Gemini
Adaptive Optics Projects

PUEO NUI Workshop – May 23rd 2003

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Overview

• Facility AO instruments
  – Altair (Gemini North)
  – GSAO (Gemini South AO)

• Dedicated AO instruments
  – Hokupa’a 85 (Gemini South)
  – NICI (Near Infrared Coronographic Imager)

• Next Generation Instruments
  – Meeting in Aspen in June 2003
  – Extreme AO and Wide-Field (Ground Layer) AO
Cassegrain Instrument Support Structure
The Altair project
History

• Background:
  – Canada 15% share in the Gemini project

• History:
  – Science case completed + order of correction chosen Jan 1996.
  – Workscope (contract) signed on Nov. 15, 1996.
  – Construction: 1999-2000
  – Integration and tests: 2001-2002
  – First light Nov 2002
  – LGS upgrade end 2004

• Key personnel:
  – Altair entirely built at HIA
  – Project manager: Glen Herriot (HIA)
  – Project scientist: Jean-Pierre Veran (HIA)
  – HIA instrument group (head: David Crampton)
  – At Gemini: Brent Ellerbroek + Francois Rigaut
Altair main requirements

• AO module requirements:
  – Cassegrain facility instrument
  – Reproduces telescope beam: exit pupil, f/ratio, focal plane, beam size
  – Feed any Gemini instrument
  – 900 kg, Centre of Gravity 1200 mm from face, 1.5 m square and 2.4 m long

• Science requirements:
  – Wavelength Coverage, 0.85-2.5 microns
  – Strehl Ratio, 0.4 at H, 45 deg ZD, median conditions
  – Field of View, 2 arcmin
  – NGS and LGS capabilities
  – Science AtmDC out to K band
  – Automatic optimal performance (one button operation)
Why is Altair Unique?

• **ALTitude conjugated Adaptive optics for Infra-Red**
  – 177 actuator DM at an image of layer 6.5 km from telescope
  – Based on turbulence measurements: Racine et al., SPIE 1995

• Loop sampling rate: 1 kHz

• Quad-cell based Shack-Hartmann WFS

• Single-CPU reconstructor self-optimized on the fly.
  – Latency: 800 ms
  – Fully automatic optimized modal control

• Gemini Instruments use On-instrument WFS (T/T/F)

• High resolution WFS (20x20) for calibration offline.
Nov 20th 2002 10:34pm
Altair first light !!!

Uncorrected image
Seeing 0.3”-0.4”

Corrected image (H band)
FWHM = 60 mas
SR = 20 %
Commissioning so far

- 4 weeks of commissioning so far
- Almost all functionalities successfully tested
  - Various offloads (Altair to M2, to M1)
  - On-Instrument WFS blending for flexure compensation
  - Altair control bandwidth optimization
  - WFS centroid gain estimation
  - Altair control from SSA (TCC)
  - Full integration with the sequence executer
- Performance characterization underway
- Available 2004A for general use
- System verification to be carried out in 2003B
  - Science verification programs
  - Altair + spectroscopy (GMOS IfU)
  - 2 half nights with OHANA in July
Performance evaluation

- 0 db rejection bandwidth (@ 1kHz)
  - 35 Hz for T/T
  - 65 Hz for high order modes (DM)
- 60-70 milliarcsec obtained regularly in J-K for seeing <0.7”.
- H band Strehl of 30-35% under 0.5” V seeing.
- 89% Science path throughput
- Able to close the loop at 1kHz (max speed) on R=12.
- Limiting mag. R~15
- Anisoplanaticity: Comparable to other systems
- Current limitations:
  - Vibrations induced by IR camera cryi-coolers
  - High spatial frequency wavefront error from telescope amplified by Altair
K band
Separ. 110 mas
M13
2003may10
Altair
NICI - Near-Infrared Coronographic Imager

• ΔMag = 14 with 0.5”
• Operates 1 – 5 um
• ONLY coronography: small field, optimized optics
• Only 4 optical surfaces for the AO module
  – AO module a copy of Hokupa’a 85
• Mask just before the dewar window uses as dichroic
  – No transmissive optics
• Diffraction limited at 1 um
  – H Strehl > 70 % at H in good seeing
• 1024x1024 Aladin science array
• Dual channel mode
• Delivery: end 2004
Gemini South AO Facility
Instrument (MCAO)

• Provide diffraction limited images (1 – 2.5 um)
• Uniform PSF over a 1 arcmin FOV
• 5 lasers GS, 3 NGS, 3 DMs
• Solves cone effect
• Science camera
  – mosaic of four HAWAII-2RG chips (Rockwell)
  – 4096 x 4096 pixels
• Critical Design Review: end 2003
• Delivery 2006 (?)
Possible HIA contributions to PUEO NUI

• HIA is interested in an instrument:
  – Able to provide cutting-edge science
  – That will serve as a test bed for Gemini and next generation telescope instruments (“extreme AO”)
  – Could be upgraded with a laser to increase sky coverage?

• HIA would like to contribute to the RTC upgrade:
  – Considered as an excellent project by the AO group
  – Our software group has already:
    » Programmers experienced with AO (Altair)
    » Existing AO function library
    » Experience distributed CPU, real-time control system (VxWorks, QNX)
    » Spare VME crate could be used for development
    » Existing development environment
    » Electronic group has strong CCD control expertise
    » Experience with interfacing instrument control software with telescope control systems