

## SCIENCE IPT

### Progress with Commission and Science Verification

Although the first week of March was lost due to the aftermath of the earthquake, the AIV and software teams were able to get the systems back into operation remarkably quickly after work resumed at the site. Since then we have been making much better progress than previously. The weather has also improved with many stretches of conditions suitable for sub-millimetre observing. Two of the antennas have been moved to the foundations intended for the ACA and we expect to complete this transition on 1<sup>st</sup> April. This will give us the short baselines needed for the most critical antenna and system tests.

At the time of writing we have a short period with one antenna still at the “phase I” location which gives us two relatively long baselines of about 550 meters and one short one of about 35 meters. This has enabled us to confirm the basic operation at these baselines and to collect data for investigation of phase-correction algorithms.

The commissioning work continues to focus on two main areas – antenna performance tests and system functionality. On the former, we have been collecting data on radio pointing and tracking and performing astronomical holography, out-of-focus beam maps and Moon scans (which give us complementary information about the accuracy of the surface). We are also making measurements of phase and amplitude stability, testing the ability to tune to random frequencies and checking the correlator functionality. For the latter we have continued to perform end-to-end operations where we use the Observing Tool to generate Scheduling Blocks. We then execute these using the three-element array at the high site, extract the data from the archive and finally process it with CASA. We have done this on a variety of astronomical objects and in general the results are encouraging.

These tests are revealing a variety of problems in the system – amplitude and phase fluctuations, data normalization errors, spurious signals, timing errors and so on. At this stage it is hard to say how many of these are “one-off” effects that will be fixed by replacing or adjusting particular items of equipment and how many will need modifications to the hardware or perhaps the firmware. Almost certainly there are at least some examples of each amongst the issues that have shown up so far. The follow-up process is not straightforward. To pinpoint the source of the problems we work with the local AIV and SE engineers and with the experts in various areas from the partners, and then we try to help the IPT's to develop solutions when needed. We are gradually learning how to do this effectively and we appreciate the support that we are receiving from all parts of the ALMA organization, but it is clear that we have some way to go to make this process efficient.

In general the software system is stable and useable but there are of course numerous issues being worked on. We still seem to be at the stage where we are finding additional problems a good deal faster than they are being solved. Our greatest concerns continue to be in the areas of the correlator software and the archive. The most critical problem, which showed up as a “data flow error” in the transfer from the correlator hardware to the archive, has been brought under control, but investigations of its exact cause and implications are continuing: there is a concern that the limitations on data rate may be more restrictive than we have been expecting. More generally we often have difficulties accessing data and scheduling blocks on the archive. A related area which is in a relatively undeveloped state is the control and monitor data base: the fact that the data is incomplete and hard to access is becoming a limitation for us.

As a general comment, we have now reached the point where we are finding that we are able to get test data faster than we can analyse it, and much faster than we can actually reach firm conclusions from the data and decide that issues can be closed. We did of course expect and predict that this would be the case and it is in a sense pleasing to be at this point. The fact that this means that on some occasions, especially when the conditions

are not good, when it is better not to try to make more measurements but instead to concentrate on analysis and report writing, does however make the team feel uncomfortable, given especially that many of us are hardened users telescopes for which there is intense competition for time. Fortunately we now have in place a series of routine monitoring observations – e.g. checking the pointing, baselines, etc., and performing a survey of calibration sources – which are easy for the operators to run but can give us valuable data in these circumstances.

The other general point to note is that we are effectively trying to operate a telescope which is still under construction. This means that, from the science side, we have to expect interruptions of various sorts to power, computer systems, communications, etc., and while people on the construction side have to get used to the fact that we are now using the systems almost all the time so that the opportunities for them to make change-overs, introduce new equipment and so forth, are highly constrained. Again this was, of course, not a surprise but it does require some changes in approach and we are having to work quite hard to make sure that the necessary communication, planning and coordination take place so that the delays to the commissioning programme are kept to a minimum.

Looking ahead, we are trying to work out plans that will give us the opportunity to make images with as many antennas as possible before the readiness review planned for October. Unfortunately, the slow rate of deliveries of front ends, calibration devices and antennas means that we will not be able to move beyond the 3 or 4 antenna stage until late July at the earliest. This is much later than planned and does pose serious problems for us in carrying out the CSV programme effectively, but unfortunately we appear to have run out of options to accelerate this significantly.

### ASAC

The face to face meeting took place in Tokyo on March 9<sup>th</sup> and 10<sup>th</sup> as planned.

### Staffing

Tom Wilson concluded his long service with ALMA in which he has taken on many roles. He is moving to the Navel observatory in Washington. Kartik Sheth completed his initial tour as ARC liaison scientist from North America. Kengo Tachihara and Martin Zwaan are with us in equivalent positions from East Asia and Europe.