Memo

To: SOAR Board

From: Gerald Cecil, Project Scientist

CC: SAC members, Tom Sebring

Date: 05/04/98

Re: Minutes of the SOAR SAC Meeting in La Serena, Chile

The SOAR SAC met on 4/16 to review project status, and on 4/18 to discuss instruments. Present were Cecil (chair & minutes), Simkin (MSU), Diaz (Brazil), Baldwin (NOAO), Elston (NOAO), & McMahan (UNC). All but Elston met on 4/19 am to finalize Part 1 of the Science Requirements document.

Project Status Briefing

Tom Sebring & Gerald Cecil reviewed the slides that they had presented to the SOAR Board in Rio. There were questions to Tom about cost & schedule. He assured the SAC that efforts were underway to keep the telescope cost to $23M. Roughly $0.5M have been identified so far of legitimate expenses to the instrument budget. This number will grow as the work breakdown structure (WBS) is further developed for the June CDR.

Instrument Program

Cecil reported that the Board had decided in Rio that **no instruments are preordained**. So all to be identified by the SAC would be subject to the same proposal process: Request for Proposals (RfP) out in mid-June, responses due mid-Sept for review by external experts, then a recommended list to the SOAR Board by mid-Oct. This synchronizes with the schedule that Cecil circulated 2 months ago. An important element of a successful proposal will be cost sharing because it is unrealistic to expect many $ from the Project. The proposal form will differ somewhat from the NSF standard but should total about the same length (12-15 pages.) More detail on the fabrication schedule, risks, and costs should be provided, and less is necessary on science drivers except to justify novel aspects of the instrument.

Cecil reviewed expected image quality. The project is building to 0."18 degradation by telescope+facility. Subsystem errors are being budgeted by Moretto. Now it is time to consider the additional degradation that we would tolerate all the way to the instrument focal planes. Cecil felt that an absolute upper limit to what would be acceptable was another 0."18, which in quadrature produces the curves labeled 0."25 in Fig. 1. Note that **we will not meet our spec without tip/tilt centroid determination close to the center of the isokinetic patch.** This means on-instrument tip/tilt sensors as close as possible to instrument focal planes. The Project will design suitable detectors on translational stages, hopefully to also provide fast-focus sensing. (We will only correct rapidly the tip/tilt, but would remove slow trends in focus.) The Project will also need to develop a way of providing the tip/tilt signal from an instrument like the Phoenix IR spectrometer, otherwise it would deliver images not significantly better than at the Blanco.

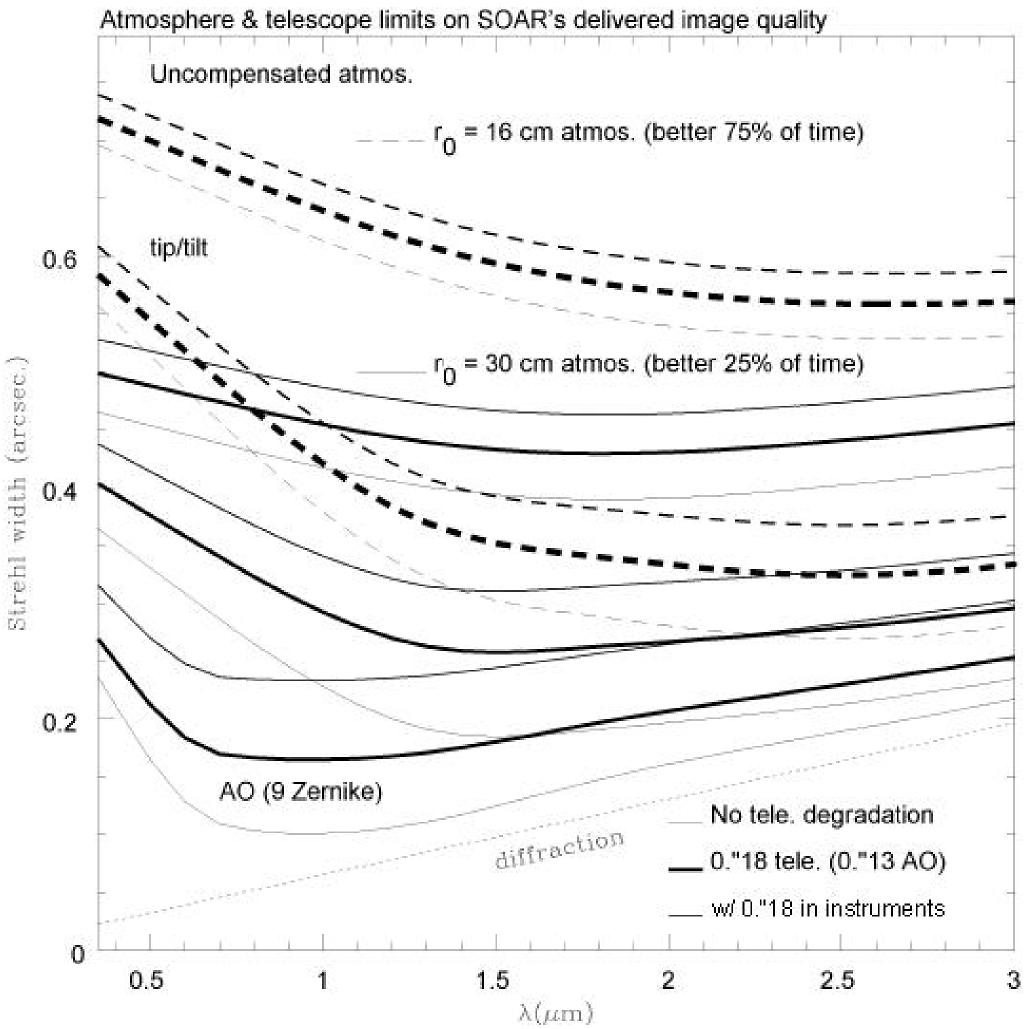

Figure 1. Seeing should be better than the dashed curves 75% of the time, and better than the solid ones 10% (not 25% as shown) of the time. The base curve of each set assumes perfection. The middle (heavy) curve degrades this by 0."18 (the Project goal for telescope+enclosure). The top curve in each set adds a similar contribution from other elements before the instrument focal planes.

SAC Science Tabulation

Cecil presented the tabulation of partner science. SAC members had polled their communities, asking them to assign fractions of their science to different observing modes. Table 1 reveals that no instrument is overwhelmingly preferred. So **all instruments should be treated similarly in the proposal process**, and we will not know what instruments are going on SOAR until after the review process when all instrument funds have been identified. Those instruments that have ample matching funds would presumably be built.

GNIRS clone

Of immediate concern is a window of opportunity for cloning the GNIRS. Gemini would pay for half of the instrument (not including detector or controller) if SOAR pays for the rest. The full SAC was sympathetic to this instrument (NOAO regards it as their top priority), but noted that it would address the same fraction of partner science, 11%, as any other instrument. In fact there was also interest in a high-efficiency cross-dispersed echelle with better performance than Phoenix, and an IR-MOS along the lines of Elston's *Flamingos* design.

The GNIRS has two notable advantages over other SOAR instruments. 1) It isn't virtual so had a better chance of attaining our image spec (especially important because SOAR will work best in the near-IR and the image slicer on the GNIRS will likely not compromise image quality). 2) It has a well developed schedule which would be available early in telescope operations. A *go* decision now would ensure its arrival at Gemini-S in April/May '02. It might then appear on SOAR for 6 months starting in Sept. or Oct. '02, rouighly 6 months after SOAR enters science operations.

Percentages of Partner Science to be Executed on SOAR									
	Capabilities			**% Partner 4m Science**					
Observing Mode	**Blanco**	**SOAR**	**Gemini**	**Brazil**	**NOAO**	**MSU**	**UNC**	**Wt. Sum**	**Which instrument?**
Spectro 0.3-1 micron								**30**	
(45' MOS)	*S,B,D*	-	-	*3*	*11*	*2*	*3*	*5*	*Hydra CTIO*
5-10' MOS	-	S,B	B	5	4	2	8	5	**15 High Throughput**
Slits over 0.5-5'	***-***	***S,B***	***B***	10	9	15	8	**10**	**Spectrometer**
1-10''. R < 10,000	(S)	S,B	B	10	11	0	2	7	**15**
1-10'', R > 20,000	(S)	-	B,D	10	8	0	12	8	**Bench + IFU**
Low R, 0.31-0.36 micron	-	S,B	-	11	3	4	0	6	(Not exclusive)
Spectro 0.9-2.3+ micron								**17**	
(45' MOS)	*<1.7 mic.*	-	-	*0*	*5*	*0*	*6*	*3*	*Hydra CTIO upgrade*
5-10' MOS	-	S,B	?	6	4	0	10	5	TBD
Slits over 10-20''	-	S,B	?	3	4	11	6	5	
Single Obj R=500-4000	<1.7 mic.	S,B	?	4	2	4	0	3	**11**
Single Obj R=5000-20,000	<1.7 mic.	S	B,D	4	4	0	2	3	**GNIRS**
Single Obj R > 30,000				2	2	0	2	2	TBD
Optical Imaging								**15**	
(40' fov, lower angular res)	*S,B*	-	-	*0*	*15*	*4*	*0*	*6*	*Blanco prime*
6' fov, higher angular res	***-***	***S,B***	***B***	11	2	17	18	**10**	
Tunable filter (R=50-1000)	-	S,B,D	-	4	4	9	6	5	
IR imaging								**17**	
(>10', low angular res)	*B??*	-	-	*3*	*4*	*0*	*0*	*2*	TBD
2-5', high angular res	***-***	***B***	***B?,F***	17	6	13	15	**12**	
Tunable filter (R=50-500)	-	D?	D?,F?	3	2	19	2	5	
Total % on SOAR				**95**	**65**	**94**	**91**	**84**	**% on SOAR**
Blanco programs in (*italics*)									

Table 1. Percentages of partner science that can execute on candidate SOAR instruments. Entries in 2^{nd}-4^{th} columns show when that instrument would be shot (S), background (B), read-noise (D), or diffraction (F) limited at the telescope indicated. Entries in the ``wt. Sum" column are weighted by the partner observing share.

SOAR Telescope Control System

German Schumacher outlined the approach being taken for the SOAR TCS (telescope control system.) The goal is to adopt as much as practical of the Gemini Observatory Control System (which the telescope operator and observer interact with), to exploit what promises to be powerful observing tools and to maintain operator commonality. Similar development tools will be used so that software customized or developed by SOAR can be resynchronized with Gemini in a few years after all three telescopes are operating. The SOAR TCS will adopt the same overall goal as Gemini: image optimization based on realtime estimation of terms in the error budgets. CompactPCI hardware will be employed instead of VME to maximize the time before obsolescence. RT-Linux will probably be adopted in preference to VXWorks. Discussions are being held with Pat Wallace (Oxford) and (soon) Jeremy Bailey (AAO) on contracts to write the pointing/tracking parts of the SOAR TCS.

McMahan questioned this piecemeal approach to software development and the possible reliance on ``fragile shareware." He suggested that the Project explore commercial software houses. Given a set of specs any of these firms would deliver a fine product on time & on budget. Treat the software exactly like the telescope hardware and seek competitive bids.

Instrument subcommittee

Cecil asked the SAC to forward names to him by the end of April. This subcommittee of the SAC would ultimately be the instrument builders. Their focus would be more technical than that of the SAC, and they would be expected to be highly motivated to stay up-to-date on these details rather than the overall science drivers of the instruments. They would be charged with presenting, debating, and resolving technical trades in instrumentation, always bound by the scientific specifications and priorities set by the SAC. Cecil will work to ensure that this group meets at least by telecon before the PDR. Their first task will be to help write the Instrument RfP and the proposal review criteria. Following the proposals, the subcommittee will write the Soar Instrument Handbook. It was agreed that the SAC and this subcommittee would try to meet the day before the PDR, June 1st.

Site monitoring update

Baldwin reported on the first few days of site monitoring. A tower has been erected at the SOAR site and should remain up until the first winter storm (but individual wind gauges will certainly blow away sooner.) The SAC hoped that the tower could be reinstalled when conditions and manpower allow. (It takes several days to erect.) Baldwin noted that the purpose of this experiment is not site monitoring *per se*. It is to verify the result --- from limited testing nearly a decade ago at the then pristine Gemini-S site --- that the wind direction altered significantly as the measurement height was reduced below 10m. This trend was consistent with the expected effect of the thermal boundary layer. Measurements now being made for the first time at the SOAR site (with the tower near the position of the future telescope pier) show that the wind blows from the same direction at all heights above 3m. Unfortunately, so far the wind has blown from all directions except the one that was predominant in the Gemini data! (Most wind blowing from the NW rather than NNE.) So it is unclear how representative the data acquired so far are, but the different wind rose does not argue for another orientation of the SOAR facility building.

Baldwin also distributed Mark Chun's (Gemini) summary of the first balloon-launching campaign from Cerro Pachon. *In situ* measurements of wind shear, temperature, etc were used to establish the C_n^2 profile of the atmosphere above CP. These were correlated with near-simultaneous SCIDAR measurements at the 1.5m telescope of image motion from discrete atmosphere layers. At the time of these observations, the C_n^2 profile was dominated by ground-level image motion. This is good news for AO because wind speeds at low levels are lower, so more correctable, than jet stream motions.

The other news is that the cumulative histogram of the seeing without compensation may be somewhat worse than was derived from the 1980's measurements used by Gemini. It seems from these first data that $r_0 > 30$ cm (1/3" seeing) occurs <10% of the time rather than 25%. This should not be taken as statistically significant until more data are acquired (more launches are planned) and El Nino subsides. The distributions are compared in Fig. 2 below.

Telescope f/ratio & Gemini Compatibility Goals

Cecil ``shared his pain" on these topics. The SAC agreed that there were no compelling reasons to change the telescope from an f/16 configuration. Optical instruments would be complicated, but over the isokinetic field (5' diameter) there would not be show-stoppers. Although most certainly not a driver in the SOAR design, thermal-

IR performance would be improved. Cecil felt that reimaging from f/9 to f/16 in the near-IR would actually be cheaper than reimaging from f/16 to f/9 in the optical. However, this really applied just to the optical imager. Cecil felt that the overall optical performance would be better with the smaller M2 at f/16. There would be less diffraction, and less impact on the overall telescope once an adaptive M2 was fitted.

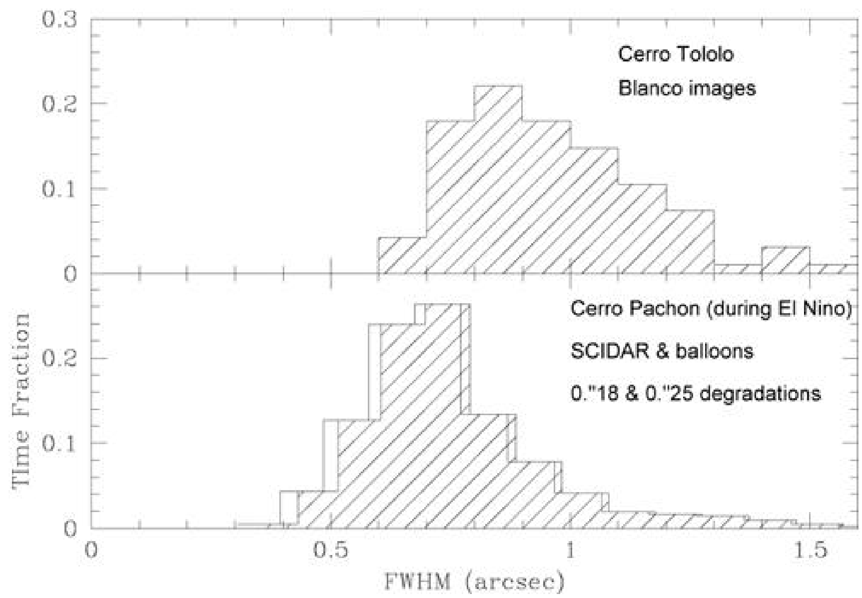

Fig. 2 Comparison of measured Tololo image FWHM with the distribution expected for Pachon. The Pachon distribution was measured by combining SCIDAR and balloon data. It has low statistical significance at present, pending further data.

Gemini compatibility was therefore set to this field size, which would limit only GMOS (highly unlikely to appear at SOAR anyway.) SOAR will remain an f/16 telescope, capable of bearing 2300 kg instruments on each side. Cecil reiterated his option that, given the nature of 1^{st} and 2^{nd} generation Gemini instruments, Gemini compatibility for SOAR more probably mean our instruments going to Gemini than *vice versa*. Only the GNIRS clone would be certain to appear on SOAR if we pay up.

The telescope focal plane layout is being developed. Fig. 3 shows a recent version. The massive Gemini instrument on one side of the telescope is only balanced partially by the two smaller instruments + facility wavefront sensor (WFS) on the other. Calibration units (not shown with their full space allocation) are located on each side. Ample-sized optical benches below the Nasmyth ports are available to mount instruments.

AO Strategy

Cecil proposed and the SAC endorsed a change in Project emphasis on AO from ``fix with an adaptive M2 on an ill-defined timescale'', to ``a Nasmyth bench-mounted solution along the lines of the Durham U. ELECTRA/NAOMI system being developed for the WHT.'' This seemed to Cecil to be the only hope of getting AO on SOAR before NSF lost interest or we were beaten by another S-hemisphere US telescope. The instrument subcommittee will look at this is more detail, but for now AO is being treated as another instrument. The goal would be to feed the IFU-fiber spectrometer with the AO beam. Additional folds would be provided in the corrected beam for dedicated optical and IR imagers. The goal is still to later add an adaptive M2, provided it does not compromise tip/tilt science over the isokinetic field. Presumably M3 would remain to do the tip/tilt correction. Still to be addressed is the laser guidestar upgrade required to cover a competitive sky fraction.

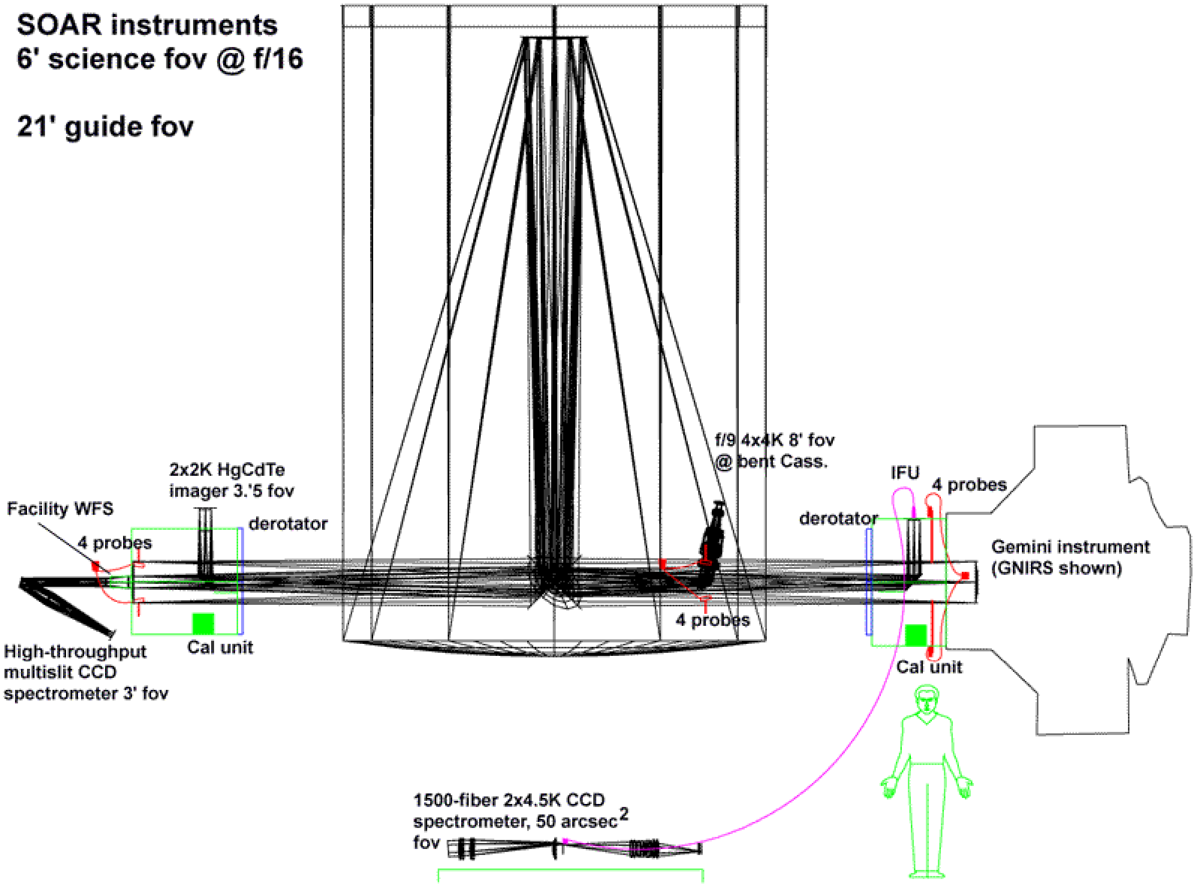

Fig. 3 One layout of the SOAR instruments. When a Gemini instrument is not present on the telescope, the instrument layout on the left side can be replicated on the right. The bench-mounted instrument is fed by a 5-meter long fiber.

Instrumentation

Tom Ingerson (CTIO) briefed the SAC on concepts for optical spectrometers. He summarized two optical spectrometers discussed a bit by the SAC, and which were the basis of the partner science tabulation in Table 1 above. First a ``bore sight'' stellar instrument with excellent UV performance, small field (3' long slit), and based on a 10 cm volume phase holographic grating with resolution certainly of R=5,000 and potentially up to 20,000. This would mount on the telescope. Second, a Nasmyth bench-mounted spectrometer that would use a lens-array integral field unit (IFU) front end to a 4m run of fibers. It would use conventional 20cm gratings for now (until larger volume phase holographic gratings become available) including an echelle for resolution up to R=30,000. SOAR cannot rely on access to CTIO's 20cm gratings. Roughly 1200 fibers would fit on the 4.5K side of a 2x4.5K CCD. The camera could be based on the Hydra-S layout. Ingerson noted that if Australia wished to build the IFU unit for SOAR, so much the better.

After discussion the SAC endorsed the IFU spectrometer. Cecil will check with the AAO to see what they would propose for the IFU. [I found that it is likely to use cylindrical microlenses of silicon rather than epoxy resin.] The SAC then turned to the high-throughput spectrometer. McMahan asked Ingerson to comment on provision for multislits because there was much interest for this. Ingerson felt that this was impractical over 10', you bought into something like GMOS which would have considerable compromises in performance and would be very expensive. However it would be easy to do over a 3' field assuming 0.''15 sampling. Spectra would be incomplete over a field 3-5'. He proposed using a low-power laser to expose a photo-resistive mask.. Slit masks could be mounted manually or via a motorized shuttle. Several would be made with different slit widths to cover different seeing at the time of observation. The SAC was very enthusiastic about this because it addressed lingering concerns about the ultimate limit of sky subtraction and scattered light control in fiber-fed instruments. There is nothing cleaner than an open slit. There were technical comments on the feasibility of atmospheric dispersion correction (necessary in the multislit case but would then cut out all UV), and the need for an invariant PSF along at least each 10-20" long slitlet to optimize sky subtraction.

The SAC then categorized desired instrument properties: requirements, highly desired options, upgrades. A proposal will not win unless it addresses a significant number of options and provides a plausible route to at least some of the upgrades. These are now tabulated in Part 4 of the Science Requirements Document, circulating within the SAC for final revisions before its release in mid-May.

SAC action items to the CDR

The SAC will complete the Science Requirements document by early May. Part 1 was drafted on the Sunday SAC meeting and summarizes science drivers. Part 2 is the already agreed upon Derived Telescope Requirements that the Project has been working to for some time. Part 3 is the completed ``SOAR niche'' document. Part 4. It exists in draft form & sets instrument requirements. This will be refined into a ``SOAR Instrument Handbook'' by the Instrument subcommittee.

The SAC agreed to reduce the frequency of telecons from weekly to monthly. They would be supplemented by occasional telecon and in-person briefings by Cecil to individual partner institutions. The next face-to-face meeting of the entire SAC will be in Tucson on the day before the CDR, June 1.