

Gemini in the Era of Multi- Messenger Astronomy

*Developing an
advanced multi-
conjugate adaptive
optics system for
high-resolution
astronomy & a rapid
response system for
time domain science.*

GEMMA

**Jennifer Lotz,
Henry Roe, Cathy Blough**

NSF GEMMA Review, 10 July 2019

www.gemini.edu/gemma

GNAO: New **Multi-Conjugate Adaptive Optics** facility at Gemini-North, with route to an **adaptive secondary mirror**

RTC: New **Real-Time Computer** for Gemini-South & -North MCAO

TDA: **Operations software** and **data pipeline developments** for **rapid follow-up Time Domain Astronomy**

PIO: **Public Information, Outreach & Education** activities centered on the themes of Time-Domain & Multi-Messenger Astronomy

4 projects under 1 program

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+ route to an **adaptive secondary mirror**

RTC: New **Real-Time Computer** for Gemini-South & -North MCAO

TDA: Operations software and data pipeline developments for
rapid follow-up **Time Domain Astronomy** [synergy with LSST]

PIO: **Public Information, Outreach & Education** activities
centered on the themes of Time-Domain & Multi-Messenger Astronomy

Now three projects under one program... GEMMA



**Gemini-S MCAO system + imager = GEMS/GSAOI;
delivers images with FWHM < 0.09" over a 1.4' field**

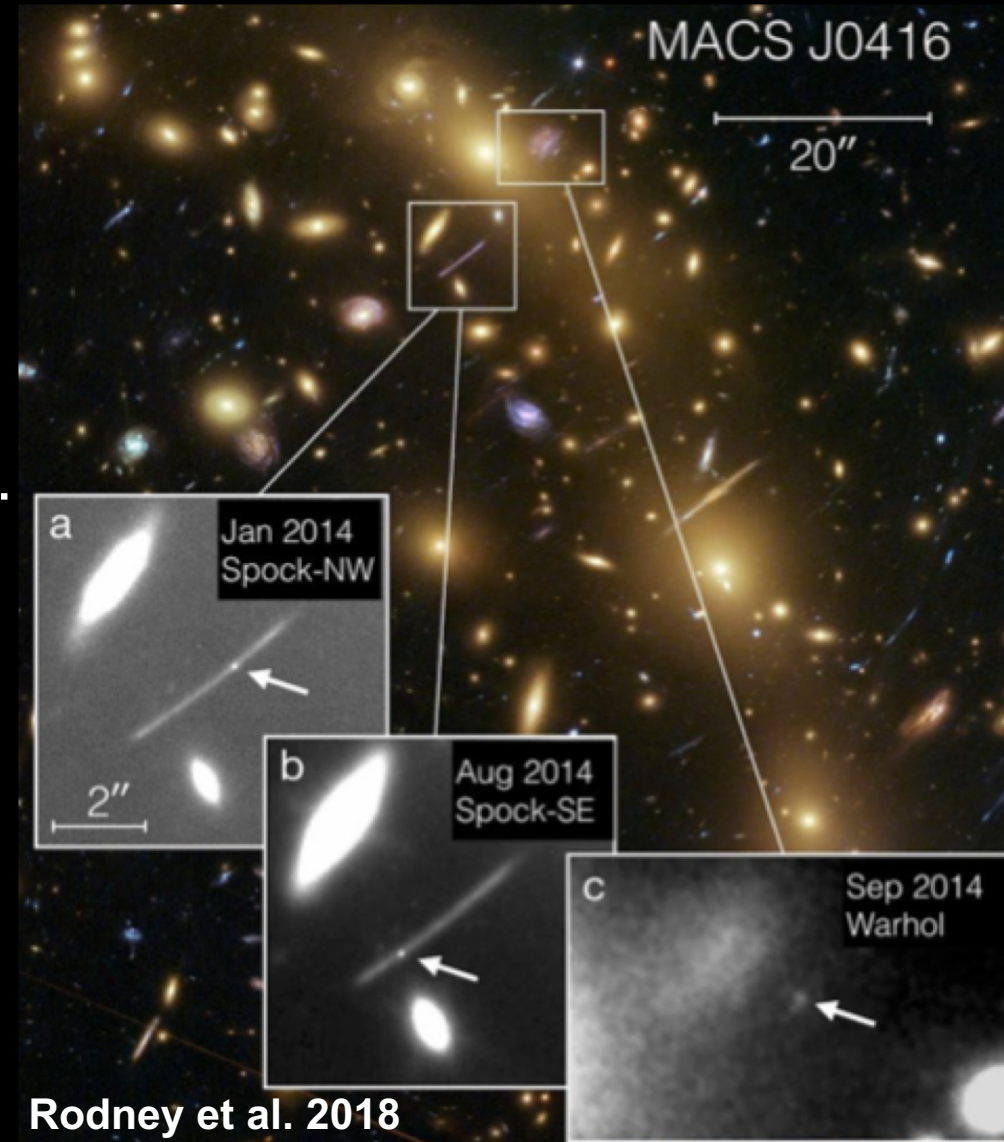
Science with GEMMA

Adaptive Optics (GNAO + RTC)

provides high-cadence, long-duration monitoring at high spatial resolution for studying stellar evolution, cosmology, solar-system, black-holes, dark matter... complementary to JWST, and LIGO/LSST follow-up

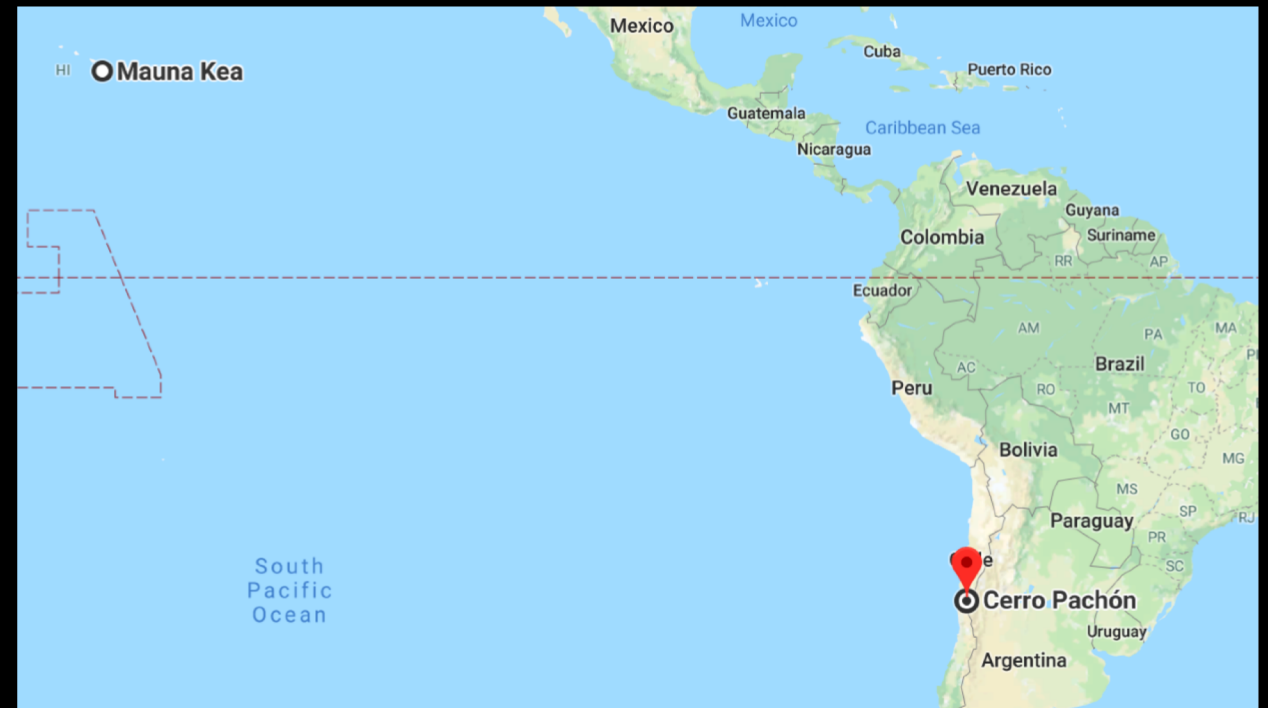
GNAO/RTC vs. GEMS

- ★ nightly operations
- ★ wider field of view
- ★ better conditions for AO on Maunakea
- ★ faster control system



Time-Domain Astronomy with Gemini Observatory

Queue observations + bi-hemisphere access → Gemini is the ideal observatory for follow-up of gravitational wave EM counterparts, LSST, and other MMA events.



Transient Follow-up System

GEMMA-TDA

Provides Gemini software infrastructure for scheduler, TOM interfaces, and rapid data analysis

TOMs
(trigger follow-up, interface with dynamical scheduler)



Data Pipeline and Archive
(rapid analysis of follow-up data)

Discovery engines

Broker services

Target & Observation Manager Systems

Observing facilities



LIGO Detects Fierce Collision of Neut

NEWS · 15 FEBRUARY 2019
Gravitational-wave observatory LIGO set to

GEMMA- Public Information and Outreach

- Professional workshops for media and astronomers on communicating multi-messenger astronomy concepts
- Education/outreach materials, internships, and activities for local and U.S. public

Credit: Victor de Schwanberg/Science Photo Library

An artist's rendering of the merger of two neutron stars from Aug. 17.
Credit Robin Dienel/The Carnegie Institution for Science

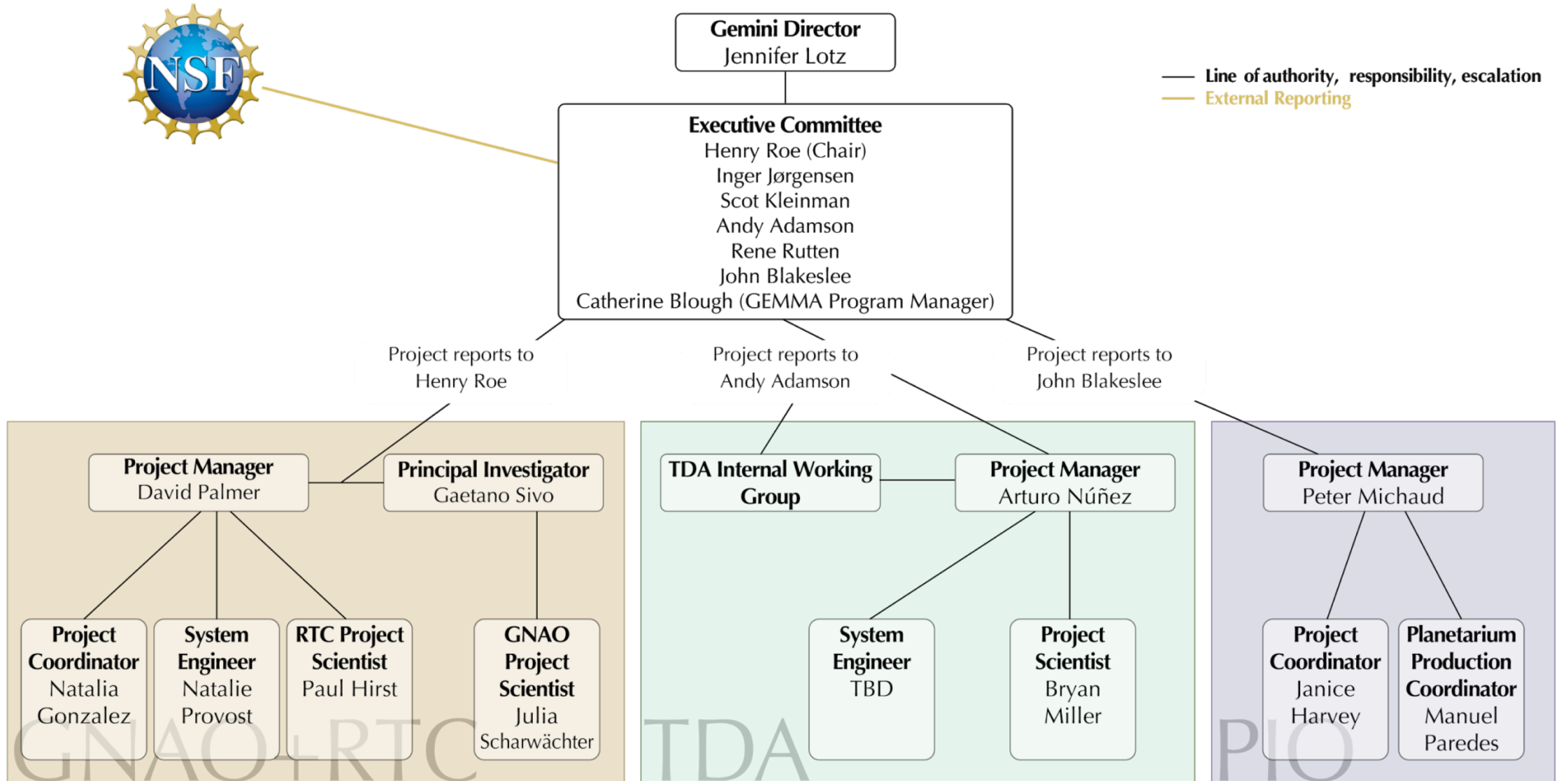
Today's Agenda

GNAO + RTC presented by **Dave Palmer - Project Manager,
Gaetano Sivo - Principal Investigator, Natalie Provost -
Systems Engineer**

TDA presented by **Arturo Núñez - Project Manager**

PIO presented by **Peter Michaud - Project Manager**

Organizational Chart



GEMMA Executive Committee Charge

The GEC is **charged with the successful delivery of the GEMMA Program's** objectives and benefits. The role of the committee is to assess and articulate program and project issues, as well as considering issues from diverse constituencies: project team members, observatory staff, and the greater Gemini community in order to recommend solutions that address those issue.

The Committee has the following responsibilities:

1. Review, evaluate, approve and/or resolve **resource requests** (labor, funds, and schedule constraints) for the projects.
2. Review and approve **change requests** above assigned project thresholds.
3. Keep informed, **assess, consult and provide recommendations** to the Director and stakeholders on matters concerning project needs and progress.
4. Serve as the **Risk Advisory Board**.
5. Provide an **internal forum** for individuals concerned about GEMMA related issues impacting the observatory.

Roles on the Committee

The GEC is comprised of members of the Gemini Directorate who participate as part of their Observatory duties:

Henry Roe (Chair)	→	Deputy Director
John Blakeslee	→	Chief Scientist
Inger Jørgensen	→	Portfolio Manager
Scot Kleinman	→	Associate Director Development
Andy Adamson	→	Associate Director Hawai'i Site
Rene Rutten	→	Associate Director Chile Operations
Catherine Blough	→	GEMMA Program Manager

The **GEC Chair**:

- Act as line manager to the GNAO+RTC project manager.
- Provide weekly updates regarding progress and exceptions to the GEC.
- Escalate issues to the director for further input and action.

The **Chief Scientist**:

Is the escalation point for issues concerning scientific scope and escalates to the Executive Committee when needed.

The **Director**:

Is the ultimate escalation point for the GEC regarding the successful completion of the GEMMA program.

Risk Management

The GEMMA Executive Committee (GEC) serves as the **Risk Advisory Board** for the GEMMA Program. The program manager who is a member of the GEC, following a risk management plan, leads the program risk management process..

The GEC is responsible for reviewing risks in the risk registers, reviewing mitigation plans and making adjustments as necessary.

The GEC measures program risks, tracks, informs and discusses them in the monthly committee meetings.

The metrics are:

- Risk Mitigation Costs
- Resources (hours of people = cost)
- Distribution of risks (are they schedule, cost, resource)
 - are there more risks in the schedule than in resource
 - what is the relationship between risks

Top Program Risks

- Resources
- Schedule
- Communications

Specific project risks to be discussed in individual project presentations

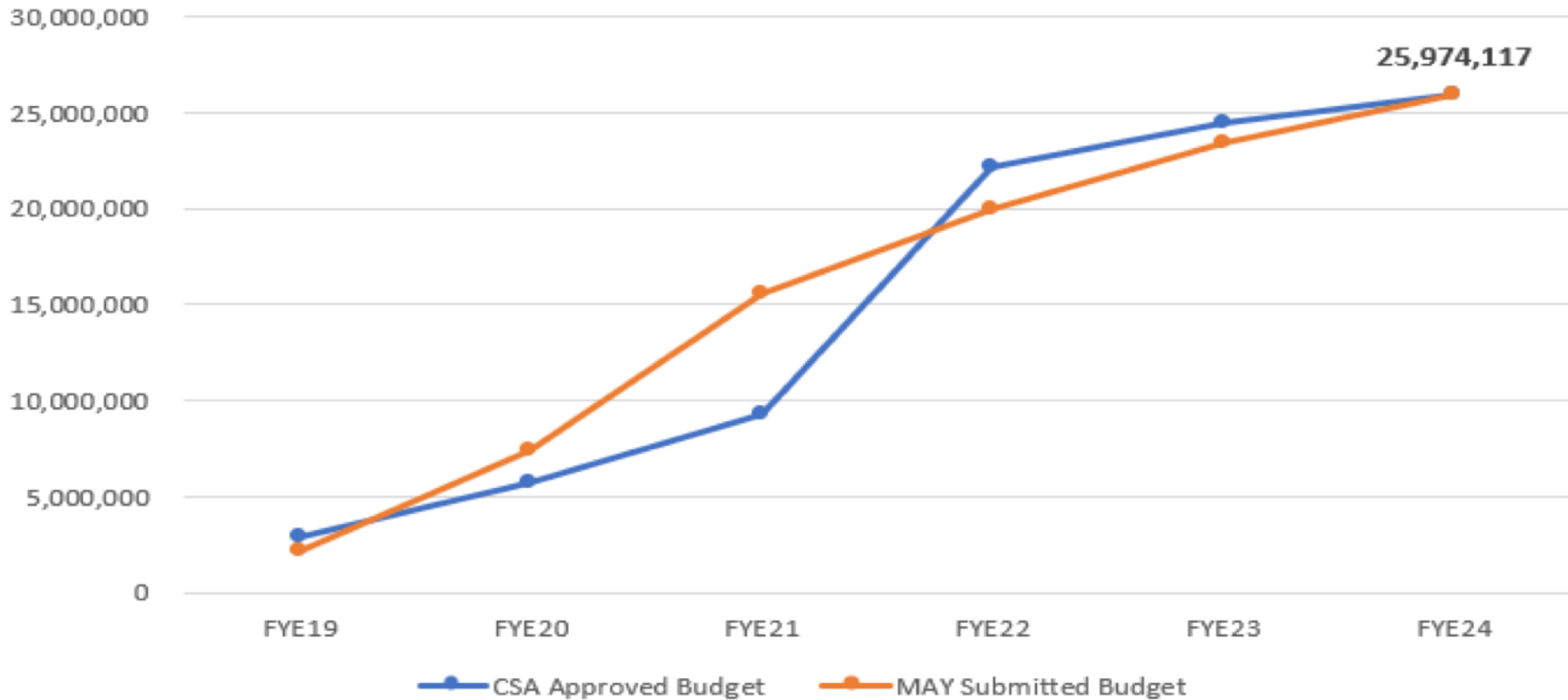
GEMMA High Level Budget Summary

GEMMA - BUDGET BY PROJECT AS SUBMITTED MAY 2019

	FYE19	FYE20	FYE21	FYE22	FYE23	FYE24	TOTAL
External Fees - Indirect Costs	189,306	333,908	538,823	218,567	115,892	83,340	1,479,836
Management	448,072	460,839	338,482	332,971	440,680	430,002	2,451,046
GNAO+RTC	1,107,996	3,191,376	6,374,268	3,636,329	2,903,838	2,033,737	19,247,544
TDA Software Upgrade	315,267	877,634	705,124	217,392	0	0	2,115,417
PIO, Publications, Education	160,082	358,924	147,763	13,505	0	0	680,273
GEMMA TOTAL	2,220,723	5,222,682	8,104,460	4,418,764	3,460,410	2,547,078	25,974,117

GEMMA High Level Budget Summary

GEMMA HIGH LEVEL SUMMARY BUDGET COMPARISON



Blue Line
Approved CSA Budget (October 1st, 2018)

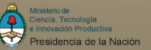
Orange Line
Projected budget as submitted May 2019

Gemini's Request of NSF

We ask NSF to review and approve the 1030 budget submitted with the revised PEPs in May and if needed amend the allocation amounts reflected in the CSA.



National Science Foundation



Cash Draw Down to Expense

CASH DRAWS TO EXPENSE (CASH BASIS) THROUGH JUNE 30

GEMMA OCT 1 2018 TO JUNE 30, 2019

at 7/2/19 - note June is not yet closed for accounting process

FY EXPENSE TO DATE

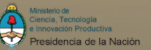
	TOTAL EXPENSE
External Fees - Indirect Costs	50,573.79
Management	185,820.29
GNAO + RTC	357,729.01
TDA Software Upgrade	74,272.96
PIO, Publication, Educ.	23,258.04
Grand Total	691,654.09

TOTAL DRAWS	(691,654.09)
TOTAL EXPENSES	691,654.09
TOTAL DRAWS EQUAL TOTAL EXPENSES	0.00



National Science Foundation

NRC · CNRC



Accomplishments to Date

PIO

MMA/TDA Communications Summit

- Date and venue confirmed, Nov. 7-8, STSci, Baltimore
- Over 20 key participants confirmed
- Facilitator contract completed
- Agenda/program developed

MMA/TDA PIO Internships

- 2 of the 4 interns interviewed and selections made

TDA

- Operational Concept Definition
- Work completed, final version sent for review end of June.
- Conceptual Design Review scheduled by August 6th.
- Scheduler
- Evaluation of suitability of Las Cumbres Observatory Scheduler completed in late 2018.
- Kick off work to prototype weighting schemes in July.

Accomplishments to Date

TDA APIs

- **Kicking off in August, after Conceptual Design Review.**

Real Time Pipelines

- **Work package started in April 2019.**
- **Initial implementation of core algorithms for wavelength calibration and for source extraction is available.**
- **Interfaces with OCS identified and ready for review.**

GNAO+RTC

Meetings and Milestones

- **Scheduled the CoDR and tentative dates for the remaining main project reviews.**
- **Set milestones on a per subsystem basis.**

GNAO+RTC

Project Management, including non-subsystem-specific SE

- Identified and added the staff needed to manage and perform the GNAO/RTC project.
- Constructed a credible, fully-resourced project plan.
- Raised the project to very high priority in the observatory.
- Organized the project team for efficient performance.
- Performed functional decomposition and flowed down requirements.

Science, including the AOWG

- Assembled a science team and Adaptive Optics (AO) working group, both involving many external participants.
- Identified and fleshed out science cases pertinent to GNAO/RTC.
- Derived near-final science requirements from the science cases.
- Progressed the Concept of Operations (ConOps) document.
- Performed detailed AO simulations to estimate performance and inform design choices.

GNAO+RTC

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Laser Guide Star Subsystem (LGS)

- **Considered several laser configurations, weighing performance and cost.**
- **Advanced several optical design concepts, leading to a near-final conceptual optical design.**
- **Advanced several mechanic design concepts, leading to a near-final conceptual mechanical design.**
- **Considered electrical needs, including re-use of existing electronics and systems.**
- **Preliminarily selected and costed hardware for the LGS.**

GNAO+RTC

Adaptive Optics Subsystem (AOS)

- Prepared a near-final conceptual optical design.
- Advanced a conceptual mechanical design.
- Preliminarily selected and costed hardware for the AOS, including WFS cameras, DMs, and TT.
- Functionally decomposed computers and software for the subsystems and the Top Level Computer (TLC).

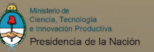
Real-Time Computer (RTC)

- Calculated required computing power and did a preliminary computer selection.
- Identified and began evaluating candidate RTC packages.

Questions



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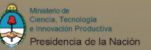


Gemini's Request of NSF

- We ask the NSF to join with Gemini staff and governance to expedite the approvals for procurements that will affect the GNAO/RTC schedule (~4-5 critical procurements). We request that NSF strive for a expedited turnaround time (e.g. 10 business days) for these critical reviews and approvals.
- We ask NSF to review a contract for the long-lead procurement for the TOPTICA laser(s) at the time of GNAO/RTC CoDR (September/October 2019).
- For purposes of project management, we expect to hold the 22% complexity factor as a separate reserve going forward, instead at the line-by-line project level (as it is currently).



National Science Foundation



Program WBS

WBS		FY19	FY20	FY21	FY22	FY23	FY24	TOTAL
1.1	GEMMA PROGRAM	\$271,616	\$246,307	\$246,636	\$254,035	\$260,653	\$284,179	\$1,563,425
1.1.2	STRATEGIC ALIGNMENT	\$51,802						\$51,802
1.1.3	PROGRAM STRUCTURE	\$88,863						\$88,863
1.1.4	PROGRAM MANAGEMENT & ADMINISTRATION	\$107,609	\$221,674	\$227,453	\$234,276	\$240,380	\$247,430	\$1,278,821
1.1.5	PROGRAM CLOSURE		\$5,937				\$15,787	\$21,723
1.1.6	REVIEWS AND TRAINING	\$23,342	\$18,696	\$19,183	\$19,759	\$20,274	\$20,962	\$122,215

Program WBS Resources

Roles ↓ / Fiscal Year →	FY19	FY20	FY21	FY22	FY23	FY24	Total per role
Program Manager	0.98	0.66	0.63	0.63	0.63	0.68	4.22
Sr. Admin. Specialist	0.48	0.80	0.80	0.80	0.80	0.85	4.53
Program Support - Various	0.64	0.68	0.68	0.68	0.67	0.68	4.04
Total per FY	2.10	2.15	2.11	2.11	2.10	2.21	12.79