HAWC Optical Calibration: Recent Progress

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Calibration system: *design goals*

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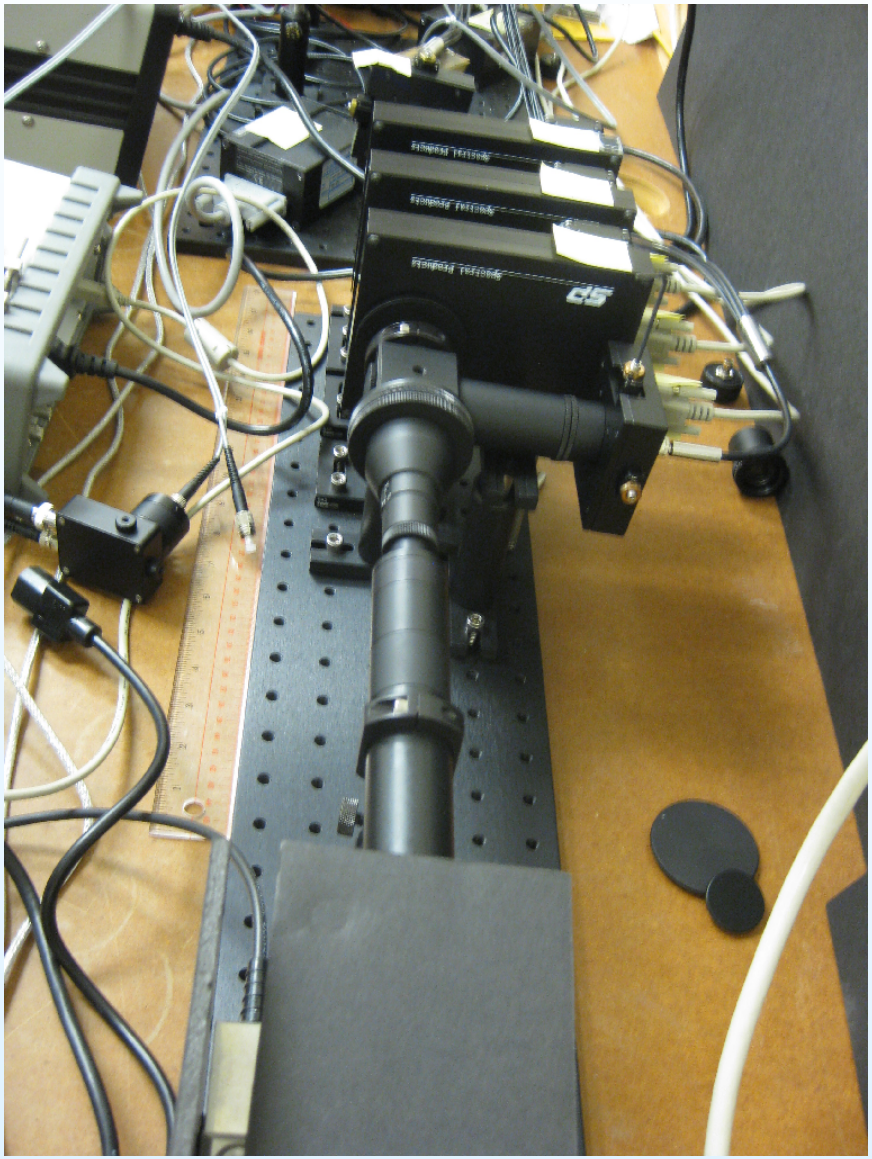
- The primary goal of the HAWC optical calibration system is to measure relative channel-to-channel time offsets VS signal size with a precision ~ 1nsec. This is done using short (< 1nsec), 532 nm laser pulses distributed using optical fibers to each water Cherenkov detector in the array. Real time measurement of laser pulse round-trip times monitor the time delay(s) and stability of our light delivery.

- A related (secondary) goal is to provide light pulses over a range of intensities from ~ 1 PE to $\sim 10^4$ PEs. This is done using filter wheels and neutral density filters at the (laser) light source.

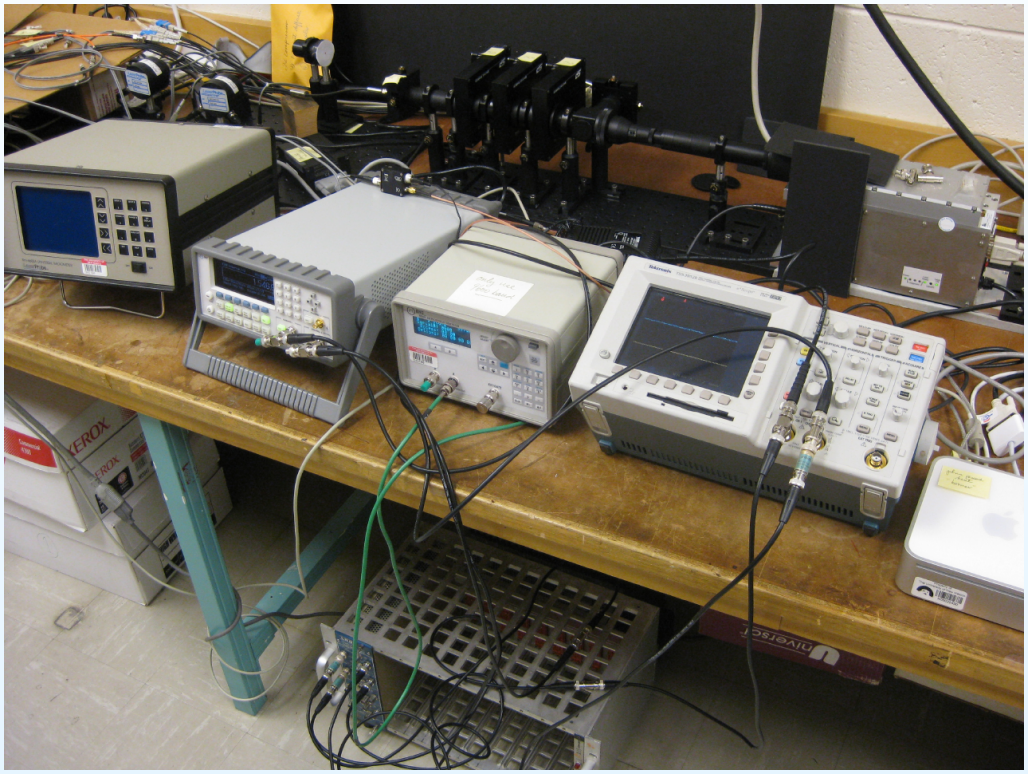
- Finally the system should be robust, easy to use and to maintain.

Calibration system: *laser source*



- Light source (optics) are relatively straightforward ...
- Control of the related instrumentation is more involved and includes:
  1. Teem photonics laser
  2. (3) filter wheels
  3. (2) (Laser Probe rm3700) radiation monitors
  4. laser trigger unit (BN555 pulser)
  5. round-trip timing monitor (BN1105 400Mhz universal counter)
  6. DiCon optical switches
  7. power sequencing of calibration instrumentation

Calibration system: *laser source control*

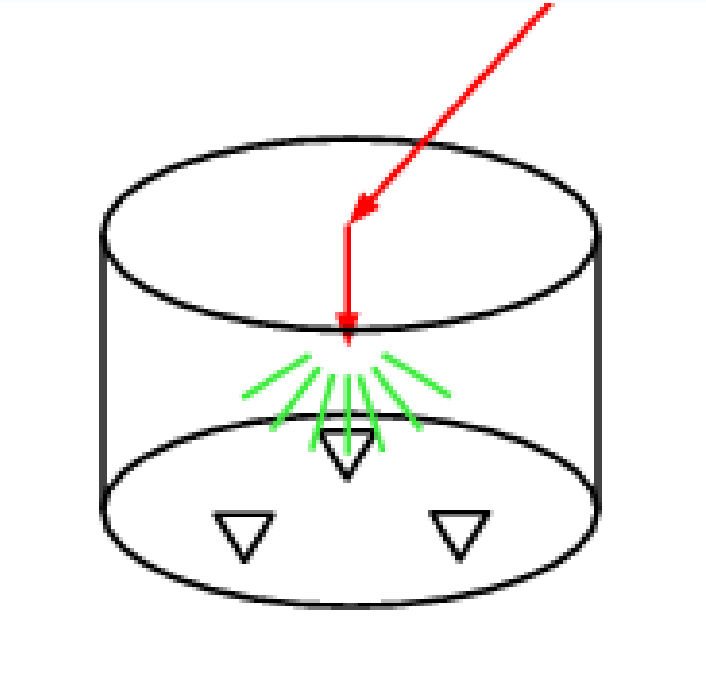


- At UNM our recent focus is on the measurement of the laser light pulse round-trip time using a Berkeley Nucleonics 1105 universal counter:
  1. laser pulses detected with Thorlabs fast photodiodes
  2. signals discriminated in Lecroy 321B
  3. 40nsec long logic pulses used to trigger the BN1105
  4. readout under computer control is working routinely but is not yet robust

Calibration system: *600' fibers*

- Prototype 600' optical fiber cable ordered from fibersys.com:
  1. indoor/outdoor optical fiber cable
  2. (4) SC connectors (field end) and (4) ST connectors (calibration room end)
  3. includes pulling *eye*
  4. on a (very large) spool
  5. high transmission efficiency (based on one fiber): 0.45 ± 0.05
  6. 18" cube boxes are light but bulky ... how to ship?

Calibration system: *next studies*



- The most critical remaining (design) issue: can the proposed system achieve light intensities up to 10^4 P.E.s? Study this in CSU water Cherenkov detector:
  - 3 working PMTs in the tank + associated DAQ + software to extract 1 PE signals (status ?)
  - diffuser float assembly (ready)
  - (4) prototype diffusers (ready)
  - prototype laser light source at CSU (ideally on the Internet) ("car" ready)

Calibration system: *outstanding issues*

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- Does our current calibration design provide up to $\sim 10^4$ PE signals in tank PMTs? The CSU water Cherenkov detector (tank) will be used for this measurement.
- What is our current cost estimate for the calibration system? The design change to use one diffuser/tank has increased the cost of the calibration system and it is likely that some contingency will be required.
- What is the status of the interface between the calibration system, the scaler system and the main DAQ? A tentative plan exists for coordination of the calibration and scaler systems. More planning is needed for coordination of the calibration and DAQ.