3-17-00

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From: Al Wootten <awootten@nrao.edu>
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        "Larry D'Addario" <ldaddari@tuc.nrao.edu>
Subject: [mmadivhd] forwarded message from Neal J. Evans II
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Folks:

I asked Neal Evans for an early draft of the ASAC receiver report so that it may be taken into consideration at next weeks CoDR. He sent me that early draft this morning, which I forward for your possible interest.
-Al

Neal:
Here is the current draft of the receiver section of our report. Please keep in mind that the whole committee has not seen this and it may be changed in the review by the full ASAC. Nontheless, it will give you an idea of what our recommendations are likely to be.

\centerline {\bf Receiver Recommendations - DRAFT 3/17/00}

NOTE: this is a working draft, which may be changed upon review by the full ASAC.

Along with the telescopes, the receiver packages largely determine the capabilities of ALMA. The Receiver Working Group (RWG) has raised a number of questions and requested clarification from the ASAC. These may be broken down into questions concerning the frequency bands and their priority, the total power stability, the WVR specs (dealt with in a separate section), polarization requirements, calibration accuracy, and receiver configurations (principally single sideband versus double sideband operation). Recommendations for each of these areas are outlined below.

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\noindent
{\bf Frequency Bands}. The ASAC concurs that the four bands to be initially installed on the array should be (in order of increasing frequency) Band 3 (86-116 GHz), Band 6 (211-275 GHz), Band 7 (275-370 GHz), and Band 9 (602-720 GHz). While we still believe that frequency coverage should be as complete as possible, we responded to the request for prioritization of the bands as follows.
\begin{itemize}
\item First Priority: Bands 3, 6, 7, and 9
\item Second Priority: Bands 1, 4, and 2 (see below)
\item Third Priority: Bands 5, 8, and 10
\end{itemize}

We strongly urge that the RWG study the possibility of

extending the lower frequency range of Band 3 to
include the SiO maser transition near 86 GHz.
If this is possible, Band 2 would drop to third priority.
The frequency intervals of the other bands are reasonable.
Band 10 is scientifically quite interesting.
It is in the third priority because the technology of
THz SIS heterodyne receivers is in an early state, and it will be
difficult to make ALMA work at its highest operating frequency.
Some delay in the installation of this band
will enable the most sensitive receivers to be installed and for the
telescope performance to be optimized.

Note that Band 1 is in the second priority list, and it must
be considered in receiver layout. If it will not be in the main
dewar, then designs for optics that allow a second dewar, possibly
also containing the WVR, should be developed.

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{\bf Total Power Stability}. For On The Fly Mapping (OTFM)
capabilities, the requisite total power stability is of order 10^{-4}
in one second. The ASAC recommends that this level be a goal, rather than
a hard specification, pending further study. The over-riding
concern is the receiver sensitivity, and better performance should not
be sacrificed for stability at this stringent level. However, this level
of stability may allow considerable simplication (avoiding nutating
subreflectors), and we encourage the WRG to study the issue and report
back to the ASAC on the prospects for achieving this level of stability
and on possible tradeoffs in doing so.

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{\bf WVR Specs}. These are discussed at length elsewhere. The WVR
receiver should be cooled, and the alignment with the highest frequency
heterodyne receivers should be of order 3$'$, but can most likely be
relaxed to of order 10$'$ for the lowest frequency bands.

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{\bf Polarization}. Polarization work will be an important part of
ALMA research. Strong efforts should be made to have the polarized
single-dish beams as stable as possible, and so the ASAC recommends
that careful consideration be given to placing the 345 GHz receiver
on-axis. For linear polarization work the basis state of feeds would
ideally be circular polarization. If circular feeds
impose important limitations on tuning range or increase
significantly the noise temperature, a system for rapid, accurate
calibration of linear feeds should be implemented. Obtaining zero and
short spacing polarization data is essential.
A nutating subreflector has a limited angular throw and introduces
varying angles with respect to the optical axis of the primary
mirror. The OTFM technique proposed for total power
observations would be ideal for polarization if the requisite gain
stability can be achieved.

Finally, the different polarization properties of the two
prototype antennas and other polarization properties of the test
interferometer and single-dish techniques should be carefully measured
as they may be a consideration in procurement decisions.

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{\bf Calibration Accuracy}. The ALMA calibration spec of 1\%~is
adequate scientifically, perhaps even a bit agressive.
A cold calibration load in the primary dewar is probably unnecessary.

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{\bf Receiver Modes}. The tremendous nature of the Chajnantor
site and the non-ideal nature of any optical system means that the
theoretical improvement in single sideband (SSB) versus double sideband
(DSB) receivers may be difficult to realize in practice. DSB receivers
are far easier and cheaper to fabricate, especially at submillimeter
frequencies, and so the ASAC recommends that a careful design study be
undertaken that assesses the likely performance loss for DSB operation.
If it is sufficiently small, considerable cost savings and ease of
operation can be realized. The ASAC would like to revisit this question
once the SSB versus DSB study is completed. It is very likely that
ALMA will become operational with both SSB and DSB receivers. This
change in operational characteristics has important implications for
the ALMA correlator, and so the ASAC also recommends that the initial
and subsequent ALMA correlators be designed with both modes of operation
in mind. This holds for the operating system and software environment also.

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{\bf Summary}. The ASAC confirms that Bands 3, 6, 7, and 9 have the
top priority and should be installed first. While complete frequency
coverage is important, we have divided the other bands into second and
third priorities. We recommend study of extending the lower end of Band 3
to include 86 GHz. In addition, the RWG should consider placing the Band 7
receiver on-axis. Designs that accomodate the Band 1 receiver are essential.
The ``relaxed'' WVR constraints may allow the Band 1 and WVR receivers to
share a dewar, and the WRG should consider such designs.
Finally, the ASAC requests a presentation at our next meeting of
a detailed plan for the mass production, integration and testing
of the ALMA Phase II receivers.