ANATAC TELECONFERENCE

15:00 UTC, Wednesday, 7th July, 2004. (Notes by DTE, 2004-07-07 last revised 2004-07-21)

PARTICIPANTS:
Barry Clark, Larry D'Addario, Darrel Emerson, John Payne, Dick Sramek, Art Symmes, Dick Thompson & Harvey Liszt.

ANATAC AGENDA, 7 July 2004

1. Outstanding issues from our last meeting's Action List:
Please see http://www.tuc.nrao.edu/~demerson/anatac/atac_2004-04-16.pdf

A. Are there remaining issues for the photonic LO & round trip measurement? Bill Shillue gave us a presentation on this topic (see http://www.tuc.nrao.edu/~demerson/anatac/bill_april.ppt .)

B. John & Larry agreed to put together a list of possible technical problem areas for ALMA to investigate.

C. Larry agreed to put together a summary of the ANATAC ALMA budget investigations, with the caveat that <2 hours were to be spent on the task.

2. ALMA LO Phase switching: The currently planned scheme uses nested Walsh functions: 128 phases within 16 milliseconds for the pi switching, with 128 phases of 16 milliseconds for the pi/2 switching & sideband separation. One possible disadvantage of this is that the first LO is required to switch every 125 microseconds, which implies that its phase lock loop has to have nearly 1 MHz bandwidth.

There are other possible switching schemes, including shifted m-sequences, complex Walsh functions, and 3-phase switching (2.pi/3 steps). There are links to some references on http://www.tuc.nrao.edu/~demerson/anatac.html .There is a good deal of expertise within ANATAC on this topic; would some scheme other than nested Walsh switching be advantageous for ALMA?

3. Cloudsat: 94 GHz cloud radar. This is a downwards-looking satellite radar due to be launched in 9 or 10 months. It is sufficiently powerful that if an ALMA dish were ever to look directly at it while it is transmitting in the direction of the ALMA site, an appreciable fraction of a watt might appear at the focus of the antenna - enough to destroy the frontend. ANATAC might be a good group in which to discuss the implications of, and possible mitigation strategies for, this radar. Other NRAO telescopes may not be immune. Some material and correspondence on the cloud radar is available via http://www.tuc.nrao.edu/~demerson/anatac.html .

ANATAC TELECONFERENCE SUMMARY: [Listed below in order of appearance on the agenda, not necessarily in order of discussion at the meeting.]

1. A. Photonics and LO issues.

John Payne reported: 6 months-year ago, were concerned with 2 aspects of photonic distribution: 1 the bandwidth needed by YIG multiplied up phase locked loop (PLL) in the antenna. Indications we were unable to get the slave and master lasers sufficiently clean to lock together to give a sufficiently pure beat note. That is no longer a concern. Bill Shillue reports that we can now accommodate any needed bandwidth on the YiG-controlled oscillator. Skip Thacker is producing systems with a lock bandwidth of 500 kHz. This is important because of the relatively rapid Walsh-function phase switching of the first LO.

Larry reported that the phase switching (180 degrees) will be carried out every 125 microseconds, so that about 1 microsecond switching time is needed. John Payne considers this is sufficiently within the PLL spec. Skip would prefer to narrow the bandwidth of the PLL, to provide some additional filtering effect and so lower phase noise. Larry considers that the current parameters are probably ok, although we won't know for certain until after the planned system tests.

Polarization changes in the fiber, different at the different laser frequencies, are another issue, resulting in phase shift on beat note that is not properly corrected by the round trip correction scheme. We now think this problem is alleviated sufficiently by careful alignment of the polarization of the 2 lasers. John point out this has still to be proven in fact.

Dick Thompson asked about worries over sensitivity to vibrations, either of the fiber or of other optical components, which might cause loss of lock. John reported that this was thought not to be a problem. Larry considers that the biggest potential problem with acoustic noise is the HVAC, inducing vibration via the airflow rather than conducted vibration.

Conclusion: at this stage, the LO, photonics and round trip system seem to be in reasonable shape, although the system tests are needed to confirm experimentally that everything works. This is no longer a major concern, but ANATAC should watch the developments.

1. B. Potential technical problem areas for ANATAC to investigate.

After discussion with John Payne before the meeting, Larry listed the following topics:

1. Digitizers. There is no working model as yet.
2. AMBSI bus interfaces. There is currently poor documentation, and we have no expert on the systems within ALMA.
3. Electronics packaging. This is divided between Frontend (FE) and Backend (BE) IPTs. These two IPTs don't talk to each other about packaging. E.g. the FE construction is based on open structures, while the BE is closed with (perhaps) an exaggerated concern for RFI. There should be some coordination in packaging standards.
4. Inconsistency in design between FE & BE electronics in DC power generation.
5. Software in general. The current control software for ALMA seems to be in an unfinished state. Much is not yet working - e.g. timing, which used to work under the old VxWorks system, is not yet implemented properly under the current system. Functionality is at a very low level.
6. (Mentioned by Dick Sramek) LO concerns - Bill Shillue says he may need to exercise the option of a central hole for the fiber routing up the axis of the

antenna. The specific cable wraps need to be implemented. Dick thinks this may be a large job.

ANATAC will discuss these (and probably other) issues at future meetings.

1.C. ANATAC investigation of the ALMA budget

A new group, headed by Marc Rafal, is to be looking at the ALMA budget. ANATAC will be represented on that group, and had agreed (see minutes of ANATAC's April meeting, at http://www.tuc.nrao.edu/~demerson/anatac/atac_2004-04-16.pdf) to pass on its results so far. Larry had created a small package of our earlier budget reports. It was agreed that Darrel would forward this package to Marc. This terminates ANATAC's efforts on the ALMA budget investigation.

2. Phase Switching schemes for ALMA

Phase switching schemes. Darrel & Larry gave a brief introduction to the current scheme. The main motivation for looking at alternatives is to reduce the LO switching rate, which could allow a tighter PLL bandwidth and so potentially give lower LO phase noise.

Larry commented that ALMA has several peculiar requirements; ALMA requires 16 ms integrations in some observing modes, such as interferometric on-the-fly observing. A relatively new requirement is for sideband separation by 90-deg switching, which is a separate switching cycle.

Barry considers that current scheme of nested Walsh function switching (i.e. 180-degree switching in the inner loop, with a 128-phase cycle completed in 16 milliseconds, with the outer pi/2 phase switching cycle consisting of 128 16-millisecond phases) is the way to go. It is possible that there may be better schemes (e.g. multi-state phase switching that might require fewer transitions) that could be made to work, but with our current knowledge the existing baseline scheme should work. Only if significant LO problems are found (such as problems with the PLL bandwidth) should we look into other possible switching schemes, along with considering a relaxation of the switching specs if we have to.

3. 94 GHz Cloud Radar

Harvey Liszt introduced the cloud radar issue. The cloud radar satellite is due to be launched in 2005, with a design lifetime 2 years. It is a downward looking radar at 94 - 94.1 GHz. The peak power is 1.7 kW from the transmitter, into a high gain antenna giving a footprint on the ground of about 1 km. Dick calculates that EIRP is $4.3*10^9$ watts (96 dBW). The crossing-time of the satellite beam over the ALMA observatory would be about 2 seconds. The antenna is an off-axis design with a 5 micron surface precision, so sidelobes of the transmitter antenna should be relatively low. The radar pulse has a repetition rate of a few kHz, with a pulse length of 3.3 microseconds. Note that the ITU allocation for the cloud radar is from 94.0 to 94.1 GHz. The active radar is part of a constellation of several satellites; the other spacecraft are passive sensors.

The satellite orbital period is about 90 minutes, with orbital tracks repeating precisely every 16 days. Some of the passive satellites in the constellation are already in orbit, so the precise orbit can not now be changed.

Dick Thompson calculates that, with a 12-meter dish looking straight at the radar, a power of -12 dBW (~60 mW) could be received, which is about 24 dB above the safe threshold for destruction of the receiver frontend. We need detailed

information about how far we need to tip our own antennas away from the radar satellite to ensure survival of our receivers.

For protection of the receivers, Larry pointed out that the planned solar attenuators (which allow mm-wave solar observing) give about 12 dB of protection, which would be helpful. We should ensure that our antennas are NEVER left parked at the zenith, which would give the highest coupling from the radar transmitter into the ALMA receivers. Satellite operators are obliged to collaborate with radio astronomy observatories. We should try to get the satellite operators to turn off the transmitter when passing over ALMA. Maybe they would agree to this?

Apart from destruction of our receivers, we need to investigate the effect on normal observations whenever the satellite is above the horizon.

Debra Vane, of the Cloudsat group, will hold a telecom with us within about the next month. Clearly ALMA people should be involved. So should CORF. We should disseminate the information. Tom Gergely must be involved.

Action: [The following reflects agreement reached in part after the meeting, rather than being a strict account of the discussion during the meeting.] As NRAO's spectrum manager, Harvey will get an NRAO Cloudsat group together and coordinate within NRAO (ALMA, the VLBA and the GBT are all potentially affected) with NSF (Tom Gergely), with CORF, with other US and international observatories and with IUCAF. Darrel will arrange for ANATAC to make and circulate a technical report on the potential impact of the radar on ALMA operations.