Low-Order Wavefront Sensor Mini-Review

April 2, 2010

LO WFS Overview

- Raison d'être
- Architecture
- Requirements Drivers
- Operational Modes

LO WFS Purpose

- Primary purpose is to measure spatial modes of the science wavefront incorrectly sensed by the LGS asterism
  - Tilt indeterminacy of any LGS beacon requires use of NGS for tip-tilt (TT) measurement
  - Blind modes of any multi-LGS asterism requires additional sensing
    - NGAO performs this two different ways…
      - Multiple NGS sensed with the LO WFS subsystem
        - » Multiple NGS also improves TT error w/ more photons, less anisoplanatism
      - Low-order modes sensed directly if moderately bright NGS is available

NGAO LO WFS Architecture

- Choice of 2 TT and 1 TTFA sensor based on trade studies of more or fewer NGS
  - KAON 452 – MOAO vs. MCAO trade study report
  - KAON 470 – Keck NGAO sky coverage modeling
  - KAON 487 – NGAO LOWFS architecture trade study
  - KAON 492 – NGAO null-mode and quadratic mode tomography error
  - KAON 504 – NGAO Performance vs. Technical FoV for LO WFS stars
  - KAON 635 – Point & Shoot Study
- Major subsystem retained largely intact after Build-to-Cost (B2C) design decisions documented in KAON 642
  - Maintenance of highest sky coverage very high priority
  - Changed IR TWFS to visible TWFS
- Post-B2C cost estimate was $2.21M
  - Estimated about $0.08M less than SDR
    - Visible TWFS and relaxed motion specifications
  - Cost to be re-visited for PD Cost Book (c. late-April 2010)

LO WFS Requirements Drivers

- 16 explicit Functional Requirements
  - Plus, a number of implicit Performance Flowdown Requirements
    - Detector QE, read noise,
- Key Requirements Drivers
  - Best sky coverage
    - Directly drives the MOAO sharpening apparatus (LOWFS DM, Patrolling LGS WFS, RTC design)
      - Choice of 32 x 32 DM set by availability and NGS Sharpening Budget
    - Drives baseline choice of low-noise, fast readout Teledyne H2RG IR array
    - Drives field of regard
    - Drives choice of J- and H-band operation
      - K-band considered, but appears marginally beneficial, at increased design and operational complexity
  - Acquisition efficiency
    - 29 seconds for acquiring NGS in LGS observing modes
      - 11 seconds for LO WFS offset sans sky background measurement
    - Drives choice of field of view, full frame readout
      - Object selection mechanism (OSM) is typically preset during telescope slew
      - Most precision motion requirements relaxed via B2C strategy of science dither via HODM TT stage

Operational Modes

- LGS Science with DAVINCI
  - TTFA typically steered to brightest NGS in FoR
    - For random field star, this is likely to be V ~ 18.9, H ~ 15.2 about 45 arcsec off-axis
  - TT's steered to ~ 1 mag fainter (and likely closer) field stars
  - Need RTC to support operation with 3, 2, or 1 off-axis NGS
    - Specific allocation of sensors to stars will depend on NGS asterism geometry and brightness
  - LO WFS focus needs to be adjusted to stay conjugate to starlight when science ADC inserted or when instrument internal focus changed (filters, plate scales, etc.)
- Interferometer Science
  - Support of off-axis visible TWFS
  - Possible utility of IF dichroic IR leakage to allow TT sensing with LO WFS (needs investigation)