AURA

Association of Universities for Research in Astronomy

Questions and Answers
Regarding
AURA's Involvement in a Thirty-Meter Telescope Program

Q. What has AURA agreed to so far with respect to CELT?
A. On June 11, 2003 AURA and CELT signed a Letter of Intent. This letter recognizes that: both organizations have carried out point design studies; both organizations are presently seeking funding; and, during the period of AURA's proposal writing, submission, and ultimate disposition, AURA will fully participate in all decision making. These decisions are likely to involve coordinating site characterization studies, deciding on early mirror technology needs, etc. AURA has also submitted a full proposal for its share of the design and development. Upon successful funding of that proposal, AURA will formally join the Celt Development Corporation.

Q. Where did this agreement come from?
A. This agreement represents an initial step towards forming a public private partnership which was the fundamental approach recommended by the Decadal Survey. It follows directly from the guidance contained in the Decadal Survey that suggests a merger of the NIO and CELT design efforts. Both are rooted in and started from the assumptions of the Decadal Survey, both reached comparable technical solutions on roughly the same time frame.

Q. What process has AURA followed in making its decision?
A. AURA is aware that multiple technology and partner paths are plausible. Our priorities will follow the Decadal Survey insofar as is possible. Secondary or fallback paths are also necessary to preserve, however, and AURA intends to let no door close. AURA has also set as a goal the development of technologies that are extensible and will support other telescope builders. The opportunity to partner with CELT was, essentially, the first such door, constituted the nominal recommended approach by the Decadal Survey, and thus constitutes our first priority. The GMT represents another valuable avenue for technology development identified by the Science Working Group.

Q. What is the status of AURA's proposal to the NSF?
A. AURA submitted a proposal for $35Million for technology development for GSMT. AURA's intent was that this work would be awarded competitively to the community. AURA is now in the process of restructuring that proposal such that it focuses on two major point designs. AURA will remain a partner in TMT, but the proposal will allow AURA to make a major subaward to another project and AURA will maintain a linkage to that work to enable an overall technology development program to be rationally structured.

Q. Why not separate proposals?

A. This will mean a divided community rather than the consensus needed to go forward. Technology development will be better served by a more collaborative transparent dialog.

Q. Why not just have a head to head competition between TMT and GMT?
A. This could promote what could become a permanent community split. It precludes convergence paths that may be possible early. Generally, a downselect can be better done for construction, not technology development phase. Finally, there is no "pot of money" at the NSF that can be competed for.

Q. Why should NSF give money to GMT absent the high leverage matching funds achieved by the TMT partners?
A. At this point, 1:1 matching funds would be an unsurmountable barrier for GMT. However achieving significant private funding by the end of the D&D effort would be a desirable goal. Providing NSF funding to GMT would hopefully allow a more active fund raising effort on their part. More private $ in astronomy is a good thing!

Q. How can AURA simultaneously advocate two different efforts?
A. We will need to establish clearly separate management and technical interfaces with the two efforts. At the technology development phase, this is not a show-stopper.

Q. How does the rest of the community have an opportunity to participate in this program?
A. The initial sub-award solicitation will be open (although it is likely GMT will be most competitive) The TMT portion of the technology work will be openly competed to the extent possible. The instrumentation technology package will be open to all.

Q. Is AURA accountable for work carried out under the GMT portion*?*
A. Yes, although we will simply ask GMT to provide us their cost control, project management approach, etc. approach. The sub-award will be limited in contract value, not open ended.

Q. How can the two efforts rationally partition the technology work?
A. TMT and GMT should immediately enter into a technology exchange series of discussions as was suggested by ACCORD. Beyond that, a group like the SWG could be charged with roadmapping the respective technology efforts.

Q. What if this restructured approach is not acceptable to the community / NSF*?*
A. At some point, AURA may need to consider withdrawing from the current TMT partnership if Federal funding becomes a remote possibility. Our original intent was to participate in decision making with the anticipation that AURA would bring federal funding to bear.

Q. Has AURA prematurely committed to operate CELT?
A. AURA will commit only to the design and development phase at this point. Future decisions on construction and an operational commitment will be made upon satisfactory completion of this phase and an examination of all options available.

Q. How will the community be involved?
A. AURA intends to evolve the present Science Working Group to act as a user committee and a mechanism for providing ongoing advice and community input over the design and development phase.

Q. Are the costs for CELT drastically underestimated? Are we committing to ourselves to an unaffordable program?
A. Both NIO and CELT have done as reliable an effort as possible in projecting the full development costs. However, we recognize that this is only an estimate and requires a full design and development phase study in order to fully understand the development and operating costs. Thus, the commitment we are making is only through this phase. The technology paths and design tools developed during this phase will enable us to define, if appropriate, a less ambitious plan (e.g. a smaller aperture) prior to any further commitments.

Q. Can GSMT really be justified on scientific grounds?
A. The Decadal Survey postulated that an order of magnitude increase in collecting power was a compelling advancement to merit its highest priority recommendation. The decadal survey recognized that an instrument with the power of GSMT is needed to provide direct observational understanding of the processes that give birth to galaxies and planetary systems. Its greater collecting area and angular resolution represent critical complements to JWST's power to detect faint objects. The potential synergy between JWST and GSMT is so compelling that the committee urged immediate investment in design and technology studies so that GSMT could begin operation early in the JWST era. This combination: power to probe critical epochs beyond the reach of current telescopes, and the importance of GSMT in fully achieving JWST's science potential resulted in the AASC ranking of GSMT as its highest ground-based priority. We recognize that the compelling science case has been described by the Science Working Group and will be further refined over the next year.

Q. Why did AURA set as its priority a Thirty-Meter Telescope (TMT)?
A. A 30m telescope was the top recommendation of the National Academy of Science's Astronomy and Astrophysics Survey Committee for this decade Drawing on the synergy emerging between Keck and HST, the Decadal Survey reasoned that the same should be established between JWST and a major ground based initiative. As stated by the Decadal Survey, a thirty meter telescope is approximately ten times the collecting area of the Keck telescopes, fourteen times the area of the new generation of 8m telescopes
It would be the most significant leap in capabilities for the diffraction-limited performance in the 0.8-2.5 micron wavelength range, and this will require Adaptive Optics (AO). Groundbased sensitivity is a function of (Telescope diameter/Image width) ^{2} or D^4 for diffraction limited telescopes. Spectroscopy (and dynamics) of the earliest galaxies already takes a significant fraction of a night, spectroscopy of the very first objects are beyond the grasp of 8m – 10m telescopes. To image and characterize the plethora of recently discovered extra-solar planets requires both the spatial resolution and the collecting area of a 30m telescope. Technical complexity and computing requirements for AO scale ~ D^3 – D^4 Scaling current 10m AO technologies to a 30m by factors 30 – 80

is a reasonable technological undertaking this decade. A 30m telescope will be able to probe the epoch of galaxy formation, provide powerful diagnostics on the nature of the first stars, and for the first time, characterize the nature of extra-solar planets. A 30m provides the necessary scientific spectroscopic capability to complement NASA's next generation space telescopes, the JWST.

Q. Is a 30m telescope feasible technically?

A. Results from 2 x 2 years of studies by CELT and AURA show:

- It is feasible to build a 30m telescope to meet our science objectives on a time scale comparable to JWST
- The optics for a ~700m^2 mirror can be manufactured, polished and tested
- Wind buffeting effects can be managed
- Plausible AO component and systems advances will enable diffraction-limited imaging and spectroscopy in the near-IR
- High contrast imaging (10^7) is achievable
- The instrumentation, though challenging, is within the capabilities of major institutions and industry

The cost for telescope construction, adaptive optics, initial instrumentation and including 30% contingency is between $600M - $700M. This is within the range of current Public and Private investments in astronomy. The combined private, federal and international capital investment in 6m – 10m telescopes ~ $1.4B. This is roughly equivalent to the combined investments made to date in both the Keck and Gemini Observatories, the European capital investment in the VLT's, and the Radio community's investment in ALMA. This is significantly cheaper than a space mission of equivalent capabilities (e.g. JWST)

Q. Why have we chosen a segmented design?

A. The Keck primary mirror system has been hugely successful and has worked almost flawlessly for over 7 years. This is acknowledged as one of the technical triumphs of the late 20th Century. The segmented approach is clearly extensible to a 30m telescope (and beyond). Recent advances in polishing, ion figuring and test methods (holographic testing) makes the "factory production" of a thousand plus, meter scale high quality optical segments a feasible undertaking. Facilities like the US and European Nuclear Ignition Facilities are already producing production quantities of high precision optics of comparable quality and quantity required for a TMT. There is no significant science "down side" in choosing a segmented approach. Recent simulations of extreme AO systems on a Keck segmented telescope show that high contrast imaging, required for planet detection, can work well. Experience at Gemini and at the VLT have shown that 8m scale mirrors are the economic limit of what is easily achieved with current production and polishing facilities. Producing large off-axis segments is as yet an undemonstrated technology. In addition, transporting 8m scale segments around the world is an expensive and risky undertaking. For similar reasons, ESO has adopted meter scale segments for its 100m OWL concept.

Q. Why start now?

A. If we start today, a 30m telescope could be on-line by 2012. By 2012 Keck will have been in operation ~ 20 years, Gemini ~ 12 years. We already understand the limits imposed by physics on the sensitivity of the current generation of groundbased 8m – 10m telescopes. A significant science requirement of the AASC recommendation for a 30m telescope was to ensure the availability of powerful groundbased O/IR facility to complement NASA's second generation space telescope (JWST) which is scheduled to launch in 2012.

Q. How will TMT be managed?

A. TMT will be overseen by a single TMT Board, representing the principle founding members of the TMT partnership. Reporting to the TMT Board will be a single TMT Project Office, managed by a Board appointed Project Manager, working in partnership with the Board appointed TMT Project Scientist. A Science Advisory Committee will provide both the Board and TMT project with oversight of the science requirements. AURA, in its role as the interface with the community, will provide a channel to this group for community input on TMT science issues. We also intend there to be a direct overlap between the Science Advisory Committee and the AURA managed Science Working Group which reports to the NSF.

Q. What are the expected operating costs of a TMT?

A. Estimates range from between $30M/yr to $60M/yr. These costs can depend on the site chosen and operating model implemented. One of the key tasks of the DDP is to explore the range of operating models and their respective costs. Instruments for a TMT are expected to cost between $20M - $50M each.

Q. Can anyone else join the TMT Partnership?

A. In principle, yes, however the partners have agreed on the following working principles:

- Only TMT Board and its stakeholders can decide to enlarge the TMT partnership
- The founding partners have made an early investment in a TMT to ensure that their respective constituencies receive a significant fraction of the time on a TMT

Any potential future dispersement of TMT shares will have to recognize the enormous value of this early, enabling investment by the founding members. In addition to joining the partnership directly, any entity may choose to work through AURA. AURA intends to organize and enhance the public participation in the thirty-meter telescope project. This could include facilitating additional parties to aspects of the design and development as a part of AURA's partnership role.