Overview of RAVEN Project

• MOAO demonstrator  (targeting 1st on 8m class)
  – Experiment in laboratory room
  – On-sky engineering & science verification

• Canadian group project
  – 6M CAD by BCKDF/CFI Leading Edge Fund
  – University of Victoria (UVic)
  – Herzberg Institute for Astronomy (HIA)

• Supported by Japanese group
  – Subaru Tel. (infra/manpower, researcher exchange, M.Ito)
  – Tohoku Univ. (basic experiment in laboratory, Y.Ono)

• Schedule
  – 2014: Test in Sim.Lab (Jan-Apr); 1st Eng.Obs. in May
  – 2nd Eng.Obs in S14B?
History

2009  Sep 24,25:  Face-to-face Meeting @ Victoria
2010  Mar 16,17:  Kick-off Meeting @ Victoria
      May 1-3:  1st Interface-meeting @ Hilo
2011  Mar 7,8:  Conceptual Design Review @ Victoria
      Dec 15:  Subaru Internal Review @ Hilo
2012  Nov 20,21:  1st Science Meeting @ Sendai
2013  Jul 25:  2nd Science Meeting @ Kona
      Nov 26:  Pre-shipping Meeting @ Victoria
2014  Jan 6:  Delivery to Hilo

Status Update: ~every 6 months
Interface Control Document: frequent update, based on e-mail discussion
Why MOAO?

Why AO unit is prepared for each object?

- For AO, it is difficult to realize both of "wide-field" and "correction performance".

- Suitable for 30m telescopes
  - large focal plane
    - the size of conventional AO will be too large
    - reasonable size if divided for each object
  - Field-of-Regard (pick-up field size) increases with the telescope diameter
Future MOAO example from feasibility study of TMT-IRMOS by UF/HIA

~20 objects (~2″φ each) over ~5′φ

□: LBG candidates in Hubble UDF (z = 2~6)
→: MOAO probe

simulated LBG image on a probe
At Subaru Telescope

- treated as a carry-in instrument
- installed on NsIR; science instrument is IRCS

Subaru NsIR platform (top view)
## System Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Science CH</td>
<td>2 (= number of DM)</td>
</tr>
<tr>
<td>WFS</td>
<td>3 NGSs +1 LGS / 10x10 SH (R&lt;14)</td>
</tr>
<tr>
<td>DM</td>
<td>11x11 (ALPAO 97)</td>
</tr>
<tr>
<td>Field size</td>
<td>FoR: 3.5’ for NGS (2’ Φ full for Sci)</td>
</tr>
<tr>
<td></td>
<td>FoV: 4” each channel</td>
</tr>
<tr>
<td>Wavelength range</td>
<td>Sci: 0.9-4um ; WFS: 0.6-0.9um</td>
</tr>
<tr>
<td>Science instrument</td>
<td>IRCS (Imaging, Grism, Echelle)</td>
</tr>
<tr>
<td>Ensquired Energy</td>
<td>&gt; 30% in 140mas slit (0.75” seeing)</td>
</tr>
<tr>
<td>System Throughput</td>
<td>&gt; 80% of AO188</td>
</tr>
</tbody>
</table>

2 NGS + 1 LGS is also possible; i.e., at least 2 NGSs are necessary in 3.5’Φ

Details are available at: http://web.uvic.ca/~ravenmoa/index.html
Expected Performance

- 3 NGS (r=45") + LGS (center) @ 0.75" seeing (FoR:2’ ~ 3’)
- element # : 10x10 (WFS: 10x10 SH, DM: 11x11)

3 bright NGS + LGS (500Hz)

3 faint (R=14.5) NGS (180Hz)

by D. Andarsen

X-axis: separation form the center of FOV in arcsec
Y-axis left: WFE in nm: ○ all modes; ▲ TT removed
right: SR ×; ■ EE (140mas)
Sky Coverage

3 NGSSs (R<14mag) within 2.7’ φ

<table>
<thead>
<tr>
<th>RA [deg]</th>
<th>0 - 60</th>
<th>60 - 120</th>
<th>120 - 180</th>
<th>180 - 240</th>
<th>240 - 300</th>
<th>300 - 360</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sky Cov [%]</td>
<td>8.6</td>
<td>24.2</td>
<td>19.5</td>
<td>18.8</td>
<td>40.3</td>
<td>21.1</td>
</tr>
</tbody>
</table>

by C. Blain
Science Cases

• Merit
  Multiplicity and/or Simultaneity

• Proposed ideas in the science meetings
  – Galactic
    • Bulge (metal poor stars, globular cluster)
    • Galactic Center (young star cluster candidates)
    • Atmosphere (protoplanet, exoplanet)
  – Extragalactic
    • Nearby Galaxies (stellar population, globular clusters)
    • Super Star Clusters
    • Kinematics (galaxy asymmetries, lensed galaxies)
    • QSO host galaxies

Slides are available at: http://web.uvic.ca/~ravenmoa/meetings.html
Resent Status: UVic Lab.

No AO

GLAO

Model-based MOAO

SCAO

Nov 26, 2013
Resent Status: Delivery

Jan 6, 2014
Resent Status: SimLab

Jan 7, 2014

Jan 17, 2014

Alignment has been done
Summary

• MOAO demonstrator
  – collaboration between Canada and Japan
  – project scale: 6M CAD / 3yr + α
  – targeting the 1st on 8m class telescope

• At Subaru Telescope
  – carry-in instrument; uses IRCS @ NsIR + LGS
  – tomography, open-loop control & calibration
  – on-sky science verification

• Observation condition
  – 2 objects over 2’φ + α FoR
    3(2) NGS (R<14) over 2.7’φ FoR + LGS (center)
  – best SR@H=0.5 (3 bright NGS+1 LGS @ 500Hz)
    =0.17 (3 faint NGS @ 180Hz)