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Streamlining the TA-V Effort: Applying Nuclear Technologies in Radiation Environments



David Saucier & Drew Tonigan

- Drew
 - Finished Senior Year at the University of New Mexico pursuing a B.S. in Nuclear Engineering with a victory lap finish to graduation in December
 - Likes flag-football, soccer, softball, occasionally throws the javelin
 - Mentor: Allison Miller (+ Mike Luker)
- David
 - Entering Senior Year at the University of New Mexico pursuing a B.S. in Nuclear Engineering
 - Loves- Computers, Outdoors and Swimming
 - Mentors: Russell DePriest and Dave Vehar
- Both 'burque natives!
- Both ANS Presidents!



Outline of Discussion

- Goals
- Overview of Pulsed Reactor Experimental Process
- Experimental Setup
 - Dose Measurement
 - Dose Rate Measurement
- Logic Controlled Switched Resistor Photoconductive Detector Technique
- PXI Data Acquisition Hardware
- High Speed Digital I/O Logic Control

➤ The Goals

- Develop scripts using NI's DIADEM software with user input to automate calculations on a variety of experimental data sets
- Reduce the amount of data acquisition hardware necessary for measuring the pulsed radiation environment by using state of the art National Instruments (NI) PXI hardware for data acquisition and instrument control



Experimental Process

Perform Experiment

- Record Measurements:
- Calorimeters
- Pin Diodes
- Photoconductive Detectors
- Self Powered Neutron Detectors.

Analyze Data

- Reduce Instrument Signals to physically meaningful units for Total Dose and Dose Rate
- Account for mixed field radiation effects and heat transfer

How'd it go?

- Compare to the expected results for radiation environment and the experimental package response



Performing the Experiment

- Need to obtain an accurate description of the environment created by a pulse to provide the customer
- Electronic Detector Equipment Accompanies Experimental Package
 - Dose Measurement: Calorimeter & Activation Foils
 - Dose Rate Measurement: Photoconductive Detector (PCD) & Self Powered Neutron Detectors (SPNDs)
 - Can be coupled with Logic Controlled Switched Resistor Board

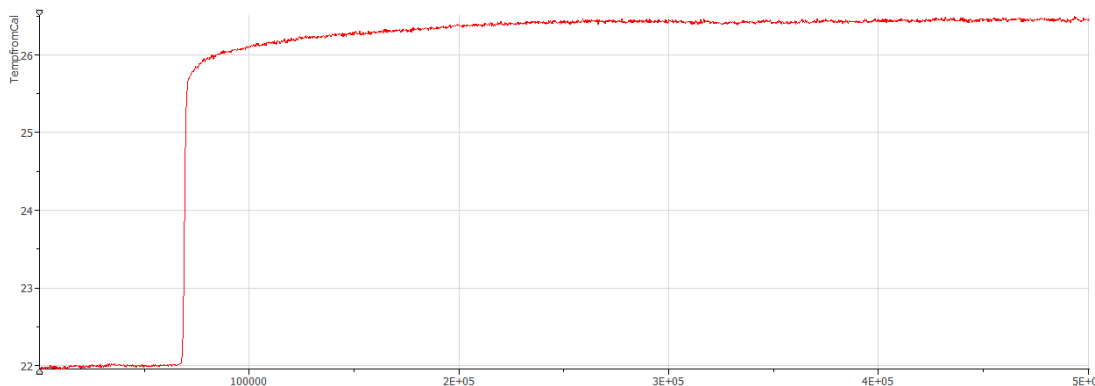


Experimental Package



Dose Measurement

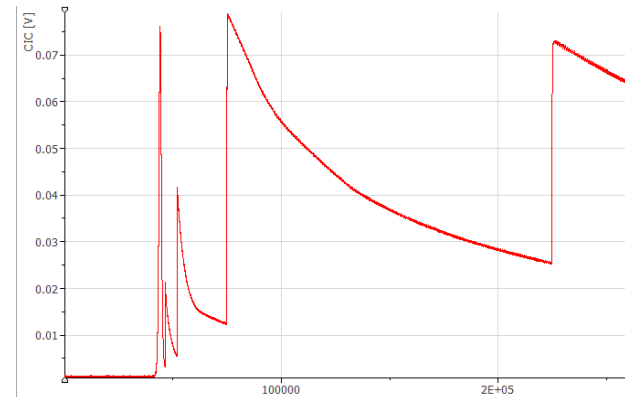
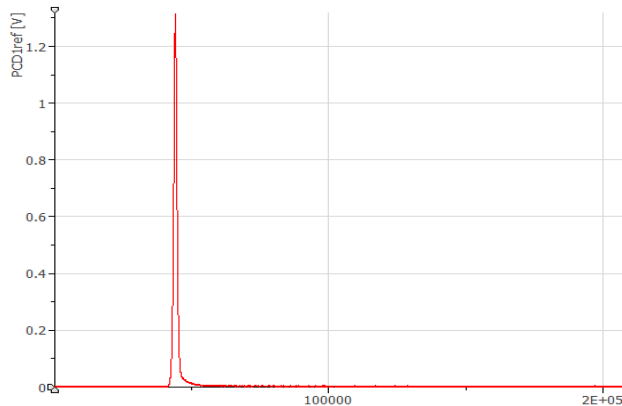
- Calorimeters Measure the change in temperature of a particular material
 - Use Calorimeter Materials to match the experimental package
 - Temperature change is found using the voltage across the material and an empirically derived 9th order polynomial fit
 - The radiation absorbed dose is then directly proportional to the change in temperature of the material



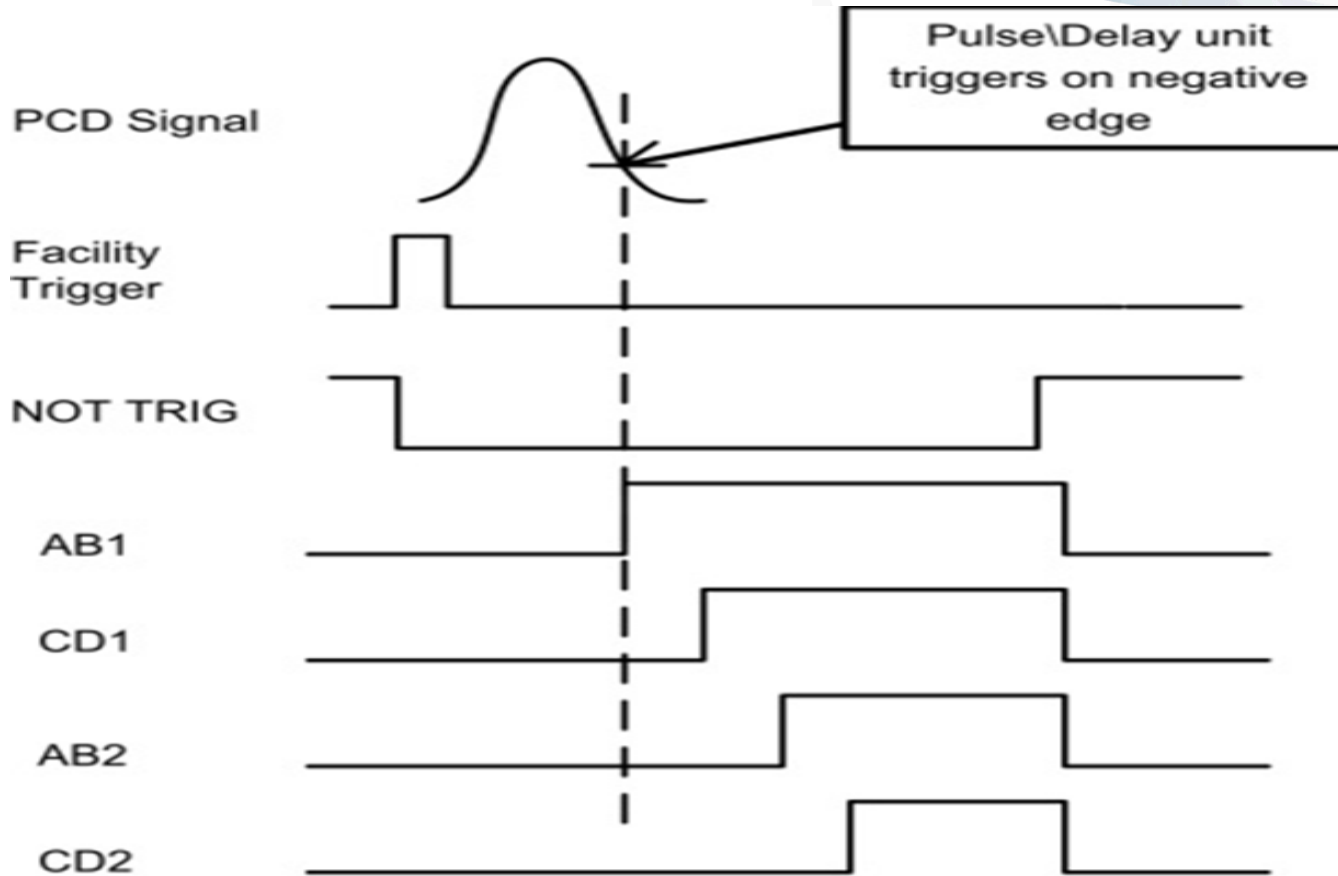
Dose Rate Measurement

➤ Photoconductive Detector

- Responses to the rate at which photons strike the diamond within the detector and is representative of dose rate provided to the experimental package. PCD's have extremely fast response to radiation.
- Can be coupled to a Logic Controlled Switched Resistor board to increase the applied voltage as the pulse progresses and increase the signal resolution

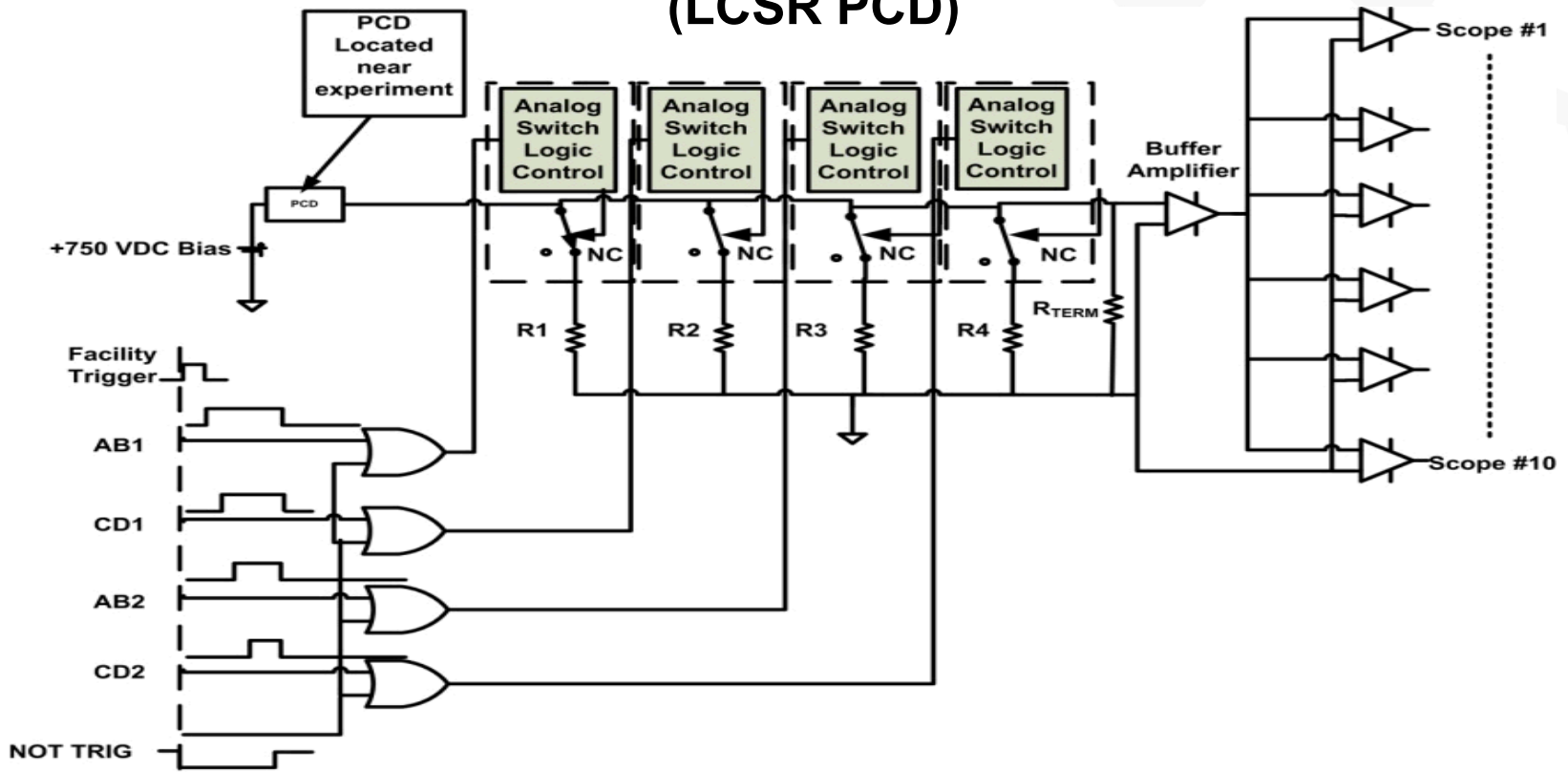


Logic Controlled Switching



Photoconductive Detector with LCSR

Logic Controlled Switched Resistor Photoconductive Detector (LCSR PCD)



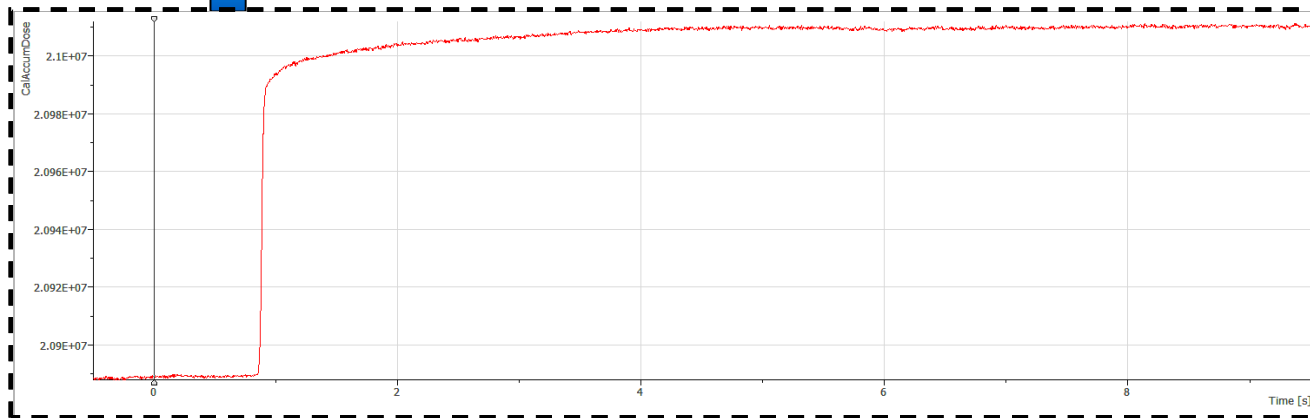
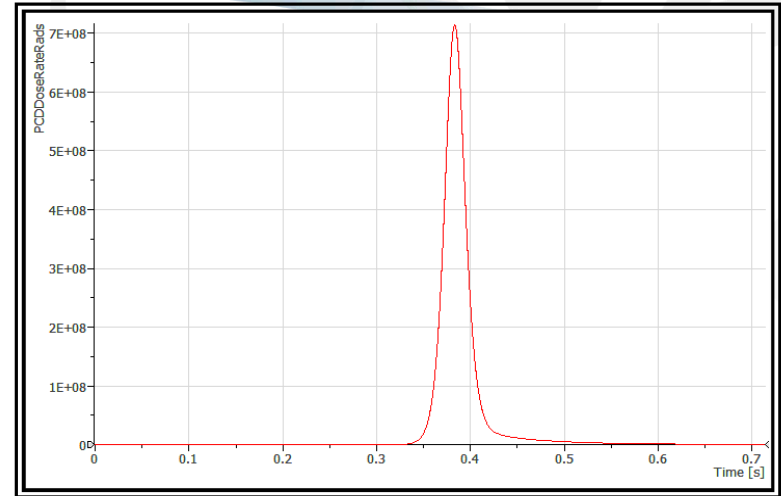
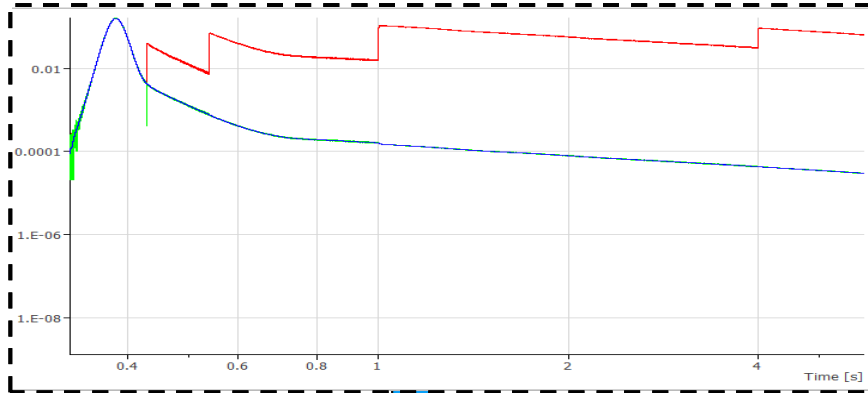
Dose Rate Data Reduction

- Change in signal voltage is directly proportional to the resistance of the circuit with each switch arrangement engaged
- The integral of the rate response of the PCD physically corresponds to the dose already obtained by the calorimeter
- Therefore this relationship can be used to convert the voltage signal of the PCD to a dose rate measurement

$$\frac{\text{Rad}_{Si}}{\text{second}} = \text{Volt}_{PCD} \frac{\text{Rad}_{Si}}{\text{Volt}_{PCD} \text{second}}$$

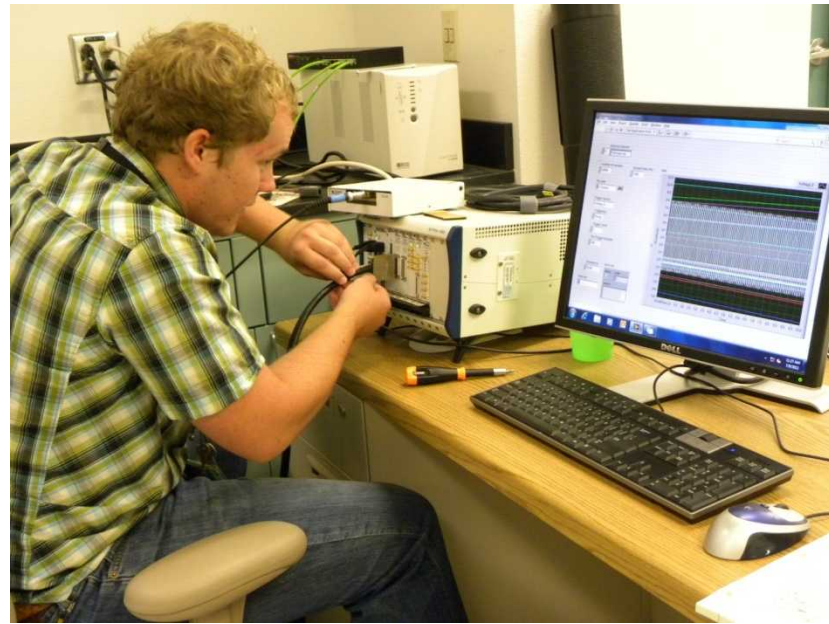


Data Analysis: Bringing it all together



Improving Acquisition: Next Generation Hardware

- The PXI system hardware can run on the Windows OS which allows its installed hardware cards to be operated by Labview software and data can be easily loaded into to DIADEM
- PXI Hardware can be fitted with NI 6358 DAQ Digitizer cards which offer comparable functionality to the Yokogawa scopes but uses high density wiring to reducing the required cabling



Improving Acquisition: Logic Control

- The PXI system can also be fitted with NI 6551 High Speed Digital I/O (HSDIO) hardware card capable of generating logic signals
- Allows for use of single PXI card to generate the logic signals for up to 4 LCSR PCD's
- Logic signals are sent through high density cable and generated in Labview



Comments or Questions

- Any questions, burning comments, etc?

