Calibration Plans for HAWC30

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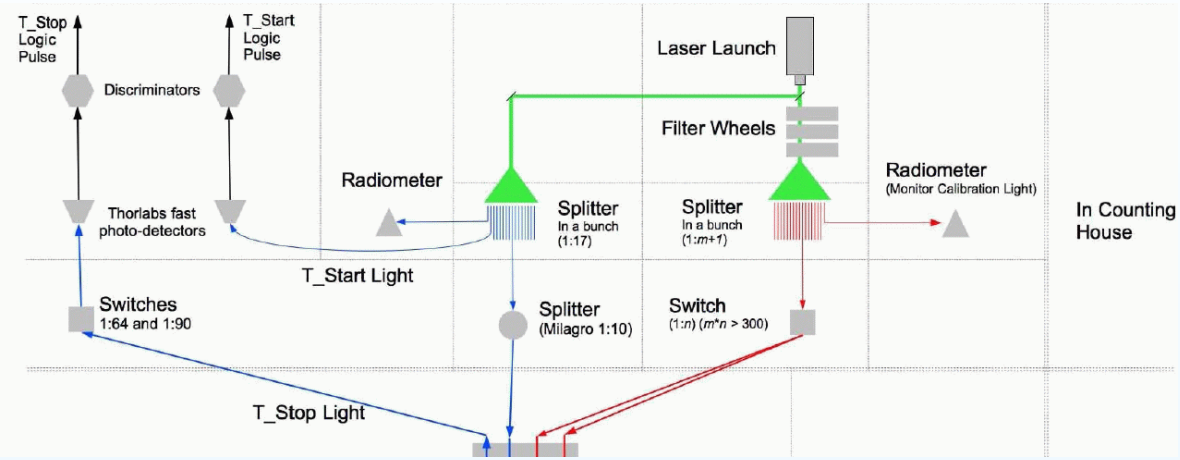
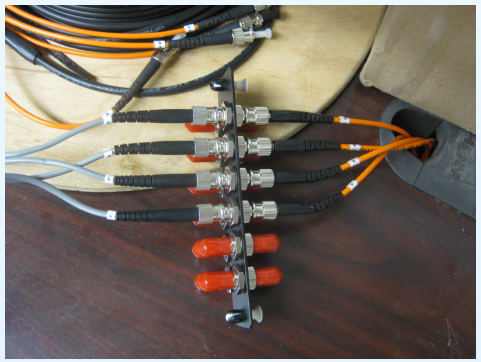
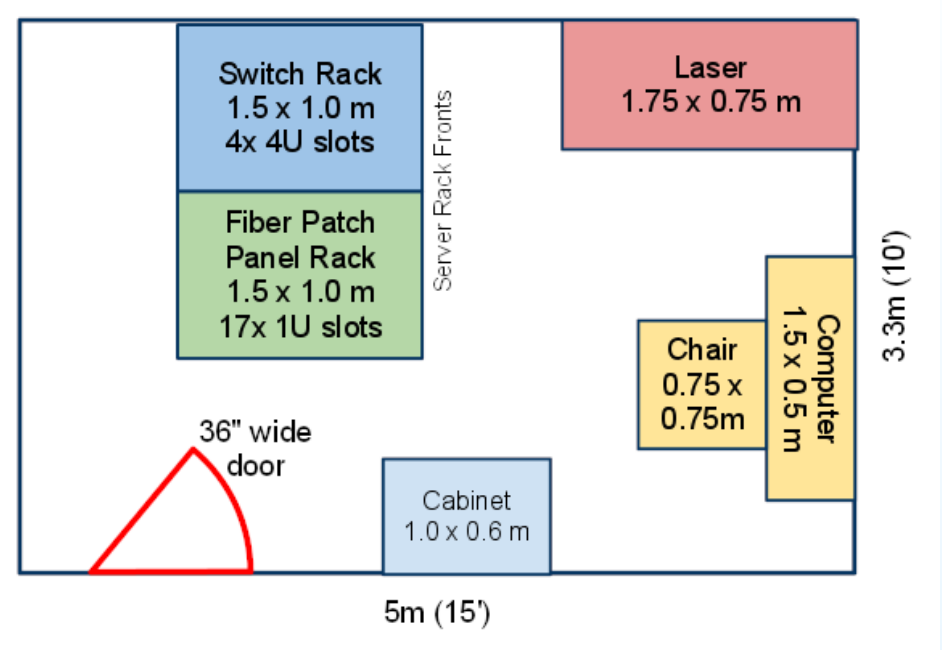
Calibration system: *Calibration Room (I)*

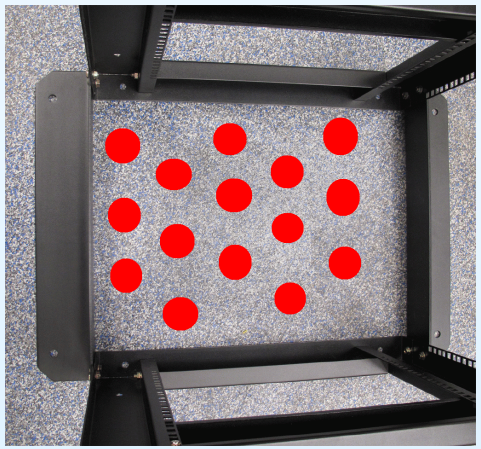




- Calibration systems are running at CSU and MTU
- To be ready for HAWC30:
  1. complete the upgrade of MTU hardware:
     (a) 3^{rd} filter wheel
     (b) 3^{rd} radiometer (to monitor light to tanks)
     (c) t_{start} and t_{stop} photo-sensors
  2. upgrade the CSU control system: computer and software
  3. be ready to ship the MTU system to Mexico
  4. continue control software development and tank calibration studies at CSU

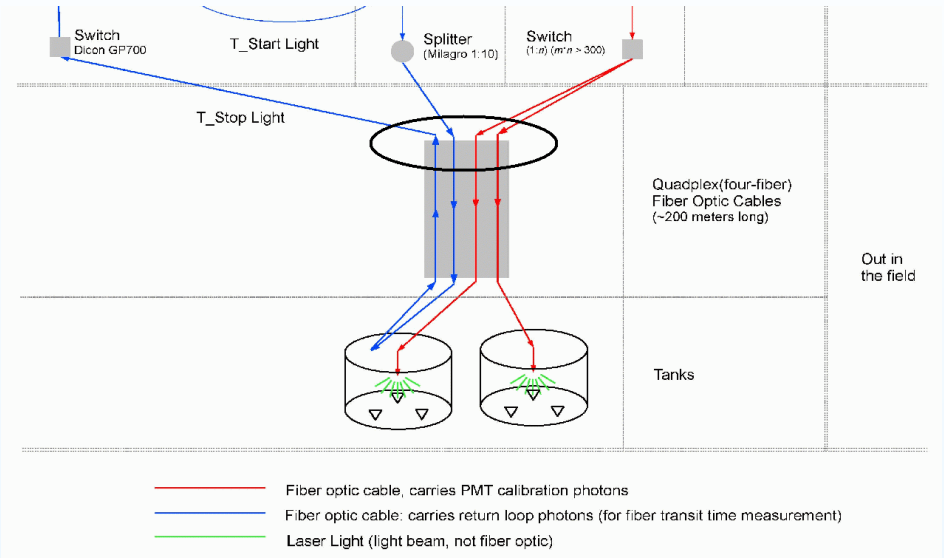
Calibration system: *Calibration Room (II)*





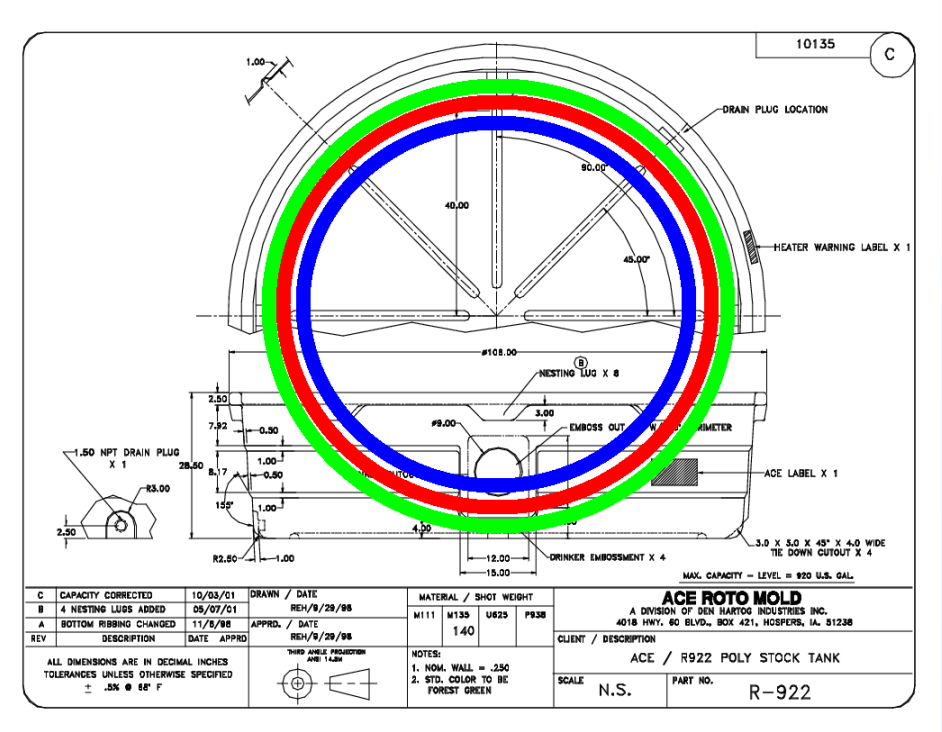
- Calibration room layout at the HAWC site:
  1. Current plan is for two electronics racks
  2. Will old Milagro racks meet our needs including good access from the sides?
  3. Conduits for the 600' fibers should terminate in the bottom of the *fiber patch panel* rack

Calibration system: *Excess Fiber Storage (I)*



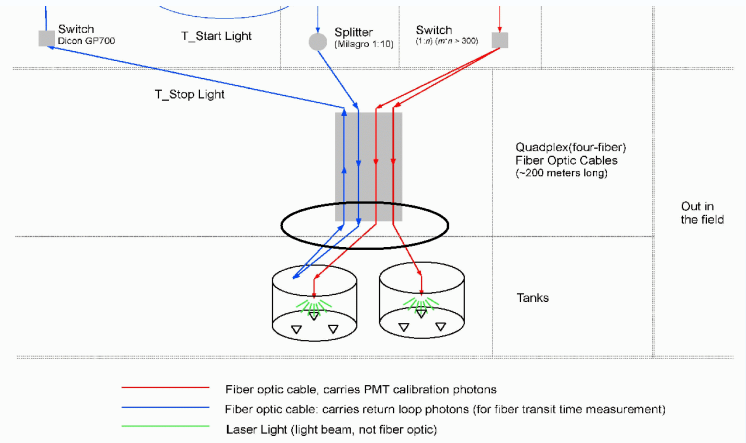
- Excess 600’ fiber will be stored in the ground just outside the calibration room
- We need to *upgrade* from what was done with the Milagro Outriggers:
  1. The fibers (cables) should be buried deeper
  2. Enclosure(s) need better drainage and cable management ...
- Confirmation on the 600’ length is needed!

Calibration system: *Excess Fiber Storage (II)*



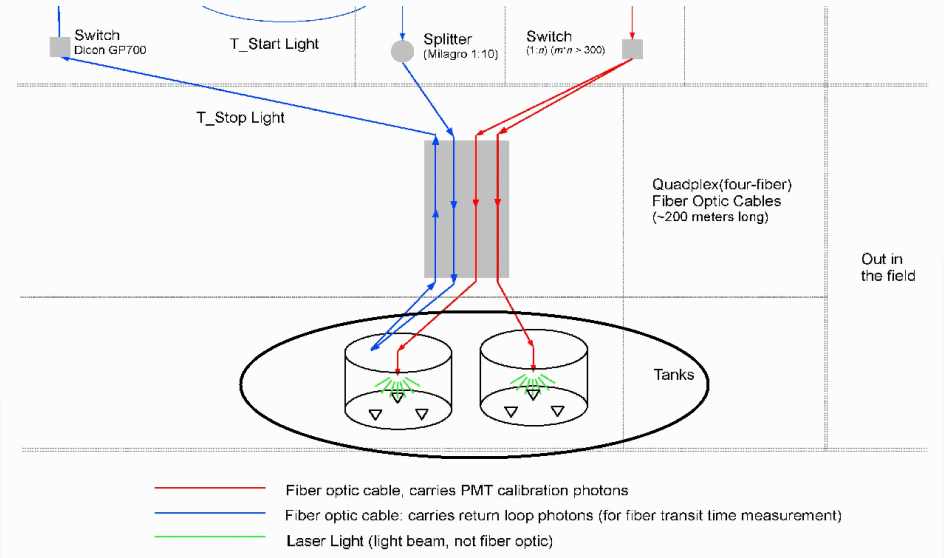
- Build a *Fiber Cable Vault* from *e.g.* two stock-tank(s):
  1. Access through a central man-hole
  2. Excess fiber is stored in a $\sim$2'-wide annular region at the tank perimeter
  3. Conduits to the *calibration room* and to the *field enclosures* are mounted between the two (clam-shell) stock tanks

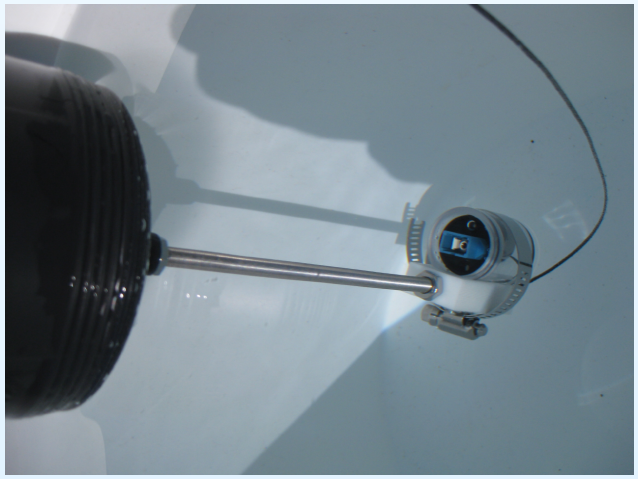
Calibration system: *field enclosure issues*



- The fiber connections in the *field enclosure* are now simple:
  1. Use commercial unions to connect the 600’ fiber to one duplex 15m and two simplex 15m fibers
  2. Excess 15m duplex fiber needs storage in this enclosure
- Is the VAMOS *field enclosure* adequate for HAWC:
  1. Is there adequate space for 4 PMT cables and the optical fibers?
  2. Is the box buried deeply enough for temperature stability?

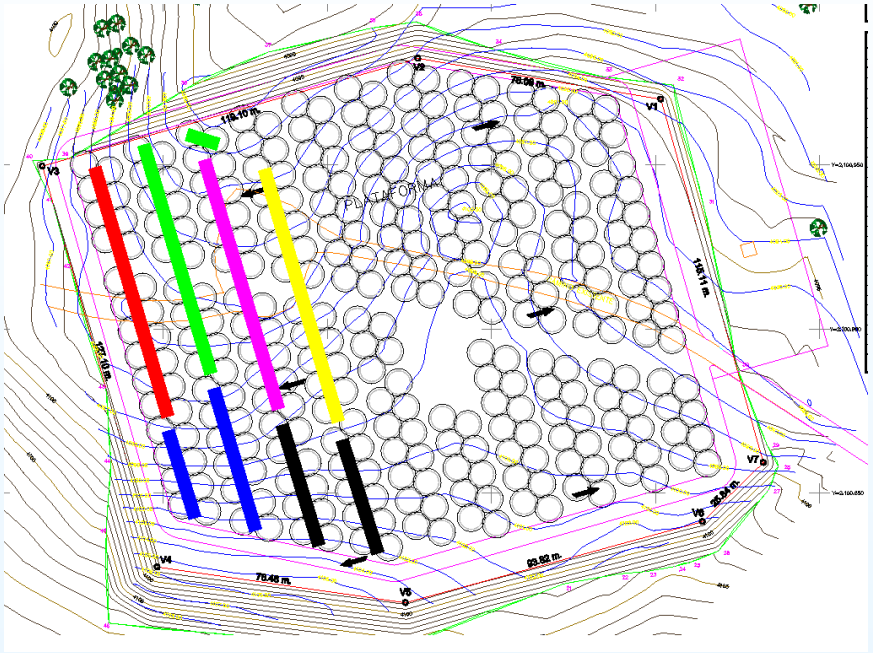
Calibration system: *tank issues*

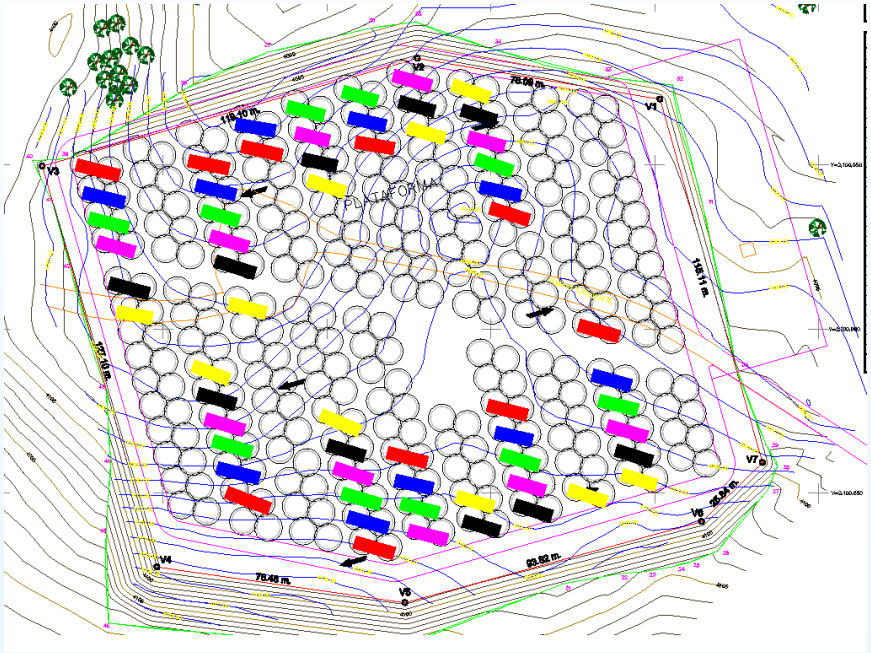




- The optical diffuser will be attached to the central PMT:
  1. The float and diffuser have been prototyped at CSU
  2. The distance of the diffuser to the central PMT is now well defined
  3. But how (precisely) will we attach the diffuser to the PMT ...

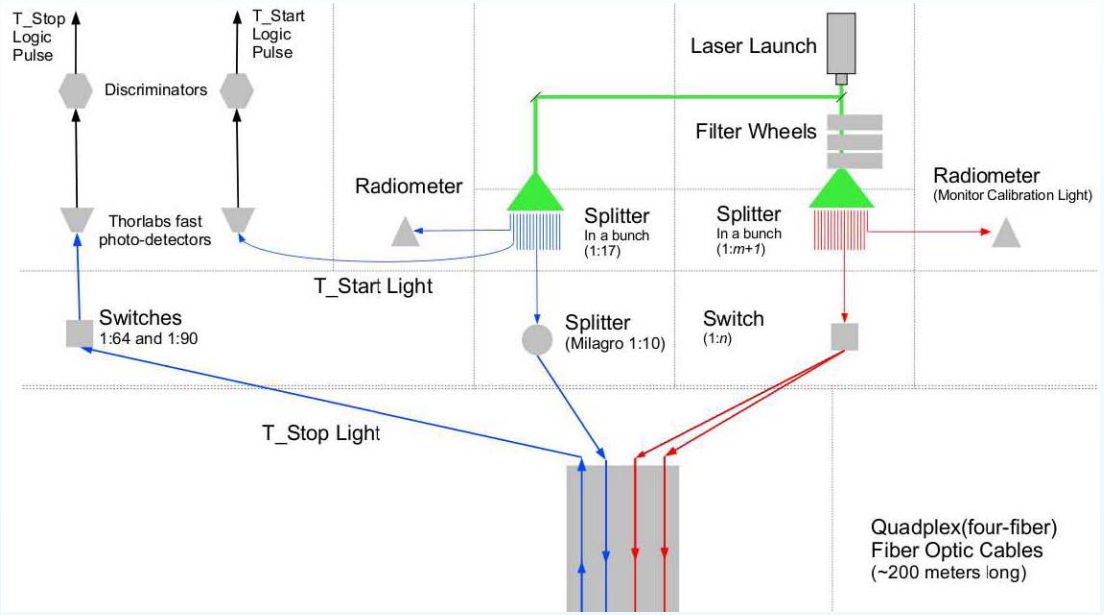
Calibration system: *possible calibration patterns*





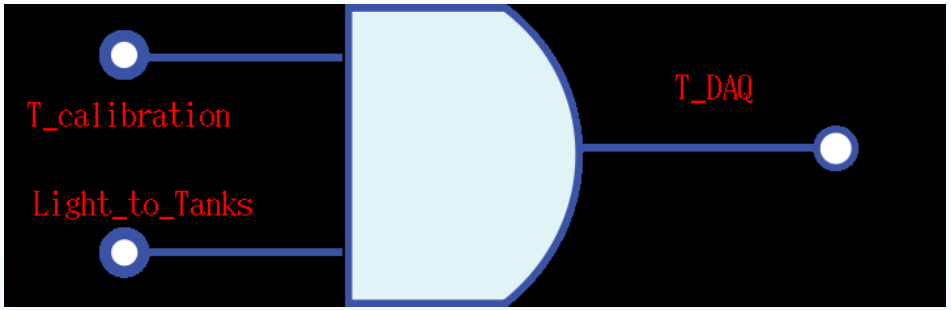
- Not a HAWC30 issue, but for HAWC100 etc ...
- Calibration optical switches map onto $1/15^{th}$ of the array:
  1. 10 DiCon switches allow us to illuminate 10 tank-pairs at one time
  2. Left: One option is to calibrate (20) contiguous tanks (at one time)
  3. Right: Another option is to distribute the calibrated tank-pairs over the array
  4. Feedback please ...

Calibration system: *timing signals (I)*



- Overview:
  1. the t_{start} pulse indicates that the laser has fired
  2. the t_{stop} pulse includes the *round trip time* delay and depends on the (current) setting of the DiCon GP700 switch
  3. internal to the calibration system a BN1105 (universal frequency counter) uses the t_{start} and t_{stop} logic pulses to measure the *round trip time* to the tank optical diffuser
  4. the prototype system at CSU results in a *round trip time* of ~ 2010 nsec

Calibration system: *timing signals (II)*



- Proposal:
  1. t_{start} is the (only) signal needed for our (CSU) analyses:
     (a) the existence of the t_{start} TDC record indicates that this is a *calibration* event (*a.k.a.* trigger-less DAQ)
     (b) PMT data are accepted in a timing window defined with respect to the t_{start} time
     (c) relative times for low and high threshold signals are again defined with respect to the t_{start} time
  2. HAWC calibration timing signals sent to the DAQ will be the logical AND of the internal timing signals with a *light to tanks* logic level signal
  3. the *light to tanks* logic level is present ONLY when light is being sent to the tanks and is generated by the BN575 unit that also triggers the calibration laser

Calibration system: *timing signals (III)*

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- Use the DAQ TDCs to monitor and cross check the calibration system:
  - digitize both the t_{start}^{DAQ} and t_{stop}^{DAQ} times ... requires 2 channels of TDC:
    1. measure the *round trip times*: $t_{stop}^{DAQ} - t_{start}^{DAQ}$
    2. compare with the same *round trip* light path measurement made with the BN1105 ... this is a cross check (consistency) of the TDC and BN1105 measurements
    3. step through different DiCon GP700 settings, *i.e.* different *round trip* light paths, to monitor the entire array
  - use a 3^{rd} DAQ TDC channel to monitor the *light to tanks* logic pulse
  - reserve a 4^{th} DAQ TDC channel for the possibility of one additional t_{stop}^{DAQ} signal

Calibration system: *timing signals (summary)*

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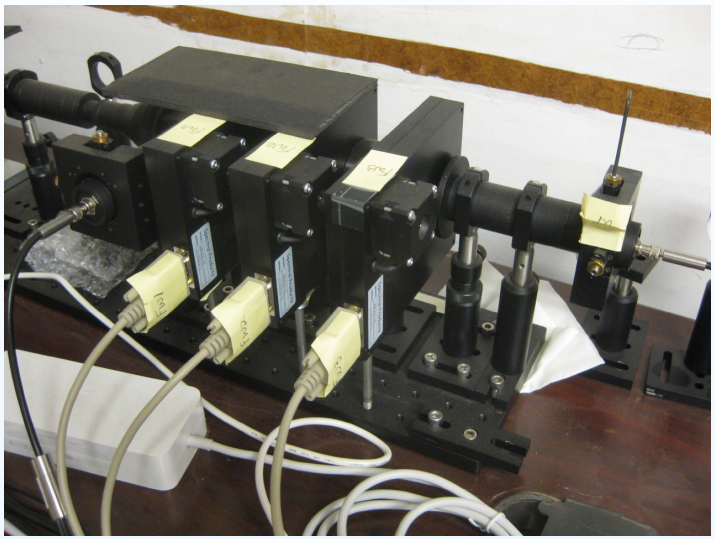
- for clarity rename the calibration internal timing signals, t_{start} and t_{stop} as $t_{start}^{calibration}$ and $t_{stop}^{calibration}$
- define new signals, t_{start}^{DAQ} and t_{stop}^{DAQ}, which are the signals to be sent to the DAQ
- the calibration internal *light to tanks* signal and the internal timing signals are ANDed to form the two logic signals sent to the DAQ:

$$t_{start}^{DAQ} = t_{start}^{calibration} \cdot light\ to\ tanks$$

$$t_{stop}^{DAQ} = t_{stop}^{calibration} \cdot light\ to\ tanks$$

Calibration system: *HAWC30 additional parts*



- For HAWC30 we need additional parts:
  1. Overall *upgrade* from 1-tank to 30^{+}-tank instrumentation
  2. Implement *minor* design changes based on CSU/MTU studies
  3. Address remaining issues ... *e.g. excess fiber storage*
- Several may involve 2^{+} month lead times ...
- Highest priority: ordering and shipping ...