

# **GEMMA**

**Gemini in the Era of Multi-Messenger Astronomy**

## **Program Execution Plan**

**May 24, 2019**

C - GPM-001

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### **Change Log**

The purpose of this log is to update the material and to improve the clarity and legibility of the Project Execution Plan. A summary of the changes for this revision is given below. Footers within each section of this document indicate the last revision date of the content in that section, while all page headers in the document include the date and NSF number of the current version of the Major Facilities Guide.

1. Inserted Change Log as new material to reflect edited sections, moved material, deleted material and updated material.
2. List of Acronyms – Updated
3. Executive Summary - Revised language clarifying the creation of a GEMMA Executive Committee and clarified the PEP as a planning document and its use as a baseline for progress described in quarterly and semi-annual reports.
4. Section 2.3 - Inserted WBS rollup table.
5. Section 3 – Reordered subsections to define revised structure in hierarchical fashion.
6. Section 3.1 – Revised description and graphic of program and project governance structure.
7. Section 3.3 – Replace graphic with updated graphic showing new GEC structure.
8. Section 4.1 – Inserted narrative from Program sub plan.
9. Section 5.6 – Removed table and revised to describe the application of the 22%.
10. Section 5.8 - Change title to Spending Profile
11. Section 6.1 – Staffing plan was revised to include GEC.
12. Section 6.2 – Revised to reflect updated WBS resource identification.
13. Section 7 – Revised content to incorporate risk management plan content in program pep and incorporation of the GEC.
14. Section 7.3 - Revised content to reflect document link to GEMMA webpage.
15. Section 8.1 – Deleted headings for SE plans and referred to plans in individual PEPs.
16. Section 9.1 - Inserted content from Scope Plan and revised description of configuration control.
17. Section 9.2 – Revised content to include the GEC.
18. Section 11.2 – Revised narrative to describe what EV attributes will be used and barriers created by the line item complexity factor.
19. Section 15.1 - Revised narrative to include information regarding the community working groups advising GNAO+RTC and TDA.
20. Section 16.2 – Remove generic language and referred to individual project PEPs.
21. Section 18 – Removed previous reference to support documents as they are linked to the GEMMA website in the applicable sections.
22. Section 18.1 – Inserted NSF Comments and Gemini response table.

23. Section 19 – Removed reference documents as they are linked to the GEMMA website in the applicable sections.

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## List of Acronyms

Acronym	Definition
AEON	Astronomical Event Observatory Network
A&G	Acquisition and Guider unit
AIS	Advanced Image Slicer
ANTARES	Arizona-NOAO Temporal Analysis and Response to Events System
Altair	ALtitude conjugate Adaptive optics for the InfraRed
ALeRCE	Automatic Learning for the Rapid Classification of Events
AO	Adaptive Optics
AOB	Adaptive Optics Bench
AURA	Association of Universities for Research in Astronomy
BTO	Beam Transfer Optics
CAS	Central Administrative Services
CCD	Charge Coupled Device (detector)
CDR	Critical Design Review
CCMP	Configuration and Change Management Plan
CMP	Change Management Plan
CoDR	Conceptual Design Review
CP	Cerro Pachón (the site of the Gemini South telescope)
CPU	Central Processing Unit
CSA	Cooperative Support Agreement
DM	Deformable Mirror
DM0	Deformable Mirror conjugated to the ground-later at 0m.
DR	Data Reduction
DRS	Data Reduction Software
DSP	Digital Signal Processor
ELT	Extremely Large Telescope
EM	Electromagnetic
EMCCD	Electron Multiplying Charge Coupled Device
ESO	European Southern Observatory
FoV	Field of View
FTE	Full-Time Equivalent
FWHM	Full-Width Half Maximum
GEC	GEMMA Executive Committee
GeMS	Gemini Multi-Conjugate Adaptive Optics System
GHOST	Gemini High-resolution Optical SpecTrograph
GIRMOS	Gemini InfraRed Multi-Object Spectrograph
GLAO	Ground Layer Adaptive Optics
GMOS	Gemini Multi-Object Spectrograph (-S located at Gemini South, -N at Gemini North)
GMT	Giant Magellan Telescope
GN	Gemini North
GNAO	Gemini North Adaptive Optics (a generic name for new AO system)
GNAOI	Gemini North Adaptive Optics Imager
GNIRS	Gemini Near InfraRed Spectrograph

GPI	Gemini Planet Imager
GW	Gravitational-wave
GS	Gemini South
GSAOI	Gemini South Adaptive Optics Imager
Hubble	Hubble Space Telescope
IRAF	Image Reduction and Analysis Facility
INTEGRAL	INTErnational Gamma-Ray Astrophysics Laboratory
ICD	Interface Control Document
IDF	Instrument Development Fund
IQ	Image Quality
IR	InfraRed
ISS	Instrument Support Structure
JWST	James Webb Space Telescope
KPP	Key Performance Parameter
KSR	Key Science Requirement
LCO	Las Campanas Observatory or Las Cumbres Observatory
LCGTN	Las Cumbres Global Telescope Network
LGS	Laser Guide Star
LGSF	Laser Guide Star Facility
LGSWFS	Laser Guide Star WaveFront Sensor
LIGO	Laser Interferometer Gravitational-Wave Observatory
LLT	Laser Launch Telescope
LPC	Laser Pointing Camera
LQG	Linear Quadratic Gaussian
LSST	Large Synoptic Survey Telescope
LTAO	Laser Tomographic Adaptive Optics
MCAO	Multi-conjugate Adaptive Optics
MMA	Multi-Messenger Astronomy
MOAO	Multi-Object Adaptive Optics
MTCS	MMA-TDA Communications Summit
MTMW	MMA-TDA Media Workshop
MUX	A readout multiplexer; can be used for testing controllers without the more expensive components of a complete detector
NASA	National Aeronautics and Space Administration
NCOA	National Center for Optical-Infrared Astronomy
NCPA	Non-Common Path Aberration
NFIRAOS	Narrow Field Infrared Adaptive Optics System TMT
NIFS	Near-Infrared Integral Field Spectrometer
NGS	Natural Guide Star
NGS2	Next Generation Sensor for Natural Guide Star
NGSWFS	Natural Guide Star WaveFront Sensor
NOAO	National Optical Astronomy Observatory
NIRCAM	Near Infrared Camera
NIR	Near InfraRed
NSF	National Science Foundation
NUMA	Non-Uniform Memory Access
O&M	Operations and Maintenance

OAP	Off-Axis Parabola
OCS	Observing Control System (Gemini operations software)
ODGW	On-Detector Guide Window
OIWFS	On-Instrument WaveFront Sensor
OIR	Optical and Infrared
PC	Personal Computer
PI	Principal Investigator
PM	Program Manager
PMB	Performance Measurement Baseline
PMKB	Program Management Knowledge Base (Gemini's Project Management Database)
PMO	Portfolio Management Office
PEP	Project Execution Plan
POLC	Pseudo Open Loop Control
PSF	Point Spread Function
PWFS	Peripheral WaveFront Sensor (two located in the A&G system)
QAP	Quality Assurance Pipeline
RfP	Request for Proposals
RTC	Real-Time Computer
rToO	Rapid Target of Opportunity
SEMP	Systems Engineering Management Plan
SFS	Slow Focus Sensor
SH	Shack-Hartmann
SHWFS	Shack-Hartmann WaveFront Sensor
SCAO	Single Conjugate Adaptive Optics
SIMD	Single Instruction Multiple Data
SOAR	Southern Astrophysical Research Telescope
SF	Science Fold
SR	Strehl Ratio
SwRI	Southwest Research Institute
TDA	Time Domain Astronomy
TMT	Thirty Meter Telescope
TOM	Target Observation Manager
ToO	Target of Opportunity
TT	Tip-Tilt
TTM	Tip-Tilt Mirror
TFS	Transient follow-up system
VIS	Visible wavelength region
VLT	Very Large Telescope
WBS	Work Breakdown Structure
WFS	WaveFront Sensor
XAO	eXtreme Adaptive Optics
ZTF	Zwicky Transient Facility

# Executive Summary

In October 2018, in response to the proposal *Gemini Observatory in the Era of Multi-Messenger Astronomy: High Image Quality and Rapid Response to Cosmic Events* (in the following referred to as GEMMA), the National Science Foundation (NSF) awarded a cooperative support agreement (CSA) to the Association of Universities in Astronomy (AURA) to fund the following projects at Gemini Observatory:

1. The Gemini North Adaptive Optics + Real Time Computer (GNAO+RTC) facility, a state-of-the-art multi-conjugate adaptive optics (MCAO) system will be deployed at Gemini North on Maunakea, Hawaii. GNAO will build on the Observatory's previous investment in the Gemini Multi-conjugate System (GeMS) at Gemini South (GS). It will employ the currently available technology for improved performance in support of the next generation of AO-assisted instruments at GN. As the first MCAO system in the northern hemisphere, GNAO will further enhance Gemini's leadership position in the area of wide-field AO. In addition to the AO facility, the project will also produce an RTC and it will be a powerful new design that can be adapted for current and future AO systems at Gemini replacing the existing RTC of GeMS with a new design, as well as providing the RTC for the new GNAO system.
2. The Time-Domain Astronomy (TDA) project, will develop and implement the software improvements required to optimize Gemini's capability for rapid follow-up of the most compelling transient sources identified by the Large Synoptic Survey Telescope (LSST) and multi-messenger astronomy (MMA) facilities. This project will also develop efficient pipelines for real-time delivery of science-quality data products to Gemini users.
3. Multi-Messenger Astronomy Public Information and Outreach (PIO), includes a multimedia planetarium program illustrating the concepts of MMA, classroom materials to promote careers in the science and technology fields involved in MMA research, training workshops for science writers and observatory staff, and an ambitious "summit" to establish a charter for public communication of MMA concepts and discoveries.

The Gemini Directorate determined the GEMMA award will be managed as a program. The day-to-day operation of the component projects are the responsibility of project managers leading project teams with appropriate scientific and technical expertise. The successful completion of GEMMA is the highest priority given the nature and requirements of the NSF award and for the long term scientific success of Gemini. The Gemini-North Adaptive Optics Imager (GNAOI) is the planned first light imager for GNAO. This is not part of the GEMMA Program scope and will be funded by the Gemini IDF and managed separately from the GEMMA program. There will be close coordination of the GEMMA GNAO+RTC project.

Given the interdependencies of GNAO+RTC the Directorate made the decision to combine GNAO and RTC into a single project under a single principle investigator and project manager. With this change the GNAO+RTC project manager will report directly to the Deputy Director.

A newly formed GEMMA Executive Committee (GEC) chaired by the Deputy Director will ensure a simplified flow of authority down through the GEMMA organizational structure, the flow of escalation and responsibility upwards is also essential for the success of the GEMMA GNAO+RTC, TDA and PIO projects. The GEC will monitor schedule, cost, scope and resources and adjust resource allocation within the observatory to ensure the success of the GEMMA Program by making GEMMA the top priority of the observatory.

This version of the PEP incorporates the revised project execution plans. Gemini will submit comprehensive semi-annual reports each year. The reports will specifically focus on the technical, schedule, budget, and risk status of the three projects against performance indicators and milestones set forth in each Project Execution Plans (PEPs). GNAO+RTC will also submit comprehensive quarterly reports specifically focusing on the technical, schedule, budget, and risk status against the GNAO+RTC revised PEP.

Gemini will conduct design reviews at appropriate times within each project's schedule of activities where appropriate. The GEMMA Program Baseline (in section 4) has been established and incorporates the baselines for each project.

## **1 Introduction**

The GEMMA program will provide coordinated management of the projects funded through NSF Award AST-1839225. The GEMMA program and its constituent projects are an outgrowth of scientific planning efforts by the various community workshops and Observatory governance committee recommendations over the past 10 years (looking back at the Aspen program where GNAO was first discussed), and is motivated in part by rapidly expanding development of computational, robotic, communications, and adaptive optics capabilities.

### **1.1 Scientific Objectives**

Gemini Observatory's mission is to advance knowledge and understanding of the Universe by providing its international user community with forefront access to the entire sky. Gemini's twin telescopes in Hawaii and Chile are among the most versatile in the world and are the only 8-meter class telescopes accessible by the entire U.S. astronomical community. It is essential for Gemini to continue to maintain and upgrade its instrumentation, operations, and user support to meet the evolving demands of modern astronomical research.

Two groundbreaking new facilities for optical-infrared astronomy will begin operations near the start of the coming decade: the Large Synoptic Survey Telescope (LSST) and James Webb Space Telescope (JWST). In order to best serve our user community, Gemini will adapt its capabilities to maximize synergies with these two forthcoming facilities. The multi-faceted GEMMA program is designed to upgrade Gemini's instrumentation and operations in order to deliver essential capabilities for forefront astronomical research in the 2020s when both LSST and JWST will be in routine operations.

The major hardware deliverable to be provided by GEMMA will be a state-of-the-art multi-conjugate adaptive optics (MCAO) facility, a key technology for the era of extremely large telescopes (ELT) to be deployed at Gemini North; referred to as GNAO. The ALTAIR system currently in operation at GN was the first facility AO laser guide star system in routine operation. This was a major innovation for its time, but it was commissioned more than 11 years ago, and ALTAIR has become outdated. Its single-conjugate design provides only a narrow-corrected field and does not take full advantage of Maunakea's outstanding conditions for AO performance. In contrast, the planned GNAO facility will provide a corrected field of view of 2 arcminutes with a spatial resolution  $< 0.1''$ , both comparable to JWST performance. This will establish Gemini North as the premier ground-based facility for wide-field AO studies.

As part of the GNAO project, Gemini will deliver an advanced, flexible Real Time Computer facility for use with the AO systems at both Gemini North and South. The RTC is the brains behind the

complex MCAO correction. The current RTC in use for GeMS is unreliable and severely limits the efficiency of GeMS observations. Moreover, its design makes it extremely difficult to adapt for other AO systems. The GNAO+RTC project will deliver an upgraded RTC for GeMS that will greatly improve the AO system reliability and enable GeMS to interface with the next generation of AO-fed instruments. The same flexible design will be used to provide the RTC for the GNAO system and will be adaptable for future AO systems operating at either telescope.

The major operations upgrade within the GEMMA program is the development of new software systems to maximize Gemini's discovery capability in the era of Time Domain Astronomy (TDA). The GEMMA TDA project involves developing all the infrastructure needed to incorporate the Gemini telescopes into an efficient transient follow-up system known as the Astronomical Event Observatory Network (AEON), based on the Las Cumbres Global Telescope Network (LCGTN). Scientific programs that have been awarded time on the AEON system will automatically trigger observations of the most interesting targets identified by "alert brokers" that monitor public alert streams from LSST and other time-domain surveys, including multi-messenger facilities such as LIGO. Gemini's telescopes will provide the largest apertures within the network, and thus will be responsible for characterizing the most challenging targets. The TDA project includes the development of robust automated data reduction pipelines for rapid delivery of science-quality data products so the user can assess the outcome in real time.

## **1.2 Scientific Requirements**

The GNAO+RTC and TDA projects within the GEMMA program each have their own set of key scientific requirements for the deliverables that they will provide. See the individual Project Execution Plans for detailed lists of deliverables, threshold and objective science requirements, and parameter specifications relevant to each project.

## **1.3 Facility/Infrastructure**

The Gemini Observatory consists of two 8.1-meter telescopes, located on prime observing sites in Hawaii and Chile, thus providing access to astronomical targets over the entire sky. The Association of Universities for Research in Astronomy, Inc. (AURA) is the managing organization of the Gemini Observatory under a cooperative agreement with the National Science Foundation (NSF). The Gemini Observatory Participant nations are the United States of America, Canada, Brazil, Republic of Korea, Argentina, and Chile.

Gemini South is situated on Cerro Pachon in central Chile at an altitude of 2722m and latitude  $-30.2$  deg, while Gemini North is located on Maunakea, on the island of Hawaii, at an altitude of 4213m and latitude  $+19.8$  deg. The two sites are separated by 85 deg in longitude. Capabilities are not identical at the two sites, but both telescopes are equipped with workhorse imagers and spectrometers as well as more specialized instruments. In addition, Gemini's Visiting Instrument Program provides opportunities for teams to mount their own instruments on the telescopes and provides additional capabilities to the user community.

Gemini features facility AO systems at each site; at present, this includes the single-conjugate, narrow-field ALTAIR system in the North and multi-conjugate wide-field GeMS in the South. The

aging ALTAIR system will be replaced by a new, more advanced MCAO system developed by the GNAO+RTC project. Gemini's ability to switch rapidly among the instruments mounted on the telescope (in less time than required for a typical telescope slew to change object) enables quick adaptation to changing observing conditions and efficient, multi-instrument follow-up observations, an input requirement for the GEMMA TDA project.

## **1.4 Scientific & Broader Societal impacts**

### **Scientific Impacts**

As discussed in the Scientific Objectives section above, GEMMA is predicated on enhancing the scientific impact of Gemini Observatory by maximizing synergies with other major facilities that will be operational during the coming decade. Two primary science areas are addressed by the projects in this program: high spatial resolution imaging using MCAO, and rapid follow-up of transient sources. The first of these areas is addressed by the GNAO+RTC projects, while the second is addressed by the TDA project.

The most compelling transient phenomena such as the multi-messenger source GW170817 and the interstellar asteroid 'Oumuamua' have until now been rare enough that they could be pursued with manual triggering and little overall coordination. However, Advanced LIGO will produce many more GW triggers with electromagnetic counterparts requiring rapid follow-up study. Early next decade, LSST operations will result in millions of transient alerts each night, ranging from small Solar System bodies to the most distant objects from the epoch of reionization. In order to maximize the discoveries in the vast new time domain opened by the new facilities, there must be an automated system in place to select, prioritize, and observe the most scientifically compelling of the transient alerts using an optimized strategy and deliver the reduced data. The GEMMA TDA project will provide this system for Gemini, streamlining the process of discovery.

Similarly, in addition to enabling a variety of self-contained science such as crowded field near-IR photometry and morphological studies, the new GNAO+RTC system will enable wide-ranging investigations involving other facilities that explore the spatial domain with high resolution, including JWST, HST, and ALMA. For example, because of pointing constraints, for any given target within  $\pm 40$  deg of the ecliptic plane (65% of the sky), JWST can only observe the target during 40% (5 months) of the year. Moreover, current plans are to limit the number of rapid target of opportunity (ToO) observations for JWST to just six per year, with a minimum turnaround time of 48 hours.

This provides an excellent opportunity for synergy: GNAO+RTC will be the only facility able to study and monitor high-priority northern targets with a similar spatial resolution and field of view as NIRCAM on JWST. A prime example of this are time-domain targets requiring high spatial resolution, such as multiply lensed supernovae and quasars, for which the predicted times of transient phenomena will depend on the structure of the lensing mass distribution. Operating regularly in Gemini's queue, GNAO will be able to monitor such targets when they cannot be observed by JWST and when Hubble itself may no longer be operational.

### **Broader Impacts**

Gemini has a very active Public Information and Outreach (PIO) office that has effectively broadened the impact of the Gemini's scientific research for nearly two decades. The PIO group leads the Observatory's community outreach activities and electronic communications, including press releases on major results and web features to showcase other interesting topics or

communicate noteworthy items. This highly experienced team will lead all of the public communications, outreach, and educational aspects of the GEMMA program.

The PIO-related effort within the GEMMA program will expand on Gemini's legacy of broader societal impacts with ambitious initiatives inspired by the scientific and technical developments supported by this program. The focus is on multi-messenger and time-domain astronomy and the role of Gemini and other ground-based facilities in this new discovery space. Ultimately, the story told through this work is of a new era in scientific exploration, enabled by cutting-edge technologies and instrumentation supported by focused NSF funding.

As instrumentation enabling multi-messenger astronomy discoveries emerge, a framework for telling a compelling story about these discoveries becomes necessary. To this end, a "summit" of leaders in science education and communications will be convened with the task of converging on a charter to guide the public education and outreach efforts for presenting multi-messenger astronomy to various audiences. This summit, tentatively entitled, "Education, Outreach and Communications in the Era of Multi-messenger Astronomy" is envisioned to include about 25 participants and to be held at the Space Telescope Science Institute in Baltimore, Maryland in fall 2019.

Science writers are the conduit through which astronomers communicate scientific ideas and discoveries to the public. Therefore, as part of the GEMMA program, we will organize a one-day workshop for science journalists in conjunction with an American Astronomical Society meeting. At this event, a small faculty of professional scientists involved in MMA research will provide perspectives on the present and future of MMA-related topics for up to 30 journalists. Break-out groups consisting of scientists, journalists, and observatory outreach specialists will brainstorm on possible story ideas. Observatory technical staff will also receive training in how to communicate ideas to the media and broader public.

Finally, the PIO funding within GEMMA will also support formal and informal educational activities. The informal education will be in the form of a new multimedia planetarium production to convey the concepts of multi-messenger and time-domain astronomy to students and the general public using an accessible, engaging, and visually stunning storyline. The more formal education will involve the development of STEM classroom educational materials and activities, focusing on topics related to the science and technology supported by the GEMMA funding. The classroom activities will build on Gemini's successful *Journey Through the Universe* program in Hawaii, but will be readily scalable and transferrable to other locations and cultures. The goal of all these educational initiatives is to inspire the next generation of scientists and innovators from across all backgrounds in their pursuit of STEM-related careers.

## **2 Organization**

### **2.1 Internal Governance & Organization and Communication**

The GEMMA program consists of three projects corresponding to the submitted proposal description of work packages. Each of the projects has a separate PEP covering details of that project. The Gemini Board and STAC have recommended that an Adaptive Secondary Mirror be incorporated into the long-term plan for the adaptive optics program at Gemini-N. Although the construction of an ASM is outside of the scope of the GEMMA program, the GNAO+RTC project will be designed to accommodate an ASM design element.

The high-level structure of Gemini’s Observatory project management includes portfolio, program, and project management.

- Portfolio management is to ensure effective use of resources across all active projects and within the observatory, and that programs and projects are prioritized to align with strategic goals.
- Program management is the management of a group of related projects that bring more value to the organization if managed together, GEMMA is one such program.
- Project management is the management of all activities needed to meet a project’s objectives. All new project requests go through a portfolio intake process and are evaluated against the observatory’s strategic goals. Projects approved for the portfolio are added to the current year portfolio or a future year portfolio.

Each project creates a team whose members may belong to different departments and provide expertise to the project related to their functional area within the observatory. Minimally, the teams consist of a project manager, project scientist, and system engineer. Their role in the project is defined by the framework described below and by the project manager in consultation with the program manager and project sponsor.

Decisions regarding resources, project trade-offs, risk management etc. are a collaborative effort between the team, the Program Executive committee and sponsor and program manager. Ultimately the project manager is responsible and accountable for implementing decisions, for the functioning of the team and for delivering the product to the customer, ie. stakeholders, operations and the science users.

This framework incorporates standards from the Project Management Institute (PMI). These standards provide a foundation for project management knowledge and represent the four areas of the profession: project, program, portfolio and the organizational approach to project management. The projects in the GEMMA program will follow the project management methodology built into the Gemini project management database. Following the categorization used by Gemini, GNAO+RTC and TDA projects are considered large tracked projects and the PIO project is considered a medium tracked project.

Large projects with Directorate oversight follow a project management methodology using phases and gates. The first phase, Start-Up, requires a Directorate approved project request to move to the second phase, the Initiation phase.

## Project LifeCycle (PLC)



The first phase of GEMMA was approved in the first quarter of fiscal year 2019. The Initiation phase requires project planning to be completed. This includes detailed planning documents and the Program and Project Execution Plans.

All projects at Gemini follow a Project Life Cycle (PLC). This life cycle may be further refined in a System Development Life Cycle (SDLC). Both are described in the Portfolio Management Office (PMO) Methodology. The model used at Gemini is based on a combination of the Project Management Institute (PMI) and PRINCE2 methodologies. In this document, the various roles and responsibilities with respect to the PLC are addressed.

## **2.2 Project Management Structure**

The GEMMA project managers were confirmed by the Directorate during the startup phase of a project. The project managers manage the day to day activities that guide the project through its life cycle. The project managers are accountable for all activities concerning the project. In order to bear this responsibility, the project manager is given the authority to make decisions with respect to the project's (among other things):

- Scope
- Requirements
- Risks
- Budget
- Resources
- Planning

Without authority, the project manager cannot perform their duties. The tolerance - or limit - of this authority is defined at the start of the initiation phase and depends on the nature of the project. The amount of tolerance may also depend on the project manager's experience level. The project authority is independent of the project manager's accountability to line management and supervisors.

## **2.3 Work Package Management**

Projects are defined to include several activities that can be initiated and executed in parallel. The project manager divides the project into work packages according to a Work Breakdown Structure (WBS) - a work package manager is appointed. The work package manager reports to the project manager and is responsible for the initiation and execution of the work package. The project manager and the work package manager agree on the freedom a work package manager has (tolerances). The project manager then coordinates and monitors the work packages. This structure also applies at the program level.

## **2.4 Program management**

GEMMA funding supports 3 projects with distinctive scope which are interdependent in terms of deliverables. This program is managed by a program manager and a GEMMA Executive Committee (see next section for detailed description) which coordinates the projects in the program and ensures that the program goals are met. The project managers remain accountable for the deliverables of their projects within the program. The program manager is accountable for the deliverables of the program.

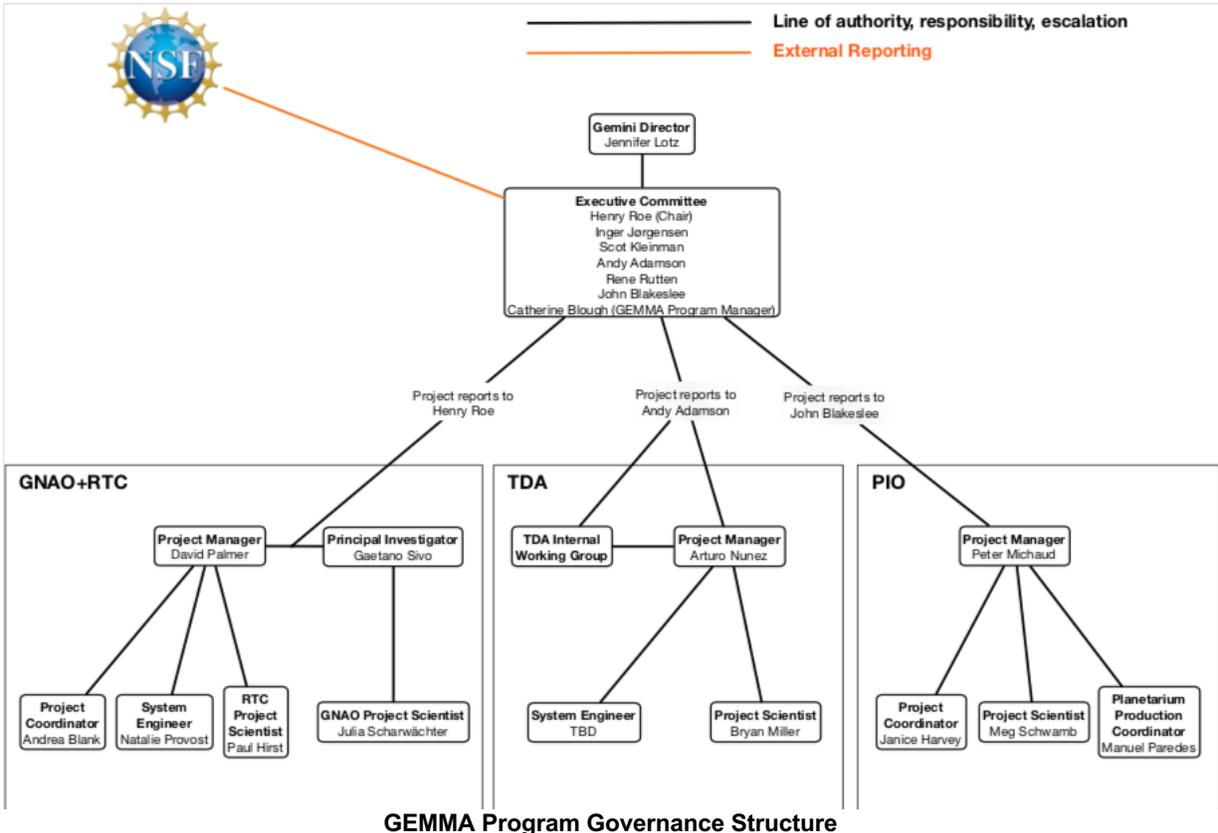
# **3 Governance structure**

## **3.1 Program governance**

The GEMMA Program differs from other Programs at Gemini, both in scale and priority, as well as in relationship amongst the projects forming the program. Although all three GEMMA projects serve to position Gemini in the era of multi-messenger astronomy, due to the terms of the agreement with the NSF, Gemini cannot substantially change the individual project's objectives or the scope of one project at the expense of another.

Due to the importance and size of the GEMMA Program and the need for GEMMA to pull resources from across nearly all areas of the Observatory, the Director has appointed a GEMMA Executive Committee, chaired by the Deputy Director. The Director has the authority to set the

membership of the Executive Committee and to make final decisions if necessary. Within the Observatory, the Executive Committee controls the resources necessary to the success of GEMMA and will resolve resource conflicts without escalation to the Director in most cases. The Executive Committee Chair will keep the Director informed about major issues and decisions.



The GEMMA Executive Committee is responsible for the successful delivery of the GEMMA Program’s objectives and benefits and will resolve conflicts, resource and otherwise. In all cases the GEC will be consulted on major project decisions that have significant external impacts, such as design choices that impact future development options, major procurements, or major changes in deliverables by the projects.

For the GNAO + RTC project, the project manager and principle investigator share management of the project. The PM is responsible for the day to day management of the project, and the PI is responsible for the alignment of the science. The project manager and the principal investigator co-equally report to the Chair and the Executive Committee. Henry Roe will also act as the line manager for the GNAO+RTC PM.

Issues arising with GNAO+RTC will be escalated to the Chair, who will work with the GEMMA Program Manager, GNAO+RTC Project Manager, and Principal Investigator to ensure the Executive Committee is kept fully informed of developing issues. The Executive Committee will pull in additional expertise as needed from across GEMMA and Gemini.

For PIO, the GEC will delegate day-to-day Project Sponsorship to John Blakeslee who will work closely with the PIO Project Manager to ensure the success of the project. Issues interrelating to other projects in GEMMA, or major changes in deliverables, will be escalated to the GEC.

For TDA, the GEC will delegate day-to-day Project Sponsorship to Andy Adamson, escalating issues as needed to the full committee. An internal working group is responsible for successful delivery of the TDA Project's objectives and benefits and will resolve conflicts, resource and otherwise, that cannot be resolved by decision-making processes within the project. The Working Group will seek consensus decisions, but the sponsor has final authority on decisions when consensus cannot be expeditiously found. Issues interrelating to other projects in GEMMA, or major changes in deliverables, will be escalated to the GEC.

The Executive Committee serves as the Risk Advisory Board for the GEMMA Program.

### **3.2 Roles and Responsibilities**

The four observatory roles described below play the same role in programs and the projects within them that they do in other Observatory work.

*Director:* The Director is the ultimate escalation point for the Chief Scientist, Portfolio Manager, and GEC regarding the successful completion of the observatory's portfolio.

*Chief Scientist:* The Chief Scientist's observatory role is to ensure the scientific capabilities and output of the Observatory meet community needs and match the Observatory's scientific strategy. The Chief Scientist applies this responsibility to programs and projects in the portfolio as well. The Chief Scientist sets attainable scientific productivity expectations and ensures that projects and programs attain their scientific goals. The Chief Scientist reviews the science cases and concepts of operations documents to ensure their scientific viability and compatibility with the Observatory's mission. The Chief Scientist is a strong project advocate for both internal and external stakeholders. The Chief Scientist is the escalation path for issues concerning scientific scope and escalates to the Executive Committee when needed.

*Portfolio Manager:* The Portfolio Manager reports to the Director and is responsible for informing the Observatory Directorate about the status of the Observatory's work. The Portfolio Manager works to ensure effective use of resources within the portfolio consistent with the Observatory's strategic goals and priorities. The Portfolio Manager provides mechanisms to measure and report the resource needs, status, and possible conflicts within the portfolio's programs and projects.

The Portfolio Manager manages the Portfolio Dashboard and oversees the Observatory's Request for Change process. The Portfolio Manager identifies resource constraints and conflicts, works with managers and sponsors to resolve, escalating to the GEC and Directorate when needed. The Portfolio Manager ensures the Project Managers adhere to the Observatory's project management methodology. The Portfolio Manager receives monthly reports from the Program and Project Managers.

*Associate Director Hawai'i Site:*

The AD for Hawaii Site directly manages the science and engineering functions in Hawaii, and serves as the local first point of contact for all local internal and external issues, staffing and financial. He maintains working relationships with the host organizations in Hawaii and represents Gemini among the Maunakea Observatories.

*Associate Director Chile Operations:*

The AD Chile Operations manages the science and engineering functions at the Gemini-S telescope. This function encompasses all the day-time and night-time operational activities in the areas of engineering and science exploitation of the facility.

### **GEMMA Program Roles**

GEC members: For each project in GEMMA there is a designated member of the GEC who holds responsibility for interfacing to the project and represents the GEC for the responsibilities listed below. For GNAO+RTC that member is Henry Roe; For TDA that member is Andy Adamson; For PIO that member is John Blakeslee.

<b>GEMMA Executive Committee</b>	
<b>Name</b>	<b>Title</b>
Henry Roe (Chair)	Deputy Director
John Blakeslee	Chief Scientist
Inger Jørgensen	Portfolio Manager
Scot Kleinman	Associate Director Development
Andy Adamson	Associate Director Hawai'i Operations
Rene Rutten	Associate Director Chile Operations
Catherine Blough (GEMMA Program Manager)	Senior Program and Project Coordinator

The GEC is responsible for the successful delivery of the project's objectives and benefits and supports project success by ensuring the project has the resources it needs.

For the projects, the GEC:

- Allocates / requests resources (labor, cash, and schedule constraints) to the project and is the escalation point for unresolved resource conflicts.
- Approves any changes suggested by the Project Manager, Principle Investigator, and/or Program Manager to project resource allocation beyond the agreed tolerances.
- Provides context, expertise, institutional guidance, and resource support to the project's management team. Helps translate Observatory strategy as it relates to the projects and ensures projects remains consistent with it.
- Advocates for the project and its needed resources and communicates project status to internal and external stakeholders.
- Reviews the Project Manager's project report to the Program Manager.
- Is the escalation point for the Project Manager for project issues with resource allocation.

*GEMMA Program Manager:* The GEMMA Program Manager has the authority and responsibility to establish the common framework for project reporting on cost, schedule, scope, and quality management consistent with Observatory standards and program reporting requirements. The GEMMA Program Manager's primary responsibility is to comply with the terms of the NSF Cooperative Support Agreement and to keep program records that prepare the program for audit. The Program Manager provides a monthly status report to the Portfolio Manager and the GEC. The report focuses on the status of the program objectives and benefits.

The Program Manager escalates any perceived out-of-tolerance risks regarding compliance, project reporting, and budgeting to the Executive Committee, informing the Portfolio Manager in the process. The Program Manager:

- Ensures projects are organized and executed in a consistent manner within established standards.
- Has a broad view of program objectives and organizational culture and processes, and in collaboration with the Executive Committee, may adjust resources (financial and human) among the projects.
- Briefs the Directorate about program progress and is responsible for the program outcome to the Portfolio Manager.
- Serves on the GEC.

### **Authority and Escalation**

Authority flows from the Director to the Executive Committee to the Program Manager, the Principal Investigator and Project Managers. The escalation path flows upward along the reverse path. Escalations involving scientific issues include the Chief Scientist. Escalations concerning program or portfolio issues include the Program and Portfolio Managers. Similarly, issues arising from the Portfolio and Program Manager are escalated to the Executive Committee

### 3.3 Project governance

The project managers are accountable to the stakeholders and is supported by the project sponsor or in the case of GNAO+RTC, the GEMMA Executive Committee (GEC). One of the tasks of the project manager is to gather the input from the stakeholders in order to define the scope of and the requirements for the project. The project deliverables go to the stakeholders. The stakeholders can be represented by the community, the Directorate, governance members, and NSF, the Executive Agency.

The project sponsors and the GEC are responsible for supporting the project manager, advocate for the project to ensure resources and manage roadblocks to ensure project success. The GEC functions as a link between the Directorate and the project managers and in collaboration with the program manager, manages the escalation process outside of the tolerances of the project manager. The roles and responsibilities of the GEC, principle investigator, program manager, project manager, sponsor and other team members are described below.

*Principal Investigator (specific to GNAO+RTC only):* The Principal Investigator and Project Manager have delegated authority to deliver the project's products within the agreed upon tolerances and constraints that flows from the Executive Committee to them. The Principal Investigator is the ultimate arbiter between the other members of the project management team for scientific issues and escalates, as needed, to the Executive Committee.

The Principal Investigator and Project Manager provide the balance between science requirements (scope) and costs and schedule. The Principal Investigator and Project Manager decide on trades between these three areas, within agreed upon tolerances, as needed. The Principal Investigator understands the scientific, technical, and management aspects of the project. The Principal Investigator escalates issues arising to the GEC.

The Principal Investigator:

- Motivates and technically leads the project team with a clear understanding of the instrument's design, capabilities, and science output.
- Serves as visible spokesperson for the project, building support within the entire range of project stakeholders.

*Project Manager:* The Project Manager and Principal Investigator have delegated authority to deliver the project's products within the agreed upon tolerances and constraints that flows from the Executive Committee to them. The Project Manager is the ultimate arbiter between the other members of the project management team for programmatic issues and escalates, as needed, to the GEC.

The Project Manager has delegated authority in conjunction with the Principal Investigator to drive the project with trades involving scope, cost, and schedule. The Project Manager plans, executes, and manages the project on a day-to-day basis within the agreed tolerances. The Project Manager is accountable for delivering the required products within the specified tolerances of time, cost, available resources, quality, scope, risk, and benefits.

The Project Manager:

- Plans, organizes, and leads the day to day project work in a manner consistent with Observatory standards.

- Provides monthly progress reports to the Program Manager and Portfolio Manager, reviewed by the GEC and Principal Investigator. Identifies and engages stakeholders.
- Manages the project budget, schedule, scope, resources, and risks according to the corresponding management plans.
- Appropriately escalate decisions or issues based on agreed upon tolerances to the GEC if needed. The Project Manager escalates to the GEC.

The TDA and PIO projects do not have a principal investigator and for those projects the above description holds with the role of the Principal Investigator removed.

*Project Coordinator:*

The Project Coordinator supports the project manager and the principal investigator with the following:

- Initiating, tracking, and managing documentation
- Creating and tracking project schedules
- Maintaining the issues log and decision tracker
- Managing action items and updating team members on their actions and the results
- Managing information flow within the team
- Assisting with reports on project schedule, risk, budget, issues

*Project Scientist:* The Project Scientist leads and ensures that the project meets its scientific mandate. While the Chief Scientist is accountable for ensuring the project meets the needs of the Gemini scientific community, the Project Scientist is responsible for developing the project's science cases. The Chief Scientist ensures these science cases meet Gemini's needs. The Project Scientist is responsible for the day to day scientific aspects of the project. The Project Scientist leads the scientific requirement and testing flow from science cases to concepts of operations to science requirements and performance validation. The Project Scientist works closely with the Chief Scientist, Principal Investigator, Project Manager, Project Engineer, and Systems Engineer. The Project Scientist:

- Leads the definition of project science requirements development, including those for data reduction and internal Gemini software changes. This work includes creating the initial science cases document and providing use cases to the Concept of Operations document.
- Identifies driving science cases and enabled science cases and ensures the project satisfies driving science cases, and adjusts the enabled science cases as the project progresses.
- Provides scientific input and validation to project trades in collaboration with the Project Manager, Systems Engineer, and Project Engineers.
- Leads the validation of science requirements through the project's lifecycle.
- Ensures the project's products meet the scientific performance requirements.
- Collaborates with the Systems Engineer to produce key performance indicators, merit functions, performance models, or simulations to assist in trade studies, project tracking, and requirements validation.
- Leads the project's combined (internal and external) science team(s). May co-lead external teams with an external Project Scientist.
- Works with the Project Manager to provide scientifically relevant information and updates to stakeholders.

- Develops good relationships with project teams and collaborates with them in improving their plans, designs, methods, and deliverables.
- Supports the Project Manager on project monitoring, reviews, and oversight.

*Systems Engineer:* The Systems Engineer ensures the project meets its requirements. This work begins with ensuring the requirements are fit for purpose (“validation”), have a complete, traceable flow from high-level science and use cases to the lowest level (“definition”), and are testable and tested (“verification”). The Systems Engineer helps the project develop a complete design.

The Systems Engineer manages the technical processes within the project, ensuring they are technically sound and suffice to produce this complete, balanced design that meets requirements. The System Engineer works closely with the Project Scientist on requirements flow and the Project Manager on technical process development and oversight. The Project Manager and Systems Engineer may agree to share and/or delegate some duties between themselves. The Systems Engineer escalates to the Project Manager. The Systems Engineer:

- Leads the requirement definition and verification processes.
- Typically owns and operates the project’s risk and configuration management processes.
- Maintains a working knowledge both of best practice in Systems Engineering and the design, development and testing of astronomical projects.
- Provides observatory interfaces to and typically serves as the primary technical contact to external teams.
- Is accountable for developing and coordinating observatory interfaces and ensuring the consistency and ultimate compliance of the relevant system and subsystem interfaces.
- Helps the project maintain robust cross-discipline communications.

*Instrument Scientist:* The Instrument Scientist supports the Project Manager, Systems Engineer, and Project Scientist by providing science-aware Observatory operations expertise to the project. It is this focus on Observatory operations-related concerns that primarily separates the Instrument Scientist role from the Project Scientist role, although it is possible for one person to assume both roles.

The Instrument Scientist provides the operations insight into the System Engineer’s requirements definition and validation processes and typically leads the final on-sky verification processes. The Instrument Scientist is responsible for producing the calibration and commissioning plans and user manuals and works with the data reduction team to provide adequate reduction software and documentation as needed. Post project closure, the Instrument Scientist assumes responsibility for stewardship of the instrument in operations.

The Instrument Scientist leads the transition from project development to operations. The Instrument Scientist provides updated relevant project information to Observatory users and seeks and communicates their concerns to the Project Manager and Project Scientist. The Instrument Scientist may share some of these roles with an external counterpart. The Instrument Scientist:

- Maintains internal web pages for use by science and engineering staff to provide project updates and technical and operational parameters.

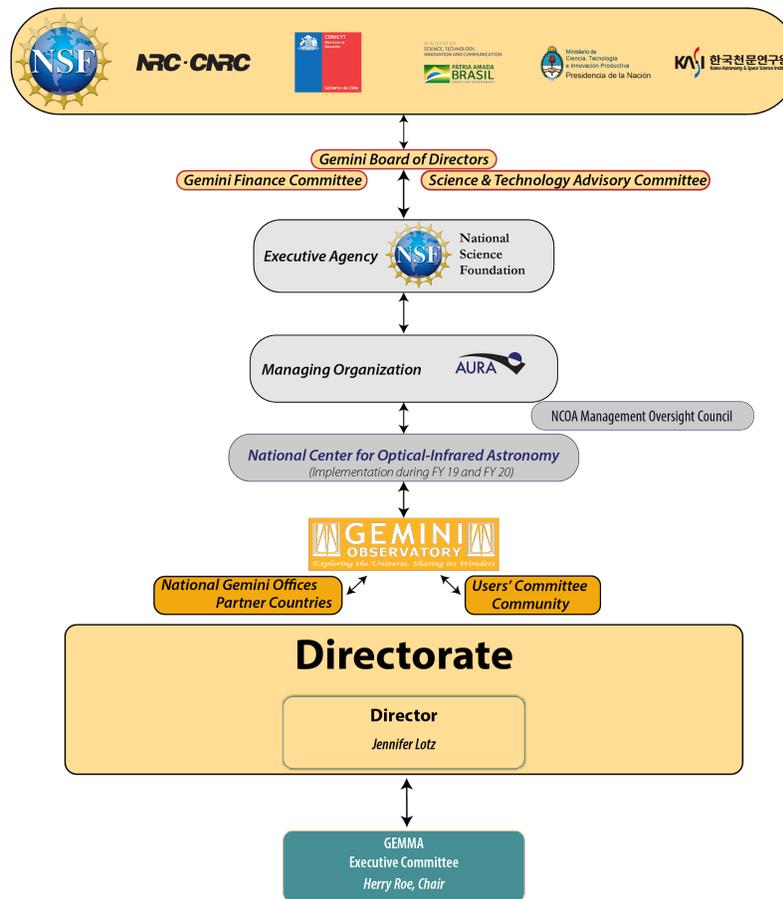
- Works with Observatory users, contact scientists and national offices to understand their project support needs and represent them to the Project Manager.
- Develops the training and support plan for the instrument post-project.
- Ensures the project design will meet the Observatory's performance and functioning monitoring needs.
- Is the primary liaison between the project and the internal software team.

### Communication

The Internal Communication Plan is found [here](#).

### 3.3 External Organization and Communication

Current Gemini Governance, showing the relationships among the Gemini Board and its Science and Technology Advisory Committee (STAC), the Executive Agency NSF, the Managing Organization AURA, the Gemini Observatory and groups with community interactions such as the NCOA Management Oversight Council and the Users' Committee. Below is a graphic representation of the governance structure.



Gemini organization governance diagram

The External Communication Plan describes how the status of the GEMMA program will be communicated to external organizations. In addition to high level objectives, this plan includes GEMMA Program Execution Plan

types of communication, method of communication, frequency of communication, who is responsible for distribution, and who will receive what communication. The objective of the plan is to maintain open communication between the observatory and the community regarding the program's progress and actively engage the stakeholders.

Please refer to the GEMMA Program External Communication Plan listed in Appendix A.

### **3.4 Roles and Responsibilities**

The Gemini Board is comprised of international participants with the United States, Canada, Chile, Brazil, Argentina, and South Korea. The board sets budgetary policy for the Observatory and carries out broad oversight functions as defined in the International Gemini Agreement.

The Gemini Finance Committee (GFC) is comprised of financial authorities from the participant countries. The GFC advises the Gemini Board on financial, budget and long-range planning issues for the Gemini Observatory.

The Science and Technology Advisory Committee advises the Gemini Board on policy matters of long-range scientific and technical importance.

The Executive Agency (NSF) serves in two capacities in the Gemini Partnership. It acts as Executive Agency according to the terms of the International Gemini Agreement, and as such is empowered to act on behalf of the Partnership to execute necessary administrative actions. In addition, the NSF serves as the U.S. funding agency, having programmatic responsibility for oversight of U.S. interests in the Partnership.

The National Center for Optical-Infrared Astronomy (NCOA) will be the foundational hub of the U.S. optical-infrared (OIR) System. NCOA will bring LSST operations, Gemini Observatory, and NOAO under a single organizational framework, with autonomy and accountability to the Gemini international participants.

The NCOA Management Oversight Council (NMOC) provides stewardship and management oversight and advocacy of Gemini operations as well as oversight of LSST operations, NOAO operations and the NCOA Transition project.

The Users' Committee for Gemini (UCG) provides feedback to the Gemini Observatory on all areas of operations that affect current users of the facility, based on the experience of the committee members as well as input collected from the larger community of Gemini users. The Observatory uses this information to improve the service it provides to users.

Each of the Gemini participants and the University of Hawaii, which has regular access to Gemini, maintain a "National Gemini Office" to support their local users.

The Directorate is responsible for the overall operation of the Observatory. Under the leadership of the Gemini Director, the Directorate defines and carries out the overall scientific mission of the Observatory as approved by the Gemini Board, and provides scientific and management leadership.

### **3.5 Partnerships**

Gemini serves a broad and diverse international partnership. For many users, the Gemini telescopes are the only large-aperture telescopes to which they have access. Therefore, Gemini must balance the need for diverse and broad capabilities at the Gemini telescopes with the rewards of intensive campaigns in specific scientific areas.

The current participants bring to Gemini diversity in their communities' needs for access to large aperture telescopes and in contributing ideas to improve Gemini's capabilities. Gemini's [Strategic Vision](#) directs Gemini to both maintain broad capabilities for its diverse community and specialize in areas that expand upon Gemini's strengths where we can lead the community and become the observatory of choice.

The projects in the GEMMA program require a number of feasibility and trade studies. We will incorporate stakeholder feedback along with the results of these studies to better tailor our work to the needs of our users. In all cases, we will be guided by our top-level project requirements. While we can alter these requirements through our change-management process, when necessary, we will endeavor to work within our initial scope and address any new demands arising from additional stakeholder or technical concerns.

### **3.6 Community Relations and Outreach**

During the execution of the GEMMA program, Gemini will maintain a public web page<sup>1</sup> to provide information on program status and updates. The GEMMA program page will be clearly accessible from Gemini's public home page and science operations web page, and it will contain links for more detailed status information on each of the component projects. We will use the same channels for general information to our user base and the general, as used for other Gemini work: Gemini Focus, e-Newscasts, and social media postings.

Community relations and public outreach are central to the PIO project within the GEMMA program. In brief, the project contains components aimed at public outreach, education, and media training. NSF funding for multi-messenger astronomy will be spotlighted by the planned "MMA summit" that will develop a charter for public communication of the concepts and discoveries related to MMA and other science enabled by the GEMMA funding. The public outreach and educational aspects will include the production and distribution of a multimedia planetarium program telling the story of multi-messenger astronomy, and the development of inquiry-based classroom educational materials and activities to inspire students to pursue STEM-related careers.

## **4 Design and Development**

### **4.1 Program Development Plan**

The purpose of the Program Development Plan is to provide a high-level view that shows the major products to be delivered by the program, when and at what cost. It states how and when the program's objectives are to be achieved, by showing the major products, milestones, activities and resources required on the projects and is revised as information on actual progress appears. It is a major control document for the program and the GEC to measure actual progress against expectations.

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<sup>1</sup> [www.gemini.edu/gemma](http://www.gemini.edu/gemma)  
GEMMA Program Execution Plan

The GEMMA Program Development Plan supports the observatory's strategic mission, to preserve and enhance PI-driven science and position Gemini as the premier 8m-class facility. The program will oversee and monitor the project management processes involved in producing the deliverables for the following projects:

#### **GNAO+RTC**

1. A MCAO system at Gemini-N, including Laser Launch system and system to apply deformable optical corrections.
2. Gemini Common RTC platform.
3. Replacement of GeMS RTC
4. GNAO+RTC
5. The integration between GNAOI and GNAO+RTC is inside the scope of the NSF CSA award and GNAO+RTC project.
6. Successful first-light science demonstration and a significant science result press-release is inside the scope of the GNAO+RTC project.

#### **TDA**

1. Gemini TDA APIs: A new set of application programming interfaces (APIs) that comply with a set of standards that will be generally applicable across a wider network of follow-up facilities. These will allow observations to be requested, provide the required feedback, and allow automated data access.
2. Gemini Plugins for Target Observation Managers (TOMs): Provide software to help Gemini users work with these new APIs.
3. Scheduler: Provide an efficient, dynamic way to schedule large numbers (order 10-100) of transient observation requests per night.
4. Real Time Pipelines: Provide a mechanism to automatically reduce imaging and longslit spectroscopic data in real-time for rapid characterization of transient sources and more responsive decision-making during night operations.
5. Product Distribution Manager: Updates the Gemini Observatory Archive to be able to deliver reduced data to users.

#### **PIO**

1. MMA -TDA Communication Summit: Identify needs and best practices for the effective communication of MMA/TDA with the public and students
2. MMA - TDA Media Workshop: Inform journalists about MMA and TDA, the technologies involved and the scientific horizons ahead in these areas
3. MMA/TDA Planetarium Program: Present the excitement of MMA and TDA to K-12 students in an engaging and understandable and accurate manner using video technologies available in portable planetaria.
4. MMA/TDA Staff Media Training: Provide staff likely to interact with the media with skills to improve their communications with the media and more effectively tell the story of MMA and TDA to the public through the media
5. MMA/TDA Internships: Provide an environment where undergraduate-level interns can develop effective and tested educational materials for K-12 students

## **4.2 Development Budget and Funding Source**

The NSF has awarded AURA funds to support the GEMMA program through Cooperative Support Agreement 1839225. Expenditure limits are determined twice a year in accordance with the yearly

budget estimates for the period October 1, 2018 - September 30, 2024 and are subject to adjustment. The initial funding profile is below and the spend plan is addressed in section 5.8.

Year	Start date	End date	NSF Committed Allocation	New Budget Profile
Year 1	10/1/2018	9/30/2019	\$2,932,767	\$2,220,723
Year 2	10/1/2019	9/30/2020	\$2,813,824	\$5,066,522
Year 3	10/1/2020	9/30/2021	\$3,489,434	\$5,492,190
Year 4	10/1/2021	9/30/2022	\$12,913,705	\$6,806,554
Year 5	10/1/2022	9/30/2023	\$2,335,415	\$3,841,050
Year 6	10/1/2023	9/30/2024	\$1,488,973	\$2,547,078
<b>Total</b>			<b>\$25,973,938</b>	<b>\$25,974,118</b>

### **4.3 Development Milestones<sup>2</sup> Schedule**

<b>GEMMA program</b>	<b>Finish</b>
Program Execution Plan Submission	1/1/19
2019A Report to NSF	5/15/19
TDA and PIO Delta-PEP Submission	5/8/19
Program and GNAO/RTC Delta-PEP submission	5/24/19
First Annual Review	7/10/19
2019B Report to NSF	9/30/19
2020A Report to NSF	5/15/20
2020B Report to NSF	11/13/20
2021A Report to NSF	5/14/21
2021B Report to NSF	11/15/21
2022A Report to NSF	5/13/22
2022B Report to NSF	11/15/22
2023A Report to NSF	5/15/23
2023B Report to NSF	11/15/23
2024A Report to NSF	5/15/24
2024B Report to NSF	11/15/24
Program Closure Report	12/31/24
<b>GNAO+RTC</b>	<b>Finish</b>
Submit documentation for CoDR	9/5/19
CoDR*	9/18/19
CoDR concludes, PD commences	9/30/19

<sup>2</sup> Milestones on the critical path  
GEMMA Program Execution Plan

Submit documentation for PDR	5/6/20
PDR*	5/19/20
PDR concludes, CD commences	5/29/20
Submit documentation for CDR	1/6/21
CDR	1/19/21
CDR concludes, Build commences*	1/29/21
Submit documents for Pre-I&T Review	9/8/22
Pre-I&T Review	9/21/22
Pre-I&T Review concludes, I&T commences*	10/3/22
Final document review	3/28/24
First Light*	4/2/24
Schedule contingency	10/1/24
<b>TDA</b>	<b>Finish</b>
Project Plan submitted to NSF	12/31/18
Concept of Operations Completed	5/15/19
<b>Scheduler Work Package Milestones</b>	<b>11/27/20</b>
Scheduler Work Started	5/16/19
Requirements and Initial Prototype	6/14/19
Final Architecture Definition	10/4/19
OCS Support Infrastructure completed	8/7/20
Scheduler Implementation completed	6/12/20
Gemini Scheduler ready*	11/27/20
<b>Gemini TDA APIs Work Package Milestones</b>	<b>3/4/20</b>
TDA APIs Work Started	5/16/19
Operational Requirements Baselined	5/29/19
TOM Interface implementation completed	9/18/19
Scheduler Interfaces Implementation completed	1/8/20
Gemini TDA APIs tested and verified*	3/4/20
<b>Interface Control Documents</b>	<b>10/1/19</b>
Pipeline Interfaces defined	10/1/19
Gemini APIs for TDA baselined	5/29/19
Scheduler Interfaces defined	6/14/19
<b>Product Distribution Work Package Milestones</b>	<b>8/3/20</b>
Product Distribution Work started	11/15/19
Updates to DRAGONS software completed	12/16/19
Updates to Gemini Archive Completed	2/18/20
Product Distribution Work ready	8/3/20

<b>Gemini Plugin for TOM Milestones</b>	<b>10/5/20</b>
Gemini Plugin for TOM Started	3/5/20
TOM plugin and user interface implemented	8/10/20
Gemini Plugin for TOM completed	10/5/20
<b>Real Time Pipelines Work Package Milestones</b>	<b>6/10/22</b>
Real Time Pipelines Work started	4/1/19
Operational modifications to support automation completed	6/30/20
GMOS Long Slit Spectroscopy data reduction implemented	6/10/22
Deployment of Quicklook mode	1/25/21
<b>Reviews</b>	<b>6/10/22</b>
Conceptual Review	7/10/19
Progress Design Review	10/2/19
Critical Design Review	12/24/19
Integration Preparedness Review	6/10/22
Project closure Review	12/31/21
Training Completed	12/25/20
Integration completed*	6/11/21
Handover to operations	6/11/21
<b>PIO</b>	<b>Finish</b>
<b>MMA-TDA Communications Summit (MTCS)</b>	<b>12/30/19</b>
Development of MTCS key objectives and outcomes*	8/30/19
MTCS Execution*	11/9/19
<b>MMA-TDA Media Workshop (MTMW)</b>	<b>1/10/21</b>
MTMW key objectives, outcomes*	5/10/20
Workshop execution*	1/10/21
<b>Staff Media Training</b>	<b>11/30/21</b>
Training objectives, outcomes, and scope*	2/28/21
GN training execution*	10/25/21
GS training execution*	11/30/21
<b>MMA/TDA Planetarium Programming</b>	<b>10/1/21</b>
Call for proposals/bids for production contract	6/5/20
Contractor selection and confirmation	6/26/20
Adaptation of Web version of segments*	10/1/21
<b>MMA/TDA Internships</b>	<b>11/30/21</b>
Initiate necessary HR paperwork for MMA-TDA internships	5/10/19
Intern #1 recruitment process*	8/30/19
Intern #2 recruitment process*	2/28/20

Intern #3 recruitment process*	10/2/20
Intern #4 recruitment process*	4/30/21

## 5 Program Definition

### 5.1 Summary of Total Program Definition

The GEMMA program consists of managing the overall costs and the risks of the three component projects, as well as the coordination and prioritization of resources across these projects.

### 5.2 Program Work Breakdown Structure (WBS)

WBS	Task Name	Start	Finish
<b>1</b>	<b>Gemini in the Era of Multi-Messenger Astronomy</b>	<b>10/1/18</b>	<b>12/31/24</b>
<b>1.1</b>	<b>GEMMA PROGRAM</b>	10/1/18	12/31/24
<b>1.1.2</b>	<b>STRATEGIC ALIGNMENT</b>	<b>10/1/18</b>	<b>9/30/19</b>
1.1.2.1	Benefits Identification	8/1/19	9/30/19
1.1.2.2	Program Benefits	10/1/18	7/31/19
1.1.2.3	Project Benefits	10/1/18	7/31/19
<b>1.1.3</b>	<b>PROGRAM STRUCTURE</b>	<b>10/1/18</b>	<b>9/30/19</b>
1.1.3.1	Program Schedule	10/1/18	12/31/18
1.1.3.2	Program Resource Plan	11/26/18	12/31/18
<b>1.1.3.3</b>	<b>Governance Planning</b>	<b>10/1/18</b>	<b>6/28/19</b>
1.1.3.3.1	Program Tolerances	1/1/19	5/31/19
1.1.3.3.2	Stakeholder Identification	10/1/18	5/31/19
1.1.3.3.3	Roles and Responsibilities	1/1/19	5/1/19
1.1.3.3.4	Communication Strategy	6/3/19	6/28/19
<b>1.1.3.4</b>	<b>Risk Management Planning</b>	<b>10/1/18</b>	<b>5/31/19</b>
1.1.3.4.1	Initial Risk Identification and Assessment	10/1/18	2/6/19
1.1.3.4.2	Risk Management Plan	1/1/19	5/31/19
<b>1.1.3.5</b>	<b>Program Deliverables</b>	<b>10/1/18</b>	<b>9/30/19</b>
1.1.3.5.1	Identify deliverables	10/1/18	12/31/18
1.1.3.5.2	Deliverables development	10/1/18	9/30/19
<b>1.1.3.6</b>	<b>Change Management Planning</b>	<b>1/1/19</b>	<b>5/31/19</b>
1.1.3.6.1	Change Management Plan	1/1/19	5/31/19

<b>1.1.4</b>	<b>PROGRAM MANAGEMENT AND ADMINISTRATION</b>	<b>10/1/18</b>	<b>9/30/24</b>
1.1.4.1	Program and Projects Scope Monitoring and Control	1/1/19	9/30/24
1.1.4.2	Program and Projects Schedule Monitoring and Control	1/1/19	9/30/24
1.1.4.3	Program and Projects Resource Monitoring and Control	1/1/19	9/30/24
1.1.4.4	Program and Projects Financial Monitoring and Control	1/1/19	9/30/24
1.1.4.5	Program and Projects Procurement Monitoring and Control	10/1/18	9/30/24
1.1.4.6	Program and Projects Risk Monitoring and Control	1/1/19	9/30/24
1.1.4.7	Program and Projects Change Monitoring and Control	10/1/18	9/30/24
<b>1.1.5</b>	<b>PROGRAM CLOSURE</b>	<b>7/1/24</b>	<b>9/30/24</b>
1.1.5.1	Financial Closure	7/1/24	9/30/24
1.1.5.2	Procurement Closure	7/1/24	9/27/24
1.1.5.3	Resource Transition	7/1/24	9/27/24
1.1.5.4	Risk Management Transition	7/1/24	9/27/24
<b>1.1.6</b>	<b>REVIEWS AND MEETINGS</b>	<b>10/1/18</b>	<b>9/30/24</b>
1.1.6.1	NSF Reviews and Audits	10/1/18	9/30/24
1.1.6.1.2	Program Execution Plan Submission	1/1/19	1/1/19
1.1.6.1.3	2019A Report to NSF	5/15/19	5/15/19
1.1.6.1.4	TDA and PIO Delta-PEP Submission	5/8/19	5/8/19
1.1.6.1.5	Program and GNAO/RTC Delta-PEP submission	5/24/19	5/24/19
1.1.6.1.6	2019B Report to NSF	11/15/19	11/15/19
1.1.6.1.7	First Annual Review	9/30/19	9/30/19
1.1.6.1.8	2020A Report to NSF	5/15/20	5/15/20
1.1.6.1.9	2020B Report to NSF	11/13/20	11/13/20
1.1.6.1.10	2021A Report to NSF	5/14/21	5/14/21
1.1.6.1.11	2021B Report to NSF	11/15/21	11/15/21
1.1.6.1.12	2022A Report to NSF	5/13/22	5/13/22
1.1.6.1.13	2022B Report to NSF	11/15/22	11/15/22
1.1.6.1.14	2023A Report to NSF	5/15/23	5/15/23
1.1.6.1.15	2023B Report to NSF	11/15/23	11/15/23
1.1.6.1.16	2024A Report to NSF	5/15/24	5/15/24
1.1.6.1.17	2024B Report to NSF	11/15/24	11/15/24
1.1.6.1.18	Program Closure Report	12/31/24	12/31/24

## **5.3 WBS Dictionary**

<b>WBS</b>	<b>GEMMA program</b>	<b>Description</b>
1.1.2	Strategic Alignment	Ensure the linkage of the observatory and the program and its projects
1.1.2.1	Benefits Identification	Initial definition is to ensure the delivery of the identified benefits and their value
1.1.2.2	Program Benefits	Using the information provided by individual projects, regarding their benefits, identify program support structure that links benefits of those projects to each other, and ensure agreement with the Observatory goals
1.1.2.3	Project Benefits	Gather GEMMA projects' business cases, justifications, and mandates, to understand the reason for the each individual project and the value they bring to Operations
1.1.3	Program Structure	Considering the established Strategic Alignment, define the overall program framework
1.1.3.1	Program Schedule	Planning of the program and projects work
1.1.3.2	Program Resource Plan	Planning of the required labor effort needed for program and projects work
1.1.3.3	Governance Planning	Established program structure and supporting activities. This includes: identifying program tolerances, establishing roles and responsibilities, as well as identifying and analyzing the stakeholders for potential influence on issues and communication requirements.
1.1.3.4	Risk Management Planning	Define how risks are treated within the program framework. This includes initial identification and assessment of program risks, as well as establishing mitigation and plans, and monitoring and closing risks for the program and its projects
1.1.3.5	Program Deliverables	Review CA, CSA MFM, PAPPG documents to identify required deliverables and create a program deliverables

		schedule and distribution list
1.1.3.6	Change Management Planning	Manages the change process and ensures control in budget, schedule, scope, communication, and resources
1.1.4	Program Management and Administration	Activities and procedures to ensure efficient overall management of the projects towards the common goal
1.1.4.1	Program and Projects Scope Monitoring and Control	Review of deliverable documents for accuracy and completeness, to ensure scope conformity
1.1.4.2	Program and Projects Schedule Monitoring and Control	Review projects' schedule progress and monitor their concurrence
1.1.4.3	Program and Projects Resource Monitoring and Control	Review resource usage and monitor effective allocation, ensuring sufficient effort is available to all projects
1.1.4.4	Program and Projects Financial Monitoring and Control	Provide periodic Budget Reports to show actual expenditures against the baseline, in order to project future expenses and ensure availability of funds
1.1.4.5	Program and Projects Procurement Monitoring and Control	Review and monitoring procurement practices, monitoring deliverable deadlines.
1.1.4.6	Program and Projects Risk Monitoring and Control	Monitor projects' use of Risk Management Plan, including escalation process.
1.1.4.7	Program and Projects Change Monitoring and Control	Monitor the change control process used to make changes in budget, schedule and scope, ensuring accuracy and completeness, including collection and document storage.
1.1.5	Program Closure	Formally close out the project by delivering required reports and documentation
1.1.5.1	Financial Closure	Ensure that all conditions of the financial terms and conditions are complete, documented and archived
1.1.5.2	Procurement Closure	Involves administrative activities to finalize procurements, update records, and archive information
1.1.5.3	Resource Transition	Activities that prepare for change and support staff to consider the impact of transition on themselves and the

		organization
1.1.5.4	Risk Management Transition	documents the successes of the project, remaining work (if applicable), success, areas for improvement, and location of project archive.
1.1.6	Reviews and Meetings	Preparations and activities related to producing documentation for reviews and audits
1.1.6.1	NSF Reviews and Audits	These correspond to the program milestones and they are all the different plans and reports required by the CSA

## **5.4 Scope Management Plan**

The GEC is responsible for the successful delivery of the GEMMA Program’s scope and benefits and will resolve conflicts, resource and others. In all cases the GEC will be consulted on major project decisions that have significant external impacts, such as design choices that impact future development options, major procurements or major changes in deliverables by the projects. Issues arising with GNAO+RTC will be escalated to committee chair, who will work with the GEMMA Program Manager, GNAO+RTC Principal Investigator and Project Manager to ensure the GEC is kept fully informed of developing issues. The Chair will escalate issues relating to potential changes in deliverables and or impact on external stakeholders to the Director. The GEC will pull in additional expertise as needed from across GEMMA and Gemini.

Currently, the GEC meets monthly to discuss overall progress and will meet on an ad hoc basis to resolve specific issues and conflicts with resources, budget and scope. The GEC chair meets weekly with the GNAO+RTC leadership team for updates and to monitor project progress, risks, issues and mitigation strategies.

Any changes to objectives or scope (deliverables) as described in the proposal “Gemini Observatory in the Era of Multi-Messenger Astronomy: High Image Quality and Rapid Response to Cosmic Events.” require NSF approval, irrespective of any changes to budget/costs. Specific procedures for change requests can be found in the NSF PAPPG.<sup>3</sup>

## **5.5 Cost Estimating Plan, Cost Reports and Baseline Budget**

This Cost Estimating Plan defines the guidelines and methodology used to prepare the cost estimate for Gemini Operations and Instrumentation Development. This document is applicable to NSF funded operations subject to the Office of Management and Budget’s (OMB) Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards. The plan covers the following topics and can be found under Reference Documents.

<sup>3</sup> [https://www.nsf.gov/pubs/policydocs/pappg18\\_1/pappg\\_7.jsp#VIIB1](https://www.nsf.gov/pubs/policydocs/pappg18_1/pappg_7.jsp#VIIB1)

- Program Planning Process
- Methods and Tools
- Software
- Project Cost Planning
- Project Cost Management
- Labor Costs
- Non-Labor Costs
- Travel
- Contracts
- Other Direct costs
- Economic Assumptions
- Complexity Factor Analysis
- Indirect Costs

## **5.6 Complexity Factor**

Gemini utilizes an analysis of project complexity factors to help determine the appropriate budget allowance. Specific factors generated are based on past experience with construction of Gemini instruments.

A 22% complexity factor is added to the labor, travel, contracts and other direct costs line items in the program budget, the GNAO+RTC project budget, and the TDA project budget.

Please refer to the Cost Estimating Plan [here](#) for further explanation of the method for calculating the complexity factor and application to the 3 projects.

## **5.7 Cost Book, Cost Model Data Set and Basis of Estimate**

The Cost Book refers to a document specific to a facility construction project and is not applicable to the GEMMA program and projects in an existing large facility.

## 5.8 Spending Profile - Summary Budget - Program and Projects

Award Number 1839225	FYE19	FYE20	FYE21	FYE22	FYE23	FYE24	TOTAL
Senior Personnel	0	0	0	0	0	0	0
Other Personnel	1,066,404	1,873,191	1,737,063	1,127,480	610,221	424,404	6,838,763
Total Salaries and Wages	1,066,404	1,873,191	1,737,063	1,127,480	610,221	424,404	6,838,763
Fringe Benefits	598,999	1,052,171	975,708	633,306	342,761	238,388	3,841,333
Total Salaries/Wages/Benefits	1,665,404	2,925,363	2,712,771	1,760,786	952,982	662,791	10,680,096
Equipment	0	0	156,160	2,768,430	380,640	0	3,305,230
Domestic Travel	104,041	93,101	70,053	48,589	46,766	39,395	401,946
Foreign Travel	101,875	160,140	96,087	52,075	48,636	82,404	541,216
Total Travel	205,916	253,241	166,140	100,664	95,402	121,799	943,161
Participant Support	0	0	0	0	0	0	0
Other Direct Costs: Materials and Supplies	28,177	38,560	35,576	16,592	60,714	11,694	191,314
Other Direct Costs: Publication/Documentation/Dissemination	0	0	0	0	0	0	0
Other Direct Costs: Consultant Services	12,000	0	12,000	0	0	0	24,000
Other Direct Costs: Computer Services	0	0	0	0	0	0	0
Other Direct Costs: Subawards	0	0	0	0	0	0	0
Other Direct Costs: Other	119,920	1,515,449	1,870,720	1,941,515	2,235,420	1,667,455	9,350,480
Total Other Direct Costs	160,098	1,554,010	1,918,297	1,958,108	2,296,134	1,679,148	9,565,794
Total Direct Costs	2,031,417	4,732,614	4,953,367	6,587,987	3,725,158	2,463,738	24,494,281
Indirect Costs - Calculated on Total Project in IDC Account	189,306	333,908	538,823	218,567	115,892	83,340	1,479,837
Total Direct and Indirect Costs	2,220,723	5,066,522	5,492,190	6,806,554	3,841,050	2,547,078	25,974,118
CSA Period of Performance Start:	10/1/18						
CSA Period of Performance End:	9/30/24						

Gemini O&M labor resources will contribute to the GEMMA program and projects with funding from the GEMMA award. The following guidelines were established for when managers, Directorate members, and staff will charge their time against the GEMMA award:

Managers and Directorate members will charge against the GEMMA award for time spent on

- Concrete deliverables, including writing sections for the PEP and any future reports
- Extensive review of documents and reports

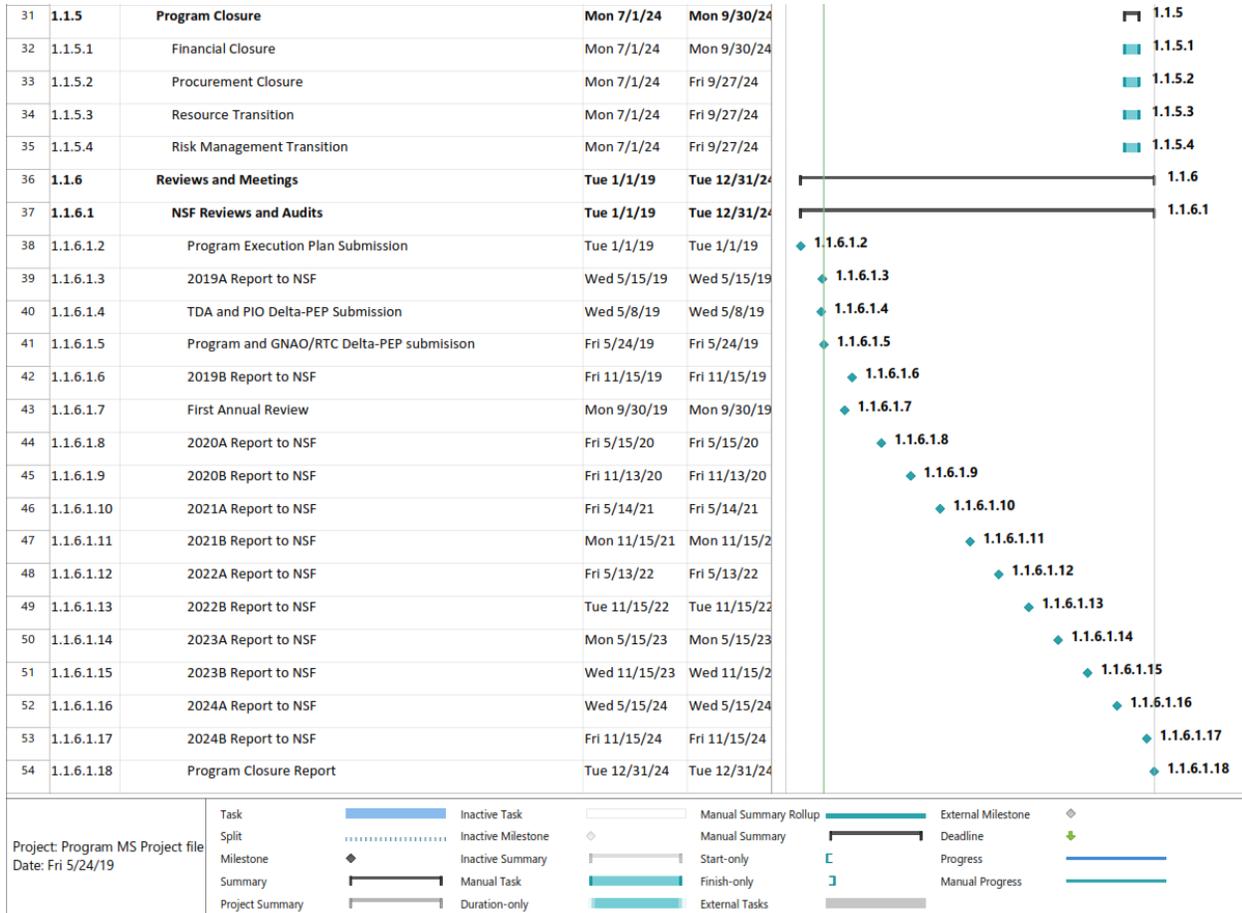
Managers and Directorate members will not charge against the GEMMA award for time spent on:

- General supervision of staff or projects
- Program and Project sponsor activities

Staff will charge against the GEMMA award for time spent on project and program management, concrete deliverables and documents, but will not charge against the award for participation in general update meetings, or the occasional request for information. Support staff from ITS and Facilities providing routine support for staff working on the GEMMA award will not charge such labor effort against the GEMMA award.

Currently, funds from CSA1 and CSA2 are segregated. A formal Segregation of Costs policy is being developed to ensure the continuous segregation of non-labor costs.





## 5.10 Schedule Contingency

Gemini will maintain a baseline schedule and include schedule contingency beyond the baseline of a reasonable amount (at least 15% beyond the critical path). The schedule, including contingency, shall not exceed the required project completion date. We will update our baseline schedule with appropriate contingency at each stage end.

The formal change control process is used to address schedule contingency via change requests and the impact on their related scope and activities.

## 6 Staffing

### 6.1 Program Staffing Plan

Roles ↓ / Fiscal Year→	FY19	FY20	FY21	FY22	FY23	FY24	Total per role
<b>Program_Manager</b>	0.98	0.66	0.63	0.63	0.63	0.68	<b>4.22</b>
<b>Admin</b>	0.48	0.80	0.80	0.80	0.80	0.85	<b>4.53</b>
<b>Program_Support</b>	0.64	0.68	0.68	0.68	0.67	0.68	<b>4.04</b>
<b>Total per FY</b>	<b>2.10</b>	<b>2.15</b>	<b>2.11</b>	<b>2.11</b>	<b>2.10</b>	<b>2.21</b>	<b>12.79</b>

The GEMMA Executive Committee will review project resources at least monthly to determine adequate resources are identified to undertake the required work to maintain schedule and budget and to identify and mitigate resource risks to the program. In addition, the Portfolio Management Office monitors and updates a resource allocation sheet, which covers all projects in the Gemini portfolio. The Directorate reviews the allocation sheet quarterly to identify projects and reallocate staff according to project priority. The allocation sheet covers the following:

- Resource
- Role
- Location
- Duration
- FTE as a function of time

Project specific staffing assignments are identified in the observatory Resource Allocation Spreadsheet (RAS). Monthly the resource list per project in the RAS is compared to the Web Time Sheets (WTS). That information is reported to the program manager and project managers and reviewed monthly by the Portfolio Manager who will escalate to the GEC and/or the Directorate if resource problems arise.

### 6.2 Hiring and Staff Transition Plan

WBS		FY19	FY20	FY21	FY22	FY23	FY24	TOTAL
1.1	<b>GEMMA PROGRAM</b>	\$271,616	\$246,307	\$246,636	\$254,035	\$260,653	\$284,179	\$1,563,425
1.1.2	<b>STRATEGIC ALIGNMENT</b>	\$51,802						\$51,802
1.1.2.1	Benefits Identification	\$16,233						\$16,233
1.1.2.2	Program Benefits	\$19,721						\$19,721
1.1.2.3	Project Benefits	\$15,849						\$15,849

<b>1.1.3</b>	<b>PROGRAM STRUCTURE</b>	<b>\$88,863</b>						<b>\$88,863</b>
1.1.3.1	Program Schedule	\$16,500						\$16,500
1.1.3.2	Program Resource Plan	\$16,830						\$16,830
1.1.3.3	Governance Planning	\$20,410						\$20,410
1.1.3.4	Risk Management Planning	\$7,480						\$7,480
1.1.3.5	Program Deliverables	\$20,163						\$20,163
1.1.3.6	Change Management Planning	\$7,480						\$7,480
<b>1.1.4</b>	<b>PROGRAM MANAGEMENT &amp; ADMINISTRATION</b>	<b>\$107,609</b>	<b>\$221,674</b>	<b>\$227,453</b>	<b>\$234,276</b>	<b>\$240,380</b>	<b>\$247,430</b>	<b>\$1,278,821</b>
1.1.4.1	Program and Projects Scope Monitoring and Control	\$6,812	\$14,033	\$14,399	\$14,830	\$15,217	\$15,734	\$81,024
1.1.4.2	Program and Projects Schedule Monitoring and Control	\$6,812	\$14,033	\$14,399	\$14,830	\$15,217	\$15,734	\$81,024
1.1.4.3	Program and Projects Resource Monitoring and Control	\$9,600	\$19,775	\$20,291	\$20,900	\$21,444	\$21,059	\$113,068
1.1.4.4	Program and Projects Financial Monitoring and Control	\$16,034	\$33,031	\$33,892	\$34,909	\$35,818	\$37,035	\$190,719
1.1.4.5	Program and Projects Procurement Monitoring and Control	\$40,138	\$82,685	\$84,841	\$87,386	\$89,663	\$92,708	\$477,420
1.1.4.6	Program and Projects Risk Monitoring and Control	\$21,798	\$44,905	\$46,075	\$47,458	\$48,694	\$50,348	\$259,278
1.1.4.7	Program and	\$6,414	\$13,212	\$13,557	\$13,963	\$14,327	\$14,814	\$76,287

	Projects Change Monitoring and Control							
<b>1.1.5</b>	<b>PROGRAM CLOSURE</b>		<b>\$5,937</b>				<b>\$15,787</b>	<b>\$21,723</b>
1.1.5.1	Financial Closure						\$4,683	\$4,683
1.1.5.2	Procurement Closure						\$4,612	\$4,612
1.1.5.3	Resource Transition						\$1,881	\$1,881
1.1.5.4	Risk Management Transition		\$5,937				\$4,612	\$10,549
<b>1.1.6</b>	<b>REVIEWS AND TRAINING</b>	<b>\$23,342</b>	<b>\$18,696</b>	<b>\$19,183</b>	<b>\$19,759</b>	<b>\$20,274</b>	<b>\$20,962</b>	<b>\$122,215</b>
1.1.6.1	NSF Reviews and Audits	\$23,342	\$18,696	\$19,183	\$19,759	\$20,274	\$20,962	\$122,215

## 7 Program Risk Management

### 7.1 Risk Management Plan Process

The Executive Committee serves as the Risk Advisory Board for the GEMMA Program. In order for program risk management to be successful, the program manager in collaboration with the GEC establish program Key Performance Indicators (KPI) that may include scientific impact, community satisfaction, and product scope, cost and quality. The program manager creates a risk management plan for the program, and a risk register to be reviewed by the GEC and updated monthly. Once KPIs are in place, program risk management includes identifying, assessing, mitigating, monitoring, fall back planning, and closing program risks.

### 7.2 Identifying Risks

Program risk identification occurs in several ways. The GEC will review the projects' risk registers and consider any of the medium or high project risks for inclusion in the program risk register. The program manager will monitor the overall projects' performance to detect any areas of potential risk not originally identified and bring those to the attention of the GEC to determine if they should be included in the risk register.

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

### **7.3 Assessing Risks**

Once the risks are identified, the GEC will score the risks in the program risk register on a scale of 1-5 in two areas, impact and likelihood. The impact score reflects the impact to the category of the risks based on KPIs. Likelihood reflects the probability that the risk will be realized.

### **7.4 Risk Response**

When the program manager creates entries in the risk register, the GEC will determine the type of response. The GEC will review the response action plans and whether they are correct and applied appropriately. If an action plan is not working as expected, the program manager will raise the concern to the GEC and the appropriate project manager and adjust the plan accordingly.

### **7.5 Fallback Plan**

Once a risk is identified, the program manager creates a fall back(contingency) plan and enters it in the risk register. Fall back plans should be created as soon as the risk is identified. If a risk is realized, the program manager will ensure that the appropriate fall back plan is activated. The exact steps to follow will depend on the documented fall back plan.

Please refer to the Part III columns in the [Risk Register](#) for Fall back Management information.

### **7.6 Internal Risk Controls**

The risk register includes a column for internal risk controls. These controls are organizational processes or procedures that are part of the organizational operations or culture and not program specific. If any internal risk controls exist, the program manager will add the description to the risk register and rank its effectiveness on likelihood, impact or both. Effectiveness is rated on a scale of one to five with one being most effective and five having minimal effect.

### **7.7 Monitoring Risks**

The program manager will regularly review the program risks with the project managers and with the GEC, if applicable. The reviews will include review of mitigation and contingency plans and adjustments to the risk register when necessary. The program manager will report the status of the medium and high risks on the periodic program status report to the GEC.

### **7.8 Closing Risks**

Once a risk is mitigated, it will remain in the risk register but moved to the closed status when it has been realized, expired or irrelevant. Once the program has ended, the GEC will review the risk register at a program closure review as part of lessons learned. The program manager will ensure all risks are closed and archive the risk register.

## **8 Systems Engineering**

## **8.1 Systems Engineering Plan**

The TDA and the GNAO+RTC projects have individual Systems Engineering Management Plans (SEMPs) included with their project execution plan.

# **9 Configuration Control**

## **9.1 Configuration Control Plan**

The Configuration and Change Management Plan (CCMP) addresses which key documents are under configuration control, file formats, and applications used, naming and numbering conventions to manage changes to the GEMMA program deliverables. The Change Management Plan (CMP) establishes change control at the *project level*, system level, and defines which level will consider what type of change depending on its impact. The CMP defines membership of the change control levels and defines which changes must be forwarded to the NSF for approval.

## **9.2 Change Control Plan**

Changes outside the tolerance of the Project Manager are requested through a Change Request Form and submitted by the individual Project Managers to the Program Manager and the GEC. The Program Manager in consultation with the GEC, TDA and PIO sponsor will assess the benefit of the change and the impact on cost, timeline and resources available, based on program impact and project need and decide if the change can be implemented. If the impact has a potential impact on other development and or observatory projects, the GEC may escalate to the Director.

A Change Request Form is a PMO template to be use for change control.

## **9.3 Documentation Control Plan**

Gemini currently has a Document Control procedure in place that describes how documents are tracked and retrieved.

For this, a Xerox supplied DocuShare application called Document Management Tool (DMT) is used. Released documents are stored in DMT and subsequent updates are uploaded while the old version is kept. Version change information is stored with each version. The tool complies with:

1. Security
2. Alerts/Notifications
3. Back-up
4. Version Control
5. Review/Approval
6. Use of different file types
7. Index/Searching (tags)
8. Reports

In addition, DMT has a secured area required for ITAR related documents.

# 10 Acquisitions

## 10.1 Acquisition Plans

Acquisition Plans will be developed as decisions are made regarding the proposed procurements during the project lifecycle. Construction for GNAO+RTC will adhere to the Office of Management and Budget's (OMB) Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards and AURA and CAS policies for all procurements. AURA policy provides levels of approval based on dollar thresholds. Approval is required from NSF, as the Executive Agency, for acquisitions >\$250k.

## 10.2 Acquisition Approval Process

Gemini follows the AURA CAS procurement policies that can be found [here](#).

# 11 Program Management Controls

## 11.1 Program Management Control Plan

Gemini has a Portfolio Management Office which guides to the program management process by providing:

- Methodology for the Project Life Cycle
- Project Management and Systems Engineering Templates
- Reporting and resource allocation tools
- Training

Please refer to the Project Methodology documents listed under Reference Documents:

- The Project Life Cycle
  - Project Startup
  - Initiation
  - Execution
  - Closeout
- The System Development Life Cycle
  - Analysis and Requirement
  - Design
  - Development
  - Validation and Verification

In addition, there are documents describing:

- Monitor and Control
- Change Management Process

### 11.1.1 Program Monitoring and Controlling

Information is gathered with monitoring and controlling processes designed to accomplish three things:

- Track, review, and regulate the progress and performance of the projects
- Identify any areas in which changes to the plan are required
- Initiate the corresponding changes

These processes include a weekly leadership team meeting (specific to GNAO+RTC) that include the GEC Chair, the Program Manager, the PI and the Project Manager. The meeting will focus on qualitative issues and events of that week, and an analysis and response if needed. A biweekly meeting between the GEC Chair and GEMMA Program Manager to discuss overall program issues and events and a monthly GEC meeting and individual meetings between the GEC Chair and the Project Manager and the PI are held. These meetings are to ensure a continuous flow of information from the GNAO+RTC project so that issues can be resolved quickly.

Monthly project progress reports will provide information to the Program Manager who will organize and analyze it in order to understand how the project's current status measures up compared to selected Key Performance Indicators (KPI).

Initial Key Performance Indicators to be measured across all projects and the program include:

- Budget, expenditure and drawdown comparison.
- Milestone deliverables
- Scope changes and schedule changes (monitored by reviewing change requests)

That information will be given to the GEC at least monthly. Issues involving resources may be escalated more frequently.

## **11.2 Earned Value Management System (EVMS)**

Earned Value Management (EVM) will be implemented to measure the efficiency for the work accomplished on the GNAO+RTC project. Planned Value (PV), Actual Costs (AC) and Earned Value (EV) may be reported in quarterly reports for GNAO+RTC as well Cost Performance Index (CPI), and Schedule Performance Index (SPI).

## **11.3 Financial and Business Controls**

AURA Central Administrative Services (CAS) provides AURA Operating Centers funded by NSF with business services. These services are aligned with federal and state laws and regulations, AURA policy and CAS procedures. CAS provides the following services:

- Procurement
- Sub-awards
- Property management
- Logistics
- Cash Management and Disbursement
- Accounting
- Payroll
- Financial and Compliance Audits
- Compliance
- Business IT

AURA CAS and Human Resources policies and procedures can be found [here](#).

## **12 Site and Environment**

### **12.1 Site Selection**

#### **Not Applicable**

The projects under the GEMMA program are funded by the NSF through an added CSA to an existing observatory management and operations CSA, and not the construction of a large facility.

### **12.2 Environmental Aspects**

#### **Not Applicable**

The projects under the GEMMA program are funded by the NSF through an added CSA to an existing observatory management and operations CSA, and not the construction of a large facility.

## **13 Cyber Infrastructure**

### **13.1 Cyber-Security Plan**

The Cyber-Security Plan is posted on the internal website and covers the following topics:

- Acceptable Use Policy
- Computer Asset Management Policy
- Computer Equipment Refresh Policy
- Computer Equipment Provisioning Policy
- Information Security Awareness & Training Policy
- Internet Postings Policy
- Master Information Security Policy
- Mobile Devices Policy
- Password Policy
- Physical Security Policy

- Remote Access Policy
- Wireless Access Policy

## **13.2 Code Development Plan**

Gemini standards for writing, testing and verifying, deploying, and documenting software, including configuration control during the stages of development are maintained by the software group and are posted on the internal website and cover the following topics.

- Documenting the Code
- Coding Practices
- Coding Styles
- EPICS Tools
- ADE Concepts
- Software Development using the ADE
- Managing External Software

## **13.3 Data Management Plan**

The Gemini Data Management Plan is [here](#).

# **14 Environmental Safety and Health**

## **14.1 Environmental Safety and Health Plans**

Gemini has an extensive Safety Manual in place that covers the following:

- Gemini Safety Organization Chart
- Roles and Responsibilities Matrix
- Normative References and Documentation
- Safety Manual Sections Applicable by Work Area
- External Injuries/Illness reporting
- Internal Accident Investigation and Review
- Safety and Health Training and Education
- Generally Safe Working Practices
- Assessment of Hazards and Mitigation of Risks
- Fire Safety
- Emergency Preparedness
- Laboratories
- Workplaces, Ergonomics, and Manual Handling
- Work Equipment and Machinery
- Electrical Installations
- Inspections
- Hazardous Substances
- Design and Construction Policies
- Cryogenics
- Laser
- Ionizing Radiation Protection
- Work Permits
- Building and Construction Safety

- Work at High Altitudes
- Personal Protection Equipment
- Safety Signage
- Summit Facility
- Stretching Program
- Safety Boards
- New Hire Safety Orientation

In addition, there is a Gemini Site Safety Plan in place that subjects all personnel and contractors.

For all work performed a Job Hazard Analysis is performed before work commences and precautions are taken to mitigate possible hazardous conditions.

Personnel receive ongoing training through Gemini's SafetyPlus web-based program.

## **15 Review and Reporting**

### **15.1 Reporting Requirements**

Gemini is required by the CSA to provide quarterly financial reports and semi-annual reports. Specific to GNAO+RTC, quarterly reports will be provided to the NSF. The reports are to coincide with other observatory reports required for the governance committees and Board. During the course of the program, Gemini will define and analyze the benefits of the projects to the observatory mission. Programmatic and science metrics will be developed with community input to demonstrate benefits and to identify how operations and the user community will capitalize from the project's completion.

Currently there are 3 working groups that have been assembled from the community to provide input into the planning and development of the GNAO/RTC and TDA projects. These include a TDA Working Group, which was formed to advise the Observatory on the implementation of Gemini's role in the AEON time-domain follow-up network, a GNAO Science Working Group, formed to develop the science cases for GNAO from which the technical requirements flow, and an AO Working Group, which provides technical advice on the design of the GNAO system.

During the first six months of the program, Gemini maintained a web form on the GEMMA website for members of the larger community to provide ideas relevant to planning the GEMMA execution. Now, we are in the process of creating a dedicated email address for gathering GEMMA-related questions and input from the community; this email address will be advertised through Gemini's standard communication channels, including the monthly e-Newscast, quarterly Gemini Focus, and regular social media posts.

In addition, we have advertised the GEMMA program and solicited community input at the AAS meeting and other venues; we will continue to do this at future meetings (e.g., the upcoming 2020 Gemini Science Meeting). Thus, community input has already played an important role in the early stages of the GEMMA program, and we expect that this will be the case throughout the lifetime of GEMMA.

### **15.2 Audits and Reviews**

Gemini will provide comprehensive written reports twice a year, in March and September and, if required by NSF, additional ad hoc reports. These reports shall complement the observatory's usual reporting (as outlined in CSA AST-1539773) and will specifically focus on the technical, schedule, budget, and risk status of the three projects referenced above in 2.1.B funded by this award. A final report will be submitted ninety days after the period of performance end date.

All reports will be submitted per the CSA programmatic reporting requirements. Each report will be shared with the Gemini Board and its Science and Technology Advisory Committee prior to their twice-yearly meetings.

## **16 Integration and Commissioning**

### **16.1 Integration and Commissioning Plan**

When the project nears the final product delivery an Integration and Commissioning plan will be developed. This will be based on the outcomes of the Systems Engineering Development efforts. The following items will be addressed as applicable for GNAO+RTC:

- Pre-assembly and Testing
- Integration
- Verification and Validation
- Pre-shipment Review
- Reliability and Cost of Ownership
- Installation plan
- Manuals
- Spare parts lists
- Maintenance plan
- Shipping

### **16.2 Acceptance / Operational Readiness Plan**

Please refer to the Acceptance Test Plan listed in in the individual project PEPs.

## **17 Program Close-out**

### **17.1 Program Close-out Plan**

An internal Closure Report will be completed at the end of the award period of performance

### **17.2 Transition to Operations Plan**

When the projects nears the final product delivery an Integration and Commissioning plan will be developed to transition to operations.

# 18 Appendix A: Support Documents

## 18. 1 Response to NSF Comments

GEMMA PEP Document Package		
GEMMA PEP		
Page	Section	Comment
7	Exec Sum.	<p>The GEMMA PEP will be updated annually; is the plan to submit the PEP to NSF as an annual report each year and as a report to the Gemini Board of Directors (GBOD) and Science &amp; Technology Advisory Committee (STAC)? This would probably work for NSF, provided sufficient budget information was included. (Our goal here is to avoid unnecessary reporting requirements.) NSF strongly encourages Gemini to include detailed milestones and clear tracking of progress in all reporting.</p> <p><i>Gemini Response: The GEMMA program will follow the CSA Programmatic Terms and Conditions 2.3 and submit a comprehensive annual report by September 30 each year. The annual report will specifically report on the technical, schedule, budget, and risk status of the three projects against performance indicators and milestones set forth in a Program Execution Plan (PEP). The comprehensive reports will be provided to the STAC and Board prior to their semi annual meetings</i></p>
13	2.3	<p>Please ensure all scope covered by this award is identified somewhere in the WBS.</p> <p><i>Gemini Response: A rollup table of the WBS for projects and program is included in section 2.3.</i></p>
15	3.2	<p>The GEMMA Program Management Matrix displayed on page 15 and described in the program resource allocation table attached to the Scope Management Plan suggests a fairly complex management structure (a GNAO-specific version is presented in the GNAO PEP, with emphasis it seems placed on the Project Manager).</p> <p><i>Gemini Response: The successful completion of GEMMA is the highest priority given the nature and requirements of the NSF award and for the long term scientific success of Gemini, it is also critical that Gemini is successful with other development projects, including: completing GHOST and SCORPIO, completing GeMS upgrades in the near-term, completing GNAOI</i></p>

		<p>in time for use with GEMMA, implementation of an adaptive secondary mirror, and other projects.</p> <p>Given the interdependencies with the development projects and in particular, GNAO+RTC a decision was made to combine GNAO and RTC into a single project under a single principle investigator and project manager. With this change the GNAO project manager will now report directly to the Deputy Director.</p> <p>A newly formed GEMMA Executive Committee (GEC) chaired by Deputy Director, Henry Roe will ensure a simplified flow of authority down through the GEMMA organizational structure, the flow of escalation and responsibility up essential for GNAO+RTC success. The GEC will monitor schedule, cost, scope and resources and adjust resource allocation within the observatory to ensure the success of the GEMMA Program by making GEMMA the top priority of the observatory.</p> <ol style="list-style-type: none"> <li>1. Please expand on the relationships between the GEMMA Program Manager, the Portfolio Manager, the PI, the Program Sponsor and the individual Project Managers. What is the role of the Assoc. Director for Development in this program? Who has absolute responsibility for each project? <p><i>Gemini Response:</i> With the new structure described above the Portfolio Manager and the Assoc. Director of Dev. are members of the GEC and participate in resolving issues brought to the group. The program manager will report programmatically to the GEC. The project manager has authority and responsibility for the project, however the GEC has significant decision making authority for issues related to resources, cost, scope and schedule. Issues can be escalated to the GEC by the program manager when deemed necessary. Weekly meetings with the GNAO+RTC PI and PM will help to ensure issues are resolved quickly and or brought to the attention of the GEC and if needed the Director.</p> </li> <li>2. If the Project Manager needs resources quickly, who has the power to allocate those resources, and how will the Project Manager communicate with that person? Will it be through the Program Manager and/or Portfolio Manager? <p><i>Gemini Response:</i> Resource concerns will still be addressed at the first level by the Portfolio Manager and Project Managers and functional Managers. If competition for resources creates a risk to the GEMMA projects, either the Portfolio Manager, the Program Manager and or the Project Manager or Principle Investigator can escalate to the GEC for resolution.</p> </li> <li>3. How will the program cope with the different time zones of the various managers: e.g. for GNAO, the Program Manager is in Tucson, the Program Scientist is in Chile, the Program Support person is in Hilo, and the Project Manager is (presumably still) in the U.K.</li> </ol>
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		<p><i>Gemini Response:</i> The creation of the GEC is an attempt to resolve issues created by a distributed workforce. The Deputy Director is in Chile and is available to staff in the south, the Program Manager has relocated to Hilo and is more accessible to staff in Hilo and GNAO+RTC project management is done by a project manager in Hilo and a PI in Chile. The interim Project Manager, S. Goodsell is transitioning back to other development duties. Weekly meetings between the GEC Chair, the Program Manager and the GNAO+RTC PM and PI will help resolve communications issues at that level. The GEC will meet at least monthly or more often if needed to further communication and problem solving.</p> <p>4. How will Gemini ensure that everyone involved in the GEMMA project is fully up-to-speed on developments?</p> <p><i>Gemini Response:</i> Given the number of staff that move in and out of GEMMA, Development and Operations projects and other observatory functions, the tentative plan is to provide a weekly GEMMA update observatory wide. This was done during the initial PEP writing and obviously needs to be resumed.</p>
18	3.6	<p>The public web page is a great idea and is a useful tool for communicating progress to the community and stakeholders. However, NSF requests that for this NSF-funded program of activities the NSF “logo” be clearly displayed at the top of the page. Further guidance is available here: <a href="https://www.nsf.gov/policies/logos.jsp">https://www.nsf.gov/policies/logos.jsp</a>.</p> <p><i>Gemini Response:</i> The GEMMA web page now displays the NSF logo at the top of the home page.</p>
19	4.3	<p>The milestones and deliverables that are on the Critical Path should also be identified. It is clear these may change as the project progresses, but it is still beneficial to have an awareness of what they are at the start of the project.</p> <p><i>Gemini Response:</i> The revised milestone and deliverables are a table inserted into section 4.3 in this revised program PEP.</p>
20	4.3	<p>Is completion of the “Build and deliver GNAO RTC” a predecessor event to either the Telescope Integration Stage or the Telescope I&amp;C Phase?</p> <p><i>Gemini Response:</i> Yes, the build and deliver phase is a predecessor event to the integration and commissioning phase.</p>
21	4.3	<p>The Integration and Commissioning milestone completes nearly 4 months ahead of the completion of the Real Time Pipelines. Are the RT pipelines not part of the TDA commissioning?</p>

		<p><i>Gemini Response:</i> We are aiming to integrate the Pipelines as soon as the availability of GMOS Long Slit spectroscopy is ready, in a quick look mode - that will allow a PI to assess the quality of their data and decide what to do next. However, the project is aiming to also provide science quality data reduction software as well, but in the plan we are not waiting for that to be completed to declare integration complete.</p>
27	5.8	<p>This is an important paragraph to establish policy to protect against mischarging between awards. It would be good to include words that speak to instances where there may be shared services (e.g. travel for GEMMA that gets coupled with some Gemini activities) and also provide instruction on where/who staff should consult if they are ever uncertain on what/how to charge time.</p> <p><i>Gemini Response:</i> The policy in draft form written by D. Calabrese at LSST was requested to use as a template to address the issue. Once we have the draft we can then modify it with the line of authority to make the determinations. Currently the Program Manager is making decisions on a case by case basis in consultation with the Portfolio Manager, HR, CAS Procurement and Project Managers.</p>
27	5.9	<p>The program needs to develop a <b>resource-loaded schedule</b> showing all activities including predecessor and successor links. This should be a controlled document and a reference to its location (document number) should be included in the PEP.</p> <p><i>Gemini Response:</i> This is currently being done and will be included with the revised Program PEP.</p>
27	6.1	<p>The staffing plan notes that the “GEMMA program management team consists of the program scientist, project managers, project scientists and sponsors for the four projects”. Will the Program Manager and Portfolio Manager be involved in the program management team?</p> <p><i>Gemini Response:</i> This structure has changed with the creation of the GEC. Both the Program and Portfolio Manager are members of the GEC. The Program Manager will still hold monthly program team meetings with the Chair of the GEC, the project managers, project scientists, project coordinators, systems engineer and in the case of GNAO+RTC the PI.</p>
30	8.3	<p>There should be interface plans developed between each of the projects and not just within individual projects.</p> <p><i>Gemini Response:</i> The newly established GEMMA Program structure, in which all the projects report up to a single Executive Council, provides for a seamless interface between the GEMMA projects via a common communication channel.</p>

30	9.1	<p>The Configuration Control Plan should be developed at the top level (GEMMA) and applied to all sub-projects (GNAO, RTC, etc.)</p> <p><i>Gemini Response:</i> This is currently being undertaken by the Project Support Department.</p>
32	11.2	<p>The Estimate to Complete (ETC) Earned Value (EV) metric should also be calculated regularly and via a bottoms-up estimate at least once annually. The EV metrics (EV, PV, AC, SV, CV, BAC, EAC) and ETC should be reported in regular (quarterly) reports; the ETC should be calculated as Estimate At Completion (EAC) minus Actual Cost to date.</p> <p><i>Gemini Response:</i> Entering the projects and program in Microsoft project will allow the use of EV. However, given contingency (complexity) is included in each individual cost, it will be very hard to track and use. For example, if the project were running exactly to plan, it would appear to be under spent (because the complexity wouldn't be being used). But, the project wouldn't be under spent, it would be running exactly to plan -- we just wouldn't be using the contingency (yet). Identifying trouble spots would be harder, too, as another example. Instead of looking for tasks that are the most overspent, project managers will need to look for tasks that are the least under spent (unless a task is really off the rails).</p> <p>A second issue is whether Gemini can move complexity dollars between line items if the need is in a different line item. Or is the dollar amount of complexity "locked" into that line item.</p> <p>This is an issue that we are trying to resolve internally before requesting a review by the NSF on how complexity is applied.</p>
36	15.1	<p>Here the PEP notes that programmatic and science metrics will be developed with community input. Please briefly expand on the process and expectations.</p> <p><i>Gemini Response:</i> Described in section 3.3 There are currently 3 working groups that have been assembled from the community to provide input into the planning and development of the GNAO/RTC and TDA projects. These include a TDA Working Group, which was formed to advise the Observatory on the implementation of Gemini's role in the AEON time-domain follow-up network, a GNAO Science Working Group, formed to develop the science cases for GNAO from which the technical requirements flow, and an AO Working Group, which provides technical advice on the design of the GNAO system. During the first six months of the program, we maintained a web form on the GEMMA website for members of the larger community to provide ideas relevant to planning the GEMMA execution.</p> <p>We are in the process of creating a dedicated email address for gathering GEMMA-related questions and input from the community; this email</p>

		<p>address will be advertised through Gemini’s standard communication channels, including the monthly e-Newscast, quarterly Gemini Focus, and regular social media posts. In addition, we have advertised the GEMMA program and solicited community input at the AAS meeting and other venues; we will continue to do this at future meetings (e.g., the upcoming 2020 Gemini Science Meeting). Thus, community input has already played an important role in the early stages of the GEMMA program, and we expect that this will be the case throughout the lifetime of GEMMA.</p>
<b>GEMMA Program Plan</b>		
4	6	<p>Assigning multiple individuals to the same WBS work package may result in confusion on who has ultimate accountability for the work. Please consider changing the “Assigned” category to “Accountable.” Creating a “Responsible, Accountable, Consulted, and Informed” (RACI) matrix is in line with project management best practice.</p> <p><i>Gemini Response:</i> Pertaining to the WBS for the Program, this is addressed in a revised WBS in section 5.2 that will address time spent on the work package. As well, a RACI matrix can be developed to reduce confusion.</p>
5	6.3	<p>Are there AURA acquisition principles that apply to all procurements, such as three-source competitive procurement, sole source justification, review and approval authorities? It might be useful to refer here to overarching AURA procurement guides to ensure uniformity across all sub-projects.</p> <p><i>Gemini Response:</i> In section 10.2 of the Program Execution Plan, a link to the AURA procurement policies and procedures is given. All projects are aware they must follow the AURA policies. All procurements are entered into the Reqless purchasing system and in order to proceed with a purchase the requestor is asked to verify allowability, including any request for single source purchasing.</p>
<b>GEMMA Scope Management Plan</b>		
5	2.5	<p>The intent of the table delineating “In Scope” and “Out of Scope” is valuable. As written it is not clear how the determinations were made. For example, the table states that the responsibility for quality of deliverables is out of scope. It seems logical that the GEMMA Program Manager would be responsible for the quality of deliverables and thus this would be an in-scope activity. Please clarify.</p> <p><i>Gemini Response:</i> The Program deliverables are indeed within scope and the quality of those deliverables is the responsibility of the Program Manager. To clarify, the out of scope quality of deliverables pertains to the individual project deliverables.</p>

5	3	<p>The definition of the acronyms “GPO” and “CMP” could not be located. Do “CCMP” and “CMP” represent the same thing?</p> <p><i>Gemini Response:</i> The Configuration and Change Management Plan, (CCMP), Change Management Plan (CMP), project specific) are now included in the Program PEP acronym list. GPO is the GEMMA Program office and now replaced with the GEC.</p>
<b>GEMMA Internal Communications Plan</b>		
1	..	<p>In the Communications Matrix, who is the “Project Coordinator”, what is their relationship to other senior personnel in the program and in each project, and how will logged “issues” be converted to trackable risks or change requests?</p> <p><i>Gemini Response:</i> Currently, each project has an assigned “project coordinator” (role described in section 3.2. Each project manager establishes how the coordinator will track issues and in what time frame they will be addressed in a change request and or risk register.</p>
<b>GEMMA Risk Management Plan</b>		
2	2	<p>The paragraph, as written, could be interpreted to say that Program metrics establish program risks. Program risks may or may not be associated with a defined program metric. All risks, quantitative and qualitative, should be identified, assessed, monitored, and if possible mitigated, during the lifetime of the program. Please add some clarification to this introductory paragraph regarding the purpose of program metrics in the context of program risk management.</p> <p><i>Gemini Response:</i> Agreed, clarification will be made in section 7.1 of the Program execution plan.</p>
2	2.1	<p>Sects. 2.1 and 2.2 describes a “risk management advisory board”, though also implies that this advisory board may not in fact be convened. Without such a group, how will the Program Manager ensure that all Project Managers and other internal stakeholders are fully aware of the risks associated with each project, particularly cross-project risks? There is a clear inter-dependence between the GNAO and RTC projects, for example.</p> <p>If the board is convened, who will be on the board, and how often will this group meet? The last sentence in the second paragraph states that the risk advisory board should meet at an appropriate interval based on the length of the program. The GEMMA program length is known and thus the meeting time and interval should be established, e.g. every 6 months, 4 weeks in advance of submission of the NSF semi-annual report.</p>

		<p><i>Gemini Response:</i> The recent restructuring of the program governance will now deal with issues related to risk. The GEC serves as the Risk Advisory Board for the GEMMA Program. The GEC will meet at least monthly to review project risks. Risks may be escalated to the full Directorate if deemed necessary.</p>
3	2.2	<p>Similar to the first comment above, the references to program metrics in the context of a risk management program is a bit distracting and confusing. Program risks should not be construed to be a function of program metrics.</p> <p><i>Gemini Response:</i> Agreed.</p>
3	2.2	<p>What (if any) external groups will be involved in risk assessment and tracking? (Similarly, what external groups will be involved in assessing performance and progress?) How will the results of this assessment be communicated to NSF and the Gemini Board?</p> <p><i>Gemini Response:</i> Risk is reported to the directorate and then to AURA in simple risk. The working groups for GNAO+RTC, and TDA may be advised of risks to elicit feedback as advisory.</p>
3	2.2	<p>Defining the scales for assessing impact and likelihood is good. However, having 2 levels of impact (4-5 and 1-2) with the same definition blurs the distinction between those levels. This same comment applies to the scale definitions for Likelihood (Sect. 2.2.2). With the current definitions NSF recommends reducing the scales to a range from 1 to 3.</p> <p><i>Gemini Response:</i> Agreed this may cause some blurring of the levels. However, the current PMO methodology for project, program and risk all use this scale which then rolls up to AURA Simple Risk. Altering the scale would have an impact beyond the GEMMA program.</p>
4	2.3	<p>Mitigation plans and action plans are not the same thing and should not be used interchangeably. Mitigation plans are intended to minimize or prevent a risk from occurring. Action plans have no standard definition in risk management. The better term is “Risk Response” to describe actions to be taken should a risk be realized. Also, not all risks require a mitigation plan. Risks can be Accepted, Avoided, Transferred, or Mitigated. Similarly, not all risks require an action plan, only those that have significant impacts.</p> <p><i>Gemini Response:</i> Agreed, risks will be further identified for an action plan.</p>
4	2.4	<p>Per Project Management Institute guidelines, contingency plans are also referred to as Fallback plans. Given that Contingency has special meaning for NSF, it is preferred GEMMA use the term “Fallback Plans.”</p> <p><i>Gemini Response:</i> The word “fallback” will be used in the PEP so as not to conflict with NSF definition of contingency. However, the PMO</p>

		methodology that projects are using will continue to use contingency in relation to risk.
4	2.7	<p>Mitigation of a risk does not mean the risk is eliminated without impact. Risk mitigation are actions taken to reduce the impact or likelihood of a risk. Risk mitigation may consist of a single action (e.g. buying currency futures to hedge against fluctuations) or multiple actions (e.g. regular safety inspections/training) and typically do not eliminate a risk. Risks should only be closed if they have been realized, expired, or are no longer relevant.</p> <p><i>Gemini Response: Agreed, section will be revised to reflect above.</i></p>