Overview of the PI type instrument

Yosuke Minowa
(New development group, Subaru telescope)

Subaru User's Meeting FY2015

Roles of the PI type instrument

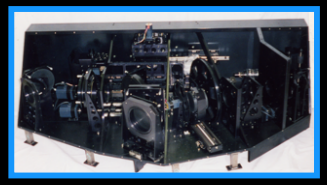
Subaru encourages to carry in the PI type instrument for:

1. Unique science capability
   - Complementary to the large facility instrument
   - Can be a single purpose science to pursue the PI's own science
2. Test bed of the latest technology for future instrument
3. Flexible operation compared to the large facility instrument
   - Short turnaround time (<5 yrs) from development to science output
   - Promote small scale development by University and provide a good educational ground for graduate students

Current PI type instruments lineup

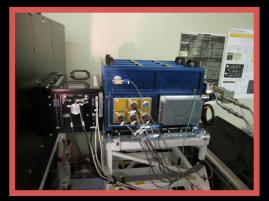
NsIR

Kyoto3DII
(~2016.2)

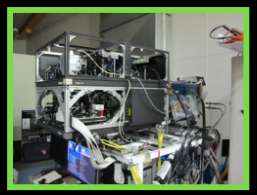


AO188

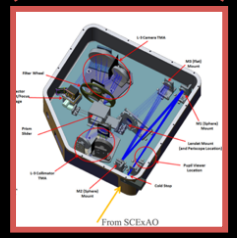
HiCIAO



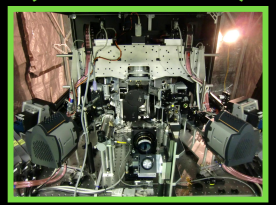
SCExAO



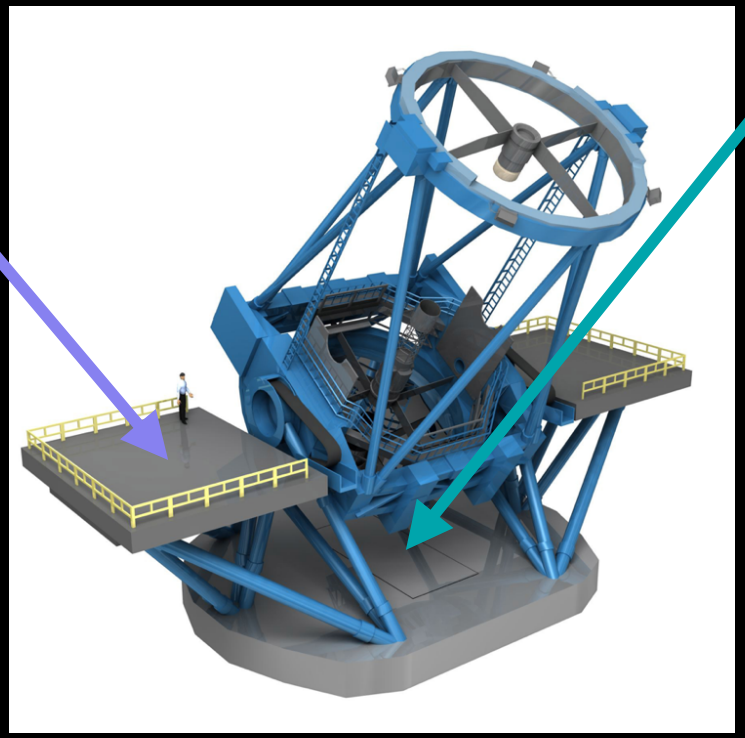
CHARIS
(2016.7~)



RAVEN
(~2015.7)



IRCS



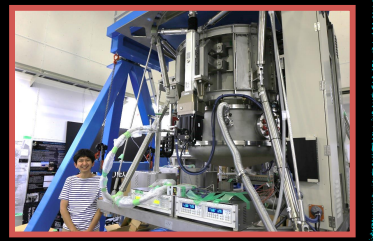
Coude

IRD(2016.7~)

Cs

SWIMS

MIMIZUKU

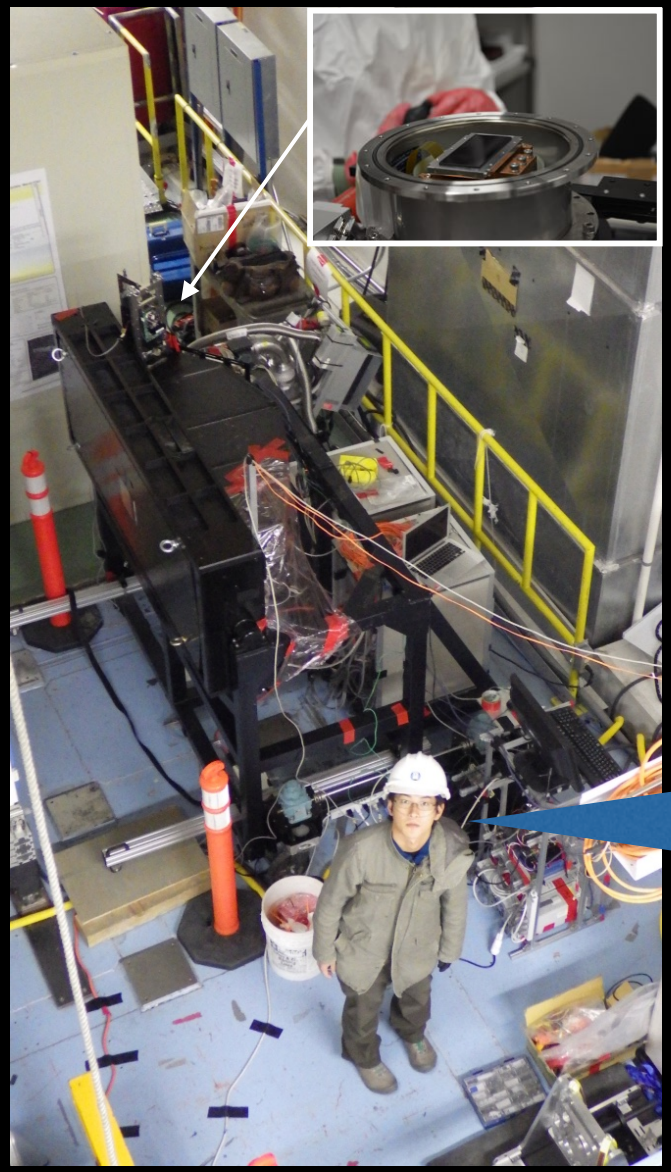


Acceptance of
SWIMS/MIMIZUKU
are now under
review process.

Existing PI type instrument

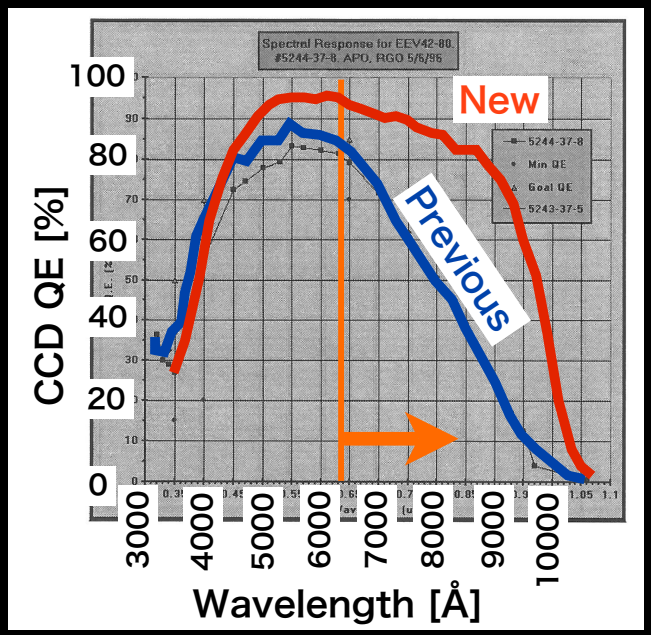
Kyoto-3DII: Visible IFU sepctrograph and Fabry-Perot imager

(PI: H. Sugai at IPMU)



- Used with AO188 at NsIR, which provides FWHM~0".1 at R-band.
- Provide the only IFU capability at the Subaru
- IFU mode was successfully commissioned with AO188 at 2012
- CCD was replaced from EEV to Hamamatsu FDCCD in S15B
- Large sensitivity improvement at around 9000A
  because of high QE and low RO noise.

Poster presentation by K. Mitsuda (IoA)

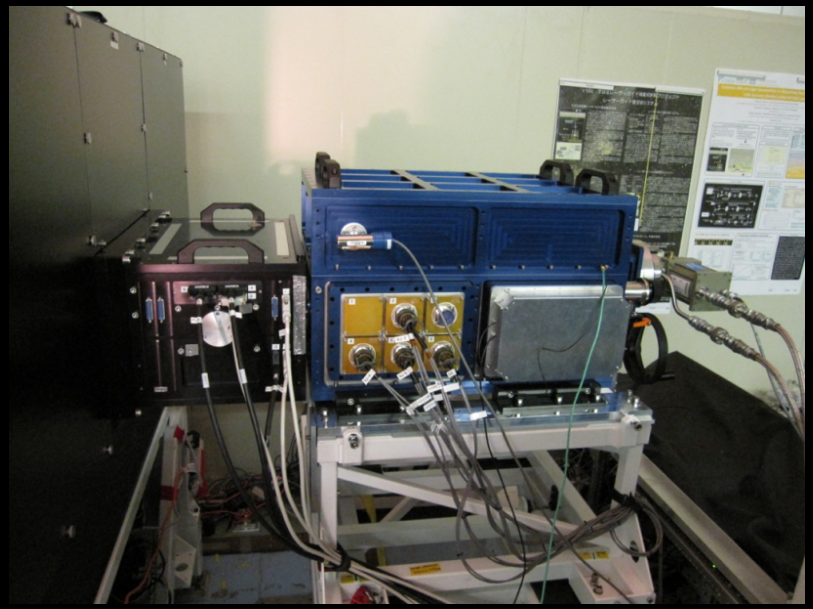


K3DII will be decommissioned after 3 open-use runs on Feb.

Existing PI type instrument

HiCIAO: High-contrast imager with AO188

(PI: M. Tamura at Univ. of Tokyo)



- DI, SDI, PDI with and w/o coronagraph for expoplanet and disk survey
- Used with AO188, SCExAO at NsIR
- Start operation since 2008
- SEEDS program (120 nights) until S15B

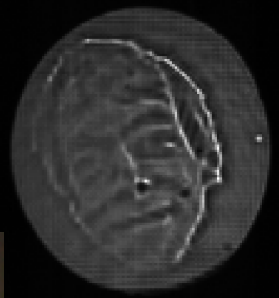
Tamura-san's talk for Science results from SEEDS

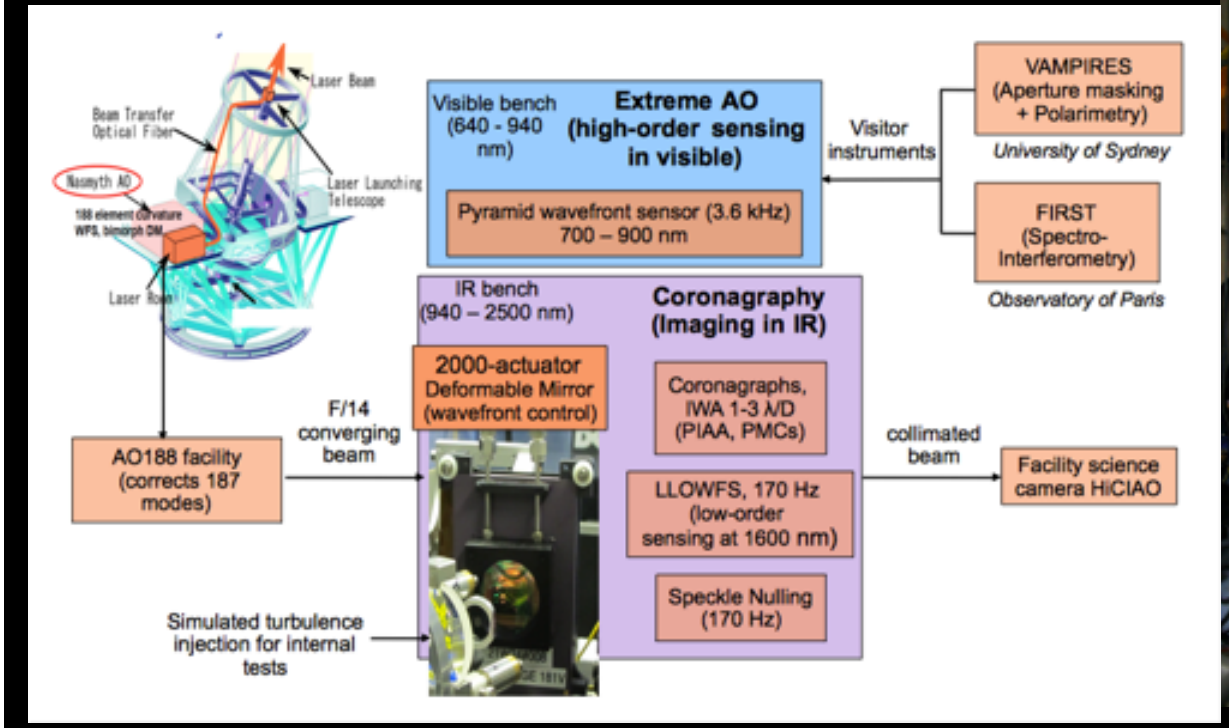
- Currently, HiCIAO is mainly used with SCExAO.
- HiCIAO team are requesting to extend the operation of HiCIAO+AO188 (w/o SCExAO) mode after S16B or later.
- Review the extension proposal before CfP of S16B to determine the availability of HiCIAO+AO188

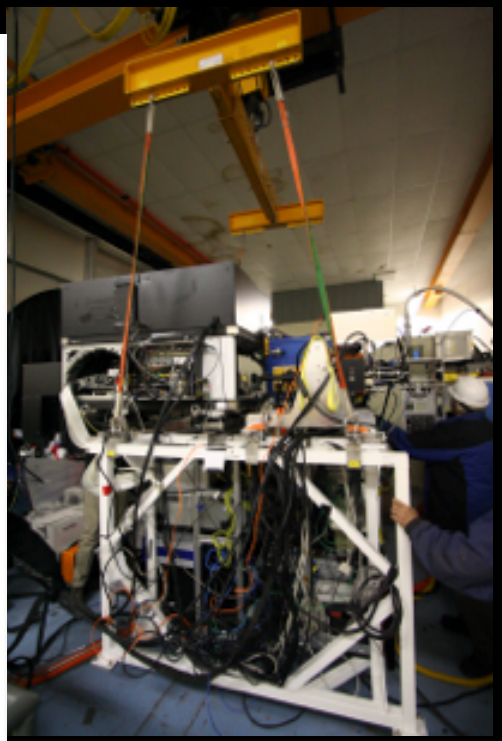
Existing PI type instrument

SCExAO: Subaru Coronagraphic Extreme Adaptive Optics

(PI: O. Guyon at Subaru)







SCExAO: high contrast imager in visible and near-IR, capable of imaging circumstellar environments (binaries, exoplanets, disks), near the diffraction limit of the telescope.

In near-IR (y, J, H and K band):

- coronagraphs provide high contrast images down to 1-3 lambda/D.
- a low-order wavefront sensor stabilizes the wavefront behind the coronagraph
- speckle nulling improves the contrast on one half of the image plane

In visible (600-940nm):

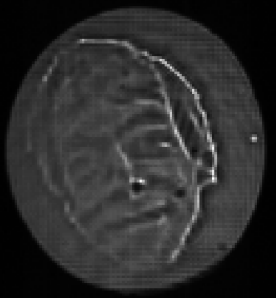
- the Pyramid Wavefront Sensor provides the cleanest wavefront possible
- 2 interferometric instruments (VAMPIRES and FIRST) can provide analysis of stellar radii, dust shells, or very close binaries (down to 10 mas)

Slide from J. Lozi

Existing PI type instrument

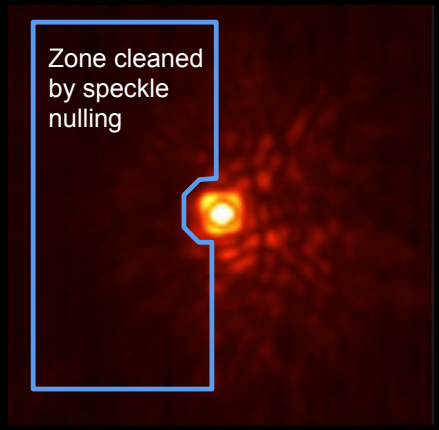
SCExAO: Subaru Coronagraphic Extreme Adaptive Optics

(PI: O. Guyon at Subaru)



Current performances (preliminary):

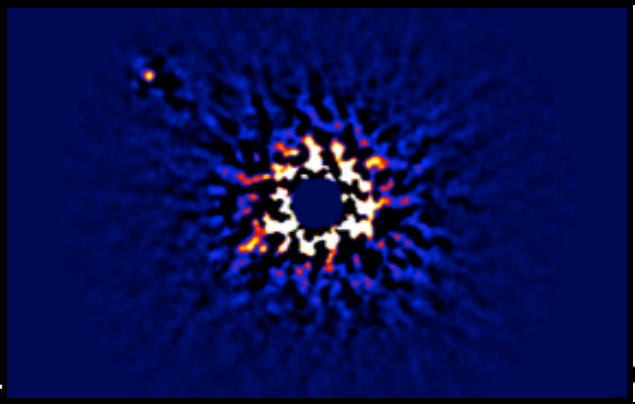
- Extreme-AO loop:
  - Commissioning incomplete, has not reached full spec yet.
  - Current performance is 70%+ Strehl in H-band on average.
    (nevertheless the best PSF quality ever seen at Subaru).
  - Will approach 90 in the next few runs.
- LOWFS, Speckle nulling and coronagraphs have been demonstrated on-sky.
- VAMPIRES is already commissioned, FIRST is being optimized.
- YOU CAN APPLY FOR TIME!

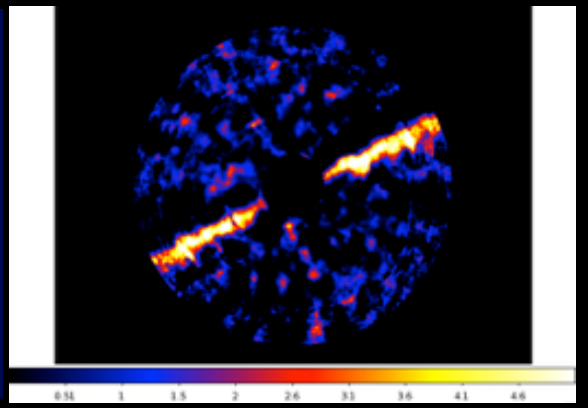


Recent preliminary results:

- kappa And b (left)
- debris disk of HIP 79977 (right)

T. Currie et al.





Future phases:

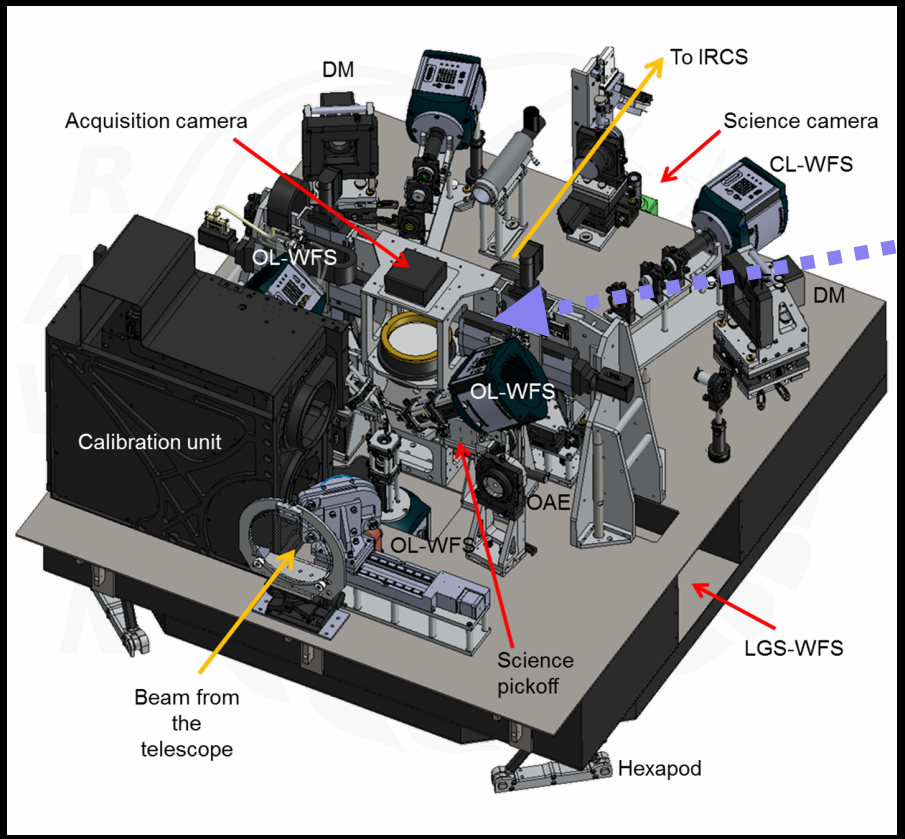
- mid-2016: commissioning of CHARIS, the Integral Field Spectrograph in NIR
- 2017: commissioning of MKIDS, a new type of photon counting detector, with discrimination of energy (low-resolution spectra with no dispersive optics)

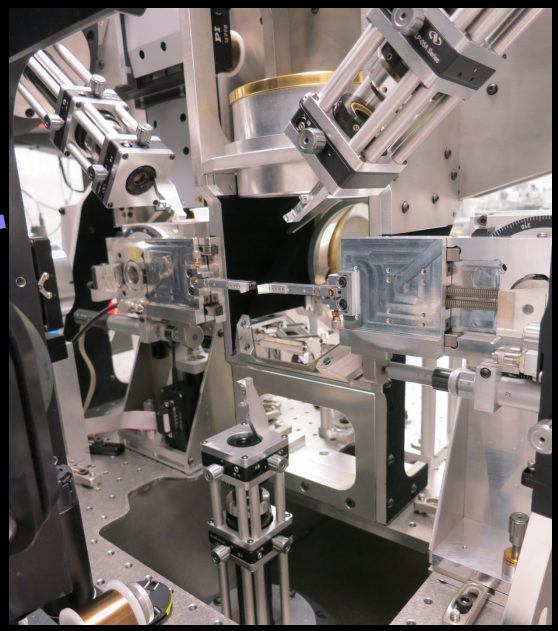
Slide from J. Lozi

Existing PI type instrument

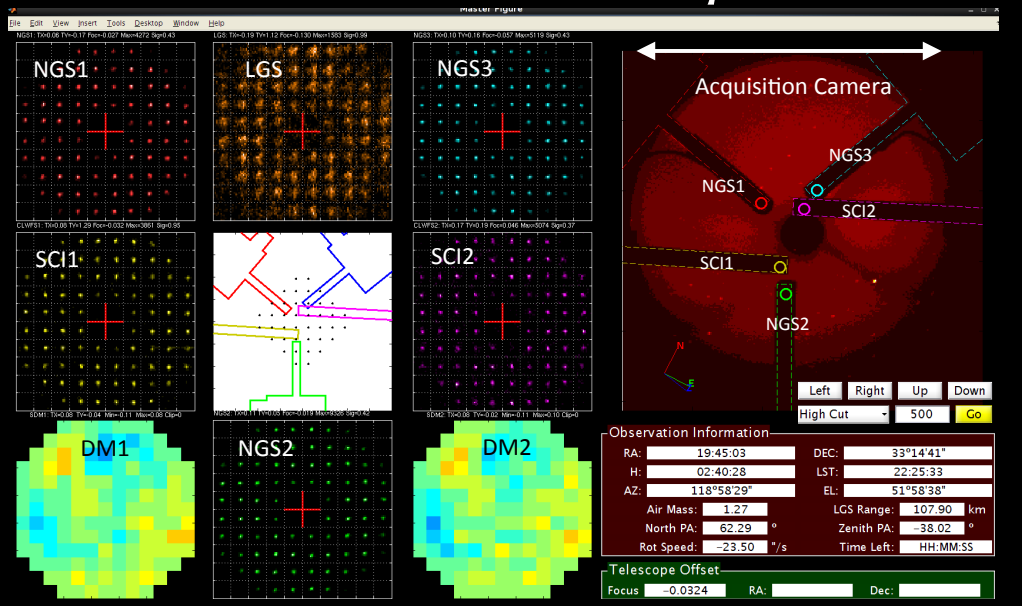
RAVEN: Multi-Object Adaptive Optics Science Demonstrator

(PI: Bradley at Univ. of Victoria, collaboration with Subaru and Tohoku Univ.)





ϕ ~3'.5



- Simultaneous obs. of two objects within Φ3'.5 FOV
- Used with IRCS at NsIR
- Test bed for TMT MOAO system
- First light on May, 2014
- Tested MOAO performance, as well as GLAO and SCAO
- Science observations using open use and staff time.

Decommissioned on Sep. 2015

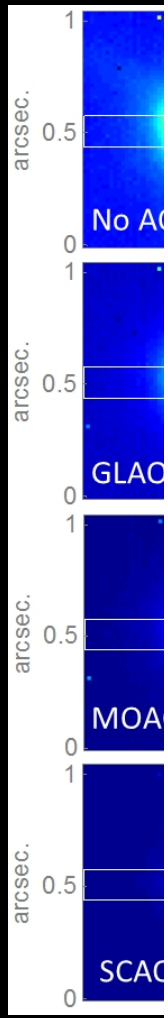
Existing PI type instrument

RAVEN: Multi-Object Adaptive Optics Science Demonstrator

(PI: Bradley at Univ. of Victoria, collaboration with Subaru and Tohoku Univ.)

On-sky performance

Science Highlights



The Astrophysical Journal, 811:133 (11pp), 2015 October 1 doi:10.1088/0004-637X/811/2/133

RAVEN AND THE CENTER OF MAFFEI 1: MULTI-OBJECT ADAPTIVE OPTICS OBSERVATIONS OF THE CENTER OF A NEARBY ELLIPTICAL GALAXY AND THE DETECTION OF AN INTERMEDIATE AGE POPULATION*†

T. J. Davidge[1], D. R. Andersen[1], O. Lardière[2], C. Bradley[2], C. Blain[2], S. Oya[3], M. Akiyama[4], and Y. H. Ono[4]
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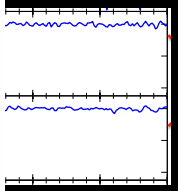
Received 2015 June 19; accepted 2015 August 28; published 2015 September 29

ABSTRACT

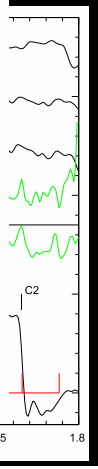
Near-infrared (NIR) spectra that have an angular resolution of ~0.15 arcsec are used to examine the stellar content of the central regions of the nearby elliptical galaxy Maffei 1. The spectra were recorded at the Subaru Telescope, with wavefront distortions corrected by the RAVEN Multi-object Adaptive Optics science demonstrator. The Ballick–Ramsey C_2 absorption bandhead near 1.76 μm is detected, and models in which ~10%–20% of the light near 1.8 μm originates from stars of spectral type C5 reproduce the depth of this feature. Archival NIR and mid-infrared images are also used to probe the structural and photometric properties of the galaxy. Comparisons with models suggest that an intermediate age population dominates the spectral energy distribution between 1 and 5 μm near the galaxy center. This is consistent not only with the presence of C stars, but also with the large Hβ index that has been measured previously for Maffei 1. The $J - K$ color is more or less constant within 15 arcsec of the galaxy center, suggesting that the brightest red stars are well-mixed in this area.

Key words: galaxies: elliptical and lenticular, cD – galaxies: evolution – galaxies: individual (Maffei 1)

First MOAO science paper published



arby
dge et al.)



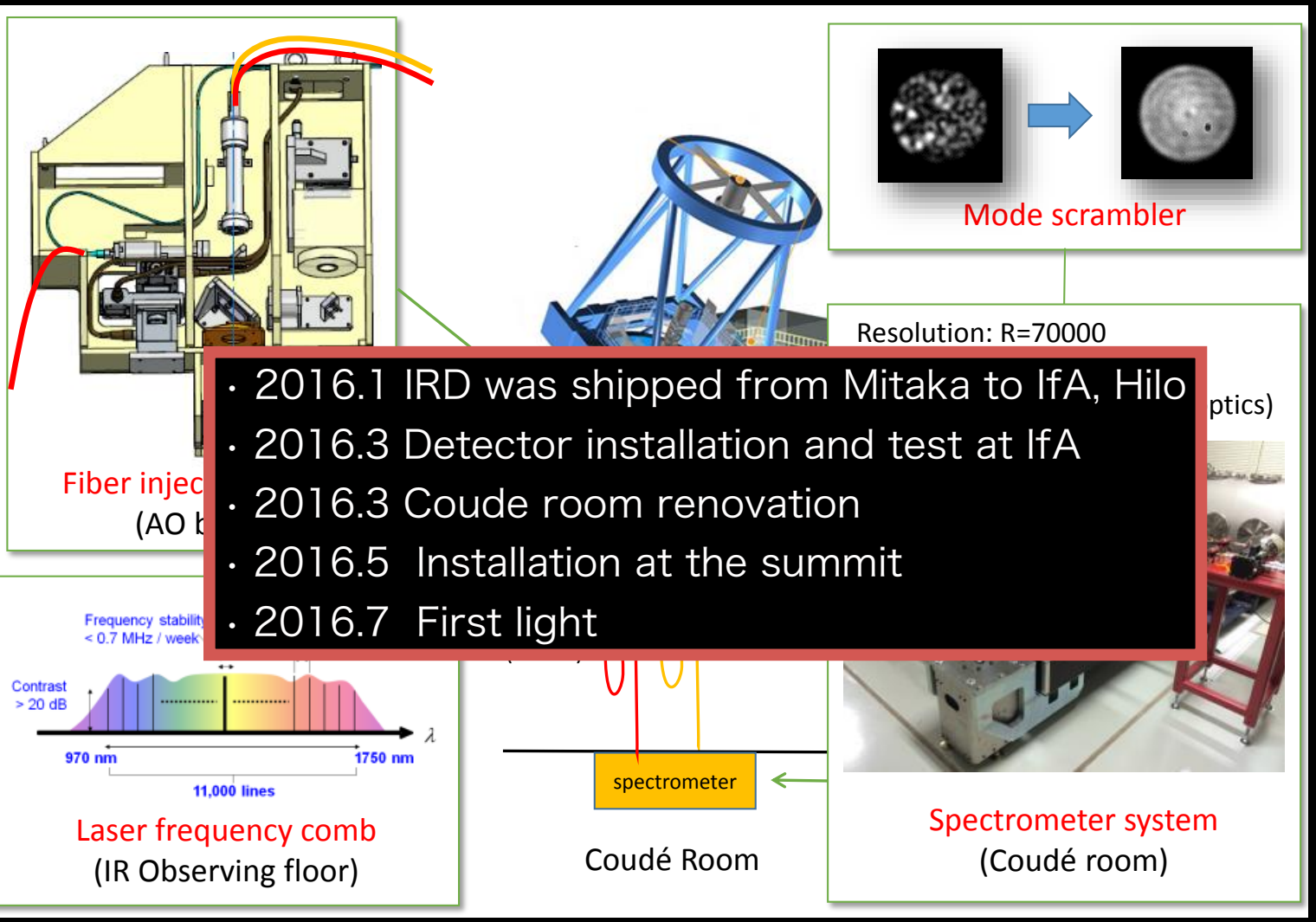
Lardiere et al. 2014

Each image = 60s exposure in H band

Upcoming PI type instrument

IRD: Infrared Doppler Spectrograph (PI: M. Tamura at Univ. of Tokyo)

Slide from T. Kotani



Next Sato-san's talk for more detail.

Upcoming PI type instrument

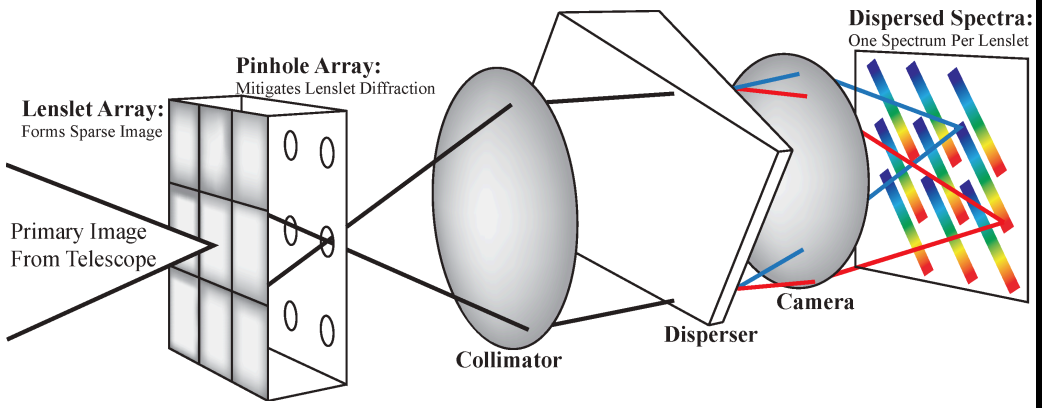
CHARIS: Coronagraphic High Angular Resolution Imaging Spectrograph

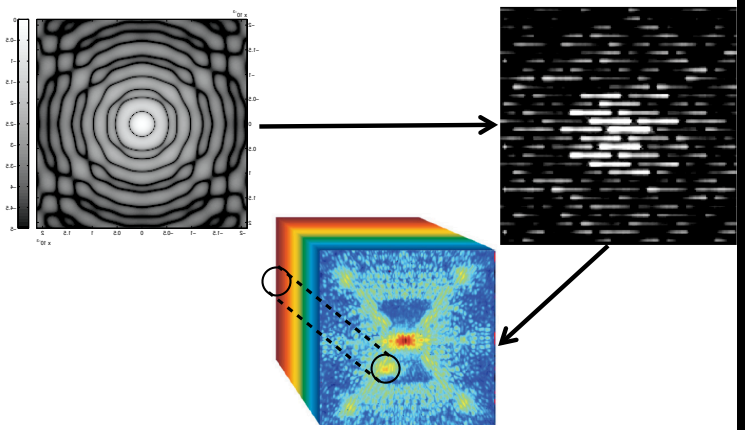
(PI: J. Kasdin at Princeton Univ., collaboration with NAOJ)

PRINCETON UNIVERSITY

The CHARIS IFS

- Major Science Objective:
  - Spectral characterization
    - Exoplanets
    - Disks
    - Brown dwarfs
  - IWA = 3 λ/D = 90 mas
  - 2.07”x2.07” FOV
  - R~19, J+H+K Band
    - 65-70% Throughput
    - 15% (10% K) Atmosphere ➔ Detector
  - R~70-90: J,H, and K Bands
    - 55-60% Throughput
    - ~15% Atmosphere ➔ Detector
  - Technology Contributions: Crosstalk Mitigation, New Dispersion Modes/Materials





Slide from T. Groff

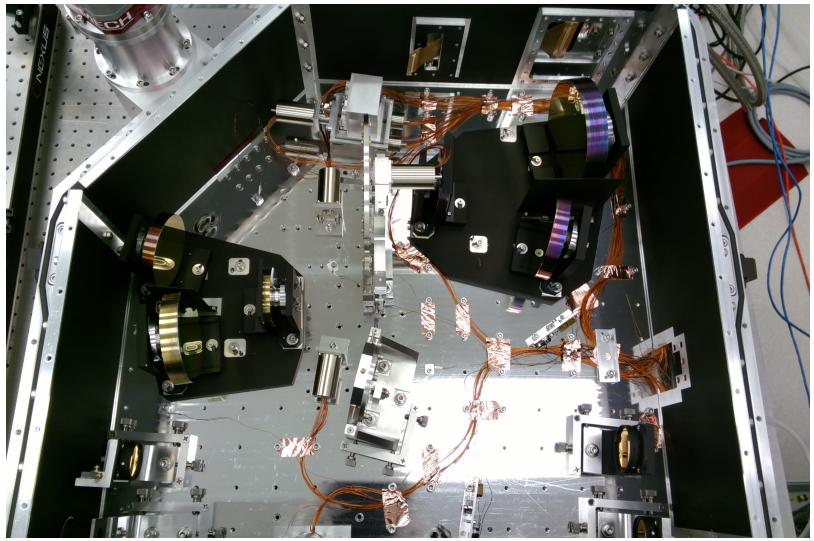
Upcoming PI type instrument

CHARIS: Coronagraphic High Angular Resolution Imaging Spectrograph

(PI: J. Kasdin at Princeton Univ., collaboration with NAOJ)

PRINCETON UNIVERSITY

Current State and Commissioning Plan

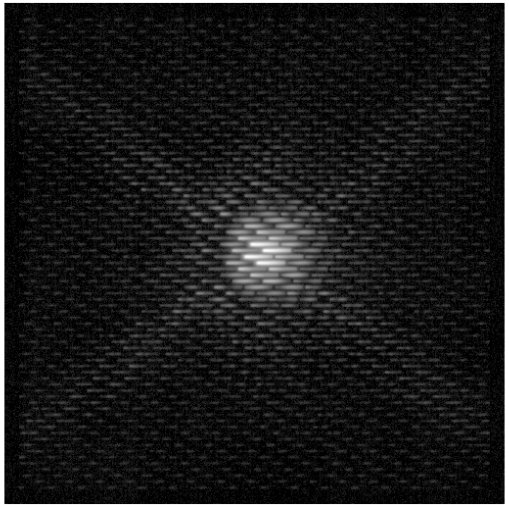


CHARIS is undergoing testing

- Flat Fielding with H2RG
- Crosstalk Verification
- Software tests of Linux-based H2RG control
- Data Pipeline Final Design
- Dispersion Profiles
- Qualification of L-BBH2 prism

Right: Simulation of a dispersed image

- CHARIS is built to work with the SCExAO FOV
- Wavefront requirements are designed for SCExAO coronagraphic image
- CHARIS is intended to augment the work done by SEEDS and Subaru exoplanet studies
- Delivery is scheduled for end of April
- Commissioning through July 2016



Slide from T. Groff

Proposed PI type instruments

TAO 6.5m telescope's facility instruments.

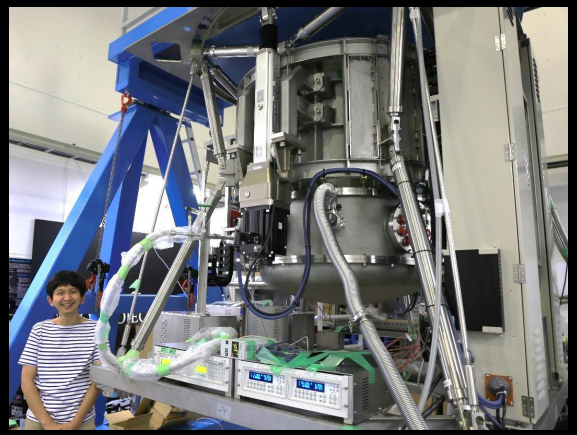
- Provide opportunities for initial instrument test
- Perform early science with Subaru

SWIMS – NIR wide field multi-color imager and MOS muti-color

(PI: K. Motohara at Univ. of Tokyo)

- 3'.3 x 6'.6 FOV at Subaru
- Simultaneous two-band imaging at NIR (zJ and HK)
- Wider spectral coverage than MOIRCS
- Proposed to ship the instrument to Subaru on July.
- Proposed First light wll be at the end of 2016.

Konishi-san's poster



MIMIZUKU – MIR multi-filed imager and spectrograph

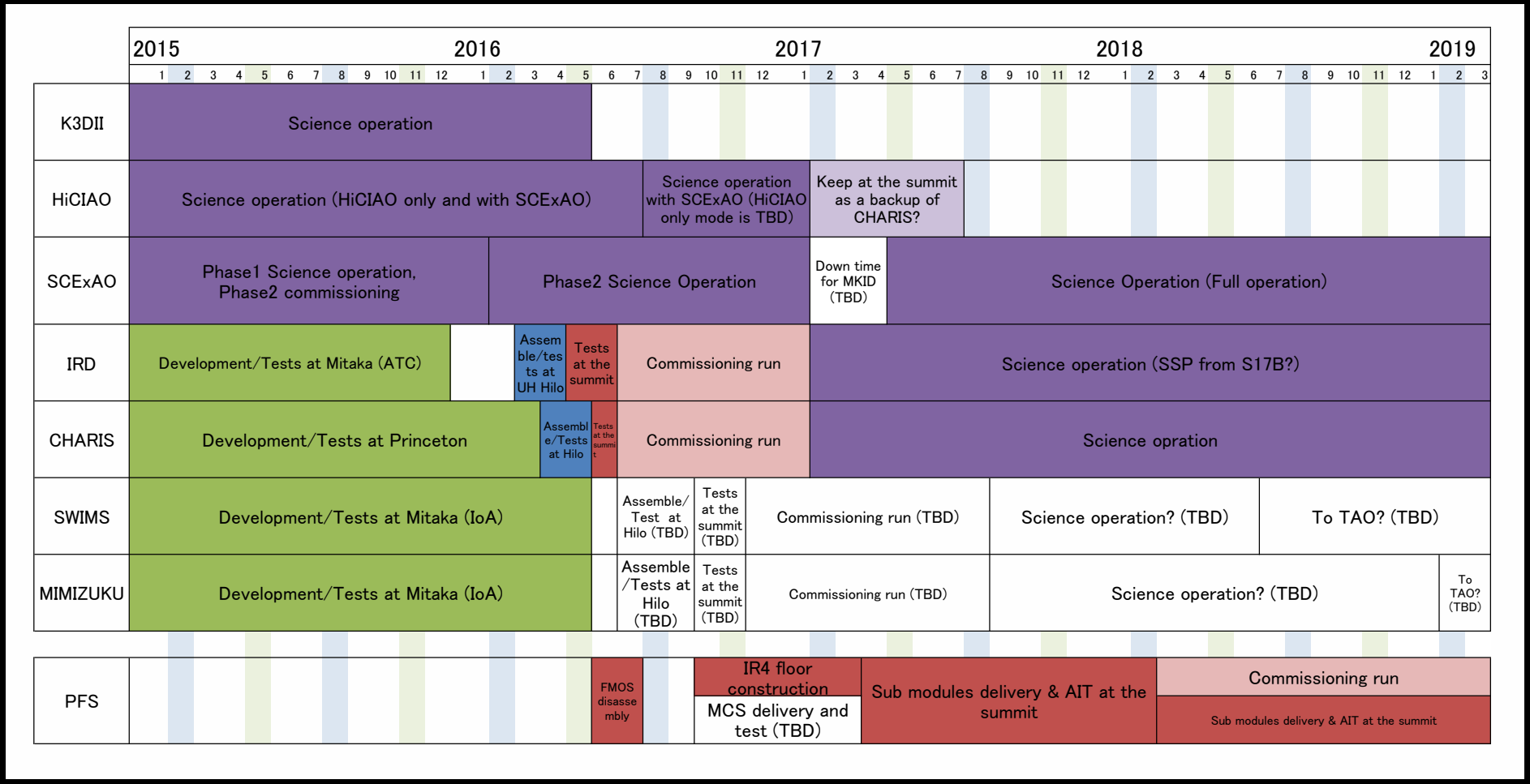
(PI: T. Miyata at Univ. of Tokyo)

- Wider wavelength coverage than COMICS: 2-26 micron
- Field stacker enables precise photometry in mid-infrared by simultaneously observing science and reference objects in the discrete two fields

Kamizuka-san's poster

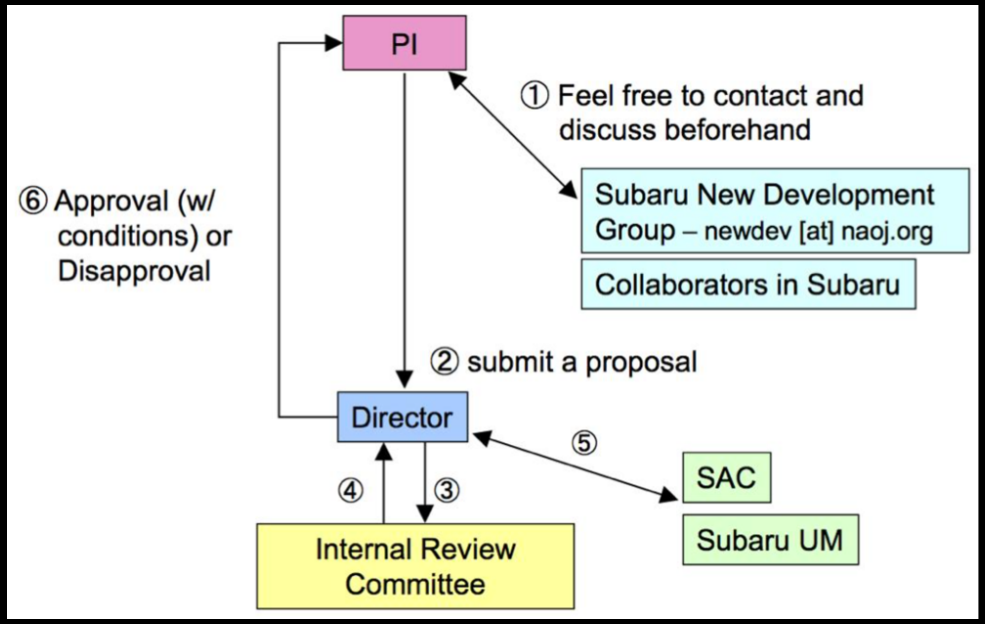
- Acceptance review for SWIMS/MIMIZUKU has been conducted on Aug. 2015
- SWIMS/MIMIZUKU has not been approved as PI type instruments (reviewing process is ongoing)

Tentative Schedule of the PI type instruments



- There will be a lot of new instrument activities in 2016 at Subaru

Carry-in proposal



Proposal is reviewed based on:

- Science merit
- Feasibility
- Impact to the observatory
  - Infrastructure
  - Man power
- Budget
- Schedule

If the carry-in proposal is approved,

- Subaru will support its installation and engineering observation.
  - Less supported by the observatory compared to the facility instrument.
- Science time is not guaranteed
  (PI team have to apply for the open use time).

Review process after the approval of the instrument

- The PI is occasionally requested to submit the status report, which will be reviewed by the internal review committee.
  - Readiness review:
    - before shipping to Hawaii
    - before transporting to the summit
  - Engineering acceptance review
    - before starting engineering observation.
  - Final acceptance review
    - before starting science observations.

Applying open use time

Requirement

- A fact sheet that summarizes the readiness and the performance
  - It must be provided by the PI team before the deadline of the proposal submission.
  - Referees will assess the feasibility of the proposed science based on the fact sheet.

- Instrument operators must be provided by the PI team for engineering and science obs.
  - Subaru does not provide a support astronomer for the PI instrument.

Who can apply?

- Not only the PI team, but also general users can use the PI type instrument.
  - General users have to obtain permission from the PI.
  - Subaru strongly recommends the PI team open their instrument to general users.