14 A General Observer Program

Ronald Allen (STScI), **Charles Beichman** (NExScI), **Stephen Unwin** (JPL), and
Todd Henry (GSU)

ABSTRACT

We anticipate the demand for, and the possible parameters of, a General Observer (GO) program for SIM Lite. This program would enable researchers in the astronomy community to share in the promise of precision astronomical science by carrying out their own research projects with SIM Lite. In general, the program would operate in a fashion similar to those put in place for other NASA missions of comparable cost and capability. However, there are several important differences owing to the special nature of SIM Lite's measurement process. In addition, some observing programs may require long lead times in order to carry out lengthy preparatory work.

14.1 Introduction

SIM Lite will provide astrometric data (positions, parallaxes, and proper motions) on stellar targets with unprecedented precision. Accurate parallaxes permit precise determinations of distances to, and hence luminosities of, astronomical objects. Precise proper motions provide vital data on the gravitational forces that govern the movement of astronomical objects, and, hence, provide information on the masses of and the mass distributions within these objects. SIM Lite data will be relevant for precision science on a wide variety of topics in general astrophysics and exoplanet research, and the demand for this capability is bound to grow as researchers become aware of it. SIM Lite is also being built with public funds and therefore ought to be open to the scientific research community for merit-based, peer-reviewed research proposals. NASA has always intended this, so the SIM Project has kept about 30 percent of the five-year mission time as yet unallocated. The precise balance between new "Key Projects" and smaller "General Observer (GO) Projects" has not been addressed in any detail. Here we take the first exploratory steps in defining a more comprehensive framework for a program whereby NASA can provide opportunities for the broader astrophysics research community to participate in the SIM Lite mission and to compete for unassigned SIM Lite observing time.

A variety of observing programs will be carried out with SIM Lite. Already envisaged are 10 Key Projects, five Mission Scientist Projects (http://planetquest.jpl.nasa.gov/SIM/sim_team.cfm), special projects carried out in Director's Discretionary Time, and a necessary allocation for engineering and calibration. The possibility that there could be a GO program for SIM Lite was acknowledged at an early stage of the project, and the first "SIM book" announced such a program in 1999. The goal of this chapter is to update those plans taking into account various advances that have been made in the intervening years and to provide a paradigm for such a program. We have taken a wide view of the topic, and left many important details to a future discussion of the implementation of this plan.

We anticipate that all remaining unallocated observing time on SIM Lite will be treated as GO time, to be assigned through a competitive peer-reviewed process. As we describe, GO projects may vary in size from the determination of distance to a single target to projects as large in size and cost as the current Key Projects.

14.2 Objectives and Examples

14.2.1 Objectives

The objectives of the GO program for SIM Lite are:

1. To enhance the scientific productivity of SIM Lite by enabling the broad participation of the astronomical community.
2. To simplify the processes of observing, reducing, and calibrating high-precision astrometric data so as to make SIM Lite measurements accessible and useful to the broad community.
3. To provide advice and support tools to the members of the community so they can explore and exploit the astrometry relevant to the research projects being carried out.

14.2.2 Examples of Possible GO Programs

By way of illustration, we list here several examples of programs that could fall in the GO category. We emphasize that these are meant only as examples, and that GO programs will not be limited to these categories. Examples might include:

- Measurement of the orbital parameters for a new list of extrasolar planet candidates determined, for example, from planetary transits.
- Measuring the astrometric parameters of a specific (small) set of stellar targets in the Galaxy in order to determine distances, kinematics, and precision spectral energy distributions (SEDs). Examples might include galactic globular clusters, a list of white dwarfs, etc.
- Synthesis imaging of compact stellar groups in order to provide high-dynamic-range structural information. The angular resolution will approximately correspond to that of a telescope with a diameter equal to SIM Lite's baseline.
- A precise distance measurement to a specific faint target star.

14.3 Current Status of SIM Science Observing Time Allocations

Approximately 36 percent of the nominal five-year baseline mission was competitively awarded to a Science Team selected by NASA Headquarters through the first Announcement of Opportunity (AO-1) in 2000. The current flight time allocations are shown schematically in Figure 14-1. The team currently consists of the Principal Investigators (PIs) of 10 Key Projects and their Co-Investigators (Co-Is) and five Mission Scientists and their Co-Is. Key Projects require both significant amounts of time on SIM Lite over the entire nominal mission lifetime and significant preparatory science in order to make effective use of that time. Mission Scientists were selected for their specific expertise in support of SIM Lite and have smaller time allocations for their science. The nature of the preparatory work varies by project and includes candidate target list preparation, observation and characterization of candidate targets, modeling of astronomical phenomena and SIM Lite observations, and theoretical studies.

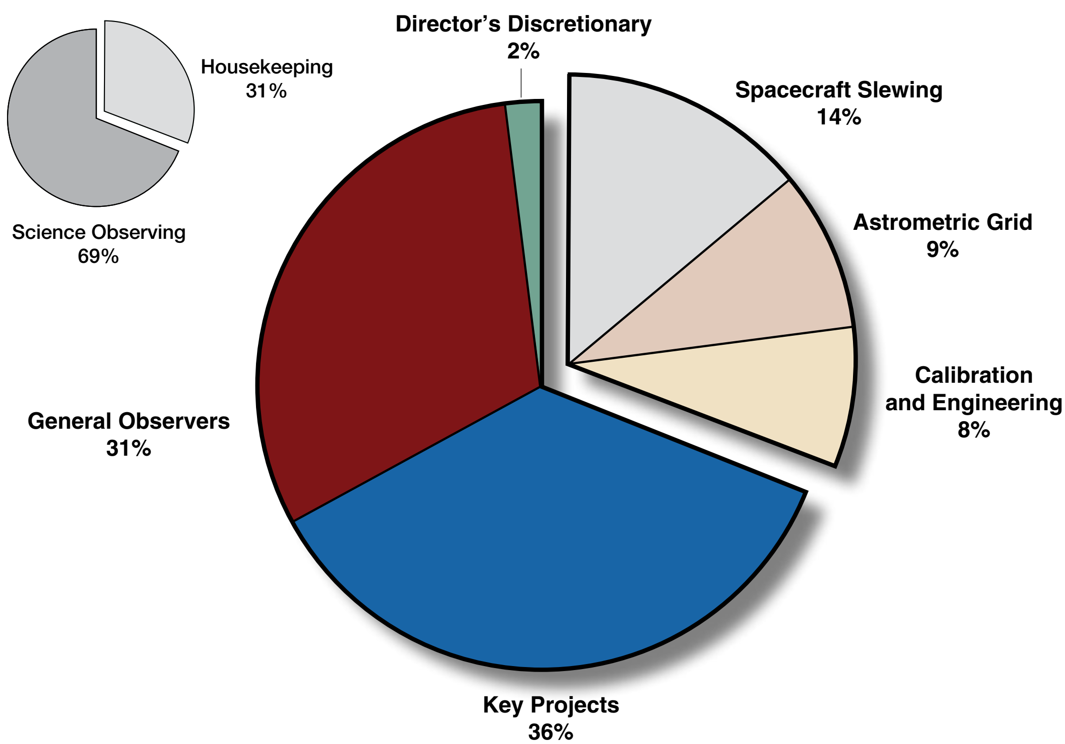

Figure 14-1. Current observing time allocations.

The SIM Lite mission has suffered unanticipated delays owing to a shortage of funds in NASA and is currently "on hold." In the meantime, the ESA mission Gaia has moved from concept studies to implementation. SIM Science Team members are therefore presently re-evaluating their projects in order to optimize the science they will do with SIM Lite. The changes are primarily intended to take account of recent advances in astronomy and to avoid unnecessary overlap with Gaia, while at the same time remaining within the confines of the specific science goals initially approved for each investigation.

Concerning a comparison of SIM Lite's capabilities with those of Gaia, it is important to note the following points:

1. SIM Lite remains superior in its astrometric precision throughout the range of stellar magnitudes accessible to Gaia.
2. Gaia cannot observe bright targets with $V < 6$ and the mission precision for faint targets ($V > 16$) is significantly less that what SIM Lite can achieve.
3. SIM Lite is unique in its ability to focus quickly on new targets in order to address new science.
4. SIM Lite is flexibly scheduled, allowing optimal observing of, for instance, binary stars or variable QSOs.

After the addition of mission time for calibrations, measurement of the grid stars, and miscellaneous engineering work, approximately 30 percent of the observing time on SIM Lite remains available for GO programs during the prime mission (first five years). Should an extended mission be approved, an additional GO call would be held toward the end of the prime mission, to re-compete all of the science. As well as continuing those programs that benefit most from the longer time baseline (e.g., proper motions), a second GO call would provide an opportunity for a fresh set of science investigations. The SIM Science Studies proposal call (Chapter 13) provides ample evidence of new ideas awaiting observations with this unique instrument.

14.4 A Framework for a SIM Lite GO Program

The concept of "Proposal Cycles," as used, e.g., by the Hubble Space Telescope, Spitzer Space Telescope, or Chandra X-Ray Observatory, will be different for SIM Lite. In that concept, essentially 100 percent of the available mission time for a limited period (e.g., one or two years) is fully subscribed, and is followed by another cycle to subscribe the next period. Since most SIM Lite observing programs require observations spread over an extended period, with many requiring the entire prime mission of five years, SIM Lite observing time will instead be allocated in mission slices, which are a percentage of the available time but may be spread through a duration of five years. In addition, analogous to the Key Projects, some large GO projects will require extensive preparatory work, whereas others may not. Figure 14-2 sketches time lines for examples of different kinds of GO programs envisaged with SIM Lite. In this figure, typical mission slices are shown as broken horizontal bars extending for various fractions of the nominal mission time. There are no "cycles" in the usual sense.

SIM Lite GO programs will fall into several categories depending on the amount of preparatory work, the required observing time, and the extent of the data processing and analysis required:

1. Large Programs: These are typically of the same scope and size as the existing Key Projects. They require significant preparatory work, observations spread over the entire prime mission time, and major analysis work after the data set is complete. (Example: study of a new set of planetary systems revealed by new transit data.)

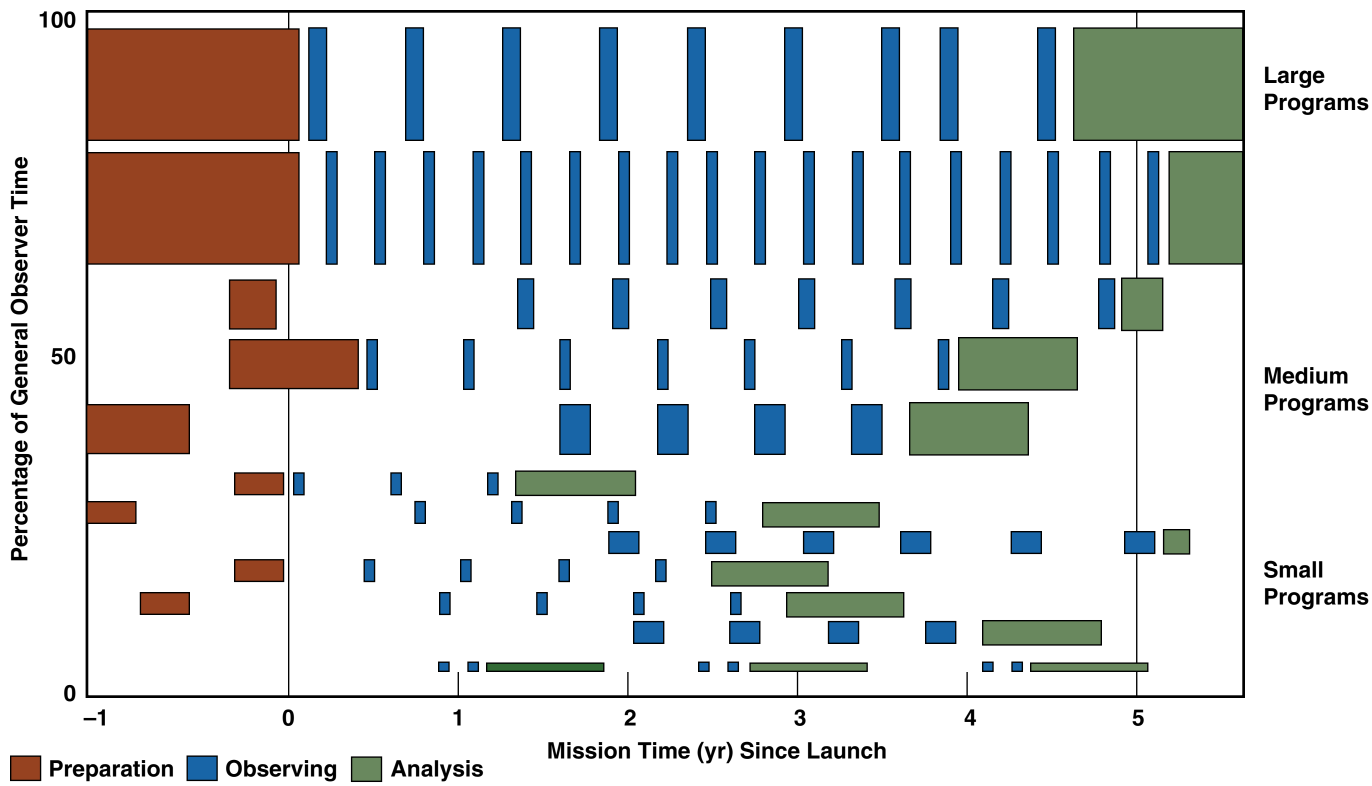

Figure 14-2. Schematic timelines for sample SIM Lite programs.

2. Medium Programs: These require only a modest amount of preparatory work, involve only a modest number of targets, require only a few observations per target over the prime mission, and need modest amounts of analysis work afterwards in order to get the science results. (Example: Proper motions of stars in an open cluster in the Galaxy.)
3. Small Programs: These typically require little or no preparatory work, involve a few targets with a handful of observations per target, and require little analysis to obtain the result. (Example: A distance to a white dwarf.) Certain targets of opportunity (TOO) may fall in this category, such as Galactic novae or cataclysmic variable stars, and certain types of microlensing events. For reasons of cost in the planning and scheduling, TOOs must meet a number of restrictions.

14.4.1 Anticipated Proposal Load Per Cycle

Proposal pressure will be the major factor driving the relative balance among the different categories of proposals listed above; this is difficult to estimate with any accuracy at present. However, some rough guess of the proposal load during a typical cycle is needed in order to estimate the resources required to support it.

We presume here that the best science is achieved with a balanced program of large, medium, and small proposals. A possible distribution could be as follows: 3 to 5 large requests, on the same order as the existing Key Projects, might be received; only 1 to 2 would likely be selected. We might reasonably expect 10 to 15 medium-sized requests, and selection of 5 to 6. Finally, small proposals, perhaps as simple as precision parallaxes of a single object or small group, could well be numerous, and half of the 40 to 60 requests might be selected.

14.4.2 Schedule

A significant complication in planning the schedule for release of announcements of observing opportunities with SIM Lite is the necessity to allow for preparatory work, which in some cases means additional ground-based observations and may require long lead times prior to the start of observations with SIM Lite. The GO Announcement of Opportunity must, therefore, be issued well before the anticipated launch of SIM Lite and proposers must explicitly address the questions of preparatory work and lead time. Judging from experience with the current Key Projects, three to four years before launch sounds reasonable.

The following draft schedule is proposed. This schedule has a symbolic launch date for SIM Lite of “L” and intervals are measured in years:

- L-4.0 — Announcement of the plan to release the GO Proposal Call, at a winter AAS meeting.
- L-4.0 — GO planning resources on line; e.g., web-based SIM Lite exposure time estimator, Reserved Observation Catalog.
- L-3.5 — GO Proposal Call released; procedures and forms online, help desk online, support website online, start posting FAQs on support website.
- L-3.5 — Proposal Workshop (a webcast, linked to a summer AAS meeting).
- L-3.0 — Proposals due. Review Panel provides recommendations.
- L-2.5 — Selection and start of successful GO proposals requiring preparatory work.
- L-2.0 — Update GO planning resources on line; e.g., web-based SIM Lite exposure time estimator, Reserved Observation Catalog.

14.4.3 Proposal Evaluation

Analogous with other NASA astrophysics missions, the evaluation of SIM Lite proposals will have a scientific and a technical component. The initial screening will be made on scientific considerations: overall scientific merit; suitability of SIM Lite for the problem; degree to which the proposal uses the unique capabilities of SIM Lite; feasibility of accomplishing the objectives; suitability of the data reduction methods; competence and experience of the PI and the role of Co-Is; and the availability of other ground, space, simultaneous, and/or contemporaneous data that can contribute to the science. Successful proposals will then be subject to a technical review in order to identify programs that are technically not feasible or that may have nonstandard requirements for the observations and/or the data reduction.

14.5 Implementation Plan

There are many more details of the nature, level, and cost of a GO program than can be discussed in this brief chapter. Such issues include user support, data products and archiving, and funding for U.S. investigators. Many of those details will have some similarities with existing missions (Hubble Space Telescope, Spitzer Space Telescope, etc.), and the body of past experience of what has already worked best can be used to deal with them. However, a few issues are unique to SIM Lite, and these must be addressed at an early stage in the development of the mission in order to make a GO program a success. The SIM Science Studies program initiated in mid-2008 (see Chapter 13) was created with strong support from the Science Team to help extend the potential SIM Lite user community beyond the current group of “black-belt” astrometrists on the Science Team. But that is still not sufficient. Whereas many members of the future SIM Lite GO community will have some familiarity with the principles governing reflecting telescopes, few of them will have the background in Fourier optics and interferometry needed for an understanding of how SIM Lite works, let alone how it can be used effectively for astrometry. A broad effort needs to be initiated soon to provide tutorials in optical interferometry and in astrometry with interferometers, and to develop SIM Lite observing templates for a representative set of typical SIM Lite GO programs. Examples of such “educational” materials can be found on the websites for existing special-purpose facilities such as the Very Large Telescope Interferometer and the Palomar Testbed Interferometer, and at more general websites such as the NASA Exoplanet Science Institute. Developing, publicizing, and disseminating this kind of information at an early stage will help to ensure the success of a GO program for SIM Lite.

14.6 Conclusion

Creating a GO program for SIM Lite is more than facilitating the observations, opening access to archival data, and supporting the research with funding. It is essential that the future user community be educated if we are to realize the full scientific potential of this mission within its limited lifetime. Many details of such a GO program remain to be addressed. The JPL SIM Project and the SIM Science Team are committed to assisting with all aspects of a GO program for this unique and exciting mission.

Acknowledgments

We are grateful for advice from a number of colleagues, including Bill Blair and Warren Moos (JHU/FUSE), Matt Mountain and Mike Hauser (STScI), and George Sonneborn (GSFC). We acknowledge past efforts to consider a GO program for SIM, including the first “SIM book” in 1999, and a draft of the present document by S. Unwin in 2006. Neill Reid provided helpful comments on an earlier draft of this chapter.