EVLA LO/IF/FO Critical Design Review
May 19-21, 2004, Socorro

Report of the Review Panel

0. The Panel

Bryan Anderson (Jodrell Bank Observatory, UK: chairman)
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1. Introduction

The review was held Wednesday through to Friday, 19 - 21 May 2004 in the auditorium at the AOC in Socorro and at the VLA site. Presentations and discussions occupied the first day and a half, there was a visit to the VLA after noon on the second day and the panel met in private on the morning of the last day. The review concluded with the panel reporting verbally their main findings to Peter Napier, Jim Jackson and Steve Durand.

2. Charge to the Panel

The purpose of the CDR of an EVLA Subsystem was principally to review four questions:

C1. Are the detailed requirements for the subsystem complete and adequate?

C2. Will the design selected for implementation meet the requirements?

C3. Are interfaces to other subsystems defined adequately and completely?

C4. Has adequate attention been given to the production and maintenance of the equipment?

The Panel has chosen to answer these questions in the broad sense rather than for each module/assembly individually. Specific comments are included in the Recommendations.

3. Additional Questions Addressed to the Panel

In the course of the review, Peter Napier asked the Panel to consider some supplementary issues. These were:

a) The EVLA could use the 3-bit, 4 GHz ADCs and demultiplexers being developed for ALMA by the University of Bordeaux but they are not ready yet. Should a commercial supplier be sought?

b) Some tests made using a broadband noise seem to indicate that very little headroom is necessary in the analogue signal path. What advice can the Panel offer?

c) Initial tests of the DTS show extremely low bit-error rates. Is the FO system over designed and could the EDFAs (optical amplifiers) be omitted?

d) Should the L301 LO module design include a DDS?

The answers to these questions are given in the Recommendations.

4. Comments

4.1. General Comments

The standards of the presentations were high and the rapport within the team seemed to be very good. Whilst software was not on the agenda, we noted the presence of several people from the software group at the presentations and at the VLA site. That presence, and the absence of any complaints, leads us to the conclusion that the software situation is well in hand. Peter Napier is to be congratulated on having the foresight to have assembled such an able and harmonious team.

During the presentations, we were told and it became obvious that, perhaps, the CDR was being conducted a few months early. Some problems in the manufacture of prototype units meant that, for some types, there were only two working units. The decision to equip Antenna 13 at the VLA and to go for first fringes, whilst understandable, has resulted in it being very difficult to perform the exhaustive testing that we needed to be able to sign off completely on the design. Nevertheless, the detection of first fringes, the substantial progress at the VLA site in laying the fibres and installing the fibre-management system are highly commendable.

Whilst the implementation and testing of the design are not yet complete, the Panel has concluded unanimously that the team are on the right lines, are nearly there and that the risks of them failing are very small. It just needs some specifications to be clarified and final testing to be performed, particularly on the second-generation modules currently being developed..

4.2. Detailed Comments

The DTS is in good shape and production could proceed with the exception of the half-transponder digital transmitter board which needs to be tested.

The round-trip phase measurement system needs a full performance demonstration before production can begin.

The LO will not be ready for production until further testing and demonstration of performance has been accomplished using final version units.

The IF system requires a system-level analysis from front end to digitizer to establish firmer requirements for gain flatness and other parameters for the individual modules. Without these, it is impossible to determine whether the specifications for the modules

are adequate. No part of the IF system should go to production until final versions of the various IF converters have been demonstrated to have adequate gain flatness, phase stability, dynamic range, and other relevant parameters.

5. Responses to the Charge to the Panel

A1. Yes, the detailed requirements for the subsystem are complete and adequate, with the exception of a system analysis of the IF conversion scheme including band flattening.

A2. Yes, the design selected for implementation meets the requirements but some specifications and modules need revision. In most cases, these revisions were in progress.

A3. Yes, interfaces to other subsystems are defined adequately and completely.

A4. Yes, adequate attention has been given to the production and maintenance of the equipment.

6. Recommendations

The recommendations that follow were made in response to direct questions posed to the Panel and to issues that arose during the review. In drawing up these recommendations, the Panel did not try to factor in other issues that might be taken into account when assigning priorities. The recommendations start with general points and then deal with more specific issues.

R1. We are satisfied that the first-fringe demonstration shows that the overall plan for the VLA upgrade is sound. We recommend that there should now be a change of emphasis of work on the LO and IF modules from demonstrations at the antenna to laboratory, system-level tests of performance.

R2. We recommend that the planned system-level analysis be conducted as expeditiously as possible. The results should include clarified specifications for each element of the analogue signal path. Specifically, the module-level requirements for phase stability and passband flatness should be addressed.

R3. (To 3b) We recommend that the signal headroom through the analogue signal path be such that performance is limited only by the 8-bit ADCs. The signal paths for the 3-bit, 4GHz ADCs have many elements in common with those of the 8-bit paths so the overhead for the 3-bit paths would be limited mostly by the final ADC drive amplifiers. The final drive amplifiers for the 3-bit ADCs barely need any headroom.

R4. We recommend that a second environmental chamber be purchased to aid in determining temperature-related drifts and for stress testing of boards. Alternatively, the tests might be conducted in a laboratory with much better environmental control. We also advise that multiple temperature cycles be used in these tests in order to be able to separate

fluctuations and drifts from real temperature effects.

R5. We recommend that each individual synthesizer module should be checked at a sufficient number of lock points to ensure proper operation. Phase-noise performance should also be checked at multiple points across the frequency-tuning ranges.

R6. We recommend carefully assessing the risks and potential costs of releasing modules for production before final preproduction examples have been demonstrated to meet the performance requirements. This applies particularly to the proposed integrated versions of the converter modules.

R7. (To 3a) We recommend that a decision on the purchase of 3-bit 4 GHz ADCs and demuxes be shelved until viable solutions have been demonstrated. The ALMA ADC and demux chips may soon prove to be viable and then a narrow window will open for their purchase. NRAO should seek clarification from potential commercial sources to establish whether their devices offer the requisite performances and features and to their availability even though not on public offer. Manufacturers of very-high-speed digital oscilloscopes might also to be approached to see whether their solutions of the ADC/demux problems might be available.

There is no great urgency except for any deadline that might be imposed by the University of Bordeaux or their chip supplier and it will be quite some time before advantage can be taken of the wider bandwidths.

R8. (To 3c) We recommend that the purchase of production quantities of EDFA optical amplifiers be delayed until the need for them has been demonstrated.

R9. We recommend that consideration be given to the possibility that leakage of LO and LO-related CWs between modules might produce in-band spurious signals via harmonic mixing.

R10. (To 3d) We recommend that the antenna-based frequency offsets required by the WIDAR correlator be introduced as early in the signal path as possible so that any internally-generated spurious signals have the best chance of being washed out in the correlator.

7. Acknowledgements

The Panel would like to thank Peter Napier and his team for the pleasant and productive atmosphere during the review. We also enjoyed many, offline, discussions and demonstrations and, of course, the hospitality.