

Gemini Observatory Update

Subaru Users' Meeting, 2024jan23-25

Atsuko Nitta & Andy Adamson

Gemini Observatory/NSF's NOIRLab

1. Statistics
2. Gemini North M1 accident,
Cyber security breach
3. Instrumentation news
4. Science highlights



Jennifer Lotz
Director of the
Space
Telescope
Science Institute



Scott Dahm
Gemini Interim Director



Andreas Seifahrt
Associate
Director of
Development



Elena Sabbi
Gemini Chief
Scientist



Leinani Lozi
Hawai'i
Education &
Engagement
Manager

Statistics

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 (DD TAC team – Chief Scientist)

- Open call (worldwide); queue, ToO

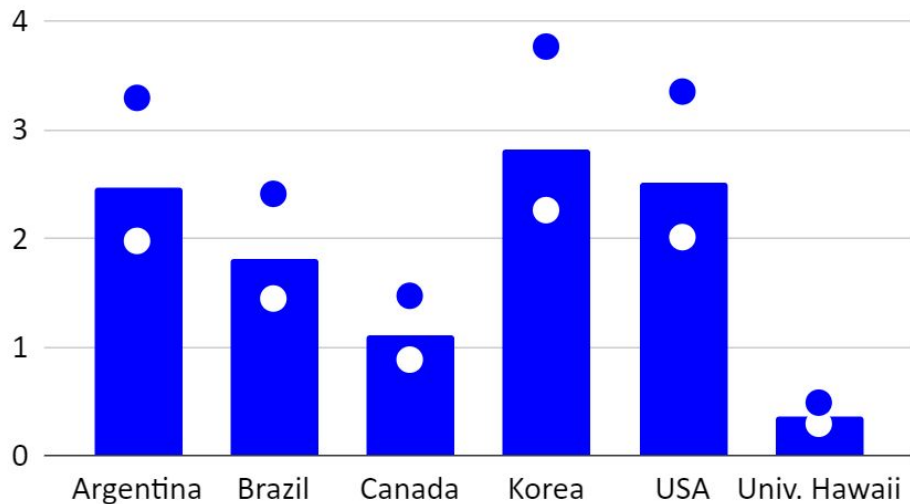
Poor Weather Programs: Bright targets and guide stars (Head of SciOps)

- Open call (Gemini community); queue

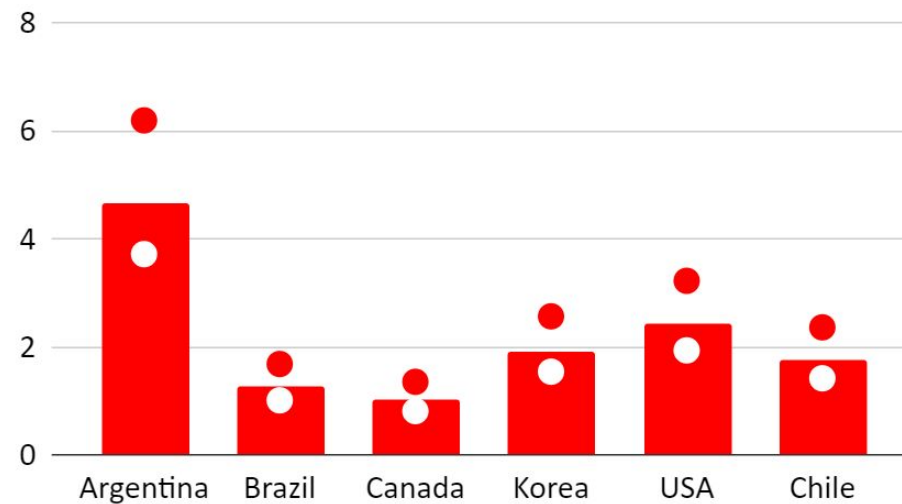
Note - we enable DARP, by Partner choice

Regular Queue Demand

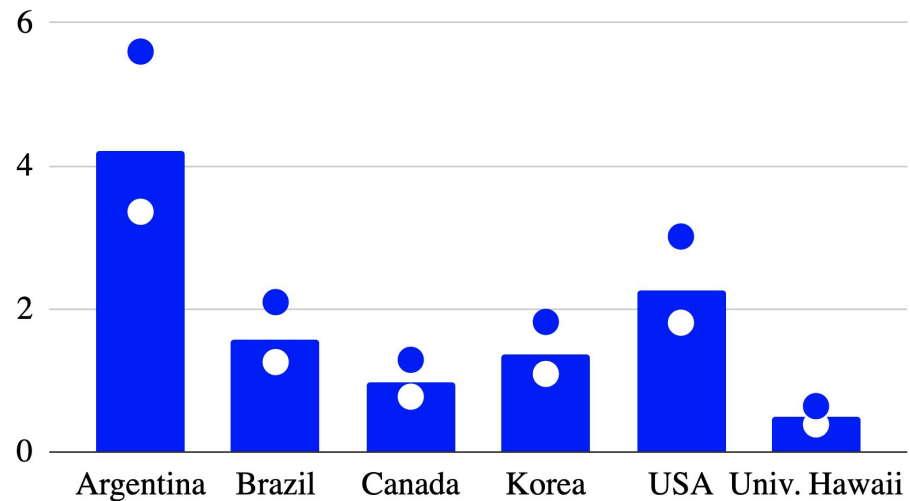
Gemini North 2023A Oversubscription



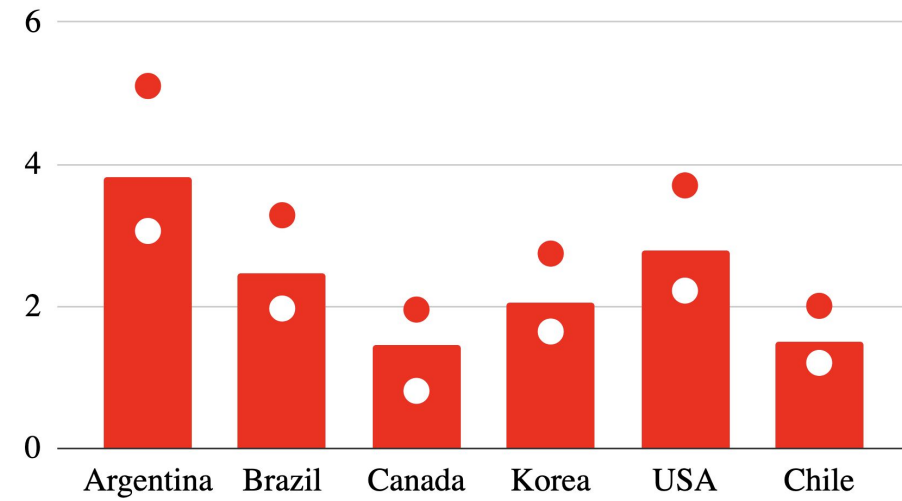
Gemini South 2023A Oversubscription



Gemini North 2023B Oversubscription

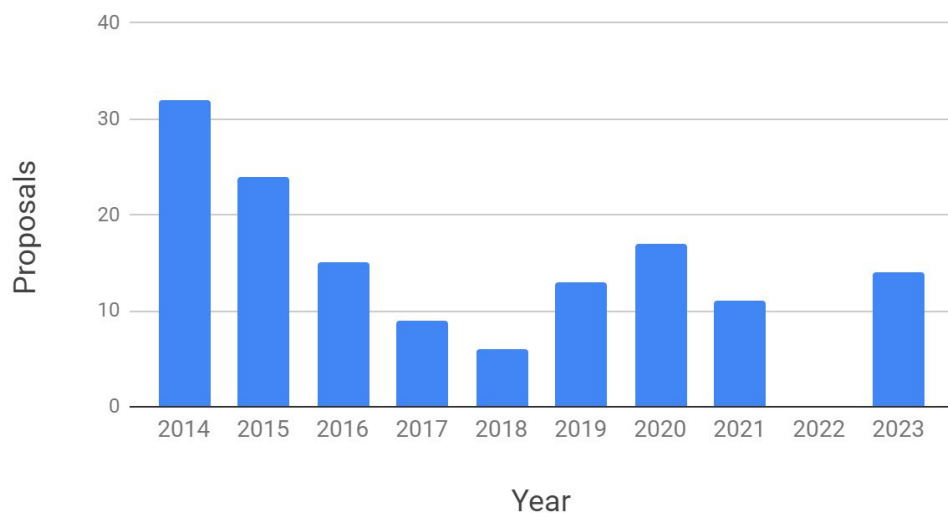


Gemini South 2023B Oversubscription

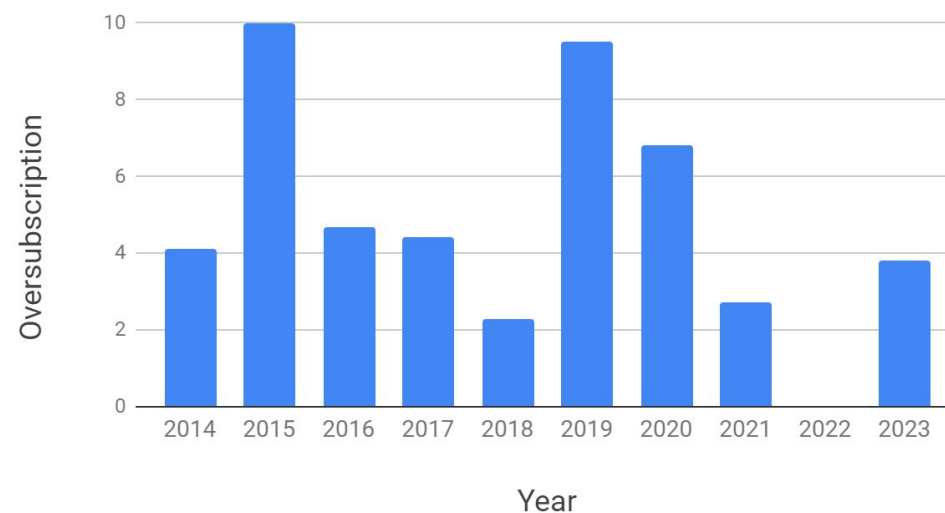


Large/Long Demand

LLP Proposals



LLP Oversubscription



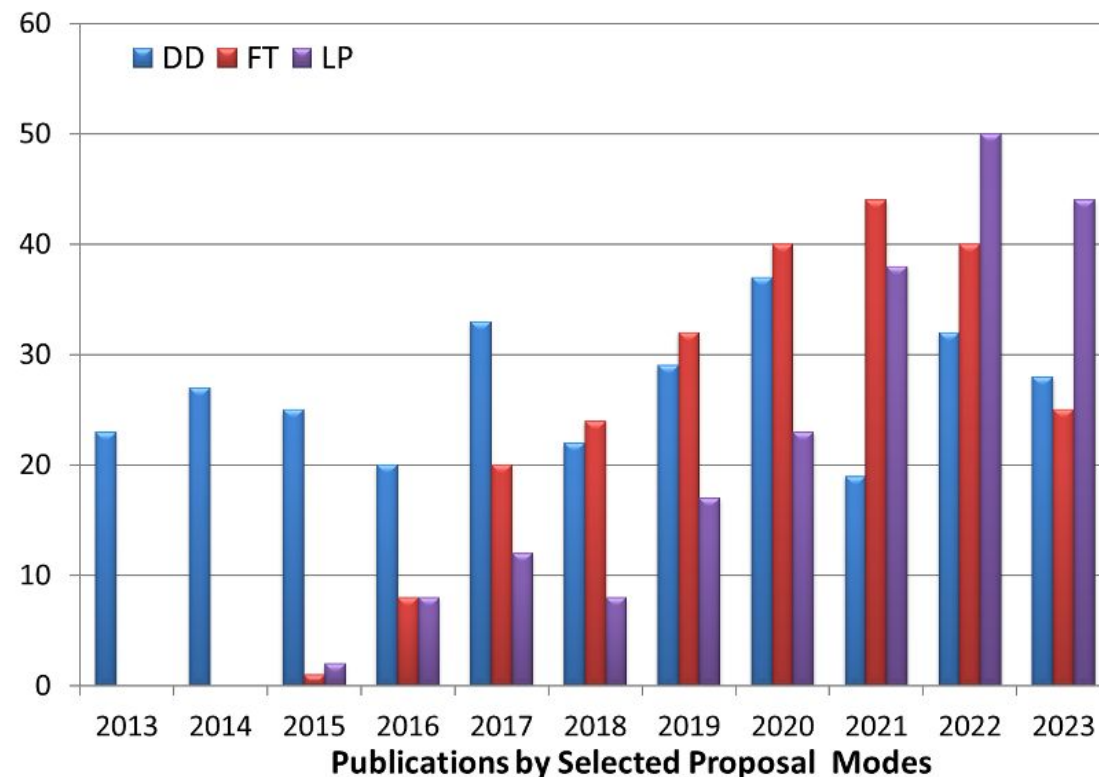
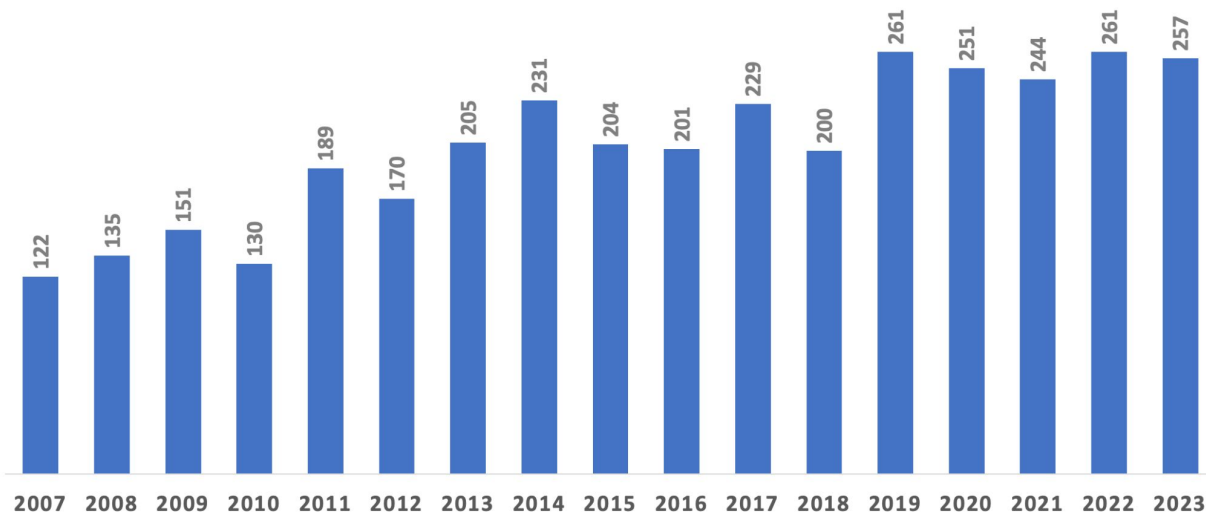
Notes

2021 - offered Band 2 only

2022 - no call

Publications

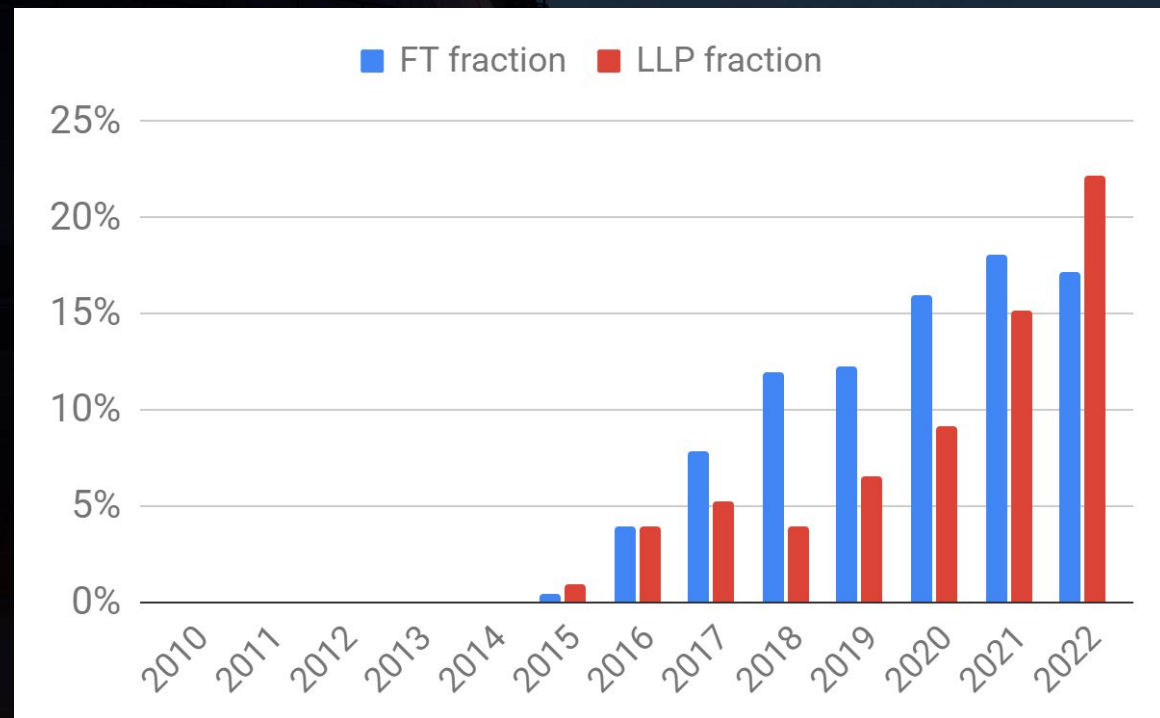
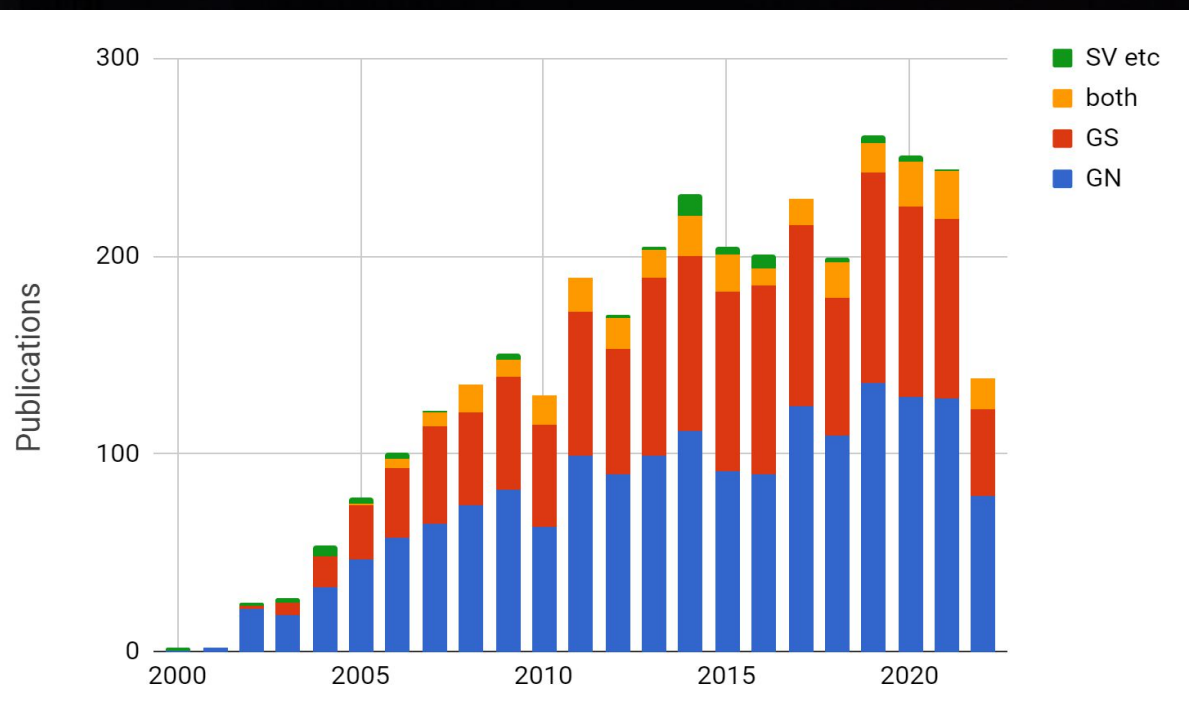
TOTAL GEMINI PUBLICATIONS BY YEAR



- Over 20 years, thesis projects have increased to **130 per semester**
- The number of Gemini publications continues to grow!
- Fast Turnaround (FT), Large & Long Program (LP) publications are increasing in number.
- Decline in FT publications during 2023 linked to the telescope shutdowns.

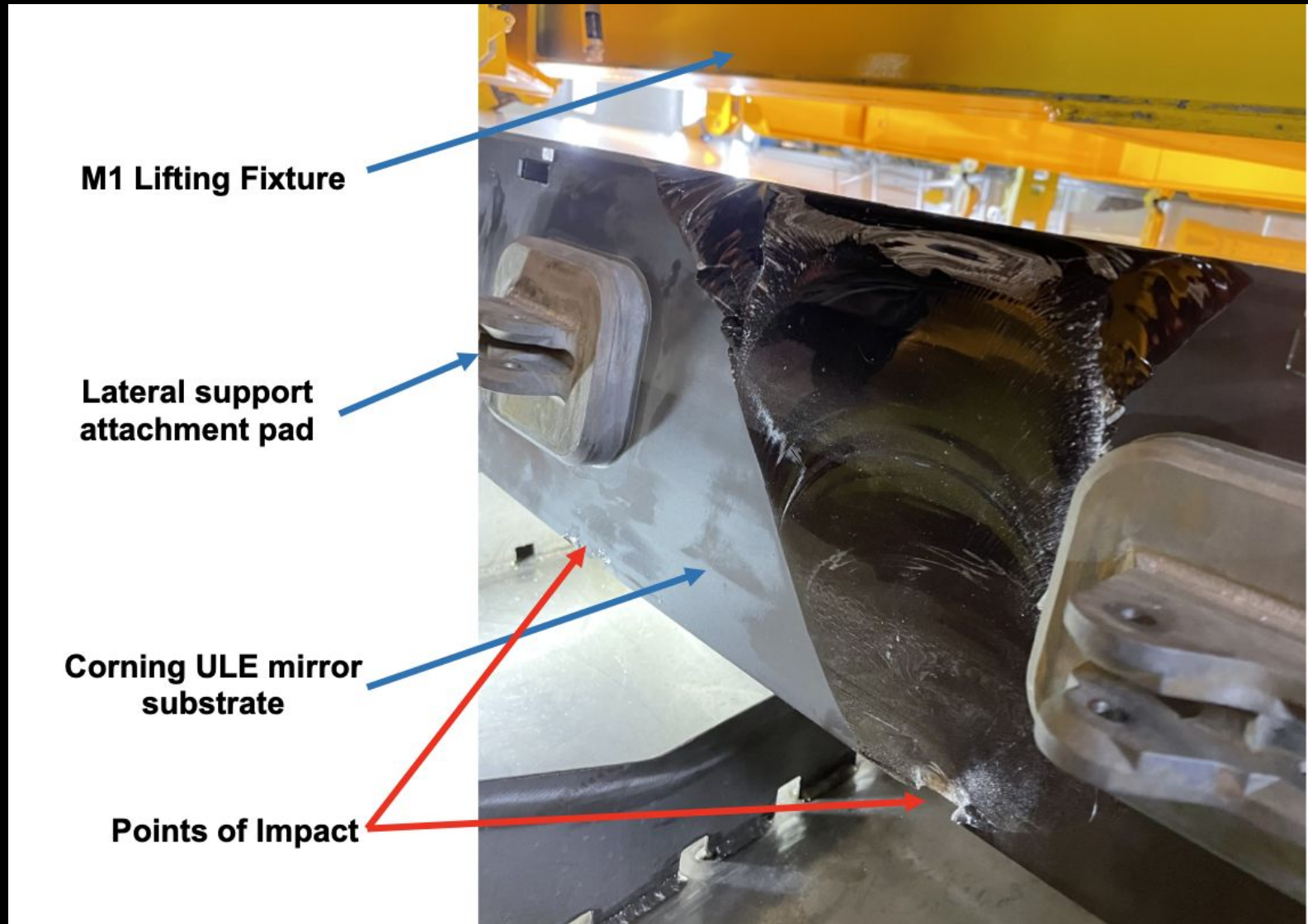
Exchange Publications

Subaru exchange time on Gemini produced 9 (7 by Subaru community, 2 by Gemini community) papers in 2023. 38 Gemini papers have Subaru community as part of the author list! (The figures have not been updated for 2023 yet.)



Gemini North M1

Damage to GN M1

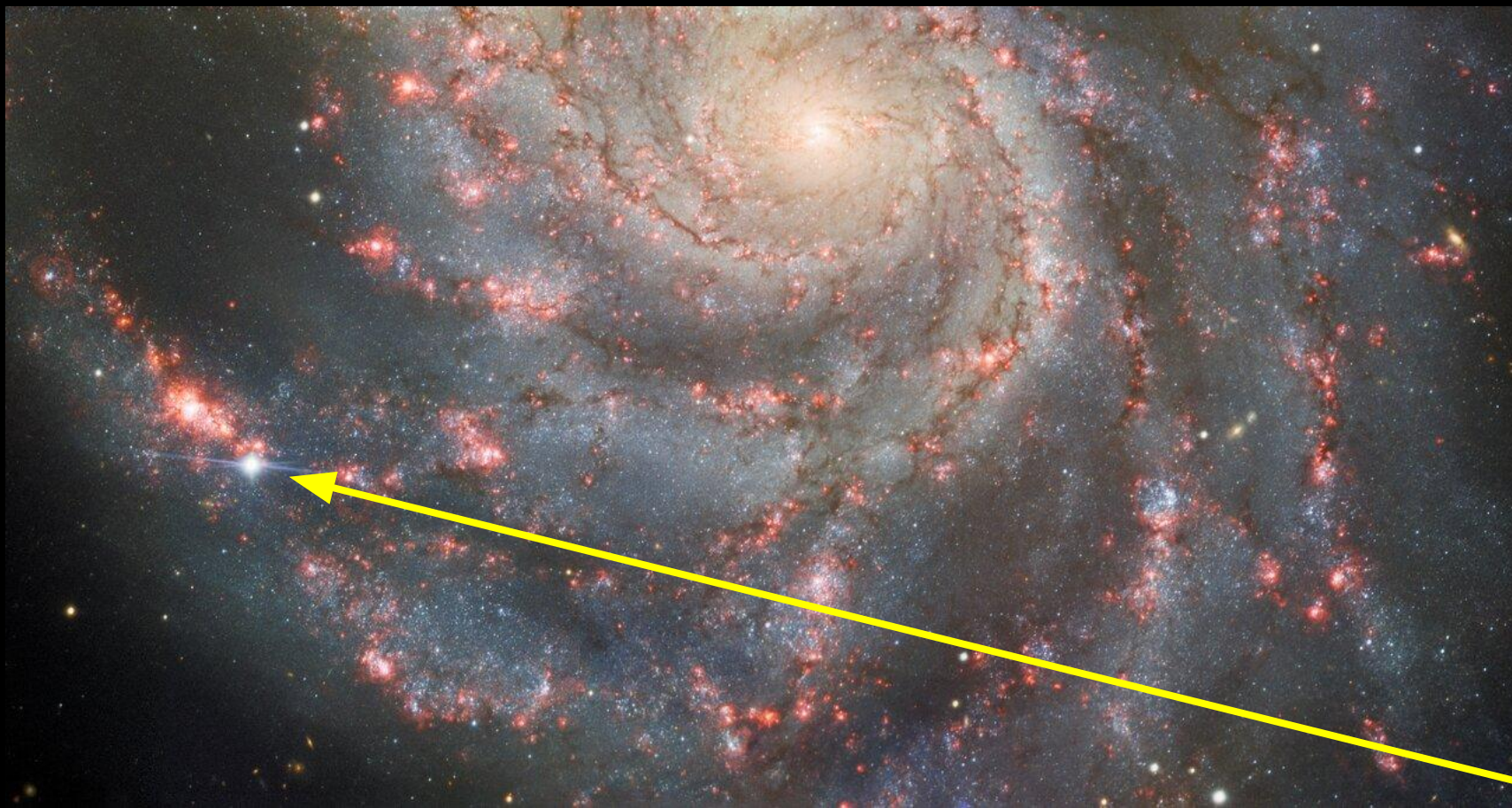


On 20 October 2022, while moving the primary mirror in preparation for stripping, the mirror contacted an earthquake restraint on the facility's wash cart, chipping the edge at two points. No-one was injured.

Multiple contributing factors culminated in human error via a radio communication mishap.

Lessons learned → Both, GN M1 and GS M1, successfully recoated.

Back with a Bang! 2023jun02 GN back onsky!



- Band1 persistent programs. Moved observations to GS if possible.
- Safran-Reosc (France) successfully completed the glass repair which followed recoating.
- Periodic monitoring of actuator loading and out-of-focus images.

**M101 SN observed
using DD time lead by
JenL+GN scistaff**

2023aug01 :Cyber Attack

2AM in Hawai'i / 7AM in Chile

- Gemini North servers begin shutting down
- Chile IT team detects suspicious activity
→ ***Network disconnected within 40 minutes of detection***

No Data Lost

Gemini N&S, CTIO telescopes taken off-line

Subsequent partial downtime necessary to rebuild the network

- Band1 programs (nonToO, facility instrument) persistent into 24A.
- Transfer observations from GN to GS.

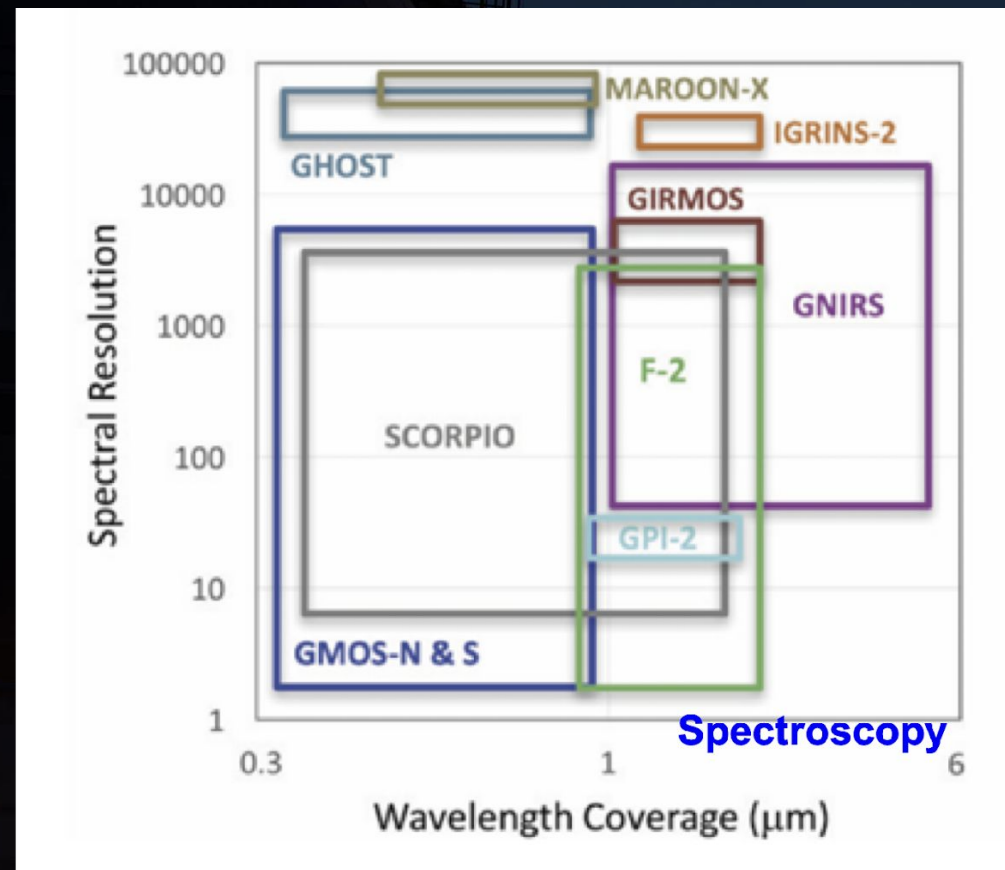
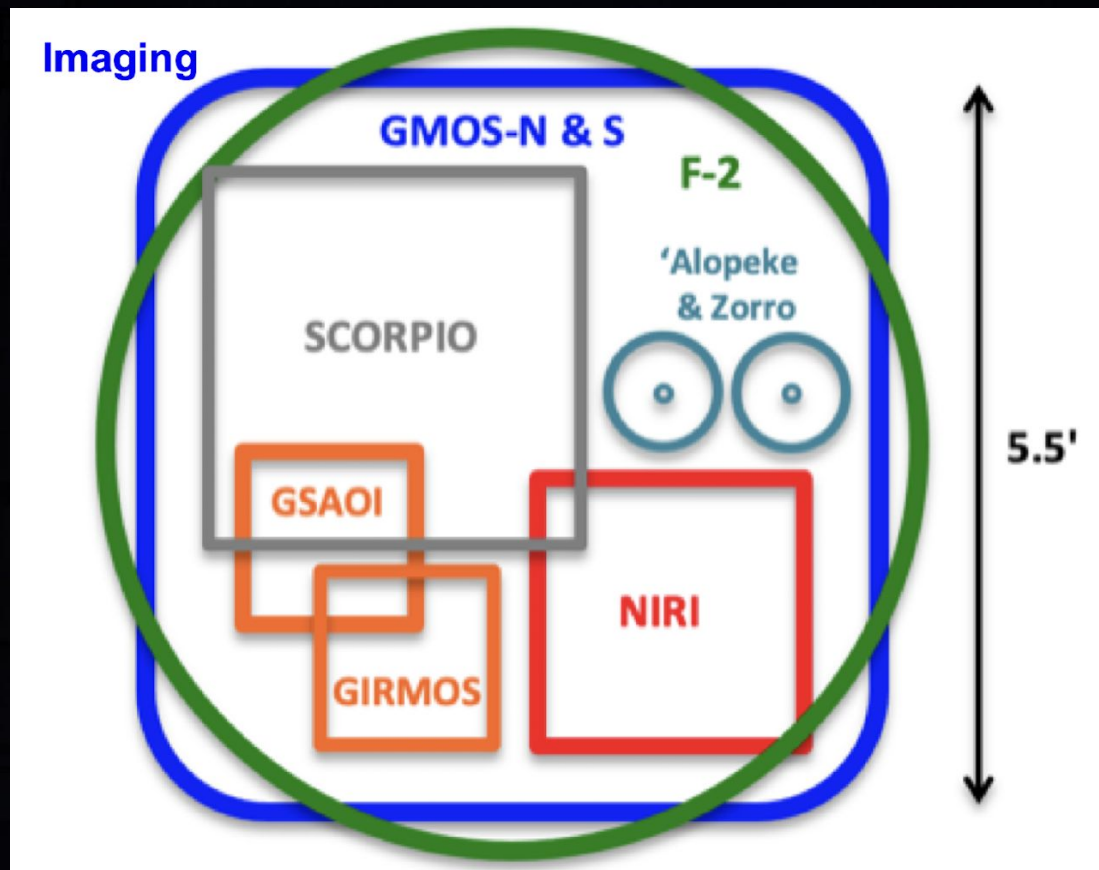
Some lessons...

- **Be Prepared - have a plan, follow your plan** : *Our cyber incident response plan was our roadmap to recovery*
- **Stay up to date with NSF's Trusted CI and other sources**
- **Carry cyber insurance** : *If you need to use the insurance, it will pay for itself*
- **Don't rush to get back on line** : *Security is critical: the hackers are likely monitoring*
- **Implement Multi-Factor Authorization — everywhere!**
- **Learn from others and share what you can*** : *We have connected with other observatories' IT teams*
- **Communicate with stakeholders frequently**: *NSF and Gemini Board. CTIO telescope teams and other stakeholders*
- **DON'T THINK THAT THIS WON'T HAPPEN TO YOU;
BE PREPARED**

*Consult your legal team!

Instrumentation

Current and Future Gemini Instruments



2023: GHOST, GNIRS IFUs
 2024: IGRINS2
 2025: SCORPIO, GPI-2
 2028: GNAO + GIRMOS

GHOST



**High-resolution optical spectrograph
to study chemical composition of
stars, distant quasars, and exoplanet
systems.**

$\lambda = 0.36 - 0.95 \mu\text{m}$

$R > 50,000$ (standard, 2 targets)

$> 75,000$ (high-res, 1 target)

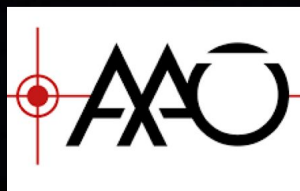
$S/N \sim 30$ at 17mag in 1hr

Weibnar:

<https://noirlab.edu/science/videos?combine=ghost23>

- Publications: Hayes et al. 2023, Placco et al. 2023, Sestito et al. 2023, Dovgal et al. 2024 and others....

McConnachie et al 2022, Nature Astronomy



Offered in regular call starting 24A.



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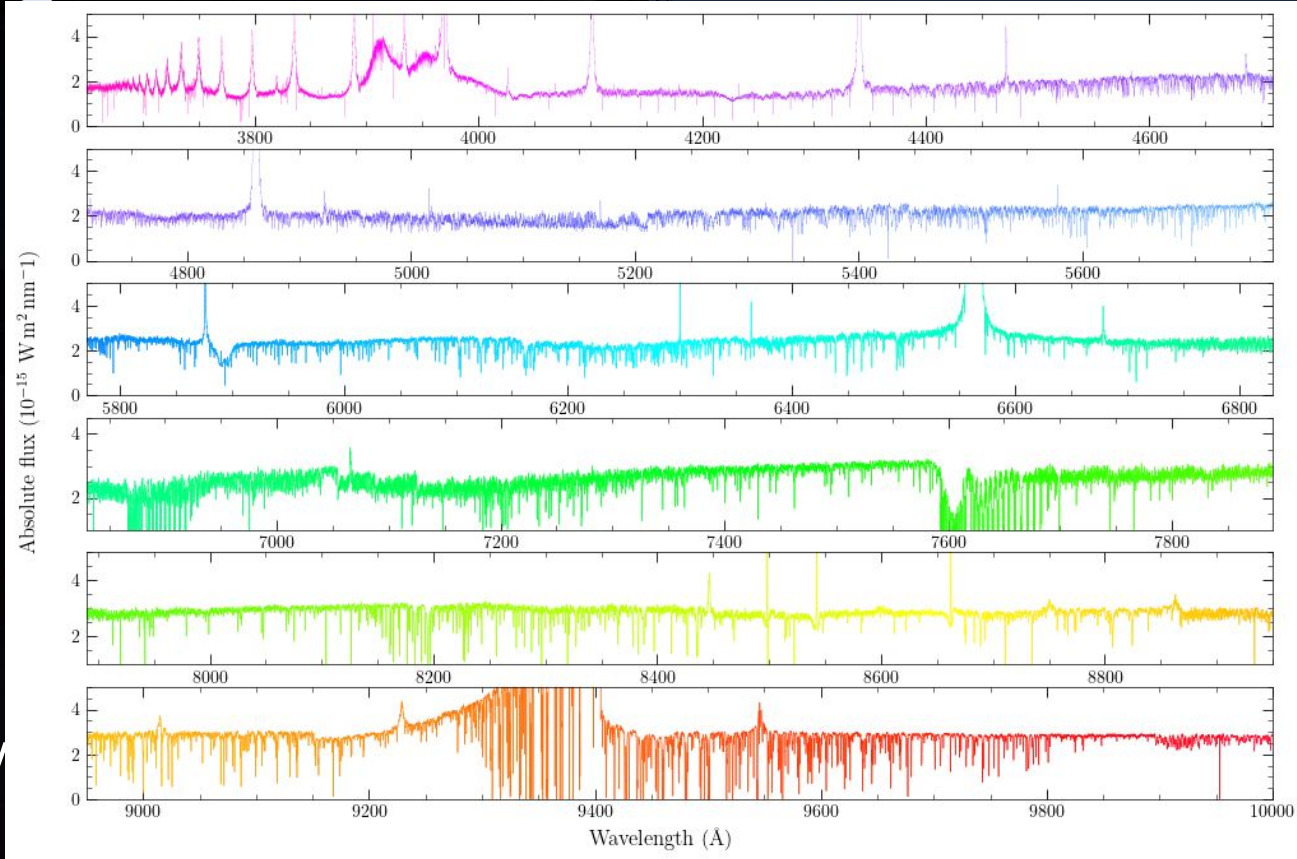


GHOST Commissioning Science Results: Identifying a New Chemically Peculiar Star in Reticulum II

Christian R. Hayes¹, Kim A. Venn², Fletcher Waller², Jaclyn Jensen², Alan W. McConnachie^{1,2}, John Pazder^{1,2}, Federico Sestito², André Anthony¹, Gabriella Baker³, John Bassett⁴, Joao Bento⁵, Trystyn Berg^{6,7}, Gregory Burley¹, Jurek Brzeski³, Scott Case³, Edward Chapin¹, Timothy Chin³, Eric Chisholm¹, Vladimir Churilov³, Adam Densmore¹, Ruben Diaz⁴, Jennifer Dunn¹, Michael Edgar⁸, Tony Farrell³, Veronica Firpo⁴, Joeleff Fitzsimmons¹, Juan Font-Serra⁴, Javier Fuentes⁴, Colin Ganton¹, Manuel Gomez-Jimenez⁴, Tim Hardy¹, David Henderson⁹, Alexis Hill¹, Brian Hoff¹, Michael Ireland^{3,5}, Venu Kalari⁴, Neal Kelly¹, Urs Klauser³, Yuriy Kondrat³, Kathleen Labrie⁹, Sam Lambert¹, Lance Luvaul⁵, Jon Lawrence³, Jordan Lothrop¹, G. Scott Macdonald¹, Slavko Mali³, Steve Margheim¹⁰, Richard McDermid³, Helen McGregor³, Bryan Miller⁴, Felipe Miranda¹, Rolf Muller³, Jon Nielsen⁵, Ryan Norbury¹, Oliver Oberdorf⁹, Naveen Pai³, Gabriel Perez⁴, Pablo Prado⁴, Ian Price⁵, Carlos Quiroz⁴, Vladimir Reshetov¹, Gordon Robertson³, Roque Ruiz-Carmona⁴, Ricardo Salinas⁴, Kim M. Sebo⁵, Andrew Sheinis¹¹, Matthew Shetrone¹², Keith Shortridge³, Katherine Silversides¹, Karleyne Silva⁴, Chris Simpson⁹, Greg Smith³, Kei Szeto¹, Julia Tims³, Eduardo Toro⁴, Cristian Urrutia⁴, Sudharshan Venkatesan³, Lewis Waller³, Ivan Wevers¹, Ramunas Wierzbicki¹, Marc White⁵, Peter Young⁵, and Ross Zhelem³

¹ NRC Herzberg Astronomy and Astrophysics Research Centre, 5071 West Saanich Road, Victoria, BC V9E 2E7, Canada; Christian.Hayes@nrc-cnrc.gc.ca, chrishayesastro@gmail.com

- GHOST now provides a high dispersion spectroscopic capability for the community
- GHOST is working as expected.
- Demand in 2024A was high!
- First results are now in press.



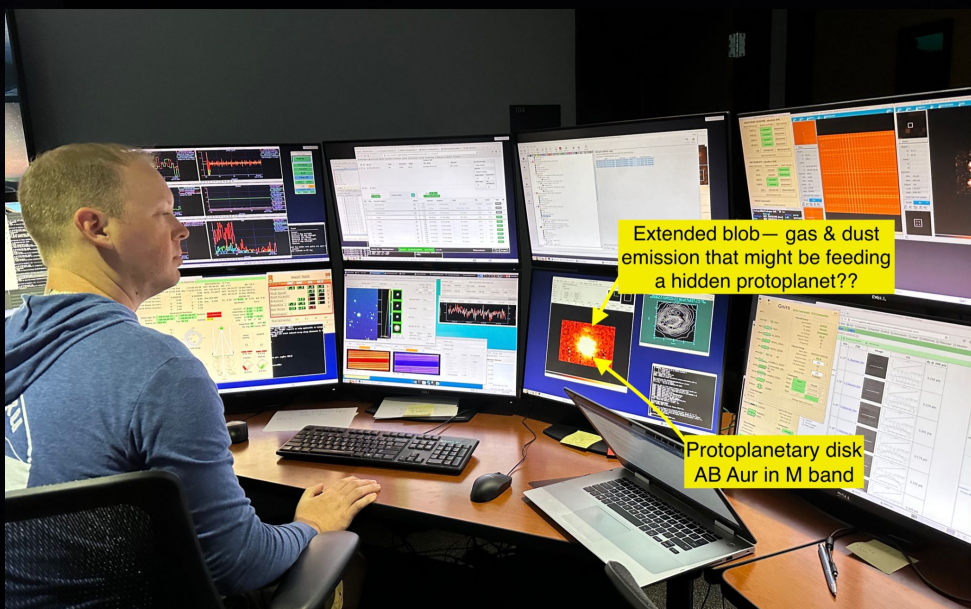
GNIRS's new IFUs

Instrument/mode	NIFS	GNIRS LR IFU	GNIR HR/AO 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"	1.25" x 1.8"
Number of Spatial Elements (Slices x detector pixels)	2000	672 (21x32)	900 (25x36)
Resolving Power	< 4,500	< 7,200	< 19,000
Spectral Range (μm)	0.94-2.4	1.0-5.0	1.0-5.0

GNIRS upgrade with 2 integral field units for galaxy evolution, star-formation

Built by Durham University, LS IFU installed in 2022 and HR IFU in 2023. Onsky commissioning tasks completed. Working on data reduction packages.

Waiting for the final documentation and release of data reduction tool (delayed due to cyber attack).



L/M-band resolution near diffraction limit (barely) beats JWST resolution

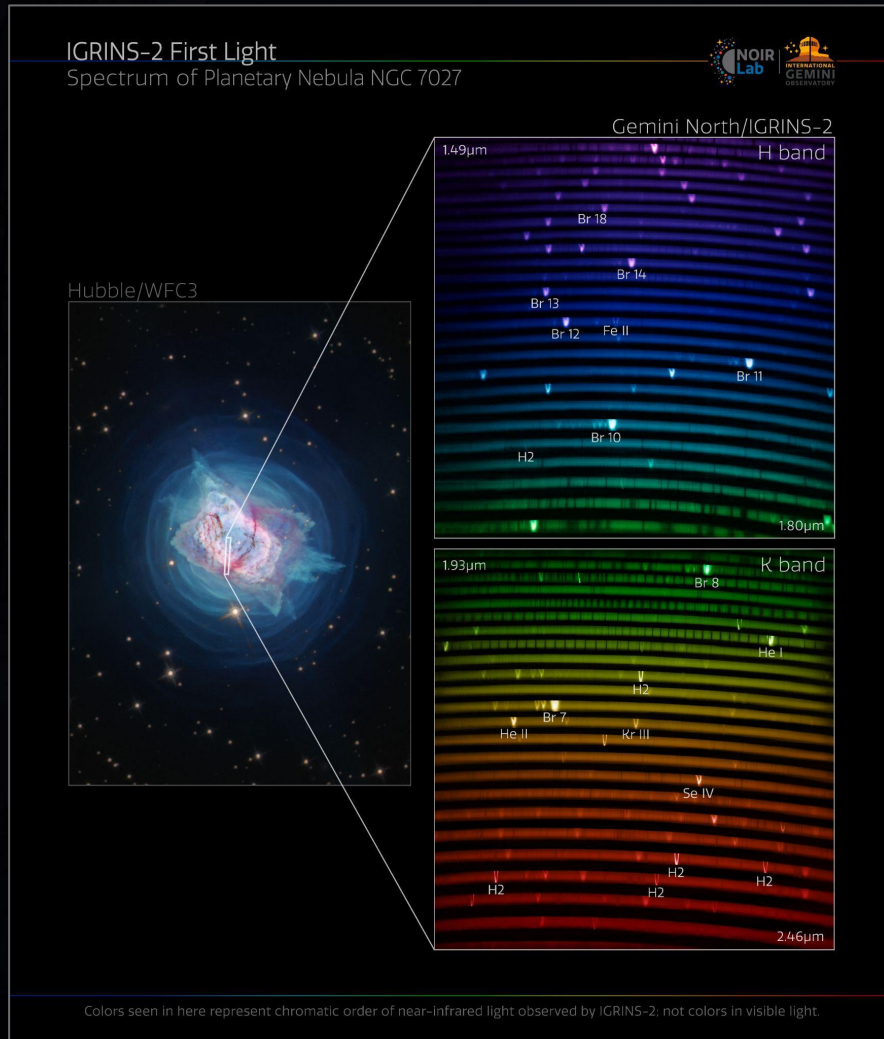
IGRINS-2 (Immersion GRating INfrared Spectrograph-2)

High resolution infrared spectrograph for interstellar medium, young stellar objects, exoplanets, and Galactic evolution studies.

R=45K, simultaneous coverage of H+K coverage

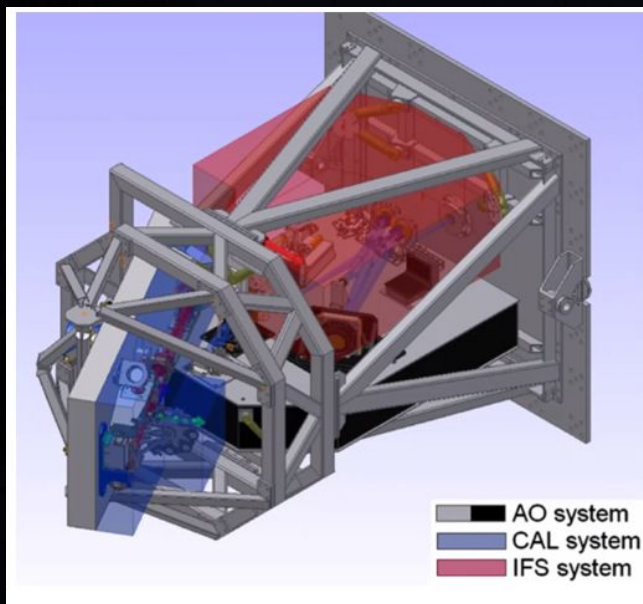
Built and funded by KASI, based on IGRINS visiting instrument.

Delivered to Gemini-North and first light in Oct, 2023. Two commissioning runs completed. Third one scheduled in April. Systems Verification run in July, 2024.



Gemini Planet Imager 2.0 (GPI-2)

The Gemini Planet Imager is an **extreme adaptive-optics imaging polarimeter/integral-field spectrometer**, to study exoplanets, brown dwarfs and dust around stars.



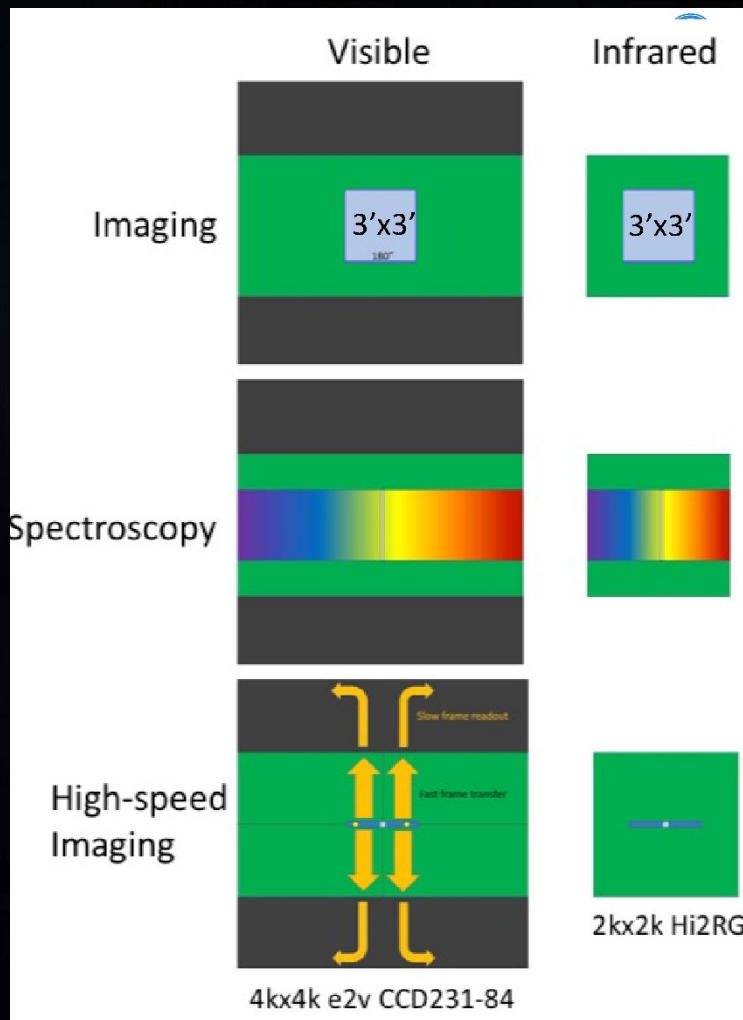
GPI 2.0 Integral Field Spectrograph and CAL 2.0 design view.

GPI is being upgraded by Notre Dame, UC San Diego and HAA to improve contrast ratio and sensitivity; funded by NSF, Heising-Simons, NRC

GPI-2.0 to arrive to Gemini-North in 2025.

- ❖ Installation and alignment of the integral field spectrograph is on-going at the **University of Notre Dame**
- ❖ The team at the **University of California San Diego** is working on the AO bench
- ❖ **Herzberg Astronomy & Astrophysics Research Center (HAA)** will deliver the CAL 2.0 upgrade

SCORPIO



Work-horse capability for time-domain science

Simultaneous 8-band optical/near-infrared imager and spectrograph built by SwRI , FRACTAL, JHU, STScI.

$\lambda = 0.38 - 2.3\mu\text{m}$ grizYJHK 3'x3' imaging or $R \sim 4000$, 3' long slit

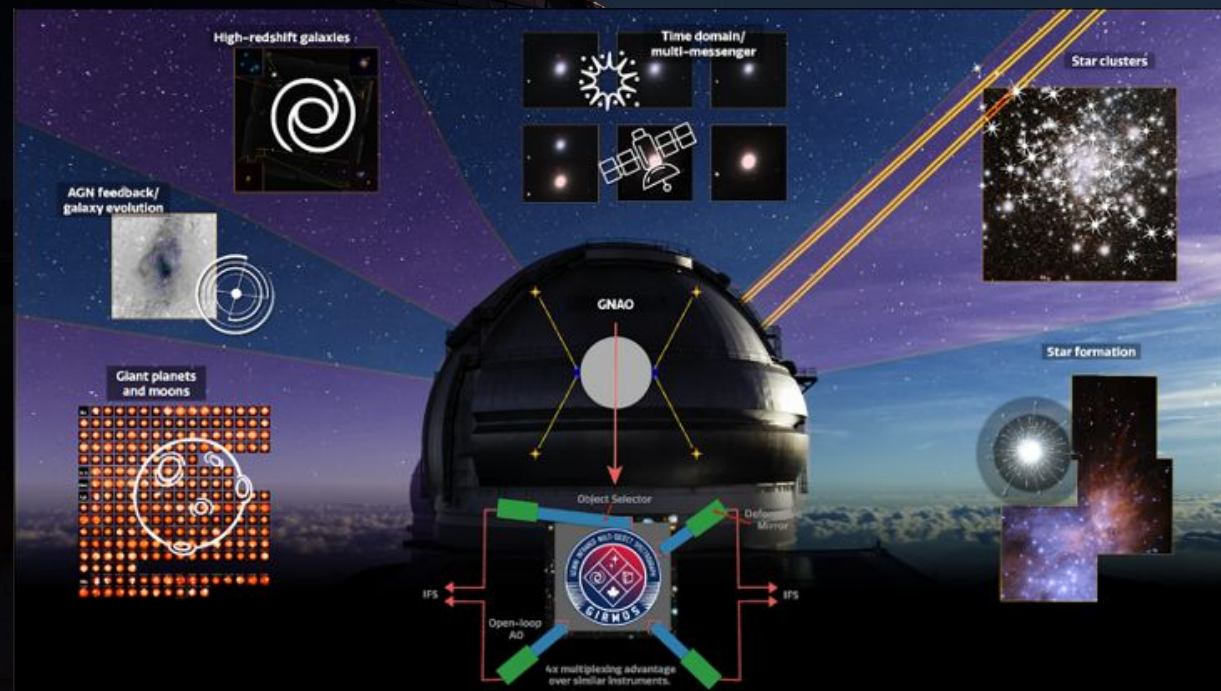
Rapid target acquisition and readout

Currently in the integration phase at FRACTAL

Delivery scheduled in 2025 to GS

GNAO + GIRMOS

- Gemini North Adaptive Optics (GNAO)
 - Replaces our current AO system, ALTAIR
 - Two AO modes
 - Narrow-field (20"x20")
 - Wide-field (2'x2')
- Gemini Infrared Multi-Object Spectrograph (GIRMOS)
 - 4 IFUs + imaging capability
 - Resolution: 3,000 and 8,000
- Science cases: high-redshift galaxies, galaxy mergers & star formation
- GIRMOS will arrive in 2027, and GNAO will be ready in 2028



Science Highlights

Subaru community using Gemini and vice versa.

- 38 papers w/ Subaru astronomers on papers using Gemini data
- 1 paper from Gemini community using Subaru data.
- Example : “Transition Probabilities of Near-infrared Ce III Lines from Stellar Spectra: Applications to Kilonova” by Domoto et al., 2023, ApJ, 956, 113 [Domoto san gave a talk on day1!]
- Example : “Deciphering the unusual stellar progenitor of GRB 210704A” by Becerra, R.L. et al., 202, MNRAS, 522, 5204

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CrossMark

Transition Probabilities of Near-infrared Ce III Lines from Stellar Spectra: Applications to Kilonovae

Nanae Domoto¹, Jae-Joon Lee², Masaomi Tanaka^{1,3}, Ho-Gyu Lee^{2,4}, Wako Aoki^{5,6}, Miho N. Ishigaki⁵, Shinya Wanajo^{7,8}, Daiji Kato^{9,10}, and Kenta Hotokezaka^{11,12}

¹ Astronomical Institute, Tohoku University, Aoba, Sendai 980-8578, Japan; n.domoto@astr.tohoku.ac.jp

² Korea Astronomy and Space Science Institute, 776 Daedeok-daero, Yuseong-gu, Daejeon 34055, Republic of Korea

³ Division for the Establishment of Frontier Sciences, Organization for Advanced Studies, Tohoku University, Sendai 980-8577, Japan

⁴ Space Policy Research Center, Science and Technology Policy Institute, 370 Sicheong-daero, Sejong 30147, Republic of Korea

⁵ National Astronomical Observatory, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan

⁶ Astronomical Science Program, The Graduate University for Advanced Studies, SOKENDAI, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan

⁷ Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Am Mühlenberg 1, D-14476 Potsdam-Golm, Germany

⁸ Interdisciplinary Theoretical and Mathematical Sciences Program (iTHEMS), RIKEN, Wako, Saitama 351-0198, Japan

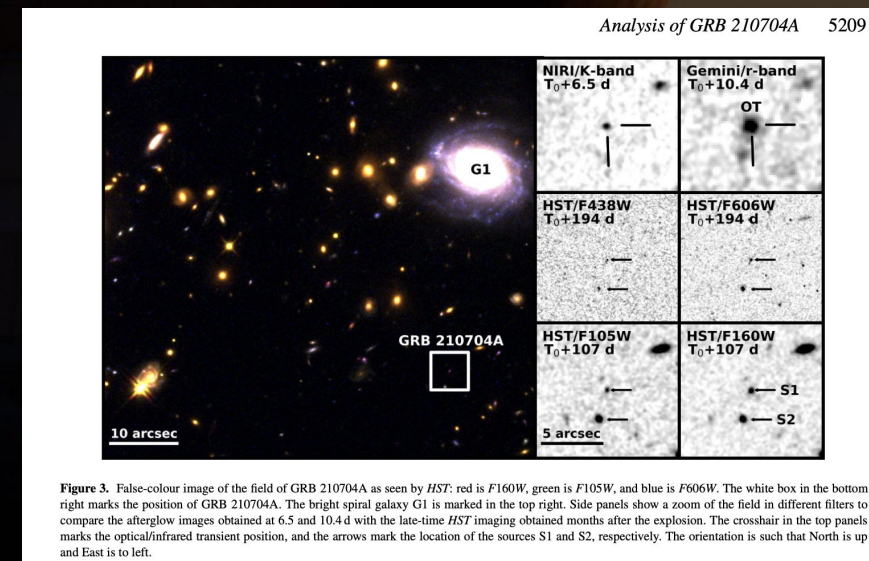
⁹ National Institute for Fusion Science, 322-6 Oroshi-cho, Toki 509-5292, Japan

¹⁰ Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Kasuga, Fukuoka 816-8580, Japan

¹¹ Research Center for the Early Universe, Graduate School of Science, University of Tokyo, Bunkyo, Tokyo 113-0033, Japan

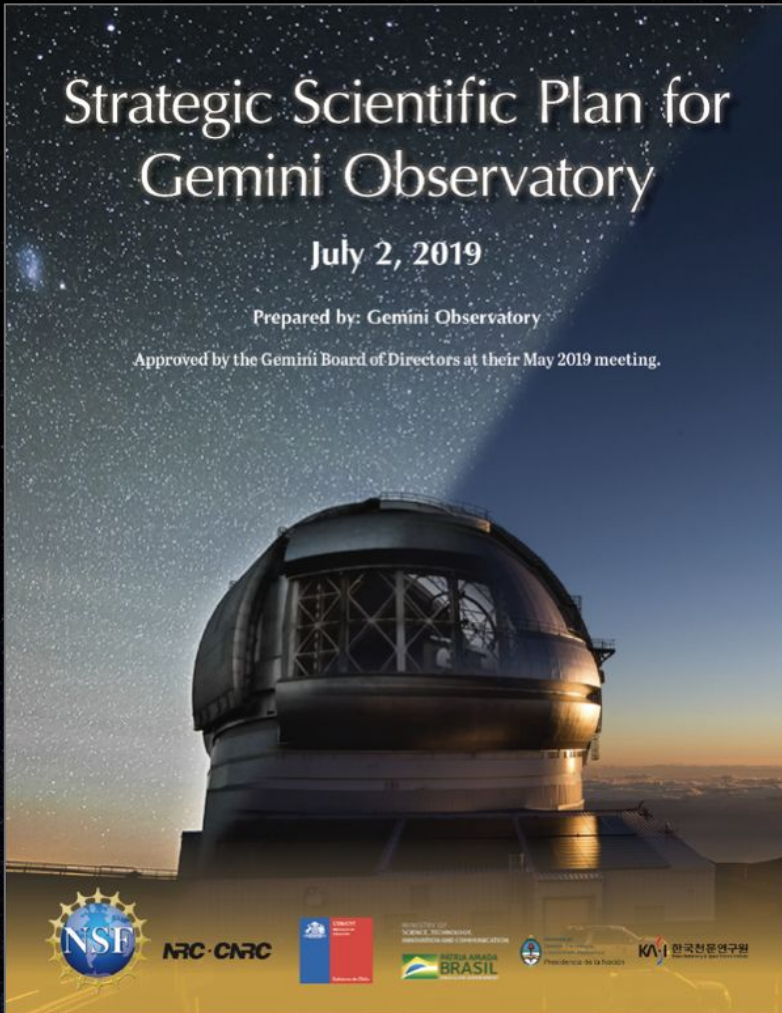
¹² Kavli IPMU (WPI), UTIAS, The University of Tokyo, Kashiwa, Chiba 277-8583, Japan

Received 2023 June 30; revised 2023 August 31; accepted 2023 September 1; published 2023 October 13



And ...

Strategic Plan for Gemini in the 2030s



- Initiating the Gemini Strategic Scientific Plan for the 2030s.
- Community survey is open from 02 January–15 February 2024.
- Soliciting feedback on complementary science, new Gemini instrumentation and infrastructure development.
- Results will be reviewed and discussed in workshops to be organized in the coming year.
- The new Strategic Scientific Plan will be presented at the 2025 Gemini Science Meeting.



NOIRLab/Gemini Sustainability Projects - Summary

In 5yr plan and funded:

- High efficiency transformers
- LED lights
- Window replacements
- Data centers hot/cold zones
- Photovoltaic systems: 1.8MW Total
- **CO₂ Neutral Gemini S.**

Future Priorities:

- Battery storage for 810 kW PV system
- More efficient transformers, windows, HVAC at all sites
- EV chargers - all sites
- Larger PV system to power 60% of Rubin summit operations

Will Reduce our CO₂ Footprint by 50% Relative to 2019 Levels

Graduate student visiting program in 24A

We will have two students at each site to visit each site (total 4 students) for about 2 weeks.

Observing

Instruments of interest (and more)

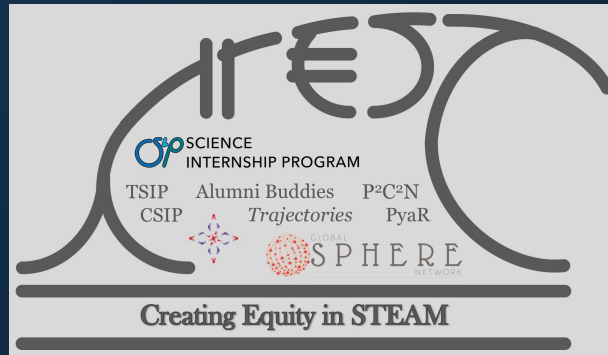
Queue planning

Data reduction

Meet staff, give a talk etc. etc.

40 students contacted us so far.

Shadow the Scientists Initiative



HEISING-SIMONS
FOUNDATION

- Many sessions from Subaru have taken place in the past.
- Three sessions (two general and one for specially requested India session) carried out since we returned on sky.
- Canada (in French) session in Feb.
- shadow@ucsc.edu,
gn-shadow@noirlab.edu

On behalf of Prof. Raja GuhaThakurta, Prof. Roy Gal, Prof. Lori Lubin, Sierra Schneider, Jameeka Marshall, the greater UCSC and Gemini-N StS teams, our outreach partners, and many others!

from Brian Lemaux's presentation for NOIRLab Faculty Meeting, Oct. 26th, 2022

Thank you!



Extra slides on Sustainability Window to the Universe

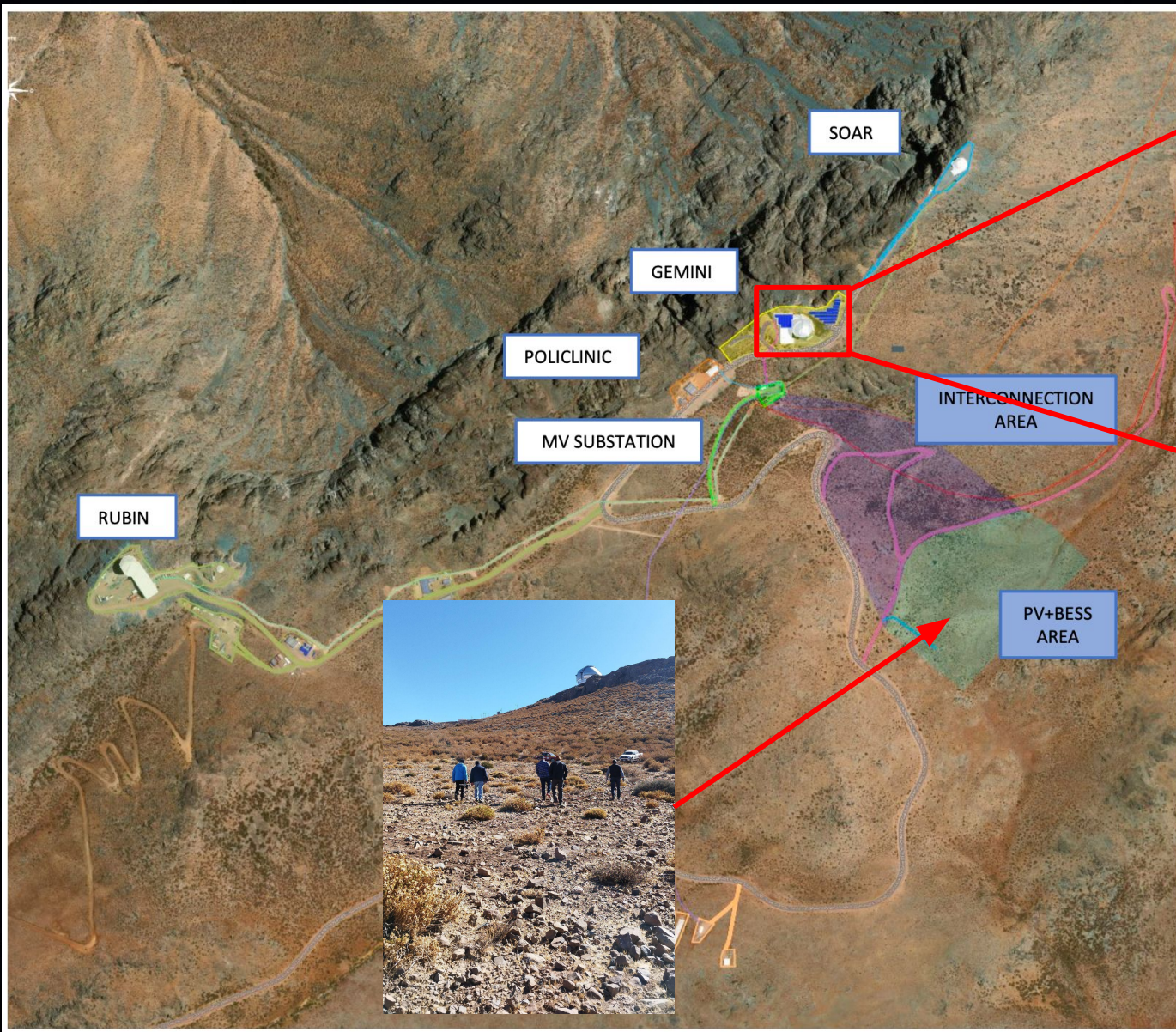
Sustainability

NOIRLab Projects

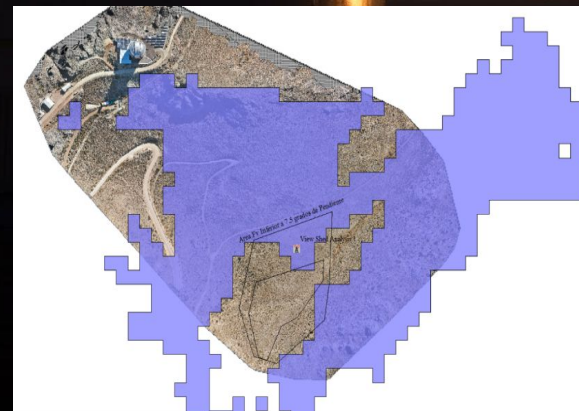
Towards zero CO₂ emission at GS

- **Gemini South and Rubin PV & batteries will be executed as one project, total funding ~\$10M**
 - PV collection capacity 2860 kW or more
 - Battery storage system 11 MWh (initial; 8.7MWh at age 7)
- **Single project, one site:**
 - Site already surveyed (geotechnical and insolation surveys)
 - Common infrastructure
 - Submission of Environmental Impact Affidavit
- **System will operate as a unit: providing 100% of Gemini South power and 60% of Rubin**

Towards zero CO₂ emission at GS



Illumination map



Towards zero CO₂ emission at GS



Gemini North:
100 kW system
Production ~650 kWh/day
~12% of usage.
Online September 2015

This image shows the Gemini North telescope dome, a large white structure with a silver-colored upper section, situated on a mountain peak. Below the dome is a large, rectangular solar panel array mounted on a building. Several white SUVs are parked in a dirt lot in front of the solar panels. The background shows a clear blue sky and distant mountain ranges.



Gemini South:
207 kW system
Production ~1000 kWh/day
~ 20% of usage.
Online July 16, 2016

This image shows the Gemini South telescope dome, a large white structure with a silver-colored upper section, situated on a mountain peak. Below the dome is a large, rectangular solar panel array mounted on a building. Several white SUVs are parked in a dirt lot in front of the solar panels. The background shows a clear blue sky and distant mountain ranges.

Funded: 810 kW PV System – Study and implementation plan under review

Windows on the Universe

Establishing the Infrastructure for a Collaborative Multi-messenger Ecosystem

(workshop held 16-18 October 2023, Tucson)



Jen Andrews, Ryan Lau, Monika Soraisam (SOC co-chairs)

Questions driving the workshop

1. *What are the main challenges to perform successful MMA/TDA campaigns and to maximize their scientific potential?*
2. *How should we coordinate MMA/TDA follow-up to reduce operational redundancy across the network of ground and space-based observatories?*
3. *How should we foster collaboration in the MMA/TDA community?*
4. *How can we ensure that the MMA/TDA field reaches its full potential over the next decade?*

Keys to address these questions

Hardware, Software, People & Policy



Thanks to the contributions from 40+ coauthors from the workshop, the White Paper was written in just two months!

Establishing the Infrastructure for a Collaborative Multi-messenger Ecosystem

THE 2023 WINDOWS ON THE UNIVERSE WORKSHOP WHITE PAPER WORKING GROUP: TOMÁS AHUMADA ¹, JENNIFER E. ANDREWS (SOC CO-CHAIR) ^{2,*}, SARAH ANTIER ³, ERIK BLAUFUSS ⁴, P.R. BRADY ^{5,*}, A.M. BRAZIER ⁶, ERIC BURNS ⁷, S. BRADLEY CENKO (EDITOR) ^{8,9,*}, POONAM CHANDRA ¹⁰, DEEP CHATTERJEE ¹¹, ALESSANDRA CORSI ^{12,*}, MICHAEL W. COUGHLIN ¹³, DAVID A. COULTER ¹⁴, SHENMING FU ¹⁵, ADAM GOLDSTEIN ^{16,*}, LEANNE P. GUY ¹⁵, ERIC J. HOOPER ¹⁷, STEVE B. HOWELL ¹⁸, T.B. HUMENSKY ⁸, JAMIE A. KENNEA ¹⁹, S.M. JARRETT ²⁰, RYAN M. LAU (SOC CO-CHAIR) ^{15,*}, TIFFANY R. LEWIS ²¹, LU LU ²², THOMAS MATHESON ¹⁵, BRYAN W. MILLER ²³, GAUTHAM NARAYAN ²⁴, ROBERT NIKUTTA ¹⁵, JAYADEV K. RAJAGOPAL ¹⁵, K.M. RUIZ-ROCHA ²⁵, JESSIE RUNNOE ^{26,*}, DAVID J. SAND (EDITOR) ^{27,*}, MARCOS SANTANDER ²⁸, HUGO A. AYALA SOLARES ^{19,*}, MONIKA D. SORAISAM (SOC CO-CHAIR) ^{2,*}, R.A. STREET ^{29,*}, AARON TOHUVAVOHU ³⁰, SARAH J. VIGELAND ⁵, SALVATORE VITALE ³¹, NICHOLAS .E. WHITE ³², SAMUEL D. WYATT ³³, AND TIANLU YUAN ²²

¹Division of Physics, Mathematics and Astronomy, California Institute of Technology, Pasadena, CA 91125, USA

²Gemini Observatory/NSF's NOIRLab, 670 N. A'ohoku Place, Hilo, HI 96720, USA

³Observatoire de la Côte d'Azur, Université Côte d'Azur, Boulevard de l'Observatoire, 06304 Nice, France

Now available on arXiv: 2401.02063

Hardware-related recommendations

- **An ecosystem of discovery and follow-up engines are required across the electromagnetic spectrum**
- **Critical to have *community-accessible* wide-field imaging facilities at optical/NIR wavelengths with full sky coverage (both Northern and Southern hemispheres)**
 - Blanco/DECam + WIYN/ODI
- **Significant investment in follow-up spectroscopy capability also desperately needed**
 - Gemini, SOAR

Software-related recommendations

Challenges for MMA/TDA are unique — coordinating observations across multiple cosmic messengers *in real time* require diverse software tools. Interoperability of these tools, including interoperability between cross-agency and international archives, essential.

Significant increase in funding opportunities for MMA/TDA software necessary. Pursue a phased approach:

- Phase 1, small scale (~\$100K, 6-12 months), Alpha release for an individual team
- Phase 2, medium scale (~\$1M, 3-5 years), Beta release for the broader community
- Phase 3, large scale, Production release for *critical infrastructure*. **Identify the vital MMA/TDA cyberinfrastructure for the community and redirect their long-term maintenance to a national lab, NASA center or NOIRLab**

People & Policy-related recommendations

1. Improved career opportunities for those developing cyberinfrastructure for the MMA/TDA enterprise. E.g.,
 - *weigh S/W contributions like publications in tenure/fellowship evaluations*
 - *NSF/NASA to highlight role of S/W contributions*
 - *industry-competitive salaries for S/W engineers*
2. Closer coordination between NASA and the NSF. E.g.,
 - ***support existing efforts to enable MMA/TDA science at their facilities via ACROSS program and AEON Network***
 - ***fund their extension to other wavelength facilities***
3. Invite MMA community and observatory staff to design MMA/TDA observing programs for which data become public immediately.
 - ***NOIRLab/Gemini could establish key projects for MMA/TDA to remove redundancies***
4. Fund training for researchers to do MMA science and outreach