Activities of
Optical-Infrared Astronomical Technology
Group of KASI

Sungho Lee
Korea Astronomy and Space Science Institute

@Subaru International Partnership Science and Instrumentation Workshop
22 Mar 2017
OIR Tech Group Activities

GMT Development Activities by KASI

Telescope Technology

FSM-P

FSM

Instrument Technology

IGRINS

G-CLEF

GMTNIRS
Doubly segmented mirror sets

- M1 - 8.36m 7 segments
- M2 - 1.06m 7 segments
- M1/M2 segments are conjugate

M2 segments of two types

- Fast-steering Secondary Mirrors (FSM, will support First light operation)
- Adaptive Secondary Mirrors (ASM, will provide AO capability to defeat atmospheric seeing)
FSM Overview and Scope

7 mirrors fabrication
- 1 mirror (on-axis)
- 6 mirrors (off-axis)

Spare: 2 mirrors fabrication (TBD)
- 1 mirror (on-axis)
- 1 mirror (off-axis)
FSM Design - Mirror and Cell

On-axis mirror

- Lateral support axial adjustment tube
- Lateral support guide rod
- Axial support
- Lateral support clamps
- Mirror cell
- Mirror segment

Dimensions:
- Height: 120 mm
- Diameter: 1058.3 mm
FSM Plan Review at GMTO

KASI OIR Technology Group Activities  22 Mar 2017  Subaru International Partnership Workshop
OIR Tech Group Activities

GMT Development Activities by KASI

Telescope Technology

FSM-P

FSM

Instrument Technology

IGRINS
IGRINS Characteristic Feature

- **Wide Wavelength Coverage**
- **Resolving Power 45,000**
- **Infrared Spectrograph**
- **Star & Planet Formation**
- **Immersion Grating**
- **High Resolution**
- **Small !!**
- **All Parts Fixed !**
IGRINS Physical Size
VLT CRIRES Physical Size
IGRINS at McDonald Observatory

- High resolution in a single exposure: R=45,000 full coverage of H & K bands
- At McDonald 2.7m Telescope: Mar 2014 ~ July 2016 total 374 nights operated

▲ H band 25 orders                             TW Hydrae                             ▲ K band 22 orders
IGRINS at McDonald Observatory

- High resolution in a single exposure: R=45,000 full coverage of H & K bands
- At McDonald 2.7m Telescope: Mar 2014 ~ July 2016 total 374 nights operated

Sample Spectra: TW Hydra (YSO)
IGRINS at DCT 4m Telescope

- Discovery Channel Telescope run by Lowell Observatory Flagstaff AZ
- DCT schedule: Oct 2016 ~ Feb 2017: >50% nights assigned for IGRINS
- 8m Gemini South Commissioning scheduled in March 2018

▲ IGRINS installed at DCT
▲ First Light Slit-viewer and H & K band Spectra
Keck NIRSPEC vs. IGRINS

Mace et al. 2012
Dr. Jae-Joon Lee (KASI) - https://github.com/igrins/plp
OIR Tech Group Activities

GMT Development Activities by KASI

- Telescope Technology
  - FSM-P
  - FSM
- Instrument Technology
  - IGRINS
  - G-CLEF
G-CLEF Instrument Overview

The GMT-Consortium Large Earth Finder (G-CLEF) properties:

- Fiber-fed optical echelle spectrograph
- General purpose instrument
- Precision radial velocity (PRV) capable
- The first light science instrument for the GMT
- Passband is 3500Å – 9000Å (Spec) / 9500Å (Goal)
- Operates in 4 resolution modes
- Has an interface to MANIFEST for MOS operation

<table>
<thead>
<tr>
<th>Mode</th>
<th>PRV</th>
<th>NS-PRV</th>
<th>MR</th>
<th>HT</th>
<th>MOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>108,000</td>
<td>108,000</td>
<td>35,000</td>
<td>19,000</td>
<td>35,000</td>
</tr>
</tbody>
</table>

PRV: Precision Radial Velocity Mode
NS-PRV: Non-scrambled PRV Mode
MR: Medium Resolution Mode
HT: High Throughput Mode
G-CLEF Collaboration

Andrew Szentgyorgyi, PI
Daniel Baldwin
Stuart Barnes
Jacob Bean
Sagi Ben-Ami
Patricia Brennan
Jamie Budynkiewicz
Moo-Yung Chun
Charlie Conroy
Jeffrey D. Crane
Harland Epps
Ian Evans
Janet Evans
Jeff Foster
Anna Frebel
Sungho Lee
Thomas Gauron
Dani Guzman
Tyson Hare
Bi-Ho Jang
Jeong-Gyun Jang
Andres Jordan
Jihun Kim
Kang-Min Kim
Claudia Mendes de Oliveira
Mercedes Lopez-Morales
Kenneth McCracken
Stuart McMuldron
Joseph Miller
Mark Mueller
Jae Sok Oh
Sanghyuk Kim
Cem Onyukels
Mark Ordway
Byeong-Gon Park
Chan Park
Sung-Joon Park
Charles Paxson
David Phillips
David Plummer
William Podgorski
Andreas Seifahr
Daniel Stark
Joao Steiner
Alan Uomoto
Ronald Walsworth
Young Sam Yu

Harvard-Smithsonian Center for Astrophysics
Steward Observatory, University of Arizona
The Observatories of the Carnegie
Pontificia Universidad Catolica de Chile
University of Chicago

Korea Astronomy and Space Science Institute
Massachusetts Institute of Technology
UCO/Lick Observatory, University of California
Universidade de São Paolo
G-CLEF Location on GMT

Gravity-Invariant Azimuth Platform

G-CLEF Fiber Optic Run

G-CLEF Spectrograph In Thermal Enclosure
G-CLEF System Design

G-CLEF Front End Assembly (GCFEA)
G-CLEF spectrograph (GCSPECT)
Multi-Object Spectroscopy feed (MANIFEST)
Calibration Light Source (GCCLS)
Science fiber feed assembly (GCSFIB)
Calibration fiber feed assembly (GCCFIB)
G-CLEF is vacuum enclosed to insulate the spectrograph thermally and stabilize the index of refraction of the immersing medium to maximize radial velocity measurement precision. Vessel is made of aluminum.
The GMT guide itself exquisitely (< 0.2 arcsec over the observable sky)

The telescope guide systems (AGWS) & G-CLEF fiber interface are not co-located.

Telescope flexure requires that G-CLEF has a dedicated Flexure Control System.

Fiber feed and flexure control system follows last relay optic in the front end.

Flexure Control Camera subsystem guides out telescope flexure.

Capability to accommodate wavefront sensor for adaptive optics control.
Double blade flexures, mount bezel, tip-tilt for alignment
OIR Tech Group Activities

GMT Development Activities by KASI

Telescope Technology
- FSM-P
  - FSM

Instrument Technology
- IGRINS
  - G-CLEF
  - GMTNIRS
GMTNIRS Design Concept

GMTNIRS is a high resolution AO-fed spectrograph for the infrared covers all of the 1.12-5.3 micron range in a single exposure through an 85 mas slit with 4 pixel sampling. \( R = 50,000 \) at JHK and 90,000 at LM.

- J: \( 1.12 \mu m < \lambda < 1.35 \mu m \), (limited at the short wavelength and by the transmission of silicon)
- H: \( 1.45 \mu m < \lambda < 1.80 \mu m \),
- K: \( 2.00 \mu m < \lambda < 2.45 \mu m \),
- L: \( 2.90 \mu m < \lambda < 4.15 \mu m \), and
- M: \( 4.50 \mu m < \lambda < 5.30 \mu m \).
GMTNIRS Design Concept

- International collaboration similar to IGRINS: KASI-UT (Carnegie-KHU)
- JHKLM five modular design - one spectrograph per band
- Subunits packaged separately for easier alignment and thermal management
An immersion grating for IGRINS
감사합니다
Thank You