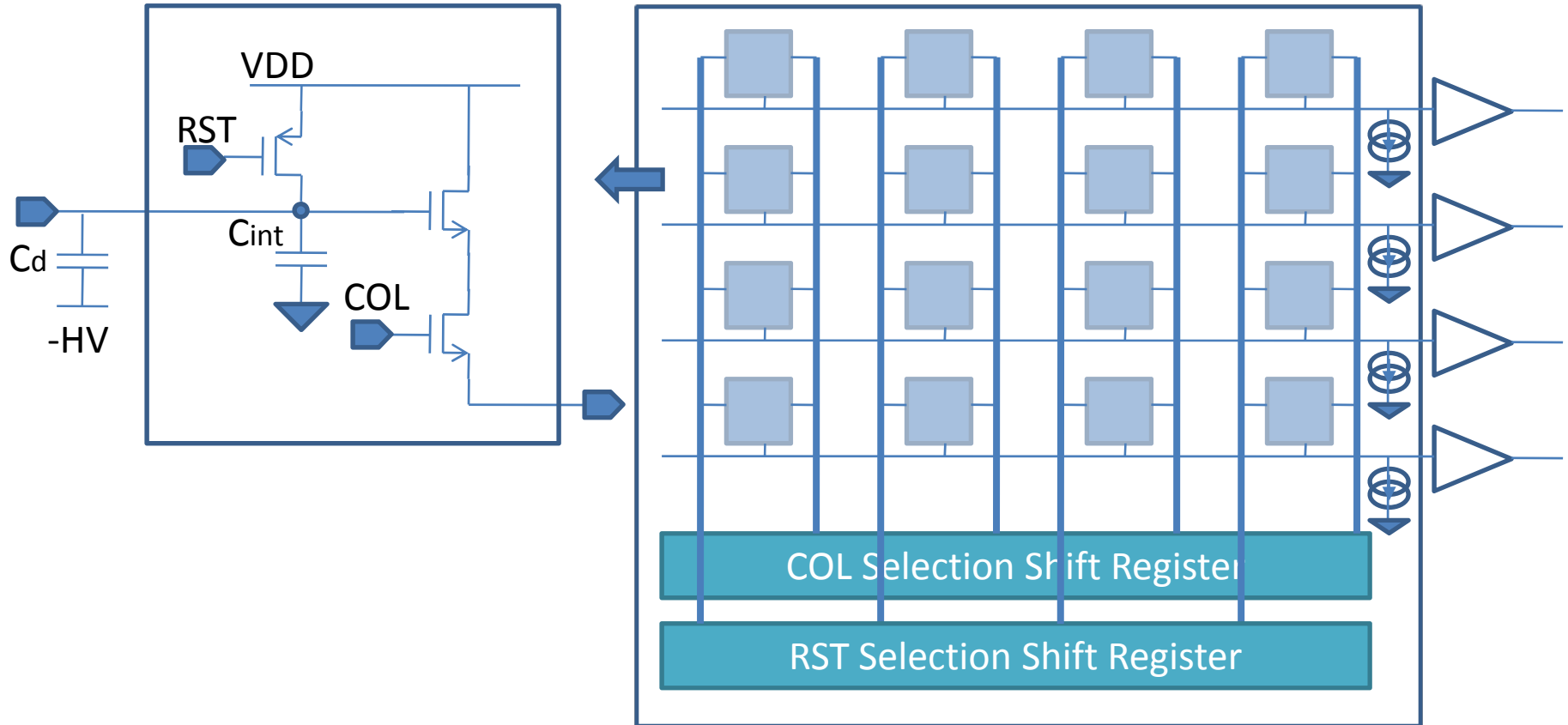
Xilinx XC4VSX35

Sampled Waveform

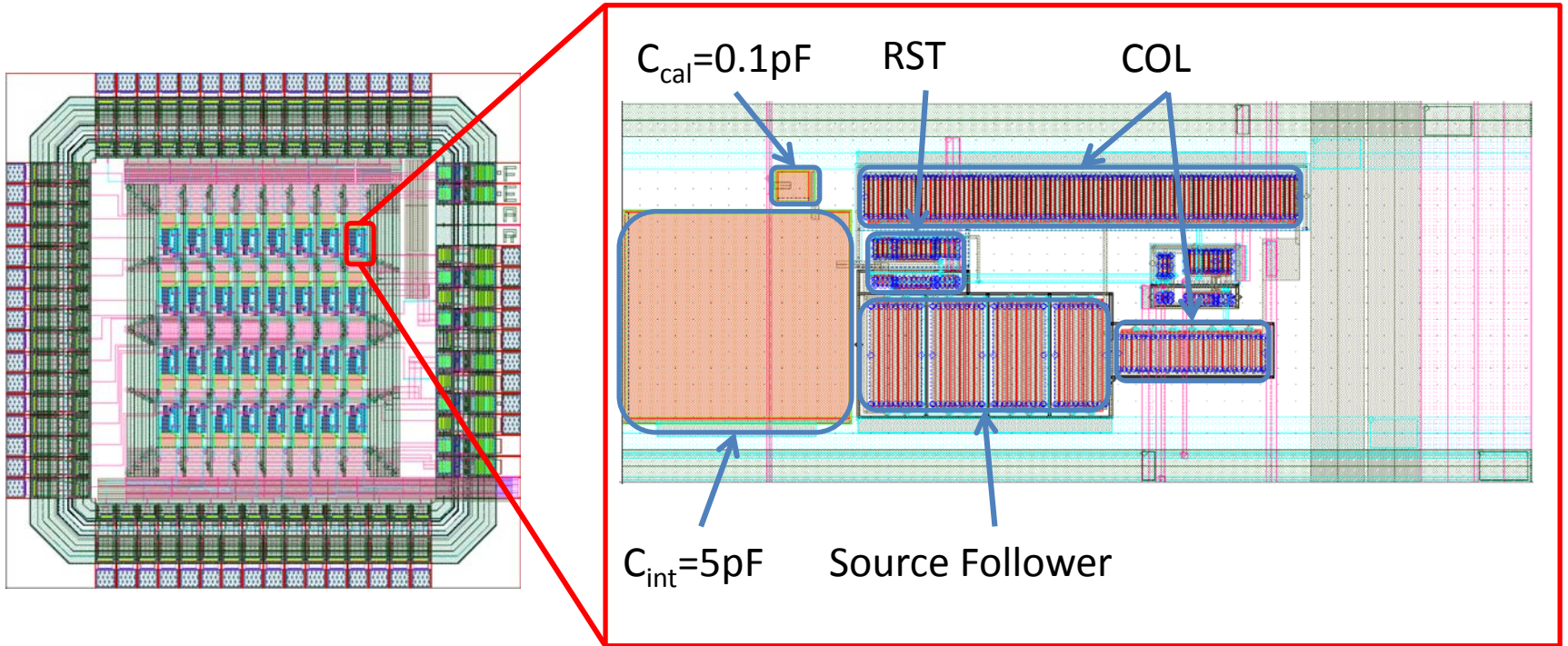


- Sampling @ 10bit 40MSPS
 - Two level buffers: Latency buffer and Derandomize buffer
 - 1000Mbps data output rate via Ethernet
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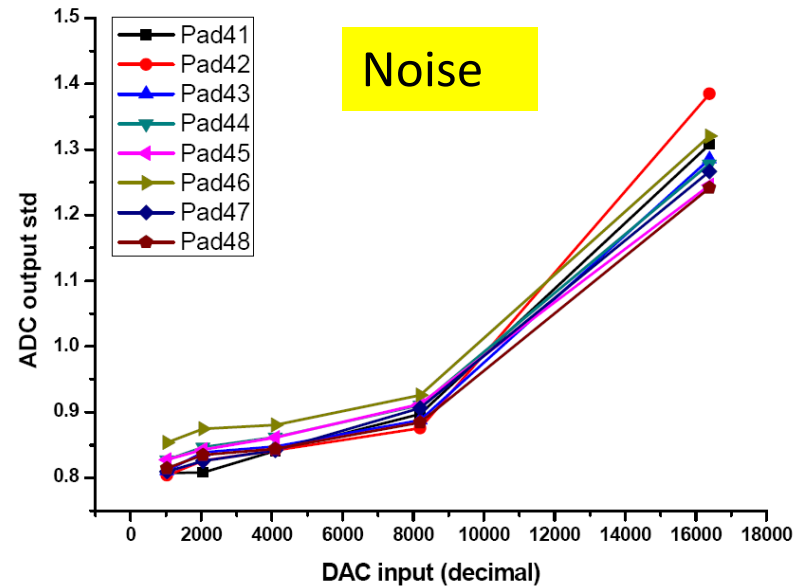
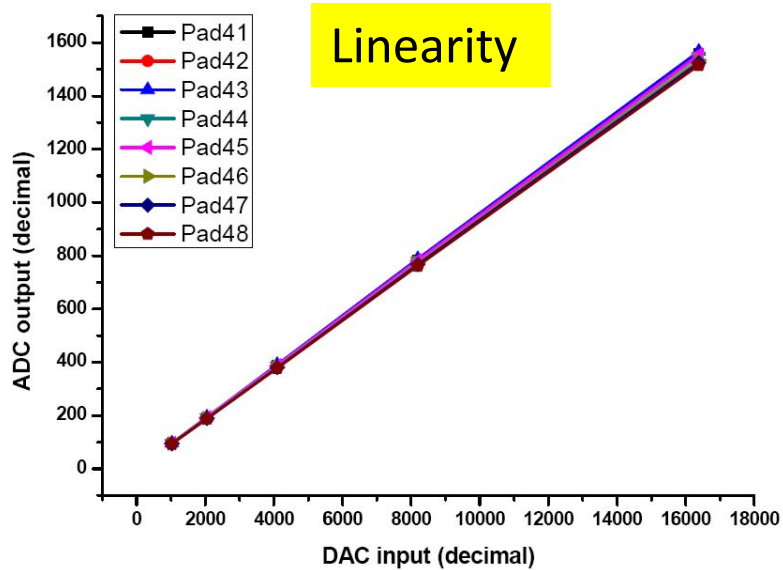
FEAR: FET Array Readout



Layout



Preliminary Test Results



Summary & Future Work

- Two different readout electronics system for GEM detector are developed for particle tracking and X-ray imaging
- Two frontend ASICs, named CASA and FEAR are designed and tested
- Further tests with detectors and dedicated DSP filter design are undergoing

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