The Upgraded OPLE Hardware Control System

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We replaced ...

We replaced ...

with

× 3

We did reuse some components ...

Advantages

- Use off-the-shelf components and cabling where possible
- Limit the use of custom electronics; those that are built use field-programmable gate arrays which can be reconfigured as needs change
- Modular system; easy to add additional delay line control (up to two more without having to rebuild the metrology distribution)
- Improved digital-to-analog (and vice-versa) resolution over the older system in a number of areas; faster signal handling

Timeline

- Summer 2017: AZ Embedded Systems of Flagstaff, AZ (Tim Buschmann) contracted to modernize/modularize our OPLE control system; Tim had already built a similar system for NPOI
- January 2019: I became the CHARA liaison for the project
- Winter/Spring 2019: Purchased off-the-shelf components for the new system
- April 2019: Brad Hines (Planet A Energy) hired to create software layer between Tim Buschmann's hardware and the CHARA software
- May 2019: Control computers and embedded metrology boxes delivered
- Fall 2019: Tim makes first visit to Mount Wilson; tests his embedded metrology box on an actual CHARA delay line
- December 2019: Racks delivered
- January 2020: Started population of racks

Timeline (continued)

- January/February 2020: Tim makes second visit to Mount Wilson; tests prototype voice coil embedded box and prototype stepper motor embedded box
- May 2020: Voice coil and stepper motor embedded controllers delivered
- June/July 2020: Rack population finished
- July 2020: Tim makes third visit to Mount Wilson; more system tests
- April/May 2021: Tim makes fourth visit to Mount Wilson; got one delay line working with mediocre tuning
- May/June 2021: Tim makes fifth visit to Mount Wilson; ironed out some software bugs
- 18 June 2021: First fringes on the sky with the new control system
- August 2021: Converted all delay lines to the new control system

The Embedded Systems

- Metrology Distribution
- Cart Metrology
- Voice Coil and Eddy Current
- Motor Supervisor

The Embedded Systems

Metrology Distribution

- Receives the 1Hz and 16MHz clock signals from `gps`
- Samples the metrology laser reference signal using a phase-locked loop
- Distributes the unknown signal, the fiducial signal, and the timing to the cart metrology embedded systems, for each delay line

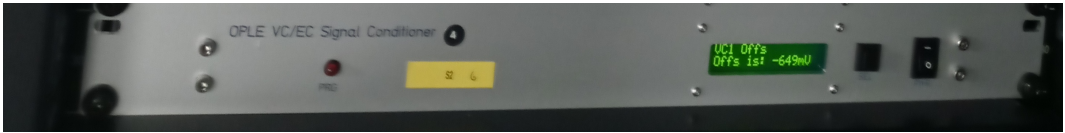
The Embedded Systems

Cart Metrology

- Takes the aforementioned unknown and fiducial signals, as well as the timing signal, to generate a cart position
- Includes a high-resolution, fast digital-to-analog converter and velocity generator to actuate the PZTs on each cart
- Implements a mechanism to directly accept fringe tracking corrections

The Embedded Systems

Voice Coil and Eddy Current



- Generates an analog voltage to drive two separate voice coils by means of a digital-to-analog converter hosted on a real-time computer
- Includes a low-noise pre-amplifier to allow fine adjustments of the output signal as well as signal conditioning
- Generates feedback from an eddy current detection system; resolution is increased from 12 bits in the old system to 16 bits in the current system

The Embedded Systems

Motor Supervisor

- Acts as a watchdog to a highly integrated motion controller hosted on a real-time computer
- Due to the vagaries of the original cabling, it also handles the cart limit and home switches as well as detecting and handling a number of fault conditions

Future Tasks

- Recalibrate eddy current sensors ... Done!
- Adjust cart pivot springs to get all carts to behave in a similar fashion
  - Some carts are biased toward the front while others are toward the back
  - Need to use a special jig to support the optics cage while loosening the pivot springs
  - Will help the various servo modes to stabilize more quickly
- Replace broken mechanical limit switches ... Underway
- Replace cable puller system with a torque-based system; Nic working with Tim on this one