Romney

GBT Science Working Group
Minutes, November 19, 1991

Participating: Aller, Backer, Bania, Barvainis, Davis, Dickey, Giovanelli, Haynes, Heiles, Moran, Mundy, Solomon, Wilkinson

1) Status Report

Seielstad summarized the foundation construction, actuator and LVDT contracts, laser ranging tests, prototype feed construction and testing, monitor and control interactions with the servo contractor, and two meetings, the National Science Board and the GBT Advisory Committee Meeting. Notes of the Advisory Committee Meeting are enclosed.

Dickey expressed hope that we would not forbid rotation of individual receivers within their mounting holes in the receiver turret. He suggests that the capability will be wanted early in the life of the GBT. Napier asked what a typical change time would be, if the turret had to be restored to horizontal before rotating. The answer depends upon elevation angle, but is of order 5-10 minutes. Condon described a brand new idea for tackling this problem. The idea is, in fact, so new that Srikanth has not had time to complete a proper analysis of the consequences. In essence, Condon points out that the L-band (1.1-1.7 GHz) receiver, even when a full 180 degrees from the on-axis receiver, is only about 6 beamwidths off axis. This offset is not so large that the gain or beam pattern degrades significantly. By changing the telescope's pointing by approximately 1 degree, the L-band receiver could be brought on line in less time than rotating the turret through 180 degrees whatever the elevation angle. A similar analysis for the 5 GHz receiver showed the same speed of change. Heiles objected, saying there should be no extra cost for providing a turntable that could be rotated when in any orientation. Heiles also requested that the turntable be stoppable in any position, instead of just at 3-degree intervals. He also reported there had been some discussion of having an open trough on the turret, so that receivers could be located anywhere, not just in eight mounting holes.

2) Prime Focus Receiver

Behrens presented his plan for prime focus receivers covering 290 to 1230 MHz, as described in GBT Memo 69.

Backer pointed out that the longest planned wavelength was 1 meter, whereas pulsar observers might want longer wavelengths. He also stated that pulsar observations want simultaneous dual frequency capability. Furthermore, pulsar observing often requires large bandwidths (e.g., 50-500 MHz was mentioned). Napier pointed out the tradeoff: to get wide bandwidth you must sacrifice sensitivity. Another tradeoff is between continuous frequency coverage and dual receivers at particular frequencies. The tradeoffs are, of course, caused by the familiar trio of finite money, people, and time. Nothing is being done that precludes all these options at some time after the GBT is in operation.

Sensitivity rose in another way: must receivers be cooled at the lowest bands, given that galactic emission is so strong? Davis reported that the best system temperature on the Arecibo antenna at 430 MHz is about 45 Kelvin, which does justify use of cryogenics. Near 200 MHz Tsystem can be approx. 300 K.

Napier reported that the VLBA will offer quick-switching capability between 300 and 600 MHz. Since these frequencies are covered by separate packages in the Behrens' plan, that switch will take hours.

A discussion of arrays of receivers at the prime focus arose around Napier's report that Ekers is proposing a 3x3 array of 21 cm receivers for the Parkes telescope. Size limitations rule out that large an array at the Gregorian focus (maybe 3 21 cm feeds at most). But an array that fit within a cylinder 6 ft in dia and 4 ft deep could be accommodated at prime focus. Dickey got a sinking feeling that if an array of receivers for galactic and extragalactic HI observations, for which the GBT should be extremely valuable, was not built for the startup phase of the GBT, years would pass before one ever appeared. Aller added that the difference between the VLA and the GBT was in the speed with which the GBT should be able to respond with new equipment to meet new scientific wishes. Some choices of what gets built first are inevitable, but the infrastructure for accommodating improved systems has to be built into the structure.

Davis and Condon described a discussion about the 7-feed, 5-GHz receiver. Since it would only be used a fraction of the time on any telescope, perhaps it could be built for sharing between the GBT and Arecibo.

3) Joint Operations Center

Preliminary design considerations had been circulated. A brief discussion ensued.

Bania objected to a large computing area divided into carrels. Others seconded that they strongly preferred assigned offices for observers. The offices need not only workstations with identical capability to the one for the on-the-telescope user, but certain standard television views of the GBT.

Users insisted upon complete computer support for the on-the-telescope user in the actual control room near the telescope operator.

Moran and Romney discussed the location of the hydrogen masers. The USNO intent is to house these in a well-protected and off-the-beaten-track location in the new Operations Center, probably in the basement.

The discussion was short and should be returned to later. SWG members and others are invited to submit e-mail or written suggestions for desirable features in a control center.

4) Next Teleconference

Tuesday
December 17, 1991
16:00 EST
(913) 749-9680, ID# A54D

Notes
GBT Advisory Committee Meeting
Green Bank
November 14-15, 1991

These notes summarize the comments made by members of the Advisory Committee or other attendees, in response to NRAO presentations. The presenter is shown in parentheses.

1) Quality Assurance Program (Serna)

Most of the comments expressed confidence in the program described.

How will we evaluate companies? We meet with their workers as well as their administrators.

How do we stay on schedule if we have to reject manufactured components? We can ask the company to add people during the catchup, or, if they are working only one shift, to add a second or third shift.

Mexia steel fabricating plant sounds good. What about Sterling plant? We get results from their CCM. We will also verify first article panels for each of 42 different configurations.

Do firms have manufacturing techniques (e.g., for panels) they do not want to reveal to us? We have approval and disapproval authority. We will get the information up front.

2) Antenna Structure (King)

Hill and Nelson raised several questions about whether AZ wheels had built-in self correction, a natural capability for steering themselves back if they strayed off. The concern was based on their experience with domes and telescopes. Was the only way to release side stress to slip? The answers were to be provided by King in private conversations with Hill and Nelson.

Nelson worried about braking the elevation structure. If the gear box failed, did we have any way to stop the elevation wheel? King's answer was no, but we had designed a large margin of safety into the gears.

Several questions were posed about the effects of adverse weather--ice, snow, and wind. Steady winds were not as worrisome as gusting or turbulent winds. The main concern was how the power in the variable component of the wind tied into the structure. Did it excite oscillations? What happened if turbulent eddies were shed off the structure? What was their size? King's answer was that the GBT behaved differently from other familiar antennas. It was so huge that it acted as a damper. But the final answers await the completed design of the tipping structure, as well as the dynamical analysis of it. NRAO is prepared to check Loral/RSi's analysis as soon as it arrives. We are aware of the concern.

A few questions were raised about the size of the elevator. No one stated its precise dimensions, but everyone involved seems satisfied the elevator will be adequate.

3) Optics (Norrod)

How long does it take to swing the prime focus arm in or out? About 5 minutes.

Is there any provision for rotating individual feeds themselves? Not in any existing NRAO design, but the possibility is not excluded. Installation of rotators would be an NRAO responsibility.

How is focusing accomplished? By moving the subreflector.

Are there plans for array receivers? Initially we are trying to maximize frequency coverage. Nothing we do will exclude array receivers in the future.

Why does turret have only 8 holes? Could the plate be open so that receivers could be mounted anyplace? The turret plate is supposed to keep the rain out of the receiver room below it.

A strong desire was expressed for the ability to rotate the turret when the antenna was in any elevation angle. This is not in the present antenna specification, and NRAO's concern was increased cost if we change the specification. Nelson proposed that the engineering problem of rotating the plate was no more difficult in any angle--if the center of gravity was on the rotation axis. In other words, NRAO should agree to balance the weight distribution around the turret plate. Then our request to the contractor for a different design might not have a cost penalty. Hill suggested that we take the initiative in suggesting a suitable design to RSi, rather than to await their initial proposal.

Seaman showed a model demonstrating the actuator-driven motion of the subreflector. This evoked some discussion about the complexity of the motions. However, once it was understood that the axes of the telescope's optics are not coincident (for engineering reasons) with the axes of the subreflector's supports, no one was able to suggest a superior scheme.

4) Pointing and Active Surface (Payne)

A discussion took place about the panel adjusting screws. Detailed drawings showed that they were locked by spherical washers so they would not rotate loose. Their length was needed to permit some bending when the dish undergoes thermal expansion.

Weinreb and Wilson pointed out that the test data showed the S/N was so high that we could integrate much less than 128 ms.

Nelson suggested adding a fourth laser system to the test setup for redundancy.

Did we need an autocollimator system monitoring the structure from the ground to the elevation axis if we had a laser system as well? The answer was that the two systems are independent. The laser system looks extremely promising, but is nevertheless an R&D project. Stabilizing as much of the structure as possible with systems partly overlapping in function seemed justified.

Open Loop Active Surface (Lacasse, Schiebel)

The lifetime of actuator units was discussed at great length. Some commercial brands survived six months of testing that was intended to simulate 10 years of actual performance. Since only 5 samples of these brands were tested, however, the statistical significance is suspect. The prime cause of failure of actuators was explained to be brushes in motors. Many questions then revolved around whether it was wiser to run actuators all the time, or as little as possible.

Weinreb worried about lightning. Lacasse answered that ground straps will go around each actuator from its covering to the backup structure to which the actuator is attached. In addition, the surface and the backup together form an effective cage. Finally, the central control units will all be isolated by special connectors.

Concern was expressed about non-linearities of LVDTs. Schiebel explained that the range of motion over to which we will subject the LVDTs in practice will be less than that over which tests were run. Furthermore, the tests showed that the devices from a particular manufacturer were similar, so that an average calibration curve might suffice as an adequate correction for all of them. The LVDTs will be purchased as single large assembly runs, so that the cores and their windings are as uniform as possible.

5) Electronics Plan (Norrod, White)

Weinreb questioned whether cooled amplifiers were needed for receivers for frequencies below 600 MHz. Norrod suggested we needed to build these amplifiers to see what improvement cooling offered.

The desire for array receivers was strongly expressed from several quarters. Their desirability is acknowledged. When it was explained that there is a direct tradeoff between ranges of frequencies covered and arrays of receivers at fewer frequencies, the discussion shifted to the amount of money for instrumentation. Nelson reported that the Keck telescope will spend 10% of its capital cost on instrumentation, and that the funds for each are not interchangeable. The GBT is about $2M short of spending 5%. NRAO is working on ways to increase the instrumentation budget.

$75M × 5% = $3.75M − $2 M = $1.75M

Hill suggested simulations and modeling to determine the ultimate accuracy we can expect from holography. The limitation may be pointing accuracy when the telescope is in a rapid

53% short or spending 2.3%

scanning mode. von Hoerner suggested distributing the integration time unequally, spending more time when far off source to improve S/N. J. Payne inquired whether anyone had considered adjusting the dish to achieve peak intensity while looking at a source, but Norrod preferred holography from which phase information can be used to isolate areas of the dish.

A proposal to investigate whether the IFs should be digitized at the receiver room and only the digitized signal sent to the Operations Center was greeted with skepticism. Weinreb pointed out that fast A/D converters have only 8-bit resolution, which might limit dynamic range needed to detect weak spectral lines in the presence of strong interference. Fisher reported that the spectral processor was operating successfully with only 6 bits. Weinreb also pointed out that receiver bandwidths are increasing in parallel with increases in sampling speeds, so that even much wider digitized IFs may not be adequate. Wilson commented that digitizing the IF should not be the only scheme NRAO pursues.

6) Joint Operations Center (Seielstad)

Since the author of this report took an advocacy position on the location of the new Joint Operations Center, he will not present as detailed an accounting of this discussion. It did seem that ample time was given for all viewpoints to be expressed. Technical, logistic, cost, efficiency, rfi, safety, philosophical, and personal preference factors were all discussed. A consensus, but not unanimous agreement, emerged to connect the new control building to the Jansky Lab to create a Joint Operations Center. At the same time, the desirability of a modest equipment room on the alidade of the GBT was clearly expressed.

7) Monitor and Control (Schraml)

A main concern was whether all the software had to be re-invented, or could portions be imported from already operating telescopes. NRAO will certainly import as much as it can, but, of course, nothing will "fit" perfectly. The realtime functions in particular will be different because the hardware differs.

Several questions concerned the user interface. The plan is to have more than one, in an attempt to offer users interfaces with which they are familiar. The 12 meter's Rambo and the 140 ft's POPS were cited as examples of interfaces we would port right away.

Heiles wondered if sensors could temporarily cancel data taking. A specific instance is when a pointing error exceeded some bound. Schraml assured that indeed you could just blank out the backend.

The software effort was estimated at several tens of thousands of lines of code, or 15-20 person-years of effort. A phased approach will be taken. Not everything will be available at the time of first light.

Schraml announced the policy that calibration observations would remain the property of NRAO rather than belonging to any particular individual. No disagreement was expressed.

George Seielstad
November 19, 1991