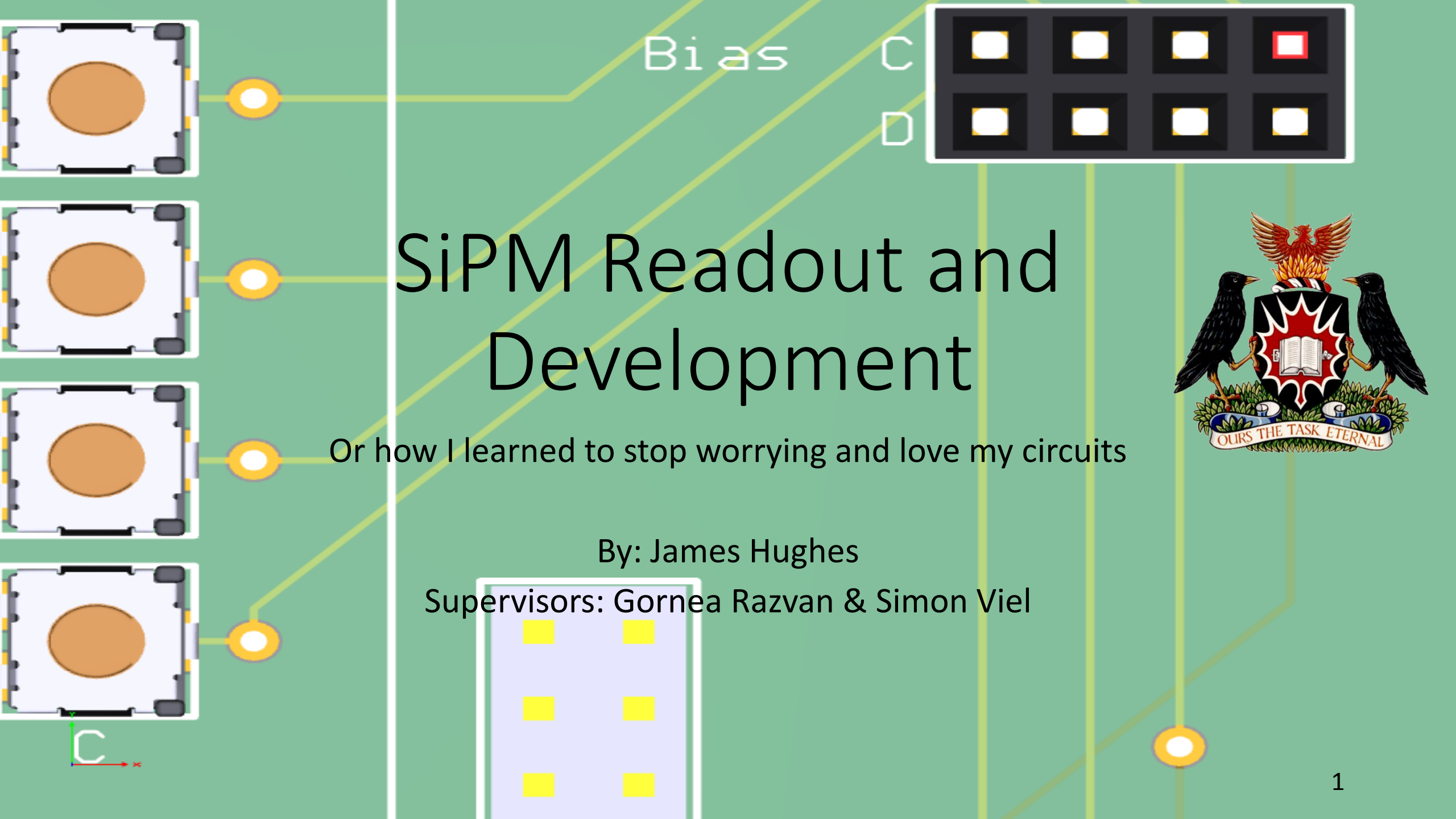


SiPM Readout and Development

Or how I learned to stop worrying and love my circuits

By: James Hughes

Supervisors: Gornea Razvan & Simon Viel

Contents

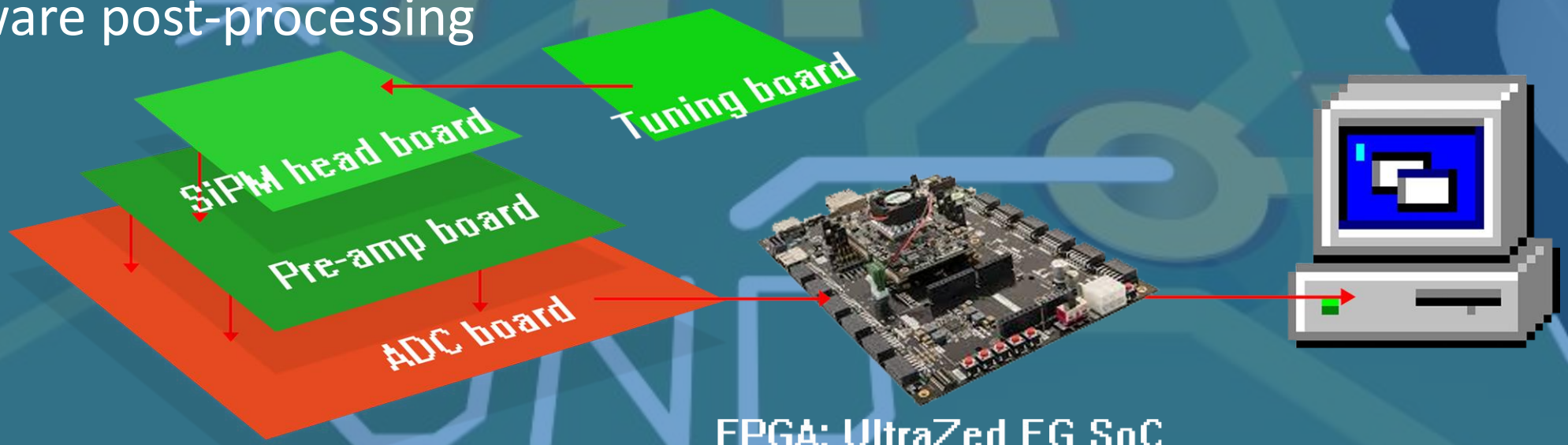
- Task & layout
- FPGA
  - What I learned and what needs to be done
- PCB design
  - What I completed, and what's next
- Final thoughts

The Principle and my Task

- This SiPM will be used to test the efficiency of the Ba extraction probe in nEXO
- To do this the SiPM will act as an alpha spectrometer which measures the energy and location of alpha particles
- The SiPM was chosen but there was no driving equipment chosen
- I was tasked with constructing the boards used to run the SiPM and some pre-processing to make the signals into information for a lab PC to handle

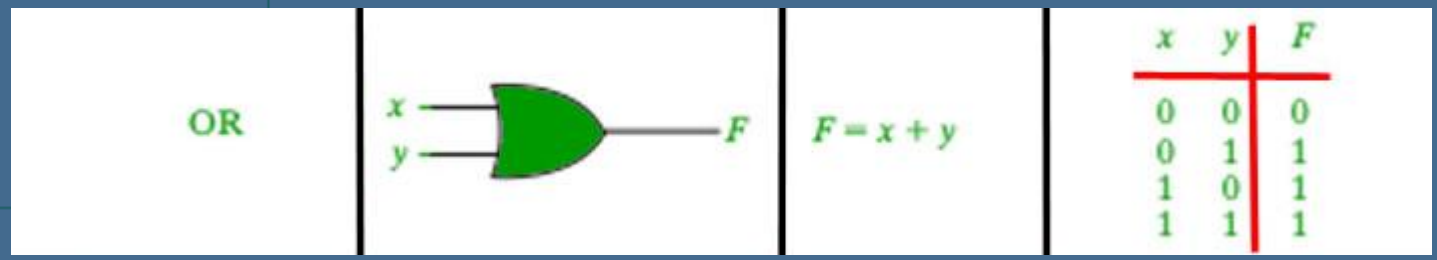
The Planned Layout

- Adapter board
- Voltage Bias board
- Pre-amp board
- ADC board / commercial solution
- FPGA pre-processing
- Software post-processing



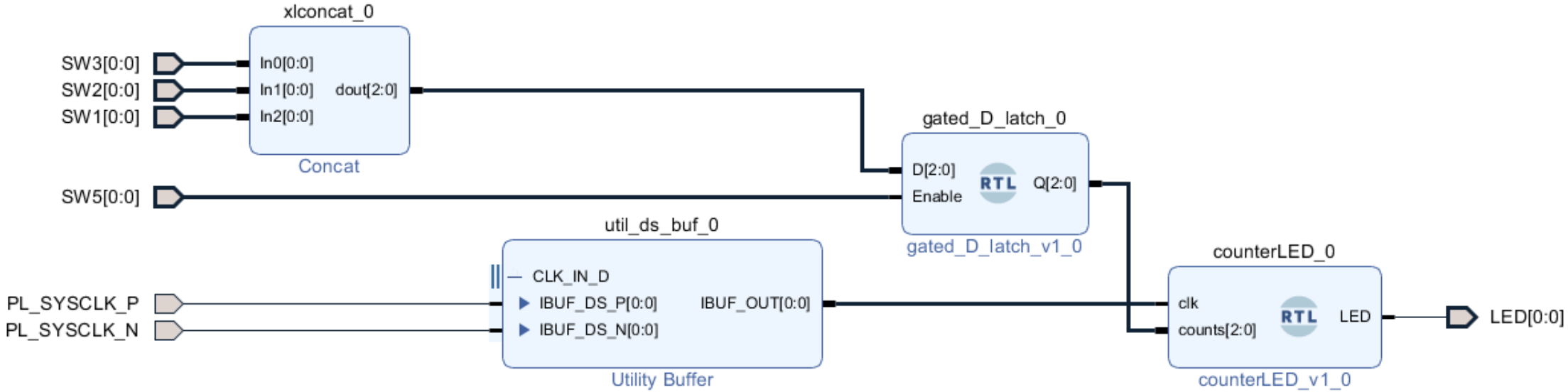
What is an FPGA, and why choose it?

- We want a unit that can take in 16 signal channels and process all simultaneously
- Micro-controllers process information in series, whereas an FPGA is a matrix of logic gates that can be configured to do multiple processes at once
- Logic gates can be thought of as circuits with 1+ inputs, and output a signal based on a truth table. Examples: ‘AND’, ‘OR’, and ‘XOR’ gates



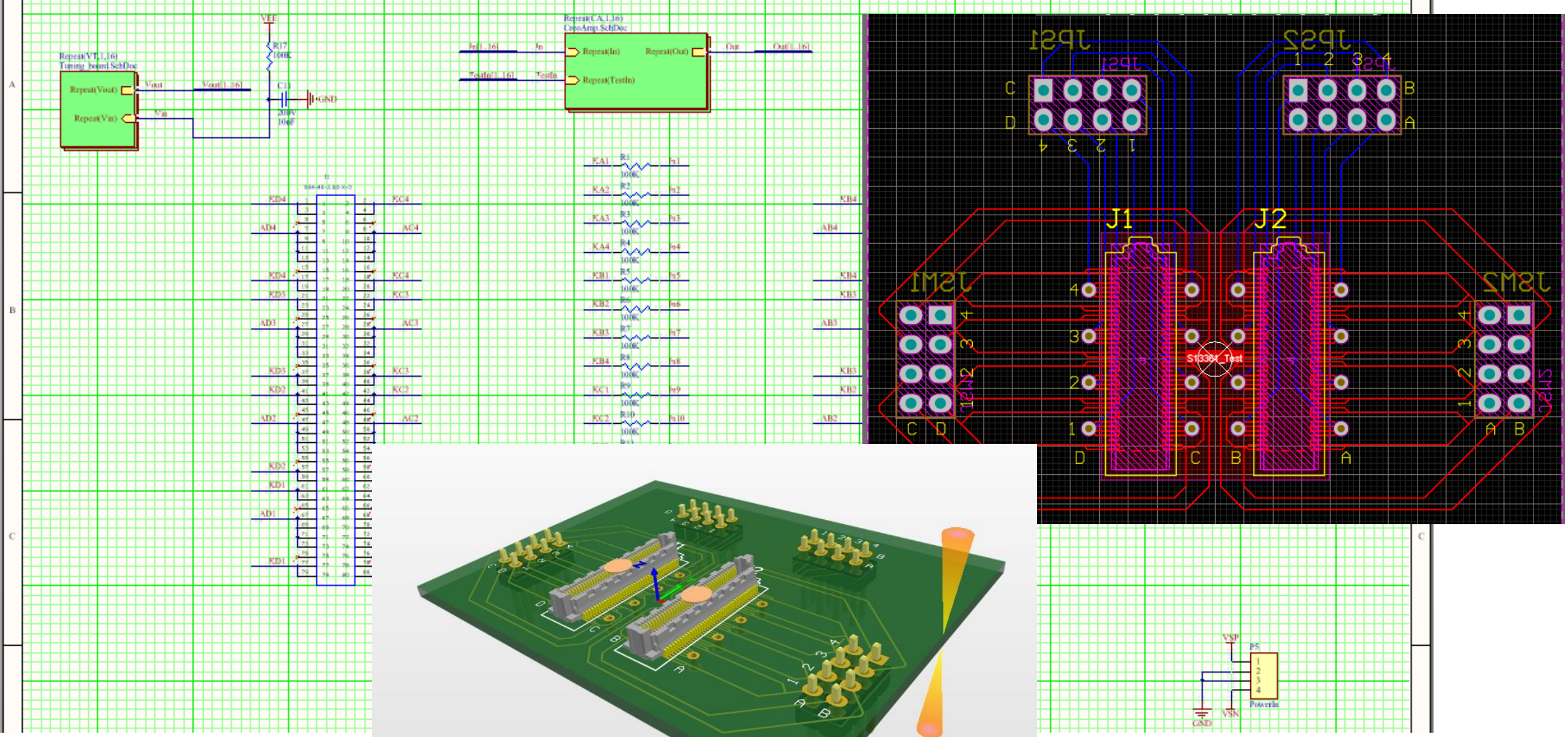
FPGAs continued

- It is also possible to ‘program’ an FPGA using a Hardware Definition Language (HDL). These ‘programs’ are sent to a piece of software that configures the circuit on the chip.
- One such language is Verilog
- Generally the first program on any FPGA is ‘Blinky’ the simplest logical program that can be run.

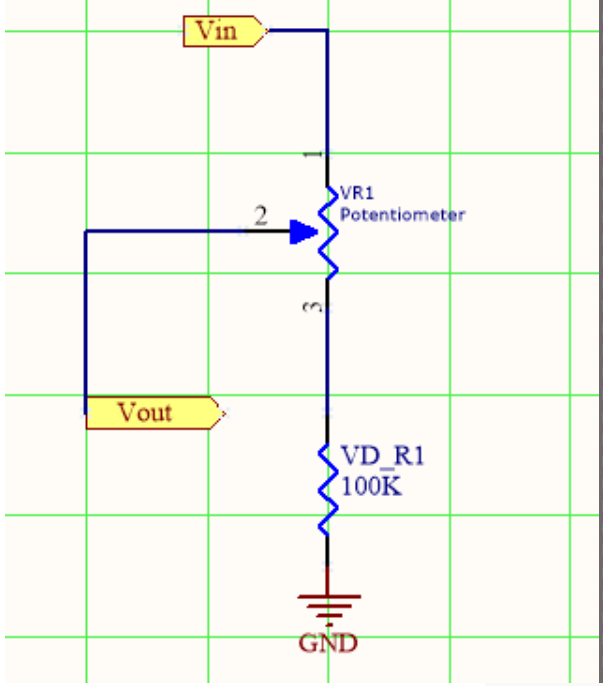


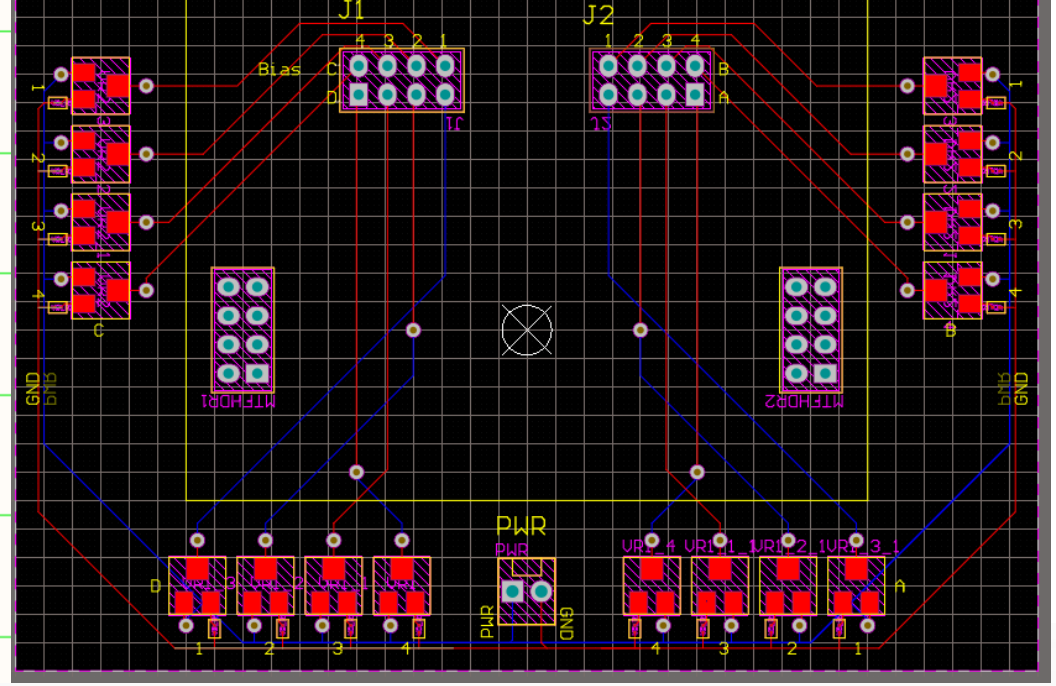
PCB design

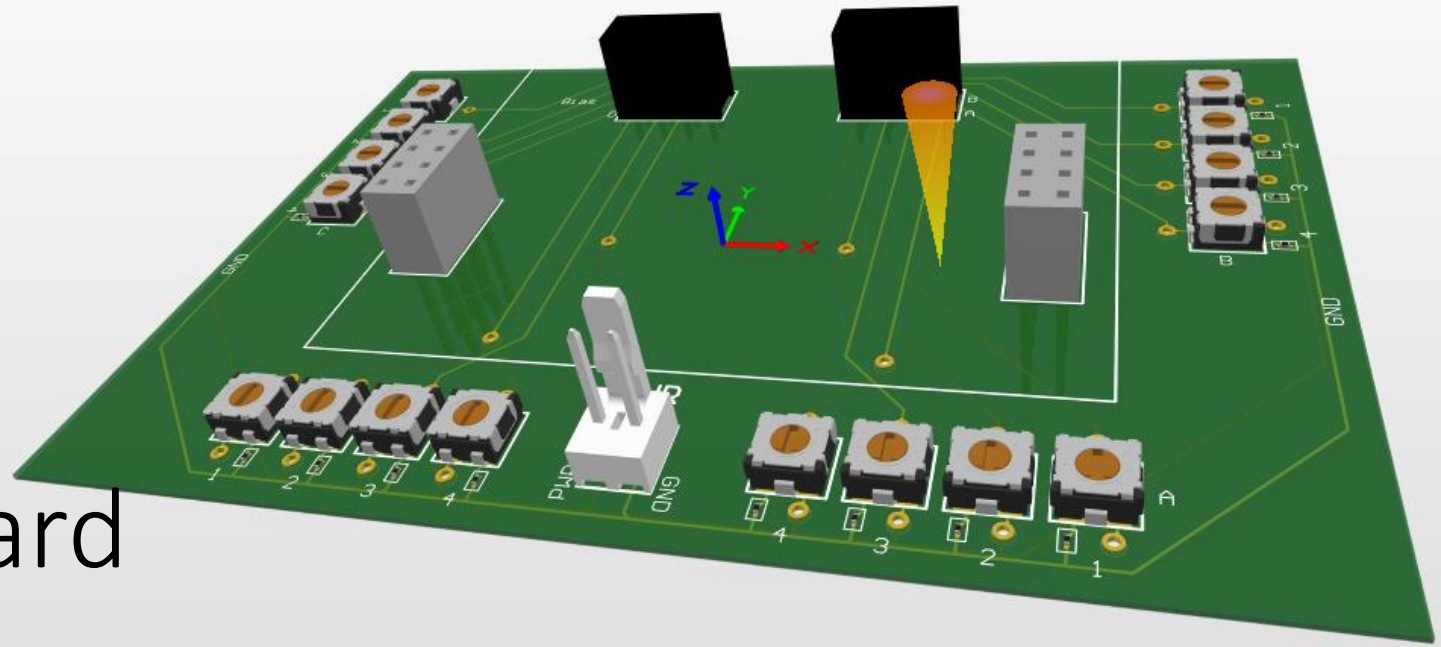
- Printed Circuit Boards are the little (typically green) boards that house chips and other various circuits.
- In order to house the detector, we had to design the circuits for it
- Designing circuit boards is like building legos



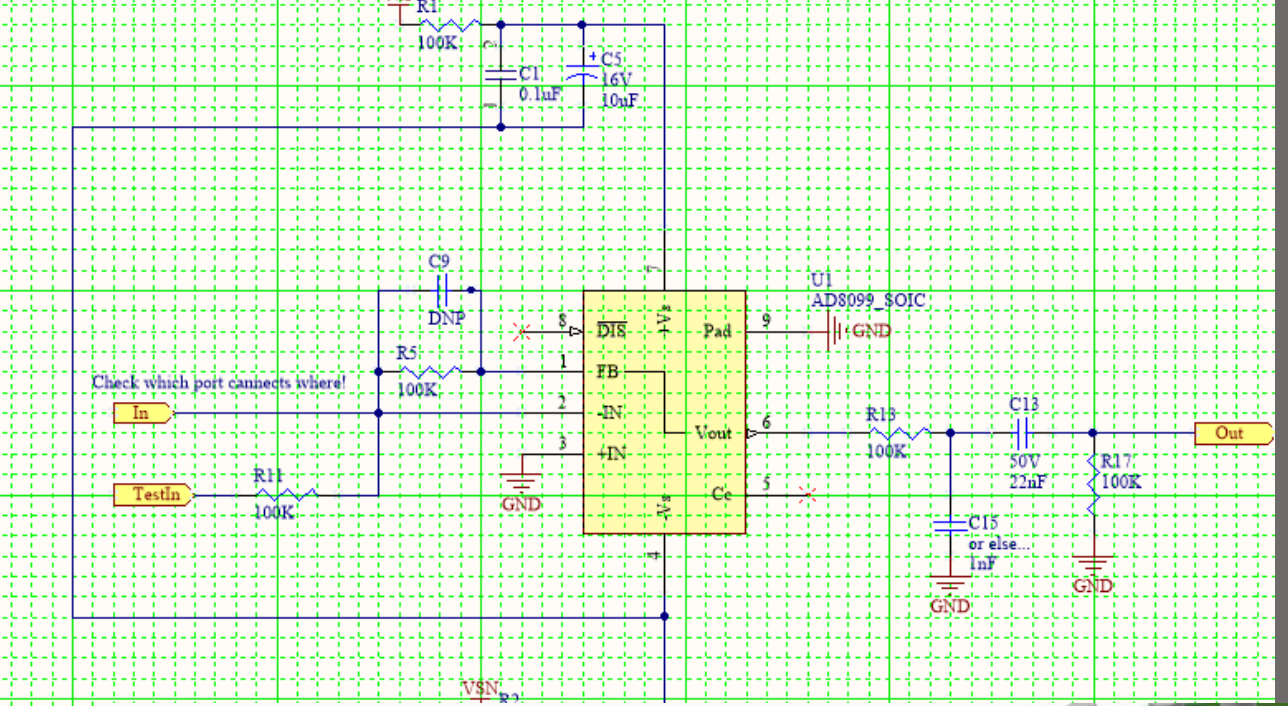
Adapter board

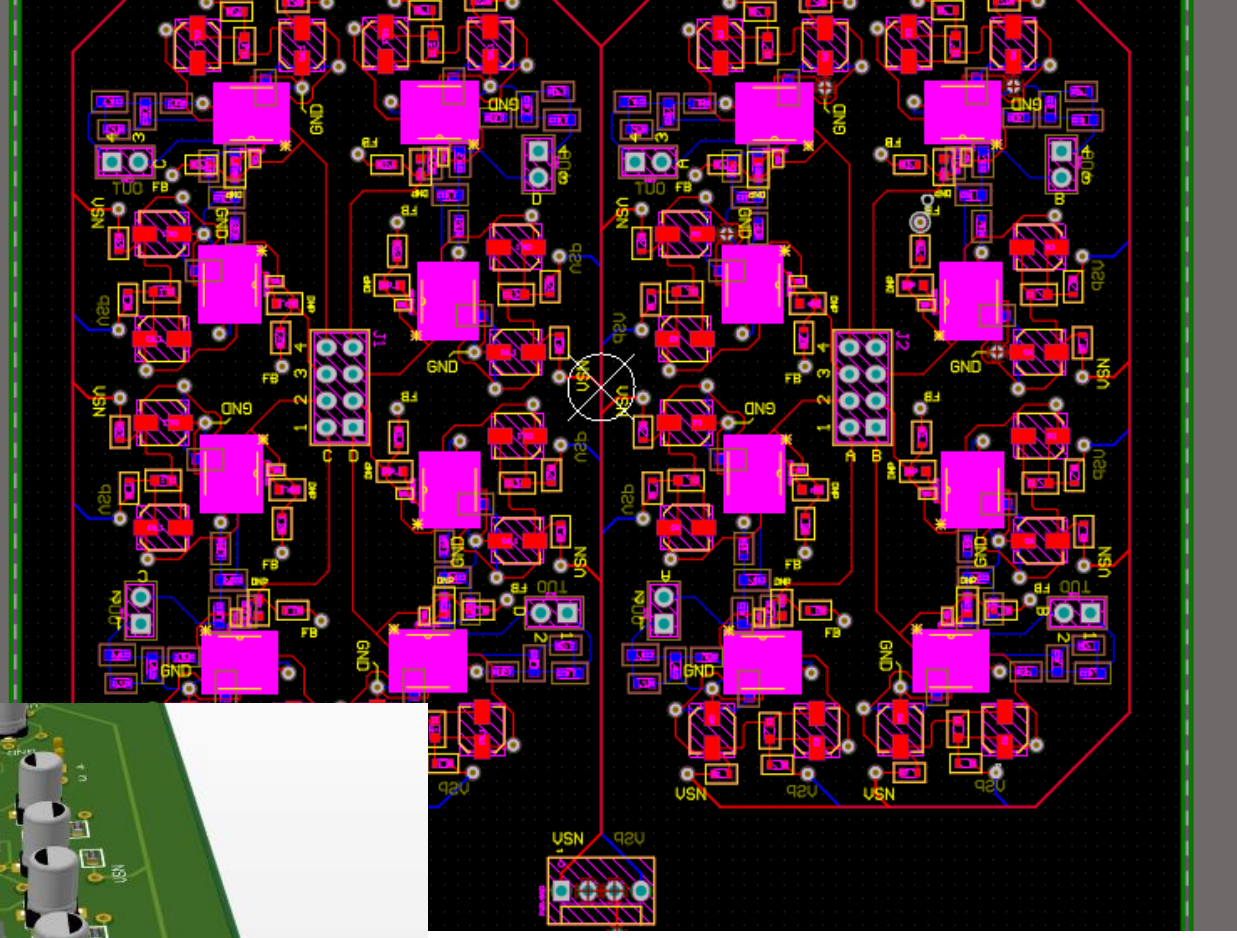


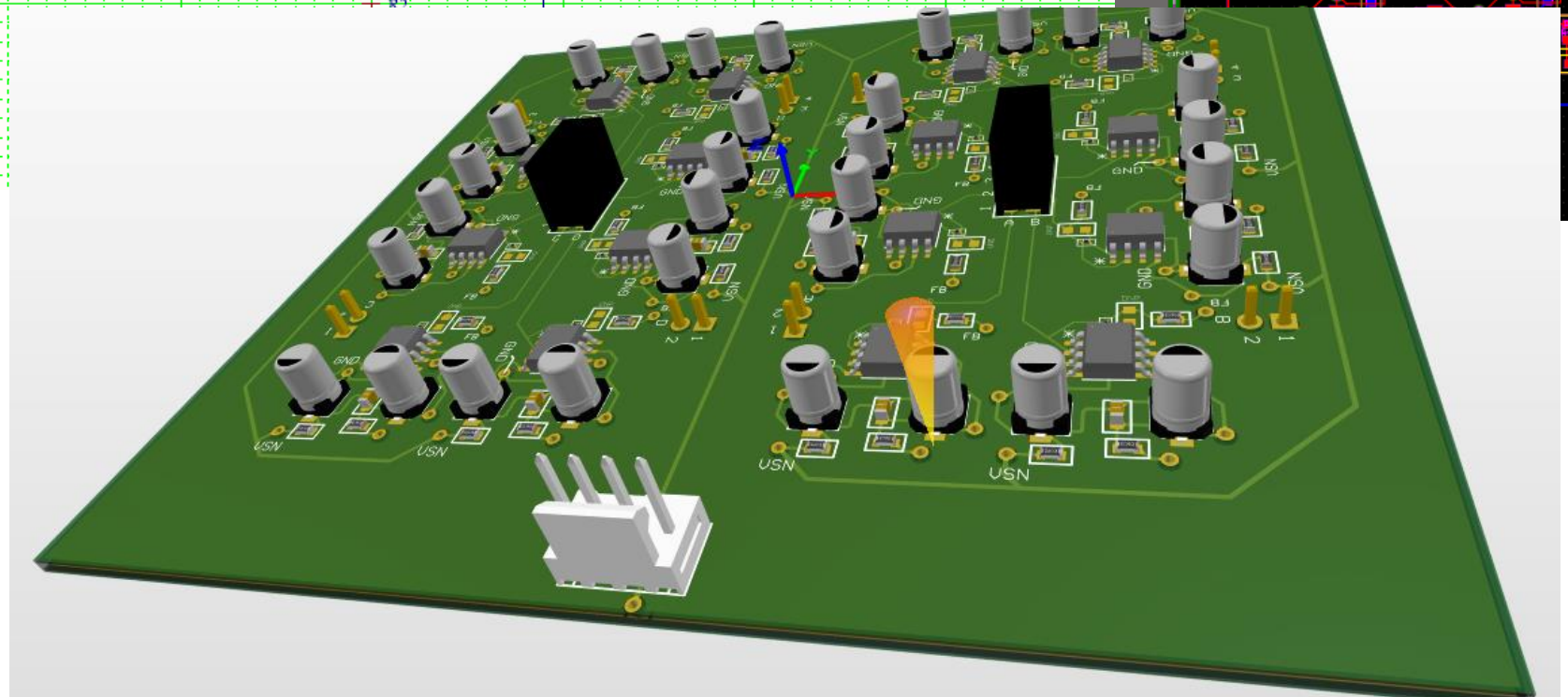




Voltage bias board







Pre-amp board

What's next with the PCB design?

- If no commercial solution can be decided on for the ADC/QDC stage or for some reason they do not meet our requirements I'll design a simple ADC board using a couple candidates we've looked at.

What I've Learned and What Needs to be Done

- I have designed a stack of modular circuitry and readout that drives and processes a 16 channel SiPM, for which there is no commercial solution
- I've learned how to design circuitry for commercial/industrial fabrication
- I've learned how to design firmware and create logical circuits for FPGAs