ALMA/GSMT WORKSHOP

Washington, DC
09 JULY, 2001
MEETING GOALS

• Identify potential synergies between ALMA and a 30-m O/IR telescope (GSMT)
• Define studies needed to quantify synergies
• Determine potential value of a larger workshop
  – Outline workshop scope
  – Identify potential dates in Q1 2002
AGENDA

0900-0910: Introduction and Goals (Strom)
0910-0945: ALMA overview (Wootten)
0945-1015: GSMT overview (Strom)
1015-1030: Break
1030-1230: Presentation by participants
1230-1315: Lunch
1315-1400: Identification of key science areas
1400-1445: Issues for further study
1445-1530: Planning a community workshop
INTRODUCTION TO GSMT

ALMA/GSMT WORKSHOP
Washington, DC
09 JULY, 2001

Stephen E. Strom
AURA NIO: Mission

• In response to AASC call for a GSMT, AURA formed a New Initiatives Office (NIO)
  – collaborative effort between NOAO and Gemini to explore design concepts for a GSMT

• NIO mission

  “to ensure broad astronomy community access to a 30m telescope contemporary in time with ALMA and NGST, by playing a key role in scientific and technical studies leading to the creation of a GSMT.”
Goals of the NIO

• Foster community interaction on GSMT
• Develop point design
• Conduct studies of key technical issues and relationship to science drivers
• Optimize community resources:
  – explore design options that yield cost savings,
  – emphasize studies that benefit multiple programs,
  – collaborate to ensure complementary efforts,
  – give preference to technologies that are extensible to even more ambitious projects.
NIO ADVISORY COMMITTEE
Present Members

John Casani  Jet Propulsion Laboratory
Alan Dressler  Carnegie Observatory
Richard Ellis  Caltech
Bob Fugate  Starfire Optical Range
Jay Gallagher  University of Wisconsin
Bob Gehrz  University of Minnesota
Roberto Gilmozzi  European Southern Observatory
Riccardo Giovanelli  Cornell University
Bob Kirshner  Harvard-Smithsonian, CfA
Rolf Kudritzki  University of Hawaii
Simon Lilly  HIA
Joe Miller  University of California
Jerry Nelson  University of California
Larry Ramsey  Penn State University
Chuck Steidel  Caltech
Developing Science Cases

• Two community workshops (1998-1999)
  – Broad participation; wide-ranging input
• Tucson task group meetings (SEP 2000)
  – Large-scale structure; galaxy assembly
  – Stellar populations
  – Star and planet formation
• NIO working groups (MAR 01 – SEP 01)
  – Develop quantitative cases; simulations
• NIO-funded community task groups (CY 2002)
• NIO-funded community workshop (CY 2002)
  – Define “Science Reference Mission”
GSMT Science Case

“The Origin of Structure in the Universe”

Najita et al (2000,2001)

From the Big Bang... to clusters, galaxies, stars and planets
Tomography of the Universe

• Goals:
  Map out large scale structure for $z > 3$
  Link emerging distribution of gas; galaxies to CMB

• Measurements:
  Spectra for $10^6$ galaxies ($R \sim 2000$)
  Spectra of $10^5$ QSOs ($R \sim 15000$)

• Key requirements:
  20’ FOV; >1000 fibers

• Time to complete study with GSMT: 3 years

• Issues
  – Refine understanding of sample size requirements
  – Spectrograph design
Mass Tomography of the Universe

Existing Surveys + Sloan

Hints of Structure at $z=3$
(small area)

100Mpc ($5^\circ \times 5^\circ$), 27AB mag ($L^* z=9$), dense sampling

GSMT 1.5 yr
Gemini 50 yr
NGST 140 yr
Tomography of Individual Galaxies out to z ~3

- Determine the gas and stellar dynamics within individual galaxies
- Quantify variations in star formation rate
  - Tool: IFU spectra
    - [R ~ 5,000 – 10,000]

GSMT 3 hour, 3σ limit at R=5,000
0.1”x0.1” IFU pixel (sub-kpc scale structures)

<table>
<thead>
<tr>
<th>J</th>
<th>H</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.5</td>
<td>25.5</td>
<td>24.0</td>
</tr>
</tbody>
</table>

Hubble Deep Field South
HST • WFPC2
Origins of Planetary Systems

• Goals:
  – Understand where and when planets form
  – Infer planetary architectures via observation of ‘gaps’
• Measurements:
  Spectra of $10^3$ accreting PMS stars ($R \sim 10^5$; $\lambda \sim 5\mu$)
• Key requirements:
  On axis, high Strehl AO; low emissivity
• Time to complete study with GSMT:
  2 years
• Issues
  Understand efficacy of molecular ‘tracers’
  Trades among emissivity; sites; telescope & AO design
Probing Planet Formation with High Resolution Infrared Spectroscopy

Planet formation studies in the infrared (5-30µm):
- Probe forming planets in inner disk regions
- Residual gas in cleared region \( \rightarrow \) low \( \tau \) emission
- Rotation separates disk radii in velocity
- High spectral resolution \( \rightarrow \) high spatial resolution

\[ S/N=100, \ R=100,000, \ \lambda>4\mu m \]

- Gemini out to 0.2kpc sample \( \sim 10\)s
- GSMT 1.5kpc \( \sim 100\)s
- NGST X

8-10m telescopes with high resolution (R~100,000) spectrographs can detect the formation of Jupiter-mass planets in disks around nearby stars (d~100pc).
Stellar Populations

• Goals:
  Quantify IMF in different environments
  Quantify ages; [Fe/H]; for stars in nearby galaxies
  Develop understanding of galaxy assembly process

• Measurements:
  Spectra of $\sim 10^5$ stars in rich, forming clusters (R \sim 1000)
  CMDs for selected areas in local group galaxies

• Key requirements:
  MCAO delivering 2’ FOV; MCAO-fed NIR spectrograph

• Time to complete study with GSMT: 3 years

• Issues
  – MCAO performance in crowded fields
GSMT System Considerations

Science Mission - DRM’s

Adaptive Optics

Active Optics (aO)

Instruments

Full System Analysis

Site Characteristics

Enclosure protection

Support & Fabrication Issues

GSMT Concept (Phase A)
End-to-End Approach

• Science Requirements (including instruments)
• Error Budget
• Control systems
• Enclosure concept
  – Interaction with site, telescope and budget
• Telescope structure
  – Interaction with wind, optics and instruments
• Optics
  – Interaction with telescope, aO/AO systems and instruments
• AO/MCAO
  – Interaction with telescope, optics, and instruments
• Instruments
  – Interaction with AO and Observing Model
# Derived Top Level Requirements

<table>
<thead>
<tr>
<th>Field of View</th>
<th>Narrow field AO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>MCAO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Low order AO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Seeing limited (PF)</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tr>
<td>Principle wavelegths</td>
<td>1.0 - 2.5 microns</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>1.0 - 2.5 microns</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>1.0 - 20 microns</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>0.4 - 2.5 microns</td>
<td>-</td>
<td>+</td>
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<tr>
<td>PSF</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>Diffraction limited</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Diffraction limited</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0.1-0.2 arcsec</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0.4-0.7 arcsec</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Stability</td>
<td>1%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Diffraction limited</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0.1-0.2 arcsec</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0.4-0.7 arcsec</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Strehl</td>
<td>80%</td>
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<td>+</td>
<td>Diffraction limited</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0.1-0.2 arcsec</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0.4-0.7 arcsec</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Photom. accuracy(derived)</td>
<td>1%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Diffraction limited</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0.1-0.2 arcsec</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0.4-0.7 arcsec</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Astrometric accuracy</td>
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<td>+</td>
<td>+</td>
<td>10^-3 arcsec</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>10^-2 arcsec</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>0.05 arcsec</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Stability timescale</td>
<td>3,600 s</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>3,600 s</td>
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<td>3,600 s</td>
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<td>+</td>
<td>+</td>
<td>10,000 s</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Emissivity</td>
<td>&lt;20%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&lt;20%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&lt;20%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maintenance/Ops</td>
<td>&lt;15%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&lt;15%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&lt;15%</td>
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<td>-</td>
<td>&lt;15%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Reliability</td>
<td>90%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>90%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>90%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>90%</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Science Efficiency</td>
<td>90%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>90%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>90%</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>90%</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

**How to read this table:**

Four telescope “Operating regimes” are defined and the specs for the telescope (not the instrument) in each regime are cited. There are columns at the right of each regime labeled 1,2,3 for the three science programs discussed in the NOAO panel Workshop. In these columns the specs are assessed in terms of the adequacy for each science program.

**Key:**

- + meets needs
- - does not meet needs
- - irrelevant or not critical

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**Matt:**

I think this mode is important, its our only "thermal IR" mode, and we may find some spectroscopy modes are

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The Enemies.....

- Wind.....
- The Atmosphere......
30m Giant Segmented Mirror Telescope
Point Design Concept

30m F/1 primary, 2m adaptive secondary
Enabling Techniques

- Active and Adaptive Optics
- Active Optics already integrated into Keck, VLT and Gemini
- Adaptive Optics “added” to Keck, Gemini (and soon) VLT
  - Active and Adaptive Optics will have to be integrated into GSMT Telescope and Instrument concepts from the start
GSMT Control Concept

Deformable M2: First stage MCAO, wide field seeing improvement and M1 shape control

Active M1 (0.1 ~ 1Hz)
619 segments on 91 rafts

10-20' field at 0.2-0.3'' seeing

LGSs provide full sky coverage

- M2: rather slow, large stroke DM to compensate ground layer and telescope figure,
- or to use as single DM at λ>3 μm. (~8000 actuators)
- Dedicated, small field (1-2') MCAO system (~4-6DMs).

1-2' field fed to the MCAO module

Focal plane
Control Systems

<table>
<thead>
<tr>
<th>System</th>
<th>Purpose</th>
<th>Bandwidth</th>
<th>Actuation</th>
<th>Sensing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Axes</td>
<td>Pointing of the structure</td>
<td>1-2 Hz</td>
<td>Drive motors, with trajectory generation, pretension, etc.</td>
<td>Main axis encoders, mean value of optical guiding</td>
</tr>
<tr>
<td>M1 Segment Gross Position</td>
<td>Remove large errors due to gravity, thermal, or static wind. Reduce stroke requirements on precision segment motions</td>
<td>0.001 Hz</td>
<td>Linear actuators, stroke of about 10 to 30 mm, accuracy of about 100 micron</td>
<td>Gravity lookup table, edge sensors, wavefront mean value (on time scale of minutes)</td>
</tr>
<tr>
<td>M1 Segment Fine Position</td>
<td>Remove residual errors due to gravity, thermal, or quasi-static wind. Reduce stroke requirements on deformable mirrors in AO</td>
<td>0.5-1.0 Hz</td>
<td>Precision linear actuators, stroke of about 1 to 2 mm, repeatability of about 10 nm</td>
<td>Edge sensors, wavefront mean value (on time scale of seconds)</td>
</tr>
<tr>
<td>M1 Segment Warping</td>
<td>Remove errors within the segments</td>
<td>0.001 Hz</td>
<td>Warping harness with actuators. Small stroke</td>
<td>Lookup table</td>
</tr>
<tr>
<td>M2 Positioner</td>
<td>Correct quasi-static rigid body motions of M2 caused by gravity, thermal, or static wind.</td>
<td>0.1 Hz</td>
<td>Precision linear actuators, five DOF, stroke of about 10-30 mm</td>
<td>Lookup table, wavefront mean value (on time scale of seconds)</td>
</tr>
<tr>
<td>M2 Fast Tip/Tilt/Focus</td>
<td>Correct dynamic misalignments of M1 and M2, and make desired tip/tilt/focus corrections required.</td>
<td>5-10 Hz</td>
<td>High bandwidth actuators. Three-axis positioning. Stroke set by requirements for stabilization</td>
<td>Local position sensors on actuators, wavefront sensor to track star position</td>
</tr>
<tr>
<td>M2 Deformation</td>
<td>Correct residual tip/tilt errors of wave front, correct residual wavefront errors from M1.</td>
<td>10-20 Hz</td>
<td>High bandwidth actuators. Density sufficient to compensate low spatial-frequency modes of M1.</td>
<td>Local position sensors on actuators, wavefront sensor to determine command</td>
</tr>
<tr>
<td>MCAO</td>
<td>Final correction of wavefront</td>
<td>100 Hz</td>
<td>Depends on technology.</td>
<td>Wavefront sensor</td>
</tr>
</tbody>
</table>
Offloading of Decentralized Controllers

- Zernike modes
  - LGS MCAO: spatial & temporal avg
  - AO (M2): spatial avg
  - Secondary rigid body: spatial average
  - Main Axes: spatial & temporal avg
  - aO (M1): spatial & temporal avg

Bandwidth [Hz]

- 0.001
- 0.01
- 0.1
- 1
- 10
- 100
An enclosure is essential:

Scaled up and taller variation of JCMT Enclosure
30m Giant Segmented Mirror Telescope
Initial Structural Model

Horizon Pointing - Mode 1 = 2.16 Hz
Wind Loading

- Driving characteristic may be wind
  - Lower wind sites with good seeing
  - How to protect telescope
    - Enclosure needs
    - May be more limiting than local seeing to performance
    - Cost drivers
    - Advance methods for correcting

More critical than for existing telescopes
Animation

Wind pressure: c0003000

test_2, day_2, Azimuth angle=00, Zenith angle=30, wind_gate:open, open; wind speed=11 m/s
Gemini South Wind Tests, May 2000

Wind data by test

DOE analysis of wind data

- L16
- L9
Average Pressure PSD Data
- Effect of Enclosure Shutters
Average Pressure PSD by EL

- Note: No elevation dependence on average pressure on primary
How to scale to 30 meters:

\[ D(d) = 0.096 \times 10^{-d^{0.41}} \]

Average Pressure SF (C00030oo)

RMS pressure differences

Spatial scale

30M
Current concept will now go through “second iteration” of design in response to wind analysis.
## AO Technology Constraints (50m telescope)

<table>
<thead>
<tr>
<th>Actuator pitch</th>
<th>$r_0$(550 nm) = 10 cm</th>
<th>S(550nm)</th>
<th>S(1.65µm)</th>
<th>No. of actuators</th>
<th>Computer power (Gflops)</th>
<th>CCD pixel rate/sensor (M pixel/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10cm</td>
<td>74%</td>
<td>97%</td>
<td></td>
<td>200,000</td>
<td>$9 \times 10^5$</td>
<td>800</td>
</tr>
<tr>
<td>25cm</td>
<td>25%</td>
<td>86%</td>
<td></td>
<td>30,000</td>
<td>$2 \times 10^4$</td>
<td>125</td>
</tr>
<tr>
<td>50cm</td>
<td>2%</td>
<td>61%</td>
<td></td>
<td>8,000</td>
<td>1,500</td>
<td>$\sim 2$</td>
</tr>
</tbody>
</table>

**SOR (achieved)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th>8,000</th>
<th>1,500</th>
<th>$\sim 2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>789</td>
<td>1,500</td>
<td>$\sim 2$</td>
</tr>
</tbody>
</table>

*Early 21st Century technology will keep AO confined to $\lambda > 1.0 \mu m$ for telescopes with D ~ 30m – 50m*
MCAO on a 30m: Summary

- MCAO on 30m telescopes should be used $\lambda > 1.25 \, \mu m$
- Field of View should be 1-2 arcminutes,

<table>
<thead>
<tr>
<th>$\lambda (\mu m)$</th>
<th>Delivered Strehl</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25</td>
<td>0.2 ~ 0.4</td>
</tr>
<tr>
<td>1.65</td>
<td>0.4 ~ 0.6</td>
</tr>
<tr>
<td>2.20</td>
<td>0.6 ~ 0.8</td>
</tr>
</tbody>
</table>

Rigaut & Ellerbroek (2000)

- 9 Sodium laser constellation
- 4 tip/tilt stars ($1 \times 17, 3 \times 20 \, Rmag$)
- PSF variations < 1% across FOV

- Assumes the telescope residual errors ~ 100 nm rms
- Assumes instrument residual errors ~ 70 nm rms
  - Equivalent Strehl from focal plane to detector/slit/IFU > 0.8 @ 1 micron
  - Instruments must have:
    - very high optical quality
    - very low internal flexure
GSMT will need an Adaptive Secondary
Options: from low to high order

30cm actuator pitch
Good conditions (0.5" seeing):
<table>
<thead>
<tr>
<th>lambda</th>
<th>diameter[]</th>
<th>%energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25000</td>
<td>0.0226732</td>
<td>0.338447</td>
</tr>
<tr>
<td>1.60000</td>
<td>0.0290217</td>
<td>0.473207</td>
</tr>
<tr>
<td>2.25000</td>
<td>0.0408118</td>
<td>0.613434</td>
</tr>
<tr>
<td>3.8</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>5.00000</td>
<td>0.0906928</td>
<td>0.758112</td>
</tr>
<tr>
<td>10.0000</td>
<td>0.181386</td>
<td>0.789314</td>
</tr>
<tr>
<td>20.0000</td>
<td>0.362771</td>
<td>0.797315</td>
</tr>
</tbody>
</table>

50cm actuator pitch
Good conditions (0.5" seeing):
<table>
<thead>
<tr>
<th>lambda</th>
<th>diameter[]</th>
<th>%energy</th>
</tr>
</thead>
<tbody>
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<td>0.251838</td>
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<tr>
<td>3.8</td>
<td>0.66</td>
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<td>5.00000</td>
<td>0.0906928</td>
<td>0.744220</td>
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<tr>
<td>10.0000</td>
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<td>0.785671</td>
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<tr>
<td>20.0000</td>
<td>0.362771</td>
<td>0.796393</td>
</tr>
</tbody>
</table>

8,960 actuators, 30cm spacing on Primary
3,225 actuators, 50cm spacing
Sky coverage and Strehl for narrow field, thermal infrared observations using an adaptive secondary (wind buffeting on M1) (Rigaut, 2001)

- for $\lambda > 10\mu$ single laser beacon required
GSMT Implementation Concept
- MCAO/AO foci and instruments

Oschmann et al (2001)

MCAO optics moves with telescope

Narrow field AO or narrow field seeing limited port

MCAO Imager at vertical Nasmyth

4m
Modeling versus Data

GEMINI AO Data
20 arcsec

M15: PSF variations and stability measured as predicted
Comparative performance of a 30m GSMT with a 6.5m NGST

Assuming a detected S/N of 10 for NGST on a point source, with 4x1000s integration

![Graph showing S/N gain for GSMT compared to NGST across different wavelengths and resolution settings.]
High resolution, high Signal/Noise observations

Detecting the molecular gas from gaps swept out by a Jupiter mass protoplanet, 1 AU from a 1 M_☉ young star in Orion (500 pc) Carr & Najita 1998

GSMT observation ~ 40 mins (30 mas beam)
Instruments

- Telescope, AO and instruments must be developed as an integrated system
- NIO team developing design concepts
  - Prime focus wide-field MOS
  - MCAO-fed near-IR MOS
  - MCAO-fed near-IR imager
  - AO-fed mid-IR HRS
  - Wide-field deployable IFU spectrograph
- Build on extant concepts where possible
- Define major design challenges
- Identify needed technologies
GSMT Implementation concept
20 arcmin. wide field MOS

Barden et al (2001)
Optical “seeing improvement” using low order AO correction

Image profiles are Lorenzian

16 consecutive nights of adaptive optics the CFHT
GSMT Implementation Concept  
- wide field MOS

20 arc minute MOS on a 30m GSMT
- 800 0.75” fibers
- R=1,000
  350nm – 650nm
- R=5,000
  470nm – 530nm
- Detects 13% - 23% photons hitting 30m primary

Barden et al (2001)
Spot Diagrams for Spectrograph

R=1000 case with 540 l/mm grating.

Circle is 85 microns equal to size of imaged fiber.

R=5000 case with 2250 l/mm grating.

Barden et al (2001)
MCAO Optimized Spectrometer

- Baseline design stems from current GIRMOS d-IFU tech study occurring at ATC and AAO
  - ~2 arcmin deployment field
  - 1 - 2.5 µm coverage using 6 detectors
- IFUs
  - 12 IFUs total ~0.3”x0.3” field
  - ~0.01” spatial sampling R ~ 6000 (spectroscopic OH suppression)
Accomplishments to Date

- Core NIO team in place and working
- Point design structural concept developed by SGH
- AO system concept
- Instrument concepts
  - MCAO imager
  - MCAO NIR MOS
  - IFU spectrograph
  - Wide-field prime-focus MOS
  - High resolution mid-IR spectrograph
- “Enhanced seeing” system concept
- Chilean site characteristics assembled
- Wind loading tests completed at Gemini N+S
- Initial analysis of point design underway
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Objectives: Next 2 years

- Develop point design for GSMT & instruments
- Attack key technical problems
  - Adaptive optics
  - Wind loading
  - Mirror segment fabrication
- Involve the community in defining GSMT science and engineering requirements
- Involve the community in defining instrumentation options; technology paths
- Carry out conceptual design activities that support and complement other efforts
- Develop a formal partnership to build GSMT
Deliverables over 2 years

• Analysis of “point design” (Q4 2001)
• Initial science - requirements flowdown
• Conceptual designs for major instruments
• Roadmap for
  – key studies
  – enabling technologies
• Design concept for GSMT; key subsystems
  – collaborative with other groups
• Site requirements and initial testing
• Negotiated partnership to design; build GSMT
Objectives: Next Decade

• Complete GSMT preliminary design (2Q 2005)
• Complete final design (Q4 2007)
• Take the lead in building
  – a key subsystem
  – a major instrument
• Serve as locus for
  – community interaction with GSMT consortium
  – ongoing operations
  – defining; providing support capabilities
  – defining interactions with NGST
Key Milestones

• 2Q01: Establish initial science requirements
• 3Q01: Complete initial instrument concepts
• 3Q01: Complete point design analysis
• 2Q02: Identify key technology studies
• 1Q03: Fund technology studies
• 1Q03: Complete concept trade studies
• 2Q03: Develop MOUs with partner(s)
• 2Q03: Initiate Preliminary Design
• 4Q03: Complete SRM; establish science requirements
• 2Q05: Complete Preliminary Design
• 4Q05: Complete next stage proposal
Resources: Next 2 years

• Core NIO activities: $2.1M
  – Support core NIO staff (‘skunk works team’)
    • Analyze point design
    • Develop instrument and subsystem concepts
  – Support Gemini and NOAO staff to
    – Explore science and instrument requirements
    – Develop systems engineering framework

• Support community studies: $1.5M
  – Enable community efforts: science; instruments
  – Enable key external engineering studies
  – Support alternative concept studies
Resources: Next Decade

- $15M in CY 2003-2006 from NOAO base
  - Enables start of Preliminary Design with partner
- $25M in CY 2007-2011 from NOAO base
- Create a ‘wedge’ of ~$10M/yr by 2010
  - Enables NOAO funding of
    - Major subsystem
    - Instruments
    - Operations
What is the AURA New Initiatives Office?

- Partnership between Gemini, NOAO and our communities
- Science Drivers for a 30m
- Complementarity to other facilities (e.g. NGST)
- Implementation Concepts
- Resources
- Interfaces or Partnership Issues
A Few Guiding Principles

- U.S. effort will likely be a private/public partnership. If so, public/community involvement should begin at the outset.
- NIO will seek to establish collaborations with all partners demonstrating a commitment to this same goal and evidence of a viable program.
- NIO work will advance generally applicable scientific and engineering concepts of general interest.
- Committed to free and open exchange of information.
- NIO will maintain all possible options for international collaboration.
NIO Structure

- Management unit of AURA
  - Reports to AURA President
- Partnership between Gemini and NOAO
- Activities overseen by management board
  - AURA president; directors of NOAO; Gemini
  - Project Manager; Project Scientist (ex officio)
- Guidance from NIO Advisory Committee
Charge to the Committee

- Advise and comment on the NIO program
- Identify opportunities for collaboration with other groups
- Broad exchange of technical and scientific ideas