Auditors' comments - real time

Webber
7-8-99

CALIBRATION and IMAGING

Findings:

1] Fast slewing is primarily needed to overcome 1/f noise for the single dish continuum measurements using raster (on the fly mapping) scanning of the dish. Currently there is no quantitative estimate of expected performance vs antenna slew rate.

WRONG

✓ 2] A 183 GHz 64 channel WVR is included (and is budgeted) within the dewar to provide simultaneous WVR measurements with a beam within 10 arcminutes of the observing beam. Exact frequencies/details are not yet decided.

✓ 3] The single dish total power performance is only critical for continuum imaging. There should be no problem with spectral line imaging.

✓ 4] Nutating subreflector in not in the budget but may be needed.

✓ 5] 25 micron antenna spec. was based upon image quality requirements at 1 mm. i.e. decision to include submillimeter wavelengths did not impact the antenna specs.

✓ 6] There is no plan for conventional vane calibration.

✓ 7] Image assessment required for commissioning and software development has been pushed into the operations budget.

Comments:

TOO HIGH 1] If a nutating subreflector is needed like those on other existing antennas it could cost 300-500 k$ per antenna.

✓ 2] The project feasibility is very good. There is very little technical risk at 1mm and longer wavelengths. Even if WVR phase calibration works poorly there will still be a large amount of time at which observations can be made at 1mm. At 230 GHz the atmospheric phase noise is less than 1 radian on a 1.6 km baseline for 43 percent of the time.

Recommendations:

ALMA does it (✓) 1] Analyze and summarize satellite phasemonitor and WVR data from the site in order to decide on the details of the 183 GHz WVR.

✓ 2] Need early tests of the total power stability using the first antenna at ~~to~~ the VLA site to help decide the possible need for a chopping subreflector.

✓ 3] Need to add a conventional vane calibrator for system temperature measurement and engineering tests in addition to the hot/cold calibrator at subreflector.

Costs more ($3M?) leave it 4] Move image assessment tasks for commissioning to the construction budget.

Allow it ✓5] The antenna contingency should include a nutating subreflector.

WBS4 Receivers

Findings

- ✓ Integration and test at Tucson pretty well thought out, lots of hiring needed. Large labor force available for technicians. Minimal staff in engineering at present.
- ✓ Schedule seems optimistic but possible.
- ✓ SIS wafer supplies at Uva and SUNY seem secure. Only one good wafer needed for each band above 100 GHz.
- ✓ Production plans can keep up with CDL mixers, regardless of rate.
- ✓ Engineering staff at CDL seems very tight, may be adequate for the job. Total reliance on 2 key people.

Comments

- ✓ 183 GHz WVR needs a place; it should go into the dewar as another insert, or share use with existing receiver. No space for the 22 GHz feed.
- Don't [illegible] — 12m support may conflict with MMA development. Is a phase out of support practical? .
- ✓ Required SIS production rate is ~3 X best present CDL rate.
- COST OF MIXERS ~~[illegible]~~ 4X HIGHER THAN LO MULTIPLIERS — WHY?

~~[illegible]~~ SIS trickier, needs lots of design & [illegible], m[illegible] be tested at 4K etc.

Recommendations

- ✓ Second test dewar needed at Tucson to keep up production. ($200-300K)
- ~~[illegible]~~ X Extra test set needed at Chile as well. will consider
- FINE WITH ME could cost — Descope option to eliminate the 31-45 GHz band may help reduce a lot of engineering effort since it helps fit all parts within the dewar.
- Yes, needed for max science — Complex IF system although receiver itself is simple.
- Not much extra effort to do sky as well as lab tests — Decide on HFET vs SIS in 90-116 band soon. All of the data needed is available. NO NEED FOR FURTHER TESTS. Decision?
- Would do this only if we can piggyback. Assumes spending $600K to get new design & wafers — Look into MMIC amps for all of the HFET bands. Wafers will go out for fabrication soon, ~~Very large~~ SIGNIFICANT cost savings possible.
- Relaxed spec on receiver performance ~~will not hurt overall array~~ NOT TRUE, will greatly enhance yield. Applies to both bandwidth and noise temp.
- ADD one more experienced SIS ~~primary~~ engineer to mitigate risk.

fine; don't have budget, tried to hire but no luck

Don't have spec — rather, have targets not out of line with present state of art — SSB & balanced look feasible, increase science.

IF

IF

Findings

Design is straightforward; little technical risk

Cost estimates based primarily on commercial components such as amplifiers, mixers, filters

Plan to test IF electronics in a low-pressure chamber to ensure adequate thermal management

Comments

Total-power stability is major concern; needs to be better tha~~t~~n SIS receivers, which are likely to limit the stability

Thermal noise is 2x10**-4 in 2 ms with 8 GHz bandwidth.   A few parts in 10**-5 in 10 minutes is the requested stability from those looking at on-the-fly mapping; obtaining this stability may require temperature control of the electronics.

Recommendations

Need to measure receiver total-power stability in order to determine how stable IF electronics needs to be in order not to limit~~ed~~ the overall performance

Don Hartill
Alan Whitney

Correlator

Findings:

- Correlator is evolution of existing design; test correlator is largely a clone of GBT correlator, but running at 1.6 Gs/s fanned out to 100 Ms/sec

- New correlator requires new custom correlator chip

- Samplers to operate at 4 Gs/s, >=3bits/~~sec~~ sample; perhaps requires custom chip (small quantities); specification in progress.

- Interfaces fairly well defined

- Thermal management may be important; as much as 30 kW dissipation

- FIR filter seems to be well in hand

- Most correlator staff is full time

Comments:

Yes, we ack. this risk

Custom chip is dependent on single individual; budget is similarly dependent on same person

✓ Other custom-chip alternatives are either high-risk, and/or high risk, and/or high power

✓ Custom-chip specification seems to be mature

✓ Plan for chip design, prototyping, fabrication and testing exists

I agree

Sampler appears to high risk; plans appear vague; budget, although small, may be severely inadequate.

✓ Aside from sampler, personnel are working full-time and appear adequate

We have them already

– State counters must be incorporated into design

Recommendations:

Good idea; but must find in budget or drop something

– Sampler must be made high-priority item and assigned adequate personnel (at least 1 full-time person)

✓ Aggressively explore commercial sampler alternatives

Will continue to look

✓ Explore alternate sources of custom correlator chip in case of loss of key chip designer

Computing Break-Out Group (Grandi, Hewitt, Kirk, Sanders)

Findings:

Control software is based on previous experience and seems well planned and of low risk.

Relies on AIPS++ heavily for data reduction software.

Not entirely

Pipeline and archiving plans and costing are based on parameters that haven't been addressed for ~~five~~ two? years

Comments:

Data rate from correlator of 1 MB/sec into archive needs to be re-addressed from scientific requirements.

Goal of producing images from pipeline in the "usual" case needs to be re-addressed from scientific requirements and parameters quantified.

Recommendations:

The committee recommends that the MMA Project create a Requirements Document that reflects a concerted effort to contact and understand user requirements for data, images, operations and other computing capability. The RD should be maintained as a living document.

The committee recommends that a Computing Plan be formulated and maintained,
based on the RD and embodying the mission of the computing project , the organization, staffing, budgets, schedules, milestones and computing products. The hardware and ~~computing projects~~ software products needed are part of this plan.

Director

There must be a formal commitment by NRAO management of "sufficient" resources from the AIPS++ project to the MMA project.

Antenna WBS 3

✓ Findings

- Costed by three methods
  - Parametric cost curves
  - Estimates from manufacturers
  - In-house estimate
- Industry is large and well established
- Technical feasibility is high
  - Examples exist
- NRAO costed antennas, transporter, workforce for monitoring, testing, installation
- Four formal bids are in-hand but unopened

Comments

- Is there enough time for testing prototypes?
  - Schedule is optimistic
  - backup plan would delay start of production antennas
- Are fast switching and radiometry both necessary?
  - 183 GHz may not work, fast switching small cost impact
- Will holography give surface accuracy needed for 700 GHz?
  - Yes, it should work
- The antenna concept is technically feasible and well conceived
- The schedule is consistent with the tasks to be Performed
  - Late delivery of prototype could delay testing
  - Production schedule ~~is lesurely~~ could be accelerated

antenna

- Management structure is adequate for job
  - Full time people identified and on job now
- Cost is probably conservative, reserve is adequate
- Options to save $ are not obvious
  - Should be some way that clever production techniques could lower cost
- Descope options
  - Eliminate fast switching (1% saving)
  - Reduce number of antennas, restore later
    - Don't descope surface accuracy or pointing

Recommendations

- First production antennas (#3) are most problemmatic
  - Should have some way to guarantee performance by additional testing of #3

FIBER OPTICS

Tom Kirk
Ben Snavely
Alan Whitney

Presenter: Dan Edmans

<u>What we asked to see:</u>

- **A succinct definition of what is included in the system being developed and costed**
- **The interface specifications**
- **Timeline for critical decisions**
- **Price model assumed for component procurements**
- **What components of the system are currently available as**
  - **Purchased items**
  - **Developed and Available**
- **Description of the organization and location of efforts**
- **Identification of technical risks**
- **Heritage of the fiber optics group**

Findings:

Edmans was well organized to provide satisfactory answers to these questions

The three fiber optic subsystems, and major components, were clearly defined in terms of schematic diagrams.

Major components are commercially available

To the extent that there is risk, it is in the validity of projecting declining costs for major components based on current vendor quotes, though the committee felt that the price model for cost reductions was reasonable

The committee feels that the highest risk area for the fiber optics system is in the LO oscillator subsystem.

Edmans projected enthusiasm and confidence in the level of staff and facilities support for this aspect of the project based on his ~10 years of experience in working fiber optical data systems

Recommendations:

The committee recommends that appropriate engineering resources be maintained to assure timely demonstration of the performance of the baseline LO distribution design.

Local Oscillator

Findings

Group presented a credible system design for the local oscillator system. Based on existing techniques with only modest extrapolation in frequency of multipliers needed.

Comments

Budget seems adequate for a well managed project.

Don't understand; refers to ½-time? [illegible] coming.

Focus of design group, especially for the multipliers does not seem to be there.

Disagree but we write things more explicitly

Interfaces seem to be ill defined. For example, multipliers will leave CDL component tested but not tested in the actual configuration that they will be used in.

Conventional aspects of the design including the reference oscillators seem to well in hand.

Availability of trainable engineers and technicians with sufficient technical expertise is a question. This may be a cost issue in terms of premium salaries.

Disagree— refers to cryo testing & isolator testing?

Pricing is on the marginal side in terms of potential use of contingency.

Recommendations

I think focus is adequate.

Potential major cost growth without a significant improvement ~~is~~ in focus. Need to use milestones as a measure of progress reviewed by outside reviewers.

Could benefit from outside consultants, especially in the high frequency bands.

SITE DEVELOPMENT (WBS 2)

Findings:

1. A well developed estimate based on:

    - Chilean A/E firm estimate
    - Consistency with project contingency procedures
    - Adjusted to current scope

2. Remote site construction problems/costs well researched with mining industry experience

3. Adequate staffing except for on-site quality assurance staff during construction

4. Inadequate definition of:

    - Whose codes to use
    - Agreements for land use

Comments: The amount and quality of the research accomplished in developing the site preparation estimate are impressive. The sole-source selection of a local A/E firm, familiar with the region and the type of construction involved was very appropriate. The response to each element of the charge to the panel is positive for WBS 2 . Potentials for "Embellishments and Mitigations" are outlined in Gordon's Cost Estimate, Version 2, page 7.

Recommendations:

jurisdiction & liability

1. Need additional research on code selections; e.g., placement of electrical and fiber optic cables (duct banks, direct burial, overhead).

2. Early resolution of agreements with Chilean Government on land use.

3. Consider flexibility in management staffing offered by including some family housing at OSF.

DONE

4. Additional research on ways to respond to power surges caused by fast switching.

(more ??)

5. Add staffing for Construction Quality Assurance on site (both AUI and local hire).

6. Consider providing facilities during construction to accommodate transition to operations; e.g., shops, test equipment, etc.

John Peoples' conclusions:

Overall - pretty good. Need more people in administration and systems integration. Getting foreign partnerships is important - no advice on how to make them work.

Major concern: coordination. Need more use of project management tools. Formal structure essential to keep funding secure (Peoples was funeral director of SSC).

2. Site development. Good plan. Need more Q/A on site. Get questions of codes, permits etc. resolved ASAP.

3. Antennas. Baars: when 2 ALMA prototypes are evaluated, might combine features even if there is some delay. Consider shipping #3 to VLA for full evaluation.

Fiber optics (Snavely): all looks good. Demonstrate LO system including fiber link ASAP. Get requirements documentation (ICDs) ASAP.

LO: make Bradley full-time. Establish milestones. Use outside consultants. Discrepancy SIS vs. multipliers.

Receivers: find another designer. Schedule OK. Questions as raised by written list.

IF: test stability

Correlator: Work on digitizer. Examine what happens if we lose Canaris. Communicate often w/ Canaris.

Cal & imaging: add vane cal. Look at assessment plans.

Computing: look at archive rate of 1MB/sec. Generate a detailed requirements document.

Systems integration

Split system engineering from system integration. Don't have a plan for establishing laboratory personnel in Chile. Should hire a dedicated system engineer. Develop a top-level requirements document. Develop a testing plan for everything & assign people for each part. Develop a plan for Chile.

Administration

WBS is "a good start", needs some cosmetic work. Good format for cost estimate. Overall cost estimate is conservative. Elaborate on operations startup plan. Control specs and goals so that something gets built. Use management tools. Overall schedule is plausible. Watch critical paths, add to effort if needed (e.g. SIS). Concerned about staffing, impact on NRAO. Out-source where possible. Make effort to coordinate sites. Put more effort into top project management. Plan, plan, plan.

Vanden Bout: thanks, appreciate effort to end US Reference Project.

Van Horn: encouraged that NSF has necessary ammo to present things to the Science Board.

Dickman: aware of stress imposed by deep scrutiny. Changes at both NSF and NRAO. Leading the way for new big projects.