
Gemini 101
Stéphanie Côté
(Canadian Gemini
Office, NRC)

All about Gemini:

1. Overview of the telescopes
2. Instrumentation
3. Operations
4. How to apply for time
5. Where to get help

1) Overview


GEMINI OBSERVATORY
Mauna Kea since 1999
Hilo, Hawaii
Gemini Observatory:
Operating two twin 8m telescopes on Mauna Kea and Cerro Pachon:
providing access to the entire sky
We are Here
We are Here
We are Here
We are Here
We are Here
We are Here
We are Here
Cerro Pachon since 2000
La Serena, Chile
Markus Kissler-Patig - Toronto 2015 - Future and Science of Gemini Observatory

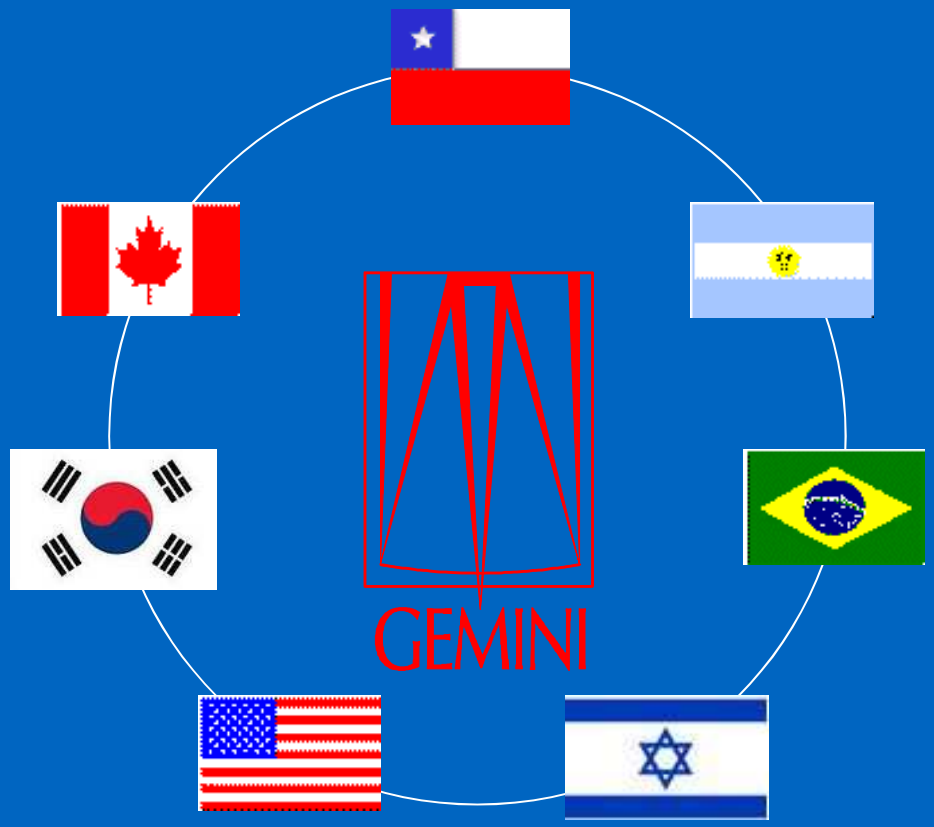
The Gemini Observatory

Partnership at the start: United States, UK, Canada, Chile, Argentina, Brazil and Australia.

Now: UK & Australia left, South Korea and Israel are ramping in

Budget : 184 M $USD

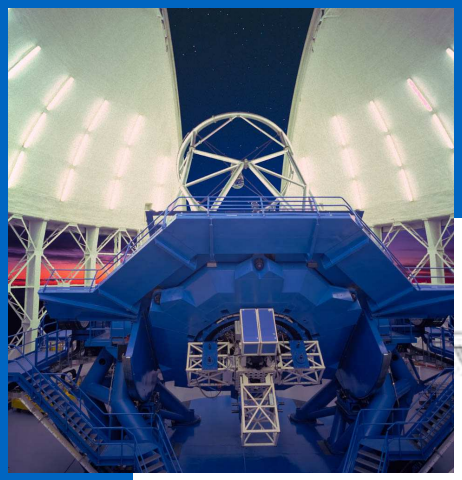
Canada:
15% share of the time at the start 18.6% now

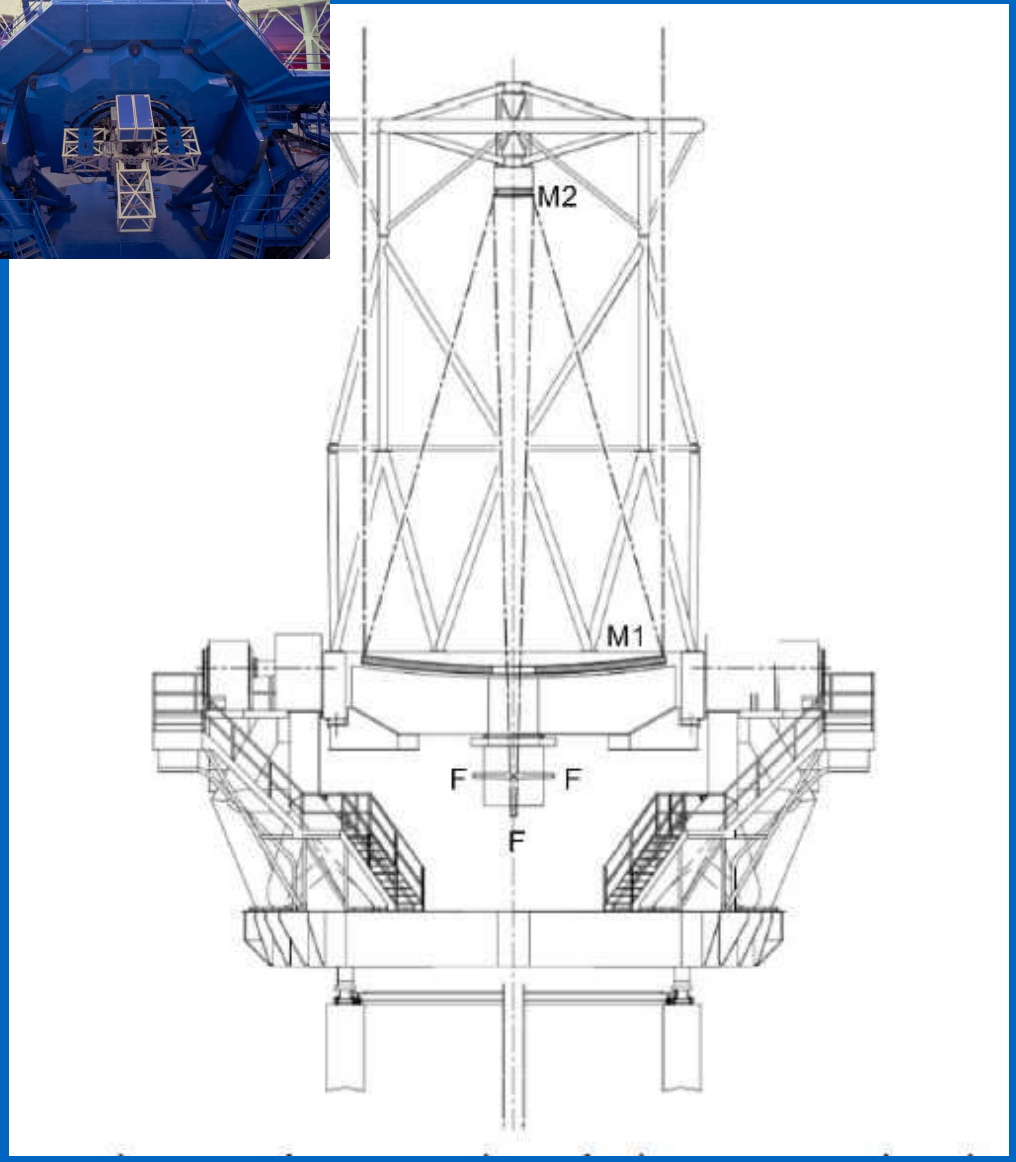


Started operations in 2000

Each partner country has a National Gemini Office
In Canada: the CGO is located at HAA, and consists of Steph Côté, Tim Davidge, Eric Steinbring and Joel Roediger

Gemini Telescope Design





Both Gemini Telescopes are of identical Alt-Az mounted, Ritchey-Chretien Cassegrain design:

Primary mirror : concave hyperboloid
8.1 m diameter

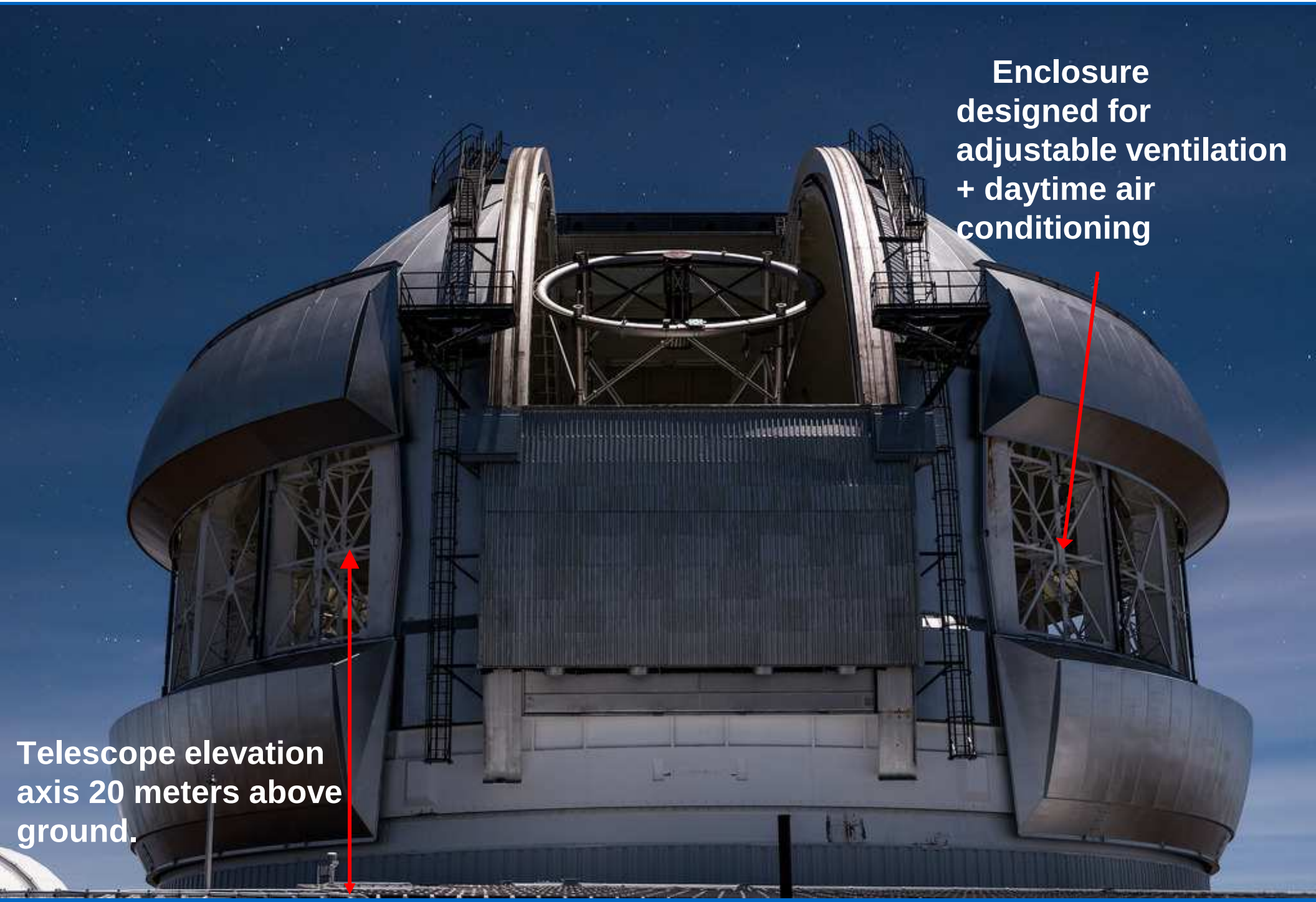
Secondary Mirror: convex hyperboloid
1m diameter

Gemini has a F/16 ratio (long):
Focal length / aperture
128 m / 8.1 m

Top level performance

The Gemini Telescopes were designed to deliver:

- Superb image quality
  - Primary mirror actively controlled and Secondary mirror tip-tilt design
  - Enclosure design with vents to allow smooth flow of air
  - AO facilities to correct for image blurring caused by atmospheric turbulence
- Optimized IR observing (extremely low emissivity)
- Versatility to take advantage of changing conditions and flexibility in scheduling
  - The great majority of Observations are done in Queue mode. Can change rapidly between selected instruments, with simultaneous mounting of 3 instruments

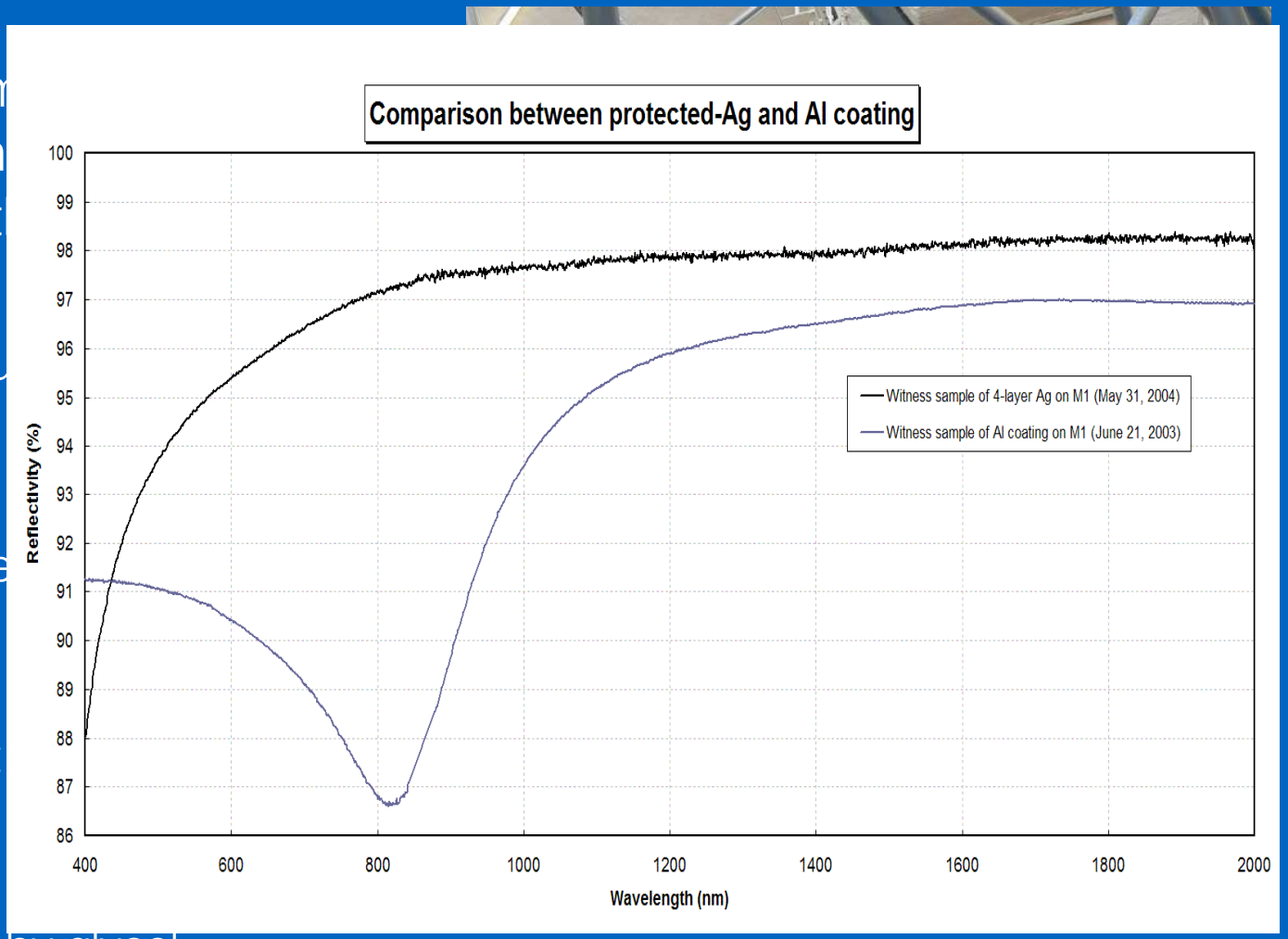


Significant Canadian scientific and technological input:

Canadian Firm AMEC was awarded the $44 Million contract for the enclosures

Primary Mirror Features

- 8m diameter, 20 cm thick, ULE weighs 22 tons.
- 120 hydraulic actuators m
  surface at its optimum sh
  telescope tracks across t
- Primary mirror: temperatu
  controlled.
  - Minimize temperature diffe
    and ambient air.
    - Target is ±1°C to meet
      requirement.
  - Rear copper plate cooled by glycol
  - Heating of mirror silver surface.



Fast Instrument Switching

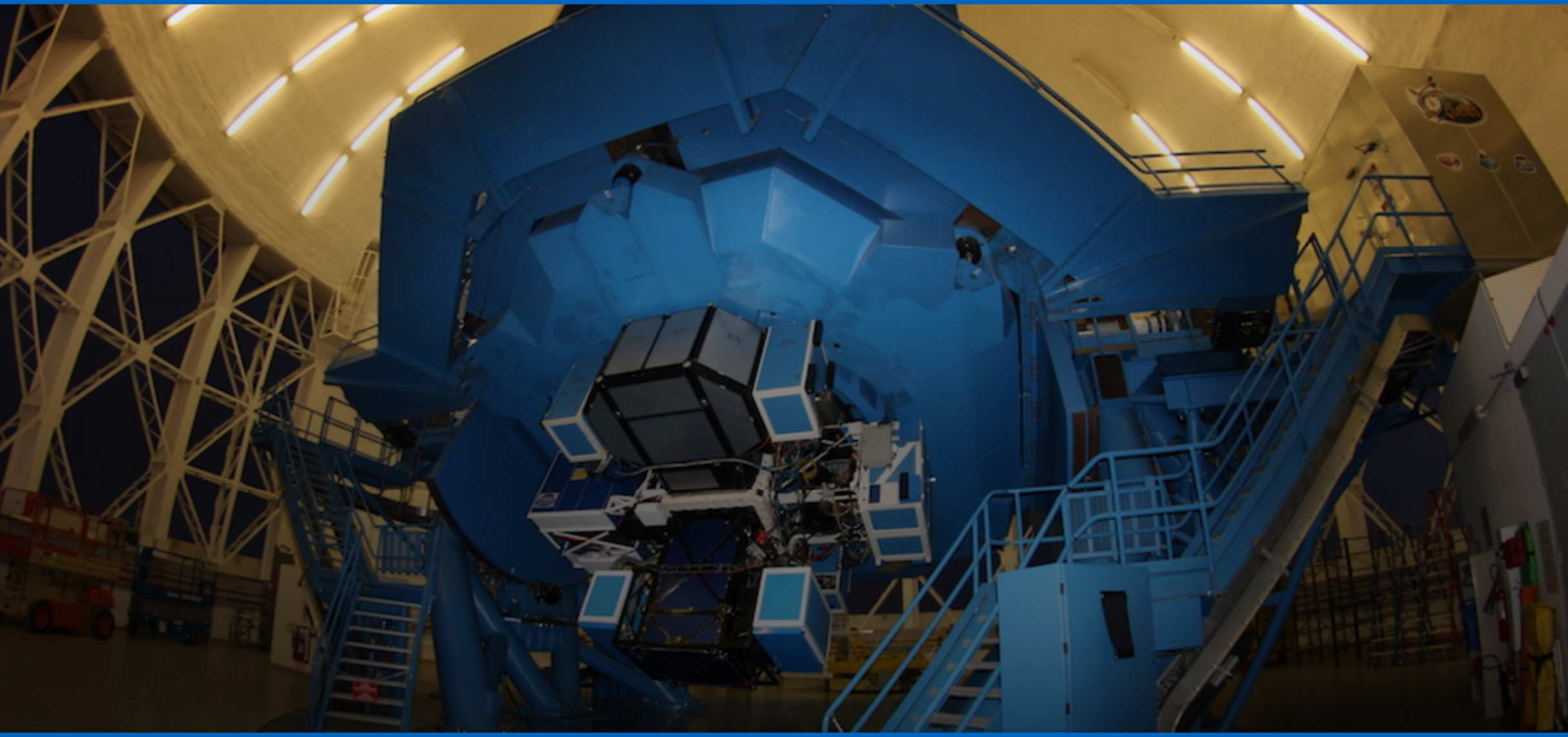


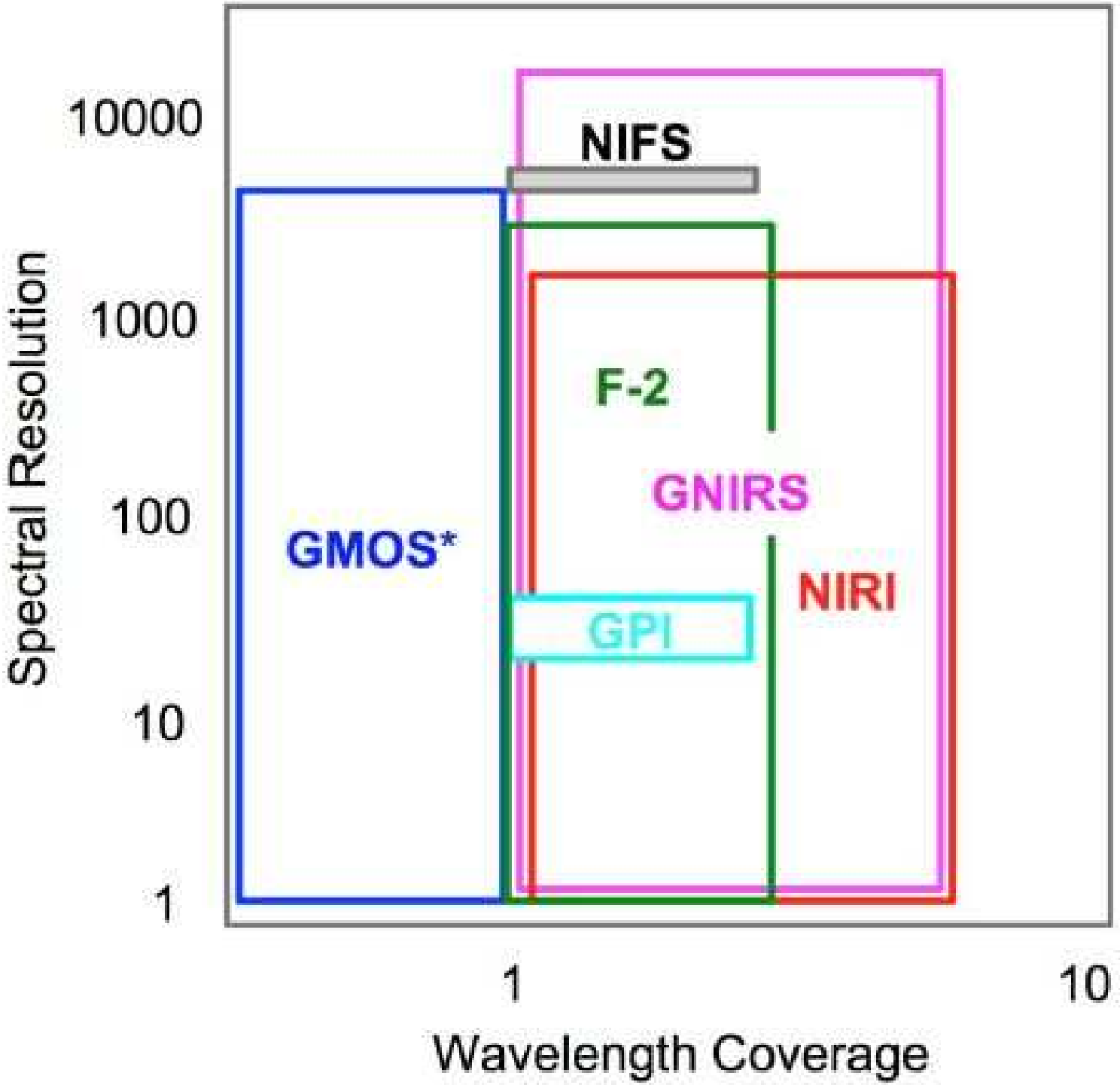
Image credit: GPI team

Gemini North

VISIBLE	NEAR-IR	MID-IR	OTHER FACILITIES
Facility Instruments			
GMOS (multi-object, long-slit and IFU spectrograph and imager) Instrument Fact Sheet	NIRI (1-5μm imager) Instrument Fact Sheet		GCAL (facility calibration unit)
	NIFS (1.0-2.5μm integral field spectrograph) Instrument Fact Sheet		ALTAIR (facility natural/laser guide star AO system)
	GNIRS (1-5μm long-slit and 0.9-2.5μm cross-dispersed spectrograph; formerly at Gemini South) Instrument Fact Sheet		
Visiting Instruments			
GRACES (0.4-1.0μm high resolution spectrograph)		TEXES*(10-20μm high resolution spectrograph)	

Gemini South

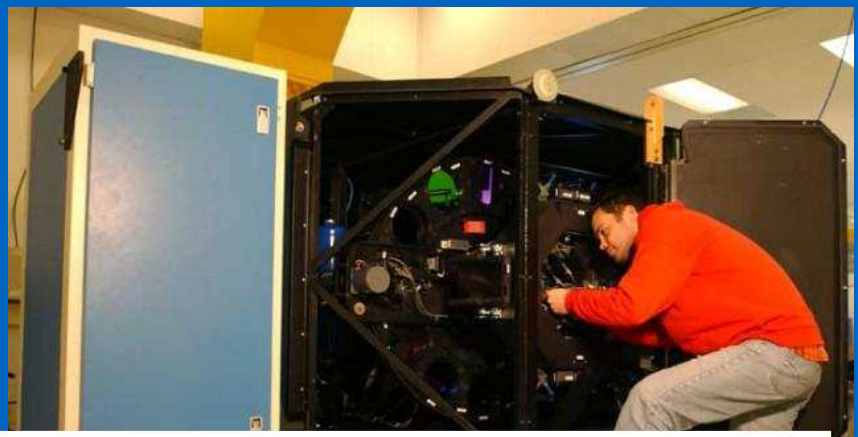
VISIBLE	NEAR-IR	MID-IR	OTHER FACILITIES
Facility Instruments			
GMOS (multi-object, long-slit and IFU spectrograph and imager) Instrument Fact Sheet			GCAL (facility calibration unit)
	GSAOI (high-resolution imager for use with Multi-Conjugate Adaptive Optics system "GeMS") Instrument Fact Sheet		GeMS (Multi-conjugate adaptive optics system)
	GPI (adaptive-optics imaging polarimeter/integral-field spectrometer) Instrument Fact Sheet		
	FLAMINGOS-2 (long-slit spectrograph and imager) Instrument Fact Sheet		
Visiting Instruments			
DSSI/Speckle** (diffraction-limited optical imager)	Phoenix** (high-resolution spectrograph)		


10000
1000
100
10
1
Spectral Resolution
NIFS
F-2
GNIRS
GMOS*
NIRI
GPI
1
10
Wavelength Coverage

GMOS

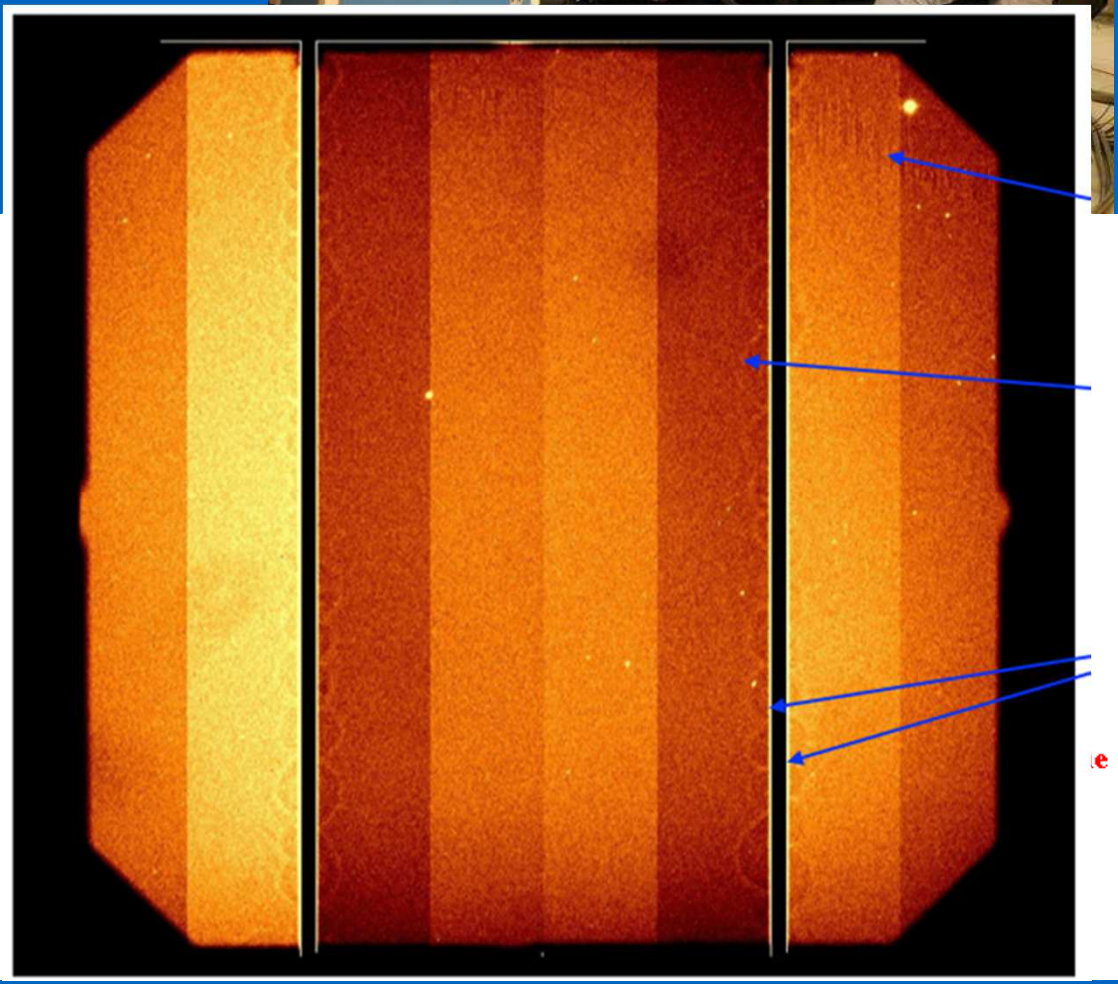
Partly built in Victoria!

Gemini Multi-Object Spectrograph

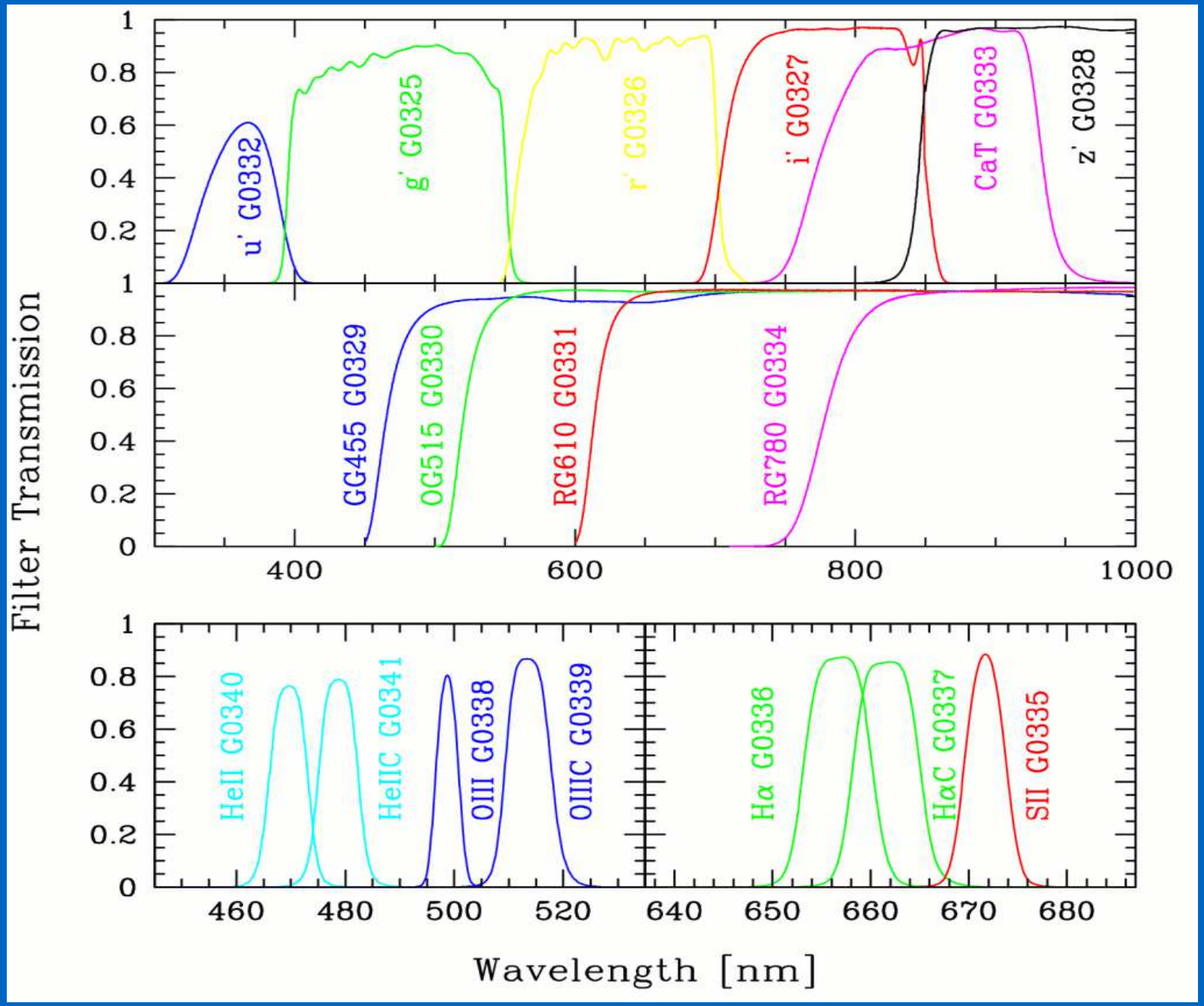


Detector	Three Hamamatsus CCDs each 2048 x 4176 pixels
Wavelength range	0.36 to 1.03 µm
Field-of-View	5.5 arcmin
Pixel scale	0.0807 arcsec/pixel 15 µm pixel size
Read noise	~4.1 e- rms

12 amplifier readout



Imaging: 0.0807”/pixel over a 5.5 arcmin Field-of-View

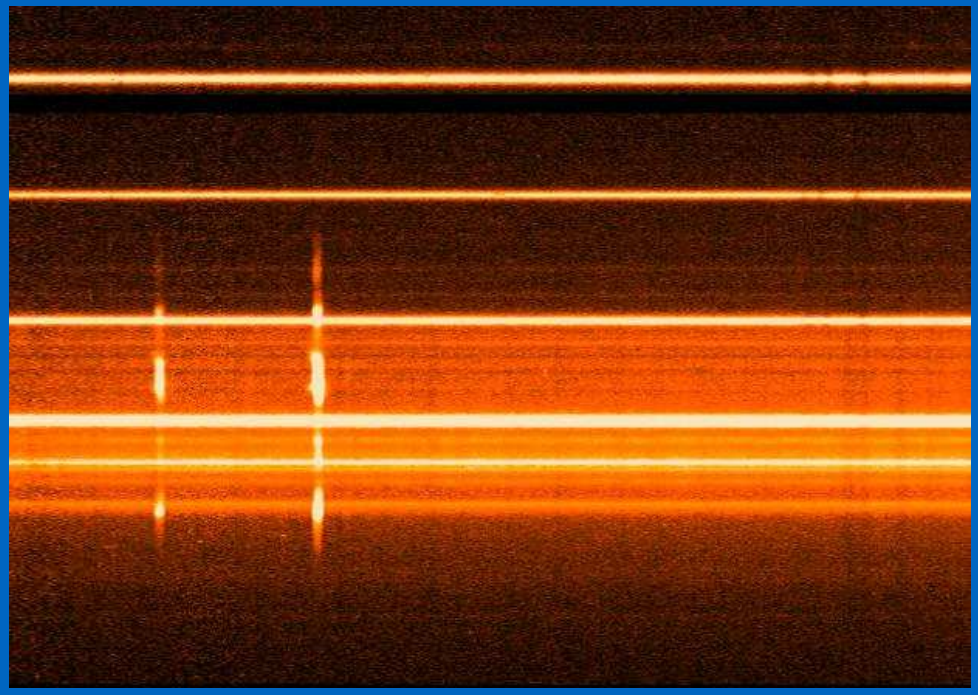


Longslit spectroscopy:

Slit widths: 0.25” to 5”

Slit Length: up to 5.5 arcmin

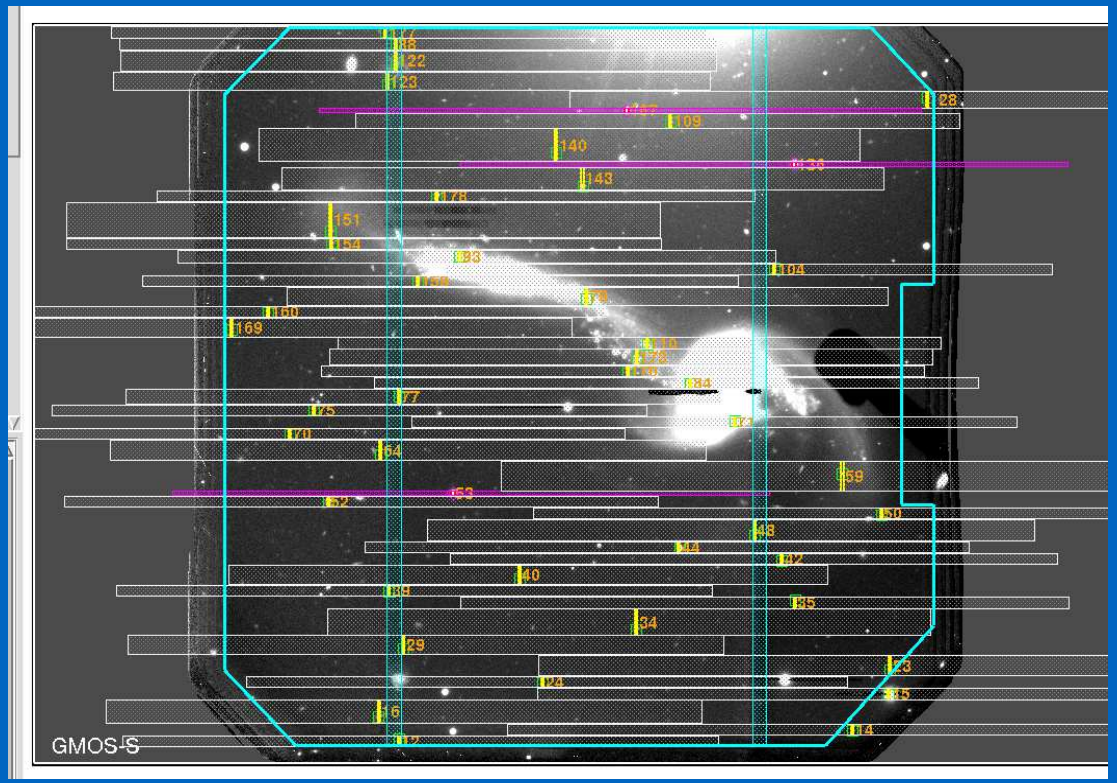
Dispersion: R~ 630 up to R~ 4400
(choice of 6 gratings)



Multi-Object spectroscopy:

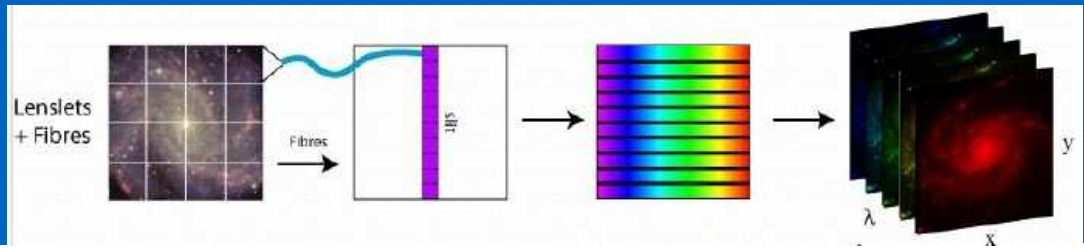
- Up to several hundred slitlets over the whole Field-of-view with any of the gratings

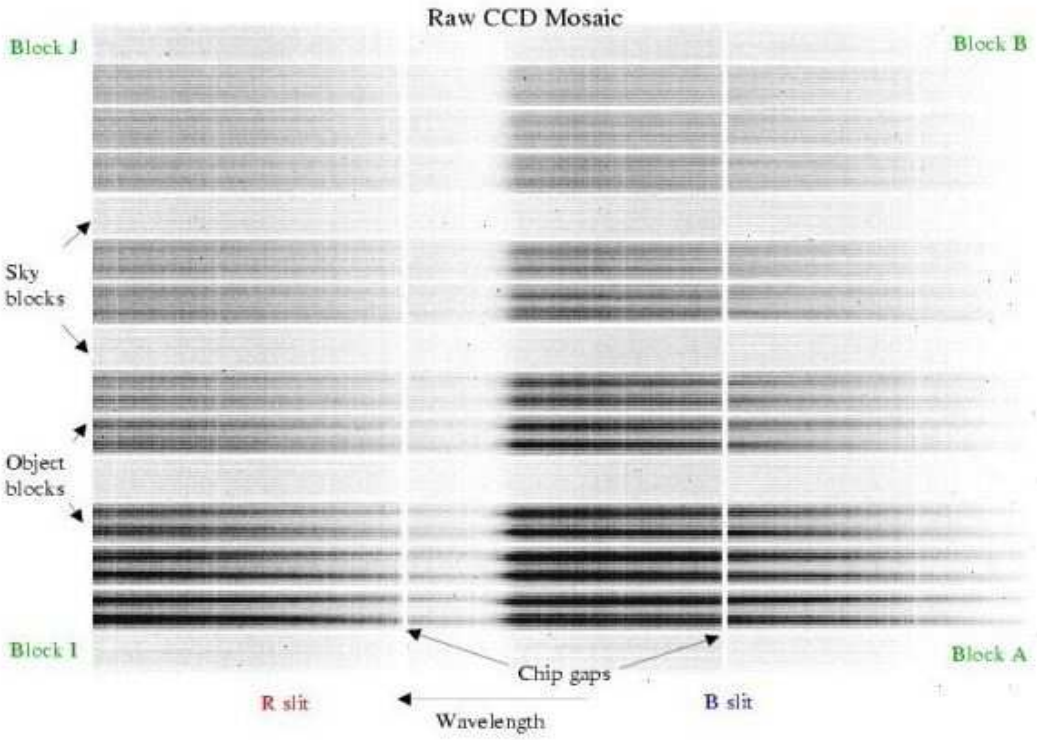
- Uses custom-designed laser-milled masks

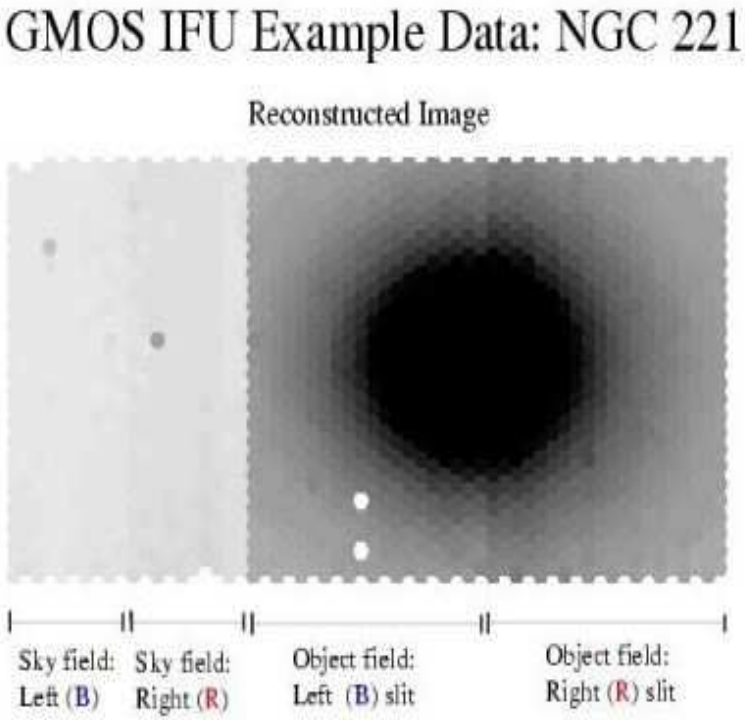


GMOS IFU

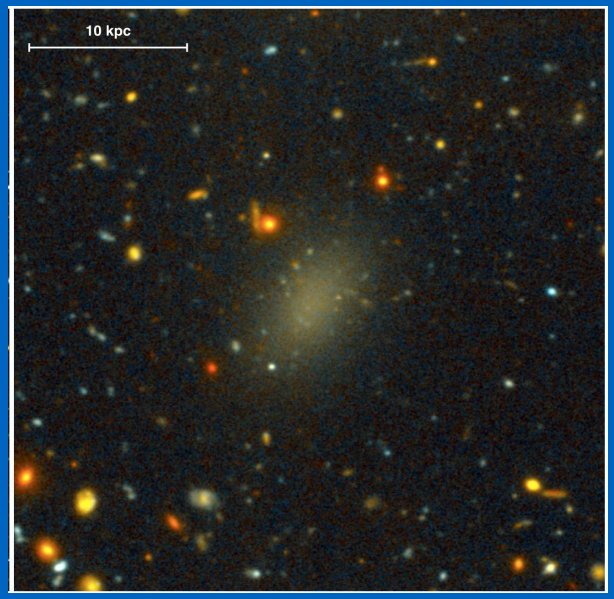
The integral field mode of GMOS provides the ability to perform spatially resolved spectroscopy. This mode uses a lenslet array of 1000 elements for a science field of view of 5"x7". The nearby sky is sampled with 500 elements.





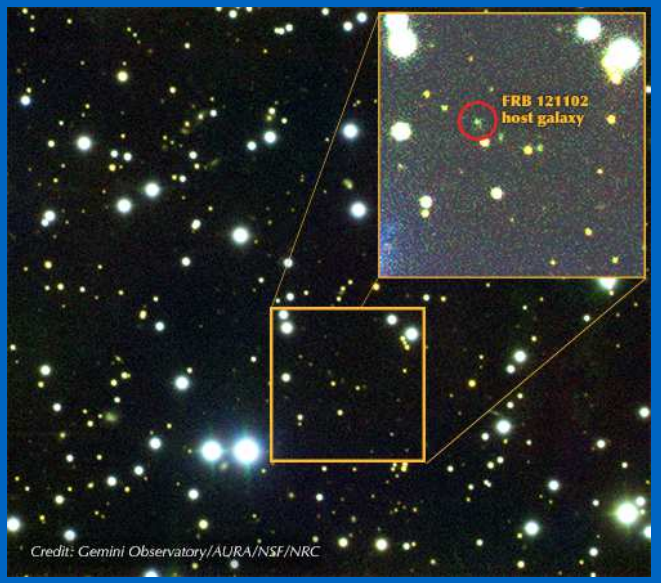


GMOS Science: recent Canadian press releases



Van Dokkum, Abraham, Brodie et al 2016
ApJ 828,L6

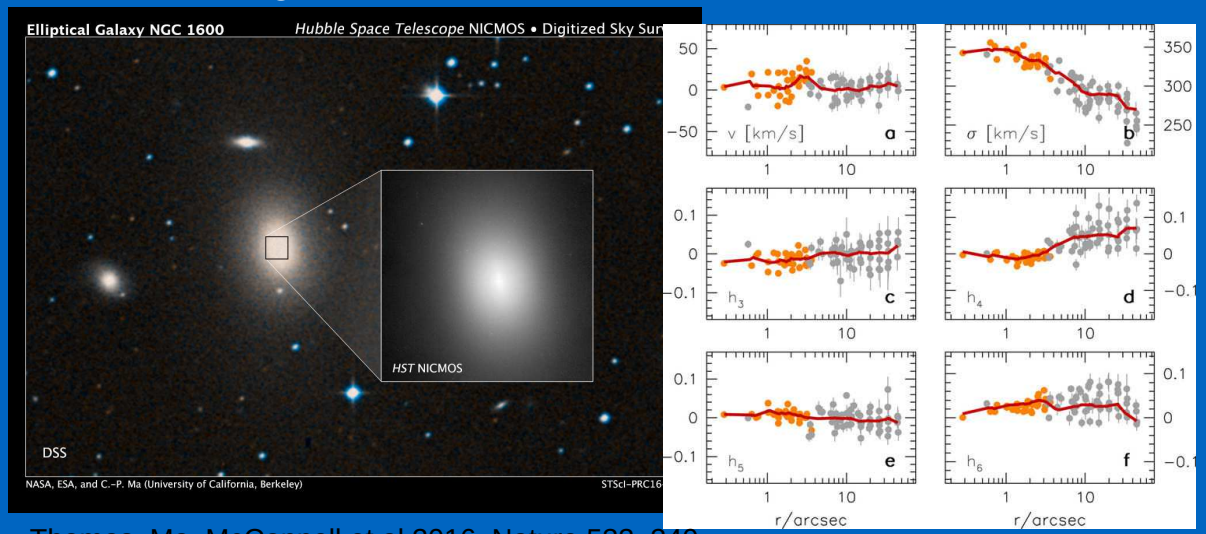
Dragonfly44:
Ultra-Compact-Dwarf
= “failed galaxy”, is
99.99% dark matter



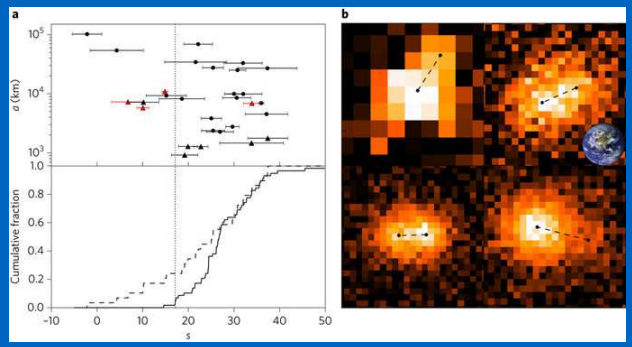
Tendulkar et al 2017 ApJ 834 L7

First optical identification
of a Fast Radio Burst =
dwarf galaxy at z=0.19

NGC1600: Super Massive Black Hole
17×10^9 $M_\odot$ in this rather isolated galaxy



Thomas, Ma, McConnell et al 2016, Nature 533, 340



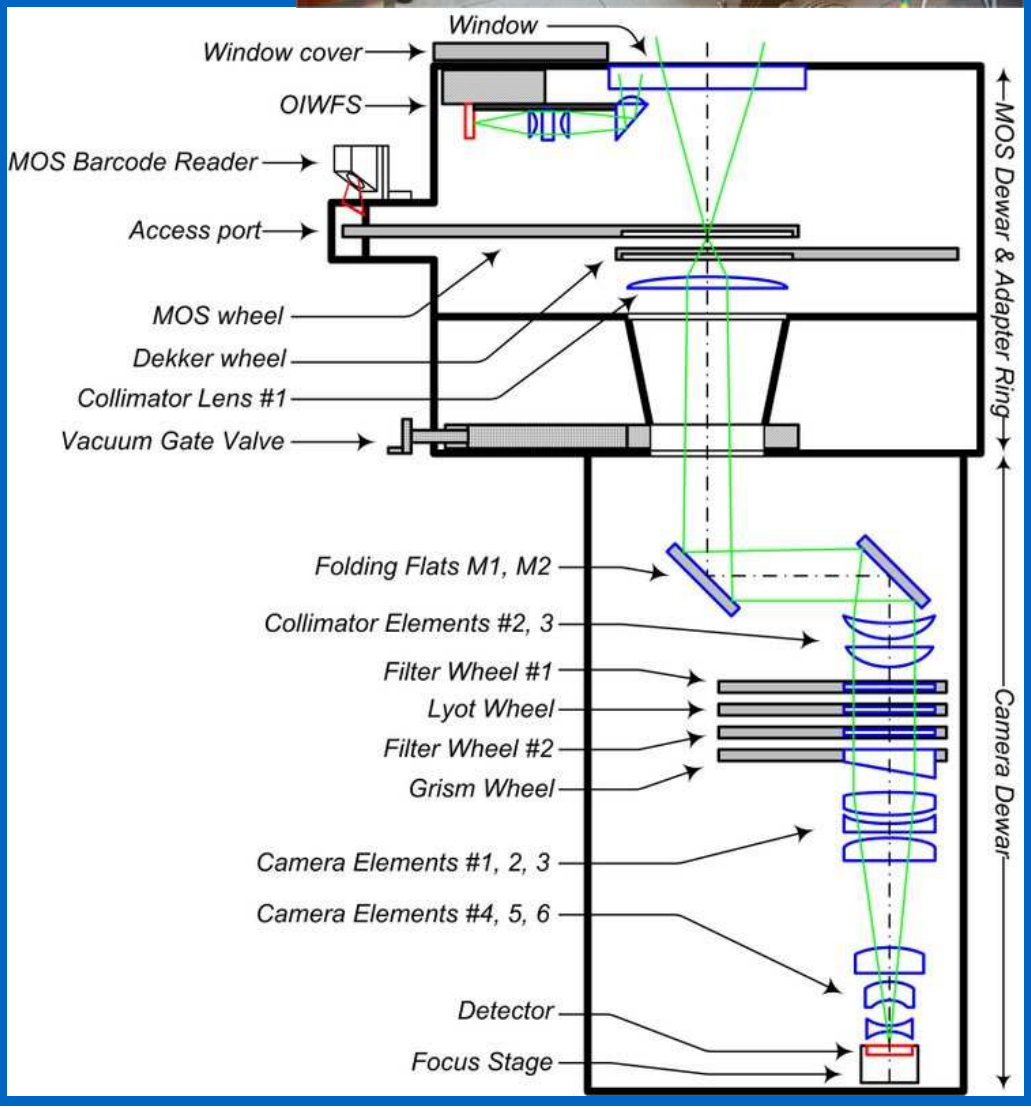
Fraser, Bannister, Pike et al 2017 Nature Astronomy 1, 88

Colors of Outer Solar System Objects: Neptune migrated outward slowly

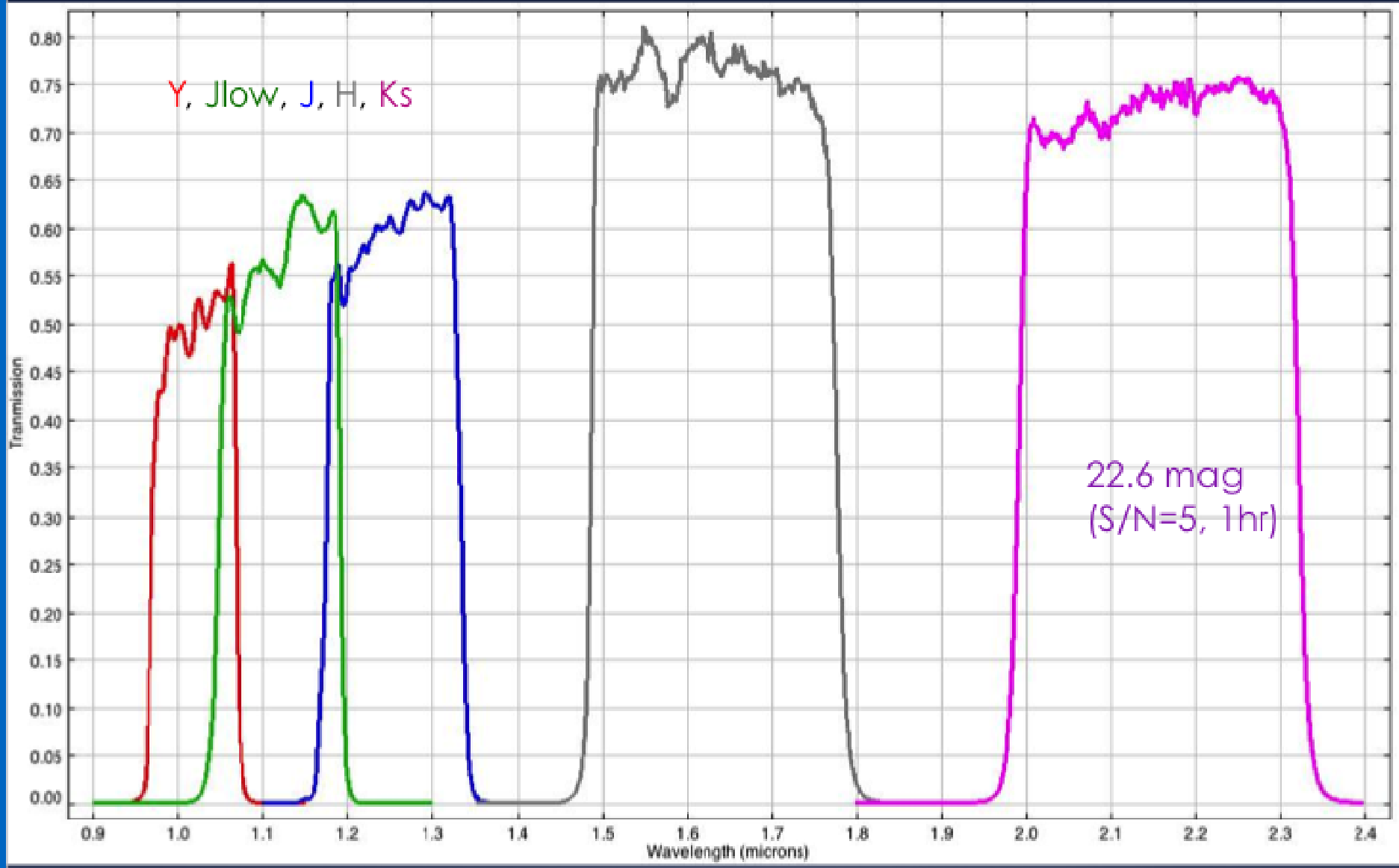
Flamingos-2

Near-Infrared Imager and Spectrograph

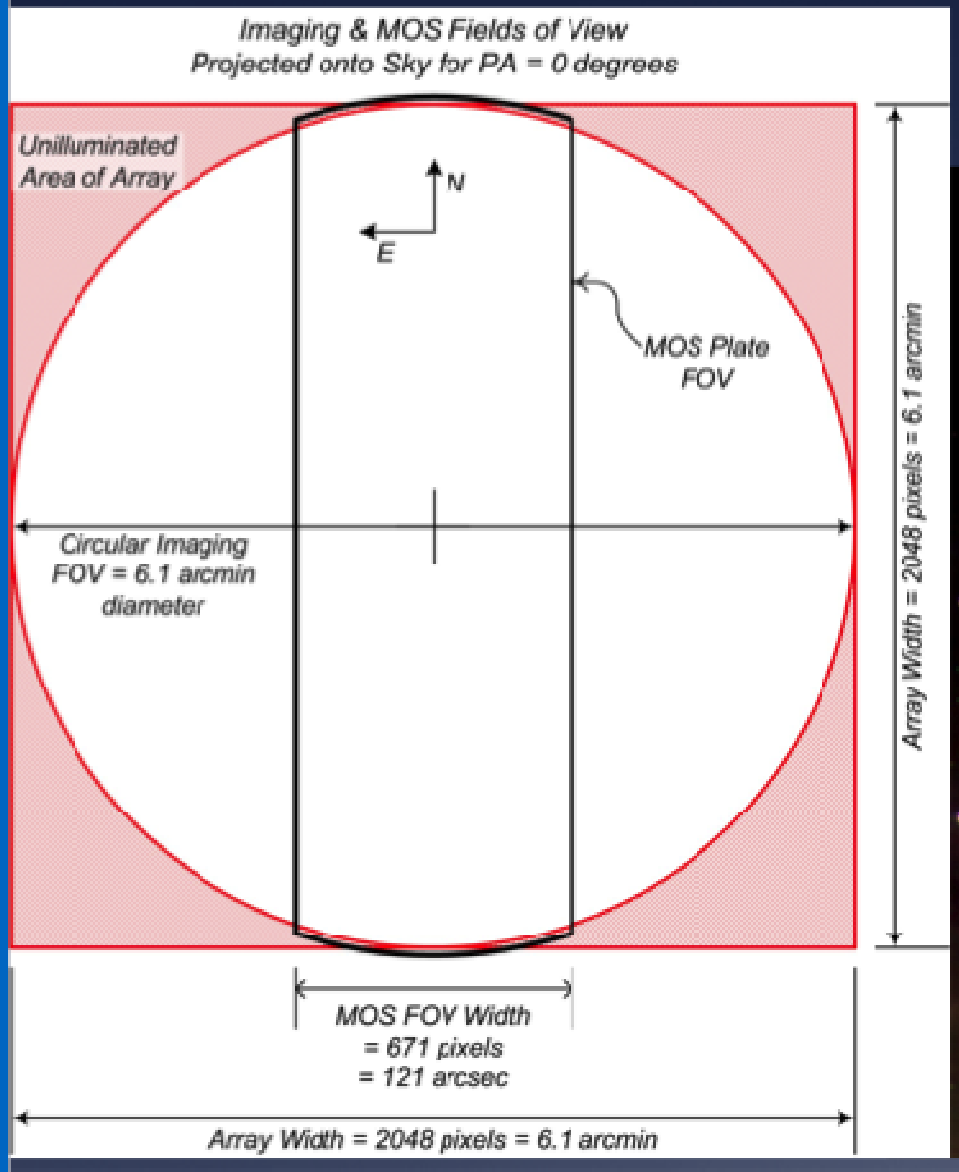
Wavelength Range	**0.9 – 2.4 microns**
Detector	**Hawaii-2 array 2048x2048 pixels**
Imaging FOV	**6.1 arcmin diameter (circular)**
Pixel scale	**0.18 arcsec/pixel**
Spectroscopic FOV	**6.1’ x 2’**
Dispersion	**Two grisms R ~ 1200 for JH or HK**
	One medium-res grism R~3000 covering one Band
Longslits	**1 to 8 pixels wide (=0.18” to 1.44”) and 4.4’ long**

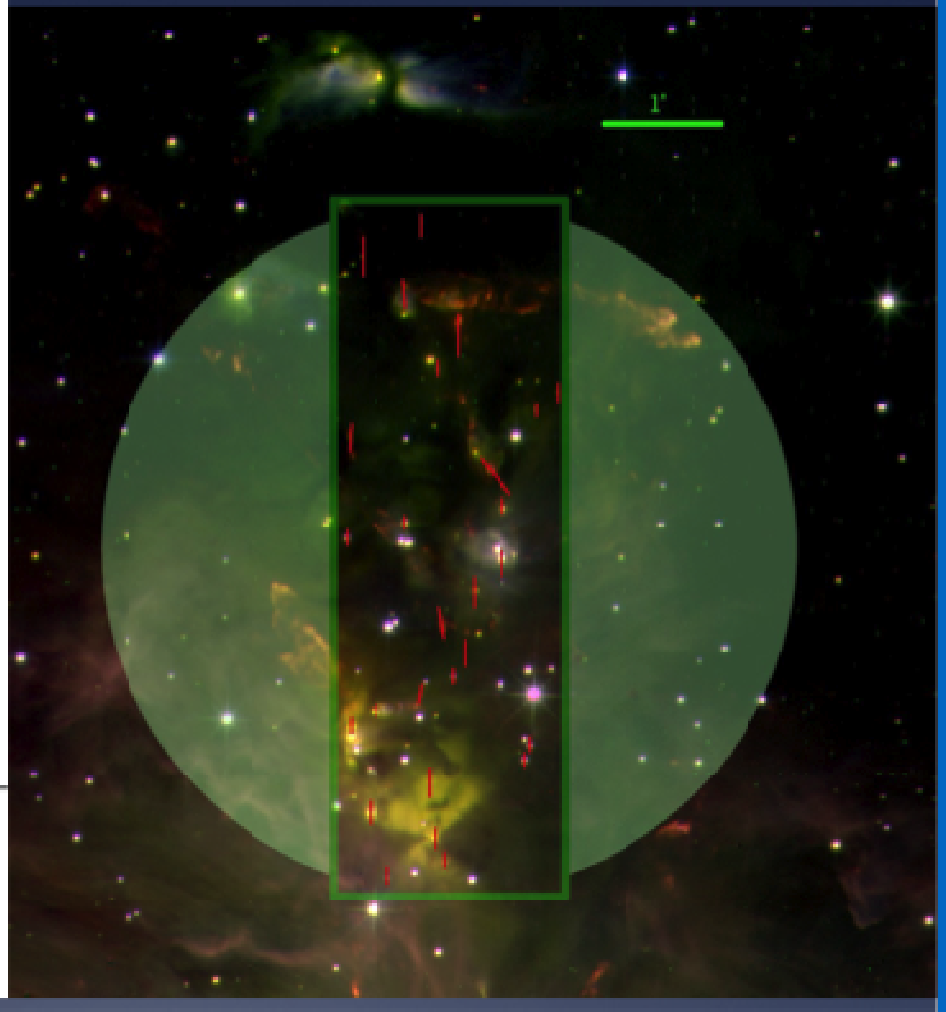


Filters Transmission

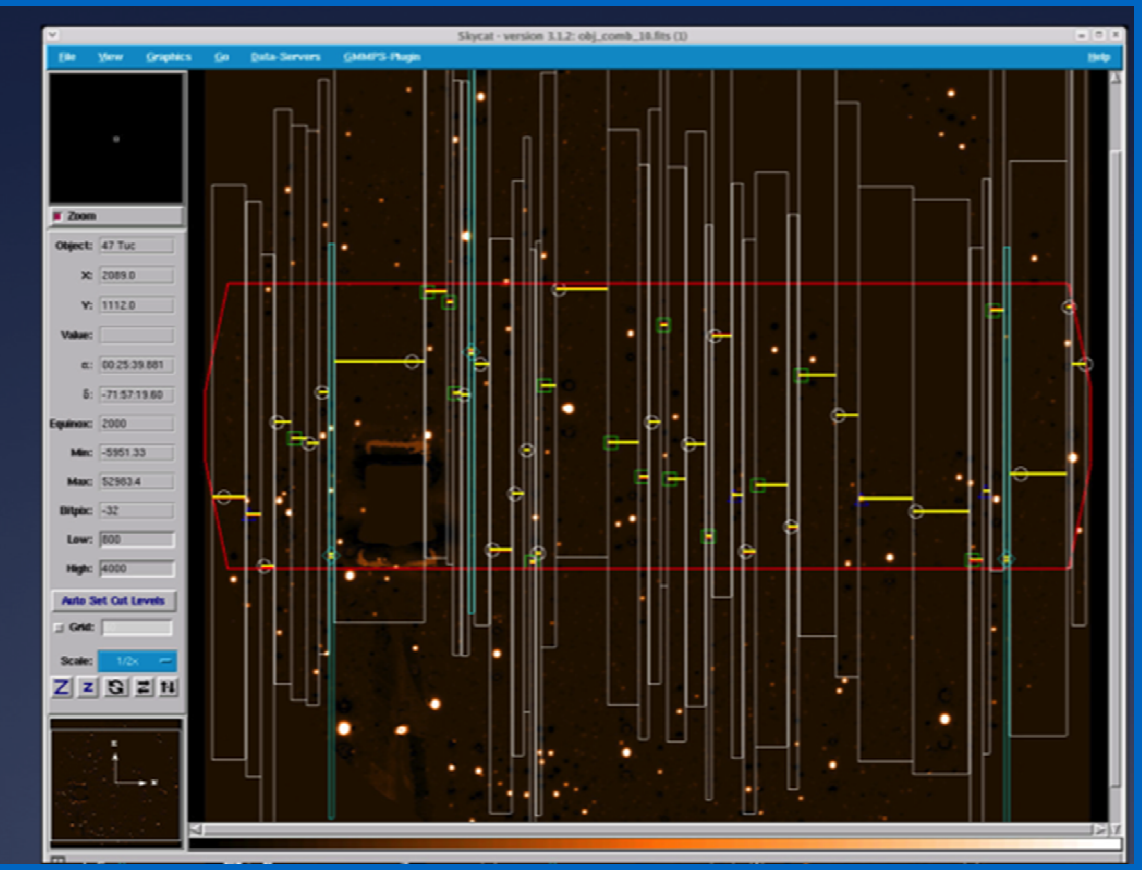


Fields of View





F2 MOS mode

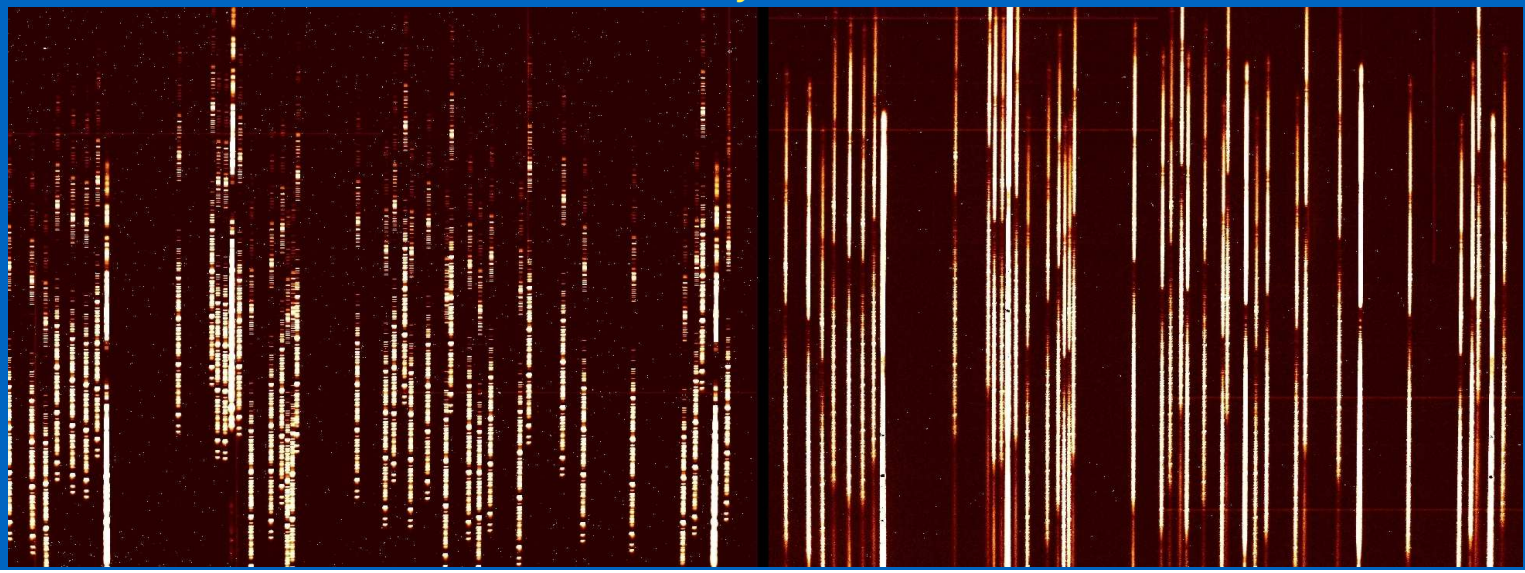


MOS Field-of-View 6.1 x 2 arcmin

MOS wheel holds 9 masks

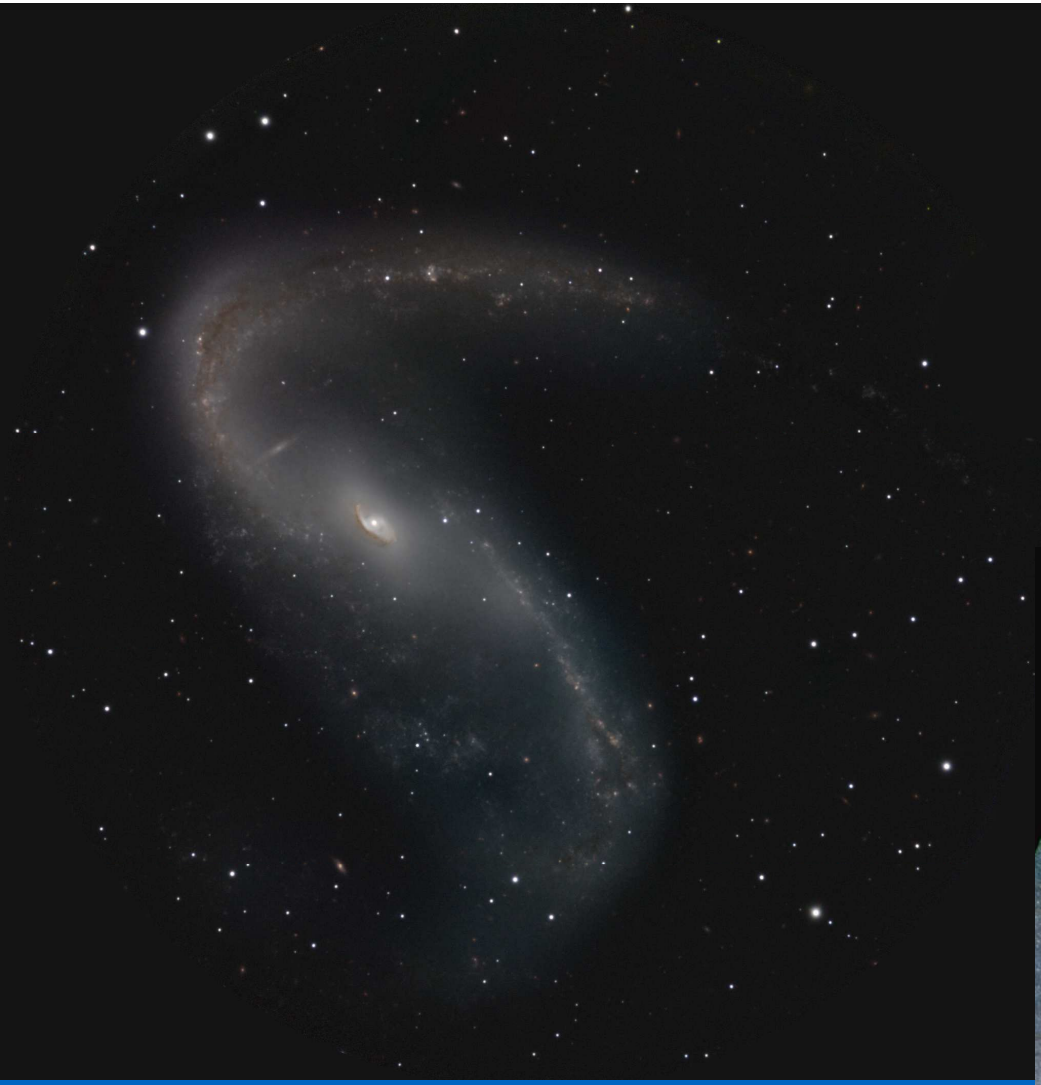
Before sky subtraction

After sky subtraction

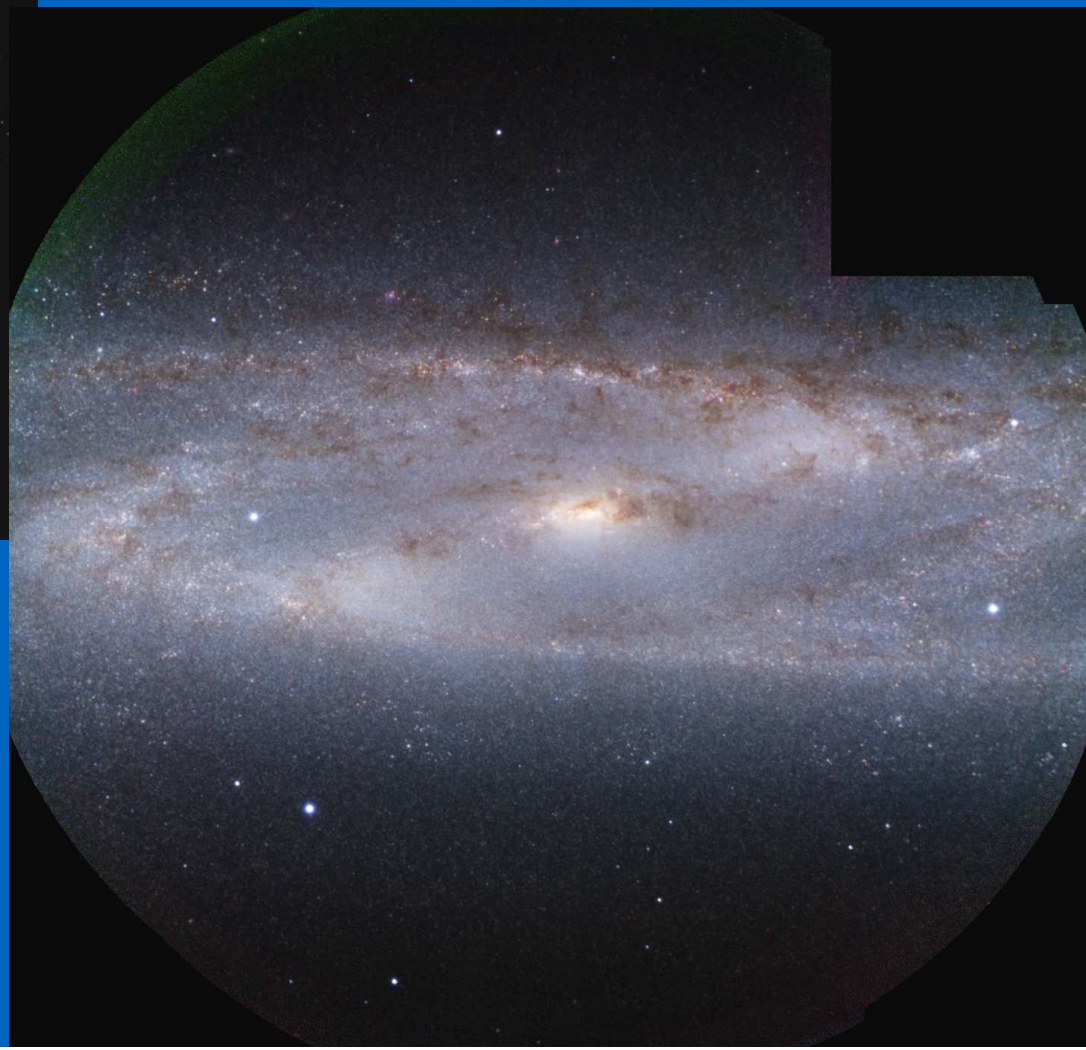


F2 Science

- Near-IR imaging applications:
  - Galactic centre and disk populations
  - resolved populations & star formation in nearby galaxies
  - late stages of stellar evolution in globular clusters, etc
  - galaxy structure and morphology in $z > 1$ clusters
  - high redshift galaxy SEDs; deep IR imaging around high-z radio sources
- Spectroscopic applications:
  - stellar spectroscopy in regions of high extinction
  - MOS spectra of red stars: red supergiants, AGB stars, in nearby galaxies
  - galaxy dynamics in distant clusters
  - internal dispersions and fundamental plane at $z > 1.4$
  - High-z galaxy surveys, z confirmations



NGC2442 in JHK, 0.6: seeing



NGC253 in JHK, 0.7” seeing

Base Facility Observing in Both Hemispheres

From the Gemini Base Facility in Hilo

…And La Serena in Chile

Image credit: Gemini Observatory

And now Observing from Victoria!

GROW-op on Observatory Hill:

Celia Blain, Ben Gerard and Zach Draper (from UVic) observing with GPI at DAO

Proposing for time at Gemini

The regular proposal: *once per semester*, through the national Time Allocation Committees (TAC)

for regular proposals

(oversubscription: <2)

70%

Two Calls per year with Deadlines: March 31st, September 30th

Large & Long Programs: *once per year*, through the Large Program TAC

for large and/or long **ambitious** proposals

(oversubscription: >5)

20%

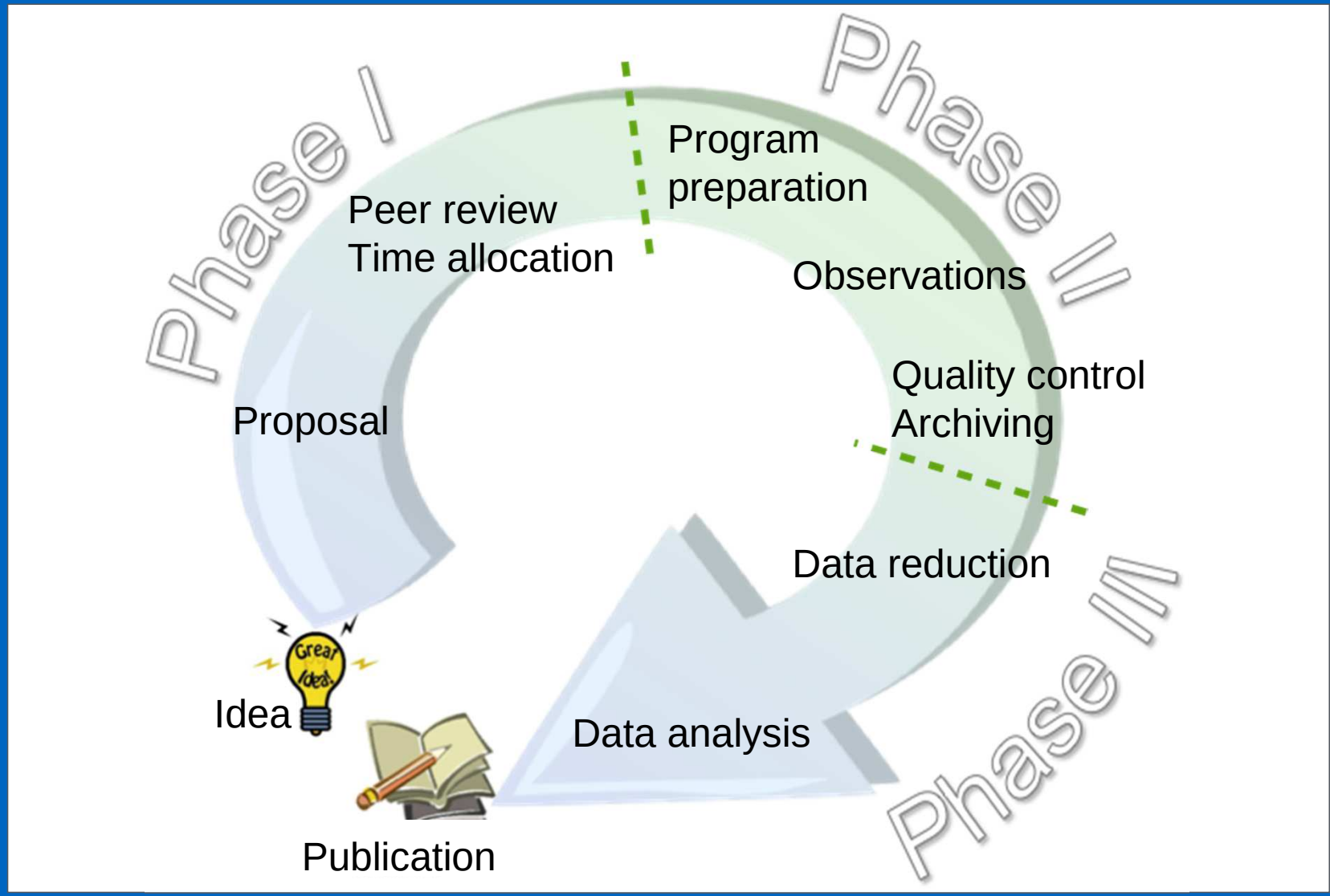
One Call per year with Deadline March 31st

Fast turnaround programs: *once per month*, peer reviewed, no TAC

for short, rapid, immediate and/or follow-up proposals

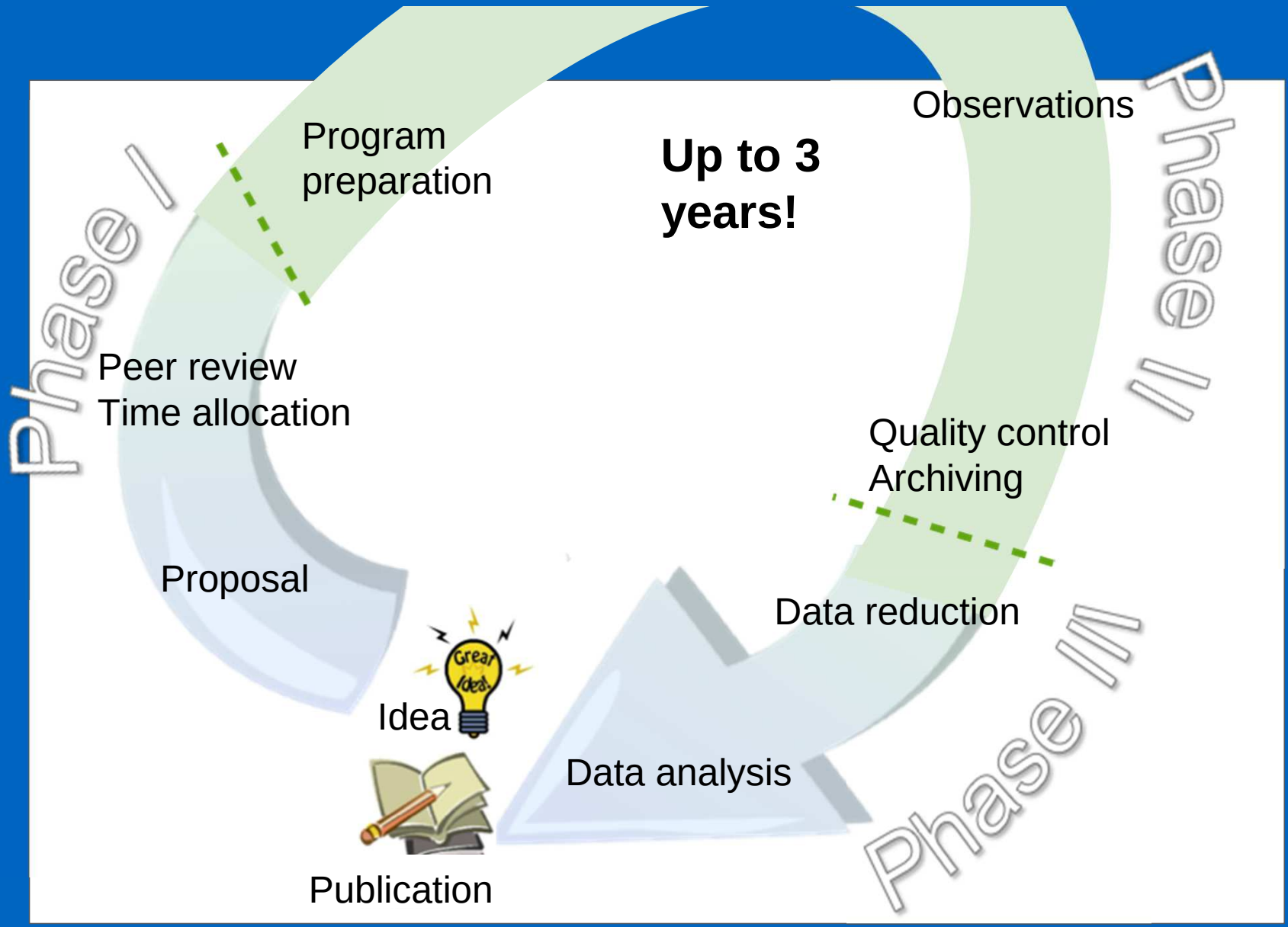
10%

The life cycle of Gemini programs



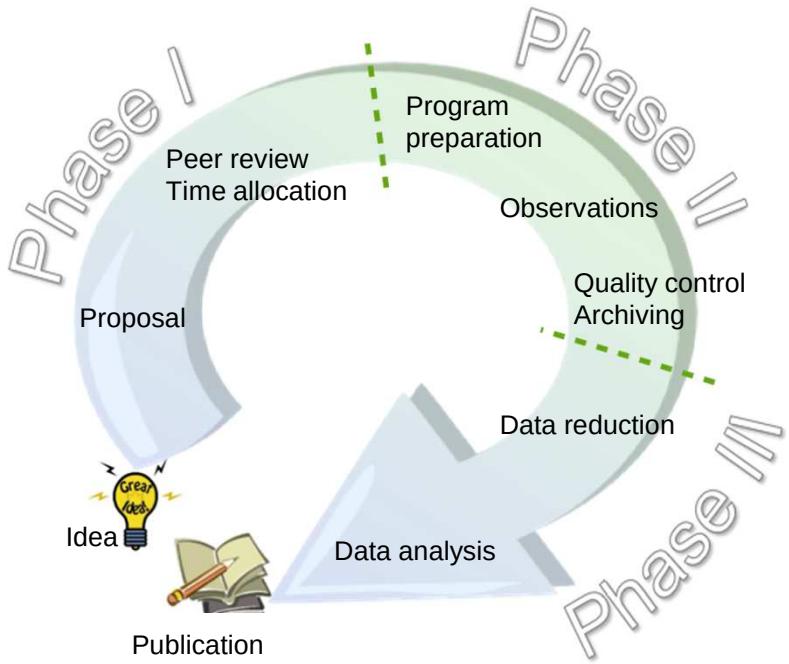

GEMINI
OBSERVATORY
Exploring the Universe, Sharing its Wonders
www.gemini.edu/llpps
@GeminiObs
Large and Long Programs
High-Impact Science Over Multiple Semesters

Life cycle of LP




Fast Turnaround Program
Monthly Proposal Calls - Data Within 4 Months
GEMINI
OBSERVATORY
@GeminiObs
www.gemini.edu/ftps

The life cycle of Gemini programs



~ 3 months between idea and data

Fast Turnaround

Fast Turnaround is good for:

- Few hours projects
- Pilot/feasibility studies
- Completing samples
- Following up unusual events
- high risk - high reward

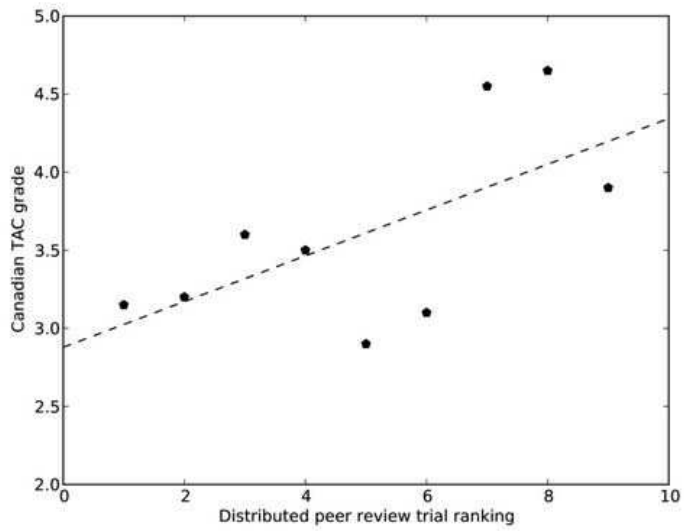
10% at both telescopes! (~20 hours per month per site)

Fast Turnaround

The proposal are reviewed by the PIs themselves. Each PI receives 8 to 10 proposals to rank.

Comments by PhD students who participated:

Comparison of proposal grades returned by the Canadian TAC for the 9 participating proposals with the final ranking from the distributed peer review trial. The CanTAC grades range from 1 (strongest) to 5 (weakest).



"I found this challenging and time-consuming but actually EXTREMELY helpful. Since I cannot fill in the knowledge blanks with the proposals, reviewing these helped me better understand how to craft an easily understandable proposal."

"I found it challenging, but definitely interesting. It felt like a very good exercise."

"I found it both interesting and challenging. It was actually very useful for learning what's going on in these fields, more so than a journal club or astro-ph discussion."

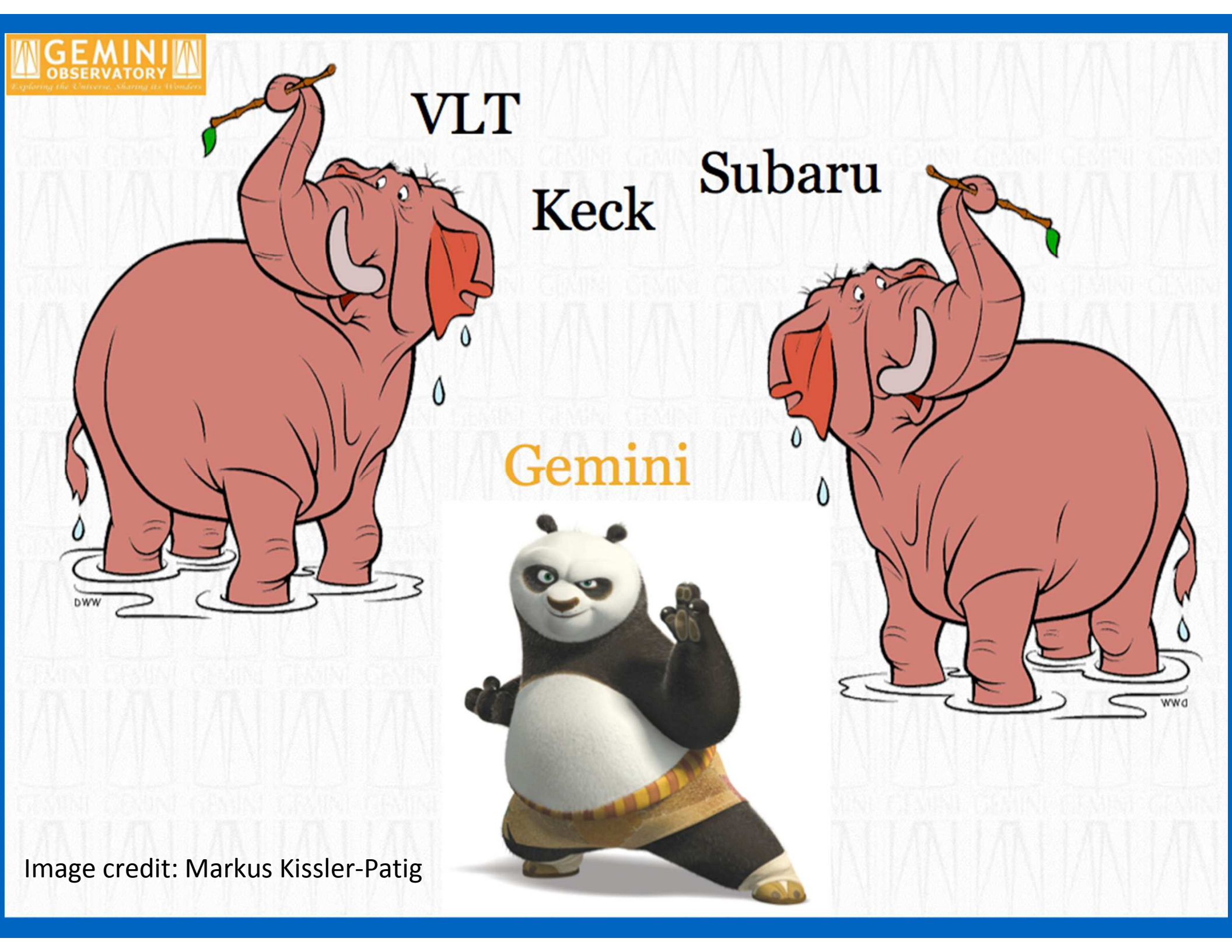
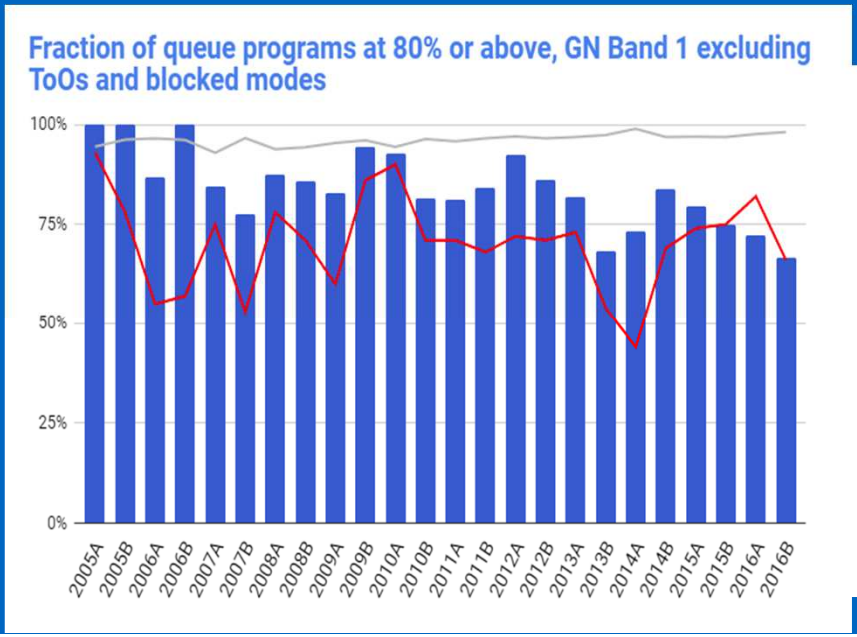
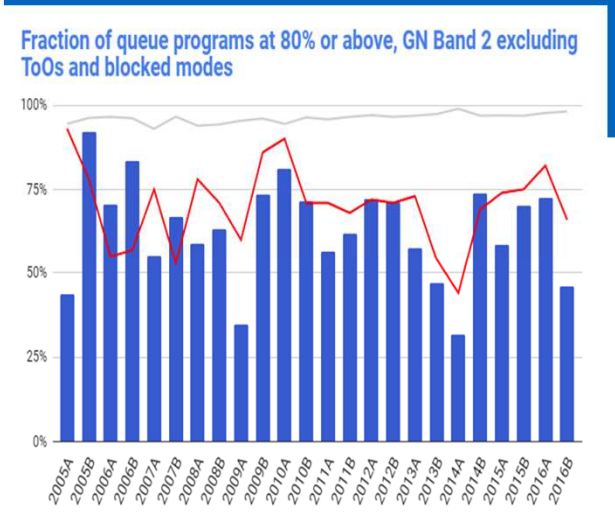


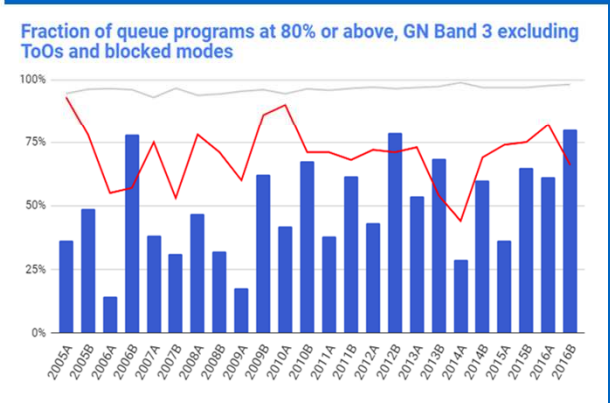
Image credit: Markus Kissler-Patig

What are the “Bands”

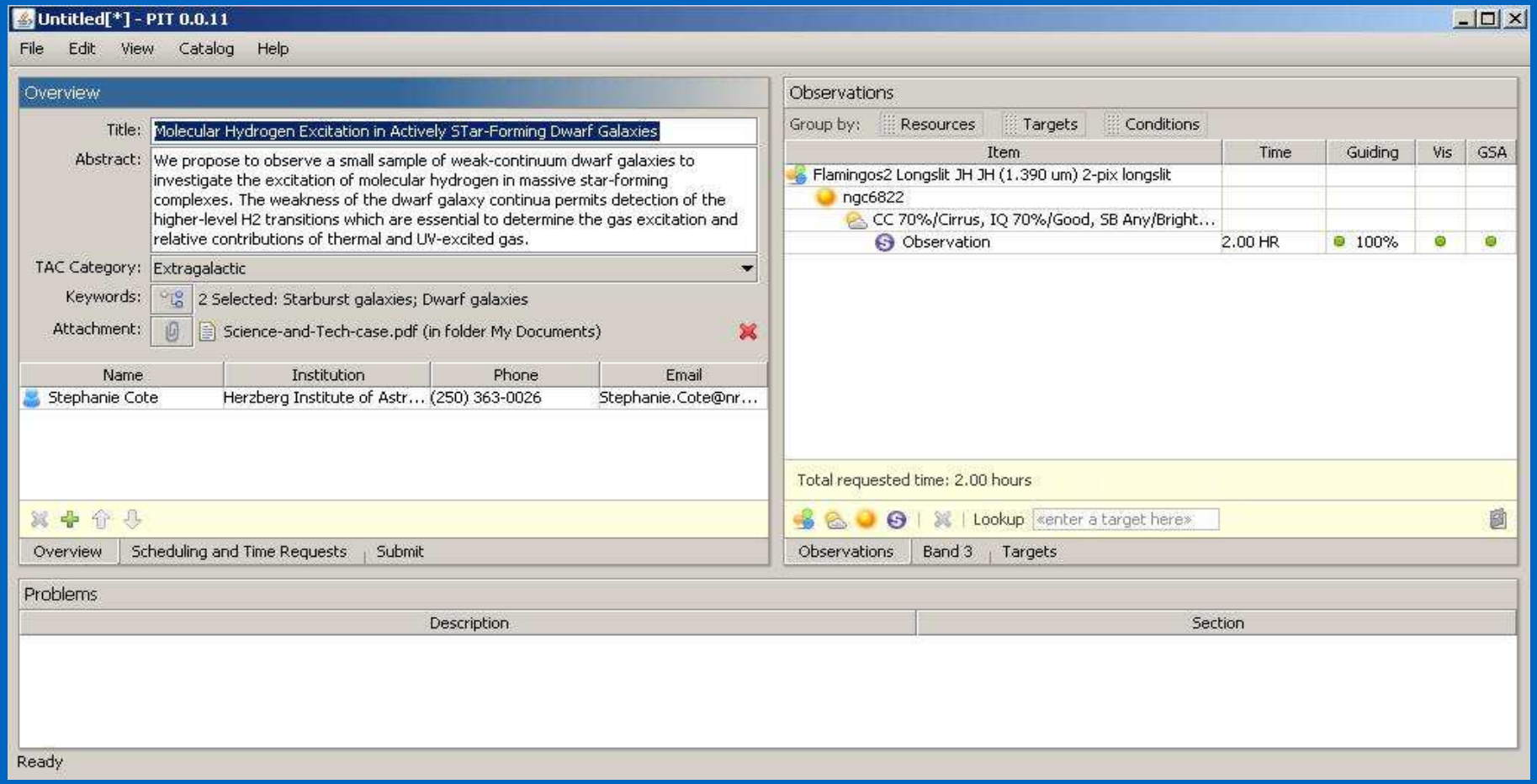
- The successful proposals are ranked by the Time Allocation committee and get assigned to Bands.
- Band 1 and 2 have priority.
- Band 3 is overfilling the queue with programs with less restrictive observing conditions that can be observed when there are no suitable Band 1 or 2 programs.
- The observing conditions are : CC = Cloud Cover; IQ=Image quality; SB= Sky Brightness; WV= Water Vapor
- Band 4 is weather loss (not charged to the partners)







Phase I Tool



- Scientific and Technical cases included as a PDF attachment, created with either LaTeX or DOC templates provided on the Gemini webpages
- Observations are entered as 'trees' containing Resources, Conditions, and Targets, with automatic guidestar and target-duplication checking from the database
- Missing information or problems are readily displayed

Phase I Tool

Scientific and Technical cases:

-One page limit for Scientific justification, excluding references

-Up to two other pages for references, including up to 3 figures with captions

-One page each for Experimental Design and Technical Justification; no extra figures

-Other sections as indicated

Scientific Justification *Be*
with figures, captions and referenc

White Dwarf (WD) stars are rei
of the age and evolution of the (
the cooling rate slows as their te
census finds more WDs at lowe
more of them. Such a census is
WDs as chronometers have com
1988). They showed that there
consequence of the finite age of
age of 8±1.5 Gyr (Leggett et a
6000 WDs found in the Sloan D
the fact that the sample include

Cool WDs have atmospheres do
the primary opacity source in H
H_2 (Hansen 1998). H-rich WD
CIA become significant below
produce broad absorption featu
into the optical (Harris et al. 20
is Rayleigh scattering, so He-ric
atmospheres, collisions between
denser than the H atmospheres
temperatures compared to pure

Due to the affect on opacity, the
determining an accurate tempe
atmospheric composition. The c
atmospheric composition is to
ultracool WDs. Bergeron & L
LHS 3250 and SDSS 1337+00,
presents their best fit solutions f
The optical and near-IR photor
SDSS is also shown. Bergeron
fit with mixed H/He models, ye

Gemini Proposal

Technical Description
requested (seeing, cloud cov
one page with no additional

Our search for ultracool
presented in Gates et al.
in Harris et al. (submitte
absorption (see Science C
obtain near-infrared phot
the IR observations for t
service proposal, and the
spectroscopy and photom

The SDSS z-band magnit
tudes to be corresponding
H and K, which are equal
NIRI ITC for CC50 IQ85

J	exp.
18.5	5×3
19.5	5×6
20.0	9×6
20.5	18×6
21.3	54×6

Using these exposure tim
SDSS0310-01 will require
(2.5 +2.5 +2.5)mins, to g
which will still allow us t
and SDSS1251+44 will r
H band photometry we
provide S/N ∼20 for SDS
9.58 hours. With acquisi
separate acquisitions are
is necessary and sufficient at J and H to distinguish between different compositions, and hence

Gemini Proposal *Page 4* *This box blank.*

Band 3 Plan *If applying for queue time and it is acceptable for the proposal to be scheduled in Band 3, describe the changes to be made to allow it to be successful in Band 3 (limit text to half a page).*

If awarded time in Band 3 we will reduce our request to 7.9 hrs, and use IQ85 and CC50 conditions. We will drop the 2hr-long K band observation for one target (getting J and H only), and the 2hr-long H band observation for another (getting J only). Also we will obtain lower S/N data at H (10 vs. 20) for another faint target, by taking data in IQ85 instead of IQ70. This would almost allow the same science, although the constraints on the two faintest targets will be weakened, and knowledge of the CIA opacity behaviour at its strongest point, in the K band, will be reduced.

Classical Backup Program *If applying for classically scheduled time, describe the program you will pursue should the weather be worse than the requested observing conditions (limit text to half a page).*

This is not a classical request.

Scheduling Constraints *If there are scheduling constraints for your program, describe them here.*

There are no constraints.

Justify Target Duplications *If your targets have been previously observed by Gemini using similar setups to those proposed here, justify the duplication below.*

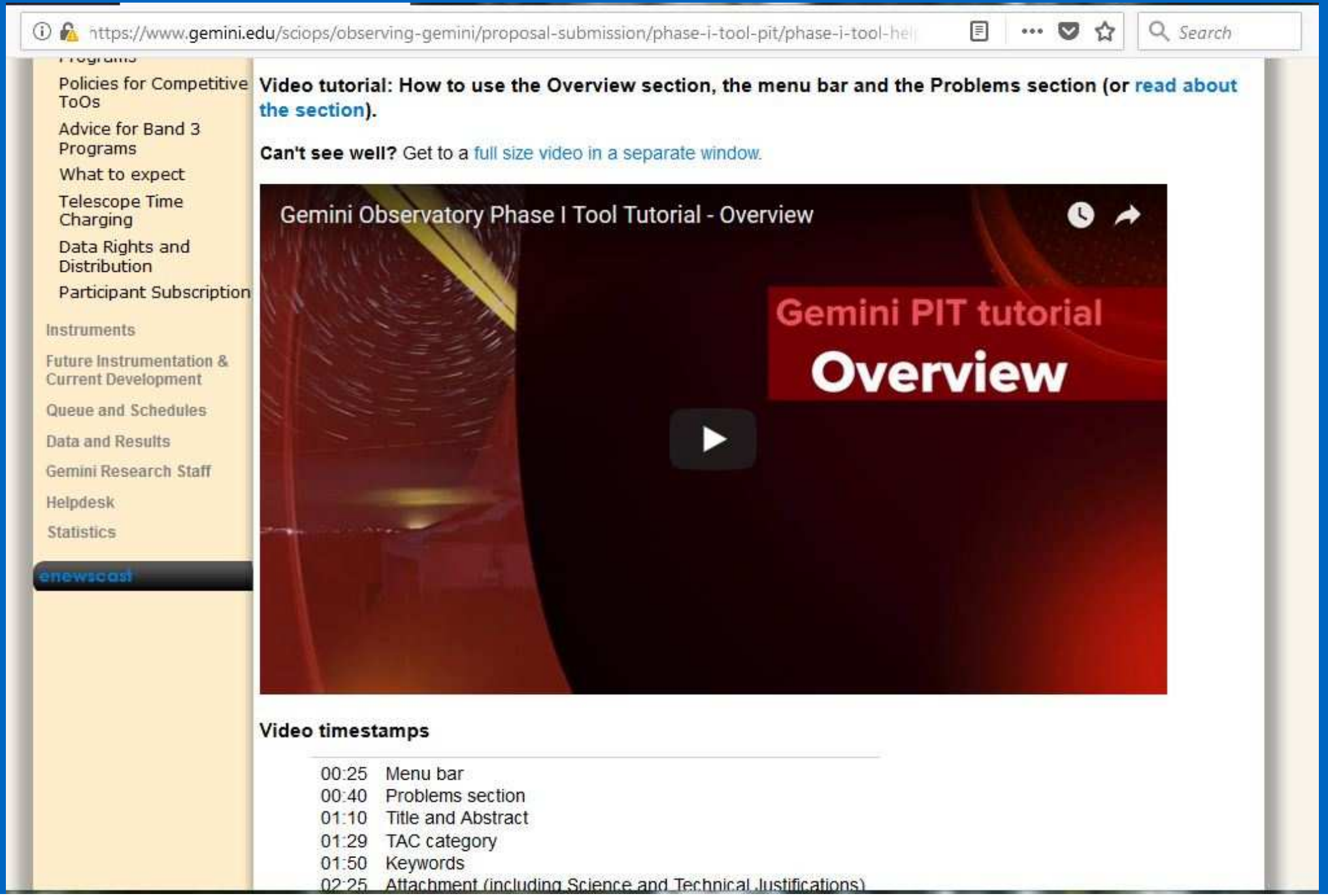
The GSA search revealed no duplicate observations.

Publications *Enter a list of publications written by the PI and Co-Is that support this proposal.*

Gates et al. 2004 ApJ 612 L129 "Discovery of New Ultracool White Dwarfs in the SDSS"
Kilic, Munn, Harris et al. 2006 AJ 131, 582 "Cool White Dwarfs in the SDSS"
Harris, Munn, Kilic et al. 2006 AJ 131, 571 "The White Dwarf Luminosity Function from SDSS Imaging Data"
Bergeron & Leggett 2002 ApJ 580, 1070 "Analysis of Two Very Cool White Dwarfs"
Bergeron, Ruiz, Hamuy et al. 2005 ApJ 625, 838 "On the Interpretation of High-Velocity White Dwarfs as Members of the Galactic Halo"

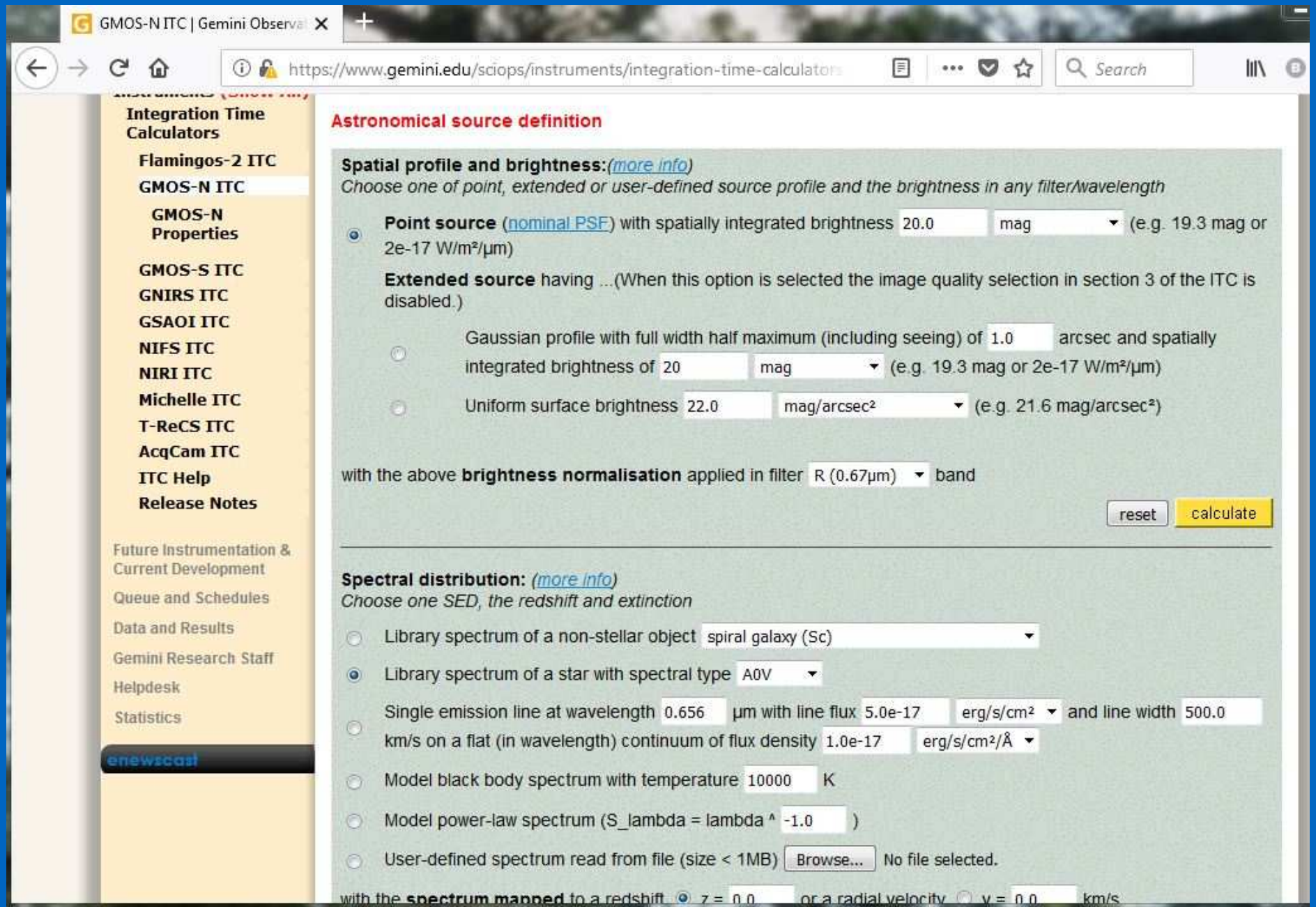
PIT Help

www.gemini.edu/sciops/observing-gemini/proposal-submission/phase-i-tool-pit/phase-i-tool-help/

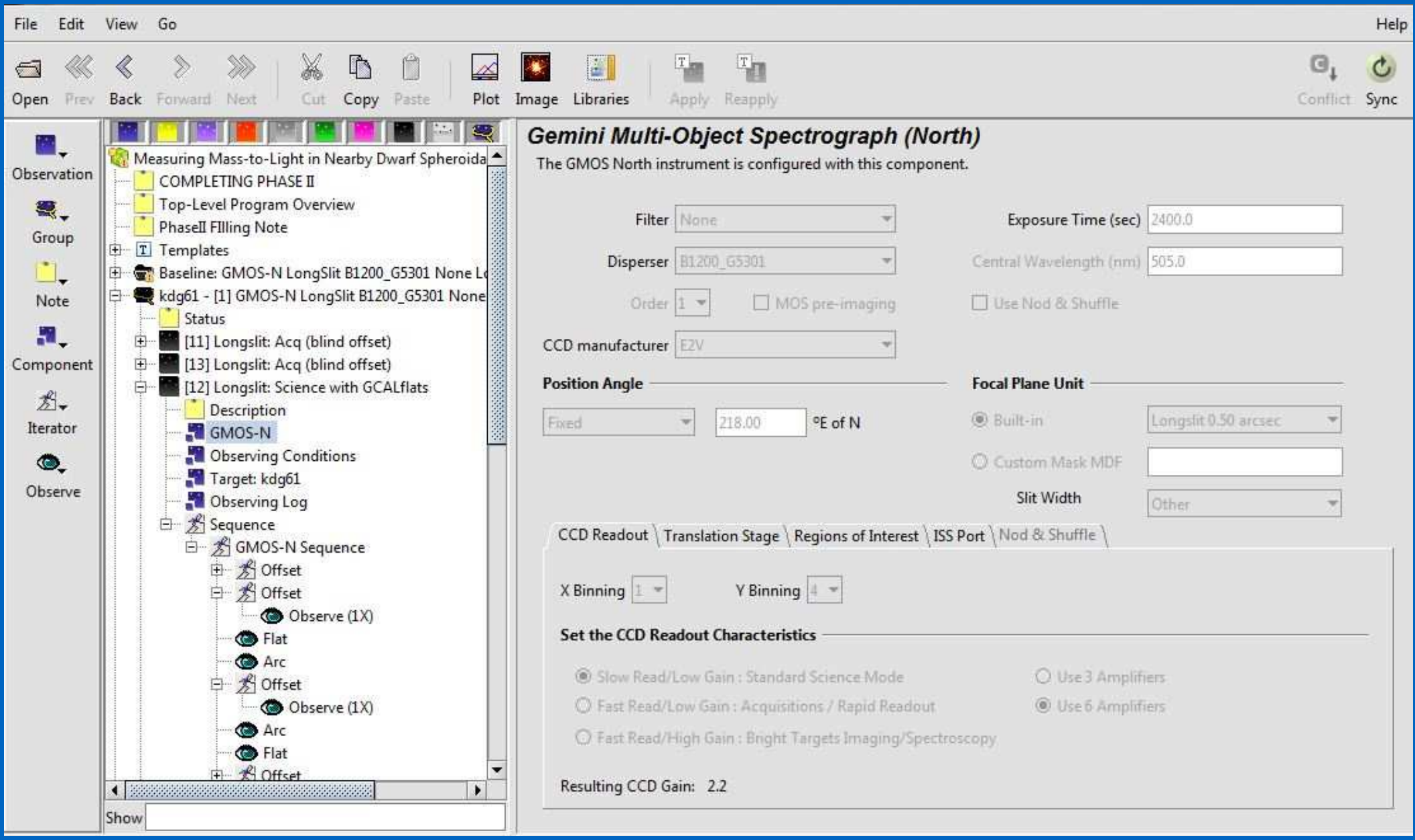


ITC (Integration Times Calculators)

www.gemini.edu/sciops/instruments/integration-time-calculators



OT (Observing Tool)



Data Reduction

Gemini provides data reduction tools for all instruments; available through the easy to install, python/pyraf based "Ureka" package http://ssb.stsci.edu/ureka/ (developed with STScI)

NEW

The User Forum:

http://drforum.gemini.edu

Helpdesk

Or email Gemini@nrc.ca

Gemini Science Fellows

- Three-year postdoctoral fellowship, with half of the Fellow's time spent on personal research, and half on Observatory support duties. Personal research is supported by the Gemini research budget.

- One fellow for each site (Hilo and La Serena) is selected annually

- Applicants propose a 3-year research program in which Gemini observations figure prominently.

www.gemini.edu/jobs