HAWC Optical Calibration: ... getting serious!

John A.J. Matthews and W. Miller (UNM)
Brenda Dingus (LANL)
Petra Huentemeyer (MTU)

johnm@phys.unm.edu

University of New Mexico
Albuquerque, NM 87131
The HAWC array is composed of 150 tank-pairs:

- We had proposed:
  1. two, identical laser sources: each source calibrates $\sim 1/2$ tanks
  2. lasers are coupled to optical fibers w/ beam expanders and passive 1:n fiber splitters

- What has changed is:
  1. Brenda had concerns with pulsing half of the 900 PMTs (with any given calibration pulse) particularly at the highest light levels: $\sim 10^4$ PE/PMT
  2. Milagro used optical switches: could HAWC benefit from this technology?
  3. twenty 1:10 high efficiency splitters are available (from Milagro)
Calibration system: revised design

Proposed new design:

1. use only one (not two) lasers ... saving \( \sim \$25k \)
2. use DiCon 532nm, MEMS, optical switches:
   - three 1:4 switches fit into a (1-wide) module ... [in GP750 crates]
   - couple three switch outputs to 1:10 splitters and one is blank (off)
   - then 150 outputs require: \( 150/(10 \times 3 \times 3) = 1 \frac{2}{3} \) switch modules
   - DiCon GP750 crate plus 2 modules \( \sim \$22k \)... a wash!
3. (with at least one switch on) we can pulse from 1/15 to 1/3 of the array (on any given laser pulse) ... but light intensities not yet measured!
Calibration system: *laser source*

Most of this figure is unchanged but:

1. **now only one source** ... so sketch is 1 of 1
2. 1:n splitter is now a much simpler (and smaller) 1:7 splitter; so probably change to $\times 3$ beam expander
3. two filter wheels with $\sim 4$ intensities/decade and $\sim 5$ decades of intensity
Calibration system: *fiber time stability*

- Use round trip time to monitor *time stability* of light pulses
- Our initial plan was to divide the array into *quarters* and add fiber delays to multiplex the (then) ~ 15 fibers/quarter of array ... so 4-FADC channels needed!
- But now there are 150 fibers to monitor!
- We have one DiCon GP700 crate with 1:64 optical switches from Milagro
- Three such switches would allow all 150 fibers to be monitored using 1-FADC!
- DiCon GP700 programmable switches are available on eBay!
Calibration system: technical issues (I)

- Milagro 1:10 splitters:
  1. 20 splitters exist ... we need 15!
  2. 2 have been characterized recently:
     - very uniform fiber:fiber illumination
     - typical coupling 5% of light into each fiber (ideal would be 10%)
Calibration system: technical issues (II)

- fiber tank penetrations:
  1. Liquid-TUFF flexible conduit:
     - easy to assemble
     - resistant to rodents and UV light
  2. (photo above) 3/4” ID conduit will “just” pass one duplex SC fiber ... thus probably 1” ID is needed
  3. right angle coupling a problem with screw-on hatch cover
  4. what similar products are available in Mexico?
Calibration system: technical issues (III)

- fiber support at PMT:
  1. need rigid support for fiber \(\sim 45\) cm above the PMT
  2. two problems with my toy design:
     - avoid nylon (Michael Schneider) e.g. use (thin) stainless steel rod(s)
     - avoid standard metal ST couplings ... they rust!
  3. hold the fiber using a (plastic) SC:SC union (just plug-in the SC connector!)
Calibration system: summary/conclusions

Several proposed changes:
- address concerns
- but (temporarily) more uncertainty in (maximum) light intensity

Petra has prepared a draft calibration document ... it needs to be updated with the latest design

Focus on few-tank prototype array is already helping resolve the next set of issues ...