

# Gemini Observatory

Subaru Users' Meeting, November 2019

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# New Organization

 NSF's National Optical-Infrared  
Astronomy Research Laboratory

ABOUT • PROGRAMS • RESEARCH • NEWS • OUTREACH • DIVERSITY

## Discovering Our Universe Together

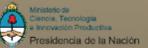
About NSF's OIR Lab



**NRC-CRRC**



Ministry of  
Science, Technology  
and Innovation  
**BRASIL**



**KASI** 한국천문연구원  
Korea Astronomy & Space Science Institute

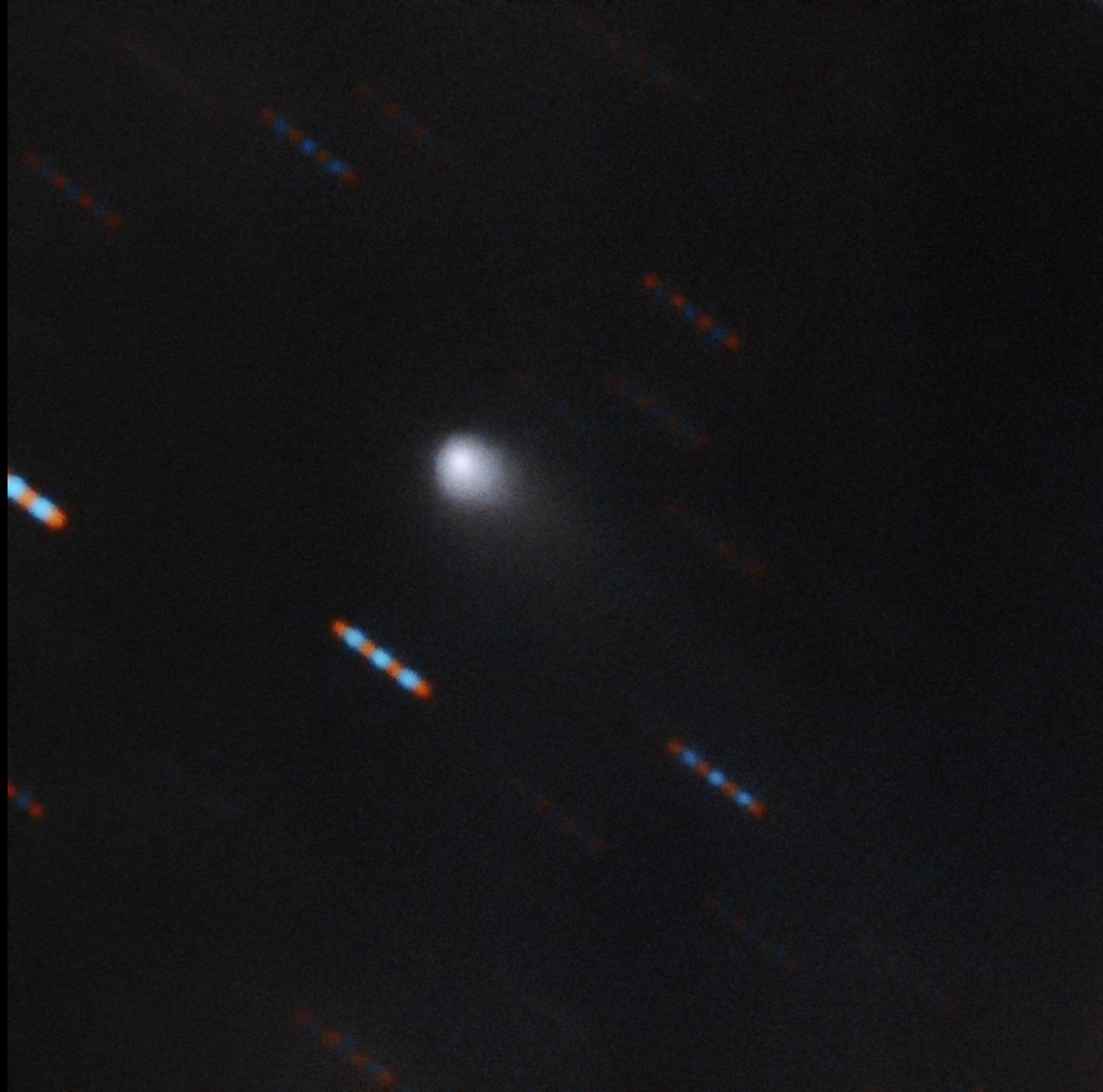
<https://nationalastro.org/>



# Telescopes



**Comet 2I/Borisov :**  
It helps to have two  
telescopes when  
studying targets like this.



# Proposal Routes

**Spring (A) & Fall (B) Semester:** Regular programs (NTAC, ITAC)

- BI-ANNUAL; queue, classical, ToO, priority visitor, eavesdropping

**Large & Long Programs:** Large allocation and/or multi semester (LLP TAC)

- ANNUAL; queue, ToO, and priority visitor, eavesdropping

**Fast-Turnaround:** Immediate, short and/or follow up (Peer review)

- MONTHLY; queue, ToO

**Director's Discretionary:** Special opportunities (Chief Scientist)

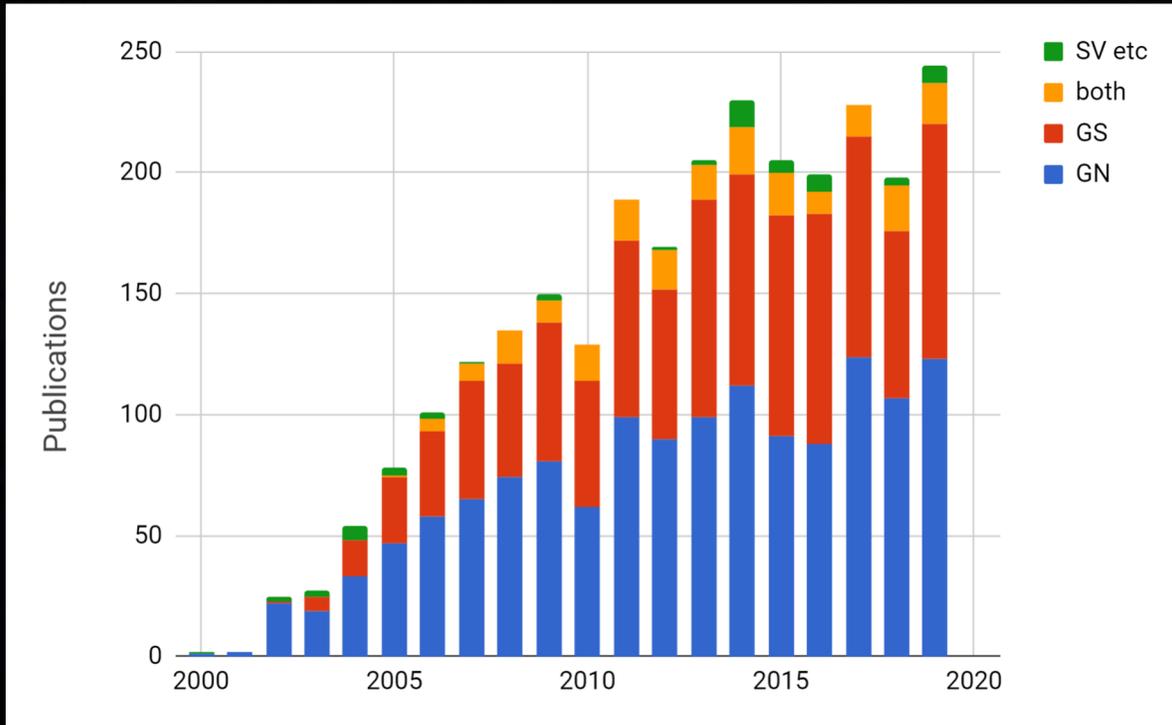
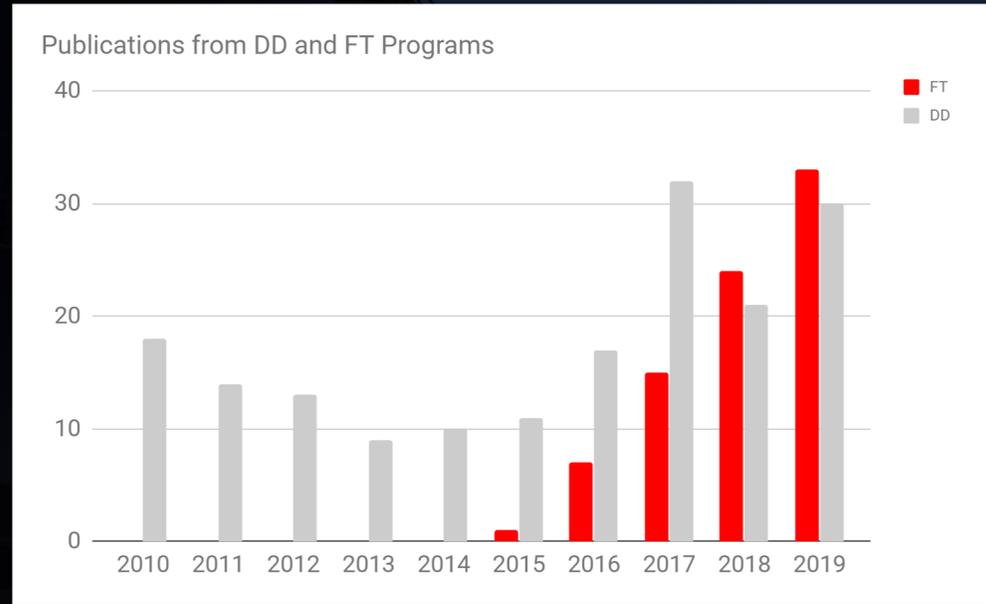
- Open call (worldwide); queue, ToO

**Poor Weather Programs:** Bright targets and guide stars (Head of SciOps)

- Open call (Gemini community); queue

# Publications

Subaru(JP) published 11 papers in 2019 so far. 4 of them are from FT programs.



~250 publications by end of 2019

# Current Capabilities



**Science Public/Images About Careers Contact**

**Announcements**  
Semester 2018A  
Contact  
Library  
PIO  
**Sciops**

**Instruments**  
Gemini Observatory > Sciops

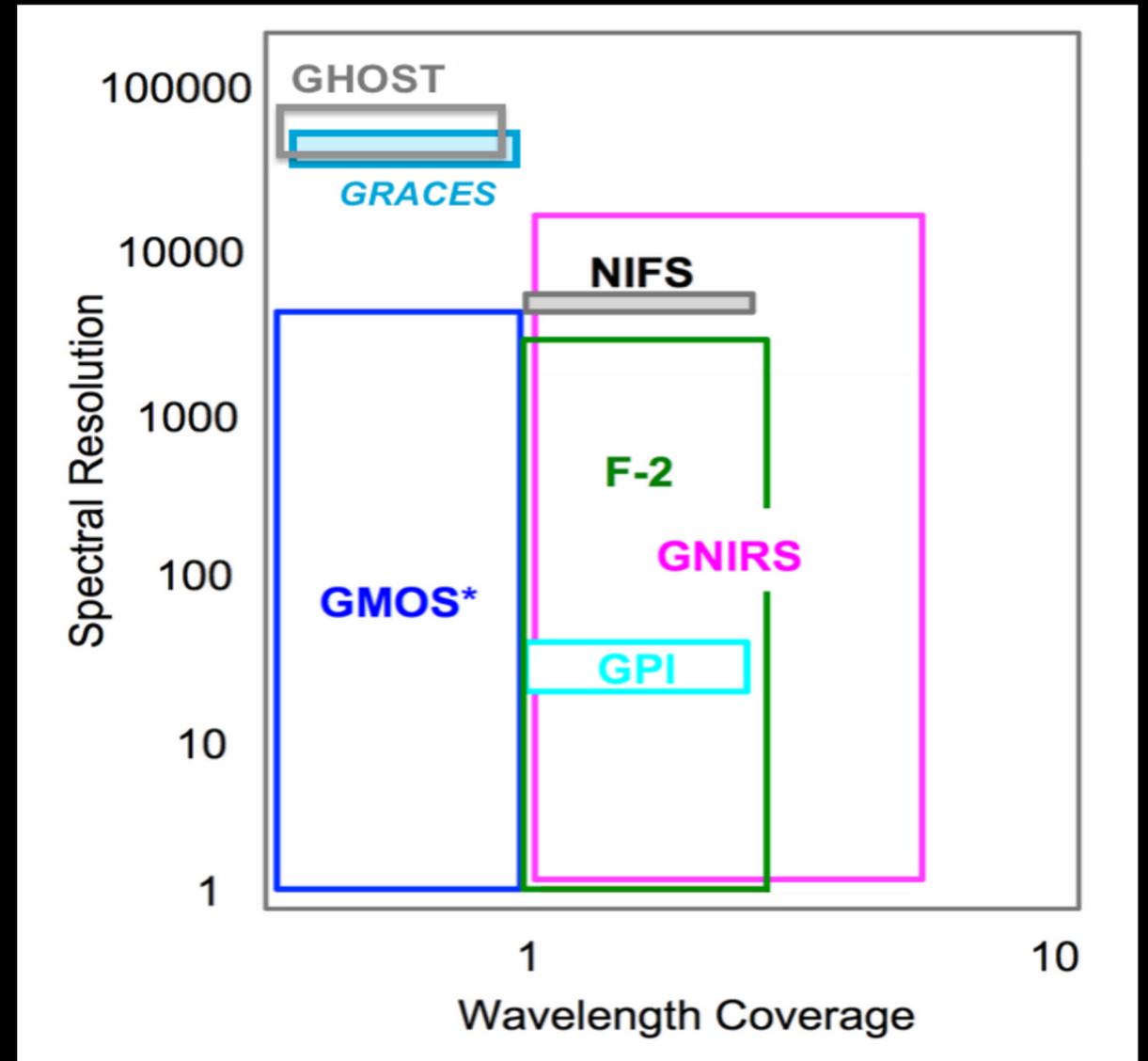
This page shows Gemini's [current facility and visiting instruments](#), and [retired instruments](#). The expected instrument availability for the coming semester is given in the current [Call for Proposals](#); information for the current and previous semesters (and the next semester when finalized) can be found in the [schedules](#) section. Recent science highlights from Gemini's instrumentation suite can be found [here](#).

**Future Instruments**  
Information about Gemini's instrument development program, may be found on the [Future Instrumentation Plans](#) page. A [summary of Gemini's ongoing adaptive optics program](#) is also available.

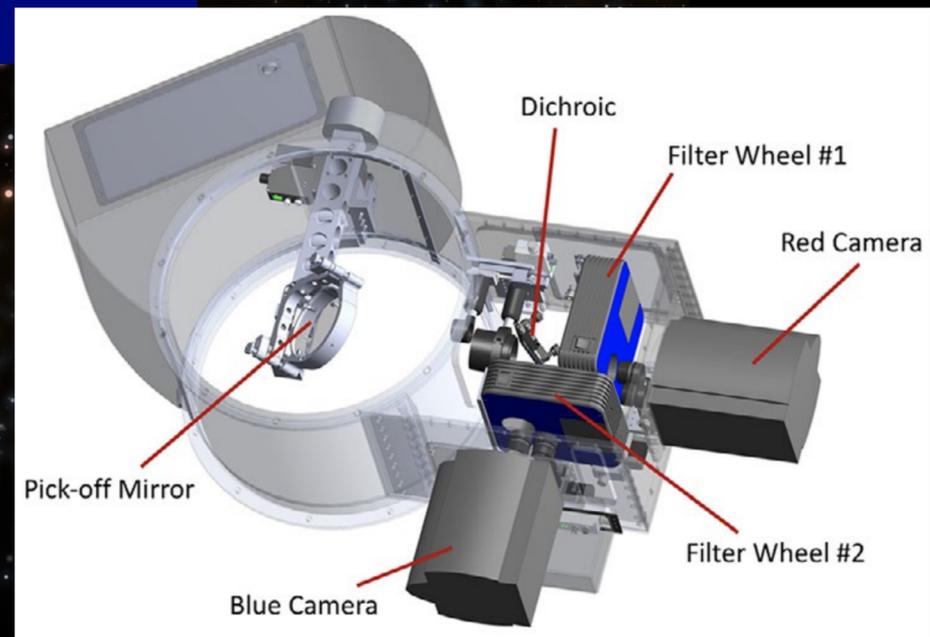
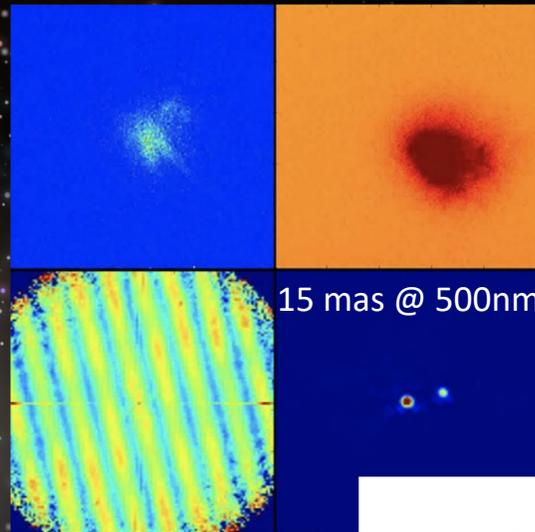
**Gemini North Instruments**

| VISIBLE  | NEAR-IR  | MID-IR | OTHER FACILITIES  |
|--|--|--------|---|
| Facility Instruments   |  |        |   |
| <b>GMOS</b> (multi-object, long-slit and IFU spectrograph and imager)<br><a href="#">Instrument Fact Sheet</a> | <b>NIRI</b> (1-5 $\mu$ m imager)<br><a href="#">Instrument Fact Sheet</a>  |        | <b>GCAL</b> (facility calibration unit)                     |
|  | <b>NIFS</b> (1.0-2.5 $\mu$ m integral field spectrograph)<br><a href="#">Instrument Fact Sheet</a>   |        | <b>ALTAIR</b> (facility natural/laser guide star AO system) |
|  | <b>GNIRS</b> (1-5 $\mu$ m long-slit and 0.9-2.5 $\mu$ m cross-dispersed spectrograph; formerly at Gemini South)<br><a href="#">Instrument Fact Sheet</a> |        |   |

**Retired Instruments**  
NORTH  
ALTAIR  
GMOS  
GNIRS  
MAROON-X  
NIFS  
NIRI  
GRACES  
SOUTH  
FLAMINGOS-2  
GeMS  
GMOS  
GPI  
GSAOI  
VISITING  
Visiting Instrument Policy  
Visiting Instrument Telescope Interfaces



# Alopeke (GN) and now Zorro (GS)



# Development

## New Facility-Class Instruments

GHOST, SCORPIO, GNAOI, IGRINS<sub>2</sub>, GPI(2)->GN

## New Instrument Upgrade Program

Internal projects: Detector controllers, ...

Community-driven: GNIRS IFUs (2020B)

## Reinvigorated Visitor Instrument Program

MAROON-X – 500-1000nm, 1m/s PRV spectrograph (Commissioning 19B)

GIRMOS – MOAO IFUs; R=3000,6000

## Continued AO Development

GeMS: NGS<sub>2</sub>, DMo, Astrometry, RTC, Operations efficiency

GNAO: MCAO at Gemini North

# GHOST

## Gemini High-resolution Optical SpecTrograph

- Team: Australian Astrophysical Observatory  
NRC-Herzberg  
Australia National University

Fiber-fed, bench mounted spectrograph

Two object + sky:  $R=50,000$  within  $7.5'$  FOV

Single object + sky:  $R=75,000$

Microlens-based  $1.2''$  IFUs for image slicing

Full simultaneous coverage: 363-950nm

Integration at NRC starts in May; delivery later 2019

# GNIRS IFU Replacement

| Instrument/mode  | NIFS             | GNIRS/Low Resolution IFU | GNIRS/High Resolution IFU |
|--|------------------|--------------------------|---------------------------|
| Spatial Sampling   | 0.103" x 0.043"  | 0.15" x 0.15"            | 0.05" x 0.05"             |
| Field of View  | 3" x 3"          | 3.2" x 4.8"              | 1.0" x 1.5"               |
| Number of Spatial Elements<br>(Slices x detector pixels) | 2000             | 798                      | 972                       |
| Resolving Power  | < 4,500          | < 7,200                  | < 19,000                  |
| Spectral Range   | 0.94-2.4 $\mu$ m | 1.0-6.0 $\mu$ m          | 1.0-6.0 $\mu$ m           |

# Visiting Instrument Program - Current & 20A

| Date         | Instrument            | PI/Team                                  | $\lambda$             | FoV, Mode, Res                                    | AO |
|--------------|-----------------------|--|-----------------------|---|----|
| Current      | TEXES (GN)            | John Lacy, UT Austin                     | 5-25 $\mu\text{m}$    | LS R: 4,000 - 85,000                              | no |
| Current      | GRACES (GN)           | CFHT/Gemini/NRC                          | $\sim$ 500-1000 nm    | see CFHT/ESPaDOnS - high-res. spectrograph        | no |
| Current      | 'Alopeke/Zorro (BOTH) | Steve Howell, NASA                       | 400-1000 nm           | two-color diffraction-limited imaging +Wide-field | no |
| Current      | POLISH2 (GN)          | Sloane J. Wiktorowicz, Aerospace Corp.   | optical               | high precision polarimetry                        | no |
| Current      | Phoenix (GS)          | Ken Hinkle, NOAO                         | 1-5 $\mu\text{m}$     | LS R: 50,000 - 80,000                             | no |
| Current      | GASP (GS)             | Andy Shearer, Galway                     | optical               | Fast polarimetry for pulsars, x-ray binaries      | no |
| <b>2020A</b> | <b>IGRINS (GS)</b>    | Daniel Jaffe, UT Austin, Chan Park, KASI | 1.5-2.5 $\mu\text{m}$ | LS R: 45,000                                      | no |

# Visiting Instrument Program - Future

| Date       | Instrument              | PI/Team  | $\lambda$       | FoV, Mode, Res                     | AO           |
|------------|-------------------------|--|-----------------|------------------------------------|--------------|
| 2020B      | <b>MAROON-X (GN)</b>    | Andreas Seifahrt, Jacob Bean, U Chicago        | ~500-1000 nm    | precision radial velocity (~1 m/s) | no           |
| 2021 (TBC) | BATMAN (GS)             | Frederic Zamkotsian, Benoit Neichel, Marseille | 400-800 nm      | DMD MOS, FoV 88x88", R-500-1500    | GeMS         |
| 2024       | <b>GIRMOS (GS? GN?)</b> | Suresh Sivanandam, U of Toronto                | 1.1-2.4 $\mu$ m | MOAO, deployable IFUs              | GeMSGN<br>AO |
| TBD        | HIPPI (GN)              | Jeremy Bailey, UNSW                            | optical         | high precision polarimetry         | no           |
| TBD        | CRISP (GN)              | Mike Pierce, Adam Myers, Univ. Wyoming         | TBC             | NIR MOS with robotic positioners   | no           |

- ❖ **MAROON-X being commissioned at GN in 19B**
- ❖ **GIRMOS entering Preliminary Design Phase**

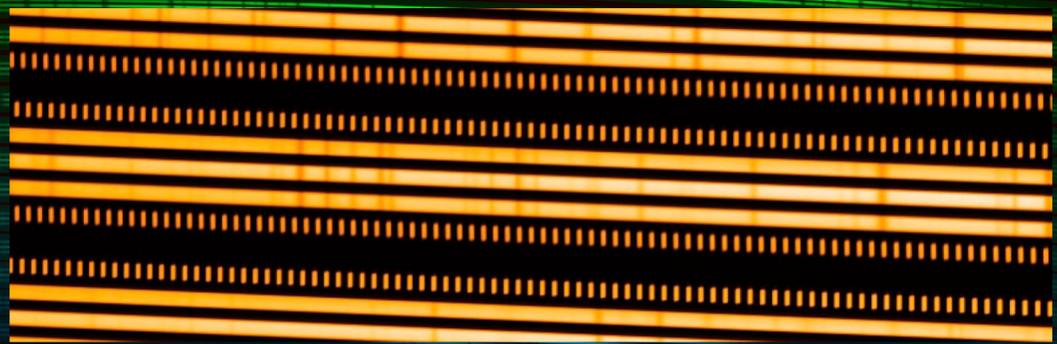
# MAROON-X



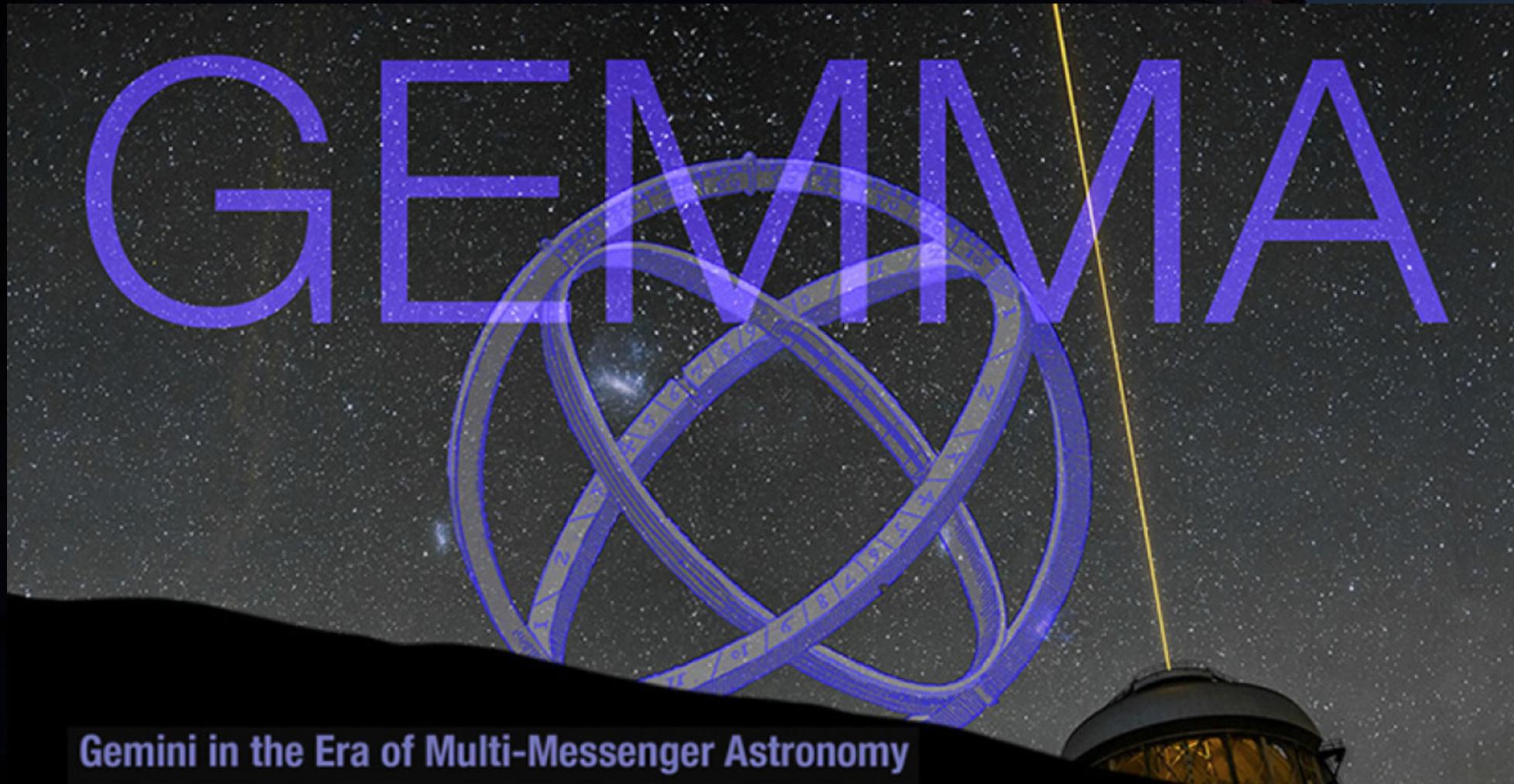
**Resolution 80000**

**Velocity precision 1m/s**

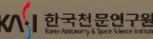
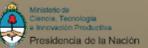
**Main science M dwarfs @  $<16^m$**



# GEMMA: NSF Funding for Ops, Dev, PIO



Gemini in the Era of Multi-Messenger Astronomy



# GEMMA

## Projects



### Adaptive Optics

The Gemini North Adaptive Optics (GNAO) upgrade project will deliver the first queue-operated multi-conjugate adaptive optics (MCAO) system in the northern hemisphere. The GNAO effort will build on experience with the Gemini Multi-conjugate System (GeMS) at Gemini South, but it will employ the latest technologies for improved performance in support of the next generation of AO-assisted instruments at Gemini North. With a corrected field-of-view of about 2 arcmin and spatial resolution similar to that of JWST, GNAO will take advantage of Maunakea's outstanding conditions for AO performance and establish GN as the premier ground-based facility for wide-field AO studies.



### Time Domain

The Time Domain Astronomy (TDA) project will develop the infrastructure for incorporating Gemini's telescopes into the Astronomical Event Observatory Network (AEON), an efficient new system for following up transients identified by LSST, LIGO, and other time-domain and multi-messenger surveys. The goal of this effort is to maximize Gemini's contributions to discoveries in the TDA era, and Gemini will provide the largest aperture within AEON to enable studies of the faintest, highest priority targets. The TDA project also includes development of automated data pipelines for rapid delivery of science-quality reduced data so that users can assess the outcome of their observations in real time.

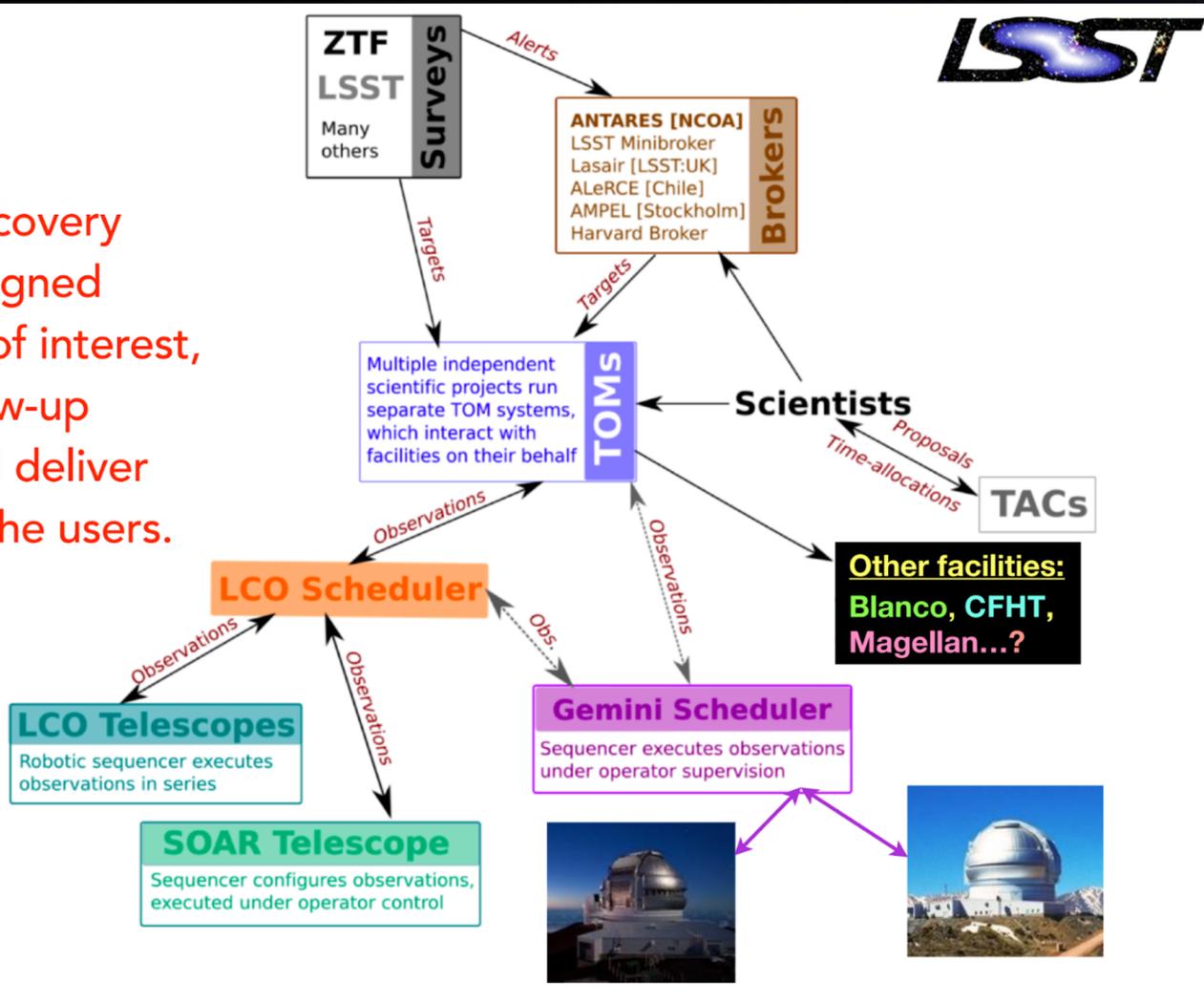


### Outreach

GEMMA enables Gemini Observatory to expand on its legacy of ambitious Public Information and Outreach (PIO) initiatives. The basis for this expanded outreach is multi-messenger astronomy (MMA) and the role of Gemini and other ground-based facilities in this new discovery arena. Specifically, the GEMMA PIO initiatives include a multimedia planetarium program to illustrate MMA concepts, classroom materials to promote careers in related science and technology fields, training workshops for science writers, and an ambitious "MMA summit" to establish a charter for the public communication of MMA concepts and discoveries.

# Future Time-Domain Astronomy @ Gemini

AEON: a new discovery "ecosystem" designed to identify alerts of interest, obtain rapid follow-up observations, and deliver reduced data to the users.



Data reduction, Operation Software must be updated to accommodate → **DRAGONS, OCS upgrade program.**

# Gemini AO + GEMMA

## GeMS

- Gemini South
- 0.08" FWHM in K (in typical seeing)
- ~1.5' field of view
- 3 DMs (DM4.5 coming)
- 5 laser spots
- Toptica laser
- NGS2 magnitude  $R < 15.5$

## GNAO

- Gemini North
- 0.06" or better FWHM in K (in typical seeing)
- ~2' field of view
- 2? DMs
- 6 laser spots?
- 2-3 Toptica lasers?
- NGS magnitude  $R < 18$ ?
- Precision astrometry
- Standard operations

# MCAO is just the beginning for GNAO

**GNAOI** – First light imager built around an H4RG  
RFP just issued

**GIRMOS?** – MOAO IFUs Canadian Visitor Instrument  
4 IFUs; 25x25 – 100x100 mas sampling; 1.1-2.4 microns;  
R=3000/6000; CoDR two weeks ago

**Adaptive Secondary** – Delivery after initial GNAO

**GLAO?** – Add additional AO modes to GNAO post-ASM

# Gemini in the 2020's

## Key Instrumentation

- High-resolution spectroscopy & imaging for exoplanets, stellar chemistry, stellar populations, astrometry, high-z & more

## Scheduling Flexibility

- Leading facility for time-domain & multi-messenger follow-up

## Future Instrumentation

- GHOST
- SCORPIO
- Visiting instruments - both niche and workhorse
- Revitalized adaptive optics: bi-hemisphere MCAO systems

# Coming Year

## South

- IGRINS returns
- F-2 MOS mode
- GHOST

## North

- MAROON-X

## Both

- Gemini 20th anniversary science meeting, Korea!

# Gemini's 20th Anniversary

**June 21 -25, 2020**  
**@ Millimium Hilton Seoul**

**Registration : 2019dec15**

<http://www.gemini.edu/gsm2020>



**GEMINI**  
OBSERVATORY  
*Exploring the Universe, Sharing its Wonders*

## Gemini Observatory Science Meeting *20th Anniversary and Beyond*

Gemini Observatory invites its international user community to Seoul, Korea, for a celebration of 20 years of forefront access to the entire sky, and a preview of the even more exciting things to come. Hosted by the partnership's newest member, this special Science Meeting will feature the latest scientific results from Gemini, news on current instrumentation projects, updates on operations developments, fabulous dining, and lively discussion of Gemini's strategic plans for the coming decade. Come join us in Seoul!

June 21-25, 2020  
Seoul, Korea

For information and registration:  
[www.gemini.edu/gsm2020](http://www.gemini.edu/gsm2020)

| LOC                           | SOC  |
|-------------------------------|--|
| Terry Lee (Chair), Gemini     | Elliott Horch (Chair), Southern Connecticut State University |
| Ji Yeon Seok (Co-Chair), KASI | John Blakeslee, Gemini Observatory                           |
| Jerry Brower, Gemini          | Xiaohui Fan, University of Arizona                           |
| André-Nicolas Chené, Gemini   | Denise Gonçalves, Universidade Federal do Rio de Janeiro     |
| Sang-Hyun Chun, KASI          | Myungshin Im, Seoul National University                      |
| Erik Dennihy, Gemini          | JJ Kavelaars, NRC Herzberg Astronomy & Astrophysics          |
| Nase Hwang, KASI              | Hwhyun Kim, Gemini Observatory                               |
| Stacy Kang, Gemini            | Quinn Konevacky, University of California, San Diego         |
| Ye Jin Kim, KASI              | Jae-Joon Lee, Korea Astronomy and Space Science Institute    |
| Heeyoung Oh, KASI             | Jennifer Lotz, Gemini Observatory                            |
| Joanna Thomas-Ostip, Gemini   | Chung-Pei Ma, University of California, Berkeley             |
| Alison Peck, Gemini           | Adam Muzzin, York University                                 |
| Soung-Chul Yang, KASI         | Adam Riess, Johns Hopkins University & STScI                 |
|                               | Carlos Saffe, Universidad Nacional de San Juan               |
|                               | Siyi Xu, Gemini Observatory                                  |

Notes on background images: Cheomseongdae (left) is an astronomical observatory constructed in the 7th century (around 633) in Gyeongju, the capital of Korea under the Silla dynasty. Namsan Tower (right) is a modern edifice located near the conference venue on Namsan Mountain in Seoul.

# Thank you!

