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GSMT SWG Meeting 2
Institute for Astronomy, Honolulu, HI
Dec 4-5, 2002

Summary of Action Items

(1) Further develop key science cases

Cosmology and large scale structure: Colless
Birth and assembly of galaxies: Barton-Gillespie
Birth and evolution of massive black holes: Bechtold
Birth of stars and planetary systems: Strom
Exploring exo-planetary systems: Strom

The individuals noted above are responsible for preparing a detailed powerpoint presentation for distribution to the SWG one week prior to the next SWG meeting in mid-February. In preparing these presentations, they should consult with colleagues on the SWG and in the community. To facilitate discussion and constructive criticism, the following template should be followed in presenting each GSMT science programs proposed under each category.

(i) Statement of problem and its importance
This should be written at two levels: congressional staff briefing; science community briefing

(ii) Status of current understanding, what advances are expected in the next decade, and why a next generation ELT is needed

This section should provide summaries at two levels: (a) a qualitative description, suitable for OMB and Congressional staff; and (b) quantitative arguments indicating what thresholds in angular resolution; sensitivity; sample size....must be crossed to enable significant progress.

(iii) Description of key measurements needed
Here what is needed is a quantitative summary of (a) angular resolution; (b) spectral resolution; (c) photometric accuracy; (d) sample size, etc. needed to address key problems. Include example of flux limits; signal/noise needed; integration times to reach flux limit at required signal/noise.

(iv) Quantitative comparison with JWST
Prepare quantitative examples clearly delineating the role of JWST and NGST in addressing the problem and carrying out key measurements. The goal is to illustrate the

synergy of GSMT with JWST in a 'system' sense, and to indicate clearly the unique role played by GSMT

The audience here is again twofold: staffers and colleagues. Prepare slides at each level.

In preparing comparisons, refer to the JWST design reference mission.

(v) Qualitative discussion of GSMT role in ALMA, Con-X, SKA.....era.
The goal here is to provide our colleagues, agencies and staffers with straightforward arguments summarizing the complementarily of GSMT to other planned ground- and space- based facilities expected to mature over the next 10-15 years. Responsible individuals should consult:

(1) the AASC Decadal survey; (2) the planetary science decadal survey; (3) the "beyond Einstein" report; and (4) the science cases for ALMA; Con-X; etc. as described on their websites.

(vi) Quantitative examples illustrating performance as a function of key design parameters.
What is suggested here is a comparison of performance of GSMT in providing key measurements as a function of (a) aperture; (b) delivered image quality; (c) field of view; (d) emissivity; (e) wavelength range available, etc. The goal is to refine our understanding of the potential scientific impact of differing GSMT designs. Recall that the role of the SWG is not to choose between or among such designs, but to provide context for understanding the relative merits of different designs. It may well turn out that public-private partnerships could result in more than one GSMT, perhaps with each optimized to provide certain capabilities.

(vii) Simulations or calculations needed to quantify or further illustrate each science program. Identify calculations or simulations that would advance quantitative understanding of each science program (flux limits; photometric accuracy; sample size;......). For example, in discussing large scale structure problems, quantify (a) time needed to reach the required S/N for a R~10000 spectrum of a distant quasar; (b) the number of lines of sight that must be probed in order to sample intergalactic gas at sufficient intervals expressed in a way that it becomes clear how our understanding increases as a function of sample size.

Circulate the need for simulations to other members of the SWG as soon as possible, in service of identifying responsible individuals on the SWG or in the community who might provide those simulations or calculations.

(2) Develop key AO simulations

The below tasks were identified by the SWG for further study. However, no specific individual was identified as the lead for each. I am therefore asking Francois Rigaut to take responsibility in consultation with Claire Max to develop an action plan based on the below summary no later than 22 Dec, 2002. This plan should identify a (realistic) prioritized group of tasks; responsible individuals; and a time by which the SWG might expect initial results.

(i) Develop more realistic simulations for crowded field photometry.
Here the goal is to use more realistic PSF variations over the field; fractional pixel centers for stellar images; and changes in delivered Strehl. As with the initial simulations in the NIO GSMT book, the AO simulators should provide a series of test fields that are presented to 'observers' who will use various techniques to produce color-magnitude diagrams. The simulations should span a wide enough range in assumed parameters to assess the potential gains of a GSMT as a function of delivered AO performance. Understand, for specific cases the trade between higher Strehl in the near-IR and lower Strehl at optical wavelengths (for using R/R-I vs J/J-K photometry to distinguish metallicity distributions in crowded fields).

(ii) Develop realistic simulations of 'extreme-AO' performance.
The SWG has identified planet detection and characterization as a potential key science driver.
Both achieved flux limits and star/planet contrast ratios are key to assessing GSMT performance for this problem. Simulations should include: (a) current AO system performance (based on extant wavefront sensors; DMs; etc); (b) 'best estimate' AO system performance (based on defensible projections of AO component and system capabilities a decade hence); and (c)likely uncorrected and uncorrectable wavefront errors introduced by imperfections and noise in the AO system components and the telescope (for example, wavefront errors likely to be introduced by segment alignment errors; wind-buffeting, etc. Identify the simplest path forward to either simulating the effect or assuming 'reasonable' values for uncorrected wavefront errors.

For a 'plausible' set of assumptions, explore more quantitatively the potential of suggested techniques (e.g. imaging in and out of Methane bands) for reducing speckle noise; closely correlated errors in delivered PSF (for example the pattern produced by segments and field rotation).

(iii) Develop a deeper understanding of the astrometric performance of AO systems on GSMT Define models to assess stability of astrometric measurements for AO systems of different design: (a) 'classical' AO with a bright natural guide star within an isoplanatic patch; (b)CAO with a laser guide star for high order wavefront correction and a 'typical' NGS for tip-tilt correction; (c) MCAO. The goal is to assess whether there are approaches that could fully exploit centroiding near-diffraction-limited images and produce astrometry at the 0.01 to 0.1 mas level.

(iv) Develop models to predict delivered image quality vs field angle for ground-layer-compensated AO.

Here the goal is to produce -- from traceable assumptions regarding atmospheric turbulence vs height -- guidelines to the science programs that can best exploit seeinglimited images delivered by a 30m GSMT (e.g. IGM probes at high z; abundances and kinematics of stars in relatively uncrowded regions).

(v) Estimate the cost of CAO and MCAO systems as a function of telescope aperture.
The goal here is to understand the cost of various types of AO systems as a function of telescope aperture. Specifically, some have argued that, to zero order, implementing an MCAO system is nearly independent of telescope aperture over the range 20-50m. If true, and if the cost of an ELT MCAO system falls between $75M and $100M, then such systems make the most sense on as large a telescope as can be afforded.

(3) Further develop an Integration Time Calculator

As the SWG further quantifies science cases, it is essential that achievable flux limits; signal/noise estimates; photometric accuracy; etc. be based on common assumptions regarding atmospheric transmission and emission; detector performance; instrument efficiency; etc. Brooke Gregory has developed an initial version of an ITC. Gregory and Mike Bolte have the action to pool ITC experience and provide (at minimum) a common set of assumptions and agreed upon algorithms for estimating exposure times; delivered S/N; etc. for the range of science cases currently being explored by the SWG. An initial list of ITC capabilities that might be available on what schedule should be provided no later than 31 Dec.