Preliminary Report of the GBS Sub-Committee to AAAC

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Charge

Assess scientific utility and priorities for the Blanco, SOAR and Gemini Telescopes for the first half of the upcoming decade

- Complementary data for LSST, multi-messenger, time domain, dark energy
- Evaluation of highest impact science given planned instrument complements
- Assessment of whether US share is adequate
- Identification of modes of multi-facility use
- Aspirations for improved instrumental and AO capabilities

Our interpretation

We consider Gemini, Blanco and SOAR telescopes to be three parts of a multi-facility “GBS” system, and develop an assessment of its scientific utility for the first half of the 2020’s, given the likely priorities of the US astronomical community.

The purpose of our report is to provide NSF with timely advice on the renewal of agreements for two of the GBS facilities, and DOE on whether there is need and priority for use of these facilities to enhance Dark Energy investigations.

We will identify missing capabilities and point to benefits attainable when operating the facilities as part of an OIR system.

GBS Sub-Committee Membership

Klaus Honscheid, Chair	Ohio State University
Federica Bianco	NY University
Ian Dell'Antonio	Brown University
Phil Hinz	University of Arizona
Lynne Jones	University of Washington
Alex Kim	Lawrence Berkeley National Laboratory
Phil Marshall	SLAC National Accelerator Laboratory
Gregory Rudnick	University of Kansas
David Sand	University of Arizona

Schedule

8/15/2018	Charge received, Committee established
8/24/2018	First committee meeting (telecon)
10/13/2018	In-person meeting @ NOAO, Tucson
11/6/2018	Preliminary report to AAAC

What is reported today and written on these slides are the committee's current considerations and preliminary findings. As is the nature of preliminary findings, they can and will change until we present our final report.

Feb. 2019	Final report to AAAC

Our approach to address the charge questions

Weekly telecons

Shared work area for reference documents and draft using a cloud service

Team split into sub-groups to address science cases:

- Small bodies
- Exoplanets
- Star Formation
- Stellar Astrophysics
- Supernovae and Variables
- Galaxies
- Dark energy and matter
- Multi Messenger

Separate section on tools for OIR system

GBS Sub-Committee Meeting @ NOAO Oct 13, 2018

Agenda

8:30	Introductions	
9:00	OIR - A few years later	(Deborah Elmegreen, remotely)
9:30	Tools for an OIR System	(Stephen Ridgeway)
10:00	Blanco	(Steven Heathcote)
	Coffee Break	
11:00	Soar	(Jay Ellias)
11:30	Gemini	(Jennifer Lotz)
12:00	Working Lunch	
1 – 4	Committee work session, group meetings	
4:00	Community Perspective on LSST	(Beth Willman)
4:30	Antares, AOEN	(Adam Bolton)
5:00	Group reports, wrap up, next steps	
5:30	Adjourn	

We would like to thank everybody for taking the time to talk to us and for the excellent presentations

A first glimpse at our report

Outline

- Executive Summary
- Introduction
- The GBS System
- Science with the GBS System
  - Small Bodies, Exoplanets, Variables and SNe, Multi Messenger, Star Formation, Stellar Astrophysics, Galaxies, Dark Energy and Dark Matter
  - Science, Impact of GBS, Missing capabilities, Benefits of OIR System, Assessment table
- Opportunities for a multi-facility GBS system
- Conclusion and assessment of the US share
- Appendices

One Example: Multi-Messenger Astronomy

Science:

Gravitational Waves

The advanced detectors (LIGO/Virgo) will start the next run with increased sensitivity next February.
Numerous binary black hole, neutron star – neutron star, and neutron star black hole mergers with possible electromagnetic signature
Localization uncertainty on sky between 10-100 deg^2.
Requires same night optical and NIR imaging and high cadence spectroscopy.

Neutrinos

0.1 - 1 PeV neutrino alerts from IceCube (Blazars, core collapse SNe) at a rate of a few per month.
Localization uncertainty on sky ~1 deg^2.
Requires imaging and spectroscopy.

GBS: DECam+Blanco are unsurpassed for localization.
Gemini/Flamingos-2 can be used for pure red kilonovae.
Gemini is well setup for intense optical and NIR imaging and spectroscopy campaign at high cadence (daily). SOAR can do the same for brighter objects.

Missing: NIR imager on SOAR to follow up red kilonova events

OIR System: Significant benefits from an ANTARES/AEON like system expanded for MMA alerts. Has to be able to take in input from multiple teams. Encourage development of a public search for optical MMA signatures with Blanco+DECam

Preliminary Findings (1)

The sub-committee finds the science opportunities for Gemini, Blanco, and SOAR for the first half of the next decade compelling. All three telescopes are great assets for the US OIR program.

- Preparations are well underway to support time domain science in the LSST era and should continue to be a high priority.
- The GBS system provides strong support for multi-messenger astronomy.
- The traditional science areas reviewed by the sub-committee can be done excellently with the GBS system.
- A balance between small and large PI-driven programs and the ToO program has to be found.

The sub-committee encourages NSF to extend the Gemini cooperative agreement.

Preliminary Findings (2)

The NSF focus on multi-messenger astronomy and time domain science is supported by all three telescopes.

The sub-committee is considering several suggestions to help strengthen this efforts.

For example:

- Queue observing is available for SOAR and Gemini and should also be made available for the Blanco.
- Establish a telescope time exchange program for the US community as suggested by the Elmegreen report. This could be the first step toward more extensive collaboration between public and private US facilities.
- Continue to evolve the TAC process to allow for coordinated ToO requests while maintaining support for PI-based programs.
- Address proprietary data issues and develop schemes to coordinate competing proposals for the same alerts

Preliminary Findings (3)

The DOE focus on dark energy science is primarily supported by all three telescopes in the time domain. The Alert Broker system is critical for this.

> GBS resources together suit the range of SN Ia magnitudes, need for spectroscopy, and the supplemental optical and NIR photometry necessary for the classification of SNe Ia from among LSST-discovered transients, determination of their redshifts, and improvements in the determination of their absolute magnitudes.

GBS spectroscopy supports probes of dark matter physics using dwarf galaxies and stellar streams. Spectroscopy of cluster galaxies provides critical calibration of photo-z's to enable cluster cosmology.

Gemini AO assisted imaging and spectroscopy will be needed to use hundreds of LSST time delay gravitational lenses for cosmology

Missing from the GBS portfolio is a multi-object spectrograph like DESI or PSF in the southern hemisphere, ideally on an 8 m class telescope, which is needed for photometric redshift training and possibly calibration.

Preliminary Findings (4)

The sub-committee encourages continuing support for the development of software infrastructure and tools for time domain science in the LSST and LIGO era.

Community input and contributions should be encouraged and solicited as developments of alert brokers, target and observation management platforms and dynamic scheduling systems continue.

The different components of such an observation network should have standard interfaces that can accept streams from other alert producers or external observation requests.

Issues regarding proprietary data need to be addressed and balanced against efficient use of resources. In some cases public follow-up campaigns could be appropriate.

Preliminary Findings (5)

Gemini instrumentation continues to improve. Continuation of this program and expeditious commissioning of the new facility instruments has to remain a high priority. A recent NSF award will help improve adaptive optics capabilities at both sites which is of great importance to many science programs. Continuing development of AO assisted imaging and spectroscopy has to remain a high priority.
The sub-committee supports the planned move of GPI to Gemini North.
The sub-committee suggests that Gemini finds a way to strengthen support for the visitor instrument program.

By the middle of the next decade, DECam will be 13 years old. The sub-committee suggests that NOAO/NCOA starts to develop a plan for future instrumentation for Blanco and SOAR telescopes. NOAO should consider including the Mayall as well as the DESI survey will come to an end in the same time frame.

A capable NIR imager on a 4-m telescope is missing from the GBS portfolio.

A high throughput, wide wavelength (0.3 – 2.4 microns), low resolution (R ~50-100) spectrograph on a 4-8 m telescope is missing from the GBS portfolio.

A wide field, multi-object spectrograph on an 8-10 m class telescope in the southern hemisphere remains missing from the US OIR portfolio. Efforts should continue to explore options for such a facility for the second half of the next decade.