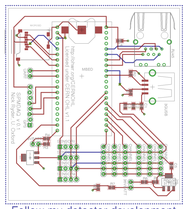

Follow my detector development at bit.ly/MondayGeekery

Microcontroller based data acquisition system for silicon photomultiplier detectors

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Topical Workshop on Electronics for Particle Physics, Oxford, September 2012

Overview

- Scintillator and wavelength shifting fibre cosmic ray detector
- Central DAQ board houses microcontroller
  - Counts triggers
  - Checks for coincidences
  - Controls trigger thresholds and SiPM bias voltages
  - Controls secondary sensors
  - Stores and transfers data
- Up to six channels
  - SiPM signal amplified
  - Compared with trigger threshold
  - Monostable pulse control
- Designed for lab and high altitude measurements

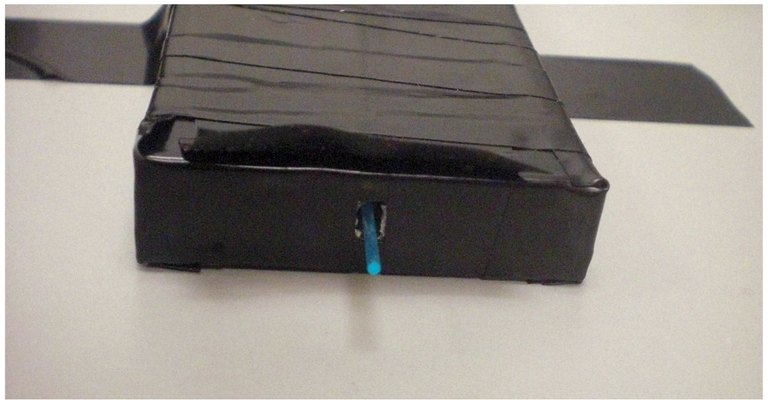

Figure: Scintillator and wavelength shifting fibre

Other measurements

- GPS timing for extended air shower search
- GPS position for high altitude measurements
- I^2C bus for other sensors
  - Temperature for SiPM calibration
  - Accelerometer and gyroscope for orientation

Powering

- 36 V for SiPMs from 3 $\times$ 12 V batteries
- Input voltage measured and regulated to 32 V
- 5 V for ICs and trigger threshold from batteries or microUSB power supply
- Input voltage measured and regulated to 5 V
- Powering allows short term portable use or long term static use

SiPMs

- SENSL MicroSL-10050-X13
- Require $<$ 30 V bias
- 1 $\times$ 1mm^2 active area
- 324 parallel Geiger mode APDs (microcells)
- 4 $\times$ 10^6 gain
- 320 ns microcell recovery time
- 22% photon detection efficiency

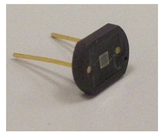

Figure: SENSL MicroSL SiPM

Main board

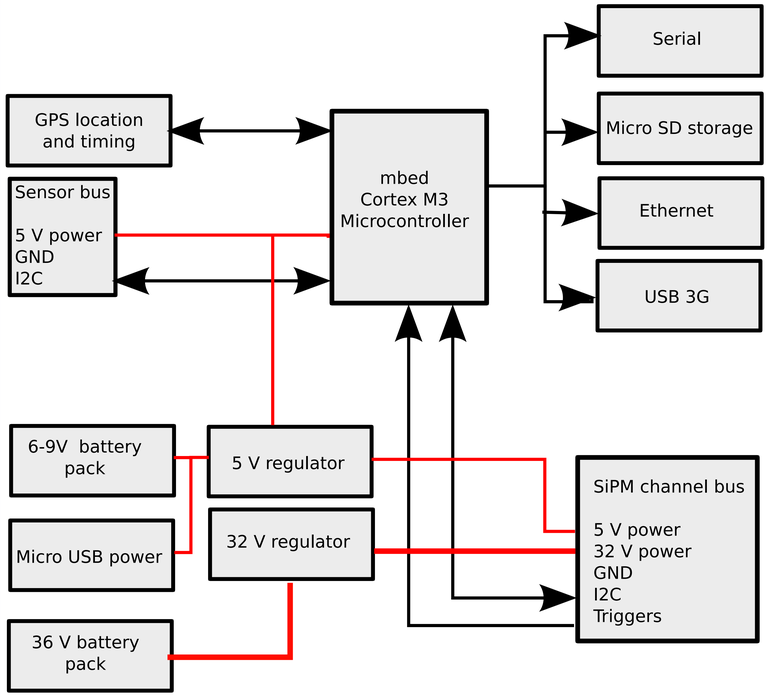

Figure: Main DAQ board

SiPM channel board

- Main board designed to connect up to six SiPM channel boards
- SiPM bias voltage controlled to remove temperature dependence
- Each channel's bias voltage and trigger threshold controlled separately via I^2C interface

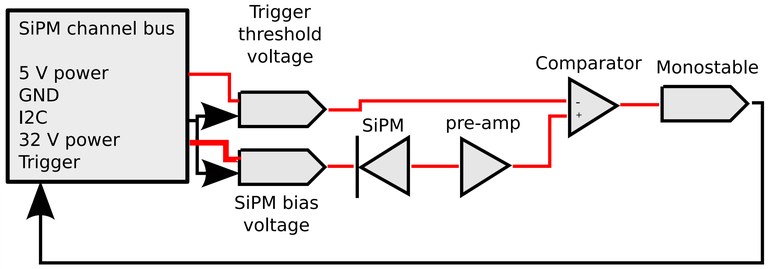

Figure: Silicon photomultiplier channel board

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- Johan Fopma and Mark Jones for help with electronic design and PCB fabrication
- Karen Aplin for funding the purchase of SiPMs

Data storage and transfer

- Local storage on (micro)SD card
- Data transfer to remote WebSocket server over internet
- Ethernet port for LAN connection
- USB port for 3G connection

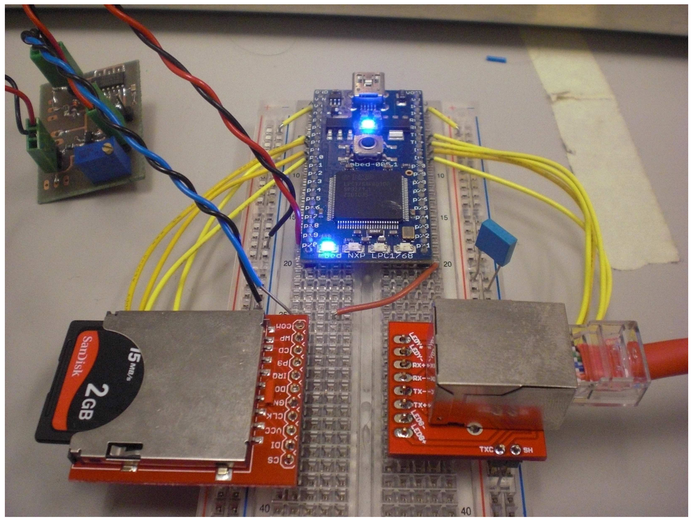

Figure: Prototyping data storage and transfer

Preliminary testing and development

- ~100 ns SiPM signal ~100 mV after preamp
- Initial testing using single channel can detect radiation source
- Coincidence trigger required to detect cosmic rays
- SD card data storage and WebSockets over LAN working
- Multiple SiPMs recently purchased
- Main board PCB designed
- SiPM channel PCB begin designed

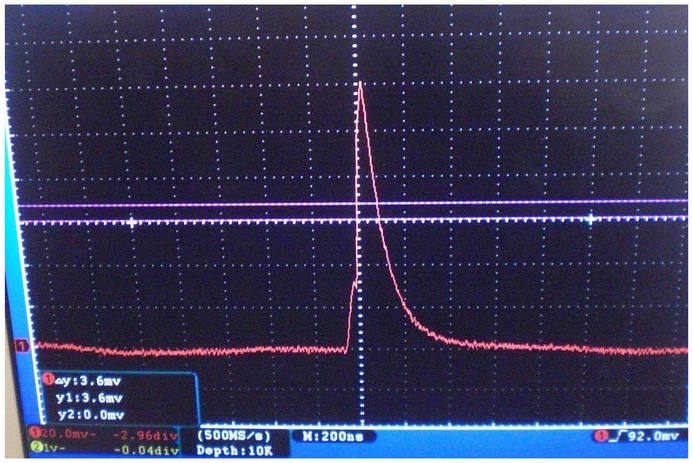

Figure: Pre-amplified silicon photomultiplier signal