NPOI Update

24 March 2014
Don Hutter
The “BASICS”

- **NPOI** = Navy Precision Optical Interferometer

- Major funding by Oceanographer of the Navy and Office of Naval Research

- NPOI is collaboration b/w USNO, NRL & Lowell Observatory

- Lowell is science partner & contractor to USNO (infrastructure & ops)

- Several external collaborators, some with independent funding (NMT, TSU)
The NPOI Team:

**USNO:**
- Paul Shankland
- Don Hutter
- Jim Benson
- Mike DiVittorio
- Bob Zavala

**AES:**
- Tim Buschmann
- David Allen

**NRL:**
- Richard Bevilacqua
- Sergio Restaino
- Tom Armstrong
- Jonathan Andrews
- Ellyn Baines
- Jim Clark
- Henrique Schmitt

**Lowell:**
- Jeff Hall
- Gerard van Belle
- Bill DeGroff
- Lisa Foley
- Victor Garcia
- Jim Gorney
- Jason Sanborn
- Susan Strosahl
- Steve Winchester
- Ron Winner

**TSU:**
- Matt Muterspaugh

**ONR:**
- 8 Navy Reservists

**NMT:**
- Anders Jorgensen
- Matt Landavaso
Expansion of Imaging Array:

Goal: Infrastructure @ 10 stations for 6 portable siderostats

- Demonstrate multi-baseline bootstrapping (5+ array elements)

- Geosatellite imaging techniques
  - Observe stars and satellites on short bootstrapped baselines

- High precision imaging
  - Observe O stars, solar analogs with 432 m baseline
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NAT

WASA

Siderostat

W10

W04
E03: siderostat cover
E06 & E07: operational
E10: ready to commission
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W04: covers complete
W07: operational
W10: commissioning in progress
N03: siderostat cover
N06: TBD (NSF/NMT)
N07: NAT/WASA cover
Integration of Long Delay Lines (LDLs):

• Controllers for (72) “Popup” Mirrors constructed, programmed & installed (50% wired in, 25% field tested). Completed this summer.

• Periscope controller design, fabrication of remaining mechanical components, TBD.
Control Systems Upgrades (1):

- PC-based siderostat controllers (SIDcons) for astrometric & imaging stations (AES) (10 constructed; 1 to finish, 8 installed)
Control Systems Upgrades (2):

- PC-based Fast Delay Line (FDL) control system (AES):
  - 6 channel FDL control system
  - PC architecture with specialized low-latency Linux Kernel
  - Tracking with typical 2-7nm jitter
  - In system programmability of all custom-built hardware
  - Metrology achieves 1.24nm resolution (sampling at 64kHz)
  - Stroke generator:
    - Upload of data per high speed USB2.0
    - 1 mbps samples with 16bit resolution output
  - In-system diagnostics of all subsystems and sensors
  - In-system tuning of all servos and pre-amps
  - Remote control via GUIs and programming APIs
    - Stroke API and FDL Api in Python and C++
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Control Systems Upgrades (3):

- New Fringe Engine for NPOI “classic” beam combiner
  
  - Hardware finished (AES)
  
  - Firmware & software (NMT) undergoing on site tests.
VISION beam combiner:

- See Victor Garcia’s presentation Tuesday.
- NSF funded (TSU)
- 6-beam, visible-light analog of MIRC
  - 11 Oct 2012: First stellar fringes (single Baseline)
  - 15 Jan 2013: First 4 station (6 Baseline) stellar fringes
  - 16 Dec 2013: First bootstrapped fringe tracking (5 stations).
  - Currently fringe tracking to 4th magnitude
1.8m telescope installation (1):

- **Goal**: large aperture array for wide-angle astrometry & visible/near-IR imaging

- **History**:
  - Nov 2010: gifted to Navy (USNO Flagstaff) by CARA
  - May 2012: Infrastructure (construction ready) plans finished
  - July 2012: Special Use Permit from US Forest Service

- **Currently**:
  - Updating construction cost estimates & contract preparations towards construction start in Fall 2014.

- Probably sufficient funds for infrastructure & install (assembly) of 2 telescopes in FY15.
1.8m telescope installation (2):

- **Future (FY16-17):**
  - Replace VME-based control system with modified NPOI siderostat controller using existing telescope motors and encoders (AES)
  - Complete LDLs (periscope control)
  - Vacuum Feed connection to array: (Windows, mirrors, vacuum cans, vacuum pipe & supports from “M7” to existing array)
  - Continue AO test bed development (NOFS, w/USNA/Lockheed; to test on NOFS 1.0m & 1.55m)
Research / Publications (1):

USNO – NPOI Astrometric Catalog (UNAC):

- Goal: Catalog of ~ 1000 stars with positions accurate to < 16 mas (tied to ICRF).

- 31 Dec 2013: internal USNO release of UNAC 1.0
  - 50 stars (19 nights data), 3 mas formal accuracy (but some bad data)

- April 2014: UNAC 1.1 expected
  - ~100 stars (~80 nights data)
  - Improved error distribution calc., only data from “locked” baselines
Research / Publications (2):

Refereed papers from previous 12 months:

- NPOI Update – Armstrong et al., 2013, J. Astrom. Instrum., 2, 1340002

See also: presentations here by Tom Armstrong, Ellyn Baines, Victor Garcia & Chris Tycner