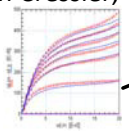
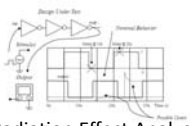
Section 2 Overview Chart

Title and Research Team

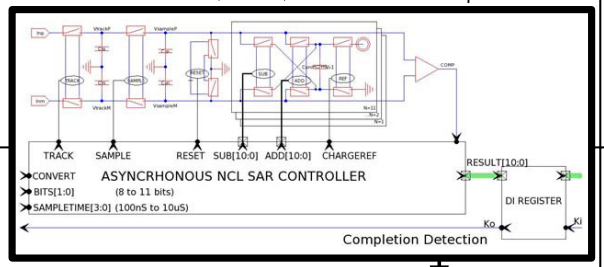
- Title: Asynchronous A/D Converter for In Situ Instruments Operating under Extreme Environments
- PI: Dr. Jia Di, University of Arkansas
- Co-PI: Dr. H. Alan Mantooth, University of Arkansas
- Subawardee: Dr. A. Matthew Francis, Ozark Integrated Circuits, Inc.
- Consultant: Dr. John Cressler, Georgia Institute of Technology



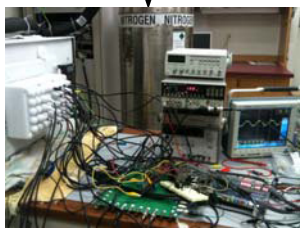
9HP Cryo Temp. Device Modeling



Radiation Effect Analysis and Circuit Optimization



9HP Asyn. ADC Design for Extreme Environments



Fabricated Prototype Testing under Extreme Temperatures

Research Objectives

- Design, optimization, fabrication, and testing of an asynchronous A/D converter using a cutting-edge semiconductor node capable of operating reliably under extreme temperatures and heavy radiation
- Compared to the prevailing clocked ADC, the asynchronous ADC eliminates temperature dependencies on clock skew, which greatly simplifies *in situ* data collection under different temperatures
- Leveraged from the 0.5µm IBM 5AM process, the use of 90nm 9HP process enables the design of extreme environment electronics with miniaturization, high performance, low power, and high robustness
- Start at TRL-2 (theoretical concept of the ADC has been formulated. Practical application has been identified - in situ space instruments. However, no experimental proof or detailed analysis is available)
- End at TRL-3 (a prototype ADC will be designed and tested, which will provide results and laboratory hardware demonstration to support the analytical study)

Approach

- 9HP device modeling for cryogenic temperatures
- Asynchronous digital cell library development and digital component design
- Analog component design
- ADC schematic integration and verification
- ADC preliminary layout
- Radiation effect analysis and circuit optimization
- ADC parasitic extraction and verification
- Test chip integration and fabrication
- Fabricated chip testing and result analysis

Potential Impact

- The elimination of external protection mechanisms (e.g., warm boxes for isolating electronics from space temperatures) to house the electronics reduces the volume and weight of spacecraft, which reduces the cost to launch the vehicle, or allows additional scientific instrumentation to be flown in lieu of the “dead weight” associated with such protection mechanisms
- New electronic architectures are made possible, e.g., distributed data processing, reliable communications, and higher fidelity measurements, which enable the exploration of new opportunities and innovations in space instruments, probes, rocket engines, and a host of other locations that the lightweight and miniaturized, but significant data collecting and processing capability of integrated circuits allows